Applications of AI

Applications

Adapted from slides kindly shared by Stuart Russell

Appreciations

- Libre Office

Share some of yours?

Announcements

Project P4: Ghostbusters out, due Dec 19 - but understand it before the final exam....

P4 last three questions: a bit of extra credit, if you really want to learn particle filters on your own!

Still time to participate on Piazza and improve your score there. But no "me too!" posts....

It is still an option to re-submit previous projects for 1/2 credit on incremental improvement

ROOM and DAY CHANGE: Final Exam in ECCR 200 Tue 2012-12-18 04:30 PM - 07:00 PM

Final will be closed book, bring 2 pages of notes, non-programmable calculator optional, 50% new material, see Piazza for topics, practice exams

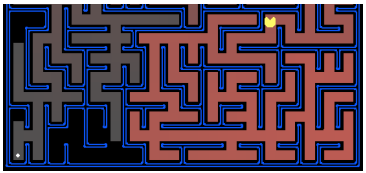
Review for final on Wednesday

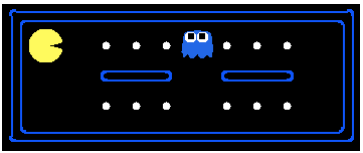
Outline

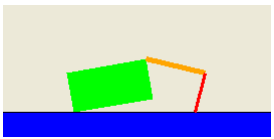
- ♢ Demo tracking
- ♢ Applications of AI
- ♢ Discussion on future impacts of AI

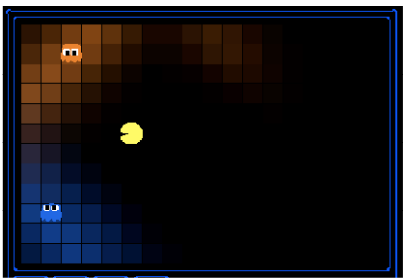
Credit to Dan Klein, Stuart Russell and Andrew Moore for most of today's slides

So Far: Foundational Methods

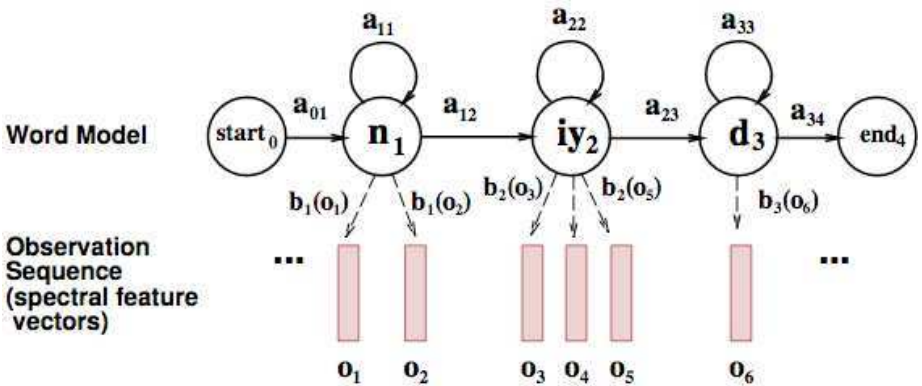








HMMs for Speech



Transitions with Bigrams

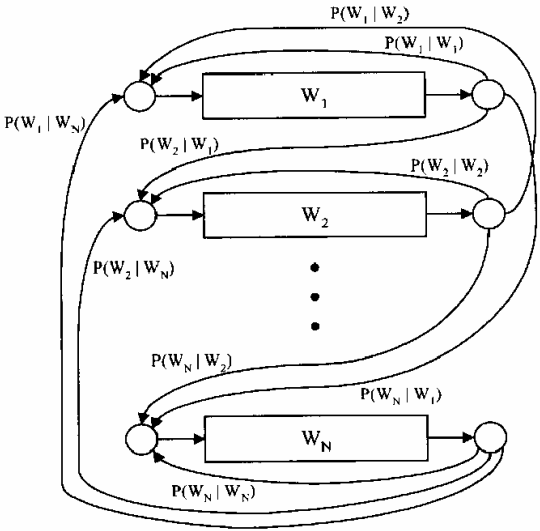


Figure from Huang et al page 618

Training Counts

198015222 the first
194623024 the same
168504105 the following
158562063 the world
…
14112454 the door

23135851162 the *

$$\hat{P}(\text{door}|\text{the}) = \frac{14112454}{23135851162}$$

$$= 0.0006$$

Example: Digit Recognition

- Input: images / pixel grids
- Output: a digit 0-9
- Setup:
  - Get a large collection of example images, each labeled with a digit
  - Note: someone has to hand label all this data!
  - Want to learn to predict labels of new, future digit images
- Features: The attributes used to make the digit decision
  - Pixels: (6,8)=ON
  - Shape Patterns: NumComponents, AspectRatio, NumLoops
  - …

0

1

2

1

??

Inverse RL: Motivation

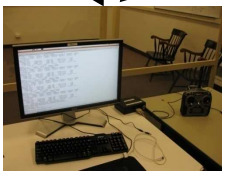
- How do we specify a task like this?

[demo: hover / autorotate]

Autonomous Helicopter Setup

Position

On-board inertial measurement unit (IMU)



Send out controls to helicopter

Helicopter MDP

- State: $s = (x, y, z, \phi, \theta, \psi, \dot{x}, \dot{y}, \dot{z}, \dot{\psi}, \dot{\theta}, \dot{\psi})$
- Actions (control inputs):
  - a_{lon} : Main rotor longitudinal cyclic pitch control (affects pitch rate)
  - a_{lat} : Main rotor latitudinal cyclic pitch control (affects roll rate)
  - a_{coll} : Main rotor collective pitch (affects main rotor thrust)
  - a_{rud} : Tail rotor collective pitch (affects tail rotor thrust)
- Transitions (dynamics):
  - $s_{t+1} = f(s_t, a_t) + w_t$

  [f encodes helicopter dynamics]

  [w is a probabilistic noise model]

- Can we solve the MDP yet?

Problem: What's the Reward?

- Rewards for hovering:

[demo: hover / tic-toc]

$$\begin{aligned} R(s) &= -(\alpha_x(x-x^*)^2 + \alpha_y(y-y^*)^2 + \alpha_z(z-z^*)^2 \\ &\quad +\alpha_{\dot{x}}(\dot{x}-\dot{x}^*)^2 + \alpha_{\dot{y}}(\dot{y}-\dot{y}^*)^2 + \alpha_{\dot{z}}(\dot{z}-\dot{z}^*)^2) \end{aligned}$$

- Rewards for "Tic-Toc"?
  - Problem: what's the target trajectory?
  - Just write it down by hand?

[demo: bad]

Apprenticeship Learning

- Goal: learn reward function from expert demonstration
- Assume $R(s) = w \cdot f(s)$
- Get expert demonstrations $\mathbf{s} = (s_0, s_1, \ldots s_n)$
- Guess initial policy π_0
- Repeat:
  - Find w which make the expert better than $\{\pi_0, \pi_1, \ldots, \pi_{i-1}\}$

$$w_i \leftarrow \text{distinguish}\left(\pi^*, \{\pi_0, \pi_1, \ldots, \pi_{i-1}\}\right)$$

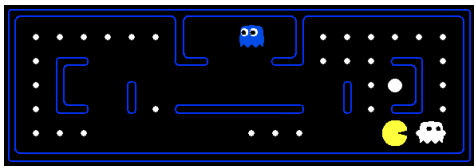
  - Solve MDP for new weights w:

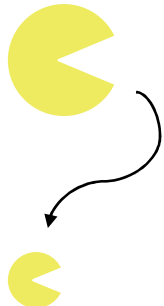
$$\pi_i \leftarrow \text{solve}\left(MDP(w_i)\right)$$

[demo: pac apprentice]

Pacman Apprenticeship!

- Demonstrations are expert games





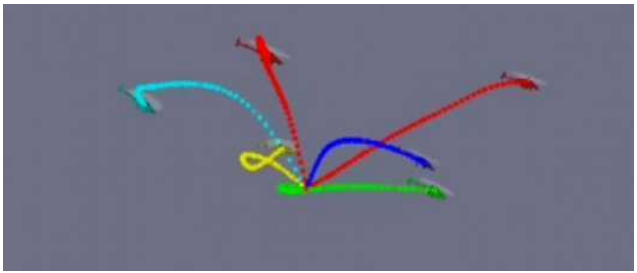
- Features defined over states s
- Score of a state given by:

$$w \cdot f(s)$$

- Learning goal: find weights which explain expert actions

[demo: unaligned / aligned]

Helicopter Apprenticeship?



Probabilistic Alignment

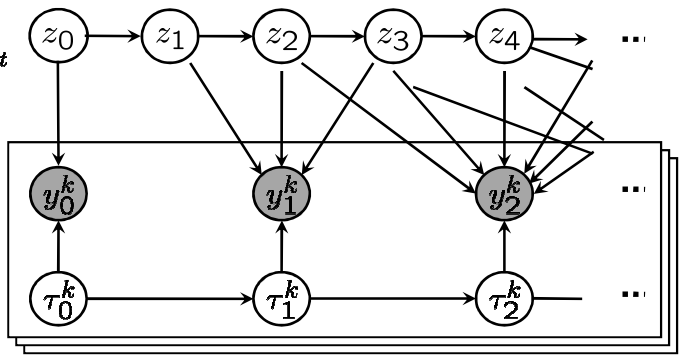
Intended trajectory

$z_{t+1} = f(z_t) + \omega_t$

Expert demonstrations

$y_j = z_{\tau_j} + \nu_j$

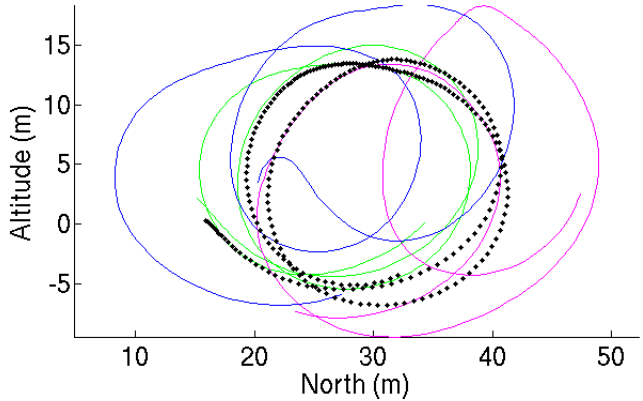
Time indices



- Intended trajectory satisfies dynamics.
- Expert trajectory is a noisy observation of one of the hidden states.
  - But we don't know exactly which one.

[demo: alignment]

Alignment of Samples



- Result: inferred sequence is much cleaner!

[demo: airshow]

Final Behavior

What is NLP?

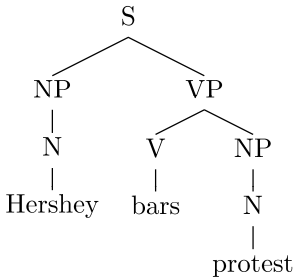
- Fundamental goal: analyze and process human language, broadly, robustly, accurately…
- End systems that we want to build:
  - Ambitious: speech recognition, machine translation, information extraction, dialog interfaces, question answering…
  - Modest: spelling correction, text categorization…

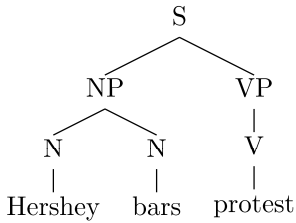
Problem: Ambiguities

- Headlines:
  - Enraged Cow Injures Farmer With Ax
  - Hospitals Are Sued by 7 Foot Doctors
  - Ban on Nude Dancing on Governor's Desk
  - Iraqi Head Seeks Arms
  - Local HS Dropouts Cut in Half
  - Juvenile Court to Try Shooting Defendant
  - Stolen Painting Found by Tree
  - Kids Make Nutritious Snacks

- Why are these funny?

Parsing as Search

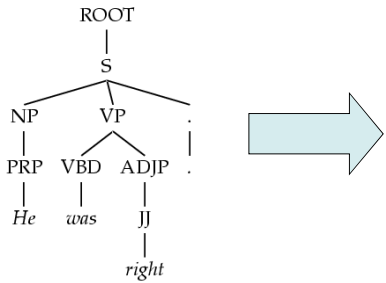




Hershey bars protest

Grammar: PCFGs

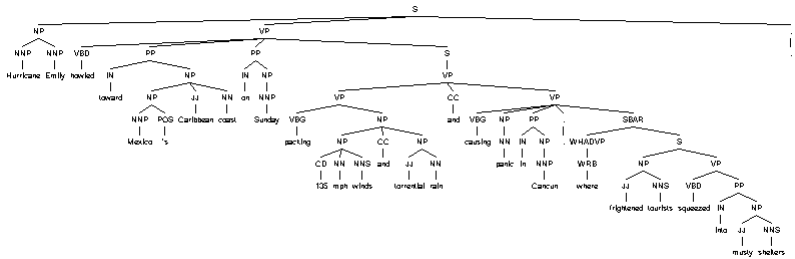
- Natural language grammars are very ambiguous!
- PCFGs are a formal probabilistic model of trees
  - Each “rule” has a conditional probability (like an HMM)
  - Tree’s probability is the product of all rules used
- Parsing: Given a sentence, find the best tree – search!



ROOT → S	375/420
S → NP VP .	320/392
NP → PRP	127/539
VP → VBD ADJP	32/401
…..	

[demo]

Syntactic Analysis



Hurricane Emily howled toward Mexico 's Caribbean coast on Sunday packing 135 mph winds and torrential rain and causing panic in Cancun, where frightened tourists squeezed into musty shelters .

Machine Translation

- Translate text from one language to another
- Recombines fragments of example translations
- Challenges:
  - What fragments? [learning to translate]
  - How to make efficient? [fast translation search]

The Problem with Dictionary Look-ups

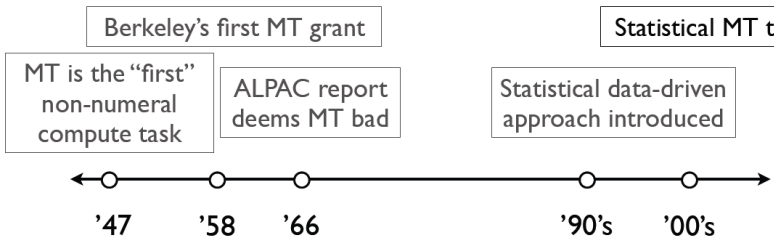
顶部	/**top**/roof/
顶端	/summit/peak/**top**/apex/
顶头	/coming directly towards one/**top**/end/
盖	/lid/**top**/cover/canopy/build/Gai/
盖帽	/surpass/**top**/
极	/extremely/pole/utmost/**top**/collect/receive/
尖峰	/peak/**top**/
面	/fade/side/surface/aspect/**top**/face/flour/
摘心	/**top**/topping/

Example from Douglas Hofstadter

A Brief and Biased History

When I look at an article in Russian, I say: "This is really written in English, but it has been coded in some strange symbols. I will now proceed to decode."

Warren Weaver

"Machine Translation" presumably means going by algorithm from machine-readable source text to useful target text... In this context, there has been no machine translation...

John Pierce