Mathematics and Big Data

Natural Language Processing - Part 1

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1. Natural Language Processing - Basics
   - Introduction
   - Why NLP ?
   - History
   - Applications
   - Challenges
   - NLP Techniques

Introduction

- Natural Language Processing, or NLP for short, is broadly defined as the automatic manipulation of natural language, like speech and text, by software.
- It is a branch of AI that helps computers understand, interpret and manipulate human language.
- NLP draws from many disciplines, including computer science and computational linguistics.
- Its pursuit to fill the gap between human communication and computer understanding.
- Its study has been around for more than 50 years to retrieve high quality information from text.

Why NLP ?

Natural language refers to the way we, humans, communicate with each other, namely, speech and text.
We are surrounded by text. Think about how much text you see each day:

- Emails
- SMS
- Web Pages
- Blogs
- Endless list of text...

History

A brief history of NLP

- Early enthusiasm (1950's): Machine Translation
  - Too ambitious
  - Bar-Hillel report (1960) concluded that fully-automatic high-quality translation could not be accomplished without knowledge (Dictionary + Encyclopedia)
- Less ambitious applications (late 1960's & early 1970's): Limited success, failed to scale up
  - Speech recognition
  - Dialogue (Eliza) **Shallow understanding**
  - Inference and domain knowledge (SHRDLU="block world")

Deep understanding in limited domain

- Real world evaluation (late 1970's – now)
  - Story understanding (late 1970's & early 1980's) **Knowledge representation**
  - Large scale evaluation of speech recognition, text retrieval, information extraction (1980 – now) **Robust component techniques**
  - Statistical approaches enjoy more success (first in speech recognition & retrieval, later others) **Statistical language models**
- Current trend:
  - Boundary between statistical and symbolic approaches is disappearing.
  - We need to use all the available knowledge **Applications**

Let's build an artificial system
that understands human language

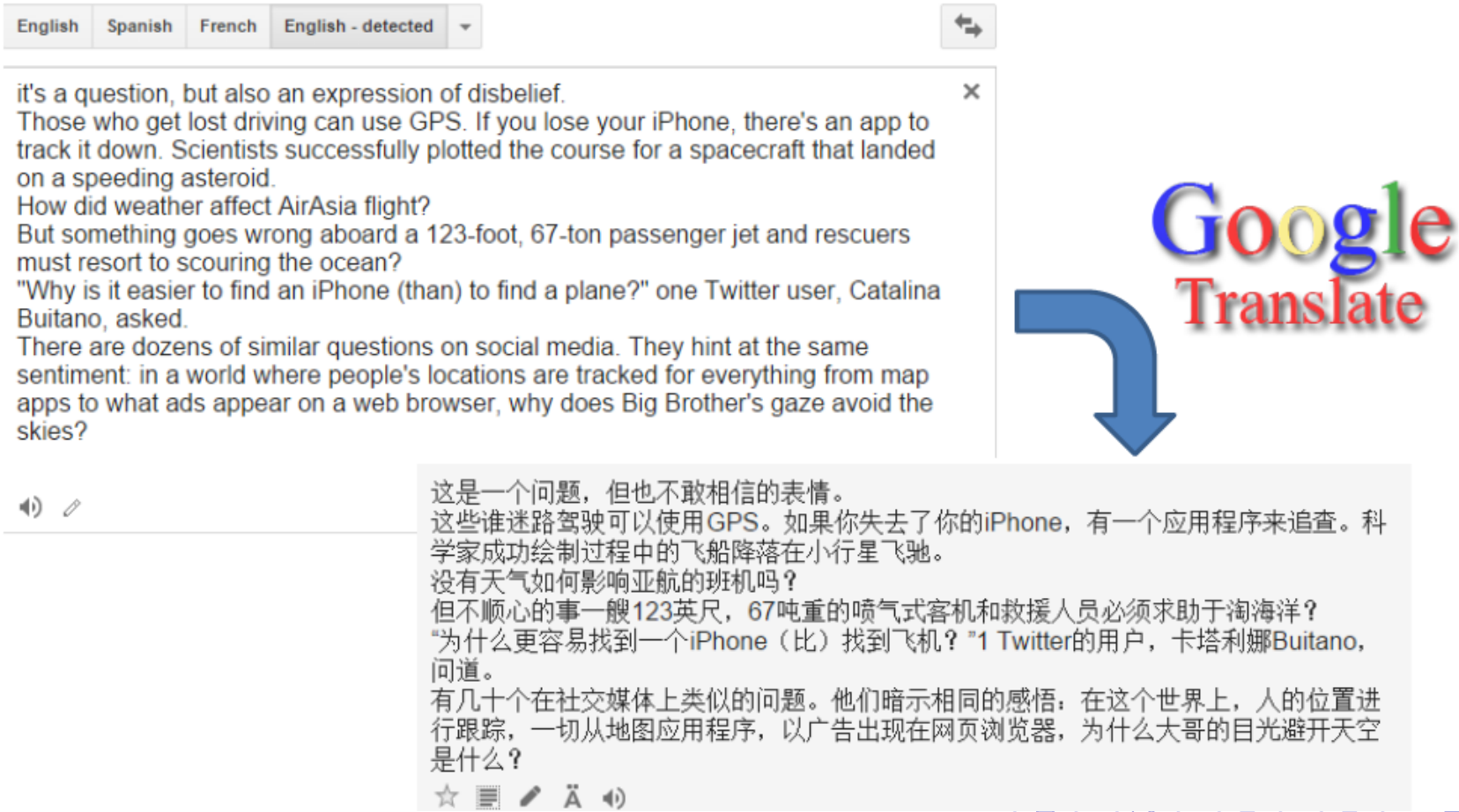
Applications

Which NLP application do we use every day?

- Google translate
- Facebook
- Twitter.
- Blogspot.
- Job seeking.
- Google search
- Yahoo search.
- Many more ...

Applications

Machine translation



Applications

The vast applications of NLP can be viewed in the following categories:

- Automatically answer our emails.
- Translate languages accurately.
- Manage, summarize and aggregate information.
- Use speech as a UI when needed.
- Talk to us.
- Litsen to us.

Challenges

Following challenges are commonly faced while working with text mining:

- Word level ambiguity
  - Words have multiple meaning e.g "Root".
  - Words can be noun or verb e.g "Design".
- Context sensitivity
  - Presupposition e.g He has quit school implies he attended school before.
- Syntactic ambiguity
- Others

Challenges

Issues in Syntax

Syntax does not deal with the meaning of a sentence, but it may help?!

"the dog ate my homework"

Who ate? →dog

The important thing when we analyze a syntax is to identify the part of speech (POS): Dog = noun ; ate = verb ; homework = noun

There are programs that do this automatically, called: Part of Speech Taggers. (also called grammatical tagging)

Accuracy of English POS tagging: 99%.

Identify collocations

mother in law, hot dog

Compositional versus non-compositional collocates

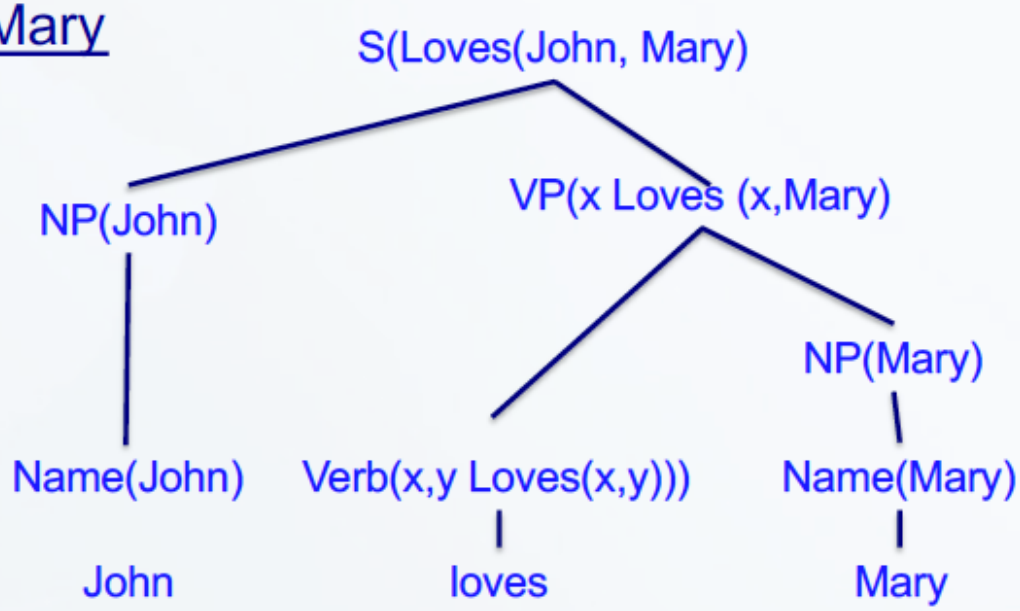
Challenges

Issues in Syntax (Part of Speech Tagging)

Based on [1]

Assume input sentence **S** in natural language **L**. Assume you have rules (*grammar* **G**) that describe syntactic regularities (patterns or structures). Given **S** & **G**, find syntactic structure of **S**. Such a structure is called a Parse Tree

Pars tree: John loves Mary



Helps a computer to automatically answer questions like -Who did what and when?

Tokenization

Tokenization/Segmentation

- Split text into words and sentences
  - Task: what is the most likely segmentation / tokenization?

There was an earthquake near Barcelona. I've even felt it in Terrassa, Sabadell, etc.

There + was + an + earthquake + near + Barcelona.

I + ve + even + felt + it + in + Terrassa, + Sabadell + etc.

Named Entity Recognition (NER)

Named entity recognition

- Determine text mapping to proper names
  - Task: what is the most likely mapping

Its initial Board of Visitors included U.S. Presidents Thomas Jefferson, James Madison, and James Monroe.

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Organization, Location, Person

Parts of Speech (POS)

Part-of-Speech tagging

- Marking up a word in a text (corpus) as corresponding to a particular part of speech
  - Task: what is the most likely tag sequence

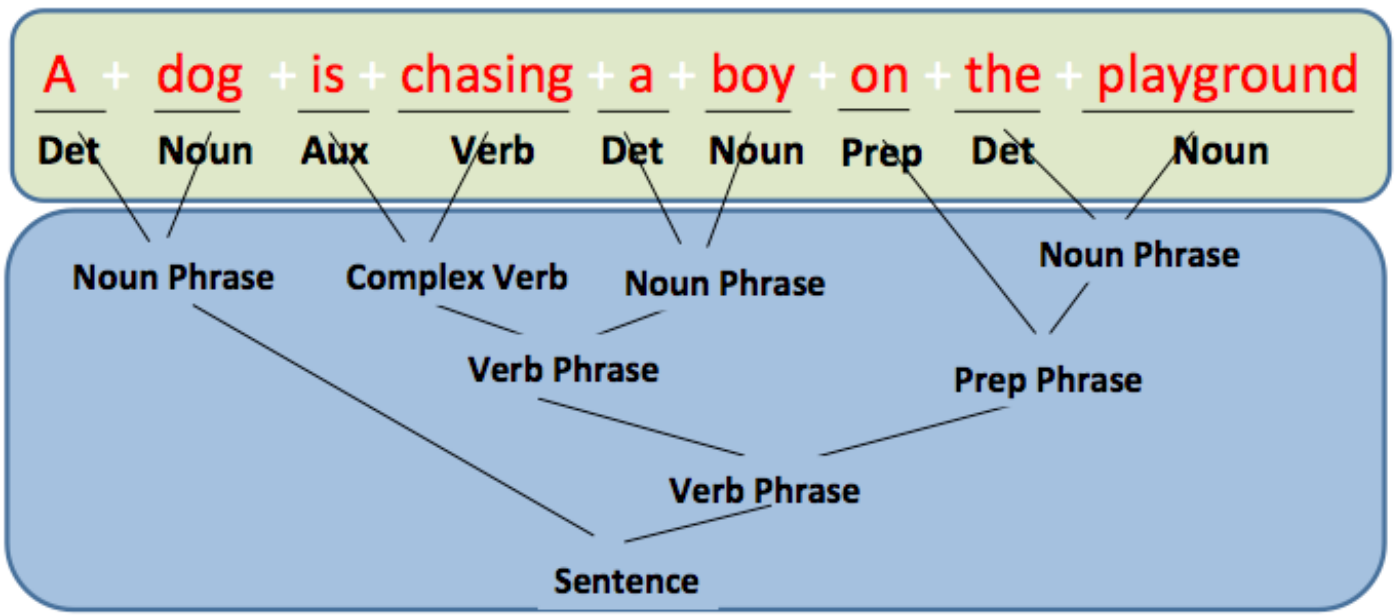
A + dog + is + chasing + a + boy + on + the + playground

A	dog	is	chasing	a	boy	on	the	playground
Det	Noun	Aux	Verb	Det	Noun	Prep	Det	Noun

Syntactic Parsing

Syntactic parsing

- Grammatical analysis of a given sentence, conforming to the rules of a formal grammar
  - Task: what is the most likely grammatical



References

References

Some of the slides in this lecture are based on the following resources , but with many additions and revision:

[1] Rada Mihalcea: Natural Language Processing, 2008
www.cs.odu.edu/~mukka/cs480f09/Lecturenotes/.../Intro1.ppt

[2] Markus Dickinson: Introduction to Natural Language Processing (NLP), Linguistics 362 course, 2006 http://www9.georgetown.edu/faculty/mad87/06/362/syllabus.html