Data Mining

Concepts & Algorithms

DSA 8102: Data mining, data storage and retrieval

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Objectives

• Determine why data mining is in high demand.

• Describe the concept of data mining and the technologies associated with it.

• Identify which kinds of data may be mined, • Describe the data mining algorithms and areas of applications.

- Discuss significant issues in data mining. ©

Why data mining?

The digital age

- Recent advances in data collection and storage technology have led to accumulation of all sorts of data.

- Unfortunately, these accumulation of data in disparate structures became overwhelming.
- The initial chaos led to the creation of unstructured and structured databases (i.e., RDBMS).
- The rapid growth of different forms of data led to the advent of **Big Data**.
- Today, we have far more information that we can handle from business transactions, scientific data, satellite pictures, text reports,

military intelligence, etc.

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Sources of data

- Here is a non-exclusive list of a variety of information:
  - Business transactions
  - Scientific data
  - Medical and personal data
  - Surveillance video and pictures
  - Satellite sensing
  - Games
  - CAD and Software Engineering data
  - Text reports and memos

(email messages)

– World Wide Web repositories

Data Mining Concept

Multidisciplinary

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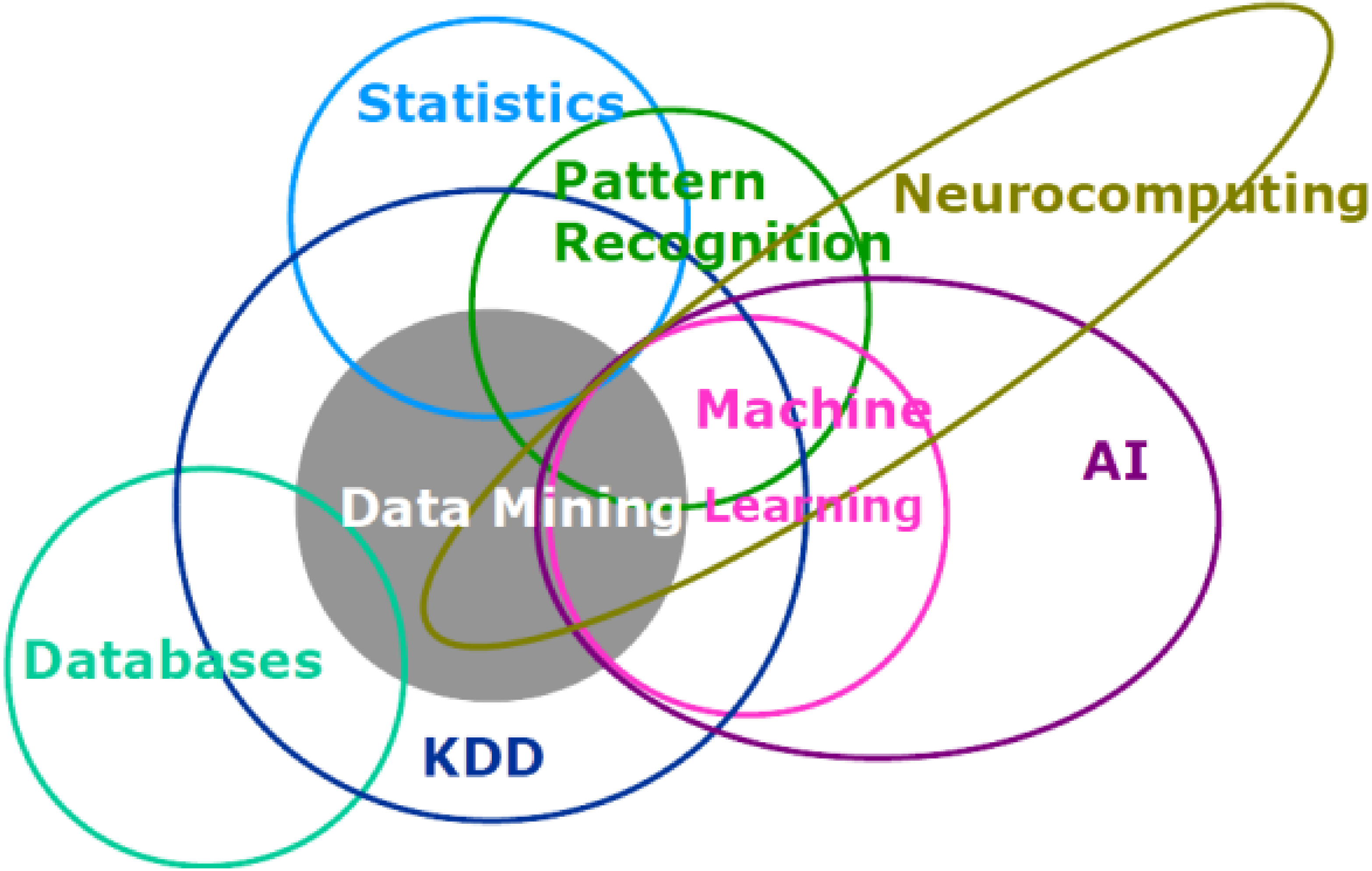
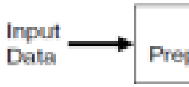


Data Mining

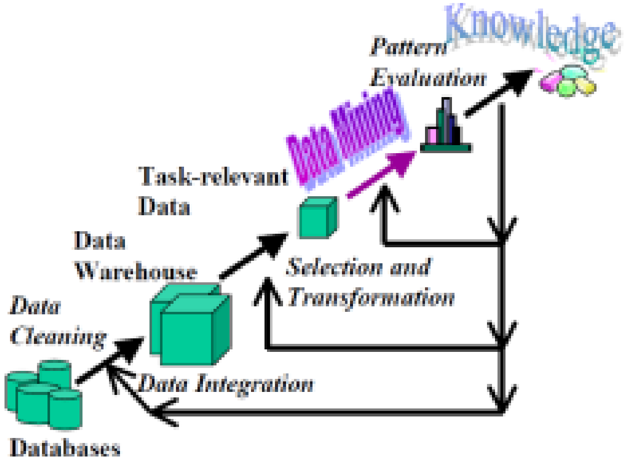
- Data mining is a crucial part of

(KDD) knowledge discovery in databases.

- It is the process of converting raw data into useful information.
  - **Input data:** Flat files, spreadsheets or relational tables)
  - **Data preprocessing:** Cleaning data to remove noise and duplicate observations
  - **Data mining:** Techniques are applied to extract patterns potentially useful
  - **Data Analysis:** Either through visualization or pattern interpretation.
  - **Information:** Output of the knowledge discovery



The process of knowledge discovery



(Zaïane, 1999)

in databases (Tan et al. 2013)

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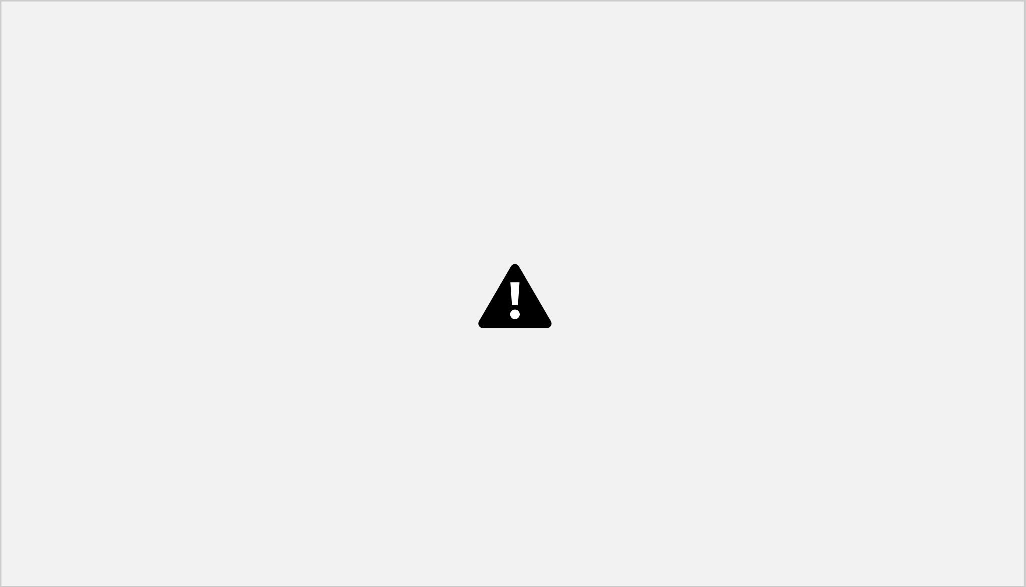
Data for mining

- In principle data mining is not specific to one type of data.
- Examples of data



sources that can be mined:

- Flat files
- Relational databases
- Data warehouse
- Transaction databases
- Multimedia databases
- Spatial databases
- Time-series databases
- World Wide Web

Common mining tasks

- **Predictive data mining:** is used to predict future outcomes.
- **Descriptive data mining:**

focuses on what has happened.

- Most common data mining tasks.
  - Classification
  - Regression
  - Time series analysis
  - Association rules
  - Clustering
  - Sequence discovery
  - Summarization

1. Classification

- Predict if a data point belongs to one of the predefined classes.

The predictions are usually from a known data set.

- Common examples:
  - Determining whether a particular credit card transaction is fraudulent or not;
  - Assessing whether a mortgage application is a good or bad credit risk;
  - Diagnosing whether a particular disease is present or not;
- Popular algorithms:
  - Decision trees, neural networks, Bayesian models, induction rules etc.

2. Regression

- One of the

oldest statistical technique used to predict a numeric or continuous value.

- Common examples:
  - Predicting unemployment rate for the following year.
  - Estimating insurance premium.
- Popular algorithms:

- Linear regression and logistic regression.

3. Clustering

- Data is partitioned into several meaningful groups. Clustering differs from classification in that there is no target variable.
- Common examples:
  - Finding customer segments in a company based on transaction, web and

customer call data.
  - For gene expression clustering, where very large quantities of genes may exhibit similar behaviour.
- Popular algorithms:
  - K-means clustering, DBSCAN

4. Time Series Analysis

Predict the value of the target variable for a future time frame based on historical value.

- Common examples:
  - Forecasting of

  - sales events,
  - Tracking daily, hourly, or weekly weather data.
  - Tracking changes in application performance.
  - Tracking network logs.
- Popular algorithms:
  - Exponential smoothing, autoregressive integrated moving average (ARIMA), regression.

5. Summarization

- Involves techniques for finding a compact description of a dataset. Presents useful information about the data, e.g. mean, charts, graphs, etc.

- Common examples:
  - Monitor the activity of a network
  - Compare different entities.
- Popular algorithms:
  - Multivariate visualization

6. Association Rules

Describes relationship between items of a data set.

- Common examples:
  - Finding out which items in a supermarket are purchased together, and which items are never purchased together,

  - Determining the proportion of cases in which a new drug will exhibit dangerous side effects.

- Popular algorithms:
  - Apriori algorithm, FP-Growth.

7. Sequence Discovery

- Discovers statistically relevant patterns in sequential data. Event occurrences are usually governed by timing constraints.
- Common examples:
  - Customer shopping sequences: First buy computer, then CD ROM, then digital camera, within 6 months.
  - Web access patterns
  - Weather prediction.
  - Medical treatments, natural disasters (e.g. earthquakes),

stocks and

markets.

- Popular algorithms:
  - Apriori, FP-Growth.

Exercise - Group Discussion

1. Differentiate between “explainable AI” and “AI” as used in knowledge discovery.

2. Differentiate between clustering and classification.

Categories

Categories of data

mining tasks

- Categorize according to the type of data source
  - spatial data, multimedia data, time-series data, text data, www, etc.
- Categorize according to the data model drawn on
  - relational database, object-oriented database, data warehouse, transactional, etc.
- Categorize according to the kind of knowledge discovered
  - characterization, discrimination, association, classification, clustering, etc.
- Categorize according to mining techniques used – machine learning, neural networks, genetic algorithms, statistics, visualization, database-oriented or data warehouse-oriented, etc.

Popular Data Mining Tools

Application Areas

Application Areas

- Healthcare:
  - reducing costs and improving patient outcomes
- Education:
  - predicting at-risk students.
- Customer relationship management:
  - know the needs of customers and build loyalty
- Manufacturing engineering:
  - forecasting the overall time for product development
- Finance and banking:
  - correlations and trends in market costs and business information
- Market basket analysis and segmentation:
  - understand the buying habits of customers
- Fraud detection:
  - identify patterns in fraudulent documents
- Etc.

Data Mining Issues

Data Mining Issues

- Note that these issues are not exclusive:
  - Security and privacy issues
  - User interface issues
  - Mining methodology issues
  - Performance issues
  - Data sources issues

Exercise

1. Describe the issues that come with data mining.
2. Discuss possible solutions to the issues described above.

References