OVERVIEW OF BUSINESS INTELLIGENCE, ANALYTICS, DATA SCIENCE, AND ARTIFICIAL INTELLIGENCE

Opening Vignette: How Intelligent Systems Work for KONE Elevators and Escalators Company

1.1 OPENING VIGNETTE: How Intelligent Systems Work for KONE Elevators and Escalators Company

KONE is a global industrial company (based in Finland) that manufactures mostly elevators and escalators and also services over 1.1 million elevators, escalators, and related equipment in several countries. The company employs over 50,000 people.

THE PROBLEM

Over 1 billion people use the elevators and escalators manufactured and serviced by KONE every day. If equipment does not work properly, people may be late to work, cannot get home in time, and may miss important meetings and events. So, KONE's objective is to minimize the downtime and users' suffering.

The company has over 20,000 technicians who are dispatched to deal with the elevators anytime a problem occurs. As buildings are getting higher (the trend in many places), more people are using elevators, and there is more pressure on elevators to handle the growing amount of traffic. KONE faced the responsibility to serve users smoothly and safely.

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Opening Vignette: How Intelligent Systems Work for KONE Elevators and Escalators Company (cont…)

THE SOLUTION

KONE decided to use IBM Watson IoT Cloud platform. As we will see in Chapter 6, IBM installed cognitive abilities in buildings that make it possible to recognize situations and behavior of both people and equipment. The Internet of Things (IoT), as we will see in Chapter 13, is a platform that can connect millions of "things" together and to a central command that can manipulate the connected things. Also, the IoT connects sensors that are attached to KONE's elevators and escalators. The sensors collect information and data about the elevators (such as noise level) and other equipment in real time. Then, the IoT transfers to information centers via the collected data "cloud." There, analytic systems (IBM Advanced Analytic Engine) and AI process the collected data and predict things such as potential failures. The systems also identify the likely causes of problems and suggest potential remedies. Note the predictive power of IBM Watson Analytics (using machine learning, an AI technology described in Chapters 4–6) for finding problems before they occur.

The KONE system collects a significant amount of data that are analyzed for other purposes so that future design of equipment can be improved. This is because Watson Analytics offers a convenient environment for communication of and collaboration around the data. In addition, the analysis suggests how to optimize buildings and equipment operations. Finally, KONE and its customers can get insights regarding the financial aspects of managing the elevators.

KONE also integrates the Watson capabilities with Salesforce's service tools (Service Cloud Lightning and Field Service Lightning). This combination helps KONE to immediately respond to emergencies or soon-to-occur failures as quickly as possible, dispatching some of its 20,000 technicians to the problems' sites. Salesforce also provides superb customer relationship management (CRM). The people–machine communication, query, and collaboration in the system are in a natural language (an AI capability of Watson Analytics; see Chapter 6). Note that IBM Watson analytics includes two types of analytics: *predictive*, which predicts when failures may occur, and *prescriptive*, which recommends actions (e.g., preventive maintenance).

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THE RESULTS

KONE has minimized downtime and shortened the repair time. Obviously, elevators/escalators users are much happier if they do not have problems because of equipment downtime, so they enjoy trouble-free rides. The prediction of "soon-to-happen" can save many problems for the equipment owners. The owners can also optimize the schedule of their own employees (e.g., cleaners and maintenance workers). All in all, the decision makers at both KONE and the buildings can make informed and better decisions. Some day in the future, robots may perform maintenance and repairs of elevators and escalators.

Note: This case is a sample of IBM Watson's success using its cognitive buildings capability. To learn more, we suggest you view the following YouTube videos: (1) **youtube.com/watch?v=6UPJHyiJft0** (1:31 min.) (2017); (2) **youtube.com/watch?v=EVbd3ejEXus** (2:49 min.) (2017).

Sources: Compiled from J. Fernandez. (2017, April). "A Billion People a Day. Millions of Elevators. No Room for Downtime." IBM developer Works Blog. **developer.ibm.com/dwblog/2017/kone-watson-video/** (accessed September 2018); H. Srikanthan. "KONE Improves 'People Flow' in 1.1 Million Elevators with IBM Watson IoT." Generis. **https://generisgp.com/2018/01/08/ibm-case-study-kone-corp/** (accessed September 2018); L. Slowey. (2017, February 16). "Look Who's Talking: KONE Makes Elevator Services Truly Intelligent with Watson IoT." IBM Internet of Things Blog. **ibm.com/blogs/internet-of-things/kone/** (accessed September 2018).

Changing Business Environments and Evolving Needs for Decision Support and Analytics

- Organizational decision can be classified into four groups:
  - Big-bet, high-risk decisions.
  - Cross-cutting decisions, which are repetitive but high risk that require group work.
  - Ad hoc decisions that arise episodically.
  - Delegated decisions to individuals or small groups.

A general managerial decision-making process:

1. Define the problem
2. Construct a model
3. Identify and evaluate possible solutions
4. Compare, choose, and recommend a solution to the problem

A more detailed decision-making process Quain (2018):

1. Understand the decision you have to make.
2. Collect all the information.
3. Identify the alternatives.
4. Evaluate the pros and cons.
5. Select the best alternative.
6. Make the decision.
7. Evaluate the impact of your decision.

Quain, S. (2018, June 29). "The Decision-Making Process in an Organization." *Small Business Chron*.

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Changing Business Environments and Evolving Needs for Decision Support and Analytics (cont…)

- The environment in which organizations operate today is becoming more and more complex, creating opportunities, and problems (e.g. globalization).

- **Business environment factors** that create pressures on organization:

FACTOR	DESCRIPTION
Markets	Strong competition Expanding global markets Blooming electronic markets on the Internet Innovative marketing methods Opportunities for outsourcing with IT support Need for real-time, on-demand transactions
Consumer demand	Desire for customization Desire for quality, diversity of products, and speed of delivery Customers getting powerful and less loyal
Technology	More innovations, new products, and new services Increasing obsolescence rate Increasing information overload Social networking, Web 2.0 and beyond
Societal	Growing government regulations and deregulation Workforce more diversified, older, and composed of more women Prime concerns of homeland security and terrorist attacks Necessity of Sarbanes-Oxley Act and other reporting-related legislation Increasing social responsibility of companies Greater emphasis on sustainability

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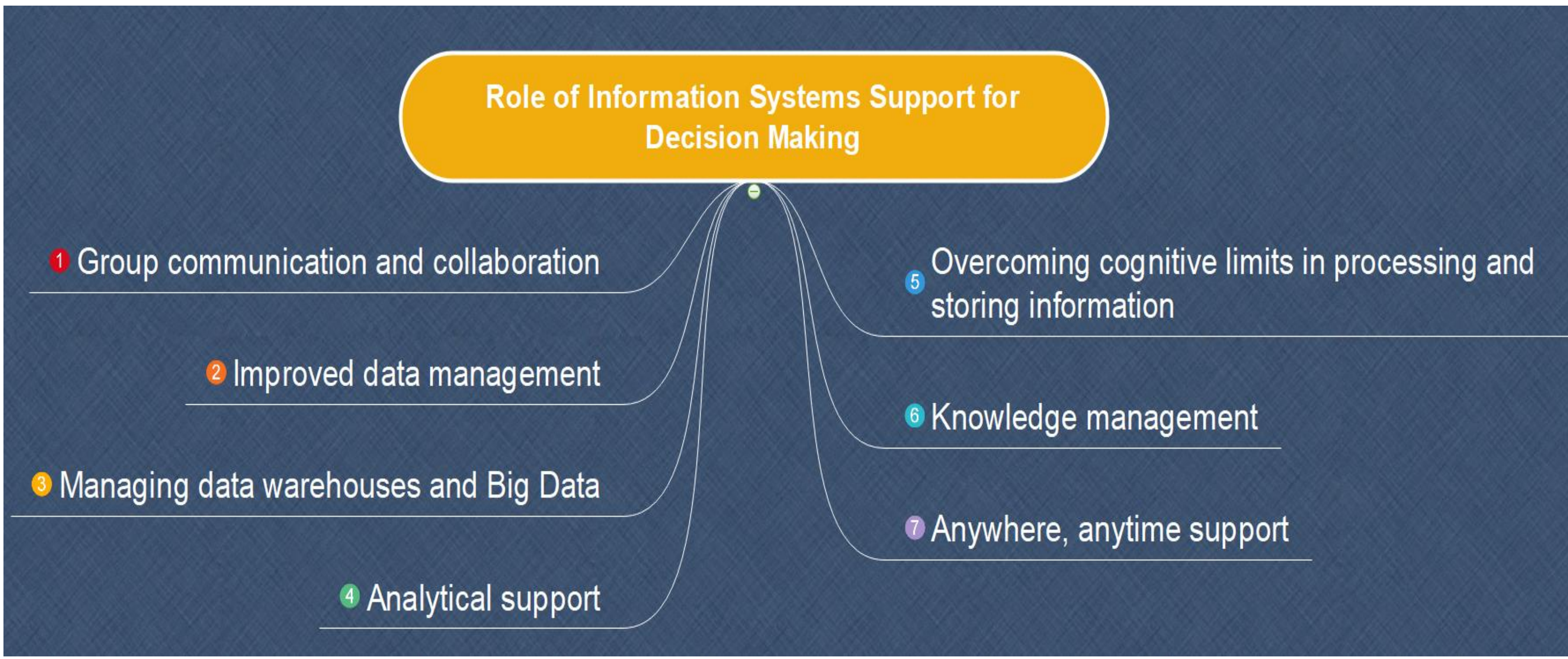
Changing Business Environments and Evolving Needs for Decision Support and Analytics (cont…)

- **Growth in hardware, software, network capacities** have contributed to facilitating the growth of decision support and analytics technologies.

- The following **capabilities/roles of information technologies** also facilitate managerial decision making:



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Decision-Making Process

- **Decision making** is a process of selecting among two or more alternative courses of action for the purpose of attaining one or more goals.

- **Characteristics** of decision making:
  - Groupthink
  - Evaluating what-if scenarios
  - Experimentation with a real system
  - Changes in the decision-making environment may occur continuously
  - Time pressure on the decision maker
  - Analyzing a problem takes time/money
  - Insufficient or too much information

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Decision-Making Process (cont…)

<u>Decision-making Disciplines</u>

Behavioral

- anthropology
- law
- philosophy
- political science
- psychology
- social psychology
- sociology

Scientific

- computer science
- decision analysis
- economics
- engineering
- the hard sciences (e.g. biology, chemistry, physics)
- management science/operations research
- mathematics
- statistics

Each discipline has its own set of assumptions and each contributes a unique, valid view of how people make decisions

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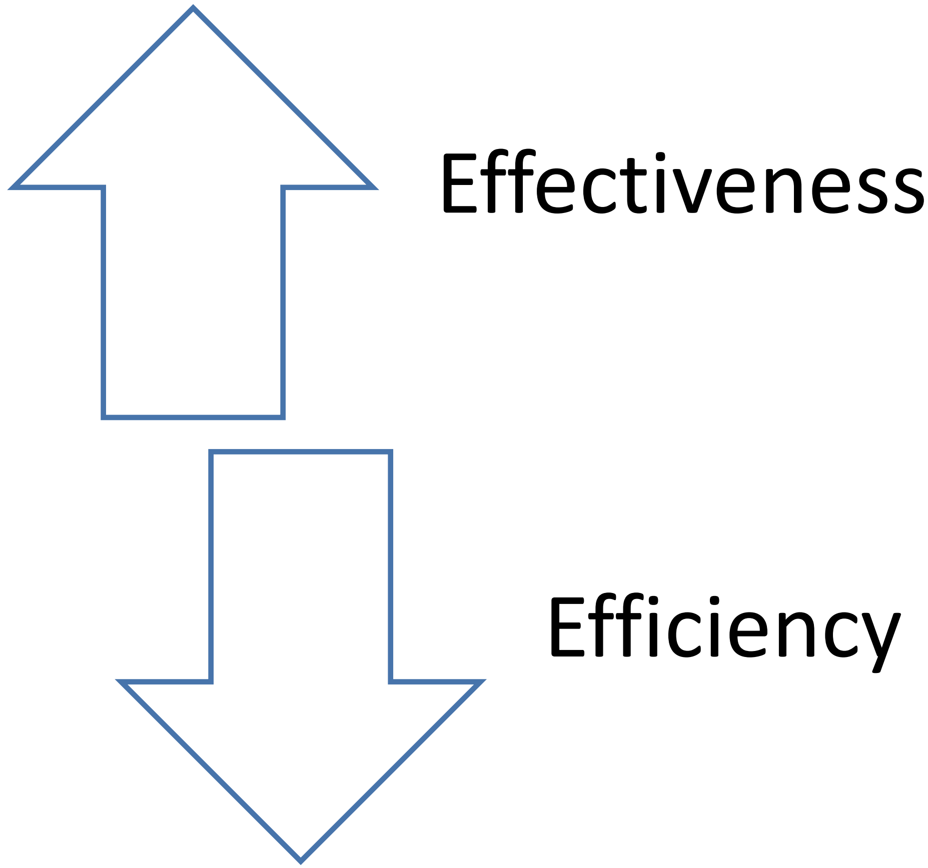
Decision-Making Process (cont…)

Decision-making Disciplines (cont…)

- Better decisions
  - Tradeoff: **accuracy versus speed**.
- Fast decision may be harmful.
- Many areas suffer from fast decisions.
- **Effectiveness versus Efficiency**.
  - Effectiveness →“goodness” “accuracy”
  - Efficiency → “speed” “less resources”
- **A fine balance** is what is needed!



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Decision-Making Process (cont…)

Simon's Decision-making Process

- Proposed in 1977 by Herbert Alexander Simon (an American economist and political scientist).
- Humans consciously or subconsciously follow a systematic decision-making process:
  - Intelligence
  - Design
  - Choice
  - Implementation
  - Monitoring

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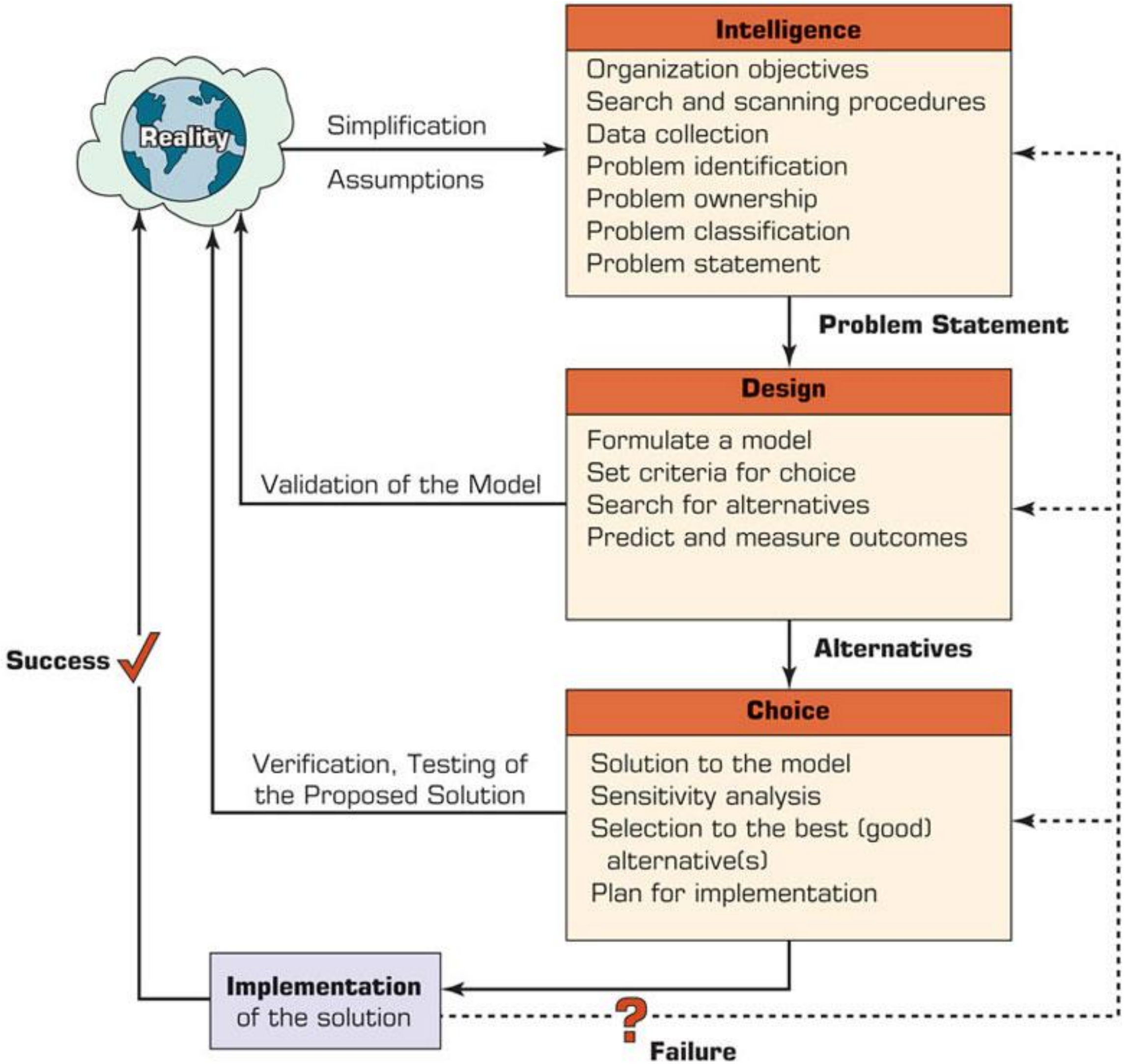
Decision-Making Process (cont…)

The Decision-making/modeling Process



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Decision-Making Process (cont…)

Decision Making: Intelligence Phase

- Scan the environment, either intermittently or continuously.
- Identify problem situations or opportunities.
- Monitor the results of the implementation.
- Problem is the difference between what people desire (or expect) and what is actually occurring
  - Symptom versus problem (caveat: must be able to distinguish between symptoms and real problems)
  - Example: excessive costs and improper inventory levels (which one is symptoms, which is the real problem?) Excessive costs is a symptoms of the improper inventory levels problem.
- Timely identification of opportunities is as important as identification of problems.

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Decision-Making Process (cont…)

Decision Making: Intelligence Phase (cont…)

- Potential issues in data/information collection and estimation
  - Lack of data.
  - Cost of data collection.
  - Inaccurate and/or imprecise data.
  - Data estimation is often subjective.
  - Data may be insecure.
  - Key data may be qualitative.
  - Data change over time (time-dependence).

Why it is important to correctly identify problem
Application Case: Making Elevators Go Faster!

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Decision-Making Process (cont…)

<u>Decision Making: Intelligence Phase (cont…)</u>

- **Problem classification**
  - Classification of problems according to the degree of structuredness (structured, semi-structured, or unstructured) – please refer to Chapter 1.
- **Problem decomposition**
  - Often solving the simpler subproblems may help in solving a complex problem.
  - Information/data can improve the structuredness of a problem situation.
- **Problem ownership**
  - A problem exists in a company only if some groups take on the responsibilities of addressing it. Also, the company must have the ability to solve it.
  - The assignment of authority to solve a problem is called problem ownership.
- **Outcome** of intelligence phase
  - A formal problem statement.

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Decision-Making Process (cont…)

Decision Making: Design Phase

- Finding/developing and analyzing possible courses of actions.
- A model of the decision-making problem is constructed, tested, and validated.
- Modeling: conceptualizing a problem and abstracting it into a quantitative and/or qualitative form (i.e., using symbols/variables)
  - **Abstraction**: making assumptions for simplification.
  - **Tradeoff (cost/benefit)**: more abstraction or less abstraction.
  - **Modeling**: both an art and a science.
- Selection of a Principle of Choice
  - It is a criterion that describes the acceptability of a solution approach.
  - Reflection of decision-making objective(s) .
  - In a model, it is the result variable.
  - Choosing and validating against
    - ❑ High-risk versus low-risk
    - ❑ Optimize versus satisfice
  - A criterion is not a constraint!

Criteria are rules/ requirements that must be followed/met
Constraints are restrictions that keep something from being valid

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Decision-Making Process (cont…)

<u>Decision Making: Design Phase (cont…)</u>

- **Normative models** (= optimization)
  - The chosen alternative is demonstrably the best of all possible alternatives.
  - Examples:
    - ❑ Which alternative will yield the maximum profit from an investment of RM5 million (maximize profit per RM invested)?
    - ❑ Maximize productivity
    - ❑ Select a router with a minimum bandwidth at the least cost
  - Assumptions of rational decision makers:
    - ❑ Humans are economic beings whose objective is to maximize the attainment of goals.
    - ❑ For a decision-making situation, all alternative courses of action and consequences are known.
    - ❑ Decision makers have an order or preference that enables them to rank the desirability of all consequences.

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Decision-Making Process (cont…)

Decision Making: Design Phase (cont…)

- **Heuristic models** (= sub-optimization)
  - The chosen alternative is the best of only a subset of possible alternatives.
  - Often, it is not feasible to optimize realistic problems which are with large size or high complexity.
  - Sub-optimization may also help relax unrealistic assumptions in models.
  - Reach a good enough solution faster.
- **Descriptive models**
  - Describe things as they are or as they are believed to be (mathematically based).
  - They do not provide a solution but information that may lead to a solution.
  - Simulation - most common descriptive modeling method (mathematical description of systems in a computer environment).
  - Allows experimentation with the descriptive model of a system.

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Decision-Making Process (cont…)

Decision Making: Design Phase (cont…)

- Good enough, or satisficing “something less than the best”
  - A form of suboptimization.
  - Seeking to achieve a desired level of performance as opposed to the “best”.
  - Benefit: time saving.
  - Simon’s idea of bounded rationality.

- Developing (or generating) alternatives
  - In optimization models (such as linear programming), the alternatives may be generated automatically.
  - In most MSS situations, however, it is necessary to generate alternatives manually.
  - Use of GSS helps generate alternatives.

- Measuring/ranking the outcomes
  - Using the principle of choice.

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Decision-Making Process (cont…)

Decision Making: Design Phase (cont…)

- Risk
  - Lack of precise knowledge (uncertainty).
  - Risk can be measured with probability.

- Scenario (what-if case)
  - A statement of assumptions about the operating environment (variables) of a particular system at a given time.
  - Possible scenarios: best, worst, most likely, average (and custom intervals).

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Decision-Making Process (cont…)

Decision Making: Choice Phase

- The actual decision and the commitment to follow a certain course of action are made here.

- The boundary between the design and choice is often unclear (partially overlapping phases)
  - Generate alternatives while performing evaluations.

- Includes the search, evaluation, and recommendation of an appropriate solution to the model.

- Solving the model versus solving the problem. The solution to a model yields a recommended solution to the problem. The problem is considered solved only if the recommended solution is successfully implemented.

- Search approaches
  - **Analytic techniques** (solving with a formula).
  - **Algorithms** (step-by-step procedures).
  - **Heuristics** (rule of thumb).
  - **Blind search** (truly random search).

- Additional activities
  - **Sensitivity analysis**.
  - **What-if analysis**.
  - **Goal seeking**.

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Decision-Making Process (cont…)

Decision Making: Implementation Phase

- “Nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things.” The Prince, Machiavelli 1500s
- Solution to a problem → change
- Change management? (how to manage changes)
- Implementation: putting a recommended solution to work

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Computerized Decision Support Framework

The Classical Decision Support System Framework

(tactical planning)

(top level, long range)

	Type of Control		
Type of Decision	**Operational Control**	**Managerial Control** (tactical planning)	**Strategic Planning** (top level, long range)
Structured (programmed)	1 Monitoring accounts receivable Monitoring accounts payable Placing order entries	2 Analyzing budget Forecasting short-term Reporting on personnel Making or buying	3 Managing finances Monitoring investment portfolio Locating warehouse Monitoring distribution systems
Semistructured	4 Scheduling production Controlling inventory	5 Evaluating credit Preparing budget Laying out plant Scheduling project Designing reward system Categorizing inventory	6 Building a new plant Planning mergers and acquisitions Planning new products Planning compensation Providing quality assurance Establishing human resources policies Planning inventory
Unstructured (non-programmed)	7 Buying software Approving loans Operating a help desk Selecting a cover for a magazine	8 Negotiating Recruiting an executive Buying hardware Lobbying	9 Planning research and development Developing new technologies Planning social responsibility

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Computerized Decision Support Framework (cont…)

The Classical Decision Support System Framework (cont…)

Type of Decision	Technology Support Needed
Structured (Programmed)	MIS, Management Science Models, Transaction Processing
Semistructured	DSS, KMS, GSS, CRM, SCM
Unstructured (Unprogrammed)	GSS, KMS, ES, Neural networks

	Type of Control		
	Operational Control	Managerial Control	Strategic Planning
Technology Support Needed	MIS, Management Science	Management Science, DSS, ES, EIS, SCM, CRM, GSS, SCM	GSS, CRM, EIS, ES, neural networks, KMS

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Computerized Decision Support Framework (cont…)

<u>Decision Support System Concepts</u>

- DSS early definition: it is a system intended to support managerial decisions in semi-structured and unstructured decision situations
- DSS were meant to be adjuncts to decision makers -> extending their capabilities
- They are computer based and would operate interactively online, and preferably would have graphical output capabilities
- Nowadays, simplified via Web browsers and mobile devices

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Computerized Decision Support Framework (cont…)

Decision Support System Concepts (cont…)

- (Gorry and Scott-Morton, 1971)
  - DSS - interactive computer-based systems, which help decision makers utilize data and models to solve unstructured problems.
- (Keen and Scott-Morton, 1978)
  - DSS - decision support systems couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions.
  - It is a computer-based support system for management decision makers who deal with semi-structured problems.
- Context-free expression.
- DS as an umbrella term to describe any computerized system that support decision making in an organization.
- Evolution of DS into Business Intelligence.

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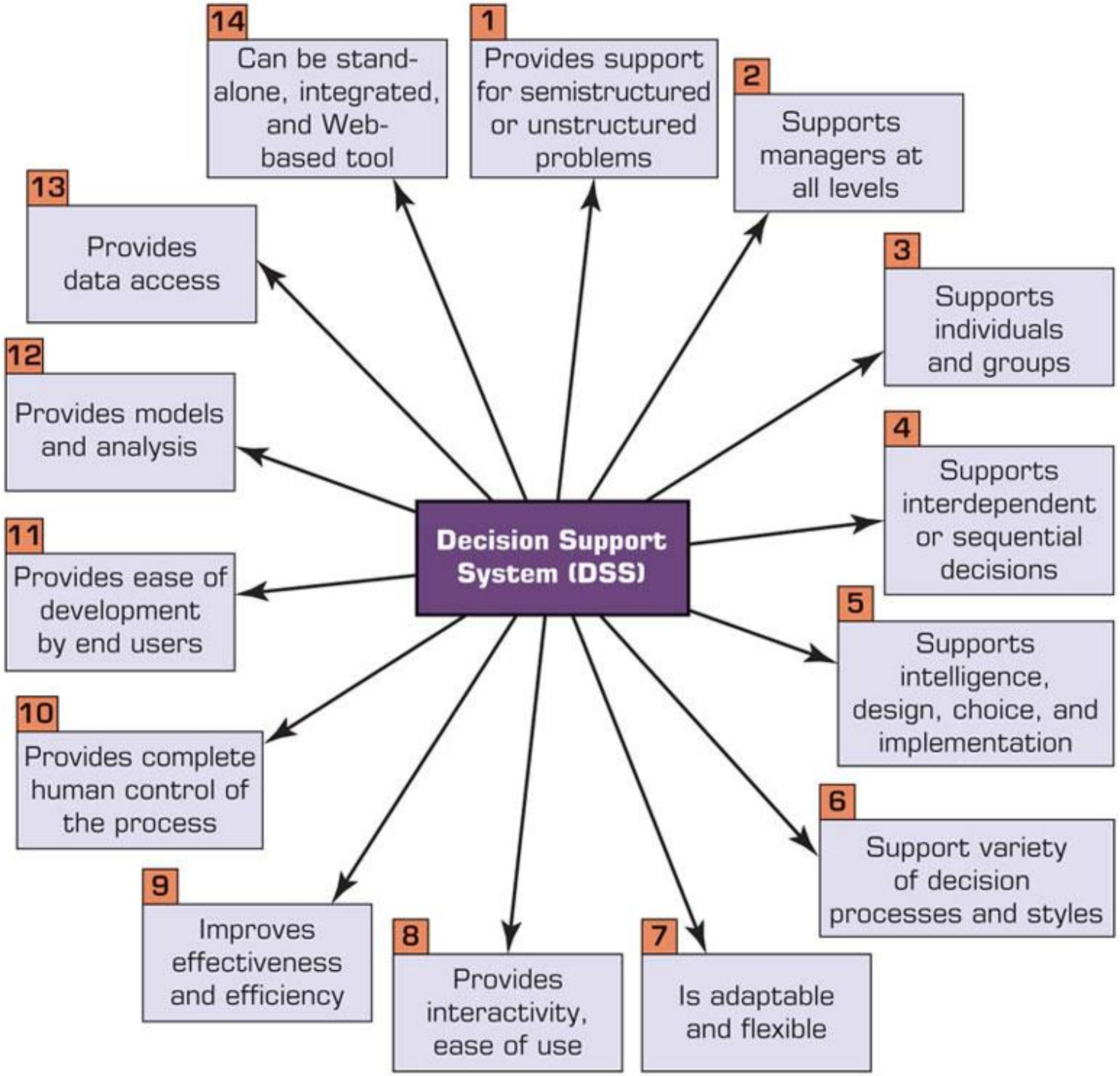
Computerized Decision Support Framework (cont…)

Decision Support System Capabilities



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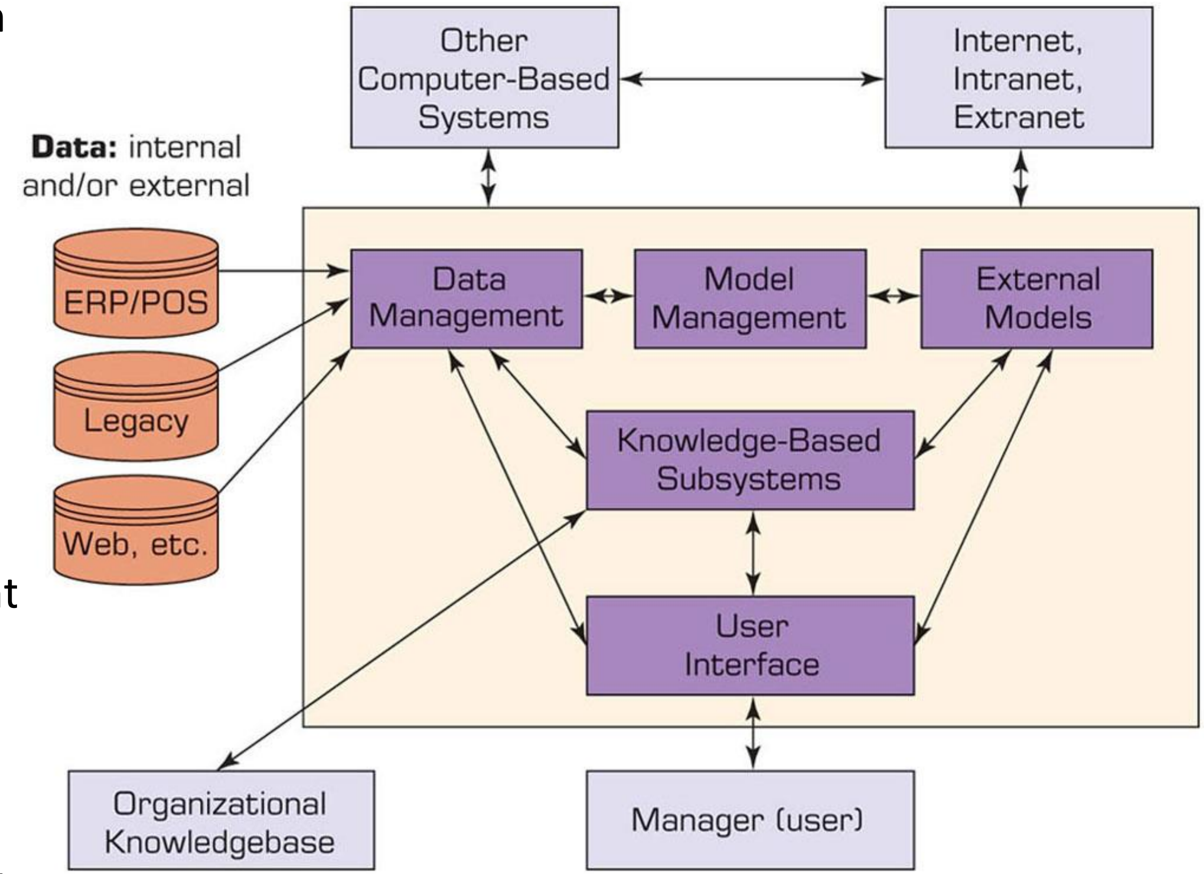
Computerized Decision Support Framework (cont…)

Components of DSS

- Data Management Subsystem
  - Includes the database that contains the data
  - Database management system (DBMS)
  - Can be connected to a data warehouse
- Model Management Subsystem
  - Model base management system (MBMS)
- User Interface Subsystem
- Knowledgebase Management Subsystem
  - Organizational knowledge base



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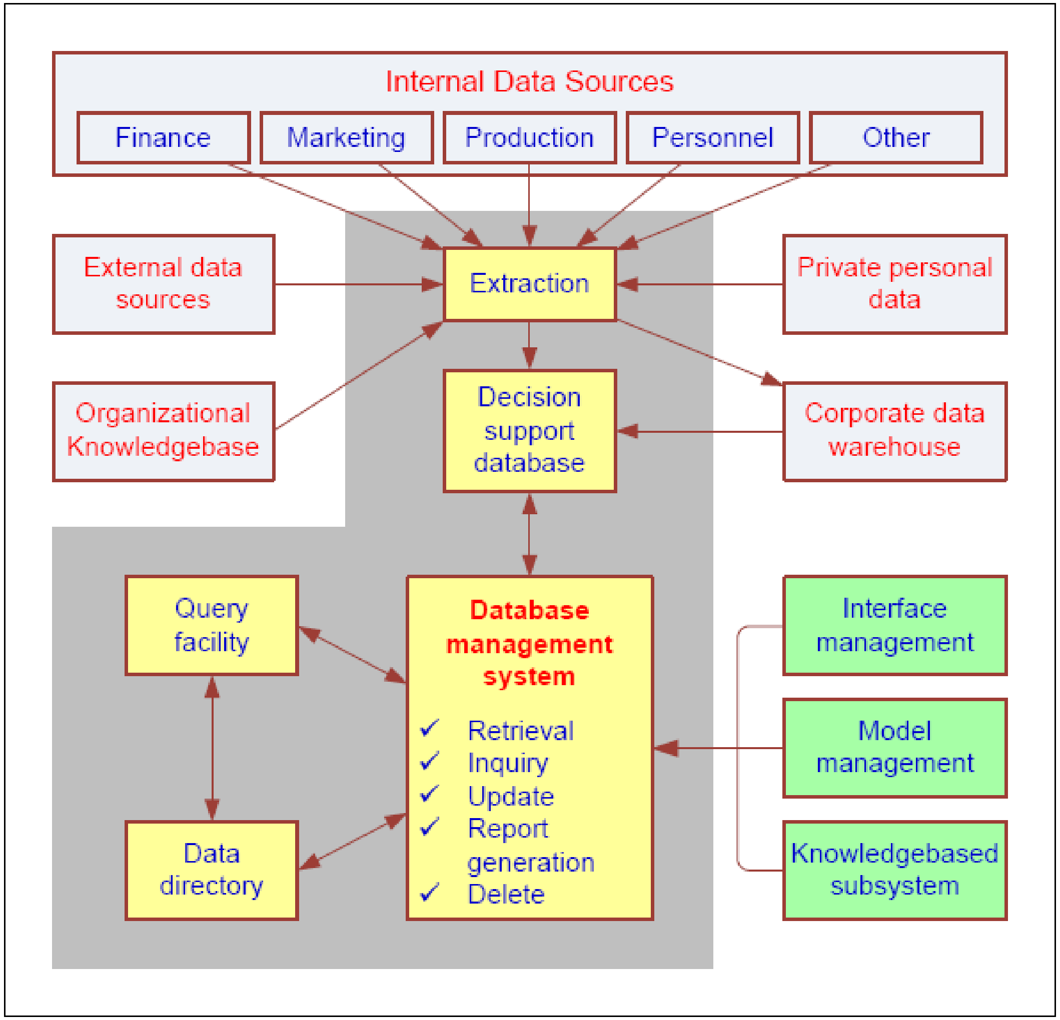
Computerized Decision Support Framework (cont…)

Components of DSS: Data Management Subsystem

- DSS database
- DBMS
- Data directory
- Query facility



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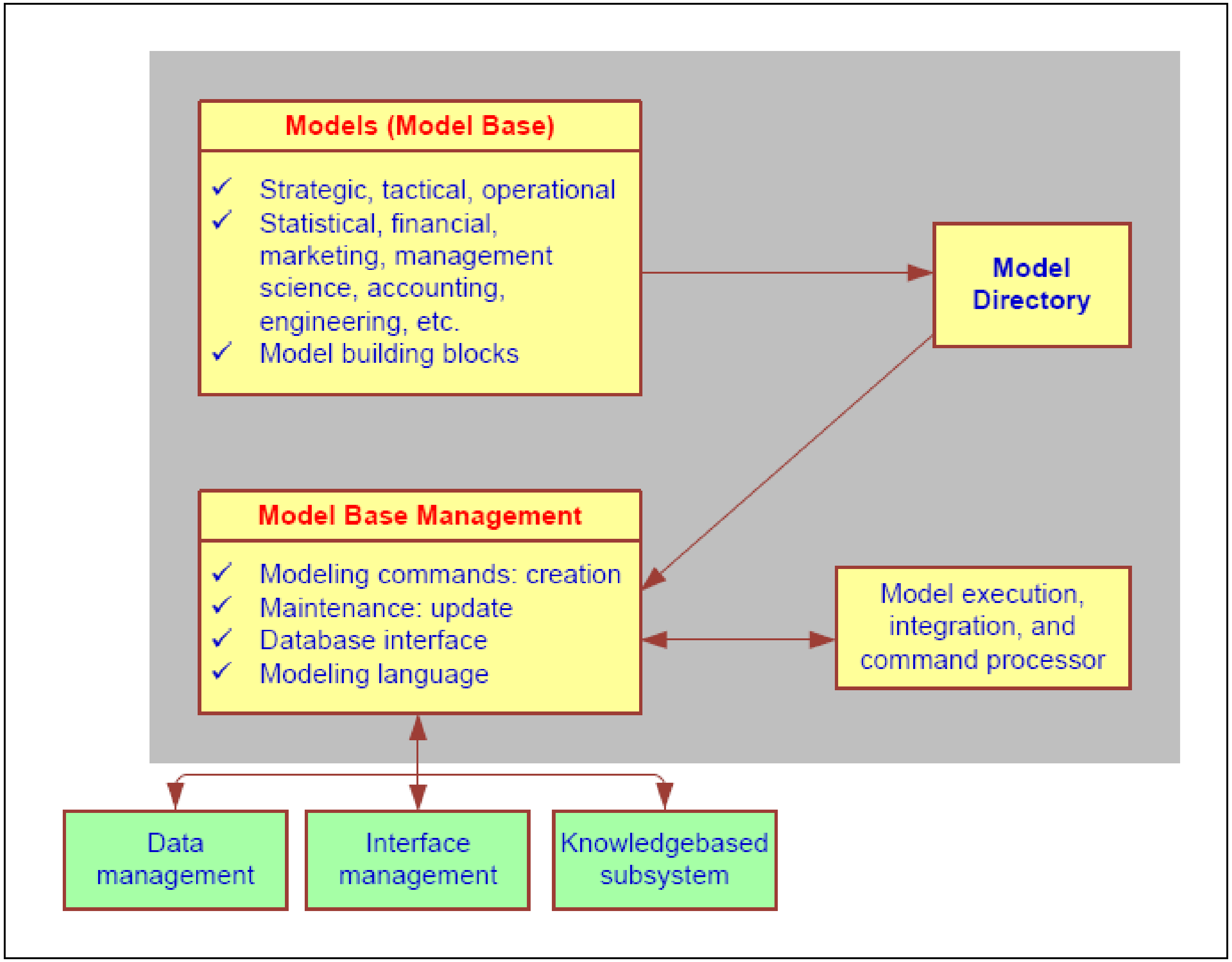
Computerized Decision Support Framework (cont…)

Components of DSS: Model Management Subsystem

- Model base
- MBMS
- Modeling language
- Model directory
- Model execution, integration, and command processor



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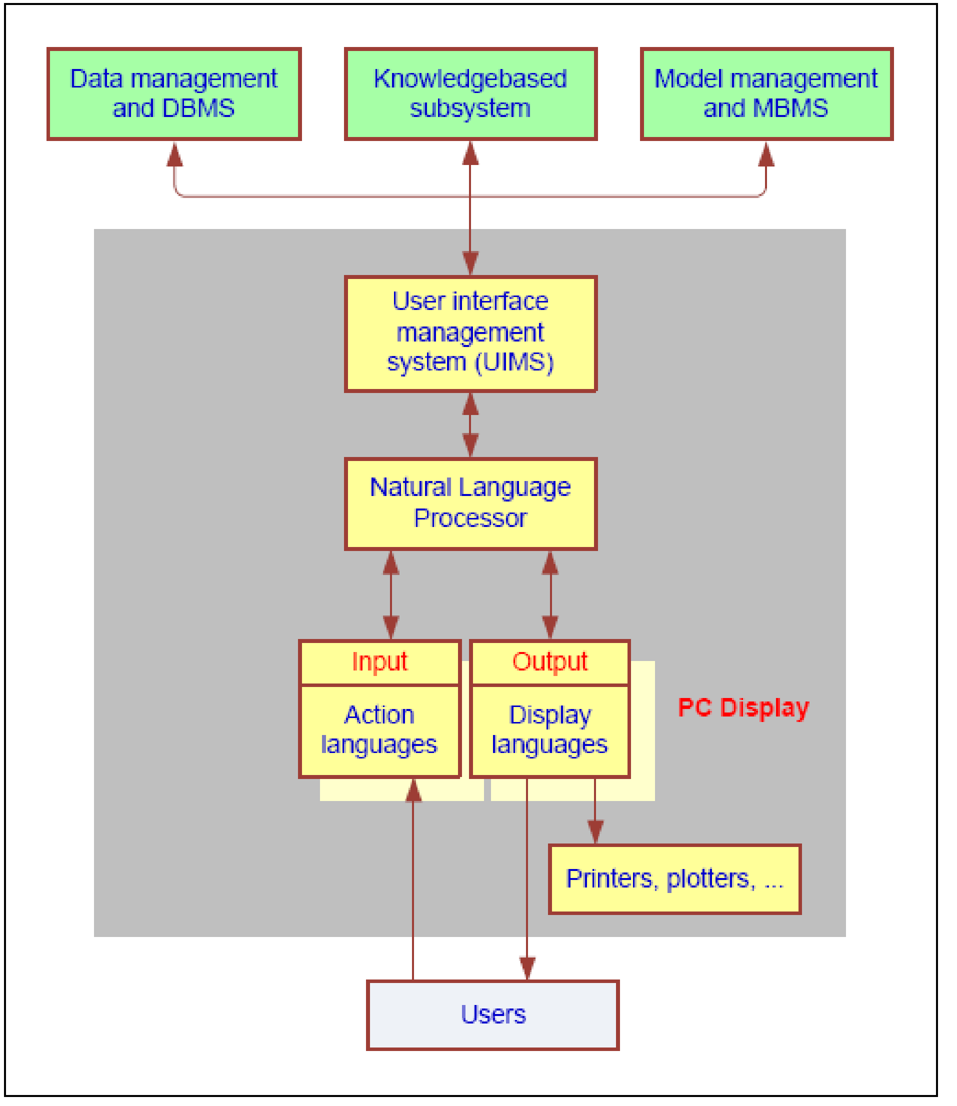
Computerized Decision Support Framework (cont…)

Components of DSS: User Interface Subsystem

- Interface
  - Application interface
  - User Interface (GUI)
- DSS User Interface
  - Portal
  - Graphical icons
    - Dashboard
  - Color coding
- Interfacing with PDAs, cell phones, etc.



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Computerized Decision Support Framework (cont…)

Components of DSS: Knowledge-based Management Subsystem

- It provides intelligence to augment the decision maker’s own.
- Interconnected with the organization’s knowledge repository (organizational knowledge base).
- Example of knowledge-based DSS: IBM’s Watson computer system.

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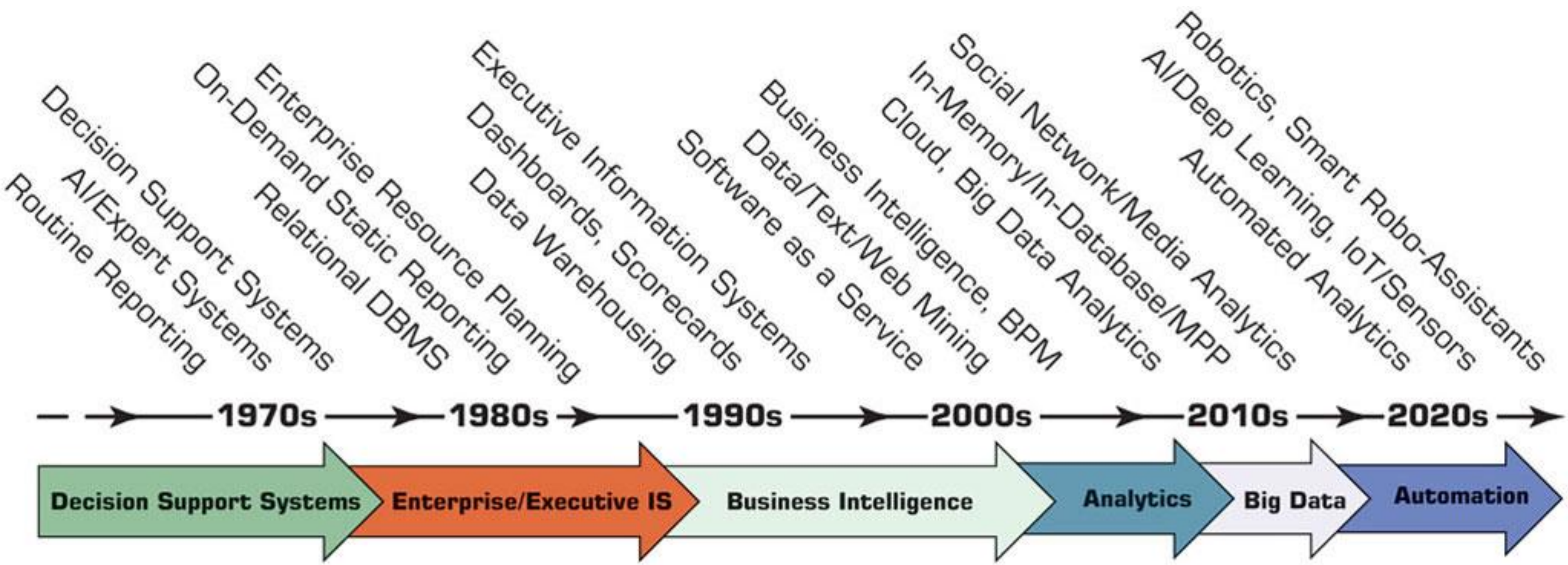
Evolution of Computerized Decision Support



Decision Support System (DSS) -> Executive Information System (EIS) -> Business Intelligence (BI) -> Analytics (BA) -> big data -> Automation -> ???

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Evolution of Computerized Decision Support (cont…)

A Framework of Business Intelligence

- BI is an evolution of decision support concepts over time
  - Then: Executive Information System.
  - Now: Everybody's Information System (BI).
- BI systems are enhanced with additional visualizations, alerts, and performance measurement capabilities.
- The term BI emerged from industry.
- BI is an umbrella term that combines architectures, tools, databases, analytical tools, applications, and methodologies.
- Again, it is a context-free expression
- BI's major objective is to enable easy access to data (and models) to provide business managers with the ability to conduct analysis
- BI helps transform data, to information (and knowledge), to decisions, and finally to action

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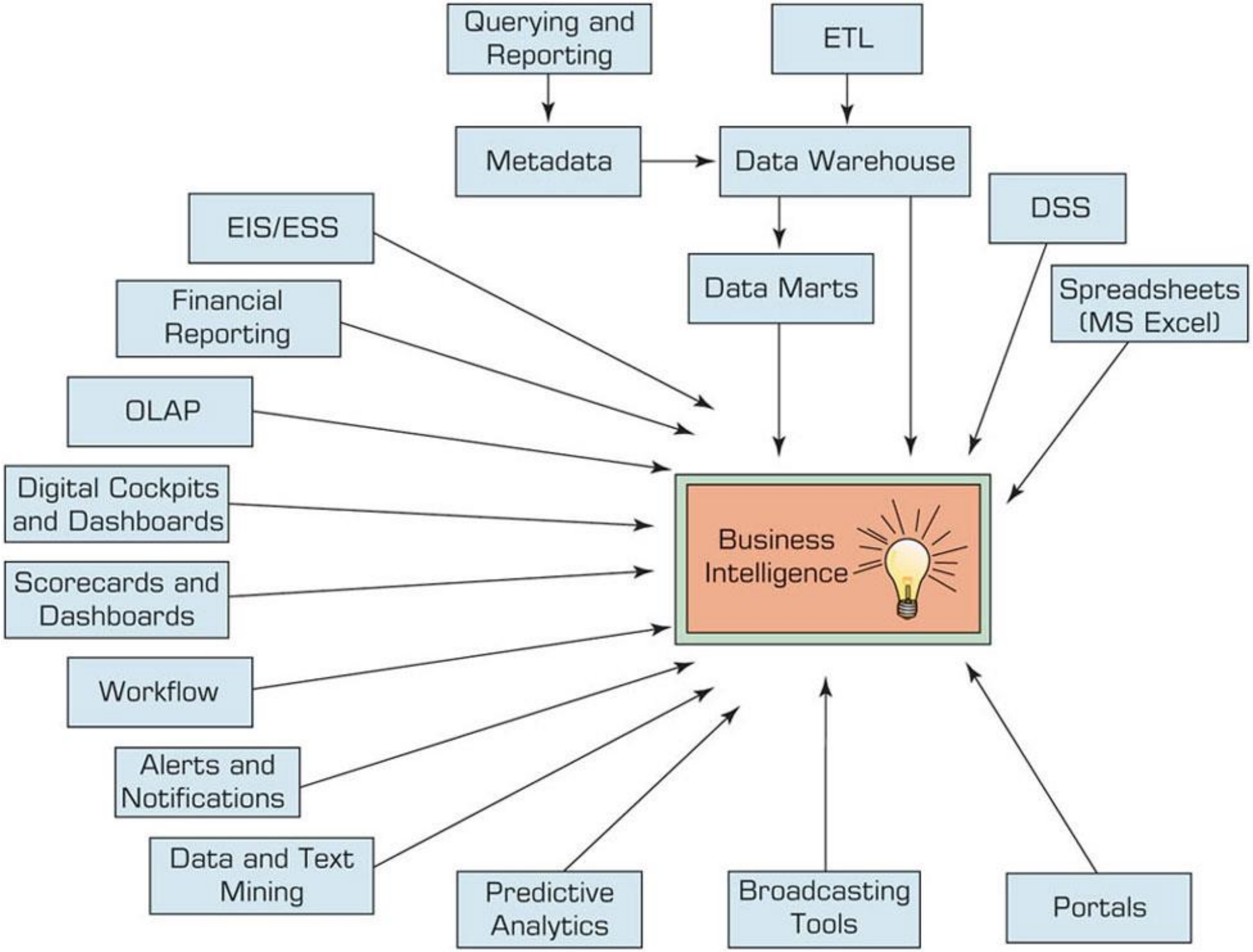
Evolution of Computerized Decision Support (cont…)

<u>Evolution of Business Intelligence Capabilities</u>



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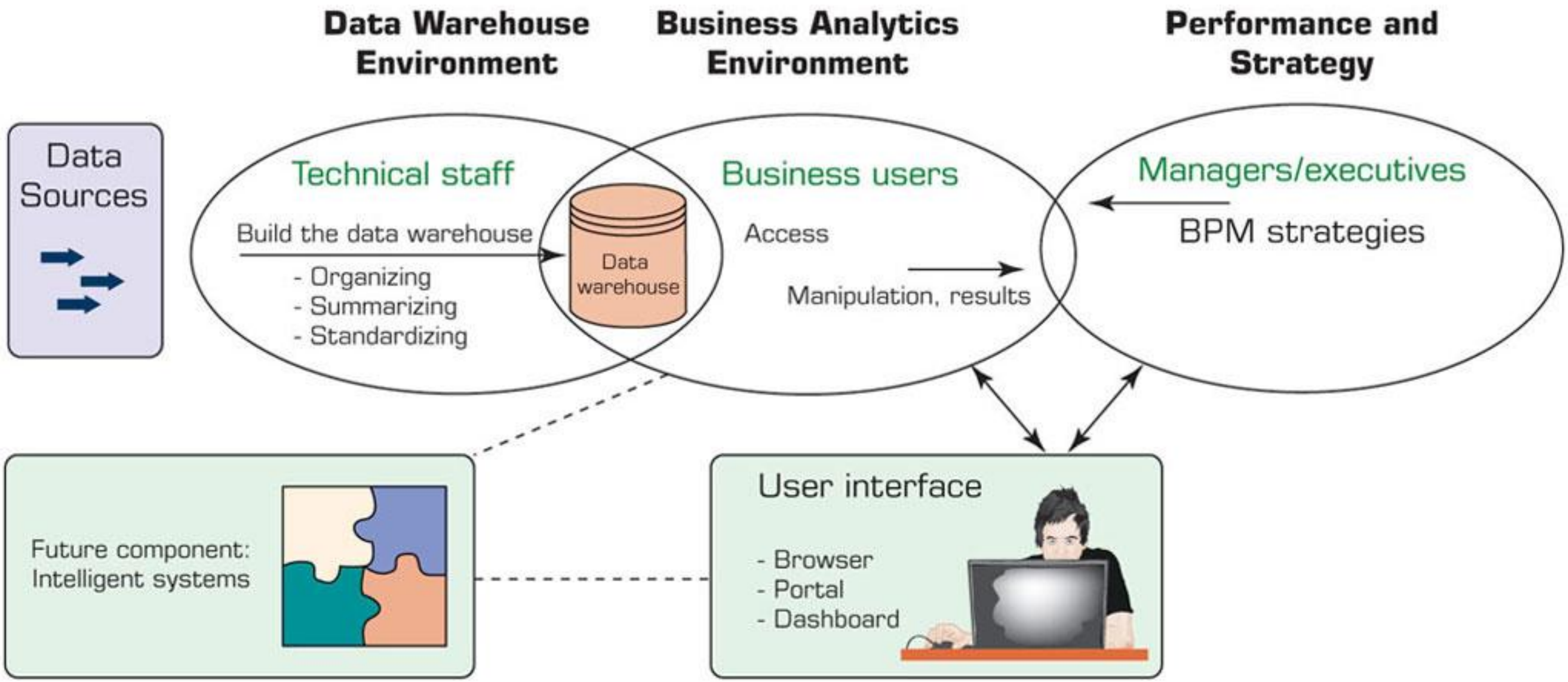
Evolution of Computerized Decision Support (cont…)

A High-level Architecture of BI:



Source: Based on W. Eckerson. (2003). *Smart Companies in the 21st Century: The Secrets of Creating Successful Business Intelligent Solutions.* Seattle, WA: The Data Warehousing Institute, p. 32, Illustration 5.

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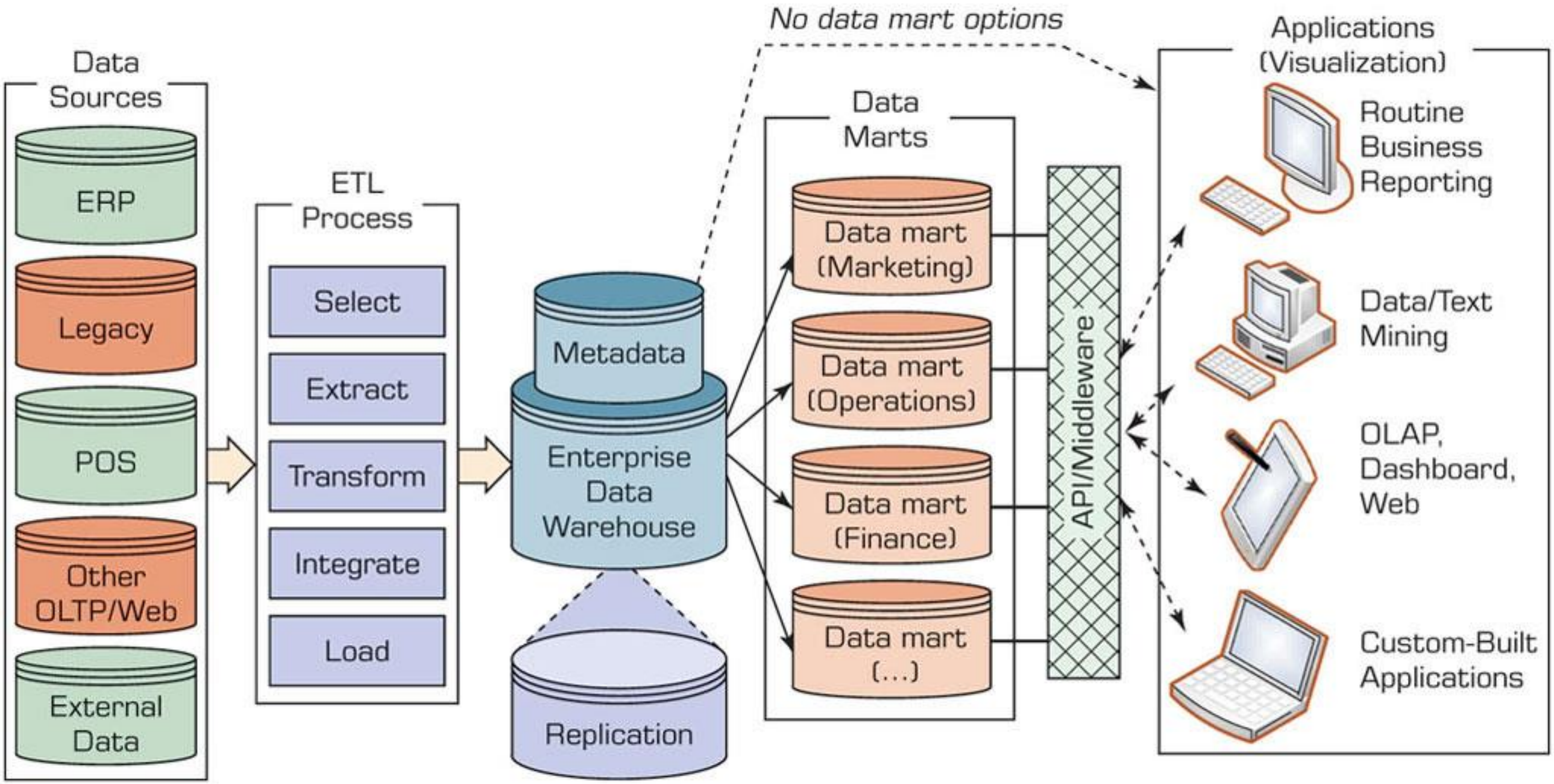
Evolution of Computerized Decision Support (cont…)

Data Warehouse as a Foundation for BI



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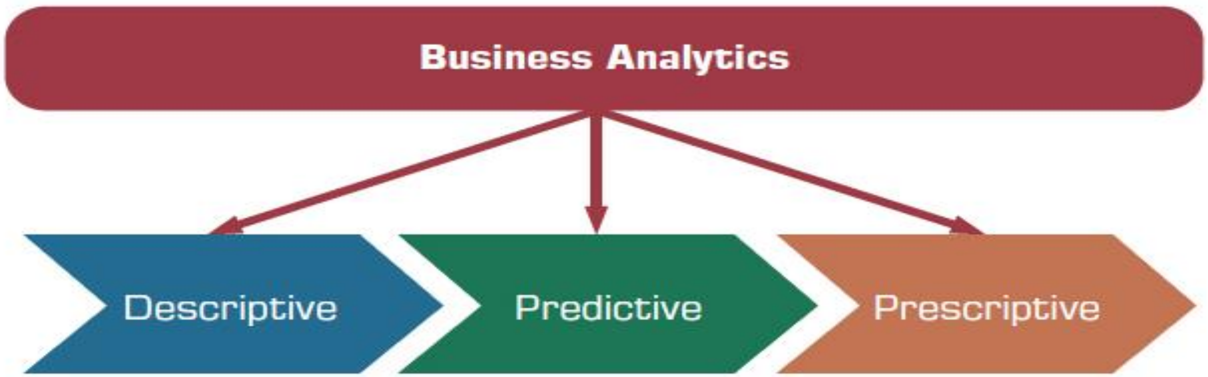
Analytics Overview

- Many practitioners and academics now use “analytics” in place of BI.
- A simple taxonomy of Business Analytics (proposed by Institute for Operations Research and Management Science (INFORMS))



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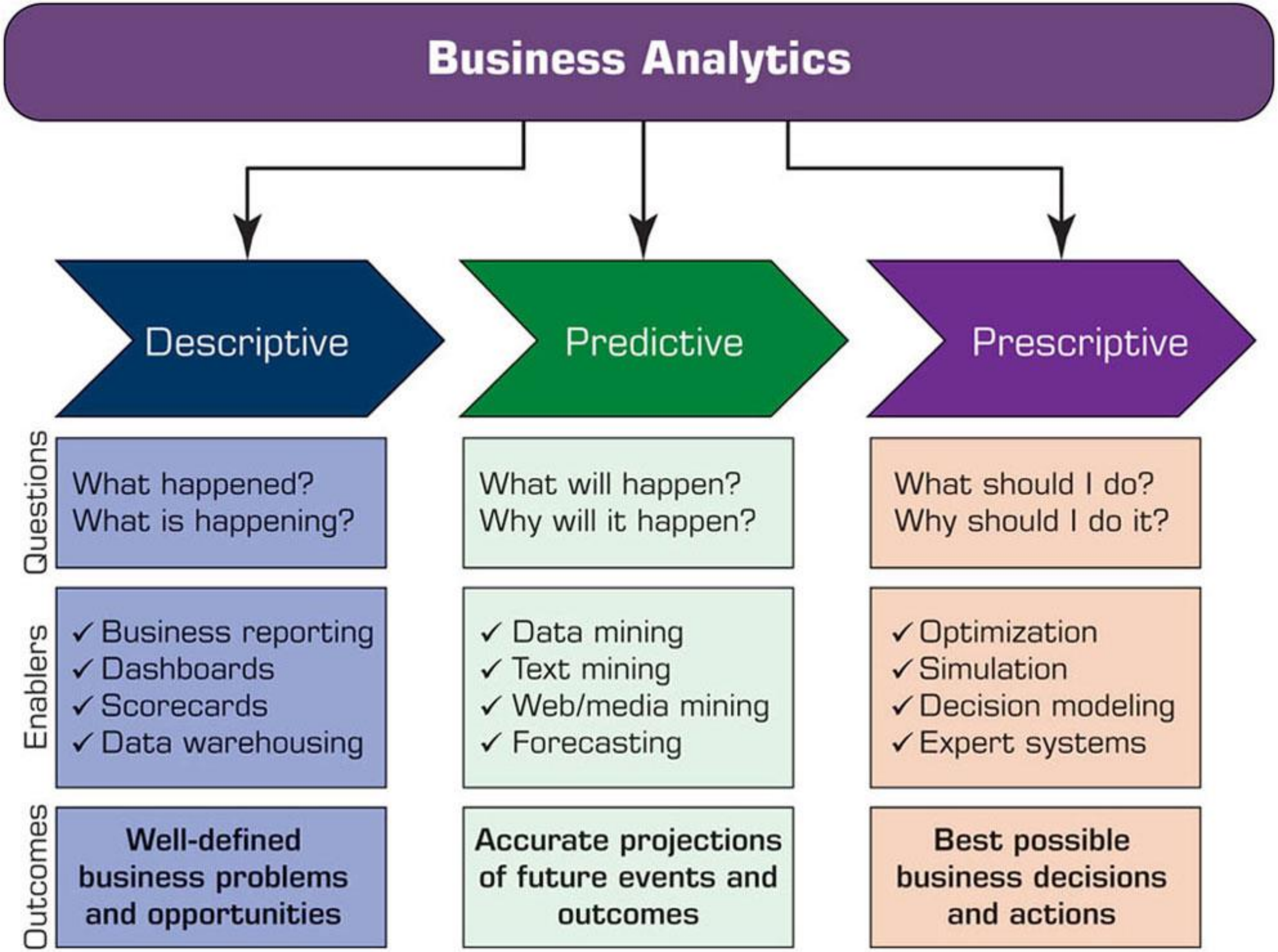
Analytics Overview (cont…)



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Analytics Overview (cont…)

Descriptive Analytics

- Also known as **reporting analytics**.
- Refer to **knowing what is happening** in the organization and **understanding some underlying trends and causes of such occurrences**.
- Consolidation of data sources and availability of all relevant data in a form that enables appropriate reporting and analysis.
- Development of infrastructure: **data warehouses**.
- Various reporting tools and techniques can then be used to create reports, queries, alerts, and trends based on the data in the data warehouses.
- **Data visualization** is a key technology.

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Descriptive Analytics (cont…)

Application Case 1.4 **Siemens Reduces Cost with the Use of Data Visualization**

Siemens is a German company headquartered in Berlin, Germany. It is one of the world's largest companies focusing on the areas of electrification, automation, and digitalization. It has an annual revenue of 76 billion euros.

The visual analytics group of Siemens is tasked with end-to-end reporting solutions and consulting for all of Siemens internal BI needs. This group was facing the challenge of providing reporting solutions to the entire Siemens organization across different departments while maintaining a balance between governance and self-service capabilities. Siemens needed a platform that could analyze its multiple cases of customer satisfaction surveys, logistic processes, and financial reporting. This platform should be easy to use for their employees so that they could use these data for analysis and decision making. In addition, the platform should be easily integrated with existing Siemens systems and give employees a seamless user experience.

Siemens started using Dundas BI, a leading global provider of BI and data visualization solutions. It allowed Siemens to create highly interactive dashboards that enabled it to detect issues early and thus save a significant amount of money. The dashboards developed by Dundas BI helped Siemens global logistics organization answer questions like how different supply rates at different locations affect the operation, thus helping the company reduce cycle time by 12 percent and scrap cost by 25 percent.

Questions for Case 1.4

1. What challenges were faced by Siemens visual analytics group?
2. How did the data visualization tool Dundas BI help Siemens in reducing cost?

What We Can Learn from This Application Case

Many organizations want tools that can be used to analyze data from multiple divisions. These tools can help them improve performance and make data discovery transparent to their users so that they can identify issues within the business easily.

Sources: **Dundas.com**. "How Siemens Drastically Reduced Cost with Managed BI Applications." **https://www.dundas.com/Content/pdf/siemens-case-study.pdf** (accessed September 2018); Wikipedia.org. "SIEMENS." **https://en.wikipedia.org/wiki/Siemens** (accessed September 2018); **Siemens.com**. "About Siemens." **http://www.siemens.com/about/en/** (accessed September 2018).

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Analytics Overview (cont…)

Predictive Analytics

- To determine **what is likely to happen in the future**.
- Based on **statistical techniques** or **data mining techniques**.
- Examples:
  - To predict if the customer is likely to switch to a competitor ("churn analysis").
  - What the customer is likely to buy next and how much?
  - What promotion a customer would respond to?
  - Whether a customer is a creditworthy risk?
- **Classification**, **clustering**, **associate mining** techniques.

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Analytics Overview (cont…)

Predictive Analytics (cont…)

Application Case 1.5 SagaDigits and the Use of Predictive Analytics

Predictive analytics is widely held to be the most actionable form of business intelligence. As IBM famously stated, if business can be considered a "numbers game," predictive analytics is the way this game is best played and won.

Many companies in China and Hong Kong are increasingly using data mining and predictive analytics to better cater to their customers' needs. This has led to the growth, in the last ten years, of enterprises specializing in these IT solutions. Among them is the award-winning SagaDigits Group.

Incorporated in 2016 in Hong Kong, the group consists of two sister organizations that work together to offer services to Asian businesses. SagaDigits Limited provides data mining, cleansing, extraction, and analytics services based on a series of methods, including natural language processing, big data, and AI technologies. Compathnion Technology Limited specializes instead in data collection, visual recognition, predictive analytics, and statistical modeling for indoor and outdoor uses.

One of the most interesting scalable solutions that SagaDigits offers its customers is Smart Box, an original, highly configurable AI solution for online and offline retail stores. When a company adopts this product for its retail business, it gets a real-time zone detection service in selected retail stores to predict the number of shoppers in those specific areas and learn their preferences based on the spatial information collected.

To successfully predict customer behavior, Smart Box employs a mixed set of indicators and information tools, including advanced visual recognition. Its sensors can detect consumers' gender, emotion, and approximate age group with a high level of accuracy. Finally, based on its own behavioral models' predictions and the historical records of similar customers' transaction histories, Smart Box provides automatic recommendations for advertisement and product selection for display.

Smart Box is one among many of SagaDigits' solutions that use predictive analytics. Another system is Smart User Pro, which uses a variety of public data and internal data to predict various marketing trends in retail and marketing for consumer goods.

Sources: Eric Seigel (2015). "Seven Reasons You Need Predictive Analytics Today." Prediction Impact, Inc. **https://www.ibm.com/downloads/cas/LKMPR8AJ** (accessed October 2019). Saga Digits. **https://sagadigits.com/about** (accessed October 2019). **https://sagadigits.com** (accessed October 2019).

Questions for Case 1.5

1. Why is predictive analytics becoming increasingly common?
2. What is the most interesting feature of Smart Box?
3. To which kind of corporate organization is Smart Box targeted?
4. Describe alternative uses of predictive analytics that Saga Digits has developed solutions for.

What We Can Learn from This Application Case

Innovative IT solutions and sophisticated tools such as predictive analytics are being increasingly used across the world. East Asia was one of the first regions to adopt them, especially places such as Hong Kong, which has many links with North American universities focused on technology and computer science. Saga Digits is one of many companies that offer predictive analytics for consumers' behaviors and future marketing trends.

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Analytics Overview (cont…)

<u>Prescriptive Analytics</u>

- Can also be termed as **decision analytics** or **normative analytics**.

- To recognize what is going on as well as the likely forecast and make decisions to achieve the best performance possible.

- This group of techniques has historically been studied under the umbrella of **operations research** or **management sciences**. Generally, to **optimize** the performance of a system.

- Examples:
  - To determine the price for a specific item.
  - To determine the airfare to charge.
  - To generate a complete set of production plans.

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Analytics Overview (cont…)

Prescriptive Analytics (cont…)

Application Case 1.6

A Specialty Steel Bar Company Uses Analytics to Determine Available-to-Promise Dates

This application case is based on a project that involved one of the coauthors. A company that does not wish to disclose its name (or even its precise industry) was facing a major problem of making decisions on which inventory of raw materials to use to satisfy which customers. This company supplies custom configured steel bars to its customers. These bars may be cut into specific shapes or sizes and may have unique material and finishing requirements. The company procures raw materials from around the world and stores them in its warehouse. When a prospective customer calls the company to request a quote for the specialty bars meeting specific material requirements (composition, origin of the metal, quality, shapes, sizes, etc.), the salesperson usually has just a little bit of time to submit such a quote including the date when the product can be delivered, prices, and so on. It must make available-to-promise (ATP) decisions, which determine in real time the dates when the salesperson can promise delivery of products that customers requested during the quotation stage. Previously, a salesperson had to make such decisions by analyzing reports on available inventory of raw materials. Some of the available raw material may have already been committed to another customer's order. Thus, the inventory in stock might not really be inventory available. On the other hand, there may be raw material that is expected to be delivered in the near future that could also be used for satisfying the order from this prospective customer. Finally, there might even be an opportunity to charge a premium for a new order by repurposing previously committed inventory to satisfy this new order while delaying an already committed order. Of course, such decisions should be based on the cost–benefit analyses of delaying a previous order. The system should thus be able to pull real-time data about inventory, committed orders, incoming raw material, production constraints, and so on.

To support these ATP decisions, a real-time DSS was developed to find an optimal assignment of the available inventory and to support additional what-if analysis. The DSS uses a suite of mixed-integer programming models that are solved using commercial software. The company has incorporated the DSS into its enterprise resource planning system to seamlessly facilitate its use of business analytics.

Questions for Case 1.6

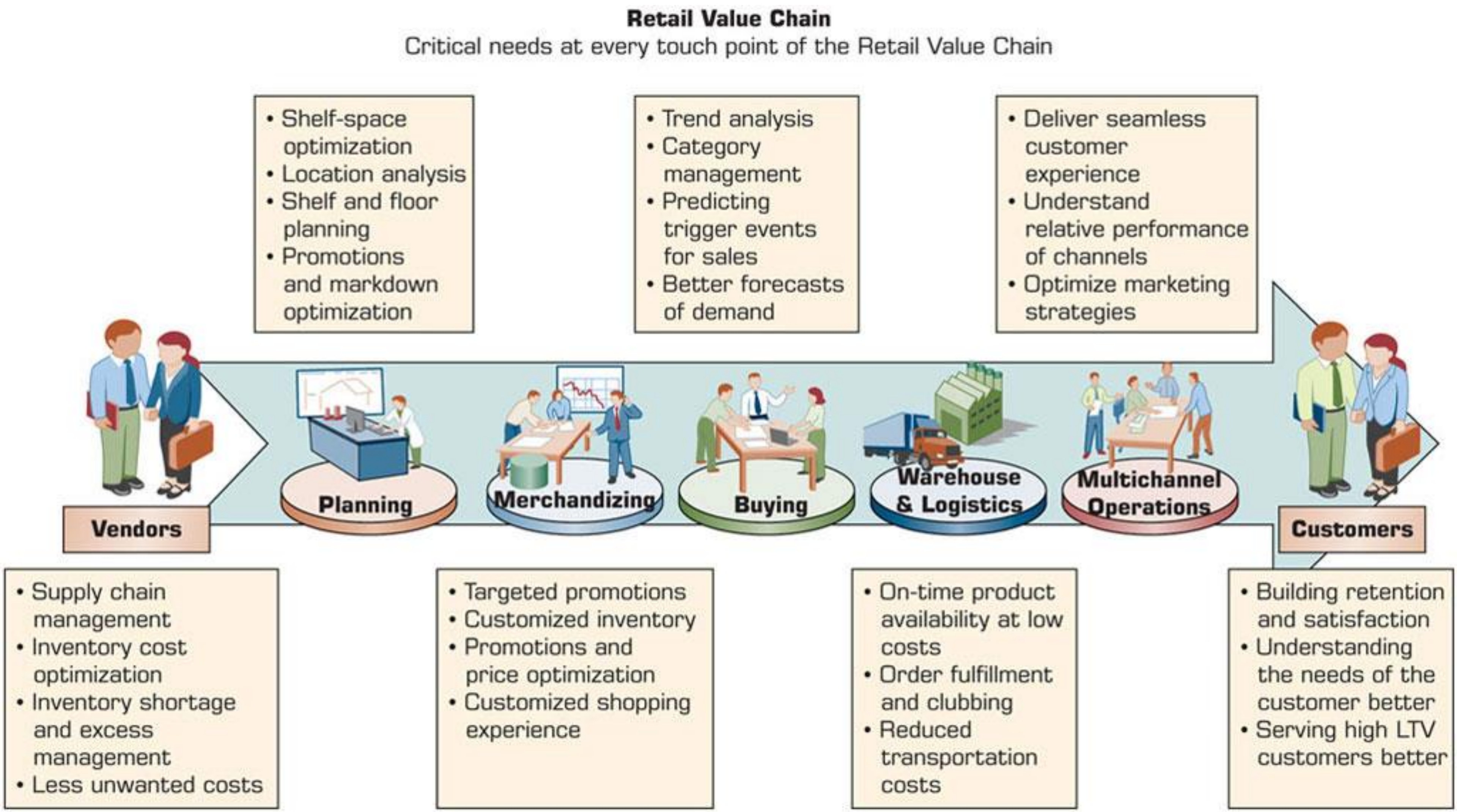
1. Why would reallocation of inventory from one customer to another be a major issue for discussion?
2. How could a DSS help make these decisions?

Source: M. Pajouh Foad, D. Xing, S. Hariharan, Y. Zhou, B. Balasundaram, T. Liu, & R. Sharda, R. (2013). "Available-to-Promise in Practice: An Application of Analytics in the Specialty Steel Bar Products Industry." *Interfaces, 43*(6), pp. 503–517. **http://dx.doi.org/10.1287/inte.2013.0693** (accessed September 2018).

Sharda, R., Delen, D., & Turban, E. (2020). Analytics, Data Science & Artificial Intelligence: System for Decision Support (11th ed., Global Edition), London: Pearson

Analytics Overview (cont…)

Business Valuesof BI Analytical Applications: Retail Value Chain



Source: Contributed by Abhishek Rathi, CEO, **vCreaTek.com.**

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Analytics Overview (cont…)

Business Valuesof BI Analytical Applications: Retail Value Chain (cont…)

TABLE 1.1 Examples of Analytics Applications in the Retail Value Chain

Analytic Application	Business Question	Business Value
Inventory Optimization	1. Which products have high demand? 2. Which products are slow moving or becoming obsolete?	1. Forecast the consumption of fast-moving products and order them with sufficient inventory to avoid a stock out scenario. 2. Perform fast inventory turnover of slow-moving products by combining them with one in high demand.
Price Elasticity	1. How much net margin do I have on the product? 2. How much discount can I give on this product?	1. Markdown prices for each product can be optimized to reduce the margin dollar loss. 2. Optimized price for the bundle of products is identified to save the margin dollar.
Market-Basket Analysis	1. What products should I combine to create a bundle offer? 2. Should I combine products based on slow-moving and fast-moving characteristics? 3. Should I create a bundle from the same category or a different category line?	1. The affinity analysis identifies the hidden correlations between the products, which can help in following values: a. Strategize the product bundle offering based on focus on inventory or margin. b. Increase cross-selling or up-selling by creating bundle from different categories or the same categories, respectively.
Shopper Insight	1. Which customer is buying what product at what location?	1. By customer segmentation, the business owner can create personalized offers resulting in better customer experience and retention of the customer.
Customer Churn Analysis	1. Who are the customers who will not return? 2. How much business will I lose? 3. How can I retain the customers? 4. What demography of customer is my loyal customer?	1. Businesses can identify the customer and product relationships that are not working and show high churn. Thus, they can have better focus on product quality and the reason for that churn. 2. Based on the customer lifetime value (LTV), the business can do targeted marketing resulting in retention of the customer.

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Analytics Overview (cont…)

Business Valuesof BI Analytical Applications: Retail Value Chain (cont…)

Analytic Application	Business Question	Business Value
Channel Analysis	1. Which channel has lower customer acquisition cost? 2. Which channel has better customer retention? 3. Which channel is more profitable?	1. Marketing budget can be optimized based on insight for better return on investment.
New Store Analysis	1. What location should I open? 2. What and how much opening inventory should I keep?	1. Best practices of other locations and channels can be used to get a jump-start. 2. Comparison with competitor data can help to create a differentiator to attract the new customers.
Store Layout	1. How should I do store layout for better topline? 2. How can I increase my in-store customer experience?	1. Understand the association of products to decide store layout and better alignment with customer needs. 2. Workforce deployment can be planned for better customer interactivity and thus satisfying customer experience.
Video Analytics	1. What demography is entering the store during the peak period of sales? 2. How can I identify a customer with high LTV at the store entrance so that a better personalized experience can be provided to this customer?	1. In-store promotions and events can be planned based on the demography of incoming traffic. 2. Targeted customer engagement and instant discount enhances the customer experience resulting in higher retention.

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Artificial Intelligence (AI) Overview

<u>What is Artificial Intelligence (AI)?</u>

- A subfield of computer science, concerned with symbolic reasoning and problem solving

- The sciences of making machines owns the following abilities:
  - **Think like humans**
  - **Think rationally**
  - **Act like humans**
  - **Act rationally**

- AI is concerned with the automation of intelligent behaviours.

- AI is also about:
  - Technology that can **learn to do things better over time**.
  - Technology that can **understand human language**.
  - Technology that can **answer questions**.

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Artificial Intelligence (AI) Overview (cont…)

Major Benefits of AI

- Reduction in the cost of performing work.
- Work can be performed much faster.
- Work is more consistent than human work.
- Increased productivity, profitability,
- …

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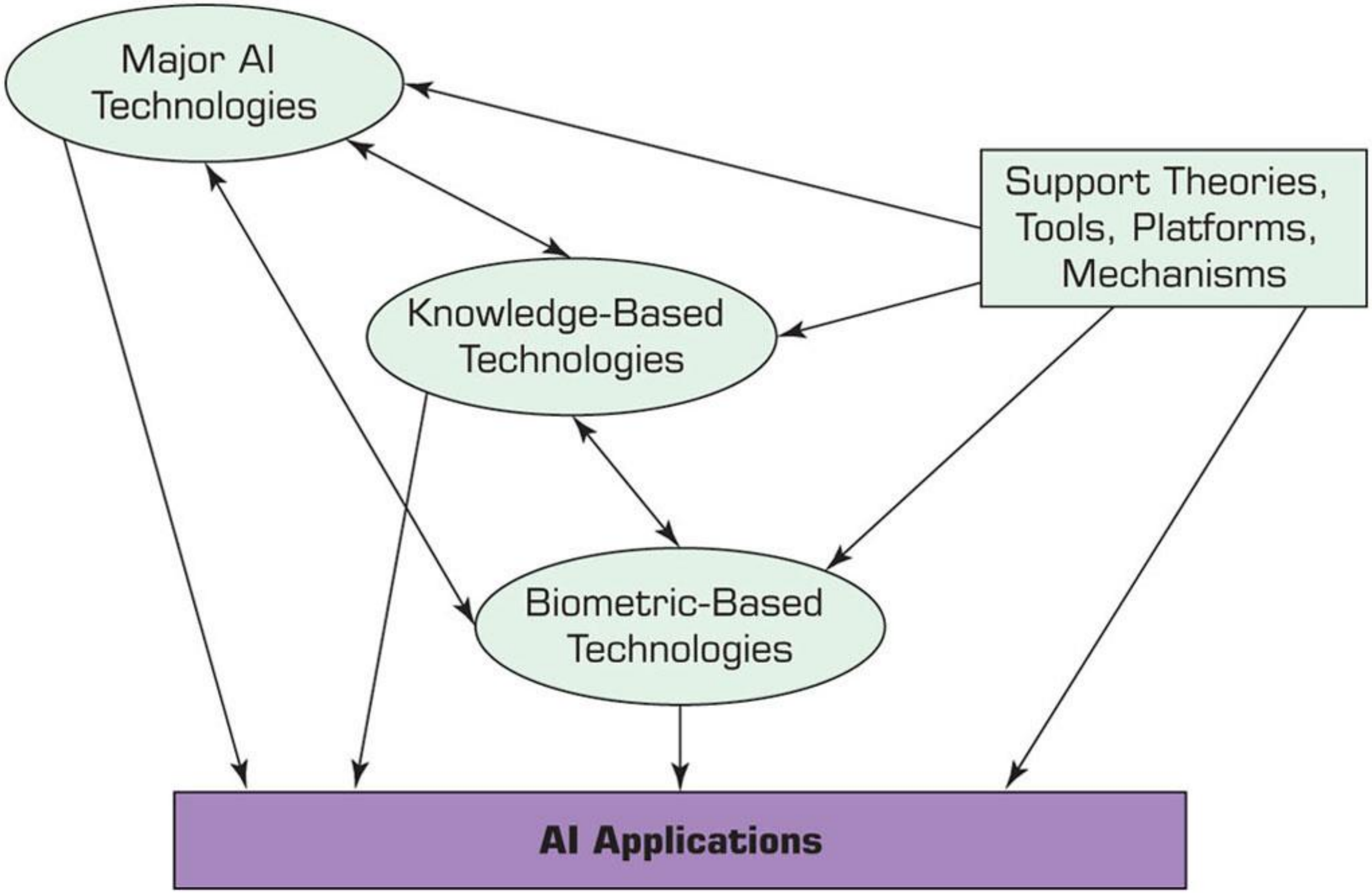
Artificial Intelligence (AI) Overview (cont…)

The Landscape of AI



Source: Drawn by E. Turban.

Examples: Smart cities, smart homes, autonomous vehicles, automatic decisions, language translation, robotics, fraud detection, security protection, content screening, prediction, personalized services, …

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Artificial Intelligence (AI) Overview (cont…)

The Landscape of AI (cont…)

AI Landscape Categories	Descriptions
Major AI Technologies	Machine learning, deep learning, intelligent agent
Knowledge-based Technologies	Expert system, recommendation engines, chatbots, virtual personal assistants, , robo-advisor
Biometric-based Technologies	Natural language processing, machine vision, scene and image recognition, voice recognition, other biometric recognition
Support Theories	Computer science, cognitive science, control theory, linguistics, mathematics, neuroscience, philosophy, psychology, and statistics Sensors, augmented reality, context awareness, logic, gestural computing, collaborative filtering, content recognition, neural networks, data mining, humanoid theories, case-based reasoning, application programming interfaces, knowledge management, fuzzy logic, genetic algorithm, big data
Tools and Platforms	IBM, Microsoft, Nvidia, …

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Artificial Intelligence (AI) Overview (cont…)

Narrow Versus General AI

- **Narrow** AI = **Weak** AI
- **General** AI = **Strong** AI
- Narrow AI focuses on one **narrow field/domain**. Examples: SIRI, Alexa, expert systems
- General AI focuses on making machines to perform the **full range of human cognitive capabilities**.
- The difference between the narrow AI and general AI is getting not apparent. Generally, AI become “smarter”.
- In an ideal situation, strong AI will be able to replicate humans. However, true intelligence is noticed only in narrow domains.

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Artificial Intelligence (AI) Overview (cont…)

Three Flavours of AI Decisions

- The capabilities of AI systems can be divided into three levels:
  - **Assisted intelligence**
  - **Autonomous AI**
  - **Augmented intelligence**

- Assisted intelligence
  - Equivalent to **narrow/weak AI**.
  - **Clearly defined inputs & outputs** are required.
  - Examples: monitoring systems in cars, low-level virtual personal assistants, healthcare monitoring and diagnosis applications.

- Autonomous AI
  - In the territory of the **general/strong AI** but in **very narrow domain**.
  - Machines will act as **experts** and have **absolute decision-making power**.
  - Examples: autonomous vehicles and robots.

- Augmented intelligence
  - In **between assisted and autonomous**.
  - Focus on **augmenting computer abilities** to **extend human cognitive abilities**.
  - Examples: cyber-crime fighting, e-commerce decisions, high-frequency stock market trading.

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Artificial Intelligence (AI) Overview (cont…)

Three Flavours of AI Decisions (cont…)

TECHNOLOGY INSIGHTS 1.1 Augmented Intelligence

The idea of combining the performance of people and machines is not new. Here we combine (augmenting) human capabilities with powerful machine intelligence. That is, not replacing people which is done by autonomous AI, but extending human cognitive abilities. The result is the ability to solve complex human problems as in the opening vignette to this chapter. The computers enabled people to solve problems that were unsolved before. Padmanabhan (2018) distinguishes the following differences between traditional and augmented AI:

1. Augmented machines extend rather than replace human decision making, and they facilitate creativity.
2. Augmentation excels in solving complex human and industry problems in specific domains in contrast with strong, general AI.
3. In contrast with a "black box" model of some AI and analytics, augmented intelligence provides insights and recommendations, including explanations.
4. In addition, augmentation technology can offer new solutions by combining existing and discovered information in contrast with assisted AI, which identifies problems or symptoms and suggests predetermined solutions.

Padmanabhan (2018) and many others believe that at the moment, augmented AI is the best option to move toward the transformation of the AI world.

In contrast with autonomous AI, which describes machines with a wide range of cognitive abilities (e.g., driverless vehicles), augmented intelligence has only a few cognitive abilities.

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Convergence of Analytics and AI

Major Differences between Analytics and AI

- **Analytics** = **descriptive** + **predictive** + **prescriptive**
- **Analytics** focus on **statistical**, **management science**, and other **computational tools** that help analyze data.
- **AI** on the other hand **mimics** the way of human **think**, **learn**, **reason**, **make decisions** and **solve problems**.
- The emphasis of **AI** is **knowledge** and **intelligence** as major tools. AI deals with **cognitive computing**.
- **Convergence of analytics and AI** is more and more **apparent**.
- **Business intelligence** and **analytics** can answer most of the **why** and **what** questions.
- Next generation of business intelligence platforms will use AI to automatic locate, visualize, narrate important things.

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Convergence of Analytics and AI (cont…)

<u>Big Data is Empowering AI Technologies</u>

- The availability of big data analytics enables new capabilities in AI.

- Big data can empower AI due to:
  - The new capabilities of processing big data at a **much reduced cost**.
  - The availability of large data sets **online**
  - The **scale up of algorithms**, including **deep learning**, is enabling powerful AI capabilities.

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Convergence of Analytics and AI (cont…)

The Convergence of AI and the IoT

- Internet of Things (IoT).

- IoT **collects** a large amount of data from **sensors** and other "**things**". These data will be **processed for decision making**.

- Examples: smart thermostat in smart homes applications, automated vacuum cleaners, self-driving vehicles.

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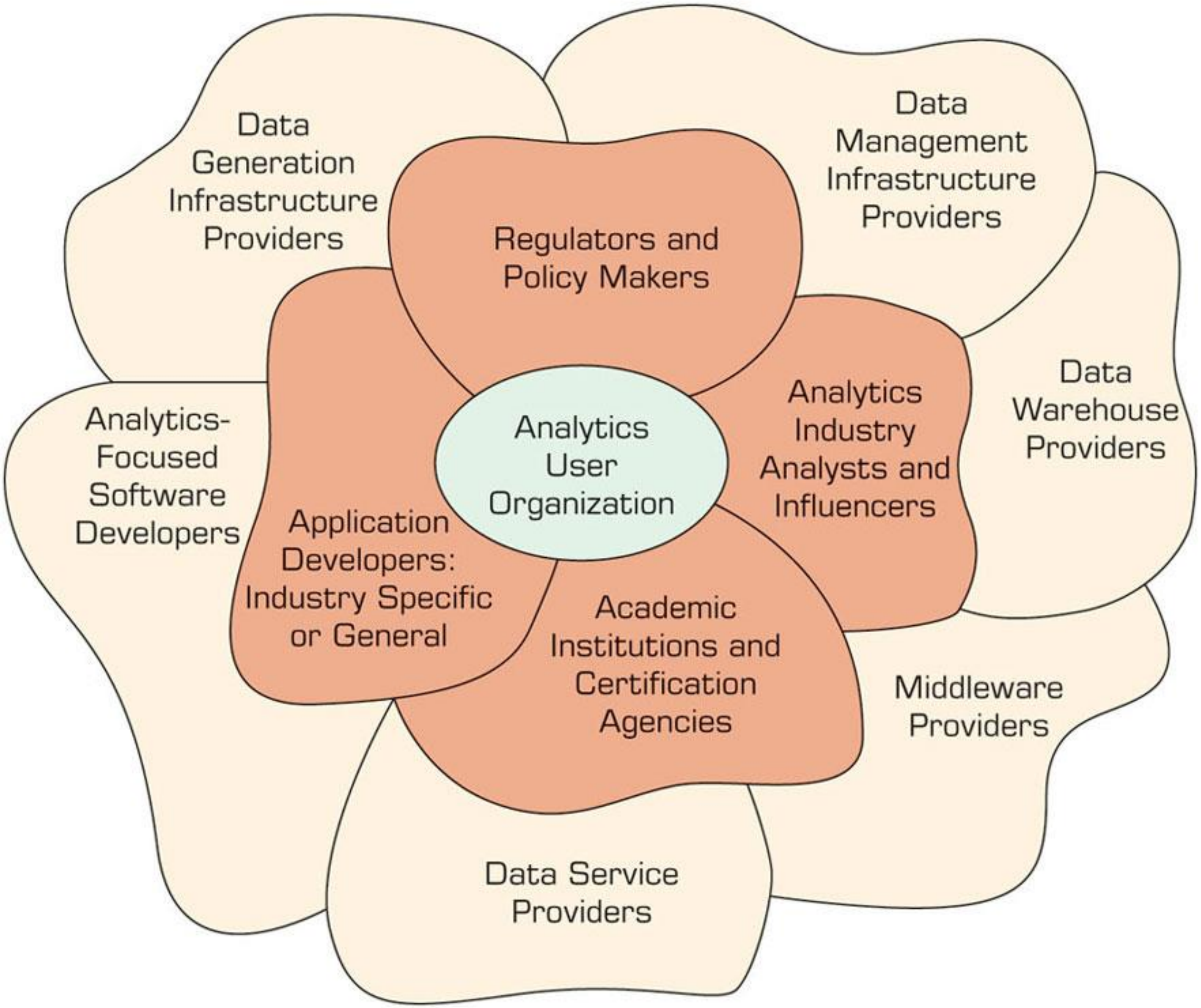
Analytics Ecosystem



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Analytics Ecosystem (cont…)

<u>Data and AI Ecosystem</u>

- Matt Turck creates some visual images that show data and AI ecosystem (https://mattturck.com/)
- 2012 - A chart of the big data ecosystem, https://mattturck.com/a-chart-of-the-big-data-ecosystem/
- 2014 - The State Of Big Data in 2014: A Chart, https://mattturck.com/the-state-of-big-data-in-2014-a-chart/
- 2016 - Is Big Data Still a Thing? (The 2016 Big Data Landscape), https://mattturck.com/big-data-landscape/
- 2017 - Firing on All Cylinders: The 2017 Big Data Landscape, https://mattturck.com/bigdata2017/
- 2018 - Great Power, Great Responsibility: The 2018 Big Data & AI Landscape, https://mattturck.com/bigdata2018/

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Analytics Ecosystem (cont…)

Data and AI Ecosystem

- 2019 - A Turbulent Year: The 2019 Data & AI Landscape, https://mattturck.com/data2019/
- 2020 - Resilience and Vibrancy: The 2020 Data & AI Landscape, https://mattturck.com/data2020/
- 2021 - Red Hot: The 2021 Machine Learning, AI and Data (MAD) Landscape, https://mattturck.com/data2021/
- 2023 - The 2023 MAD (Machine Learning, Artificial Intelligence & Data) Landscape, https://mattturck.com/mad2023/
- 2024 - Full Steam Ahead: The 2024 MAD (Machine Learning, AI & Data) Landscape, https://mattturck.com/mad2024/