Introduction to Natural Language Processing

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Questions

- How do we write programs to manipulate natural language?
- What questions about language could we answer?
- How would the programs work?
- What data would they need?
- First: what do they look like?

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Searching Pronunciation Dictionary

```
ACCUMULATIVELY / AH0 K Y UW1 M Y AH0 L AH0 T IH0 V L IY0
AGONIZINGLY / AE1 G AH0 N AY0 Z IH0 NG L IY0
CARICATURIST / K EH1 R AH0 K AH0 CH ER0 AH0 S T
CIARAMITARO / CH ER1 AA0 M IY0 T AA0 R OW0
CUMULATIVELY / K Y UW1 M Y AH0 L AH0 T IH0 V L IY0
DEBENEDICTIS / D EH1 B EH0 N AH0 D IH0 K T AH0 S
DELEONARDIS / D EH1 L IY0 AH0 N AA0 R D AH0 S
FORMALIZATION / F AO1 R M AH0 L AH0 Z EY0 SH AH0 N
GIANNATTASIO / JH AA1 N AA0 T AA0 S IY0 OW0
HYPERSENSITIVITY / HH AY2 P ER0 S EH1 N S AH0 T IH0 V AH0 T IY0
IMAGINATIVELY / IH2 M AE1 JH AH0 N AH0 T IH0 V L IY0
INSTITUTIONALIZES / IH2 N S T AH0 T UW1 SH AH0 N AH0 L AY0 Z AH0 Z
INSTITUTIONALIZING / IH2 N S T AH0 T UW1 SH AH0 N AH0 L AY0 Z IH0 NG
MANGIARACINA / M AA1 N JH ER0 AA0 CH IY0 N AH0
SPIRITUALIST / S P IH1 R IH0 CH AH0 W AH0 L AH0 S T
SPIRITUALISTS / S P IH1 R IH0 CH AH0 W AH0 L AH0 S T S
SPIRITUALISTS / S P IH1 R IH0 CH AH0 W AH0 L AH0 S S
SPIRITUALISTS / S P IH1 R IH0 CH AH0 W AH0 L AH0 S
SPIRITUALLY / S P IH1 R IH0 CH AH0 W AH0 L IY0
UNALIENABLE / AH0 N EY1 L IY0 EH0 N AH0 B AH0 L
UNDERKOFFLER / AH1 N D ER0 K AH0 F AH0 L ER0
```

Minimal Sets from Lexicon

kasi	–	kesi	kusi	kosi
kava	–	–	kuva	kova
karu	kiru	keru	kuru	koru
kapu	kipu	–	–	kopu
karo	kiro	–	–	koro
kari	kiri	keri	kuri	kori
kapa	–	kepa	–	kopa
kara	kira	kera	–	kora
kaku	–	–	kuku	koku
kaki	kiki	–	–	koki

Modelling Text Genres

```
lo, it came to the land of his father and he said, i wil
wife unto him, saying, if thou shalt take our money in t
cattle, in thy seed after these are my son from off any
that is this day with him into egypt, he, hath taken awa
pass, when she bare jacob said one night, because they w
hundred years old, as for an altar there, he had made me
pitcher upon every living creature after thee shall come
yea,
```

Exploring Syntax

```
VBP ADVP-TMP PP-PRD PP *BUT* VBP VP
VBZ VP *BUT* VBZ NP PP-CLR
PP-TMP VBZ VP *BUT* VBD ADVP-TMP S
VBZ SBAR *BUT* VBZ SBAR
VBD SBAR *BUT* VBD RB VP
VBD SBAR *BUT* VBD S
VBP NP-PRD *BUT* VBP RB ADVP-TMP VP
VBN PP PP-TMP *BUT* ADVP-TMP VBN NP
MD VP *BUT* VBZ NP SBAR-ADV
VBD ADVP-CLR *BUT* VBD NP
VBN NP PP *BUT* VBN NP PP SBAR-PRP
VBD NP *BUT* MD RB VP
VBD NP PP-CLR *BUT* VBD PRT NP
VBZ S *BUT* MD VP
```

The Richness of Language

- basic needs and lofty aspirations; technical know-how and flights of fantasy
- ideas are shared over great separations of distance and time

1. Overhead the day drives level and grey, hiding the sun by a flight of grey spears. (William Faulkner, *As I Lay Dying*, 1935)
2. When using the toaster please ensure that the exhaust fan is turned on. (sign in dormitory kitchen)
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4. Iraqi Head Seeks Arms (spoof headline, `http://www.snopes.com/humor/nonsense/head97.htm`
5. The earnest prayer of a righteous man has great power and wonderful results. (James 5:16b)
6. Twas brillig, and the slithy toves did gyre and gimble in the wabe (Lewis Carroll, *Jabberwocky*, 1872)
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Disciplines Studying Language

1. linguistics
2. translation
3. literary criticism
4. philosophy
5. anthropology
6. psychology
7. law
8. hermeneutics
9. forensics
10. telephony
11. pedagogy
12. archaeology
13. cryptanalysis
14. speech pathology

Language and the Internet

- unprecedented volume of information:
  mostly unstructured text
- 8 Tb books in 2003
- 24 hours of scientific literature would take 5 years to read
- fraction of work/leisure time spent navigating this information
- a great challenge for natural language processing
- despite success of web search engines, we need skill, knowledge, and luck to answer the following questions:
  1. *What tourist sites can I visit between Philadelphia and Pittsburgh on a limited budget?*
  2. *What do expert critics say about Canon digital cameras?*
  3. *What predictions about the steel market were made by credible commentators in the past week?*
- requires a combination of language processing tasks, e.g. information extraction, inference, and summarisation

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The Promise of NLP

- importance in scientific, economic, social and cultural arenas
- growing rapidly as its theories and methods are deployed in new technologies
- therefore a wide range of people should have a working knowledge of NLP
  - academia: humanities computing, corpus linguistics, computer science, artificial intelligence
  - industry: HCI, business information analysis, web software development
- the goal of the book is to open the field of NLP to a broad audience.

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NLP and Intelligence

- long-standing challenge to build intelligent machines
- chief measure of machine intelligence has been linguistic: Turing test
- research on spoken dialogue systems, also MT
  — *integrated NLP systems which future users would regard as highly intelligent*
- Example human-machine dialogue illustrates a typical application:

  S: How may I help you?
  U: When is Saving Private Ryan playing?
  S: For what theater?
  U: The Paramount theater.
  S: Saving Private Ryan is not playing at the Paramount theater, but it's playing at the Madison theater at 3:00, 5:30, 8:00, and 10:

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NLP and Intelligence (cont)

- today's systems limited to narrowly defined domains
- couldn't ask above system for other information, e.g.:
  - driving instructions
  - details of nearby restaurants
- to add such support we would have to:
  - store the required information
  - incorporate suitable questions and answers into the system
- common-sense reasoning vs business logic
- need to make progress on natural linguistic interaction without recourse to this unrestricted knowledge and reasoning capability

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Language and Symbol Processing

- origin of the idea that natural language could be treated computationally: philosophy of language work in early 1900s, to reconstruct mathematical reasoning using logic
- language as a formal system
- three further developments:
  1. formal language theory
  2. symbolic logic
  3. principle of compositionality
- more recent developments:
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Google hits	**adore**	**love**	**like**	**prefer**
absolutely	289,000	905,000	16,200	644
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