CSE 150 Homework 4

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Fall 2018

1 Maximum Likelihood Estimation

$$P_{ML}(X_i = x|pa_i = \pi) = \frac{count(X_i = x, pa_i = \pi)}{\sum_{x'} count(X_i = x', pa_i = \pi)}$$

(a)

$$P(Y = y) = \frac{count(Y = y)}{T}$$

$$P(X = x|Y = y) = \frac{count(X = x, Y = y)}{count(Y = y)}$$

$$P(Z = x|Y = y) = \frac{count(Y = y, Z = z)}{count(Y = y)}$$

(b)

$$P(Z = z) = \frac{count(Z = z)}{T}$$

$$P(Y = y|Z = z) = \frac{count(Y = y, Z = z)}{count(Z = z)}$$

$$P(X = x|Y = y) = \frac{count(X = x, Y = y)}{count(Y = y)}$$

(c) Left DAG:

$$\begin{aligned} P(X = x, Y = y, Z = z) &= P(Y = y) \cdot P(X = x|Y = y) \cdot P(Z = z|Y = y) \\ &= \frac{count(Y = y)}{T} \cdot \frac{count(X = x, Y = y)}{count(Y = y)} \cdot \frac{count(Y = y, Z = z)}{count(Y = y)} \\ &= \frac{count(X = x, Y = y) \cdot count(Y = y, Z = z)}{T \cdot count(Y = y)} \end{aligned}$$

Right DAG:

$$\begin{aligned} P(X = x, Y = y, Z = z) &= P(Z = z) \cdot P(Y = y|Z = z) \cdot P(X = x|Y = y) \\ &= \frac{count(Z = z)}{T} \cdot \frac{count(Y = y, Z = z)}{count(Z = z)} \cdot \frac{count(X = x, Y = y)}{count(Y = y)} \\ &= \frac{count(X = x, Y = y) \cdot count(Y = y, Z = z)}{T \cdot count(Y = y)} \end{aligned}$$

2 Survey

Done

3 Statistical language modeling

(a)

(b)

(c)

(d)

(e)

(f)

4 Markov modeling

(a) **Unigram model**

(b) **Bigram model**

(c) **Likelihoods**

(d) **Likelihoods**