Chapter -4

Decision support and Intelligent systems

Information System *(CT 751)* **BCT IV/II**

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Outline

- **Decision support and Intelligent systems**
  - DSS, operations research models
  - Group decision support systems
  - Enterprise and executive decision support systems
  - Knowledge Management, Knowledge based Expert system
  - Al Neural Networks, virtual reality, Intelligent Agents
  - Data mining, Data ware housing, OLAP, OLTP

Decision Making

- Decision making is the process of making a choice between a number of alternatives and committing to a future course of actions.
- Decision making process consists of several different activities that take place at different times.
- The decision maker has to identify and understand problems.
- Once perceived, solutions must be designed; once solutions are designed, choices have to be made about a particular solution; finally, the solution has to be carried out and implemented.
- Four different stages in decision making are
  - Intelligence
  - Design
  - Choice
  - Implement

Stages of Decision Making

- Stage 1: Intelligence
  - identify the problems/opportunities and then, collect data or information
- Stage 2: Design
  - analyze/develop the possible solutions for the feasibility
  - GO back to stage 1 if there is insufficient data.
- Stage 3: Choice
  - Choose one alternative
  - Go back to stage 1 or 2 if there are no satisfactory solutions.
- Stage 4: Implementation
  - Implement the selected alternative
  - Failure of implementation → go back to stage 1 or 2 or 3

E.g. Buying a new car

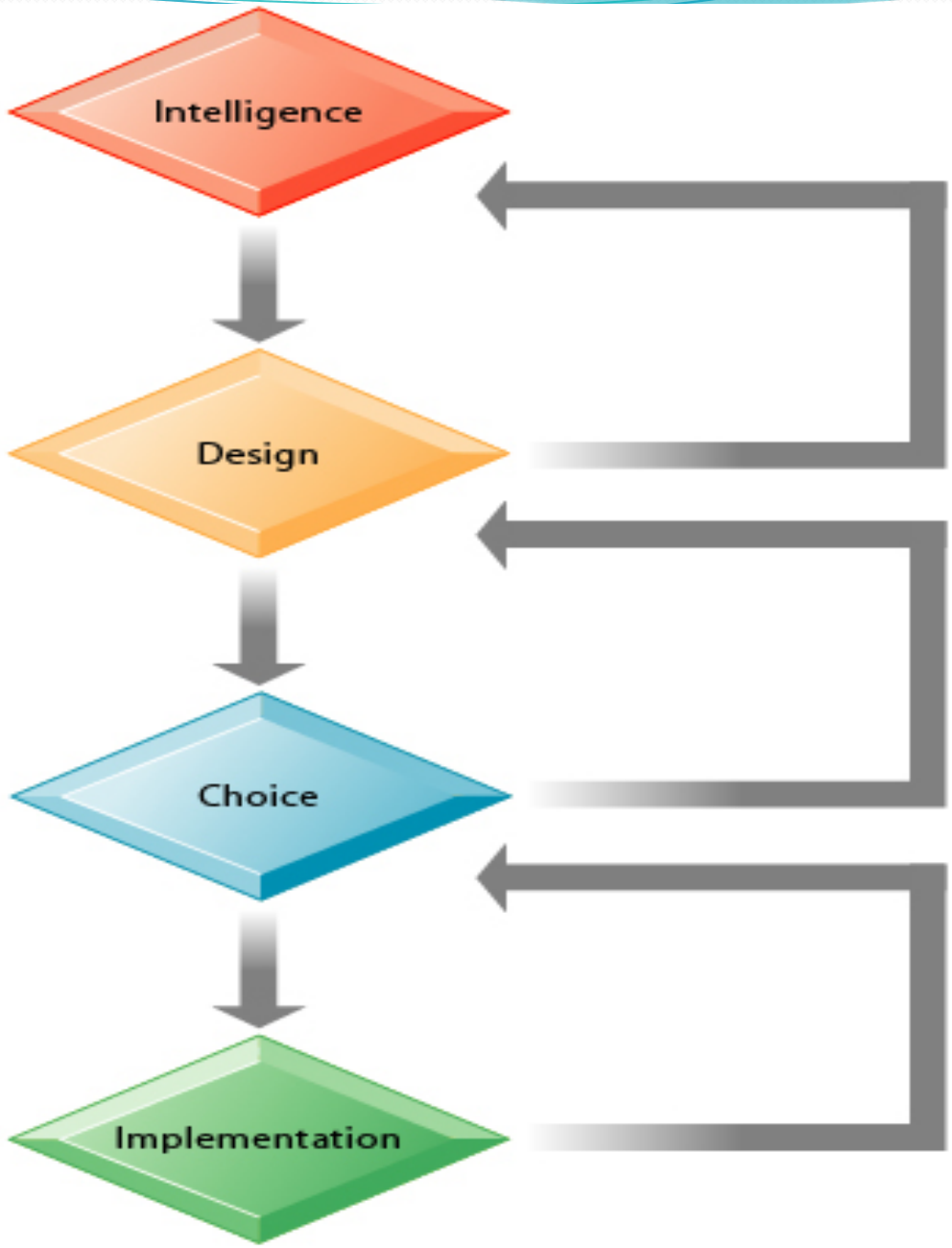
Decision Making Stages

Problem discovery:
What is the problem?

Solution discovery:
What are the possible solutions?

Choosing solutions:
What is the best solution?

Solution testing:
Is the solution working?
Can we make it work better?



Decision Support System

- The decision support system basically helps the information system in the intelligence phase to identify the problem and then go to the design phase for solution.
- The choice of selection criteria varies from problem to problem.
- *It is required to go through these phase again and again till the satisfactory solution is found.*

Decision Support System

- A **decision support system** is an interactive computer-based system that helps decision makers in the solution of semi-structured and unstructured problems.
- Offer potential to assist in solving both semi-structured and unstructured problems .
- A properly designed DSS is an interactive software-based system planned to help decision makers and to identify and solve problems and make decisions.

Continued

- DSS serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance.
- DSS are used to collect data, analyze and shape the data that is collected, and make sound decisions or construct strategies from analysis whether computers, databases, or people are involved generally it does not matter.
- The nature of the decision is such that the decision makers need a variety of information.
- The reason for changing the demands is also because the methods of decision making a change from time to time.

DSS Types of Decisions

- Structured / Programmed Decisions :
  - Schedule decisions
  - Organization develops specific process for handling
  - Rules of decision making system are predetermined
  - Routine & repetitive, predictable problems
  - Standard solutions exist

DSS Types of Decisions

- Unstructured / Non-programmed Decisions :
  - Rules of decision making system are not fixed or predetermined
  - It requires every time the user has to go through the decision-making cycle.
  - Decision support systems can be built in case of programmable decision situation.
  - Non-routine, unpredictable, “fuzzy” complex problems
  - No cut-and-dried solutions

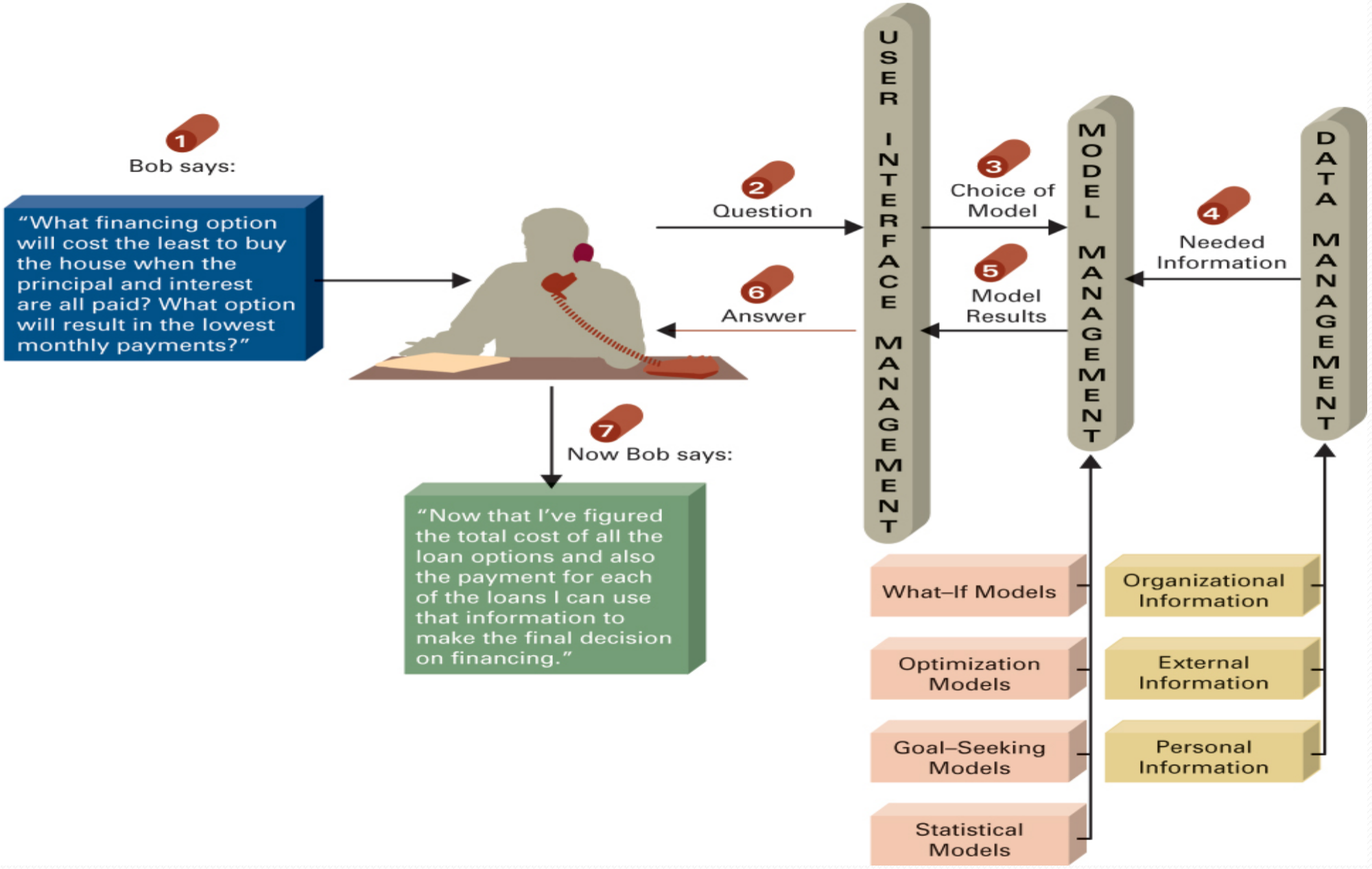
DSS Types of Decisions

- Semi structured Decisions:
  - Some decision procedures can be specified in advance, but not enough to lead to a definite recommended decision.
  - non-routine, predictable,
  - Require a combination of standard solution procedures and individual judgment

Three Fundamental Components of a DSS

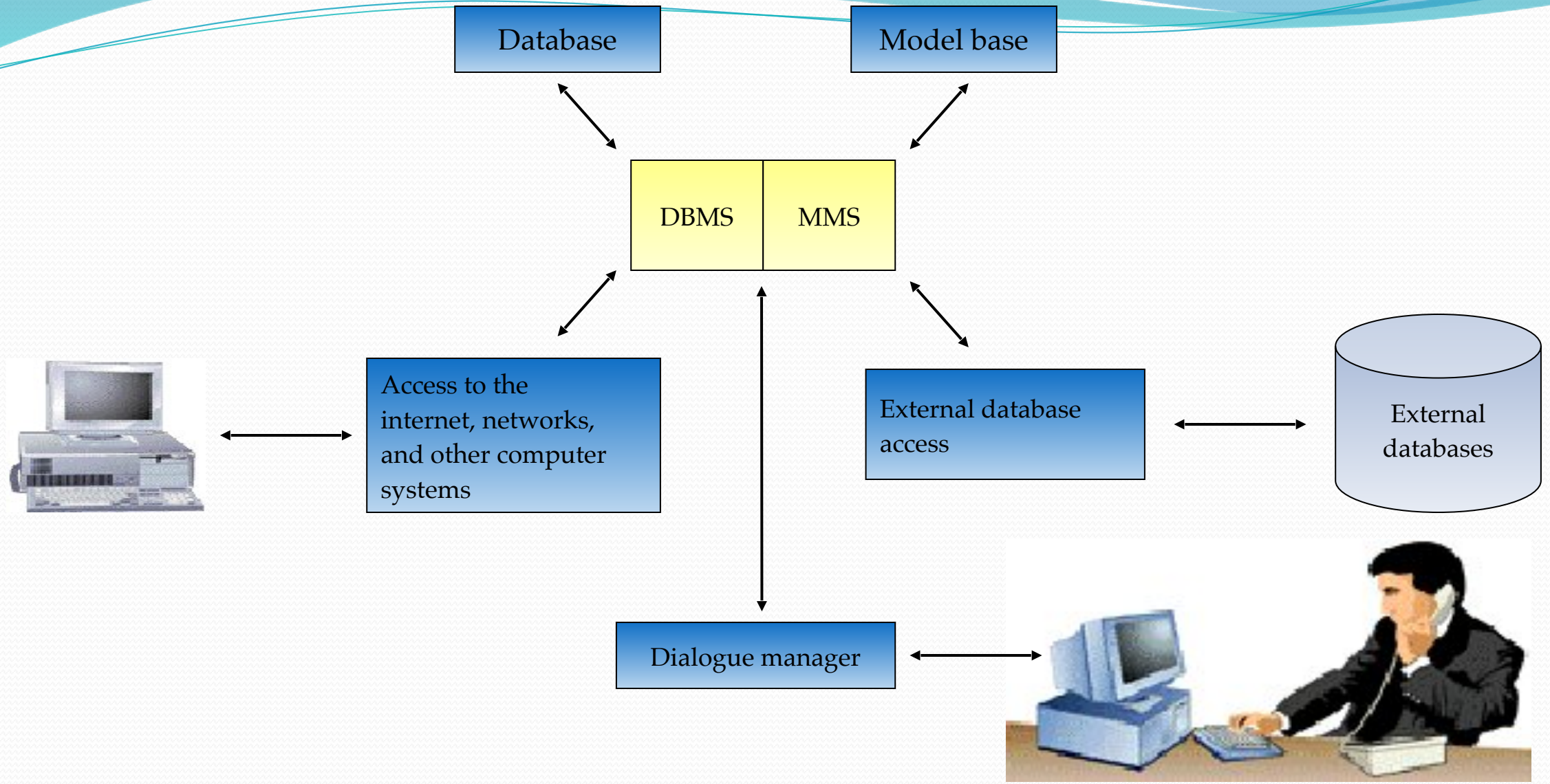
- **Model management component** – consists of both the DSS models and the model management system
- **Data management component** – stores and maintains the information that you want your DSS to use
- **User interface management component** – allows you to communicate with the DSS

Three Fundamental Components



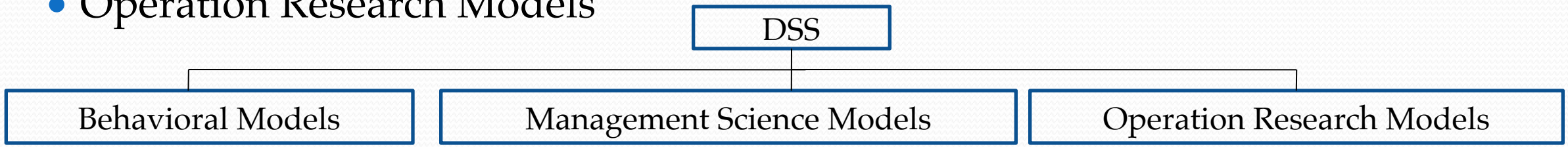
Model Base

- Model Base
  - Provides decision makers with access to a variety of models and assists them in decision making
- Models
  - Financial models
  - Statistical analysis models
  - Graphical models
  - Project management models


Database
Model base
DBMS
MMS
Access to the internet, networks, and other computer systems
External database access
External databases
Dialogue manager

Decision Support System Models

- Types of Decision Support System Models :
  - Behavioral Models
  - Management Science Models
  - Operation Research Models



Behavioral Models

- The decision maker can make the decisions for such behavioral relationships.
- For e.g.: The trend (development) analysis, forecasting and statistical analysis models.
- The trend analysis indicates how different variables behave in trend setting in the past and hence in future.
- In Market Research method, they can forecast or judge the behavior of the customers buying decisions. (i.e. The questionnaire are designed and computerized to evaluate customer's buying behavioral).

Management Science Models

- Management Science Models :
  - These models are developed on the principles of the business management, accounting and economics.

    For eg: the budgetary systems, cost accounting system, inventory management system.
  - In the budgetary system, budgets are used for planning and control.
  - In all the organization, budgets are prepared with the use of graphical representation in the form of line charts or bar charts.
  - For eg : Sales Budget, Production Budget etc.

Operation Research Models

- **Operation Research Models :**
  - The Operation Research models are the mathematical models in providing guidelines to managers for making effective decisions within the state of the current information, or in seeking further information if current knowledge is insufficient to reach a proper decision.

  Some applications

  - Telecommunications / Road / Rail Network Design
  - Organization Supply Chain Strategy
  - Just-in-Time Manufacturing Planning
  - Retail Shop floor Layout
  - Revenue, Pricing and Promotions
  - Demand Forecasting
  - Project Planning

  For eg : Linear Programming is mathematical modeling technique useful for guiding quantitative decisions in business planning, industrial engineering, and—to a lesser extent in the social and physical sciences.

Benefits of Decision Support System

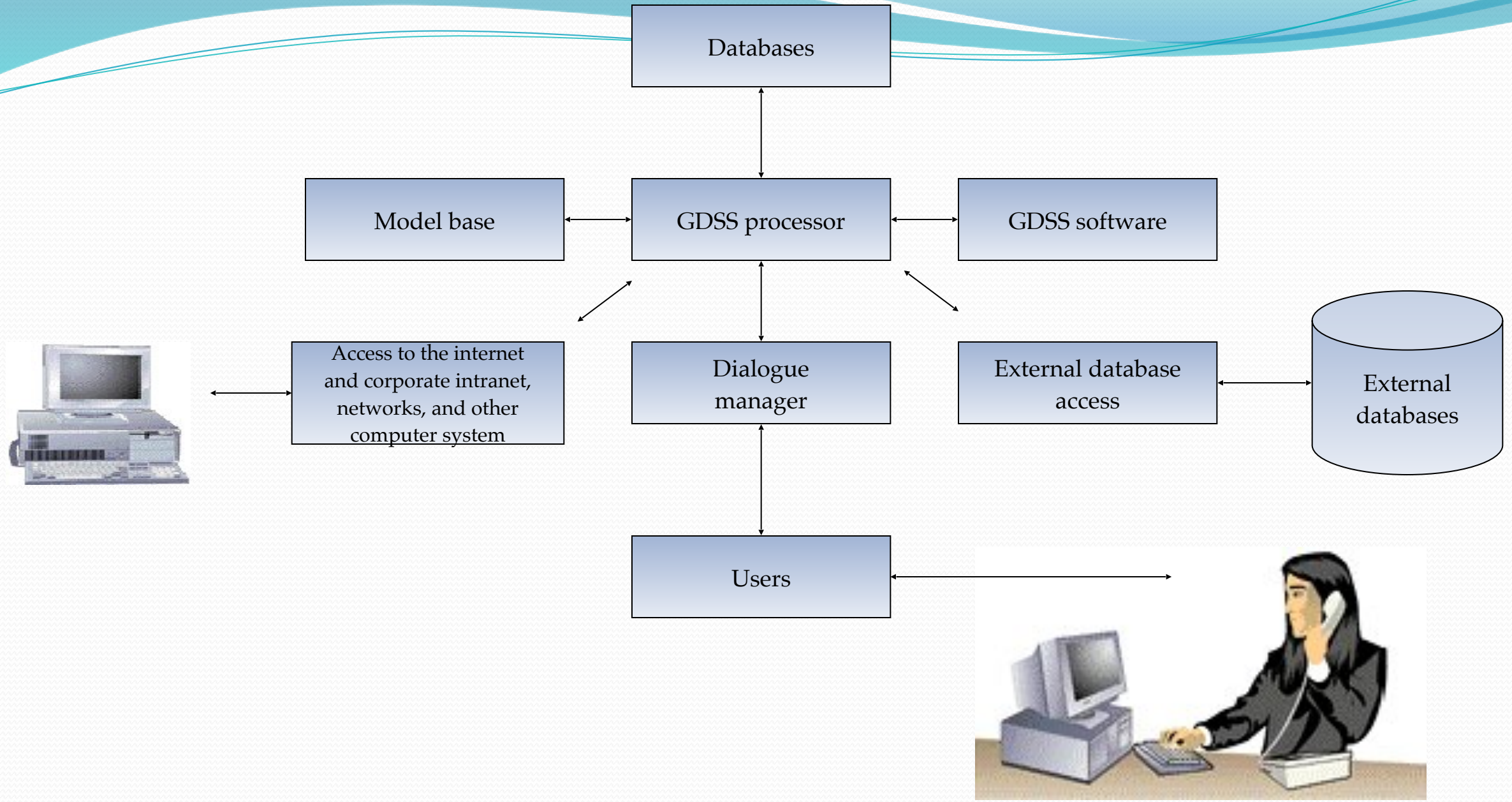
1) Improves the efficiency of decision-making
2) Supports the decision-making process
3) Provides support for various administrative levels
4) Ability to understand and evaluate the business performance
5) Increases regulatory oversight by the decision maker
6) Reveals new ways of thinking in the space of the problem
7) Encourages exploration and discovery on the part of the decision maker
8) Accelerate us the solution of problems (accelerates progress in solving problems in the organization)
9) Encourages learning or training
10) Ability to control the risk exposure in decisions
11) Facilitates communication between people

Group Decision Support System(GDSS)

- Group Decision Support System
  - Information technology supports decision-making where there is a group participation. Such decision support system is called as Group Decision Support Systems (GDSS).
  - GDSS has come to mean computer software and hardware used to support group functions and processes.
  - GDSS supports Manager and Staff working in groups.
  - Contains most of the elements of DSS
    support in group decision-making se

Components of a GDSS and GDSS Software

- Database
- Model base
- Dialogue manager
- Communication capability
- Special software (also called GroupWare)
- E.g., Lotus Notes
  - people located around the world work on the same project, documents, and files, efficiently and at the same time


Databases
Model base
GDSS processor
GDSS software
Access to the internet and corporate intranet, networks, and other computer system
Dialogue manager
External database access
External databases
Users

Group Decision Support System

- *There are four **configurations** of group members are possible.*
  - Group members **in one room** operating on network with common display screen to share the display for all members.
  - Group members **sit at their respective locations** and use their desktop to interact with other members.
  - Group members **are in different cities** and they come together through **teleconferencing or video conferencing** with prior planning GDSS operations.
  - Group members are at remote locations may be **in different countries** and they come together through long **distance telecommunication network.**

GDSS Time/Place Environment

Same-Time **Same-Place** (Most widely used GDSS-computers with projectors, voting tools)	**Same-Time** **Different-Place** (team room, tools, audio conferencing, screen sharing, chat)
Different-Time **Same-Place** (audio/video conferencing, document sharing)	**Different-Time** **Different-Place** (voice mail, email, bulletin boards)

Why GDSS?

- High level managers can spend 80% of their time making decisions in groups. Applied correctly, GDSS can reduce this time, arriving at a better decision faster.
- GDSS provides the hardware, software, databases and procedures for effective decision making.

Advantages of GDSS

- **Parallel Communication –** eliminate monopolizing, providing increased participation, better decisions
- **Automated record keeping –** no need to take notes, they're automatically recorded
- **Ability for virtual meetings –** only need hardware, software and people connected
- **Portability -** Can be set up to be portable…laptop
- **Global Potential -** People can be connected across the world.

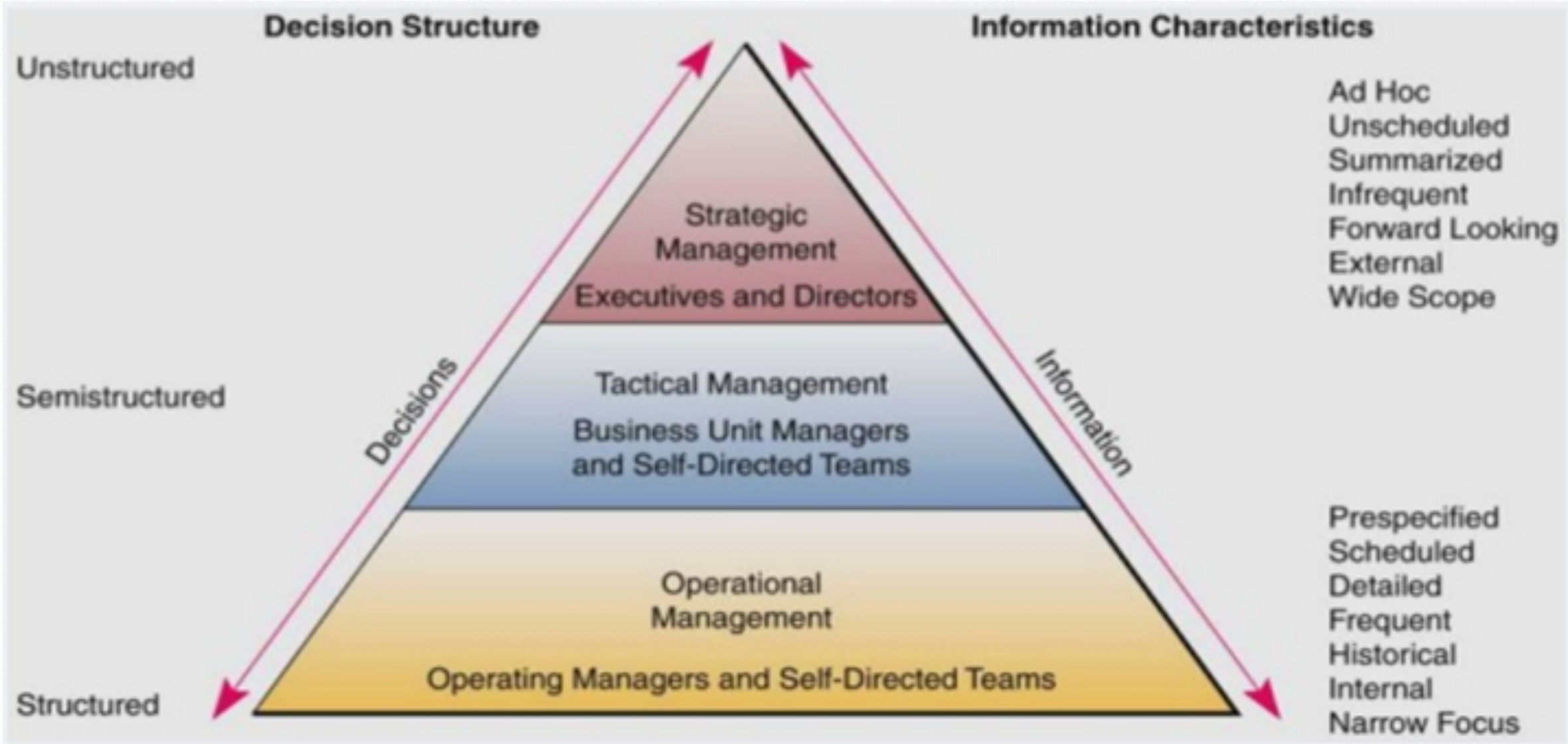
Disadvantages of GDSS

- **Cost –** infrastructure costs to provide the hardware and software/room/network connectivity can be very expensive
- **Security –** especially true when companies rent the facilities for GDSS; also, the facilitator may be a lower level employee *who may leak information to peers*.
- **Technical Failure –** power loss, loss of connectivity, relies heavily on bandwidth and LAN/WAN infrastructure properly setup system should minimize this risk.

Enterprise Decision Support System

- The Enterprise Decision Support System is a multi-disciplinary organization that provides technical and program/project leadership for Departmental Information Technology, applications and systems.
- Enterprise use decision support systems to quickly perform complex analyses over large amounts of data whose results are used to inform critical business decisions.

Enterprise and Decision Making



Executive Decision Support System

- **Executive Decision Support System** is a specialized decision support systems designed specifically for the information needs of top executives level and **provides for:**
  - Rapid access to timely information;
  - Direct access to management reports;
  - Very user friendly and supported by graphics.
- **Executive Decision Support Systems** support the informational roles of executives.

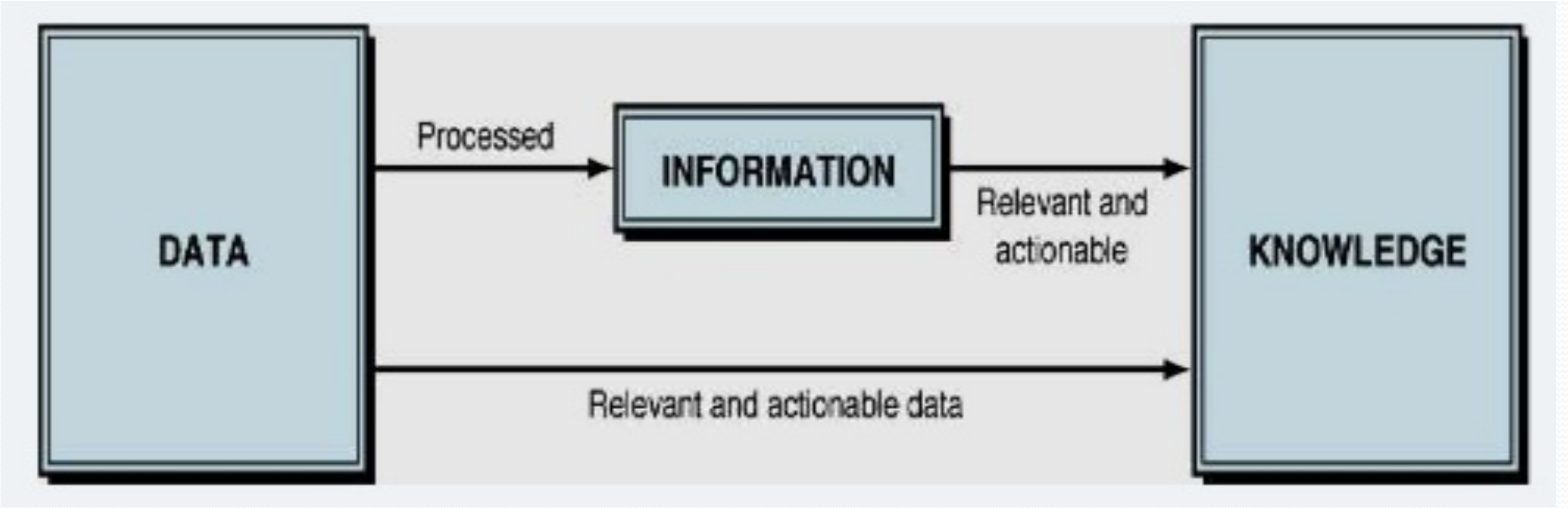
ESS(Con..)

- **Exception reporting** – reporting of only the results that deviate from a set of standards.
- **Drill down reporting** – investigating information in increasing detail.
- Include analysis support, communications, office automation and intelligence support.

Knowledge

- **Knowledge** is something that comes from information processing.
- Knowledge is applied by knowledge workers who are involved in a particular job or task.
- People use their knowledge in making decisions as well as many other actions .
- Knowledge is processed information that is contextual, relevant, and actionable.

Data, Information and Knowledge

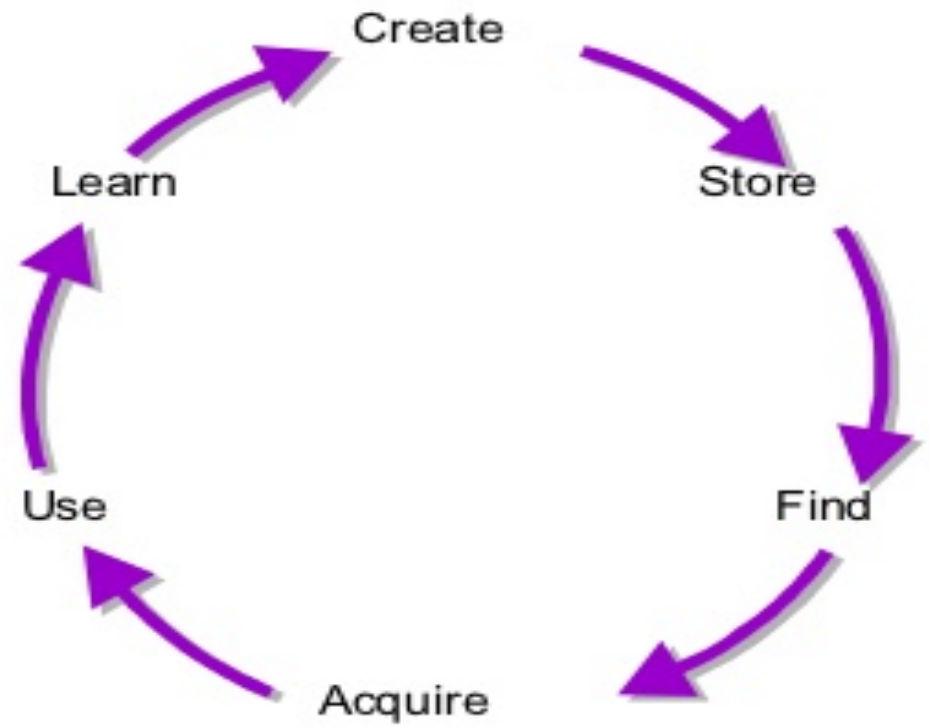


Knowledge Management

- **Knowledge Management** (KM) comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences.
- KM is a process that helps organizations identify, select, organize, disseminate, and transfer important information and expertise that are part of the organization's memory.
- KM is the process of systematically and actively managing and leveraging stores of knowledge in an organization.

Knowledge Management System

- Knowledge Management System refers to a (generally IT based) system for managing knowledge in organizations for supporting creation, capture, storage and distribution of information.



Knowledge Life Cycle

Knowledge Management System

- Knowledge Management System
  - **Create :** Knowledge must be created either within or outside the organization. This is typically comprised of iterative tacit and explicit loops until the knowledge is ready for distribution for those outside the creating group.
  - **Store :** Knowledge can be stored somewhere, either tacitly or explicitly so that it is accessible for others to find and use.
  - **Find :** Those who need the specific knowledge must then find out where it is, when they need it, by searching in the right places and asking the right people.

Knowledge Management System

- **Acquire :** Once the knowledge source is found, the user will then go through the act of actually acquiring it. This will involve gaining personal knowledge from other humans or documented sources.
- **Use :** Once acquired, the knowledge can be put to use towards some productive purpose.
- **Learn :** Having been used, perhaps repeatedly, the user will learn what worked well and not so well as a result of applying the knowledge gained. This can then be taken as significant input into further iterations of the knowledge creation and distribution process.

Knowledge Management System

- IT that helps gather, organize, and share business knowledge within an organization.
- Hypermedia databases that store and disseminate business knowledge. It may also be called **knowledge bases.**
- Best practices, policies, business solutions entered through the enterprise knowledge portal.

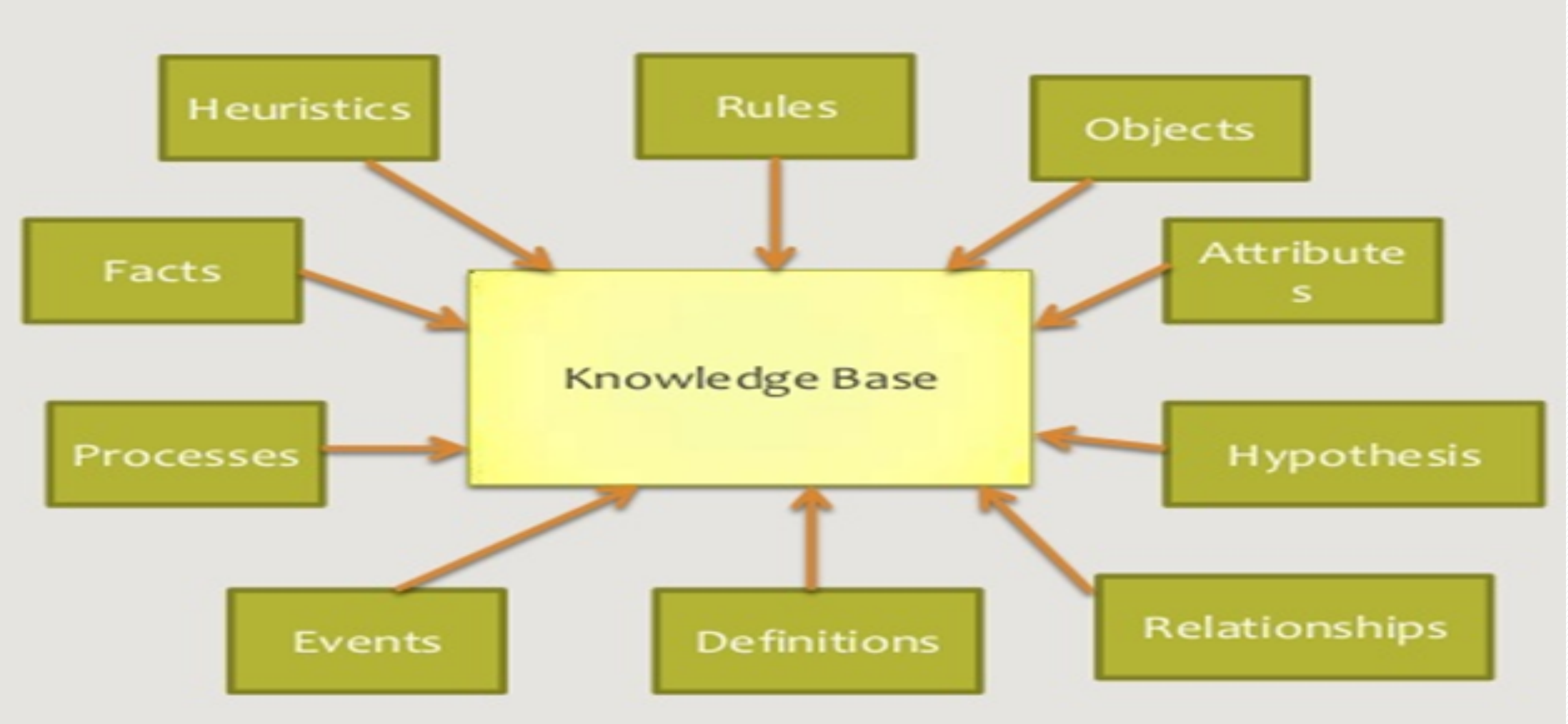
Knowledge Based Expert System

- A Knowledge Based System is a computer program that uses artificial intelligence to solve problems within a specialized domain that ordinarily requires human expertise.
- Typical tasks for expert systems involve classification, diagnosis, monitoring, design, scheduling, and planning for specialized tasks.
- Knowledge-based system is a more general than the expert system.

KBS as Real world Problem Solvers

- Problem-solving power does not lie with smart reasoning techniques nor clever search algorithms but domain dependent real-world knowledge.
- Real-world problems do not have well-defined solutions
- KBS allow this knowledge to be represented and creates an explained solution.
- KBS draws upon the knowledge of human experts captured in a knowledge-base to solve problems that normally require human expertise.
- Uses Heuristic (cause-and-effect) rather than algorithms KBS as real-world problem solvers.

Knowledge Base



Expert System

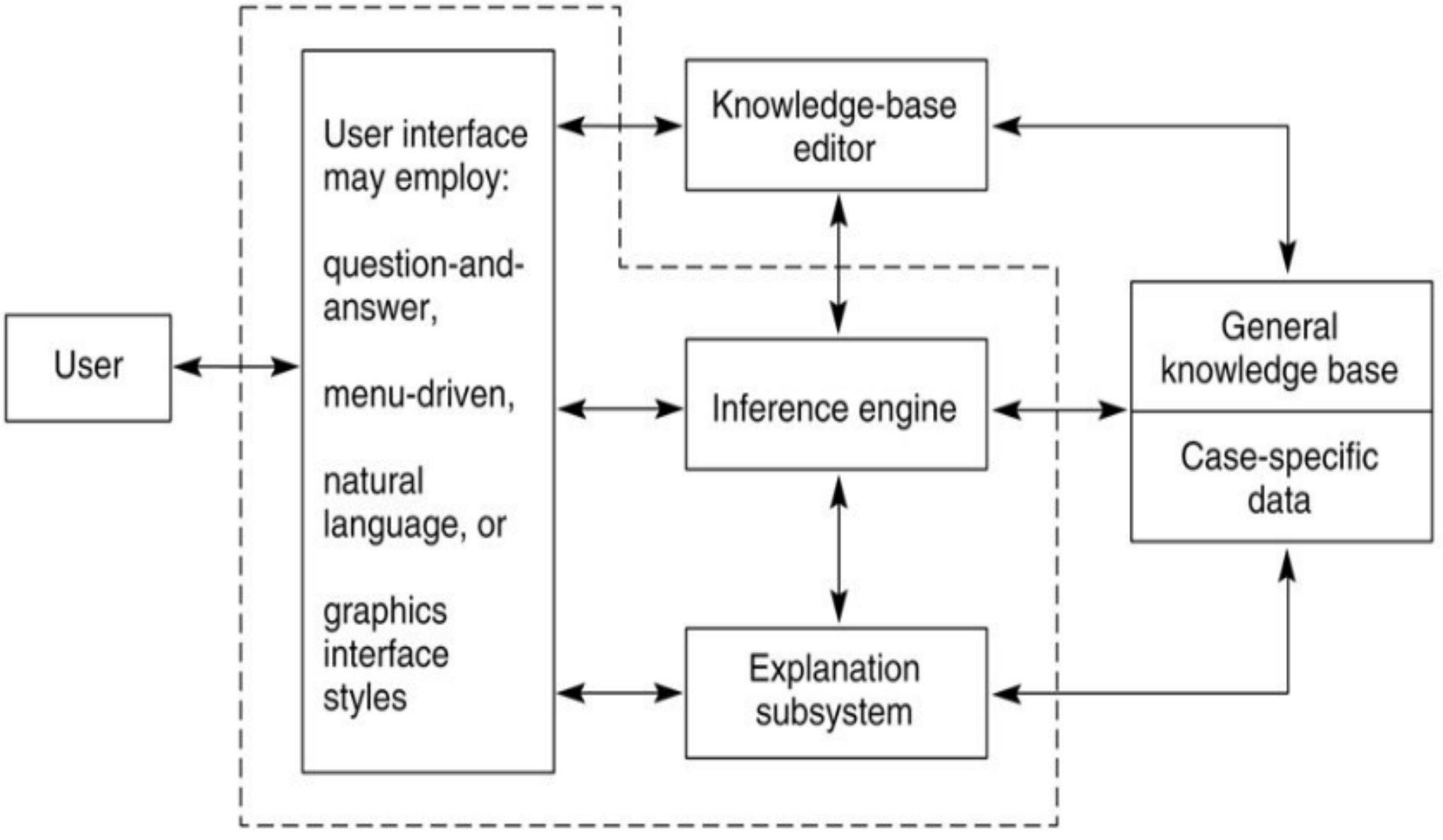
- Expert System is an extension of the decision support system.
- **Expert system**, a computer program that uses artificial-intelligence methods to solve problems within a specialized domain that ordinarily requires human expertise.
- **Expert system** is an information system application that captures the knowledge and expertise of a problem solver or decision maker, and then simulates the 'thinking' of that expert for those who have less expertise.
- Expert systems are implemented with **artificial intelligence** technology, often called expert system shells.
- Expert System application areas in action

  1.Medical Diagnosis

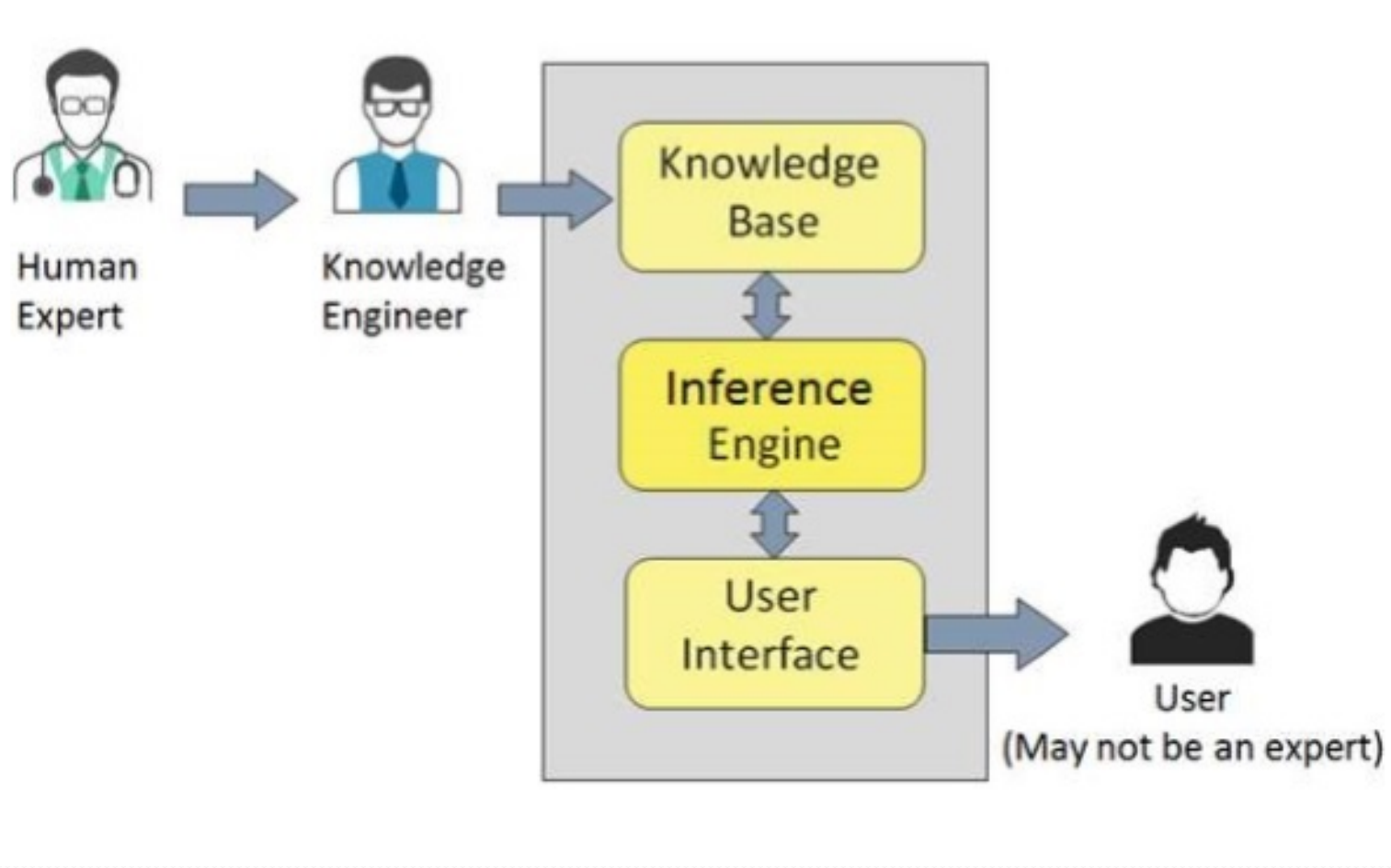
  2.Telephone Network Maintenance

  3.Detection of Common Metals etc.

Architecture of a Typical Expert System



Expert system Architecture(Simplified)



Early Expert Systems

- DENDRAL – used in chemical mass spectroscopy to identify chemical constituents
- MYCIN – medical diagnosis of illness
- DIPMETER – geological data analysis for oil
- PROSPECTOR – geological data analysis for minerals
- XCON/R1 – configuring computer systems

Inference Engine

- An inference engine tries to derive answers from a knowledge base.
- It is the brain of the expert systems that provides a methodology for reasoning about the information in the knowledge base, and for formulating conclusions.
- User Interface
  - It enables the user to communicate with an expert system.

Expert Systems

Characteristics of Expert System

- Like a human expert, an expert system is expected to
  - Be specialist : know facts and procedural rules
  - Use heuristics : interpolate from known facts
  - Justify its conclusions : to establish credibility and confidence.
  - The user can ask/be able to learn : be able to absorb new knowledge and apply it estimate the reliability of its answer.

Benefits of Expert System

- Benefits of Expert System
  - Increased output and productivity
  - Decreased decision making time
  - Increased process and product quality
  - Reduced downtime (machine failure detect and repair time)
  - Easier equipment operation
  - Elimination of the need for expensive equipment
  - Operations in hazardous environments (no human required.)
  - Ability to work with incomplete or uncertain information
  - Knowledge transfer to remote locations
  - Enhancement of other information systems

Artificial Intelligence and its Domains

- Domains of AI
  - Three major areas
    - Cognitive science
    - Robotics
    - Natural interfaces
- Cognitive science
  - Focuses on researching how the human brain works & how humans think and learn
  - Applications
    - Expert systems
    - Adaptive learning systems
    - Fuzzy logic systems
    - Neural networks
    - Intelligent agents

Domains of Artificial Intelligence

- Robotics
  - Produces robot machines with computer intelligence and computer controlled, human like physical capabilities
- Natural interfaces
  - Natural language and speech recognition
  - Talking to a computer and having it understand
  - Virtual reality

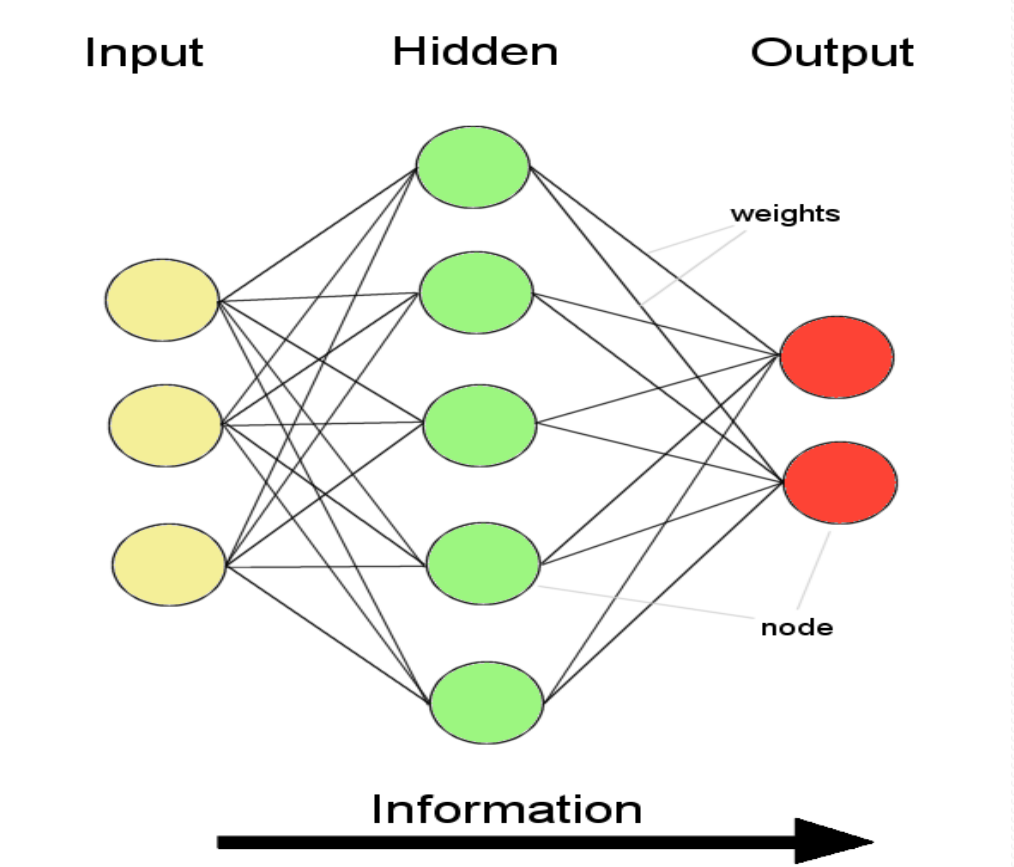
Neural Networks

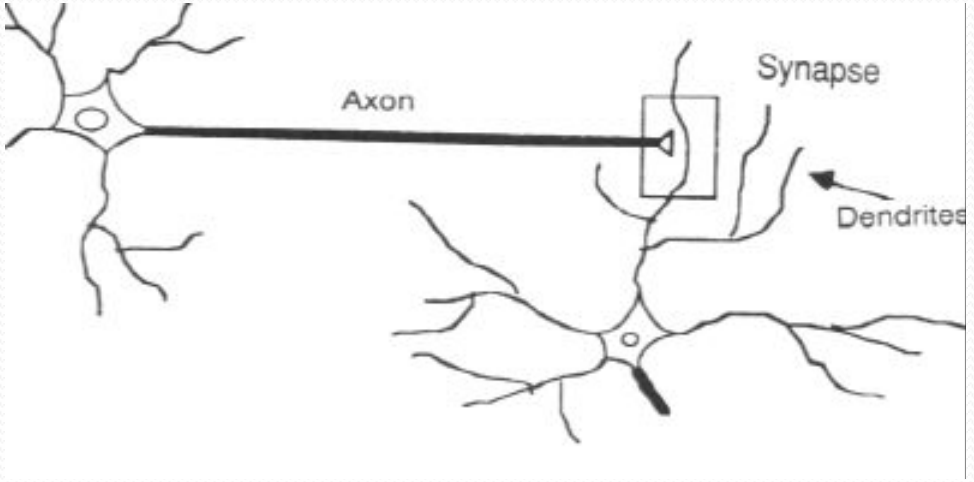
- **Neural networks** is a system of programs and data structures that approximates the operation of the human brain.
- **Neural networks** are particularly good at recognizing subtle, hidden and newly emerging patterns within complex data as well as interpreting incomplete inputs.
- An artificial neural network is composed of many artificial neurons that are linked together according to a specific network architecture.
- *The objective of the neural network is to transform the inputs into meaningful outputs.*

Neural Network

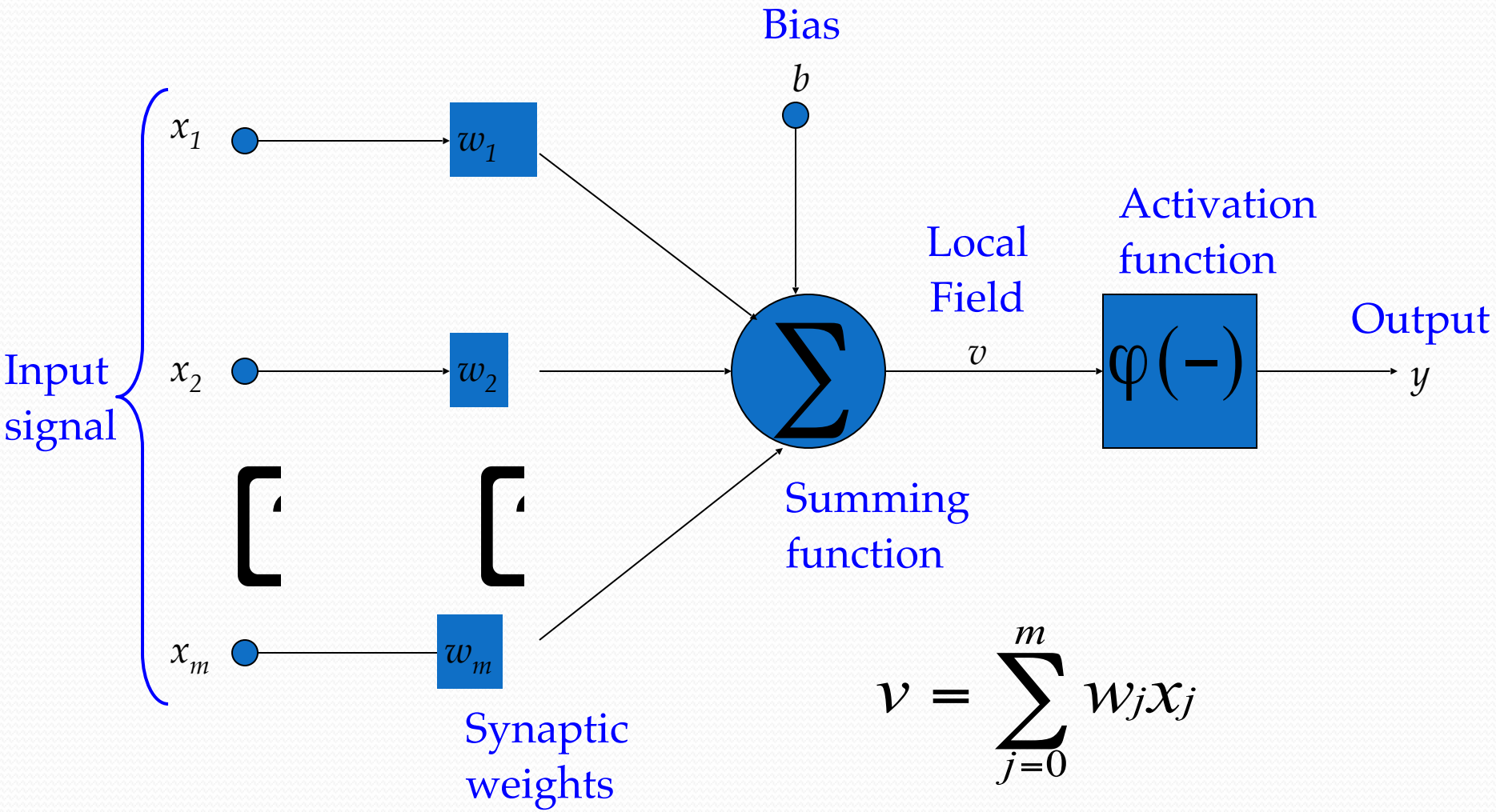
ANNs incorporate the two fundamental components of biological neural nets:

1. Neurones (nodes)
2. Synapses (weights)





Neural Network



$$v = \sum_{j=0}^{m} w_j x_j$$

$$w_0 = b$$

Virtual Reality

- Virtual reality is plainly speaking, seeing an imaginary world, rather than the real one.
- Just about any simulated environment a user can actively experience
- Virtual Reality (VR) is the illusion of a three-dimensional, interactive, computer-generated reality where sight, sound, and sometimes even touch are simulated to create pictures, sounds, and objects that actually seem real.
- A medium composed of interactive computer simulations giving users the feeling of being present in the simulations.
- Virtual Reality refers to a high-end user interface that involves real-time simulation and interactions through multiple sensorial channels.

Why Virtual Reality is needed?

Why Virtual Reality is needed?

- **Operations in dangerous environments**
  - There are still many examples of people working in dangerous or hardship environments that could benefit from the use of VR-mediated teleportation.
  - Workers in radioactive, space, or toxic environments could be relocated to the safety of a VR environment where they could handle any hazardous materials without any real danger using teleoperation or telepresence.

Why Virtual Reality is needed?

- Why Virtual Reality is needed?
  - **Scientific Visualization**
    - Scientific Visualization provides the researcher with immediate graphical feedback during the course of the computations and gives him/her the ability to 'steer' the solution process.
    - Application at NASA Ames Research Center is the Virtual Planetary Exploration. It helps planetary geologists to remotely analyze the surface of a planet. They use VR techniques to roam planetary terrains.
- NASA VR Mars navigation simulation Geologists remotely analyzing the surface of a planet at NASA

Why Virtual Reality is needed?

- Why Virtual Reality is needed?
  - **Medicine**
    - Until now experimental research and education in medicine was mainly based on dissection and study of plastic models. Computerized 3D human models provide a new approach to research and education in medicine. Experimenting medical research with virtual patients will be a reality.
    - We will be able to create not only realistic looking virtual patients, but also histological and bone structures. With the simulation of the entire physiology of the human body.

Why Virtual Reality is needed?

- Why Virtual Reality is needed?
  - **Education and training**
    - The most common example is the flight simulator. This type of simulator has shown the benefits of simulation environments for training. They have lower operating costs and are safer to use than real aircraft.
    - They also allow the simulation of dangerous scenarios not allowable with real aircraft.

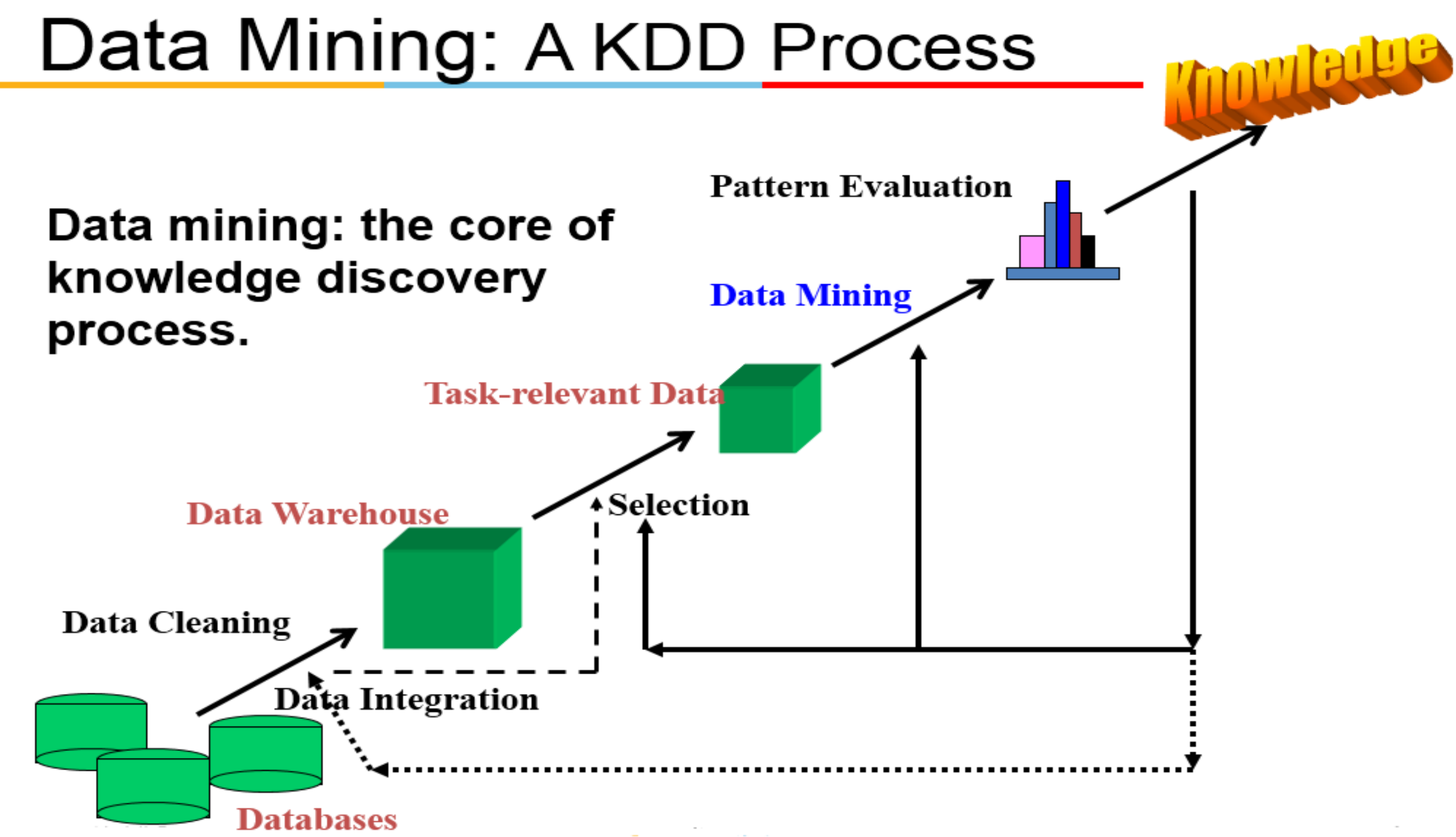
Data Mining

- Data mining is the search for relationships and global patterns that exist in large databases but are `hidden' among the vast amount of data, such as a relationship between patient data and their medical diagnosis.
- Data mining is looking for hidden, valid, and potentially useful patterns in huge data sets.
- Data Mining is all about discovering unsuspected / previously unknown relationships amongst the data.
- Data Mining is also known as knowledge Discovery in Databases(KDD)
- These relationships represent valuable knowledge about the database and the objects in the database and, if the database is a faithful mirror, of the real world registered by the database.
- The data is often voluminous, but as it stands of low value as no direct use can be made of it; it is the hidden information in the data that is useful.

Major Data Mining Tasks

- **Classification:** predicting an item class
- **Clustering:** finding clusters in data
- **Associations:** e.g. A & B & C occur frequently
- **Visualization:** to facilitate human discovery
- **Summarization:** describing a group
- **Deviation Detection**: finding changes
- Estimation: predicting a continuous value
- Link Analysis: finding relationships
- …

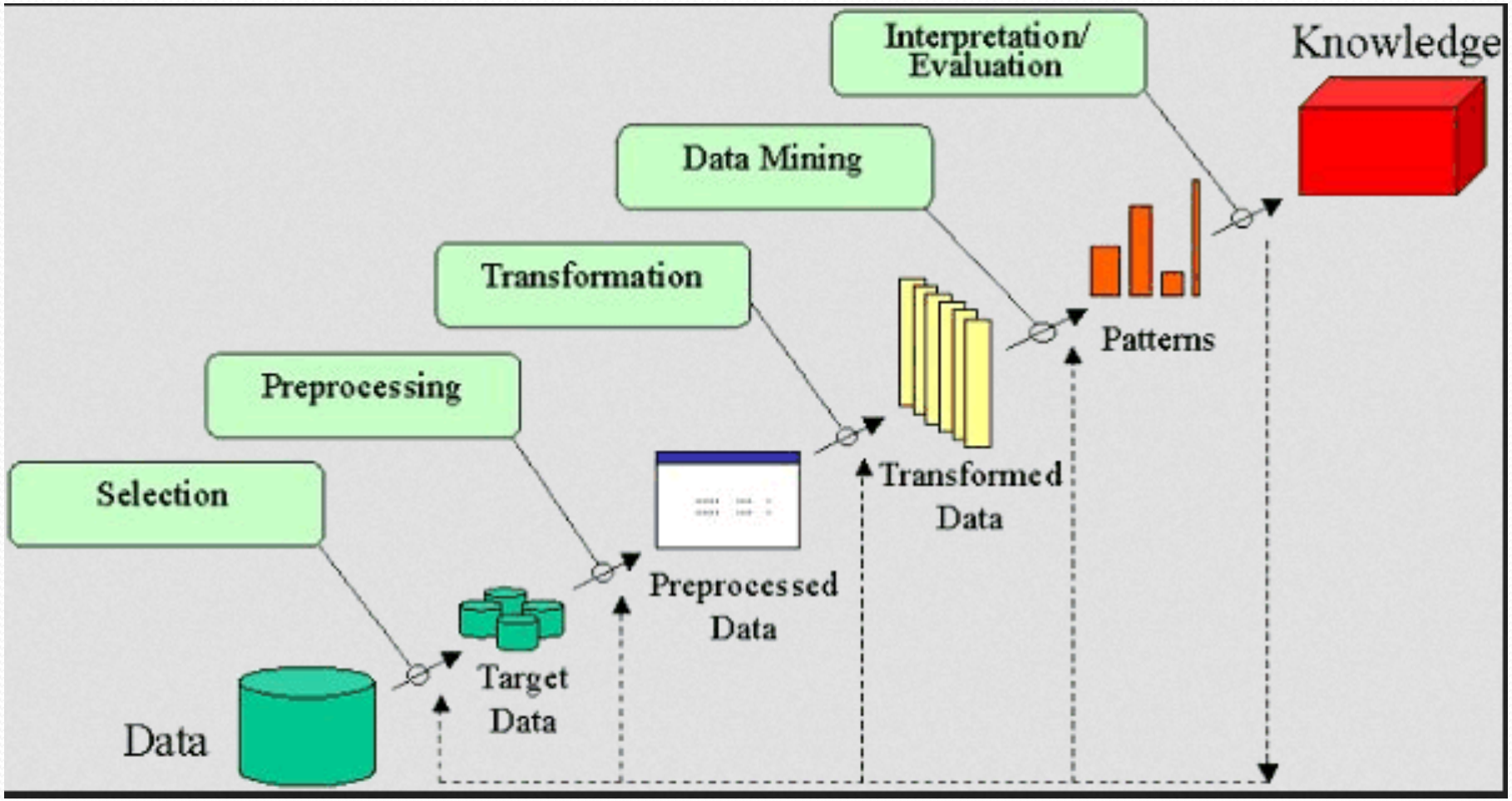
Data Mining: A KDD Process



Steps of a KDD Process

- Learning the application domain:
  - relevant prior knowledge and goals of application
- Creating a target data set: data selection
- Data cleaning and preprocessing: (may take 60% of effort!)
- Data reduction and transformation:
  - Find useful features, dimensionality/variable reduction, invariant representation.
- Choosing functions of data mining
  - summarization, classification, regression, association, clustering.
- Choosing the mining algorithm(s)
- Data mining : search for patterns of interest
- Pattern evaluation and knowledge presentation
  - visualization, transformation, removing redundant patterns, etc.
- Use of discovered knowledge

Data mining steps



Why is Data Mining necessary?

- Make use of your data assets
- There is a big gap from stored data to knowledge; and the transition won't occur automatically.
- Many interesting things you want to find cannot be found using database queries

  "find me people likely to buy my products"

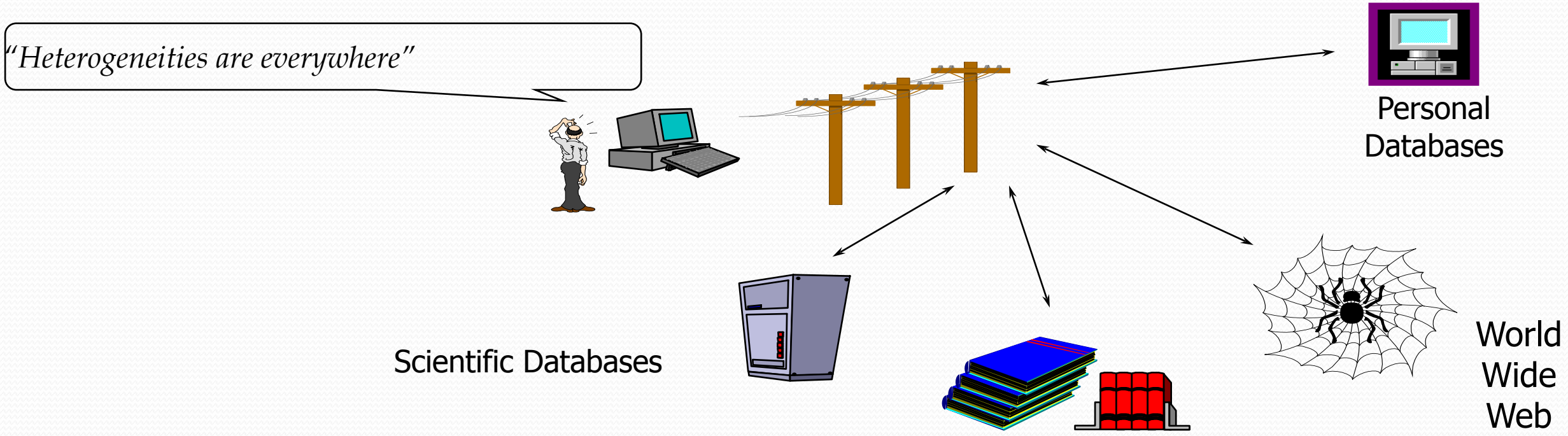
  "Who are likely to respond to my promotion"

Data Warehouse

- Data Warehouse is a physical repository where relational data are specially organized to provide enterprise-wide, cleansed data in a standardized format.
- Characteristics
  - Subject oriented, Integrated, Time Variant, Non-volatile
  - Web-based, Relational/multidimensional, Client/server, Real-time
  - Include metadata

Data Warehousing is process of constructing and using data warehouses which requires data integration, data cleaning, and data consolidation.

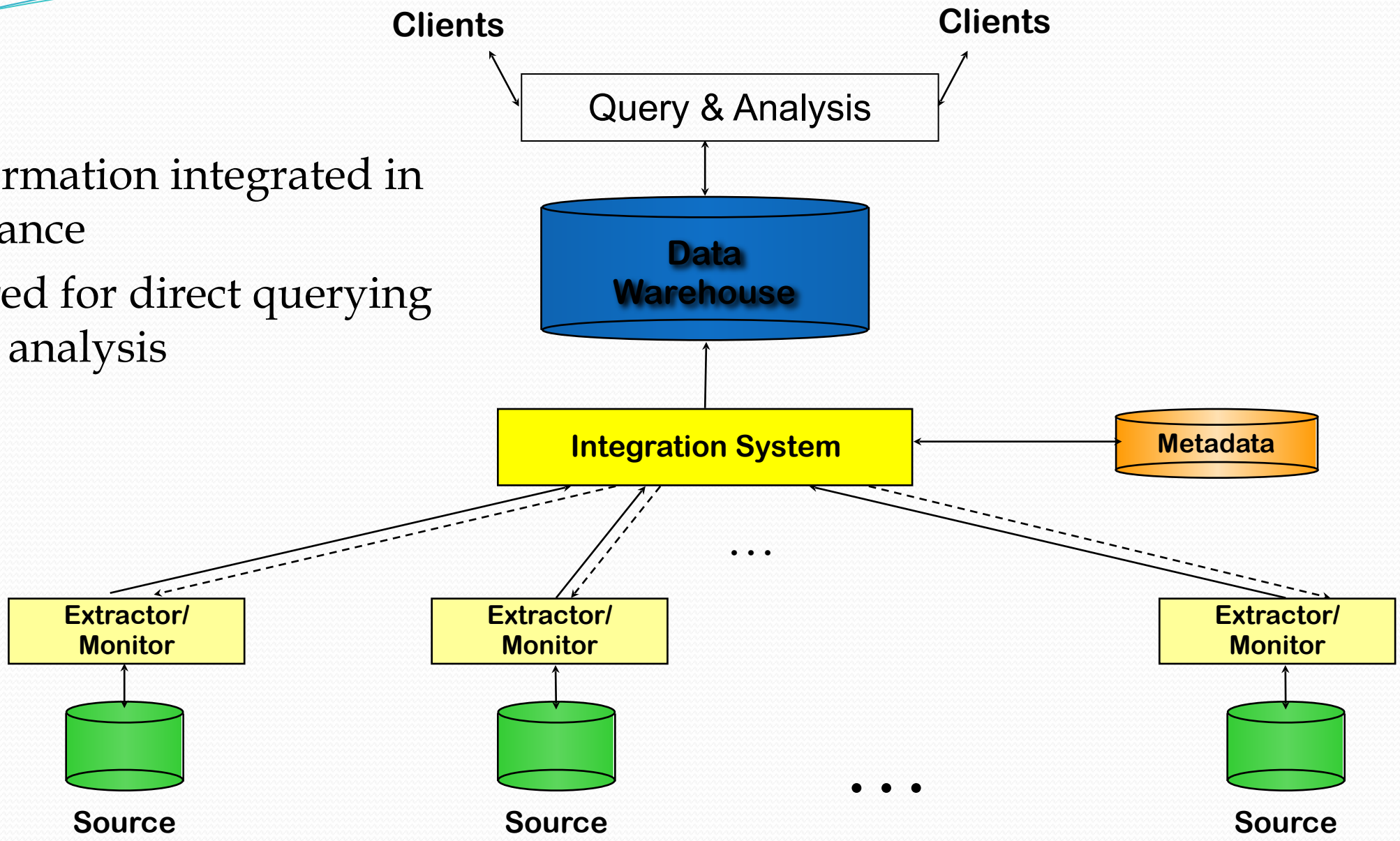
Problem: Heterogeneous Information Sources



- Different interfaces
- Different data representations
- Duplicate and inconsistent information

The Warehousing Approach

- Information integrated in advance
- Stored for direct querying and analysis



Warehouse is a Specialized DB

Standard DB

- Mostly updates
- Many small transactions
- Mb - Gb of data
- Current snapshot
- Index/hash on p.k.
- Raw data
- Thousands of users (e.g., clerical users)

Warehouse

- Mostly reads
- Queries are long and complex
- Gb - Tb of data
- History
- Lots of scans
- Summarized, reconciled data
- Hundreds of users (e.g., decision-makers, analysts)

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

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.

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”

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

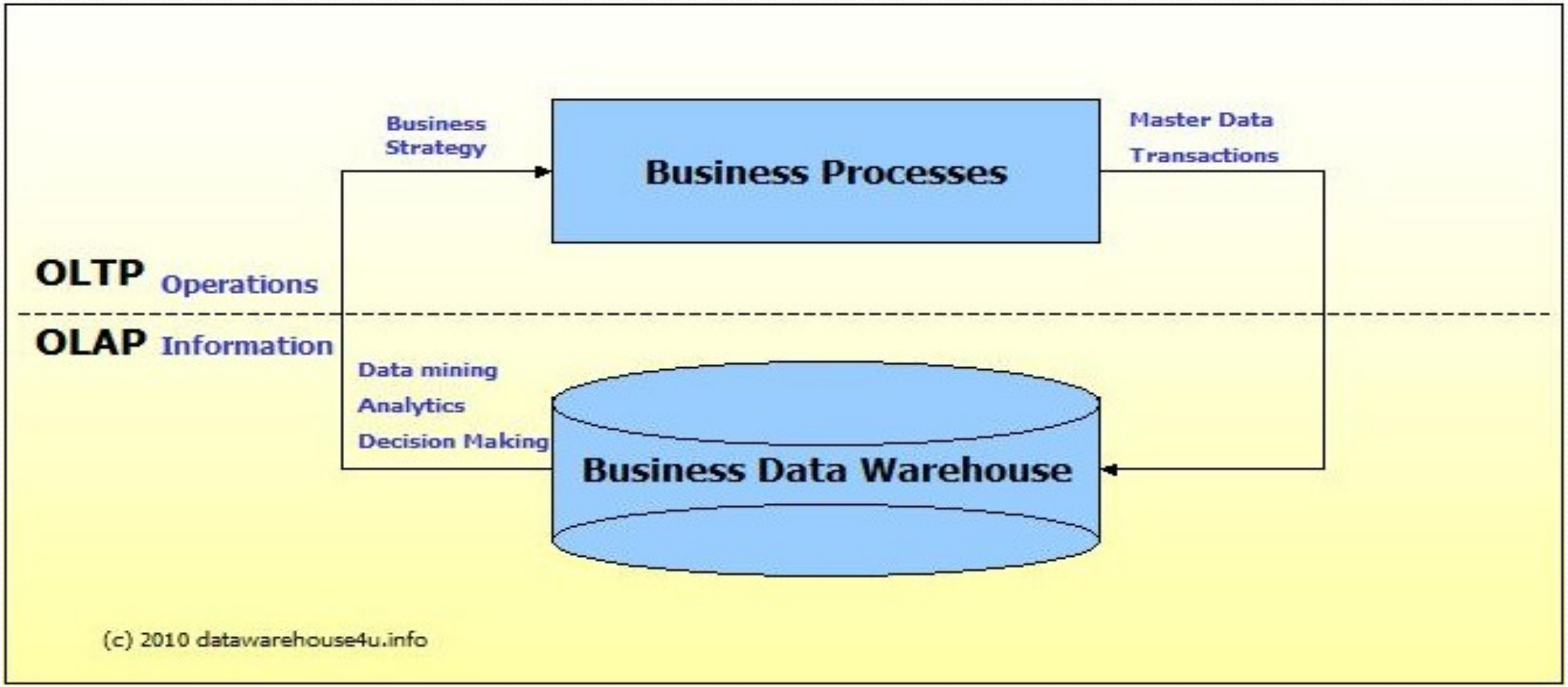
OLTP vs. OLAP

Divide IT systems into transactional (OLTP) and analytical (OLAP).

In general, assume that OLTP systems provide source data to data warehouses, whereas OLAP systems help to analyze it.

- 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

OLTP Vs OLAP


Business Strategy
Business Processes
Master Data
Transactions
OLTP Operations
OLAP Information
Data mining
Analytics
Decision Making
Business Data Warehouse
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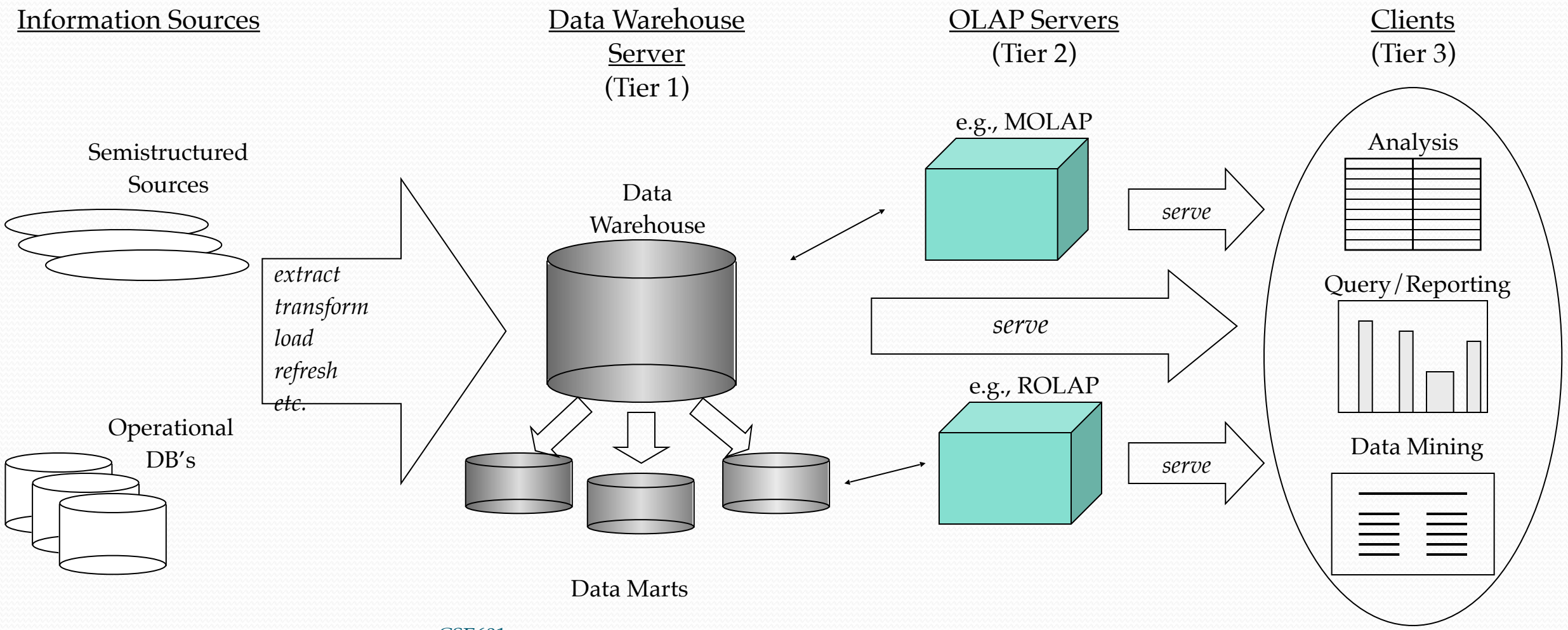
OLTP vs. OLAP

- OLTP: On-Line Transaction Processing
  - Many short transactions (queries + updates)
  - Examples:
    - Update account balance
    - Enroll in course
    - Add book to shopping cart
  - Queries touch small amounts of data (one record or a few records)
  - Updates are frequent
  - Concurrency is biggest performance concern

- OLAP: On-Line Analytical Processing
  - Long transactions, complex queries
  - Examples:
    - Report total sales for each department in each month
    - Identify top-selling books
    - Count classes with fewer than 10 students
  - Queries touch large amounts of data
  - Updates are infrequent
  - Individual queries can require lots of resources

	OLTP System Online Transaction Processing (Operational System)	OLAP System Online Analytical Processing (Data Warehouse)
Source of data	Operational data; OLTPs are the original source of the data.	Consolidation data; OLAP data comes from the various OLTP Databases
Purpose of data	To control and run fundamental business tasks	To help with planning, problem solving, and decision support
What the data	Reveals a snapshot of ongoing business processes	Multi-dimensional views of various kinds of business activities
Inserts and Updates	Short and fast inserts and updates initiated by end users	Periodic long-running batch jobs refresh the data
Queries	Relatively standardized and simple queries Returning relatively few records	Often complex queries involving aggregations
Processing Speed	Typically very fast	Depends on the amount of data involved; batch data refreshes and complex queries may take many hours; query speed can be improved by creating indexes
Space Requirements	Can be relatively small if historical data is archived	Larger due to the existence of aggregation structures and history data; requires more indexes than OLTP
Database Design	Highly normalized with many tables	Typically de-normalized with fewer tables; use of star and/or snowflake schemas
Backup and Recovery	Backup religiously; operational data is critical to run the business, data loss is likely to entail significant monetary loss and legal liability	Instead of regular backups, some environments may consider simply reloading the OLTP data as a recovery method

The Complete Decision Support System



Thank you

Next Class:

Chapter-5: Planning for IS