

Information Extraction

CIS, LMU München
Winter Semester 2021-2022

Prof. Dr. Alexander Fraser, CIS

Information Extraction – Administravia - I

- Vorlesung
 - Learn the basics of Information Extraction (IE)
 - Weekly lecture from me here in BU 101
 - Exactly the same scientific content as last year
 - "Administravia" is slightly different, see these slides (also uploaded after class)
 - 2020-2021 videos are available, use these to review
- Seminar
 - There are two seminars! **You come to just one of the two sessions**, either Wednesdays 10:00 (Group 01) or Thursdays 10:00 (Group 02)
 - You should have received an LSF-email stating which day you are registered for
 - Wed is in this building, Thurs is in main building
 - You will present an oral report and then submit a written version later
 - Oral reports will be done in groups of 3 students working on a single topic

Information Extraction – Administravia - II

- Registration:
 - If you are a CIS Student: check whether you are registered for **both** the Vorlesung and the Seminar (these are **two things** in LSF!)
 - Please **ignore the Modulteilprüfung** entries
 - Make sure you are registered for the Seminar and the Vorlesung
 - There are a good number of people only in the Vorlesung
 - There are just a couple of people only in the Seminar

Information Extraction – Administravia - III

- Vorlesung and Seminar are two separate courses (in same module for CIS people)
 - However, there will be some shifting around of slots
- Vorlesung (Grade):
 - Klausur in February entirely determines the Vorlesung grade
- Seminar (Grade):
 - Referat
 - Hausarbeit (write-up of the Referat) (6 pages, independent for each student, due **3 weeks** after you hold your Referat)
- Grades of Vorlesung and Seminar are independent
- CIS-ler: No Notenverbesserung

Information Extraction – Administravia - IV

- Syllabus: see WS last year
 - Brief idea at end of this slide deck
- List of Referatsthemen for the Seminar
 - This will be presented *here* in the Vorlesung, in two weeks on Nov 3rd
- Literature:
 - Required: **Sunita Sarawagi. Information Extraction.** Foundations and Trends in Databases, 1(3):261–377, 2008. (good survey paper, somewhat brief)
 - **Please read the introduction for next week (it is available on the web page!)**
 - Optional: Christopher D. Manning, Prabhakar Raghavan and Hinrich Schuetze, *Introduction to Information Retrieval*, Cambridge University Press. 2008. (good information retrieval textbook, preview copies available from the book website: <http://nlp.stanford.edu/IR-book/>)

- Questions?

Information Extraction

- An introduction to the course
 - The topic "Information Extraction" means different things to different people
 - In this course we will look at several different perspectives
 - There is unfortunately no comprehensive textbook that includes all of these perspectives

My Biases

- As you may have noticed by now: I am from the US (PhD in Computer Science from USC/ISI, Artificial Intelligence division)
- I am a professor here at CIS
- I do research in the broad area of **statistical NLP**
 - I mostly work on **machine translation**, and related structured prediction problems (e.g., treebank-based syntactic parsing, generation using sequence (tagging) models)
 - I also work on other multilingual problems such as cross-language information retrieval
- With respect to **rule-based NLP** (with manually written rules), I'll try to be as fair as humanly possible
 - I do use these techniques sometimes too

Outline for today

- Motivation
 - Problems requiring information extraction
 - Basic idea of the output
- Abstract idea of the core of an information extraction pipeline
- Course topics

A problem



Mt. Baker, the school district

Baker Hostetler, the company


Baker, a job opening

[Bakery Jobs on CareerBuilder.com](#)

www.careerbuilder.com/jobs/keyword/bakery 


Jobs 1 - 25 of 579 – Looking for **Bakery Jobs**? See currently available job **openings** on CareerBuilder.com. Browse the current listings and fill out job applications.

[Baker Jobs, Employment | Indeed.com](#)

www.indeed.com/q-Baker-jobs.html 

Jobs 1 - 10 of 16047 – 16047 **Baker Jobs** available on Indeed.com. one search. all jobs.

[Job Openings - Baker University](#)

www.bakeru.edu > Jobs 

If you are seeking employment in any of these areas, contact **Baker** University.

[Baker, LA Jobs on CareerBuilder.com](#)

www.careerbuilder.com/Jobs/Baker/ 

Jobs 1 - 25 of 948 – Looking for **Baker, LA Jobs**? See currently available **job openings** on CareerBuilder.com. Browse the current listings and fill out **job ...**

[Down Under Bakery Pies: Job Openings at DUB Pies](#)

www.dubpies.com/jobs.php 

Listing of **job openings** at DUB Pies. Down Under **Bakery** (DUB) Pies is looking for more staff - check out our list of vacancies.

[Field Engineers | Geoscience | Jobs and Careers at Baker Hughes](#)

jobs.bakerhughes.com/ 


... Oil and Natural Gas? **Baker Hughes** has career information for you on these, more. ... Search **Jobs**. **Baker Hughes Jobs** ... Recent **Job Openings**. Completion ...

[Corner Bakery Job Openings | Glassdoor](#)

www.glassdoor.com/Job/Corner-Bakery-Job-Openings-E297310_P2... 

45 Corner **Bakery job openings**. Search job openings, see if they fit - company salaries, reviews, and more posted by Corner Bakery employees.

[Jobs - Baker University](#)


www.bakeru.edu/jobs 

See links at left for a complete list of **Baker** University **job openings**. It is the policy of **Baker** University to afford equal opportunity for all persons without distinction ...

A solution

job search find employment careers @ FlipDog.com free! - Microsoft Internet Explorer
Address http://www.flipdog.com/home.html

FlipDog.com
Home Find Jobs Your Account Resource Center Support Employers
Job Search at FlipDog.com: Employment & Career Management


647,514
Job Opportunities
from **53,641** Employers
[Find a Job!](#)
[Post Your Resume](#)
Employers
click here for
Products & Services

Job Seekers: Find your dream job!

- ▶ Check our 'Best Places to Find a Job' [January report](#).
- ▶ Open your [FREE account](#) and put your [resume online](#).
- ▶ Search 24x7 with our FREE automatic [JobHunters](#)™.
- ▶ Research our database of over [50,000 employers](#).
- ▶ Get [expert advice](#) at our new [Resource Center](#).
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- ▶ Use FlipDog.com to search jobs right from your desktop! Download [Snippets](#) today!

Pigskin Places

- Health Care in NY [2,770](#)
- Health Care in MD [1,262](#)
- Sales in NY [3,751](#)
- Sales in MD [958](#)
- Computing in NY [8,050](#)
- Computing in MD [4,114](#)

Jobs for Sports Fans

- [Head Football Coach](#)
- [Football Coach](#)
- [Asst. Football Coach](#)
- [High School Football Coach](#)
- [Univ. Asst. Football Coach](#)

Job Seeker Newsletter

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Showcase Jobs

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Looking for a Vice President of Academic Affairs to oversee planning, operation and evaluation of the college's academic programs.
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WhizBang!

 "Top 100 Web Sites"
PC Magazine, Nov. 2000

 "Top 10 Career Web Site"
Media Matrix, Sept. 2000

 "Top 10 Job Site"

Internet



FlipDog.com

Fetch Your Next Job Here™

Employers Support

Home

Find Jobs

Your Account

Resource Center

Return to Results | Modify Search | New Search



Learn While You Earn
MBA, BA, AA Degrees
Online & Project Mgt.

Click here to e-mail your resume to 1000's
of Head Hunters with
ResumeZapper.com



Breakthrough ebook
shows why most people
are WRONG about how
to apply for jobs.

1 - 25 of 47 jobs shown below

1 2 Next >

Search these results for:



Search tips

Show Jobs Posted:

For all time periods

View: Brief | Detailed

Web Jobs: FlipDog technology has found these jobs on thousands of employer Web sites.

Food Pantry Workers at Lutheran Social Services	October 11, 2002	Archbold, OH
Cooks at Lutheran Social Services	October 11, 2002	Archbold, OH
Bakers Assistants at Fine Catering by Russell Morin	October 11, 2002	Attleboro, MA
Baker's Helper at Bird-in-Hand	October 11, 2002	United States
Assistant Baker at Gourmet To Go	October 11, 2002	Maryland Heights, MO
	October 10, 2002	Beaverton, OR
	October 10, 2002	Alta, UT
	October 10, 2002	Huntsville, UT
School District	October 10, 2002	Garden Grove, CA
	October 10, 2002	Houma, LA
	October 10, 2002	Nisswa, MN
	October 10, 2002	Big Sky, MT
	October 08, 2002	Willowbrook, IL
Cake Decorator/Baker at Mandalay Bay Hotel and Casino	October 08, 2002	Las Vegas, NV
Shift Supervisors at Brueggers Bagels	October 08, 2002	Minneapolis, MN

Job Openings:
Category = Food Services
Keyword = Baker
Location = Continental U.S.

Extracting Job Openings from the Web

OPUS International, Inc., an executive search firm focusing on the Food Science industry. - Microsoft Internet Explorer

File Edit View Favorites

Back Forward Stop

Address http://www.foodscier.com/jobs_midwest.html#top

Links AMEX Rewards Time DogHouse My Yahoo!

Welcome

About OPUS

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Job Hunt Hints

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OPUS INTERNATIONAL INC.

About | Staff | Job

OPUS: Job Listings - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites

Address http://www.foodscience.com/jobs_midwest.html#top

Links AMEX Rewards Time DogHouse My Yahoo!

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Test Kitchen - Consumer Food Relations

Major food manufacturer in Chicago area seeks a consumer food professional to write and test recipes. Will make presentations and marketing; will be a key player on a cross-functional team. Requires a BS in human ecology, nutrition, Food Science, or related field, plus a minimum three years applicable experience.

Contact: Moira: e-mail: 1-800-488-2611

Ice Cream Guru

If you dream of cold creamy chocolate or gooey cookie, there's a great opportunity for you to maintain and expand this major corporation's high-end ice cream brand. Will be based in the Upper Midwest for about a year. After that, California here I come! Requires a BS in Food Science or dairy, plus ice cream formulation experience. Will consider entry level with an MS and an internship.

Contact: Susan: e-mail: 1-800-488-2611

Title: Ice Cream Guru

Description: If you dream of cold creamy...

Contact: susan@foodscience.com

Category: Travel/Hospitality

Function: Food Services



Another Problem

The screenshot shows an eBay Express search results page for "Necklaces & Pendants". The browser window title is "eBay Express: Necklaces & Pendants in Pendants & Lockets, Solid Gold items for sale - Mozilla Firefox". The address bar shows the search URL. The page features a navigation bar with categories like Apparel & Accessories, Books, Computers & Networking, Consumer Electronics, Home & Garden, Jewelry & Watches, Sporting Goods, Fall Fashion, and More Categories. A search bar is present with the text "Necklaces & Pendants" and a "Search" button. Below the search bar, the page indicates "2,239 matches found" and "New items only".

Filters are applied for Style (Pendants & Lockets), Metal & Material (Solid Gold), and Gemstone & Stone (Diamond). The main content area displays a list of filter options:

- Pendant Shape, Theme**
 - Hearts & Love (893)
 - Solitaires (499)
 - Cross (479)
 - Flowers (121)
 - More choices...
- Gold Type**
 - White Gold (1,222)
 - Yellow Gold (616)
 - Rose Gold (13)
 - Not Specified (388)
 - More choices...
- Main Shape**
 - Heart (649)
 - Round (364)
 - Square, Princess (88)
 - Emerald (18)
 - More choices...
- Total Carat Weight**
 - 0.29 to 0.45 carats (105)
 - 0.46 to 0.69 carats (183)
 - 0.70 to 0.99 carats (115)
 - 1.00 to 1.49 carats (299)
 - More choices...

A pop-up window titled "Options to Browse" is open, showing a list of pendant shapes and themes with checkboxes and item counts:

- Pendant Shape, Theme**
 - Angel (2)
 - Cluster (26)
 - Cross (467)
 - Flowers (122)
 - Hearts & Love (878)
 - Letters, Initials (4)
 - Lockets (50)
 - Solitaires (494)
 - Stars (13)
 - Not Specified (147)

The page also shows a "More options to browse" section with links for Price, Brand, Gender, and Condition. At the bottom, there is a "Grid View" and "List View" toggle, and a "Sort by" dropdown menu. A small image of a necklace is visible in the bottom left corner.

Often structured information in text

0.44 CT ROUND CUT DIAMOND PENDANT 14 K WHITE GOLD Classic style and beauty, this comfortable 14 K White gold pendant contains:
An Ideal cut Round 0.44 CT Diamond, in a magnificent high polish bezel.

- Color: F
- Clarity: SI-1
- Setting: 14 K White Gold
- Chain: 16 inches 14 K White Gold
- Weight: 3.4 g
- Measurements: 10 mm x 10 mm

- Retail Price: \$2,319.00
- Close Out Price: \$889.00

EXAMPLE

Another Problem

A Critical Evaluation of Commensurable Abduction Models for Semantic Interpretation (1990) (Correct) (5 citations)

Peter Norvig Robert Wilensky University of California, Berkeley Computer...
Thirteenth International Conference on Computational Linguistics, Volume 3

Download: [norvig.com/coling.ps](#)
Cached: [PS.gz](#) [PS](#) [PDF](#) [DjVu](#) [Image](#) [Update](#) [Help](#)

From: [norvig.com/resume \(more\)](#)
Home: [R.Wilensky](#) [HPSearch](#) [\(Correct\)](#)

NEC ResearchIndex [Bookmark](#) [Context](#) [Related](#)

[\(Enter summary\)](#)

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Abstract: this paper we critically evaluate three recent abductive interpretation models, those of Charniak and Goldman (1989); Hobbs, Stickel, Martin and Edwards (1988); and Ng and Mooney (1990). These three models add the important property of commensurability: all types of evidence are represented in a common currency that can be compared and combined. While commensurability is a desirable property, and there is a clear need for a way to compare alternate explanations, it appears that a single scalar measure is not enough to account for all types of processing. We present other problems for the abductive approach, and some tentative solutions. [\(Update\)](#)

Context of citations to this paper: [More](#)

.... (break slight modification of the one given in [Ng and Mooney, 1990] The new definition remedies the anomaly reported in [Norvig and Wilensky, 1990] of occasionally preferring spurious interpretations of greater depths. Table 1: Empirical Results Comparing Coherence and...

.... costs as probabilities, specifically within the context of using abduction for text interpretation, are discussed in [Norvig and Wilensky \(1990\)](#). The use of abduction in disambiguation is discussed in Kay et al. 1990) We will assume the following: 13) a. Only literals...

Cited by: [More](#)

[Translation Mismatch in a Hybrid MT System - Gawron \(1999\)](#) (Correct)
[Abduction and Mismatch in Machine Translation - Gawron \(1999\)](#) (Correct)
[Interpretation as Abduction - Hobbs, Stickel, Appelt, Martin \(1990\)](#) (Correct)

Active bibliography (related documents): [More](#) [All](#)

0.1: [Critiquing Effective Decision Support in Time-Critical Domains - Gertner \(1995\)](#) (Correct)
0.1: [Decision Analytic Networks in Artificial Intelligence - Matzkevich, Abramson \(1995\)](#) (Correct)
0.1: [A Probabilistic Network of Predicates - DeRose, Liu \(1992\)](#) (Correct)

Definition of IE

Information Extraction (IE) is the process of extracting structured information (e.g., database tables) from unstructured machine-readable documents (e.g., Web documents).

Elvis Presley was a famous rock singer.

...

Mary once remarked that the only attractive thing about the painter Elvis Hunter was his first name.

**Information
Extraction**



GName	FName	Occupation
Elvis	Presley	singer
Elvis	Hunter	painter
...	...	

“Seeing the Web as a table”

Defining an IE problem

- In what I will refer to as "classic" IE, we are converting documents to one or more table entries
 - There are other kinds of IE, we will talk about those later
- The **design** of these tables is usually determined by some business need
- Let's look at the table entries for a similar set of examples to the ones we just saw

Motivating Examples

579 Jobs in Northern California

Refine your search

Keyword(s)

Search Results

Job Title / Description (show titles only)	Company
<p>RN-Registered Nurse/LVN-Licensed Vocational Nurse - View similar jobs</p> <p>Job type: Full-Time/Part-Time Maxim's office in Sherman Oaks is seeking compassionate Registered Nurses (RN) and Licensed ... Maxim's office in Sherman Oaks is seeking...</p> <p>View full job description Save to MyCareerBuilder Email to a friend</p>	Maxim Healthcare Services, Inc
<p>Nurse Practitioner - Acute Care Nurse Practitioner - View similar jobs</p> <p>Job type: Full-Time Vanderbilt University Medical Center is currently hiring Nurse Practitioners to join our team ... Vanderbilt University Medical Center is...</p> <p>View full job description Save to MyCareerBuilder Email to a friend</p>	Vanderbilt University Medical Center (VUMC)

(Pipeline) Business Strategy Associate - Release Engineer - Quality Assurance \$50k - \$50k

Senior Flash Memory Technologist - Storage Architect - SSD \$160k - \$200k

Title	Type	Location
Business strategy Associate	Part time	Palo Alto, CA
Registered Nurse	Full time	Los Angeles
...	...	

Motivating Examples

Biography for

Elvis Presley [More at IMDb](#)

Date of Birth

[8 January 1935](#), [Tupelo, Mississippi, USA](#)

Date of Death

[16 August 1977](#), [Memphis, Tennessee, USA](#) (cardiac arrhythmia)

Birth Name

Elvis Aron Presley

Nickname

The Pelvis
The King
The King Of Rock 'n'

Height

6' (1.83 m)

Mini Biography

Elvis Aaron Presley

Name	Birthplace	Birthdate
Elvis Presley	Tupelo, MI	1935-01-08
...	...	



The image shows a banner for the 'Discover Elvis' website. On the left is a black and white portrait of a young Elvis Presley. To the right of the portrait is the text 'DISCOVER ELVIS' in a large, bold, orange font with a reflection effect. Below the portrait is the word 'Biography' in blue, followed by a navigation menu with links for 'Overview', '1935-1957', '1958-1965', '1966-1969', and '1970-1977'. Below the navigation menu is the word 'Overview' in orange, followed by a paragraph of text: 'Elvis Aaron Presley, in the humblest of circumstances, was born to Vernon and Gladys Presley in a two-room house in Tupelo, Mississippi on January 8, 1935. His twin brother, Jessie Garon, was stillborn, leaving Elvis to grow up as an only child. He and his parents moved to Memphis, Tennessee in 1948, and Elvis graduated from Humes High School there in 1953.'

Motivating Examples

Information Extraction: Techniques and Challenges

Ralph Grishman

Information Integration Papers

[Answering Queries Using Templates With Binding Patterns](#). In PODS 1995, specify binding patterns.

[The TSIMMIS Approach to Mediation: Data Models and Languages](#). A survey appears in *J. Intelligent Information Systems* 8:2, pp. 117-132, March, 1997.

Author	Publication	Year
Grishman	Information Extraction...	2006
...

Motivating Examples



Ballroom Dance Shoe
1 new from **\$49.95**
 (5)
[Show only So Danca items](#)



X-Strap Ballroom Dance Shoe
1 new from **\$49.95**

[Show only So Danca items](#)



Compare

Dynex™ - 32" Class / 720p / 60Hz / LCD HDTV
 Model: DX-32L150A11 | SKU: 9558089
 3.8 of 5 (180 reviews)
[Check Shipping & Availability >](#)



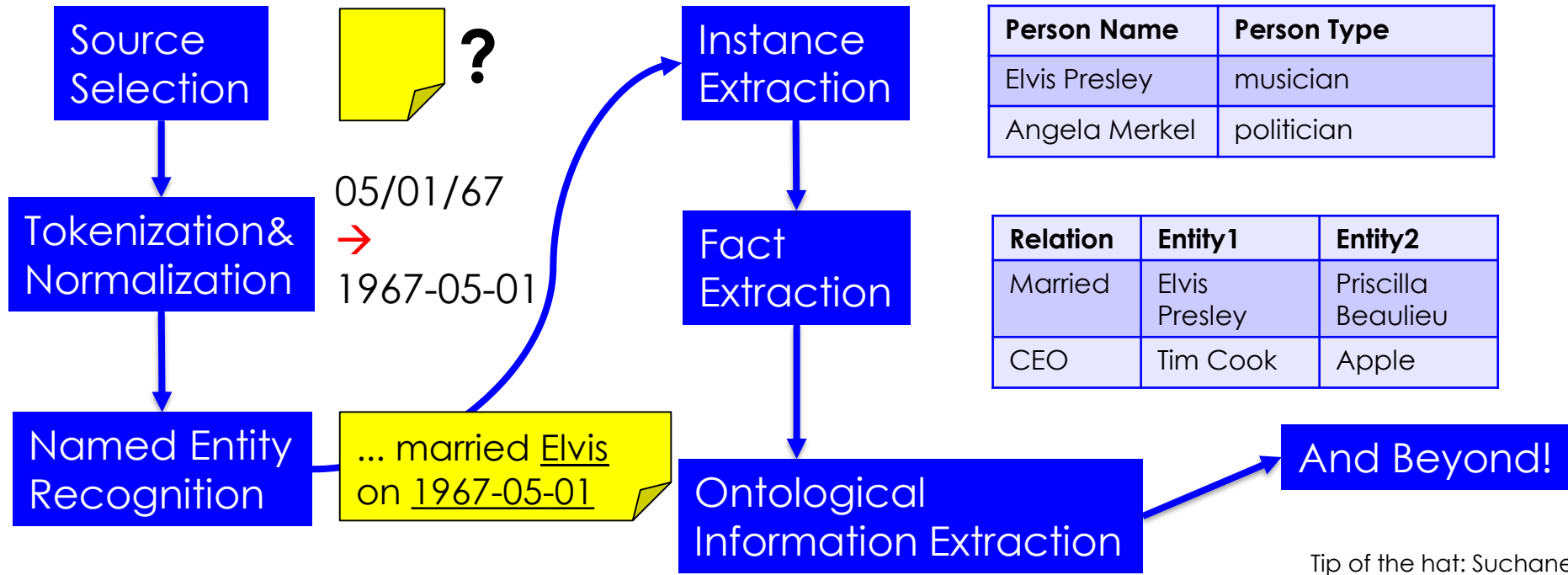
Compare

Dynex™ - 24" Class / 1080p / 60Hz / LCD HDTV
 Model: DX-24L150A11 | SKU: 9848048
 4.3 of 5 (54 reviews)
[Check Shipping & Availability >](#)

Product	Type	Price
Dynex 32"	LCD TV	\$1000
...	...	

Information Extraction

Information Extraction (IE) is the process of extracting **structured information** from unstructured machine-readable documents



Information Extraction

Traditional definition: Recovering structured data from text

What are some of the sub-problems/challenges?

Management Team
Board of Directors
Our Firm & WOMMA
FAQs
Contact Us
Careers

Board Members

- **Itzhak Fisher**
Chairman of Nielsen BuzzMetrics
- **Thom Mastrelli**
Executive Vice President/Corporate Development, VNU
- **Jonathan Carson**
CEO of Nielsen BuzzMetrics
- **Mahendra Vora**
CEO and Owner, Vora Technology Park
- **Ori Levy**
President of Nielsen BuzzMetrics Israel
- **Ron Schneier**
Senior Vice President and General Manager, Nielsen Ventures
- **James O'Hara**
Senior Vice President and Chief Financial Officer, VNU's Media Measurement and Information Group

Information Extraction?

- Recovering structured data from text
 - Identifying fields (e.g. named entity recognition)

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Board Members

◦ Itzhak Fisher Chairman of Nielsen BuzzMetrics	◦ Ori Levy President of Nielsen BuzzMetrics Israel
◦ Thom Mastrelli Executive Vice President/Corporate Development, VNU	◦ Ron Schneier Senior Vice President and General Manager, Nielsen Ventures
◦ Jonathan Carson CEO of Nielsen BuzzMetrics	◦ James O'Hara Senior Vice President and Chief Financial Officer, VNU's Media Measurement and Information Group
◦ Mahendra Vora CEO and Owner, Vora Technology Park	

Information Extraction?

- Recovering structured data from text
 - Identifying fields (e.g. named entity recognition)
 - Understanding relations between fields (e.g. record association)

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◦ Mahendra Vora CEO and Owner, Vora Technology Park

◦ Ori Levy President of Nielsen BuzzMetrics Israel
◦ Ron Schneier Senior Vice President and General Manager, Nielsen Ventures
◦ James O'Hara Senior Vice President and Chief Financial Officer, VNU's Media Measurement and Information Group

Information Extraction?

- Recovering structured data from text
 - Identifying fields (e.g. named entity recognition)
 - Understanding relations between fields (e.g. record association)
 - Normalization and deduplication

James O'Hara (I)



Date of birth (location)
[11 September 1927](#)
[Dublin, Ireland](#)

Date of death (details)
[3 December 1992](#)
Glendale, California, USA.

Trivia
Brother of [Maureen O'Hara](#)

Sometimes Credited As:
James Lilburn / Jim O'Hara

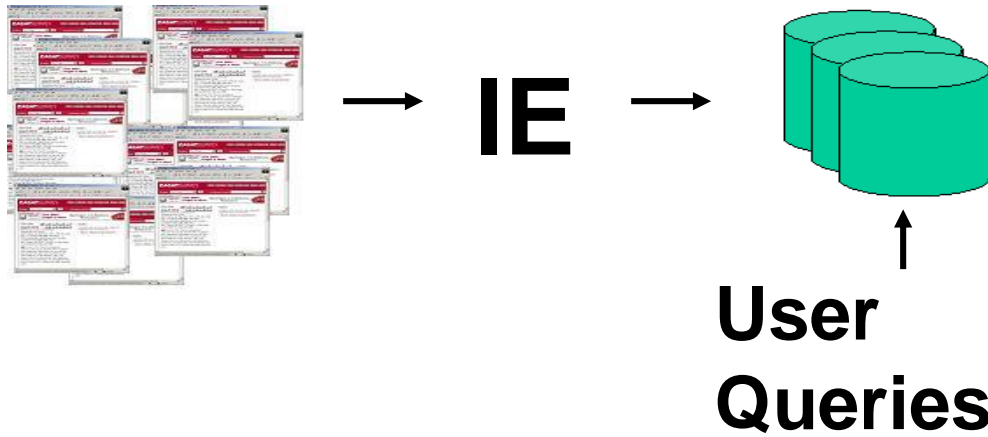
 [IMDbPro Details](#)  [Add IMDb Resume](#)

- **James O'Hara**
Senior Vice President and Chief Financial Officer, VNU's Media Measurement and Information Group

Herkovic	Jane is a member of the Nielsen senior leadership team and a senior member of the VNU MMI Finance team. She is based in New York and reports to both Susan Whiting, president and CEO of Nielsen Media Research, and Jim O'Hara , senior vice president and chief financial officer for VNU Media Measurement and Information.
Susan D. Whiting	
Douglas Darfield	
Paul J. Donato	
Sara Erichson	
Dave Harkness	
Jack Loftus	

Information extraction

- Input: Text Document
 - Various sources: web, e-mail, journals, ...
- Output: Relevant fragments of text and relations possibly to be processed later in some automated way



Not all documents are created equal...



- Varying regularity in document collections
- Natural or unstructured
 - Little obvious structural information
- Partially structured
 - Contain some canonical formatting
- Highly structured
 - Often, automatically generated

Natural Text: MEDLINE

Journal Abstracts

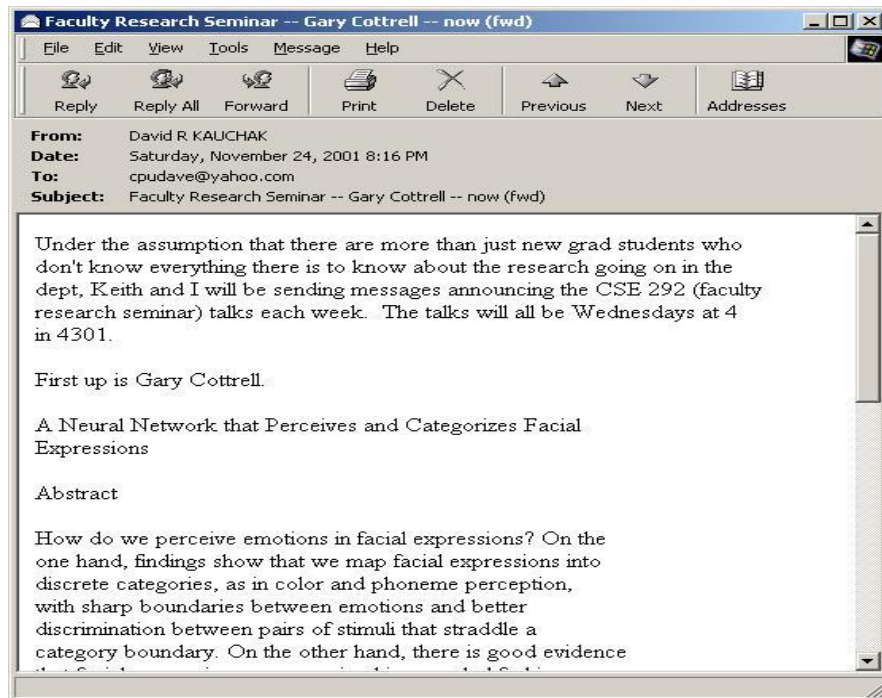
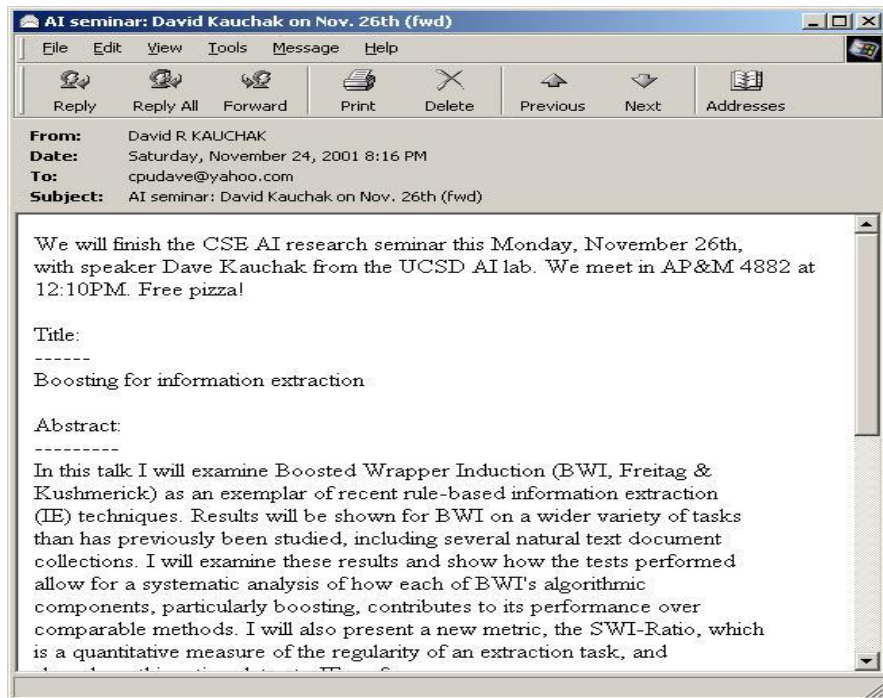
Extract number of subjects, type of study, conditions, etc.

BACKGROUND: The most challenging aspect of revision hip surgery is the management of bone loss. A reliable and valid measure of bone loss is important since it will aid in future studies of hip revisions and in preoperative planning. We developed a measure of femoral and acetabular bone loss associated with failed total hip arthroplasty. The purpose of the present study was to **measure the reliability and the intraoperative validity of this measure** and to determine how it may be useful in preoperative planning. **METHODS:** From July 1997 to December 1998, **forty-five consecutive patients** with a failed hip prosthesis in need of revision surgery were prospectively followed. Three general orthopaedic surgeons were taught the radiographic classification system, and two of them classified standardized preoperative anteroposterior and lateral hip radiographs with use of the system. Interobserver testing was carried out in a **blinded fashion**. These results were then compared with the intraoperative findings of the third surgeon, who was blinded to the preoperative ratings. Kappa statistics (unweighted and weighted) were used to assess correlation. Interobserver reliability was assessed by examining the agreement between the two preoperative raters. Prognostic validity was assessed by examining the agreement between the assessment by either Rater 1 or Rater 2 and the intraoperative assessment (reference standard). **RESULTS:** With regard to the assessments of both the femur and the acetabulum, there was significant agreement ($p < 0.0001$) between the preoperative raters (reliability), with weighted kappa values of >0.75 .

There was also significant agreement ($p < 0.0001$) between each rater's assessment and the intraoperative assessment.

Partially Structured: Seminar Announcements

Extract time, location, speaker, etc.



Landscape of IE Tasks: Document Formatting

Text paragraphs
without formatting









Astro Teller is the CEO and co-founder of BodyMedia. Astro holds a Ph.D. in Artificial Intelligence from Carnegie Mellon University, where he was inducted as a national Hertz fellow. His M.S. in symbolic and heuristic computation and B.S. in computer science are from Stanford University.

Grammatical sentences
and some formatting & links

Dr. Steven Minton - Founder/CTO
Dr. Minton is a fellow of the American Association of Artificial Intelligence and was the founder of the Journal of Artificial Intelligence Research. Prior to founding Fetch, Minton was a faculty member at USC and a project leader at USC's Information Sciences Institute. A graduate of Yale University and Carnegie Mellon University, Minton has been a Principal Investigator at NASA Ames and taught at Stanford, UC Berkeley and USC.

- Press
- **Contact**
- General information
- Directions maps

Non-grammatical snippets,
rich formatting & links

Barto, Andrew G. Professor. Computational neuroscience, reinforcement learning, adaptive motor control, artificial neural networks, adaptive and learning control, motor development.	(413) 545-2109	barto@cs.umass.edu	CS276	 
Berger, Emery D. Assistant Professor.	(413) 577-4211	emery@cs.umass.edu	CS344	 
Brock, Oliver Assistant Professor.	(413) 577-0334	oli@cs.umass.edu	CS246	 
Clarke, Lori A. Professor. Software verification, testing, and analysis; software architecture and design.	(413) 545-1328	clarke@cs.umass.edu	CS304	 

Tables

8:30 - 9:30 AM	Invited Talk: Plausibility Measures: A General Approach for Representing Uncertainty <i>Joseph Y. Halpern, Cornell University</i>				
9:30 - 10:00 AM	Coffee Break				
10:00 - 11:30 AM	Technical Paper Sessions:				
Cognitive Robotics	Logic Programming	Natural Language Generation	Complexity Analysis	Neural Networks	Games
739: A Logical Account of Causal and Topological Maps <i>Emilio Remolina and Benjamin Kuipers</i>	116: A-System: Problem Solving through Abduction <i>Marc Denecker, Antonis Kakas, and Bert Van Nuffelen</i>	758: Title Generation for Machine-Translated Documents <i>Rong Jin and Alexander G. Hauptmann</i>	417: Let's go Nats: Complexity of Nested Circumscription and Abnormality Theories <i>Marco Cadoli, Thomas Eiter, and Georg Gottlob</i>	179: Knowledge Extraction and Comparison from Local Function Networks <i>Kenneth McGarry, Stefan Wermter, and John MacIntyre</i>	71: Iterative Widening <i>Tristan Cazenave</i>
549: Online-Execution of ccGolog Plans <i>Henrik Grosskreutz and Gerhard Lakemeyer</i>	131: A Comparative Study of Logic Programs with Preference <i>Torsten Schaub and Kewen</i>	246: Dealing with Dependencies between Content Planning and Surface Realisation in a Pipeline Generation	470: A Perspective on Knowledge Compilation <i>Adnan Darwiche and Pierre Marquis</i>	258: Violation-Guided Learning for Constrained Formulations in Neural-Network Time-Series	353: Temporal Difference Learning Applied to a High Performance Game-Playing

Landscape of IE Tasks

Intended Breadth of Coverage

Web site specific

Formatting

Amazon.com Book Pages

amazon.com. VIEW CART

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Resumes

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Research Interests

My research interests lie in the automated analysis of data for the purposes of classification.

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Objective

A position in a dynamic, highly-skilled applied research and development team using statistical machine learning to solve large-scale, real-world tasks such as Information Retrieval and Text Classification.

Education

Carnegie Mellon University Pittsburgh, PA
Ph.D., Computer Science, in progress
M.S., Computer Science, 1999
Technical University of Berlin Berlin, Germany
Exchange Fellow, 1992-1993
University of Michigan Ann Arbor, MI
M.S.E., Computer Science and Engineering, 1994 B.S.E.,
Computer Engineering, Summa Cum Laude, 1992

Research Experience

Carnegie Mellon University 1994-present

I am currently pursuing my dissertation research: a hierarchical probabilistic model for novelty detection in text. This work is being done as part of the Topic Detection and Tracking project at CMU, under the direction of Yoram Yona. The

Wide, non-specific

Language

University Names

8:30 - 9:30 AM	Invited Talk: Plausibility Measures: A General Approach <i>Joseph Y. Halpern, Cornell University</i>		
9:30 - 10:00 AM	Coffee Break		
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Cognitive Robotics	Logic Programming	Natural Language Generation	Complexity Analysis
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Dr. Steven Minton - Founder/CTO
Dr. Minton is a fellow of the American Association of Artificial Intelligence and was the founder of the Journal of Artificial Intelligence Research. Prior to founding Fetch, Minton was a faculty member at USC and a project leader at USC's Information Sciences Institute. A graduate of Yale University and Carnegie Mellon University, Minton has been a Principal Investigator at NASA Ames and taught at Stanford, UC Berkeley and USC.

Frank Huybrechts - COO
Mr. Huybrechts has over 20 years of

- Press Contact
- General information
- Directions maps

Landscape of IE Tasks :

Complexity of entities/relations

Closed set

U.S. states

He was born in Alabama...

The big Wyoming sky...

Regular set

U.S. phone numbers

Phone: (413) 545-1323

The CALD main office is 412-268-1299

Complex pattern

U.S. postal addresses

University of Arkansas

P.O. Box 140

Hope, Al

Headquarters:

1128 Main Street, 4th Floor

Cincinnati, Ohio 45210

Ambiguous patterns, needing context and many sources of evidence

Person names

...was among the six houses
sold by Hope Feldman that year.

Pawel Opalinski, Software
Engineer at WhizBang Labs.

Landscape of IE Tasks:

Arity of relation

Jack Welch will retire as CEO of General Electric tomorrow. The top role at the Connecticut company will be filled by Jeffrey Immelt.

Single entity

Person: Jack Welch

Person: Jeffrey Immelt

Location: Connecticut

Binary relationship

Relation: Person-Title

Person: Jack Welch

Title: CEO

Relation: Company-Location

Company: General Electric

Location: Connecticut

N-ary record

Relation: Succession

Company: General Electric

Title: CEO

Out: Jack Welch

In: Jeffrey Immelt

"Named entity" extraction

Association task = Relation Extraction

- Checking if groupings of entities are instances of a relation
 1. Manually engineered rules
 - Rules defined over words/entities: “<company> located in <location>”
 - Rules defined over parsed text:
 - “((Subj<company>) (Verb located) (*) (Obj <location>))”
 2. Machine Learning-based
 - Supervised: Learn relation classifier from examples
 - Partially-supervised: bootstrap rules/patterns from “seed” examples

Relation Extraction: Disease Outbreaks

May 19 1995, Atlanta -- The Centers for Disease Control and Prevention, which is in the front line of the world's response to the deadly Ebola epidemic in Zaire, is finding itself hard pressed to cope with the crisis...

**Information
Extraction System**

<i>Date</i>	<i>Disease Name</i>	<i>Location</i>
Jan. 1995	Malaria	Ethiopia
July 1995	Mad Cow Disease	U.K.
Feb. 1995	Pneumonia	U.S.

Relation Extraction: Protein Interactions

“We show that CBF-A and CBF-C interact with each other to form a CBF-A-CBF-C complex and that CBF-B does not interact with CBF-A or CBF-C individually but that it associates with the CBF-A-CBF-C complex.”

CBF-A $\xleftrightarrow[\text{complex}]{\text{interact}}$ CBF-C

CBF-B $\xrightarrow{\text{associates}}$ CBF-A-CBF-C complex

Resolving coreference (both within and across documents)

John Fitzgerald Kennedy was born at 83 Beals Street in Brookline, Massachusetts on Tue 29, 1917, at 3:00 pm,[7] the second son of Joseph P. Kennedy, Sr. and Rose Fitzgerald; R turn, was the eldest child of John "Honey Fitz" Fitzgerald, a prominent Boston political fi was the city's mayor and a three-term member of Congress. Kennedy lived in Brookline years and attended Edward Devotion School, Noble and Greenough Lower School, and the School, through 4th grade. In 1927, the family moved to 5040 Independence Avenue in l Bronx, New York City: two years later, they moved to 294 Pondfield Road in Bronxville, N where Kennedy was a member of Scout Troop 2 (and was the first Boy Scout to become President).[8] Kennedy spent summers with his family at their home in Hyannisport, Massachusetts, and Christmas and Easter holidays with his family at their winter home in Beach, Florida. For the 5th through 7th grade, Kennedy attended Riverdale Country School, a private school for boys. For 8th grade in September 1930, the 13-year old Kennedy attended Canterbury School in New Milford, Connecticut.



Rough Accuracy of Information Extraction

Information type	Accuracy
Entities	90-98%
Attributes	80%
Relations	60-70%
Events	50-60%

- Errors cascade (error in entity tag → error in relation extraction)
- These are very rough, actually optimistic, numbers
 - Hold for well-established tasks, but lower for many specific/novel IE tasks

What we will cover in this class (briefly)

- PART I: basic information extraction (through Named Entity Recognition)
 - History of IE, Related Fields
 - Source Selection
 - Tokenization and Normalization
 - Named Entity Recognition (NER)

What we will cover in this class (briefly)

- PART II: machine learning in depth (mostly tagging models used for named entities)
 - Decision Trees and Overfitting
 - Linear Models
 - Feature Engineering
 - Word Embeddings
 - Deep Learning (Non-Linear Models)

What we will cover in this class (briefly)

- PART III: advanced information extraction
 - Instance Extraction
 - Fact/Event Extraction
 - Ontological IE/Open IE

Last words

- The seminar tomorrow is cancelled
- The topics will be presented on November 3rd
- Also, don't forget the reading for next week!
- **Sarawagi: Information Extraction** (available from web page)
Read the introduction!
- These slides will be uploaded as well
 - The video of this lecture from WS 2020-2021 is available, note that the "Administravia" is different

- Thank you for your attention!