KE5205 TEXT MINING 2018

INFORMATION EXTRACTION

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Outline for this Module

- **What is Information Extraction (IE)?**
- **How does an IE System work?**
  - Rule based methods for IE
  - Statistics based methods for IE
  - Coreference Resolution
- **Practical Information Extraction**
  - Example on how to extract concepts using a tool
  - Analysis of the tool and the results

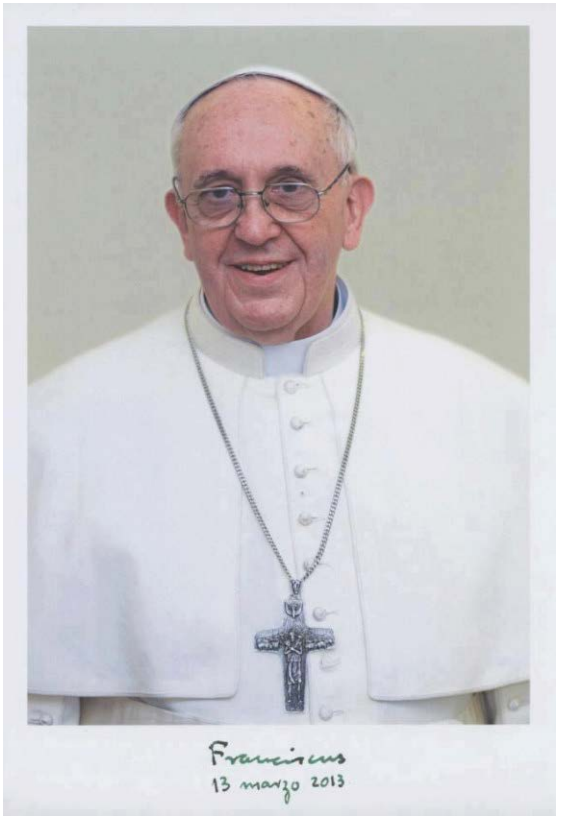
FROM WORDS TO CONCEPTS

What's a word?

- A word is a bunch of characters separated by spaces or punctuation
  - "**The cat is sitting on the mat**" has 7 words
- How about "**The cat's sitting on the mat**" – how many words?
- How about "**新加坡**" (Chinese) – how many words? Characters?
- How about "**memperkuasakan**" (Malay) – how many words?

What's a concept?

- **"Cardinal Jorge Mario Bergoglio of Buenos Aires was elected the 266th pope of the Catholic Church on 13 May 2013, taking the name Pope Francis"**
- **Cardinal: a concept = a prince of the Catholic Church**
- **Jorge Mario Bergoglio: a concept = Cardinal of Buenos Aires**
- **Buenos Aires: a concept = city in Argentina**
- **Pope: a concept = head of Catholic Church**
- **Catholic Church: a concept = religious organization**
- **13 May 2013: a concept = a date**
- **Pope Francis: a concept = current Pope**



Greedy heuristic ☺

How do you "automatically" create concepts

- **Start with nouns or names or simple named entities (NEs)**
  - Identify NEs using dictionaries = lists = gazetter = …
  - Eg, name lists: boy names, girl names, world names,…
  - Eg, days, months, cities, countries, … (can be multiwords)
  - Proper nouns = words that start with Capitals (in the middle of sentence)
- **If nouns or names are contiguous, then aggregate them**
  - Jorge + Mario + Bergoglio = "Jorge Mario Bergoglio"
  - Pope + Francis = "Pope Francis"
  - Catholic + Church = "Catholic Church"
- **Some lexical and syntactic markup can help**
  - Cardinal $_{[title]}$+ Jorge Mario Bergoglio$_{[name]}$+ of$_{[prep]}$+Buenos Aires$_{[place]}$
  - with the right rule: "Cardinal Jorge Mario Bergoglio of Buenos Aires" is a concept

Concept vs. Named Entity vs. Information

- **Name Entity = lowest level of recognition by an IE system**
  - Normally recognized by dictionaries or rules
- **Concept = rule or heuristic to create an abstraction**
  - Sometimes called a “natural class” = different people at different times and in different places would refer to the same referent with that concept
  - “president of the United States” vs. “president of the United Kingdom”
- **Information = words, named entities, concepts which fulfill a need**
  - So if you have a question, and a phrase answers that question, then that phrase is an example of information
  - Information is often regular, i.e., with a pattern
    - Eg, information about a person = name, age, sex, address, hp#, …
    - Information about a company = name, address, stock symbol, Chairman, …

EXERCISES

The National University of Singapore and The Hebrew University of Jerusalem (HUJ) are launching a Joint Doctor of Philosophy degree programme in biomedical science from August 2013. Professor Tan Eng Chye, NUS Deputy President and Provost, and Professor Menahem Ben-Sasson, President of HUJ signed the joint degree agreement at NUS, in the presence of Ambassador of Israel to Singapore Her Excellency Amira Arnon and about 30 invited guests.

Identify concepts from the text above, and categorize the concepts. Follow the examples below:

#	Concept	Category	#	Concept	Category
1	National University of Singapore	Place	7		
2	Tan Eng Chye	Name	8		
3			9		
4			10		
5			11		
6			12		

- Professor Tan Eng Chye, NUS Deputy President and Provost, and Professor Menahem Ben-Sasson, President of HUJ signed the joint degree agreement at NUS, in the presence of Ambassador of Israel to Singapore Her Excellency Amira Arnon and about 30 invited guests.
- *The following is a simple lexical rule to recognize names of universities in the paragraph above:*

$$\textbf{“The” + word}_{\textbf{[capitalized]}}\textbf{ + “University” + “of” + Place}$$

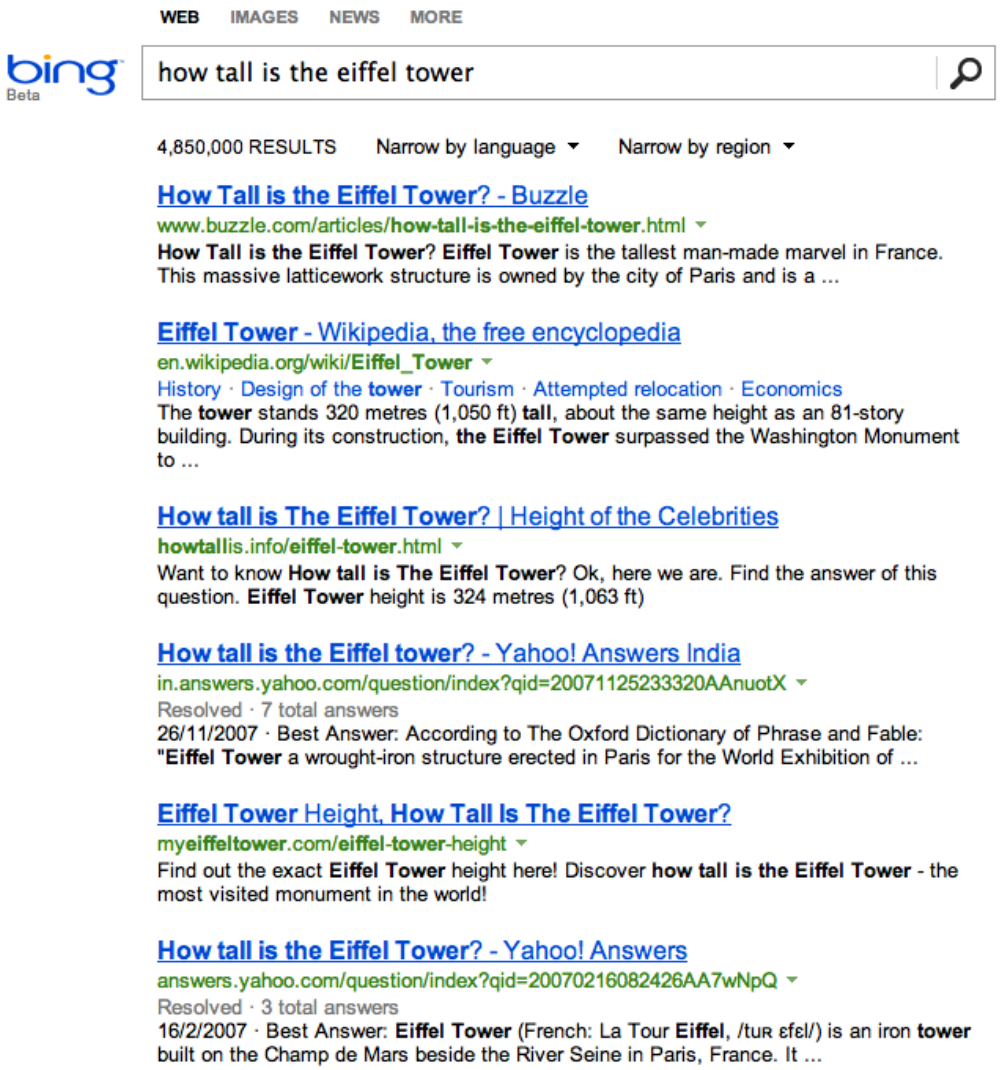
- *Write a rule similar in structure to recognize the names of persons mentioned in the paragraph above. You may assume reasonable dictionaries (lists) exist and that suitable parts of speech and meaningful markup has been done:*

WHAT IS INFORMATION (CONCEPT) EXTRACTION

Contrast with a search engine

How tall is the Eiffel Tower?

- A search engine returns a list of documents which (hopefully) includes the answer
- The user needs to open/read the document to get the answer



Information extraction version

Google

how tall is the eiffel tower

Mun Kew Leong 3 + Shar

Search

About 2,420,000 results (0.26 seconds)

Web
Images
Maps
Videos
News
Shopping
More

Show search tools

324 m
Eiffel Tower, Height
Hide details

How tall is the Eiffel Tower - answers.com
The Eiffel tower is located in Paris, France. It is **324 m** ...

Eiffel Tower Height, How ... - myeiffeltower.com
Eiffel Tower height - **324 m**. of iron parts! In 1889 ...

How tall is the eifel tower? - Yahoo! Answers - yahoo.com
... the structure is **324 m** (1058 ft) ...

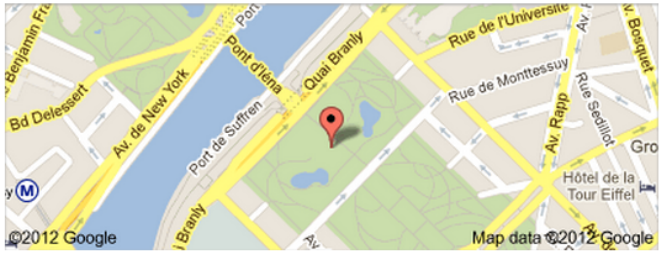
Is this accurate? Yes - No

Eiffel Tower - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/**Eiffel_Tower**
Jump to Lattice towers **taller** than the **Eiffel Tower**: The **Eiffel Tower** is a puddled iron lattice tower located on the Champ de Mars in Paris, named ...
History - Design of the tower - Tourism - Attempted relocation

How tall is the Eiffel Tower
wiki.answers.com › ... › France › Paris › Eiffel Tower
The **Eiffel Tower** is 100 meters **tall**. **How tall is the Eiffel tower** and which city is it in? The **Eiffel tower** is located in Paris, France. It is **324 m** (1,063 ft) **tall**.

Would Shard critics once have slammed the **Eiffel Tower**? | Daniel ...
www.guardian.co.uk/commentisfree/.../shard-critics-**eiffel-tow**... Share
5 Jul 2012 – But while the main body of the **Eiffel Tower** is only 300 metres **tall**, it stands at 324 metres once you add the base and television antenna.

Eiffel Tower Directions



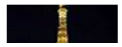

en.wikipedia.org

The Eiffel Tower is a puddled iron lattice tower located on the Champ de Mars in Paris, named after the engineer Gustave Eiffel, whose company designed and built the tower. Wikipedia

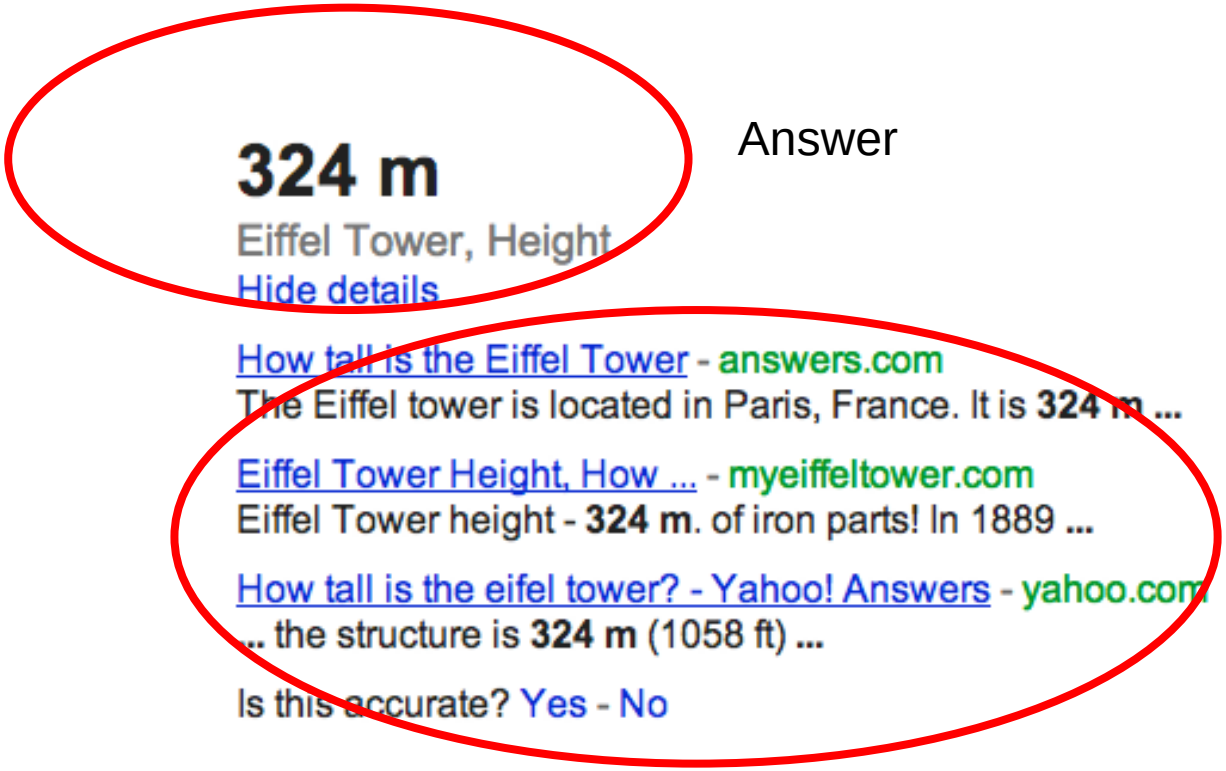
Height: 324 m
Construction started: January 28, 1887
Hours: Mon-Sun 9:30am–11:45pm
Address: Avenue Gustave Eiffel, 75007 Paris, France
Phone: 0892 70 12 39
Architect: Stephen Sauvestre

People also search for




How tall is the eiffel tower?

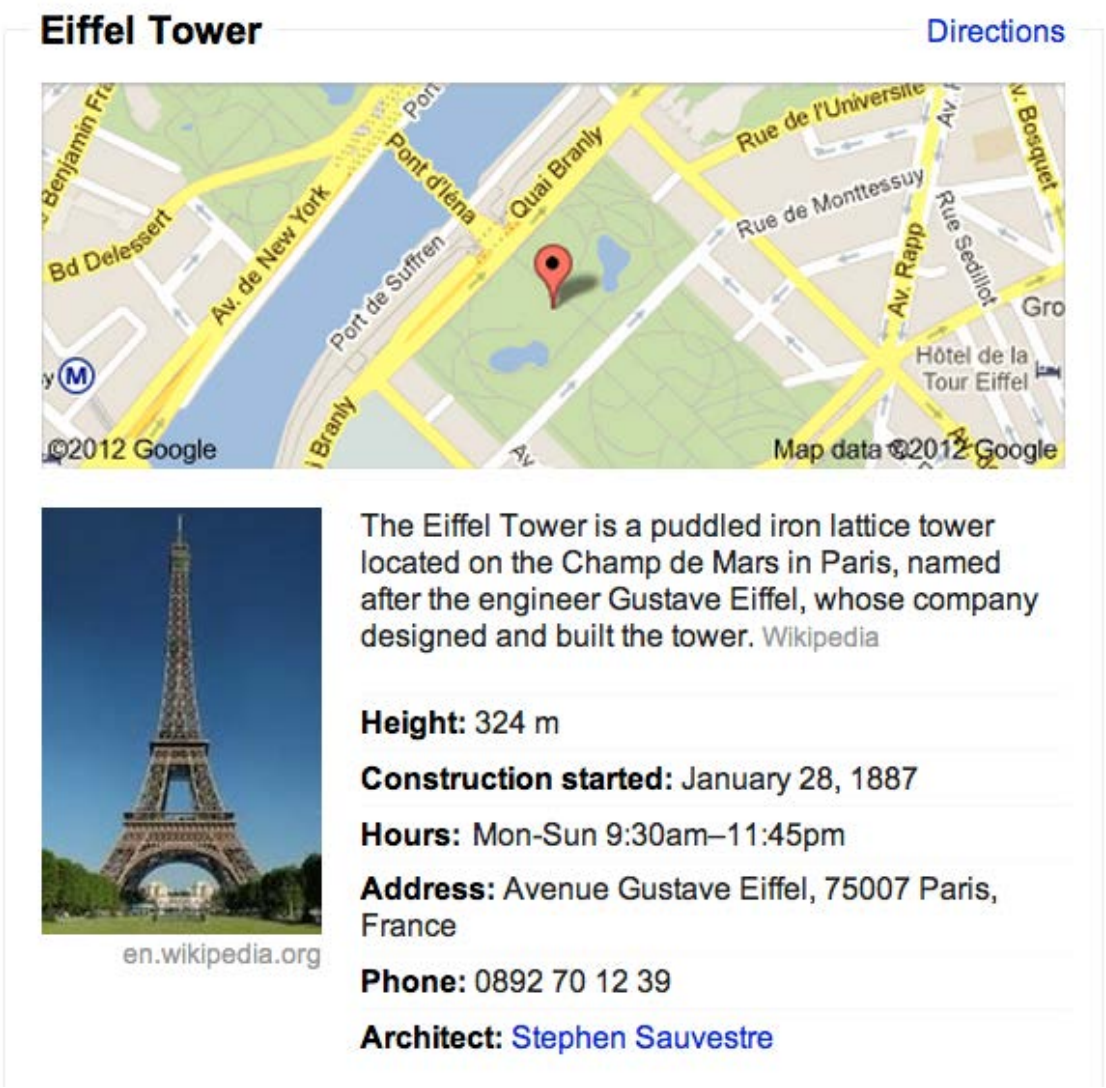


Answer

Sources (evidence)

Template version

- **Automatic template filling**
  - Different fields for different places
  - Depends on sources; not fixed template
- **Information Extraction**
- **High degree of accuracy**
- **Human checking?**



Lincoln Memorial

Directions

en.wikipedia.org

The Lincoln Memorial is an American national monument built to honor the 16th President of the United States, Abraham Lincoln. It is located on the National Mall in Washington, D.C. across from the Washington Monument. Wikipedia

Height: 30 m

Area: 66 ha

Address: 2 Lincoln Memorial Cir NW, Washington, DC 20037

Hours: Mon-Sun Open 24 hours

Architectural styles: Beaux-Arts architecture, Doric order

Architect: Henry Bacon

White House

Directions

plus.google.com

The White House is the official residence and principal workplace of the President of the United States. Wikipedia

Construction started: 1792

Address: Alexander Hamilton Place Northwest, Washington, DC 20005

Phone: (202) 208-1631

Hours: Mon-Sun 7:30am–4pm

Architectural styles: Neoclassicism, Palladian architecture, Neoclassical architecture

Architect: James Hoban

Angkor Wat

en.wikipedia.org

Angkor Wat is the largest Hindu temple complex in the world. The temple was built by King Suryavarman II in the early 12th century in Yasodharapura, the capital of the Khmer Empire, as his state temple and eventual mausoleum. Wikipedia

Construction started: 1125

Address: Angkor Wat, Siem Reap 82720, Cambodia

Phone: (0)63 764444

Function: Place of worship

Architectural styles: Dravidian architecture, Khmer architectural style

Machu Picchu

en.wikipedia.org

Machu Picchu is a pre-Columbian 15th-century Inca site located 2,430 metres above sea level. Machu Picchu is located in the Cusco Region of Peru, South America. Wikipedia

Address: Muro de la Ciudad, Peru

Management: Government of Peru

Phone: (0)1 610 0400

What is information extraction?

- **The automatic extraction of (possibly pre-specified) information from natural language documents**
  - Facts about types of entities, events, relationships

- **The automatic population of a structured information source (template) from natural language documents (i.e., create a table!)**
  - Documents may be semi-structured (eg., patents), unstructured (e.g., websites) or free text (e.g., documents)

Things to note…

- **IE does not specify the documents to be read; rather it extracts the salient information from the documents and presents just those information to the user**
- **Normally maintains links from facts to source documents**
  - Allows evidence trail, context, further discovery
- **Accuracy is variable – both in completeness and reliability**
- **Certain information (e.g., person names; organizations) have high reliability. Other information (e.g., sentiment) have *very* poor accuracy.**

Drilling down on information…

- **Entity/Concept:**
  - an object of interest (date, person, building,…)
- **Attribute:**
  - property of an entity (name, height, type)
- **Fact:**
  - a predicate about an entity, e.g., tall(X)
  - a relationship between two or more entities, e.g., married(X,Y)
- **Event**
  - an abstraction over a possibly sequential relationship of several entities e.g., terrorist attack, birthday party, etc.

Example (Entities and Facts)

- Fletcher Maddox, former Dean of the UCSD Business School, announced the formation of La Jolla Genomatics together with his two sons. La Jolla Genomatics will release its product Geninfo in June 1999. Geninfo is a turnkey system to assist biotechnology researchers in keeping up with the voluminous literature in all aspects of their field.
- Dr. Maddox will be the firm's CEO. His son, Oliver, is the Chief Scientist and holds patents on many of the algorithms used in Geninfo. Oliver's brother, Ambrose, follows more in his father's footsteps and will be the CFO of L.J.G. headquartered in the Maddox family's hometown of La Jolla, CA.

Persons:	Organizations:	Locations:	Artifacts:	Dates:	
Fletcher Maddox	UCSD Business School	La Jolla	Geninfo	June 1	99
Dr. Maddox	La Jolla Genomatics	CA	Geninfo		
Oliver	La Jolla Genomatics				
Oliver	L.J.G.				
Ambrose					
Maddox					

PERSON	Employee_of	ORGANIZATION
Fletcher	Employee_of	UCSD Business
Maddox	Employee_of	School
Fletcher	Employee_of	La Jolla Genomatics
Maddox	Employee_of	La Jolla Genomatics
Oliver		La Jolla Genomatics
Ambrose		
ARTIFACT	Product_of	ORGANIZATION
Geninfo	Product_of	La Jolla Genomatics
LOCATION	Location_of	ORGANIZATION
La Jolla	Location_of	La Jolla Genomatics
CA	Location_of	La Jolla Genomatics

From: Ron Feldman, *Information Extraction: Theory and Practice*, http://cs.fit.edu/~pkc/icdm03/printing/tutorials/extraction/extraction.tutorial.pdf

Events and Attributes

COMPANY-FORMATION_EVENT:

COMPANY:	La Jolla Genomatics
PRINCIPALS:	Fletcher Maddox Oliver Ambrose
DATE:	
CAPITAL:	

RELEASE-EVENT:

COMPANY:	La Jolla Genomatics
PRODUCT:	Geninfo
DATE:	June 1999
COST:	

NAME:	**Fletcher Maddox** **Maddox**
DESCRIPTOR:	**former Dean of the UCSD Business School** **his father** **the firm's CEO**
CATEGORY:	**PERSON**
NAME:	**Oliver**
DESCRIPTOR:	**His son** **Chief Scientist**
CATEGORY:	**PERSON**
NAME:	**Ambrose**
DESCRIPTOR:	**Oliver's brother** **the CFO of L.J.G.**
CATEGORY:	**PERSON**
NAME:	**UCSD Business School**
DESCRIPTOR:	
CATEGORY:	**ORGANIZATION**
NAME:	**La Jolla Genomatics** **L.J.G.**
DESCRIPTOR:	
CATEGORY:	**ORGANIZATION**
NAME:	**Geninfo**
DESCRIPTOR:	**its product**
CATEGORY:	**ARTIFACT**
NAME:	**La Jolla**
DESCRIPTOR:	**the Maddox family's hometown**
CATEGORY:	**LOCATION**
NAME:	**CA**
DESCRIPTOR:	
CATEGORY:	**LOCATION**

From: Ron Feldman, *Information Extraction: Theory and Practice*, http://cs.fit.edu/~pkc/icdm03/printing/tutorials/extraction/extraction.tutorial.pdf

Unstructured Text

POLICE ARE INVESTIGATING A ROBBERY THAT
ELEVEN STORE LOCATED AT 2545 LITTLE RIVE
LINCOLNIA AREA ABOUT 12:30 AM FRIDAY. A 2
ALEXANDRIA AREA EMPLOYEE WAS APPROAC
DEMANDED MONEY. SHE RELINQUISHED AN U
OF CASH AND THE MEN LEFT. NO ONE WAS IN
DESCRIBED AS BLACK, IN THEIR MID TWENTIE
FEET NINE INCHES TALL, WITH MEDIUM BUILD
CLEAN SHAVEN. THEY WERE BOTH WEARING
BLACK COATS. ANYONE WITH INFORMATION A
OR THE SUSPECTS INVOLVED IS ASKED TO CA
5555.

Structured (Desired) Information

Crime	Address	Town	Time	Day
ABDUCTION	8700 BLOCK OF LITTLE RIVER TURNPIKE,	ANNANDALE	11:30 PM	SUNDAY
...	...	...	...	...
ROBBERY	7- ELEVEN STORE LOCATED AT 2545 LITTLE RIVER TURNPIKE,	LINCOLNIA	12:45 AM	FRIDAY
ROBBERY	7- ELEVEN STORE LOCATED AT 5624 OX ROAD,	FAIRFAX	3:00 AM	FRIDAY

From: Ron Feldman, *Information Extraction: Theory and Practice*, http://cs.fit.edu/~pkc/icdm03/printing/tutorials/extraction/extraction.tutorial.pdf

QUICK EXERCISE

Read this text:

- During the Boston Marathon on April 15, 2013, two pressure cooker bombs exploded at 2:49 pm EDT killing 3 people and injuring 264 others. The bombs exploded about 13 seconds and 210 yards (190 m) apart, near the finish line on Boylston Street. The Federal Bureau of Investigation (FBI) took over the investigation, and on April 18, released photographs and surveillance video of two suspects. The suspects were identified later that day as the Chechen brothers Dzhokhar and Tamerlan Tsarnaev.

(from: https://en.wikipedia.org/wiki/Boston_Marathon_bombings)

Fill up this template:

Attribute	Value
Occurrence	
Event	
Location	
Start Date	
Start Time	
End Date	
End Time	
Method	
Incident_1	
Incident_2	
Incident_3	
Perpetrators	
Caught (Y/N)	

- Switzerland, Sweden and Singapore are the three most innovative countries in the world, according to the Global Innovation Index (GII) 2012, a ranking of 141 countries co-produced by INSEAD and the World Intellectual Property Organization (WIPO, a specialised agency of the United Nations) published in Geneva on July 3, 2012. Currently in its fifth year, the GII measures the degree to which countries and economies integrate innovation into their political business and social spheres. Knowledge partners for the GII 2012 are Alcatel-Lucent, Booz & Company and the Confederation of Indian Industry (CII).
- This is the second year running that Switzerland, Sweden and Singapore have been in the top three positions. The rest of the top ten this year are: Finland, the United Kingdom, the Netherlands, Denmark, Hong Kong (China), Ireland and the United States. Canada dropped out of the top ten this year, while the U.S. fell to tenth position from number seven last year, changes which the report attributes to cutbacks in spending on, and support of, education and research and development.

(from: http://knowledge.insead.edu/innovation/global-innovation-index-2012-481)

- ***Read the text above and fill in the table below:***

Country	2012 Rank	2011 Rank	Country	2012 Rank	2011 Rank
	1			6	
	2			7	
	3			8	
	4			9	
	5			10	

HOW DOES AN IE SYSTEM WORK?

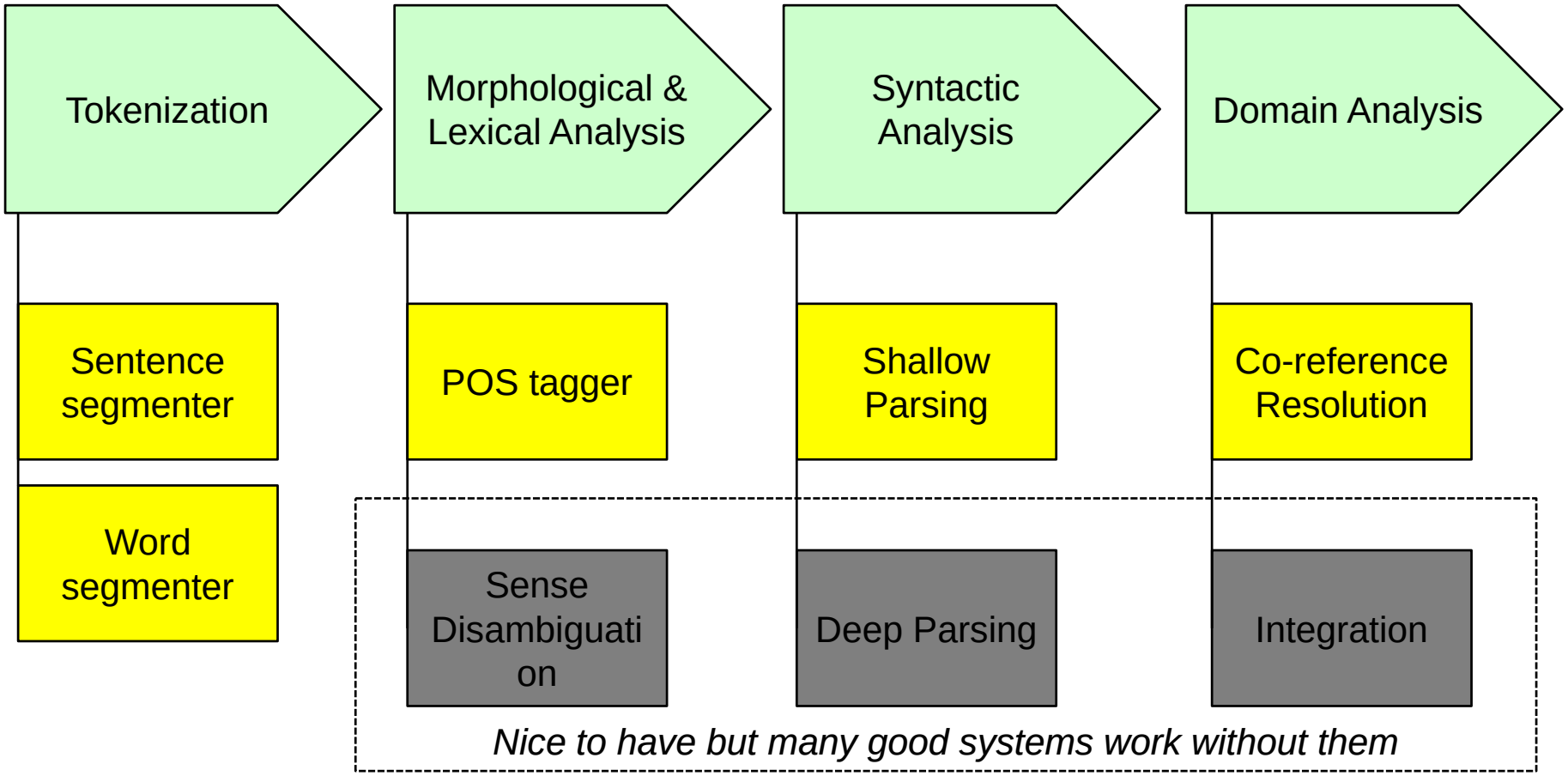
Types of IE systems

- **Rule-based Systems**
  - Hand-coded rules
    - Coded by linguists, with domain input
    - Iterative method based on document inspection
    - Slow but very good results
  - Induced (machine learning) rules
    - Fully machine learning
      - Given an annotated corpus, derive a basis set of rules that cover a pre-determined % of the annotated examples (and only the annotated examples)
      - Heuristic approach: one rule at a time!
    - Hybrid systems – machine learning to fine-tune the rules

Approaches to building an IE system

- **Statistics-based Systems**
  - Start with a well-annotated corpus
  - Depending on the method (e.g., Hidden markov models), derive statistical rules to create a model that generates the examples
  - Advantages compared to Rule based systems
    - Language independent (within representational limits)
    - No linguistic or domain knowledge needed in the team
    - Relatively small effort in creating the models
  - Issues
    - The complexity moves to the corpus – must be well annotated and must cover the full space of possibilities
    - Requires very large number of training examples to get good results

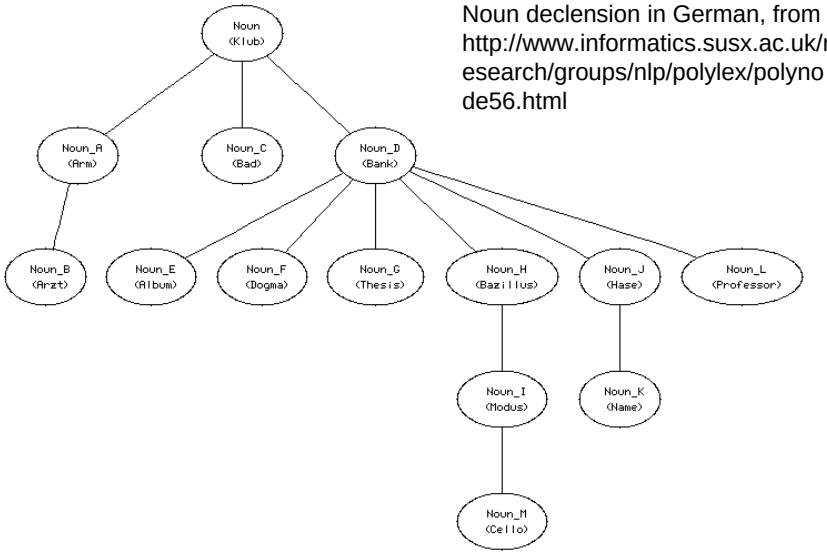
Main components of an IE system



From: http://www.youtube.com/watch?v=gsAATmT0qEc

Issues in IE - Tokenization

- **Language Considerations**
  - Morphology is easy in English, much harder in German, Hebrew
  - Word boundary easy in roman script, ambiguous in character scripts
  - English is one-dimensional, other languages have more than one



Noun declension in German, from http://www.informatics.susx.ac.uk/research/groups/nlp/polylex/polynode56.html

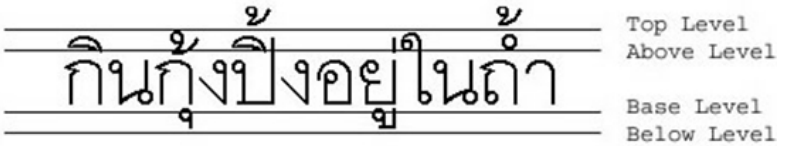
original, un-segmented text

再往远些看，随着汉字识别和语音识别技术的发展，
中文计算机用户将跨越语言差异的鸿沟，
在录入上走向中西文求同的道路。

separated word entities after segmentation

再 往 远 些 看 ， 随着 汉字 识别 和 语音 识别 技术 的 发展 ，
中文 计算机 用户 将 跨越 语言 差异 的 鸿沟 ，
在 录入 上 走 向 中 西文 求 同 的 道路 。

Word segmentation in Chinese, from http://blog.faroo.com/2009/06/09/lightweight-chinese-word-segmentation/



Word composition in Thai, from http://www-01.ibm.com/software/globalization/topics/thai/character.html

Issues in IE – Language in use (pragmatics)

Examples of difficulties:

- **Sarcasm**
  - John is really smart…like a coconut!
- **Negation and ambiguity**
  - "*All that glitters is not gold*"
    - *For all (x), if x glitters, then x is (not gold)
    - It is not the case that (for all (x), if x glitters, then x is gold)
- **Prosody**
  - John and Anne are *married*? I thought the wedding was next year!
  - John and Anne *are* married? I thought they were just going out!
  - John and *Anne* are married? I thought John was interested in Mary!
  - *John* and Anne are married? I thought Anne was going out with Tom!
  - John *and* Anne are married? I thought they were both single!
- **Colloquialisms**
  - "Referee *kayu*! Blind like donkey, is it?! So obvious ball out one leh!"

Issues in IE – Structure

- **Genres ("styles" of documents)**
  - Newspapers, journal articles, patents
    - Semi-structured – there is a pattern to how artifacts are created
  - Emails, tweets, SMSs
    - Semi-structured, well defined fields
    - Short or very short "sentences"
  - Speech transcripts (e.g., court documents, Hansard, etc.)
    - Natural speech is rarely fluent
      - Interjections, repetitions, hesitations, malapropisms, indexicals, etc.
- **Structure**
  - Information in tables, in captions
  - Precedence (implied order)

RULE-BASED IE METHODS

When to use rule-based systems?

- **Rule-based systems can and do work well**
  - Corpus is relatively static (in terms of vocabulary, language structure, etc.)
  - Can be fast especially in well-defined limited domains
    (compared to annotating training examples)
- **A typical rule-based system comprises**
  - Set of rules
  - Policies to control when and how (multiple) rules are applied, e.g., order, looping.

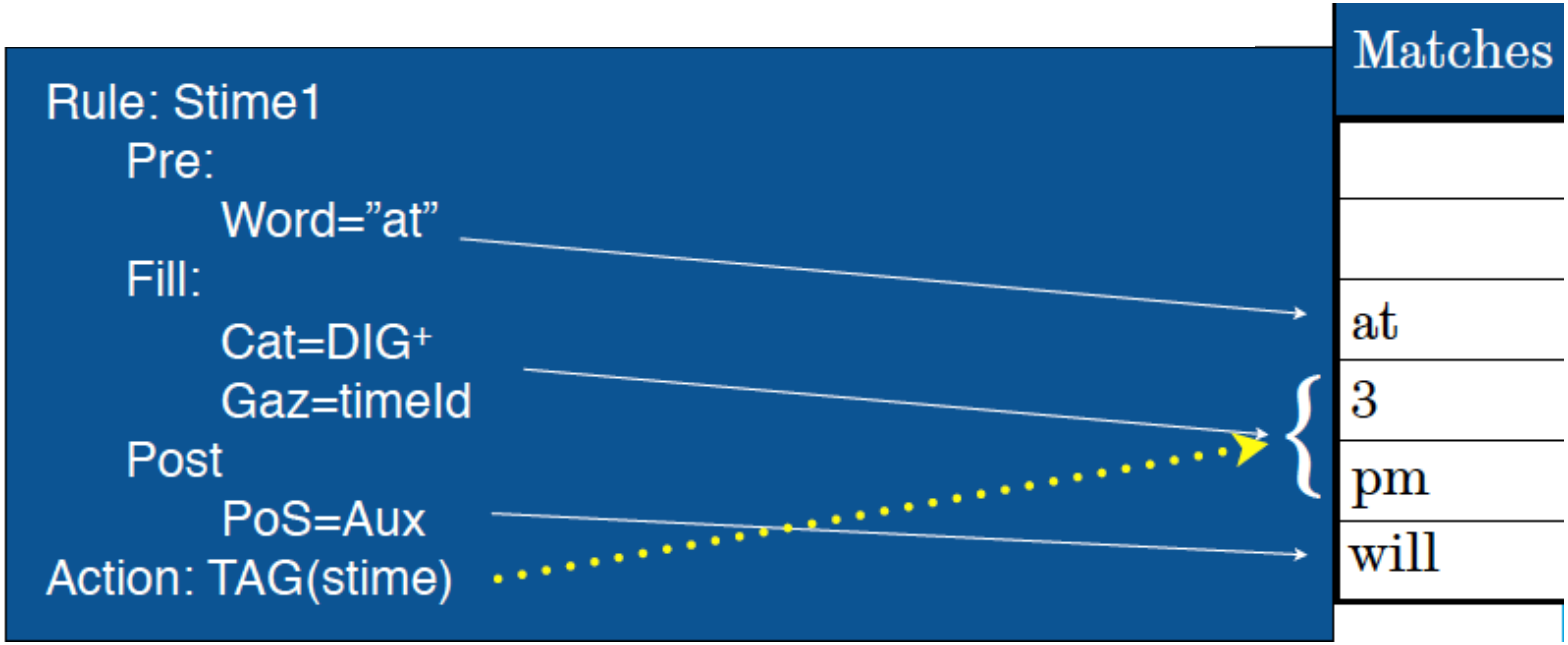
What does a rule look like?

- **Form:**
  - Match(pattern) then Do(action)

```
Rule: Company1                                          from gate.ac.uk
    ( ( {Token.orthography == upperInitial} )+
        {Lookup.kind == companyDesignator}
    ):match
 -->
    :match.NamedEntity = { kind=company, rule="Company1" }
```

Types of IE recognition rules

- **Lexical pattern matching – whole entity patterns**
  - Classic rule: (left context + filler + right context) patterns
  - Simplistic: entities are considered independent
  - More natural for hand-coded rules



Types of IE recognition rules

- **Lexical pattern matching – boundary patterns**
  - Start boundary is distinct from end boundary
  - Different rules are required to recognize the entity
  - Developed primarily for machine learning of rules

Types of IE recognition rules

- **Structural pattern recognition**
  - Typically used only for highly structured text
  - Can recognize more than one entity at a time

Example:

<p> Capitol Hill- *1* br twnhme. D/W W/D. Pkg incl
$*675*. *3* BR upper flr no gar. $*995*. (206)999-9999

Rule:

ID:7
Pattern: * ('Capitol Hill') * (*Digit*) * '$' (*Number*)
Output: Rental {Neighborhood $1} {Bedrooms $2} {Price $3}

Rule from: STEPHEN SODERLAND:
Learning Information Extraction Rules for Semi-structured and Free Text,
Machine Learning 1, 440

STATISTICS BASED IE METHODS

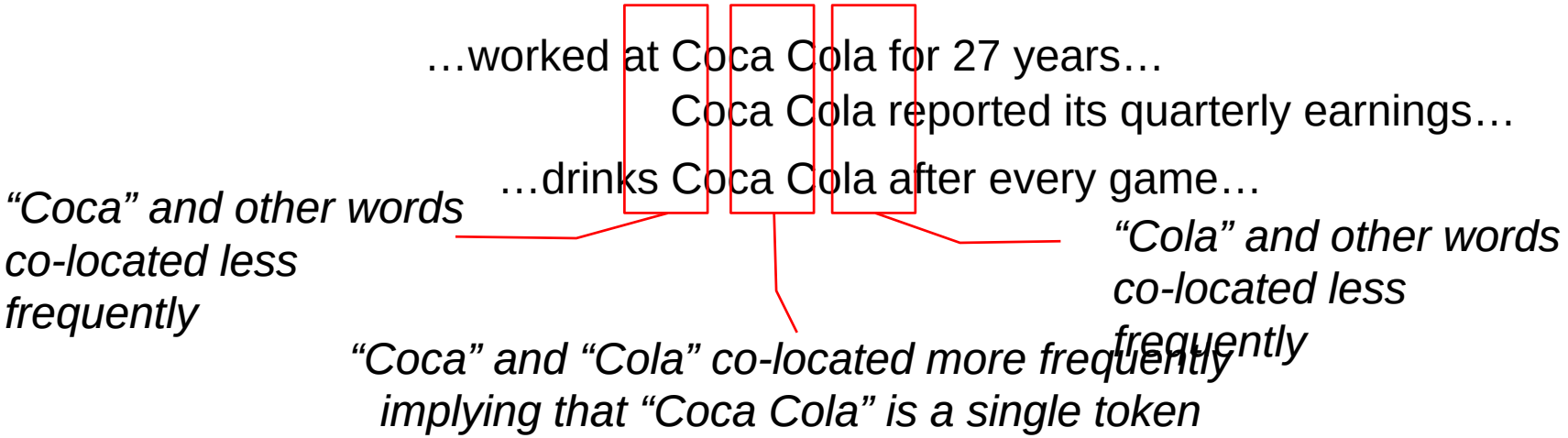
When to use statistics based systems?

- **Current top performing systems are statistics based**
  - Machine learning (ML) on very large corpora is state-of-the-art
  - Beyond the scope of this course
- **Annotation based corpora for training**
  - You have a well annotated corpora with many features
  - Various ML techniques from simple to sophisticated
  - Relatively homogeneous real data (not training data) in any given domain. Note that models don't transfer well across domains
  - You don't have domain or language resources in that area

Simple model is at token level

- **Text is a linear sequence of tokens (such as words)**
- **Token boundaries can be fairly easily derived in some languages, e.g., space & punctuation for English, but much harder for others, e.g., Chinese**
- **Simple tokenization**
  - Dictionary based
  - Colocation frequencies (see next page)
- **Alternatives**
  - Ignore multi-unit tokens
  - Bi-grams, tri-grams, multi-grams

Colocation frequencies identify boundaries



- **Colocation frequencies (given sufficient examples) can very accurately identify token boundaries.**
- **Greedy algorithm – the longer the token, the better**
- **Works on non-English languages, e.g., Chinese**

Token model IE

Apple Inc	(AAPL)	reported	its	earnings	for	Q3	2010
Organization	Stock symbol	Null	Null	Null	Null	Quarter	Year

Neil	Armstrong	died	August	25	,	2012	in	Cincinnati
Null	Null	Null	dateStart	dateContinue	DateContinue	DateEnd	Null	Null

- **The IE task is to assign a pre-defined entity label to each token in the stream**
- **Two examples above – different methods**
- **Treated as a generative model**
  "Null" is the output when the model fails

Popular models

- **Hidden Markov Models (HMM)**
  - Simple, joint probability
- **Conditional Random Fields (CRF)**
  - Conditional probability
  - Considers features of current token, and of preceding *n* tokens (window=*n*)
- **Similarity algorithms**
  - Measure distance of group of words to a dictionary list
  - Works especially well for jargon and other terminology
- **Support Vector Machines (SVM)**
  - Training method for standard perceptron
  - Optimize the points to determine the hyperplane dividing the positive training samples from the negative ones

COREFERENCE RESOLUTION

What is coreference?

- **Coreference resolution**
  - Determine relationship between entities which are related
    - Identity relation (morning star vs. evening star)
    - Whole-part relation
  - Simple version
    - Determine entities which have the same referent
      - Anaphora (Pronouns)
      - Proper names, proper nouns, noun phrases,…
    - Definite descriptions (may be time dependent)
      - Usain Bolt & “the fastest man in the world”

Examples & Discussion

Coreference Examples

- Anaphora
  - The elephant stepped on the rabbit and it died.
  - The elephant stepped on the landmine and it died.
- Proper nouns
  - John Smith and Mary Brown were married this morning. The groom was dressed in a white tuxedo while the bride was…
- Definite descriptions
  - Usain Bolt has won the Olympic 100m gold medal. The fastest man in the world successfully defended his title last night.

What do you need to know to do accurate co-reference?

PRACTICAL INFORMATION EXTRACTION

Making the right choice

- Buy an IE package
  - **Economies of scale**
  - **Expensive, but much cheaper than building your own**
  - **One size fits all (mostly)**
  - **Use out-of-the-box**
    - Start fast; explore; prototype
  - **Limited customization**
    - Still need skills

- Build an IE package
  - **Needs special skills**
  - **Needs a lot of time**
  - **You have training data**
  - **Get exactly what you want**
  - **When the out-of-the-box system is the limiting factor**
  - **When it's for sustainable strategic advantage**

Reference & Resources

- Ron Feldman, ***Information Extraction: Theory and Practice***, http://cs.fit.edu/~pkc/icdm03/printing/tutorials/extraction/extraction.tutorial.pdf
- Fabio Ciravegna, ***Tutorial on Information Extraction from Text***, http://www.isweb.uni-koblenz.de/files/ssms09/SSMS_Slides/ciravegna-IE text.pdf
- Chris Manning & Hinrich Schutze, ***Foundations of Statistical Natural Language Processing***, MIT Press, 1999
- NLP resources: http://nlp.stanford.edu/links/statnlp.html