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7. Prediction
Prediction

0:00 / 0:00 1.25x

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Predictions of a Generative Multinomial Model

1/1 point (graded)

Consider using a multinomial generative model M for the task of binary classification consisting of two classes which are denoted by + (positive class) and - (negative class).

Let the parameters of M that maximize the likelihood of training data for the positive class be denoted by θ^+ and for the negative class be denoted by θ^-.

Also, suppose that we classify a new document D to belong to the positive class iff

$$\log \frac{P\left(D|\theta^+\right)}{P\left(D|\theta^-\right)} \geq 0$$

where $P\left(D|\theta\right)$ stands for the probability that document D is generated using a multinomial distribution with parameters θ.

Which of the following option(s) is/are true about this generative classifier? Choose all that apply from the statements below:

- [x] A document is classified as positive iff $P\left(D|\theta^+\right) \geq P\left(D|\theta^-\right)$
- [ ] A document is classified as positive iff $P\left(D|\theta^+\right) < P\left(D|\theta^-\right)$
- [x] The generative classifier M can be shown to be equivalent to a linear classifier given by $\sum_{w \in W} \left(\text{count}\left(w\right) \theta'_w\right) \geq 0$ where $\theta'_w = \log \frac{\theta^+_w}{\theta^-_w}$
- [ ] The generative classifier M can be shown to be equivalent to a linear classifier given by $\sum_{w \in W} \left(\text{count}\left(w\right) \theta'_w\right) \geq 0$ where $\theta'_w = \log \frac{\theta^-_w}{\theta^+_w}$

Solution:

Note that we classify a new document D to belong to the positive class iff $\log\left(\frac{P\left(D|\theta^{+}\right)}{P\left(D|\theta^{-}\right)}\right) \geq 0$ and to the negative class otherwise.

$$\log \frac{P\left(D|\theta^{+}\right)}{P\left(D|\theta^{-}\right)} \geq 0$$

is equivalent to

$$P\left(D|\theta^{+}\right) \geq P\left(D|\theta^{-}\right)$$

.
Recall from the lecture that,

$$\log \frac{P\left(D|\theta^{+}\right)}{P\left(D|\theta^{-}\right)}$$

$$= \log P\left(D|\theta^{+}\right) - \log P\left(D|\theta^{-}\right)$$

$$= \log \prod_{w \in W} \left(\theta_{w}^{+}\right)^{\text{count}(w)} - \log \prod_{w \in W} \left(\theta_{w}^{-}\right)^{\text{count}(w)}$$

$$= \sum_{w \in W} \text{count}\left(w\right) \log \theta_{w}^{+} - \sum_{w \in W} \text{count}\left(w\right) \log \theta_{w}^{-}$$

$$= \sum_{w \in W} \text{count}\,(w) \log \frac{\theta_w^+}{\theta_w^-}$$

Submit You have used 1 of 2 attempts

Answers are displayed within the problem

Linear Classifier of the Generative Multinomial Model

1/1 point (graded)

Consider the prediction classifier for the two classes θ^+ and θ^- introduced in the above video. For this problem, let 0 and 1 represent the classes $+$ and $-$, respectively.

Let $W = \{\text{Thor}, \text{Loki}, \text{Hulk}\}$. Let
$p\,(\text{Thor}|0) = p\,(\text{Loki}|0) = p\,(\text{Hulk}|0) = 1/3$ and let
$p\,(\text{Thor}|1) = p\,(\text{Loki}|1) = 1/4$ and $p\,(\text{Hulk}|1) = 1/2$.

We see the following document $D = \text{Thor Thor Hulk Loki Loki}$. To what class would you classify the document to using the linear classifier for the generative multinomial model? (Type “0" for class 0 (+) and “1" for class 1 (-)).

0 ✔ **Answer:** 0

Solution:

The counts of the words are
$\text{count}\,(\text{Thor}) = 2, \text{count}\,(\text{Loki}) = 2, \text{count}\,(\text{Hulk}) = 1.$

Using the notation developed in the video,

$$\hat{\theta}_{\text{Thor}} = \log\left(\frac{4}{3}\right) \approx 0.124939,$$

$$\hat{\theta}_{\text{Loki}} = \log\left(\frac{4}{3}\right) \approx 0.124939,$$

$$\hat{\theta}_{\text{Hulk}} = \log\left(\frac{2}{3}\right) \approx -0.176091.$$

Therefore,

$$\sum_{w \in \mathcal{W}} \text{count}\,(w)\,\hat{\theta}_w = 4 \cdot 0.124939 - 0.176091 > 0,$$

which would classify the document to class 0 (+).

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Answers are displayed within the problem

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? How do we get the different parameters for positive and negative cases when we don't have labels to begin with? 1

Should we use natural log (ln) or log10 in the second question? 7

Should we use natural log (ln) or log10 in the second question?