Artificial Intelligence

Fiona Yan Liu
Department of Computing
The Hong Kong Polytechnic University
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

\[ P(A|B) = \frac{P(A \cap B)}{P(B)}. \]

\[ P(B|A) = \frac{P(A \cap B)}{P(A)}. \]

\[ P(A|B) \cdot P(B) = P(A \cap B) = P(B|A) \cdot P(A). \]

\[ P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}. \]
Bayes’ Rule

\[ P(C \mid x) = \frac{P(C)p(x \mid C)}{p(x)} \]

\[
P(C = 0) + P(C = 1) = 1
\]

\[
p(x) = p(x \mid C = 1)P(C = 1) + p(x \mid C = 0)P(C = 0)
\]

\[
p(C = 0 \mid x) + P(C = 1 \mid x) = 1
\]
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?

Given:
- \( P(J) = 0.4 \)
- \( P(C|J) = 0.9 \)
- \( P(C|\sim J) = 0.2 \)

Using Bayes' Theorem:

\[
P(J | C) = \frac{P(C | J) * P(J)}{P(C)}
\]

\[
P(C | J) = 0.9
\]

\[
P(C | \sim J) = 0.2
\]

\[
P(J | C) = \frac{0.9 * 0.4}{0.9 * 0.4 + 0.2 * (1 - 0.4)}
\]

\[
P(J | C) = \frac{0.36}{0.36 + 0.2 * 0.6}
\]

\[
P(J | C) = 0.75
\]
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

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

\[
P(C \mid S) = P(C \mid S, J)P(J \mid S) + P(C \mid S, \sim J)P(\sim J \mid S)
\]
\[
= 0.95 \times P(J) + 0.9 \times P(\sim J)
\]
\[
= 0.95 \times 0.4 + 0.9 \times 0.6
\]
\[
= 0.92
\]
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
\[ P(E|C) = 0.58 \]

Economic Environment
\[ P(E) = 0.5 \]
- \[ P(S|E) = 0.1 \]
- \[ P(S|\neg E) = 0.5 \]
- \[ P(J|E) = 0.8 \]
- \[ P(J|\neg E) = 0.1 \]

Special Funding
- \[ P(C|J,S) = 0.95 \]
- \[ P(C|J,\neg S) = 0.9 \]
- \[ P(C|\neg J,S) = 0.9 \]
- \[ P(C|\neg J,\neg S) = 0.1 \]

Good Job
- \[ P(C|J,S) = 0.95 \]
- \[ P(C|J,\neg S) = 0.9 \]
- \[ P(C|\neg J,S) = 0.9 \]
- \[ P(C|\neg J,\neg S) = 0.1 \]

Promising Career

Oct. 13, 2015