Chapter 7: Naïve Bayes Classifier

Naïve Bayes Classifier:

- Naive Bayes is a statistical classification technique based on Bayes Theorem.
- It is called naïve because it assumes features are independent.

- **Making Predictions using Naïve Bayes:**
- We can make predictions using Bayes Theorem
  - **P(A|B) = P(B|A) * P(A) / P(B)**

- In fact, we don't need a probability to predict the most likely class for a new data instance. We only need the numerator and the class that gives the largest response, which will be the predicted output.
  - **max(P(B|A) * P(A))**

Playing Classifier:

PN	Weather	Play
1	Sunny	No
2	Sunny	No
3	Overcast	Yes
4	Rainy	Yes
5	Rainy	Yes
6	Rainy	No
7	Overcast	Yes
8	Sunny	No
9	Sunny	Yes
10	Rainy	Yes
11	Sunny	Yes
12	Overcast	Yes
13	Overcast	Yes
14	Rainy	No

For the given dataset, apply Naïve-Bayes Algo to predict the outcome of Weather = {Rainy}

P(Yes) =

P(No) =

Outlook	Yes	No
Sunny		
Overcast		
Rainy		

P(X|Yes) =			
P(X|No) =			
Normalizing P(X|Yes) =			
Normalizing P(X|No) =			

PN	Weather	Play
1	Sunny	No
2	Sunny	No
3	Overcast	Yes
4	Rainy	Yes
5	Rainy	Yes
6	Rainy	No
7	Overcast	Yes
8	Sunny	No
9	Sunny	Yes
10	Rainy	Yes
11	Sunny	Yes
12	Overcast	Yes
13	Overcast	Yes
14	Rainy	No

For the given dataset, apply Naïve-Bayes Algo to predict the outcome of Weather = {Sunny}

P(Yes) = 9/14

P(No) = 5/14

Outlook	Yes	No
Sunny	2/9	3/5
Overcast	4/9	0/5
Rainy	3/9	2/5

P(X|Yes) =	**P(Sunny|Yes) * P(Yes)**		
P(X|No) =	**P(Sunny|No) * P(No)**		
Normalizing P(X|Yes) =			
Normalizing P(X|No) =			

PN	Weather	Play
1	Sunny	No
2	Sunny	No
3	Overcast	Yes
4	Rainy	Yes
5	Rainy	Yes
6	Rainy	No
7	Overcast	Yes
8	Sunny	No
9	Sunny	Yes
10	Rainy	Yes
11	Sunny	Yes
12	Overcast	Yes
13	Overcast	Yes
14	Rainy	No

For the given dataset, apply Naïve-Bayes Algo to predict the outcome of Weather = {Overcast}

P(Yes) = 9/14

P(No) = 5/14

Outlook	Yes	No
Sunny	2/9	3/5
Overcast	4/9	0/5
Rainy	3/9	2/5

<table>
<tr><td rowspan="2">P(X|Yes) =</td><td colspan="3">P(Overcast|Yes) * P(Yes)</td></tr>
<tr><td colspan="2"></td><td></td></tr>
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Laplace Smoothing:

- ❑ Laplace smoothing is a smoothing technique that helps tackle the problem of zero probability in the Naïve Bayes machine learning algorithm.
- ❑ Working of Laplace Smoothing
    1. A small-sample correction, or pseudo-count, will be incorporated in every probability estimate.
    2. Consequently, no probability will be zero.
- ❑ This is a way of **regularizing Naive Bayes**, and when the pseudo-count is zero, it is called Laplace smoothing.

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<tr><td rowspan="2">P(X|Yes) =</td><td colspan="3">P(Overcast|Yes) * P(Yes)</td></tr>
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GO-OUT/STAY-HOME CLASSIFIER

DN	Weather	Car	Result
1	sunny	working	go-out
2	rainy	broken	go-out
3	sunny	working	go-out
4	sunny	working	go-out
5	sunny	working	go-out
6	rainy	broken	stay-home
7	rainy	broken	stay-home
8	sunny	working	stay-home
9	sunny	broken	stay-home
10	rainy	broken	stay-home

For the given dataset, apply Naïve-Bayes Algo to predict the outcome of a X = {sunny, working}

P(go-out) =

P(stay-home) =

Weather	go-out	stay-home
Sunny		
Rainy		

Car	go-out	stay-home
Working		
Broken		

P(X|go-out) =			
P(X|stay-home) =			
Normalizing P(X|go-out) =			
Normalizing P(X|stay-home) =			

DN	Weather	Car	Result
1	sunny	working	go-out
2	rainy	broken	go-out
3	sunny	working	go-out
4	sunny	working	go-out
5	sunny	working	go-out
6	rainy	broken	stay-home
7	rainy	broken	stay-home
8	sunny	working	stay-home
9	sunny	broken	stay-home
10	rainy	broken	stay-home

For the given dataset, apply Naïve-Bayes Algo to predict the outcome of a

X = {rainy, broken}

P(go-out) = 5 / 10

P(stay-home) = 5 / 10

Weather	go-out	stay-home
Sunny	4/5	2/5
Rainy	1/5	3/5

Car	go-out	stay-home
Working	4/5	1/5
Broken	1/5	4/5

P(X|go-out) =	**P(rainy|go-out) * P(broken|go-out) * P(go-out)**		
P(X|stay-home) =	**P(rainy|stay-home) * P(broken|stay-home) * P(stay-home)**		
Normalizing P(X|go-out) =			
Normalizing P(X|stay-home) =			

NBC Advantages:

- Naïve Bayes is one of the fast and easy ML algorithms to predict a class of datasets.
- It can be used for Binary as well as Multi-class Classifications.
- It performs well in Multi-class predictions as compared to the other Algorithms.

NBC Disadvantages:

Naive Bayes assumes that all features are independent or unrelated.

NBC Application:

- Text Classification problem such as:
    - Spam filtration
    - Classifying articles
- Credit Scoring
- Medical data classification