

CSCI 446 – ARTIFICIAL INTELLIGENCE EXAM #2

Mon. 11/1/2021

Equations you may or may not need:

Probability:

Conditional Probability

$$P(a|b) = \frac{P(a, b)}{P(b)}$$

Product Rule

$$P(y)P(x|y) = P(x, y)$$

Chain Rule

$$P(x_1, x_2, x_3) = P(x_1)P(x_2|x_1)P(x_3|x_1, x_2)$$

$$P(x_1, x_2, \dots, x_n) = \prod_i P(x_i|x_1 \dots x_{i-1})$$

Bayes Rule:

$$P(x|y) = \frac{P(y|x)P(x)}{P(y)}$$

Normalization Trick:

$$val_{new} = \frac{val_{old}}{\sum_{i=1}^n val_i}$$

Independence:

$$P(X, Y) = P(X)P(Y)$$

Conditional Independence:

$$\forall x, y, z : P(x, y|z) = P(x|z)P(y|z)$$

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Hidden Markov Models:

Belief:

$$B(X_t) = P(X_t | e_{1:t})$$

Belief After Time Passes:

$$B'(X_{t+1}) = \sum_{x_t} P(X' | x_t) B(x_t)$$

Belief After Evidence:

$$B(X_{t+1}) \propto_{X_{t+1}} P(e_{t+1} | X_{t+1}) B'(X_{t+1})$$

Most Likely Explanation:

$$\arg \max_{x_{1:t}} P(x_{1:t} | e_{1:t})$$

Bayesian Networks:

Factors:

1. Joint Distribution: $P(X, Y)$
2. Selected Joint: $P(x, Y)$
3. Single Conditional: $P(Y | x)$
4. Family of Conditionals: $P(X | Y)$
5. Specified Family: $P(y | X)$

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Value of Information:

Maximum Expected Utility:

With Information:

$$MEU(e) = \max_a \sum_s P(s|e) U(s, a)$$

With Additional Information:

$$MEU(e, e') = \max_a \sum_s P(s|e, e') U(s, a)$$

Expected Value of Getting Information:

$$MEU(e, E') = \sum_{e'} P(e'|e) MEU(e, e')$$

Value of Information:

$$VPI(E'|e) = MEU(e, E') - MEU(e)$$