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**DBKDA 2016, Lisbon, 28.06.2016**

# *Current Trends in Information Searching/Query Answering*

*Moderator*

*Fritz Laux, Reutlingen University, Germany*

*Panelists:*

*Jerzy W. Grzymala-Busse, University of Kansas, USA*

*Dimitar Hristovski, University of Ljubljana, Slovenia*

*Andreas Schmidt, Karlsruhe University of Applied Sciences & Karlsruhe Institute of Technology, Germany*



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## Topics of the Panelists

- *Jerzy W. Grzymala-Busse: „Incompleteness versus inconsistency in Data Mining"*
- *Dimitar Hristovski: „Answering biomedical questions using semantic relations"*
- *Andreas Schmidt: „Named entity recognition and Disambiguation"*
- *Fritz Laux: „Answering Queries with Crowdsourcing"*

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## Crowdsourcing

- *Portmanteau: Crowdsourcing = Crowd + Outsourcing*
- *Definition: Outsourcing tasks to many Web users (the Crowd) Many complicated definitions:*
  - Jeff Howe: "Simply defined, crowdsourcing represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call."[1)]
  - Daren Brabham: ""online, distributed problem-solving and production model."[2)]
  - Christian Papsdorf: Crowdsourcing is the strategy of outsourcing working power by an organization or individual of usually internally performed payed services to a number of unknown persons to gain freely usable and direct economical benefit. (translated from [3)])
- *Using crowd intelligence to execute small, well defined human intelligence tasks (HIT)*

1) *Jeff Howe, "Crowdsourcing: A Definition" , URL: http://crowdsourcing.typepad.com/cs/2006/06/crowdsourcing_a.html, (2006).*
2) *Daren C. Brabham," Crowdsourcing as a Model for Problem Solving", URL: http://www.webcitation.org/67BLxbafe*
3) *Ch. Papsdorf, „Wie Surfen zu Arbeit wird", Crowdsourcing im Web 2.0, Campus Verlag2009, S. 69. ISBN: 359339040X*

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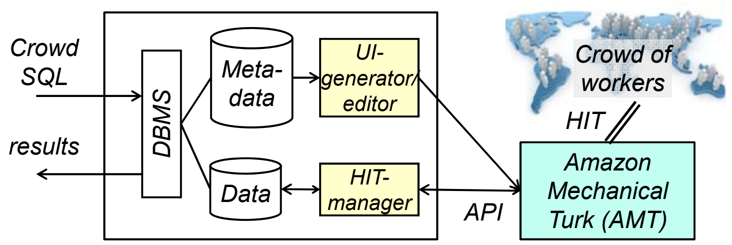
## Answering Queries with Crowdsourcing

- *Idea*
  - Combine human work and machine processing to get better semantics and more comprehensive query results
  - Using the Crowd to do work requiring human intelligence and split it into small tasks, called HITs
- *An Example: CrowdDB[1)]*
  - CrowdDB is a database with SQL extension for crowdsourcing. It uses Amazon Mechanical Turk (AMT)




[1)] *M. Franklin, D. Kossmann, T. Kraska, S. Ramesh, R. Xin; „CrowdDB: Answering Queries with Crowdsourcing", ACM SIGMOD 2011, Athens, Greece*

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## CrowdDB

- *New functionality: Answer queries the cannot be answered by computer only, e.g.*
  - Processing requires human input that is missing
  - Performing functions like matching, ranking or summary based on fuzzy criteria
  - Closed world assumption is given up
- *Small extension of SQL required*
  - Crowd colums/tables, CNULL
- *Problems*
  - How to identify and divide the workload for crowdsourcing
  - Formulate precise HITs → cultural background
  - Quality of results

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## SQL Extension[1] of CrowdDB

- *SQL DDL Extensions*
  - *Crowdsourced column (→ missing values suppl. by crowd)*
  - *Crowdsourced table (→ missing records supplied by crowd)*
- *Examples*
  - *SELECT market_capitalization FROM company WHERE name = "I.B.M."*
    - ⇨ *Empty answer if no record for "I.B.M." is found or name was entered differently*
    - ⇨ *Easy to find answer for a person with internet access*
  - *SELECT image FROM picture WHERE subject like "business" ORDER BY relevance LIMIT 1*
    - ⇨ *Easy to answer for humans*
    - ⇨ *If no relevance to a specific topic or if the name instead of the subject has been previously stored this query cannot be answered by the computer*

*[1] M. Franklin, D. Kossmann, T. Kraska, S. Ramesh, R. Xin; „CrowdDB: Answering Queries with Crowdsourcing“, ACM SIGMOD 2011, Athens, Greece*

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## Generating query forms for crowdsourcing

- *Query Interfaces for Crowdsourcing generated from the DB-Schema*
  - Similar to other Tools like MS Access, Oracle Forms
- *Helps to produce forms for micro tasks*
- *Only well defined simple tasks like*
  - Searching for simple facts (e.g. phone number, number of inhabitants, prices)
  - Fuzzy tasks (e.g. finding similarities of pictures, providing a short description of a picture, entity disambiguation)

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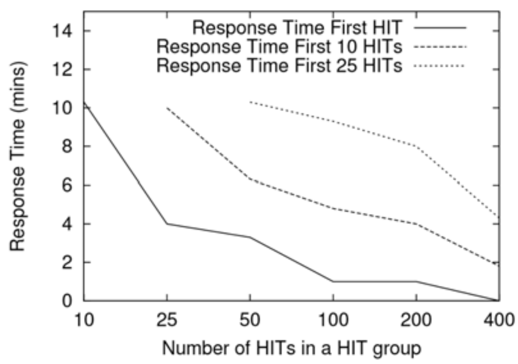
## Experimental Results I

- *CREATE TABLE company (name VARCHAR PRIMARY KEY, phone_no CROWD VARCHAR(32), address CROWD VARCHAR(256));*
- *SELECT phone_no, address FROM company;*




- *Similar tasks (a HIT-group) lead to faster first response*
- *For HIT-groups > 200 HITs a majority result can be expected within < 4 min*

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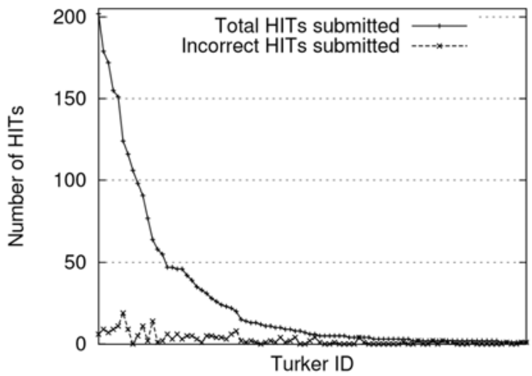
## Experimental Results II

- *CREATE TABLE company (name VARCHAR PRIMARY KEY, phone_no CROWD VARCHAR(32), address CROWD VARCHAR(256));*
- *SELECT * FROM company;  (5 Assignments/HIT)*




- *Highly skewed performance of workers (community)*
- *Error rate is nearly independent of the performance*

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## Experimental Results III

- *SELECT p FROM picture*
  *WHERE subject = "Golden Gate Bridge"*
  *ORDER BY CROWDORDER(p,*
  *"Which picture visualizes better %subject");*


*Pictures of the Golden Gate Bridge from Flickr ordered by workers*
*Legend of the numbers a,b,c: a = votes from workers, b = rank based on votes from workers, c= rank by experts*

- *The Crowd is very good in ordering pictures*

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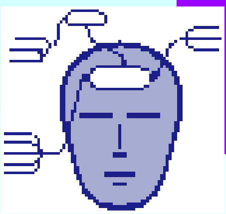

# Biomedical Question Answering using Semantic Relations


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Thomas C Rindflesch[3]

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*Medical faculty, University of Ljubljana*
*[2] Medical faculty Maribor, Slovenia*
*[3]National Library of Medicine, National Institutes of Health, Bethesda, MD, U.S.A.*

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# Introduction

- Avalanche of information in biomedicine
- Evidence-based Medicine. Clinical practice should be based on evidence. On average, 2 min available for answering a question, but 30 min needed to find answer
- The importance of bibliographic databases, especially MEDLINE
- Information retrieval (IR) tools (e.g. Entrez for PubMed) most frequently used to search MEDLINE

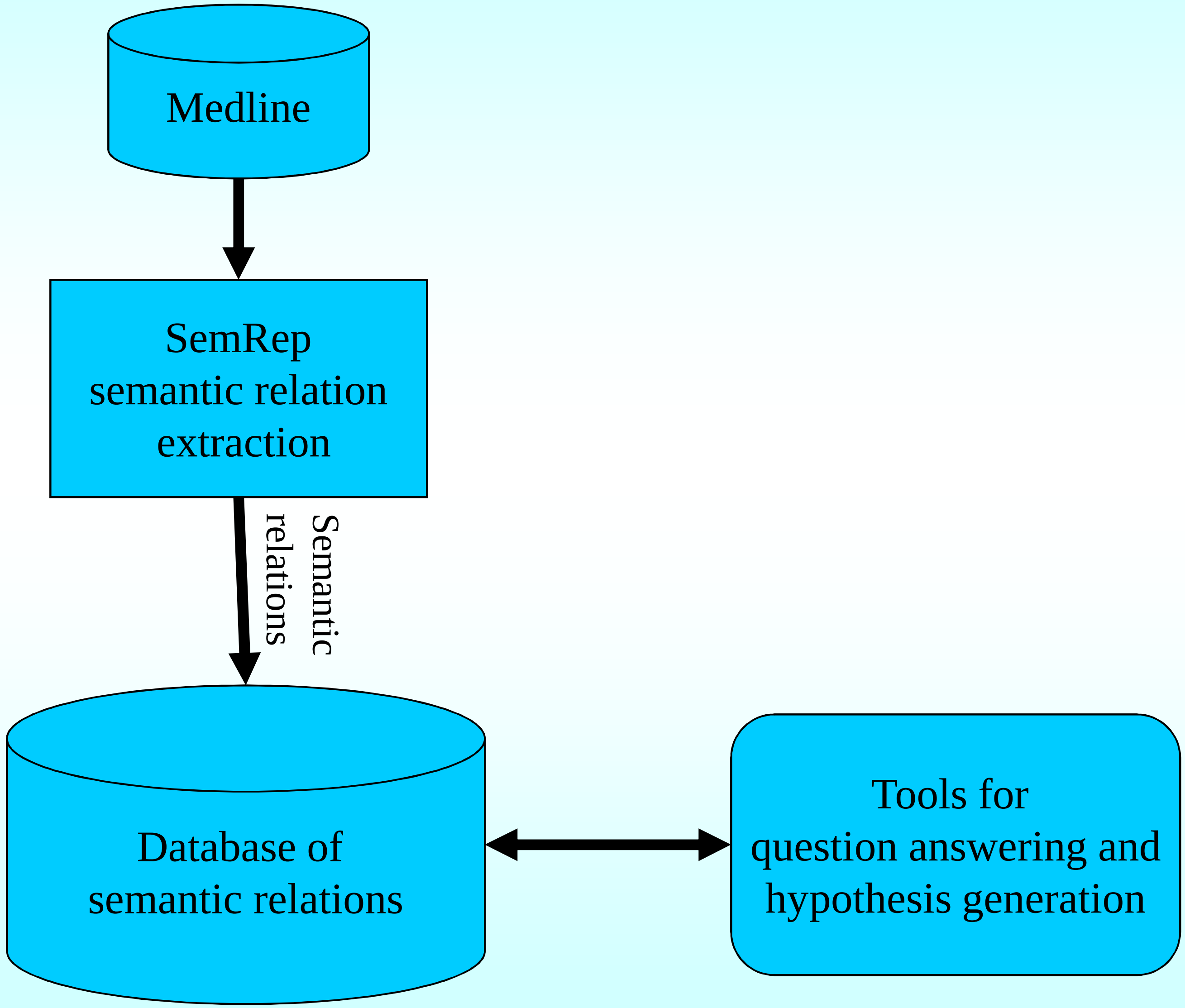
# Information Retrieval Tools

- Fast and robust, but:
- Return hits (bibliographic records) as results
- Users must read the returned hits to extract the facts (<u>answers</u>)
- Users cannot ask: Which drugs are used to treat disease X?
- But only: Find relavant <u>articles</u>, which talk about how to treat disease X!

# Question Answering

- Allows more precise questions with relations between concepts:
  - Which drugs are used to treat disease X?
  - Which diseases are treated with drug Y?
  - What is causing X?
- First returns facts (answers) and then, on demand, the articles
- Benefits for the user:
  - Less to read
  - Faster and easier to more precise answers

# Our Approach - SemBT



# What is used to treat Alzheimer's disease

Relations found: 1145

## SemBT Biomedical Question Answering and Discovery

Semantic relation search

Query:

TREATS Alzheimer's disease

Expand: none Filters:

Microarray Filter

Experiment: none . Limit arguments any to top N 100

all genes at p <= 0.0001 .

Search

*Semantic Relations:*

| Subject | Sem Relation | Object | Frequency |
|---|---|---|---|
| Cholinesterase Inhibitors | TREATS | Alzheimer's Disease | 443 |
| donepezil | TREATS | Alzheimer's Disease | 404 |
| Acetylcholinesterase Inhibitors | TREATS | Alzheimer's Disease | 340 |
| Memantine | TREATS | Alzheimer's Disease | 222 |
| Galantamine | TREATS | Alzheimer's Disease | 216 |
| Tacrine | TREATS | Alzheimer's Disease | 204 |
| rivastigmine | TREATS | Alzheimer's Disease | 196 |
| Intervention regimes | TREATS | Alzheimer's Disease | 165 |
| Immunotherapy | TREATS | Alzheimer's Disease | 132 |
| Assessment procedure | TREATS | Alzheimer's Disease | 119 |
| Application procedure | TREATS | Alzheimer's Disease | 110 |
| Therapeutic agent (substance) | TREATS | Alzheimer's Disease | 92 |
| Diagnosis | TREATS | Alzheimer's Disease | 90 |
| Expression procedure | TREATS | Alzheimer's Disease | 79 |
| Antioxidants | TREATS | Alzheimer's Disease | 75 |
| Pharmacotherapy | TREATS | Alzheimer's Disease | 56 |
| Physostigmine | TREATS | Alzheimer's Disease | 55 |

# Evidence for the Answers

Evaluate   You are signed in as: mitko

| donepezil | TREATS | Alzheimer's Disease | Correc |
|---|---|---|---|
| The acetylcholinesterase inhibitors, **donepezil** , galantamine and rivastigmine have been approved for the **treatment** of mild-to-moderate **Alzheimer's dementia** , the NMDA inhibitor memantine is approved for moderate-to-severe Alzheimer's disease. (PMID: 15376702) | | | - |
| RESULTS: Saffron at this dose was found to be effective similar to **donepezil** in the **treatment** of mild-to-moderate **AD** after 22 weeks. (PMID: 19838862) | | | - |
| **Donepezil for Alzheimer's disease** in clinical practice--The DONALD Study. (PMID: 15084792) | | | - |
| AD2000: **donepezil in Alzheimer's disease** . (PMID: 15220027) | | | - |
| **Donepezil for** severe **Alzheimer's disease** . (PMID: 16581383) | | | - |
| Metaanalysis of randomized trials of the efficacy and safety of **donepezil** , galantamine, and rivastigmine for the **treatment** of **Alzheimer disease** . (PMID: 15249273) | | | - |
| OBJECTIVES: To compare directly, in the same patient cohort, the ease of use and tolerability of **donepezil** and galantamine in the **treatment** of **Alzheimer's disease** (AD), and investigate the effects of both treatments on cognition and activities of daily living (ADL). (PMID: 14716700) | | | - |
| Data were pooled from three randomized, placebo-controlled trials of **donepezil for** severe **AD** to further evaluate treatment effects and overall tolerability/safety. (PMID: 19735164) | | | - |
| BACKGROUND: Cholinesterase inhibitors, such as galantamine, **donepezil** and rivastigmine are approved for symptomatic **treatment** of **Alzheimer's Disease** (AD) in Canada. (PMID: 14675494) | | | - |
| **Donepezil** for the **treatment** of mild to moderate **Alzheimer's disease** in France: the economic implications. (PMID: 14560059) | | | - |
| A long-term comparison of galantamine and **donepezil** in the **treatment** of **Alzheimer's disease** . (PMID: 12875613) | | | - |
| [Effect of memantine treatment on patients with moderate-to-severe Alzheimer's disease treated with donepezil]. (PMID: 20201245) | | | - |
| Are there long-term benefits of **donepezil in Alzheimer's disease** ? (PMID: 15559925) | | | - |
| To create a reproducible observation, the sentences occurring at five specific text sites in all 18 RCTs of **donepezil for AD** were tabulated, as were study design, sources of financial support, and outcomes that could | | | - |

# Argument expansion and faceting

Relations found: 15849

## SemBT Biomedical Question Answering and Discovery

**Filters:**

***Subject:***

| Value | Count |
|---|---|
| Lesion | 447 |
| Genes | 59 |
| TP53 | 54 |
| TP53 gene | 53 |
| Smoking | 52 |
| Single Nucleotide Polymorphism | 46 |
| response | 43 |
| Alcohol consumption | 40 |
| Antimicrobial susceptibility | 40 |
| Cigarette Smoking | 40 |
| Observation parameter | 40 |
| MicroRNAs | 38 |
| Proteins | 38 |
| CDKN2A | 37 |
| Consumption-archaic term for TB | 37 |
| Obesity | 37 |
| DNA | 35 |
| Body mass index | 34 |
| EGFR | 34 |
| Behavior | 32 |
| Estrogens | 32 |
| GSTM1 | 32 |
| Carrier of disorder | 31 |

Semantic relation search

Query: arg_name:neoplasms AND relation:PREDISPOSES

Expand: both Filters: ☑

Microarray Filter

Experiment: none . Limit arguments any to top N 100

all genes at p <= 0.0001 .

Search

*Semantic Relations:*

| Subject | Sem Relation | Object | Frequency |
|---|---|---|---|
| Prostate-Specific Antigen | PREDISPOSES | Malignant neoplasm of prostate | 262 |
| Estrogens | PREDISPOSES | Malignant neoplasm of breast | 209 |
| Smoking | PREDISPOSES | Malignant neoplasm of lung | 199 |
| Obesity | PREDISPOSES | Malignant neoplasm of breast | 155 |
| Fibrosis | PREDISPOSES | Primary carcinoma of the liver cells | 148 |
| Alcohol consumption | PREDISPOSES | Malignant neoplasm of breast | 122 |
| Helicobacter Infections | PREDISPOSES | Malignant neoplasm of stomach | 111 |
| BRCA1\|BRCA1 gene | PREDISPOSES | Malignant neoplasm of breast | 110 |
| Carrier of disorder | PREDISPOSES | Malignant neoplasm of breast | 91 |
| Sun Exposure | PREDISPOSES | melanoma | 83 |
| Smoker | PREDISPOSES | Malignant neoplasm of lung | 81 |
| Single Nucleotide Polymorphism | PREDISPOSES | Malignant neoplasm of breast | 79 |
| Cigarette Smoking | PREDISPOSES | Malignant neoplasm of lung | 78 |
| Physical activity | PREDISPOSES | Malignant neoplasm of breast | 77 |
| Genes | PREDISPOSES | Malignant neoplasm of breast | 76 |
| Simian B disease | PREDISPOSES | Primary carcinoma of the liver cells | 74 |

# Conclusion

- Tool for biomedical question answering presented
- Based on semantic relations extracted from the biomedical literature
- Able to answer various biomedical questions
- Complementary to existing information retrieval systems
- Available at: **http://sembt.mf.uni-lj.si**
- Paper: Hristovski2015, BMC Bioinformatics 2015 16:6

# Incompleteness versus Inconsistency in Data Mining

**Jerzy W. Grzymala-Busse'''**

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'' Department of Expert Systems and Artificial Intelligence,

University of Information Technology and Management, 35-225 Rzeszow, Poland

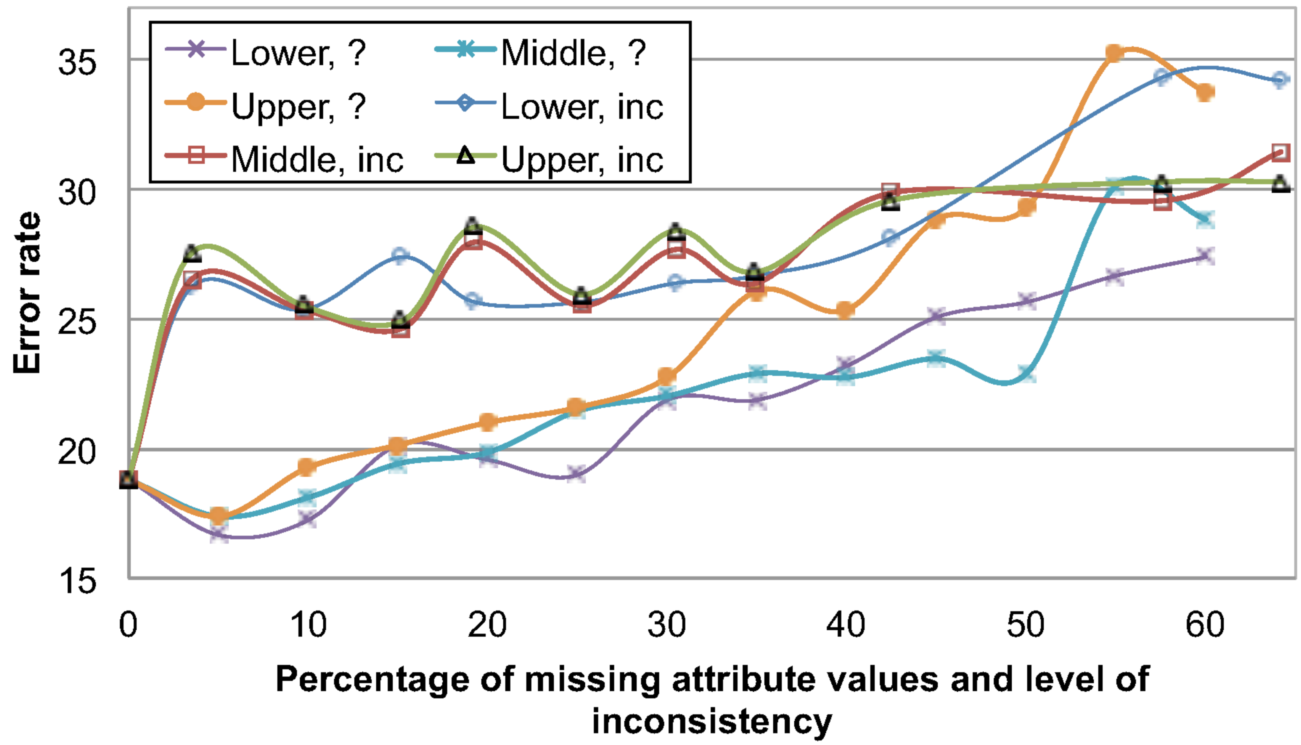
# An Incomplete Data Set

| | Attributes | | | Decision |
|---|---|---|---|---|
| Case | Age | Cholesterol | Weight | Risk |
| 1 | ? | 180..210 | 140..170 | low |
| 2 | 45..60 | ? | 170..210 | low |
| 3 | 20..45 | ? | ? | low |
| 4 | 45..60 | 180..210 | 170..210 | low |
| 5 | 45..60 | ? | 170..210 | high |
| 6 | ? | 210..220 | ? | high |
| 7 | 45..60 | 180..210 | ? | high |

# An Inconsistent Data Set

| | Attributes | | | Decision |
|---|---|---|---|---|
| Case | Age | Cholesterol | Weight | Risk |
| 1 | 20..45 | 180..210 | 140..210 | low |
| 2 | 45..60 | 180..210 | 140..210 | low |
| 3 | 45..60 | 180..210 | 140..210 | low |
| 4 | 45..60 | 210..220 | 140..210 | high |
| 5 | 45..60 | 180..210 | 210..220 | high |
| 6 | 20..45 | 210..220 | 140..210 | high |
| 7 | 20..45 | 210..220 | 140..210 | low |

# *Australian* data set



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**The Eight International Conference on Advances in Databases, Knowledge, and Data Applications**

**June 26 - 30, 2016 - Lisbon, Portugal**

# PANEL on DBKDA/GraphSM/WEB

# Topic: Current Trends on Information Searching/Query Answering

**Andreas Schmidt**

**Department of Informatics and**
**Business Information Systems**
**University of Applied Sciences Karlsruhe**
**Germany**

**Institute for Applied Computer Sciences**
**Karlsruhe Institute of Technologie**
**Germany**

# Semantic Search

- Understanding the semantic of text (content analysis) is an essential key asset for advanced searching
- To understand the semantic of text, we have to determine
  - the identity of the (main) entities (i.e. Paul -> 'Pope John Paul')
  - the relations between the identified entities ( <a> lives_in <b>)
  - the hierarchies of the identified relations

Named Entity Disambiguation

# Named Entity Recognition (NER)

- Discovering single-word or multi-word phrase entities (mentions) in text, like
  - Persons
  - Organizations
  - Locations
  - Temporal expressions
  - Works of Art
  - Product names

accuracy > 90%
Popular system:
Stanford NER [FGM05]

- Approaches based on
  - handcrafted, rule based algorithms
  - linguistic grammar-based techniques
  - statistical models (machine learning)

## Example (from [AIDA])

Michael was the father of Ingres and Postgres, two relational database systems developed at Berkeley. Research at Stanford led to a search engine company, founded by Page and Brin.

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# Step 1 - NER

**mentions**

Michael was the father of Ingres and Postgres, two relational database systems developed at Berkeley. Research at Stanford led to a search engine company, founded by Page and Brin.

# Step 2- NED

[Michael Jackson]

[Michael Moore]

[Michael Stonebraker]

[Michael Pollan]

[ ... ]

Michael was the father of Ingres and Postgres, two relational database systems developed at Berkeley. Research at Stanford led to a search engine company, founded by Page and Brin.

[ ... ]

[William Berkeley (governor)]

[Berkeley, California]

[University of California, Berkeley]

[Berkeley Square]

[Lennox Berkeley]

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Michael was the father of Ingres and Postgres, two relational database systems developed at Berkeley. Research at Stanford led to a search engine company, founded by Page and Brin.

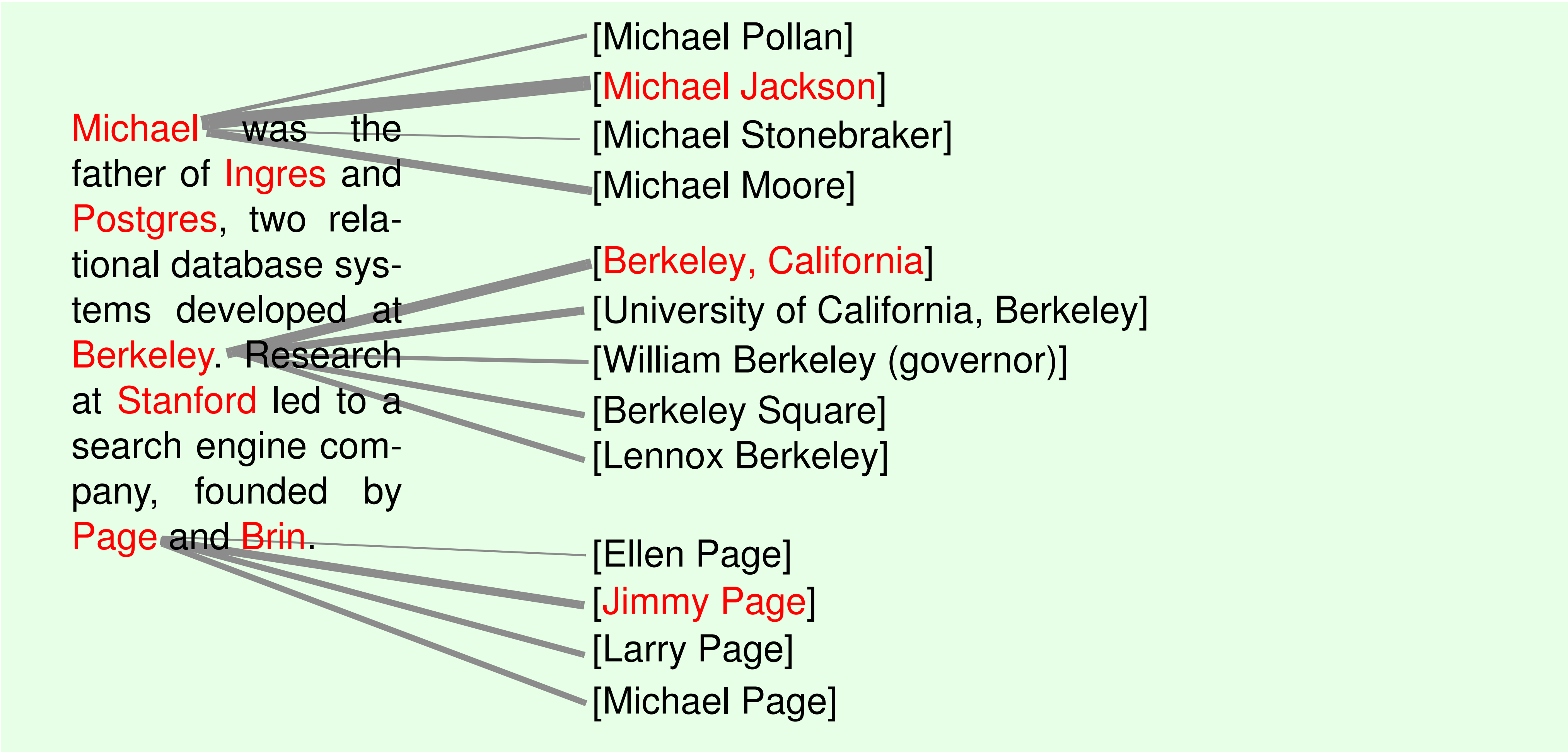
[Michael Pollan]
[Michael Jackson]
[Michael Stonebraker]
[Michael Moore]

[Berkeley, California]
[University of California, Berkeley]
[William Berkeley (governor)]
[Berkeley Square]
[Lennox Berkeley]

[Ellen Page]
[Jimmy Page]
[Larry Page]
[Michael Page]

# **NED -** How to disambiguate a mention?

- Baseline:
  - Choose the most prominent entity (longest wiki article, arti-cle with most inlinks, biggest city, ...)
  - Choose the entity that uses the mention most frequently as link anchor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[Lennox Berkeley]
[Ellen Page]
[Jimmy Page]
[Larry Page]
[Michael Page]

# **NED -** How to disambiguate a mention?

- Baseline:
  - Choose the most prominent entity (longest wiki article, article with most inlinks, biggest city, ...)
  - Choose the entity that uses the mention most frequently as link an-chor
- Improvement:
  - Consider multiple mentions at once and consider the semantic re-latedness between the possible entities

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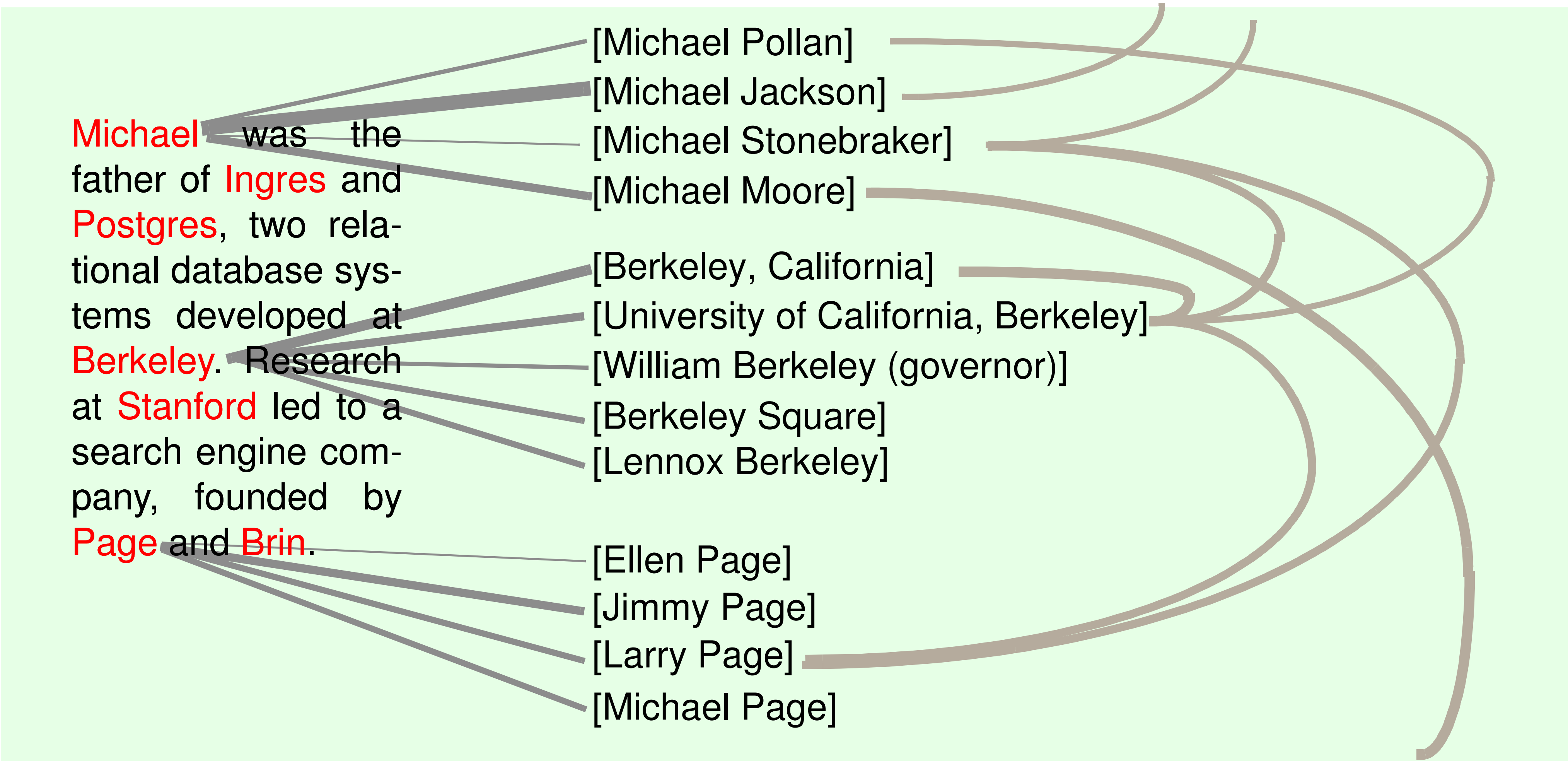

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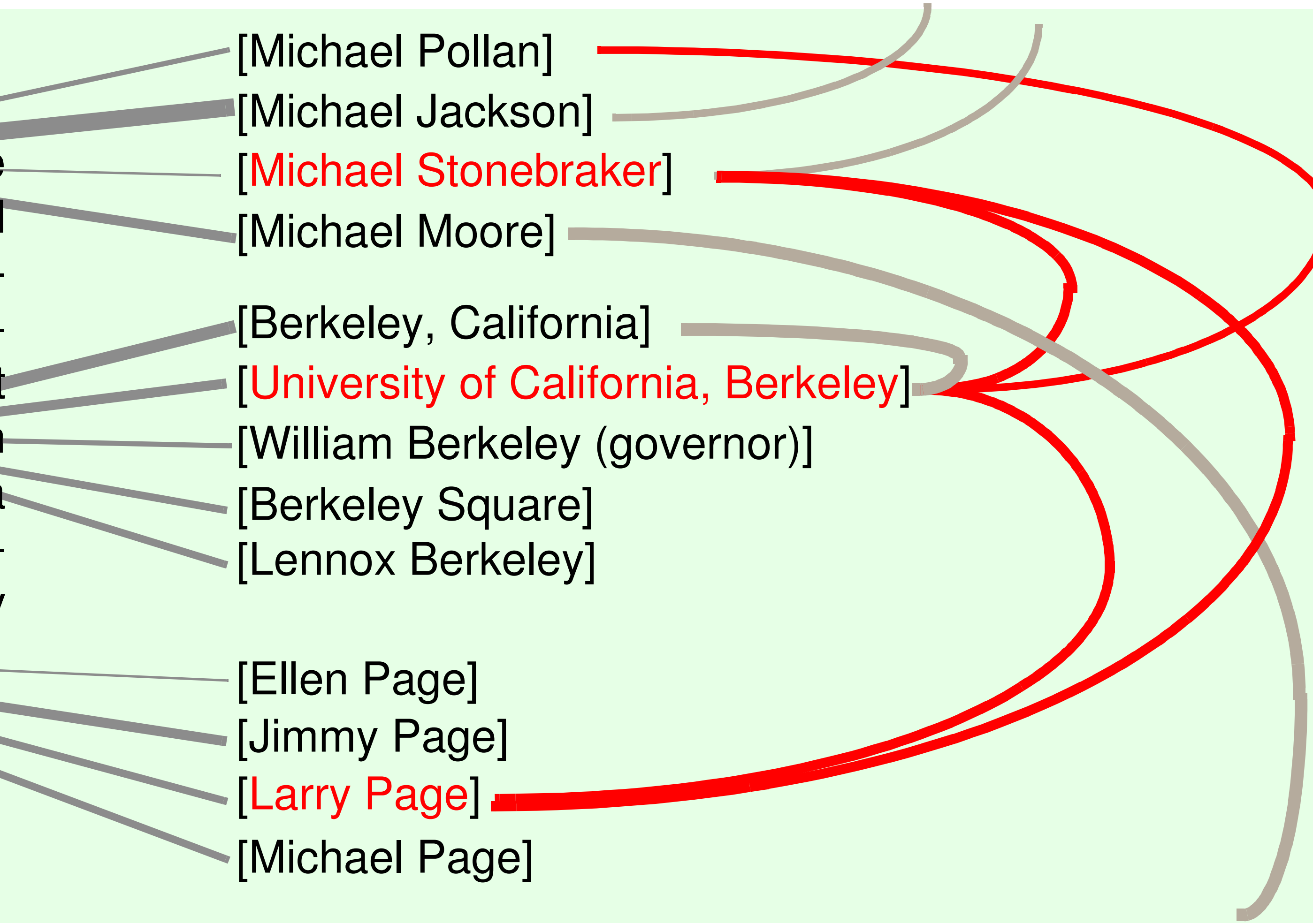

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# Further (difficult) Examples of Disambiguation (from [Hof15])

- Italy recalled Marcello Cuttitta on Friday for their friendly against Scotland at Murrayfield [...].

Murrayfield_Stadium

Scotish_Rugby_Team

Marcello_Cuttitta_(Rugby Player)

Italian_Rugby_Team

# Can you disambiguate this?

When Page played Kashmir at Knebwort, his Les Paul was uniquely tuned

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# Can you disambiguate this?

When Page played Kashmir at Knebwort, his Les Paul was uniquely tuned

Jimmy Page

Kashmir_(Song)

E-Guitar

Rock_Festival

# References


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