CS1571 HW 4 Written

Tianjian Meng

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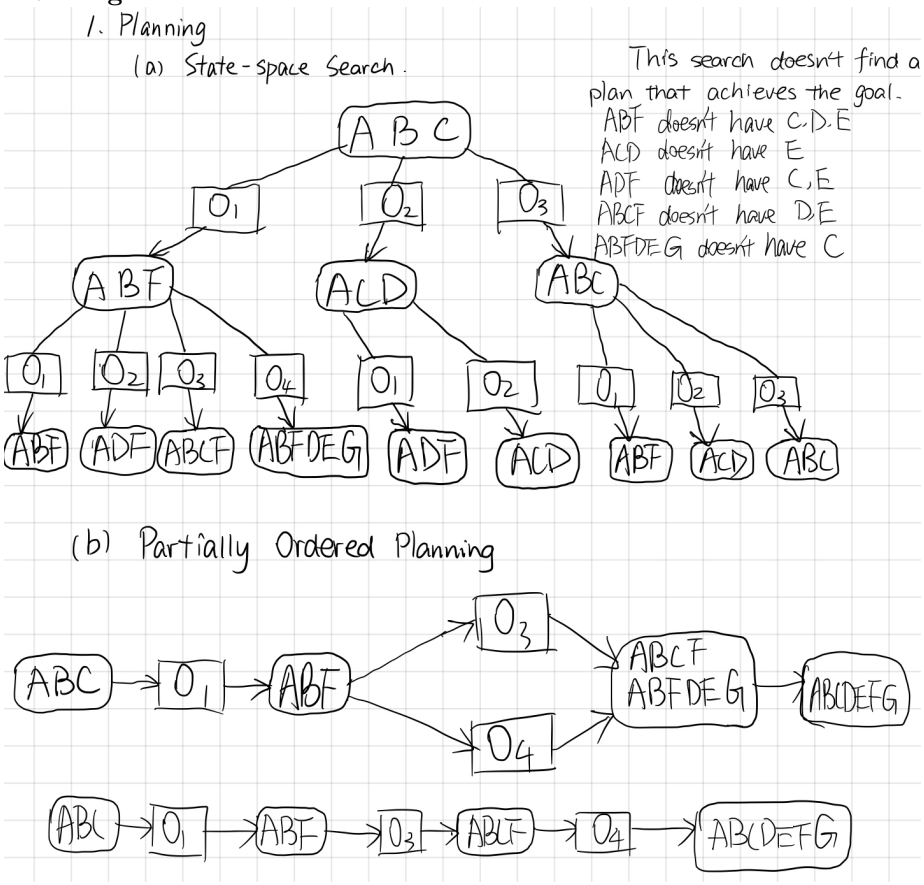
1. **Planning**



2. **Probability**

   a. $P(Toothache) = 0.108 + 0.012 + 0.016 + 0.064 = 0.2$

   b. $P(Cavity) = 0.108 + 0.012 + 0.072 + 0.008 = 0.2$

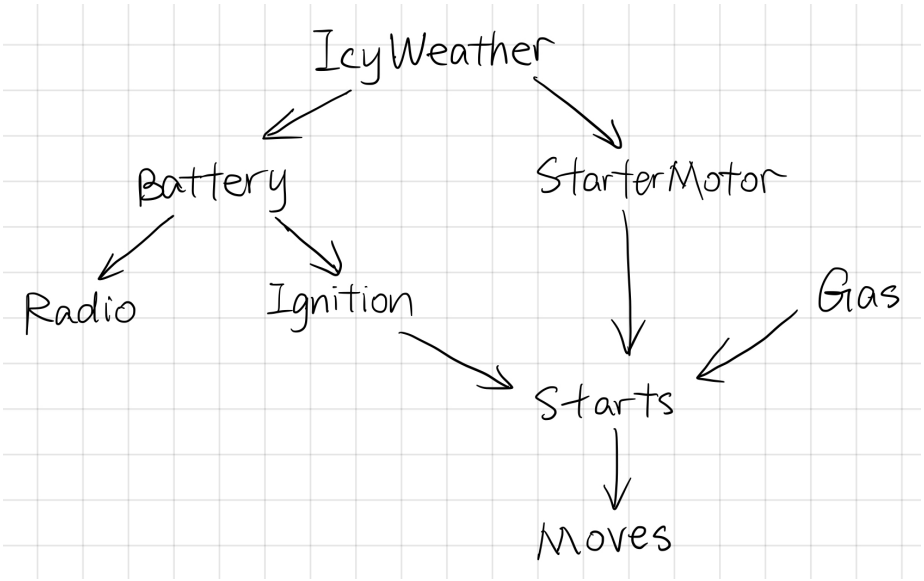
   c. $P(Toothache|cavity) = P(Toothache \wedge cavity)/P(Cavity) = (0.108 + 0.012)/0.2 = 0.6$

d. $P(Cavity|toothache \wedge catch) = P(Cavity \wedge toothache \wedge catch)/P(toothache \wedge catch) = 0.108/(0.108 + 0.016) = 0.87$

3. **Probability**

   1. $P(X) = 0.02$
   2. $P(\neg Y|X) = 0.06$
   3. $P(Y|\neg X) = 0.09$
   4. $P(Y) = P(Y|X) * P(X) + P(Y|\neg X) * P(\neg X) = (1 - P(\neg Y|X)) * P(X) + P(Y|\neg X) * (1 - P(X)) = (1 - 0.06) * 0.02 + 0.09 * (1 - 0.02) = 0.107$
   5. $P(X \wedge Y) = P(Y|X) * P(X) = (1 - P(\neg Y|X)) * P(X) = (1 - 0.06) * 0.02 = 0.0188$
   6. $P(X|Y) = P(X \wedge Y)/P(Y) = 0.0188/0.107 = 0.1757$

4. **Bayesian Networks**

   a. 

   b. (a) $P(IcyWeather) = 0.3$
      (b) $P(Battery|IcyWeather) = 0.9$
      (c) $P(Battery|\neg IcyWeather) = 0.99$
      (d) $P(StarterMotor|IcyWeather) = 0.9$
      (e) $P(StarterMotor|\neg IcyWeather) = 0.99$
      (f) $P(Radio|Battery) = 0.999$
      (g) $P(Radio|\neg Battery) = 0.1$
      (h) $P(Ignition|Battery) = 0.99$
      (i) $P(Ignition|\neg Battery) = 0.01$

(j) $P(Gas) = 0.99$

(k) $P(Starts|Ignition, StarterMotor, Gas) = 0.999$

(l) $P(Moves|Starts) = 0.99$

(m) Other entries not assigned above is 0

c. $2^8 - 1 = 255$

d. $1 + 2 + 2 + 2 + 2 + 1 + 8 + 2 = 20$

e. $P(Battery = T, Radio = T, Ignition = T, Gas = F, Starts = T, Moves = F)$
$= P(Battery = T) * P(Radio = T|Battery = T) * P(Ignition = T|Battery = T) * P(Gas = F) * P(Starts = T|Ignition = T, Gas = F) * P(Moves = F|Starts = T)$

f. $P(Moves = F)$
$= \sum_{b\in\{T,F\}} \sum_{r\in\{T,F\}} \sum_{i\in\{T,F\}} \sum_{g\in\{T,F\}} \sum_{s\in\{T,F\}} P(Moves = F|Starts = s) * P(Starts = s|Ignition = i, Gas = g) * P(Gas = g) * P(Ignition = i|Battery = b) * P(Radio = r|Battery = b) * P(Battery = b)$

5. **Diagnosis using Bayesian Networks**

1. $P(Fever = T, Paleness = F, Cough = T, HighWBCcount = F|Pneumonia = T)$
$= P(Fever = T|Pneumonia = T) * P(Paleness = F|Pneumonia = T) * P(Cough = T|Pneumonia = T) * P(HighWBCcount = F|Pneumonia = T) = 0.9 * (1 - 0.7) * 0.9 * (1 - 0.8) = 0.0486$

2. $P(Fever = T, Paleness = F, Cough = T, HighWBCcount = F|Pneumonia = F)$
$= P(Fever = T|Pneumonia = F) * P(Paleness = F|Pneumonia = F) * P(Cough = T|Pneumonia = F) * P(HighWBCcount = F|Pneumonia = F) = 0.6 * (1 - 0.5) * 0.1 * (1 - 0.5) = 0.015$

3. $P(Pneumonia = T|Fever = T, Paleness = F, Cough = T, HighWBCcount = F)$
$= P(Fever = T, Paleness = F, Cough = T, HighWBCcount = F|Pneumonia = T) * P(Pneumonia = T)/(P(Fever = T, Paleness = F, Cough = T, HighWBCcount = F|Pneumonia = T) * P(Pneumonia = T) + P(Fever = T, Paleness = F, Cough = T, HighWBCcount = F|Pneumonia = F) * P(Pneumonia = F))$
$= 0.0486 * 0.02/(0.0486 * 0.02 + 0.015 * (1 - 0.02))$
$= 0.062$