بنام خدا

پایگاه داده ۲

DATA WAREHOUSE

بصیری
دانشکده برق و کامپیوتر
دانشگاه صنعتی اصفهان

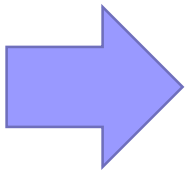
مراجع

- Han, Jiawei, Micheline Kamber, and Data Mining. "Concepts and techniques." *Morgan Kaufmann* 340 (2006): 94104-3205.
- Kimball, Raiph. *The data warehouse toolkit*. John Wiley & Sons, 2006.
- Inmon, William H. *Building the data warehouse*. John wiley & sons, 2005.

What’s a Data Warehouse?

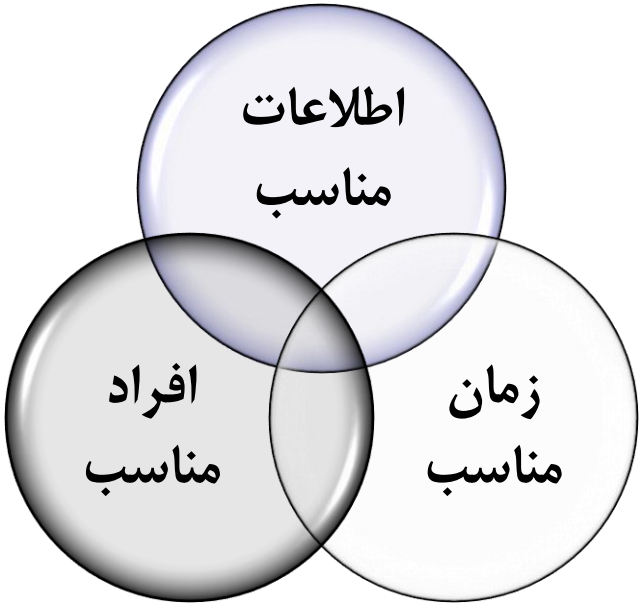
انـبـار داده یک منبع واحد از داده‌هـــاست که داده‌های منابع مختلف اطلاعاتی سازمان در آن جمع آوری، دسته‌بندی، خلاصه‌سازی و ذخیره شده تا تصمیم‌گیری را در سازمان تسهیل نماید.

- برای دسترسی آسان کاربران به حجم زیادی از داده‌ها طراحی شده است، و دسترسی به دیتا عموما به وسیله ابزارهای تحلیلی ویژه و اپلیکیشن‌ها پشتیبانی می‌شود.



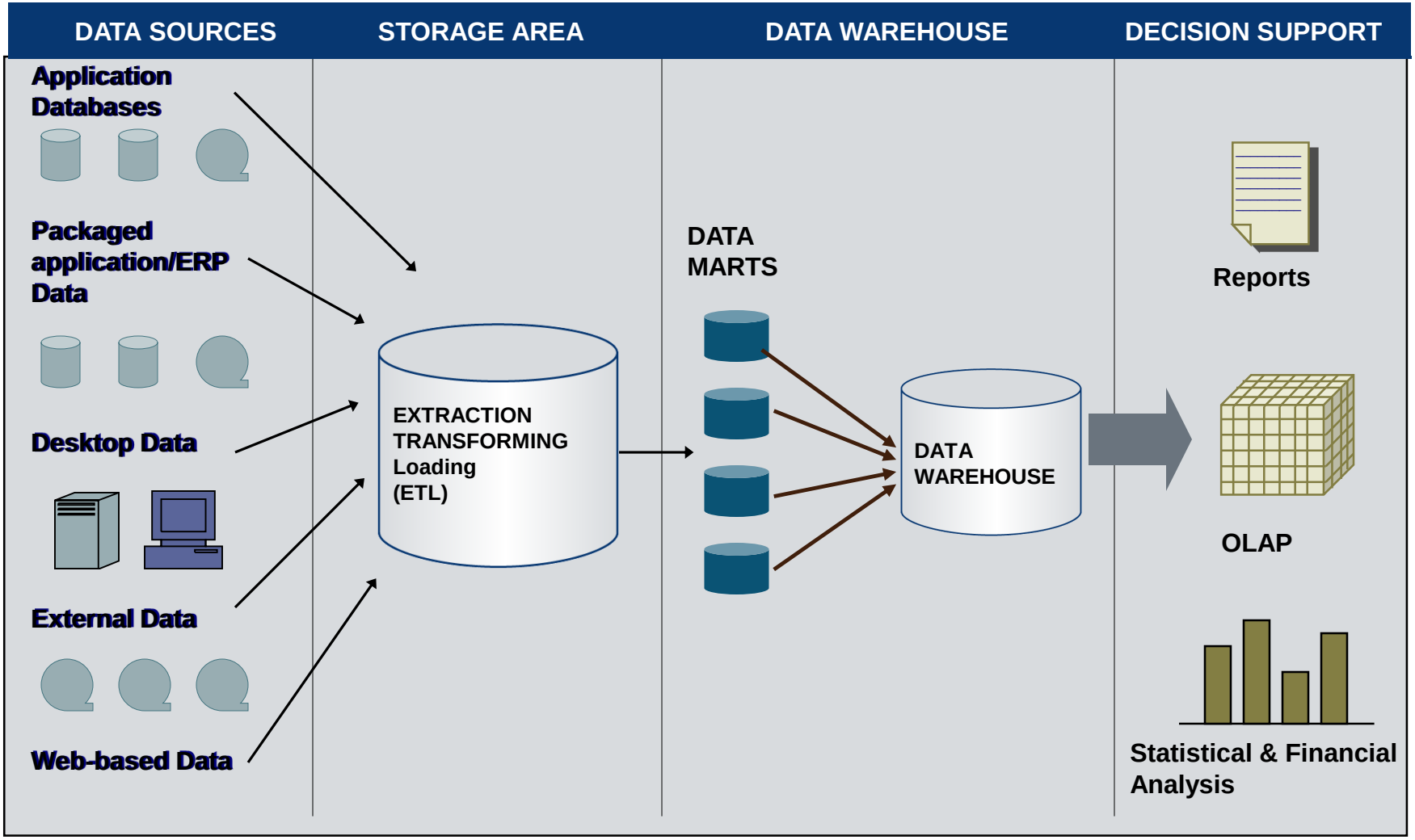
ابزارهای OLAP دسترسی به انبارداده را تسهیل نموده است.

هوش تجاری (Business Intelligence)



هوش تجاری یعنی دراختیار قراردادن **اطلاعات مناسب** به **افراد مناسب** در **زمان مناسب** برای اخذ **تصمیم مناسب**

BI Architecture



تمرین ۱

Productid	Trdate	Branch	Invoice_num	Unit_sold

ابزارهای هوش تجاری

- BizzScore Suite
- Board Management IntelligenceToolkit
- Business Objects Enterprise
- IBM Cognos
- JasperSoft
- Microsoft BI tools
- Microstrategy

- Oracle
- WebFocus
- Tableau Software
- Style Intelligence
- SAS
- SAP
- QlikView
- Pentaho BI Suite
- Actuate
- .....

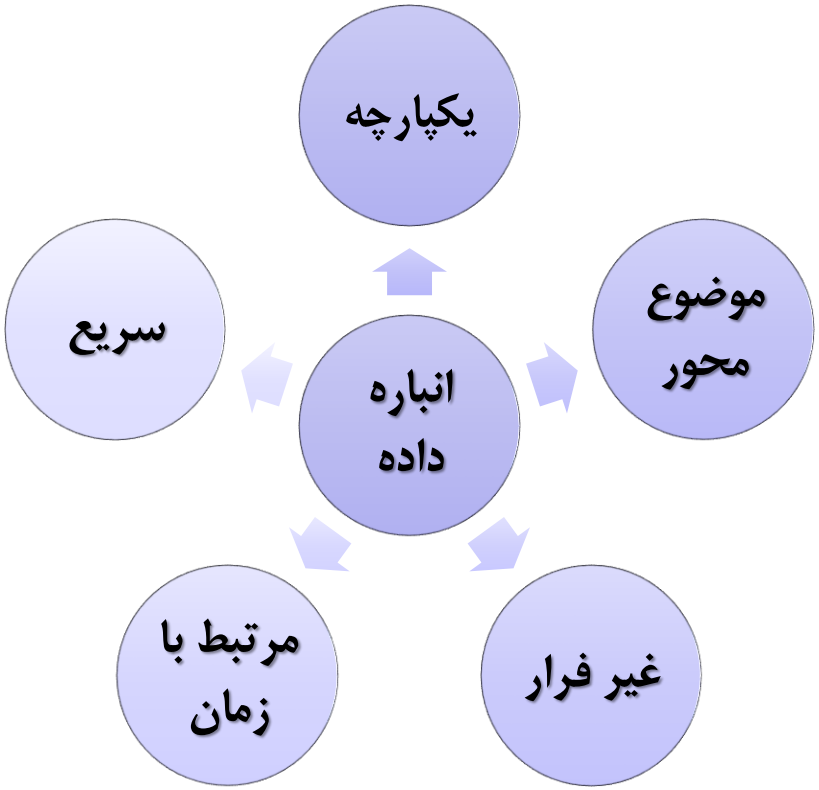
چرا به انبار داده و هوش تجاری نیاز داریم؟

- نیاز به یک چارچوب تصمیم‌گیری برای تسریع در اتخاذ تصمیمات موثر
- **دسترسی سریع به تمام اطلاعات موجود**
- **امکان ساخت هر گونه گزارش به صورت دینامیک**
- **امکان تحلیل اطلاعات به صورت Historical(مبتنی بر زمان) از کل به جزء(Drill Down) با استفاده از تجمیع ها(Aggregation)**
- **امکان انجام تحلیلهای آماری و مبتنی بر داده کاوی**
- **ایجاد مرجع واحد آمار و گزارشات**
- **امکان برنامه نویسی و تولید نرم افزارهای خاص منظوره**

Data Warehouse Characteristics

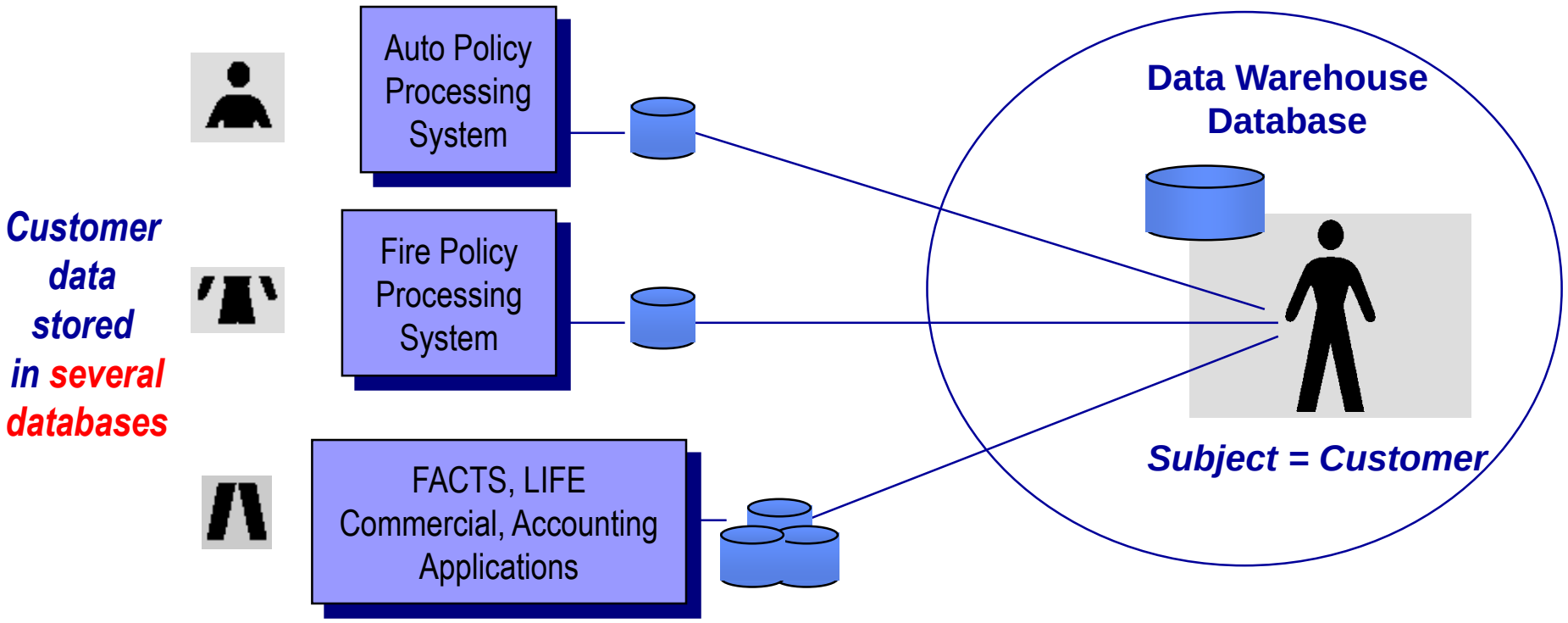
- Key Characteristics of a Data Warehouse

- Integrated
- Time-variant
- Non-volatile
- Subject-Oriented
- Fast



Integrated(یکپارچه)

- **Data is stored once in a single integrated location (e.g. insurance company)**

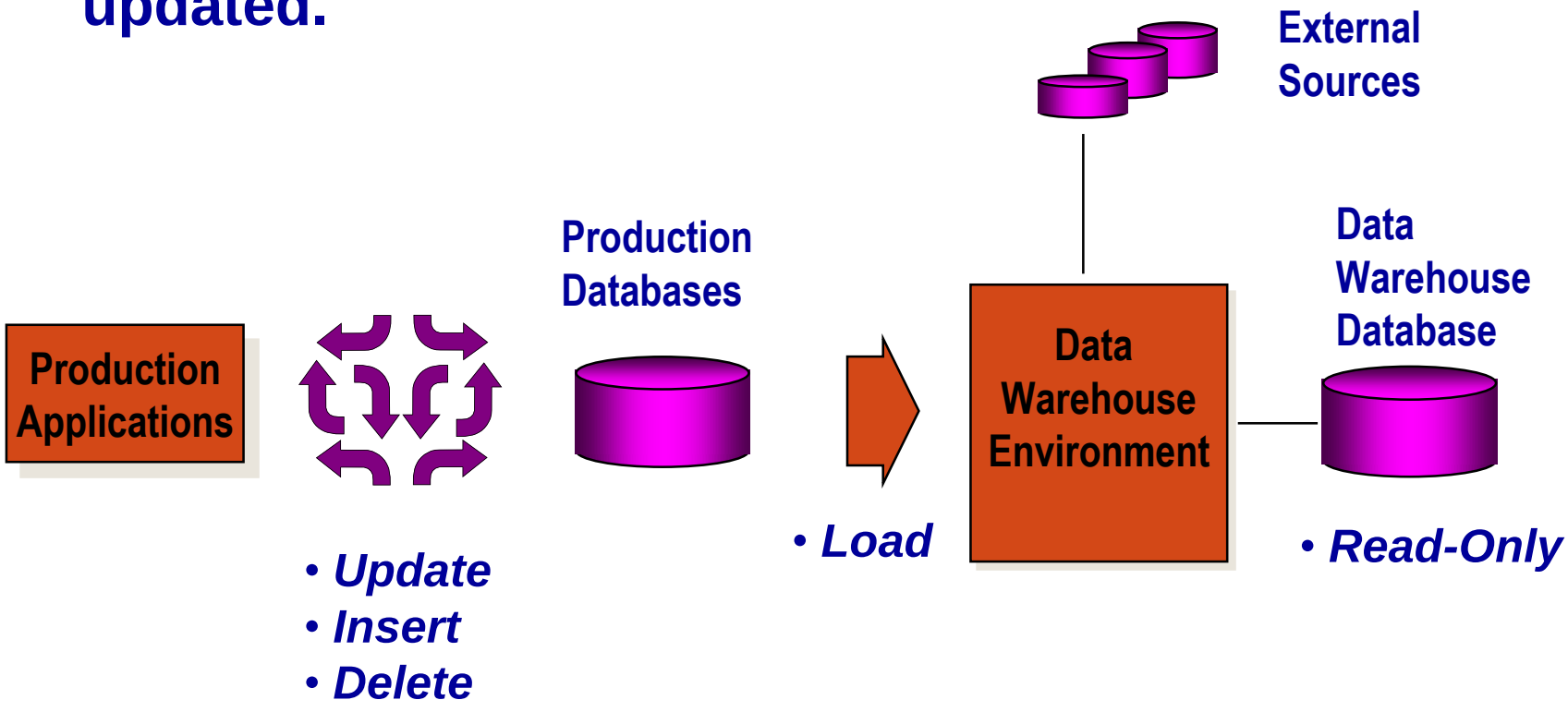


Data Warehouse—Time Variant(مرتبط با زمان)

- 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”

Non-Volatile (غير فرار)

- **Existing data in the warehouse is not overwritten or updated.**



Data Warehouse—Subject-Oriented(موضوع محور)

- 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

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

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	GB to high-order GB	>=TB
metric	transaction throughput	query throughput, response

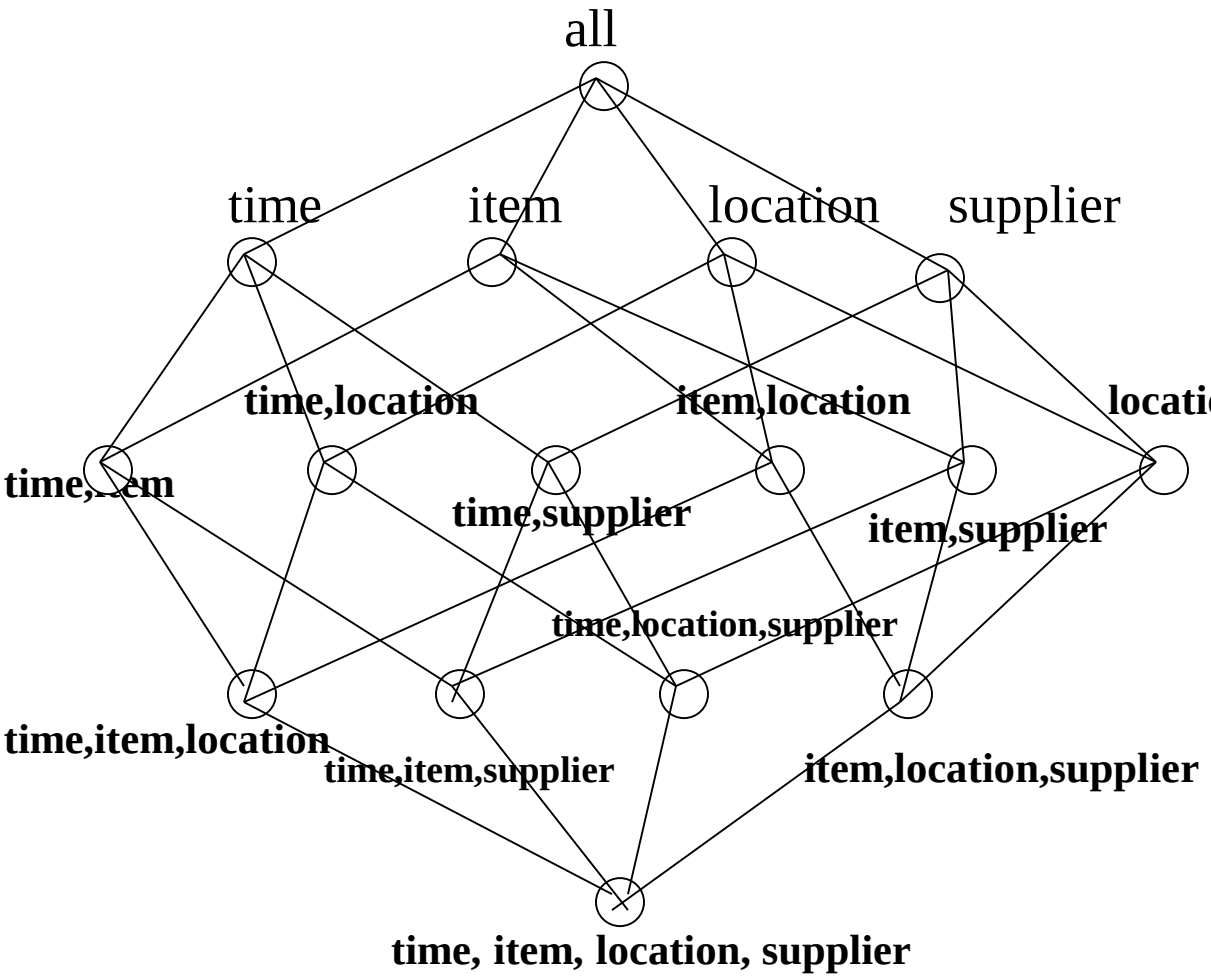
Why Separate Data Warehouse?

- High performance for both systems
  - DBMS— tuned for OLTP: access methods, indexing, concurrency control, recovery
  - Warehouse—tuned for OLAP: complex OLAP queries, multidimensional view, consolidation
- Different functions and different data:
  - missing data: Decision support requires historical data which operational DBs do not typically maintain
  - data consolidation: DS requires consolidation (aggregation, summarization) of data from heterogeneous sources
  - data quality: different sources typically use inconsistent data representations, codes and formats which have to be reconciled
- Note: There are more and more systems which perform OLAP analysis directly on relational databases

From Tables and Spreadsheets to Data Cubes

- A data warehouse is based on a multidimensional data model which views data in the form of a data cube
- A data cube, such as sales, allows data to be modeled and viewed in multiple dimensions
  - Dimension tables, such as item (item_name, brand, type), or time(day, week, month, quarter, year)
  - Fact table contains measures (such as dollars_sold) and keys to each of the related dimension tables
- In data warehousing literature, an n-D base cube is called a base cuboid. The top most 0-D cuboid, which holds the highest-level of summarization, is called the apex cuboid. The lattice of cuboids forms a data cube.

Cube: A Lattice of Cuboids



0-D(apex) cuboid

1-D cuboids

2-D cuboids

3-D cuboids

4-D(base) cuboid

Conceptual Modeling of Data Warehouses

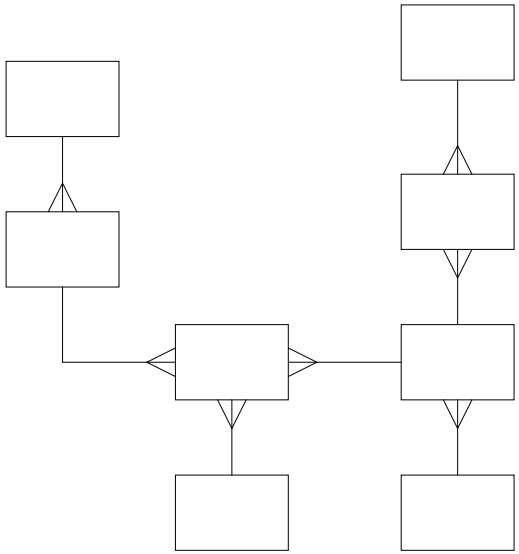
- Modeling data warehouses: dimensions & measures
  - Star schema: A fact table in the middle connected to a set of dimension tables
  - Snowflake schema: A refinement of star schema where some dimensional hierarchy is normalized into a set of smaller dimension tables, forming a shape similar to snowflake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

Dimensional Modeling

- Dimensional modeling = data warehouse modeling technique
- 2 types of tables: facts and dimensions.
- A fact table contains one or more measures (usually numerical) of a subject that is being modeled for analysis.
- Dimension tables contain various descriptive attributes (usually textual) that are related to the subject depicted by the fact table.
- The intent of the dimensional model is to represent relevant questions whose answers enable appropriate decision making in a specific business area

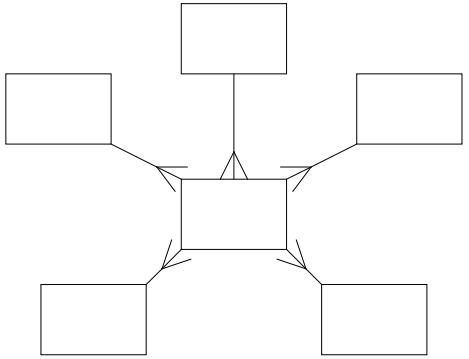
مدل ذخیره داده

Operational System



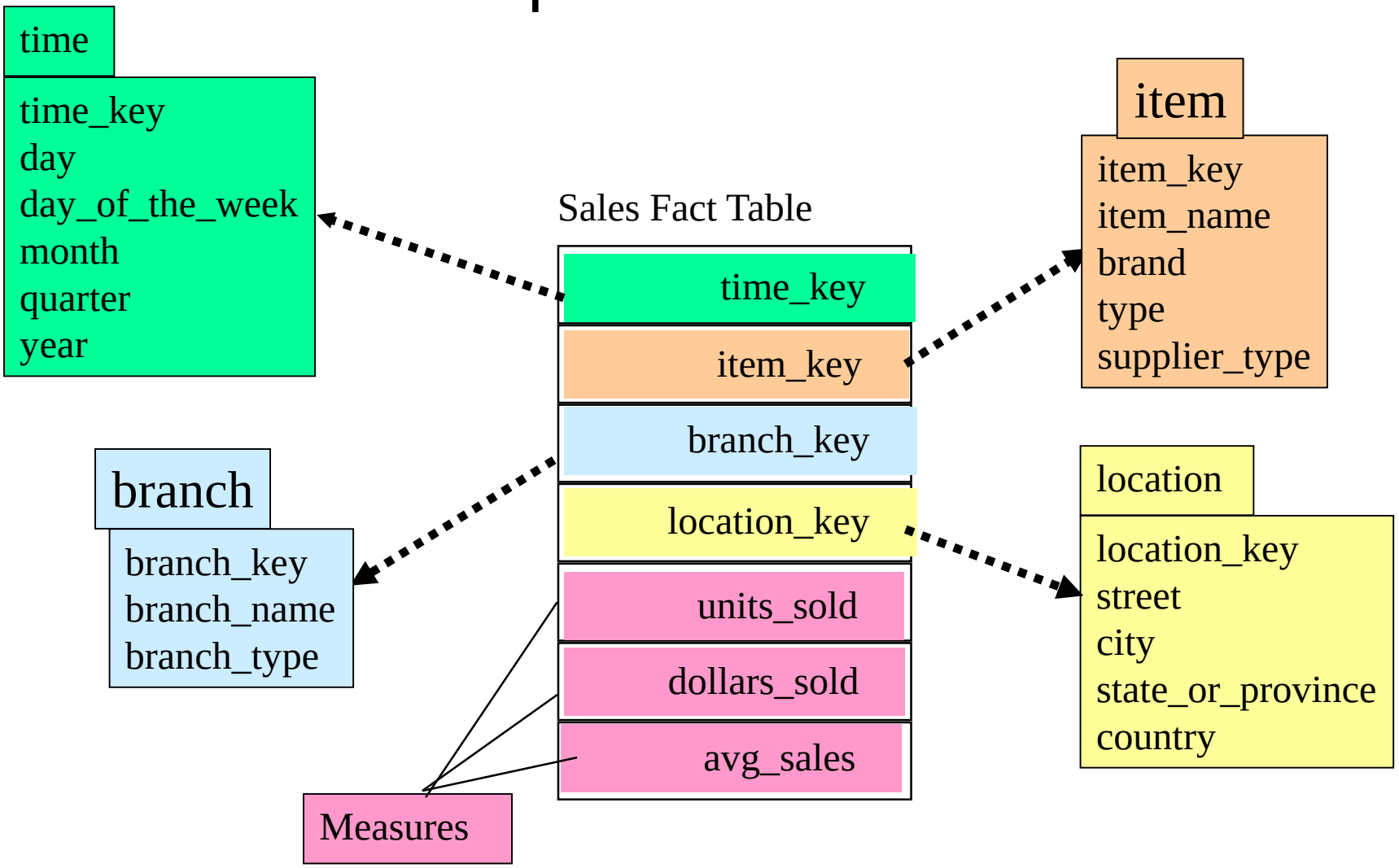
ER Diagram

Data Warehouse

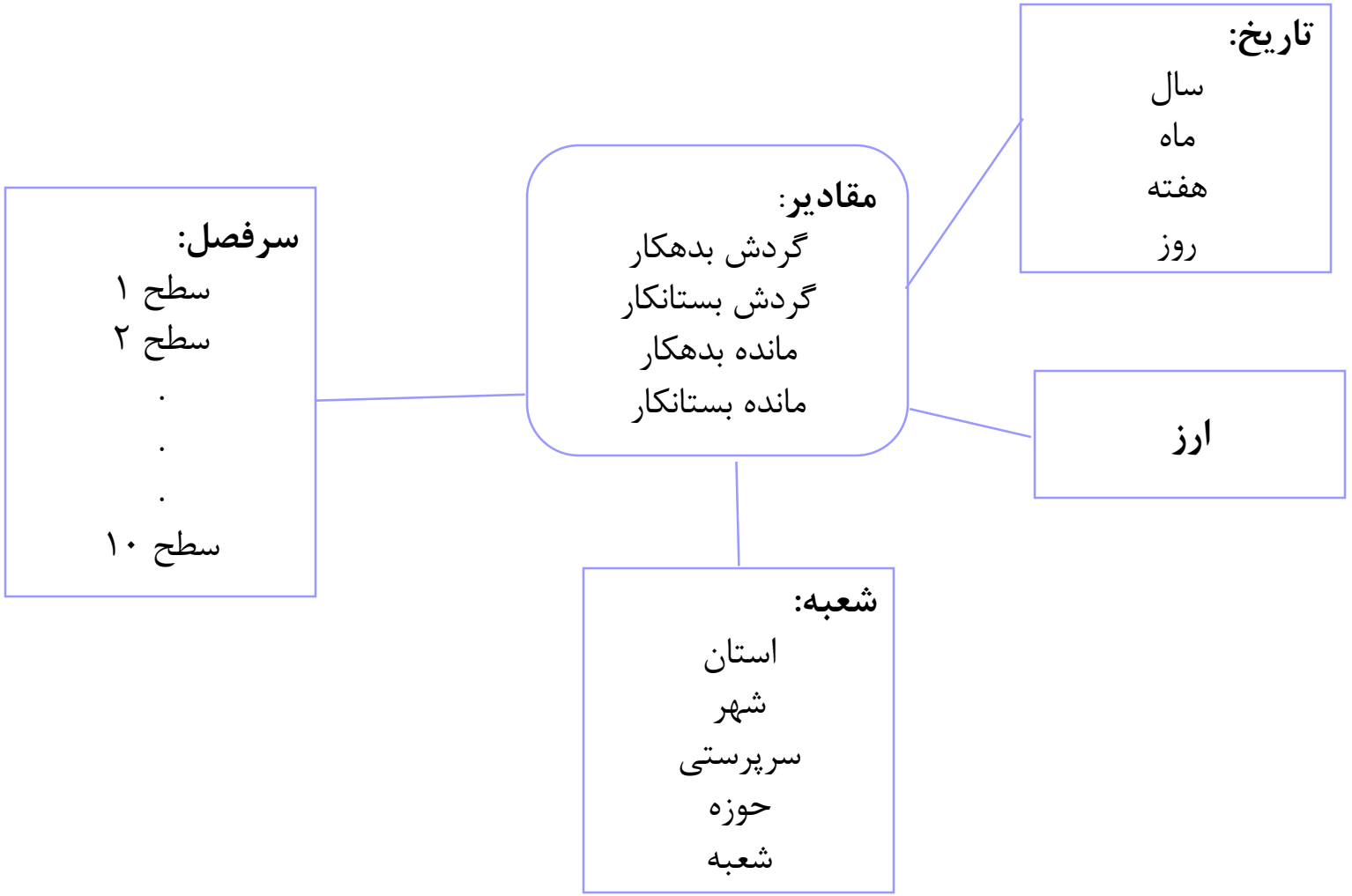


Star Schema

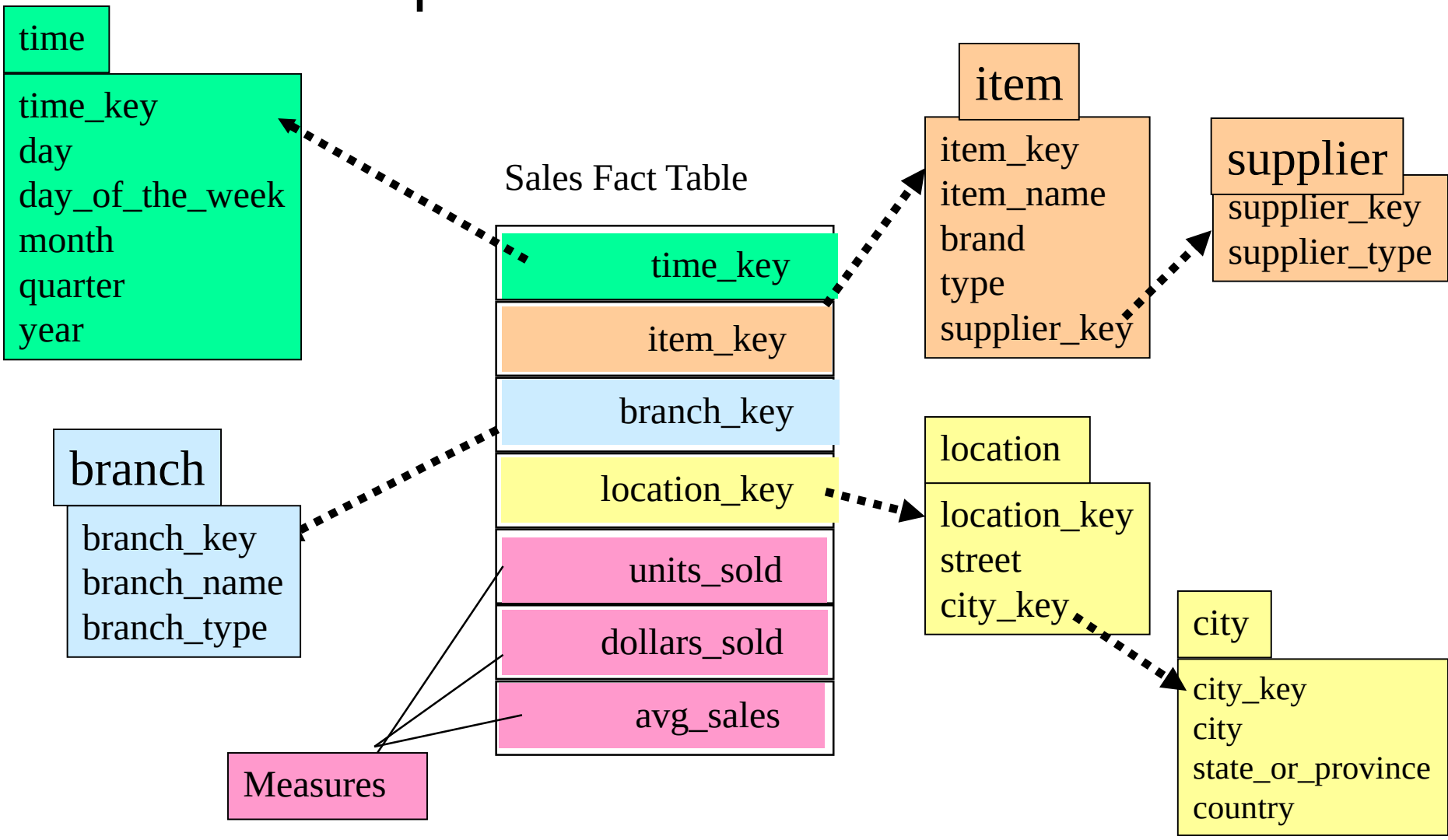
Example of Star Schema



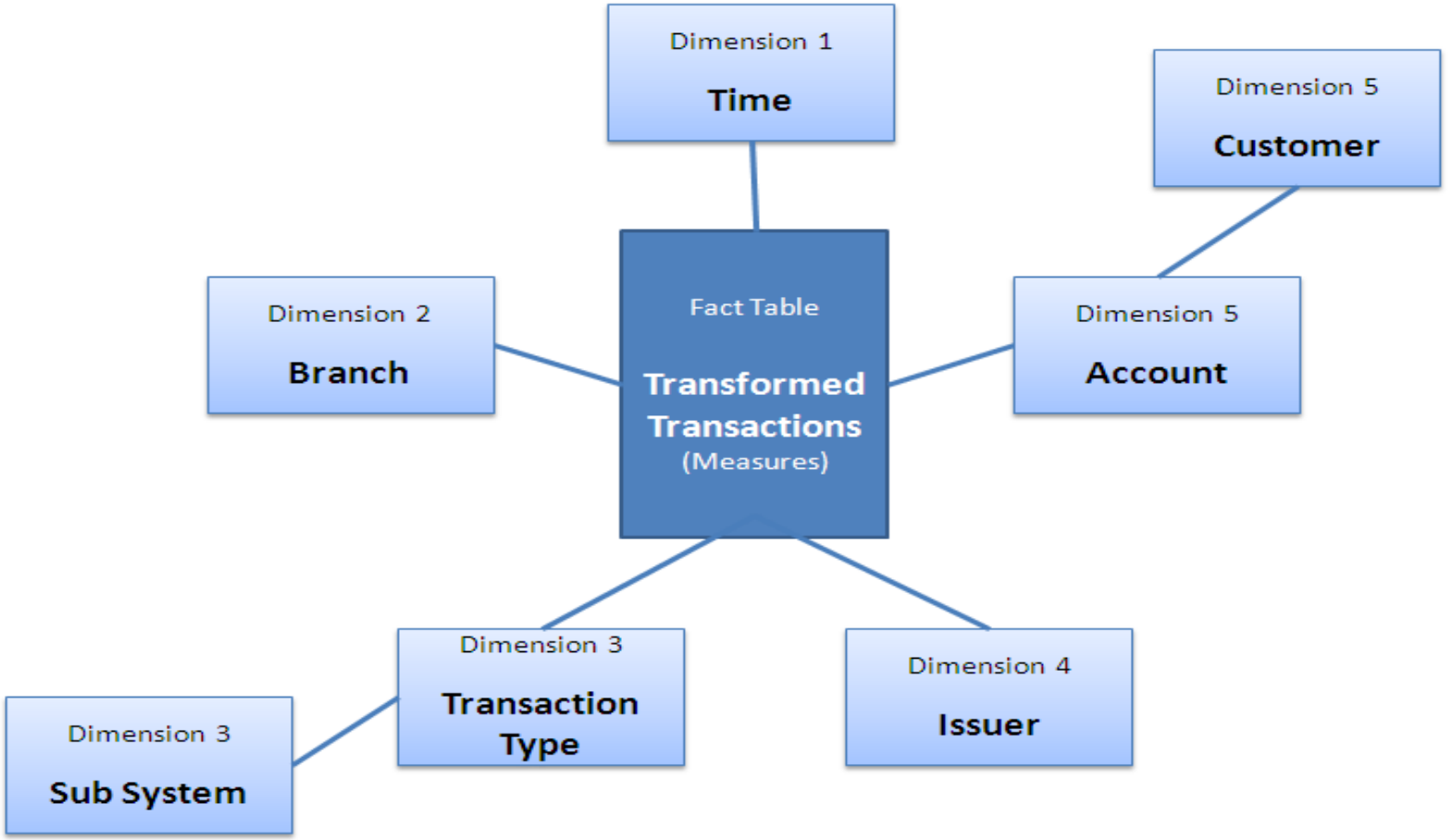
مثال مدل STAR



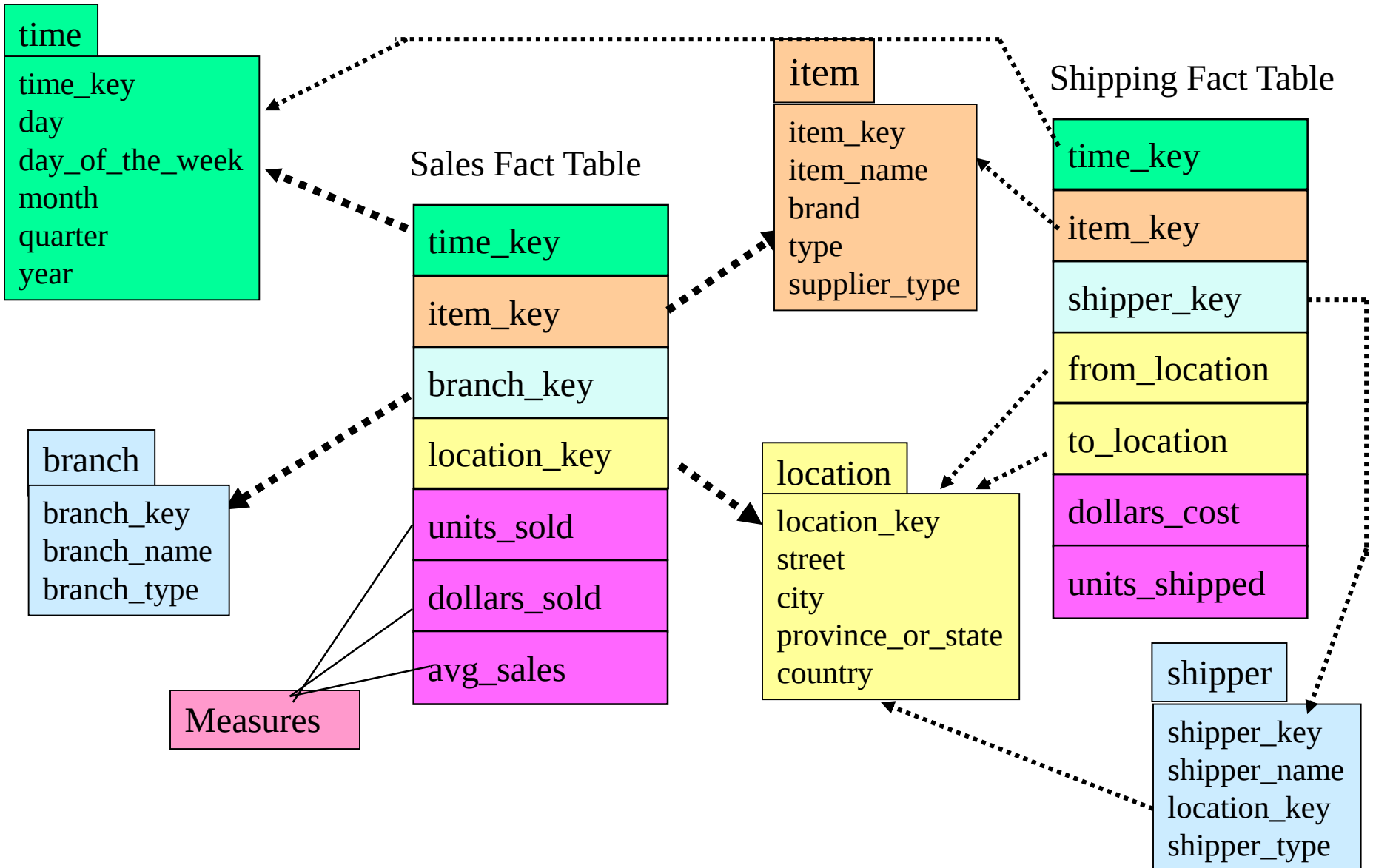
Example of Snowflake Schema



Snowflake Schema مثال



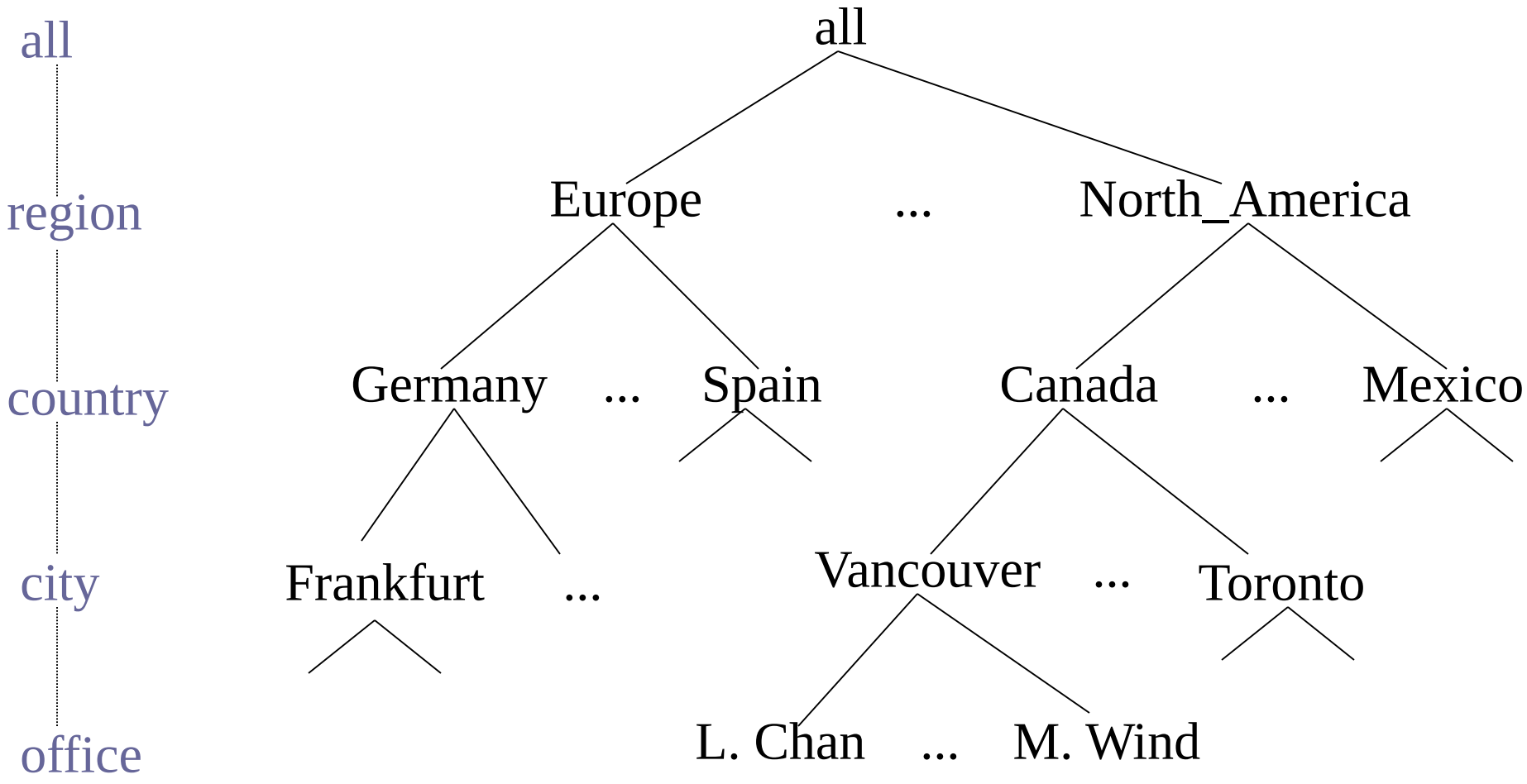
Example of Fact Constellation



Measures of Data Cube: Three Categories

- Distributive: if the result derived by applying the function to *n* aggregate values is the same as that derived by applying the function on all the data without partitioning
  - E.g., count(), sum(), min(), max()
- Algebraic: if it can be computed by an algebraic function with *M* arguments (where *M* is a bounded integer), each of which is obtained by applying a distributive aggregate function
  - E.g., avg(), min_N(), standard_deviation()
- Holistic: if there is no constant bound on the storage size needed to describe a subaggregate.
  - E.g., median(), mode(), rank()

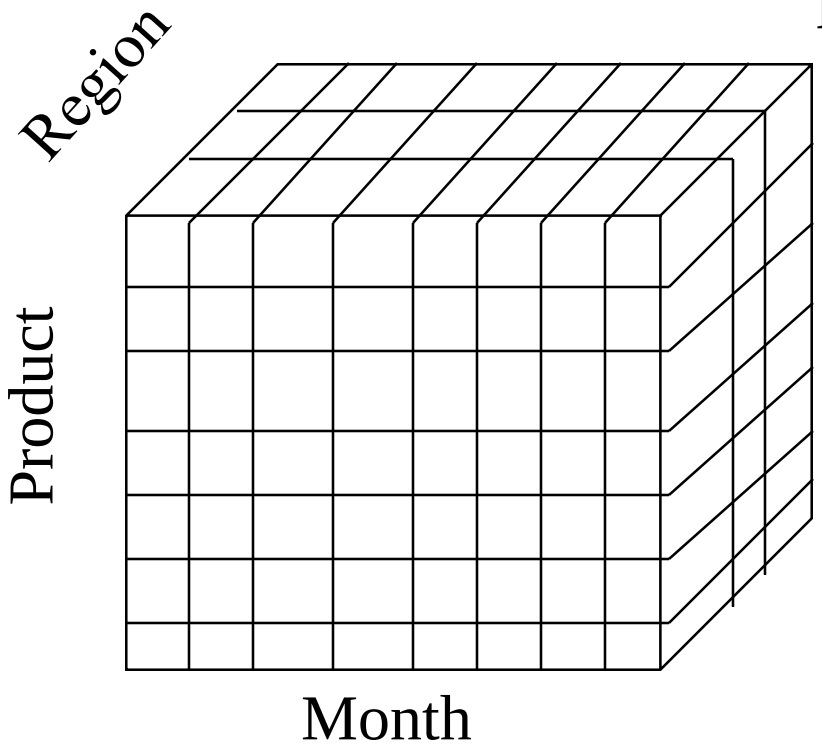
A Concept Hierarchy: Dimension (location)

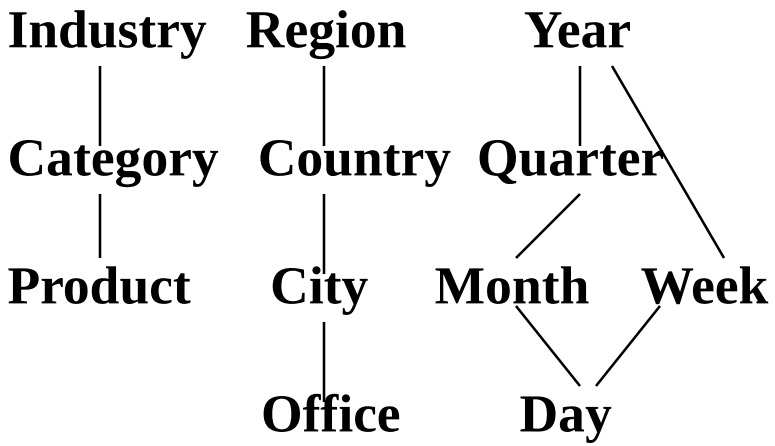


Multidimensional Data

- Sales volume as a function of product, month, and region

Dimensions: Product, Location, Time
Hierarchical summarization paths





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

Typical OLAP Operations