Chapter 2

The Nature of Knowledge

Chapter Objectives

- Understand the difference between knowledge, data, and information

- Explain the alternative views of knowledge

- Understand the different types of knowledge

- Recognize the various locations of knowledge

What is Data?

- *Data* represents raw numbers or assertions

- Data comprises facts, observations, or perceptions

- <u>Data is just bits: lots of zeros and ones.</u>

What is Data?

- **Example 1.** Bits representing a restaurant sales order including two large burgers and two medium-sized soft drinks.

- **Example 2.** One bit representing the observation that a tossed coin lands on heads.

- **Example 3.** 64 bits representing the wind component (u and v) coordinates for a particular typhoon's trajectory at specific instances of time.

What is Information?

- *Information* is data with context and relevance
  - ◆ In contrast, data can include millions of useless garbage bits, which are nothing more than uninterpretable zeros and ones

- Information involves manipulation of raw data
  - ◆ Often, information can be used to obtain a more meaningful indication of trends or patterns

- Information is data with semantics.

What is Information?

- **Example 1.** For the restaurant manager, numbers that he understands to indicate the daily sales of burgers and soft drinks.

- **Example 2.** Assume the context is a bet: John offers to pay $10 for heads and take $8 for tails. Susan understands that the last 100 tosses included 40 heads and 60 tails. This is much more information than the outcome of a single toss, and can be interpreted to compute an expected value. (Information theory!)

- **Example 3.** A series of u and v components can be interpreted by storm software models to create a forecast of the typhoon trajectory.

What is Knowledge?

- *Knowledge* is information with decision-making and action-directed utility and purpose

- Knowledge is defined by some as "a justified true belief" (Nonaka and Takeuchi 1995)

- Different from data & information

  - Knowledge is at the highest level in a hierarchy with information at the middle level, and data to be at the lowest level

  - It is the richest, deepest & most valuable of the three

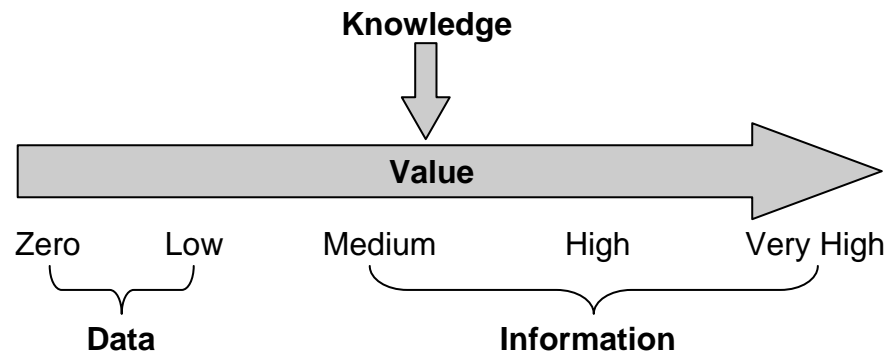- <u>Knowledge is information with direction.</u>

What is Knowledge?

- **Example 1.** The daily sales of burgers (plus other information like the amount of bread in the inventory) can be used to compute the amount of bread to buy (which is still information, but is more valuable information). The *relationship* between the quantity of bread to be ordered, the quantity of bread currently in the inventory, and the daily sales of burgers (and other products that use bread) is knowledge.

- **Example 2.** The expected value of the bet is still information, but is more valuable information. The *relationship* between the probability of heads, the number of times the coin lands heads, and the total number of tosses (probability theory) is knowledge.

- **Example 3.** The knowledge of a storm researcher as to the *relationship* of a series of u and v components to the probability of trajectories is used to predict a specific typhoon trajectory.
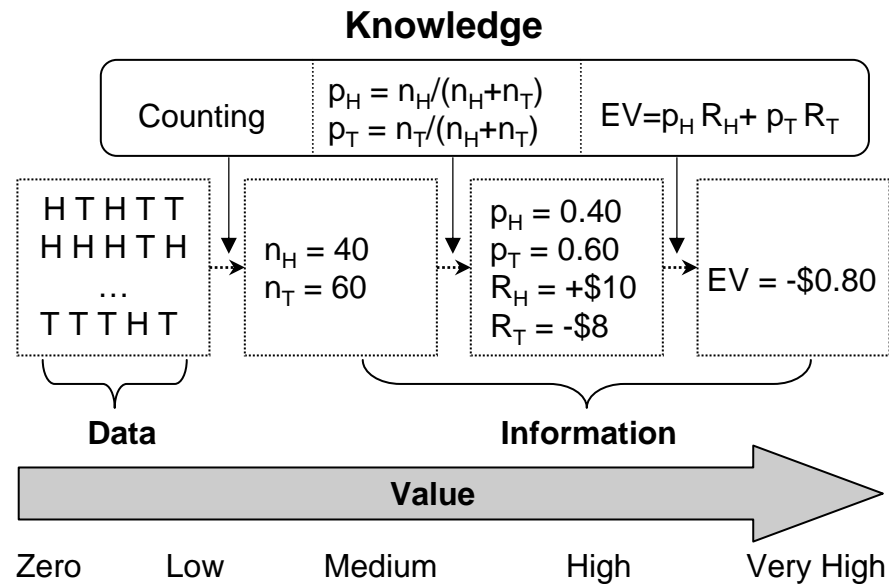
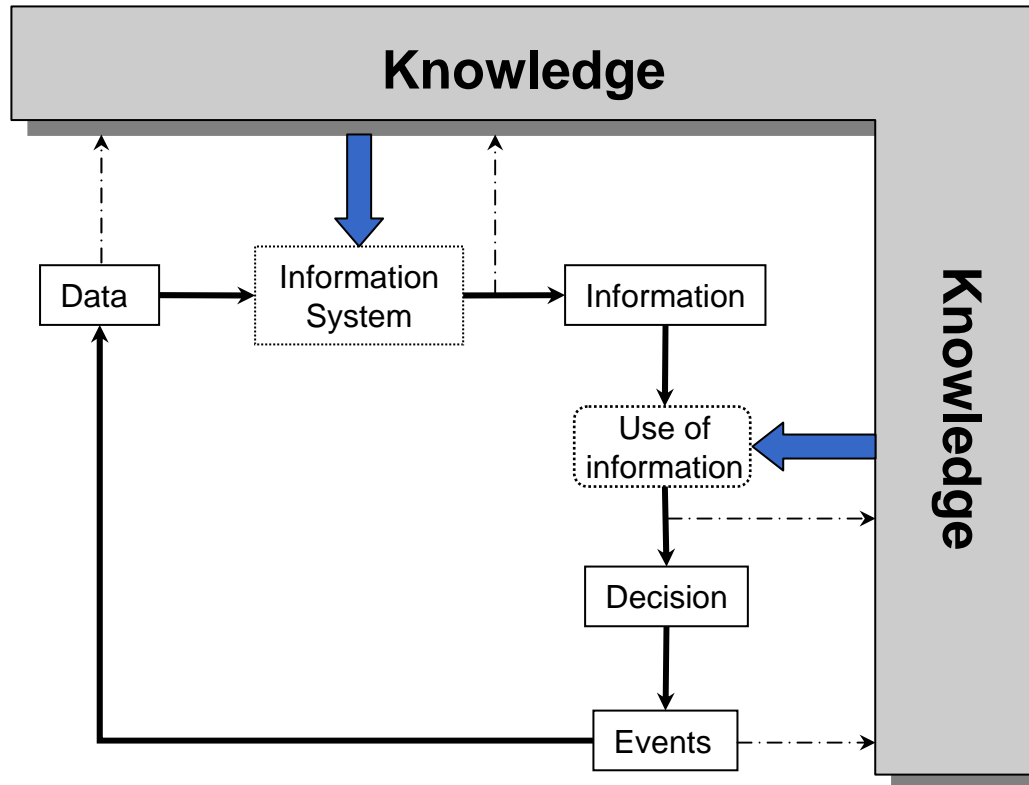# Data, Information, and Knowledge

- Knowledge is information that helps to
    - produce information from data, or
    - produce more valuable information from less valuable information

Data, Information, and Knowledge:Example

Knowledge

Counting	$p_H = n_H/(n_H+n_T)$ $p_T = n_T/(n_H+n_T)$	$EV = p_H R_H + p_T R_T$

H T H T T H H H T H … T T T H T	$n_H = 40$ $n_T = 60$	$p_H = 0.40$ $p_T = 0.60$ $R_H = +\$10$ $R_T = -\$8$	$EV = -\$0.80$

Data　　　　　　　　　　**Information**

Value

Zero　　　Low　　　Medium　　　High　　　Very High

Types of Knowledge

e·pis·te·mol·o·gy *n.* The branch of philosophy that studies the nature of knowledge, its presuppositions and foundations, and its extent and validity.

(*American Heritage Dictionary of the English Language, Fourth Edition*)

- Epistemology is a very old field with a long history.
- There are many classifications and characterizations of types of knowledge, e.g.:
  - individual, social, causal, conditional, relational and pragmatic
  - embodied, encoded and procedural
  - etc.
- *We must know what knowledge is, if we wish to manage it effectively!*

Subjective View of knowledge

- According to the subjective view, reality is entirely dependent on human perception, and is socially constructed through interactions with individuals.
  - Knowledge has no existence independently of social practices and human experiences.
  - Knowledge is not an independent object.
  - Knowledge has no single location.
  - Knowledge is viewed as an ongoing accomplishment, which continuously affects and is influenced by social practices.

- Knowledge as State of Mind
- Knowledge as Practice

Objective View of knowledge

- According to the objective view, reality is independent of human perceptions and can be structured in terms of *a priori* categories and concepts.
  - Knowledge can be located.
- Knowledge as Objects
  - Something that can be stored, transferred, and manipulated.
  - Object-oriented programming analogy: instances of structs (classes).
- Knowledge as Access to Information
  - Knowledge enables access and utilization of information.
  - Object-oriented programming analogy: Interfaces and methods are more important than structs.
- Knowledge as Capability
  - Not merely access to information – instead, emphasizes knowledge as a strategic capability that can potentially be applied to seek a competitive advantage.

Procedural vs. Declarative Knowledge

- *Declarative knowledge* (or *substantive knowledge*) focuses on beliefs about relationships among variables.
    - e.g., "all other things being equal, greater price charged for a product would cause some reduction in its number of sales"
    - Can be stated in the form of logical propositions, expected correlations, or formulas relating concepts represented as logical symbols and/or mathematical variables.
    - Often characterized in KM circles as "<u>know-what</u>".
- *Procedural knowledge* focuses on beliefs relating procedures or processes: sequences of steps or actions to desired (or undesired) outcomes.
    - e.g., the procedure that should be followed in a government organization in deciding on whom to ward the contract for a particular area (e.g., information system development)
    - Often characterized in KM circles as "<u>know-how</u>".

Procedural vs. Declarative: Automobile Manufacturing

- *Declarative knowledge regarding quality/cost optimization*
  - Effect that quality of each component would have on final product
    - Reliability, fuel consumption, deterioration over time, quality of the ride
  - Set of components needed for each model
  - Prices of various alternatives for each component
- *Procedural knowledge regarding assembly process*
  - Steps in engine assembly process
  - Which tasks can be performed in parallel
  - Amount of time each step should take
  - Amount of waiting time between successive steps

Tacit vs. Explicit Knowledge

- *Explicit knowledge* refers to knowledge that has been expressed into words and numbers
    - e.g., basic principles for stock market analysis as in a textbook
        - Such knowledge can be used by investors to make buy/sell decisions
    - Can be shared formally and systematically in the form of data, specifications, manuals, drawings, audio or videotapes, computer programs, patents, etc.
- *Tacit knowledge* includes insights, intuitions, and hunches, that are not verbalized or documented
    - e.g., stock market analysts who make recommendations to investors concerning likely short-term and long-term market trends within some industry, based on years of observation
    - Difficult to express and formalize
    - Therefore often difficult to share (can't tell somehow how to do it!)
- We can convert explicit knowledge to tacit knowledge

Tacit vs. Explicit Knowledge

- We often convert explicit knowledge to tacit knowledge

  - e.g., when an individual reads a book and learns from it (but not by rote memorization, which would still be explicit knowledge)

- We can sometimes convert tacit knowledge to explicit knowledge

  - e.g., when an individual with lots of tacit knowledge writes a book formalizing that knowledge

  - Often a difficult conversion that requires hard efforts!

General vs. Specific Knowledge

- *General knowledge* is possessed by a large number of individuals and can be transferred easily across individuals
  - ◆ e.g., headache is one symptom of brain hemorrhage
- *Specific knowledge*, or "*idiosyncratic knowledge*", is possessed by a very limited number of individuals, and is expensive to transfer
  - ◆ e.g., how to operate on a patient suffering a stroke

Technically vs. Contextually Specific Knowledge

- *Technically specific knowledge* is deep knowledge about a specific area.
    - Includes tools and techniques for solving problems in that area.
    - Often acquired via formal training + experience in the field.
    - e.g., scientific knowledge possessed by a physicist
    - e.g., knowledge about computer hardware possessed by an engineer
- *Contextually specific knowledge* refers to the knowledge of particular circumstances of time and place in which work is to be performed.
    - e.g., the detailed knowledge that design engineers possess about the idiosyncrasies of the particular design group in which they are working
    - e.g., a basketball forward's detailed knowledge of the team's center
    - Cannot be acquired through formal training.

Illustrations of the Different Types of Knowledge

		General	Contextually Specific	Technically Specific
Declarative	Explicit	A book describing factors to consider when deciding whether to buy a company's stock. This may include price to earnings ratio, dividends	A company document identifying the circumstances under which a consultant team's manager should consider replacing a team member who is having problems with the project.	A manual describing the factors to consider in configuring a computer so as to achieve performance specifications
	Tacit	Knowledge of the major factors to consider when deciding whether to buy a company's stock.	A human relations manager's knowledge of factors to consider in motivating an employee in a particular company.	A technician's knowledge of symptoms to look for in trying to repair a faulty television set.
Procedural	Explicit	A book describing steps to take in deciding whether to buy a company's stock.	A company document identifying the sequence of actions a consultant team's manager should take when requesting senior management to replace a team member having problems with the project.	A manual describing how to change the operating system setting on a computer so as to achieve desired performance changes.
	Tacit	Basic knowledge of the steps to take in deciding whether to buy a company's stock.	A human relations manager's knowledge of steps to take in motivating an employee in a particular company.	A technician's knowledge of the sequence of steps to perform in repairing a television set.

Knowledge and Expertise

- *Expertise* can be defined as knowledge of higher quality
- An "expert" is one who is able to perform a task much better than others
- Often, an expert possesses many different types and levels of knowledge
- Expertise is within a *domain*
  - ◆ Domains can be of various degrees of sophistication
    - ▪ expert brain surgeon > medical intern
    - ▪ expert mathematician > secondary school math student
    - ▪ expert bus driver > novice driver
- AI *expert systems* attempt to mimic expertise
  - ◆ varying degrees of success, heavily depending on:
    - ▪ domain
    - ▪ type of expertise

Types of Expertise

- Associational Expertise

- Motor Skills Expertise

- Theoretical (Deep) Expertise

Types of Expertise: Associational Expertise

- In most fields: desirable for experts to have detailed understanding of underlying theory
- But not always necessary!
  - e.g., TV repairman
    - can fix nearly all common problems
    - but does not understand transistor theory or CRT/LCD/plasma display theory
    - works mainly by *associating* observations of performance/symptoms to specific repair actions
    - based on experience, rather than analysis
- Can have expert-level *associational* knowledge
- May not understand the inner workings of the device
  - may not know how to proceed when encountering a new, previously unseen problem
  - may not be able to invent or design new devices well

Types of Expertise: Motor Skills Expertise

- Motor skill knowledge is predominantly physical rather than cognitive
- Humans learn this type of knowledge via repeated performance (practice)
- E.g.,
  - ◆ Riding a bicycle
  - ◆ Kicking a football
  - ◆ Wakeboarding or water skiing
- Expert reactions seem spontaneous and automatic
  - ◆ From encountering thousands of past instances
  - ◆ A small amount of conscious thinking is still necessary…
  - ◆ … but too much conscious thinking can actually degrade performance

Types of Expertise:
Theoretical (Deep) Expertise

- Finding solutions to technical problems often requires going beyond a superficial understanding of the domain

- Must apply creative ingenuity

- Based on theoretical knowledge of the domain

- Cannot be solved via associational expertise

- Acquired via formal training and hands-on problem solving

- Very easily forgotten unless continually used, due to theoretical and often abstract nature

- E.g., engineers and scientists

Types of Knowledge:
Knowledge Complexity

- Simple knowledge focuses on one basic area

- Complex knowledge draws upon multiple distinct areas of expertise

Types of Knowledge: Role of Knowledge within Organizations

- Support knowledge relates to organizational infrastructure and facilitates day-to-day operations

- Tactical knowledge pertains to the short-term positioning of the organization relative to its markets, competitors, and suppliers

- Strategic knowledge pertains to the long-term positioning of the organization in terms of its corporate vision and strategies for achieving that vision

Explicitness of Knowledge

- *Explicitness* refers to the extent to which knowledge exists in an explicit form (as opposed to a tacit form).

- Emphasizes that "explicit" and "tacit" are often not black-and-white, but rather a continuous scale.

- Any particular knowledge falls somewhere along the continuum of explicitness.

Codifiability and Teachability of Knowledge [Zander & Kogut 1995]

- *Codifiability* reflects the extent to which knowledge can be articulated or codified (i.e., made explicit) …
  - even if the resulting codified (explicit) knowledge might be difficult to teach to another individual …
  - e.g., it's hard to teach the explicit knowledge of how to fix PC problems.
- *Teachability* reflects the extent to which the knowledge can be taught to other individuals (e.g., through training, apprenticeship, etc.) …
  - even if the taught knowledge might remain in tacit form …
  - e.g., it's relatively feasible to teach the tacit knowledge of how to play basketball.
- Both codifiable and teachable → definitely explicit
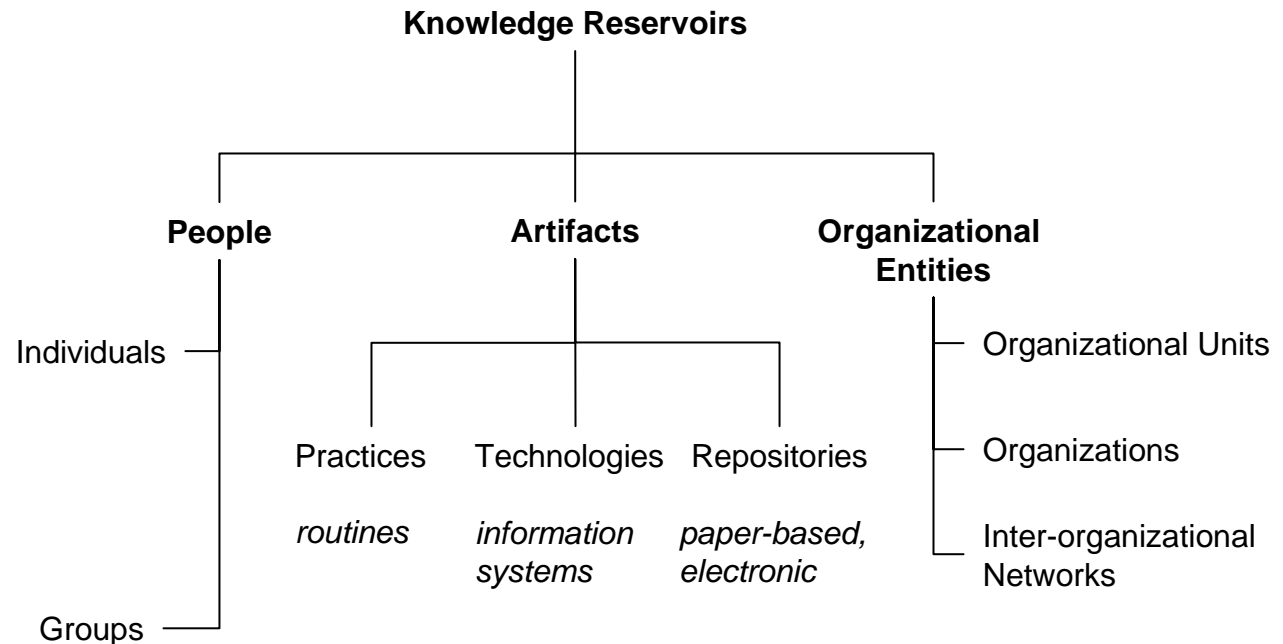- Neither codifiable nor teachable → definitely tacit

Specificity of Knowledge

- *Specificity* refers to the extent to which knowledge is specific (as opposed to general).

- Emphasizes that "specific" and "general" are often not black-and-white, but rather a continuous scale.

- Any particular knowledge falls somewhere along the continuum of explicitness.

- High level of specificity $\rightarrow$ knowledge that
  - can be acquired or effectively used only by individuals possessing certain specific knowledge
  - is possessed by a very limited number of individuals
  - is expensive to transfer

Reservoirs of Knowledge

Knowledge Reservoirs

- **People**
  - Individuals
  - Groups

- **Artifacts**
  - Practices
    - *routines*
  - Technologies
    - *information systems*
  - Repositories
    - *paper-based, electronic*

- **Organizational Entities**
  - Organizational Units
  - Organizations
  - Inter-organizational Networks

CoP (Communities of Practice)

Characteristics of Knowledge

- Explicitness
- Codifiability
- Teachability
- Knowledge Specificity

Conclusions

- Knowledge is different from data & information
- Knowledge in an area can be defined as justified beliefs about relationships among concepts relevant to that particular area
- Knowledge can be of different types
- Knowledge has several characteristics
- Knowledge resides is several different places

A2: Individual Assignment
(Due at beginning of class Jun 16)

1. **Daily life:** Consider five decisions you have made today. (They could be simple, such as taking a turn while driving or even choosing a soft drink at a store.)

   a) In each case determine the (1) data, (2) information, and (3) knowledge that were involved in your decision.

   b) Now consider how those decisions would have been influenced by the lack of preexisting data, information, or knowledge.

2. **Knowledge in your organization:**

   a) Determine the various locations of knowledge within your organization. Classify them appropriately.

   b) Now speculate on the negative effects of not having one or more of those knowledge repositories and accordingly determine which repository is the most critical to the organization. Which is the least?

Chapter 2

The Nature of Knowledge