HYATT REGENCY NEW ORLEANS
August 9 - 11, 2018

EXPERIENCE THE FUTURE NOW

IT SHOWCASE COMPETITION PROCEEDINGS

AUGUST 8 - 11, 2018

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CONTENTS

A LETTER FROM DR. JESSE L. BEMLEY AND MS. JANICE A. LEE

Welcome and thank you for participating in the 16th Annual National BDPA IT Showcase. The theme for the 2018 Annual BDPA Technology Conference is *Experience The Future Now*. The judges for the IT Showcase are Janice Lee, Chief Judge, and Chontay Turner of The Climate Corporation, and Regan Scruggs and Timothy Brown of Johnson and Johnson.

These proceedings contain papers, bios and photos of 18 students (9 college and 9 high school), IT Showcase history, and the photos of the 2017 winners.

The Presentations/Projects were judged earlier this morning in two categories, college and high school. Three awards are made in each category for 1st, 2nd, and 3rd place. Certificates to all participants are to be presented at the end of the IT Showcase session on Thursday evening. Awards for first place winners are presented at the Awards Banquet on Saturday.

During the first fifteen years, 2003-2017, of the IT Showcase, there were 81undergraduate papers and 99 high school papers presented. The students represented 2 countries 17 states, 41 high schools, 6 universities and 5 community colleges. Their papers covered database technology, web design technology, wired and wireless communication technology, cyber security, data mining, soft computing, high performance computing, cloud computing, virtual technologies, nanotechnology, robotics, operating systems, IT certification, social media, Big Data, health information systems, systems on a chip (SoC), and the Internet of Things (IoT).

Again, thanks for joining us at the **BDPA IT Showcase!**

Jesse L. Bemley, Ph.D. and
Janice A. Lee, MBA, PMP

Jesse L. Bemley, Ph.D.
Janice A. Lee, MBA, PMP

IN MEMORIAM OF WAYNE HICKS AND MALCOM MATHIS

"Brotha" Wayne

It was no secret Mr. Wayne Hicks was a huge supporter of the IT Showcase. In fact, according to Dr. Jesse L. Bemley, it was "Mr. Hicks in 2003 as BDPA President Elect who asked Dr. Bemley to accept the challenge" to get IT Showcase up and running after a 2002 attempt. "Wayne wanted an event that would keep the HSCC alumni moving academically toward the Ph.D." says Dr. Bemley. Over the years Wayne worked diligently behind the scenes securing primary corporate sponsors, Lilly and Johnson & Johnson to support IT Showcase Competition year after year. Under Wayne's leadership at BETF, he has promoted the Dr. Jesse Bemley Scholarship, which was established in 1992 to honor the winners of the high school computer competition and with the support of Johnson & Johnson in support of IT Showcase students pursuing higher education.

Malcom

Representing Monsanto and BDPA St. Louis Chapter, in 2014, Malcom just jumped right in and volunteered as a judge for the IT Showcase. Come to find out, this was typical of Malcom as he was very active supporting causes within the African American community and especially for youth programs. Malcom last served as President of the St. Louis Chapter and no doubt was on a mission and gearing up to send students to participate in the 2018 IT Showcase.

It's Doable!

Who can ever forget Wayne's student chapter rollcall at the conference opening ceremonies to get the students all pumped-up, ready to compete and enjoy all the youth and college activities…*awe yes!* Or perhaps the sponsor dollar challange…just bring your business card up and pledge big time to support BETF!

Honestly, these few words do not even begin to reflect the impactful moments each of us experienced with Wayne and Malcom. For the IT Showcase team and students, we'll best remember Wayne and Malcom for their unwavering support and enthusiasm for the future Ph.Ds.' in training.

Wayne Hicks and Malcom Mathis are both sorely missed but would expect us to continue to grow and exceed expectations with more students and scholarships.

"Brotha" Wayne…we got this and yes…DOABLE!

Jesse L. Bemley, Ph.D. and
Janice A. Lee, MBA, PMP

Jesse L. Bemley, Ph.D.
Janice A. Lee, MBA, PMP

THE IT SHOWCASE STORY

The idea that led to the creation of the IT Showcase has taken several twists and turns over the years. As far back as the late 1980s, a UNISYS communications engineer in Philadelphia talked about a BDPA computer science fair. The computer science fair would be patterned after the traditional high school science fair.

The idea was put on the back burner because of the all-consuming activities of the pilot HSCC which was held in Atlanta in 1986. During the New Orleans Convention in 1987, the Artificial Intelligence Model of a Black Teenager was presented by three teenage girls. The model was an expert system developed from the AI language Prolog. The student presentation was a component of Dr. Jesse Bemley's workshop.

Bemley's National Conference workshops included high school students from 1989 – 1992. The students' names were not a part of the conference program. Instead the workshops had separate programs as handouts.

In 1993 Margaret Jennings suggested that Bemley's students participate in the Youth Conference as the High School Computer Science Fair at the BDPA National Conference in Kansas City, MO. For the very first-time students' names were published in the official conference Youth Activities Guide. Five high school students presented papers. Their research areas included expert systems, logic puzzles, neural networks, and fractals. The activity continued until the 1997 conference in Houston, TX.

There were no further computer science fairs. The national conference co-coordinator did not want students making presentations to Youth Conference participants, only adult presenters.

In 2001 Dwight Huggett, then HSCC coordinator, proposed an IT Showcase where the projects of college and high school students would be highlighted. The effort did not get off the ground. There was a subsequent attempt in 2002. Again, the resources were not available.

In 2003, BDPA President Elect Wayne Hicks asked Bemley to accept the challenge. Which he did. Hicks wanted an event that would keep the HSCC alumni moving academically toward the Ph.D. Bemley modified the requirements for participation to include: a 10-page paper in a leading-edge topic, a 15-minute PowerPoint presentation, a 3ft by 4ft poster which graphically depicts the paper, a one-page bio with photo, and a trip report due a week after the conference. The 2003 BDPA National Conference in Philadelphia hosted the first IT Showcase. Atlanta, GA is hosting the 2016 BDPA National Technology Conference and the 14th BDPA IT Showcase.

The Cincinnati Chapter hosted the first regional IT Showcases in 2005 and another in 2011. The BDPA-DC Regional Technology Conference in Washington, DC in 2007 - 2016, held very successful Regional IT Showcases. The Northern Delaware Regional IT Showcase was held on May 15, 2010. It can be used as a model for other regional IT Showcases who don't wish to use the traditional IT showcase paradigm. Greater Columbia Chapter hosted the Washington, DC Chapter in 2012 at a very successful Southeast Regional IT Showcase.

2017 IT SHOWCASE HIGH SCHOOL WINNERS

First Place High School Winner

Second Place High School Winner

Rahil Thanawala
Hamilton Southeastern High School
Indianapolis, IN

Isis Washington
Grosse Pointe North High School
Harper Woods, MI

Third Place High School Winner

Kaylin Johnson
Herron High School
Indianapolis, IN

2017 IT SHOWCASE COLLEGE WINNERS

First Place College Winner

Second Place College Winner

Deja Lindsey
Georgetown University
Washington, DC

Lauren Ravenell
Ball State University
Muncie, IN

Third Place College Winner

Teshome Woldeyes
Cincinnati State Technical and Community College
Cincinnati, OH

MEET THE IT SHOWCASE JUDGES

Chief Judge: Janice Lee

A certified Project Manager Professional with 20+ years of IT experience. In recent years she served as Program Manager and Sr. Project Manager as a Healthcare IT Consultant for Leidos Health managing large/medium enterprise software and hardware deployments. Janice's specializes in mobilizing teams and providing solutions to organizations. Janice holds a Bachelor's (University of Cincinnati) and Master Business Administration (University of Phoenix) in Information Systems -Technology. She is long-time BDPA volunteer with the Cincinnati Chapter since 1992.

Her first introduction to BDPA was on the campus of University of Cincinnati. Since the introduction, Janice volunteer role has progressed over the years from working with students at the Computer Camps, Chapter Outreach Director, Chapter Vice President and Chapter President 2008 – 2010. More recent year, whatever the Chapter Presidents or BETF Executive, Wayne Hicks had deemed as "special projects" to support the chapter's goal.

One of her most exciting and proud BDPA moments was networking with Dr. Jesse Bemley at previous National Conference after an IT Showcase Competition. Janice was simply floored by the students' deep intellectual research topics and presentations. This informal meeting turned into an informal mentorship over the years. Dr. Bemley has encouraged her to start a local IT Showcase for the Cincinnati Chapter and host the first ever local BDPA IT Showcase Competition!

Janice is honored to continue to work with Dr. Jesse Bemley on the National BDPA IT Showcase Program and serving an impressive group of High School and College students.

Judge: Chontay Turner, Climate Corporation

A native of St. Louis, Missouri. She has a Master of Science degree in Biology from Tennessee State University and a Bachelor of Arts degree in Psychology from Fisk University. She is a certified surgical assistant and holds an Associates in Liberal Arts degree with a certificate in Business Administration. She completed 2 years of intensive research in Biomedical Engineering at Vanderbilt University. She has over 13-year experiences in Pharmaceutical and Medical device sales and employed as an IT- scientific product specialist at Monsanto where she is the project manager for their BDPA mentoring program initiative. Currently she is at The Climate Corporation.

Her memberships include W.I.N –Women in Neuroscience, WIT- Women in Information Technology, Delta Sigma Theta Incorporated, and BDPA. She is also a board chairwoman for the Triumphant Life Services Non-for-profit Foundation. Chontay was inducted into the Zhi Phi Lambda Honor Society for Science and Engineering while under the mentorship of Dr. Halston at Tennessee State University. She is an orator and has presented scientific research at several Biomedical Conferences and has published abstracts with cohorts from Vanderbilt University's School of Biomedical Engineering. She most recently served as a judge in last year's competition.

Judge: Timothy Brown, Johnson and Johnson

An Information Technology Senior Manager with significant experience leading global initiatives and driving transformational change throughout Johnson & Johnson's Technology organization.

Timothy is responsible for the deployment of Enterprise Portfolio/Program Management (PPM) capabilities that improve investment decisions with greater transparency of portfolio and project execution data, higher value creation, greater strategic alignment, and enhanced governance.

Timothy earned his MBA from Purdue University, MS in Electrical Engineering from Georgia Institute of Technology, and BS in Electrical Engineering from Syracuse University. Timothy is a proud father of three accomplished children and married to a phenomenal woman. Timothy is a past IT Showcase judge and we welcome him back!

IT SHOWCASE SCHEDULE AT-A-GLANCE

WEDNESDAY, AUGUST 8
Practice Session and Poster Setup
Starting at 6 p.m.
(Closed to Public)

THURSDAY, AUGUST 9
Poster Presentation Judging
10:00 a.m. - 12:00 p.m.

(Closed to Public)

Lunch
12:00 p.m. – 1:00 p.m.

Welcome and Introductions
Dr. Jesse Bemley, IT Showcase Founder
1:00 p.m. – 1:30 p.m.

Presentations
High School and College
1:30 p.m. – 4:30 p.m.
Presentation of Certificates
Lilly Presentation
Terry Morris, National BDPA President

4:30 p.m. – 5:00 p.m.

Closing Remarks
Dr. Jesse Bemley, IT Showcase Founder
4:30 p.m. – 5:00 p.m.

FRIDAY, AUGUST 10
Poster Presentations Public Viewing
9:30 a.m. – 12:00 p.m.

SATURDAY, AUGUST 11
Awards Gala 1st Place Winners
6:30 p.m. – 8:30 p.m.

MEET THE HIGH SCHOOL PARTICIPANTS AND RESEARCH TOPICS

Elisée K. Djapa

Parkdale High School, Riverdale, MD

Data Science: Big Data Analytics

A recent graduate of the class of 2018, from Cameroon and starting as a rising freshman at Morgan State University. He plans to major in Computer Science. He has been involved with BDPA since his Junior year of high school. At his high school, he has held some position of leadership in Prince George`s Regional Association of Student Government (PGRASG). Served as a page at the Maryland General and served on the Smithsonian Youth Secretary Advisory Council.

Liliana Gordon

North Point High School, Waldorf, MD

Fuzzy Logic: A Bridge to Autonomy

A rising freshman at North Point High School in Maryland. She will be in the school's Engineering Program this fall. She is also currently enrolled at the College of Southern Maryland, taking college courses in the hopes of earning her Associate degree by the time she finishes high school. Liliana has previously spoken at Capitol Christian Academy's Annual Science, Engineering, and Robotics Symposium and BDPA's I.T. Showcase, sharing her love of fuzzy logic and other mathematical disciplines. Her hobbies are piano, martial arts, reading, and creative writing. Liliana intends to pursue a career in the computational cognitive sciences.

Milton J. Turner

Turner Classical Academy, Salt Lake City, Utah

The Risk Within a Smart City

Milton J. Turner attends Turner Classical Academy in Salt Lake City, Utah. His favorite subjects are history and creative writing. Milton plays several instruments including, violin, piano and percussion. He is on the high school lacrosse team and 4H shooting club. He loves to read, fly hos drones, build computers and loves trekking the globe with his family. His love for building and machines is what drives him to his career in the technology field. Milton will find a way to finish something even when he does not have all the pieces.

MEET COLLEGE PARTICIPATION AND RESEARCH TOPICS

Yaw Asante

Princeton University, Princeton, NJ

The Application of Computational Network Analysis in Advancing Drug Discovery

A student with the BDPA Cincinnati Chapter, a Cincinnati, graduate of Walnut Hills High School, and a sophomore at Princeton University where I study computer science. I have varied set of interests beyond my major where I indulge through both challenging coursework (chemistry, physics, calculus and biology) and extracurriculars. I'm environmentally-conscious on school campus – beginning with my involvement as officer in my high school's Sustainability Club and progressing to my current interest in Princeton's green initiatives - and engaging in leadership development opportunities with organizations like Inroads, BDPA. I hope to continue to leverage the opportunities provided by my field of study and by programs like BDPA to grow as both an intellectual and a leader to others.

Christopher Choice

Florida A&M University, Tallahassee, FL

Artificial Intelligence: Part of Our Past, Prominent in the Present, Shaping our Future

Hailing from Gainesville, Florida, Choice is a third-year student at the Florida Agricultural and Mechanical University. There, he serves as the President of the FAMU BDPA Chapter. His journey for knowledge has pushed him to pursue a B.S. in Computer Information Systems with a concentration in security. Choice is also a member of Secured Rattlers, an on-campus club that focuses on Cyber Security, CISMO, a mentoring program for CIS majors, and a member of STARS, an outreach program for teaching kids K-12 about programming and functional usage.

Kourtney Coleman

Indiana University, Bloomington, IN

Digital Business

An Indianapolis, Indiana native, attended Cathedral High School, and then continued her studies at Indiana University. She recently completed her undergraduate studies from Indiana University Kelley School of Business with a BS in Business degree with majors in marketing, international business and a minor in Spanish. She is now pursuing a MS in Information Systems degree at the Kelley School of Business at Indiana University, and she hopes to concentrate her studies in digital enterprise. She secured an internship with Elanco, a subsidiary of Eli Lilly. Served as the president of Tau Chapter of Alpha Kappa Alpha Sorority and Vice President of marketing for the Kelley School of Business Undergraduate Business Diversity Council.

Oladokun Ekundayo

Virginia Military Institute, Baltimore, MD

Cybersecurity: The Domestic Solution to International Conflict

Hailing from Baltimore, Maryland, a first-class cadet at the Virginia Military Institute. Serves as the Band Company commander. Her quest for knowledge has pushed her to pursue not only a B.S. in Computer Information Science, minor in Cyber Security and National Security. Institute Honors Program and working to complete National Security thesis. An Academic Excellence Chair-NSBE, member of the Superintendents Advisory Board, Phi Eta Sigma Scholastic Honors Society, CIS Dept. Advisory Committee, regimental and jazz bands, women's rugby team, cyber club, and timber framer's guild.

Brian Lenori

Bowie State University, Bowie, MD

Raspberry PI as a Desktop Computer

A native of Washington, D.C. and graduate of Laurel Senior High School in 2017. Currently a sophomore studying Computer Technology at Bowie State University. Was invited and will participate in the workshop for the 8th International Conference on Appropriate Technology (8th ICAT) Intern. My current research involves investigating Raspberry Pi features from models A thru 3B+.
Currently employed as a Walmart Associate since high school.

Asmamaw Mersha

Bowie State University, Bowie, MD

Up Squared Board (UP²) Configuration

A junior Computer Technology student who pursues to gain a BA degree at Bowie State University. Spends time conducting research on projects and internship programs with instructors and present research material. Asmamaw is honor student at the Bowie State University and member of Dean's List since the first semester. After graduation, Asmamaw plans to pursue Master of Arts degree at the University of Maryland to further glorify my computer networking skills.

Lauren Ravenell

Ball State University, Muncie, Indiana

Technology in Athletics

Lauren Ravenell is a rising Senior at Ball State University where she is studying Telecommunications. She is also pursuing minors in Computer Science and Spanish. At Ball State, Lauren is actively involved in Working Together in Technology, Women Working in Technology and PhD Pathways. She is on the Dean's List and is actively involved with BDPA. She will also be an intern for Eli Lilly and Company this summer.

Alison Tuiyott

Miami University, Oxford, OH

Natural Language Processing

A rising junior pursuing her Bachelor of Science and Master of Science in Statistics from Miami University in Oxford, Ohio. Her co-major is Analytics and a concentration in Computer Science, hoping to graduate in May 2020. Her interests include Big Data, Machine Learning as well as Natural Language Processing. At Miami University, Alison is the President of StatHawks, the American Statistical Association (ASA) Student Chapter. During the school year, Alison interns for the Center for Analytics and Data Science at Miami University. She previously interned at General Electric in an IT internship and currently at Eli Lilly in the Clinical Labs and Data Science space.

Anushri Walimbe

Winona State University, Winona, MN

Virtual Reality Technology for the Disabled

A rising senior pursuing her degree in Business Administration at Winona State University. She has participated in BDPA for 7 years in the Southern MN chapter. Within BDPA she's been involved in the Youth Computer Training Program (YCTP) and the High School Computer Competition (HSCC). During her time in HSCC, her team won the Midwest Regional Competition. Last year, at BDPA's first ever Codejam Competition, her team was one of the top three teams chosen winners. She describes BDPA as a multidimensional experience, where young people are given opportunities within the world of technology.

THE FUTURE IS NOW!

HIGH SCHOOL ¤ RESEARCH

DATA SCIENCE: BIG DATA ANALYTICS

Elisée K. Djapa

Parkdale High School
Riverdale, Maryland

INTRODUCTION

Data is everywhere; in fact, the amount of digital data that exists is growing at a rapid rate, doubling every two years, and changing the way we live. According to IBM, 2.5 billion gigabytes (GB) of data was generated every day in 2012. As our societies technological progress continues to advance, more data is also created be it from scientific research, social media, e-health, e-commerce or other mediums. In addition to that, the analyzed data gives a lot of insight, value and serves very useful to organizations ranging from the government, public and private sectors.

Data is increasingly cheap and ubiquitous. We are now digitizing analog content that was created over centuries and collecting myriad new types of data from web logs, mobile devices, sensors, instruments, and transactions. IBM estimates that 90 percent of the data in the world today has been created in the past two years. At the same time, new technologies are emerging to organize and make sense of this avalanche of data. We can now identify patterns and regularities in data of all sorts that allow us to advance scholarship, improve the human condition, and create commercial and social value. The rise of "big data" has the potential to deepen our understanding of phenomena ranging from physical and biological systems to human social and economic behavior

Data science is a field of big data geared toward providing meaningful information based on large amounts of complex data. Data science, or data-driven science, combine different fields of work in statistics and computation to interpret data for decision making. Big data consists of very large volumes of varied data generated, often, at high speeds. These data sets cannot be managed and processed using traditional data management tools and applications. Thus, requires the use of a new set of tools, applications, and frameworks to process and manage the data. Big data analytics is the process of examining large and varied data sets -- i.e., big data -- to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful information that can help organizations make more-informed business decisions.

HISTORY

Data science or big data is not just a concept or theory that originated in a day however over the course of data recording and usage over time. Early discoveries indicate it originated from the earliest recording forms, which was about 7000 years ago by the Mesopotamian Empire for accounting purposes, to help record the growth of crops and herds. It has evolved and is still growing to this our present century.

The term "Big Data" itself has been around only since 2005 after it was launched by O`Reilly media that year. The earliest remembrance of modern data was from 1887 when Herman Hollerith invented the computing machine that could read holes punched into paper cards to organize census data. The following century being the 20th a first major data project is created in 1937 and was ordered by the Franklin D. Roosevelt's administration in the USA. After the Social Security Act became law in 1937, the government had to keep track of contribution from 26 million Americans and more than 3 million employers. IBM got the contract to develop punch card-reading machine for this massive bookkeeping project.

In 2005 Roger Mougalas from O'Reilly Media coined the term Big Data for the first time, only a year after they created the term Web 2.0. It refers to a large set of data that is almost impossible to manage and process using traditional business intelligence tools (big data). Modern records point to many scientist, mathematicians, and physicists as the early founders of the term big data as a new field or focus of technology. What this teaches us is that Big Data is not a new or isolated phenomenon, but one that is part of a long evolution of capturing and using data. Like other key developments in data storage, data processing, and the Internet, Big Data is just a further step that will bring change to the way we run business and society. At the same time, it will lay the foundations on which many evolutions will be built.

The concept of big data analytics has been around for years; most organizations now understand that if they capture all the data that streams into their businesses, they can apply analytics and get significant value from it. But even in the 1950s, decades before anyone uttered the term "big data," businesses were using basic analytics (essentially numbers in a spreadsheet that were manually examined) to uncover insights and trends. The new benefits that big data analytics brings to the table, however, are speed and efficiency. Whereas a few years ago a business would have gathered information, run analytics and unearthed information that could be used for future decisions, today that business can identify insights for immediate decisions. The ability to work faster – and stay agile – gives organizations a competitive edge they didn't have before.

CONCEPTS

Big Data has three of the following characteristics at a high rate known as the original 3V`s:

Volume: Data quantity

Velocity: Data Speed

Variety: Data types

TOOLS ON WHICH BIG DATA IS RUN

Big data is running on Apache Hadoop open source software, whereby companies modify the software to meet and satisfy their business needs and standards. Another tool on which companies run their large data sets in on the cloud. Cloud computing, meaning over the internet.

a. Hadoop: it's a framework of tools and open-source software, licensed under Apache. Used for distributing, storing and processing of big data applications using MapReduce programming

model. It consists of computer clusters built from commodity hardware, designed to store and to process large volumes of data distributed across a cluster of commodity servers and commodity storage.

b. Cloud: The cloud is a refers to accessing computer, information technology (IT), and software applications through a network connection, often by accessing data centers using wide area networking (WAN) or Internet connectivity.

Hadoop consists of mainly four modules, included in the basic framework from the Apache Foundation.

1. **Hadoop Common**: These are libraries and utilities used by other Hadoop modules.
2. **Hadoop Distributed File System (HDFS)**: The Java-based scalable system that stores data across multiple machines without prior organization.
3. **Hadoop YARN (Yet Another Resource Negotiator)**: Provides resource management for the processes running on Hadoop.
4. **Hadoop MapReduce**: A parallel software framework, it is comprised of two steps. Map step is a master node that takes inputs and partitions them into smaller subproblems and then distributes them to worker nodes. After the map step has taken place, the master node takes the answers to all of the sub-problems and combines them to produce output.

All the modules in Hadoop are designed with a fundamental assumption that hardware failures (of individual machines, or racks of machines) are common and thus should be automatically handled by the framework. The entire Apache Hadoop "platform" is now considered to consist of some related projects that include:

- **Ambari**: A web interface for managing, configuring and testing Hadoop services and components.
- **Avro™**: A data serialization system.
- **Cassandra**: A distributed database system.
- **Flume**: Software that collects, aggregates and moves large amounts of streaming data into HDFS.
- **HBase**: A nonrelational, distributed database that runs on top of Hadoop. HBase tables can serve as input and output for MapReduce jobs.
- **HCatalog**: A table and storage management layer that helps users share and access data.
- **Hive**: A data warehousing and SQL-like query language that presents data in the form of tables. Hive programming is similar to database programming.
- **Mahout™**: A Scalable machine learning and data mining library.
- **Oozie**: A Hadoop job scheduler.
- **Pig**: A platform for manipulating data stored in HDFS that includes a compiler for MapReduce programs and a high-level language called Pig Latin. It provides a way to perform data extractions, transformations and loading, and basic analysis without having to write MapReduce programs.
- **SolR**: A scalable search tool that includes indexing, reliability, central configuration, failover, and recovery.
- **Spark**: An open-source cluster computing framework with in-memory analytics.

- **Sqoop**: A connection and a transfer mechanism that moves data between Hadoop and relational databases.
- **Zookeeper**: An application that coordinates distributed processing.

GETTTING DATA INTO A HOOP

Beneath are a few ways to get big data into a Hadoop cluster:

- Use of third-party vendor connectors (like SAS/ACCESS or SAS Data Loader for Hadoop).
- Use of Sqoop to import structured data from a relational database to HDFS, Hive, and HBase. It also extracts data from Hadoop and exports it to relational databases and data warehouses.
- Use Flume to load data from logs into Hadoop continuously.
- Load files to the system using simple Java commands.
- Creating a cron job to scan a directory for new files and puts them in HDFS as they show up. Useful for things like downloading email at regular intervals.
- Mounting HDFS as a file system and copy or write files there.

The concept of cloud computing arises from the interplay of three concepts:

1. **SaaS (Software as a Service):** It is software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network, typically the internet. The vendor provides daily technical operation, maintenance, and support for the software provided to their client. Examples include: Google Apps, Microsoft Office 365, Google docs and Amazon Web services

2. **IaaS (Infrastructure as a service):** A model in which an organization outsources the equipment used to support operations, including storage, hardware, servers and networking components. The service provider owns the equipment and is responsible for housing, running and maintaining it. Ex. Amazon Elastic Compute Cloud (EC2) and Rackspace.

3. **PaaS (Platform as a Service):** Is a paradigm for delivering operating systems and associated services over the Internet without downloads or installation. Ex. Salesforce and Google App Engine.

IMPORTANCE OF BIG DATA ANALYTICS

1. **Cost reduction.** Big data technologies such as Hadoop and cloud-based analytics bring significant cost advantages when it comes to storing large amounts of data – plus they can identify more efficient ways of doing business.

2. **Faster, better decision making.** With the speed of Hadoop and in-memory analytics, combined with the ability to analyze new sources of data, businesses can analyze information immediately – and make decisions based on what they've learned.

3. **New products and services.** With the ability to gauge customer needs and satisfaction through analytics comes the power to give customers what they want. Davenport points out that with big data analytics, more companies are creating new products to meet customers' needs.

APPLICATION OF BIG DATA ANALYTICS

Data analytics is applied in sectors, ranging from public, government and private communities. Some areas include:

GOVERNMENT:

The United States Federal Government owns six of the ten most powerful supercomputers in the world.

- The $200 million Summit supercomputer, stationed at the Department of Energy's Oak Ridge National Laboratory, was conceived to research the fields of human diseases such as Alzheimer and cancer, astrophysics, fusion energy, and climate change. Summit occupies 5,600 square feet of space and weighs over 340 tons.

- The Utah Data Center: constructed by the United States National Security Agency. The facility will be able to handle a large amount of information collected by the NSA over the Internet. The exact amount of storage space is unknown, but more recent sources claim it will be on the order of a few Exabyte's

- Big data is being used in the analysis of large amounts of social disability claims, made to the Social Security Administration (SSA), that arrive in the form of unstructured data. The analytics are used to process medical information rapidly and efficiently for faster decision making and to detect suspicious or fraudulent claims.

- Compliance and regulatory analysis: The Food and Drug Administration (FDA) uses big data to detect and study patterns of food-related illnesses and diseases. Thus, allowing for a faster response which has led to faster treatment and less death.

BANKING AND SECURITY

- Fraud detection and prevention: It detects the misuse of credit cards, misuse of debit cards, archival of inspection tracks, venture credit hazard treatment, business clarity, customer statistics alteration, and public analytics for business.

- The Securities and Exchange Commission (SEC) uses this big data to keep track of all the commercial market movements. They are currently using network analytics and natural language processors to catch illegal trading activity in the financial markets.

HEALTH

- Big data analytics has helped healthcare improve by providing personalized medicine and prescriptive analytics to patients individually.

- Clinical risk intervention, waste and care variability reduction, automated external and internal reporting of patient data, Reimbursement modeling, Public health reporting, Clinical data transparency, Clinical trial design and analysis

- With the option of e-Health and wearable technologies, Doctors can easily access and monitor patients' vital organs.

- Virtual care and wearable healthcare technologies. Ex. Heart monitors, smartwatches.

E-COMMERCE AND RETAIL

- Event/behavior-based targeting, Cross-channel customer service optimization

- Customer recommendation, Campaign management and optimization, Micro-segmentation of consumers and markets, and Location-based marketing

CHALLENGES TO BIG DATA ANALYTICS

- Dealing with data growth and quality. Retaining and gaining insight from data. Cost management. Privacy and security. Lack of internal analytics skills and the high cost of hiring experienced data scientists and data engineers to fill the gaps.

- Visual Representation Data : Representing the data in a well-structured format which is readable and understandable to the audience is vitally important. Handling the unstructured data and then representing it in a visual format can be a challenging job which organizations implementing big data are going to face soon. To cater to this need, different types of graphs or tables can be used to represent the data.

CONCLUSION

Big data is rapidly evolving. And as many such organizations are turning to big data for certain insights and help in decision making and ideas to stay ahead of the competition. Big data systems are uniquely suited for surfacing difficult-to-detect patterns and providing insight into behaviors that are impossible to find through conventional means.

However due to the help of tools such as Hadoop and the cloud storing and analyzing these data has become easier and cheaper. Challenges still arise, but with time solutions will be put in place to amend these shortcomings

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FUZZY LOGIC: A BRIDGE TO AUTONOMY

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INTRODUCTION

The goal of most modern innovators is to make autonomous and human-like machinery. Moreover, whether it is virtual assistants or independently programmed machines, we are trying to increase the ability of technologies to adopt aspects of the human intelligence to relieve us of some of our duties. And, over time, scientists and engineers have concluded that the recognition of nuance and distinction when making decisions is a very important human skill. Scientists have also drawn connections between how language and abstract principles are used in practical applications and decision-making. In 1965, an electrical engineer and mathematician, combined the theories and disciplines of previous thinkers to establish the mathematical approach fuzzy logic (Metz, Cade nytimes.com). His initial goal was to link human intelligence and language through mathematics and logic (Metz, Cade nytimes.com). Since then, through fuzzy sets, logical operations/statements, fuzzy logic has been applied to many systems better deal with problems in complex situations.

OVERVIEW

Fuzzy logic is more formerly defined as a mathematical approach that deals with degrees of truthfulness and falsehood rather than absolute true and false values (Rouse, Margaret techtarget.com). Furthermore, fuzzy logic allows an element/object to correspond to a set-in degree of membership or correspondence rather than absolutely corresponding to that set. We often see examples of this when categorizing events and objects. A day can be somewhat hot and somewhat cold to varying degrees. Similarly, an element can be somewhat in one set, and somewhat in another without the two being mutually exclusive. In fuzzy logic, this principle is used to define the idea of concept. For instance, if my idea of a fast bicycle is roughly 40-70 miles per hour, this would be me categorizing a fast speed as being within a range of values rather than being a precise number.

HISTORY

While fuzzy logic is a relatively new mathematical discipline, its overall ideas can be sourced as far back as Plato (as seen in Figure 1), who believed that there were degrees of membership when making predictions about future events (*Fuzzy Logic: A Practical [...],* page 9). The later Irish clergymen George Berkley and philosopher Scott David Hume built on Plato's theories through their idea that each concept has a crisp (precise) inner core in which similar concepts are in some way "attracted" (page 9). However, the biggest shift in fuzzy logic was in the 20th century, when more people began to divert from crisp logic reasoning towards mathematical vagueness. This is mostly due to the work of English mathematician and philosopher Bertrand Russell, who studied the equivocality of language as well as precision, concluding that something could be equivocal or vague to a degree (pages 9-10). Ludwig Wittgenstein, too, studied the vagueness and ambiguity of language through homonyms (page 10).
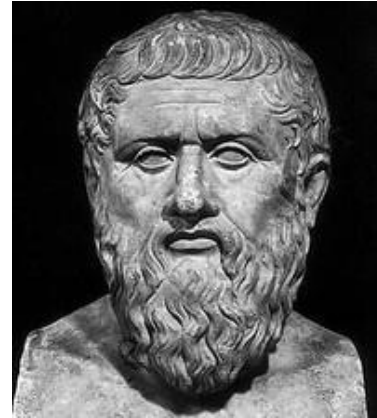

Figure 1. Portrait Bust of Plato

Nonetheless, the first "logic of vagueness" was developed by Jan Łukasiewicz in 1920, who devised sets with potential membership values of 0, .5, and 1. He later extended to all numbers in between 0 and 1 (page 10).
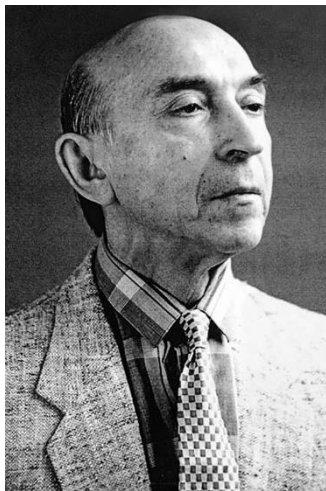

Figure 2. Lotfi Zadeh

However, with all these related disciplines and theories, fuzzy logic was not officially established until 1965, by the electrical engineer and mathematician Lotfi Zadeh (as seen in Figure 2) (Metz, Cade nytimes.com). The purpose of creating fuzzy logic was to allow machines to make distinctions to better make decisions (McNeil page 11). Traditionally, machines used crisp or binary logical reasoning to make decisions. Moreover, instead of an element/object being able to partially belong t o a set, an object could only be either completely belong to or not belong to a set. For instance, if you are driving and you want to make a left, you would likely not turn the steering wheel all the way in one direction. Instead, depending on the curve of this turn, you may make slight adjustments rather than a complete 360. During his studies at the University of Berkley, Dr. Zadeh found a growing need for computer programs to make small distinctions based on bigger, more nuanced understandings of circumstances. He further reasoned that if he connected ambiguous human language and human intelligence through logic and mathematics, machines recognize these distinctions, further allowing them to think like humans (McNeil page 11). Dr. Zadeh did this by combining Łukasiewicz's sets and Russell's theory of degrees of equivocality

into his own discipline. Since then, fuzzy logic has helped progress the linguistical and decision-making aspects of artificial intelligence (Metz, Cade nytimes.com).

FUZZY SETS

Fuzzy sets are a way in which mathematicians represent the degrees to which ideas and object are related. This is done by making each element in a set correspond to it within a range of 0 (not belonging to a set) and 1 (completely belonging to a set). In each set, there are traditionally 3 numeric values that define a set. The middle value or definition of the set is called an apex. The apex is the number that has the greatest membership to a set. This further means that if we identify the set by name, we would further define it as the

Figure 3. Fuzzy Number/Set 2

number with the highest membership value. The other two of the values are called the bases. These have the lowest memberships to the set. The base less than the value of the apex is called the low base, while the number that is more than the value of the apex is called the high base (McNeil pages 27-28). Usually, a fuzzy set takes on the form of a triangular function (McNeil pages 33-34) in which the apex value is the tip of the triangle and the bases are the 2 other points. The fuzzy triangular membership function 2 or (1, 2, 3) is represented in Figure 3.
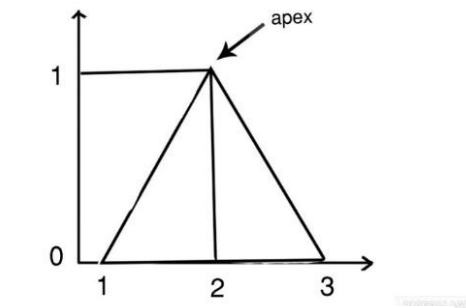
Fuzzy numbers are numeric values that have an apex and bases that have membership values to a set within a range of 0 and 1. Importantly, any fuzzy number can be represented as a fuzzy set (McNeil pages 32-35). For instance, consider the set (1, 2, 3) in Figure 3. Because each element within the set is a numerical value that corresponds to the set 2 of some degree. Like the fuzzy set (1, 2, 3), the fuzzy number (1, 2, 3) has a numeric value of 2 that has the highest membership to the set and two bases of 1 and 3 that have the lowest membership values to the set.

Fuzzy sets and numbers allow an element to belong to multiple groups in varying degrees   without each correspondence being mutually exclusive. Furthermore, both represent the complexity of elemental and numerical relationships, allowing programs and computers to better understand the nature of the correspondences to degrees.

LOGIC OPERATIONS

When dealing with different numbers and sets, logic operations are performed to simplify the result of the sets. In fuzzy logic, applying logic operations to fuzzy sets and numbers is like classical set theory.

Recall that between two sets there are two possibilities. They can either be "partners" merged in a domain or they are related based on their shared elements (McNeil page 34). If the sets are

combined as "partners", you perform a union (for single element sets) or a disjunction (for multi-element sets) (McNeil page 34). In fuzzy logic, the products of a disjunction or union operation indicates the product of the maximum value (or maximum number of elements in a set) of the two fuzzy sets involved (McNeil page 34). If some elements from the sets are shared, you perform a conjunction (for single-element sets) or intersection (multielement sets).

In fuzzy logic, the product of a conjunction or intersection operation indicates the product of the minimum value (or minimum number of elements in a set) of the fuzzy sets involved (McNeil 36-37). Lastly, if you want to perform a complement, you find the portion of the domain not contained in the set (McNeil 37)

LOGICAL STATEMENTS

Logical statements are closely related to logical operations in fuzzy logic. While logic operations are represented with symbols, logical statements can be the representation of the operations through words and rules. Importantly, logical statements outline the decision-making processes of the computer system, further helping me list the conditions of actions done on a device like the Raspberry Pi.

A common logical statement or rule used in fuzzy logic are rules of inference. Like most syllogisms, rules of inference derive true conclusions from proven/true premises (McNeil pages 46-48). There are three general forms of rules of inference. The first is called modes ponens which deals with implication,

As A is true, Then B is true

Or,

As   A

And $A{\rightarrow}B$

Then   B

The second rule type is modus tollens in which implication and negation is performed,

Given that B is false, and A implies B, then A is also false.

Or,

As $\neg$ A

And $A{\rightarrow}B$

Then $\neg$ B

The last fuzzy rule I will mention is the compositional rule of inference, in which you model an explicit relationship between two objects,

For instance,

As   Apple #1 is very ripe

And   Apple #2 is not quite as ripe as Apple #1

Then   Apple #2 is ripe

(McNeil pages 46-48)

CONTROL AND ANALYSIS METHOD

The Fuzzy Logic Control and Analysis Method or Fuzzification and Defuzzification Processes (FDP) are one of the most important principles in fuzzy logic. Their purposes are to enable programmers, experts, and other users of system to control and simplify input data in the form of complex qualitative data into tangible outputs (as shown in Figure 4).
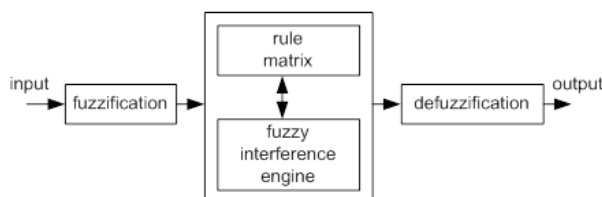

Figure 4. Representation of FDP

Consider that only situations that are complex, dynamic, and ambiguous (McNeil page 2) use fuzzy logic. Furthermore, the more qualitative and abstract the system is, the better suited it may be to utilize fuzzy logic. In this 8-step method, users change input values into "fuzzy terms" or linguistic variables and then change the fuzzy output back into numerical values (through a computer program that takes inputs, fires rules, and results in outputs (McNeil page 76)) for further action. A few major concepts you also must consider when using FDP are hedges and linguistic variables. Linguistic variables are qualitative values that represent an input (Janelle Green). A hedge, then, would be a special kind of linguistic variable that modifies and/or renames existing rules (McNeil page 52).

Through these series of methods and a fuzzy logic program, a computer system can process data to make better decisions. Furthermore, FDP allows systems to better understand the conditions of a situation by defining the inputs and outputs with numerical values, representing the possible outcomes based on different conditions, and then converting the linguistic outcomes into numerical values.

There are many ways in which to perform FDP based on the needs and type of system the expert is using. The FDP I used above is for a knowledge-based system. In an inference system, for example, one maps the given input to the output. Like the knowledge-based system, it includes membership function, logical operations, and rules (McNeil page 76).

APPLICATIONS

After Dr. Zadeh published his research paper, "Fuzzy Sets", scientists and researchers began to implement fuzzy logic into many systems. The first commercially sold fuzzy system was a fuzzy shower head, exclusively sold in Japan (goldengooseaward.org). Other applications during this period were washing machines, vacuum cleaners, and washing machines (McNeil pages 80-81). By using the FDP, scientists were able to determine the best decision based on the complex and varied conditions of the environment.

Since then, mathematicians and scientists have been able to apply fuzzy logic algorithms in many other systems. Virtual assistants are a special kind of artificial intelligence that interpret the language of the users to aid them in daily activities. More specifically, these technologies help us by making choices based on the conditions of the circumstance. Thus, like the FDP, the system interprets the situations, assigns linguistic values to the inputs of the system, and goes through a series of processes to convert ambiguous language into tangible outputs. A few of these technologies include Siri and Alexa (as seen in Figure 5) (Cutts, Marcel, blog.red-badger.com). Another more recent application are weather stations. By assessing the conditions of the environment, such as precipitation, fuzzy logic can help determine energy usage of a system, further enabling system autonomy.

Figure 5. Alexa

PROS AND CONS

Fuzzy logic has proven to be very helpful in decision-making and computer processing. By evaluating multiple conditions and inputs, it allows the user to fully assess the needs to create an appropriate output under specific conditions. In many examples such as in driving or in representing complex situations, fuzzy logic provides a practical solution to indefinite circumstances. It is also a very flexible way to dealing with problems, because it modifies outputs based on small changes in the conditions (McNeil page 16).

Because of these benefits, fuzzy logic has advanced linguistical artificial intelligence by allowing technologies to use language to make decisions. However, fuzzy logic is also a very vague and abstract discipline that makes it harder for others to base a model from a fuzzy system (McNeil page 17). Fuzzy systems require experienced programming and simulation for them to work. Additionally, while outlining inputs and conditions are helpful, they can be tedious and impractical when trying to come up with a faster solution.

Unfortunately, there is no way in which these problems can be easily solved. Fuzzy logic thrives on its linguistic inputs and ambiguous conditions. However, the rules and ambiguity that the discipline is dependent on can be the "drawbacks" to the technology. Put simply, fuzzy logic

should only be applied to a system when the user wants "to map an input space to an output space" (Zadeh, Lotfi, radio.feld.cvut.cz). When this is not the case, fuzzy logic should not be used.

FUTURE OF FUZZY LOGIC

There is more data than ever before. It is more important to understand how we deal with the data to produce better solutions. Furthermore, as there becomes an increase in data, there will grow an increase in the number of machines and artificial intelligence technologies that will deal with the data. Additionally, because fuzzy logic is applied to different aspects of artificial intelligence such as language processing and decision-making skill. I see promise for fuzzy logic in the I.T. field because of its flexibility and utilization of natural language to enable machines to "make" decisions. However, because data is growing exponentially, it's important that we find fast and practical ways in which to deal with data. And, given that majority of fuzzy logic is expert-based and requires high expertise, it seems equally probable that it will not be applied to future technologies to combat this problem. Nonetheless, I do believe fuzzy logic is very important in data processing and has great potential to be applied to other disciplines in the sciences (sociology, physics…) to provide better solutions under more precise circumstances.

CONCLUSION

Fuzzy logic allows abstract, qualitative principles to be converted into numerical and practical decisions. And, while it is a new discipline, Dr. Lotfi Zadeh built on other philosophers' and mathematicians' theories and findings to create a process that optimizes nuanced observation in decision making skills. This is done by a series of methods and concepts, such as fuzzy sets, logical operations, fuzzy numbers, and the FDP. By using these principles, technologies such as virtual assistants and washing machines have been developed. However, while fuzzy logic does offer promise, because it is a very time-consuming to simulate and practically use, fuzzy logic's future in the I.T. field is questionable. Yet, the progress fuzzy logic has made, has lead us closer to achieving autonomy in the computer sciences.

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THE RISKS WITHIN A SMART CITY

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INTRODUCTION

Smart Cities don't have an official definition to their name, it's only an idea of industrial and residential revolution; the next step in modern technology, and for cities. Data in a Smart City is collected from residents, businesses and assets of the city, then used to enhance the city, its citizens, businesses, hospitals, first responders, power grids, and schools. Due to the intense level of technology, there are risks of having everything connected, and most would question the privacy of the data from public use. The following will present research on the security of a Smart City, its residents, businesses, the connections, and how a domino effect could be produced from anything connected to the internal system.

SMART CITY

A Smart City is managed by automatic systems that controls nearly, if not everything, in the city; including smart grids, smart roads, automatic services, (anything that can be connected to the internet). This allows many machines to become self-sufficient, like Artificial Intelligence (A.I).

From buildings, homes, power plants, businesses, banks, and cars, anything that can be operated by a machine and will eventually be operated by a machine. With that, anything-that connects to the internet can and will be considered an Internet of Things (IoT). Having most linear jobs (like fast foods, deliveries, cutting grass, watering crops, etc.), and being able to use machines is great; but how does a machine know when to start, stop, update, change task, or do it in a specific way? With Data science and Machine learning programmers can make dumb Artificial Intelligence (a term from the popular Halo game franchise) (A.I) that can learn and adapt to the change in their fields. For Example, Google's "Nest", a thermostat that has the capability to learn and automatically adjust to its user's preferences.

Smart Cities greatly rely on the Internet of Things to collect data from houses, businesses, and assets. Any information that can be used will be utilized by the city and sent to the cloud, this is called Data Democratization.

Data Democratization is a belief, that all data should be free, easy to interpret and open to the public for use, including competition. Many believe Data Democratization is an important thing for a Smart City; this thought comes without thinking of the consequences of the open and free data taken from businesses, homes, and industries. Data Democratization should have no place in any Smart City based on the following: At what point should a hard-working employee give up his work for others to use for free? This is like forcing an inventor that created something world

changing, to give it up for public use without any compensation and recognition, despite being patented or not. The owner of the data should be compensated for his contribution of data before anyone can use it, because at that point, who needs a data analyst? Making all data easy to interpret and easy for others to use will take away jobs from honest working data analysts that get paid to study and translate data for use. No business is going to pay an analyst to do a job that will ultimately be done for free.

Companies ask customers to sign a contract for "terms-of-service agreement"; where the product use and policies are agreed upon between the company and the consumer (varying on the company and the product in use). In some of the terms and depending on both the company and product, customers are giving companies permission to share their data. If that is true, the information given to a third party from any customer's house could be damaging depending on what they need. This is one of many "worst case scenarios" that Smart Cities will want to avoid at all cost. While the chance of this is happening is very low, one must never leave their weakness open to exploit. "A plan will always have a weak point and there will always be those looking to exploit it." - Emily Thorne

A greater worry comes when discussing the information that a Smart City receives from their customer's homes. For example, if it was a home security system it could tell the company when someone is away or if the alarm system is activated. If the company gave the information to a hacker or anyone that is connected to the cloud (knowingly or unknowingly), they could shut off the alarm system or even take out the power in the house. Realistically, this is a worst-case scenario that most likely will never happen. This is not to say that the cloud won't have security, or the information is out on the internet, the question is what happens if hackers get access to one point in security and tries to access everything else? Will there be more levels of security or does he have unlimited access to all data from private information, to the power grid?

INTERNET OF THINGS

IoT connects almost everything in a Smart City, meaning that everything is connected in the cloud. Any data that has been sent is out in the open for all to access (like posting a picture on Facebook without sending it to a specific group). That may not sound like a bad thing; except, if you are sending private or sensitive data to a specific person, company, or group like health insurance or credit card information.

What role does IoT have in these situations: everything? It can be seen by all who are connected to the Smart City. It won't be plastered everywhere, but if someone is looking for it, looking for data on you, or cross references anything about you, it could come up. Let's drop data out of the conversation and just talk about devices, could some connect to my car or house, through my phone, Wi-Fi or cloud? What security measures are going to be in place to keep my home, devices, and data safe?

A cloud server in a Smart City will be connected to everything electronic, but who has access to look into the data and how does it affect citizens' private lives? Companies, if given the chance, will no doubt take the opportunity to have access to any data from the public that could attract

potential customers; even if it also means their data will also be given out to both customers and business competition. This raises a question, will the cloud separate private information from the data that both the public and companies have access?

The idea of a cloud for a Smart City where everyone has access to the same data has a lot of holes in it, or at the very least has not been specified. What happens if there is a bug in the system and how will anyone know or even report? What happens when the cloud needs maintenance and what data is sent over is lost? How someone can recover it? These are things that need to be considered before trying to make a Smart City itself, data is a major factor in Smart Cities so to lose any data at any given moment could be disastrous sooner or later.

SECURITY

The cloud implemented in the Smart City must have "access points" for every area, a user can be given permission to access certain areas of data while others block user access. Levels of security will be a necessity if vital information will be on the cloud but given that the cloud belongs to the city, someone must give and take away access keys from citizens both joining and leaving. The only problem is that no one person can or should give access out for everything. Someone who has access can also deny access outside of regulations, the problem is not the probability of it happening but why give the opportunity for anyone to do wrong. This person would be responsible for every person's level of access in the entire city for job designations, house rent/ownership and whenever someone possibly wants car ownership, the workload is too much for any one person to be responsible for. The best solution is to have the office for citizenship (if needed), jobs and homeowners to give access to users.

Jobs like first responders can give an additional level of access in their fields of work given by the recruiter and/or boss of the office for their job designation. This way, someone can make sure no one is running around with access after being let go, fired, resigned or taking time off (with and without pay). Companies should be able to give job designation status for their employees but should not be able to give access outside of their designated workspace, this way no data of or for the company is open to all. Home owners can give a renter or buyer a key to the house and access pass to its security. If rent is not paid after the resident is given warnings or alerts, an eviction notice will give the current resident a few days (in Utah, it would be three-days to either pay or until the court order is issued) before the resident no longer has access to the house.

DATA RIGHTS AND ACCESS

Data is a large part of a Smart City, it contains resources, bank information, company statistics, and home and security information. A record of access to data and access points should be recorded this way if someone who is not allowed to access the data can be flagged through a warning system, they can be found and questioned with warning, and depending on how severe, detained. Someone who have access to the program, most likely will have access to the system but who has the right to give access to my data, and who has the right to my data? Who holds the keys to the data cloud and when do they have a right to investigate private date?

Investigators who need information on a case may need a reliable and legal source for data on their suspect, with a warrant investigators and policemen should be able to view certain parts of a user's data involving the charge or case, should anything come up lawyers should be able to show it in court if necessary. No one has a right to someone else's data beyond an agreement between two or more parties working with the data that is given to be viewed (but no one in said party should be forced to add any personal data outside of work or agreement). Programmers or companies don't need someone's personal information outside of what was agreed in the terms and conditions of service/use, even if the device being used by the customer is able to send that information. The Government should have no right to a person's data more than they should have a right over someone's stock.

Recently on April 14, 2016, a new law in the European Union was enforced on May 25, 2018, called "General Data Protection Regulations". It simply states that while private data for both citizens and businesses can be collected and stored, they must not be released to the public, without the owner's explicit permission. This affects not only current businesses and corporations in Europe, but also every business on every continent that works or services citizens in the European Union. This means that Smart Cities, while able to retrieve and store personal data, are not allowed to release it on public cloud servers without facing legal consequences.

GOVERNING

The greatest concern in a worst-case scenario is "what happens if my information is leaked", what kind of danger can someone expect if anyone else gets access to my data and key permissions and what can someone do to recover their access key?

If someone has technical questions or needs tech support, who should they call to receive help, the city, the company or the government? Identity fraud should be avoided in this scenario but that does not mean there should be no way to fix the issue if the problem ever occurs. This could be solved the same or similar ways regardless if the city is owned by a company or of the government.

Cities are built usually by issue from the government but what if a company wanted not only own but build a Smart City, what happens then? While a company can own and possibly govern a city the overall law of the land still belongs to the government of the nation, if the company abides by the law of the government, everything else in the city will be fair game to the company, such as business and housing conditions. This helps with answering who will be responsible for the city, however, if any problems occur the company will be looking to the government for answers.

If the Smart Cities are by ran by the U.S, the government would run the city just as if any individual city would. Nothing different would happen besides everything being connected on a more federal level. Location comes in to play in terms of governing, to list a few, it depends on if the city was already established, what state it's in and what part, whether it has Home or Dillon's Rule, all these things have come into play that will determine on how the city will be governed. The Federal Government would have an overall say in law that all states in the U.S must abide by the law.

Home Rule is where the citizens are giving local government more control over how things are being run. With Dillion's Rule the elected governor and citizens would decide who is in charge, if there is believable doubt that the local government was given authority, then most likely they don't

have authority. A Smart City will run just like any other city, depending on the government and the nation you live in, while a Smart City will be more advanced than most cities, it does not need special governing or control, just more regulations around data and its use. Only governing and policies may be in question if a company owns the city.

BREACHES

Often do phones, computers, and websites ask for "permissions" to use, do or download something and often people let them, but should they? The United States government have discussed before about hacking into home game systems, in 2012 the Department of Homeland Security and American Navy bought used Xbox 360, Wii, PlayStation 3 systems from foreigners, and chose Obscure Technologies to hack into them to extract data from credit card information, to conversations. In that same year, hackers called "The Cyber fighters of Izz Ad-Din Al-Qassam" use denial of service attacks to disrupt targeted bank websites, and later found out to be funded by the Iran government.

Hackers if they can and want to, could hack a system whether for money, blackmail, bragging rights or just for kicks. What happens if they breach the system and what will they have access to? Depending on what section of the system they hack, hackers could either receive something harmless or something disastrous. The security system should have the same level of defense but differ from other sections, so it will not be too like the point where hackers can use the same trick on all the others. If such a breach were to occur, while the company of the system won't be to blame but they will be looked to for answers and rectification to the system.

Users will most likely not be accused if they leaked information on their account/access point, they won't have access to the system itself only their personal data. The blame for the breech would either go to the coders, the hackers or the administrator, if and if they told anyone how the system works and how to gain access. The next problem comes if someone tried to fix/patch the system, will it shut it down, run patch in the background or will it lose any data on the cloud? If one small breech or power outage can cost the Smart City data and not be able to recover it, should it be built and implemented?

HOW MUCH IS TOO MUCH?

"Your scientists were so preoccupied with whether or not they could that they didn't stop to think if they should" - Dr. Ian Malcolm.

Will a Smart City be too much, the city can have all the resources and technology that the heart can desire but would anyone really need it or really use it? No one person needs over ten devices to do similar or the same task, most don't even need five. Would someone who hears or thinks of a Smart City think that it's all just a technologic utopia for scientist and engineers? What can be done to not just show but be more than just technology?

What can be considered too much, technology, resources, data, is there to be a limit on Smart Cities? No, there should be no limit in advancing technology if there is a balance between tech and

social interactions. Why stop its advancement if there is no danger to human life or the earth, technology is only as distracting or dangerous as allowed?

WHAT HAPPENS WHEN THE CAPACITY IS FULL?

A.I will alert the owners of a resource cache nearly being full and if they may need to upgrade storage units. Statistics will let the city know if the servers are being overloaded and need to be plunged or upgraded. In terms of housing, more houses always being built to accommodate more residents. Not enough demand in terms of resources can also be fixed; for example, when store owners notice the steadily decline in demand, owners won't have to order as much supply as they did before. Larger increase of demand will also increase supply, which would bring more profit for businesses to be able to open more stores either in or near the city.

If the city needs more space (in terms of the system having too many connections) and is risking slower connections, it will need to make either a smaller Smart City or a sister Smart City to support the main one. The new Smart City will need thrice as much storage space implemented to support itself and the original Smart City. If the Smart City needs more space for housing, a smart district can be built with transport between the district and the Smart City.

SMART DISTRICTS (HOUSING)

Smart Districts are like districts with the characteristics of a Smart City; they could be interlocked and connected to the city without being inside or a part of the city. Having a transit able to go through the district and the city would help decrease traffic, districts would have banks, grocery stores, housing and schools. Smart districts/neighborhoods would be beneficial to save space in a Smart City by being in the outskirts, and families of greater numbers or in need bigger house space for other reasons. Townhouses would be an excellent asset in Smart Cities, especially for those that live alone or need to live closer to work. The down side though is that they would not have a lot of land space and would always be near traffic; which could disturb the sleep for those who cannot stand the loud noises, children, or have issues sleeping. Smart districts can solve things like land layouts, space, and housing issues that might have interfered with the development of the city.

City and housing expansion will be easier in districts, with transits going between districts and the city. If maglev trains can be utilized, going at 375mph with smart technology, it would take a matter of minutes going from point A to point B. A 50-mile distance will take little time for maglevs to cross and will give plenty of expansion room for both the Smart City and district to take advantage.

HOW WILL A SMART CITY AFFECT JOBS?

With most almost everything being done with or by machines how much will people do, from self-driving cars, automated services among other things will people have a choice of doing things themselves or have a machine do it for them? With self-driving cars companies will more than likely take out human interface if possible to avoid accidents caused from human error. Doing this

takes away the skill of driving from every car owner, especially if it is no longer legal to drive the automated car within Smart City limits (or not being able to drive at all without a driver interface. While teachers, architects, programmers, engineers and scientist in general will most likely appreciate the city, what will people like lawyers, policemen, doctors, bankers, businesses and every person who works in an office, what will they benefit from inside a Smart City?

Lawyers and bankers will find it easier to track a customer's needs and information, without having to wait several businesses days before somethings done. Policemen will have records and alerts coming in faster which in turn will allow a faster response. Whether it's a warrant for arrest or investigation, officers will benefit from a system that updates every second. Doctors will have an easier time with smart medicine, they will be able to rely on monitoring technology both in house and wearable. This could help keep track of their patient's vitals, and records will be easier to obtain with little hassle.

Business offices will still be needed for Smart Cities, while everything is connected, and data will be open to the public. It's possible that those who work in offices won't see much of a difference in work from a regular city than a Smart City, outside of information coming in faster with IoT. School districts will have an easier time scheduling, managing teachers and students. With real-time monitoring and security system, being able to lock down the school after hours and during school hours will only take seconds. Businesses will function normally in Smart Cities, depending on what the office is for, files and information will be easier and safer.

CONCLUSION

Smart Cities could be the next big thing if given a chance but having a Smart City won't mean much without inhabitants. If suspicion arises about security problems, invasion privacy issues, technical errors, bugs or even viruses in the city, people will be very hesitant to join. Smart Cities will be refined but they won't be perfect, just as everything made by man is not perfect. A security risk is no laughing matter and it could cost lives if unchecked, a Smart City is to make life easier if not simpler, not more difficult with more problems to solve surrounded by paranoia.

If Smart Cities are to become our next step, the world must know that their information is safe, and the change is welcoming; not risky and intimidating. If we could prove that living in a Smart City would be better by being an example and volunteering to live in one, more would soon follow when it works.

Businesses and employees alike will have an easier time to schedule their work hours and work Access levels; no one will try to steal or misuse company information. Updates to someone profile, job occupation, medical records or criminal records would make things easier on a mass scale. Having "access points" and "access keys" will be a necessity to keep private data and information for companies, homes and residents safely guarded, if hackers had access to data, no matter what someone may think if it's a possibility someone either has or will try to do.

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QUOTES

"A plan will always have a weak point and there will always be those looking to exploit it." - Quote by Emily Thorne played by Emily VanCamp, in Revenge Season 2, Episode 11 Recap: "Double-Crosses" And "Death In 'Sabotage'"(2013)

"Your scientists were so preoccupied with whether or not they could that they didn't stop to think if they should" - Quote by Dr. Ian Malcolm played by Michael Crichton, in Jurassic Park (1998)

IMAGES

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THE APPLICATIONS OF COMPUTATIONAL NETWORK ANALYSIS IN ADVANCING DRUG DISCOVERY

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INTRODUCTION

Recent advances in computing software have made it possible for individual scientists to perform complex analysis of large volumes of data and reveal significant, undiscovered trends that had previously daunted researchers for years. Arguably, no field is poised to benefit more from these innovations in data science than biomedical science, which encompasses the millions upon millions of lines of gene, molecule, and cell data discovered in the human body. One need only look to the Human Genome Project, the massive undertaking to discover and publish the billions of base pairs that make up the human genetic code, and the subsequent medical tools that it has yielded to see how employing computational categorization has helped to advance the human health [1]. But while computers have helped to conquer major problems in the field, there are still subfields in biomedical science that remain daunting even when faced with complex forms of analysis. Consider drug development, the process by which scientists identify new chemical compounds for the treatment of diseases. Before a drug can be approved for a sale in the United States, it requires an intensive analysis of molecular interactions and human chemical pathways to select a drug for use in testing (called drug discovery), laboratory (pre-clinical) and patient (clinical) testing, and a lengthy period of review according to the regulations put in place by the Food and Drug Administration [2]. While computing can help narrow a list of potential drug candidates in the discovery stage, the testing the drug on patients and getting approval from the FDA are still largely time-consuming processes. Possible solutions, based within the science of the networks, are indicative of both the massive role information technology has had on the drug development space and the frontiers that it is poised to open moving forward.

THE BACKGROUND SCIENCE OF NETWORKS

Before further steps can be taken in outlining possible solutions to the issues facing drug development, it is essential that we address the fundamental science behind networks, data analysis tools central to both approaches that will be analyzed later in this paper. The beginnings of networking as a scientific concept date back nearly three hundred years to the famed mathematician Leonhard Euler. Faced with an optimization problem known as the Seven Bridges of Konigsberg, which asks whether one can build a route to each part of the city of Konigsberg that crosses each bridge only once, he sought to define the relationship between the destinations, which are now called nodes, and the routes of travel to the destinations, likewise called edges [3]. While the model itself seems simplistic, the idea presents to scientists a potent tool in visualizing complex systems and, in more recent times, statistically analyzing them. Major network visualizer programs like Cytoscape and Gephi, published in 2002 and 2010 respectively, have dramatically expanded the number of trends and patterns that can be realized in the selected nodes, adding to

the system measures of relative significance like clustering and modularity [4][5]. These weighted measures, combined with intricate visual displays of data, provide complex levels of categorization across as many as thousands of nodes that at the same time are easily apparent; this combination of factors is what makes these tools versatile enough to deliver relevant data for both forms of the forms of drug discovery.
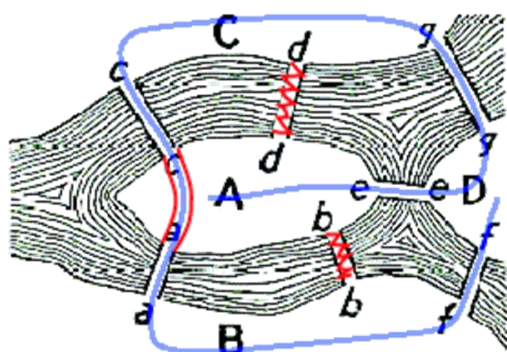

Figure 38. Geographic Map: The Königsberg Bridges.

Figure 1: A model of the Bridges of Konigsberg problem. [6]

METHODOLOGY

Approaching the high costs of drug development from a scientist's perspective, there are two ways forward: changing the algorithm that interprets the data or changing the input data itself. The former path refers to those researchers who have sought to increase the return on investment (ROI) by increasing the accuracy and potency of the drug targeting networks; this approach is favored by many in the commercial research space. The latter path refers to those who, rather than yield to the demands poised by the traditional process, chose to innovate and leverage network analysis to shift the focus from the novel discovery of drugs to the more cost-effective repurposing of already available drugs. Academics, like the researchers of the Cincinnati Children's Hospital Medical Center's Division of Biomedical Informatics (DBI), have expressed support for this kind of approach through published works, some of which being emblematic of the sweeping impact that information technology has had on the field. In examining these two promising, possible advances in drug discovery, this paper both demonstrates the merits of two distinct approaches to one of the most compelling problems in the consequential field of human health.

ADVANCING DRUG DISCOVERY WITH MACHINE LEARNING NETWORKS

The process of drug discovery was revolutionized by the computer modeling of chemical interaction networks and, following from that example, some researchers have sought to innovate in the field by advancing the underlying technology itself. One of the key ideas behind furthering networking technology is the implementation of machine learning. Machine learning is a rapidly expanding field that encompasses any program that "amasses its skill through … reinforcement" of targeted behaviors [7]. The process is largely dependent on dynamic networks called neural

networks – like those used in artificial intelligence – and their capability to "learn" from prior molecular models and predict the formation of new compounds. In use here are networks built with a design known as deep learning, an advancement in machine learning that allows the algorithm to "determining on [its] own if [its] prediction[s] are accurate or not" [8]. Recently, DeepMind, a research team owned by Google, has demonstrated the capabilities of deep learning by showing how its game playing artificial intelligence AlphaGo Zero was able to learn a "thousands of years of human knowledge of the game before inventing better moves of its own, all in the space of three days" [7]. Now commercial forces are pushing this kind of technology into the bioinformatics space. In his 2018 article for *Medium,* Dr. Khurana from the University of Calcutta details how technology has become central to the drug development arms race. According to his analysis, "currently, the healthcare artificial intelligence market is valued at around $0.7b and is expected to grow at a whopping CAGR [compound annual growth rate] of 53%, reaching $8b by 2022", with applications targeting drug discovery cornering "over 35%" of the market. Within that 35% is a wide array of companies employing a wide array of methodologies for improving how researchers can build newer, more effective drugs. Turbine, a startup that placed its resources in "molecular models for cancer biology for better biomarkers", would most likely employ a network based on molecular interactions while another company like Roche, which is working to develop cancer drugs, would be able to leverage a network based on oncogenes – one of the root causes of human cancers. Some of these companies have even started working with titans of the pharmaceutical industry: BenevolentAI and Berg are working household names like Johnson & Johnson and AstraZeneca, respectively [9].
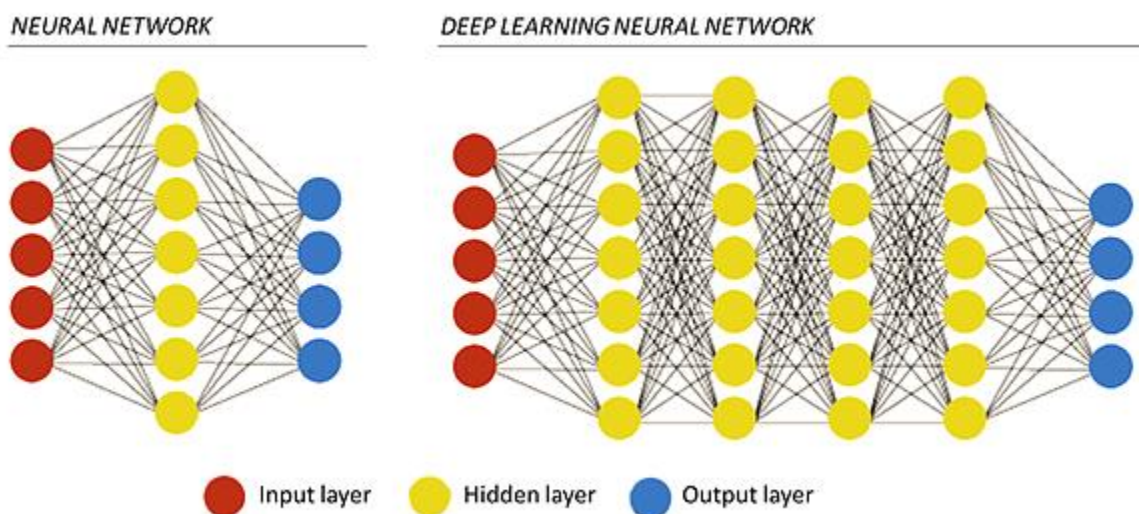
Figure 2: A diagram of how deep learning neural network technology expands on the framework of a traditional network to process a data in a more complex system before outputting. [9]

PROSPECTIVE COSTS OF ATTEMPTING NOVEL DRUG DEVELOPMENT

Improving the accuracy of drug targeting represents a significant achievement in the field but its impact is undercut when placed before the increasing costs of novel drug development. As many scientists are quick to point out, the costs of drug development are great and often lacking in ROI.

Stated quantitatively, "The world's 12 biggest drug companies are making a return of just 3.2 per cent on their research and development spending this year — down from 10.1 per cent in 2010" according to a 2017 article from Financial Times [10]. This is especially troublesome when one factors in the rising costs of development. A 2014 report from the Tufts Center for the Study of Drug Development (CSDD) "peg[ed] the cost of developing a prescription drug that gains market approval at $2.6 billion, a 145% increase, correcting for inflation, over the estimate the center made in 2003" [11]. Worse still, Figure 3 – showing a chart from the article – demonstrates a nearly quadratic trend in costs that shows no sign of tapering off. While the CSDD posits that "higher costs [are] due to the increased complexity of clinical trials, a greater focus on chronic and degenerative diseases, and tests for insurers seeking comparative drug effectiveness data.", the key takeaway from a data science perspective is that many of the roadblocks in the way of cheaper drug development arise from sources that may be beyond the reach of technological innovation in the network space.
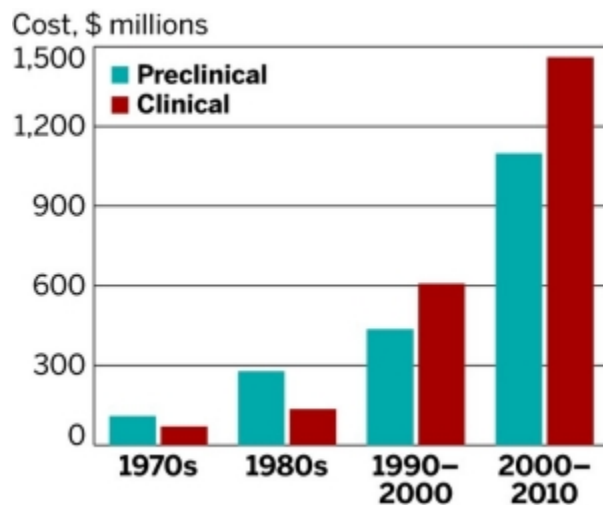

Figure 3: The following is a bar graph detailing the cost of research and development at both the pre-clinical and clinical stages of drug development from 1970 to 2010.

AN ALTERNATIVE SOLUTION WITH DRUG REPURPOSING

While network-based analysis of the drug interactions has yielded insights in the past, the researchers with DBI have targeted their efforts toward proving the practical utility of drug repurposing. Intuitively, two essential components of a worthwhile drug repurposing process are distinctness of groups – can disease(s) be matched into groups by nontrivial factors? – and distinctness of connections – can drugs be introduced into a network with distinct groups and target them nontrivially. Seeking to answer these questions, the results reached by "the orphan disease networks" and "Computational drug repositioning through heterogeneous network clustering", both publications of the Jegga Lab of DBI, demonstrate the feasibility of attaining both former and the latter, respectively.

THE FEASIBILITY OF SPECIFIC DISEASE ORGANIZATION

To best understand how the DBI's researchers demonstrated the first feasibility in their paper, it is essential that we address the one of that paper's central impetuses, "The human disease networks", written four years earlier by the laboratory of Dr. Albert-Laszlo Barabasi. The opening of the paper details its change in approach from earlier ventures in the field of relating human diseases. The authors write "Here we take a conceptually different approach, exploring whether human genetic disorders and the corresponding disease genes might be related to each other at a higher level of cellular and organismal organization", demonstrating a departure from "recent efforts to map protein-protein interactions in humans" [12].What this means is that the network the researchers intended to build – and ultimately built - uses genes and diseases as nodes, rather than attempting to connect huge numbers of proteins. The change seems simple in theory and suggests an attempt to overcome what may have been technical limits that imposed a cap on the number of diseases that could be analyzed at a time. However, the system boasted profound implications, with the authors themselves proposing a conceiving that "it should be possible … to link systemically all genetic disorders … with the complete list of disease genes … resulting in a global view of … the combined set of all known disorder/disease gene associations". A tool of such scale would open vast possibilities for future researchers, enabling them to reference the relevant genes of specific diseases as well as discern significant patterns in all known human diseases through visual network tools. However, this system comes with a major limitation. As one would expect, the links between diseases in the network proposed here requires that the diseases in question have relevant genes on record to connect them. While the effect of this key omission is less apparent when visualizing a general swath of human diseases, the DBI's Jegga laboratory demonstrates in its paper one of the key consequences of this oversight and, in so doing, presents a functional model of discerning distinct classifications for human diseases that is applicable to drug discovery.
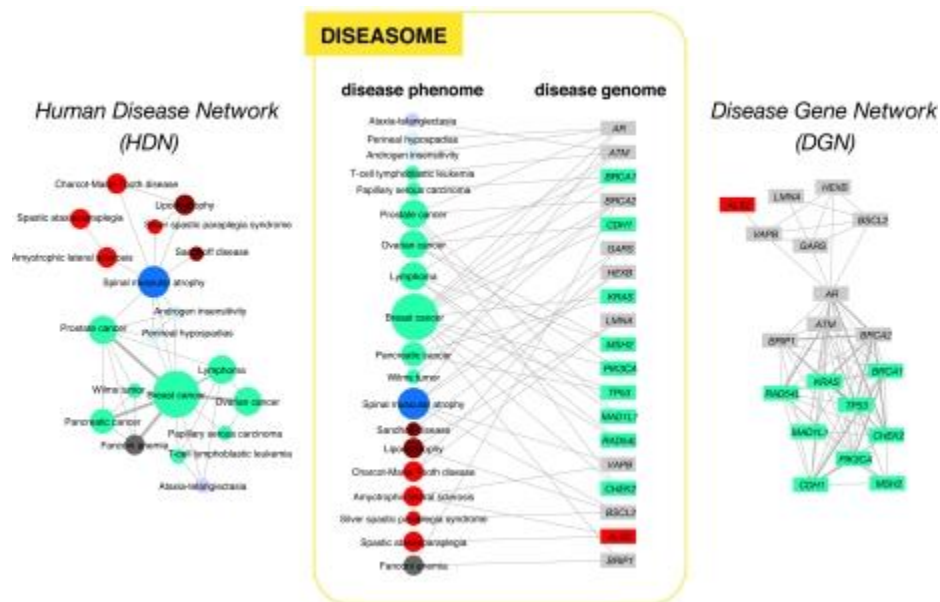

Figure 4: A diagram detailing the process that the Barabasi et al undertook to link diseases by related genetic factors. Notice the number of connecting lines between disease names and relevant

genes as it demonstrates the quantity of significant links that can exist even when using a simplified form of analysis. [12]

In "The orphan disease networks", the researchers extend their analysis beyond just disease-gene interactions to demonstrate the insights that can result when multiple sources are included in the network. The focus on orphan diseases is noteworthy, as orphan diseases are defined in the paper as those with low prevalence "equivalent to approximately 6.5 patients per 10,000 inhabitants" [13] and, as such, tend to have a small volume of prior research to draw from in a network analysis. It is this key limitation that draws the authors of this paper to global network analysis, global here referring to the total available pool of orphan diseases. Further, the lack of prior research led the scientists to also "analyze OD networks on the basis of shared enriched features (biological processes, cellular components, pathways, phenotypes, and literature citations)". From these two types of network building – one based in gene connectivity, the other in feature connectivity – resulted two conclusions with lasting implications. The first was that an assertion made in "the human disease network", that "the majority of disease genes are nonessential", was false for orphan diseases. In fact, the opposite was true, with their networks showing that "genes whose mutations cause orphan diseases … are ubiquitously expressed … and … essential". The second was that the networks created with feature-based connectivity were observed by the authors to be "largely different", revealing in one case "670 related and diverse [orphan disease to orphan disease] relationships that are [not] identified … by shared genes". These conclusions demonstrate the both the potential oversights that can result from a lack of prior data and/or the limits of one's own framework of analysis. In seeking a multifactor design for their networks, the authors innovate in the face of a dearth of data and provide what would become part of the basis for their drug repurposing analysis.

THE FEASIBILITY OF DRUG-DISEASE NETWORK ANALYSIS

Working from the foundation that diseases can be targeted for drugs as significantly distinct groups, one can then look to "Computational drug repositioning through heterogeneous network clustering", a more recent paper by the Jegga Lab, for an example of how the comprehensive, heterogeneous network approach demonstrated in "The orphan disease networks" can supplement drug repurposing. One of the key reasons that the authors cite in the beginning as reason for their writing the paper is becomes of how few other reports "undertook a direct analysis of heterogeneous disease-drug network and … used network clustering-based approaches on heterogeneous networks to identify drug repositioning candidates" [14]. Stated plainly, this paper has as its central focus a disease to drug network linked by a variety of factors and analyzes said network with calculations used to grant weights to the connected nodes. The content of the paper is largely technical, divulging various methods used to cluster the 1041 disease-drug pairs from the KEGG Medicus database. Much of what is detailed is beyond the scope of an information technology paper, as this detail focuses on either the in-depth nuances of their approach to clustering or of unexpected biochemical phenomena. However, the paper as a whole has significance as it demonstrates both how innovative computational methods can illuminate novel disease-drug pairs that are "far from … obvious", a clear achievement in the realm of natural science, and how products of information technology – networks, algorithms, and graphs – can

dominate almost the entirety of a major, published work in biology, an almost unthinkable result in the years before computers took the world by storm.
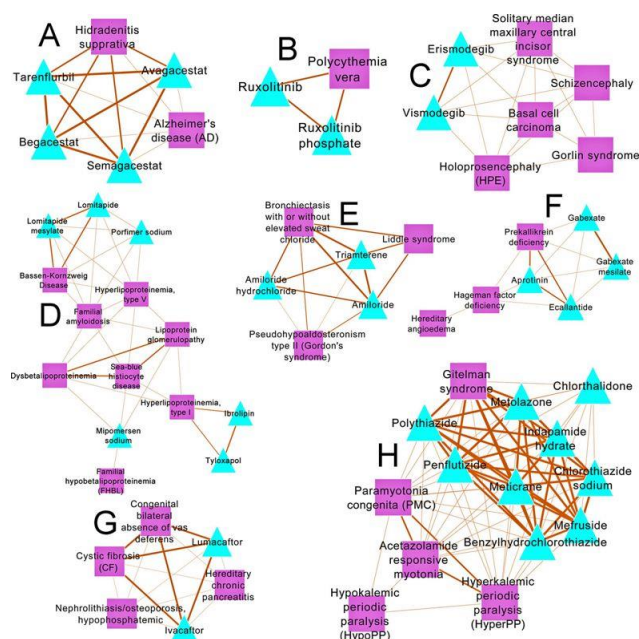

Figure 5: The following figure depicts a few of the clusters that make up the disease-drug network in "Computational drug repositioning through heterogeneous network clustering", with triangles representing drugs and squares representing diseases. As is stated in paper, "the edge width [thickness of the lines connecting the shapes] is proportional to the number of genes/feature categories shared", demonstrating how multiple factors can add levels of complexity to supplement the already present clustering.

CLOSING

The opportunities available in the field of drug development are varied, combining the ingenuity of academia with the goals of industry and the ever-increasing capabilities of computers. Even the reminder that the research discussed above is in its infant stages is undercut when placed in context with the yet-to-come advances in processing power that these networks will intrinsically benefit from in near future and the sheer capacity that the field has for growth as these systems strive for human-like complexity.

In closing this analysis, I feel that there are two key ideas for one to keep in mind after having read the above paper which should be stated expressly. The first is that, despite the typical conventions of a paper that details two distinctive entities, the approaches detailed in this paper exist not as opposition but as complements. Biochemical data about interactions discovered in drug repurposing analysis may be used to assist in novel drug development and visa-versa. The second key idea is that although advances in computer processing, algorithms, and data management systems may seem to naturally foster innovation, the insights and considerations of the researchers that use these tools are the primary drivers of new frontiers in the field. It is through enabling the researchers that information technology has made itself a fixture of the drug development field

and, as the work discussed above proves, this integration has been a benefit with wide-ranging prospects for those working to understand and ultimately improve human health.

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ARTIFICIAL INTELLIGENCE: PART OF OUR PAST, PROMINENT IN THE PRESENT, SHAPING OUR FUTURE

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INTRODUCTION

Artificial Intelligence (AI) is an area of computer information and sciences that is involved with giving advanced machines the power to match, or in some cases even exceed common human intelligence. As of now, there are four known, distributed and different types of artificial intelligence. Each of these four types of artificial intelligence could help us as a community be better at outreach in computation and better at teaching programming and computer knowledge.

FOUR TYPES OF AI

I. Reactive machine AI is the simplest and well known, bases its intelligence off of pre-programmed knowledge and does not learn well.

II. Limited memory AI is the next step up in artificial intelligence, depends on pre-programmed knowledge and learns simple things slowly.

III. The third most intelligent AI is 'Theory of Mind' AI, based off of its namesake Computational Theory of Mind. This AI makes sense of the world around it and the knowledge programmed within itself. It can store memories and ideas, mimic human emotions and interactions, also mimics muscle movements based on programs.

IV. The fourth and most advanced AI technology that we know of is Self-Aware AI, colloquially known as Turing AI. To explain this type of artificial intelligence, some brief history should be known.

Alan Turing was a computer scientist and logician who did great work in the art of theoretical computer science. During World War II, he developed what would become known as the Turing Test. The test is implemented to see a computer or machine's ability to exhibit intelligence equal to or exceeding that of a human being. This type of technology being implemented into AI allows it to do things like read and adapt in human interactions. They could read our emotions, hear inflections in our voices or might even feel something that could be a semblance of emotion

themselves. Some think that using these artificial intelligence types will take years for actual effects to happen, but AI is not only for the future. AI is here all around us already, in some places one wouldn't even expect or know about.

Reactive machine AI, as already stated, cannot use anything past what is programmed into it to make choices and perform actions. This type of AI is good at only one specific thing. An example of this type of machine is IBM's Deep Blue AI. This machine was first programmed and created in 1989 to be excellent at the game of chess. It went on to be so good at the game that it managed to first tie the reigning world champion of chess, Garry Kasparaov, and after a few tweaks and upgrades was eventually able to defeat him. This type of machinery was not only revolutionary in the past but is still making strides and progress in the present.

Alphabet Inc., the parent company of Google, implemented a modern version of this type of machine in 2015 by having a machine play against the best players of the popular online board game *Go*. This is a big step up from playing chess because it creates more probability issues from a computer's standpoint. Alphabet's AlphaGo computer beat two champions of the board game and beat many other world champions in a series of sixty online games it played. The computer won all sixty. This technology is not and should not only be contained to games. It could be used to diagnose injury, since these types of machines perceive the world directly for what it is. It could also be problematic in its use towards anything that isn't a game, as it doesn't do well at seeing how things react to the world around them except for what they are designed to see, sort of a computational tunnel vision.

AI PAST EXPERIENCES

<u>Limited memory AI</u> can learn from past experiences to make better or more informed decisions. This type of AI is most commonly used in self-driving vehicles, so that they can read and react to other drivers and their behavior to make safer decisions for its passengers. They also learn to read the traffic signs and signals around them and send it back to a data center, or cloud, that other self-driving cars could access. Self-driving cars are unfortunately some of the best of what can be done with limited memory machines. Digital personal assistants such as Amazon's Alexa or Google Home use their consumers eating, spending and lifestyle habits to suggest actions and purchases that their owners are likely to make. There has not been a lot of ventures into this type of AI other than cars and assistants, as it isn't s applicable to things like reactive machines are. But limited memory AI could be more valuable if used more liberally.

<u>Reactive machine AI</u> can be used at restaurants to manage orders and seating, or at schools to help teach and manage students. It may sound miniscule or inconsequential in scale, but it would go a long way into making people's lives and jobs easier. There is a downside to this AI type too. Some people may consider it to be a scare tactic or something not to be too worried about, but a machine could learn too much about you. At what point does the assistant stop consulting you about purchases or asking permissions. To make it clear, I am not talking about sentience or self-awareness from limited memory machines because that simply is not possible. Accidental

purchases or actions by a computer is not uncommon or unheard of though. The next type of artificial intelligence machine is steps ahead of limited memory AI. In fact, these las two types are AI that haven't been fully developed or have not even been fully considered.

'Theory of Mind' AI is what many say should be the last step to ensure safe human-machine interaction. This kind of intelligence interprets the world around it and the people in it to an advanced degree. It has the capability and capacity to fully understand a human's emotions or thoughts and can react accordingly to them. The name comes from a psychological theory that only humans, or only things with working minds can fully understand other humans or things with working minds. Artificial intelligence on this level would be monumental in so many areas of study and work. Even though the work is fiction and far from technically possible, a great example of what can be done with this is the android C-3PO from Star Wars. Human and machine interaction with these types of AI could mimic actual human interactions. It could help deal with psychological issues, offer some assistance to those with physical issues (if the AI is housed in moving parts), even be able to communicate with other AI. On the other side of the coin though, there could be worrisome outcomes to making machines this smart. Not to hyperbolize an unlikely machine uprising or anything of that sort, that of course comes in the next step of artificial intelligence, which is sentience. What's worrisome about these 'Theory of Mind' AI is that they could mimic human interaction convincingly enough to fool other humans, which could branch out a litany of different ways, some of them maliciously. None more threatening than the next step in artificial intelligence.

PUSHING THE BOUNDARIES

Self-aware computing systems are defined as having or possessing the characteristics of autonomy, social ability, reactivity and proactivity. If this can be achieved, then it would have to be closely monitored and safeguarded due to the unpredictable and unprecedented nature of the idea. If achieved, what could be done with this type of technology would certainly be helpful. Microsoft CEO Satya Nadella said this about trying to be better at customer outreach and understanding:

"We needed to build deeper empathy for our customers and their unarticulated and unmet needs."

Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for everyone (2017)

With AI that can not only understand but also mimic humans, they could do this much easier and to a greater extent with machines. On a smaller scale, telemarketers are already beginning to phase in phone bank systems to deal with calls and customer service, though that is not really artificial intelligence. One of the main issues I see stemming from this type of intelligence and its implementation is the fact that it's new and fairly unknown technology, and new tech can be scary to people. I do believe that adaptability will still not be hard to obtain, due to this quote from Scott Galloway:

"Consider that the telephone took 75 years to reach 50 million users, whereas the television was in 50 million households within 13 years, the internet in 4, … and Angry Birds in 35 days. In the tech era, the pace is accelerating further: it took Microsoft Office 22 years to reach a billion users, but Gmail only [took] 12, and Facebook 9."

Scott Galloway, The Four: The Hidden DNA of Amazon, Apple, Facebook, and Google (2017)

There is a spectrum that people see technology on, and at the two ends of it are confused and enamored. The people who are enamored will always buy into the new technology and will always adapt. The people confused by it, or synonymously scared, will either wait a while to bridge the gap, or not bridge it at all. It has been proven throughout the history of technological advances and would be the same if this type of artificial intelligence were to be used prominently or if it were to be commercialized. Even though it will probably be well past adaptable and used, there are still some who would be stingy, or even fear using it.

The fear some people might have for this type of machinery is fully understandable though. Elon Musk, co-founder and CEO of Tesla, Inc. and SpaceX, said this:

"I think we should be very careful about artificial intelligence. If I had to guess at what our biggest existential threat is, it's probably that. …I'm increasingly inclined to think that there should be some regulatory oversight, …, just to make sure that we don't do anything very foolish. I mean with artificial intelligence we're summoning the demon."

Elon Musk, Interview at MIT, 2014

As humans, we do have a distinct history of pushing the boundaries and limitations of moral and ethical behavior, and AI is another example to add to that case. Television shows and movies such as *2001: A Space Odyssey* portrayed the negative and somewhat sensationalized view of what could happen if we let AI run rampant and/or out of control. This type of media portrayal of self-aware artificial intelligence only lends to the feeling of uneasiness in advancing our technological bounds. It is understandable that people feel this way because even a tech giant like Elon Musk, who is one of the biggest supporters and enactors of advancement of robots, feels uneasy with it.

CONCLUSION

Artificial intelligence can and has been monumental in the way we view and communicate with robot machinery. From the beginnings of modern AI in 1955, to the 'father of AI' John McCarthy, to the most recent AI we have with machines like IBMs Watson, who excelled at Jeopardy or Alibaba, a language processor at Stanford University there have been many strides. With the way we develop and create new tech now, there's no telling where we will be in a decade in this field of study. In video games and movies, you have personal assistants that do your bidding, or in the aforementioned *2001: A Space Odyssey*, computers like Hal that are the equivalent to co-pilots and assistants. We also must be careful with this. Too much knowledge given to any sentient being could be dangerous and come back to bite us.

There is only one way to find out, and that is to keep making advancements.

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DIGITAL BUSINESS

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WHAT IS THE HISTORY OF THE DIGITAL BUSINESS?

About 10-15 years ago, the idea of digital business was just starting to form, even though IT had been around for years and technology had evolved drastically over a short period of time. The IT department was not seen as essential to business success across companies and industries. And, the roles of CIOs were very limited, especially when it came to be being involved in a company's business strategy. Overall, the value of IT in business was constantly questioned. A 2007 digital IQ report from Diamond Management & Technology Consultants studied the answers from 456 C-level business and technology executives regarding their beliefs and views about IT (p.1). According to that study, 30% of executives said that 11% to 20% of IT projects were not completed as expected. From this same study, "less than 40% of executives agreed that the CIO was involved in strategic planning, and only a third of CEOs supported and saw the importance of technology," (p.1). What appeared to be lacking at the time was business and technology alignment, and the terms digital and IT were interchangeable with each other.
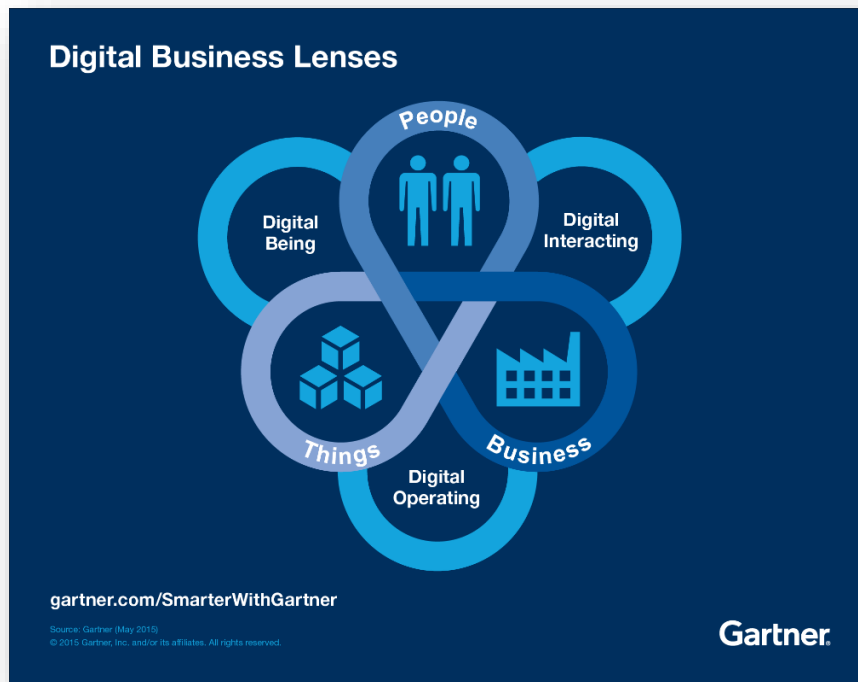
Fast forward to a 2017 digital IQ report from PwC, and the definition of being digital has grown rapidly over the course of 10 years. The study shows that digital now has multiple meanings amongst industries and firms; there is no longer a simple, synonymous meaning with IT. CIOs have become an integral contributor to business and digital strategy, CEOs support IT functions, and companies are starting to merge business and digital operations across all business units. However, the digital IQ of firms still seems to be lacking despite the positivity surrounding digital business. According to the 2017 digital IQ study, 52% of companies rate their digital IQ as strong which is a 15% drop from the last survey (p. 4). This may be because technology is changing faster than ever before, and it is becoming increasingly difficult for firms to keep up. As time continues to move forward, the easier it is for firms to fall further behind in the digital realm.

Prior to digital business, enterprise software was used to create business solutions. When a business unit encountered a problem, that business unit would result to using enterprise software to solve the issue by "providing a software stack", which would then be connected to a database (Crosland). This is how all business applications were "developed, implemented, and managed", which limited innovation and became very inefficient (Crosland). Digital business changed all of that. According to a CIO article, "Why it's important to understand the digital business", there are 3 pillars that make digital business better than traditional ways of doing business and from just simply digitizing a few aspects of business. The 3 pillars that are crucial to digital business are market insight, collaborative leadership, and multiple technology platforms. These pillars are

necessary because digital business is defined by Gartner as "the creation of new business designs by blurring the digital and physical worlds".

WHAT ARE THE COMPONENTS OF DIGITAL BUSINESS AND HOW DOES THE TECHNOLOGY WORK?

Digital Business Lenses

Digital Being · Digital Interacting · Digital Operating

People · Things · Business

gartner.com/SmarterWithGartner

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Gartner.

Digital business adds disruption to the business world. It focuses on combining the physical and digital worlds of people, things, and businesses. Digital business is "about the interaction and negotiations between business and things" (Lopez). A digital business strategy can yield a competitive advantage, greater efficiency, and increased revenue for firms. It is about how companies leverage technology and information to add overall business value and create better customer experiences. New technology advancements such as mobile technologies, cloud computing, Big Data, analytics, machine learning, artificial intelligence, blockchain, and the Internet of Things are the drivers of digital business causing firms to undergo digital transformation ("Digital Business and Transformation."). This is what has caused drastic changes in business models and the innovation of new products and services ("Digital Business and Transformation.").

An example of how digital business could be portrayed in real life is using "intelligence and sensors in aircraft engines to improve passenger jet performance and to reduce the need for aircraft maintenance" (Lopez). Another example of this could be in the retail industry where a company focuses on "integrating the digital and physical aspects of the store and its products" (Lopez). For this example, "a customer could try on a piece of clothing, and the store system would know which item a customer had tried on, which could it then show an image of the customer with the clothing item on and make additional proposals or suggestions of other items to buy in the store while allowing customers to place price limits" (Lopez). The last example given from the Forbes article, "Digital business is everyone's business", is in the financial industry in which a bank "would have the ability to reassess a loan portfolio risk with real-time reporting directly from financed physical assets". According the article, this could occur in a car crash where "systems would notify first

responders of the crash, of the health of the passengers, and of the condition of the car" (Lopez). The systems would also be able to disclose this information to the bank as well, which would "assess the risks associated with the portfolio of the passengers in real time and the bank would then know whether or not to prepare for a loan default" (Lopez).

HOW IS DIGITAL BUSINESS USED IN SOCIETY AND WHAT IS THE IMPACT?

The initial impact in society of digital business and digital transformation was pure disruption of business models, frameworks, innovation, productivity, customer experiences, and more. A 2016 Harvard Business Review (HBR) article surveyed 2,000 C-level executives on the disruption of new digital technologies in various industries. Executives in the media industry anticipated 72% disruption within the next 12 months, which had the highest anticipation rate (Grossman). The telecom industry followed with 64%, and the consumer financial services industry followed that at 61% (Grossman). The retail industry, technology industry, insurance industry, consumer products industry, nonprofit industry, business and professional services industry, and education industry also all anticipated rates of disruption at 50% or above (Grossman). Due to this disruption, companies have been forced to develop a digital transformation plan and a digital strategy for the future.

According to the 2018 State of the Digital Business Transformation report by IDG, 44% of organizations have "started implementing a digital-first approach to business processes, operations, and customer engagement" (p.4). 19% of organizations are integrating technological and operational changes throughout the entire organization (IDG p.4). 18% of organizations are actually in the execution phase of their digital plans and are creating process, operational, and technological changes within departments and business units (IDG p.4). Only 7% of organizations have completed the implementation process of their digital-first approaches and are now currently focused on the maintenance of their approaches (IDG p.4).

While companies are making the digital transition, they are also formulating goals that are expected to be reached from their investments in digital business. 64% of companies are hoping to improve process efficiency by using automation. 58% are hoping to improve customer experiences. 50% want to increase employee productivity. 43% are expecting to drive revenue growth through digital business (IDG p.4). Along with that, 32% of IT decision-makers have already stated that digital business has allowed their businesses to reach revenue growth at an average of 23%.

These investments in digital business are not cheap though. They come with a price, and businesses are expanding their budgets to make the necessary changes. 21% of organizations plan to spend $1 million - $10 million on digital transformation efforts, while 15% plan to spend greater than or equal to $10 million digital transformation efforts within the next 12 months (IDG p.4). The overall average of money to be spent on digital transformation efforts is roughly $14.3 million, which is dependent on firm size. Larger firms with 1,000 or more employees are expected to spend approximately $27.5 million, and smaller firms are expected to spend approximately $1.8 million.

While these costs may appear to be hefty initially, they may allow companies to see a greater return on investment.

Intel is a prime example of a company that has experienced increased business value, increased efficiency, and increased creativity and innovation. In the 2016-2017 Intel IT Annual Performance Report, Intel had a total of 106,000 employees, and 5,775 of those employees were IT employees (p.3). Intel also had a total 23 IT sites which supported 150 Intel sites in 49 countries. According to the report, Intel has actually decreased its IT spending over the last few years. In 2014, Intel spent $13,500 per employee on IT, and in the following year, it spent $13,000 per employee on IT. In 2016, the company was able to reduce spending even more to $12,700 per employee. This report also shares how many devices Intel managed, which was a total of 220,680 devices for 2016-2017. 151,900 of those devices were mobile PCs, while 14,500 were desktops, and 500 were tablets. In addition to that, Intel also managed 53,780 smart phones. Intel also managed to increase its IT server storage as well as its IT servers in total in 2016 with 183 PB of storage and roughly 185,000 servers. This has allowed Intel to have 58 data centers and to use approximately 85% of its servers for design.

Not only has Intel been able to increase its device management, IT storage, and IT servers, it has also increased its ability to develop applications. In the 2016-2017 Intel IT Annual Performance Report, Intel had 1,719 IT owned applications, 696 mobile applications, and 99 SaaS solutions. Overall it had over 2,500 security certified applications. Intel also made adaptions to the number of solution-enabled conference rooms it had. In 2016, it had 2,600 rooms, which saved 50,000 hours of productivity. By mid-2017, Intel had increased its number of solution-enabled conference rooms to 4,000, which saved 180,000 hours of potential productivity. Intel was also able to increase its number of invention filings due to its digital integration strategy. The company had 347 inventors. In 2016-2017, the company saw 143 user interaction app inventions, 34 client system inventions, 29 network app inventions, 26 security inventions, and 23 sensors inventions. From all of the above advancements, Intel has made significant strides as a business, and is finding ways to leverage technology in order to create competitive advantages for itself.

By integrating people, business, and technology, Intel has adapted its digital and business strategy in order to create opportunities for the future. In the 2016-2017 Intel IT Annual Performance Report, Intel was able to discover a new customer focused experience from "connected sales and marketing data and unified business processes", which has ultimately increase sales revenue and customer satisfaction. This allowed Intel to have $500 million in realized revenue. In addition to that, Intel was able to utilize machine learning to decrease its time to market and to improve its product quality. Intel improved its time to market to an estimated 39 weeks. Lastly, Intel found that using predictive analytics across business units to make digital transformations and to generate significant business value. Intel was able to add $656 million in business value from its digital initiatives.

While Intel is a great example of a company that integrated digital initiatives to its entire business strategy, Waze is another company that found different ways to integrate digital initiatives to create a competitive advantage. Waze is a GPS application that can be used on mobile devices to give directions to people while they are driving. However, Waze is not like any other mobile GPS

application or traditional navigation system. Instead, Waze has found ways to capitalize on technology and user generated content to provide users with the best route at the time to get to a desired destination. Ehud Shabtai, Uri Levine, and Amir Shinar wanted Waze to detect current road conditions such as traffic, construction, accidents, and more. To do this, the system needed "to know more than where a car was on the road, where other cars were on the road, and how fast they were moving" (Brynjolfsson p.39). Smart phones made the success of Waze possible. The founders used the "software in the application to turn the smart phones using the application into sensors that could constantly upload location and speed information to the firm's servers" (Brynjolfsson p.39). This exploitation of technology made it possible for Waze to become more accurate as more users used the application and provide real time traffic updates to users. Waze is a true example of a digital business by combining people, business, and technology to add value. Waze is a unique mobile GPS system because it is able to capitalize on the network effect, which allows the application to become more and more useful as the number of users grows. In 2013, Waze had 50 million total users that were able to generate numerous amounts of data and updates for other users on the go (Brynjolfsson p.40). Like Waze, other firms can learn to adapt to digital business by using technology to gain insights from free user-generated content such as blogs, social media, discussion forums, and more to develop a progressive business strategy and add business value.

WHAT ARE THE BARRIERS FOR USE OF DIGITAL BUSINESS?

There are several barriers that often stand in the way of companies completing a digital transformation and fully becoming a digital business. They range from issues with skill and knowledge levels to issues with integrating all business units to issues with budget constraints to issues with involving all C-suite executives to issues with simply keeping up with the fast pace changes in the technological world. According to the IDG 2018 State of Digital Business Transformation report, 39% of companies stated that insufficient budgets are the biggest challenges to being successful in digital business. 36% of companies stated that their major challenge to successful digital business is the lack of staff and the appropriate skills, while 34% attribute their challenges to the "need to replace legacy systems" (IDG p.2). Lastly, 33% of companies attributed their challenges to success in digital business to cultural issues.

Company CEOs play major role in whether or not a digital transformation is feasible for a company. The CEO must carry a positive tone and attitude towards the idea of digital business, technology, and IT. Thus, the CEO paves the way for other C-suite executives to jump in agreeance with making a digital transformation successful. However, many of the other C-suite executives of very important business units tend to not be involved at all in digital transformations or anything regarding digital (PwC: A decade of digital). Only the CIO and CEO lead the way for digital transformation in most companies, which can be troublesome when trying to digitally integrate an entire company and all business units. This serves as a major barrier to success in digital business.

Another important barrier to success may be that technology is always changing and becoming more abundant. This may make it difficult for companies to appropriately develop a digital strategy. The fast pace environment in digital business can cause companies to feel like they are

not making changes fast enough, which can lead to a more complex and confusing digital transformation.

WHAT ARE SOME SUGGESTIONS TO OVERCOME THE BARRIERS FOR USE OF DIGITAL BUSINESS?

Six Key Steps to Build a Successful Digital Business (Gartner)

- STEP 1 — Create the Right Mindset and Shared Understanding
- STEP 2 — Put the Right Leaders in Place
- STEP 3 — Launch a Digital Business Center of Excellence
- STEP 4 — Formulate digital Strategy to Respond to Opportunities and Threats
- STEP 5 — Find, Develop & Acquire Digital Business Skills + Roles
- STEP 6 — Create New Digital Business Capabilities

3 roles (not titles)
- The digital strategist
- The digital marketing leader
- The digital business unit leader

5 elements to address:
- New Digitally Enabled Business Models
- The Product and Service Portfolio
- Information as an Asset
- Technology
- Content, Media and Channels

http://www.gartner.com/newsroom/id/2745517

Digital Business Innovation Leadership

LEADERSHIP TO ESTABLISH CLARITY, CONFIDENCE, AND COMMITMENT TO DELIVERING TRANSFORMATIVE RESULTS

Digital Strategy — Define a **Digital Strategy** to raise awareness, set direction, and drive decision making

Innovation Model — Apply a best practice organizational **Innovation Model** and culture including agile solution development processes to drive digital business value

IT Operating Model — Establish a collaborative and agile **IT Operating Model**, allowing for incubation of new approaches

Platform and Tools — Deliver the right **Platform and Tools** to support enterprise-wide transformation and innovation required by digital business model changes

There are multiple ways to overcome the challenges of creating a successful digital business, some of which are outlined in the images above. However, a significant common factor amongst each way to achieve digital business success starts with leadership. According to an article published on the Insider (a digital marketing website) titled "The Future of Digital Transformation: What

Does it Look Like & How to Plan for It?", senior leadership should focus on the following 3 tasks to have a smooth digital transformation: "clarify who's in charge, address the digital skills shortage, and prepare for big changes".

Clarifying who's in charge means making sure everyone has a clear understanding of his or her roles in the digital transformation. This prevents confusion and allows for better team efficiency. With this responsibility, there is also the task of picking the right leadership for the job at hand and ensuring that the leadership can collaborate with each other. The Insider article suggests that the CDO and CMO should be working alongside the CIO to advance the digital transformation and lead to a successful digital business.

Addressing the digital skills shortage refers to the need for companies to find the appropriate talent to understand emerging technologies. Many companies struggle with this and find that it is one of the main reasons holding them back from a successful digital transformation. Ways to combat this are to identify the weak areas in a company, create discussion forums for employees to share and learn from each other, and offer digital tools, resources, and workshops to employees to decrease the learning curve of this new digital age.

Lastly, preparing for big changes means to prepare for the new emerging and disruptive technologies, prepare to invest in new technologies and skills, and prepare to adapt to changing trends with customer interactions. Artificial intelligence and machine learning are 2 of the most disruptive technologies in the business world right now. Understanding how to leverage these will be crucial for the future success of most businesses. On the other hand, less disruptive technologies, such as blockchain, can give companies great power if they are equipped to use it to their advantage. Lastly, customer interactions will become much more direct in the future. Understanding how to better communicate with customers and monitor customer trends will be essential to the success of companies.

Similarly, the Harvard Business Review article, titled "The Industries That Are Being Disrupted the Most by Digital", shared some insights on how to approach these barriers and disruptions to business. The first piece of advice is to use new employees as catalysts to accelerate the digital transformation. As an example of this, the article suggests that hiring a new Chief Digital Officer (CDO) is first on the to-do list. Bringing in someone new challenges tradition. However, the position must be well defined and have support before the right person can be found to fill it. The CDO focuses on integrating digital into the core of businesses. Other possible catalyst positions that are becoming increasingly necessary and popular are Chief Growth Officers (CGO) and Chief Customer Officers (CCO) which are focused on "strategy, corporate development, investment, and operations" (Grossman).

Secondly, the HBR article suggests that the culture of companies may need to change to see digital business success. For example, companies that are driven by decisions made by experienced leaders may need to make a switch to decision that are made with the support of data. Data-based decisions are becoming increasingly important in allowing companies to predict upcoming trends and to be proactive about them. No longer do senior leaders with years of experience solely influence major decisions in firms. Data has now become the key to making smart decisions in collaboration with the critical analysis provided by leaders in a firm.

Lastly, the HBR article states that commitment is crucial to being successful. An entire business needs to commit to becoming more digitally oriented and fully make a digital transformation from top to bottom. Only committing halfway will not allow firms to combat the disruptive technologies and use them to their advantage.

WHAT IS THE FUTURE OF DIGITAL BUSINESS AND ITS IMPACT?

The future of digital business is bright. More and more opportunities will become readily available due to technological advancements. Currently 95% of start-up companies already have plans for digital business, and 87% of traditional companies (companies that are 50 years or older) have digital business plans (Columbus). There is an increasing opportunity for companies to increase revenue by implementing a digital-first approach. For start-ups, an increase in revenue by 34% is possible and across all firms an increase of 23% is possible. The top technologies currently being implemented into digital business plans are Big Data and analytics, mobile technologies, public cloud, application programming interfaces, and embeddable technologies. In the near future, technologies such as the Internet of Things, artificial intelligence, and machine learning will be the drivers of digital business.

The Forbes article titled "6 Predictions About the Future of Digital Transformation" states that "IDC expects the percentage of enterprises creating advanced digital transformation initiatives will more than double by 2020 from today's 22% to almost 50%," (Press). The IDC also foresees a new digital transformation economy in which there will be a rise in "algorithmic businesses" and "programmable economies" driven by Big Data analytics, the Internet of Things, and artificial intelligence (Press). Additionally, the article makes 6 predictions about the future of digital transformation.

The first prediction is that digital transformation will be a strategic decision for CEOs. Both B2B industries and B2C industries will continue to "bridge the digital gap" to maintain competitiveness and uphold changing customer expectations (Press). The second prediction is that digital business initiatives will continue to be combined into one vision and strategy for an entire enterprise. The third prediction is that digital business will continue to mandate new skills, knowledge bases, and IT investments. An increase in budget and competition for talented personnel is to still be expected. The fourth prediction is that Big Data analytics will continue to be a driver of digital transformation and will save successful firms time and money. The fifth prediction is that the Internet of Things will allow for increased connection and expansion of digital business globally than ever before. By 2020, there will be 30 billion IoT endpoints, and by 2025, there will be 80 billion IoT endpoints (IDG p. 2) The sixth and last prediction is that artificial intelligence will create new revenue streams, increased efficiency, and reduce costs for firms through automation.

The overall expectation of digital business is that business, people, technology, and things will work together to create new opportunities. This will lead to the automatic collaboration of digitized assets and applications to yield new capabilities, business strategies, and competitive advantages. "In the past, people were a proxy for things in business, but in the future, things will be an agent for themselves and will thus shift the way a business views its opportunities," (Lopez).

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CYBERSECURITY: THE DOMESTIC SOLUTION TO INTERNATIONAL CONFLICT

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INTRODUCTION

I am generally interested in international conflict. More specifically, I am interested in the conflict or potential conflict between technologically advanced states. My questions that have come from this are one, how exactly are states weaponizing their cyber technological capabilities, and two, what, if anything, constitutes an act of war in cyberspace. Cyberspace and the "Age of Information" it has brought about have shifted the warring field from boots on the ground to data exchange and tampering. I have always been fascinated by the idea of cyberspace. From the time I was a child through my collegiate studies, I have found no end to the possibilities the computer and its programs had to offer. In my tinkering, I tapped into the vast universe of cyber technology. In my education, I have discovered the architecture of cyberspace.

As a computer scientist I have asked and been challenged to answer many questions concerning the relationship between cybersecurity and national security. These questions have included, but are not limited to: what exactly is cyberspace? If cyberspace a new frontier of war, what does this frontier look like? Is cyberspace a national security concern? The problem here is that cyberspace reaches across many disciplines. Thus, a definition for a political scientist is different for a computer scientist like me. So then, what is it? Countries like India that are still developing see cyberspace as a lawless space (Pathak 2017). Smaller countries like Scotland see it as a challenge to "safety and security" (Raab 2017) Technologically advanced countries like the United States and China see it as a tool that can be used to carry out national objectives (Harold *et al* 2016). Plainly explained by Deibert and Rohozinski (2010) cyber space is a human made material and virtual domain made up of public and private networks.

CYBERSECURITY NATIONAL SECURITY ISSUE

So why is cybersecurity a national security issue? Let's look and the relationship between the private sector and cyber threats. Attacks against Equifax, Target and US banks have had significant effects on the public. Suspected perpetrators have created sense of distrust and fear of cyber technologies and interconnectivity. This fear and distrust can be rightly ignored due to the fact that the flow of information through technology is so integrated within state infrastructure that disconnecting will likely, do more harm to state infrastructure than provide an advantage over the adversary. More importantly then, is the result of this data jacking. What has the adversary gathered by attacking banks, healthcare information, and consumer data? A social profile. An enemy can exploit the private sector to perform reconnaissance on the society it wishes to attack. These put forth the indirect method of challenging an enemy-through the private sector. As

mentioned before interconnectivity between technologies brings the public sector into the light. Attacks directed to military operations, hospitals, and banks are common. We see countries ranging from the US and China to Scotland and Ukraine facing cyber-attacks directed towards their infrastructure. Depending on the magnitude of the attack, the functionality of all types of states – large, small, developing, and advanced are equally likely to suffer.

The point is, cybersecurity is a national security issue. So, how do we combat it? First, we have to understand what exactly cyberspace is as we have done previously. Next, we must evaluate how state actors and nonstate actors behave on this plane, both directly and indirectly. Lastly, we must frame these behaviors in a way that can enable the US to counter or deter them. Framing behaviors has been the most difficult part of addressing cyber security. This is particularly evident in the evaluation of non-state actors that, with the level playing field that the internet provides, have the same capabilities as a state actor. That is, depending on their knowledge of vulnerabilities. Eriksson and Giacomello (2006) point out that this problem would "be seen as a marker of continuity rather than dramatic change" by realists, another source of interdependence by liberals, and a tedious identity crisis by constructivists. He concludes that IR theories are simply too rigid to allow for adaptation. Furthermore, that we should take a pragmatic approach to generating an IR theory related to the information age. Smith and Ingram   (2017), who studied Australian cybersecurity found that Australia has relied heavily on underinvested civilian organizations as well as military and intelligence organizations to handle the domestic cyber issues and policy. They show that international collaboration has helped form international cybersecurity policy and response capabilities. Furthermore, they argue that civilian reliance on the military and intelligence organizations – whose focus is on international cybersecurity, may lead to confusion of targets on the domestic level and lessen the credibility of domestic response capabilities. Ultimately, their approach to collaboration on solutions to cybersecurity between international and domestic actors is a skeptical one- and rightfully so.

The focus on the civilian side of cybersecurity is justified because more problems in policy arise here than on the international level- due to international cooperation on policy and standards. What makes this dynamic interested is the exploitation of domestic vulnerabilities by international actor.

This exploitation of civilian response capabilities has created a frenzy around the unknown or predicted effects of cyber war. Moreover, this focus on solving domestic cybersecurity issues through international collaboration is misguided because it has ignored the way states have exploited domestic cybersecurity. So, while pragmatic approach seems ideal I believe that the approach may lead to reliance on international frameworks. Klimburg (2014) says that cyber conflict is tied directly to internet governance – the management of world's internet resources. By defining this relationship, he shows that interconnectivity between international and domestic cyber conflict is rooted in governance and policy – a major problem today. This definition is accurate but creates, like other studies of the relationship between international and domestic conflict, a dangerous path.

With all this, I see that people have tried to address cyber conflict on both the domestic and international level. Many have used international collaboration as a foundation and the changing landscape as the foundation of their solutions. Still, few or no scholars have not first stopped- and rid themselves of the transient cyberspace excuse- to look and consider how states *have used domestic exploits to wage a silent war against their adversary*. What are states doing now? Many

countries are pushing to build STEM education to keep up the changing landscape of cyber warfare and compete with other countries who are trying to do the same. Just as the United States has put money into weapons research and development, they have done the same in building centers of excellence for cyber education.

CONCLUSION

While this competition is interesting, I believe exploring how/if domestic cyber conflict has influenced the STEM push and if a solution to domestic cybercrime can be found here rather than pulling from international policy for inspiration. Furthermore, while the world is focused on the nature on international cyber conflict I believe addressing gaps in domestic cybersecurity issues will contribute to finding the answer to combating this silent war. Thus, my hypothesis is as follows: If states address the gaps in their domestic cybersecurity standards, policy, and law, then they are more likely to defend against international cyber-attacks.

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USING THE RASPBERRY PI AS A DESKTOP COMPUTER

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INTRODUCTION

This research paper relates to the Raspberry Pi 3 versus the Raspberry Pi Zero and the various differences in the propriety features. The Pi 3 is designed to meet the requirements of a self-contained hand-held computer with all of the bells and whistles; whereas, the Pi Zero is not only designed smaller in size but with lesser capabilities. The Pi Zero would not be classified as being self-contained, however, is adaptable to some of the missing components.

HARDWARE

RASPBERRY PI 3

Figure 1

The Raspberry Pi3B+ in Figure 1 is the third generation of Pi. Unlike the raspberry Pi 2 the Raspberry Pi 3B+ supports Wi-Fi and Bluetooth without the need of separate adapters, and also includes 1 GB of RAM with a 1.2 GHz 64-bit quad core processor and four USB ports While most USB devices work, some such as external hard drives or HD webcams require more power than the Pi can supply so be sure to consider buying a powered USB Hub. A highly recommended port hub is the Adafruit's seven-port hub (www.adafruit.com/products/961). If we would like to stay wired the Pi 3 comes with an Ethernet port but if you don't buy the starter kit, you can use an Ethernet

cord and a HDMI port that can be used for a monitor. There is a video/audio port as well as a port to connect the official Raspberry Pi camera. With the 40 GPIO (General Purpose Input/Output) there are pins on the side which are used for hardware projects such as push buttons, light LEDs, and connect sensors. The microSD card slides easily into a port on the end of the Pi but make sure the Pi is off before removing it. However, the Pi is designed without a built-in power switch, but it can be powered down through Raspbian.

RASPBERRY PI – ZERO
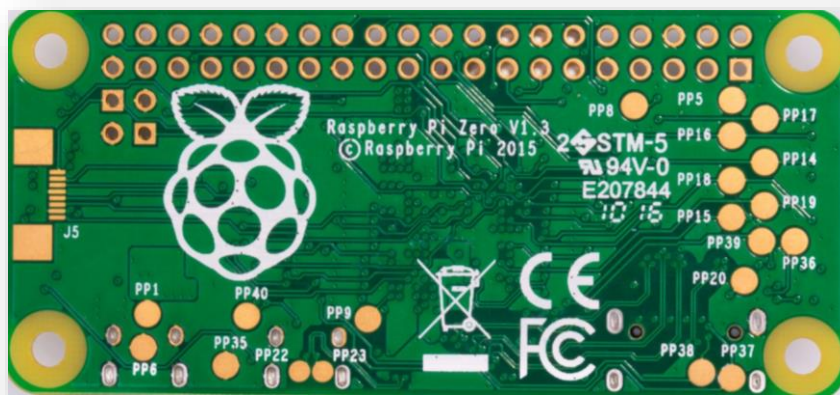
Figure 2

The Raspberry Pi Zero shown in Figure 2 is smaller and less powerful than the Pi 3. Unlike the 3 the Zero has been designed to be smaller in size for where size matters, therefore do not support all the features of the bigger model like Bluetooth or WI-FI and of course cheaper. The Zero does not support a regular sized USB port, but is adaptable to a micro-USB to allow connection to normal USB devices. The adapter kits for the Raspberry Pi Zero are currently being sold on many websites.

OPERATING SYSYTEM

RASPBIAN

Raspbian is specifically designed to work with the Pi technology. In fact, since 2015 the Raspbian has been deemed the primary operating system for the family of the Raspberry Pi single-board computers, thanks to the creators, Mike Thompson and Peter Green.

APPLICATIONS

OFFICE SUITE

Libre Office is the word processor used in the Raspberry Pi. And though Libre Office fits into a small device it is more than just a word processor offering document formatting as an intricate part of the software. Not to mention the other five applications, Base, Calc, Draw, Impress, and Writer that are associated with Libre Office.

Figure 3

Libre Office as shown in Figure 3 is a front-end database manager that can be used to create forms and reports from a variety of databases.

Libre Office is the word processor used in the Raspberry Pi. Although Libre Office fits into a small device it is more than just a word processor offering document formatting as an intricate part of the software. Not to mention the other five applications, Base, Calc, Draw, Impress, and Writer that are associated with Libre Office. Don't be fooled, the front-end database manager can be used to create forms and reports from a variety of databases.

Libre Office Calc is the spreadsheet software and a popular choice for academic, home, and business users looking for the spreadsheet experience but is a little less expensive. Of course, there are pros and cons, as with anything. The downside to Libre Office Calc is that the team experience cannot be captured with real-life simultaneous edits. On the other hand, the pros of the Calc software are the compatibility with most common file formats, and the ability to read and write to Microsoft Excel files.

Libre Office Draw feature enables eye-popping graphic documents. Draw offers a max page size of 300cm by 300cm and can handle anything from a quick sketch to a more difficult type technical plan producing drawings, brochures, posters and even the latest "3D" art.

Libre Office Impress is very versatile when it comes to creating slides thanks to different editing and viewing modes. The Impress offers features controlled by five modes that are responsible for these various functions, Normal (general editing), Outline (organizing and outlining your text content), Notes (organizing and editing the notes attached to a slide), Handout (producing paper-based material), and Slide Sorter (thumbnail sheet that lets you quickly order and locate your slides).

Libre Office Writer is the last feature to be highlighted under Libre Office and is a modern fully-featured word processing and desktop publishing tool. Again, this modern offer full featured software that gives the capability to write something very quickly or the option of writing a full book with contents, diagrams, and etc.

WEB BROWSING

Chromium as shown in Figure 4 is the chosen default browser for the Raspbian Pi foundation. And the Chromium speed was boosted to shockingly incredible speeds when Raspbian was updated in 2016. Chromium is an open-source web browser project started by Google. One of the major aims of the project is for Chromium to be tabbed a window manager, or a shell for the web as opposed to be a traditional browser application.
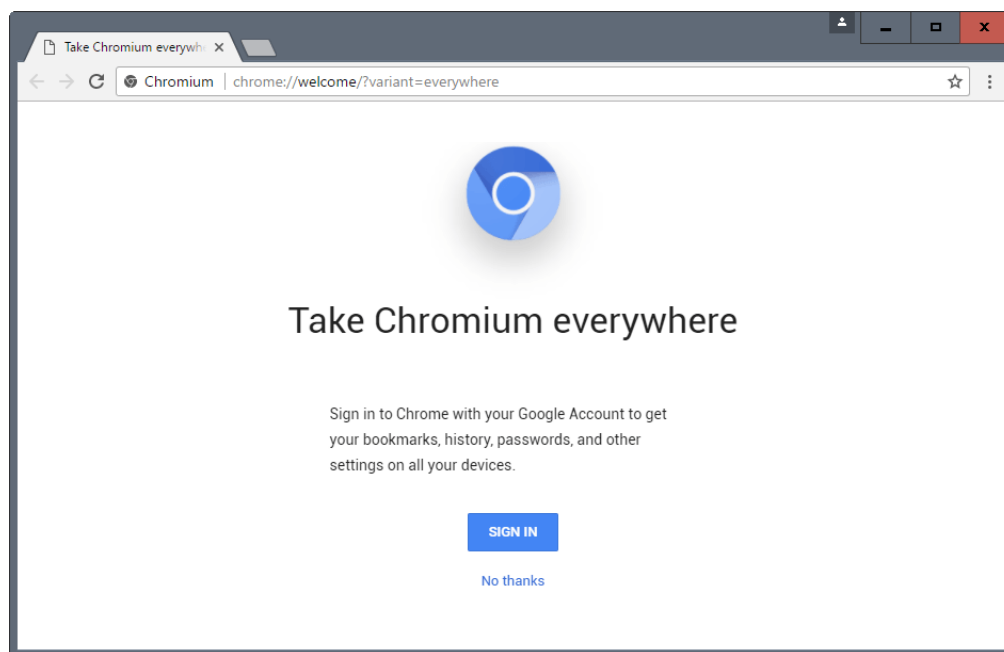
Figure 4

CODING/PROGRAMMING

There are two main programming languages supplied with the Pi and they are Scratch and Python.

SCRATCH

Scratch is a visual programming language that brings a rich learning environment for citizens of all ages. Scratch as shown in Figure 5 is great for learning the basics of programming. It allows you to create interactive, media-based projects, featuring animated stories, book reports, games, simulations, and just about and project to exist. Scratch's visual programming environment enables you to explore areas of knowledge that would otherwise be inaccessible. It also provides multi-media tools that can be used to create different applications. Scratch also promotes problem-solving skills not for just programming but for life. The barriers to entry are very low, while the ceiling is limited only by your own creativity and imagination. Scratch is mainly targeted for children, but everybody can use it. Scratch encourages the sharing, reuse, and combination of code. The slogan is Imagine, Program, and Share. The operating systems used for Scratch are Windows, MacOS, and Linux.

Figure 5

PYTHON

Python as shown in Figure 6 is an interpreted high-level programming language for general purpose programming. The first thing to know about python is that unlike Scratch it is entirely text-based. This doesn't mean it can't create graphics, but that the program code is text rather than drag-and-drop blocks. Created by Guido Van Rossum was first released in 1991. Python features a dynamic type system and automatic memory management. Python also supports multiple programming paradigms, which include object-oriented, imperative, functional and procedural, and also has a comprehensive standard library.

Figure 6

CONCLUSION

In conclusion The Raspberry Pi can be bought as a cheap desktop but used as a high-class standard desktop, which is The Raspberry Pi 3 and Raspberry Pi Zero. However, the primary operating system used for the Pi is Raspbian. Instead of Microsoft Office Libre Office is the primary focus for the Pi. Chromium is the most recommended Web Browsing source for the Pi with its high-speed. Not to forget to mention Coding is also a big part of the desktop which is also featured on the Pi whether it's Scratch or Python.

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UP SQUARED BOARD (UP²) CONFIGURATION

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INTRODUCTION

My project is using Intel's UP Squared Grove IoT Development Kit that provides guidelines how UP Squared board interacts with sensors. The purpose of this project is to show how UP Squared board and Grove Pi board configured and interacts with sensors. The kit comes with various materials that are needed for the Kit to function properly. These materials include UP Squared board, Grove Pi Board, Micro USB Cable, UP Squared Board Power Cable, Ethernet cable, and various sensor devices.

I completed this project with the assistance of Dr. Jesse Bemley (Bowie State University professor and JEF coordinator). It took me more than 6 weeks to complete. However, because of budget and time restraints, this project is limited to the configuration of UP Squared board using Intel's UP Squared Grove IoT Development Kit. I have used online articles throughout the research. The project will help as an introductory point for those who are interested to do further research.

IOT DEVELOPMENT KIT MATERIALS

The project is to build UP Squared IoT Development Kit that will make it easier to use for users. **IoT (Internet of Things)** is the network of physical objects or devices embedded with electronics, software, sensors, and network connectivity that allows these objects to collect and exchange data. This kit includes various materials that are needed for the Kit to function properly. As it is shown in Figure 1 below, the kit comprises UP Squared board, Grove Pi Board, Micro USB Cable, UP Squared Board Power Cable, Ethernet cable and internet access, and host computer connected to the Internet.
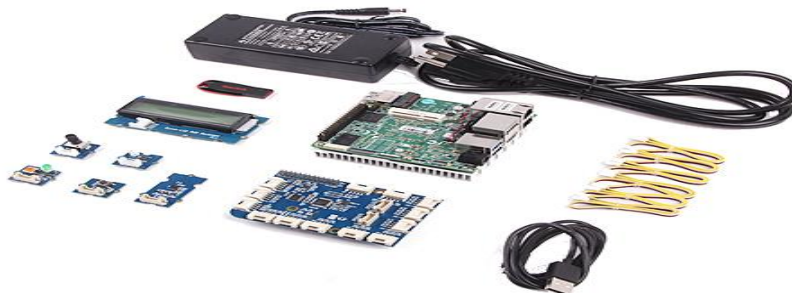

Figure 1: *UP Squared IoT Grove Development Kit materials*

"While the UP Squared board (located below in Figure 2) is one of the most powerful maker boards ever in Intel, Grove Pi Board (a rectangular shape with many ports located at the top of UP squared board in Figure 2) has no need for soldering or breadboards: just plug in the Grove sensors and start programming directly" (https://create.arduino.cc/getting-started/up2). Grove is an easy to use collection of more than 100 inexpensive plug-and-play modules that sense and control the physical world. The UP Squared IoT Grove Development Kit offers pre-installed Ubuntu 16.04 and Arduino Create, which includes over 400 sensor libraries.

By connecting Grove Sensors to Raspberry Pi, it empowers the Pi in the physical world. With hundreds of sensors to choose from Grove families, the possibilities for interaction are endless.

BUILDING UP SQUARED (UP²) BOARD

UP Squared board (UP²) is the world's fastest x86 maker board based on latest Intel platforms Apollo Lake. UP is the bridge between your hobby and your future business. UP² board is the most powerful maker board ever in Intel. Features of the UP² Board are multiple USB 3.0 ports, double Gigabit Ethernet, and HDMI making it ideal for solutions in the Internet of Things (IoT). "The vector units' image processing unit and precision timing management synchronize the CPU with the I/O, making graphic processing effortless, and with a 40 Pin I/O connector, expansion c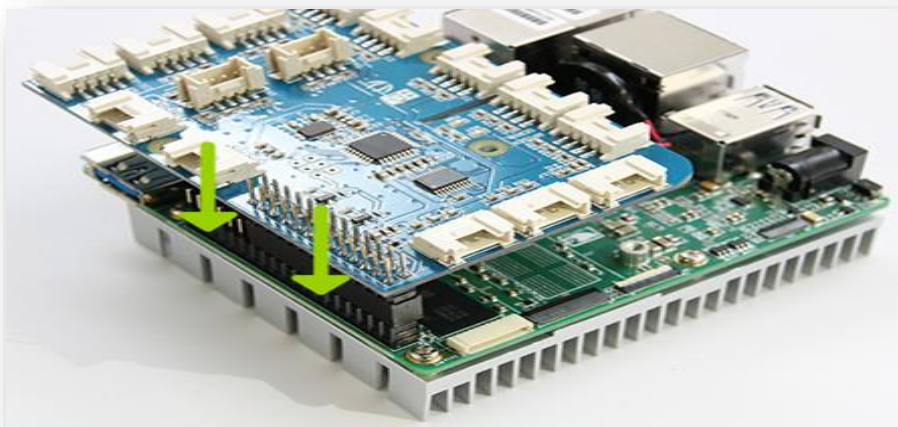apabilities of the UP² go further with more possibilities" (https://www.mouser.com/new/aaeon-up/aaeon-up2-squared-boards/).

Figure 2: *Up Squared board with Grove Pi+ board*   In order to build the UP Squared IoT Development Kit, there are three major steps. Each step will have various sub-steps and instructions. The major steps to build UP Squared IoT Development Kit are: to make Board connections, connect to Arduino Create, and run the blink application. All the steps, definitions, and instructions to configure each of the above three steps are discussed below.

MAKE BOARD CONNECTIONS

To make the board connection you need Grove Pi+ board, micro UP Squared board, and Ethernet for the system that connects the board to an Internet connection. Figure 3 below shows a diagram of Arduino Create with UP Squared IoT Grove Development Kit. The board connection looks like the following after completing all connections including Arduino Create.
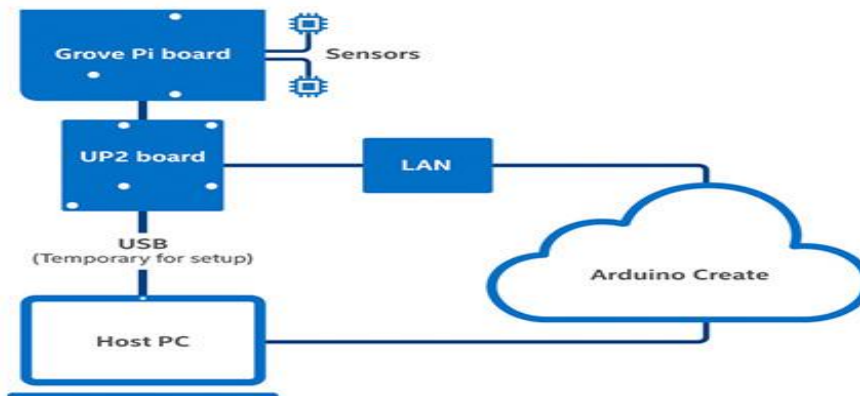

Figure 3: *A diagram for Arduino Create with UP Squared Board.* Making board connections on the UP squared board follows three major guidelines such as the following. First, install the Grove Pi+ board. To install the Grove Pi board, locate the small white arrow on the UP² board. Look for small white arrow (triangle shaped) at the tip of the UP² board right next to the gold screw. Then, locate the connector 1 on the UP² board and connector pins on the Grove Pi+ board. Once you locate both the connector1 and pin on the Grove Pi+ board, line up pin 1 on Grove Pi+ board and connector 1 on UP² board. Then, carefully press down the Grove Pi+ board to the UP² board. Make sure all the pins on the Grove Pi+ board slide neatly into the connectors on the UP² board. Do not bend any of the pins on the Grove Pi+ board which will cause damage and the system will not function properly.

Second, plug the Micro USB Cable into the UP² board. Identify or locate the Micro USB 3.0 port on the UP² board. Once you identify the port, plug the Micro USB cable in to the UP2 board. Since there is dual Micro USB 3.0 port on the UP² board, plug the Micro USB cable into the left side of the USB port. Make sure you plugged the Micro USB 3.0 cable properly to correct port on the UP² board. Then, once you plug the Micro USB cable to the UP² board, connect the Micro USB cable to your host computer so that it can transfer any data or information to the host computer.

Connect the Ethernet Cable to the UP squared Board and to your Router. Identify the Ethernet port on the UP squared Board and plug the Ethernet cable into the UP squared Board. Ethernet port is a **port** on a computer device that allows you to insert an Ethernet connector. These ports are highly important in a local area network (LAN) setup.

Once you insert the Ethernet cable in to the UP squared Board, plug the other end of the cable into your router. The router is a device that provides network signal to your UP squared board. However, your host device does not have to be in the same network with the UP² board. It can be connected to another network. In this project the researcher has used the same network for the host

computer and UP² board provided by JEF Inc. computer laboratory. Therefore, the Ethernet cable was coming out of the router/switch, and the switch is connected to the server which receives all data from the network provider.

Last, Power up your board. After completing all other connections, the next step is to plug in your UP² board to the power supply and plug the power supply into an electrical outlet. If you completed the connection correctly, you will see the orange LED light blinking at the top of your Ethernet port and power LED light on the left side of your power supply jack. While the orange LED light implies your UP² board Ethernet connection, the green power LED light shows the UP² is ultimately connected to the power supply. In addition, you can either press the small white button next to the blue LED or simply unplug the power cable. At this point your connection is complete.

CONNECT TO ARDUINO CREATE

Arduino Create is an integrated online platform that enables Makers to write code, access content, configure boards, and share projects. "Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world" (https://www.arduino.cc/en/Main/Create). Despite your skill level, Arduino Create features brief guided flows to help easily configure online services like the Web Editor and Cloud.

The Arduino Web Editor allows you to write code and upload sketches to any Arduino board Intel based platforms from your web browser after installing a simple plug-in. Since it is hosted online, it will always be up-to-date with the latest features and will always support any new board of the Arduino system. The Arduino Web Editor is supported on Windows, Linux, Mac and Chrome OS. In order to configure Arduino, Create, we will follow the following three steps.

CONFIGURE THE UP SQUARED BOARD

On your host computer, go to https://create.arduino.cc/getting-started/up2. Then click Login. When you click Login, it will ask you to sign in or sign up for Arduino Create. If you do not have an account, follow the onscreen instruction to sign up. You have to activate your account and log into the site using your new password and user name.

You will be asked to install Arduino plugin if this is your first time using Arduino Create. To install Arduino plugin, follow the onscreen instruction. If you get an error message saying *we are not able to detect the installed plug in*, locate the Arduino plugin icon and Right click on the icon ∞ , then select Open plugin. Therefore, these steps will help to install the Arduino plugin. If you are creating a new account, make sure you can remember your password and username. The password is case sensitive, it needs, both numbers and letters. It will also ask for your first and last

name. Once you logged in with your user name and password, you will be asked to upload the Arduino Connector to your UP² board. Then click Upload**.**

VERIFY YOUR BOARD'S CONNECTION

After you complete the plugin, you will be asked to double check if your board is properly connected so the connector can be installed. As it is indicated on Figure 4 below, make sure all connections are properly connected including power supply and network.

Figure 4: *UP Squared board connection*

After installing the plugin, verify if it is still powered on and click **Next.**

UPLOAD THE ARDUINO CONNECTOR TO YOUR BOARD

Once you verified your board is properly connected, the next step to upload the Arduino connector to UP Squared Board. You will be asked to upload the Arduino Connector to your UP Squared board. Then Click Upload**.** The process will take about 3 minutes in order for your board to connect to Arduino Create.

Make sure to wait at least 3 minutes for the connection process, and you will see the message saying Congratulations! You are all set. If your board cannot connect within 3 minutes, check your connections such as Ethernet, power, micro USB, and others and try the same steps again and again.

TROUBLESHOOTING

If the above steps do not work to connect your board to Arduino Create, apply the following troubleshooting guidelines:
- ✓ **Restar**t your UP Squared board

✓ Minimize all windows to see if you have missed a pop-up message "**Do you want to install a driver**" or other forms of pop-up messages.
✓ Make a **hard refresh** on the Arduino web pages.
✓ Refer to a **troubleshooting guide** on Arduino pages or YouTube.

NAME YOUR BOARD

Once your board is connected with Arduino Create, give your board a name, such as UP1, UP2, or UP3 as shown below (see figure 5).
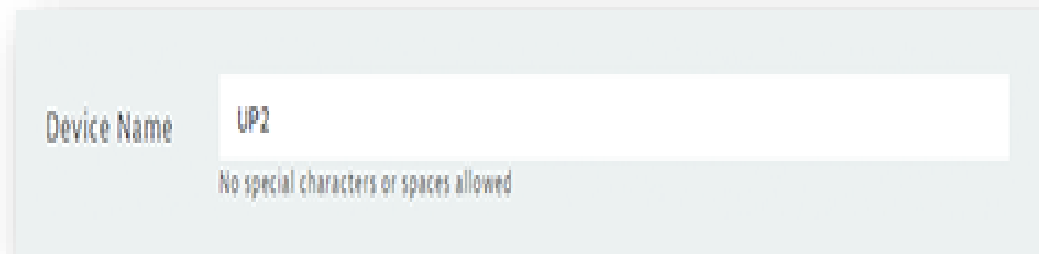

Figure 5: Creating a Device Name

At this point you are ready to do your very first program using Arduino Create software. As your board is connected with Arduino Create software using internet, you can start project development on it.

RUN THE BLINK APPLICATION

You will run a blink application using your UP Squared board and Arduino Create application. You will run a sample Blink Application by connecting LED into your board. You will also upload the sketch using Arduino Create and write software code that runs the Blink Application.

CONNECT AN LED

Before you connect an LED light, get the Grove Green LED and locate **D4** on the Grove pi board which is located on the right behind Ethernet port circled in Green. Use a Grove Cable to connect the LED to **D4**. The LED have two pins, a longer and shorter. While the longer pin is positive charge, the shorter pin is carrying a negative charge. Hence, when you plug in the LED, make sure you connect the longer wire to the positive terminal. You can leave the board ON when plugging in the LED.

OPEN THE SAMPLE BLINK APPLICATION

In order to do the sample Blink application, open the Arduino Web Editor page from Arduino Create page and open the Blink Examples. Once you open the Arduino Web Editor, go to **Examples > FROM LIBRARIES > UP Squared GROVE IOT DEV KIT > Blink.**

UPLOAD YOUR BLINK APPLICATION USING ARDUINO CREATE

Open Arduino Create page to upload the blink application using Arduino Create. Then, from the drop-down menu, choose your board **via Cloud** as it is indicated on figure 6 below.
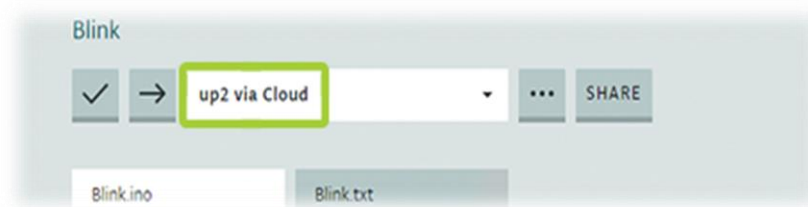

Figure 6: *Upload your blink application Using Arduino Create*

Then click **Upload** (the right arrow sign on figure 6) to upload and run the blink application. When you click Upload button, you are uploading and running the blink application on your target device. However, if you want to compile your sketch without uploading and running it, Click the **Verify** button to the left side of the **Upload** button as it is shown on figure 6 above.

YOUR BLINK APPLICATION IS RUNNING

At this moment it is time to confirm that your sketch is running. In order to confirm this process, you will get a process ID (PID) at the bottom of the screen as indicated below.
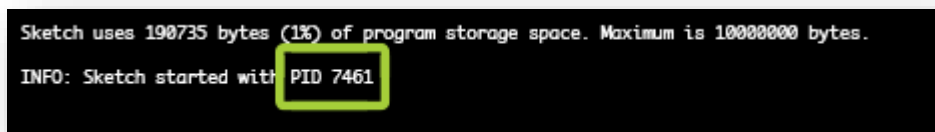
Now you should see the LED is flashing. The LED will flash slowly, and it is a little bright so if you do not see it go a little closer to it and you will see the LED flashing slowly.

If your LED is not flashing, follow the next guidelines or steps to troubleshoot the LED:

➢ Check if you have connected the LED to the right connector on your Grove Pi board (**D4**)
➢ Check if your board is still connected.
➢ Check if the LED is plugged correctly
➢ Make sure you selected **via cloud** board

➢ Re-try it again.

CONCLUSION

This project mainly shows how the UP Squared board and Grove pi board can be configured to allow multiple IoT sensors connected to the board in such a way that the sensors collect and exchange data with the board. The board is connected with a host computer and an online software (Arduino Create) with a local area network to write, access, and share online resources. The project lists all materials needed to configure the UP Squared board, and it lists a step by step process how to complete the configuration safely.

In general, the major steps to verify UP Squared board connection are connecting UP Squared board to the PC, Ethernet, power supply, and check the power LED and Ethernet port LED is ON. The project also includes how to troubleshoot the UP squared board connection. Finally, it shows to run a sample blink application using Arduino Create software code. In order to confirm this process, you will get a process ID (PID) at the bottom of the screen.

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TECHNOLOGY IN ATHLETICS

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INTRODUCTION

When technology was first introduced to the world of athletics, it was simple yet revolutionary. Most of the original technology was video based and geared towards the fan's experience. Since then, the world of sports has come a very long way. For example, In-Helmet Headsets for football players, introduced in 1994, have improved their ability to communicate with coaches as well as other players[1]. A fan favorite, instant replay, has given referees more of an ability to call games fairly and concussion helmets, introduced in 2002, have made players safer.[2] The advancements in technology for athletes has provided them many opportunities, specifically in their mechanics, performance improvement and their athletic care.

MECHANICS

For most athletes one of the biggest things they are always paying attention to is how they can run faster, jump higher and boost their endurance. For some, this means waking up before the sun comes up and putting in that extra hour or staying after practice to work with the coaches to gain that extra perspective. With the help of various forms of technology, players can gage how they are performing in practice and during games.

In volleyball most of the game requires players to jump, especially those in the front row. The higher they can get into the air the higher their probability of a block or a successful kill. The science behind the height of the jump is directly related to the momentum and strength of the player. While the coaches could run after each player with a tape measure to see how high their jump was, it is very inefficient and inaccurate. Instead players wear Jump Vert (Figure 1) which

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[1]http://www.complex.com/pop-culture/2013/06/the-20-biggest-tech-advancements-in-sports-history/lighter-flatter-track-shoes

[2]http://www.complex.com/pop-culture/2013/06/the-20-biggest-tech-advancements-in-sports-history/lighter-flatter-track-shoes

is a small device that can be clipped to the body that records the height of the players' jump instantaneously.

Figure 1

With regards to speed, many different sports uses Radar Guns (Figure 2 & 3). This is particularly key in baseball and softball. During the movie The Rookie, a movie about a 35-year-old high school teacher who becomes a pitcher for major league baseball, Dennis Quaid (who portrays Jim Morris) throws pitches past a speed display board for cars to see how fast his pitch is. In real life this cannot technically happen unless the sensors are adjusted to pick up something the size of a baseball; however, the concept of radar guns are used for pitchers. The pitcher's ability to strike out the person at bat helps to determine the course of the game and the knowledge of how fast the ball is going improves that probability.

Figure 2   **Figure 3**

PERFORMANCE IMPROVEMENT

The ability to improve the mechanics of a sport for an athlete leads to overall performance improvement. Along with various technology for the science of the sport, the technology to

improve in the sport as a whole is often influenced by player's interest in watching film. Watching game film is one of major things most of the successful athletes have done to improve their performance. While the overall concept of watching game film spreads across all sports, many sports have different avenues, primarily because the technology is designed specifically for that sport.

One of the most notable ways players and coaches watch game film is through Hudl. This technology hosts game/ practice film as well as provides a capability to manipulate the video in a way that allows players and coaches to gain a broader understanding of what they are seeing. This brings coaching and playing to a new level because both are given the opportunity to see the game from a different perspective, ultimately heightening their performance. Originally designed for football players and coaches, it is now versatile to other sports such as soccer and basketball. The essential services of Hudl are to Record and Upload, Review, Teach (through video and stats), Analysis, Sharing and Highlights (for recruiters, fan engagement and player contribution).[3]

Hudl is divided into two groups, Sports and Products. The Products support the sports, some in more specific ways than others. For example, of the sports that Hudl provides services for, Volleyball is the only sport with its only separate entity; Volleymetrics, because it was recently acquired by Hudl. Volleymetrics (Figure 4) is designed to give a variety of groups involved in the volleyball world access to opportunities for improvement. Players and Teams are the areas with the most capabilities in terms of how they can manipulate the information provided. Teams are categorized by level and given the opportunity for professional analysis as well as a wide variety of other capabilities including video sharing, third- party compatibility and extensive storage. Along with being able to access their film, players have access to highlights created by their coaches and are able to submit suggestions for edits of those highlights.[4]

Figure 4

All of the categories have the ability to see the analysis of various matches, specifically the Tournament and Leagues categories[5]. Since having a knowledge base of the matches is essential everyone in the volleyball world but especially for tournaments and leagues, it is imperative that they have access to those videos and that data, and that is was Volleymetrics provides. Other capabilities include, but are not limited to, stats, commenting, and live streaming.

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[3] https://www.hudl.com/products/hudl

[4] http://volleymetrics.com/home/players/ | http://volleymetrics.com/home/teams/

[5] http://volleymetrics.com/home/tournaments/ | http://volleymetrics.com/home/leagues/

When considering other products that Hudl provides, it is important to include Sportscode in the conversation as it was recently acquired by Hudl and provides athletes and coaches with a more advanced experience.[6] There are three different levels as seen in Figure 5. Sportscode is primarily used for recruiting and video analysis (which is uploaded to Hudl) and is third-party compatible as well. The benefit to using Sportscode is the instantaneous updates and processes as many of the elements are live updates.

Figure 5

A notable aspect of Hudl is its accessibility and with that is paired with three additional products (Figures 6, 7, & 8), Assist, Sideline and Technique. Each is specific to a part of the game, for example, assist is professional analysis within 24 hours while Sideline is for replays during the game allowing for updates and improvement during the game. The other is Technique which is an app that is mostly paired for golfers, because of the slow motion and drawing tool elements.
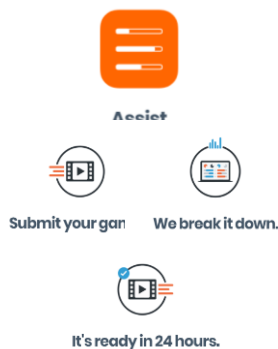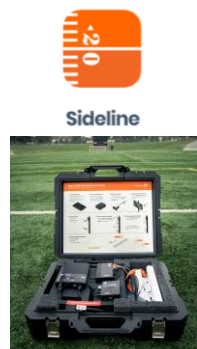

Figure 6

Figure 7
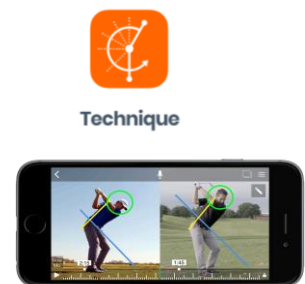

Figure 8

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[6] https://www.hudl.com/elite/sportscode

This variety of products helps to pinpoint areas for the 10 sports that are supported through Hudl. With the exception of Volleyball, each sport has a similar platform within Hudl with adjustments being made based on the needs of the sport.

BATS! Is a type of baseball video software designed to scout and analyze baseball players and their techniques.[7]   There is software similar for Baseball/Softball on Hudl, but BATS! is the software primarily used. BATS! is mostly used by the MLB yet they designed BATS! for college teams to have access to the video software program. The program includes instant video viewing and data analysis allowing players to examine and study their play on the field. This feature of BATS! gives players the opportunity to instantly correct or adjust certain aspects of their game to provide maximum performance. In addition to instant video, the program comes with up to four cameras creating multi-angle video for players. The multiple angles can add an additional perspective for players and coaches to look at when analyzing different plays as seen in Figure 8. Comparing videos, slow motion mode, and frame by frame print outs are also features a part of the video program. All three allow the athlete and coach to analyze specific parts of a certain, pitch, swing, or play on the field. It also provides stats to be reviewed during and/or after the game for the entire season including specific player breakdowns. BATS! Is just one of the many film programs that can help athletes (specifically baseball players) improve their performance.

Figure 9[8]

Two of the largest benefits of Hudl, BATS!, and other performance analysis technology, are their interactivity and accessibility. Being able to review plays and players visually allows athletes to have the opportunity to correct or prevent aspects of their game.

INJURY PREVENTION

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[7] http://www.sydexsports.com/html/baseball.html
[8] http://www.sydexsports.com/assets/images/4_Angle.jpg

Athletic Training has been around since the late 1800s/ early 1900s with the founding of NATA (National Association of Athletic Trainers) in 1950.[9] Throughout the history of sports it has been one of the areas that technology has impacted greatly. It is in this area that some of the most intricate and advanced technology in sports have been designed. The health of the athlete is the most important thing when thinking about their performance and success. Without it they would not be able to play in any games or grow in that sport.

In 2015, the movie Concussion made its debut in theaters and it was through this movie that the general public was given more of a perspective of the severe effects of concussions on the brain. The movie is centered on Dr. Bennet Omalu, a forensic pathologist and his discovery chronic traumatic encephalopathy (CTE), which is a brain degeneration that is primarily suffered by football players.[10] Dr. Omalu has worked diligently to share his work with the world and specifically the NFL, with efforts to encourage a safer environment for football players. It was through his discovery and perseverance that the NFL began to enforce stricter safety rules to prevent concussions. For example, an impact indicator (Figure 9) is placed in helmets of football players that notifies trainers of hits directed at the head at alarming rates.

Figure 10

Injury preventive technology for athletes can be the difference between a permanent injury and a scratch. Most people are familiar with braces, which are designed to give athletes more support around joints and icing which helps with muscle tissue but there have been further advancements in both of these areas as well as completely new technology for muscles. In the area of braces, athletes can make them custom fit for their body. For example, ankle braces can be designed to fit the athlete's foot for optimum comfort and support. Simple icing of a sore area is important for muscle tissue which is where Game Ready (Figure 6) comes into play. It is timed automated icing that allows the athlete to ice the sore area for the proper amount of time because icing for too long

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[9] https://www.nata.org/about
[10] https://www.imdb.com/title/tt3322364/

can also lead to injury. Some newer technology in the area of injury prevention in leg muscles is Normatec. This is a system that players wear around the legs or arms and it stimulates muscle pumping to enhance muscle tissue recovery[11] as seen in Figure 7. For instance, a common muscle issue within athletes is lactic acid buildup in the muscles which can create a burning sensation around those muscles[12]. Normatec breaks up that build up and helps the body to drain the lactic acid from the muscles.
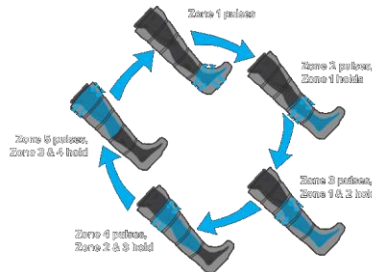

Figure 11[13]

Figure 12

If an injury does occur, athletic trainers are also equipped with the technology to assist in the rehabilitation process. BioWave technology that blocks pain through therapeutic electrical impulses is frequently used by athletic trainers (Figure 8). Underwater treadmills are also used to watch the way you run or walk to track the recovery process and to make sure joints and muscles are moving correctly.
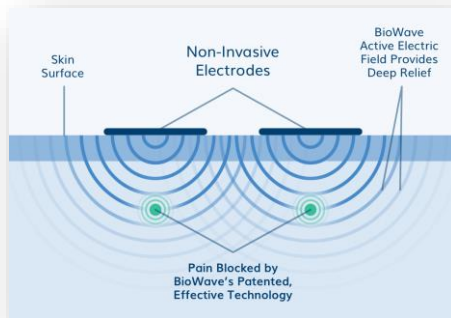
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[11] https://www.normatecrecovery.com/how-compression-works/how-and-science/

[12] https://www.scientificamerican.com/article/why-does-lactic-acid-buil/

[13] https://gameready.com/wraps/

CONCLUSION

The use of technology for athletes has improved the overall athletic experience for both players and coaches through injury prevention, performance improvement and mastering the mechanics of the sport. The basic care of the athlete is enhanced by the technology made available especially in the area of preventive care. Watching game film is an essential part of performance improvement and is complemented by interactivity and accessibility to players and coaches alike. Along with watching game film, other technologies have helped players to improve the mechanics and overall science of the

Figure 13[14] game to increase results. The use of technology throughout this field has become an essential piece to the success of athletes on and off the court and as technologies continue to improve, so will injury prevention, performance and the overall science of the game.

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https://www.imdb.com/title/tt3322364/
https://www.normatecrecovery.com/how-compression-works/how-and-science/
https://www.scientificamerican.com/article/why-does-lactic-acid-buil/
https://gameready.com/wraps/
http://www.biowave.com/what-is-biowave/

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[14] http://www.biowave.com/what-is-biowave/

NATURAL LANGUAGE PROCESSING

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INTRODUCTION

Natural. Language. Processing. What in the world is that? Wikipedia's definition states: Natural language processing (NLP) as an area of computer science and artificial intelligence concerned with the interactions between computers and human (natural) languages, in particular how to program computers to process and analyze large amounts of natural language data. This really means that household names like Siri, Alexa, and the other devices are all examples of NLP. Tools that allow a machine to communicate to users by using written or verbal human text is the intention of NLP. Free tools like Google Translate have helped tons of people stuck on their Spanish or their French or whatever other language homework. Millennials like myself have grown up with these tools. The concept of NLP is not new. Wouldn't it be great if your computer could understand your mood based on the tweets you sent out today? That might be a little personal, but the concept is what is really intriguing. Can we program computers to understand sentiment or predict future text based on what was previously said? These kinds of questions represent a fraction of the multitude of questions that make up the vast world of NLP.

PURPOSE

The ultimate purpose of NLP is to "to accomplish human-like language processing"(Liddy 3). This includes: paraphrasing input text, translating text into another language, answering questions about the contents of the text, and drawing inferences from the text (Liddy 3). Tools like Siri and Alexa use NLP to answer questions that users ask it. Every time someone says, "Okay, Google" and then proceeds to ask the gadget to perform a task and the gadget responds accordingly, that is NLP. Google Translate as well as other translating resources can help users translate text into another language. There are also paraphrasing tools online that can be used to help users condense or simplify large bodies of text. However, there aren't as many options for tools that can draw inferences from text. Can we program computers to interpret text and reach conclusions on their own?

HISTORY

It would be a shame to continue discussing NLP without providing context for its origin. NLP can be dated back to the late 1940s (Liddy 4). In the age of war, machines that could decode the enemies' communication were essential. NLP was gaining substantial funding for research for about twenty years until the United States Government created an organization in 1964 to evaluate

the progress of computational linguistics and machine translation called the Automatic Language Processing Advisory Committee ("ALPAC."). The United States Government considered machine translation and NLP so trivial that in 1964, they created this organization to emphasize the pain points and lack of basic research in order to defund efforts to develop machine translation. To truly gain perspective on United States history in 1964 when this organization was created, let's be reminded that that was the same year the Civil Rights Act of 1964 was signed into law by President Johnson (Pearson). It was also the same year that gas was approximately 30 cents to the gallon (Pearson). That was the same year Cassius Clay (also known as Muhammad Ali) beat Sonny Liston for World Heavyweight championship (Pearson). At that time in history, NLP was seen as frivolous. Imagine what NLP would be if we had continued efforts to fund this research area. This just goes to show the magnitude of a topic like NLP.

AUTOMATIC LANGUAGE PROCESSING ADVISORY COMMITTEE

ALPAC was created in 1964; however, it wasn't until 1966 when the organization published their report when the research community would be affected. The organization investigated the current status of machine translation. This report stressed the supply and demand of machine translation for that specific point in history, when translating Russian to English. And when evaluating time and cost, the organization came to a 9-point recommendation list for what the United States Government should be supporting research on. The recommendations are:

1. Practical methods for evaluation of translations;
2. Means for speeding up the human translation process;
3. Evaluation of quality and cost of various sources of translations;
4. Investigation of the utilization of translations, to guard against production of translations that are never read;
5. Study of delays in the over-all translation process, and means for eliminating them, both in journals and in individual items;
6. Evaluation of the relative speed and cost of various sorts of machine-aided translation;
7. Adaptation of existing mechanized editing and production processes in translation;
8. The over-all translation process; and
9. Production of adequate reference works for the translator, including the adaptation of glossaries that now exist primarily for automatic dictionary look-up in machine translation

(Translations)

Overall, the recommendations emphasized the need to consider quality and cost of machine translation. The United States Government was using this report to justify a cut to the research being developed on machine translation. Only two of the nine listings mentioned machine translation. The committee basically said that machine translation is not important enough at the moment because it is not faster than humans. This is not to say that NLP was anywhere close to what it is today. The machine translating technology often produced poor results and would need

to be reviewed by scientists. All in all, multiple sources claim that this published report set back and may have even signaled to the scientific community that machine translation and even NLP

as a whole is a dead end.

POST-ALPAC NATURAL LANGUAGE PROCESSING

After ALPAC succeeded in reducing funding for NLP research, there were fewer developments in the NLP community. Regardless, throughout the early 1970s, there were some advancements in both theory and in prototype systems. Some advancements in theory included: case grammar, semantic networks and conceptual dependency (Liddy 5).

CASE GRAMMAR

Case grammar is a system created by Charles Fillmore that focuses on the relationship between the number of subjects, objects, etc. of a verb and the grammatical context of the verb used. Wikipedia states that the theory "analyzes the surface syntactic structure of sentences by studying the combination of deep cases (i.e. semantic roles) -- Agent, Object, Benefactor, Location or Instrument—which are required by a specific verb". For example, the verb "smell" requires an Agent (a) and an optional Object (o). *Susie (a) smells roses (o) outside her garden*. Fillmore's theory basically said that each verb has a set amount of deep cases and sometimes a set amount per deep case. You can't say, *Smells roses (o)*. In this example, the verb "smell" requires an Agent in the beginning or the sentence wouldn't be grammatically correct. However, if we say, *Roses (a) smell*. This gives us the Agent we needed with the verb and is still grammatically correct.

SEMANTIC NETWORKS

Semantic Networks is where concepts are represented as hierarchies of interconnected nodes with nodes linked to certain attributes (Steyvers). This theory explains verbally what most people do naturally. When unsure about a word, often times, we look up the word in the dictionary. For example, let's take the word "abject". Let's say we saw this word in an article and were unsure about its meaning. When we look it up in the dictionary, it says: self-abasing or completely without pride. Next, we look up self-abasing. It says, belittling or degrading oneself. At this point, if we understand, we can stop, or else we simply continue until we reach a word we understand. Semantic Networks is how all of those words are connected to each other. The idea is that all words are connected to each other based on all the different meanings. We can start with one word and it can link us to another and another and so forth. This idea can represent in a graph or node-to-node like structure as can be seen below.
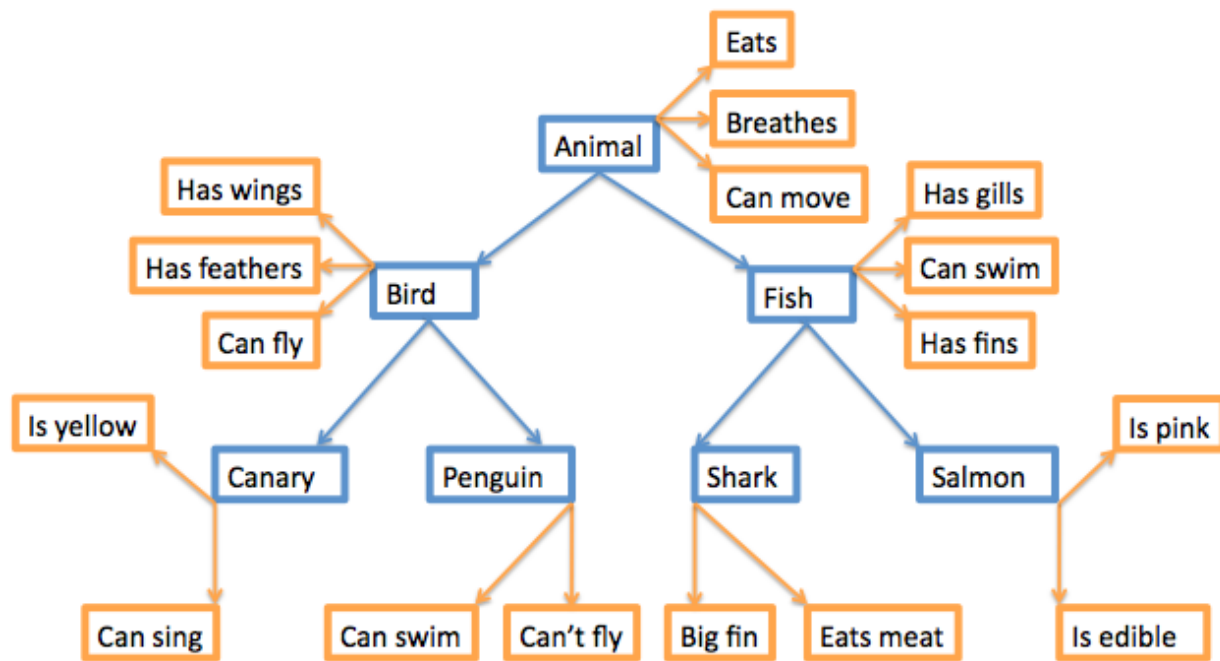
Figure 1: Semantic Network Graph Example (Amayo)

In this example of Semantic Networks, we can see that animals are associated with many verbs including: eating, breathing, and moving. Two examples of animals are birds and fish. Two examples of birds are Canaries and Penguins. The list goes on. This visual can help people understand the complexities of semantics.

CONCEPTUAL DEPENDENCY

Conceptual Dependency theory of Schank was developed to explain syntactic anomalies and provide semantic representations (Libby 5). This theory broke down sentences into a set of primitives that would make it easier to come up with inferences based on their organization throughout a sentence. Primitives are the foundational meanings behind words. If we combine a few primitives, we can create numerous sentences all explaining different things. According to Schank's theory, there are 11 primitive actions:

1. ATRANS: to change an abstract relationship of a physical object
   Ex. give, take, etc.

2. ATTEND: to direct a sense organ or focus an organ towards a stimulus
   Ex. listen, taste, etc.

3. INGEST: to take something inside an animate object
   Ex. eat, drink, etc.

4. EXPEL: to take something from inside an animate object and force it out
    Ex. throw, cry, etc.

5. GRASP: to physically grasp an object
    Ex. hold, etc.

6. MBUILD: to create or combine thoughts
    Ex. ideate, etc.

7. MTRANS: to transfer information mentally
    Ex. tell, etc.

8. MOVE: to move a body part
    Ex. go, etc.

9. PROPEL: to apply a force to
    Ex. push, etc.

10. PTRANS: to change the location of a physical object
    Ex. went, etc.

11. SPEAK: to produce a sound
    Ex. sing, etc.

(Jose)

There are also conceptual categories:

PP: Physical Objects

Ex. Susan, John, The community, etc.

ACT : Primitive Actions (listed above)

Ex. atrans, speak, etc.

AA: Modifiers of Actions

Ex. velocity, etc.

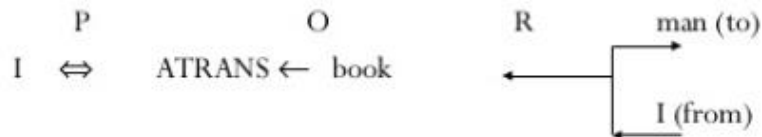PA: Attributes of PP's (an object)

Ex. red in a red sock, etc.

(Jose)

When we combine conceptual categories and primitive actions, we can create any sentence. For example, Susan ate red apples. That sentence is a combination of a physical object (Susan), ingest (ate), attributes of a physical object (red), and physical object (apples). Schank's theory also comes

with a graphical representation with arrows that mean different things. An example is shown below:

Example

- I gave a book to the man. CD representation is as follows:

$$
\begin{array}{ccc}
P & O & R \quad \text{man (to)} \\
I \Leftrightarrow & \text{ATRANS} \leftarrow \text{book} & \\
& & I \text{ (from)}
\end{array}
$$

- It should be noted that this representation is same for different saying with same meaning. For example
  - I gave the man a book,
  - The man got book from me,
  - The book was given to man by me etc.

Figure 2: Conceptual Dependency Graph Example (Jose)

In this example, the double arrow between *I* and *ATRANS* represents the two-way link between the physical object (*I*) and the primitive action (*ATRANS*). The *P* represents the past. The *O* represents the relationship between the object and the verb. And the *R* represents relationship between the recipient (man) and the actor or the "do-er" of the action. Graphical representations like the one shown in Figure 2 are common to break down sentences when explaining conceptual dependency.

All in all, conceptual dependency is a deep concept that involves understanding the foundations of a sentence. It is impressive that this research and insight came from research done in 1970s.

NATURAL LANGUAGE PROCESSING TODAY

Technology and research have discovered so much since the 1970s. The growth in NLP is expected to continue growing exponentially in the years to come. Now, NLP is divided into two different categories: Natural Language Understanding and Natural Language Generation. Natural Language Understanding includes mapping input text into useful representations and analyzing different aspects of the language, similar to the conceptual dependency theory of Schank ("Artificial Intelligence Natural Language Processing."). Natural Language Generation is producing phrases or sayings from some internal representation ("Artificial Intelligence Natural Language Processing."). Both of these branches of NLP are important in the need to understand natural language, understand enough to program computers to do the same.

TYPES OF NATURAL LANGUAGE PROCESSING

There are many different aspects that make up NLP. There is "automatic summarization, translation, named entity recognition, relationship extraction, sentiment analysis, speech recognition, and topic segmentation" (Kiser). Most of these items we can associate with the latest technological advancements we use on a daily basis. Topics like translation, speech recognition and topic segmentation are what make gadgets like smartphones and virtual assistants stand out. Some of the most recent intrigue is sentiment analysis. This is where artificial intelligence can detect the sentiment or tone of a message. This concept is what can help companies understand if their product is doing well in the market, especially when analyzing sentiment of posts in social media. Named entity recognition and relationship extraction is a mix of Schank's conceptual dependency theory and semantic networks. Automatic summarization is "the process of creating a short and coherent version of a longer document" (Brownlee). There are even tools online that can summarize for us! NLP has blossomed into a trendy research area as more and more companies are investing in utilizing all they can to understand text.

NATURAL LANGUAGE PROCESSING SOFTWARE

In 2018, there are so many NLP API's or application programming interfaces that will do most of the work for us. On one hand, we have Google's Cloud Natural Language tools that promise "reveals the structure and meaning of text by offering powerful machine learning models in an easy to use REST API" (). Google Cloud's features include syntax analysis, content classification, entity recognition, sentiment analysis, and translation. But they aren't the only company that has created API's for users. Microsoft's Azure, IBM's Watson, and Amazon's Comprehend are similar tools that help users understand their text.

For a school project, my classmates and I compared the sentiment analysis for Google, Microsoft and IBM. We obtained tweets about a specific airline that were already manually classified as positive, negative, or neutral. We queried each API and compared the results to the true manual classification for the tweets. We also attempted to create our own at-home classifier that we tested to compare our abilities to the abilities of three multi-billion-dollar companies. Our results favored IBM's API and ranked Microsoft and Google's API as the same. Our naive model couldn't compare to the other API's, but it was a great experience of testing the quality of the API's in the market. This project reiterated the point consistently mentioned throughout this paper which is that NLP is in high-demand and the more we can develop this area the more we can understand about the world.

CONCLUSION

In conclusion, the intricacy of Natural Language Processing is too much to sum up in one paper. However, after learning about the rich history and understanding the fundamentals like case grammar, semantic networks and conceptual dependency, we can start to understand why there is so much more that needs to be researched in this field. Natural Language Processing has provided us with tools like API's that can do most of the hard processing for us, but the algorithms in the back-end are where most of the statistical and machine learning action occurs. Natural Language Processing is popular now, but it might be here to stay.

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VIRTUAL REALITY REHABILITATION TECHNOLOGY FOR DISABLED PEOPLE

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INTRODUCTION

By 2025, virtual reality alone will take it's immersive upbringing, currently, at $1.0 billion to $12.6 billion, annually, according to Business Wire's news report from Tractica. Companies such as Facebook/Oculus, HTC, and Samsung have been using Virtual Reality (VR) technology to improve efficiency, productivity, and overall results to better our current quality of life.

Through VR technology, there have been breakthroughs in terms of Medical technology when dealing with disabled people through rehabilitation. Proven benefits of VR in pain management, physical and cognitive rehabilitation, interventions, and research studies have shown in various conditions such as Parkinson's disease, cerebral palsy, autism, and anxiety disorders ("Virtual Reality: Recent Advances in Virtual Rehabilitation System Design).

HISTORY OF VIRTUAL REALITY

Virtual reality is a form of a virtual environment computer technology in which people interact with generated simulated objects. Basically, VR cancels out your own worldview to the digital world, created to fool your senses. This is a form of mental teleportation. The beginning of VR technology dates back to the 1800s, in 1838, the first stereoscope was invented by Sir Charles Wheatstone. Using twin mirrors to project a single image which then created the View-Master, patented in 1939 and continues to produce today.

In 1962, Morton Heilig, a filmmaker, created the Sensorama. It was an arcade styled cabinet, with a 3-D display, vibrating seat, stereo sound, fan, and produces aromas. The Sensorama was a multisensory simulation more used in the motion picture industry, in which you can feel as if you were "in" the movie. The Sensorama allows you to have an experience in a world where you see, hear, feel, and smell the "designed world" ("History of Virtual Reality."). For example, if you experienced a place in which you "rode" in a car, the Sensorama allows you to see the road, hear the engine, feel the vibration, and smell the motor's exhaust in that world. In 1968, MIT's computer scientist, Ivan Sutherland, also known as "the godfather of virtual reality displays"
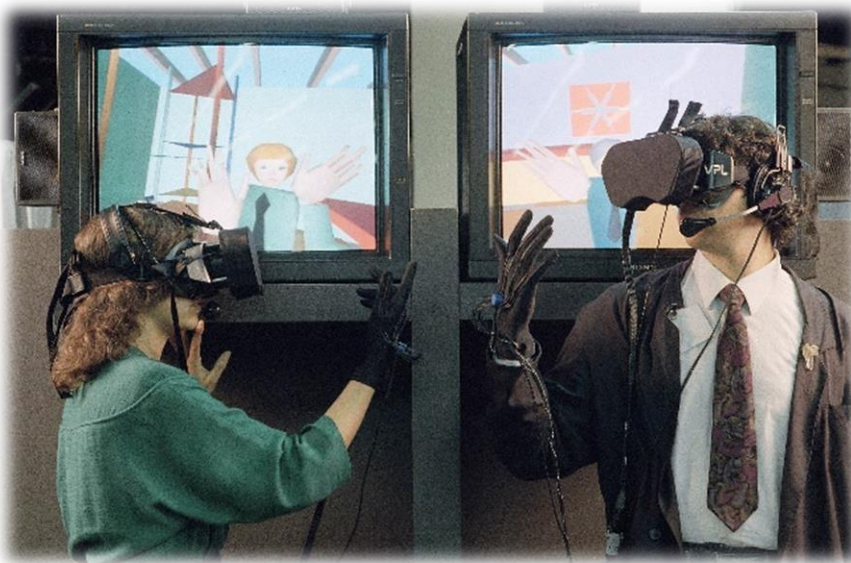
created the first VR headset (Coldfustion, director). He and his colleagues were working on the first virtual headset experiment. He was considered a "low-key genius" (Coldfustion, director). He was the same person who invented the sketchpad in 1963, an advanced software for Computer-Aided-Design (CAD), a breakthrough for computer interaction.

In 1987, American computer philosopher and a computer scientist, Jaron Lanier coined the term "virtual reality." He founded Visual Programming Language (VPL) Research and was among the first startup company to create the VR hardware, developing gear such as goggles and gloves ("the company literally created and 'Eyephone'") (Hamilton, Ian). The Eyephone is a head-mounted display (HMD) unit used to visually immerse its user in a virtual environment (*Virtual Reality Society*). By increasing the amount of immerse, each liquid crystal display (LCD) screens included a slight difference of image, creating the illusion of depth (*Virtual Reality Society*). The most popular VR symbol is the HMD.

During that time, NASA Ames Research Center, the Virtual Interface Environment Workstation (VIEW) system included both a head-mounted device with gloves to allow interaction through kinesthetic communication recreating that sense of touch by applying forces, vibrations, or motions to the user, also known as haptic technology ("Haptic Technology."). Since the late 1960s, the VR hardware has been greatly used among universities in a bigger form. It focused more towards the limits of our brains' perception systems versus the use for mainstream consumer products. It was also a helpful tool for PTSD and cognitive therapy patients. In modern day, we have explored especially learning from those who have pioneered the way through new discoveries and now managing to continuously improve our efforts in the world of virtual technology.

Research has stated that of those with a disability has increased their "motor functionality," capacity by participating in motor exercise and "rehabilitation regimen, independent adherence" towards specified preventative and/or rehabilitative programming outside the clinic setting is "notoriously low" (Rizzo, A). Being interactive amongst VR systems are intended to captivate and stimulate that individual. Essentially, it is motivating them to be involved, as they take part in that "game-driven" activity whether it's mental and/or physical activities and rehabilitation programming.

SCIENCE OF VIRTUAL REALITY

Virtual Reality technology plays with our sense by convincing our brain, making us believe we have transported to an alternate reality. The question is, how does one virtually transport to such place and how does one's brain react, scientifically speaking? Our brain builds on our past experience, developing a way on how we interpret the world. We create certain rules for our brains to operate more efficiently, for example, we know the sky tells you which way is up, a shadow tells you where light is coming from, and the size of things allows you to recognize which one is farther away ("The Science of Virtual Reality"). The VR developers learn to understand our interpretation and try to include info for our brain in that virtual world. "In an effective virtual environment, moving objects should follow your expectations of the laws of physics" ("The Science of Virtual Reality"). You can identify the depth and distance through shading and texture. Even with the most sophisticated computer, the human brain is still much more complex, scientists are trying to understand which cues are most important to prioritize ("The Science of Virtual Reality").

In 2014, a discovery awarded the Nobel Prize about how when we navigate through space, our brain creates a mental map using an "inner GPS" ("The Science of Virtual Reality"). Recent studies tested on rats shows their brains in virtual environments do not create the same detailed map as in

a real physical space. A subsection of multisensory integration takes place in your brain at all times this is called visual processing ("The Science of Virtual Reality"). Now, as these newly advance VR technologies begin to involve more of our senses, this can result into being more riveting. Currently, with the interaction between VR and the brain, there have been applications in health and medicine for treatments include PTSD, surgical training, and physical therapy ("The Science of Virtual Reality"). The insightful exploration that scientists look into is whether VR able to change social attitudes by allowing people to view the world from a different person's perspective ("The Science of Virtual Reality").

Many VR environments use visual experiences viewed on either a computer screen or on a special stereoscopic display, but some simulations incorporate additional sensory information, for example, sounds through speakers or headphones (*ScienceDaily*). Advanced haptic systems in medical and gaming applications use force feedback also known as tactile information (*ScienceDaily*). Interacting with a virtual environment or virtual artifact (VA) can be used either through standard input devices (keyboard and mouse) or through multimodal devices (wired glove) (*ScienceDaily*). Engaging in a simulated environment can be similar to the real world such as simulations for pilot or combat training (*ScienceDaily*).

IMPROVING HEALTH THROUGH VIRTUAL REALITY

Over the years, companies like Nintendo have attempted to bring VR to the consumer market, their efforts have failed, majorly. Because of these failures, "the technology wasn't there" and the gateway to building a convincing headset was too high, until now (ColdFusion, director). In modern day, VR is relevant within the gaming industry, 3-D artists, architects and real estate agents, teachers and students, and even astronauts. Simulated environments provide activities accessible as well give therapeutic benefits.

According to the US Census Bureau, overall, the percentage of people with disabilities in the US in 2016 has slowly increased to 12.8% ("2017 Disability Statistics Annual Report.").
Through

FIG 1. Percentage of People in the US with Disabilities, 2008-2016

research, virtual reality has shown its success to recover motor and cognitive skills because of it being perceived by the brain. For the population who's cognitively impaired within the VR system
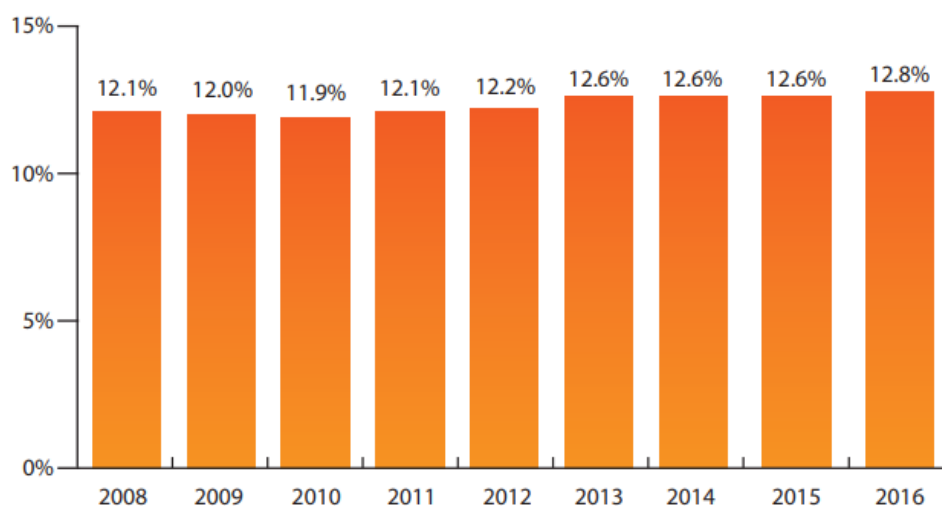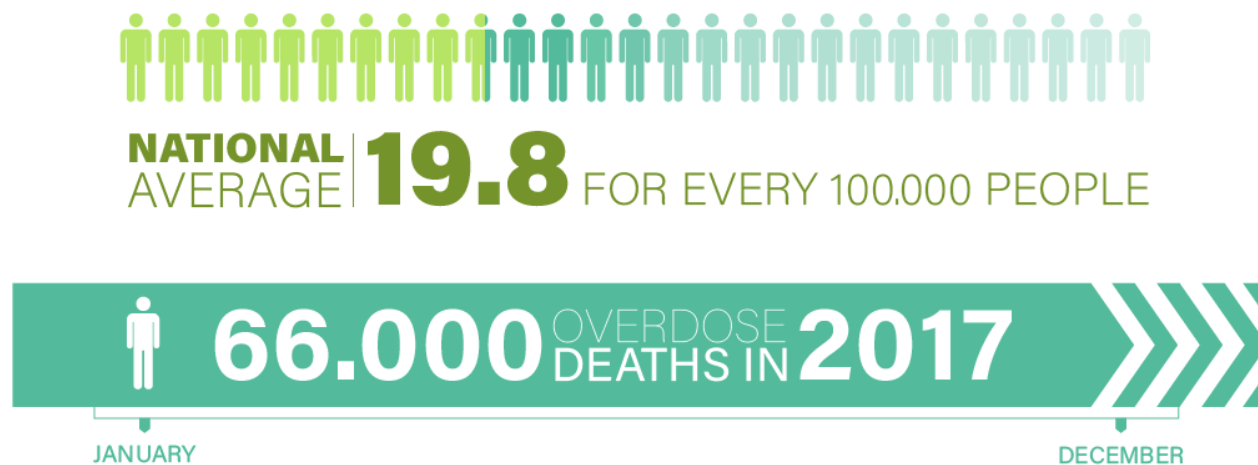
has been told to be "innovative, challenging, and relatively little researched," this is coming from an occupational therapist consultant (Leichman, Abigail Klein). This may have been invented for entertainment but taking advantage of such resource can become a therapeutic tool.

Treatments for chronic pain have been into virtual reality distraction techniques for adjunctive therapy. VR is meant to provide a satisfying and engaging experience, they say "real-time physiological monitoring was used as a guide to determine the effectiveness and sustainability of this intervention" (Wiederhold, Brenda K.). This method has been shown to be safe and effective for these patients. It exhibits a significant relief of pain for the patient, this connects with the objective measurements of peripheral, noninvasive physiological measures.

PAIN MEDICATIONS VS. VIRTUAL REALITY

The third most written prescription today are pain medications today. More than 50% treated patients from the few prescription pain drugs achieve an appropriate amount of pain relief. Most common cause of pain comes from chronic illness, accidents, surgery, advanced cancer, lower back problems, arthritis, shingles, headaches, and fibromyalgia (Wiederhold, Brenda K.). Many patients who acquire these types of pain have trouble to control it. VR decreases the amount of pain by drawing the attention away from "patients' mental processing" (Wiederhold, Brenda K.). VR changes the way the brain physically registers the pain. Few examples of these techniques include deep breathing, viewing videotapes, listening to music, and playing video games show an innovative use from this system. This is what I like to call VR medicine, instead of ingesting pills to temporarily stop or discontinue the pain, alleviate the pain through the VR technology for that sense of relief. When it comes to serious pain, people can get prescribed pain reliever medication such as opioids, which is also an addicting and illegal (if not prescribed) drug. In 2015, drug overdose was the leading cause of accidental death in the U.S ("Social Workers' Role in Ending the Opioid Epidemic"). Every day, more than 115 people in the U.S. die after overdosing on opioids (National Institute on Drug Abuse.). Americans make up 5% of the world's population but consume 80% of the global opioid supply ("Social Workers' Role in Ending the Opioid

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NATIONAL AVERAGE 19.8 FOR EVERY 100,000 PEOPLE

66,000 OVERDOSE DEATHS IN 2017

JANUARY   DECEMBER

Science correspondent, Miles O'Brien explored the mechanics of pain and possible alternatives for coping with it learning through various patients. One patient, Kevin Walsh, spoke about how he froze up when he got burned by hot grease from a commercial kitchen where he worked. On a pain scale from 0 to 10, he said it was a 15. The treatment protocol for burn victims is almost as painful as the injury itself. They do a procedure called debridement in which they repeatedly remove the dressings and scrub the wounds. He adds, "Sometimes, they really get in there, and they will scrub pretty hard… it gets very, very painful" (PBSNewsHour). Through that pain he takes opioids, the most effective pain treatment medicine offers. When the nurses do their work, he plays a VR video game called SnowWorld. A game that is simple yet absorbs his attention. When the nurses peel off his bandage he remembers thinking in his head that this should hurt a bit more, but he so focused in the game trying to "shoot a penguin, and not really worrying about them taking his dressing off" (PBSNewsHour).

David Tauben heads the Division of Pain Medicine, he says, "We underestimate the power of our brains and our minds to shape and regulate our own experiences" (PBSNewsHour). The late John Bonica was a doctor, but his previous career was a professional wrestler. He earned fame, fortune, and a long list of injuries. Hobbling by arthritis, he knew pain inside and outside. The Center of Pain Relief was the first place to treat pain as the problem instead if it just as a symptom of something else. This approach is multidisciplinary, "many professionals who work in this area (psychologists, physical therapists, and a lot of non-drug providers) was based eliminating the opioids and the sedatives, that how many patients were put on," says David Tauben. Opioids are

similar to naturally produced chemicals that are attached to nerve cells called receptors in our brains and central nervous systems (PBSNewsHour). Opioids affect our limbic brain, this manages out emotions, giving us feelings of pleasure, relaxation, and contentment (PBSNewsHour). Our brain stem controls unconscious activity such as breathing, coughing, and pain (PBSNewsHour). It's attached to receptors in the spinal cord, barricading pain messages sent back to the brain (PBSNewsHour).

Throughout the course in the Civil War, doctors used opioids widely on soldiers to treat pain, many started showing signs of addiction which led to doctors conserving in prescribing opioids (PBSNewsHour). In 1980, The New England Journal of Medicine positioned that statement differently, stating how throughout 40,000 hospitalized patients, 12,000 of them received opioids, and only 4 of them became addicted (PBSNewsHour). Concluding, the development of addiction among medical patients is considered a rare case where there isn't a history of addiction. This influence was much greater based on a survey of existing databases versus looking at a rigorous peer-reviewed study. Opioid drug prescriptions increased dramatically which was good for the pharmaceutical manufacturers who promote these agents, being their main incentive to minimize those associated risks. The push for opioids also made it difficult to receive reimbursement for other alternatives.

Another patient who's debilitated with intense chronic neuropathic pain, the lasting result of contracting the Guillain-Barre virus 6 years ago (PBSNewsHour). The patient describes the pain as an electrical shock, feels like a sharp, shooting pain. He was very active in his career, but his horrible pain ended all of that. For a while, opioid may have seemed like the solution it soon made matters much worse almost putting him into a depressed state. When he cut down even a little bit of consuming opioids, he seemed to have a more positive attitude. He takes about 3-4 pills a day, now it's more like 3-4 pills a week. Pain is essential for survival, consider it as nature's alarm bell, a way to protect us from further harm. No one really knows why pain persists long after the body has healed. Acute pain is a nice warning that you need to make a change in what you're doing. If you feel like it's wrong, but that signal continues, and that can be overwhelming for many people. Some people deal with chronic pain, this may come from a place that doesn't exist.

For amputee patients, it's called phantom pain. There was a patient whose left arm is amputated and exhibits this form of pain (called a phantom limb). Basically, the brain is filling the blanks, expecting there to be a hand. The director of the Virtual Reality Research Center and the creator of Snow World, Hunter Hoffman, says that phantom pain is called top-down, meaning, it's in the head. That patient's limb is a great example of the brain's expectations and predictions, even without the physical limb (PBSNewsHour). Usually, chronic pain is top-down, with Hoffman's creating of SnowWorld, it's designed with bottom up (PBSNewsHour). Keeping in mind acute pain sufferers such as the amputee patient we previously mentioned. With inflicted pain on the amputee patient, Hoffman stated how people make pain inducers with a thermal simulator and an adjustable heater. With the amputee patient in the VR SnowWorld game, his intent was towards "hurling snowballs at penguins," he didn't feel the heat and any phantom pain at all as well as it reduced his chronic pain. This shows how VR game addresses pain as the coming going from the brain. O'Brien states how "pain needs an audience, and the better we get at focusing on other things the more we can manage it, without turning to narcotic drugs" (PBSNewsHour).

VIRTUAL REALITY PLANS TO STAY

Many people think VR is a trend that may fade out like the previous hype cycles of the technologies in the 1980s and 1990s. Yet our current technology is far more advanced and realistic. Imagine its power similar to the smartphone, incorporating a balanced blend for artificial intelligence (AI) and virtual intelligence (VI) applications. The product, price, and consumer demand begin to create that altered reality spark (ColdFusion, director). VR experiences will be more common in 2025, if done right, this technology shows incredible potential!

## RESULTS OF VIRTUAL REALITY REHAB'S INFLUENCE

Patients undergoing VR rehabilitation, experience more arm and hand improvements compared to conventional rehab after four weeks of therapy. Studies have found that doctors observed virtual reality patients continued to have better mobility than the non-virtual reality patients. This is similar to other research that has shown the results on cerebral palsy patients who underwent rehab for balance problems. This system allows the doctors to analyze the patients, inferring how it has impacted them through their observations. A study published in Scientific Reports explained how a group of participants who had a spinal cord injury for at least three years underwent long-term training which included VR. All of these people have gained some motor control. Using Oculus Rift, the results were achieved by placing the participants in a virtual reality environment. This was where they learned to use brain activity to control an avatar of themselves. They were wearing t-shirts specially designed to give haptic feedback to the patients' forearms, allowing to virtually touch the ground"(Virtual Reality (VR) Is Transforming the Healthcare and Rehab Industries."). This is meant to fool the brain to feel as if they were walking while they moved their arms. Some may have heard of the "Jedi mind trick", this is a form of a "VR trick", in which you're tricking your brain into thinking you're somewhere when in actuality, you're not.

This image is an example of full-coverage haptic feedback, this product is called the Hardlight VR Suit. The product features include comfortability, lightweight, adjustable fit, compatible, sweatproof, body tracking, over 15 game titles, and an audio mode.

Each of the muscle groups includes its own haptic zone. The feeling of when you've been hit, shot, knocked or touch can be felt in your shoulders, chest, arms, abdomen, and upper back ("Hardlight VR Suit - Don't Just Play the Game.

Feel It."). The Hardlight VR suit is said, "Other haptic devices out there don't fit the comfort and flexibility needed for true VR gaming" ("Hardlight VR Suit - Don't Just Play the Game. Feel It."). This was built with years of research and testing to maximize comfort and total freedom, their current selling price for the suit is at $299 ("Hardlight Suit."). Hardlight VR has said in the past on how their price should be affordable for everyone.
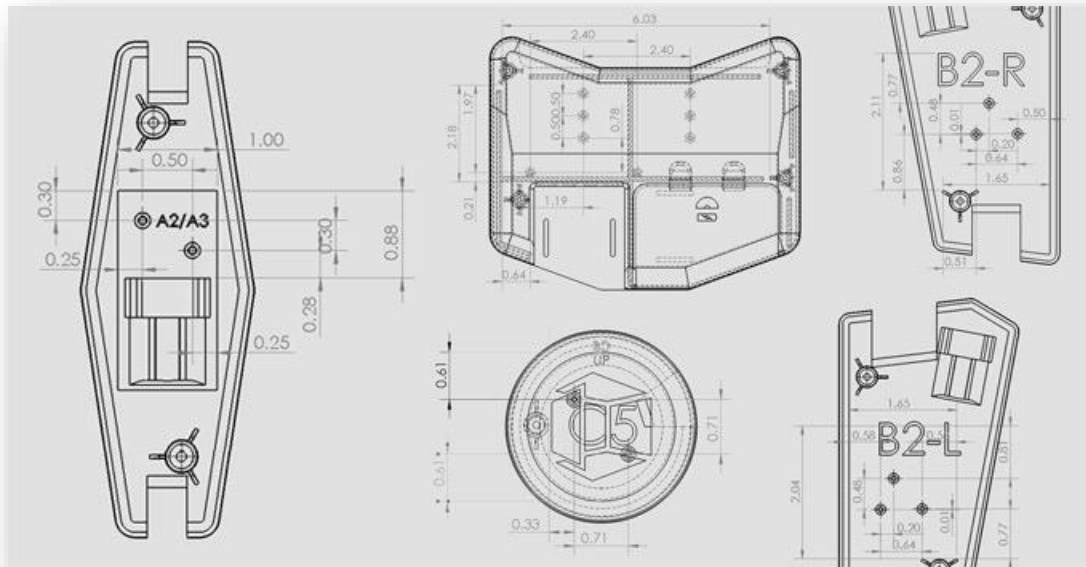
This design shows how it can simulate a powerful punch and precise enough to feel the lightest taps of rain" ("Hardlight VR Suit - Don't Just Play the Game. Feel It.").

BRAIN IMAGING TECHNOLOGY

Investigators at the Kessler Foundation explore to improve disabling deficits in individuals (individuals dealing with multiple sclerosis, spinal cord injury, and stroke) through a device called the C-Mill designed by Motek. C-Mill is a treadmill that trains the user to avoid obstacles by creating a pattern and project cues on safe walking surfaces (KesslerFdn.). C-Mill's flexibility allows researchers to program for specific environments to develop all-around standards to measure and improve mobility from the neurological conditions. This enables "better training and evaluation of gait pattern and gait adaptability" (KesslerFdn). When testing the C-Mill, they plan to analyze neurofunctional changes underneath cognitive and motor enhancements in individualized testing. These studies may result to "help reduce loss of independence and improve daily functioning in people with disabilities by providing critical biomarkers for post-intervention changes in learning and memory, fatigue, gait and balance" (KesslerFdn)**.** Clinicians and researchers are provided needed resources from Motek to build a "dynamic, high-quality technology solutions" that can customize the needs of the patient (KesslerFdn).
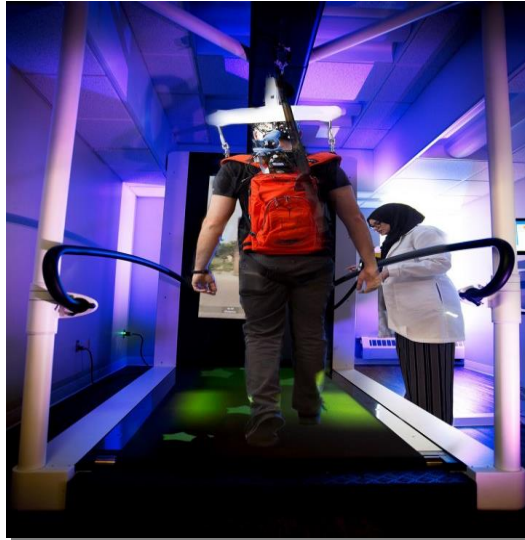
CONCLUSION

All in all, virtual reality for disabled people can benefit by engaging in various activities in a simulator. Research has been proven that knowledge and skills obtained by individuals who're disabled in simulated environments improved more than the ones who were non-virtual reality participants. Throughout the years, the changes it has made have helped the high-quality device be easily accessible at low cost. Breaking that barrier, freeing that limit that was inflicted upon by their disability, in a safe manner. VR technology, essentially, has created an innovative use to enable the disabled to lead an independent life ("Virtual Reality (VR) Is Transforming the Healthcare and Rehab Industries."). Alongside with augmented reality, the way that VR is different from any other forms of technology is that it directly effects the perceptions and processes of the human mind in an obvious way (Coldfustion, director). That form of technology is the only technology that provides packaged experiences (Coldfustion, director). There's so much that can be done, and I cannot wait to see new discoveries! 2025 is going to be grand.

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