CSE 150 Lecture 1 1/04

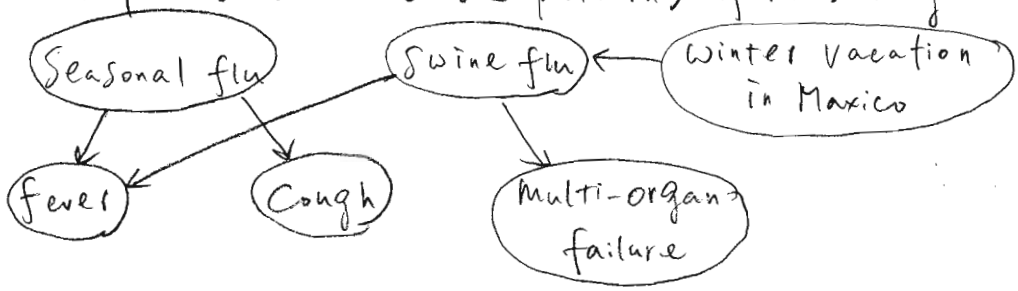
Course segments:

Probabilistic reasoning

Ex: Medical diagnosis.

- Knowledge representation: diseases causes symptoms.
- Modeling uncertainty: Some diseases, some symptoms more likely than others.
- Reasoning: infer diseases from symptoms.
- Probability: Quantitative, self-consistent framework that captures commonsense patterns of reasoning

Graphical model



How do graphs represent correlation, causation, statistical independence?
Marriage of probability and graph theory.

Classification

Ex: Spam filtering.

- Inputs: email message
- Output: {Spam, Non-Spam}
- How to represent input?

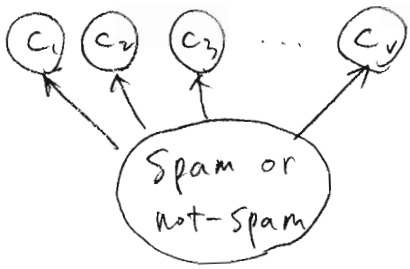
  Convert text to vector of word counts.

text  $\Rightarrow \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_V \end{bmatrix}$

V = vocabulary size

c_i = # times that i-th word appears in text.

· Graphical model



Certain words more likely in Spam. How to quantify? estimate?

Sequential modeling

How to model systems where "state" changes over time?
(or has a similarly extended representation)?

Ex: text (written language)

"states" = words

Which sentence is more likely?

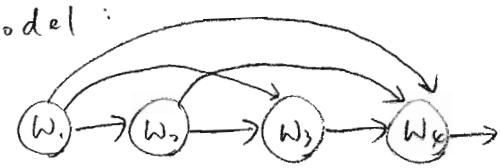
① Mary had a little lamb.

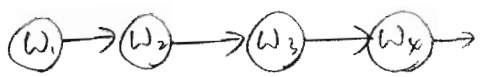
② Colorless green ideas sleep furiously.

⇒ Markov models for statistical language processing.

W_ℓ = word at the ℓ^{th} position in sentence (with V possible values)

Graphical model:

(A): 

(B): 

model (A) is richer but harder to estimate.

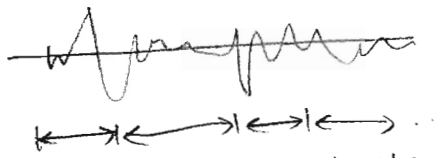
model (B) is wrong but easier to estimate.

Trade-off: power / expressiveness vs tractability / learning.

Ex: speech (spoken language)

States = words (or syllables or smaller units of speech)

Observations: sounds or waveforms.



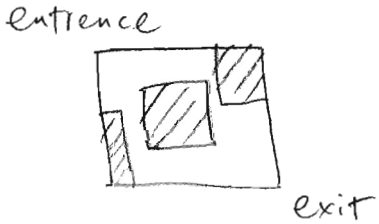
Mary had a little

How to infer words from waveforms?

⇒ hidden Markov models for speech recognition.

Planning and decision-making

Ex: robot navigation



- 2d grid world
- "states" = cells of 2d grid
- actions = north, south, east, west
- noisy dynamics in world.
- rewards = feedback from environment: { delay vs. immediate; evaluative vs instructive

- More generally:

  how can autonomous agent learn from experience?

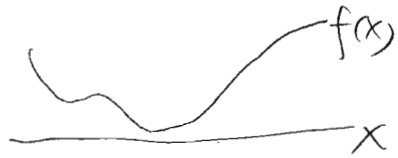
  ⇒ Markov decision process.

  Reinforcement learning

- other "embodied" agents: helicopter, elevator.
- other "embedded" agents: game-playing AI, telephone operators

Core ideas of modern AI

1) probabilistic modeling of uncertainty.
2) learning as optimization



Variable X describes agent's behavior or mode.
function f(x) measures agent's performance.
How to optimize f(x)?

3) Knowledge as predictions (dynamic)
not fact (static)

- old, classical AI

  fact #1: a canary is a bird.
  fact #2: a boot is on the table.

- modern, agent-centric AI

  prediction: if action a, then observe consequence with probability p.

Themes of class

1) power vs tractability

how to develop computer representations of complex worlds?

2) principles vs. heuristics

Optimization
Probability vs. Rules-of-Thumb
Calculus

3) Synergies of AI: Inference and learning
perception and action,
theory and practice.