INF5020

Philosophy of Information:

Computing and Information Processing

THIS SESSION – *The goal*

History:

- We first talked about computation, complexity and information.
- We then looked at several definitions of information.
- Later, we also tried to understand information within the context of data, knowledge, communication.
- We started to look at how language fits in. We characterized language, but ended up with a warning.

Goal:

- We want to look closer at language first.
- We then want to be able to understand how computing and information processing relate to each other.
- We also want to see what "processing information" implies.

LANGUAGE AS COMMUNICATION MEDIUM – *Questions*

- From last session: Language is one possible medium of communication.
- Shall we accept this without any reservations?

- **SANITY CHECK:**
  Assuming that it is one possible medium of communication, we do, how do we then characterize it with respect to other media?

- What are the other media?
  - TV is said to be a communication medium.
  - Both being of the same kind (i.e., both being communication media), language and TV should be comparable
  - Are they comparable?

LANGUAGE AS COMMUNICATION MEDIUM – *Suspicions*

- Claim: Language is one possible medium of communication.
  - Intuitively yes, since we use it for communicating.
  - But no if we are going to call TV a communication medium as well.

- Then is our original characterization of language wrong?

- We won't have an answer before we define language properly.

LANGUAGE – *A more formal definition*(1) #1

Informally, we define language in its broadest sense as a means for communication or as a communication *tool*. A more formal definition is provided below. The definition is … based upon the works of Mario Bunge on language and systems [7-9] as cited in and interpreted by Dillinger [11].

7. Bunge, M., The GST Challenge to the Classical Philosophies of Science. International Journal of General Systems, 1977. **4**: p. 29-37.
8. Bunge, M., Philosophical Problems in Linguistics. Erkenntnis, 1984. **21**: p. 107-173.
9. Bunge, M.A., A world of systems. 1979, Dordrecht ; Boston: Reidel. xvi, 314 p.
11. Dillinger, M., The Concept of 'a Language', in Studies on Mario Bunge's Treatise, P. Weingartner and G.J.W. Dorn, Editors. 1990, Editions Rodopi B.V.: Amsterdam - Atlanta, GA.

(1) From: Akkøk, M.N., Defining Visual Immediacy, the Underused Gift of Diagrammatic Modeling Languages. (preparing for re-submission to) Journal of Visual Languages and Computing, Elsevier, 2003

LANGUAGE – *A more formal definition*(1) #2

Dillinger … refers to Bunge's General Systems Theory (GST) that defines a system as consisting of a *composition* ***C***, *environment* ***E*** and *structure* **S**, which we will refer to as a *Bunge-system*. A language system $\boldsymbol{S}_L$ is then formulated as a Bunge-system composed of representing and represented systems, with communication systems (producers and comprehenders) as its environment, and with an internal and an external structure as follows:

***C*:** Representing systems, represented systems

***E*:** **Ref.** Communication system(s), $\boldsymbol{COM}_s$ (producers and comprehenders)

***S*:** **Internal:** Designation, representation, denotation
External: Relevance, appropriateness, cognitive relations

Note that the environment ***E*** refers to another system, a communication system in this case, which is defined in Dillinger in the same manner, i.e., as composed of the communicators (producers and comprehenders) within the environment of any material or social system and with a specific structure that we do not need detailed here. Note also that the composition ***C*** refers to a representing system and a represented system, both of which are systems again.

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Definition 1: Language.

A language **L** is a system $\mathbf{S_L}$ of its vocabulary $\mathbf{V_L}$, production rules $\mathbf{P_L}$ and interpretation rules $\mathbf{I_L}$, i.e. $\mathbf{S_L}(\mathbf{V_L}, \mathbf{P_L}, \mathbf{I_L})$, where the interpretation rules of the language are defined as mappings from the constructs (productions) of the language to the constructs of one or more other languages or other constructs of the same language..

(1) From: Akkøk, M.N., Defining Visual Immediacy, the Underused Gift of Diagrammatic Modeling Languages. (preparing for re-submission to) Journal of Visual Languages and Computing, Elsevier, 2003

This definition implies a slightly different language system than Dillinger's, but it is still to be interpreted within the context of the following Bunge-system:

***C*:** Represented systems, *representing systems*, *interpreting systems*

E*:** **Ref.** *Communication system(s)*, ***COMs – i.e., producers, comprehenders *and other actors and contributors* in the environment of the language system including the *vocabulary system*

***S*:** **Internal:** Designation, representation, *denotation*
External: Relevance, appropriateness, cognitive relations

The composition ***C*** still refers to representing and represented systems, and we now have *interpreting systems* in addition. Furthermore, we take the *representing systems* as *production systems* producing syntactic representations that are void of semantics, where the semantics of these productions are given by the interpreting systems. Note that there may be more than one production to represent whatever is being represented, and there may be more than one interpretation of any representation (see figure 1 on next page).

(1) From: Akkøk, M.N., Defining Visual Immediacy, the Underused Gift of Diagrammatic Modeling Languages. (preparing for re-submission to) Journal of Visual Languages and Computing, Elsevier, 2003

LANGUAGE – *A more formal definition*(1) #5

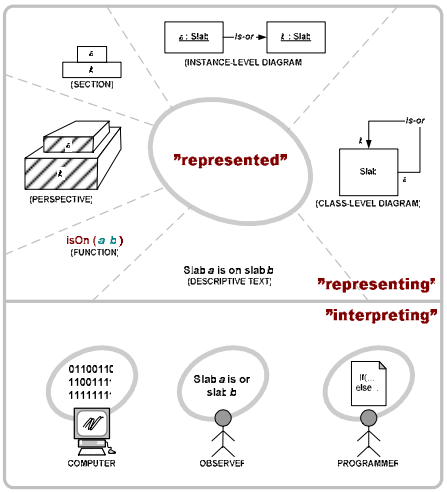

Figure 1. Language systems context for the interpretation of the definition of language

(1) From: Akkøk, M.N., Defining Visual Immediacy, the Underused Gift of Diagrammatic Modeling Languages. (preparing for re-submission to) Journal of Visual Languages and Computing, Elsevier, 2003

LANGUAGE – *A more formal definition #6*

Interpretation of the definition and its consequences:

- Production rules (~syntax) are void of interpretation (~semantics).
- There is no limit to how many interpretations there may be for the same vocabulary and set of production rules
  - Think of Kanji – practically the same production rules, two totally different languages, i.e., Chinese and Japanese.
- Assuming p_L denotes productions in language **L** and → denotes mappings:

  $p_{L1} \rightarrow p_{L2}$ and $p_{L1} \rightarrow p_{L3}$ and $p_{L1} \rightarrow p_{LN}$ and …

More interpretation and consequences:

- Since interpretation rules map productions a language into productions of other languages, there are potentially infinite transformations (levels of interpretation). Assuming p_L denotes productions in language **L** and → denotes mappings:

  $p_{L1} \rightarrow p_{L2} \rightarrow p_{L3} \rightarrow \ldots \rightarrow p_{LN} \rightarrow ?$

- So where is the interpretation (the semantics)?

Thesis 1. Language semantics

The semantics of a language are provided by its interpretation rules only.

Thesis 2. Multiplicity of the semantics of a language

By virtue of a language's capacity for its productions to map onto the productions of multiple languages (including itself), the semantics of a language depends upon which language it is interpreted in.

Thesis 3. Equivalence of multiple semantics

All interpretations (semantics) of a language are equivalent.

Thesis 4. Transformational semantics

All equivalent interpretations (semantics) of a language are transformable to each other.

Interpretation of the interpretation rules:

We need rules of termination in the chain of interpretations.

Thesis 5. Semantic terminators

Mapping productions into productions of other languages can terminate only by productions mapping onto an computing medium (the machine) or cognizing medium (the mind).

How do these semantic terminators impart semantics?

Thesis 6. Semantics endorsed by "the machine"

Computing media (machines) interpret (impart semantics) by executing the productions mapped onto them.

This is visible only in the behavior of the machine.

Thesis 7. Semantics endorsed by "the mind"

Cognizing media (minds) interpret (impart semantics) by understanding (turning into knowledge) the productions mapped onto it.

This is visible only in the behavior of the mind (the sentient being).

INFORMATION versus COMPUTATION – *Yet another thesis*

DATA-PROCESSING and COMPUTING MACHINERY

Computation has often been defined as data-processing. Later on, also as information processing, when computing machinery graduated from being sophisticated (arithmetic) calculators to being building blocks in information systems.

COMPUTATION

A programming language is a language and code is a model of execution (by virtue of the machine being a natural interpreter of the programming language productions, i.e., code).

INFORMATION PROCESSING

If we define modeling (broadly) as using language, then information processing is modeling at its broadest sense.

BUT, IS LANGUAGE A COMMUNICATION MEDIUM? – *Consequential answer*

WELL, not really…

We choose to let TV be a medium (channel) of communication.

Language is a tool. A representation and expression tool.

TV, text, mathematics, algorithmics (communication media) will all have their languages – i.e., tools of communication each with their vocabulary, production rules and interpretation rules.

Each of these language are tools for creating/designing (modeling/implementing) information for the respective media.

BUT the tool is so central that it has been colloquialized to mean (more-or-less) the same…

NEXT TIME:
ONTOLOGY, A BIT EPISTEMOLOGY
AND A CRITICAL LOOK AT INFORMATION REPRESENTATION,
STORAGE, RETRIEVAL AND PROCESSING

ANY QUESTIONS SO FAR?