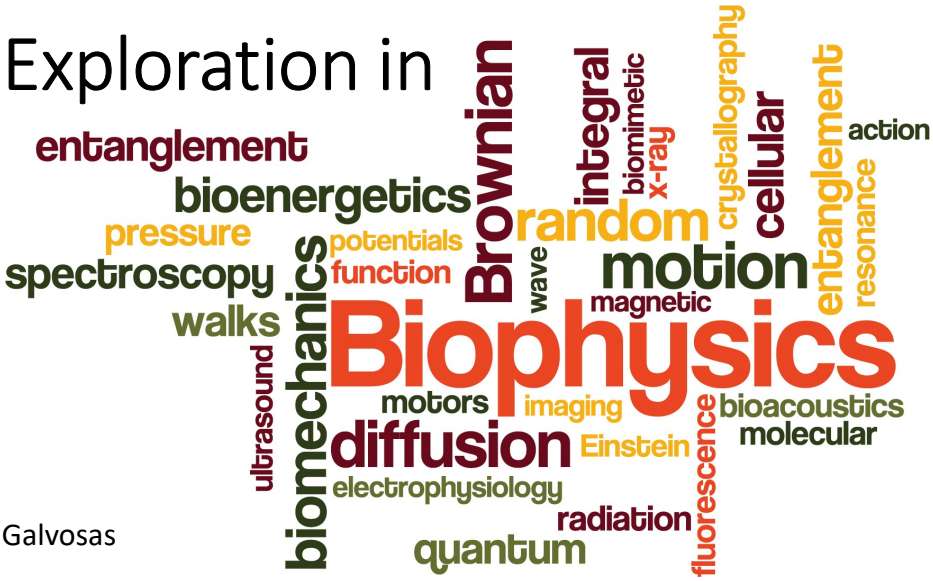
A Small Exploration in



Yile Ying @VUW
Supervisor: Petrik Galvosas
3rd May, 2018

Image Source: York University

Comparative/Ecological Biomechanics

- Sweeping wave: 30m/s; 500m/s^2
- Temperature: 40^{o}C; 10^{o}C
- Moisture: Dry; Submerged
- Salinity: 0 psu; 4 times of sea water

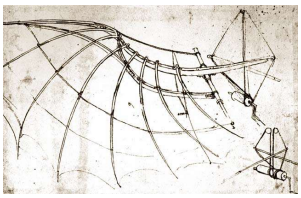
Comparative/Ecological Biomechanics

- Mechanical functions, e.g. locomotion
- Adaptations to physically variable environments
- Interactions with other organisms

compare across history and taxa

- Classical Mechanics
- Engineering
- Material Physics

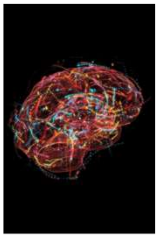
- Physiology
- Neuroscience
- Ecology
- Evolution



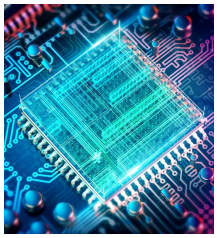
Quantum Biology

- Photosynthesis
- Avian Magnetoreception
- Olfaction
- "Quantum Brain"

- Quantum mechanics
- Physical/theoretical chemistry
- Molecular biology
- Physiology



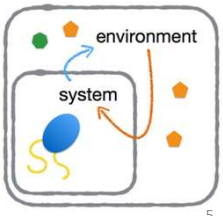
- The boundary between classical and quantum mechanics
- Better quantum machine
- "Byproducts", e.g. medical diagnosis techniques, experimental techniques



Source: QuantaMagazine (featuring Matthew Fisher, University of California, Santa Barbara), 2018

Statistical Physics in Biology

- Draw analogies to biological systems, e.g. self-assembly network, collective/emergent properties
- Study underlying physical constraints or driving force for biological systems



Source: Jeremy England, MIT, 2015

Energy cost of information processing

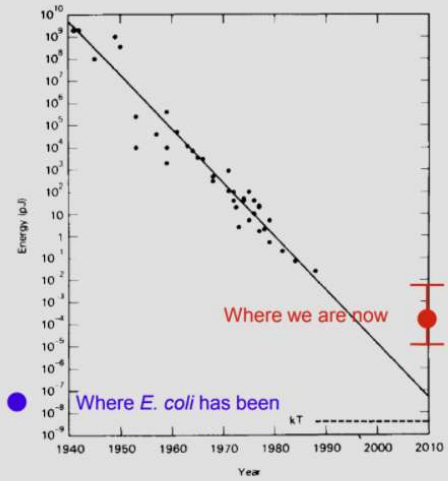
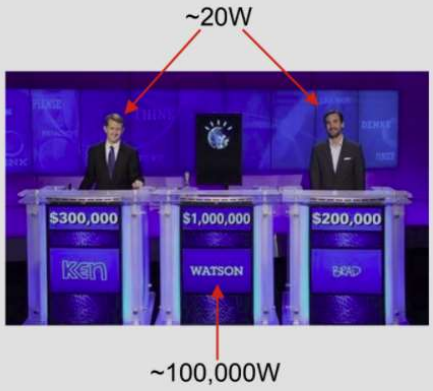


Fig. 1 The decrease in energy dissipated per logic operation over recent decades.

(Rolf Landauer, Nature 1988)



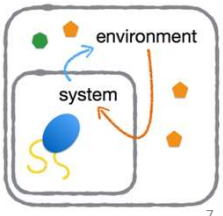
Can we learn something from biology about efficient computing??

Source: Yuhai Tu, IBM, 2015

Statistical Physics in Biology

- Draw analogies to biological systems, e.g. self-assembly network, collective phenomena, emergent properties
- Study underlying physical constraints or driving force for biological systems
  - ✓e.g. non-equilibrium thermodynamics in life-formation

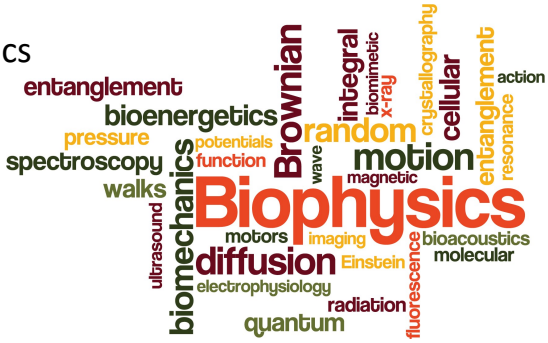
- Mathematical and statistical modelling, programming
- Thermodynamics, stochastic mechanics, condensed matter theories
- Bioinformatics or related areas



Source: Jeremy England, MIT, 2015

Join Me!

- Comparative/Ecological Biomechanics
- Quantum Biology
- Statistical Physics in Biology
- ……much more



Source: York University

Thanks! ☺

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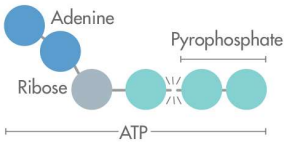
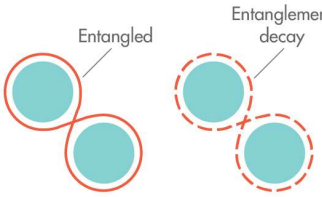
QUANTUM BRAINS

If you want to build a quantum computer, you have to find a way to keep individual quantum bits of information — qubits, for short — linked to one another, or entangled, for sufficiently long periods of time. The task is difficult in the lab. It is thought to be impossible in the warm, wet mess that is the body. But a new proposal details how the brain might maintain quantum connections for seconds, if not hours or days.

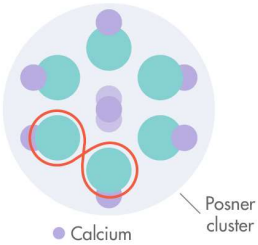


1 The biological molecule adenosine triphosphate (ATP) can release pyrophosphate, made from two phosphate molecules.

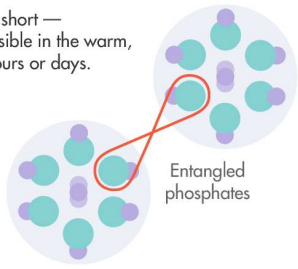


2 Each phosphate carries a quantum spin, and the two phosphates can become entangled with each other.

3 Unprotected, the phosphate entanglement will decay, or decohere, in short order.



4 But if the phosphates are grouped together into protective clusters called Posner clusters, which are made of phosphate and calcium ions, the entanglement might survive for a longer time.



5 If a pair of entangled phosphates split into different Posner clusters, they will remain entangled even as the clusters transport them far from each other. In this way, the entanglement can be distributed over fairly long distances in the brain. This allows for the possibility of a quantum basis for brain function.

Source: Matthew Fisher, University of California, Santa Barbara, 2018