MODULE 5

Prof. Mohammed Tanzeem Agra

Module 5 – Contents

1) Text Mining
2) Naive – Bayes Analysis
3) Support Vector Machines
4) Web Mining
5) Social Network Analysis

NAIVE-Bayes Analysis

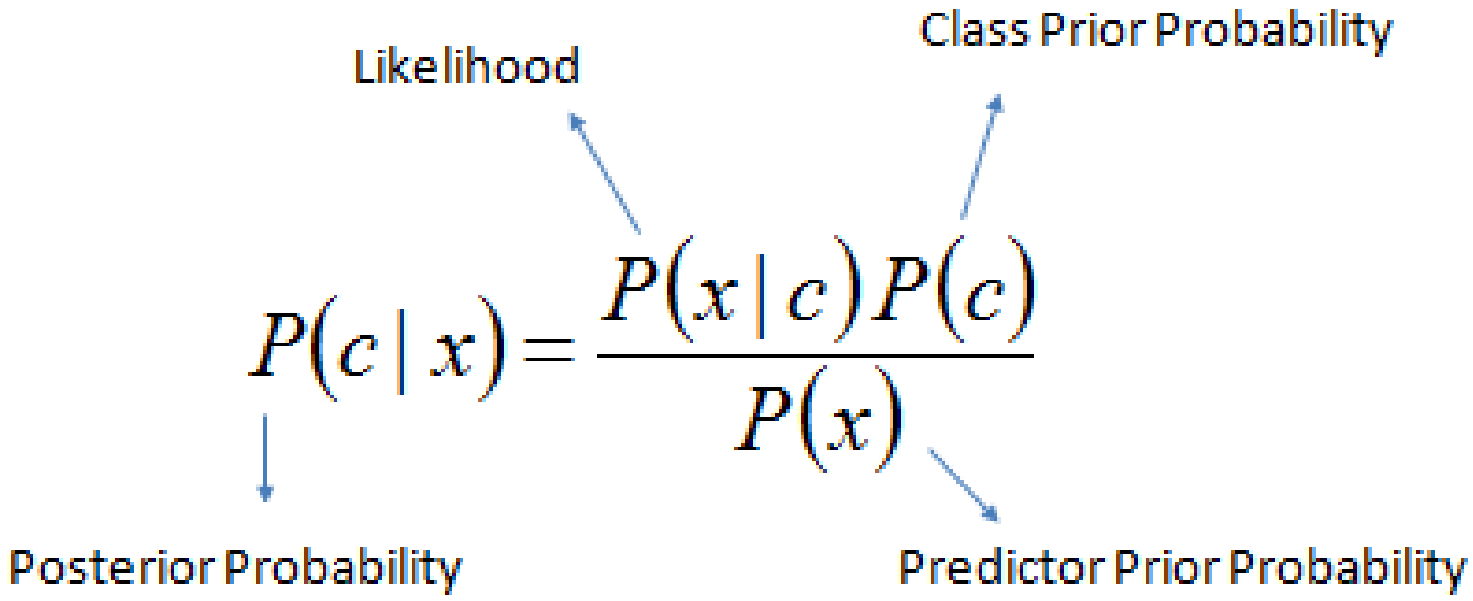
- NB tech is a supervised learning tech that uses probability theory based analysis.
- It computes the probability of an instance belonging to each one of many target classes.
- Example : classifying text documents.
- Probability : from past records, the probability of something happening in the future can be reliably assessed.
- Example: the probabilty of dying from an airline accident, by the total no:of airline accident related deaths in a time period by the total no:of flying durring that time.

Advantages and Disadvantages

- The NB Logic is simple for classification of instances.
- Conditional Probability can be computed for descrete data.
- It computes the probability of a new occurence not only on the recent record, but also on the basis of prior experience.

- Posterior probability computation required time.
- When there are no :of variables in the vector X then the problem can be modeled using probability function. Such as : normal, lognormal,gamma and poisson.

NAIVE-BAYES MODEL



$$P(c \mid \mathbf{X}) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

SIMPLE CLASSIFICATION EXAMPLE

- Suppose a salon needs to predict the service required by the incoming customer.
- If there are only two service offered : Hair Cut (R) and Manicure-pedicure (M)
- Predict : whether the next customer will be R or M
- Let the no:of classes K = 2
- Data of one year : 2500 customer R and 1500 customer for M
- Ans : the default probability for the next customer to be for R is 2500/4000 or 5/8 and for M is 1500/4000 or 3/8, next customer would likely to be for R.
- Example Sequence : R,M,R,M,M
- NB Posterior Probability P(R)= 5/8*2/5 = 10/40 = 0.25
- NB Posterior Probability P(M) = 3/8*3/5 = 9/40 = 0.225

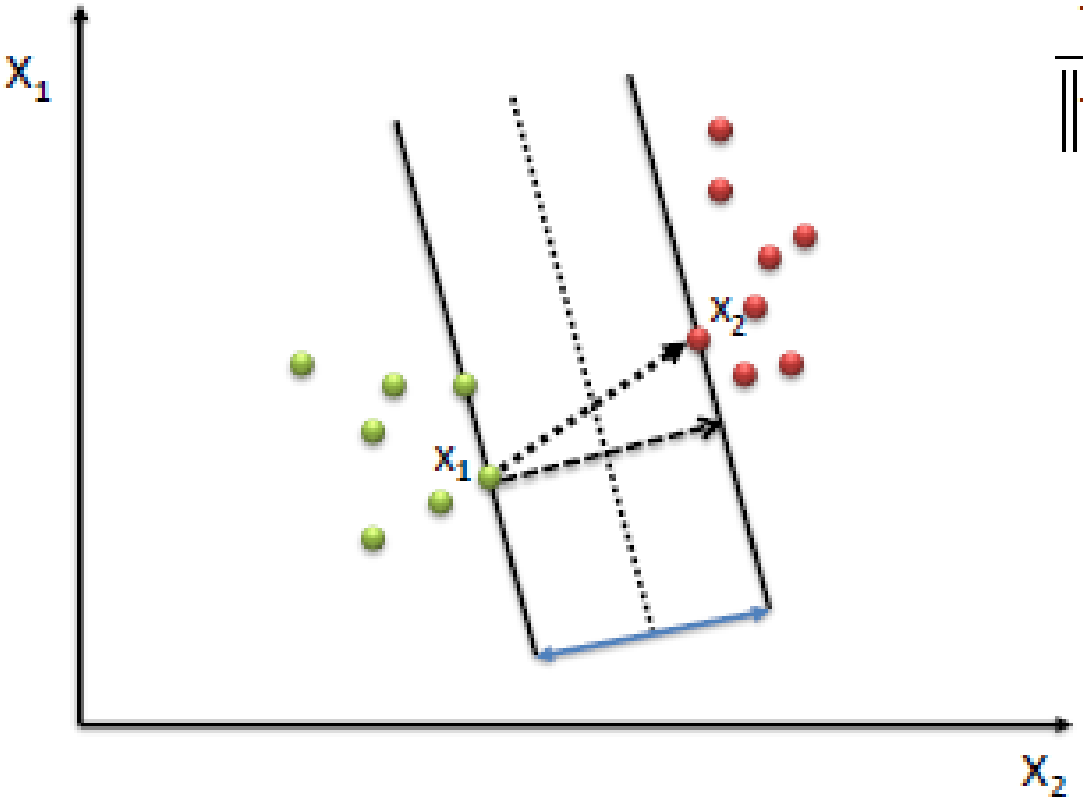
TEXT CLASSIFICATION EXAMPLE

TRAINNING SET	DOCUMENT ID	KEYWORDS IN THE DOCUMENT	CLASS = H (HEALTY)
	1	Love Happy Joy Joy Love	Yes
	2	Happy Love Kick Joy Happy	Yes
	3	Love Move Joy Good	Yes
	4	Love Happy Joy Pain Love	Yes
	5	Joy Love Pain Kick Pain	No
	6	Pain Pain Love Kick	No
TEST DATA	7	Love Pain Joy Love Kick	?

SUPPORT VECTOR MACHINE(SVM)

- SVM is a supervised Machine Learning Algorithm which can be used for both classification and regression challenges. However, it is most widely used in classification problem.
- Application : Face Detection, Text and Image Classification, Handwritting Recognition.
- In this algorithm, we plot each data item as point in a n-diemnsional space with the value of each feature being the value of a particular coordinate
- We perform the classification by finding the hyper-plan that differenciate the two classes very well called segments.

DIAGRAM



$$\frac{w}{\|w\|}\cdot(x_2-x_1)=\text{width}=\frac{2}{\|w\|}$$

$$w\cdot x_2+b=1$$

$$w\cdot x_1+b=-1$$

$$w\cdot x_2+b-w\cdot x_1-b=1-(-1)$$

$$w\cdot x_2-w\cdot x_1=2$$

$$\frac{w}{\|w\|}(x_2-x_1)=\frac{2}{\|w\|}$$

SVM MODEL (How it Works)

- An SVM is a classifier function in a high-diemensional space that defines the decesin boundary between two classes.
- Classify the label set of points into two classes called segments. The goal is to find the best classifier between the two points of the two type.
- SVM takes the widest street approach to demarcate the two classes and thus finds the hyperplane that has the widest margin.
- In diagram, the dotted line is the optimal hyperplane. The hardlines are the gutters on the sides of the two classes.
- The gap between the gutters is the maximum margin.
- The classifier is defined by only those points that fall on the gutters on both side. This points are called Support Vector.
- Rest of the data point are irrelevant for defining the classifier.

SVM MODEL

- Notations
  - The training data of n-points : (X1,Y1)...(Xn,Yn)
  - X will represent two binary class value 1 or -1
  - The classifier hyperplan that satiesfy the equation **W.X + b = 0** ; where W = normal vector to the hyperplan
  - The Hard Margin can be defined ; **W.X + b = 1 and W.X + b = -1**
  - The width of the hard margin can be calculated **2/|W|**

THE KERNEL METHOD

- The of heart of an SVM algorithm is the kernel method. Most kernel algorithm is based on optimization in a convex space.
- Kernel methods operate using what is called the “Kernel trick”.
- Trick involves computing and working with the inner products of only the relevant pairs of data in the feature space.
- The kernel trick makes the algorithm much less demanding in computational and memory resources.

THE KERNEL METHOD

- There are several types of support vector models including linear, polynomial, and sigmoid.
- In all types, we assign high weights to the abnormal situation and very low weight to the normal situation.
- SVM is more flexible and be able to tolerate some amount of misclassification. By categorising Soft Margin and Hard Margin.

ADVANTAGES AND DISADVANTAGES

- SVM work very well when no:of features are larger then the instances.
- It can work on data set with huge features space; example : spam filtering.
- SVM are easy to undersatnd. They create an easy-to-undersatnd linear classifier.
- They are computationally efficient.
- SVM are now available with almost all data analytics toolsets.

- It works well only with real numbers. All the data should be defined in numerical values.
- It works only with binary classification problem.
- Training the SVM is an ineeficient and time consuming process. When the data is large
- SVM does not work well when there is much noise in the data.
- SVM will also not provide a probability estimate of classification.

TEXT MINING

- Text Mining is the art and science of discovering patterns from an organized collection of textual database.
- Textual mining can help with frequency analysis of important terms and their semantic relationship.
- Text mining can help be applied to large scale social media data for gathering preferences and measuring emotional sentiments.

5.1.1: TEXT MINING – EXAMPLE

- Format : Word Documents, PDF Files, XML Files, Text messages etc
- In Legal Profession: text sources would include law, court delibration, court orders etc
- Academic Research : published papers and articles
- World of Finance : statutory reports, internal histories, discharge summaries etc
- Medicine : medical journels, patient history, discharge summaries
- Marketing : advertisement, customers comments etc.

5.1.2:Text Mining Applications

- Marketing
- The voice of the customer can be captured in its native and raw format and then analyzed for customer preference and complaints.
- Social Personas are a clustering technique to develop the customer segments of interest.
- Listening platform is a text mining application, that in real time gethers social media, blogs and other textual feedback and filters out the chatter to extract true consumer sentiments.
- The BPO conversation and records can be analysed for pattern of customers complaints.

Text Mining Applications

- Business Operations
  - Social Network Analysis and Text Mining can be applied to email, blogs and social media to measure the emotional status and the mood of employee populations.
  - Studying people as emotional investors and using text analysis of the social internet.
- Legal

–Lawyers can more easily search case histories and law for relevant documents in a particular case

–E-discovery platforms that help in minizing risk in the process of sharing legal documents.

Text Mining Applications

- Governance and Politics
  - Social Network analysis and text mining of large scal social media data can be used for measuring emotional state and the mood of contituent populations.
  - In geo political security, internet chatter can be proceed for real time information and to connect the dots on any emerging threats.

5.1.3 : DATA MINING PROCESS

- There are three levels
- *Level 1 : Identifying frequent words*
  - This create a bag of important words. Text documents or smaller messages – can then be ranked on how they match to a particular bag-of-words
  - *Establishing the corpus of text and organized.*
- *Level 2 : Identifying the meaningful phrases from the words.*
- *Example : ice and cream will be two different key words that often come together. However there is a more meanigful phrases by combining the two words into "ice cream". This is also called "Structure Using Term Document Matrix"*
- *Level 3 : Multiple Phrases can be combined or Mine TDM for Patterns*
  - *The two phrases can be put into a common busket and this busket is called "Desserts"*
- *Refer diagram in page no : 138*

TDM : TERM DOCUMENT MATRIX

- This is the heart of structuring process. Text can be converted into numerical data, which can then be mined using regular data mining technique.
- One could call key words, phrases or a topic as a term of interest. This approach measure the frequencies of selecting important term occurring in each document. This create a txd, where t=no:of terms and d= no:of documents.

MINING THE TDM

- The TDM can be mined to extract the patterns/knowledge. The variety of tech can be applied.
  - Visualize the highest frequency term, this can be done using wordcloud tech.
  - Predictors of desirable terms, example the word “profit” is a desirable word in a document. The no:of occurence of the word profit in a document could be regressed against many other terms in the TDM.

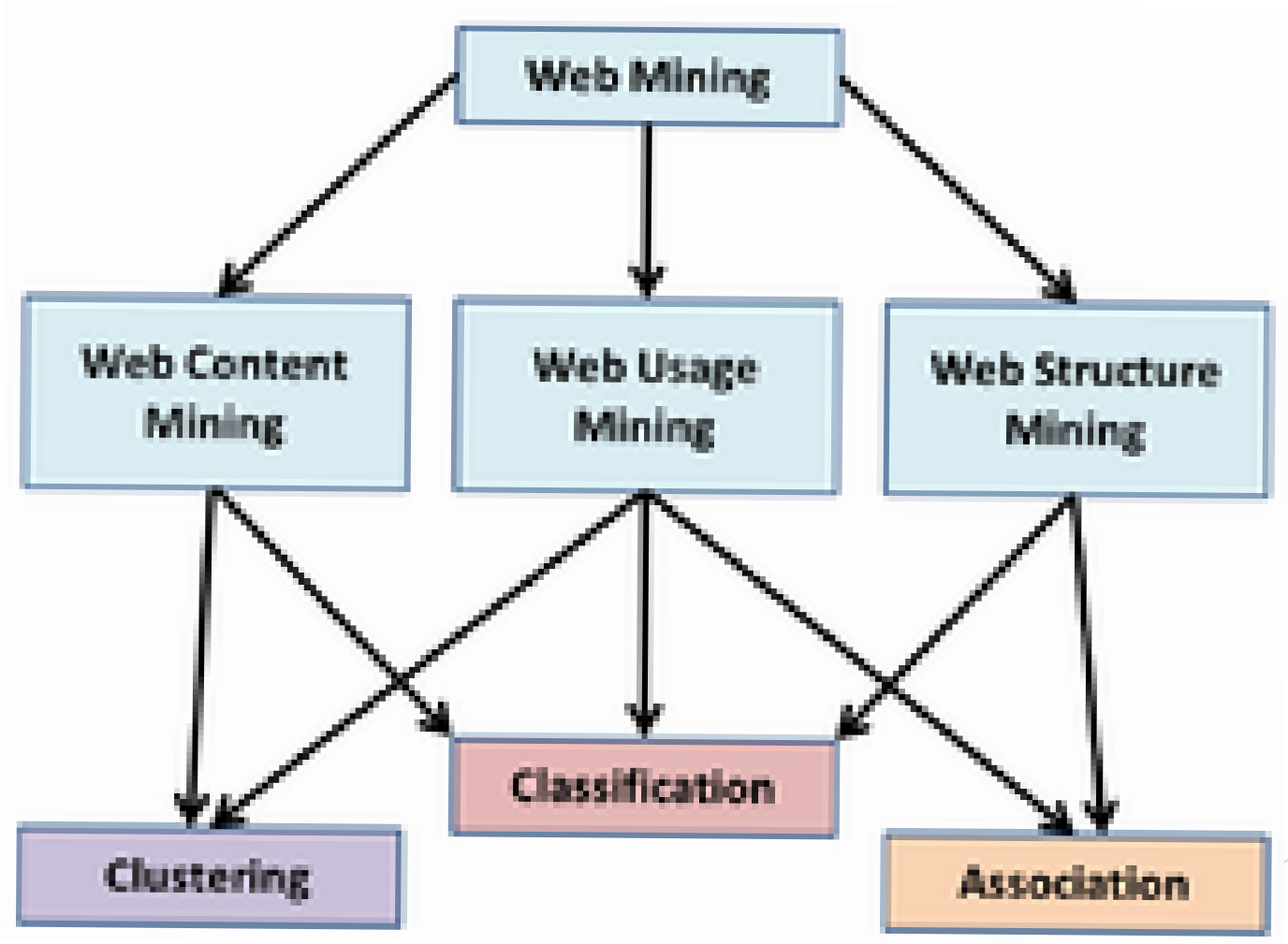
WEB MINING

- Web Mining is the art and Science of discovering patterns from WWW so as to improve.
- The WWW is at the heart of the digital revolution, billions of users are using it every day for a variety of purposes.
- The web is used for electronic commerce, business commuincation, and many other application.
- Data for web mining is collected via web crawlers, web logs and other means.

Characteristics of web sites

- **Appearance** : Attractive Design, well-formatted content, easy to scan and navigate, good color contrasts.
- **Content** : well-planned information architecture with useful contents, Fresh content, SEO, link to other good sites.
- **Functionality** : Accessible to all the autorised users, fast loading time, usable form, mobile enabled.
- **FeedBack Analysis** : FeedBack data can be used for commercial advertisement and even for social engineering.

TYPES OF WEB MINING (3 TYPES)



Web Content Mining

- A web site is designed in the form of pages with distinct URL. A large website may contain thousand of web pages.
- These pages are managed by a specialized software called Content Management Systems.
- Every page may have text, graphics, audio, video, forms, applications, and more kind of content.
- The website keeps a record of all request received for its URL, including the requester information using cookies.
- The log of these requests could be analyzed to gauge the popularity of those pages among different segment of the population (PageRank Algorithm).

Web Content Mining

- The text and application content on the pages could be analyzed for its usage by visit counts.
- Use quality contents to attract the users.
- Unwanted and unpopular pages could be weeded out or they can be transfered with different contents and style.
- Assign more resources to keep more popular pages fresh and inviting.

WEB STRUCTURE MINING

- The web works through a system of hyperlinks using the http.
- Any page can create a hyperlink to any other pages (Link to another pages), self referral nature of web lends itself to some unique network analytical algorithms.
- There are two basic strategic models for successful websites – **Hubs** and **Authorities**.

WEB STRUCTURE MINING

- Hubs (Gathering Point) :
  - These are pages with large no:of interesting liks, media site like yahoo.com or government site could serve that purpose.
  - More focus site like www.google.com could aspire to become hub for new emerging areas.
- Authorities:
  - The page which provide the most complete and authoritative information on a particular subject.
  - Example : news, advice, user reviews etc
  - These web site have maximum no:of inbound link from other web sites.
  - Example : www.mayoclinic.com (medical opinion), www.nytimes.com (daily news)

WEB USAGE MINING

- The goal of the web usage mining is to extract useful information and patterns from data generated through web page visits and transactions.
- The activity data comes from data stored in server access log, referrer logs, agent logs, and client-side cookies.
- The user characteristics and usage profile are also gathered directory or indirectly through sydicate data.
- Meta data such as page attributes, content attribute and usage data are also gathered.

Web Content Analysis

from data stored in server access logs, referrer logs, agent logs, and client-side cookies. The user characteristics and usage profiles are also gathered directly or indirectly through syndicated data. Further, metadata such as page attributes, content attributes, and usage data are also gathered.

The web content could be analyzed at multiple levels (Figure 14.2).

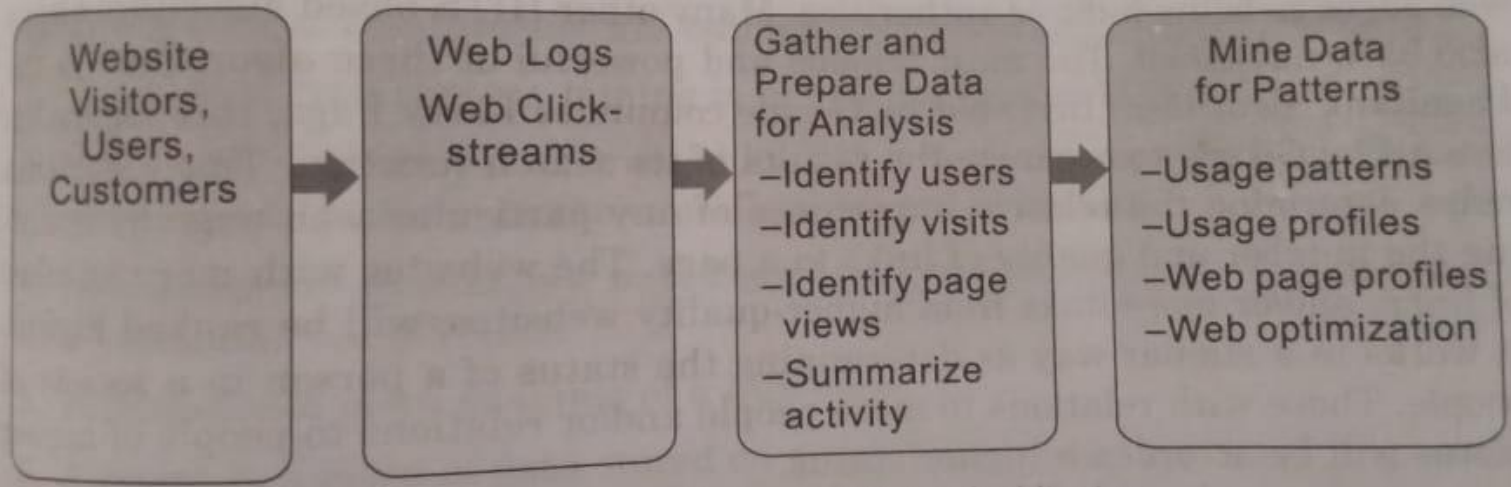


FIGURE 14.2 Web Usage Mining Architecture

- The *server side analysis* would show the relative popularity of the web pages could be hubs and authorities.

There are two types of web usage mining

- The **Server Side Analysis**
  - Display the relative popularity of the web pages accessed. Those web sites could be hubs and authorities.
- The **client – side Analysis**
  - Focus on the usage pattern or the actual content consumed and created by users.
  - Clickstream analyse web activity for pattern of sequence of clicks and location and duration of the visit on web sites.
  - Clickstream analysis can be useful for web activity analysis, software testing, market research and analysing employee productivity.

There are two types of web usage mining

- The **client - side Analysis**
  - Textual information can be analyzed using text mining technique called bag-of-words.
  - Bag-of-words matrix mine using cluster analysis and association rules for patterns such as popular topic and sentiment analysis.
  - Application : it can help to predict user bahavior based on previously learned rules and users profile and can help to determine life time value of clients.
  - Can be used to designed cross marketing strategy by using association rule.