

# Overview of the basic works in Systems Biology



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# Major publications

*sole author, except one (indicated)*

## #1. Cognition problems

"The Dimensionality of the Informational Structures in the Space of Perception", ***Biophysics***, Vol. 21, No 4, pp. 945-947, 1976

"Probing the architecture of the brain in experimentation with afterimages", **Proceedings of the IJCNN'99**, IEEE, Volume 1, pp. 69-73, 1999

## #2. Organism development

"Mechanism for Controlling Development in Biological Systems", ***Automation and Remote Control***, V. 38, No. 2, pp. 945-947, 1977

"A cybernetical model of the internal cellular clock", **Medical Hypotheses** 7: 1347-1357, 1981

"Probability of Monozygotic Twinning as a Reflection of the Genetic Control of Cell Development", ***Mechanisms of Ageing and Development***, 31(1985), pp. 147-154 (co-author S. Bloom)

"Informational Structure of the Developmental Tree of Multi-Cellular Organisms", Proceedings of the Thirty Fourth Brookhaven Symposium in Biology, pp. 22-33, Plenum Publishing Corporation, New York, 1987 - **INVITED PRESENTATION**

## #3 Genome functionality

"On the difference between dead and living matter: making sense of pseudo-random sequences of DNA nucleotides", ***The Noetic Journal***, 2, pp. 42-51, 1999

"On the remote interaction of biological objects with close genetic structures", ***Annals of the European Academy of Sciences***, pp. 111-130, 2003

"On the 'barcode' interpretation of DNA, or the Phenomenon of Life in the Physical Universe", **Dorrance Publishing Co**, Pittsburgh, PA, 2003

## #4 Brain design

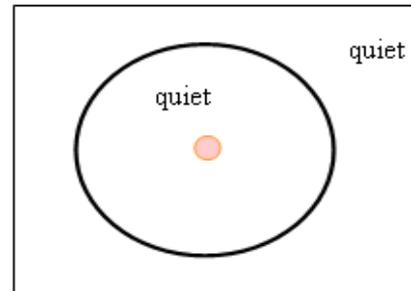
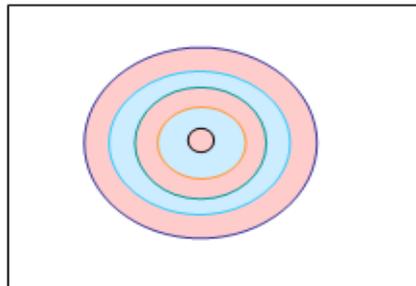
"On the Information Processing Capabilities of the Brain: Shifting the Paradigm", ***Nanobiology***, v. 2, pp. 99-107, August 1993

"Formation of Artificial and Natural Intelligence in Big Data Environment", **Springer, Network Science and Cybersecurity Advances in Information Security**, Volume 55, pp. 189-203, 2014

"Organization of the Brain in Light of the Big Data Philosophy", **Proceedings COM.Geo 2014**, IEEE, 2014 (to appear)

# #1 Why space has three dimensions?

Huygens' principle --- Wave propagation with a sharp front --- 3D



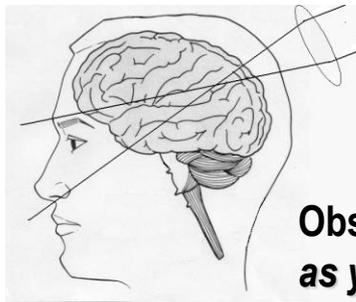
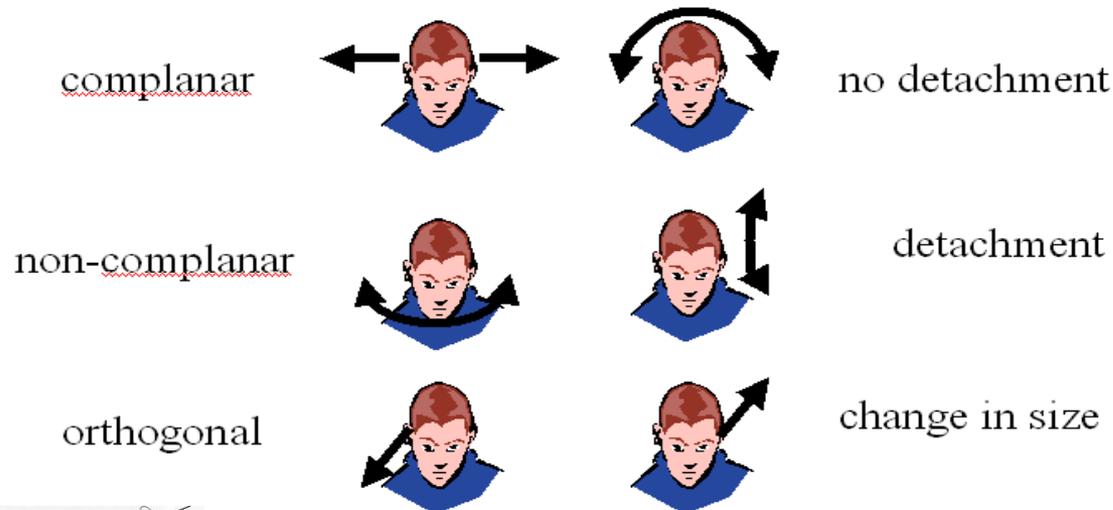
In a strict sense Huygens' principle is efficacious only in a 3D space for 2D structures.  
Thus, the holographic model of the brain can directly manipulate only with 2D objects.  
For 3D objects spatial locality is recognized through time sequences of 2D cross-sections.  
As to objects of higher dimensions, their representation in holographic model is not viable.  
The three-dimensionality of the physical and perceptual space become interrelated.  
Another important consequence: 2D structure of the cortical map

**H. Poincaré, Dernières pensées, Pourquoi l'espace a trois dimensions?, Paris, Flammarion, 1913**  
**“Holographic model of human memory and tridimensionality of the space of perception”**

<http://structurevisualspacegroup.blogspot.com/2010/10/holographic-model-of-human-memory-and.html> , 2010

# #1 Experimentation with afterimages

Probing the detachment of afterimages  
with different movements of the head



**Explanation of the detachments of afterimages by holographic processing**  
**Can be directly verified by neuroimaging techniques**

**Observation of a novel effect of changes in size with orthogonal movements:**  
***as you move ahead the afterimage shrinks, disappears, and then reappears again***

F. V. Taylor, "Change in size of afterimage induced in total darkness", *Journal of Experimental Psychology*, **29**, pp. 75-80, **1941**

R. L. Gregory, J.G. Wallace, and F.W. Campbell, "Changes in the size and shape of visual after-images observed in complete darkness during changes of position in space", *Quarterly Journal of Experimental Psychology*, **11**, pp. 54-55, **1959**

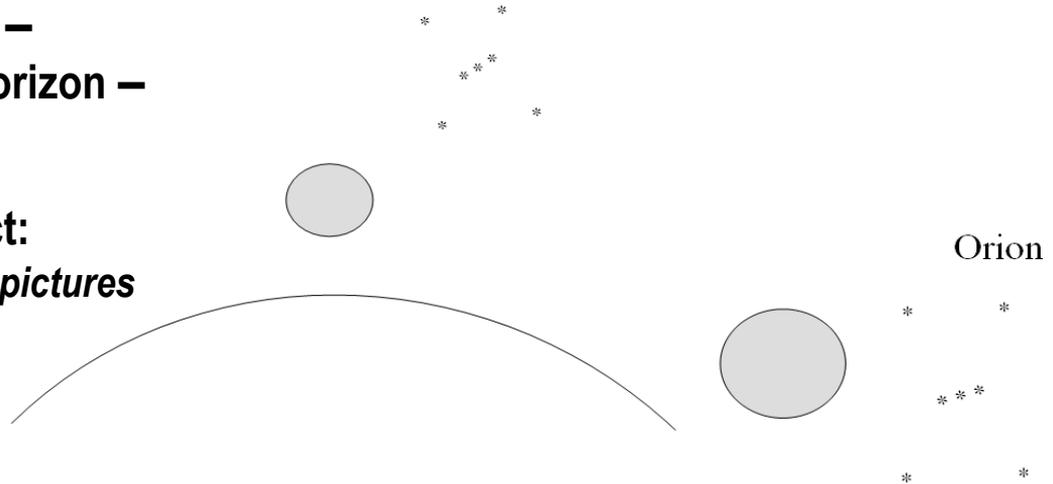
# #1 Moon Illusion: the 2,500 years mystery

The scientific study of the moon illusion –  
amplification of celestial bodies at the horizon –  
is as old as science itself

It is a psychological, not a physical effect:  
*the big Moon never appears on photographic pictures*



Supermoon 2014: July, August, September



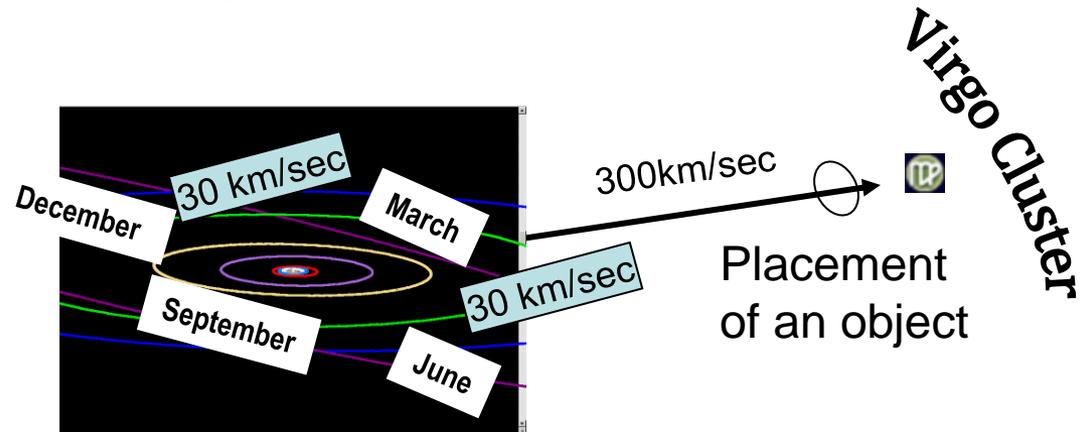
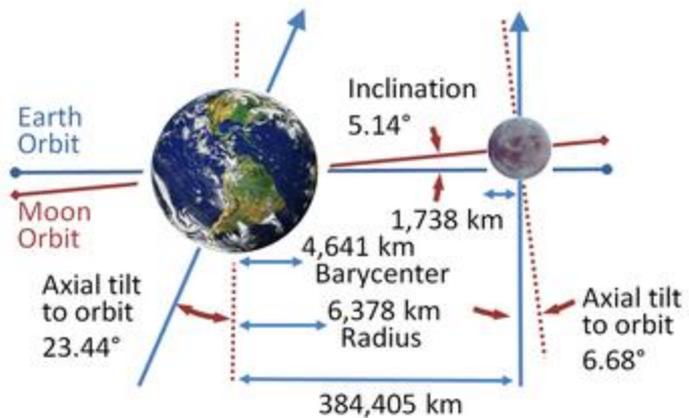
More research on Moon Illusion “will be of little value”: “A more fruitful approach would be to direct research to fundamental issues in visual space perception. If agreement can be reached about those issues, an understanding of the moon illusion would probably be self-evident.”

M. Hershenson, editor, “The Moon Illusion”, Lawrence Erlbaum Associates, Publisher, Hillsdale, New Jersey, 1989

Explanation of the Moon Illusion by holography image magnification

# #1 *Experimentum crucis* for the organization of Life in the Holographic Universe exploring the “Moon Illusion”

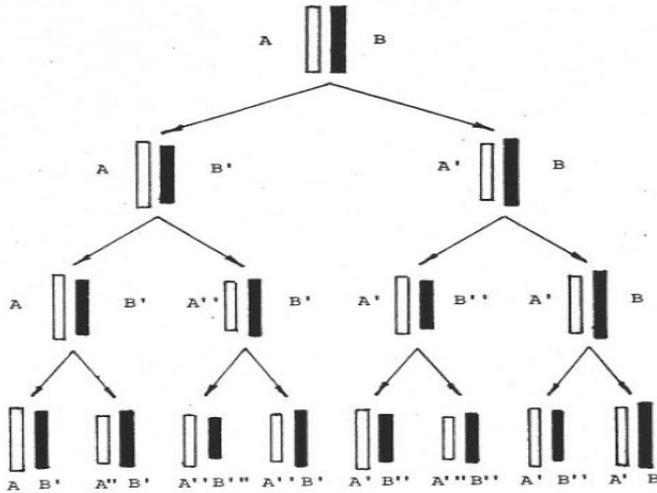
Eccentric postioning of the Solar system in the Holographic Universe (see slide 12)



**Visual perception: inverted images from the retina are written in the holographic memory, and then reconstructed back to the visual cortex in the direct way in some different sizes**

Images on Earth orthogonal to the Solar system eccentricity vector are reconstructed in a larger size. This is the case of the horizon Moon when it is on the ecliptic plane, as the Moon rises its apparent size decreases.. This situation occurs around the line of connecting September-March zodiac constellations. Since Moon's orbit is slightly inclined the Moon illusion pattern repeats with about a decade.period. This periodicity is can be predicted with the renown astronomical accuracy as for lunar and solar eclipses.. Other celestial bodies would have different periodicity pattern for their horizon amplification: constellation Orion - permanent, Sun, as determined solely by ecliptic inclination – around one year period. The “Moon Illusion” conditions can be created for artificial objects by respective placing of the objects.

# #2 Cell differentiation, appearance of monozygotic twins, and cancerization



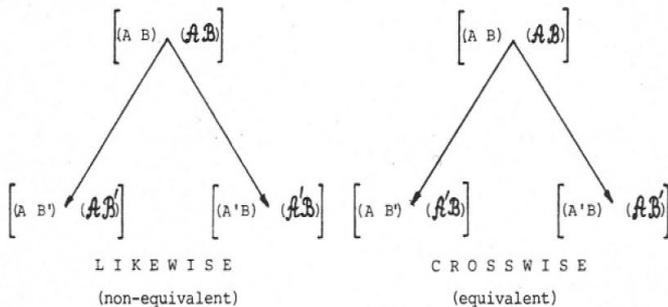
The origin of labeling information  
In chromosome replications

Telomeres control information  
*ab ovo* and at the apoptosis

Cell-labeling - likewise and crosswise -  
at the initial zygote division

Probability of monozygotic twins is  $(\frac{1}{2})^k$ :

1	out	256	in	human
1	out	64	in	mice
1	out	16	in	peanuts

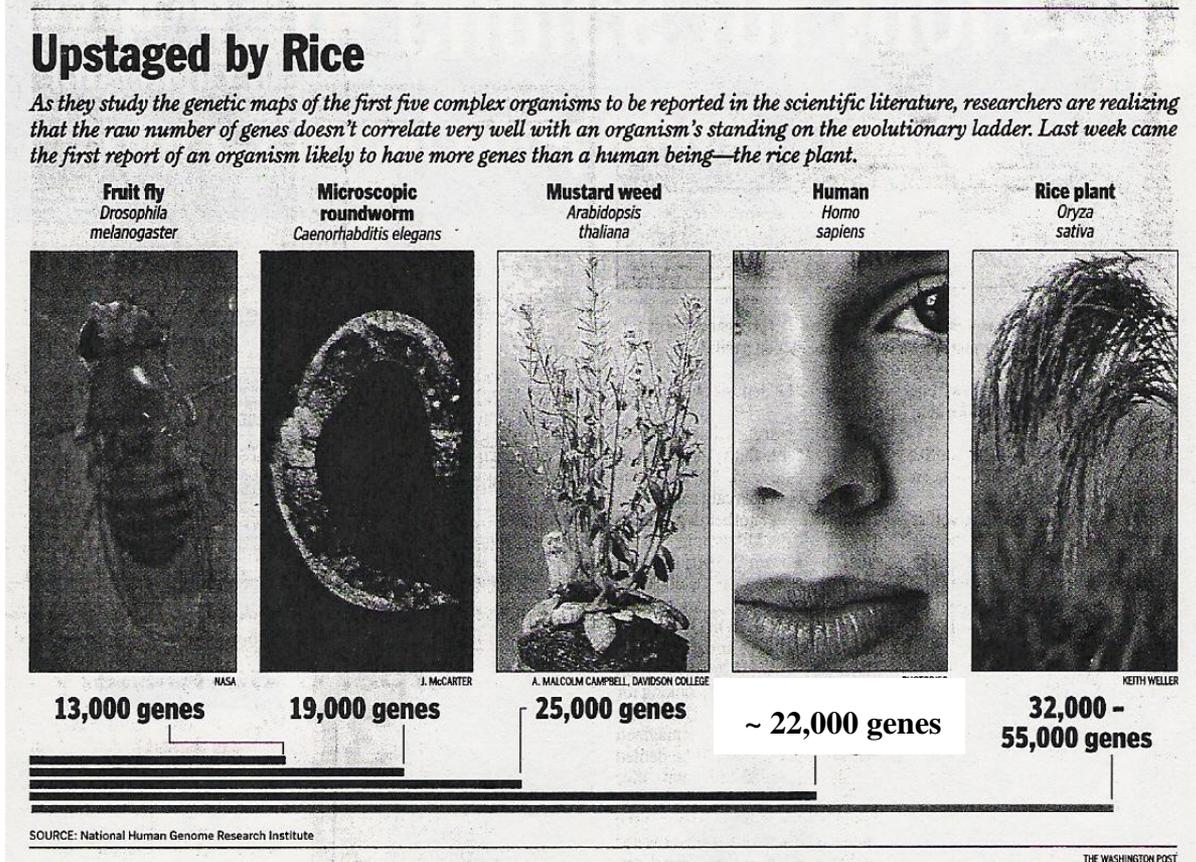


$$Z_T \approx \frac{\ln(3-2/k)}{M + \alpha\sqrt{M}} \sim \frac{1}{M}$$

Probability threshold for cancerization between  
cell divisions, M - Hayflick's limit

Small doses of radiation may not produce cancer

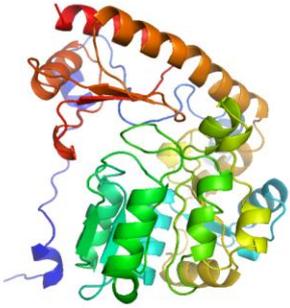
# #3 Genome functionality: principle of requisite variety



Biological information control must comply with "the basic law of requisite variety": appropriate selection is absolutely dependent on the processing of at least that quantity of information. "Future work must respect this law, or be marked as futile even before it has been started"

Ashby, W. R. (1962). Principles of the self-organizing system. In H.V.Foster and G.W.Zopf (editors), Principles of Self-Organization, Pergamon Press Oxford, pp. 255-278.

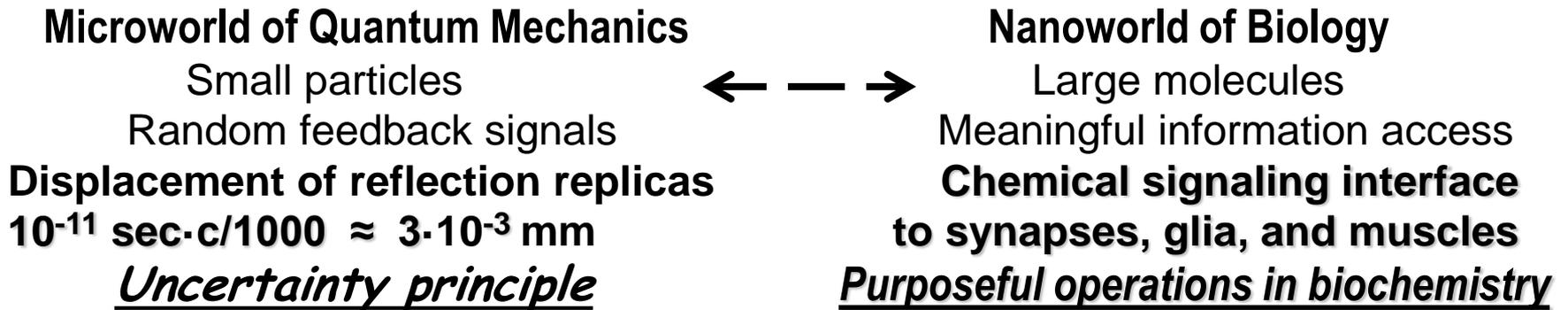
# #3 Genome functionality: specificity of macromolecules



“ We know that most of the phenomena are described by existing laws of physics, but I think that one of the main properties of the living matter – *to reproduce itself* – may appear as a result of some forces of Nature, which are yet unknown and unexplainable by identified laws of interactions between elementary particles. We do not have any data to disallow sufficiently long sequences of atoms with certain rules of arrangement to attain a new property corresponding to the property of self-reproduction in living matter. In singular atoms and simple molecules this property may go unnoticeable. ”

P. L. Kapitsa, “Future of Science”, In: “Experiment, Theory, Practice”, Publishing House “Science”, Moscow ,1987, pp. 395-418 (in Russian)

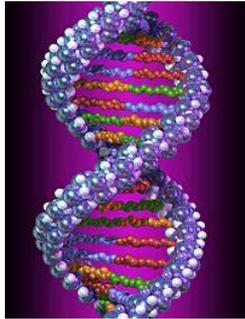
*The main puzzle of Nature is the difference between dead and living matter*



*The determinative factor — size of macromolecules:  
length of the access code*

# #3 Genome functionality: reference architecture

**DNA: DATA or INSTRUCTIONS? --- ACCESS CODE: "PASSWORD"**



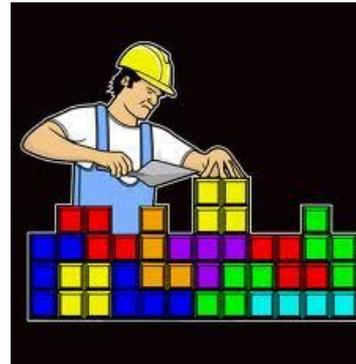
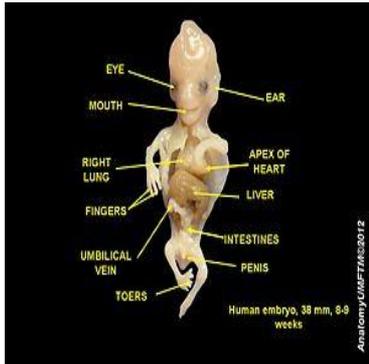
Direct control problems

- (1) Insufficient information: ~ 22,000 genes
- (2) Unrelated complexity and potentials
- (3) Solely purpose: protein synthesis
- (4) Non-working "junk" DNA
- (5) Petty differences between species genomes

DNA is an identification label with classification tags - serves as a signal transducer

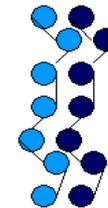
## Morphogenesis: 3D printing of macromolecules

Digital manufacturing --- Bricklayer allegory

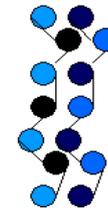


## Algorithm for protein reproduction

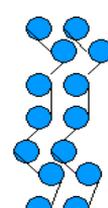
Stage 1  
Holography  
replication



Stage 2  
Uncertainty  
randomization



Stage 3  
Closure  
restoration



Quantum "Xerox machine"  
Uncertainty principle interplay

Claverie, J.-M. (2001) *What if There Are Only 30,000 Human Genes?*, *Science*, 291, 1303

Hanan Al Shargi and S. Berkovich, "Biological Information Processing as Cloud Computing", Second International Conference on the Applications of Digital Information and Web Technologies, pp. 417-422, London, 2009

# #3 Genome functionality: Life is a collective effect

## ***Cosmic habituation: “decline effect” --- The problem of replicability***



Something strange: the therapeutic power of the drugs appeared to be steadily waning.  
A recent study showed an effect that was less than half of documented in the first trials  
**In the field of medicine, the phenomenon seems extremely widespread.**

Jonah Lehrer, *The Truth Wears Off, Is there something wrong with the scientific method?*, New Yorker, Dec.13, 2010

## ***Antibiotic resistance: one of the greatest threats to modern health***

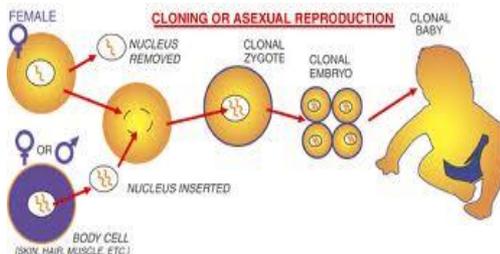
### **Longitude Prize 2014**



"Antibiotics are losing their effectiveness at a rate that is both alarming and irreversible"

Antibiotic-resistant bacteria have been detected in humans and animals in remote areas where antibiotic exposure has been absent or minimal

## ***Interoperability of clones: shared memory interactions***



A prediction of the developed concept:: producing clones may shorten the lifespan of clone donors

# #4 Brain design: Holographic Mechanism of the Universe

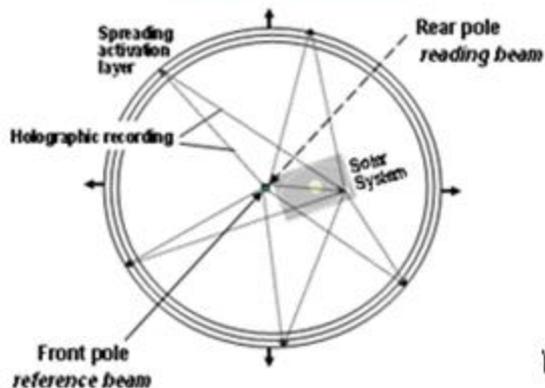
David Bohm and Karl Pribram: *Reality has holographic properties*

P. Pietsch: *without this idea there had been a total absence of even the prospects of general theory of biological memory*

R. L. Gregory: *one of the difficulties in understanding the brain is that it is like nothing so much as a lump of porridge*

Popular appeal to Holographic Universe omits engineering embodiment intricacies

Extracorporeal placement of human memory --- Cloud Computing



**Shared access  
in the  
Holographic  
Universe**

Working frequency  $\sim 10^{11}$  Hz

Von Neumann's estimate for brain's memory:  $2.8 \cdot 10^{20}$  bits

D.R.Forsdyke , “Long-Term Memory: Scaling of Information to Brain Size”, Frontiers in Human Neuroscience, 2014  
<http://journal.frontiersin.org/Journal/10.3389/fnhum.2014.00397/full>

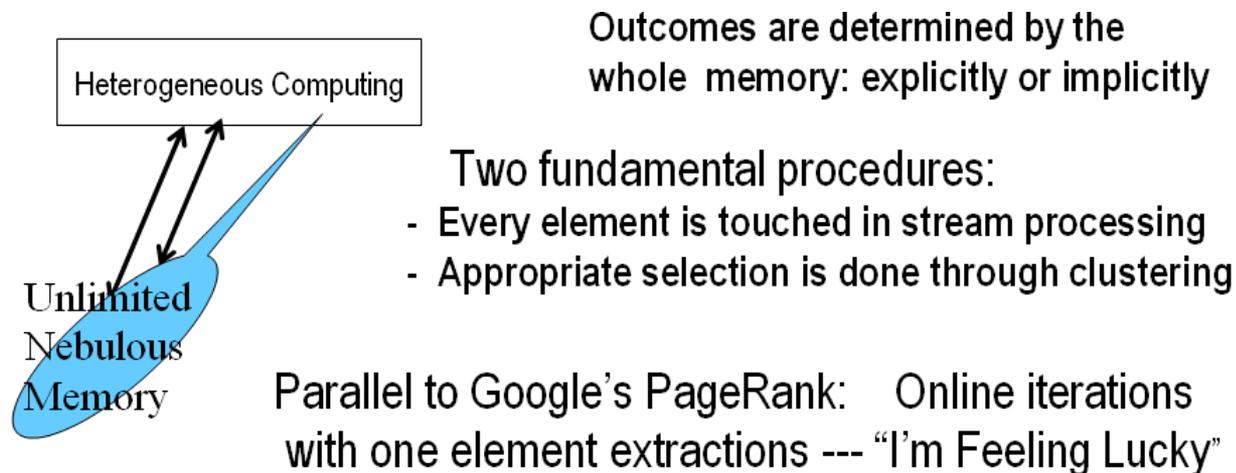
# #4 Brain design: Bounded Rationality

Big Data situation requires a qualitatively different approach to information processing

**Big Data computational model: Context-Addressable access**

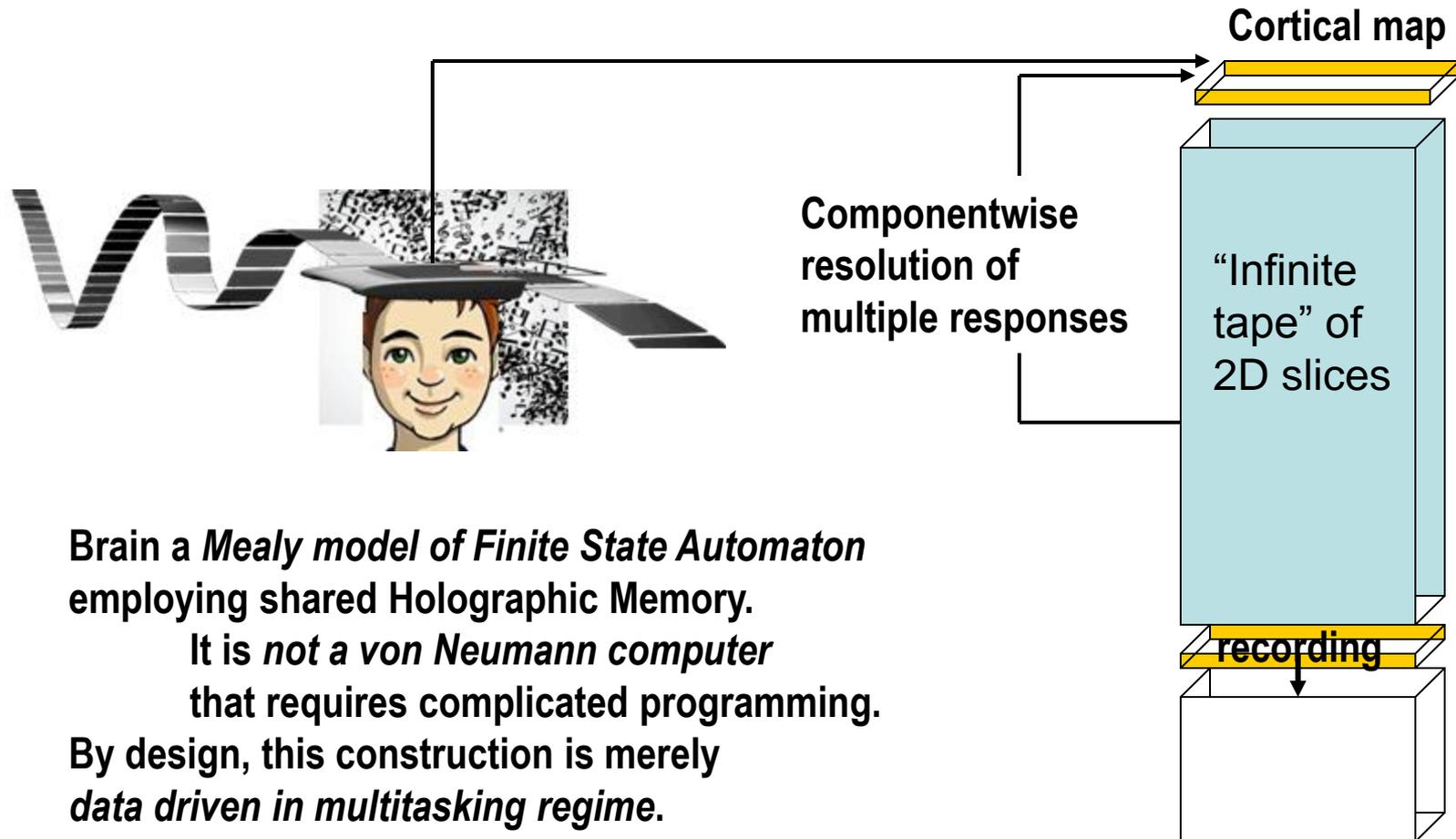
**Emulation of Oracle Machine with “Intuition from Context”**

**The fundamental role of Freud’s idea of unconsciousness**



# #4 Brain design: organization of computations

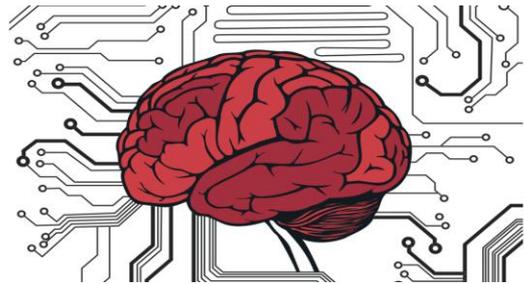
## Intelligent Software Defined Storage with Turing style of computations



Brain a *Mealy model of Finite State Automaton* employing shared Holographic Memory.  
It is *not a von Neumann computer* that requires complicated programming.  
By design, this construction is merely *data driven in multitasking regime*.

# #4

## Brain design: basic computer innovations

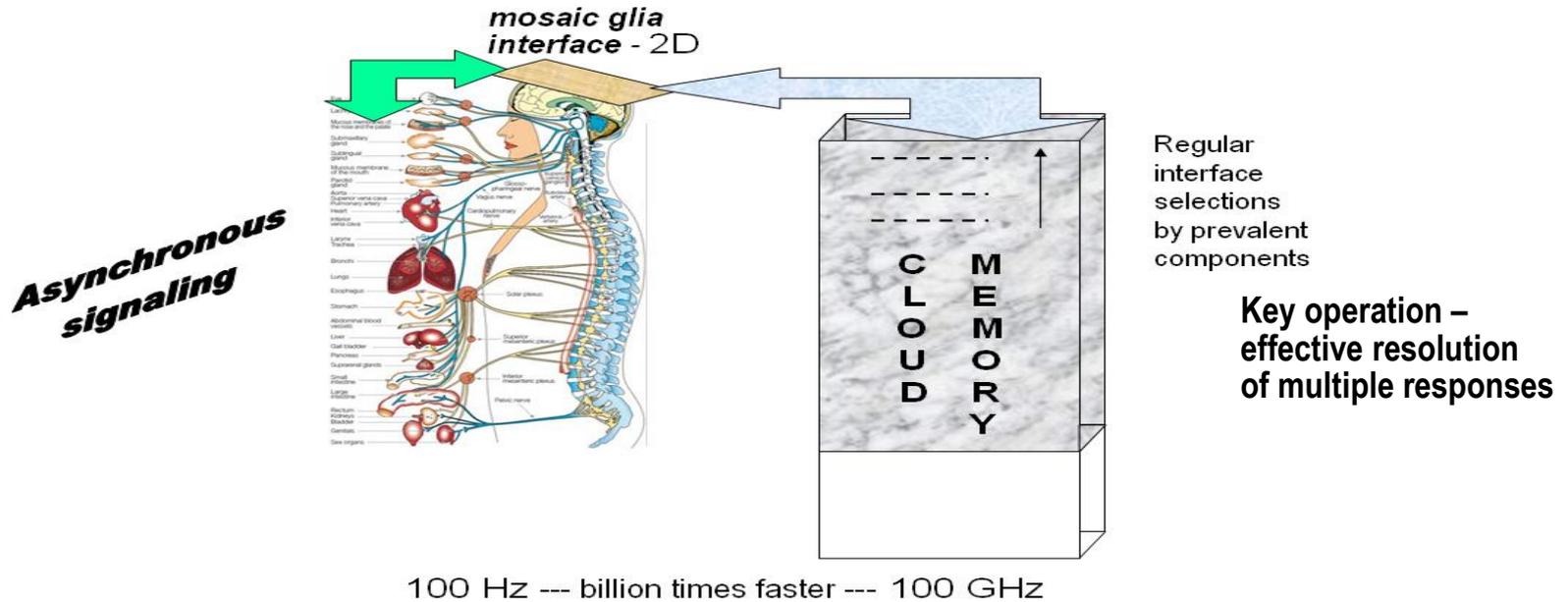


magical  
transition →



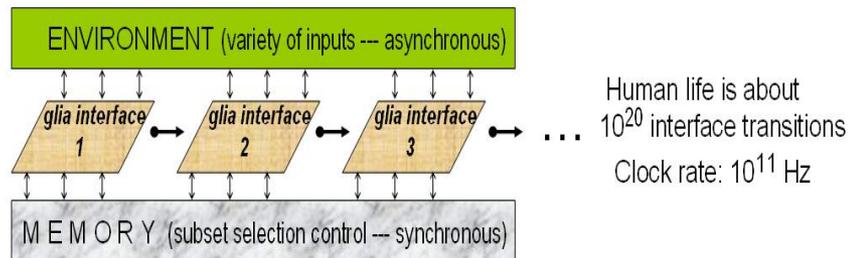
1. New structure of holographic associative memory ---  
**combined recording and searching**  
**Illusion of short-long term memory in one level storage**
2. New method for resolution multiple responses ---  
**rational extraction of a predominant element**  
**Unconsciousness and intuition analogous to “Oracle” machine**
3. New simple way of programming by data-driven control ---  
**“mosaic” transformations of different brain regions**  
**Continuous self-awareness through integration of inputs**
4. New principle for fault-tolerance ---  
**the so-called neuroplasticity, “mind over matter”**  
**Adaptations for graceful degradation and progressive enhancement**

# #4 Brain design: realization of a cyber- physical process



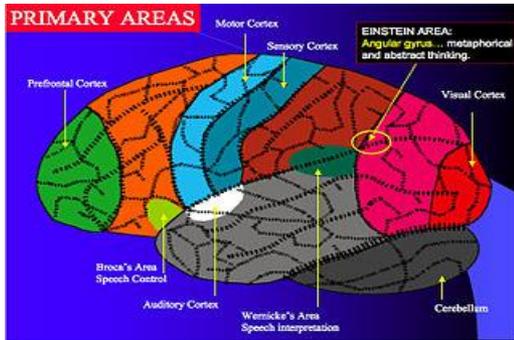
**Ageing is a Big Data algorithmic constraint rather than a biochemical deterioration**

Different species have different lifetimes



# #4

## Brain design: Mind over Matter



*Graceful degradation and progressive enhancement*  
*Cortical map rearrangements: alleged to neuroplasticity*  
*Curing a wide range of somatic and mental distortions*

**DARPA chip implants to restore active memory**  
**Stimulating certain neurons noticed to produce memories**

### Rehabilitation of Alzheimer's dementia

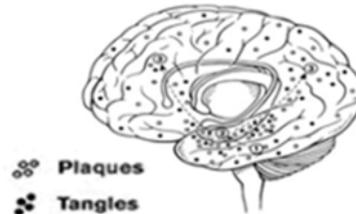
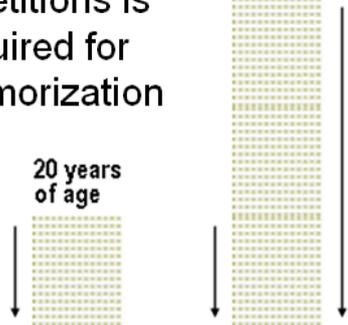
First signs of Alzheimer's disease

**Short Term Memory loss** --- destruction of proteins as involved in “Writing”  
**Recall of earlier events** --- destruction of proteins as involved in “Reading”

Three times less repetitions is required for memorization

60 years of age

20 years of age



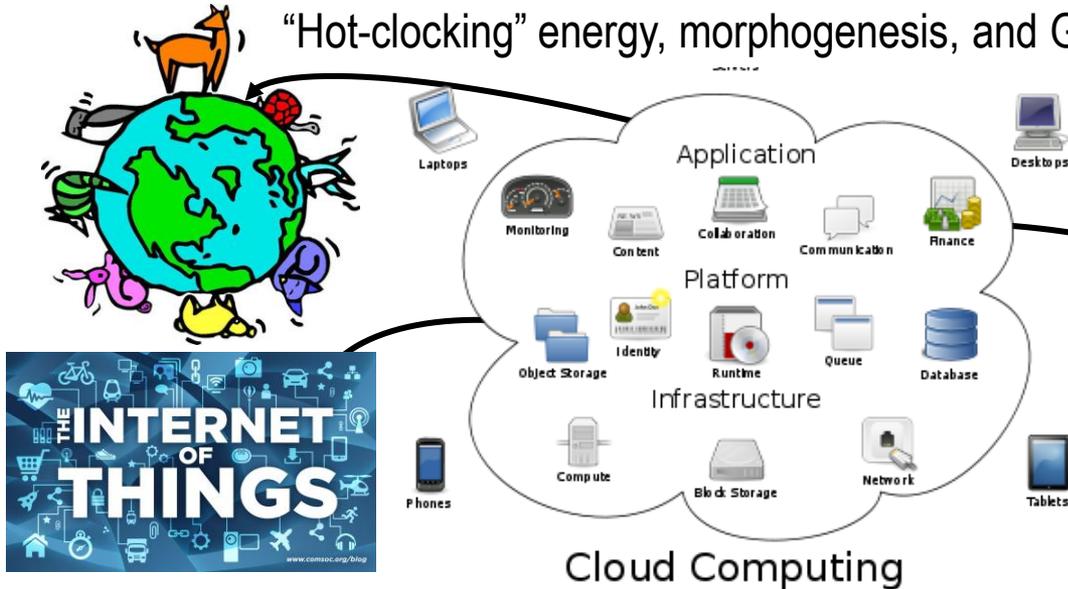
Protein deposits in the onset of Alzheimer's disease

**Primary effect of reduced access to data subsets** --- **loss of sophistication: humor and creativity**  
**Intellectually stimulating activities make the development of Alzheimer's disease less likely**  
How can this happen? --- “Software” impacts: cortical map readjustments  
**Motivated current recordings enhance sampling subsets with predominance of recent events**

# Conclusion: Infrastructure is Life



“Hot-clocking” energy, morphogenesis, and GPS navigation of animals



**Google glasses  
(cf. regular perception)**



**“Moon Illusion”  
2500 years unsolved mystery  
Holography image amplification**

**“How memories are stored in the brain is not likely to be affected by the discovery of the final theory”** S. Weinberg, Nobel laureate, “Dreams of a final theory”. New York, 1992

**Physics that can not explain biology is not just incomplete, it is wrong  
May be we should take the contrary road, so explaining the brain would lead to  
the resolution of the problems in physics?**

**Methodological advantage: algorithms for information processing are  
more certain then postulates for physical problems**

S. Berkovich, “Physical world as an Internet of Things”, in *COM.Geo '11 Proceedings of the 2nd International Conference on Computing for Geospatial Research and Applications*, Article No. 66, ACM, New York, 2011, [www.ogcnetwork.net/system/files/Berkovich\\_220-397-I-RV.pdf](http://www.ogcnetwork.net/system/files/Berkovich_220-397-I-RV.pdf)