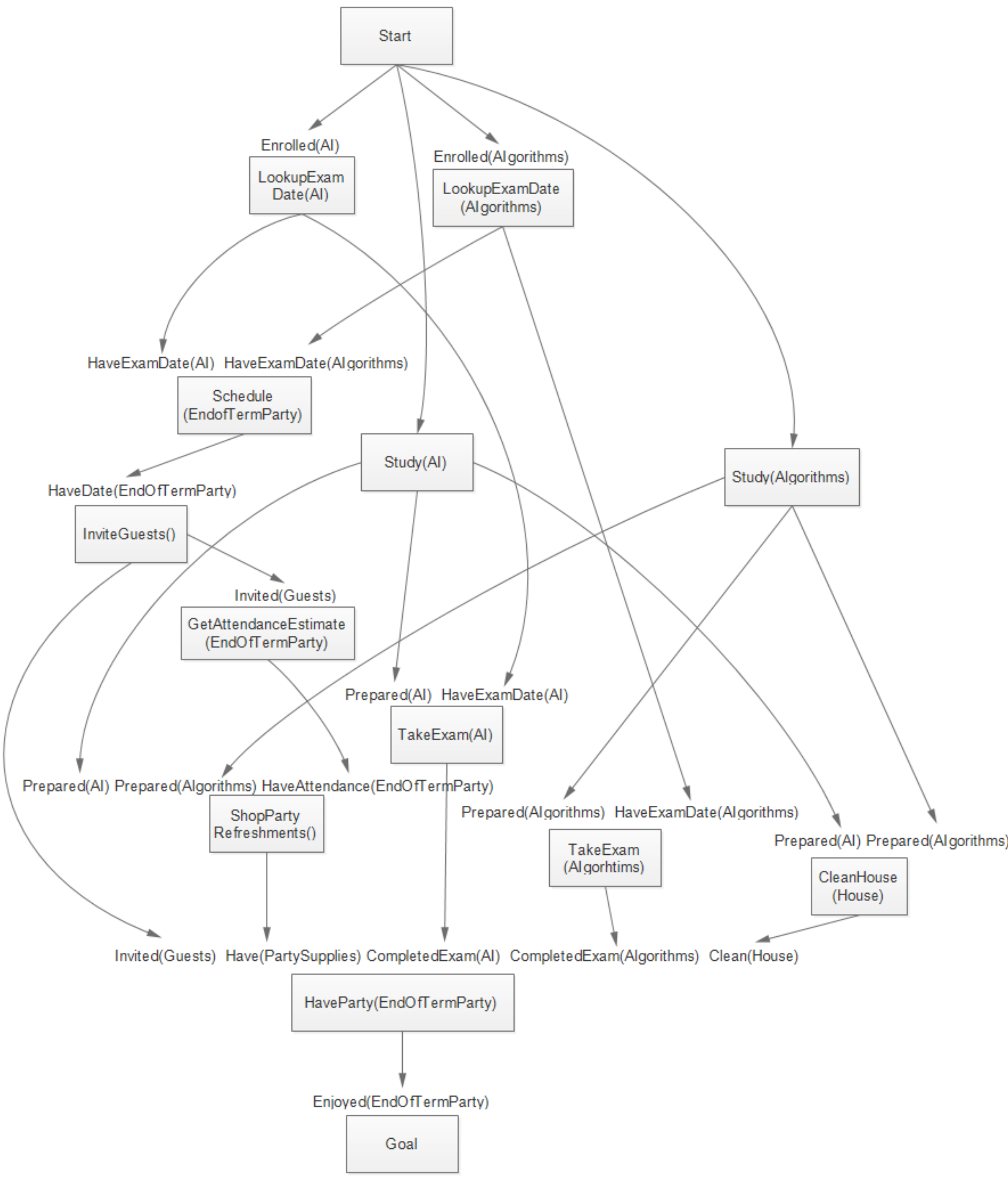
1- Multiple Choice Questions

1) d 2) a 3) f 4) d 5) e

2- True/False Questions

1) F 2) F 3) T 4) T 6) F 7) T 8) F 9) F 10) T

3- Planning



4- Bayesian Probabilities

1) a) P (strep| fever) = $\frac{P(fever \mid strep) * P(strep)}{P(fever)}$ = $\frac{P(fever \mid strep) * P(strep)}{P(fever \mid strep)*P(strep)+P(fever \mid \sim strep)*P(\sim strep)}$ =

$\frac{0.6*0.15}{0.6*0.15+0.3*0.85}$ = 6/23 = 0.261

b) P(strep|~fever) = $\frac{P(\sim fever \mid strep) * P(strep)}{P(\sim fever)}$ =

$\frac{P(\sim fever \mid strep) * P(strep)}{P(\sim fever \mid strep)*P(strep)+P(\sim fever \mid \sim strep)*P(\sim strep)}$ = $\frac{0.4*0.15}{0.4*0.15+0.7*0.85}$ = 12/131 =0.092

2) a) P(strep | fever, test) = $\frac{P(fever,test \mid strep) * P(strep)}{P(fever,test)}$ =

$\frac{P(fever \mid strep)*P(test \mid strep)* P(strep)}{P(fever|strep)P(test|strep)P(strep)+P(fever|\sim strep)P(\sim strep)P(\sim strep)}$ = $\frac{0.6*0.95*0.15}{0.6*0.95*0.15+0.3*0.1*0.85}$ =57/74 =0.770

b) P(strep | fever, ~test) = $\frac{P(fever, \sim test \mid strep) * P(strep)}{P(fever, test)}$ =

$\frac{P(fever \mid strep)*P(\sim test \mid strep)* P(strep)}{P(fever|strep)P(\sim test|strep)P(strep)+P(fever|\sim strep)P(\sim strep)P(\sim strep)}$ = $\frac{0.6*0.05*0.15}{0.6*0.05*0.15+0.3*0.9*0.85}$ =1/52=0.019

3) a) P(S,E,K,~A) = P(S) * P(E|S) * P(K|S) * P(~A|E,K) = 0.7 * 0.3 * 0.8 * 0.1 = 0.0168

b) P(K | S, E) = P (K | S) = 0.8

c) P(S | A) = $\frac{P(S,A)}{P(A)}$ = = $\frac{\sum_K \sum_E P(S,A,K,E)}{\sum_K \sum_E \sum_S P(S,A,K,E)}$ =

$$\frac{P(S,A,K,E)+P(S,A,K,\sim E)+P(S,A,\sim K,E)+P(S,A,\sim K,\sim E)}{P(S,A,K,E)+P(S,A,K,\sim E)+P(S,A,\sim K,E)+P(S,A,\sim K,\sim E)+P(\sim S,A,K,E)+P(\sim S,A,K,\sim E)+P(\sim S,A,\sim K,E)+P(\sim S,A,\sim K,\sim E)}$$

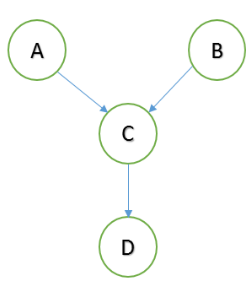
Nominator = 0.7*0.9*0.8*0.3+0.7*0.5*0.8*0.7+0.7*0.6*0.2*0.3+0.7*0.1*0.2*0.7

Denominator = Nominator

+0.3*0.9*0.4*0.8+0.3*0.5*0.4*0.2+0.3*0.4*0.6*0.8+0.3*0.1*0.6*0.2

4) a) A : 1 , B : 1 , C : 2 , D : 4

b)



5) **Decision Tree Learning**

1) I(P) = I ($\frac{12}{16}$, $\frac{4}{16}$) = $\frac{-3}{4}$ log($\frac{3}{4}$) - $\frac{1}{4}$ log($\frac{1}{4}$) = 0.81 (not wanted)

2) a) weather: sunny → 6 yes , 0 no entropy = -1 * log(1) - 0*log(0) = 0

weather: cloudy → 3 yes , 3 no entropy = -0.5*log(0.5) – 0.5*log(0.5) = 1

b) IG (choresToDo) = I (Hike) – remainder (choresToDo) =

$0.81 – [\frac{1}{2} * I(\frac{4}{6}, \frac{2}{6}) + \frac{1}{2} * I(\frac{5}{6}, \frac{1}{6})] = 0.81 – [0.5*0.92 + 0.5*0.65] = 0.025$

IG(weather) = I (Hike) – remainder(weather) =

$0.81 – [\frac{1}{2} * I(1,0) + \frac{1}{2} * I(0.5,0.5)] = 0.81 – 0.5 = 0.31$

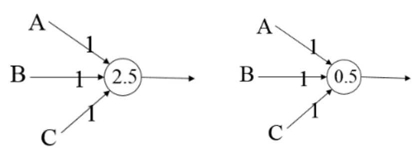
c) weather is the better choice. Because the information gain (IG) from it is more.

6) Perceptrons and Neural Nets

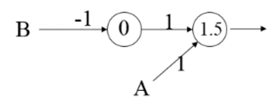
1) a) 1

b) a: stay the same , b: decrease c: decrease

2) a) 1)

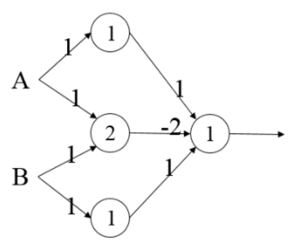


2)



b) 1) a single layer perceptron can only represent linearly separable functions. XOR is not a linearly separable function.

2)



7) Learning – Naïve Bayes

1) a) 1) P(win | SPAM) = $\frac{n+1}{N+k} = \frac{1+1}{16+18} = \frac{1}{17}$ 2) P (my | HAM) = $\frac{n+1}{N+k} = \frac{0+1}{+18} = 1$

b) P(SPAM | msg) = $\frac{P(msg|SPAM)\,P(SPAM)}{P(msg|SPAM)\,P(SPAM) + P(msg|HAM)\,P(HAM)}$

P(msg | SPAM) = P(win|SPAM) * P(your|SPAM) * P(free|SPAM) * P(card|SPAM)

P(msg | HAM) = P(win|HAM) * P(your|HAM) * P(free|HAM) * P(card|HAM)

P(SPAM | msg) = $\frac{\frac{1}{16}*\frac{0}{16}*\frac{2}{16}*\frac{2}{16}*\frac{3}{5}}{\frac{1}{16}*\frac{0}{16}*\frac{2}{16}*\frac{2}{16}*\frac{3}{5}+\frac{0}{10}*\frac{1}{10}*\frac{0}{10}*\frac{0}{10}*\frac{2}{5}} = 0$

2) yes

3) a) Precision(yes) = $\frac{count(correctly\ classified\ as\ yes)}{count(classified\ as\ yes)} = \frac{8}{10}$

b) Recall(no) = $\frac{count(correctly\ classified\ as\ no)}{count(belongs\ in\ no)}$ = $\frac{1}{3}$

c) F = $\frac{2*precision*recall}{precision+recall}$ = $\frac{2*\frac{8}{10}*\frac{8}{8}}{\frac{8}{10}+\frac{8}{8}}$ = $\frac{8}{9}$