NLP
Introduction to NLP

Background for NLP
Linguistic Knowledge

• Constituents:
  – Children eat pizza.
  – They eat pizza.
  – My cousin’s neighbor’s children eat pizza.
  – Eat pizza!

• Collocations:
  – Strong beer but *powerful beer
  – Big sister but *large sister
  – Stocks rise but ?stocks ascend
    • in the past: 225,000 hits vs. 47 hits on Google, now 550,000 vs 57,000

• How to get this knowledge in the system:
  – Manual rules
  – Automatically acquired from large text collections (corpora)
Linguistic knowledge

• Knowledge about language:
  – Phonetics and phonology – the study of sounds
  – Morphology – the study of word components
  – Syntax – the study of sentence and phrase structure
  – Lexical semantics – the study of the meanings of words
  – Compositional semantics – how to combine words
  – Pragmatics – how to accomplish goals
  – Discourse conventions – how to deal with units larger than utterances

• Separate lecture
Finite-state automata
Theoretical Computer Science

• Automata
  – Deterministic and non-deterministic finite-state automata
  – Push-down automata
• Grammars
  – Regular grammars
  – Context-free grammars
  – Context-sensitive grammars
• Complexity
• Algorithms
  – Dynamic programming
Artificial Intelligence

• Logic
  – First-order logic
• Agents
  – Speech acts
• Search
• Planning
• Constraint satisfaction
• Machine learning
Mathematics and Statistics

• Statistics
  – Probabilities
  – Statistical models
  – Hypothesis testing

• Mathematics
  – Linear algebra
  – Some calculus
  – Optimization
  – Numerical methods
Mathematical and Computational Tools

• Language models
• Estimation methods
• Context–free grammars (CFG)
  – for trees
• Hidden Markov Models (HMM)
  – for sequences
• Conditional Random Fields (CRF)
• Optimization
Statistical Techniques

- Vector space representation for WSD
- Noisy channel models for MT
- Random walk methods for sentiment analysis

\[
\hat{E} = \arg\max_{E \in \text{English}} P(F \mid E) P(E) \\
= \arg\max_{E \in \text{English}} \frac{P(F \mid E) P(E)}{P(F)} \\
= \arg\max_{E \in \text{English}} P(F \mid E) P(E)
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