Class Overview

Note Title

Prereqs — CS 380
— MATH 311/410
[or equivalent]

"Stochastic Process"
↓
sequence of random variables

dealing w/ uncertainty

→ perception vs. reality

[what did I observe] vs. [what really happened]

Bayes' Rule — given $Prob(P|Q)$
what is $Prob(Q|P)$

e.g. Physician examines patient with symptom a

Knows if patient has disease X, will have symptom a w/prob P_{ax}

" " " b w/prob P_{bx}

" " " c w/prob P_{cx}

if patient has disease Y, will have symptom a w/prob P_{ay}

" " " b w/prob P_{by}

" " " c w/prob P_{cy}

i.e., $\text{Prob}(a|X) = P_{ax}$, etc.

Suppose patient has symptom a, what is $\text{Prob}(X|a)$?

→ **Prediction** :

- What is the likelihood of rain tomorrow?

  based on past performance, what may happen next?

  Yesterday + day before ...

  OR

  For the past 10 years, in January,
  when it rained for 2 days, on the third day

  Rain — 30%

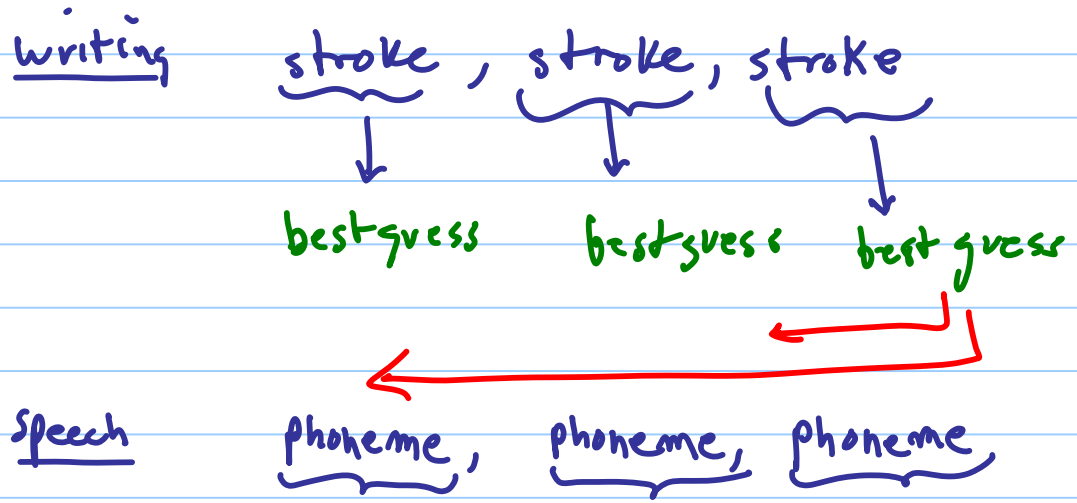
  Sunny — 10%

  ⋮

- Stock/bond performance ——

→ **filtering** [hindsight]

- Now that I have collected more data, what really happened last week?
  [Maximal Likelihood, etc.]
- Speech / handwriting recognition



iPhone Keyboard

Key Key Key Key Key Key Key Key

K u n g

→ prediction "Pao"

o f

filter

"King of"

- Robotics: where is your robot, exactly?

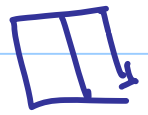
  given previous position (imprecisely known)

  and commands to move forward a certain distance in a certain direction (imprecisely executed) where is it now?

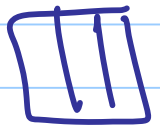
Playing a card game [Poker]

yourself

face down



face up



opponent → partially unknown

2 face down

3 face up → completely observed

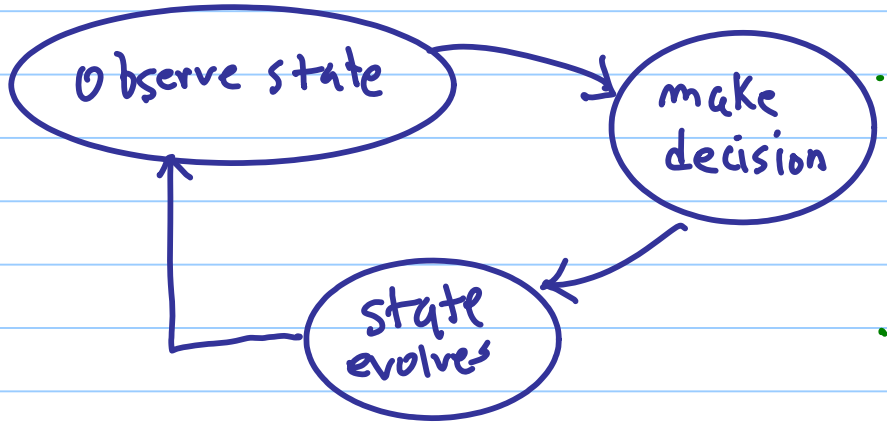
other observations: betting patterns, discards, etc.

→ [twitches, tone of voice]

Markov Decision Processes –

Decision Process –

based on state of system, what do you do next?



..... decision may affect how state evolves

..... decision may incur a cost or a reward

for each state, determine an action to take
so that the overall long term cost is minimized
or the overall long term reward is maximized

Markov Processes

Markov assumption: — (usually a simplification) —

next state depends only on current state, not on previous states —

[e.g. probability of getting "heads" on
next flip of coin

Machine Learning

- based on collected evidence,

  observations → classifications

Note: training may not be comprehensive!

Q: How will these rules work in the "real world"? ←

① "Training Set" of Data

Known results for given observations

② Find rules that classify these correctly

Neural Nets — based on concept of how brain is organized