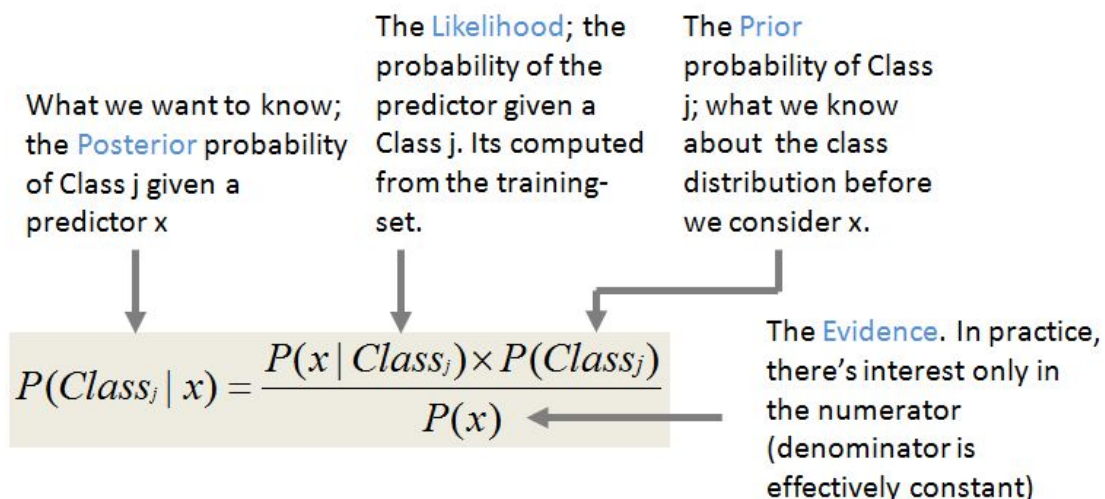


# Naive Bayes

## Basic Concepts

# Naive Bayes



Applying the **independence** assumption

$$P(x | Class_j) = P(x_1 | Class_j) \times P(x_2 | Class_j) \times \dots \times P(x_k | Class_j)$$

Substituting the independence assumption, we derive the Posterior probability of Class  $j$  given a new instance  $x'$  as...

$$P(Class_j | x') = P(x'_1 | Class_j) \times P(x'_2 | Class_j) \times \dots \times P(x'_k | Class_j) \times P(Class_j)$$

# Naive Bayes

	Predictors				Response
	Outlook	Temperature	Humidity	Wind	Class Play=Yes Play=No
Day1	Sunny	Hot	High	Weak	No
Day2	Sunny	Hot	High	Strong	No
Day3	Overcast	Hot	High	Weak	Yes
Day4	Rain	Mild	High	Weak	Yes
Day5	Rain	Cool	Normal	Weak	Yes
Day6	Rain	Cool	Normal	Strong	No
Day7	Overcast	Cool	Normal	Strong	Yes
Day8	Sunny	Mild	High	Weak	No
Day9	Sunny	Cool	Normal	Weak	Yes
Day10	Rain	Mild	Normal	Weak	Yes
Day11	Sunny	Mild	Normal	Strong	Yes
Day12	Overcast	Mild	High	Strong	Yes
Day13	Overcast	Hot	Normal	Weak	Yes
Day14	Rain	Mild	High	Strong	No

# Naive Bayes

$P(\text{Outlook}=o   \text{Class}_{\text{play=Yes No}})$	Frequency		Probability in Class	
<b>Outlook =</b>	Play=Yes	Play=No	Play=Yes	Play=No
Sunny	2	3	$2/9$	$3/5$
Overcast	4	0	$4/9$	$0/5$
Rain	3	2	$3/9$	$2/5$
	total= 9	total=5		

$P(\text{Temperature}=t   \text{Class}_{\text{play=Yes No}})$	Frequency		Probability in Class	
<b>Temperature =</b>	Play=Yes	Play=No	Play=Yes	Play=No
Hot	2	2	$2/9$	$2/5$
Mild	4	2	$4/9$	$2/5$
Cool	3	1	$3/9$	$1/5$
	total= 9	total=5		

$P(\text{Humidity}=h   \text{Class}_{\text{play=Yes No}})$	Frequency		Probability in Class	
<b>Humidity =</b>	Play=Yes	Play=No	Play=Yes	Play=No
High	3	4	$3/9$	$4/5$
Normal	6	1	$6/9$	$1/5$
	total= 9	total=5		

$P(\text{Wind}=w   \text{Class}_{\text{play=Yes No}})$	Frequency		Probability in Class	
<b>Wind =</b>	Play=Yes	Play=No	Play=Yes	Play=No
strong	3	3	$3/9$	$3/5$
weak	6	2	$6/9$	$2/5$
	total= 9	total=5		

# Naive Bayes

$$\begin{aligned}P(\text{Class}_{\text{Play=Yes}}|x') &= [P(\text{Sunny}|\text{Class}_{\text{Play=Yes}}) \times P(\text{Cool}|\text{Class}_{\text{Play=Yes}}) \times \\&\quad P(\text{High}|\text{Class}_{\text{Play=Yes}}) \times P(\text{Strong}|\text{Class}_{\text{Play=Yes}})] \times \\&\quad P(\text{Class}_{\text{Play=Yes}}) \\&= 2/9 \times 3/9 \times 3/9 \times 3/9 \times 9/14 = 0.0053\end{aligned}$$

$$\begin{aligned}P(\text{Class}_{\text{Play=No}}|x') &= [P(\text{Sunny}|\text{Class}_{\text{Play=No}}) \times P(\text{Cool}|\text{Class}_{\text{Play=No}}) \times \\&\quad P(\text{High}|\text{Class}_{\text{Play=No}}) \times P(\text{Strong}|\text{Class}_{\text{Play=No}})] \times \\&\quad P(\text{Class}_{\text{Play=No}}) \\&= 3/5 \times 1/5 \times 4/5 \times 3/5 \times 5/14 = 0.0205\end{aligned}$$