

Consciousness, Physics, and Computer Science

Richard Shoup

Boundary Institute
Los Altos, California, USA

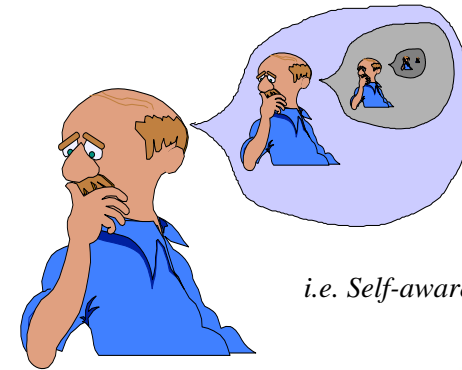
shoup@boundary.org

Shoup – SSE '07

Copyright © 2007 - All Rights Reserved

Boundary Institute

Consciousness?



i.e. Self-awareness

Shoup – SSE '07

Boundary Institute

Key Elements of Consciousness

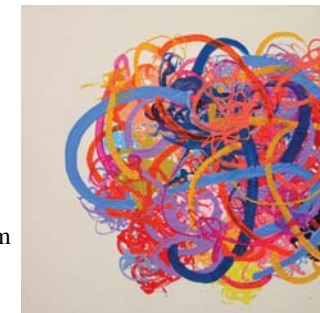
- Self / Identity: “How do you explain my *experience*, my internal states, my feelings, my rich inner life, etc?”
=> Instead, one should be asking “Who is the *I*?”
- Conscious phenomena:
emotion, modeling, learning, creativity, Psi, etc
- Free Will: Non-determinism, freedom of personal choice
=> Randomness, causeless events?

Shoup – SSE '07

Boundary Institute

Tangled Concepts

- Consciousness
- Measurement
- Entanglement
- Randomness
- Causality, 2nd Law
- Psi, anomalies
- Free Will, determinism
- Gödel theorems
- Artificial Intelligence



“Tangle”, Martina Nehrling

Shoup – SSE '07

Boundary Institute

Leaps of Consciousness - Pitfalls

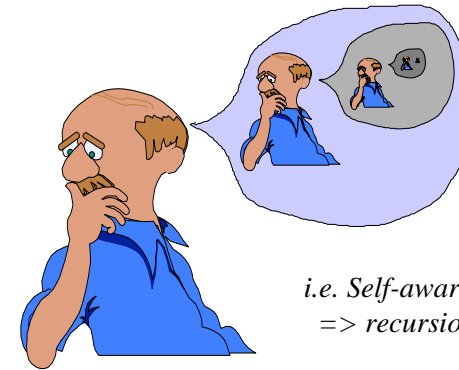
- Internal experiences (feelings, qualia) are so inexplicable that quantum states are required in the brain.
- Conscious is necessary and essential to quantum measurement.
- Conscious phenomena violate physical principles, especially cause-and-effect.
- Godel's theorems imply that the mind cannot be a computer.
- Godel's theorems imply there are some things we cannot know.

"... take experience itself as a fundamental feature of the world, alongside mass, charge, and space-time." – David Chalmers

Shoup – SSE '07

Boundary Institute

Consciousness?

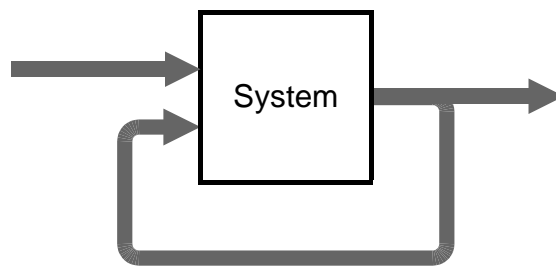


*i.e. Self-awareness
=> recursion?*

Shoup – SSE '07

Boundary Institute

System with Feedback



Self-aware?

Shoup – SSE '07

Boundary Institute

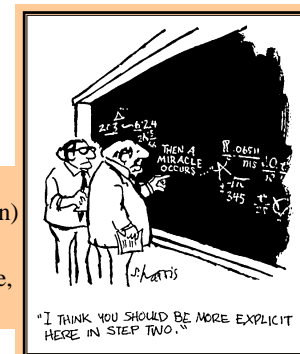
Quantum Theory

Unitary evolution (U)

(Schrödinger equation)
linear, unitary, conservative,
reversible, deterministic

Measurement (R)

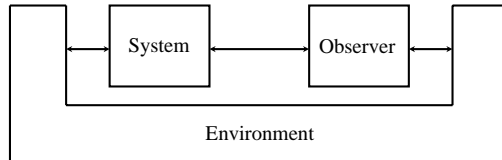
("collapse" of the wavefunction)
non-linear, non-unitary, non-
conservative, non-reversible,
random, unpredictable



Shoup – SSE '07

Boundary Institute

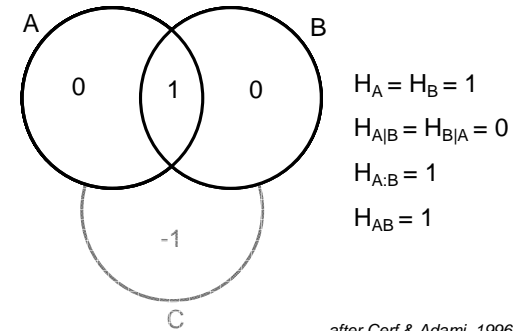
Measurement Interaction



Shoup – SSE '07

Boundary Institute

Quantum Measurement

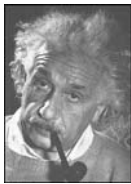


after Cerf & Adami, 1996

Shoup – SSE '07

Boundary Institute

Is Nature Probabilistic?

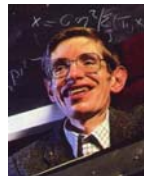


“[QM] yields much, but it hardly brings us closer to the Old One's secrets. I, in any case, am convinced that He does not play dice.”

– A. Einstein, letter to Max Born, 1924

“Not only does God definitely play dice, but He sometimes confuses us by throwing them where they can't be seen.”

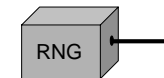
– S. Hawking, 1995



Shoup – SSE '07

Boundary Institute

REG/RNG: Uninfluenceable, Unpredictable



- No inputs
- No memory

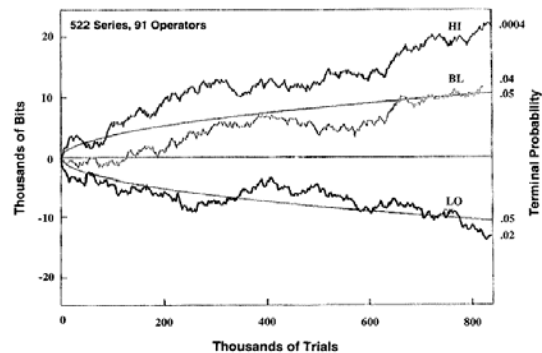


Tests: Diehard, NIST, Comscire, etc.

Shoup – SSE '07

Boundary Institute

Conscious Influence?

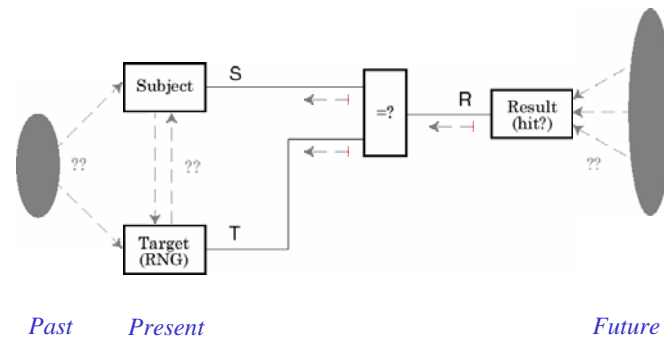


Shoup – SSE '07

Jahn & Dunne, JSE, Vol 19, No 2, 2005
PEAR: www.princeton.edu/~pear

Boundary Institute

Simple Experiment



Shoup – SSE '07

Boundary Institute

Summary

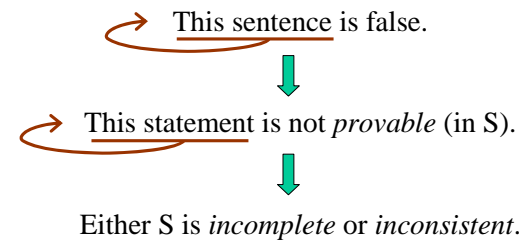
- All quantum evolution is unitary; no collapse
- Cause-and-effect => bidirectional relations, time symmetry
- Correlations in the present due to interactions in the future
- Some Psi phenomena are explained
- No need or evidence for quantum phenomena in the brain

*“That is not to suggest that we understand how brains compute.
But so far, there seems to be no need for quantum skyhooks.”*
-- Christof Koch and Klaus Hepp in Nature

Shoup – SSE '07

Boundary Institute

Gödel's Theorems



“Any paradox will do.” -- Gödel to Gregory Chaitin

Shoup – SSE '07

Boundary Institute

Gödel Implications?

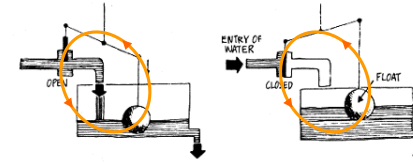
“Gödel's message is that mankind will never know the final secret of the universe by 'finitistic' or constructivistic thought alone.” -- Casti (1991)

“For what [Gödel] appears to have shown is that no such system of rules can ever be sufficient to prove even those propositions of arithmetic whose truth is accessible, in principle, to human intuition and insight – whence human intuition and insight cannot be reduced to any set of rules.” – Roger Penrose, Shadows of the Mind

Shoup – SSE '07

Boundary Institute

Self-Reference, Feedback, and Paradox



Negative feedback

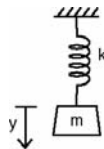
“All Cretans are liars.” -- Epimenides the Cretan
 “This sentence is False.” -- anonymous
 “The set of all sets not containing themselves.” -- Bertrand Russell
 “This statement is unprovable.” -- Kurt Gödel
 “This program does not halt.” -- Alan Turing

Shoup – SSE '07

Boundary Institute

Classical Self-Reference (Feedback)

- Mechanical systems
- Control Theory
- Systems Theory
- Cybernetics
- etc ...



$$y = -\frac{m}{k} \frac{d^2 y}{dt^2}$$

$$= C_1 e^{+i\omega t} + C_2 e^{-i\omega t}$$

$$= C \sin(\omega t + \phi)$$

Negative feedback is commonly used in engineering,
 ... but paradox has been forbidden in Logic and Set Theory

Shoup – SSE '07

Boundary Institute

Imaginary Numbers & Logic Values

Numbers

$$x = -1/x \quad (x^2 = -1)$$

$$x = \pm\sqrt{-1} = i \text{ or } -i$$

$$1, -1, i, -i \cdot$$

Logic

$$x = \sim x$$

$$x = i \text{ or } j$$

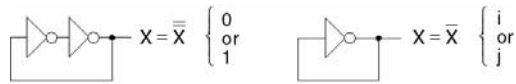
$$F, T, i, j \otimes$$

G. Spencer-Brown, Laws of Form, 1969

Shoup – SSE '07

Boundary Institute

Self-Reference in Circuits



X_{in} _____

X_{out} _____

Autonomy (Memory)

X_{in}

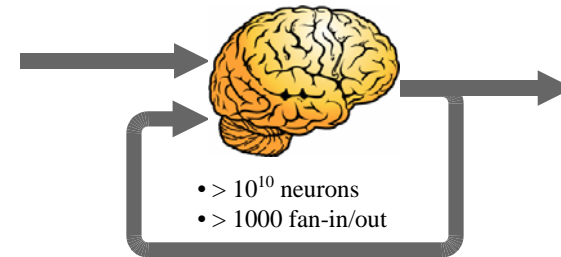
X_{out}

Antinomy/Paradox (Clock)

Shoup – SSE '07

Boundary Institute

System with Complex Self-Reference



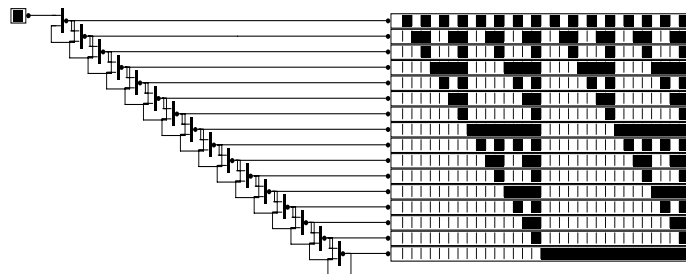
- > 10^{10} neurons
- > 1000 fan-in/out

- self-reference at all levels
- cell assemblies etc (Hebb)

Shoup – SSE '07

Boundary Institute

Local Self-Reference



16-Sierpinski – local fractal

Shoup – SSE '07

Boundary Institute

Summary

- Paradoxes are useful, and should be fully integrated.
- Analogy: imaginary logic values \Leftrightarrow imaginary numbers
- Self-reference is central to understanding consciousness.
- The brain produces the Self from complex self-reference.

Shoup – SSE '07

Boundary Institute

Some Consciousness-Related Phenomena are Interesting

- Psi, including psychometry
- Hauntings, ghosts
- Metal bending
- Intentional healing
- Apparent reincarnation
- Communication with deceased
- Near-death & out-of-body experiences
- ...

Shoup – SSE '07



Progress of Science – I

- Deeper, simpler principles
 - Pantheon of gods, myriad of rules
 - Gravity => Accelerated motion
 - Atomic theory => Standard Model
 - Relativity, Matter \Leftrightarrow Energy
 - ...
 - U & R processes => U (no “collapse”)
 - String Theory, Quantum Gravity
 - ...
 - Distinctions (Laws of Form)

Shoup – SSE '07



Progress of Science – II

- Relinquishing “specialness”
 - Earth is not special (Copernicus)
 - Elements are not special (atomic theory)
 - Motion states are not special (relativity)
 - Life is not special (contra vitalism)
 - ...
 - *I am (Self is) not special*

"The most important scientific revolutions all include, as their only common feature, the dethronement of human arrogance from one pedestal after another of previous convictions about our centrality in the cosmos." -- Stephen Jay Gould

Shoup – SSE '07



www.boundary.org
www.boundarylab.org

shoup@boundary.org