

Announcements

HW 6 Due tomorrow

- Heuristics
- Online solvers probably not worth time
- Get better α without solving problems

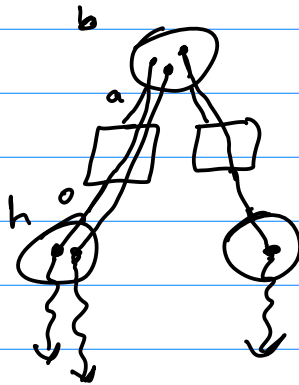
Last Time

Online POMDP Methods

This Time

Bayesian Networks

MCTS for POMDPs / PO-UCT "POMCP"

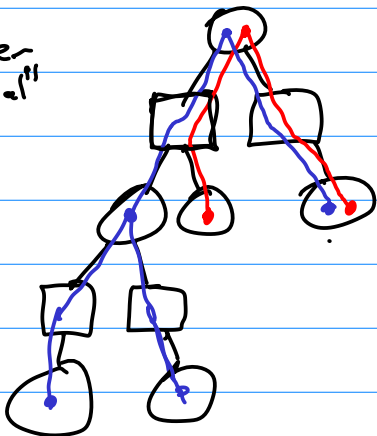


DESPOT

Determinized "Scenarios" - fix random numbers

Not MCTS; is heuristic

After
1 "Trial"



$U(b)$ $U(b,a)$ Expand
 $L(b)$ actions that maximize U
observations that maximize $U-L$

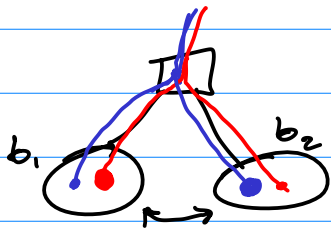
DESPOT is easier to get to work better

Easier to specify U, B

→ AR-DESPOT

↑ ↑
Anytime Regularized

DESPOT- α



$$L(b_1) = b^1 \cdot \alpha_L$$

$$L(b_2) = b^2 \cdot \alpha_L$$

policy graphs

α , belief updates

Quiz: Bandits, POMDPs, Bayesian, Normal-Form Games

Sequential Decision
Probabilistic Modeling

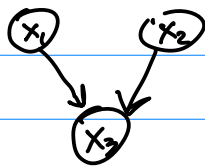
Bayesian Network

DAG

represents a joint distribution

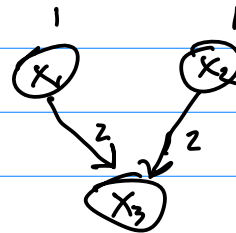
Arrow means

$$P(X_i | X_1, \dots, X_{i-1}, X_{i+1}, \dots, X_n) = P(X_i | Pa(X_i))$$



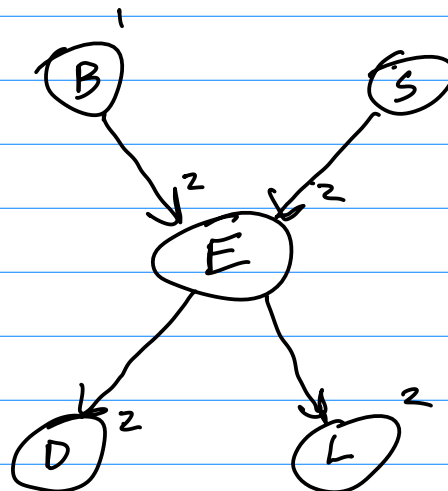
X_1	X_2	X_3	$P(X_1, X_2, X_3)$
0	0	0	
0	0	1	
0	1	1	

$2^n - 1$
7 parameters



6 params

31 parameters



10 params

$D \perp L ? \quad C = \emptyset$

Independence

$$X \perp Y \Leftrightarrow P(X, Y) = P(X)P(Y)$$

Conditional Independence

$$X \perp Y | Z$$

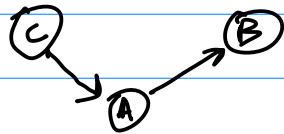
X and Y are conditionally independent given Z if

$$P(X, Y | Z) = P(X | Z)P(Y | Z)$$



$$P(X | Z) = P(X | Y, Z)$$

Quiz 1 Question 3



A, B, C

$$P(C=1) = 0.6$$

$$P(A=1|C=1) = 0.1$$

$$P(A=1|C=0) = 0.7$$

$$B=1 \quad A=0 \quad 0.5$$

$$B=1 \quad A=1 = 0.6$$

$$P(B|A, C) = P(B|A)$$



$$B \perp C | A$$

Are B and C independent?

$$P(B=1, C=1) = 0.306$$

$$P(B=1)P(C=1) = 0.3204$$

B and C are not independent.

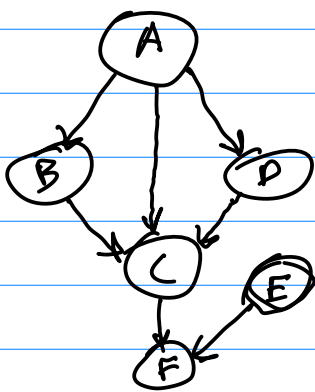
d-separation Rules

A path between A and B is d-separated by C if any of the following are true:

1. The path contains a chain $X \rightarrow Y \rightarrow Z$ s.t. $Y \in C$
2. The path contains a fork $X \leftarrow Y \rightarrow Z$ s.t. $Y \in C$
3. The path contains an inverted fork ("v-structure") $X \rightarrow Y \leftarrow Z$ such that $Y \notin C$

We say that A and B are d-separated by C if all paths between A and B are d-separated by C

$$\text{d-separation} \iff A \perp B | C$$



$$B \perp D | A ?$$

$$C = \{A\}$$