MACHINE LEARNING

Shoaib Farooq

Department of Computer Science

Disclaimer: This presentation includes contents available online including images copied from Google search and contents of presentations of other professors. I don't claim any image or text to be my own. All the credit goes to the original authors.

Instructor Information

Instructor	Shoaib Farooq	E-mail	m.shoaib1050@gmail.com
GitHub	https://github.com/SHOAIB1050		
YouTube	https://www.youtube.com/c/pakithub		
LinkedIn	https://www.linkedin.com/in/shoaib-farooq-b5b190105/		

Let's Start .....

Lecture #4

GOALS

- This Lecture Will Cover:
- Basic Statistics
- NAÏVE BAYES

NAÏVE BAYES – CONDITIONAL PROBABILITY

- Taking decisions based upon uncertainty,
- The discipline which studies uncertainty scientifically is known as **"Probability".**
- "Probability theory is nothing but common sense reduced to calculation." **- Laplace**

PROBABILITY THEORY

- Uncertainty is a key concept in pattern recognition and machine learning
- It arises both from measurement noise and from finite size datasets
- Probability theory provides consistent framework for the quantification and manipulation of uncertainty
- When combined with decision theory, it allows us to make optimal predictions, given all the information available, even when that information is incomplete or ambiguous

PROBABILITY

- Probability is the formal study of the laws of chance. Probability allows us to manage uncertainty.
- The sample space is the set of all outcomes. For example, for a die we have 6 outcomes : {1,2,3,4,5,6}
- Probability allows us to measure many events. The events are subsets of the sample space. For example, for a die we may consider the following events: Even: {2,4,6}; odd: {1,3,5}, greater than four {5,6}
- We assign probabilities to the events P(Even) = 3/6

PROBABILITY

- The following two laws are key concepts of probability:
  - The probability of an event A is the sum of the probabilities of all sample points in A, i.e., 0 <= P(A)<=1
  - If an experiment can result in any one of N different equally likely outcomes, and if exactly n of these outcomes correspond to event A, then the probability of even A is P(A) = n / N

PROBABILITY

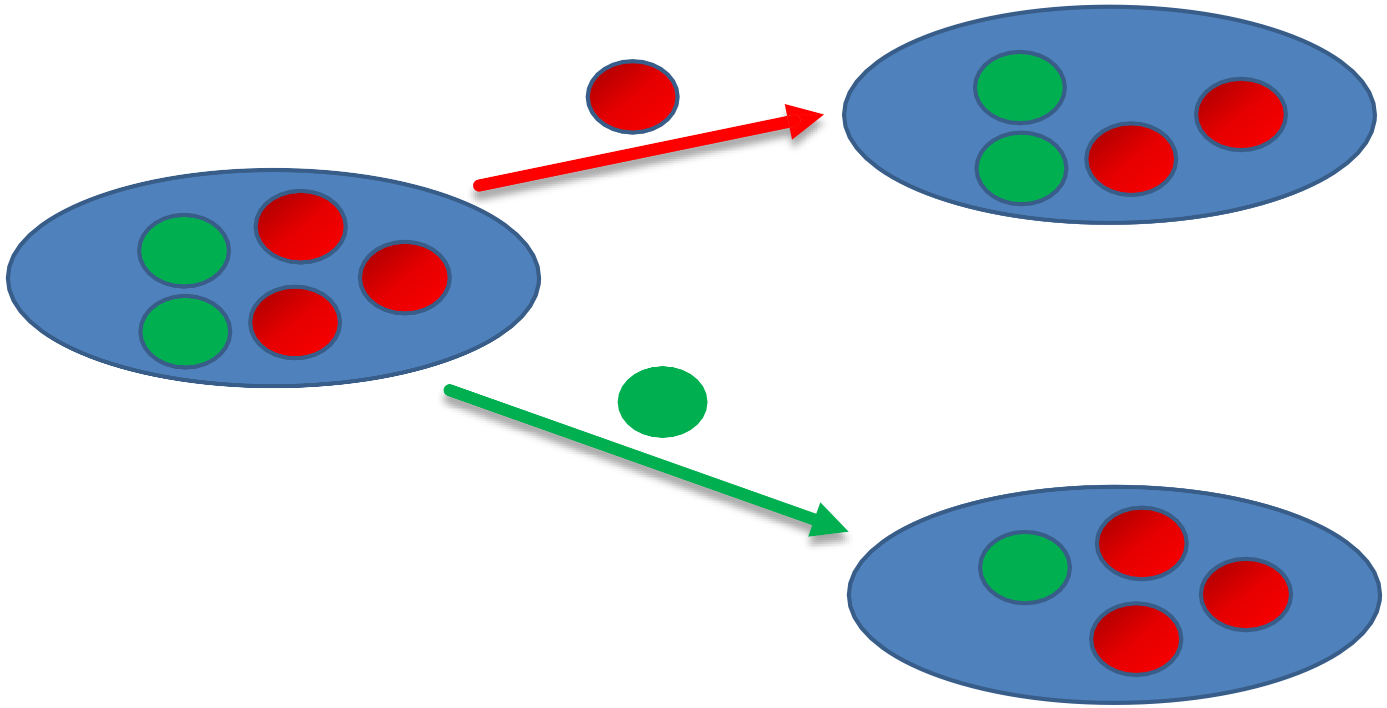
- Given two events, A and B, that are not disjoint, we have:
  - **P(A U B) = P(A) + P(B) – P(A and B)**
- If A and B are mutually exclusive, then
  - **P(A U B) = P(A) + P(B)**
- If A and A’ are complementary events, then:
  - **P(A) + P(A’) = 1**

INDEPENDENT EVENTS

- Each toss of a coin is a perfect isolated thing.
- What it did in the past will not affect the current toss.
- The chance is simply 1-in-2, or 50%, just like ANY toss of the coin.
- So each toss is an Independent Event.

DEPENDENT EVENTS

- But events can also be "dependent" ... which means they can be affected by previous events



CONDITIONAL PROBABILITY

- The probability of an event B occurring when it is known that some event A has occurred is called Conditional Probability represented as P(A|B) .

Probability of

Event B

Given

$$P(A \text{ AND } B) = P(A) \times P(B|A)$$

Event A

TOWARD BAYESIAN RULE

P (Data) x P(Hypothesis|Data) = P(Hypothesis) x P(Data | Hypothesis)

P(Hypothesis|Data) = P(Hypothesis) x P(Data | Hypothesis) / P (Data)

P(Class | Data) = P(Class) x P(Data | Class) / P (Data)

WEATHER DATASET

Outlook	Temp	Humidity	Windy	Play
Sunny	Hot	High	FALSE	No
Sunny	Hot	High	TRUE	No
Overcast	Hot	High	FALSE	Yes
Rainy	Mild	High	FALSE	Yes
Rainy	Cool	Normal	FALSE	Yes
Rainy	Cool	Normal	TRUE	No
Overcast	Cool	Normal	TRUE	Yes
Sunny	Mild	High	FALSE	No
Sunny	Cool	Normal	FALSE	Yes
Rainy	Mild	Normal	FALSE	Yes
Sunny	Mild	Normal	TRUE	Yes
Overcast	Mild	High	TRUE	Yes
Overcast	Hot	Normal	FALSE	Yes
Rainy	Mild	High	TRUE	No

PROBABILITIES FOR WEATHER DATA

Outlook			Temperature			Humidity			Windy			Play	
	Yes	No		Yes	No		Yes	No		Yes	No	Yes	No
Sunny	2	3	Hot	2	2	High	3	4	False	6	2	9	5
Overcast	4	0	Mild	4	2	Normal	6	1	True	3	3		
Rainy	3	2	Cool	3	1								
Sunny	2/9	3/5	Hot	2/9	2/5	High	3/9	4/5	False	6/9	2/5	9/14	5/14
Overcast	4/9	0/5	Mild	4/9	2/5	Normal	6/9	1/5	True	3/9	3/5		
Rainy	3/9	2/5	Cool	3/9	1/5								

PROBABILITIES FOR WEATHER DATA

Outlook			Temperature			Humidity			Windy			Play	
	Yes	No		Yes	No		Yes	No		Yes	No	Yes	No
Sunny	2	3	Hot	2	2	High	3	4	False	6	2	9	5
Overcast	4	0	Mild	4	2	Normal	6	1	True	3	3		
Rainy	3	2	Cool	3	1								
Sunny	2/9	3/5	Hot	2/9	2/5	High	3/9	4/5	False	6/9	2/5	9/14	5/14
Overcast	4/9	0/5	Mild	4/9	2/5	Normal	6/9	1/5	True	3/9	3/5		
Rainy	3/9	2/5	Cool	3/9	1/5								

- A new day:

Outlook	Temp.	Humidity	Windy	Play
Sunny	Cool	High	True	?

Likelihood of the two classes

For "yes" = 2/9 x 3/9 x 3/9 x 3/9 x 9/14 = 0.0053

For "no" = 3/5 x 1/5 x 4/5 x 3/5 x 5/14 = 0.0206

Conversion into a probability by normalization:

P("yes") = 0.0053 / (0.0053 + 0.0206) = 0.205

P("no") = 0.0206 / (0.0053 + 0.0206) = 0.795

Thank You ☺