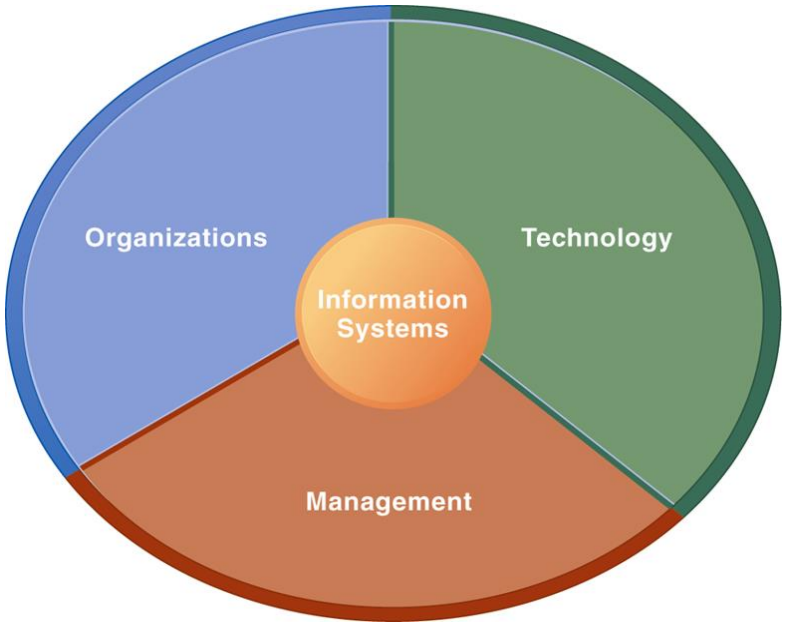
Intelligent Decision Support Methods

Hung Son Nguyen

University of Warsaw

Information Systems

"I know of no commodity more valuable than information."



Management Information System (MIS)

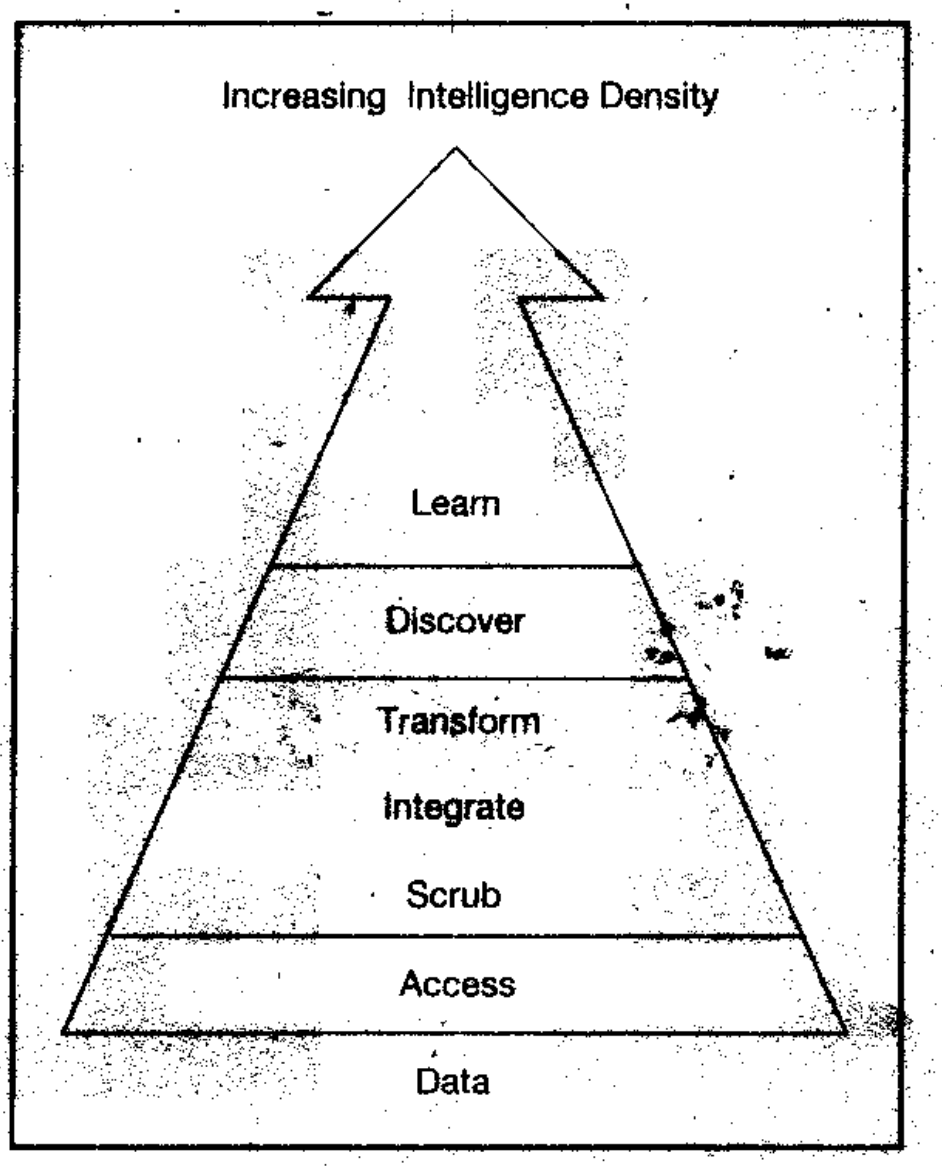
- Transaction Processing Systems (TPS)
  - Accurate Record Keeping
- Decision Support Systems (DSS)
  - Model-Driven DSS
  - Data-Driven DSS

Intelligence Density

- **DEF**: A Metric for Knowledge Work Productivity.
- **Knowledge Intensive** organizations *transform* raw data into something useful „*knowledge*" and *deliver* the knowledge to the part of the organization where it can be used most effectively.
- **Intelligence Density**: How quickly can you get the essence of the underlying data from the output?

The Vocabulary of Intelligence Density

- Quality of Model
  - Accuracy, Explainability, Speed, Reliability..
- Engineering Dimension
  - Flexibility, Scalability, Ease of Use,...
- Quality of Available Resource
  - Learning Curve, Tolerances for Noise, Complexity,...
- Logistical Constraints
  - Independence from Experts, Computational Ease, Development Time,..



1 - Steps for Increasing Intelligence Density

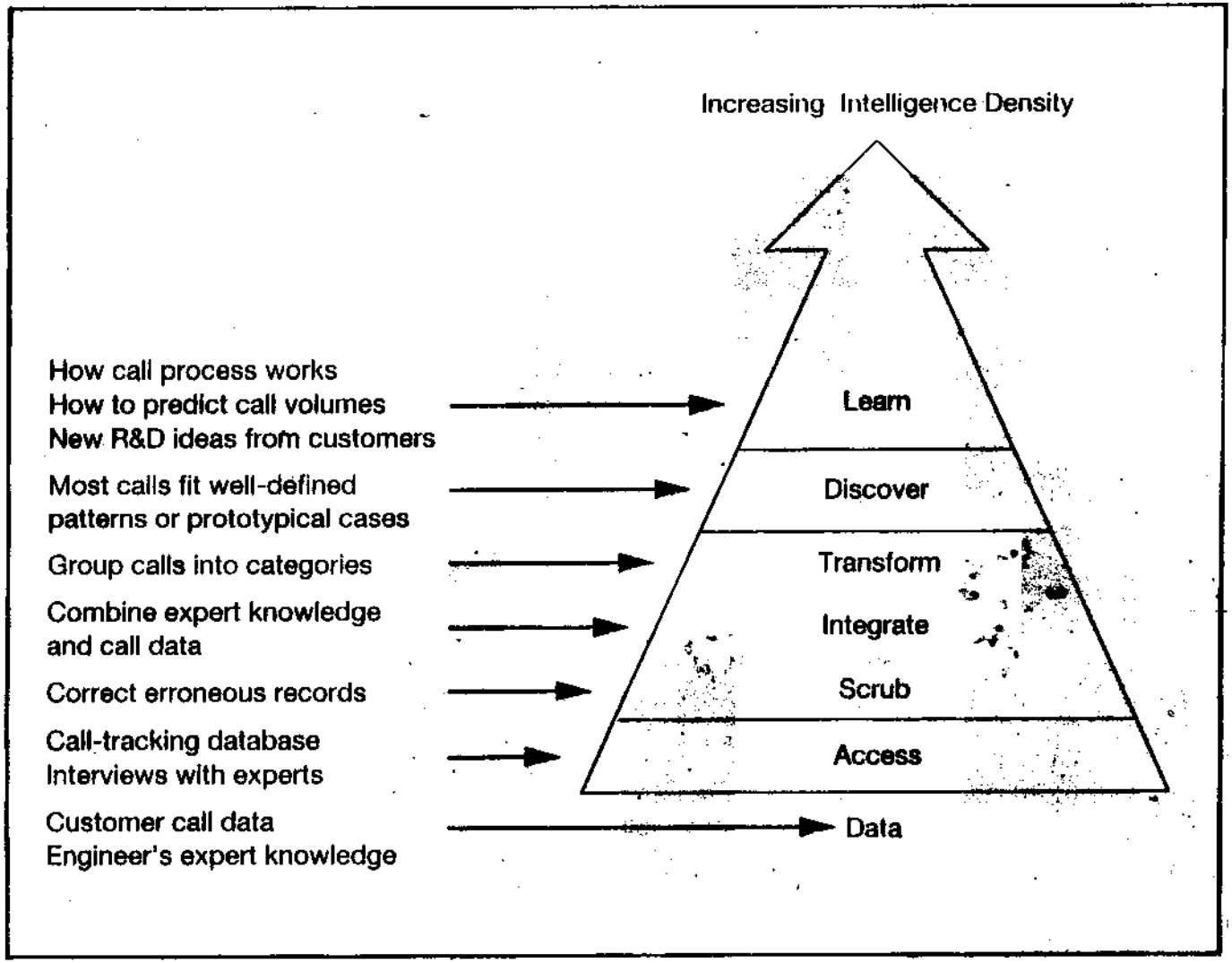


FIGURE 2.2 Jetstream's Steps for Increasing Intelligence Density

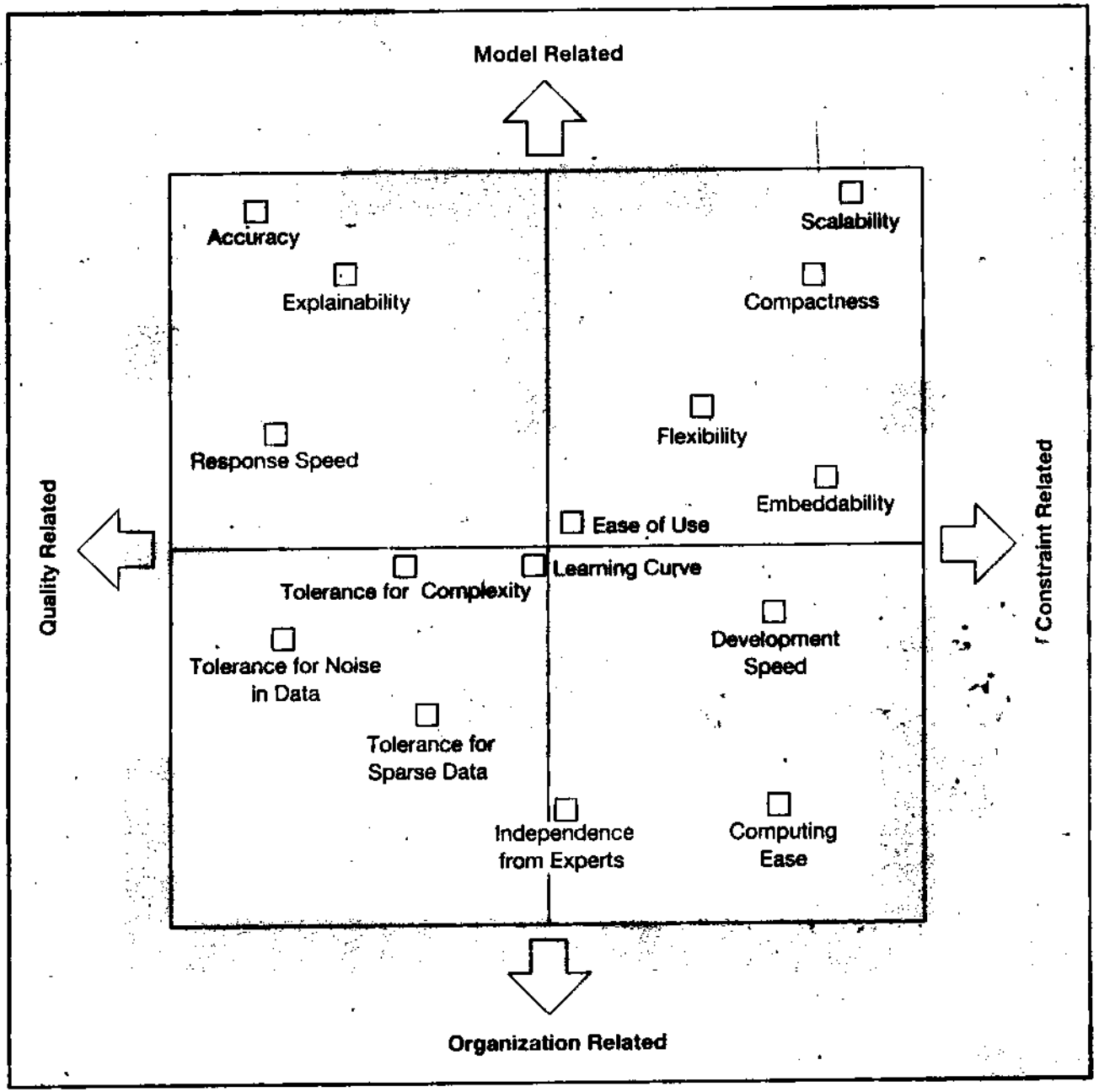


FIGURE 3.5 The Stretch Plot: A Comprehensive View of Intelligence Density

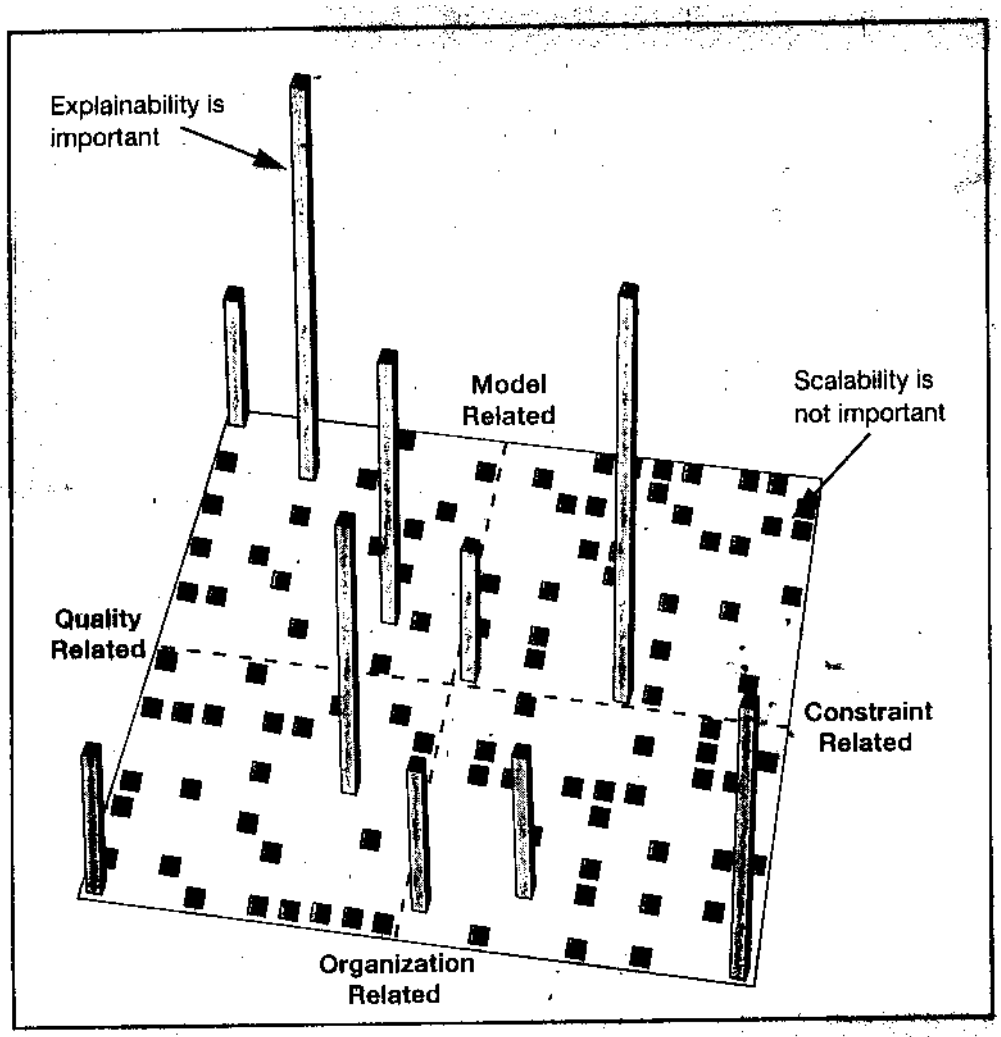


FIGURE 3.6 An Example of an ID Profile for a Problem

Dimensions of Problems and Solutions

- Intelligence Density Dimensions: Quality of Systems
- How Well is the System Engineered?
- Quality of Available Resources
- Logistical Constraints

Intelligence Density Dimensions: Quality of Systems (1/2)

- Accuracy
  - measures how dose the outputs of a system are to the correct or best decision. Can you be confident that the errors(results that are not accurate)are not so severe as to make the sys-tem too costly or dangerous to use?

- Explainabilitv
  - is the description of the process by which a conclusion was reached. Statistical models explain the output to some degree in the sense that each independent variable influences or 'explains' the dependent variable in that it accounts for some portion of the variance of the dependent variable.

Intelligence Density Dimensions: Quality of Systems (2/2)

  - Other systems, where rule-based reasoning is involved, show exp1icitly how conclusions are derived, yet others, such as neural networks, generate opaque mathematical formulas. These are sometimes referred to as 'black boxes', because for the user they are the mathematical equivalent of the magician's black box: Data go in at one end and results come out the other, but you cannot (easily) see the rationale behind the conclusion.

- Response speed
  - is the time it takes for a system to complete analysis at the desired level of accuracy. The flip side to this dimension is confidence in the sense that you can ask how confident you are that a certain period of time, within which the system must provide an answer, will be sufficient to perform the analysis. In applications that require that results be produced within a specified timeframe, missing that time frame means that no matter how accurate and otherwise desirable the results are, they will be useless in practice.

How Well is the System Engineered? (1/3)

- Scalability
  - involves adding more variables to the problem or increasing the range of values that variables can take. For example, scalability is a major issue when you're interested in going from a prototype system involving 10 variables to one with 30 variables. Scalability can be a real problem when the interactions among variables increase rapidly in unpredictable ways with the introduction of additional variables(making the system brittle)or where the computational complexity increases rapidly.
- Compactness
  - refers to how small (literally, the number of bytes) the system can be made.Once a system has been developed and tested, it needs to be put into the hands of the decision makers within an organization. It must be taken out into the field, be that the shop floor, the trading floor, or the ocean floor.

How Well is the System Engineered? (2/3)

- Flexibility
  - is the ease with which the relationships among the variables or their domains can be changed, or the goals of the system modified. Most systems are not designed to be used once and then thrown away. Instead they must be robust enough to perform well as additional functionality is added over time. In addition, many of the business processes that you might model are not static (i.e., they change over time). As a result, the ability to update a system or to have the system adapt itself to new phenomena important.
- Embeddability
  - refers to the ease with which a system can be coupled with or incorporated into the infrastructure of an organization. In some situations, systems will be components of larger systems or other databases. If this is the case, systems must be able to communicate well and mesh smoothly with the other components of the organization infrastructure. A system that requires proprietary software engineer,or specific hardware will not necessarily be able to integrate itself into this infrastructure.

How Well is the System Engineered? (3/3)

- Ease of use
  - describes how complicated the system is to use for the businesspeople who will be using it on a daily basis. Is it an application that requires a lot of expertise or training, or is it something a user can apply right out of the box?

Quality of Available Resources

- Tolerance for noise in data
  - the degree to which the quality of a system, most notably its accuracy, is affected by noise in the electronic data.
- Tolerance for data sparseness
  - is the degree to which the quality of a system is affected by incompleteness or lack of data.
- Tolerance for complexity
  - is the degree to which the quality of a system is affected by interactions among the various components of the process being modeled or in the knowledge used to model a process.
- Learning curve requirements
  - indicate the degree to which the organization needs to experiment in order to become sufficiently competent at solving a problem or using a technique.

Logistical Constraints

- Independence from experts
  - is the degree to which the system can be designed, built, and tested without experts. While expertise is valuable, access to experts within an organization can be a logistical nightmare and can be very expensive.
- Computational ease
  - is the degree to which a system can be implemented without requiring special-purpose hardware or software.
- Development speed
  - is the time that the organization can afford to develop a system or, conversely, the time a modeling technology would require to develop a system.

Topics

- Data-Driven Decision Support
- Evolving Solutions: Genetic Algorithms
- Neural Networks
- Rule-Based Expert Systems
- Fuzzy Logic
- Case-Based Reasoning
- Machine Learning

Learning Objectives

- Identify the changes taking place in the form and use of decision support in business.
- Identify the role and reporting alternatives of management information systems.
- Describe how online analytical processing can meet key information needs of managers.
- Explain the decision support system concept and how it differs from traditional management information systems.

Learning Objectives

- Explain how the following information systems can support the information needs of executives, managers, and business professionals:
  - Executive information systems
  - Enterprise information portals
  - Knowledge management systems

Learning Objectives

- Identify how neural networks, fuzzy logic, genetic algorithms, virtual reality, and intelligent agents can be used in business.
- Give examples of several ways expert systems can be used in business decision-making situations.

Supporting Decision Making

I. Introduction

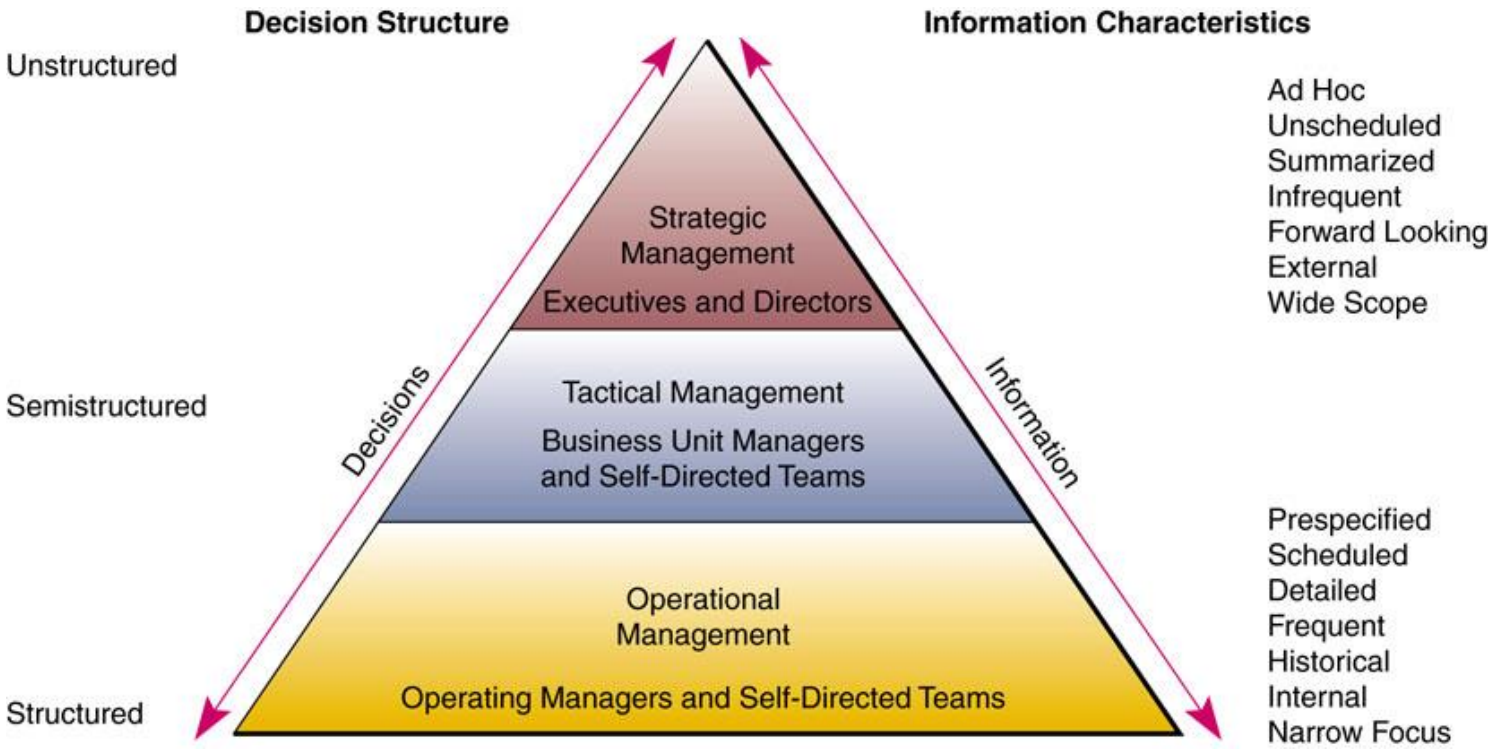
- An organization is a nexus of decisions with information needs supplied by an Information System
- Information, Decisions, and Management – the type of information required by decision makers is directly related to the level of management decision making and the amount of structure in the decision situation
  - Strategic Management – executive level, long-range plans, organizational goals and policies, and objectives
  - Tactical Management – mid-level management, medium- and short-range plans to support objectives made by executives, and allocation of resources and performance monitoring of organizational subunits
  - Operational Management – short-range plans, day-to-day operations, direct the use of resources and performance of tasks

I. Introduction

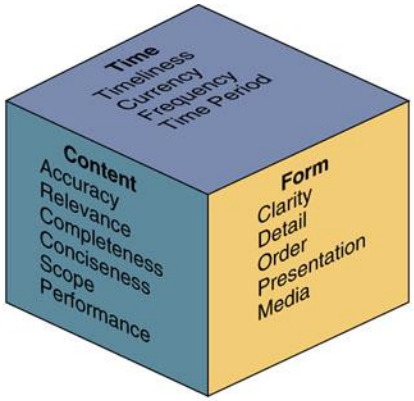
- Information Quality – characteristics of information products
  - Timeliness – was information present when needed?
  - Accuracy – was the information correct & error free?
  - Completeness – was all the needed information there?
  - Relevance – was the information related to the situation?
- Decision Structure
  - Structured – operational level, occur frequently, much information available
  - Semistructured – managerial level (most business decisions are here), not as frequent, less information available
  - Unstructured – executive level, infrequent, little information available

I. Introduction

Information Requirements of Decision Makers



I. Introduction



Dimensions of Information

Time Dimension	
Timeliness	Information should be provided when it is needed.
Currency	Information should be up-to-date when it is provided.
Frequency	Information should be provided as often as needed.
Time Period	Information can be provided about past, present, and future time periods.
Content Dimension	
Accuracy	Information should be free from errors.
Relevance	Information should be related to the information needs of a specific recipient for a specific situation.
Completeness	All the information that is needed should be provided.
Conciseness	Only the information that is needed should be provided.
Scope	Information can have a broad or narrow scope, or an internal or external focus.
Performance	Information can reveal performance by measuring activities accomplished, progress made, or resources accumulated.
Form Dimension	
Clarity	Information should be provided in a form that is easy to understand.
Detail	Information can be provided in detail or summary form.
Order	Information can be arranged in a predetermined sequence.
Presentation	Information can be presented in narrative, numeric, graphic, or other forms.
Media	Information can be provided in the form of printed paper documents, video displays, or other media.

II. Decision Support Trends

- Using IS to support business decision making is increasing
- Business Intelligence (BI) – improving business decision making using fact-based support systems
- Business Analytics (BA) – iterative exploration of a firm's historical performance to improve the strategic planning process

Hyatt Hotels: Dashboards Integrate Financial and Operational Information

- **What did Hyatt want that was different from traditional dashboards?**
- **What made this necessary?**
- **What tool did they adopt to do this?**
- **What benefits does it provide?**

III. Decision Support Systems

- **IS providing interactive support to managers during the decision-making process**
- **DSS Components – DSS relies on model-bases as well as databases**

United Agri Products: Making Better Decisions Using Models and Data

- **What BI tools was UAP unhappy with? Why?**
- **What tools did the new system supply and why were they better than the old ones?**
- **What benefits did they bring to UAP?**

IV. Management Information Systems

- Supports day-to-day managerial decision making
- Management Reporting Alternatives – MIS reports:
  - Periodic Scheduled Reports – supplied on a regular basis
  - Exception Reports – created only when something out of the ordinary happens
  - Demand Reports and Responses- available when requested
  - Push Reporting – reports sent without being requested

V. Online Analytical Processing

- Enables examination/manipulation of large amounts of detailed and consolidated data from many perspectives
  - Consolidation aggregation of data
  - Drill-Down – displaying details that comprise the consolidated data
  - Slicing and Dicing – looking at a database from different viewpoints
  - OLAP Examples – the real power of OLAP is the combining of data and models on a large scale, allowing solution of complex problems
  - Geographic Information (GIS) and Data Visualization (DVS) Systems
    - GIS – facilitate use of data associated with a geophysical location
    - DVS – represent complex data using interactive 3-dimensional models, assist in discovery of patterns, links and anomalies

Direct Energy: Mining BI to Keep Its Customers

- What was the problem with the old business intelligence at Direct Energy?
- What BI technique did they use for the new system?
- What benefits did Direct Energy obtain from it?

JPMorgan and Panopticon: Data Visualization Helps Fixed income Traders

- **What does Panopticon provide for JPMorgan?**
- **What does this provide for JPMorgan's customers?**
- **How does the software present the data to the customers?**
- **How does this help a business?**

VI. Using Decision Support Systems

- Involves interactive analytical modeling for exploring possible alternatives
- What-If Analysis – change variables and relationships among variables to see changing outcomes
- Sensitivity Analysis – special case of what-if; change one variable at a time to see the effect on a pre-specified value
- Goal-Seeking Analysis – reverse of what-if; changing variables to reach a target goal of a variable
- Optimization Analysis – complex goal-seeking; finding the optimal value for a target variable

Casual Male Retail Group: On-Demand Business Intelligence

- What type of system was Casual Male using?
- What were its weaknesses?
- How did they solve this problem?
- What business tools does this system provide?

VI. Using Decision Support Systems

- Data Mining for Decision Support – providing decision support through knowledge discovery (analyze data for patterns and trends)
  - Market Basket Analysis (MBA) – one of the most common and useful types of data mining; MBA applications:
    - Cross-Selling – offer associated items to that being purchased
    - Product Placement – related items physically near each other
    - Affinity Promotion – promotions based on related products
    - Survey Analysis – useful to analyze questionnaire data
    - Fraud Detection – detect behavior associated with fraud
    - Customer Behavior – associate purchases with demographic and socioeconomic data

Warner Home Video: Predicting Harry Potter DVD Sales

- What does Warner use to help in sales forecasting?
- What does this help them do?
- What are the first steps and what do they do with that information?
- What does this better data enable them to do?

VII. Executive Information Systems (EIS) a.k.a. Executive Support Systems (ESS)

- Popular to the point of being called "Everyone's Information Systems"
  - Features of an EIS – can be tailored to preferences of the executive, provides drill-down capabilities and "dashboards"

PureSense and Farming: Watering Plans Based on Minute-by-Minute Data

- **Although the farmer was receiving more information than ever before, he wanted …. ?**
- **Why would a dashboard be important? Or helpful?**
- **Even with the experience ot analyze all the data, many of the decisions are … ? Why?**

VIII. Enterprise Portals and Decision Support

- **Enterprise Information Portals (EIP) – Web-based interface with integration of MIS, DSS, EIS, etc., to give intranet/extranet users access to a variety of applications and services**

IX. Knowledge Management Systems

- Use of IT to gather, organize, and share knowledge within an organization
  - Enterprise Knowledge Portal – entry to knowledge management systems

Mitre and 3M: Two Takes on Knowledge Management

- **What is the organizational culture that should be fostered to support knowledge management?**
- **How does social networking support this culture?**
- **How can this culture help a business?**

Advanced Technologies for Decision Support

I. Business and AI

- A variety of ways to support decision making and improve competitive advantage

II. An Overview of Artificial Intelligence (AI)

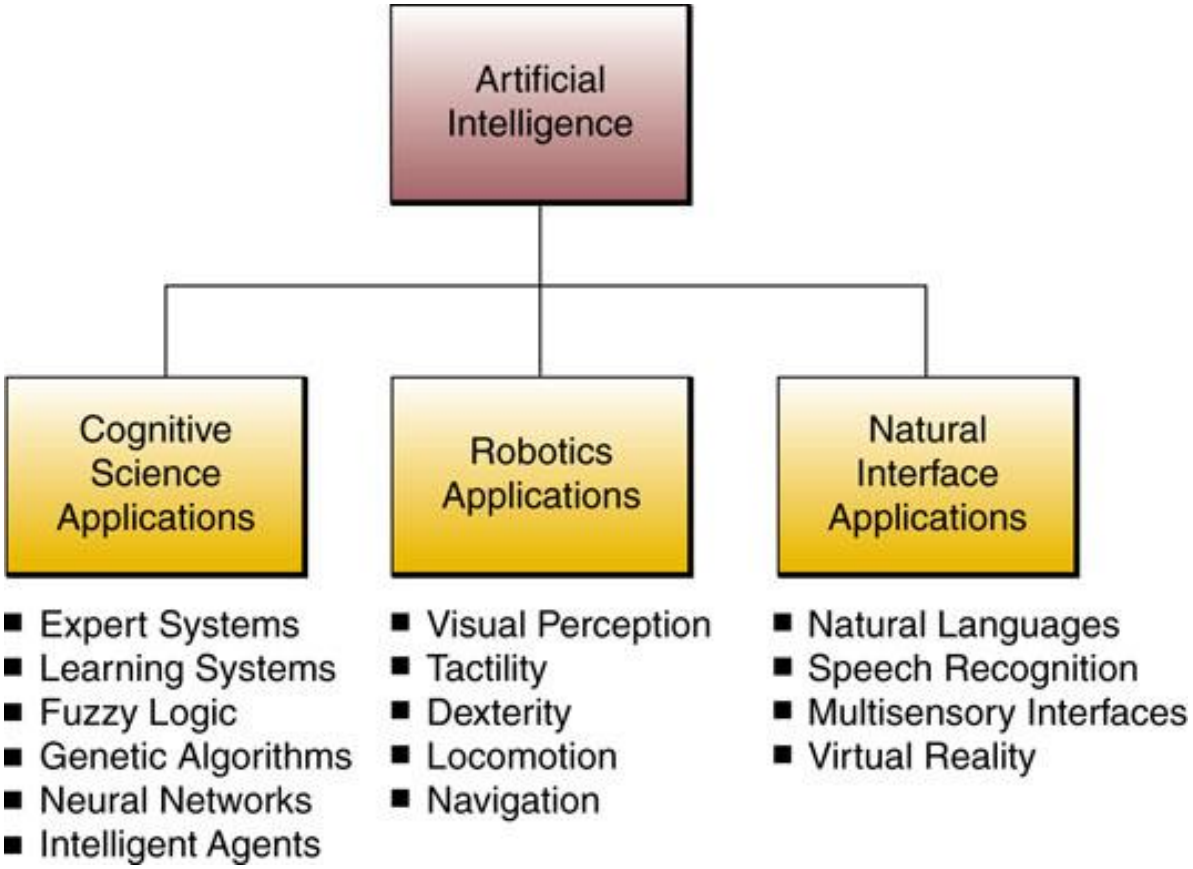
- Goal of AI is to simulate the ability to think – reasoning, learning, problem solving
- Turing Test – if a human communicates with a computer and does not know it is a computer, the computer is exhibiting artificial intelligence
- CAPTCHA (Completely Automated Public Turing Test) – a test to tell people from computers – a distorted graphic with letters/numbers; a human can see the letters/numbers a computer cannot

II. An Overview of Artificial Intelligence (AI)

- **Domains of Artificial Intelligence**
  - **Cognitive Science – how humans think and learn**
  - **Robotics – machines with intelligence and human-like physical capabilities**
  - **Natural Interfaces – speaking to a computer in a normal voice**

II. An Overview of Artificial Intelligence (AI)

Applications of Artificial Intelligence



Artificial Intelligence Gets Down to Business

- What sort of things do AI applications do?
- What is at the heart of AI applications?
- What benefits can businesses obtain from AI?

III. Expert Systems

- Components of an Expert System
  - Knowledge Base – contains facts and the heuristics (rules) to express the reasoning procedures the expert uses
  - Software Resources –
    - Inference Engine – the program that processes the knowledge (rules and facts)
    - Interface – the way the user communicates with the system

III. Expert Systems

- Expert System Applications
  - Decision Management – consider alternatives, recommendations
  - Diagnostics/Troubleshooting – infer causes from symptoms
  - Design/Configuration – help configure equipment components
  - Selection/Classification – help users choose products/processes
  - Process Monitoring/Control – monitor/control procedures/processes
- Benefits of Expert Systems – captures expertise of a specialist in a limited problem domain
- Limitations of Expert Systems – limited focus, inability to learn, cost

Healthways: Applying Expert Systems to Health Care

- What is the key to successful disease management?
- How does Healthways generally improve its members' health outcomes?
- What is Healthways' goal?
- How is Healthways using technology to meet this goal?

IV. Developing Expert Systems

- Easiest is an expert system shell – an experts systems without the knowledge base
  - Knowledge Engineering – a knowledge engineer (similar to a systems analyst) is the specialist who works with the expert to build the system

V. Neural Networks

- Computing systems modeled after the brain

BioPassword: Neural Networks Applied to Authentication

- What are the basic tradeoffs when dealing with security?
- What are the three basic approaches to providing security?
- What is the new approach from BioPassword?
- What are the advantages of this method?

VI. Fuzzy Logic Systems

- Reasoning with incomplete or ambiguous data
  - Fuzzy Logic in Business – rare in the U.S. (preferring expert systems), but popular in Japan

VII. Genetic Algorithms

- Simulates evolutionary processes that yield increasingly better solutions

United Distillers: Moving Casks Around with Genetic Algorithms

- **What is the forgotten side of the business at United Distillers?**
- **What technology did they use to remedy this?**
- **What are the results of using this technology?**

VIII. Virtual Reality (VR)

- Computer-simulated reality
- VR Applications – CAD, medical diagnostics, flight simulation, entertainment

IX. Intelligent Agents

- Use built-in and learned knowledge to make decisions and accomplish tasks that fulfill the intentions of the user

Real Students Practice on Virtual Surgeries

- **What does this virtual software allow medical students to do?**
- **What may be the location of their instructors?**
- **Why is this important?**
- **What benefits would this software offer?**

Security Uses of Intelligent Software Agents

- How did the Army use intelligent agents?
- What are intelligent agents good at doing?
- How much effort did intelligent agents save the Army?

...From Aphorismus Book...

...Wisdom is nontransferable. The sage' knowledge which he try to transfere, sounds always like nonsense...

(... Mądrości nie można przekazać. Wiedza, którą próbuje przekazywać mędrzec, brzmi zawsze jak głupota...),

...Study period is the time when you are instructing by somebody you don't want to know, about something you don't want to know...

(... Okres nauki to czas gdy jesteś pouczany przez kogoś kogo nie chcesz znać, o czymś czego nie chcesz wiedzieć ...)

…Knowledge is powerless unless it prepares you to do the right thing at the right time…

(…Wiedza nic nie daje, jeżeli nie przygotowuje cię do podjęcia właściwej decyzji we właściwym czasie…)

Subject:

…Management Information System – refers to (means) a collection of computerized and net technologies whose objective is to support managerial work and especially decision making…

…System designed to provide past, present, and future information appropriate for planning, organizing, and controlling the operations of functional areas in an organization…

(Turban E., at all: IT for Management … 2008)

Some definitions (glossary)…

- ***Data items*** – refer to an elementary description of facts and figures relatively important for users, data item – an elementary description of things, events, activities, and transactions, that are recorded, classified, and stored but not organized to convey any specific meaning: can be numeric, alphanumeric, figures, sounds or images
- **A database** – consists of stored data items organized for retrieval

- ***Information*** – is processed, meaningful data… data that have been organized, so they have meaning and value to the recipient

- Data items typically are processed into information by means of an application, represents a more specific use and a higher added value than simple retreieval and summarizing from a database
- ***Knowledge*** – data and/or information that have been organized and processed to convey (distribute) understanding, experience, accumulated learning, and expertise (what to do with information)
- ***Wisdom –*** the ability to make sensible (rational) decisions and give good advice because of the experience, intuition and knowledge that you have (how to use knowledge, how to do it in rational way)

Some definitions (glossary)…

- ***Data items*** – a student first name, name, grade in a class, the number of hours an employe worked in a certain week, etc.
- ***Information*** – a student's grade point average (GPA), the application transforminf data in information might be a Web-based inventory management system, a univerity online registration, or e-commerce (internet-based buying and selling) system
- ***Knowledge*** – GPA of a student applying to Erasmus Students Exchange can be compared with GPA of the other students applying to this sholarship and be over average of all students from faculty (average is only criteria of selection)
- ***Wisdom –*** see above case – inspite of level of GPA you know from your experience or partner's knowledge that in Italy or Spain in most cases courses are in Italian or Spanish, so you first of all send there students speak these languages…

Some definitions (glossary)…

- *System* – group of elements integrated with common purpose of achieving an objective (…) by transforming input resources to output resources…
- *Information system* – group of programs integrated in three areas: programme, logical and technical…, a physical process, that supports an organization in collecting, processing, storing nad analyzing data, and disseminating information to achieve organizational goals.
- *Information Technology* – the technology component of an information system (a narrow definition), or the collection of the computing systems in an organization (the broad definition)
- *Information infrastructure – the physical arrangement of: harware, software, databases, networks, and information management personnel*
- …*Decision making* – a process of choosing among alternative courses of action for the purpose of attainings a goal or goals…

  What should be done? When? How? Where? By whom?
- *Model (in decision making)* – a simplified representation or abstraction of reality; can be used to performs virtual experiments and analysis

Some definitions (glossary)…

A computer-based information system **is an information system that uses computer and net technology to perform some or all of its intnded tasks.**

- **The basic components of the system are *hardware, software, database(s), telecommunication networks, procedures and people*.**
- **Hardware is a set of devices that accept data and information, process them, and display or raport them.**
- **Software is a set of programs that enable the hardware to process data.**
- **A database is a collection of related files, tables, relations, and so on that stores data and the associations among them.**
- **A network is a connecting system (wireline or wireless) that permits different computers to share resources.**
- **Procedures are the set of instructions about how to combine the above components in order to process information and generate the desire output.**
- **People (users or final users, maybe curtomers) are those individuals who work with the information system, interface with it, or use its outputs**

Some definitions (glossary)…

- **Information system:**
  - Set of interrelated components
  - Collect, process, store, and distribute information
  - Support decision making, coordination, and control

- **Information vs. data**
  - Data are streams of raw facts
  - Information is data shaped into meaningful form

Some definitions (glossary)…

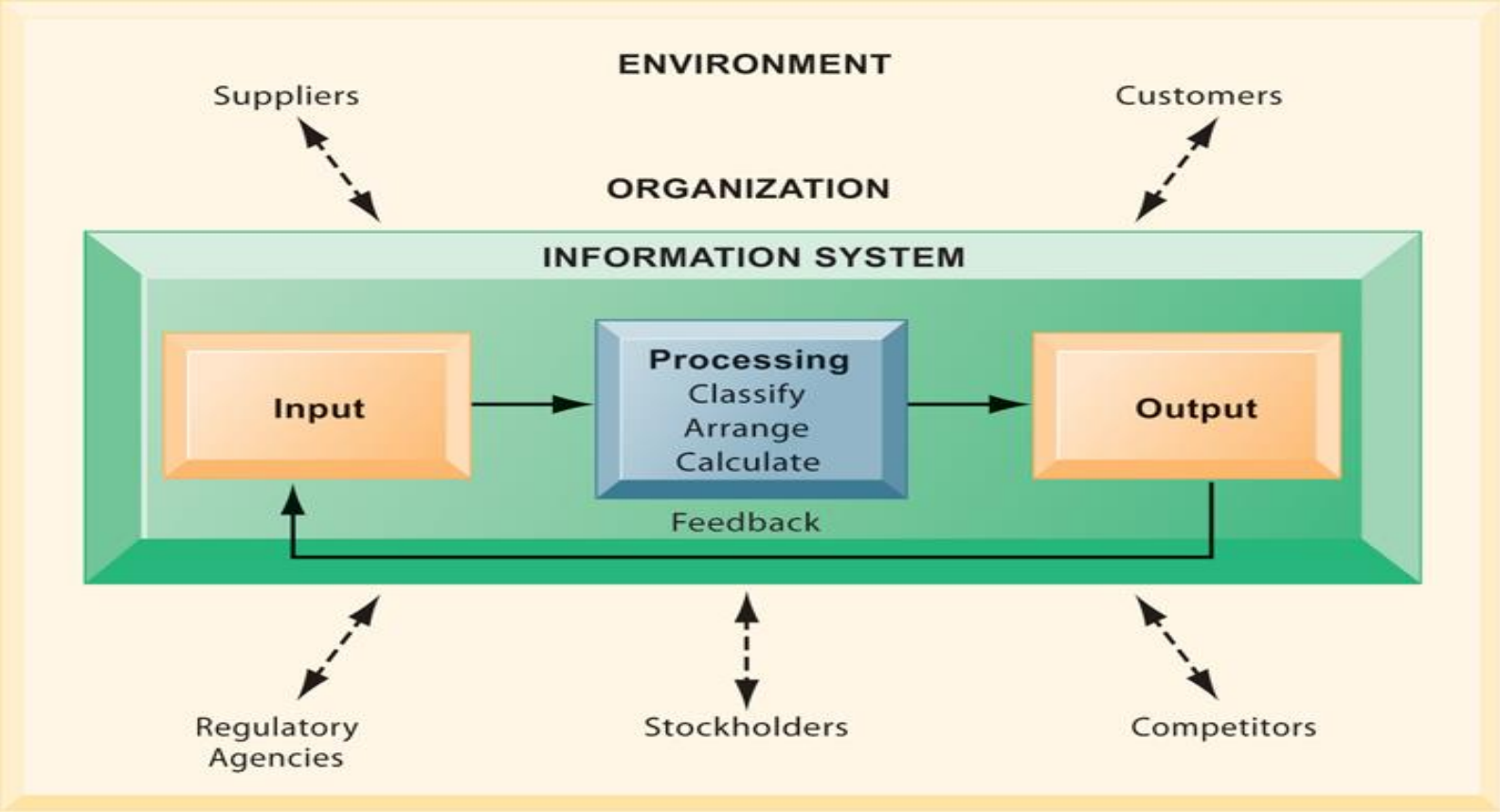
- **Information system:** three activities produce information organizations need
  - **Input**: Captures raw data from organization or external environment
  - **Processing**: Converts raw data into meaningful form
  - **Output**: Transfers processed information to people or activities that use it
- **Feedback**:

Output returned to appropriate members of organization to help evaluate or correct input stage

- **Computer/Computer program vs. information system**

Computers and software are technical foundation and tools

Functions of an Information System



An information system contains information about an organization and its surrounding environment. Three basic activities—input, processing, and output—produce the information organizations need. Feedback is output returned to appropriate people or activities in the organization to evaluate and refine the input. Environmental actors, such as customers, suppliers, competitors, stockholders, and regulatory agencies, interact with the organization and its information systems.