Poster #800

Can a subjective information theory generalize a test for consciousness?

DOI: 10.13140/RG.2.2.10638.11844

Tiffany M. LaByer
Independent Scholar – Burbank, California

Takeaway

Problem: No general test for consciousness, and no way to test the validity of the many theories of consciousness.

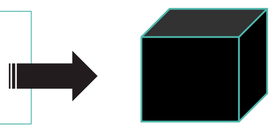
My Take: Model the information that conscious systems deal in.

Result: Systems holding subjective information are marked by:
- A limit on the transmission of information
- A higher processing heat cost

Postulates on Subjective Information

1. Subjective information is bounded.
2. Subjective information systems are discrete.
3. Subjective information is accessed by a system through self-measurement.

The Barrier Problem : the inability to directly measure subjective information in another experiencer.



Definition 1 A system is said to be conscious if it houses subjective information, and satisfies postulates 1, 2, and 3.

Background and Physical Motivation

- By **Landauer's Principle** info is physical; computation has a heat cost [1].
- **QBism** interprets the WF as an agent's degree of belief, and measurement as an experience [2].
- Human reasoning exhibits signatures of quantum-like dynamics [3].
- **No-Go Thm for observer indep facts** and **Local Friendliness Thm** suggest subjectivity may be fundamental to QM [4-6].
- Ebits mediate entangled qubit to cbit transitions and are a resource for quantum state mergers [7,8].
- **Strong subadditivity** bounds information in subsystems [9].

Assumptions

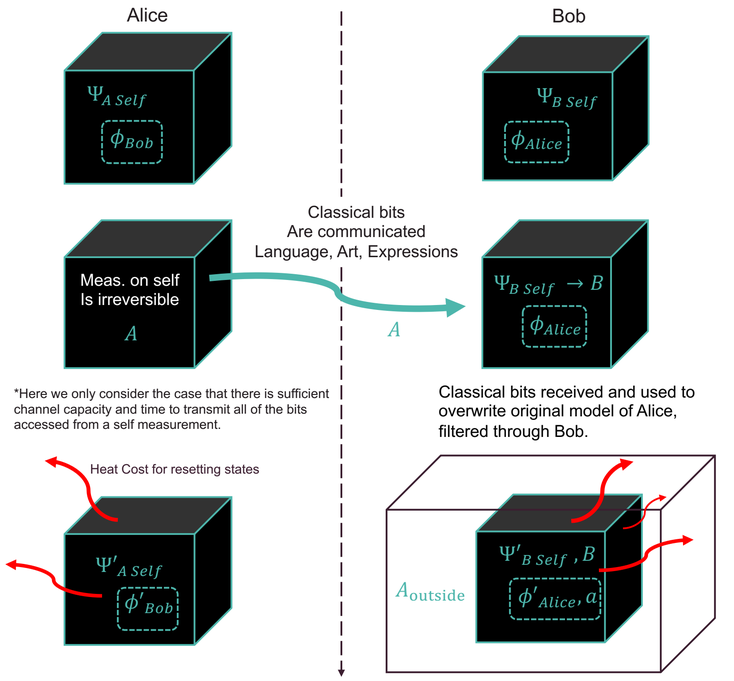
1.) Conscious systems can be modeled quantumly

2.) A conscious system models itself quantumly

3.) A conscious system models other systems quantumly

4.) A measurement on the self produces an experience composed of classical bits

Communicating Conscious Systems



*Here we only consider the case that there is sufficient channel capacity and time to transmit all of the bits accessed from a self measurement.

Classical bits received and used to overwrite original model of Alice, filtered through Bob.

Heat cost will be double, plus a cost for any used ebit.

$Q \geq 2k_B Tln2 + .55k_B Tln2$

Do to presence of self-measurement

$Q_{Subj.Sys.} \approx 2.55\ Q_{no\ self\ meas.}$

$S(a|B) < 0$, the internal systems share ebits

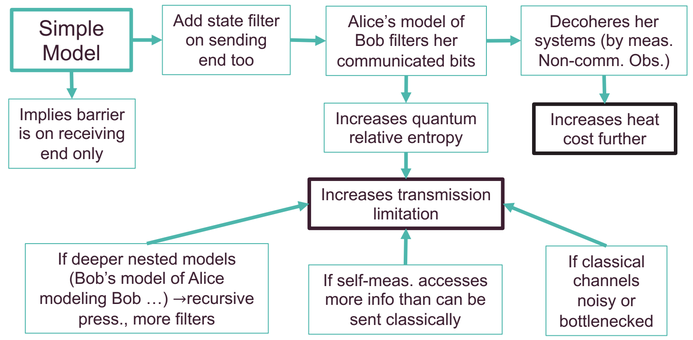
$\rho_A = Tr_{Ba}(\rho_{ABa})$, total info about A
$\rho_{A|a} = Tr_B(\rho_{ABa})$, Ψ_B filters info to Φ_a

$I(A:a) = I(A:Ba) - I(A:B|a)$, strong subadd
Where $I(A:B|a) > 0$, because B, a correlated
$\Longrightarrow I(A:a) < I(A:Ba)$, $\Phi_{Alice} \neq A_{outside}$

Bob cannot ever have an accurate model of Alice

*assumed that Φ_a cannot know Ψ_B exactly

Limitations



Implications, more limitations, and Analogous Models

- Increased energy signature could provide a way to test artificial systems for subjective information, but would require:
  - computing at/near the Landauer limit
  - OR a very strict accounting of all the heat generating sources
- Implies the possibility of a phase change merging conscious systems if they share any ebits
  - Comparison to theories like IIT, Tegmark's Consc. as St. matter, and GNWT
- Could point to actual quantum computation beyond just simulated
- Analogous models could be used to compare assumptions behind theories on emergence, why info "trapped"/integrated, fields, etc.
  - Superconductor model of info flow
  - Black hole model and AdS/CFT correspondence

References

[1] R. Landauer, *Phy. Today* **44**, 23 (1991)
[2] C. Fuchs et al., arXiv:1612.07308v2 [quant-ph] (2017)
[3] J.R. Busemeyer, Z. Wang, *Curr. Direc. Psych. Sci.* **24**, 163 (2015)
[4] Č, Brukner, *Entropy* **20**, 350 (2018)
[5] D. Frauchiger, R. Renner, *Nat. Commun.* **9**, 3711 (2018)
[6] K.W. Bong et al., *Nat. Phys.* **16**, 1199 (2020)
[7] N.J. Cerf, C. Adami, *Phys. Rev. Lett.* **79**, 5194 (1997)
[8] M. Horodecki et al., *Commun. Math. Phys.* **269**, 107 (2007)
[9] P. Hayden et al., *Commun. Math. Phys.* **246**, 359 (2004)

Scan me!