LECTURE

5

Information Systems

Veronika Vlčková, Zuzana Bělinová

Faculty of Transportation Sciences, CTU in Prague

LECTURE 5 - OVERVIEW

Basic types

Data-information-knowledge-wisdom

Meaning triangle

Data and its collection

Design of information systems

Expert systems

INFORMATION SYSTEMS

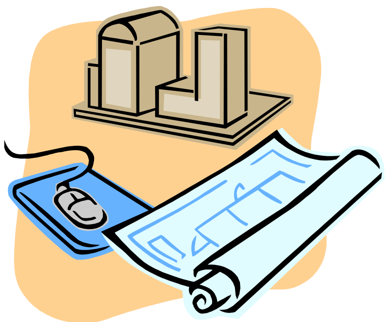
Class b) – relationship parameter is emphasized

- parameters of language, metrics, data carriers, hierarchy

Systems type class	Emphasized part of systems definition	Viewpoint for distinguishing systems type
a	A/F	Pragmatic characteristic of an element, type and level of production function
b	**R/P**	**parameter on relationship, based on differentiation of system dimension, orientation of processes**
c	M	Based on the magnitude (cardinality) of the system – universal or special systems, e.g. adaptive, sensitive systems
d	γ	Based on elements of surroundings included in systems relations – introverted (epistemic) and extrovert (cooperating) systems = based on prevailing processes in goal behaviour
e	δ	Prevailing processes in the genetic code (genetic behaviour) – conservative or dynamic systems

INFORMATION SYSTEMS

a) Language x original → image (model)



b) Image (model) x original → original

Add a) creation of an image (a model) of the object (original)

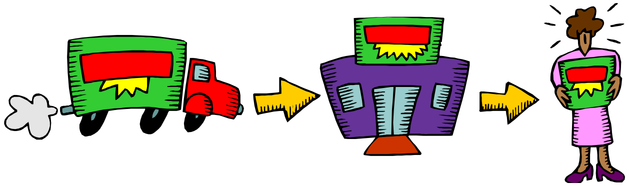
Add b) Using the image (model) for control of objects (originals)

Function x - set of methods and techniques for creation and usage of the image (model) of the original

INFORMATION SYSTEMS

Two basic types

- Syntactic information systems – i.e. databases
- Process information systems – systems supporting production functions control
  - In transportation e.g. traffic control
  - Logistic processes
  - Vehicle control
  - Monitoring systems
  - Identification systems – both process and syntactic part



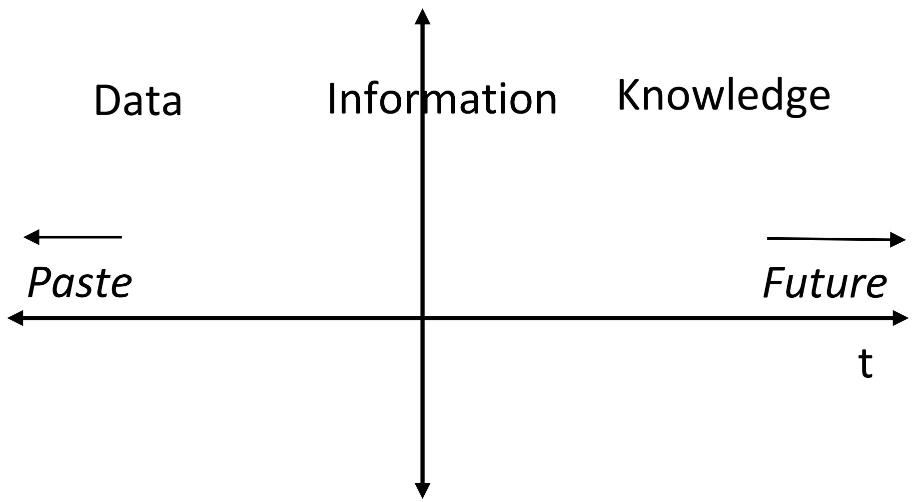
DATA-INFORMATION-KNOWLEDGE-WISDOM CONCEPT

Data - pure components without context

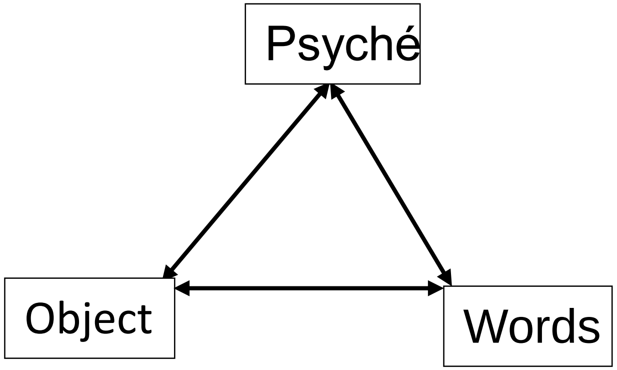
Information - meaningful and functional component ensemble, reduces entropy

Knowledge - know-how used to perform activity, related to future

Wisdom - understanding of background and impact of activity performance



GNOSEOLOGY TRIANGLE



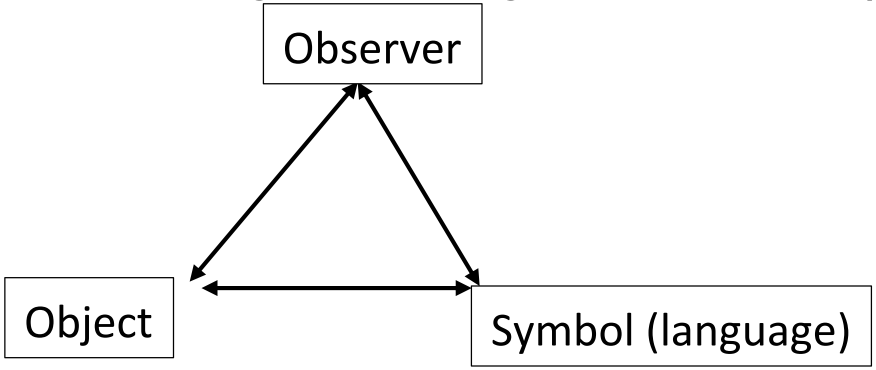
Based already at Aristotle findings

Distinguishes

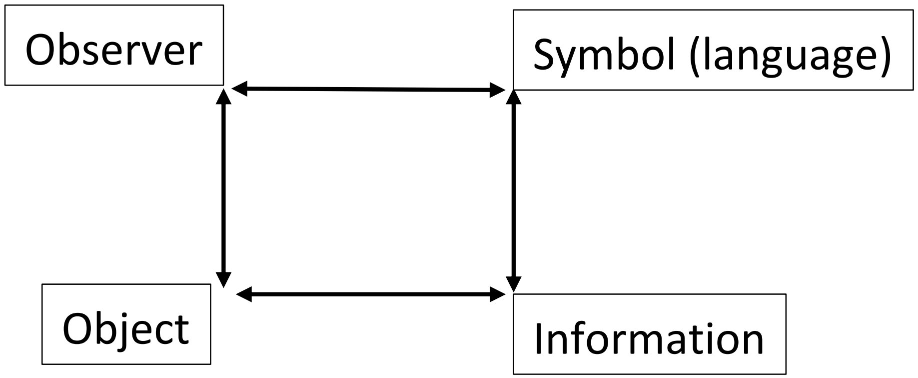
- objects,
- the words that refer to them,
- and the corresponding experiences in the *psychê*

Ogden & Richard's (1923) triangle of meaning

(also known as semiotic triangle or triangle of reference)



GNOSEOLOGY SQUARE



All relations bi-directional

Influencing one-another

Important: information is always communicated in a language – language is very important part

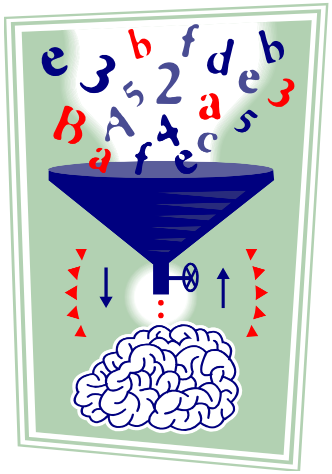
DATA

Data collection

Data transfer

Data storage

Data processing



DATA COLLECTION

3 phases of data collection

- Naming – need to assign language to data (including the level of distinguish, metrics)
- Collection of data – not only the transfer, but also decision where to collect the data, when, etc.
- Ensuring reliability – important aspect, no set procedure to ensure it
    - E.g. experiment (repeated acquisition)
        - serial (data collected anew) – can give different results, as time is not the same
        - or parallel – can give different results, as place is not the same

TYPES OF DATA COLLECTION SYSTEMS

Active x passive

- Active – collecting the data
- Passive – necessity to input the data – system activated by the object

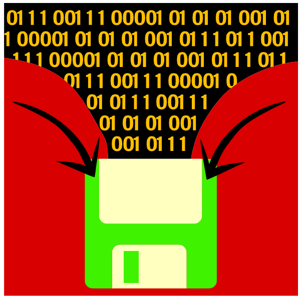
Invasive x non-invasive

- Invasive – influencing the object
- Non-invasive – without influence

These two possibilities apply also to questionnaires

With filtration x without filtration

- Without filtration – including noise, etc.
- With filtration – using only values of interest



Continuous x discrete

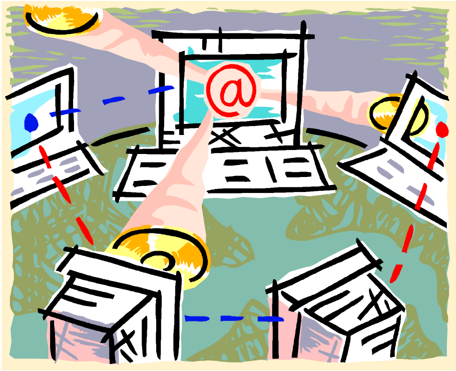
On-line x off-line

With data pre-processing x without pre-processing

Etc.

DATA TRANSFER

Transfer – 3 parts



- Network (where to transfer the data)
- Efficiency of the network (if the transfer is finished in time, etc.)
- Language compatibility (the same language ability at both ends of the transfer)

Goal – the elimination of prior ignorance (depending on the targetted subject of the information)

DATA STORAGE

Storing the data – to last over time interval

Important issue

- Storage capacity
- Compatibility of data format
- Durability

Possibility for solving storage problems– forgetting algorithms, priority assignment, data compression algorithms

Who sets the priority?

→ expert systems

DATA PROCESSING

Usage of data

2 phases

- implementation – the receiver understands the message
- Implantation – usage – phase of introducing the image conditions into the object

DESIGN OF INFORMATION SYSTEMS

Architecture

Evaluation

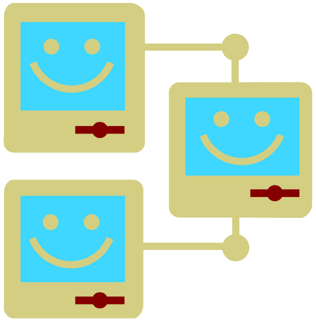
Information models and distinguish level

Design methods

ARCHITECTURE

Information architecture presents concept (hierarchy) among data, information and knowledge

Types of architecture based on the topology



- Central – high integrity, ensuring authorization
- Distributed – elements on the same level
- Shared – all elements share common data
- Pyramidal - hierarchical
- Process – base on processes and project, structure not firmly assigned

ARCHITECTURE

System architecture can be viewed also as unification construction of three system models

object (what)

infrastructure (where, when)

purpose (how, why).

- If we stress the **object**, it is the developing architecture
- If we stress the **infrastructure**, it is the real architecture
- If we stress the **purpose**, it is the theoretical architecture, preferring the system theoretical viewpoints

EVALUATION

- Integrity

  Compactness of the system
- Redundancy

  Goal to eliminate duplicate information in information systems
- Efficiency

  Ability to perform changes in the system (e.g. with minimum bits)
- Readiness

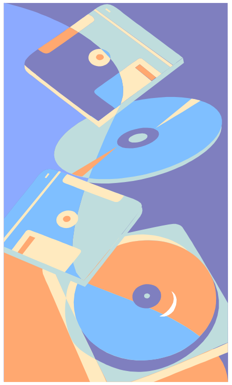
  To deliver the expected outcome in the shortest time
- Orderliness

  Increases the ability to adapt, adjust, etc.

EVALUATION OF INTEGRITY

Evaluation of the

- compactness,
- continuity
- cohesion



Internal integrity – assess the mutual coherence of the system components

EVALUATION OF REDUNDANCY

In information systems goal to eliminate redundancy (on the contrary e.g. human speech contains at least 25% redundancy)

„information ecology“ – not to create information waste

In some systems redundancy is needed – e.g. transaction systems (systems where there must be no collision of data even in case of energy failure, e.g. – bank systems) – until the whole transaction is finished, there is always back-up to return to the original state

EVALUATION OF EFFICIENCY

Based on the ability to make changes in the system ordering using minimal amount of signs (words, language constructs)

Usage of coding, etc.

EVALUATION OF READINESS

Characteristics enabling the system in the shortest time possible to

- Deliver the required data format,
- Aggregate the data
- Create information
- Prepare particular knowledge

EVALUATION OF ORDERLINESS

In case there is need to

- Correct
- Change
- Adapt

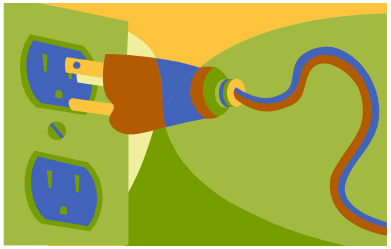
If the structure is highly non-homogeneous, adaptation is difficult

STRUCTURE PARAMETERS OF THE INFORMATION SYSTEMS

Intensity – evaluating flow, speed, etc.

State (potential) - content

(similar to electric current and voltage)



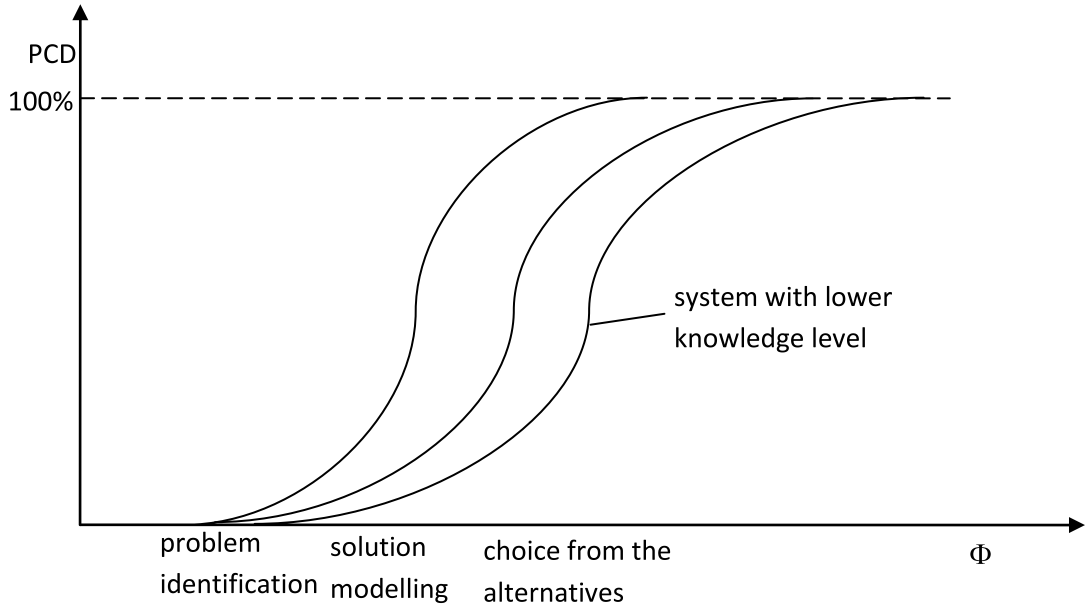
Information flow Φ[bit/s]

Information content I ~ knowledge (measured using the pragmatic value of information (in money, or probability of right decision)

DECISION PROCESS GRAPH

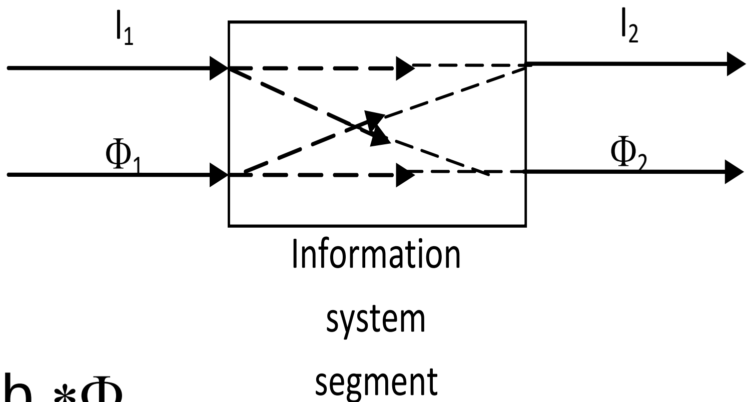
Probability of correct decision

Decision stress $S = \frac{\Delta PCD}{\Delta \Phi}$



STRUCTURE PARAMETERS OF THE INFORMATION SYSTEMS

Every part of the information system (every department) has input, output, internal function



$I_2 = a * I_1 + b * \Phi_1$

$\Phi_2 = c * I_1 + d * \Phi_1$

a, b – information content increase factor

c, d– information flow increase factor

EXPERT SYSTEMS

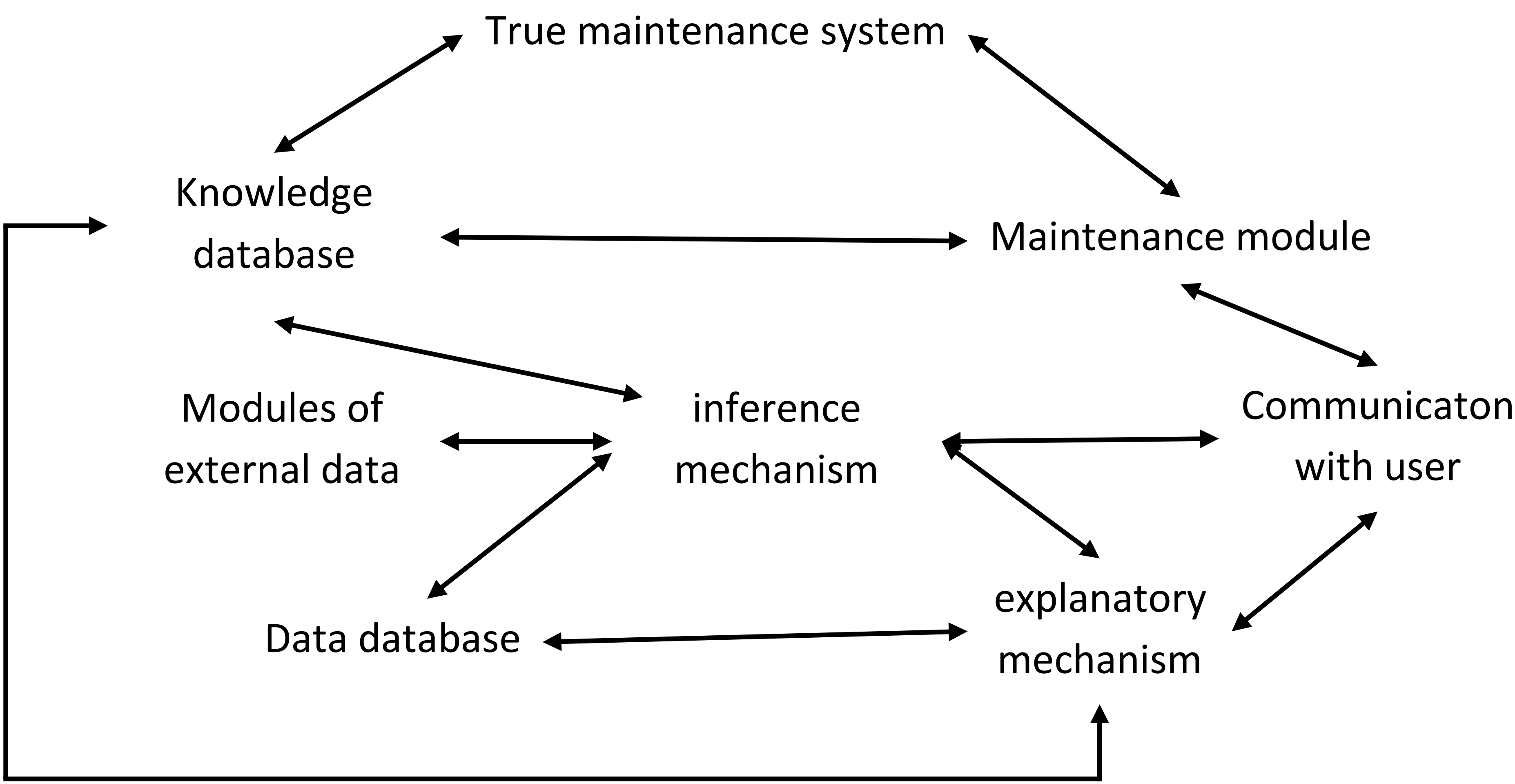
Two types of content

- measured
- derived - knowledge

Architecture of expert system

- Base of facts
- Inference rules
- Created knowledge
- Verification of the knowledge

EXPERT SYSTEM ARCHITECTURE



PARTS OF EXPERT SYSTEM

Inference mechanism (engine) – choosing applicable rules

Explanatory mechanism (engine) – giving information on how the system has derived the conclusions

User communication – presenting system results, presenting the knowledge

Maintenance module – creation and editing of the knowledge base

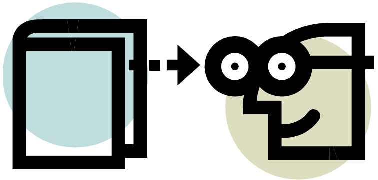
Knowledge base – knowledge saved in the form of rules, objects and frames

TMS (true maintenance system) system for recognition of the truthfulness of the knowledge base

EXPERT SYSTEM PRINCIPLES

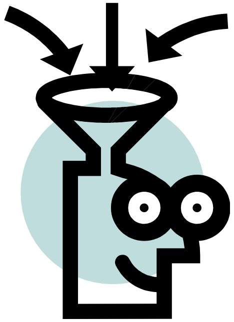
Forward

Uses the known data to formulate conclusions



Backward

From the conclusions and the data create the rules



EXPERT SYSTEM CHALLENGES

Creation of knowledge database

Work only with delivered inputs

Usage of flat knowledge – we know what, when but do not know why

Thank you for your attention

REFERENCES

Vlček J. Systémové inženýrství (in Czech)

Vlčková V. Kudy tudy systémovým inženýrstvím (in Czech)