淡江大學　99　學年度第 2 學期　期中　考試命題紙（參考解答）

考試科目：資料倉儲　開課班別：資管　系 四 年 P 班　命題教授：戴敏育

考試日期：100 年 4 月 19 日（星期二）第 5 節	※請務必註記，准帶項目打「V」，否則打「X」。					1. 需加發計算紙(B5 白紙)或答案紙請在試題內封袋備註。 2. 本命題紙為 A4 大小，印刷格式統一由閘場判斷是否放大或合併印刷，如有特殊需求，請註記：
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1. What is Data Warehouse? (10%)

Ans: "A data warehouse is a subject-oriented, integrated, time-variant, and nonvolatile collection of data in support of management's decision-making process." ."—W. H. Inmon

Ref: 992DW04 p.4, pp.5-9

What is Data Warehouse?

- Defined in many different ways, but not rigorously.
  - A decision support database that is maintained separately from the organization's operational database
  - Support information processing by providing a solid platform of consolidated, historical data for analysis.
- "A data warehouse is a subject-oriented, integrated, time-variant, and nonvolatile collection of data in support of management's decision-making process."—W. H. Inmon
- Data warehousing:
  - The process of constructing and using data warehouses

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Data Warehouse—Subject-Oriented

- Organized around major subjects, such as customer, product, sales
- Focusing on the modeling and analysis of data for decision makers, not on daily operations or transaction processing
- Provide a simple and concise view around particular subject issues by excluding data that are not useful in the decision support process

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Data Warehouse—Integrated

- Constructed by integrating multiple, heterogeneous data sources
  - relational databases, flat files, on-line transaction records
- Data cleaning and data integration techniques are applied.
  - Ensure consistency in naming conventions, encoding structures, attribute measures, etc. among different data sources
    - E.g., Hotel price: currency, tax, breakfast covered, etc.
  - When data is moved to the warehouse, it is converted.

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Data Warehouse—Time Variant

- The time horizon for the data warehouse is significantly longer than that of operational systems
  - Operational database: current value data
  - Data warehouse data: provide information from a historical perspective (e.g., past 5-10 years)
- Every key structure in the data warehouse
  - Contains an element of time, explicitly or implicitly
  - But the key of operational data may or may not contain "time element"

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Data Warehouse—Nonvolatile

- A physically separate store of data transformed from the operational environment
- Operational update of data does not occur in the data warehouse environment
  - Does not require transaction processing, recovery, and concurrency control mechanisms
  - Requires only two operations in data accessing:
    - *initial loading of data* and *access of data*

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2. How is a data warehouse different from a database? How are they similar? (10%)

Ans:

Ref: 992DW03 p.10, p.11

Differences between a data warehouse and a database

- Data warehouse:
  - A data warehouse is a repository of information collected from multiple sources over a history of time stored under a unified schema and used for data analysis and decision support
  - There could be multiple heterogeneous databases where the schema of one database may not agree with the schema of another.
- Database:
  - A database is a collection of interrelated data that represents the current status of the stored data.
  - A database system supports ad-hoc query and on-line transaction processing.

Source: Han & Kamber (2006) 10

Similarities between a data warehouse and a database

- Both are repositories of information storing huge amounts of persistent data.

Source: Han & Kamber (2006) 11

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3. What are OLTP and OLAP? What are the differences between OLTP and OLAP? (10%)

Ans:

Ref: 992DW04 p.11, p.12

Data Warehouse vs. Operational DBMS

- OLTP (on-line transaction processing)
  - Major task of traditional relational DBMS
  - Day-to-day operations: purchasing, inventory, banking, manufacturing, payroll, registration, accounting, etc.
- OLAP (on-line analytical processing)
  - Major task of data warehouse system
  - Data analysis and decision making
- Distinct features (OLTP vs. OLAP):
  - User and system orientation: customer vs. market
  - Data contents: current, detailed vs. historical, consolidated
  - Database design: ER + application vs. star + subject
  - View: current, local vs. evolutionary, integrated
  - Access patterns: update vs. read-only but complex queries

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OLTP vs. OLAP

	OLTP	OLAP
users	clerk, IT professional	knowledge worker
function	day to day operations	decision support
DB design	application-oriented	subject-oriented
data	current, up-to-date detailed, flat relational isolated	historical, summarized, multidimensional integrated, consolidated
usage	repetitive	ad-hoc
access	read/write index/hash on prim. key	lots of scans
unit of work	short, simple transaction	complex query
# records accessed	tens	millions
#users	thousands	hundreds
DB size	100MB-GB	100GB-TB
metric	transaction throughput	query throughput, response

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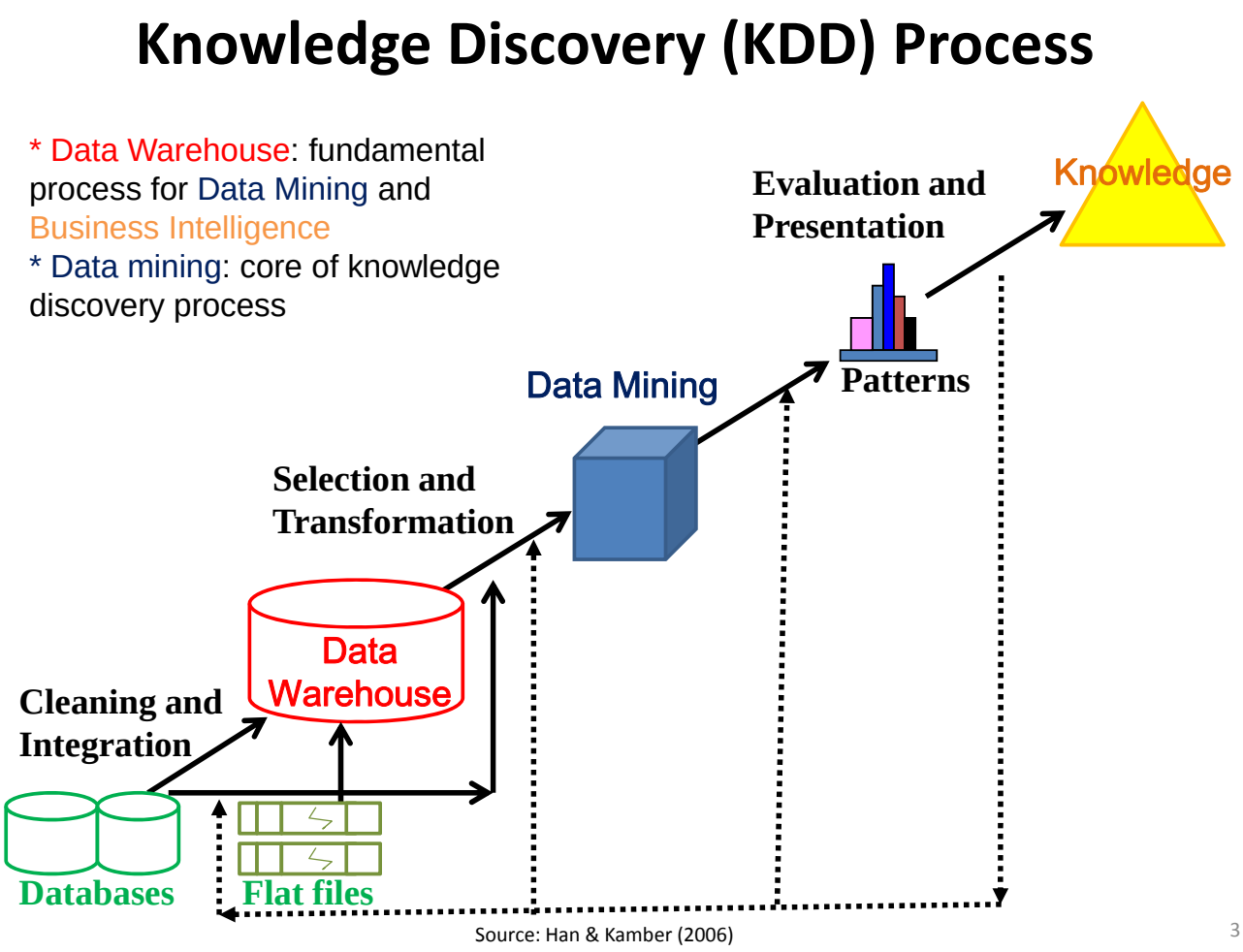
4. What is the knowledge discovery (KDD) process? (10%)

Ans:

Ref: 992DW02 p.3 (992DW01 p.5)



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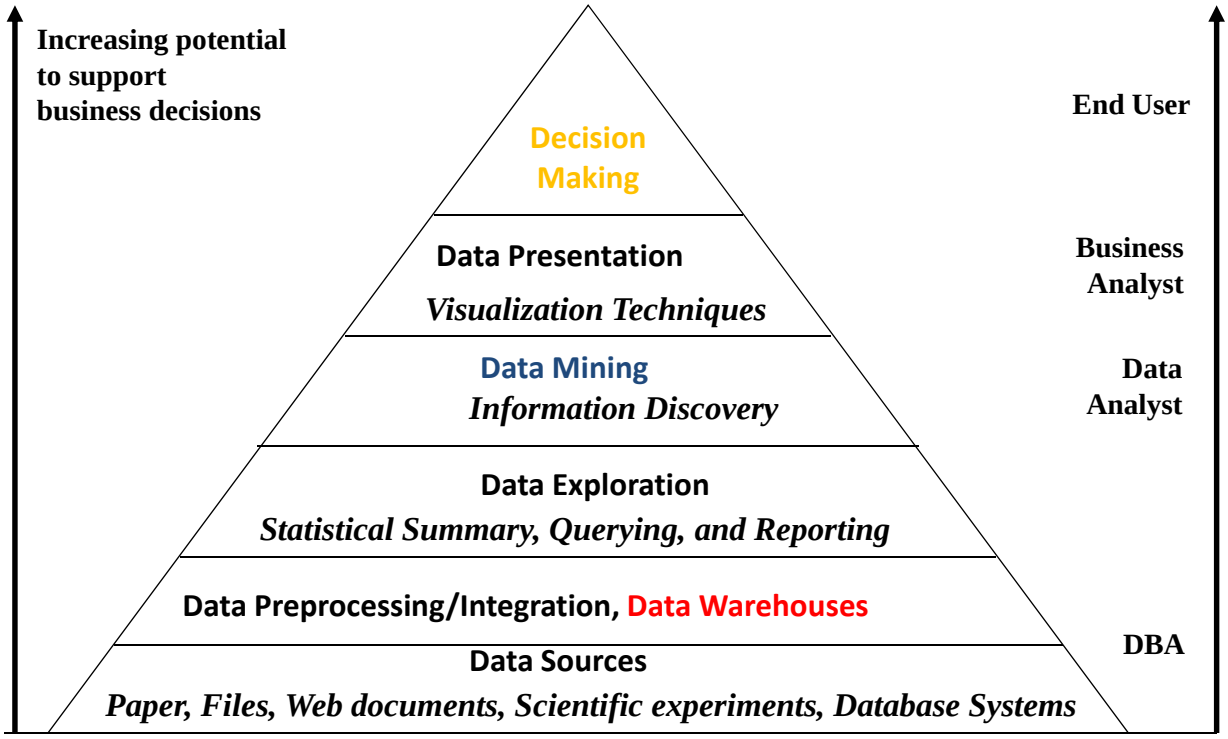
5. What are the relationships between Data Warehouse, Data Mining, and Business Intelligence? (10%)

Ans:

Ref: 992DW02 p.4 (992DW01 p.6)

Data Warehouse

Data Mining and Business Intelligence



Source: Han & Kamber (2006)

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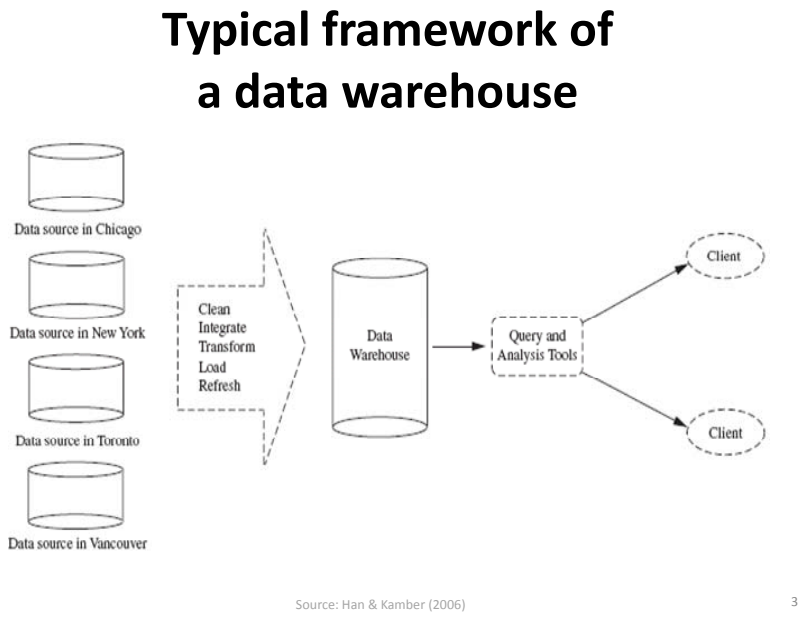
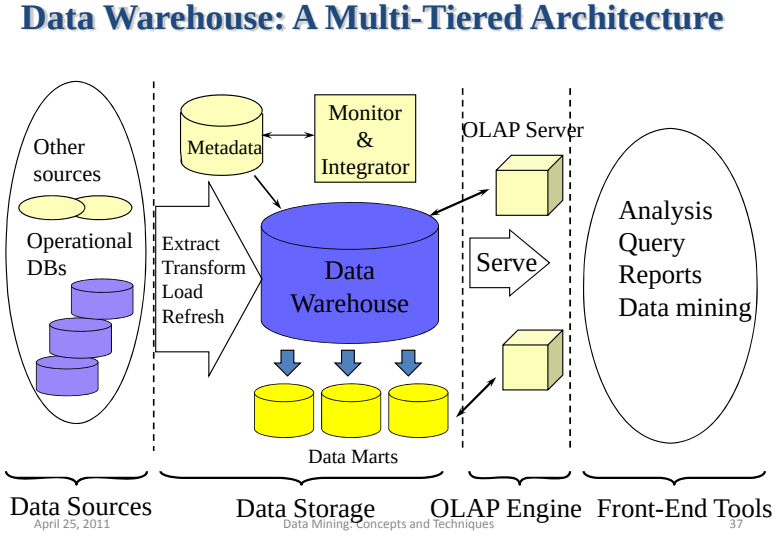
6. What is the typical framework of a data warehouse? What is the multi-tiered architecture of data warehouse? (10%)

Ans:

Ref: 992DW03 p.3; 992DW04 p.37





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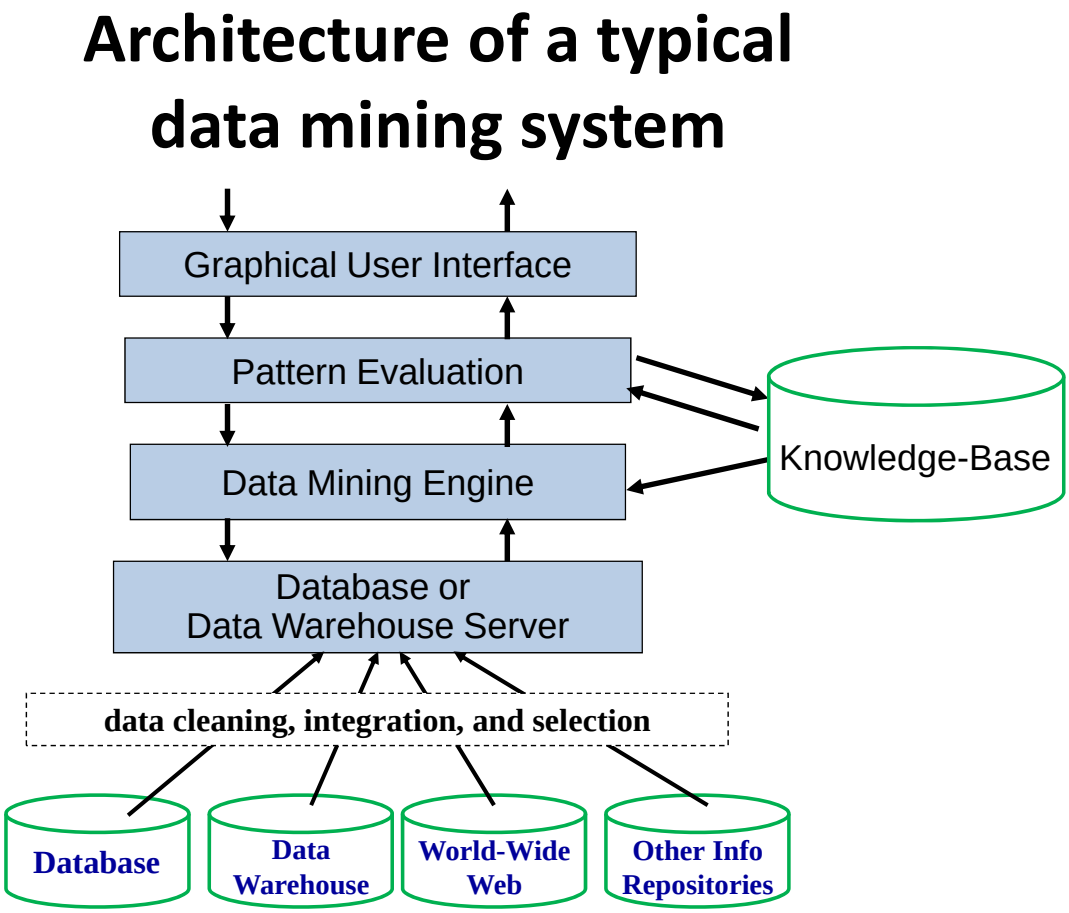
7. What is the architecture of a typical data mining system? (10%)

Ans:

Ref: 992DW03 p.6



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8. Why is data preprocessing important? What are the major tasks in data preprocessing? (10%)

Ans:

(1) Why is data preprocessing important?

- No quality data, no quality mining results!
  - Quality decisions must be based on quality data
    - e.g., duplicate or missing data may cause incorrect or even misleading statistics.
  - Data warehouse needs consistent integration of quality data
- Data extraction, cleaning, and transformation comprises the majority of the work of building a data warehouse

(2) What are the major tasks in data preprocessing?

- Data cleaning
  - Fill in missing values, smooth noisy data, identify or remove outliers, and resolve inconsistencies
- Data integration
  - Integration of multiple databases, data cubes, or files
- Data transformation
  - Normalization and aggregation
- Data reduction
  - Obtains reduced representation in volume but produces the same or similar analytical results
- Data discretization
  - Part of data reduction but with particular importance, especially for numerical data

Related (Optional):

Why Data Preprocessing?

- Data in the real world is dirty
  - incomplete: lacking attribute values, lacking certain attributes of interest, or containing only aggregate data
    - e.g., occupation=“ ”
  - noisy: containing errors or outliers
    - e.g., Salary=“-10”
  - inconsistent: containing discrepancies in codes or names
    - e.g., Age=“42” Birthday=“03/07/1997”
    - e.g., Was rating “1,2,3”, now rating “A, B, C”

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- e.g., discrepancy between duplicate records
- Why Is Data Dirty?
- Incomplete data may come from
  - "Not applicable" data value when collected
  - Different considerations between the time when the data was collected and when it is analyzed.
  - Human/hardware/software problems
- Noisy data (incorrect values) may come from
  - Faulty data collection instruments
  - Human or computer error at data entry
  - Errors in data transmission
- Inconsistent data may come from
  - Different data sources
  - Functional dependency violation (e.g., modify some linked data)
- Duplicate records also need data cleaning

Ref: 992DW03 p.14, p. 16, (p.12, p.13)

Why Is Data Preprocessing Important?

- No quality data, no quality mining results!
  - Quality decisions must be based on quality data
    - e.g., duplicate or missing data may cause incorrect or even misleading statistics.
  - Data warehouse needs consistent integration of quality data
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Source: Han & Kamber (2006) 14

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Major Tasks in Data Preprocessing

- Data cleaning
  - Fill in missing values, smooth noisy data, identify or remove outliers, and resolve inconsistencies
- Data integration
  - Integration of multiple databases, data cubes, or files
- Data transformation
  - Normalization and aggregation
- Data reduction
  - Obtains reduced representation in volume but produces the same or similar analytical results
- Data discretization
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Source: Han & Kamber (2006)

16

Why Data Preprocessing?

- Data in the real world is dirty
  - incomplete: lacking attribute values, lacking certain attributes of interest, or containing only aggregate data
    - e.g., occupation=“ ”
  - noisy: containing errors or outliers
    - e.g., Salary=“-10”
  - inconsistent: containing discrepancies in codes or names
    - e.g., Age=“42” Birthday=“03/07/1997”
    - e.g., Was rating “1,2,3”, now rating “A, B, C”
    - e.g., discrepancy between duplicate records

Source: Han & Kamber (2006)

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Why Is Data Dirty?

- Incomplete data may come from
  - “Not applicable” data value when collected
  - Different considerations between the time when the data was collected and when it is analyzed.
  - Human/hardware/software problems
- Noisy data (incorrect values) may come from
  - Faulty data collection instruments
  - Human or computer error at data entry
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  - Functional dependency violation (e.g., modify some linked data)
- Duplicate records also need data cleaning

Source: Han & Kamber (2006)

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9. What is the conceptual modeling of data warehouses? Please illustrate the major schemas used in data warehouse. (10%)

Ans:

- Modeling data warehouses: dimensions & measures
  - Star schema: A fact table in the middle connected to a set of dimension tables
  - Snowflake schema: A refinement of star schema where some dimensional hierarchy is normalized into a set of smaller dimension tables, forming a shape similar to snowflake
  - Fact constellations: Multiple fact tables share dimension tables, viewed as a collection of stars, therefore called galaxy schema or fact constellation

Ref: 992DW04 p.16, 17, 18, 19.

Conceptual Modeling of Data Warehouses

- Modeling data warehouses: dimensions & measures
  - Star schema: A fact table in the middle connected to a set of dimension tables
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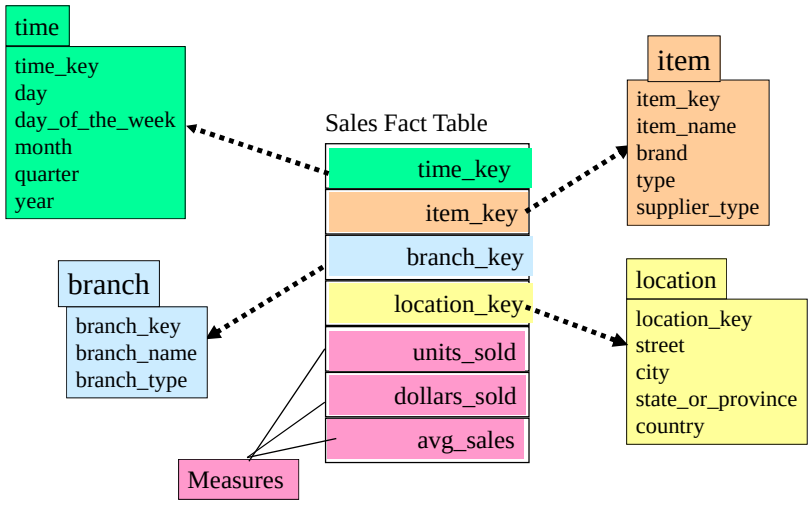
Example of Star Schema



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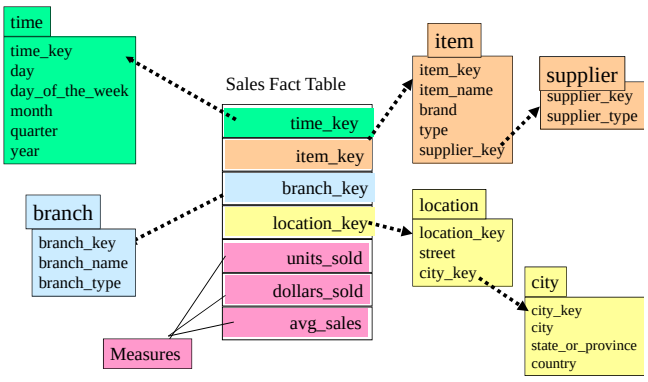
Example of Snowflake Schema



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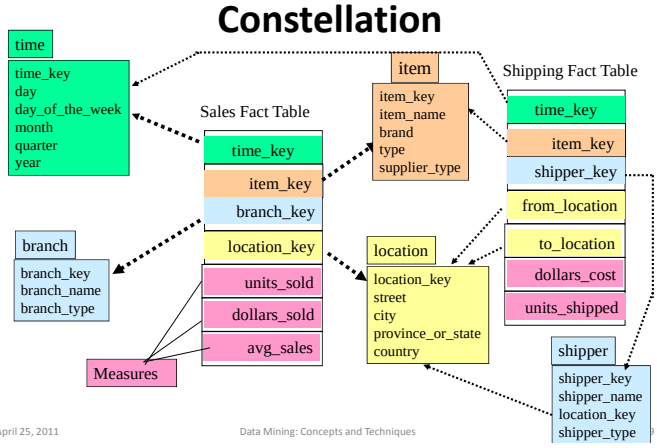
Example of Fact Constellation



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10. What are the typical OLAP operations in data warehouse? (10%)

Ans:

Ref: 992DW04 p.31, 32

Typical OLAP Operations

- Roll up (drill-up): summarize data
  - *by climbing up hierarchy or by dimension reduction*
- Drill down (roll down): reverse of roll-up
  - *from higher level summary to lower level summary or detailed data, or introducing new dimensions*
- Slice and dice: *project and select*
- Pivot (rotate):
  - *reorient the cube, visualization, 3D to series of 2D planes*
- Other operations
  - *drill across: involving (across) more than one fact table*
  - *drill through: through the bottom level of the cube to its back-end relational tables (using SQL)*

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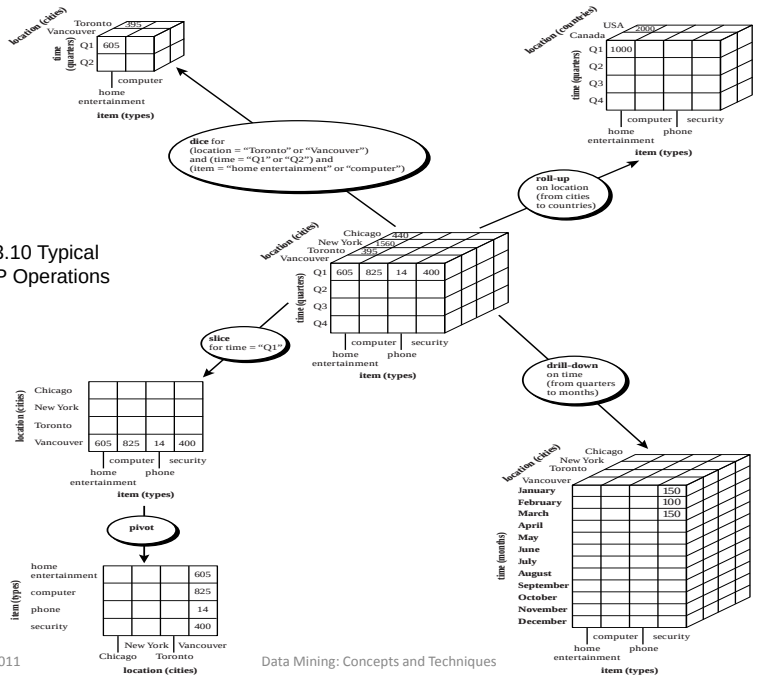

Fig. 3.10 Typical OLAP Operations

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