

# Introdução ao Processamento de Linguagem Natural e a Recuperação de Informação

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# Definições

`https://en.wikipedia.org/wiki/Information\_retrieval`

`https://en.wikipedia.org/wiki/Natural\_language\_processing`  
(veja “see also”)

`https://encyclopediaofmath.org/wiki/Mathematical\_linguistics`

# Querying a knowledge base

**User query** Has my order number 4291 been shipped yet?

**Database:**

ORDER

Order number	Date ordered	Date shipped
4290	2/2/13	2/2/13
4291	2/2/13	2/2/13
4292	2/2/13	

**USER:** Has my order number 4291 been shipped yet?

**DB QUERY:** order(number=4291,date\_shipped=?)

**RESPONSE:** Order number 4291 was shipped on 2/2/13

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Similar strings mean different things, different strings mean the same thing:

1. How fast is the TZ?

Ambiguity:

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- ▶ Do you sell Sony laptops and disk drives?
- ▶ Do you sell (Sony (laptops and disk drives))?
- ▶ Do you sell (Sony laptops) and disk drives)?

# Wouldn't it be better if ...?

The properties which make natural language difficult to process are essential to human communication:

- ▶ Flexible
- ▶ Learnable but compact
- ▶ Emergent, evolving systems

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Synonymy and ambiguity go along with these properties. Natural language communication can be indefinitely precise:

- ▶ Ambiguity is mostly local (for humans)
- ▶ Semi-formal additions and conventions for different genres

# Reflections

<https://xkcd.com/191/>

[https://www.imdb.com/title/tt2543164/?ref\\_=fn\\_al\\_tt\\_1](https://www.imdb.com/title/tt2543164/?ref_=fn_al_tt_1)

<https://twitter.com/emilymbender/status/1527039334645280768>

<https://youtu.be/8rXD5-xhemo?t=845> language is an incredible new device for humans!

# Some NLP applications

- ▶ spelling and grammar checking
- ▶ predictive text
- ▶ optical character recognition (OCR)
- ▶ screen readers
- ▶ augmentative and alternative communication
- ▶ machine aided translation
- ▶ lexicographers' tools
- ▶ information retrieval
- ▶ document classification
- ▶ document clustering
- ▶ information extraction
- ▶ sentiment classification
- ▶ text mining

# More NLP applications ...

- ▶ question answering
- ▶ summarization
- ▶ text segmentation
- ▶ exam marking
- ▶ language teaching
- ▶ report generation
- ▶ machine translation
- ▶ natural language interfaces to databases
- ▶ email understanding
- ▶ dialogue systems

# Opinion mining: what do they think about me?

- ▶ Task: scan documents (webpages, tweets etc) for positive and negative opinions on people, products etc.
- ▶ Find all references to entity in some document collection: list as positive, negative (possibly with strength) or neutral.
- ▶ Construct summary report plus examples (text snippets).
- ▶ Fine-grained classification: e.g., for phone, opinions about: design, performance, battery life ...

## iPhone 8 review (Guardian 29/9/2017)

*The iPhone 8 has Apple's latest and best processor. The six-core A11 Bionic has two high-performance cores and four power-efficient cores and is apparently the most powerful so far because it can use a combination of all six at once.*

*Performance was excellent, but I struggled to see a real difference in day-to-day speed compared to the iPhone 7. But what I'm very pleased to be able to report is that Apple has finally improved battery life for the 4.7in iPhone. We're not talking a two-day battery here, but the iPhone 8 lasted just over 26 hours ...*



# Sentiment classification: the research task

- ▶ Full task: information retrieval, cleaning up text structure, named entity recognition, identification of relevant parts of text. Evaluation by humans.
- ▶ Research task: preclassified documents, topic known, opinion in text along with some straightforwardly extractable score.
- ▶ Movie review *corpus* (Pang et al 2002): strongly positive or negative reviews from IMDb, 50:50 split, with rating score.

# Sentiment analysis applications

`https://www.imdb.com`

`https://www.amazon.com`

`https://www.google.com/maps`

# Bag of words technique

- ▶ Treat the reviews as collections of individual words.
- ▶ Classify reviews according to positive or negative words.
- ▶ Could use word lists prepared by humans, but machine learning based on a portion of the corpus (*training set*) is preferable.
- ▶ Use human rankings for training and evaluation.

# Some sources of errors for bag-of-words

- ▶ Negation:  
*Ridley Scott has never directed a bad film.*
- ▶ Overfitting the training data: e.g., if training set includes a lot of films from before 2005, *Ridley* may be a strong positive indicator, but then we test on reviews for 'Kingdom of Heaven'?
- ▶ Comparisons and contrasts.

# Contrasts in the discourse

*This film should be brilliant. It sounds like a great plot, the actors are first grade, and the supporting cast is good as well, and Stallone is attempting to deliver a good performance. However, it can't hold up.*

# Doing sentiment classification ‘properly’ ?

- ▶ Morphology, syntax and compositional semantics:  
who is talking about what, what terms are associated with what, tense . . .
- ▶ Lexical semantics:  
are words positive or negative **in this context**? Word senses (e.g., *spirit*)?
- ▶ Pragmatics and discourse structure:  
what is the topic of this section of text? Pronouns and definite references.
- ▶ Getting all this to work well on arbitrary text is very hard.
- ▶ Ultimately the problem is *AI-complete*, but can we do well enough for NLP to be useful?

# IR, IE and QA

- ▶ Information retrieval: return documents in response to a user query (Internet Search is a special case)
- ▶ Information extraction: discover specific information from a set of documents (e.g. company joint ventures)
- ▶ Question answering: answer a specific user question by returning a section of a document:  
*What is the capital of France? Paris has been the French capital for many centuries.*

# MT

- ▶ Earliest attempted NLP application.
- ▶ High quality only if the *domain* is restricted (or with very close languages: e.g., Swedish-Danish).
- ▶ Utility greatly increased in 1990s with increase in availability of electronic text.
- ▶ Good applications for bad MT ...
- ▶ Spoken language translation is viable for limited domains.



# Natural language interfaces and dialogue systems

All rely on a limited domain:

- ▶ LUNAR: classic example of a natural language interface to a database (NLID): 1970–1975
- ▶ SHRDLU: (text-based) dialogue system: 1973
- ▶ Current spoken dialogue systems

Limited domain allows disambiguation: e.g., in LUNAR, *rock* had one sense.

# NLP subtasks

- ▶ input preprocessing: speech recognizer, text preprocessor or gesture recognizer.
- ▶ morphological analysis
- ▶ part of speech tagging
- ▶ parsing: this includes syntax and compositional semantics
- ▶ disambiguation, inference
- ▶ context processing
- ▶ discourse structuring
- ▶ realization
- ▶ morphological generation
- ▶ output processing: text-to-speech, text formatter, etc.

# Subtasks in natural language interface to a knowledge base

<https://arxiv.org/pdf/2012.01707.pdf>

# General comments

- ▶ Even 'simple' applications might need complex knowledge sources.
- ▶ Applications cannot be 100% perfect.
- ▶ Applications that are  $< 100\%$  perfect can be useful.
- ▶ Aids to humans are easier than replacements for humans.
- ▶ NLP interfaces compete with non-language approaches.
- ▶ Typically: shallow processing on arbitrary input or deep processing on narrow domains.
- ▶ Limited domain systems require expensive expertise to port or large amounts of (expensive) data.
- ▶ External influences on NLP are very important.