UCLA Samueli School of Engineering

CS161 WEEK8 DISCUSSION 1C

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Contributed by Shirley and Yewen’s course materials

Agenda

BAYSIAN NETWORK

Bayesian Network

The abc:

$P(A,B)$ | $P(A\cap B)$ $\qquad$ $P(A|B)$ | $P(A) = \sum P(A|B=i) * P(B=i)$

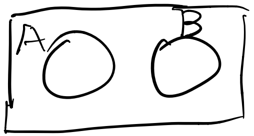
- Probability theory: joint probability, conditional probability
- Bayes Rule:

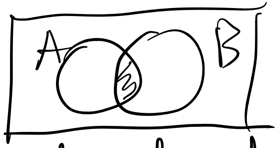
$$P(A|B) = \frac{P(A,B)}{P(B)} = \frac{P(B|A)P(A)}{P(B)}$$

$$P(A,B,C,D\ldots\ldots)$$
$$= P(A|B,C,D\ldots)P(B,C,D\ldots)$$
$$= P(A|B,C,D\ldots)P(B|C,D..)*\ldots$$
$$= \ldots\ldots$$

- Independence:

Independent $\Rightarrow P(A,B) = P(A)P(B)$





$$P(A\cup B) = P(A) + P(B) - P(A\cap B)$$

Conditional independence: $A \perp B$ given C

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

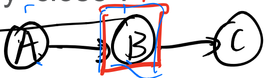
Bayesian Network

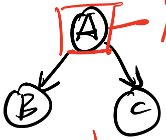
D-SEPERATION

What does it mean by ‘close’?

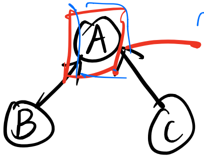
- Sequential
- Divergent
- Convergent

Know

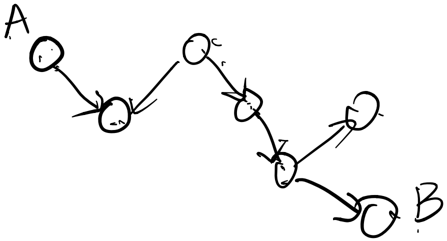




Know

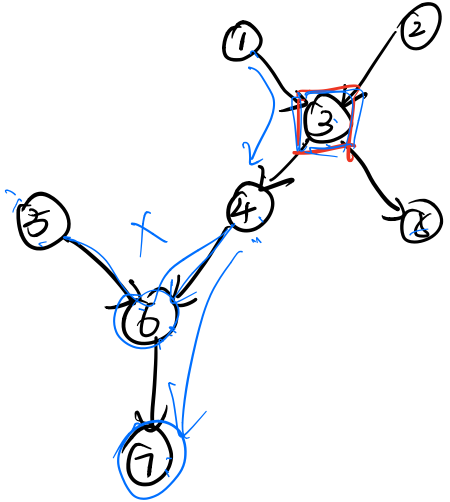


not know &
not know its children



Bayesian Network

D-SEPERATION



We know 3

Node i	Node j	D-sep
1	4	T
1	2	F
4	5	T
4	7	F

We know 7

5	8	T

Bayesian Network

Identify all vars & vals

Identify all edges

Conditional Probability Table (CPT)

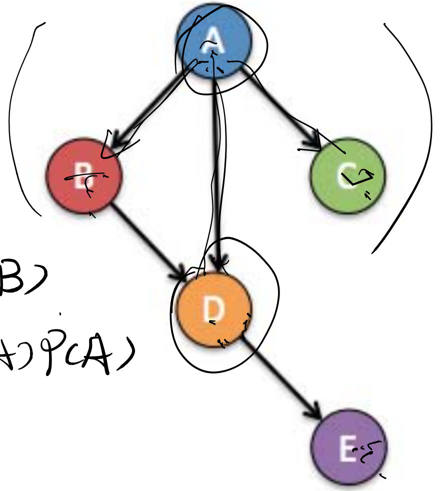
Bayesian Network

PRACTICE

$P(E|\cdots)P(E)$

1. Expand P(A,B,C,D,E) (we start with E)

$$
\begin{aligned}
P(A,B,C,D,E) &= P(E|ABCD)P(ABCD) \\
&= P(E|D)P(D|ABC)P(ABC) \\
&= P(E|D)P(D|A,B)P(C|AB)P(A,B) \\
&= P(E|D)P(D|A,B)P(C|A)P(B|A)P(A)
\end{aligned}
$$



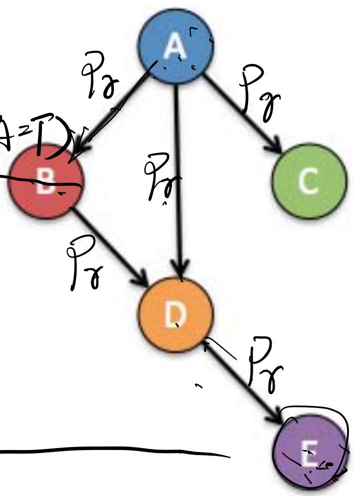
Bayesian Network

$P(E=T|A=T) = P(E|D, \ ) * \underline{P(D|A)}$

PRACTICE

$\{T, F\}$

2. Expand P(E=T | A=T)



$$\boxed{P(E=T|A=T)} = \sum_{\substack{B,D \\ =\{T,F\}}} P(E=T|D)\,P(D|B,A=T)\,P(B|A=T)$$

$P(E=T|D=T)$, $P(E=T|D=F)$

$P(D=T|B=T, A=T)$ . . . . . .

A	B	C	D	E
T	T	F	F	T
F				

HW5

2. (30 pts) Consider the following sentences:

- John likes all kinds of food.
- Apples are food.
- Chicken is food.
- Anything someone eats and isn't killed by is food.
- If you are killed by something, you are not alive.
- Bill eats peanuts and is still alive. *
- Sue eats everything Bill eats.

$\leftrightarrow \neg Eats(Bill, z) \vee Eats(Sue, z)$

(a) Translate these sentences into formulas in first-order logic.
(b) Convert the formulas of part (a) into CNF (also called clausal form).
(c) Prove that John likes peanuts using resolution.
(d) Use resolution to answer the question, "What does Sue eat?"
(e) Use resolution to answer (d) if, instead of the axiom marked with an asterisk above, we had:

- If you don't eat, you die.
- If you die, you are not alive.
- Bill is alive.

$\forall x\,(\neg \exists y\ Eat(x, y)) \Rightarrow Die(x)$ | $\forall x\,(\forall y\ Eat(x,y)) > Die(x)$

$\forall x\ \ Die(x) \Rightarrow -Alive(x)$

$Alive(Bill)$

$Eat(x, F(x)) \vee Die(x)$

$-Die(b) \vee -Alive(b)$

$\neg \exists a\ F(a) \Leftrightarrow \forall a\ -F(a)$

$Eat(x, F(x)) \vee -Alive(x)$ → $Eat(Sue, F(Bill))$

$\boxed{Eat(Bill, F(Bill))}$

$Kill(F(Bill), Bill) \vee \boxed{Food(F(Bill))}$

$-Kill(d, Bill)$

$Food(F(Bill))$

$Eat(Sue, F(Bill))$

(F(Bill) has to be food)

$\forall x\ \ Eat(Sue, x) \wedge Food(x)$

$\forall x\ \ Eat(Sue, \cancel{x}) \wedge Food(x) \Rightarrow IsAnswer(x)$

$-Eat(Sue, p) \vee -Food(p)\ IsAnswer(p)$

$-Eat(Sue, F(Bill)) \vee IsAnswer(F(Bill))$

$\boxed{IsAnswer(F(Bill))}$

Q&A