From SIRN (Synergetic inter-representation networks) to IA (Information adaptation) and back again

Juval Portugali

ESLab (Environmental simulation lab), Department of Geography and the Human Environment, Tel Aviv University, Tel Aviv 69978, Israel, Tel: +972(3)640-8661, Fax: +972(3)640-6243, Email: juval@post.tau.ac.il, Web: www.eslab.tau.ac.il

Academic Urban Design

Kees Dorst, Juval Portugali, Taeke de Jong

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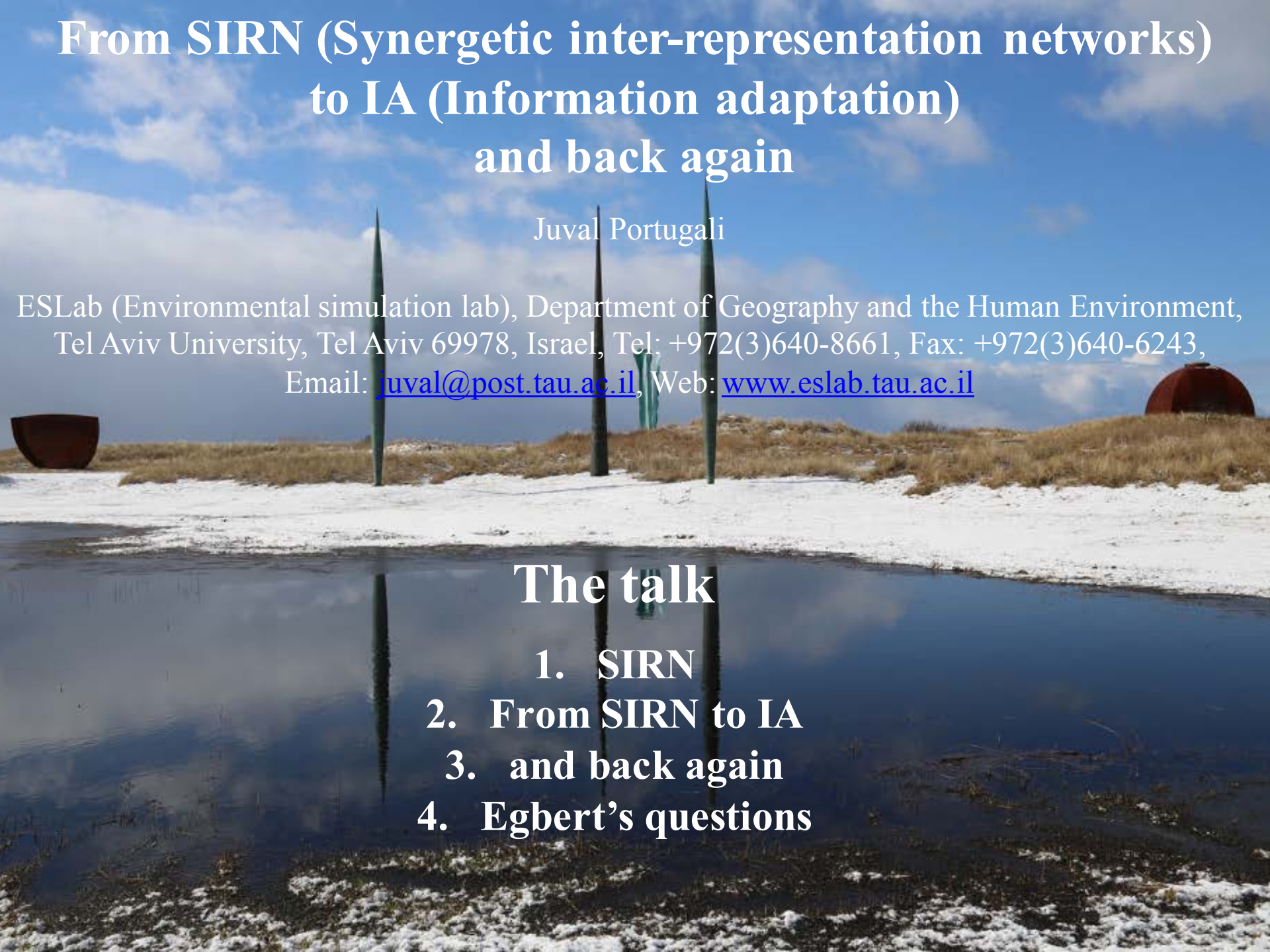

The talk

1. SIRN
2. From SIRN to IA
3. and back again
4. Egbert's questions

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1. SIRN
(Synergetic inter-representation networks)

SIRN started from a conjunction between CTC and cognitive maps:
People behave and act in the city according to their cognitive maps of the city.
Cognitive maps are created by IRN (Inter-representation nets):
An on going interaction between internal representations created in the mind/brain and external representations created in the world.
In this process we can identify two kinds of IRN processes:
technical processes such as the multiplication of, say, two four-digit numbers (6793 x 2857) and
creative processes such as painting, sculpturing, developing an idea by means of writing, and so forth.

It is here where Synergetics – Haken's theory of complex, self-organizing systems – enters and the process becomes SIRN (Haken & Portugali, 1996)

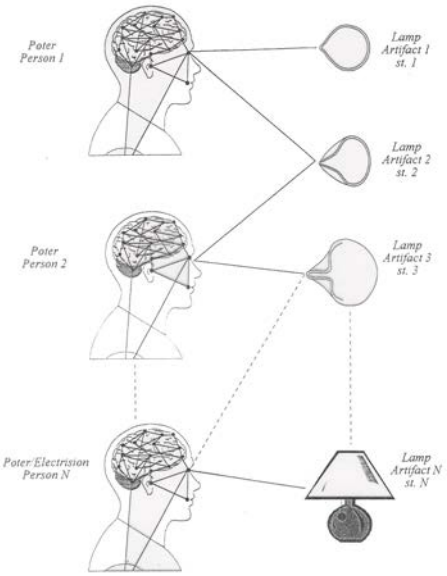
In developing SIRN, we have identified three types of processes: intra-personal, inter-personal and collective.

The first refers to an SIRN process as evolving by a single person. The second refers to a sequential interaction between several persons, and the third to a collective process in which several persons are acting simultaneously and interact via a collective (emerging) medium, for example, a city.

The Kiss by Brabkusi

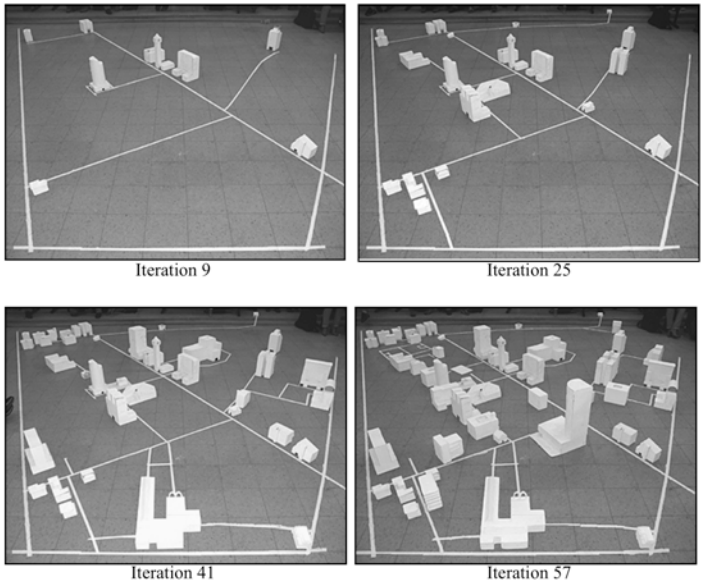
Intrapersonal

Lamps' production



Interpersonal

Urban dynamics



Collective

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2. From SIRN To IA

But what are external and internal representations,
and how do they interact?

Our answer (H&P 2015): representations are constructs that enfold and convey information with the implication that they give rise to brain processes by the exchange of information.

But then, what constitutes information?

Our first attempt to answer was by reference to Shannon's information theory (SHI) and with respect to external representations [The face of the city is its information (H&P 2003)]:

:

External representations are objects in the world that convey different quantities of SHI

Shannon's information theory

Information theory as developed by C. Shannon deals with the capacity of information channels. This capacity depends on statistical properties of the signals, **but not on their meaning**, be it the contents of the text in some language, a melody, or a picture. In this sense channel capacity is a fixed physical quantity in each specific case.

For example, is the case of rolling a die, $Z=6$ and I – the quantity of Shannonian information enfolded in the process of rolling of a die – is about 2.5 bits.

As can be seen from this definition, Shannonian information is not related to any meaning

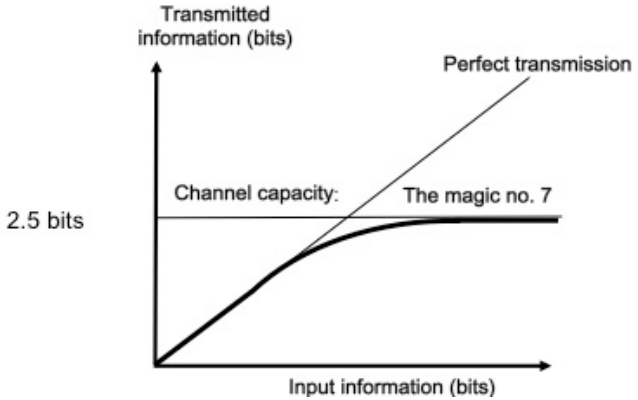
Shannonian information

sheer quantity, information with meaning exorcised.

Shannon information entropy:

$$i = -K \sum_k p_k \ln p_k, \qquad \sum_k p_k = 1$$

when P_k = relative frequency of occurrence of event k.



Applications to cognition

A famous application to cognition is Miller's (1956) "magic number seven": The relations between input information and transmitted information: up t about 2.5 bits of information there is perfect transmission; beyond that threshold, transmitted information levels off

"The *good gestalt* is a figure with .. high degree of internal redundancy" (Attneave 1954, 1958). Example: rotation of a circle (good gestalt) vs. rotation of L-shape

Objects in the world convey different quantities of information to perceivers

"The face of the city is its information" (Haken and Portugali, 2003):

1. Different elements in the city afford different levels of information that can be measured by Shannon's information bits

When all buildings are similar ***i is low***

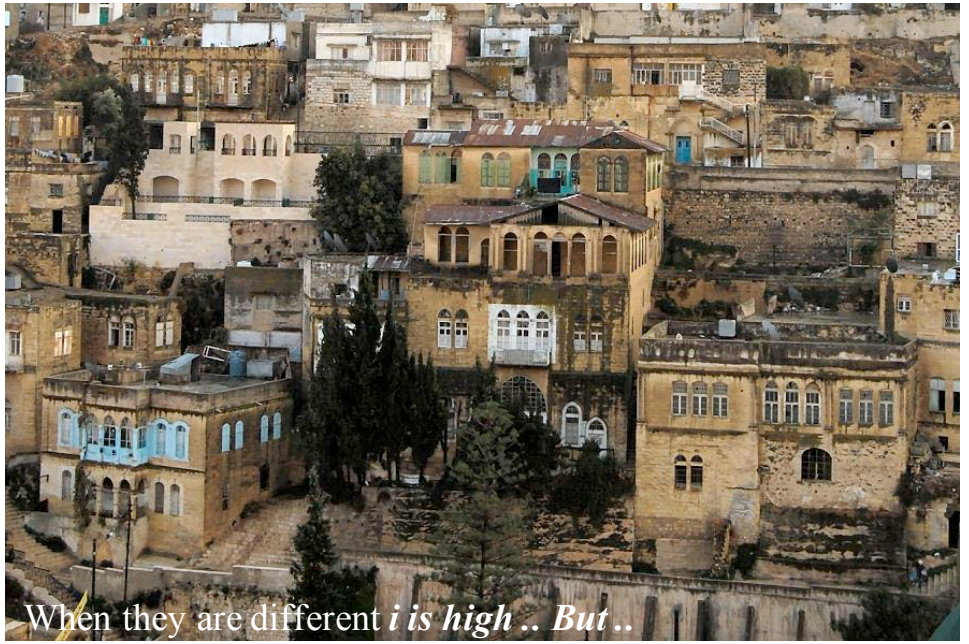
When they are different ***i is high***

but hard to memorize (+-7 …)

When landmarks are added apart from each other, ***i is high***

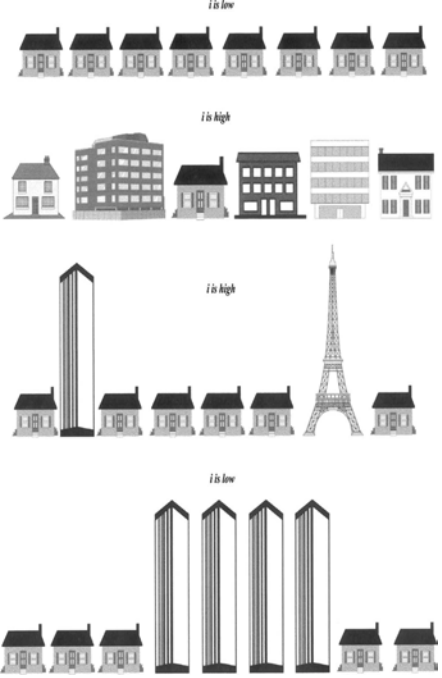
When they are grouped, ***i is low***

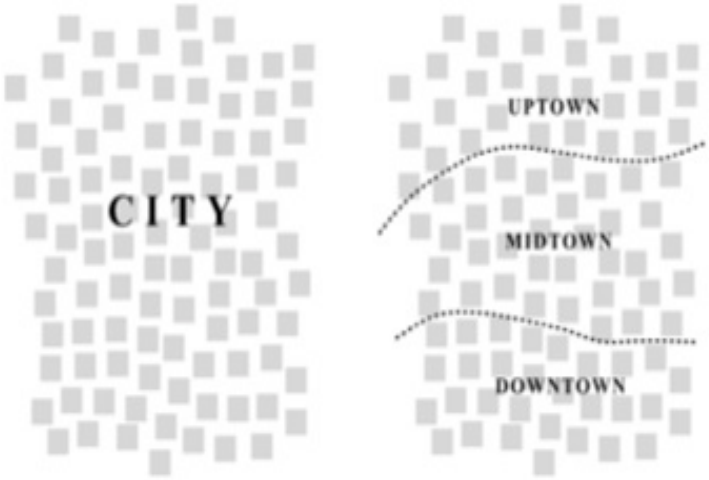

When all buildings are similar *i is low*

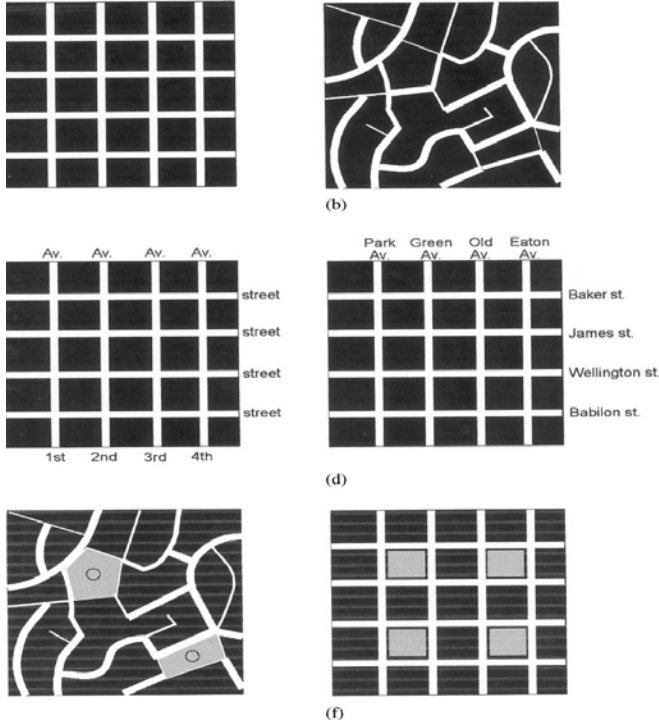

When they are different *i is high .. But ..*


The tower house at Piazza del Campo, Siena,
When landmarks are added apart from each *I is high*

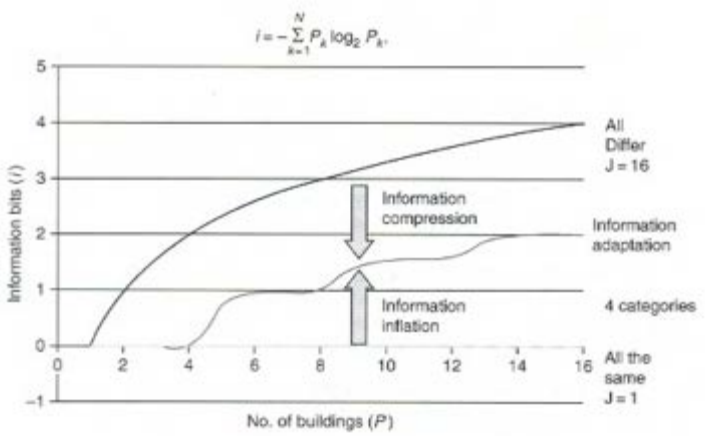

The tower houses of San Gimignano
When they are grouped, *i is low*







Adapting the face of the city to humans' information processing capabilities By means of language/text



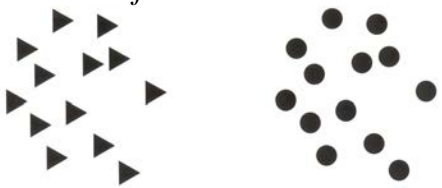
Surprise: ("The face of the city is its information" (Haken and Portugali, 2003): **SI (Semantic information=with meaning) enters in disguise into Shannonian information** via the choice of the index j to which implicitly or explicitly meaning should be given

$$s = -\sum_j p_j \log_2 p_j$$

One pattern with 3 attractors (E, NW, SW) and three meanings

A pattern of triangles that can be perceived in three different ways

$$I = \log_2 3 \approx 1.5 bits$$



One pattern with one attractor and one meaning

A pattern of dots that can be perceived in one way only

$$I = \log_2 1 = 0 bits$$

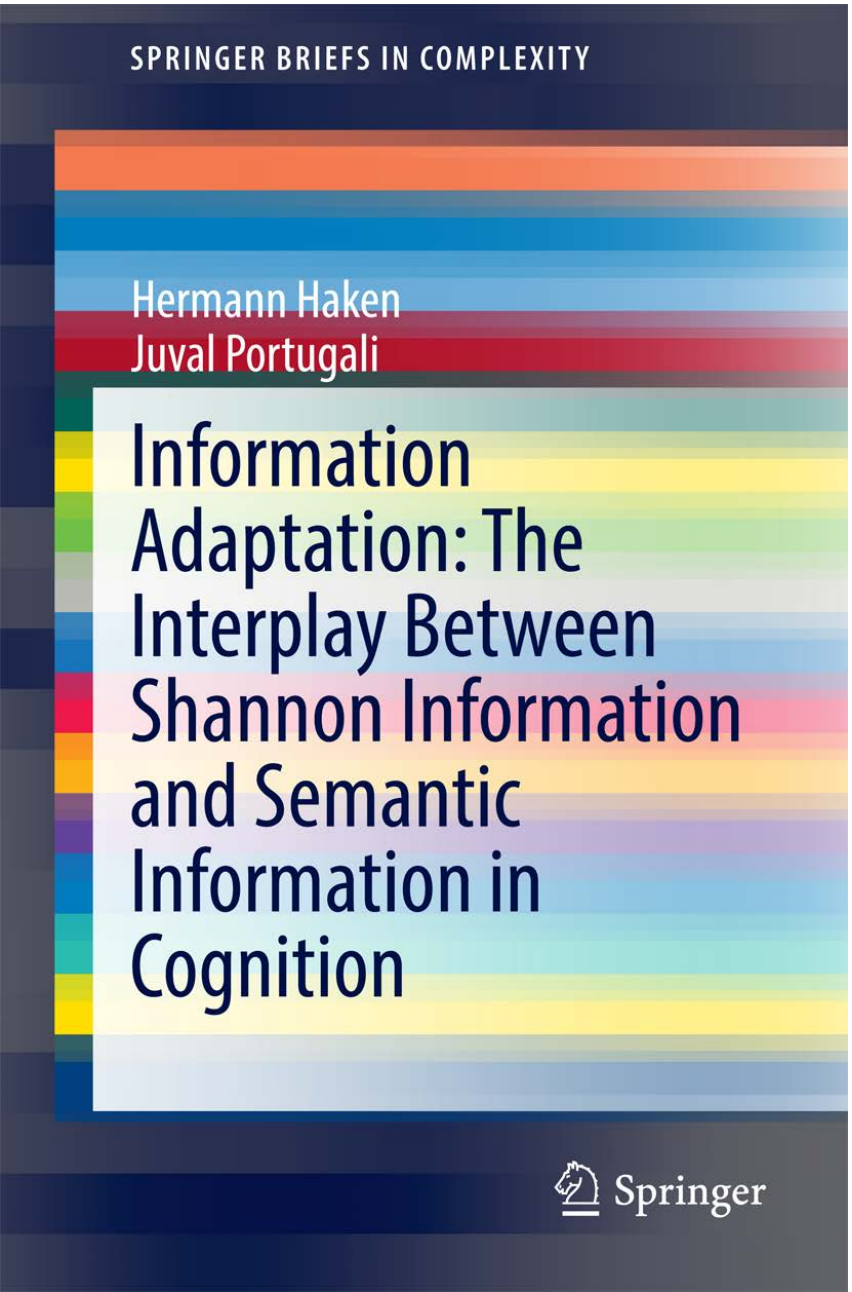
When all buildings are similar ***i is low***

When they are different ***i is high***

Similar buildings = single meaning (style, size, age ..) to a set of entities = semantic information

SI enters in disguise into SHI,
but what about the effect of SI on SHI?
and what are the relations between the two?

A new book



Information adaptation

SHI and semantic information are two aspect of a process of **information adaptation**:

SHI *generates* semantic information
While
Semantic information *controls* Shannon information

In cognition, adaptation of Shannonian information to semantic information is implemented by information *inflation* or *deflation*

Our empirical bases are vision and pattern recognition

Example 1: Vision as Information Adaptation:
Bottom-up

Hubel and Wiesel (1959, 1962, 1965): The brain's processing of optical information **starts bottom up** in the retina …. The optical fiber transports the signal …to the neurons of the visual cortex (Fig.) with its Areas V1-V4. …

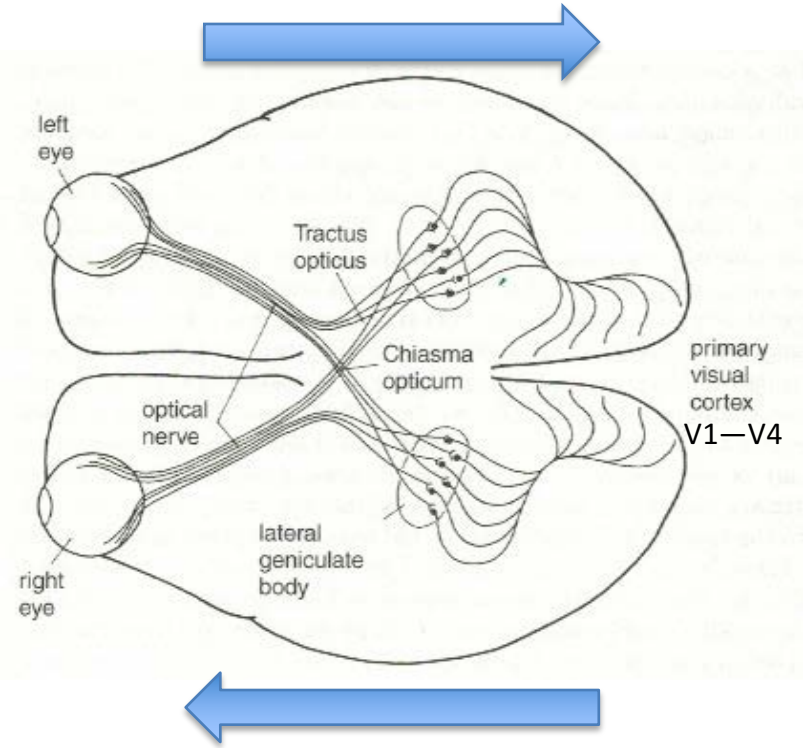
and top down

Then, at higher levels, **top down** neurons getting inputs from lower areas, react to specific orientations of lines, corners. **Livingstore 2009, Freiwald and Tsao 2010; Kandel 2012:** The process of reconstruction/synthesis is implemented by the brain's semantic (meaning giving) capabilities

Data from the environment is bottom-up transformed into local information features (lines, corners);

their interaction generates order parameter(s) that top-down determines vision as global information

Bottom-up

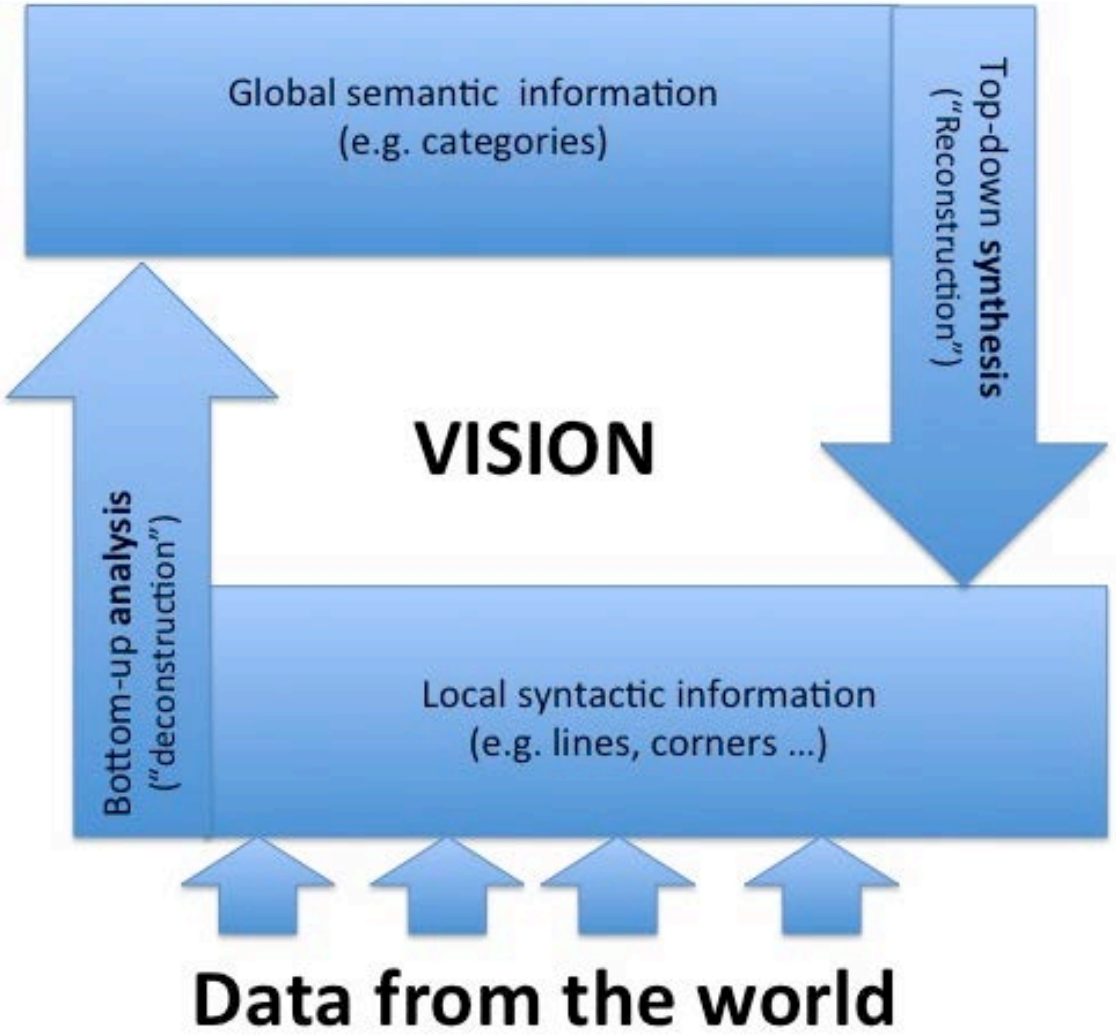


Top down

Schematic representation of the visual pathway of a human

schematic description of the process of vision:

data from the world is first analyzed ("deconstructed" in Kandel's words) by the mind/brain, in a bottom-up manner, into local information of lines, corners etc.



This local information triggers a top-down process of synthesis ("reconstruction" in Kandel's language) that gives rise to global information, that is, to seeing and recognition.

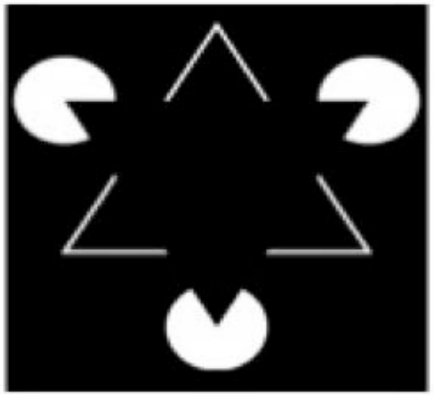
(For more details see Haken and Portugali 2015.}

Information adaptation in cognition

the cognitive process of information adaptation is implemented by **inflation** or **deflation of SHI**:

In some information adaptation cases the brain adds data that doesn't exist in the row data/information (*left*), while in other cases the brain implements adaptation by the exact opposite - by ignoring data/information that exists in the row information (*center* and *right*).

The Kaniza triangle illusion: **the MBB adds data**



The "Olympic rings" illusion

The gorilla illusion: When the observers' attention is directed to the ball and players, 50% of them do not see the gorilla**:** **the MBB extracts data**

SI – information with meaning (semantic and pragmatic)

As we've just seen, **perception** (e.g. seeing) involves the bottom-up and top-down **action of IA**, i.e., the interplay between SHI, SI. Both SI and PI are thus associated with action:

In the case of PI we are dealing with
externally observed action and behavior,

while in SI with ***internally observed*** action that involves:

- change the state of neurons (observable by means of e.g. fMRI, EEG, MEG, local field potentials etc.), which
- triggers thoughts, ideas, emotions … and
- subconscious storage

In accordance with the above, in our IA we use the notion of **semantic information** as a general term referring to information with meaning – semantic and pragmatic.

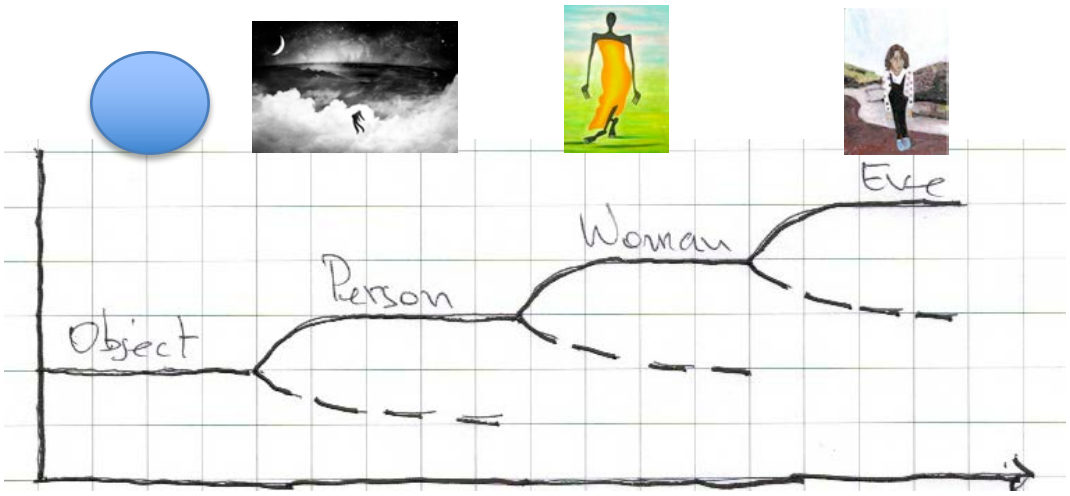
Example 2: Sequential IA by "Punctuated pattern recognition"

Imagine the following scenario: You stand in an open area and you observe at the horizon an object moving towards you. At this stage there is little data and the object can be anything and thus the information (uncertainty) is high.

As the object gets closer, more data are added and you realize that it is a person, that is, your MBB adapts to the incoming data by deflating the information (uncertainty) and by pattern recognizing the moving object as a the SI category 'person'.

As this person gets still closer …, you realize that it is the SI 'woman' – …

Finally, as this woman gets even closer you realize that this is Eve – …



The time-space evolution of the process of information adaptation is not linear and smooth but rather it evolves in punctuations. While data increases continuously, the pattern recognition process of information adaptation is abrupt and thus discrete: a moving object, person, woman, Eve.

At these points of punctuation, in each case a **phase transition** connected with the **emergence** of a new "**category"** (or the reverse) happens.

IA and embodied cognition

(Heidelberg conference)

Two new forms of information adaptation

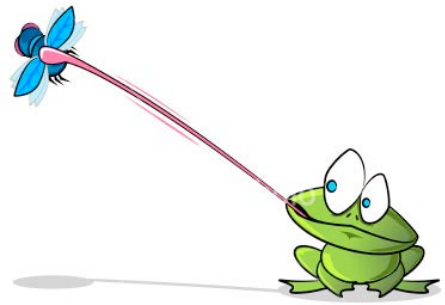
So far our focus was on cognitive processes such as perception, learning and pattern recognition.

Here we want to draw attention to two additional forms of information adaptation that are related to embodied cognition:

- Information adaptation by means of ***behavior*** and,
- Information adaptation by means of ***artifacts,*** that is, by means of acting on the environment.

IA by means of embodied behavior

(From **reflexive action** to **pragmatic action-perception)**



Maturana et al (1960):"Frogs .. feed on worms, flies, and other insects which they catch directly with the mouth or by striking them with the tongue; for this they use only visual clues. … frogs prey only on moving insects, .." This behavior of frogs can be characterized as ***reflexes*** in response to ***frog-specific cues***. Or:

Reflexive-action

There is ***no*** choice here; the specific sensory cue fixes the action ***uniquely***: An environment with small, fast moving object affords one action only: **Attack!** An environment with large, slow moving object affords **flight**. In both cases there is no choice nor role/place for perception and thus for meaning. No role for PI or SI, and as a consequence, SHI is: $I=log_2 1=0bit$; *No information = full certainty*

Is information = choice?

Weaver: SHI "is a measure of one's freedom of choice" (Shannon&Weaver 1949, 25)

Dogs, Cats and other animals also have reflexes, but in addition they have the cognitive capability of choice making which requires some kind of thinking, i.e. **Semantics/pragmatics** –making guesses on the total situation. Given an environmental situation, dogs and Cats perceive two meaningful actions. Their choice will depend also on their **previous experience**. We thus have here

Pragmatic perception-action

$I=log_2 2=1bit$

IA by means of artifacts

Humans are different from both: they have reflexes, they have pragmatic thinking capabilities (and thus choices), but in addition they have the interrelated cognitive capabilities of

abstraction, **MTT** and the **production of artifacts**.

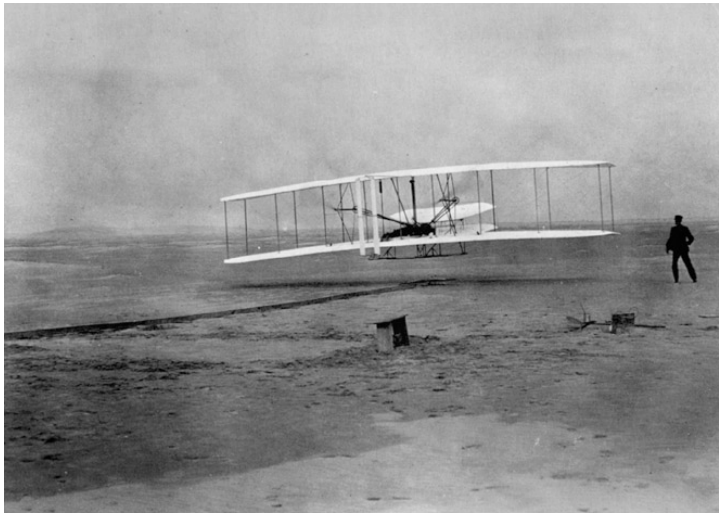
Thus, unlike dogs, cats and other animals, they make a distinction between SI and PI, they see in their imagination artifacts not yet existing and by means of their production of artifacts capabilities they can overcome their bodily limitations/constraints.

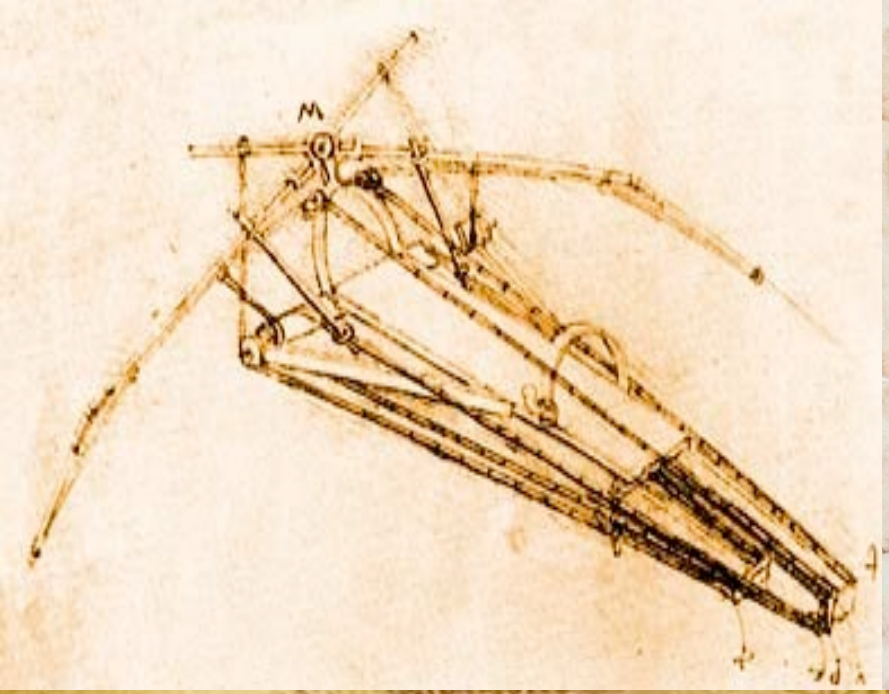
Ikaros and Daedalus

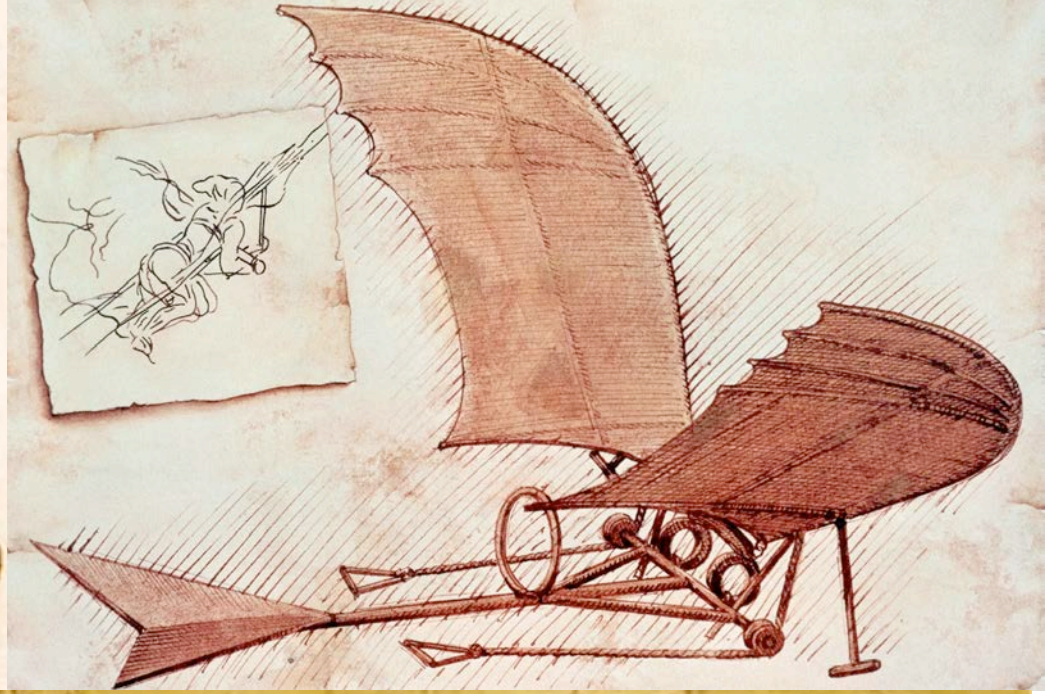
Beyond embodied cognition

Thus, while humans' embodied cognition does not afford flying, humans can still produce wings or flying machines and fly

Wright brothers








Leonardo
Da Vinci
inventions

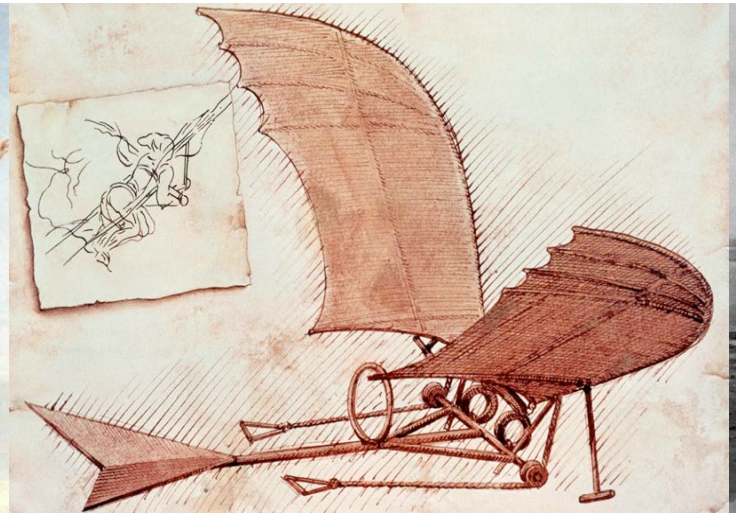
Design:

A journey from the past myth, or from future MTT imagination, to the here and now

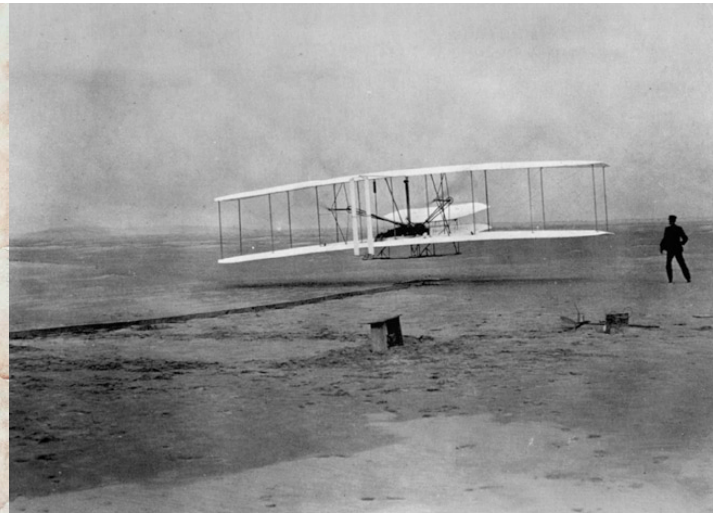
In some cases the journey takes millennia, in others, years, months, days or few minutes

Ikaros and Daedalus

Leonardo De Vinci



Wright brothers



The above reminds one of

Henri Bergson, *Creative Evolution* (Chap. II The Divergent Directions of the Evolution of Life -- Torpor, Intelligence, Instinct, p. 139):

"If we could rid ourselves of all pride, if, to define our species, we kept strictly to what the historic and the prehistoric periods show us to be the constant characteristic of man and of intelligence,

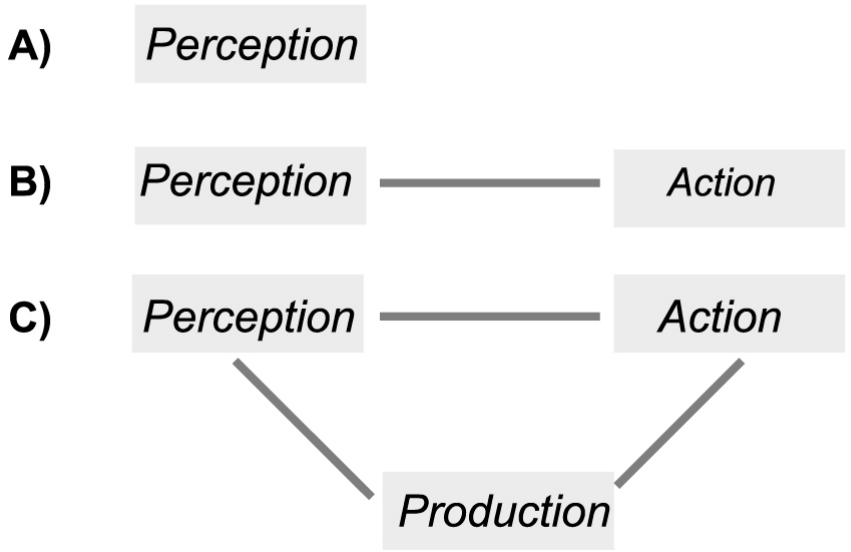
we should say not *Homo sapiens,* but *Homo faber*.

In short, *intelligence, considered in what seems to be its original feature, is the faculty of manufacturing artificial objects, especially tools to make tools, and of indefinitely varying the manufacture."*

A) Classical cognitivism

B) Embodied cognition

C) SIRN: production of artifacts as part of cognition



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3. and back again

SIRN/IA and urban design

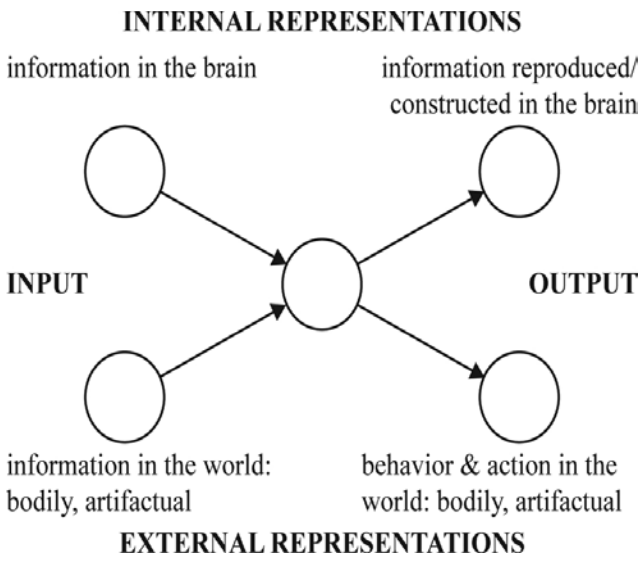
(P&H 2015, JOSS**)**

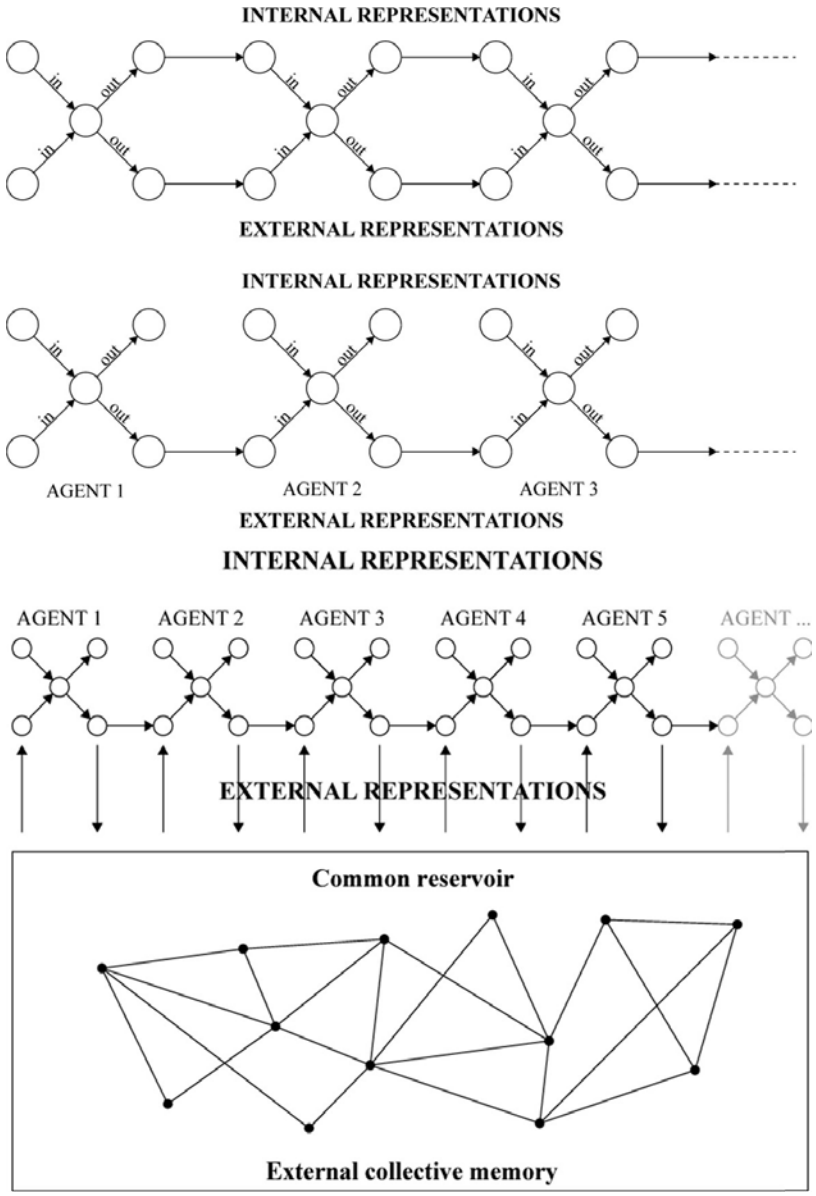
So far we have studied IA as a single act: given an information source, how does the mind/brain adapt this to its information processing capabilities and instruments, and memorised information.

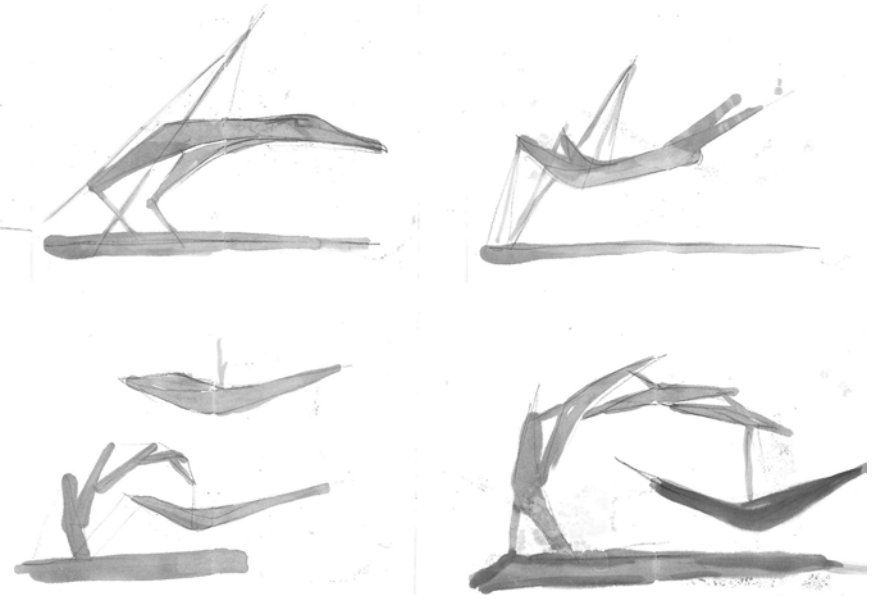
The conjunction between SIRN and IA adds a new dimension to IA - namely, that in several cases IA is implemented by an interplay between internal and external representations and by implication, **by means of design.**

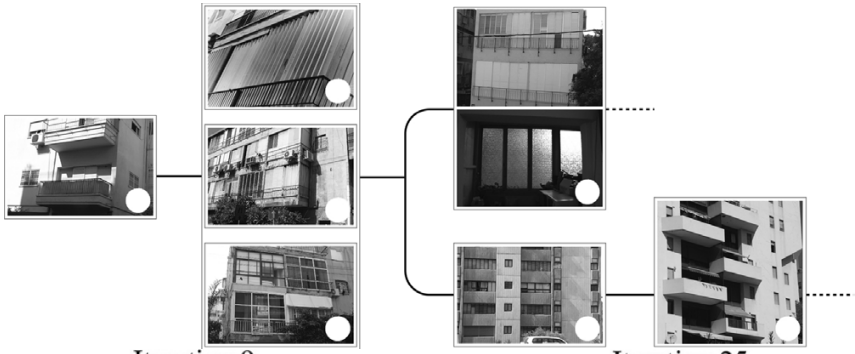
Point of departure: Our (P&S) paper "A SIRN view on design thinking—an urban design perspective", in *Environment and Planning B: Planning and Design* 2014, volume 41, pages 829 – 846

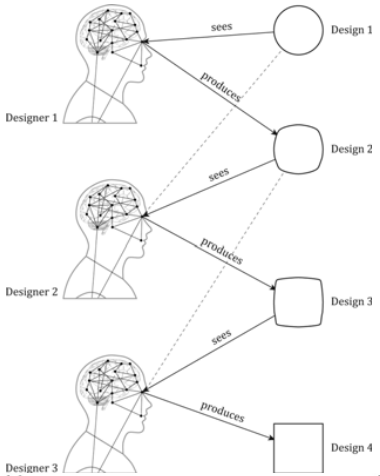
In this paper we (P&S 2014) have reformulated SIRN and its three submodels as design models









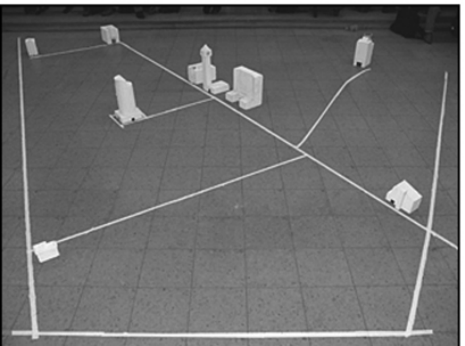


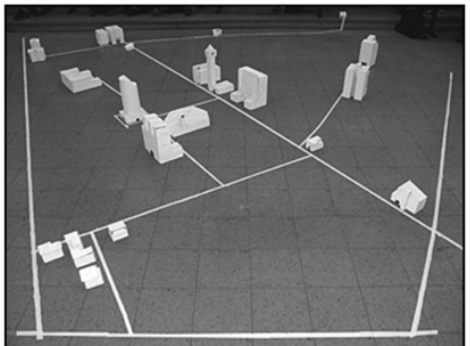
Iteration 9

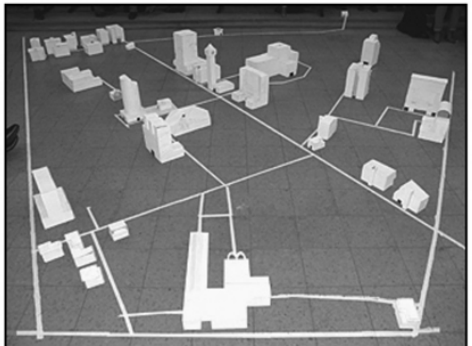
Iteration 25

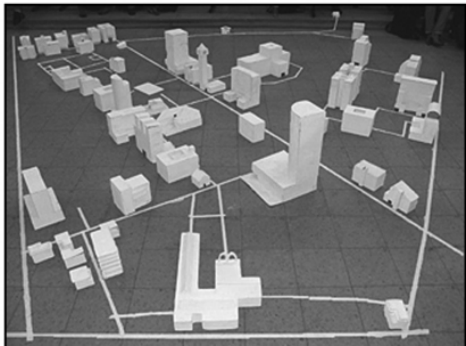
Iteration 41

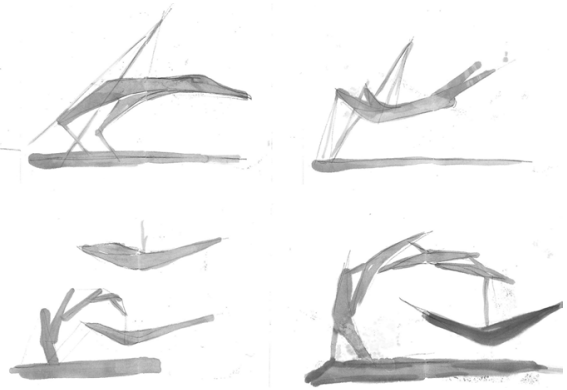
Iteration 57





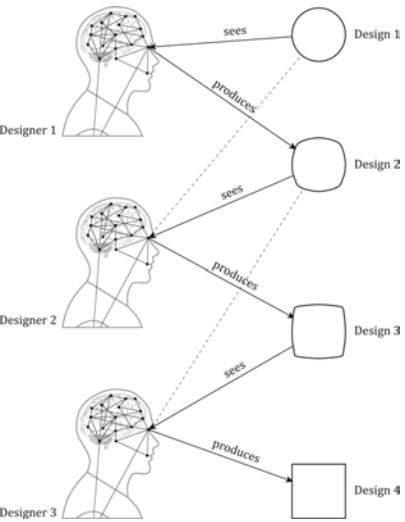






Design by means of sketch as intra-personal SIRN/IA process

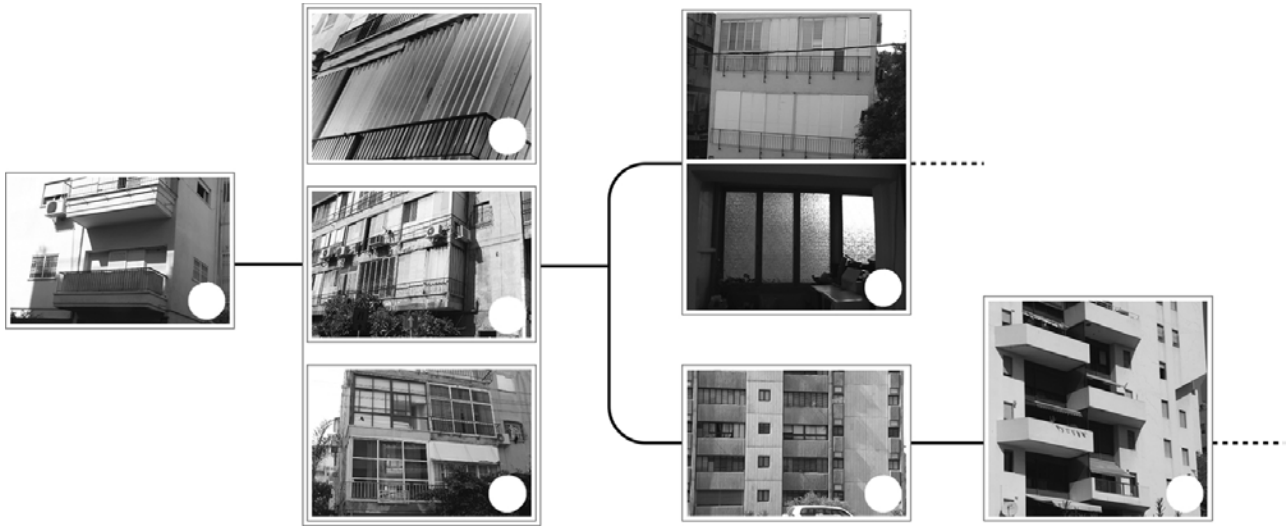
Sketches can be interpreted in several ways; in terms of IA implies several meanings (SI) and high SHI (uncertainty). Consequently, when internalised again, this induces new ideas, possibilities .., in an interplay between internal and external representations. In the case of design, the purpose of the process is to deflate SHI and reach a single SI = the resultant final design and/or plan.



Tel Aviv's balconies as an inter-personal SIRN/IA process

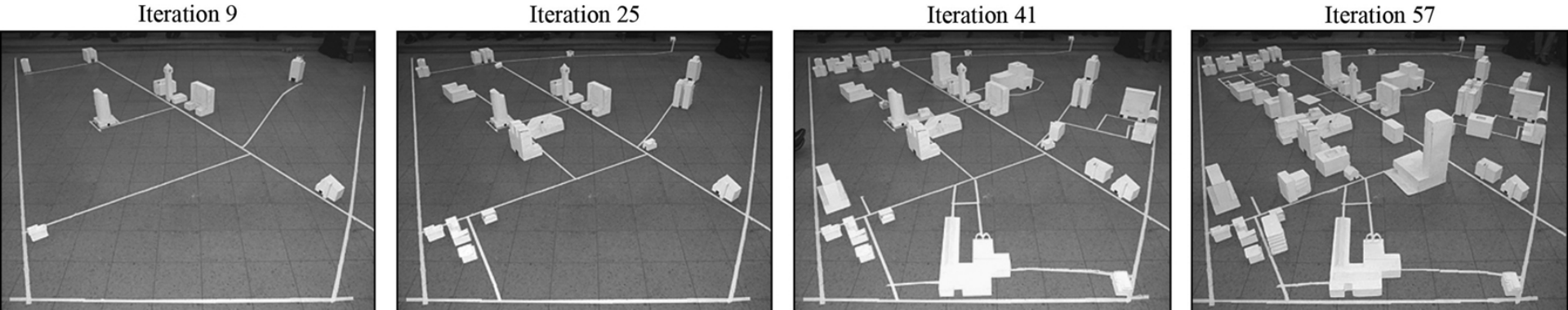
Open balcony: SHI=0; Closed balconies: SHI=1

Inter-personal, Self-organizedSIRN/IA design process commenced that has transformed the face of the city of Tel Aviv



The city game as an inter-personal with a common reservoir SIRN/IA process

The city games exhibit the main properties of SIRN/IA: a sequential interplay between internal and external representations, emerging urban order and the various properties of the process of self-organisation as conceptualised by synergetics. However, this has led to the addition of a new property, namely, that here the city as a whole functions as the medium of information exchange for the SIRN/IA process.



From SIRN (Synergetic inter-representation networks)
to IA (Information adaptation)
and back again:

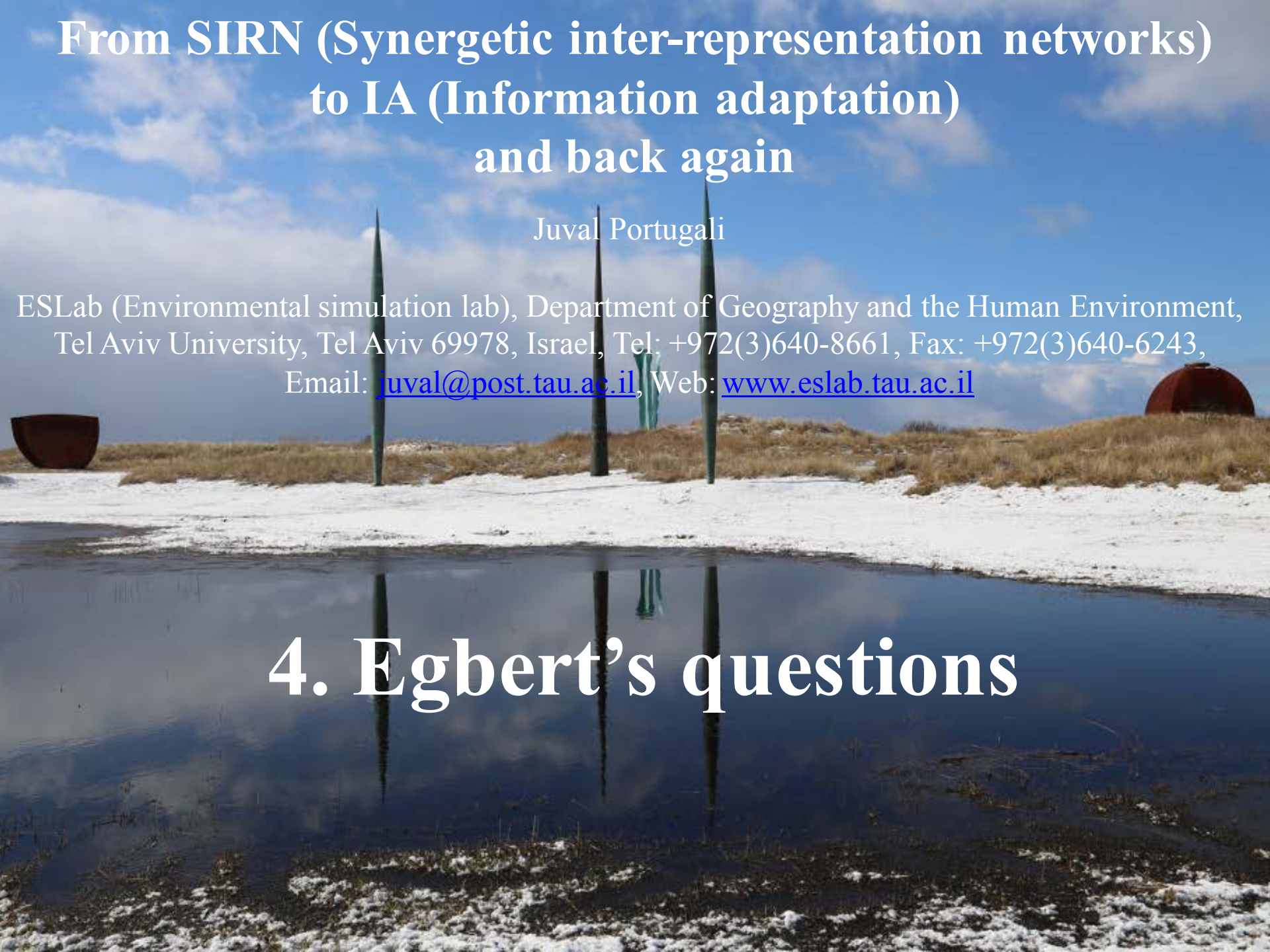
SIRN
is determined by IA
which in its turn
is determined by SIRN
Which is then determined by
IA

a.s.o
In circular cusality

From SIRN (Synergetic inter-representation networks) to IA (Information adaptation) and back again

Juval Portugali

ESLab (Environmental simulation lab), Department of Geography and the Human Environment, Tel Aviv University, Tel Aviv 69978, Israel, Tel: +972(3)640-8661, Fax: +972(3)640-6243, Email: juval@post.tau.ac.il, Web: www.eslab.tau.ac.il



4. Egbert's questions

If design is a basic human capability, it is used by non-professional and professional designers.

To what extend are design processes domain-dependent or domain-independent?

Proposition/question 1

Urban design is related to (implemented by) both professional and non-professional domains.
Due to planning and design behavior, urban dynamics is an on-going interaction between .. In some cases

Urban designers design across scales, from small scale environments to whole cities and regions.

What are the implications of moving across scales in the design process in terms of control on the final outcome?

Proposition/question 2

IA: The larger is the scale, higher in the information (= uncertainty), less is the control, more it determined spontaneously by means self-organization

The future is unpredictable in nature. Humans generate predictions, for example in design.

What is, or should be, the role of exploring the future in the urban design process?

Proposition/question 3

Due to MTT, humans cannot not plan, design, explore the future.
The results: Planning behavior and design behavior: behavior and action according to a reality that doesn't yet exist and might never exist.

What's your view on the future development 'academic urban design'? What might be the impact on practice and education?

Final question 4

Some of my best friends are historians. They spend their life arguing about what "really" happened in the past, and cannot (will never) come to an agreement.

As for the future?

We'll see!

From SIRN (Synergetic inter-representation networks) to IA (Information adaptation) and back again

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Thank you