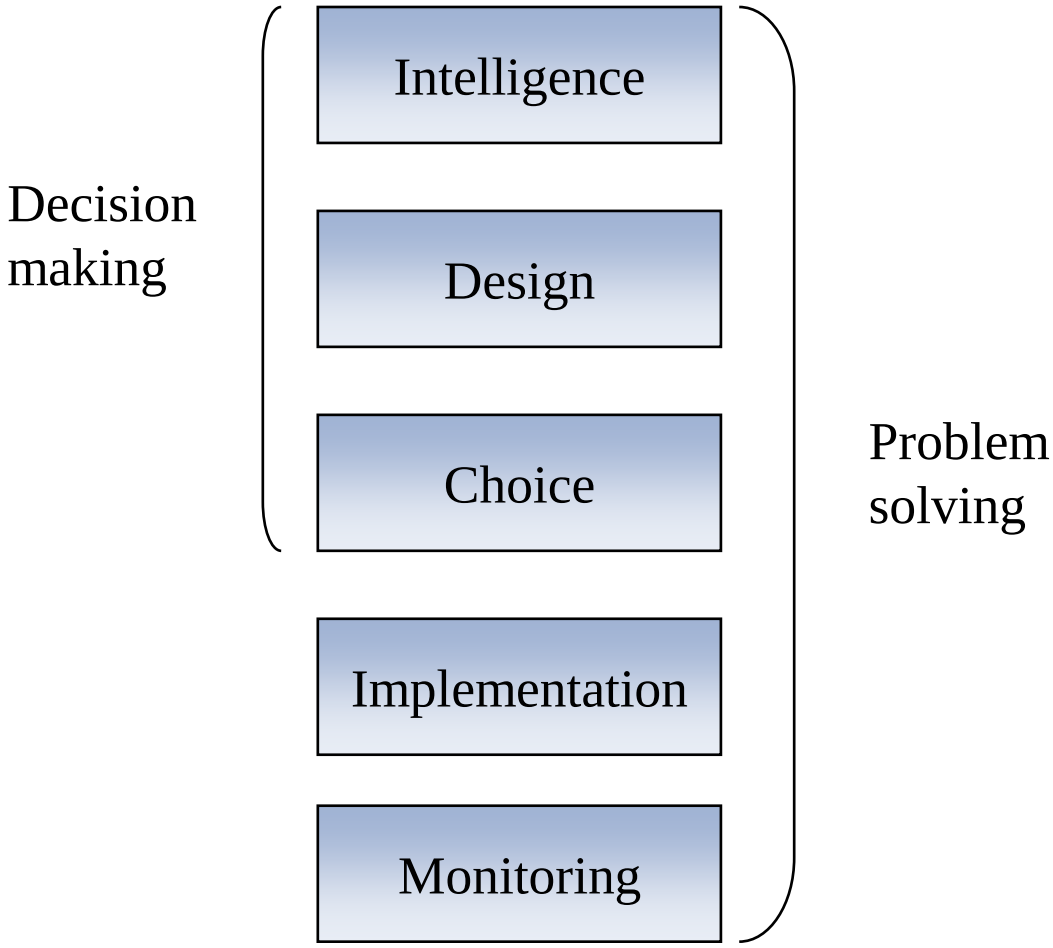
Decision Support and Intelligent Systems

Decision Making

- Information is used to make decisions. Decision making is not a single activity that takes place all at one.
- The 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

Decision Making as a Component of Problem Solving



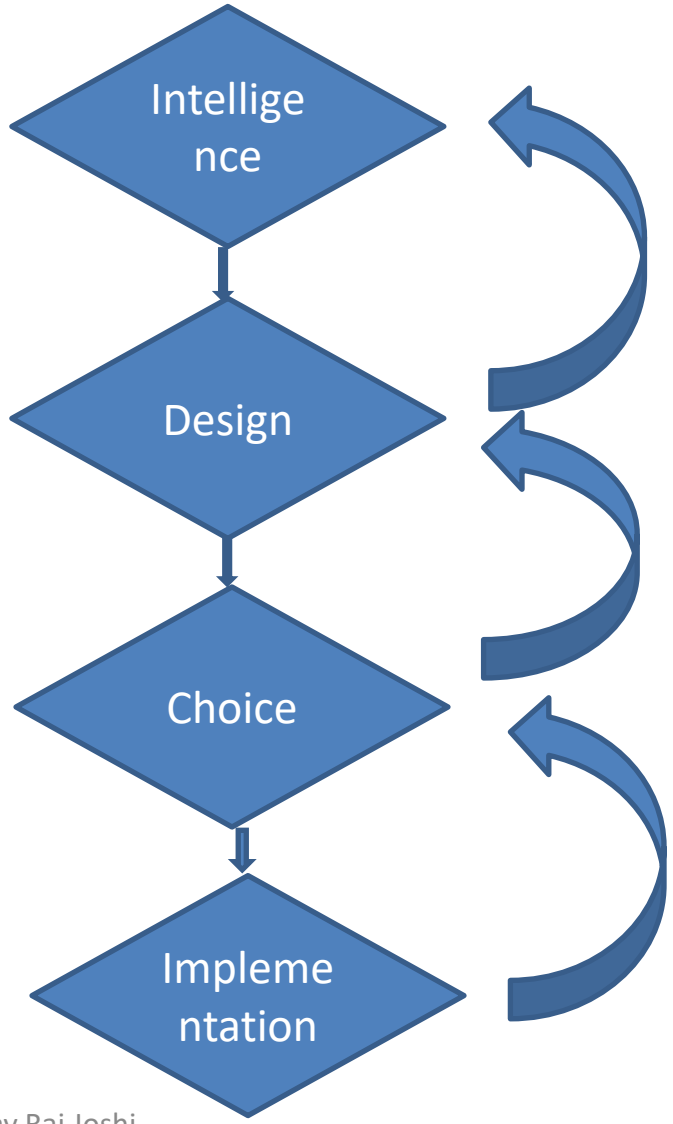
Decision Making Stages

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?



What is Decision Support System?

- A DSS is a computer-based information system that supports business or organizational decision-making activities.
- A DSS is a collection of integrated software applications and hardware that form the backbone of an organization's decision making process and help to make decisions, which may be rapidly changing and not easily specified in advance

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.

Characteristics of a DSS

- **Facilitation** : DSS facilitate and support specific decision- making activities and/or decision processes.
- **Interaction** : DSS are computer-based systems designed for interactive use by decision makers or staff users who control the sequence of interaction and the operations performed.
- **Repeated Use** : DSS are intended for repeated use. A specific DSS may be used routinely or used as needed for ad hoc decision support tasks.
- **Identifiable** : DSS may be independent systems that collect or replicate data from other information systems OR subsystems of a larger, more integrated information system.

- **Task-oriented** : DSS provide specific capabilities that support one or more tasks related to decision-making, including: **intelligence and data analysis; identification and design of alternatives; choice among alternatives; and decision implementation.**
- **Decision Impact** : DSS are intended to improve the accuracy, timeliness, quality and overall effectiveness of a specific decision or a set of related decisions.
- **Supports individual and group decision making** : It provides a single platform that allows all users to access the same information and access the same version of truth, while providing autonomy to individual users and development groups to design reporting content locally.
- **Comprehensive Data Access** : It allows users to access data from different sources concurrently, leaving organizations the freedom to choose the data warehouse that best suits their unique requirements and preferences.

DSS Objectives

- Increase the effectiveness of the managers decision- making process.
- Supports the manager in the decision-making process but does not replace it.
- Improve the directors effectiveness of decision making.

DSS Components

- DSS components may be classified as:
  - **Inputs** : Factors, numbers, and characteristics to analyze.
  - **User Knowledge and Expertise** : Inputs requiring manual analysis by the user.
  - **Outputs** : Transformed data from which DSS "decisions" are generated.
  - **Decisions** : Results generated by the DSS based on user criteria.

DSS Requirements

- Data collection from multiple sources (sales data, inventory data, supplier data, market research data. etc.).
- Data formatting and collation.
- A suitable database location and format built for decision support -based reporting and analysis .
- Robust tools and applications to report, monitor, and analyze the data.

DSS Advantages

- Time savings
- Enhance effectiveness
- Competitive advantage
- Cost reduction
- Increase decision maker satisfaction
- Promote learning
- Improves personal efficiency

DSS Applications

- Medical diagnosis
- Business and Management
- Agricultural production
- Price and route selection in airlines
- Customer profile monitoring in banks
- Trains dispatching and routing

DSS Types of Decisions

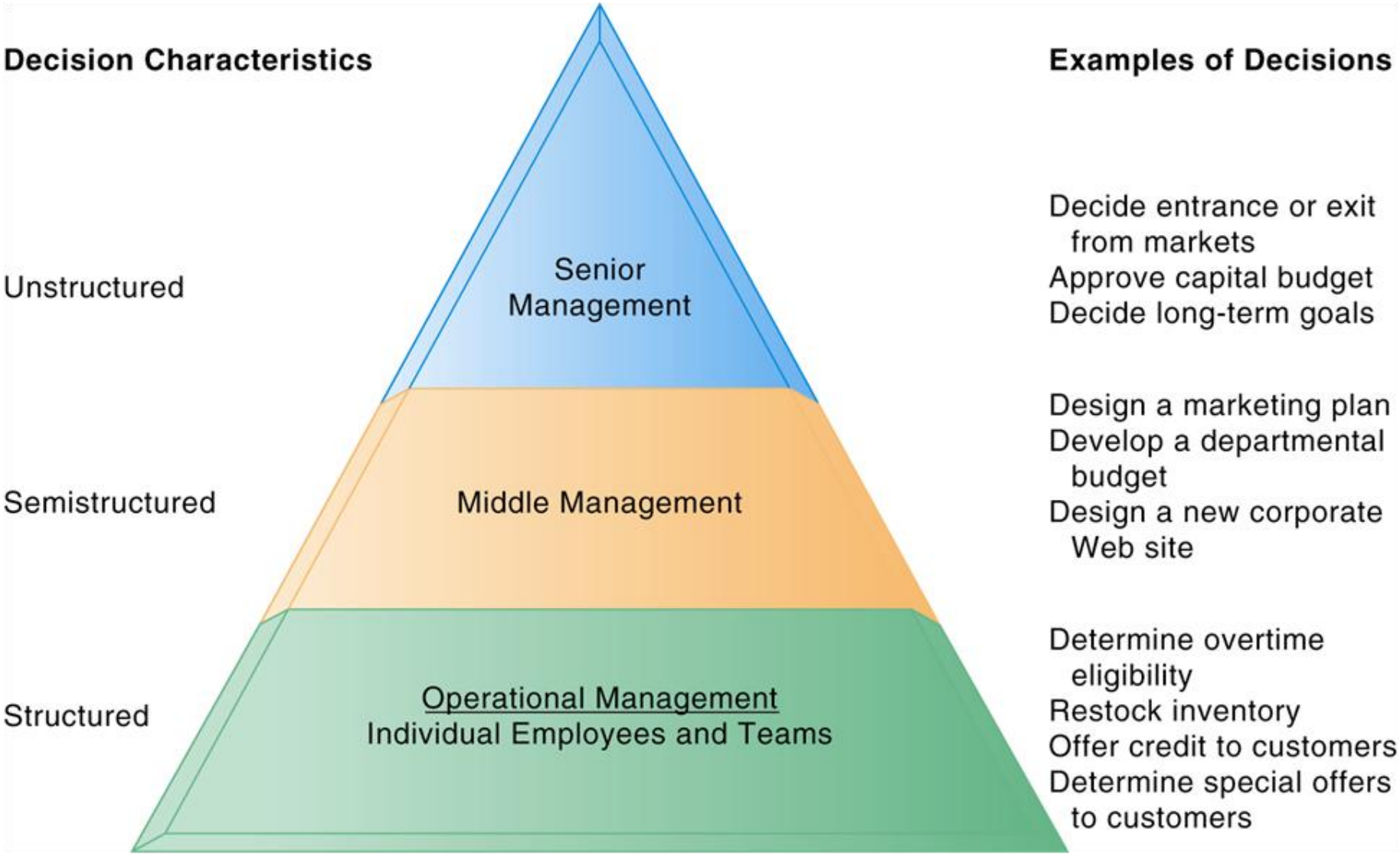
- Structured / Programmed Decisions :
  - Schedule decisions
  - Organization develops specific process for handling
  - Rules of decision making system are predetermined

DSS Types of Decisions

- Unstructured / Non-programmed Decisions :
  - Repetitive decisions
  - Handled by general problem solving process
  - Decision taken by Decision Support Systems
  - Rules of decision making system are not fixed or predetermined
  - It requires every time the user has to go through the decision-making cycle.

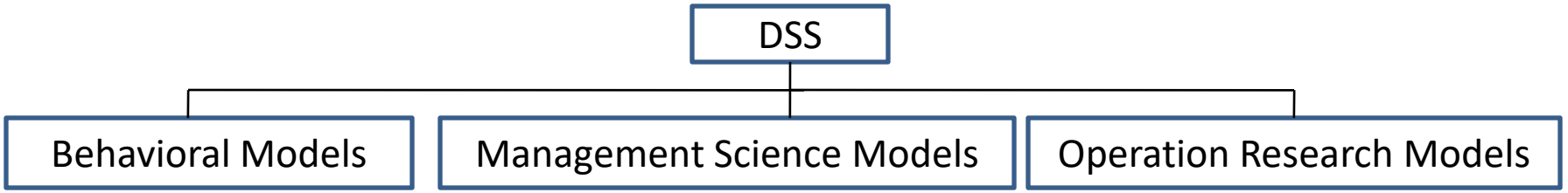
DSS Types of Decisions

- Semistructured Decisions:
  - Some decision procedures can be specified in advance, but not enough to lead to a definite recommended decision


Decision Characteristics
Examples of Decisions
Unstructured
Semistructured
Structured
Senior Management
Middle Management
Operational Management
Individual Employees and Teams
Decide entrance or exit from markets
Approve capital budget
Decide long-term goals
Design a marketing plan
Develop a departmental budget
Design a new corporate Web site
Determine overtime eligibility
Restock inventory
Offer credit to customers
Determine special offers to customers

Decision Support System Models

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



Types of Models

Behavioral Models

- Behavioral Models :
  - The decision maker can make the decisions for such behavioral relationships.

    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.

  e.g: 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.
- E.g. : Sales Budget, Production Budget

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

  e.g : 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.

Group Decision Support System

- 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.

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 [redacted] document sharing)	**Different-Time Different-Place** (voice mail, email, bulletin boards)

WHY USE 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.

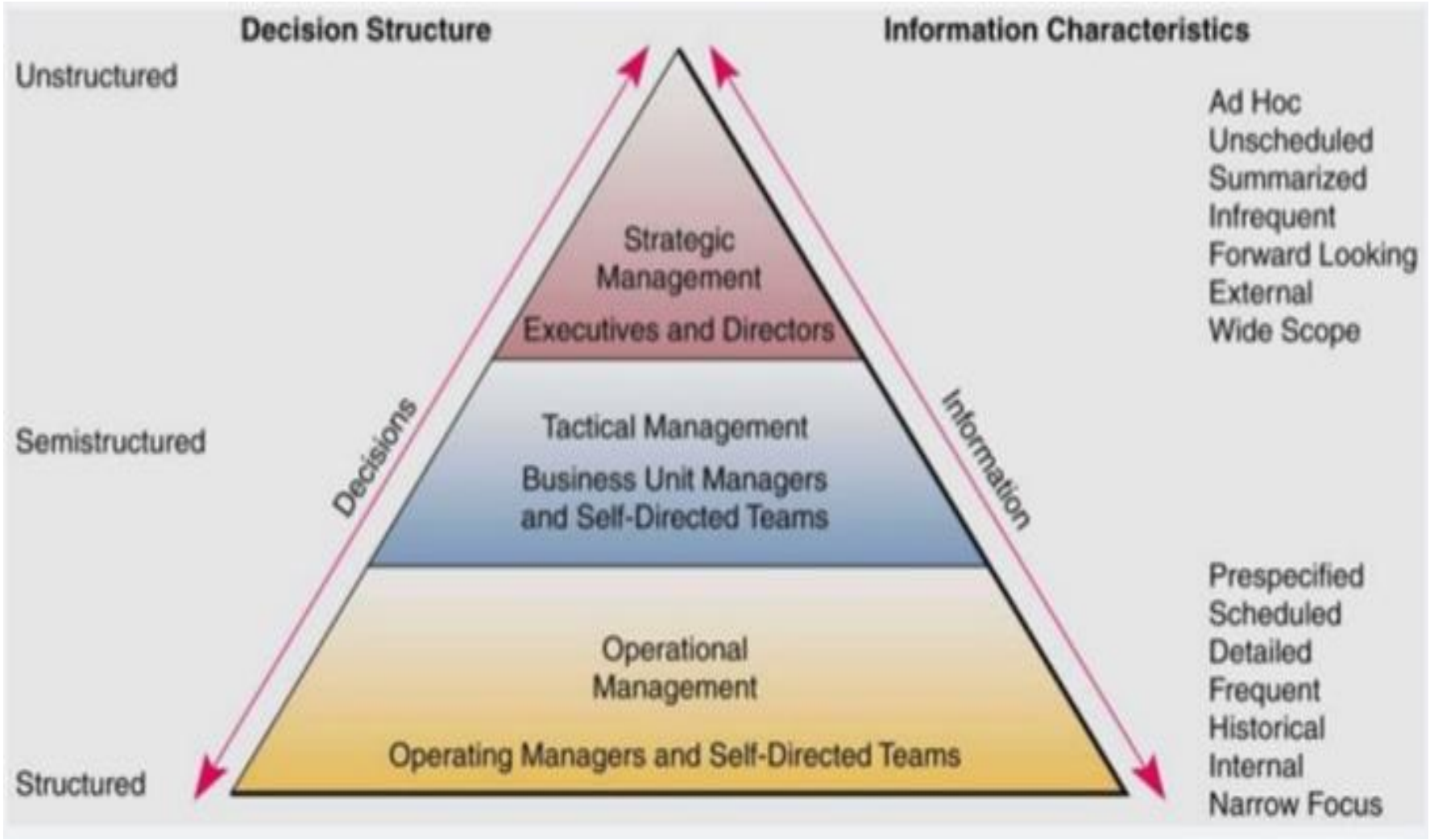
Disadvantages of GDSS

- **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 computer-based technology 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.

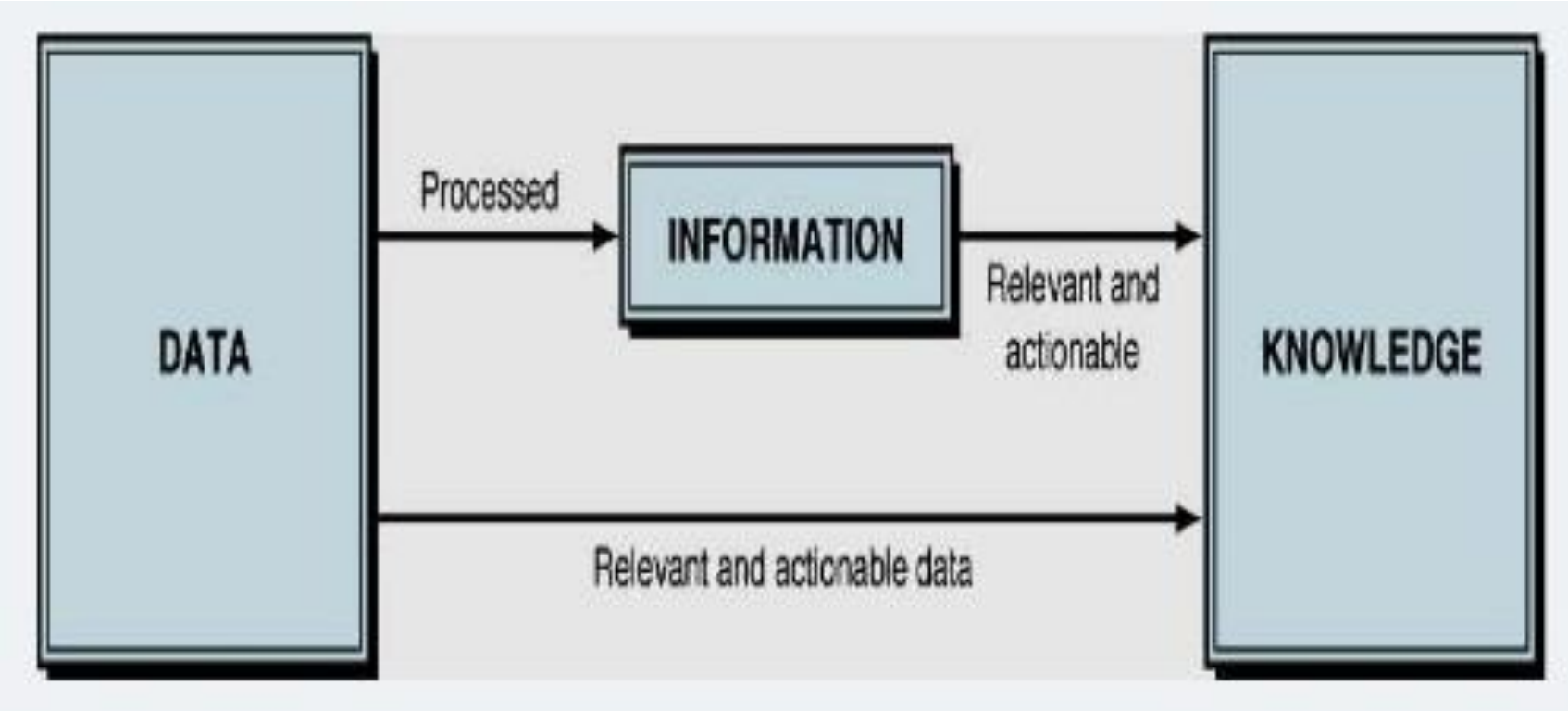
ESS(Continued)

- **Executive Support Systems** – specialized decision support systems designed to meet the needs of senior management.
- **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 processed by using data.
- 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 information that is contextual, relevant, and actionable.

Data, Information and Knowledge



Data, Information and Knowledge

- Data

  refers to isolated facts such as individual measurement No meaning on their own

- Information

  fact about situation, person, events

- Knowledge

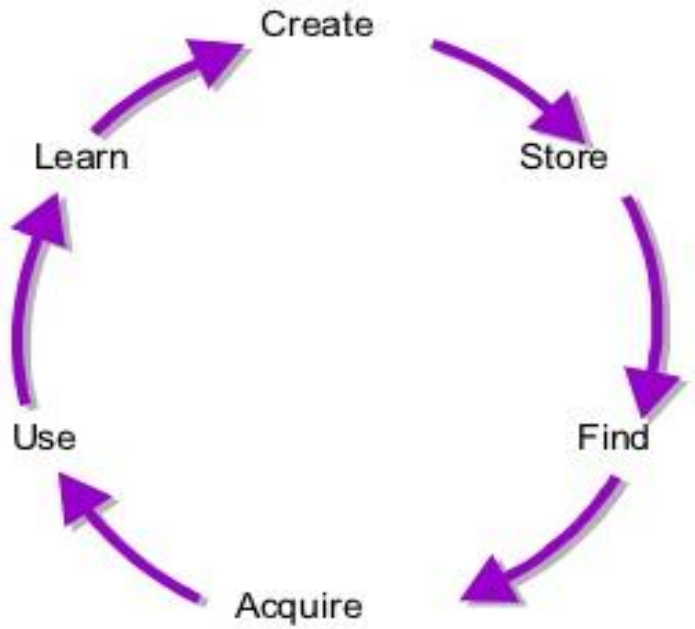
  experience

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.

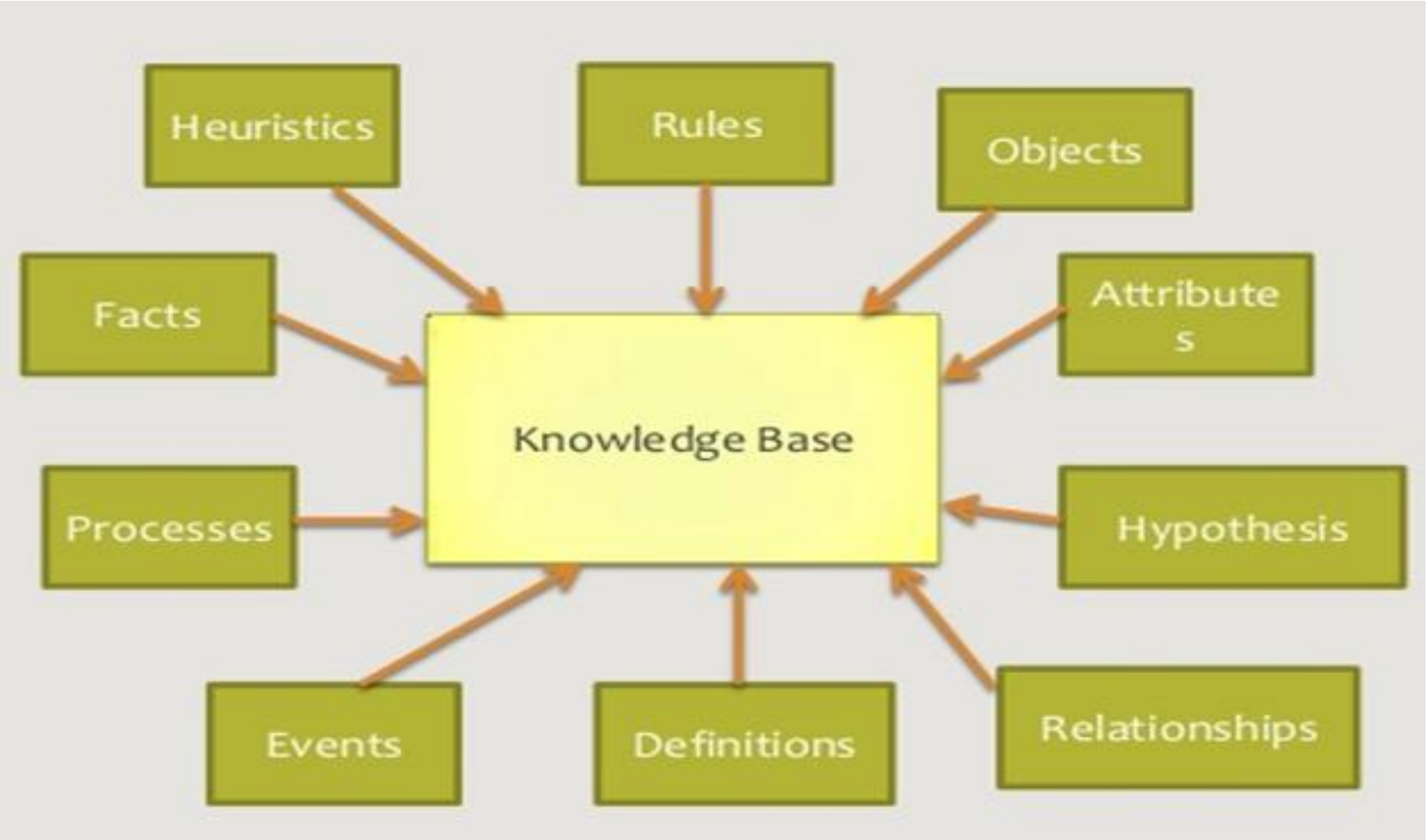
Knowledge Management System

- 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.

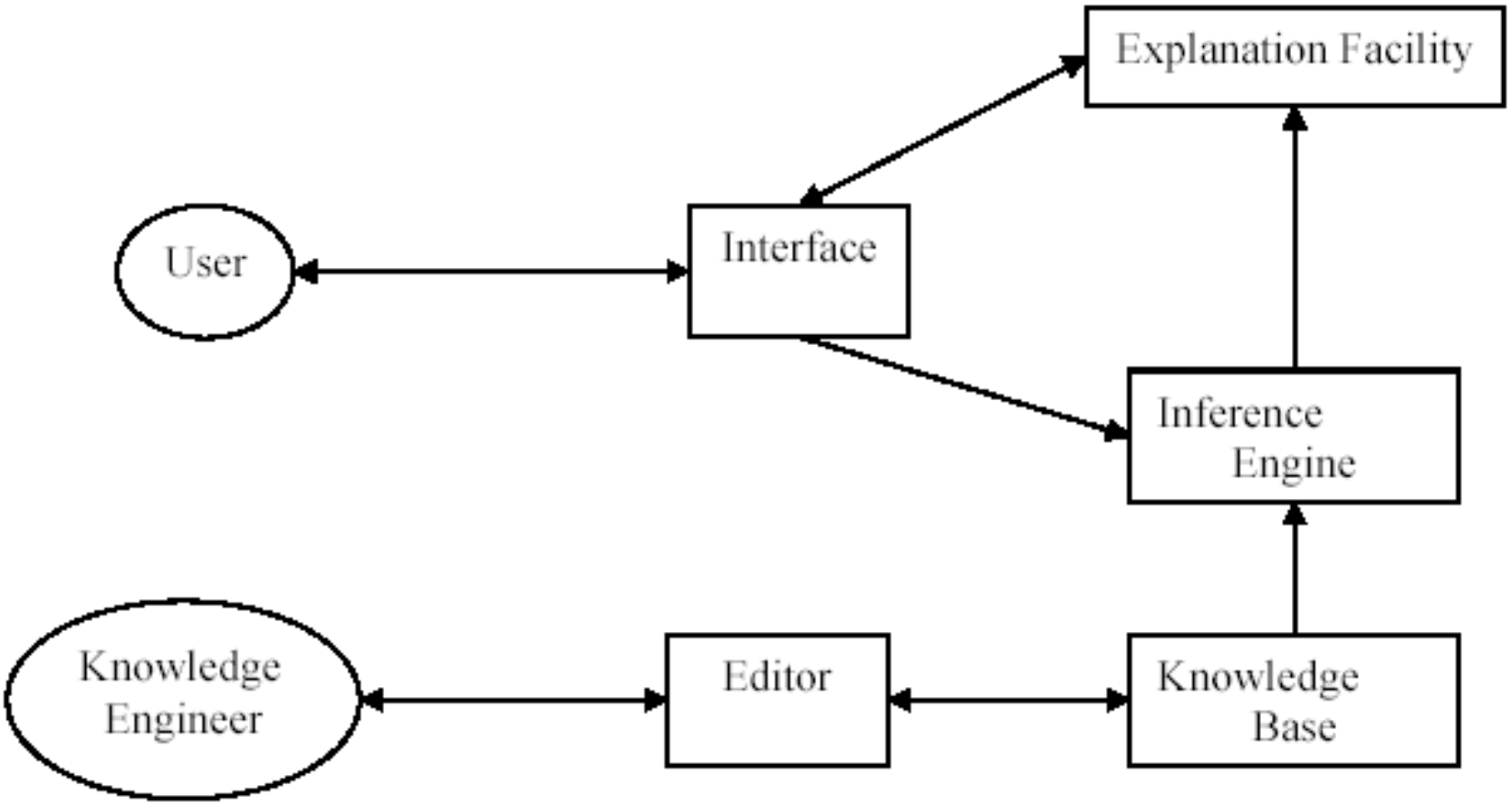
Knowledge Base



Expert System

- Expert System is an extension of the decision support system.
- **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

Expert System Architecture



Architecture of a Typical Expert System

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.

Knowledge Engineer

- Knowledge Engineer
  - A knowledge engineer is a computer scientist who knows how to design and implement programs that incorporate artificial intelligence techniques.
- Knowledge Engineering
  - The art of designing and building the expert systems is known as Knowledge Engineering, knowledge engineers are its practitioners.
  - Knowledge engineering relies heavily on the study of human experts in order to develop intelligent & skilled programs.

Knowledge Engineer

- The engineer then translates the knowledge into a computer- usable language, and designs an inference engine, a reasoning structure, that uses the knowledge appropriately.
- He/she also determines how to integrate the use of uncertain knowledge in the reasoning process, and what kinds of explanation would be useful to the end user.
- When the expert system is implemented, it may be:
  - The inference engine is not just right
  - Form of representation of knowledge is awkward
- An expert system is judged to be entirely successful when it operates on the level of a human expert.

Expert Systems

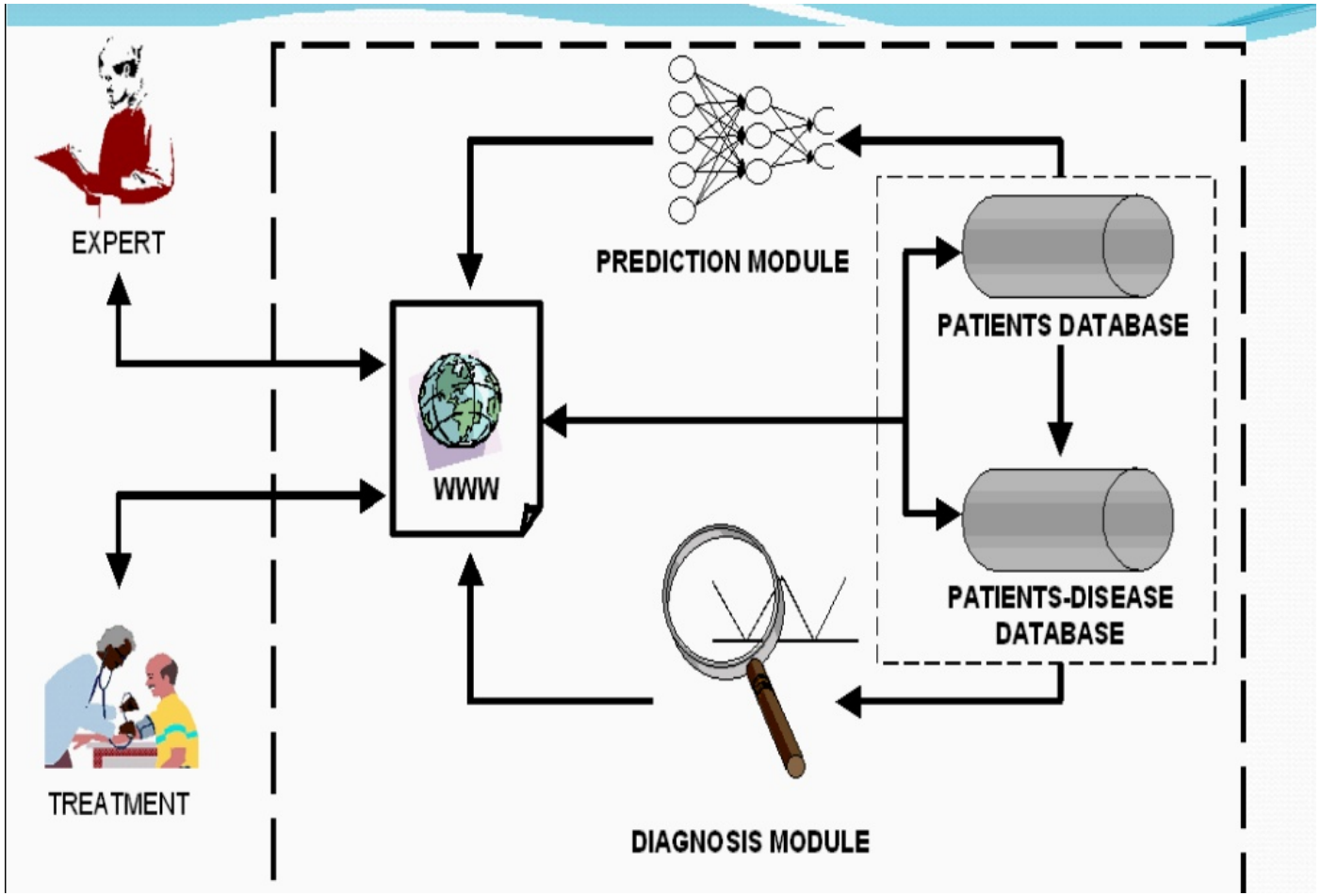
Characteristics of Expert System

- 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)
  - Capture of scarce expertise
  - 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

Example of Expert System



PXDES – expert system

- What it does
  PXDES, is a expert system that uses an inference engine to determine the type and degree of pneumoconiosis, or lung cancer.

  It uses X-rays to look at shadows on the lungs. These shadows then are used to determine the type and degree of lung cancer.
- Gives the result faster than human experts can

Example: AGREX

- It gives correct advice to farmers.
- Topics of advice are fertilizer application, crop protection, irrigation scheduling and diagnosis of diseases in paddy and post harvest technology of fruits and vegetables

Intelligent System

- **Intelligent systems** is a term that describes the various commercial applications of AI.
- **Artificial Intelligence (AI)** is a subfield of computer science concerned with:
  - studying the thought processes of humans;
  - recreating those processes via machines, such as computers and robots.
- **Behavior by a machine that, if performed by a human being, would be considered intelligent.**
- **Turing test** is a test for artificial intelligence, in which a human interviewer, conversing with both an unseen human being and an unseen computer, cannot determine which is which: named for British Mathematician **AI** pioneer (Alan Turing).

Artificial Intelligence

- A field of science and technology based on disciplines such as computer science, biology, psychology, linguistics, mathematics, & engineering
- At the machine level, think like human and act like human means Artificial Intelligence.
- Goal is to develop computers that can think, see, hear, walk, talk, and feel.
- Major thrust to development of computer functions normally associated with human intelligence reasoning, learning, problem solving

Domains of Artificial Intelligence

- Domains of AI
  - Three major areas
    - Cognitive science - study of the mind and its processes
    - 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 -observes through sensors and acts upon an environment using actuators and directs its activity towards achieving goals

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 Network

- A method of computing, based on the interaction of multiple connected processing elements.
- A powerful technique to solve many real world problems.
- The ability to learn from experience in order to improve their performance.
- Ability to deal with incomplete information

Virtual Reality

- Virtual reality is plainly speaking, seeing an imaginary world, rather than the real one. Seeing, hearing, smelling, testing, feeling. The imaginary world is a simulation running in a computer. The sense data is fed by some system to our brain.
- A medium composed of interactive computer simulations giving users the feeling of being present in the simulations.

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.

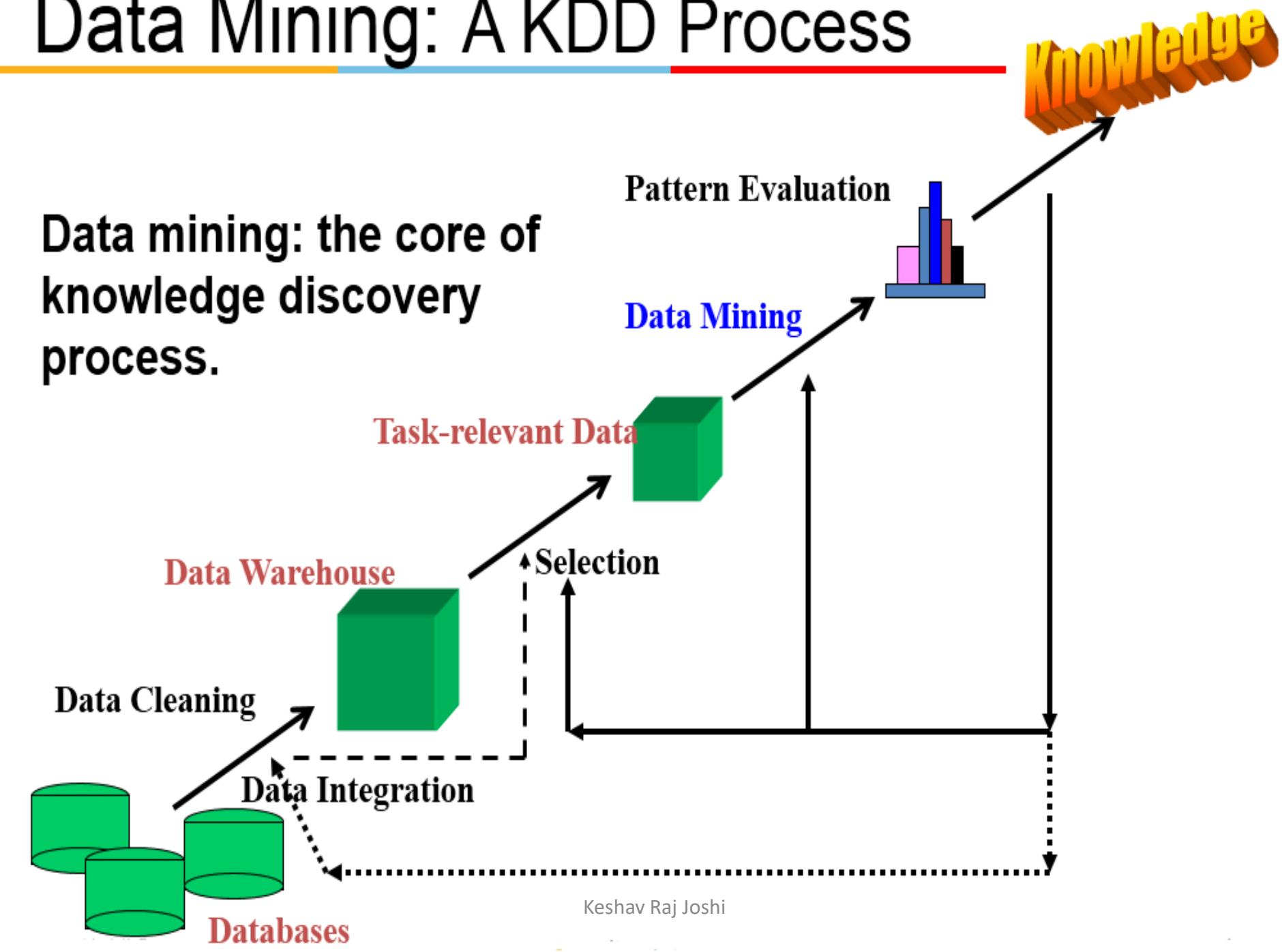
Data Mining

- 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 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.

Data Mining

- Data mining refers to using a variety of techniques to identify nuggets of information or decision-making knowledge in bodies of data, and extracting these in such a way that they can be put to use in the areas such as decision support, prediction, forecasting and estimation.
- 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.

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

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"

Why Data Mining

- Credit ratings/targeted marketing:
  - Given a database of 100,000 names, which persons are the least likely to default on their credit cards?
  - Identify likely responders to sales promotions
- Fraud detection:
  - Which types of transactions are likely to be fraudulent, given the demographics and transactional history of a particular customer?
- Customer relationship management:
  - Which of my customers are likely to be the most loyal, and which are most likely to leave for a competitor?

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.

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

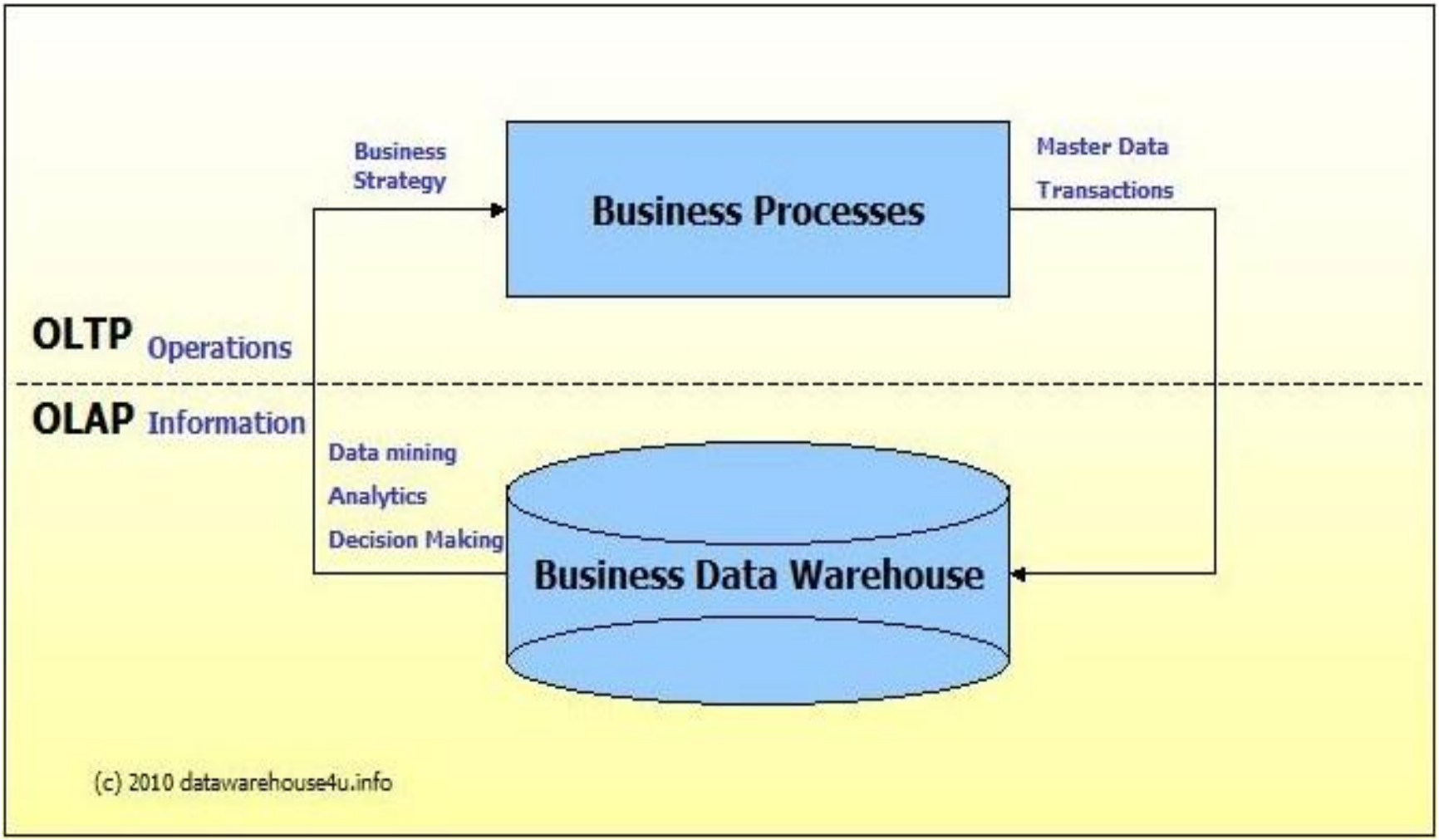
OLTP vs. OLAP

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

Thank you