Summary of Naïve Bayes

- Hypotheses: H_1 through H_n.
- Features (data): F_1 through F_m.

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\begin{aligned}
H^{\text{MAP}} &= \operatorname*{argmax}_i P(D \mid H_i) P(H_i) \\
&= \operatorname*{argmax}_i P(F_1, \ldots, F_m \mid H_i) P(H_i) \\
&= \operatorname*{argmax}_i \Big[P(F_1 \mid H_i) \cdots P(F_m \mid H_i) \Big] P(H_i) \\
&= \operatorname*{argmax}_i \Big[\prod_{j=1}^{m} P(F_j \mid H_i) \Big] P(H_i)
\end{aligned}
$$

- $P(H_i)$ for i = 1 to n.
- $P(F_j \mid H_i)$ for j = 1 to m and i = 1 to n.

Spam example 1

- Suppose I know 80% of my email is spam.
- I have three features, "luxury," "brands," and "save."
- I know:
  - P(luxury | spam) = 0.4 P(luxury | ~spam) = 0.01
  - P(brands | spam) = 0.3 P(brands | ~spam) = 0.2
  - P(save | spam) = 0.4 P(save | ~spam) = 0.1
- Suppose a new, incoming email contains "luxury" and "save" but not "brands." Should it be classified as spam or ~spam?

Spam example 2

Suppose I have 20 emails that have been already classified into spam (15 emails) and non-spam (5 emails). Suppose I only care about the presence or absence of the words **luxury**, **brands**, and **save**.

Suppose 6 of the spam emails contain "luxury," 3 of the spam emails contain "brands," and 7 of the spam emails contain "save."

Suppose 1 of the non-spam emails contains "luxury," 2 of the non-spam emails contain "brands," and 2 of the non-spam emails contain "save."

Suppose a new email arrives that contains the words "luxury" and "save" but not "brands." Should this be classified as spam or not spam?