

**ISIS Summit Vienna 2015**  
**The Information Society at the Crossroads**  
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**The brain is processing information, not data.  
Does anybody care?**

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We are on the verge of a paradigm shift :

From a Computational view on the world

to a Cognitive view on it.

Sixty years ago, the things were simple and clear: computer was a new and an exciting concept, “brain-as-a-computer” was considered as a natural sequel of that concept, and the field of science was full of fresh green shoots:

**Computational biology, Computational ecology,  
Computational neuroscience, Computational genomics,  
Computational chemistry, Computational endocrinology,  
Computational intelligence, Computational linguistics,  
and so on.**

**But the world is changing fast and today every move and every task accomplishment requires Cognitive skills and abilities (in an increasing demand). For that reason, the Computational paradigm is being replaced with the Cognitive paradigm. And we have now:**

**Cognitive biology,  
Cognitive ecology,  
Cognitive neuroscience,  
Cognitive genomics,  
Cognitive endocrinology,  
Cognitive intelligence,  
Cognitive linguistics,  
and even Cognitive computing.**

**It is generally acknowledged that Computational paradigm involves intensive data processing. At the same time, Cognitive paradigm is busy with information processing.**

**What is the difference between data and information processing?  
What is the difference between data and information?  
The question does not have a consensus answer.  
Shannon's Information Theory has contributed a lot to the misperception of these issues.**

**Information – it is not what you mean**

**In quest for a suitable answer to the question “What is information?”**

**I have developed my own theory**

**Which is based on the Kolmogorov’s definition of information.**

**A slightly twisted and extended version of Kolmogorov’s definition today sounds like this:**

**“Information is a linguistic description of structures observable in a given data set”.**

**Information – it is not what you mean**

Two types of structures usually could be distinguished:  
**Primary and Secondary data structures.**

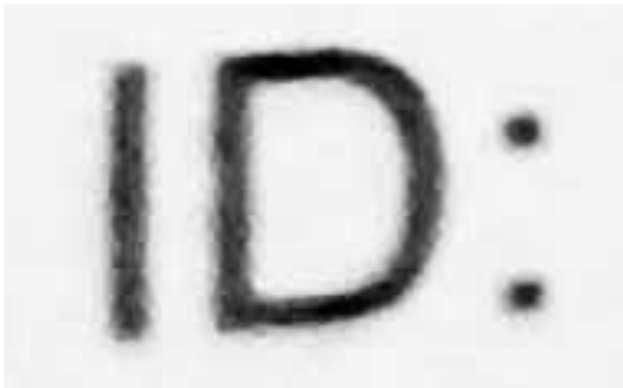
Primary data structures are formed under the guidance of natural physical laws. Therefore, they could be called physical data structures.

**The description of physical data structures  
should be called Physical Information.**

Secondary data structures are composed from consolidated Primary data structures. The process takes place in the mind of an external observer. Therefore, Secondary data structures could be called

**meaningful or semantic data structures.**  
**The description of semantic data structures  
should be called Semantic Information.**

Some examples of primary and secondary data structures



Physical information is an objective thing, determined by objective physical laws. Semantic information is a subjective thing, determined by observer's conventions, habits, and customs.

Physical information (descriptions) could be implemented in different languages (mathematics is one of them). Semantic information descriptions could be implemented only by natural language means.

Every information description is a string of symbols (letters) which together form a sequence of words, a phrase, a piece of text. In the case of brain studies, the letters are nucleotides and the text-pieces are DNA-like, RNA-like and protein-like sequences.

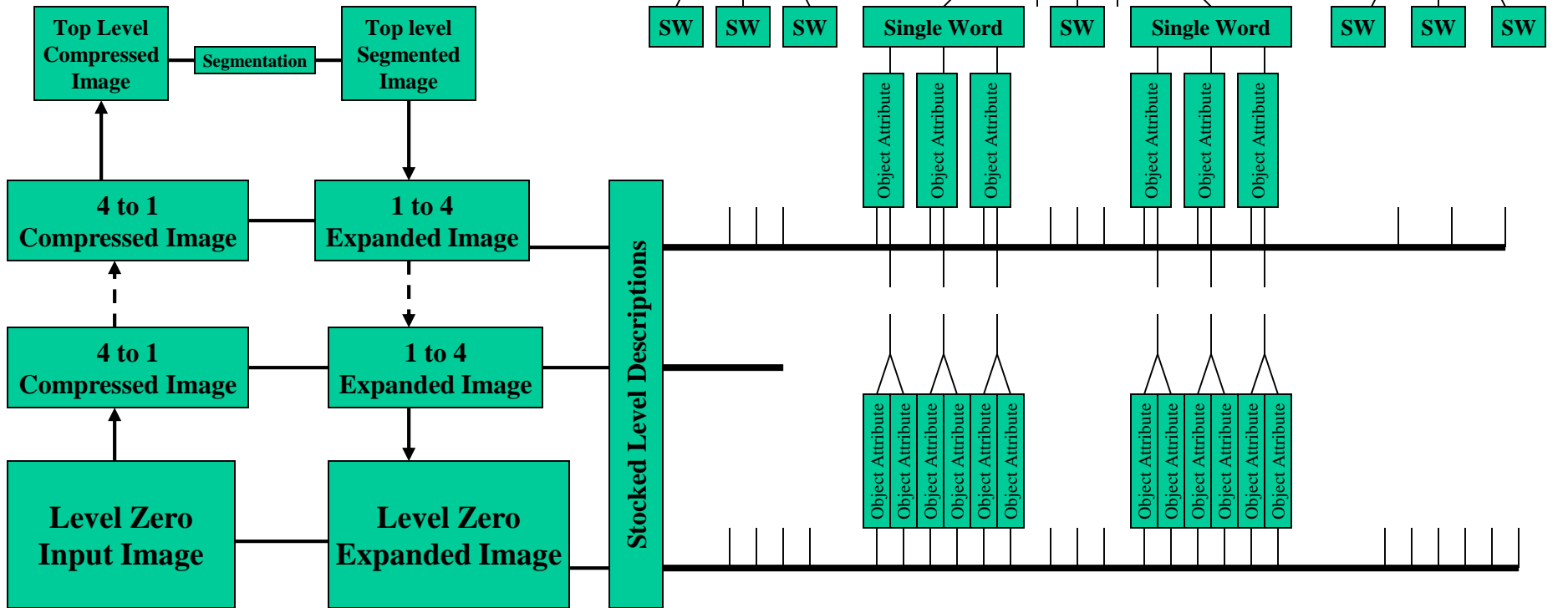
The most common mistake in contemporary science is the attempt to derive Semantic information from the palpable and omnipresent Physical information. That does not work! But people are doing this again and again.



# A Hypothetical Cognitive Information-processing Architecture

## Semantic Information (Knowledge Base) Hierarchy

## Physical Information Hierarchy



## Here are some examples of widespread misunderstandings

European Commission Document “ICT Work Programme 2009/2010, (C(2009) 5893)” in its “Part 4.2 Challenge 2: Cognitive Systems, Interaction, Robotics” specifies as a problem that Robotic systems have to cope with **“extracting meaning and purpose from bursts of sensor data or strings of computer code...”**

**This is a false and a misleading statement**

- sensor data does not possess semantics, and therefore meaning and purpose can not be extracted from it.

DARPA’s Document “Deep Learning” (RFI SN08-42) states that: **“DARPA is interested in new algorithms for learning from unlabeled data in an unsupervised manner to extract emergent symbolic representations from sensory input...”**

**Again, that is a false and a misleading statement**

- symbolic representations (semantics) could not be learned from data.

**Sorry, but any attempt to reach such a goal is doomed to be a failure.**

## Information – that is not what you mean

The most significant consequences of overlooking the duality of information are damages caused to the two Mega-projects of today:

The European Union's Human Brain Project and the USA Brain Initiative.

Aimed at the highest level of Brain research, both programs are not even mention the problem of brain information processing. The result will be obviously a failure just like failures in the previous Mega-projects: The Cognitive Robotics research initiative in the frame of European FP5-FP7 programme and the USA DARPA's Cognitive Robotics enterprise.

**Thank you for your patience**