Course Overview & Introduction

COMP90042

Natural Language Processing

Lecture 1

Prerequisites

- COMP90049 “Introduction to Machine Learning” or COMP30027 “Machine Learning”
  - Modules → Welcome → Machine Learning Readings
- Python programming experience
- No knowledge of linguistics or advanced mathematics is assumed
- Caveats – Not “vanilla” computer science
  - Involves some basic linguistics, e.g., syntax and morphology
  - Requires maths, e.g., algebra, optimisation, linear algebra, dynamic programming

Expectations and outcomes

- Expectations
  - develop Python skills
  - keep up with readings
  - classroom participation
- Outcomes
  - Practical familiarity with range of text analysis technologies
  - Understanding of theoretical models underlying these tools
  - Competence in reading research literature

Assessment: Assignments and Exam

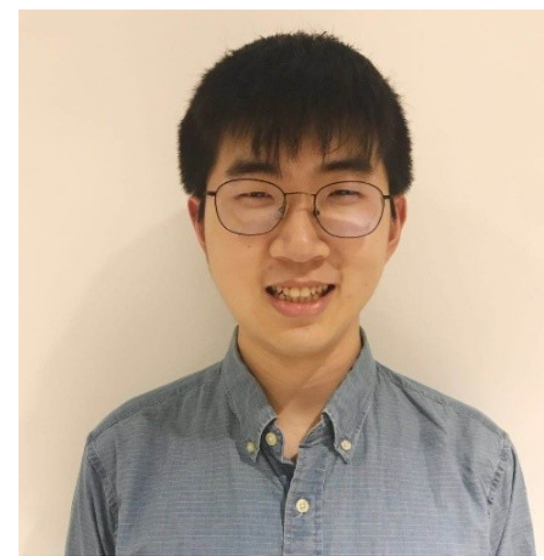
- **Assignments** (20% total = 6-7% each)
  - Small activities building on workshop
  - Released every few weeks, given 2-3 weeks to complete
- **Project** (30% total)
  - Released near Easter & due near end of semester
- **Exam** (50%)
  - two hour, closed book
  - covers content from lectures, workshop and prescribed reading
- **Hurdle** >50% exam, and >50% for (assignment + project)

Teaching Staff

Lecturer

Jey Han Lau

Head Tutor



Zenan Zhai

Tutors

- Aili Shen
- Biaoyan Fang
- Dalin Wang
- Fajri
- Haonan Li
- Jun Wang
- Nitika Mathur

Recommended Texts

- Texts:
  - *Jurafsky and Martin*, *Speech and Language Processing*, 3rd ed., Prentice Hall. draft
  - *Eisenstein*; *Natural Language Processing*, Draft 15/10/18
  - Goldberg; *A Primer on Neural Network Models for Natural Language Processing*
- Recommended for learning python:
  - *Steven Bird, Ewan Klein and Edward Loper*, *Natural Language Processing with Python*, O'Reilly, 2009
- Reading links or lecture slides will be posted to Canvas

COMP90042_2020_SM1 › Modules › Lectures › Slides

2020 Semester 1

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- Outcomes
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- Settings

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Slides

Textbooks

- **JM3**: Jurafsky, Daniel S.; Martin, James H.; *Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition*, Third Edition (incomplete draft)
- **E18**: Eisenstein, Jacob; *Natural Language Processing*, Draft textbook 15/10/18
- **G15**: Goldberg, Yoav; *A Primer on Neural Network Models for Natural Language Processing*

Date	Week	Lecture	Title	Topic	Readings
2 March	1	L1	Course Overview & Introduction	Introduction	N/A
		L2	Text Preprocessing		JM3 Chapter 2 on Normalisation
9 March	2	L3	N-gram Language Models	Words/Documents	E18 Chapter 6 (skip 6.3)
		L4	Text Classification		E18 Chapter 1 & 2
16 March	3	L5	Part of Speech Tagging	Sequence Labelling	JM3 Chapter 8, 8.1-8.3, 8.5.1
		L6	Sequence Tagging: Hidden Markov Models		JM3 Appendix A
23 March	4	L7	Deep Learning for NLP: Feedforward Networks	Deep Learning	G15 Section 4
		L8	Deep Learning for NLP: Recurrent Networks		G15 Section 10
30 March	5	L9	Lexical Semantics	Semantics	
		L10	Distributional Semantics		
6 April	6	L11	Contextualised Representations		
		L12	Discourse		
Easter Break					

Contact hours

- Lectures
  - Mon 09:00-10:00 Glyn Davis (B117)
  - Mon 16:15-17:15 Law GM15 (David P. Durham)
- Workshops: several across the week
  - Bring any questions you have to your tutors
  - May run office hour, if there is sufficient demand
- First method of contact — ask questions on the Canvas discussion board

Python

- Making extensive use of python
  - workshops feature programming challenges
  - provided as interactive ‘notebooks’
  - homework and project in python
- Using several great python libraries
  - NLTK (text processing)
  - Numpy, Scipy, Matplotlib (maths, plotting)
  - Scikit-Learn (machine learning tools)

Python

- New to Python?
  - Expected to pick this up during the subject, on your own time
  - Learning resources on worksheet

https://talktotransformer.com/

Natural Language Processing

- Interdisciplinary study that involves linguistics, computer science and artificial intelligence.
- Aim of the study is to understand how to design algorithms to process and analyse human language data.
- Closely related to **computational linguistics**, but computational linguistics aims to study language from a computational perspective to validate linguistic hypotheses.

Why process text?

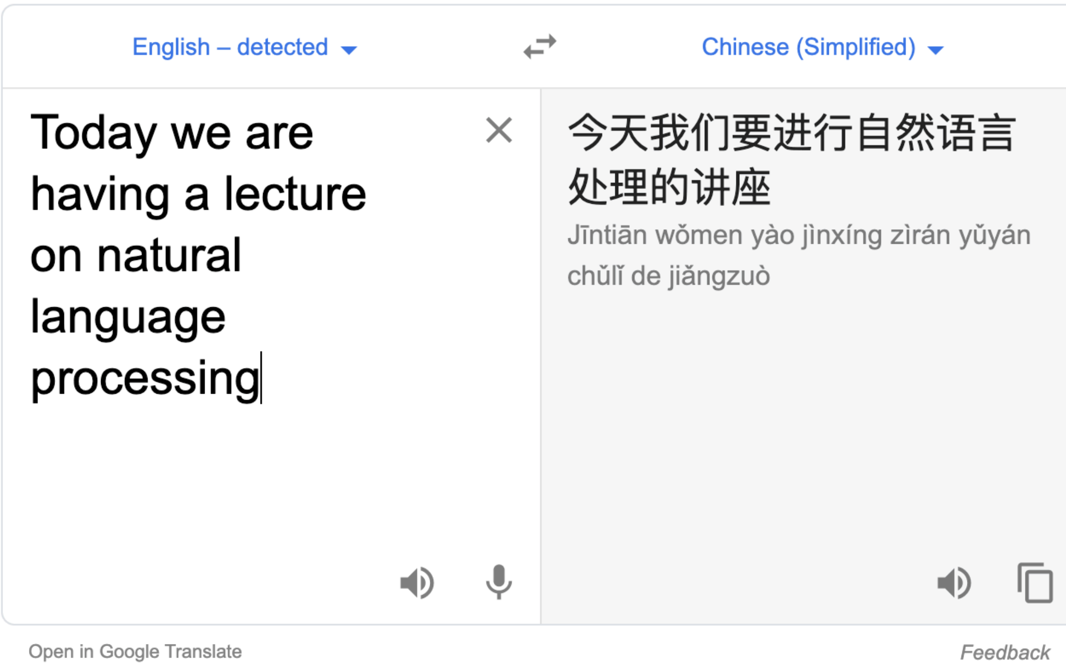
- Masses of information ‘trapped’ in unstructured text
  - How can we find this information?
  - Let computers automatically reason over this data?
  - First need to understand the structure, find important elements and relations, etc…
  - Over 1000s of languages....
- Challenges
  - Search, displaying results
  - Information extraction
  - Translation
  - Question answering
  - …

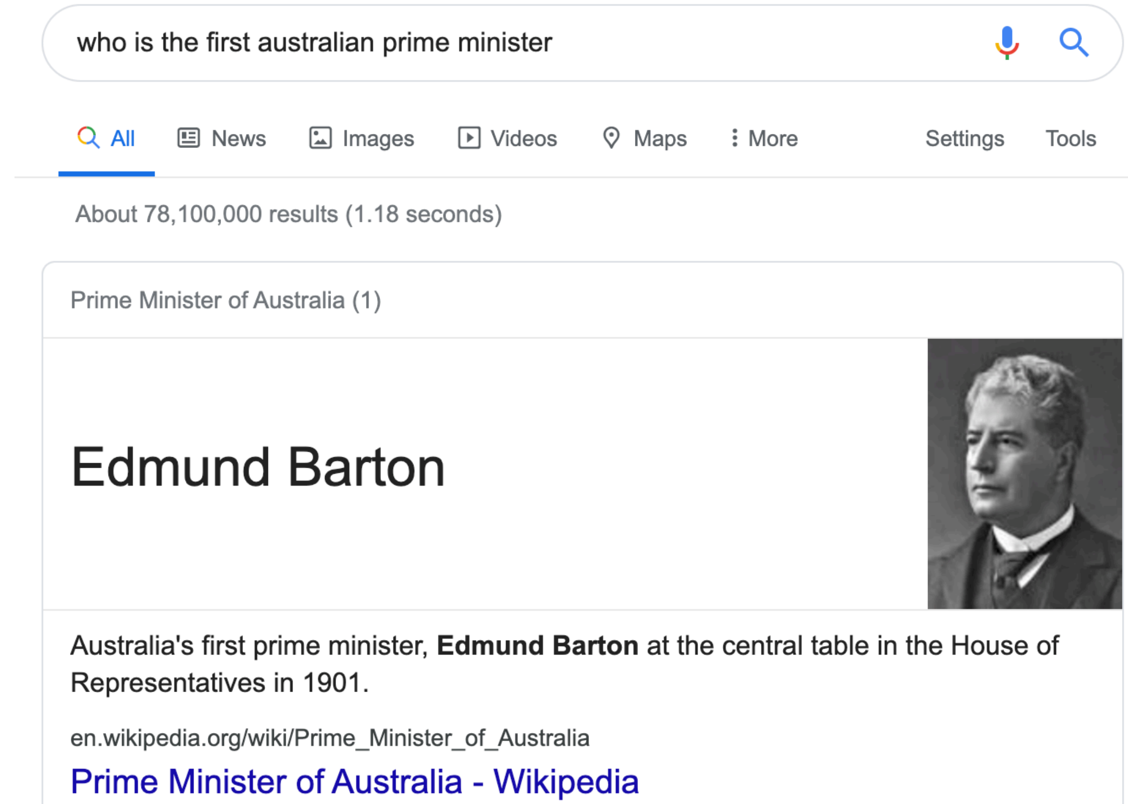
Motivating Applications

- Intelligent conversational agent, e.g. TARS in Interstellar (2014)
  - https://www.youtube.com/watch?v=wVEfFHzUby0
  - Speech recognition
  - Natural language understanding
  - Speech synthesis

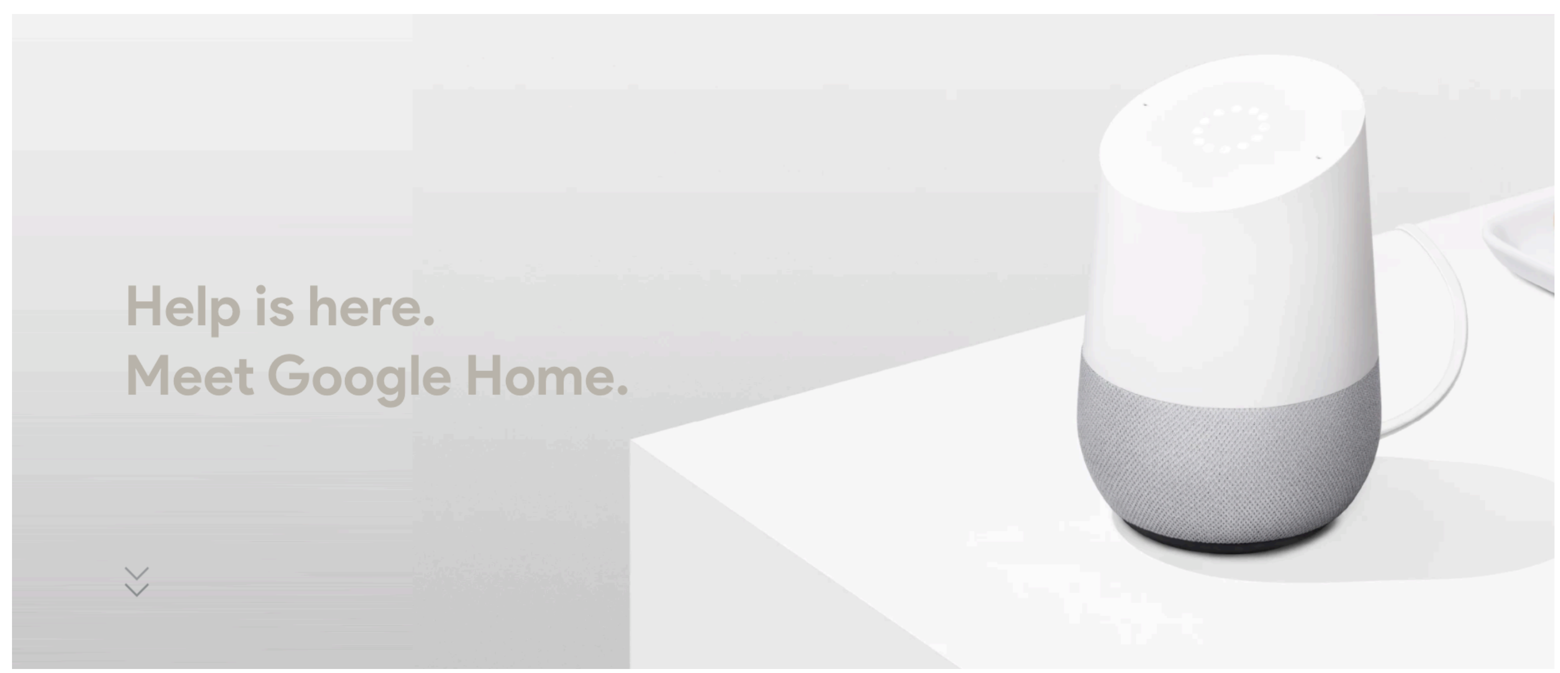
Motivating Applications

- IBM ‘Watson’ system for Question Answering
    - QA over large text collections
        - Incorporating information extraction, and more
    - https://www.youtube.com/watch?v=FC3IryWr4c8
    - https://www.youtube.com/watch?v=lI-M7O_bRNg (from 3:30-4:30)
- Research behind Watson is *not* revolutionary
    - But this is a transformative result in the history of AI
    - Combines cutting-edge text processing components with large text collections and high performance computing


English – detected
Chinese (Simplified)
Today we are having a lecture on natural language processing
今天我们要进行自然语言处理的讲座
Jīntiān wǒmen yào jìnxíng zìrán yǔyán chǔlǐ de jiǎngzuò
Open in Google Translate
Feedback


who is the first australian prime minister
All
News
Images
Videos
Maps
More
Settings
Tools
About 78,100,000 results (1.18 seconds)
Prime Minister of Australia (1)
Edmund Barton
Australia's first prime minister, **Edmund Barton** at the central table in the House of Representatives in 1901.
en.wikipedia.org/wiki/Prime_Minister_of_Australia
Prime Minister of Australia - Wikipedia


google translate
google translate **english to spanish**
google translate **audio**
google translate **english to french**
google translate **website**
google translate **statistics**
translate **to hindi**
translate **to english**
inside google translate


Help is here.
Meet Google Home.

Course Overview

- **Word, sequences, and documents**
  - Text preprocessing
  - Language models
  - Text classification
- **Structure learning**
  - Sequence tagging (e.g. part-of-speech)
- **Deep learning for NLP**
  - Feedforward and recurrent models

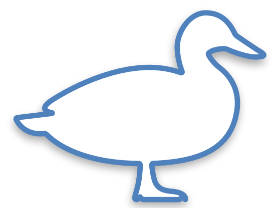
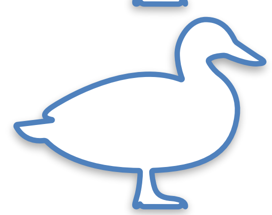
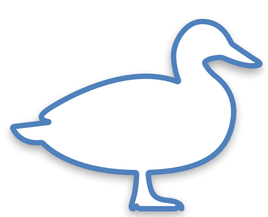
Course Overview

- **Semantics**
    - How words form meaning
- **Syntax**
    - How words are arranged
- **Applications**
    - Machine translation
    - Information extraction
    - Question answering

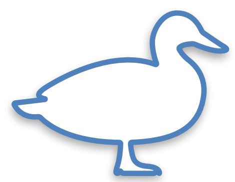
Models and Algorithms

- State machines
  - Formal models that consist of states, transitions between states, and input. E.g. finite-state automata.
- Formal rule systems
  - Regular grammars, context-free grammars to explain syntax
- Machine learning
  - Hidden Markov models for understanding sequences
  - Logistic regressions, SVMs for classifying text
  - Neural networks (deep learning)

Ambiguity in Language

- *I made her duck:*
  - *I cooked*  *for her*
  - *I cooked*  *belonging to her*
  - *I caused her to quickly lower her head or body*
  - *I waved my magic wand and turned her into a* 
- Why so many possible interpretations? Language is hard!

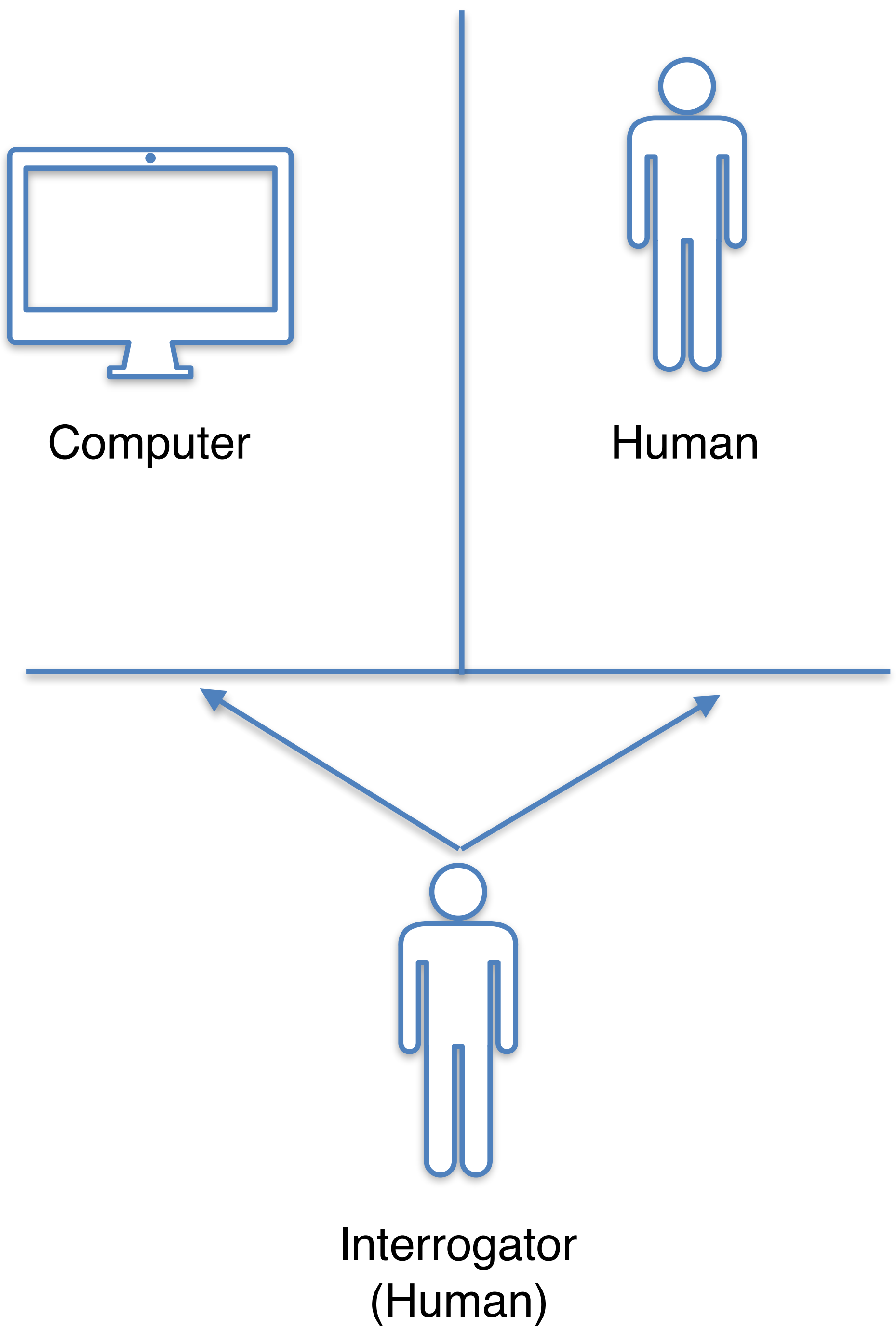
Ambiguity in Language

- *Duck* can mean:
  - Noun: 
  - Verb: move head or body quickly down (e.g. to dodge something)
- *Her* can be a dative pronoun (i.e. indirect object to a verb) or possessive pronoun
- *Make* is syntactically ambiguous:
  - Transitive (takes one object: *duck*)
  - Ditransitive (1st object: *her*; 2nd object: *duck*)
  - Can take a direct object and verb: object (*her*) is caused to perform the verbal action (*duck*)

Language and Thought

- The ability to process language can be seen as a litmus test for truly intelligent machines.
- Because effective use of language is intertwined with our general cognitive abilities.
- Alan Turing, famously proposed the **Turing test**, to assess whether a machine is intelligent

Turing Test



- 3 participants: 2 humans and a computer
- One of the humans is an interrogator
- Test involves a conversation between 2 parties
- The role of the interrogator is to determine which participant is the machine by asking a series of questions
- Machine is intelligent if it can fool the interrogator into thinking that he/she is talking to a human

Are Machines Intelligent Yet?

- Alan Turing predicted that by the end of 20th century a machine with 10 gigabytes of memory has 30% of fooling the human interrogator.
- The smartest conversational agent we have today are far away from being truly intelligent...
- You can, however, build programs that can *cheat* the test. The ELIZA program is one such example.

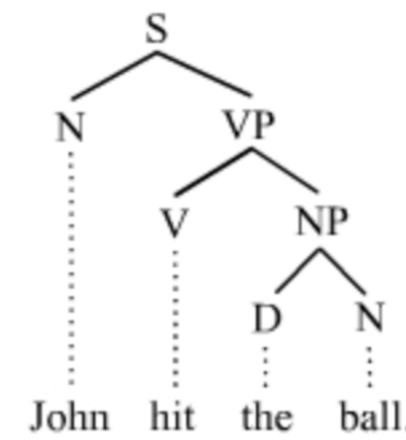
ELIZA

- User: You are like my father in some ways
- ELIZA: What resemblance do you see
- User: You are not very aggressive but I think you don't want me to notice that
- ELIZA: What makes you think I am not aggressive
- User: You don't argue with me
- ELIZA: Why do you think I don't argue with you
- User: You are afraid of me
- ELIZA: Does it please you to believe I am afraid of you

A brief history of NLP: 1950s

- "Computing Machinery and Intelligence", Alan Turing
  - Turing test: measure machine intelligence via a conversational test
- "Syntactic Structures", Noam Chomsky
  - Formal language theory: uses algebra and set theory to define formal languages as sequences of symbols
  - *Colourless green ideas sleep furiously*
    - Sentence doesn't make sense
    - But its grammar seems fine
    - Highlights the difference between semantics (meaning) and syntax (sentence structure)

1960-1970s



- Symbolic paradigm
  - Generative grammar
    - Discover a system of rules that generates grammatical sentences
  - Parsing algorithms
- Stochastic paradigm
  - Bayesian method for optical character recognition and authorship attribution
- First online corpus: Brown corpus of American English
  - 1 million words, 500 documents from different genres (news, novels, etc)

1970-1980s

- Stochastic paradigm
  - Hidden Markov models, noisy channel decoding
  - Speech recognition and synthesis
- Logic-based paradigm
  - More grammar systems (e.g. Lexical functional Grammar)
- Natural language understanding
  - Winograd's SHRDLU
  - Robot embedded in a toy blocks world
  - Program takes natural language commands (*move the red block to the left of the blue block*)
  - Motivates the field to study semantics and discourse

1980-1990s

- Finite-state machines
  - Phonology, morphology and syntax
- Return of empiricism
  - Probabilistic models developed by IBM for speech recognition
  - Inspired other data-driven approaches on part-of-speech tagging, parsing, and semantics
  - Empirical evaluation based on held-out data, quantitative metrics, and comparison with state-of-the-art

1990-2000s: Rise of Machine Learning

- Better computational power
- Gradual lessening of the dominance of Chomskyan theories of linguistics
- More language corpora developed
  - Penn Treebank, PropBank, RSTBank, etc
  - Corpora with various forms of syntactic, semantic and discourse annotations
- Better models adapted from the machine learning community: support vector machines, logistic regression

2000s: Deep Learning

- Emergence of very deep neural networks (i.e. networks with many many layers)
- Started from the computer vision community for image classification
- Advantage: uses raw data as input (e.g. just words and documents), without the need to develop hand-engineered features
- Computationally expensive: relies on GPU to scale for large models and training data
- Contributed to the AI wave we now experience:
  - Home assistants and chatbots

Future of NLP

- Are NLP problems solved?
  - Machine translation still is far from perfect
  - NLP models still can't reason over text
  - Not quite close to passing the Turing Test
    - Amazon Alexa Prize: https://www.youtube.com/watch?v=WTGuOg7GXYU