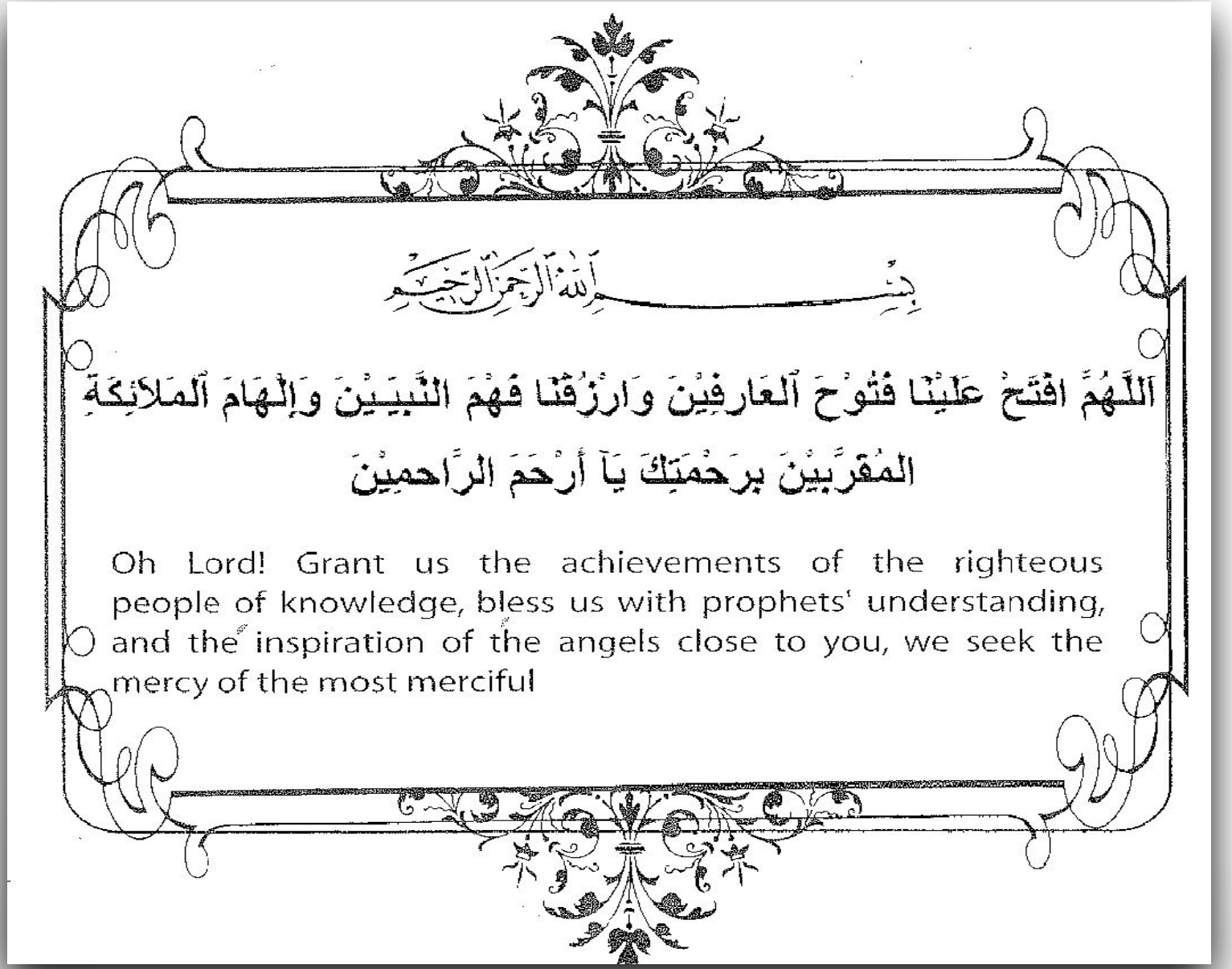
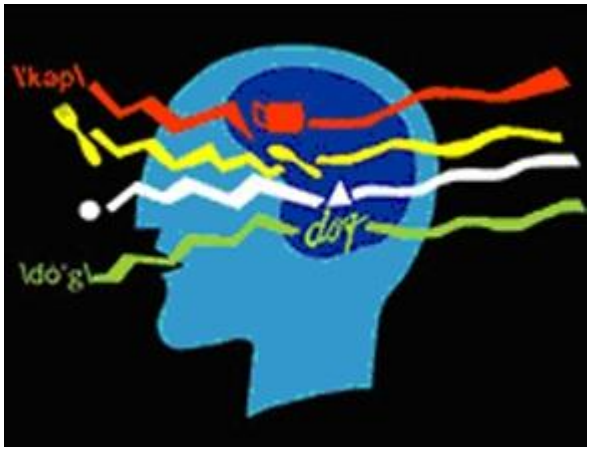
Du`a for Study



Topic 1:

Introduction to Natural Language Processing (NLP)



Content

- NLP Trend
- What is NLP?
- NLP and the Turing Test
- Why NLP?
- Levels of NLP Processing and Analysis
- NLP Phases
- Goals of NLP
- NLP common tasks
- NLP applications

NLP Trend

The internet is huge and easily accessible with almost unlimited source of information BUT information is mainly **UNSTRUCTURED**

Simple scraping and web crawling are usually sufficient but sometimes they are not.

NLP helps to solve the problem of converting free texts (unstructured information) to some kind of structural form.

What is NLP?

- A field of computer science, artificial intelligence, and linguistics concerned with the interactions between computers and human (natural) languages.
- The study of human languages and how they can be represented computationally, analyzed and generated algorithmically.

- The book is on the shelf on(shelf, book)
- The book is on the mat on(shelf, mat)
- That is a thick book and a very old book -> (that, is, a, thick, book, and, very, old) -> <1,1,2,1,2,1,1,1>

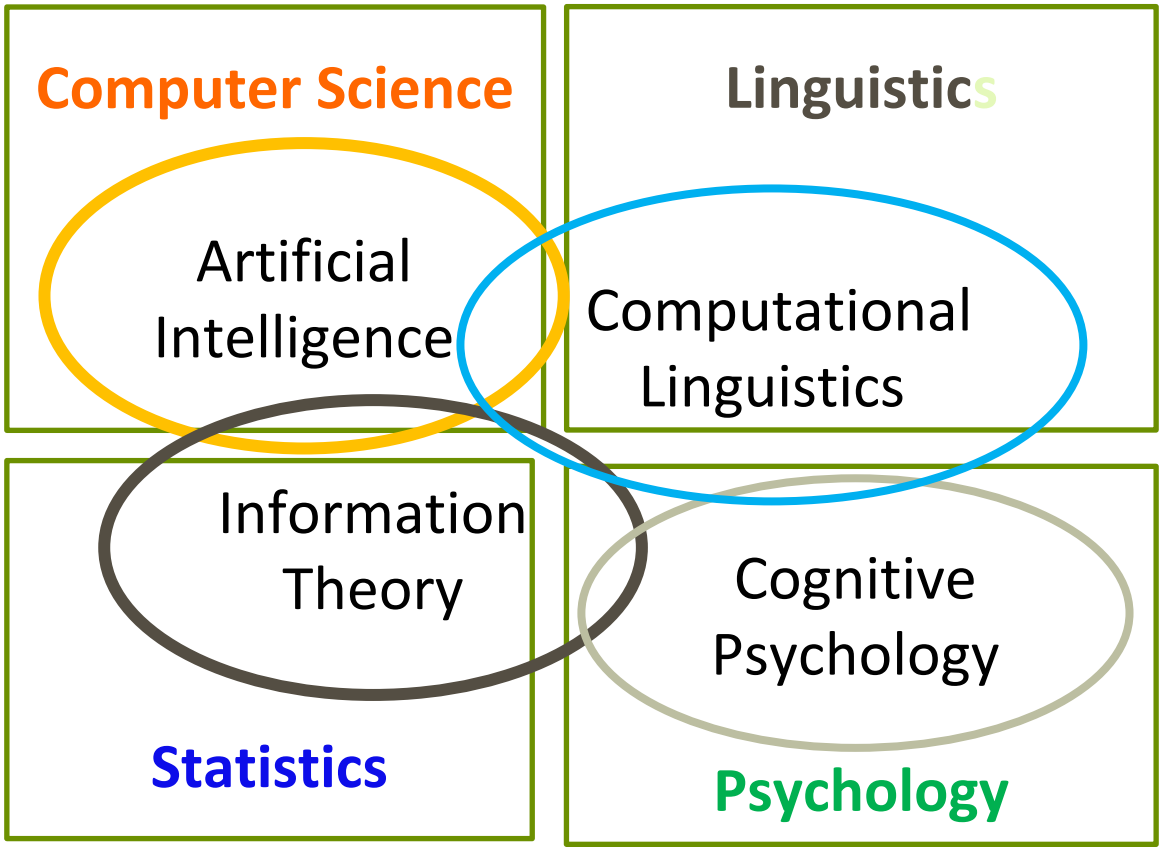
Other NLP Definitions

- The process of building computational models for understanding natural language.
- A coherent study of the human language from the point of views of several disciplines : Linguistics, Psychology, Cognitive Science, Computer Science, Statistics and Mathematics.
- A theoretically motivated range of computational techniques for analyzing and representing naturally occurring texts at one or more levels of linguistic analysis for the purpose of achieving human-like language processing for a range of tasks or applications

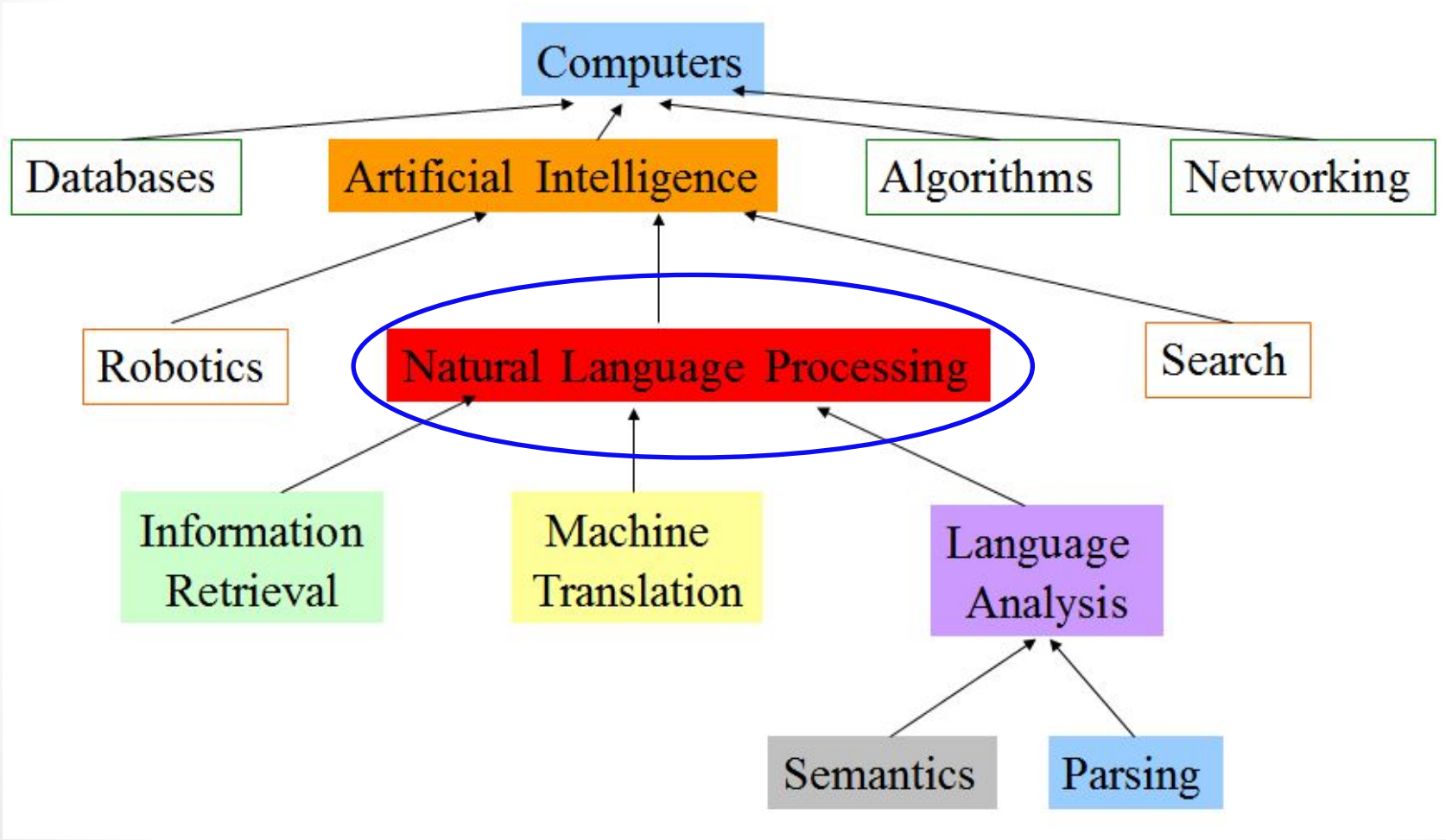
Other names for NLP

- Computational Linguistics (CL)
- Human Language Technology (HLT)
- Natural Language Engineering (NLE)
- Speech and Text Processing

Multidisciplinary NLP



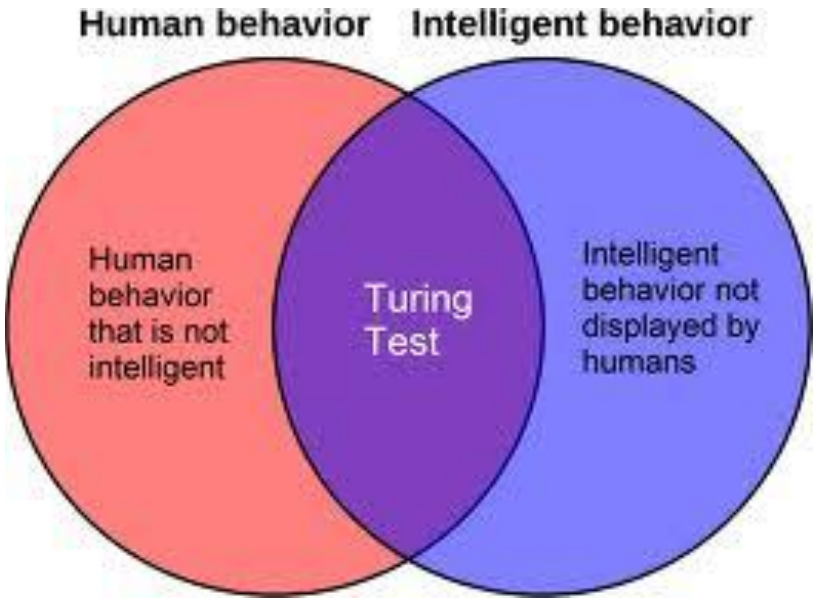
Where does NLP fit in CS?



NLP and the Turing Test

- Can machines think?
  - What does it mean to say that a machine can think???
- The basis to determine if a machine could think is a computer's use of language
  - Empirical test Turing game
- Using human language (by itself) is sufficient as a test for intelligence

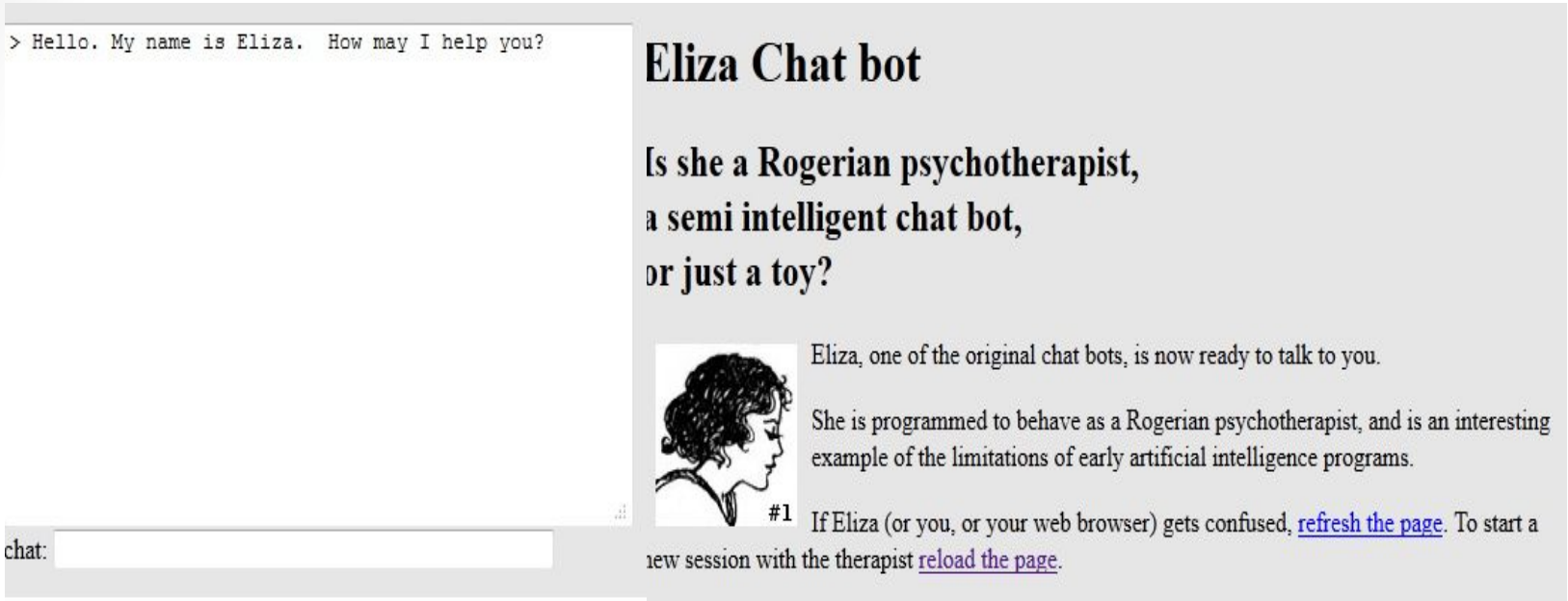
NLP and the Turing Test



NLP and the Turing Test

- The Test
  - 3 participants : 1 human interrogator, 1 participant, 1 computer
  - Goal of computer: Fool the interrogator into believing it is a person by responding like a human to the interrogator's questions.
  - Goal of participant: Convince the interrogator that the other participant is the machine and that she is human.
  - Goal of interrogator: Determine which participant is the machine through a series of questions
- Turing's prediction:
  - By end of the 20th century, a machine with 10 GB of memory would have approx. 30% chance of fooling a human interrogator after five minutes of questioning (Jurafsky & Martin, 2008)

ELIZA (1964-1966) http://nlp-addiction.com/eliza/



- A simple program ("chatterbot") simple program that uses pattern matching to process the input and translate it into suitable outputs
- Models the behaviour of a psychiatrist ("active listening" strategies of a Rogerian therapist).
- ELIZA's relevance to Turing test: Many people who interacted with ELIZA is convinced that it really understood them and their problems.

ALICE (1995-Present)

http://alice.pandorabots.com

A.L.I.C.E. and judge

You said: I knew because you are developed by the Artificial Intelligence Foundation.
A.L.I.C.E.: How, specifically, do you know?. Good reason.. Thanks for telling me that I am developed by the Artificial Intelligence Foundation.

You say: Say

Get an A.I. Foundation membership certificate.

Conversation Log:

judge: Hi Alice! How are you doing today?
ALICE: Hi there! Not too bad.
judge: That is good to hear. Do you like Articial Inteliigence class?
ALICE: Is it good to hear? No, I don't care for it.
judge: Why? Aren't you an inspiration from Artificial Intelligence?
ALICE: If I knew why, I wouldn't be sitting here. Yes I am an inspiration from Artificial Intelligence. How did you know?
judge: I knew because you are developed by the Artificial Intelligence Foundation.
ALICE: How, specifically, do you know?. Good reason.. Thanks for telling me that I am developed by the Artificial Intelligence Foundation.

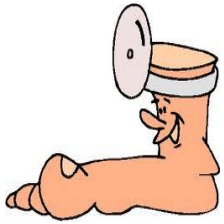
- A.L.I.C.E. (Artificial Linguistic Internet Computer Entity) is an award-winning free natural language artificial intelligence chat robot. Uses a free (open source) software known as AIML (Artificial Intelligence Markup Language) for responses and input.
- The development of A.L.I.C.E (by Dr. Richard S.Wallace) was inspired by Eliza Chatbot.

Why NLP?

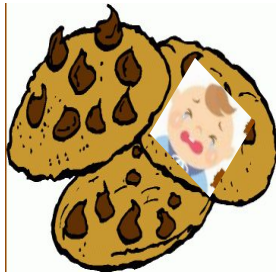
- Ambiguities in human language
  - Some input can be ambiguous when alternative linguistic structures are possible
- Resolving ambiguity:
  - Introduce models or algorithms to resolve ambiguity
  - E.g models: finite state machines, rule systems, logic, probabilistic models and vector space models.
  - E.g algorithms: Dynamic programming, Expectation Maximization, Artificial Neural Network, State space search or other machine learning algorithms

Ambiguities and Complexities in Language

- *"Hospitals are sued by 7 Foot doctors"*



- *"Include your children when baking cookies"*



- *"Kids make nutritious snacks"*
- *"There is a boy, who lost his toy, who jumped with joy, who drank the soy, who made everyone annoyed*

Goals of NLP

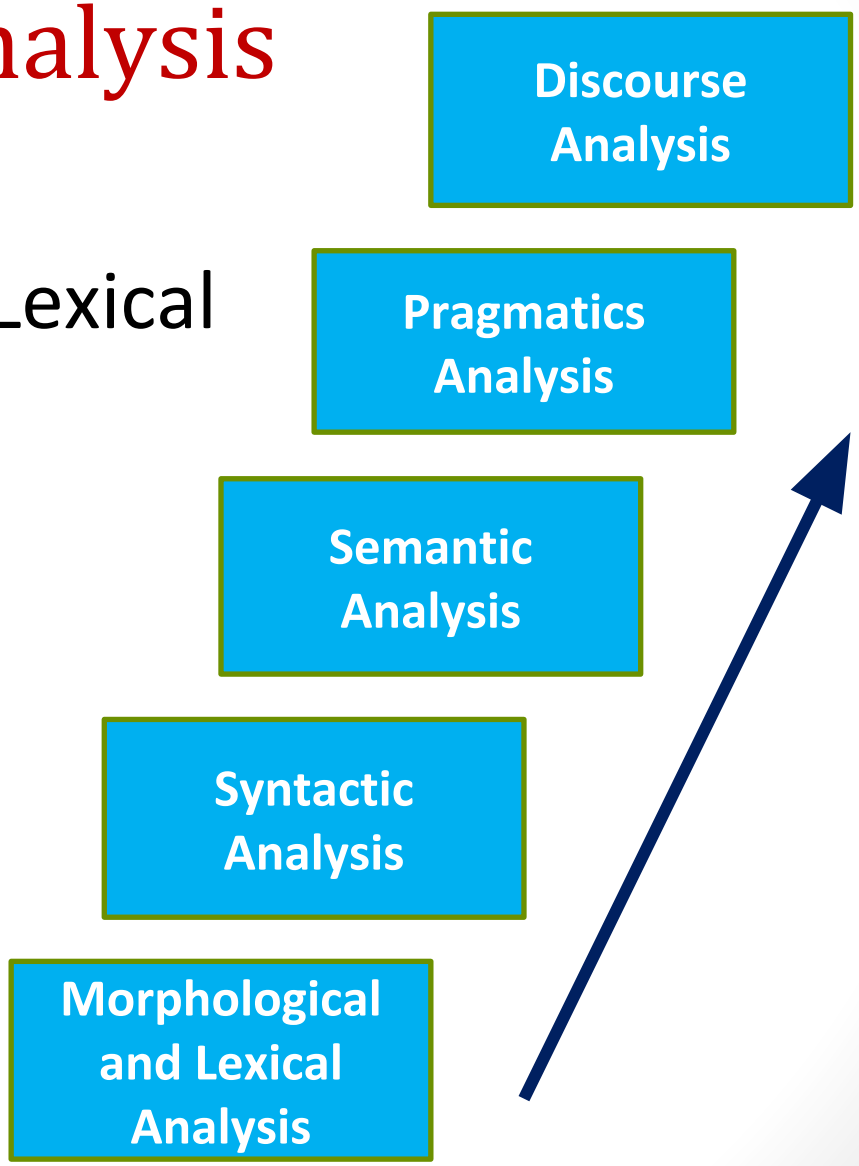
- Group 1
  - cleanup, tokenization
  - stemming
  - lemmatization
  - part-of-speech tagging
  - query expansion
  - sentence segmentation
- Group 2
  - information extraction
  - named entity recognition (NER)
  - sentiment analysis
  - word sense disambiguation
  - text similarity

Goals of NLP by Group

- Group 3
  - machine translation
  - automatic summarisation
  - natural language generation
  - question answering
- Group 4
  - optical character recognition (OCR)
  - speech processing
  - speech recognition
  - text-to-speech

Levels of Language Processing & Analysis

- Morphological and Lexical Analysis
- Syntactic Analysis
- Semantic Analysis
- Pragmatics Analysis
- Discourse Analysis

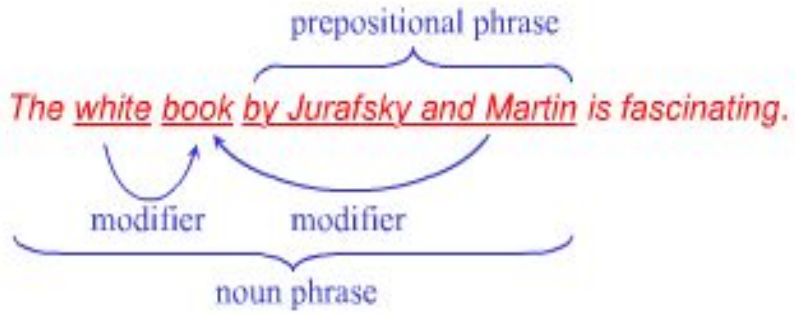


Phases of NLP

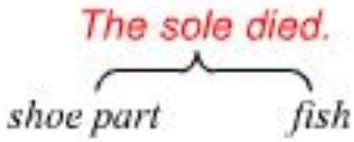
- Engaging in complex language behaviour requires various kinds of knowledge of language
  - Phonetics and Phonology - knowledge about linguistic sounds (tap, butter, chip, sheep)
  - Morphology - knowledge of the smallest meaningful units of words and their composition (cats, children, checked, buys, friendly)

Phases of NLP

- Syntax - knowledge of the structural relationships between words (i.e., in a sentence)



- Semantics - knowledge of meaning of words



(selectional restrictions)

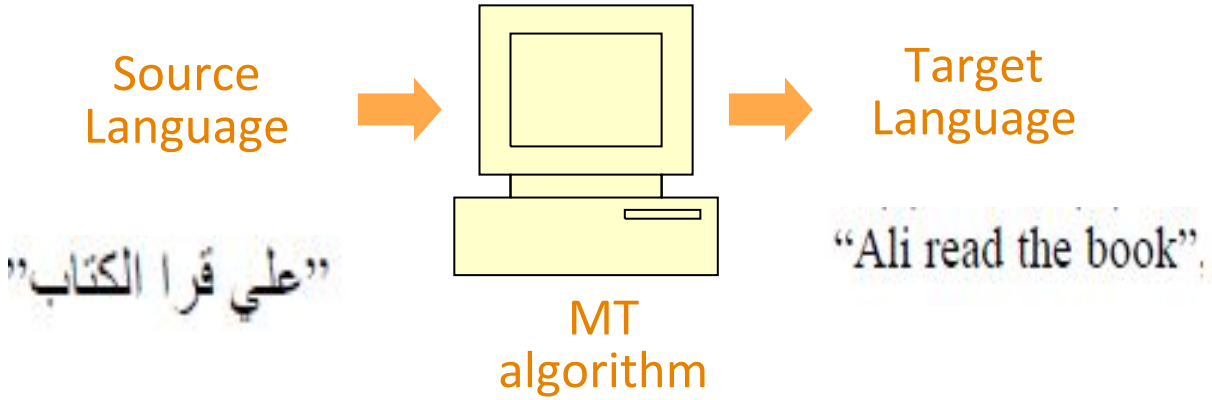
– bass fishing, bass playing (word sense disambiguation)

Phases of NLP

- Pragmatics - knowledge of the relationship of meaning to the goals/intentions of the speaker
- Discourse - knowledge about linguistic units larger than a single utterance

Goals of NLP

- An automated system that analyzes text from source language and produces "equivalent" text in the target language

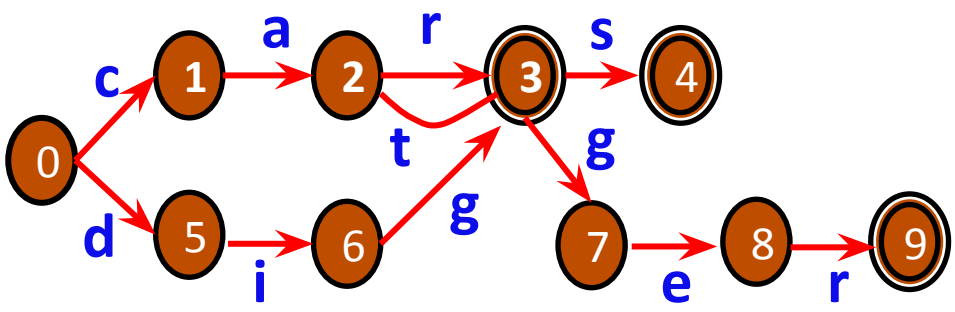


Common NLP Tasks

- Computational Morphology
- Part-of-Speech Tagging
- Text Summarization
- Topic Categorization
- Named Entity Recognition
- Word Sense Disambiguation
- Sentence Parsing
- Sentiment Analysis
- Co-reference Resolution
- Machine Translation
- Speech Recognition

Computational Morphology

- Processing of words and word forms, in both their graphemic (written form) and their phonemic (spoken form)
- Example: finite state morphology



Part-of-Speech Tagging

- Assigning a **part-of-speech (noun, verb, adjective, …)** to each word in a sentence

*"Malaysia**/N** has**/V** 23**/NUM** million**/N** people**/N**"*

Text Summarization

- Text Summarization
  - Automatically reducing a text document to create a summary that preserves the most important points of the original document
  - Example : Given a single document, produce abstract, outline and headline

Topic Categorization

- Classifies documents according to their topics

  "Serena and Nadal relieved after surviving tough opponents in Madrid" [Sports]

  "Facebook eyes $1billion deal for GPS app Waze" [Technology]

  "Property, constructions to lead stock market" [Business]

  "All eyes on cabinet lineups" [Politics]

Named Entity Recognition

- Identifies and labels sequences of words in a text that represents names of things (proper names), such as persons , locations and organizations.
- Classification into a set of predefined categories

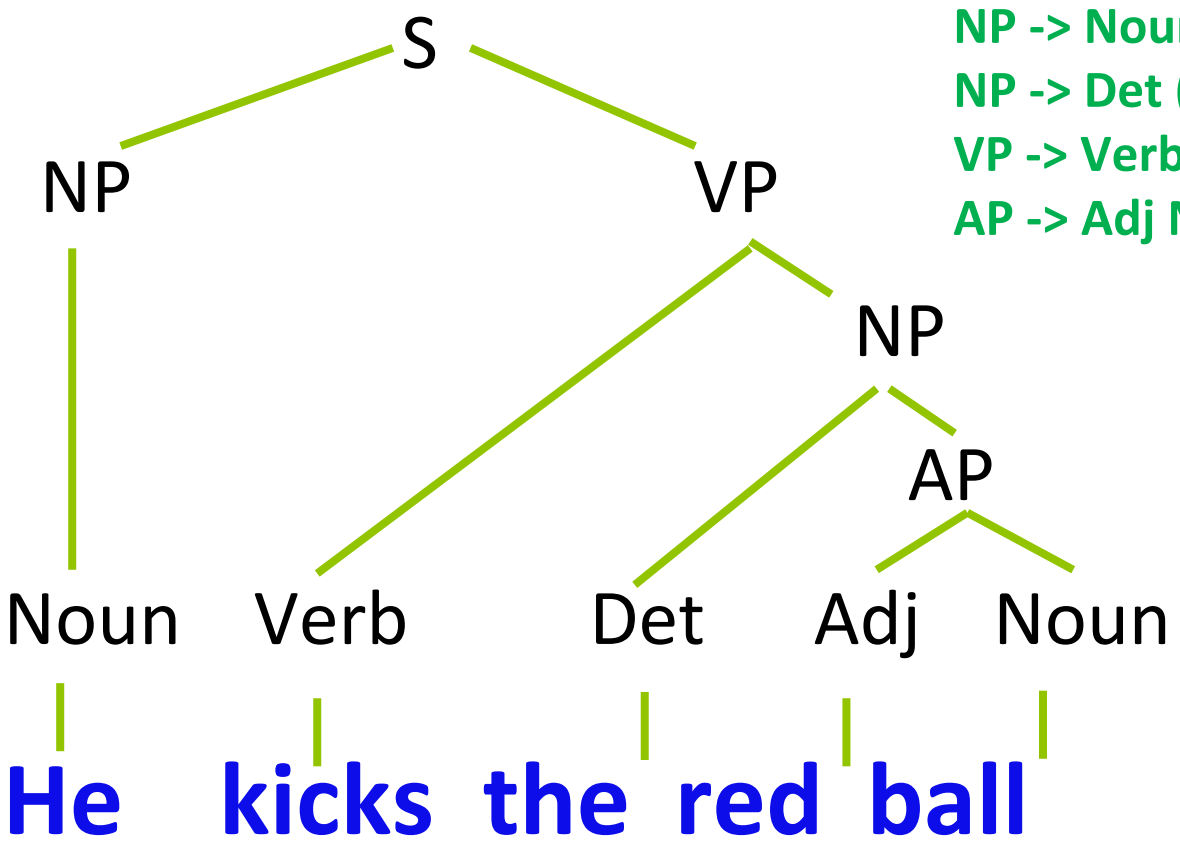
"The World Cup (tournament) took place in England (country)"

Word Sense Disambiguation

- Identify which sense of a word (i.e. meaning) is used in a sentence (in a context), when the word has multiple meanings.
- Classify an occurrence of the word in context into one or more of its sense classes (e.g: bank (financial) vs bank (river))

Sentence Parsing

- Analysing a sentence into its component categories and functions



S -> NP VP
NP -> Noun
NP -> Det (Adj) Noun
VP -> Verb NP
AP -> Adj Noun

Sentiment Analysis

- Identify, analyze and classify opinions in text into categories such as "positive" , "negative" or “neutral”

  “I love Macintosh.” (Positive)

  “I hate Windows! ” (Negative)

  “What a great car, it did not start the first day” (positive or negative???)

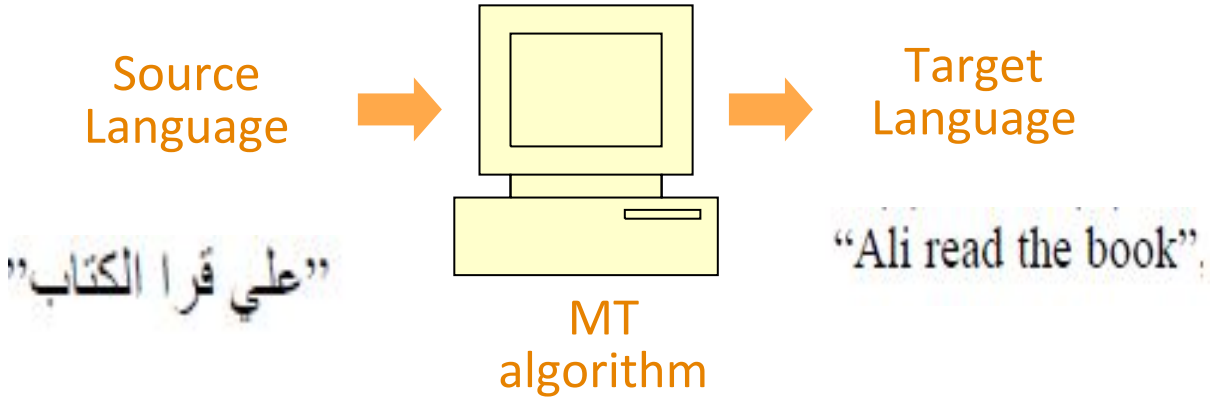
Co-reference Resolution

- Two textual entities that refers to the same object in the "real world" (Mitkov)

Saha Hisham Ismail $_1$***, 45, said poor drainage*** $_2$ ***in the village*** $_3$ ***was the main cause of the problem*** $_4$***. "We*** $_{1,3}$ ***have reported it*** $_2$ ***to the authorities*** $_5$ ***and they*** $_5$ ***have promised to look into it*** $_2$***, but nothing has been done to rectify the problem*** $_2$***."***

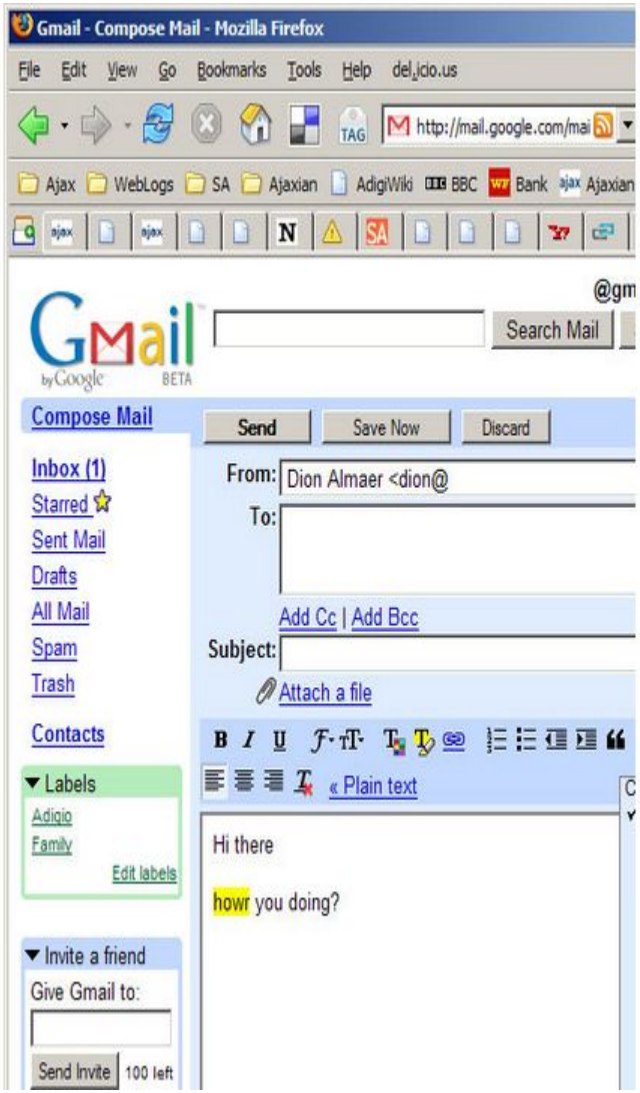
Machine Translation

- An automated system that analyzes text from source language and produces "equivalent" text in the target language



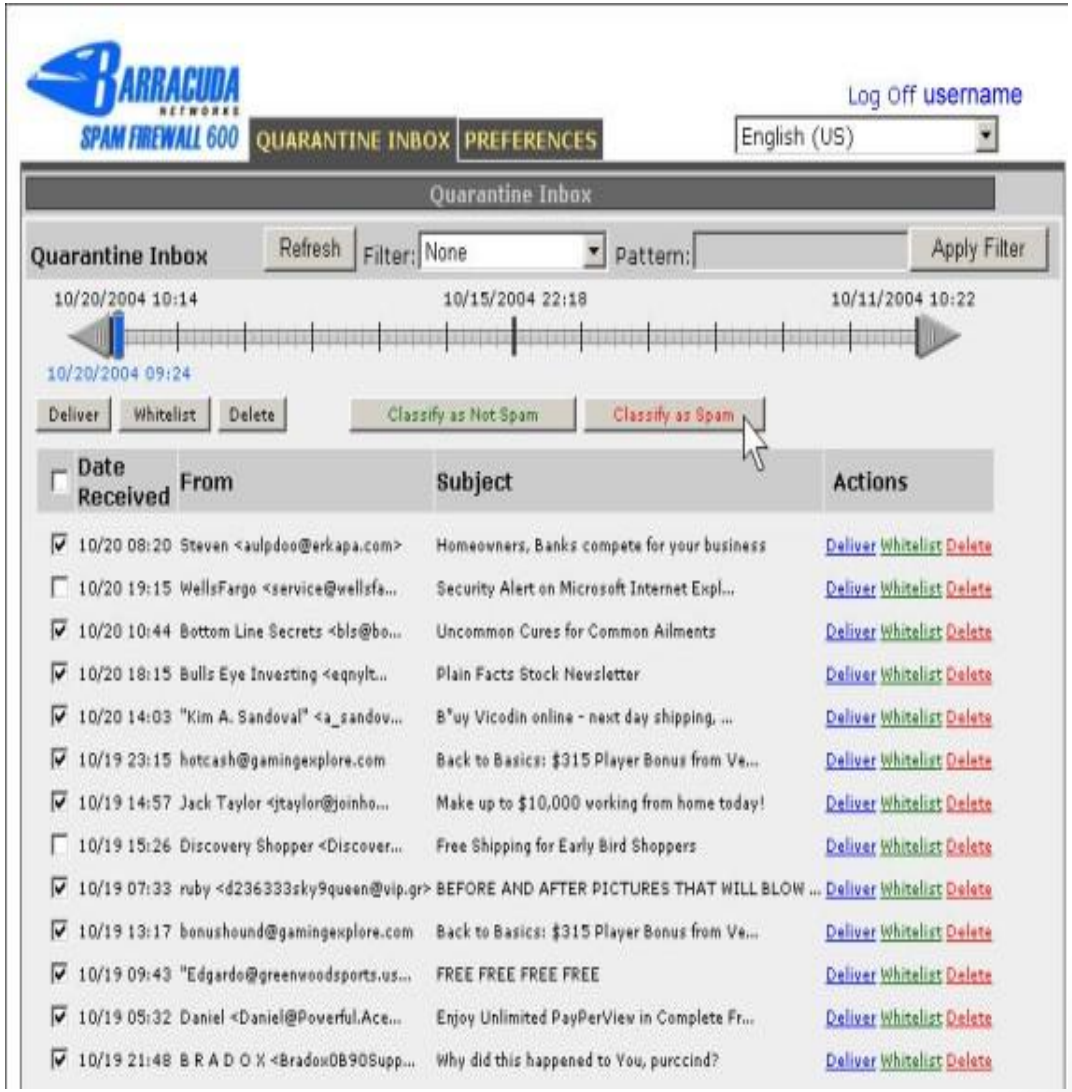
NLP Applications

- Gmail Spell Checker



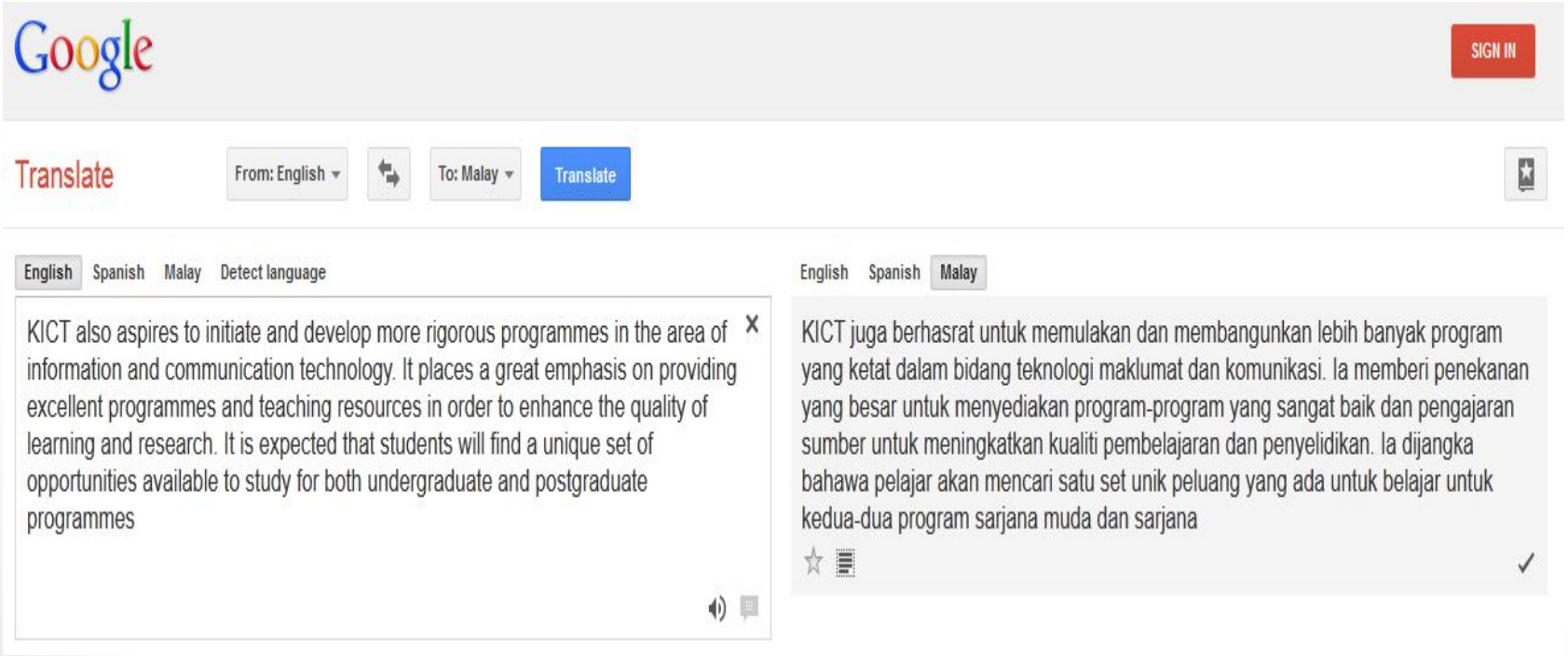
NLP Applications

- Spam Classifier



NLP Applications

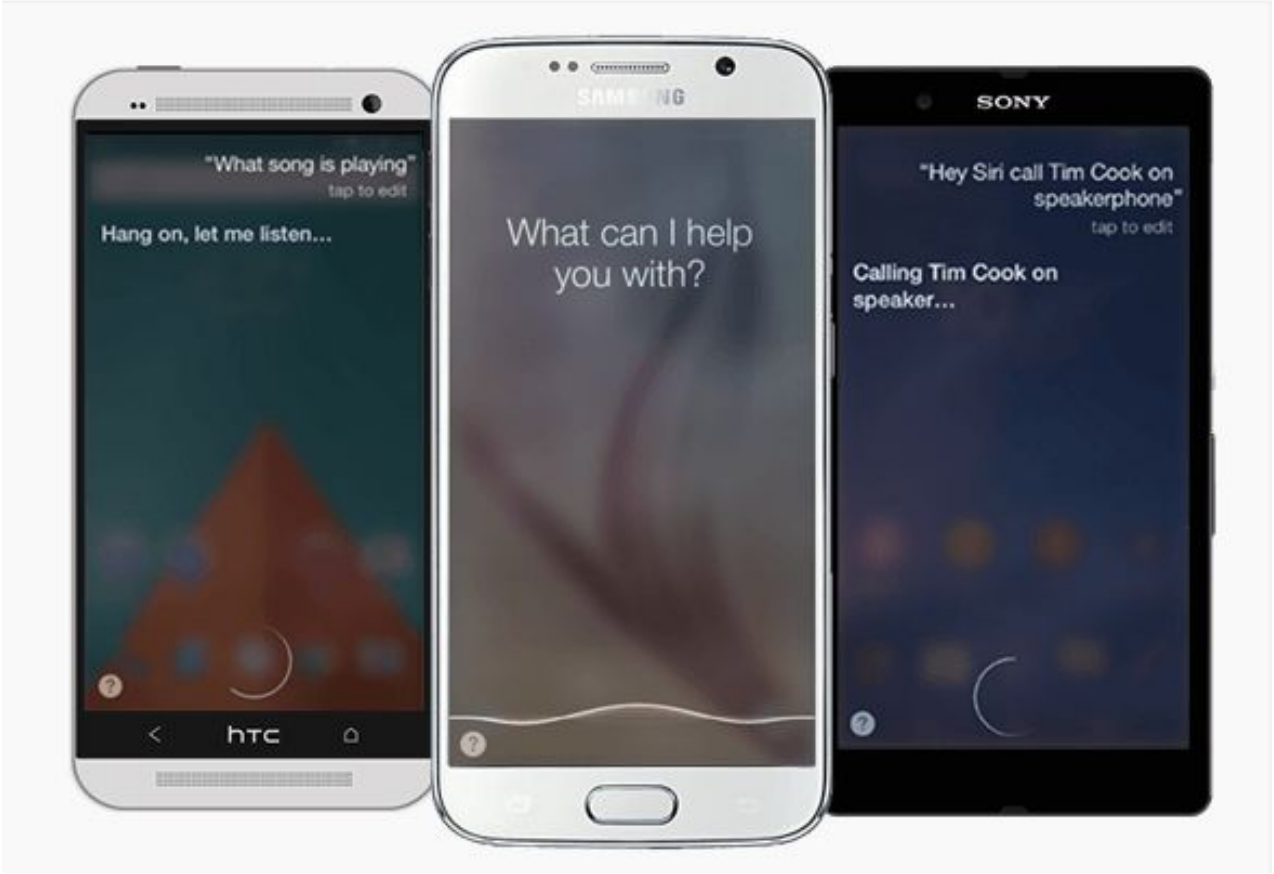
Google Translate



https://translate.google.com/

NLP Applications

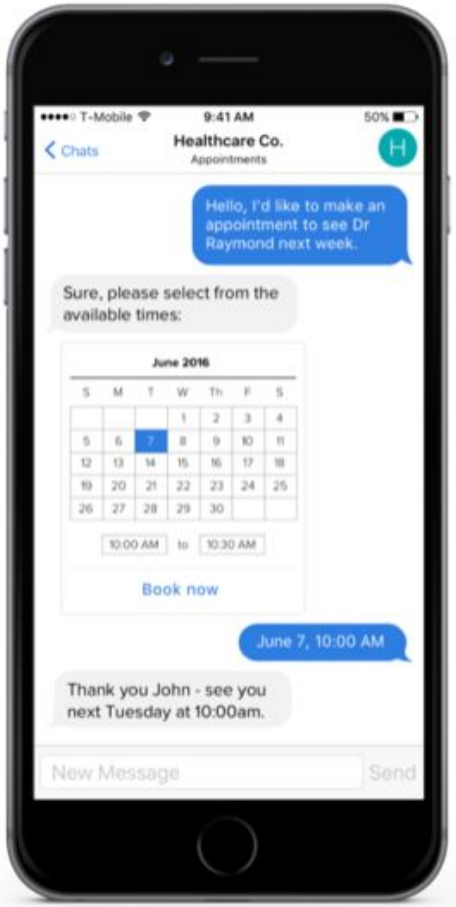
Personal Assistant (Speech-to-Text) : SIRI ANDROID



http://sirionandroid.com/

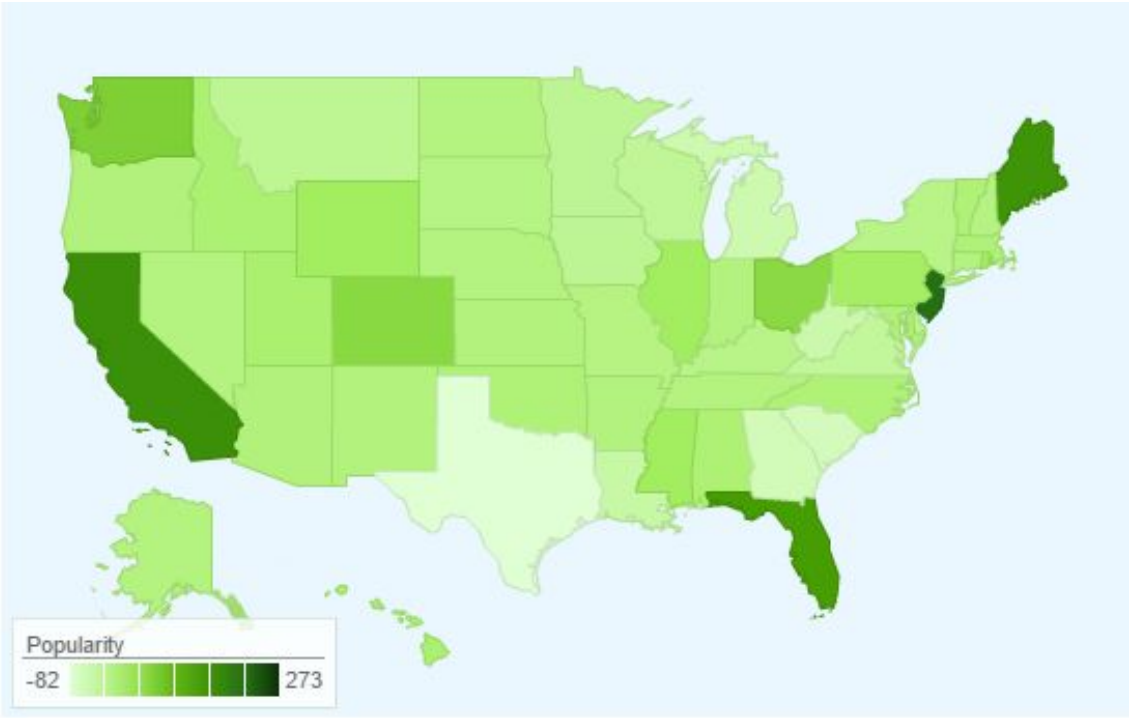
NLP Applications

Chatbot for Business:
Helpdesk agent/Call Centers



NLP Applications

Text Analytics App: Prediction on US Presidential Election

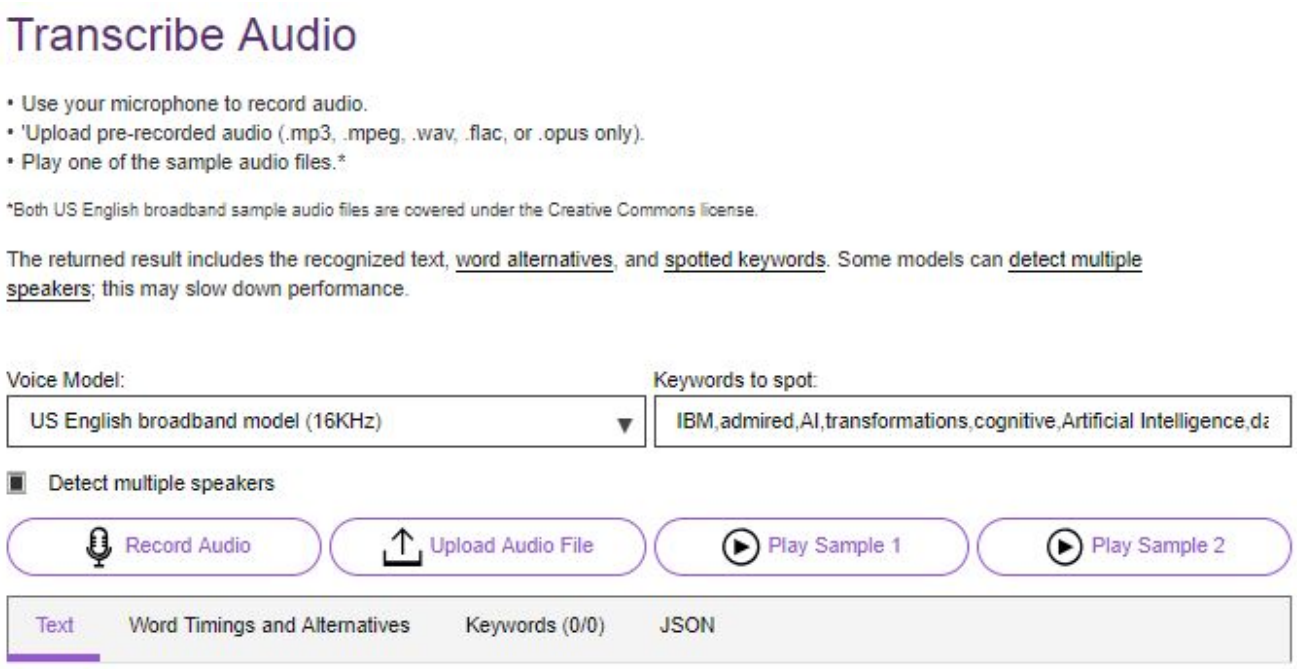


The following Geomap shows Romney's popularity results:

http://www.kazemjahanbakhsh.com/codes/election.html

NLP Applications

IBM Watson Cognitive supercomputer : Speech-to-text service



https://www.ibm.com/watson/services/speech-to-text/

The Future of NLP

https://www.newgenapps.com/blog/trends-for-natural-language-processing-in-2019

https://aibusiness.com/2019-trends-natural-language-processing/

https://www.analyticsvidhya.com/blog/2018/12/key-breakthroughs-ai-ml-2018-trends-2019/