

# Introduction to Data Science

## Navie Bayes Classification



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# Probability

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- $P(A \wedge B) = P(A) \cdot P(B|A) = P(B)P(A|B)$

- Bayes theorem:  $P(A|B) = \frac{P(A) \cdot P(B|A)}{P(B)}$

# Naive Bayes

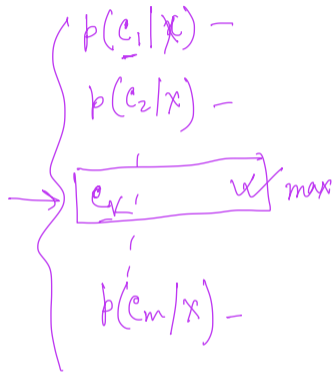
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$$\underline{p(c_i/x)}$$



Height, weight

# Naive Bayes

- Let  $X = (x_1, \dots, x_n)$  need to be classified into one of  $m$  classes  $C_1, \dots, C_m$
- We compute the probability of each possible class given  $X$

• By Bayes theorem,  $P(C_i|X) = \frac{P(C_i) \cdot P(X|C_i)}{P(X)}$

$P(c_j|x) = \frac{P(c_j) \cdot P(x|c_j)}{P(x)}$

$x_1 - c_1$   
 $x_2 - c_2$   
 $\vdots$   
 $x_n - c_k$

$$\frac{c_i}{|x|}$$

# Naive Bayes

- Let  $X = (x_1, \dots, x_n)$  need to be classified into one of  $m$  classes  $C_1, \dots, C_m$
- We compute the probability of each possible class given  $X$

- By Bayes theorem,  $P(C_i|X) = \frac{P(C_i) \cdot P(X|C_i)}{P(X)}$

- Final class will be  $\hat{C}(X) = \arg \max_{i=1, \dots, m} P(C_i) \cdot P(X|C_i)$

# Naive Bayes

- Let  $X = (x_1, \dots, x_n)$  need to be classified into one of  $m$  classes  $C_1, \dots, C_m$
- We compute the probability of each possible class given  $X$
- By Bayes theorem,  $P(C_i|X) = \frac{P(C_i) \cdot P(X|C_i)}{P(X)}$   $\neq$
- Final class will be  $P(C_i|X) = \arg \max_{i=1, \dots, m} P(C_i) \cdot P(X|C_i)$
- Assuming independent world (naive assumption)



# Example

- Given the following observations

Day	Outlook	Temp	Humidity	Beach?
1	<u>Sunny</u>	<u>High</u>	<u>High</u>	<u>Yes</u>
2	Sunny	High	Normal	Yes
3	Sunny	Low	Normal	No
4	Sunny	Mild	High	Yes
5	Rain	Mild	Normal	No
6	Rain	High	High	No
7	Rain	Low	Normal	No
8	Cloudy	High	High	No
9	Cloudy	High	Normal	Yes
10	<u>Cloudy</u>	<u>Mild</u>	<u>Normal</u>	<u>No</u>

# Example

- Given the following observations
- Find  $P(\text{Beach} | (\text{Sunny}, \text{Mild}, \text{High})) = ?$

$$= P(B) P(S, M, H | B)$$

$$= \frac{P(B)}{4/10} \cdot \frac{P(S|B)}{3/4} \cdot \frac{P(M|B)}{1/4} \cdot \frac{P(H|B)}{2/4} = \underline{\underline{0.03}}$$

$$3/4, \boxed{1/2}$$

Day	Outlook	Temp	Humidity	Beach?
1	Sunny	High	High	Yes
2	Sunny	High	Normal	Yes
3	Sunny	Low	Normal	No
4	Sunny	Mild	High	Yes
5	Rain	Mild	Normal	No
6	Rain	High	High	No
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# Example

- Given the following observations
- Find  $P(\text{Beach} | (\text{Sunny}, \text{Mild}, \text{High})) = ?$  0.03
- Find  $P(\text{NoBeach} | (\text{Sunny}, \text{Mild}, \text{High})) = ?$

$$P(\text{NB}) \cdot P(\text{S} | \text{NB}) \cdot P(\text{M} | \text{NB}) \cdot P(\text{H} | \text{NB})$$

$\approx \underline{0.01}$

Day	Outlook	Temp	Humidity	Beach?
1	Sunny	High	High	Yes
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$\frac{1}{10}$

$2^{10}$

$\uparrow$   
 $\frac{0}{1}$