Artificial Intelligence

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Learning Outcomes Knowledge based Agents

- Knowledge base (KB)
  - A set of sentences expressing in knowledge representation language
  - Represent some assertion about the world
- Knowledge-based Agent
  - Tell the knowledge base what it perceives
  - Ask the knowledge base what action is should perform
  - Tell the knowledge base which action was chosen
  - The agent executes the action
- Ask: query what is known
  - Forward chaining and backward chaining
- Tell: add new sentences to the knowledge base
  - Decision tree

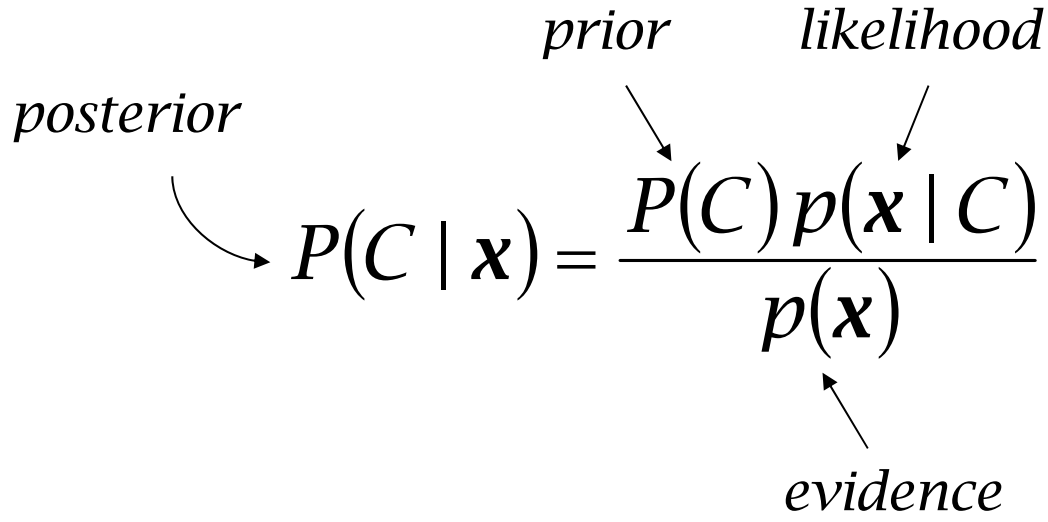
Bayesian Theorem

$$P(A|B) = \frac{P(A \cap B)}{P(B)}. \qquad P(B|A) = \frac{P(A \cap B)}{P(A)}.$$

$$P(A|B)\,P(B) = P(A \cap B) = P(B|A)\,P(A).$$

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

Bayes' Rule



$$P(C=0)+P(C=1)=1$$

$$p(\boldsymbol{x})=p(\boldsymbol{x}\mid C=1)P(C=1)+p(\boldsymbol{x}\mid C=0)P(C=0)$$

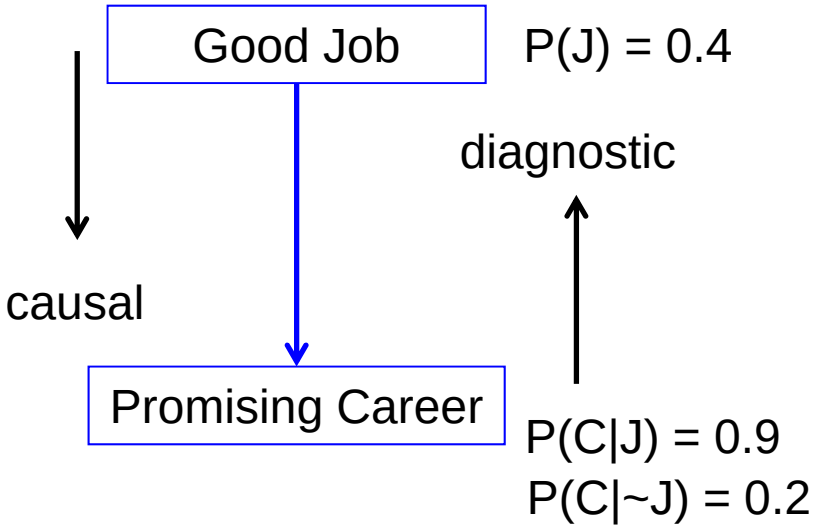
$$p(C=0\mid \boldsymbol{x})+P(C=1\mid \boldsymbol{x})=1$$

Problem

- 40% students can get a good job when they appear as freshman in job market
  - 90% students have promising career path if the first job is good
  - 20% students have promising career path even if the first job is not good

Diagnostic Inference

- Diagnostic inference
  - Knowing promising career,
  - What is the probability that the good first job is the cause?



$$P(J \mid C) = \frac{P(C \mid J) * P(J)}{P(C)}$$

$$= \frac{0.9 * 0.4}{P(C \mid J) * P(J) + P(C \mid \sim J) * P(\sim J)}$$

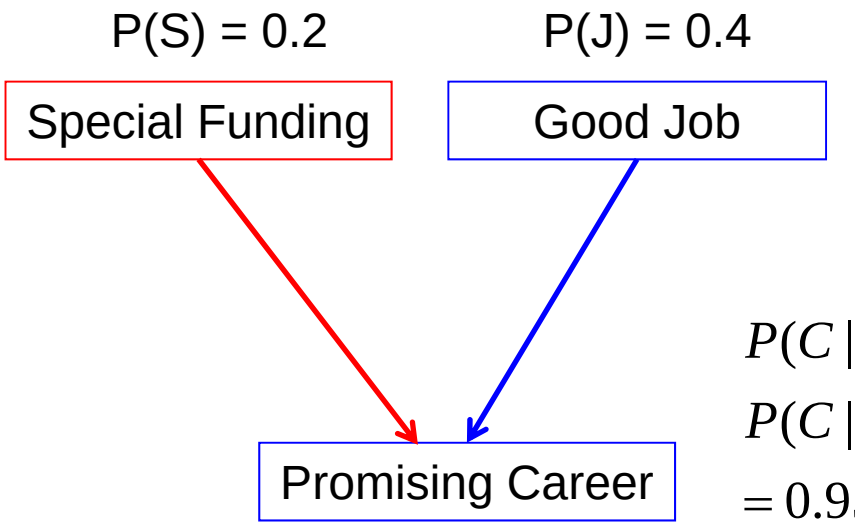
$$= \frac{0.36}{0.36 + 0.2 * (1 - 0.4)}$$

$$= 0.75$$

Problem

- 40% students can get a good job when they appear as freshman in job market
  - 90% students have promising career path if the first job is good
  - 20% students have promising career path even if the first job is not good
- Government has 20% probability to set special funding for young person to startup
  - With both good job and special funding, 95% students have promising career path
  - Without good job and special funding, 10% students have promising career path
  - With good job and no special funding, 90% students have promising career path
  - Without good job but have special funding support, 90% students have promising career path

Causal vs Diagnostic Inference



P(C|J,S) = 0.95

P(C|J,~S) = 0.9

P(C|~J,S) = 0.9

P(C|~J,~S) = 0.1

- Causal inference
  - Knowing special funding,
  - What is the probability leading to promising career?

$$P(C \mid S) =$$

$$P(C \mid S, J)P(J \mid S) + P(C \mid S, \sim J)P(\sim J \mid S)$$

$$= 0.95 * P(J) + 0.9 * P(\sim J)$$

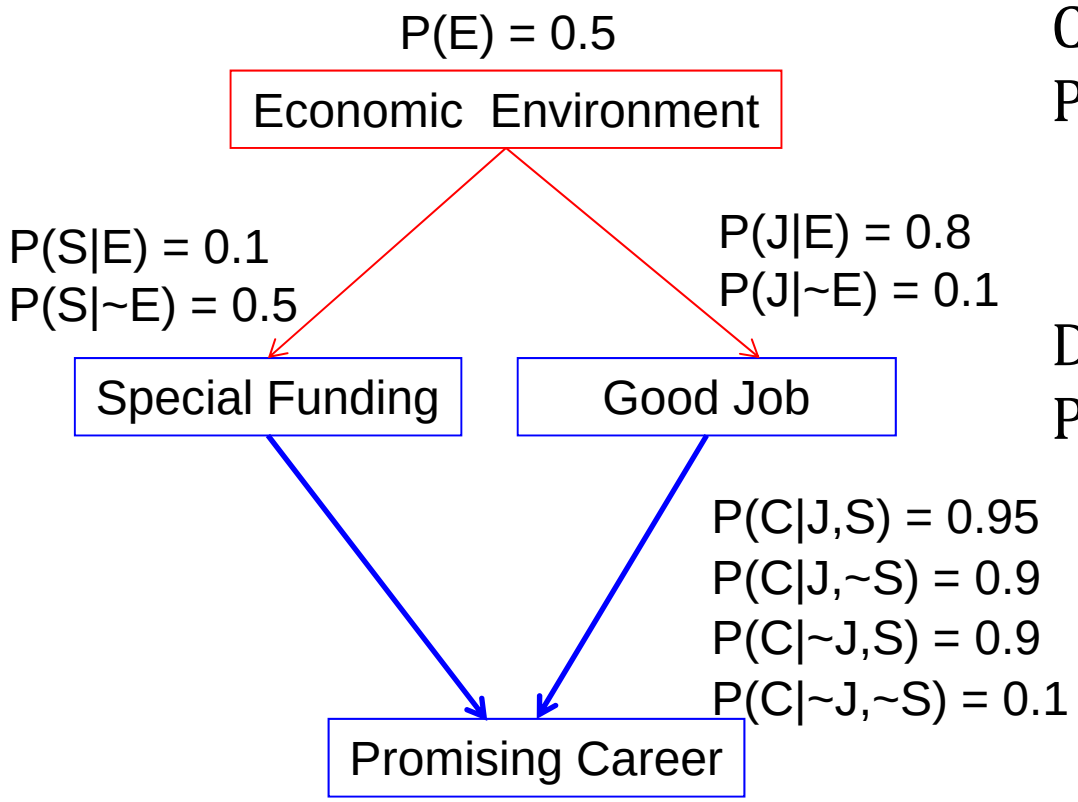
$$= 0.95 * 0.4 + 0.9 * 0.6$$

$$= 0.92$$

Problem

- When the economic condition is good
  - 80% students can get a good job
  - Otherwise, 10% can get a good job
- When the economic condition is good
  - Government has 10% probability to set special funding for young person to startup
  - Otherwise 50% probability to set special funding for young person to startup
- The probability of good economic condition is 50%
- What is the probability of promising path when the economic environment is good
  - What is the probability of the economic environment is good when we observe the promising career path

Bayesian Networks



Causal inference

$P(C|E) = 0.76$

Diagnostic inference

$P(E|C) = 0.58$