CS 161 HW 6

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1a) $\{x/A, y/B, z/B\}$

1b) No unifier exists

1c) $\{x/John, y/John\}$

1d) No unifier exists

2a)
i. $\forall y\ Food(y) \Rightarrow Likes(John, y)$
ii. $Food(Apples)$
iii. $Food(Chicken)$
iv. $\forall xy\ \left(Eat(x, y) \wedge \neg madeSick(y, x)\right) \Rightarrow Food(y)$
v. $\forall xy\ madeSick(y, x) \Rightarrow \neg isWell(x)$
vi. $Eat(Bill, Peanuts) \wedge isWell\ (Bill)$
vii. $\forall y\ Eat(Bill, y) \Rightarrow Eat(Sue, y)$

2b)
I. $\neg Food(y) \vee Likes(John, y)$
II. $Food(Apples)$
III. $Food(Chicken)$
IV. $\neg Eat(x, y) \vee madeSick(y, x) \vee Food(y)$
V. $\neg madeSick(y, x) \vee \neg isWell(x)$
VI. $Eat(Bill, Peanuts)$
VII. $isWell\ (Bill)$
VIII. $\neg Eat(Bill, y) \vee Eat(Sue, y)$

Using the unifier $\{y/Apples\}$,

IX. $Likes(John, Apples)$ from I and II

Using the unifier $\{y/Chicken\}$,

X. $Likes(John, Chicken)$ from I and III

2c) Using the unifier $\{y/Peanuts\}$,

XI. $Eat(Sue, Peanuts)$ from VI and VIII

3) I. $Mother(Mary, Tom)$

II. $Alive(Mary)$

III. $\neg Mother(x, y) \vee Parent(x, y)$

IV. $\neg Parent(x, y) \vee \neg Alive(x) \vee Older(x, y)$

Using the unifier $\{x/Mary,\ y/Tom\}$

V. $Parent(Mary, Tom)$ from I and III

VI. $\neg Alive(Mary) \vee Older(Mary, Tom)$ from IV and V

VII. $Older(Mary, Tom)$ from II and VI

4) $H(y) = H\left(\frac{2}{5}\right) = -\left(\frac{2}{5}\right)\log_2\left(\frac{2}{5}\right) - \left(\frac{3}{5}\right)\log_2\left(\frac{3}{5}\right) = 0.97$

Attribute A_1:

Entropy = $P(A_1 = 0)\, H(y|A_1 = 0) + P(A_1 = 1)\, H(y|A_1 = 1)$

= $\left(\frac{1}{5}\right) H(0) + \left(\frac{4}{5}\right) H\left(\frac{1}{2}\right) = 0.8$

Information Gain = $0.97 - 0.8 = 0.17$

Attribute A_2:

Entropy = $P(A_2 = 0)\, H(y|A_2 = 0) + P(A_2 = 1)\, H(y|A_2 = 1)$

= $\left(\frac{2}{5}\right) H(0) + \left(\frac{3}{5}\right) H\left(\frac{2}{3}\right) = 0.552$

Information Gain = $0.97 - 0.552 = 0.418$

Attribute A_3:

Entropy = $P(A_3 = 0)\, H(y|A_3 = 0) + P(A_3 = 1)\, H(y|A_3 = 1)$

= $\left(\frac{3}{5}\right) H\left(\frac{1}{3}\right) + \left(\frac{2}{5}\right) H\left(\frac{1}{2}\right) = 0.952$

Information Gain = $0.97 - 0.952 = 0.018$

Attribute A_2 has the most information gain so we split on that. Given $A_2 = 1$, attribute A_1 has the most information gain so that is the next attribute we split.