Injury Control and Probabilistic Linkage

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Introduction to Probabilistic Linkage

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Probabilistic Linkage

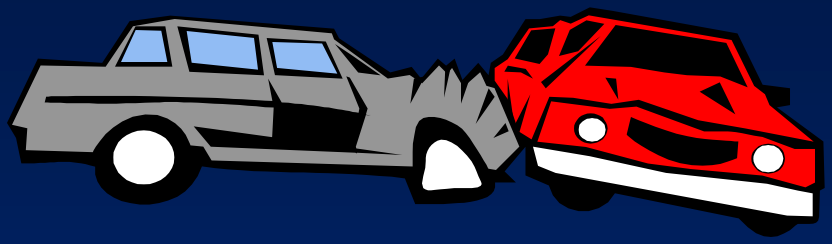
- Probabilistic is a method that uses properties of variables common to databases to determine the probability that two records refer to the same person and/or event
- Probabilistic linkage is NOT a method that produces results that are probably right

Utah CODES

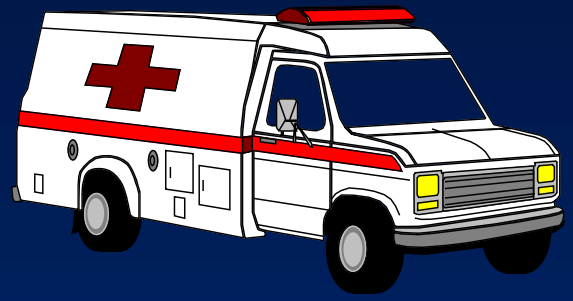
- Crash Outcome Data Evaluation System
- Funded by the National Highway Traffic Safety Administration (NHTSA)
- Goal – better understand the medical outcomes of crashes

Crash Outcomes

- 1996 CODES Report to Congress
- Are safety belts and motorcycle helmets effective at preventing injuries resulting from motor vehicle crashes?
  - Safety belts are 45% effective
  - Motorcycle helmets 26% effective
    - 66% effective at preventing brain injuries



Crash



EMS

Analysis
Database

ED

Inpatient

Probabilistic Linkage Studies

Shop Class Injuries

One Year ED

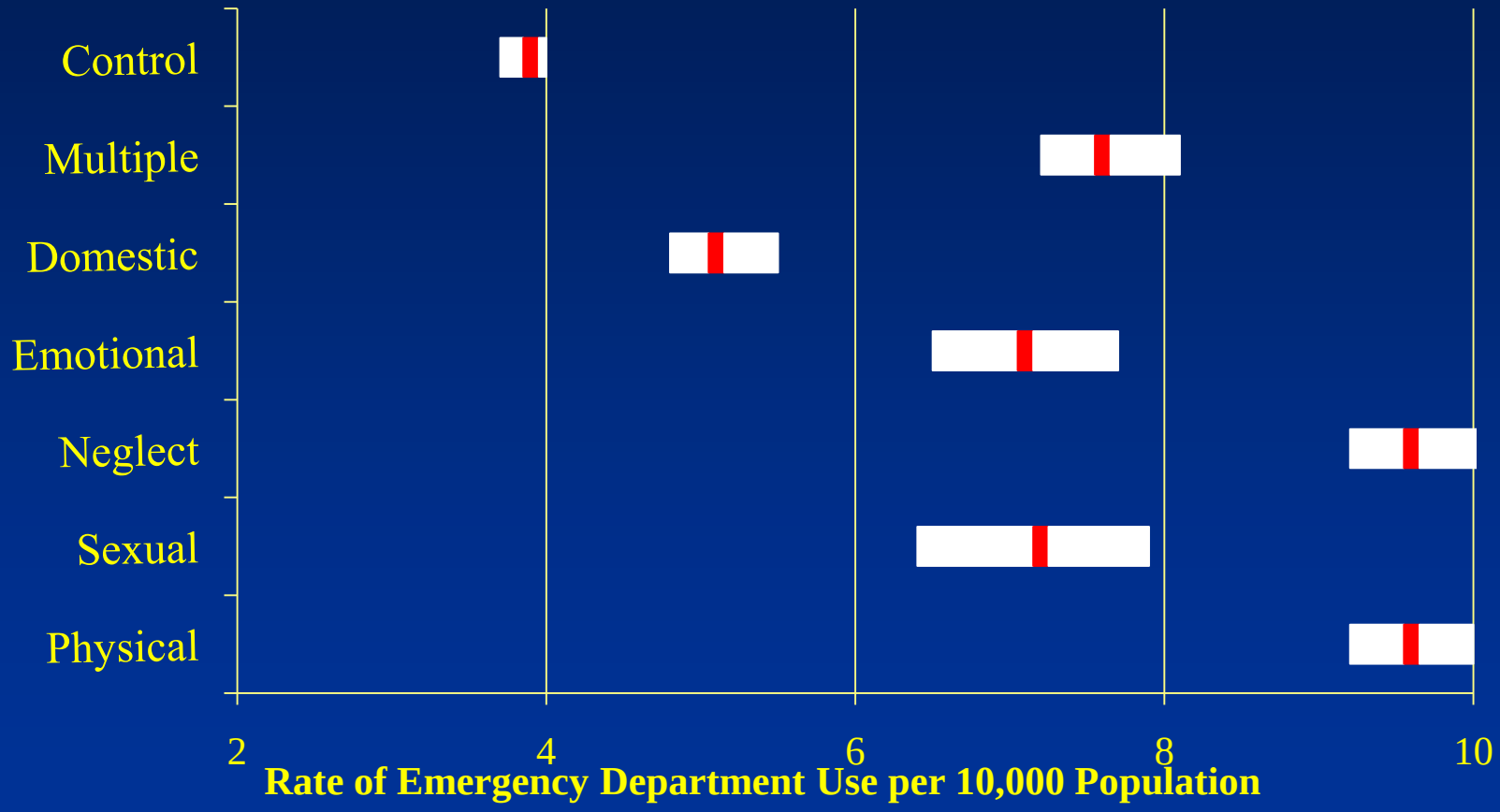
- 167 in class injuries
- 45 seen at ED
- ½ were saw related
- $16,571 ED charges

Five Year Hospital Discharge

- 1,008
- 7 admitted
- 6 table saw related
- 3 amputations
- $26,767 hospital charges

Knight S, Cook LJ, Nechodom PJ, Olson LM, Reading JC, Dean JM. (2001). Shoulder belts in motor vehicle crashes: a statewide analysis of restraint efficacy. *Accid Anal Prev*, *33*(1), 65-71.

Rates of ED Use by Type of Child Abuse



Guenther E, Knight S, Olson LM, Dean JM. Prediction of child abuse risk from emergency department use. *J Pediatrics*. 2008

Probabilistic Linkage Basics

Let’s Play 20 Questions

I’m thinking of a person

Probabilistic Linkage Theory

Reliability (m)

Probability that a common variable agrees on a **matched** pair. Approximately 1 - error rate.

Discriminating Power (u)

Probability that a common variable agrees on an **unmatched** pair. Approximately the probability of agreeing by chance.

Record Linkage with Imperfect Data

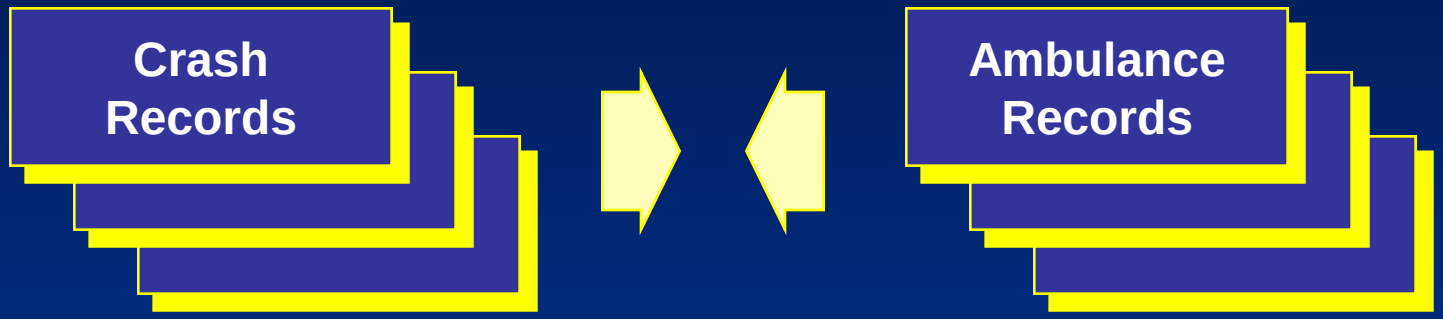
Crash Record

Mary Smith F 05/05/45 07/15/96 11:40 Weber US5 Seat=1 Belt=N

Ambulance Record

Mary Smith Sanchez F 05/05/44 07/15/96 11:51 Weber Fracture Mem Hosp

Probabilistic Record Linkage



If each ambulance record matches to one crash record in a file of 100,000 crashes then the odds for a match at random are 1:99,999 or probability of true match = 0.00001.

Probabilistic Record Linkage

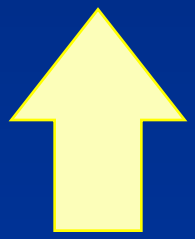
Crash Record

Mary Smith /15/10 11:47 Weber US5 Seat=1 Belt=N

Probability of
true match = 0.0009

Ambulance

Mary Smith S /15/10 11:55 Weber Fracture Mem Hosp



Probabilistic Record Linkage

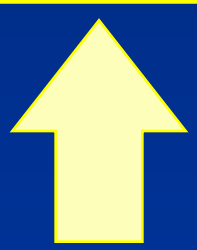
Crash Record

Mary Smith F ... 7 Weber US5 Seat=1 Belt=N

Probability of
true match = .0192

Ambulance Record

Mary Smith Sanchez F ... 5 Weber Fracture Mem Hosp



Probabilistic Record Linkage

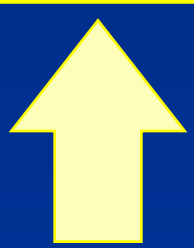
Crash Record

Mary Smith F 05/05/45 US5 Seat=1 Belt=N

Probability of
true match = .0385

Ambulance Record

Mary Smith Sanchez F 05/05/44 Fracture Mem Hosp



Probabilistic Record Linkage

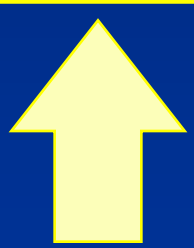
Crash Record

Mary Smith F 05/05/45 07/1 Seat=1 Belt=N

Ambulance Record

Mary Smith Sanchez F 05/05/44 07/1 ture Mem Hosp

Probability of a
true match = 0.1429



Probabilistic Record Linkage

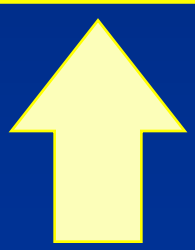
Crash Record

Mary Smith F 05/05/45 07/15/10 11 Belt=N

Ambulance Record

Mary Smith Sanchez F 05/05/44 07/15/10 11 m Hosp

Probability of a
true match = 0.9836



Probabilistic Record Linkage

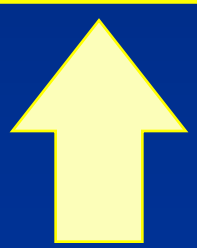
Crash Record

Mary Smith ... 10 11:47 Weber US5 Seat=1 Belt=N

Probability of a true match = 0.9817

Ambulance Re

Mary Smith Sanc ... 10 11:55 Weber Fracture Mem Hosp



Probabilistic Record Linkage

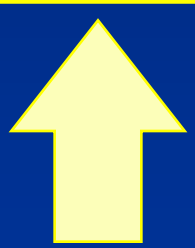
Crash Record

Mary Smith F ...7 Weber US5 Seat=1 Belt=N

Probability of a
true match = 0.9999

Ambulance Record

Mary Smith Sanchez F ...5 Weber Fracture Mem Hosp



Probabilistic Record Linkage

Crash Record

Mary Smith	F	05/05/45	07/15/10	11:47	Weber	US5	Seat=1	Belt=N

Ambulance Record

Mary Smith Sanchez	F	05/05/44	07/15/10	11:55	Weber	Fracture	Mem Hosp

This pair of records has both agreements and disagreements. Our calculations say that the odds are p = 0.9999 that the records refer to the same individual and crash event.

What Do You Need For Probabilistic Linkage

Data Files

- IRBs
- Data sharing agreements

- Variables common to both files
- Variable definitions same on each file

Are Names Necessary for Probabilistic Linkage?

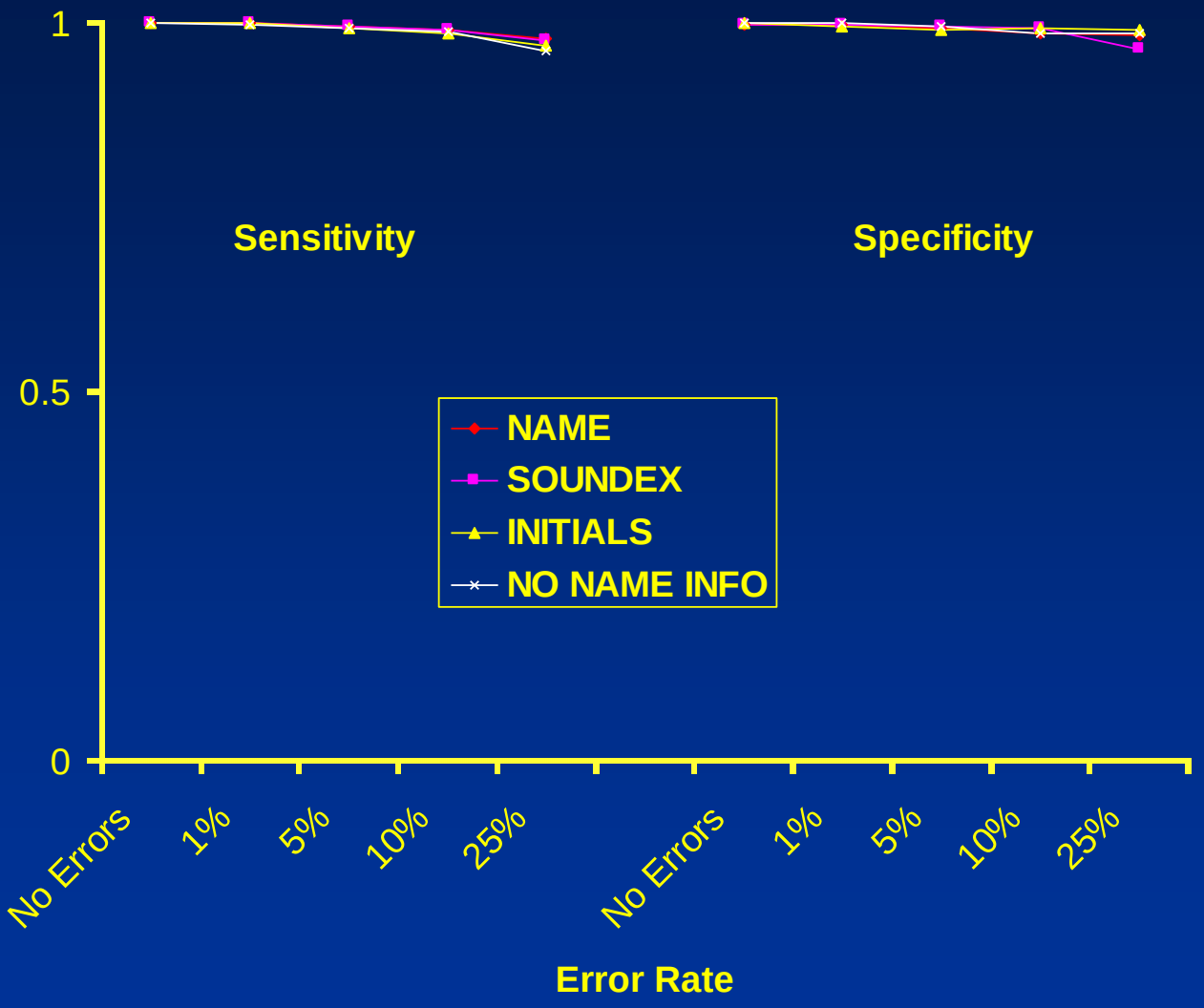
Name Dilema

- Name are powerful identifiers
- Confidentiality concerns
- Names may not be collected in database
- Simulation study to determine effect of name information on linkage projects
  - We know the answers

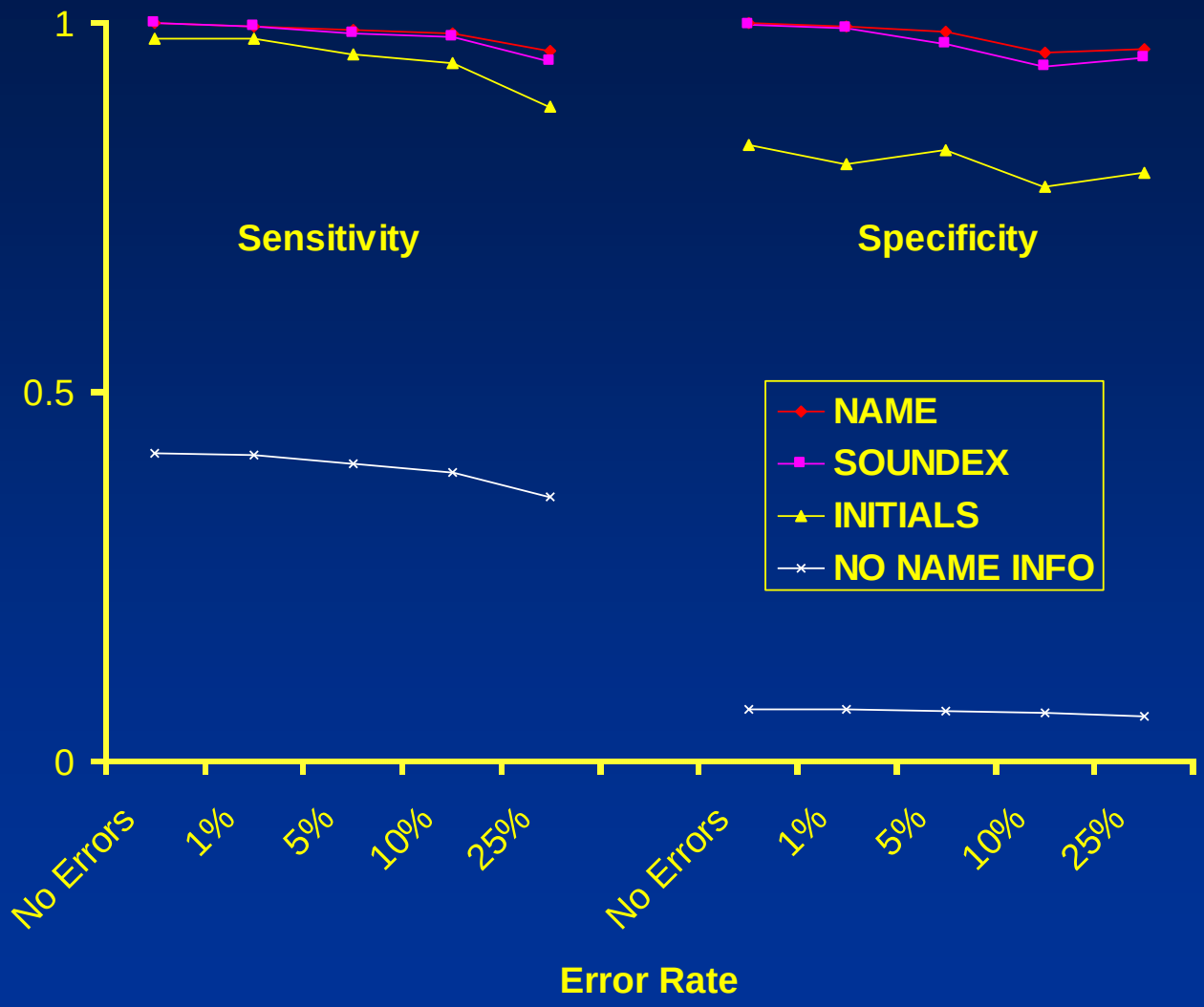
Linkage Performance Measures

- Sensitivity - Ability to recognize true matches
  - % of true matches identified
- Specificity - Ability to recognize incorrect matches
  - 1 – false positive rate

DOB, Gender, County, Time, Incident Date



DOB, Age, Gender, County, Time, Incident Date



Summary

- Is name information necessary?
  - If many non-name identifiers are available then name information may not be needed
  - If few non-name identifiers are available then name information becomes crucial
- Linkage feasibility test
  - Cook LJ, Olson LM, Dean JM. (2001). Probabilistic record linkage: relationships between file sizes, identifiers and match weights. *Methods Inf Med*, *40*(3), 196-203.

Software

Software

- CODES2000/LinkSolv
- Link Plus (CDC)
- Link King
- LinkageWiz
- Write your own
  - *Handbook of Record Linkage Methods for Health and Statistical Studies*, Howard Newcombe
- Pricing - Free to $$$$$

Software Checklist

- Add custom variable types and comparisons
- Unduplication / self match
- Link more than two files
- Size of databases
- Training and documentation

Other Record Linkage Hurdles

- Confidentiality concerns
  - IRBs & data sharing/use agreements
  - Separate tables of identifiers
- Databases
  - Missingness and accuracy of matching fields
  - Standardizing elements
  - Timeliness
- Analysis

Questions?

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