

What is life? (Particularly, human life)

Kyoto Univ. is well-known by its academic freedom.

Research on Life



Some pictures found on the Internet

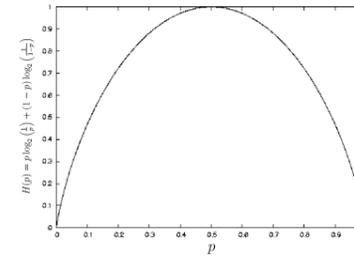


暗黒バエ (Dark fly), since 1954 (ab. 1600 generations so far)



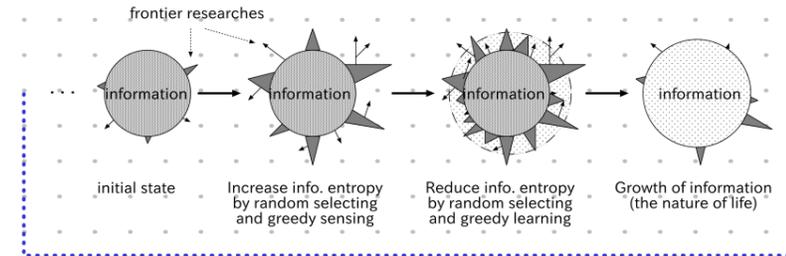
inheritance and mutation

<https://commons.wikimedia.org/w/index.php?curid=25850558>



Information Wisdom Theory (me, 2021, [4]):

- * Wisdom is a set of actions to live.
- * The nature of to live is to grow information.
- * Growing information is done by learning and random selecting.



definitions of entropy in different contexts

* thermodynamics (Clausius, 1865): Q/T

* statistical physics (Gibbs, 1878): $S = k \sum_{\omega} p(\omega) \ln \frac{1}{p(\omega)}$

* information science (Shannon'49):

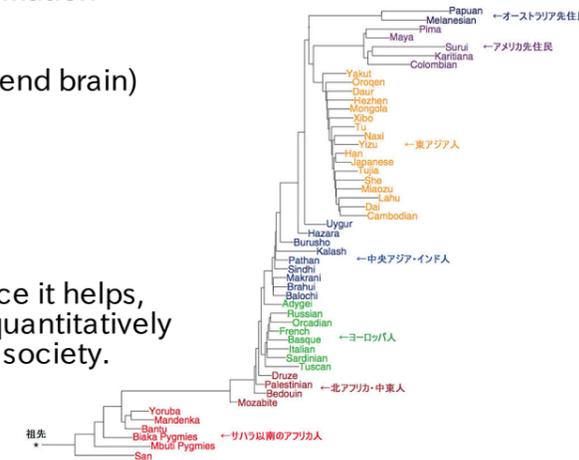
$$H = \sum_i p_i \log_2 \frac{1}{p_i}$$

media for keeping/growing information

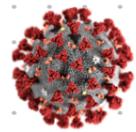
- * gene (can't change after birth)
- * brain (can grow after birth)
- * digital (can enhance or transcend brain)

- * Brain activity (fiction sharing) is the secret of sapiens (e.g., [1]).
- * Modern society proves the victory of brain against gene (e.g., stop of discrimination based on skin color, race, gender, etc.).

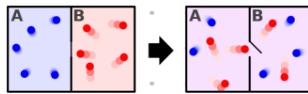
Digital society is promising since it helps, for the first time, that we may quantitatively study life and unite the human society.



<http://ja.wikipedia.org/wiki/系統樹>. Original: Jun Z. Li, et al, Science 319, 1100 (2008)



Virus is not life (though I can't agree)



Entropy increases.

Entropy: a measurable property to describe a state of disorder, randomness, uncertainty.

From 200 y. b., "life" is biologically defined by "inheritance" + "metabolism" + "cell".

Second Law of Thermodynamics

- Observation by scientist (Schrödinger'44 [1] and after)
- * nature/matter: entropy increases (follow natural law)
 - * life: keep or decrease entropy (not follow)

at a price to increase the entropy of environment.

thus the environmental problem can't be solved, and sustainability is important to delay the process of collapse of Earth.

Birth of IT and AI => Machines are used to find and construct orders.

AI can be a threat.

Life 3.0 (Tegmark, 2017, [3])

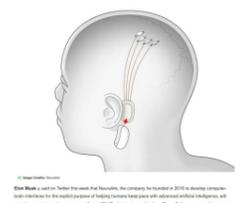
- * 1.0: Evolves by inheritance and mutation (bacteria)
- * 2.0: 1.0 + evolves by brain (e.g., human)
- * 3.0: Evolves without a body (future life)

Posthuman/transhuman: Life 2.5?

Human merger with machines will create a hybrid race of super gods, says top expert

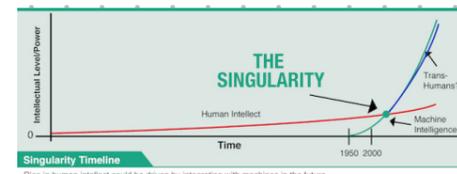


Elon Musk sets update on brain-computer interface company Neuralink for August 28

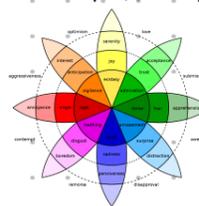


New orders (digital order)

- * IT giants (GAFA etc) are taking control of daily life.
- * Fintech companies are taking control of finance.
- * Evolutionary orders emerge by the advance of IT, IoT, AI.
- * An extreme fiction of the Technology Singularity



<https://cwtejp1.wikispaces.com/2045+The+Singularity>



Plutchik's wheel

Examples:

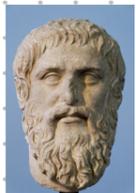
- * Food similarity
- * Trump emphasizes the natural side (free, disorder).
- * Biden emphasizes the other, the life-like side (order).
- * Environmental destruction => environmental protection
- * Why we are always curious in exploring (e.g., Mars)
- * What creativity is
- * Why it is harder to have peace than to get into war
- * Why there are more negative emotions than positive

Birth of the universe (13.8B years before)

Earth (4.6B y. b.)
Life (4.4B y. b.)

Recent studies consider spirit as a kind of function, will, ability etc.

Evidences from science (e.g., neuroscience) suggest they are activities of the brain.



Knowledge about human (life) 2000 y. b.

- * body: natural order
- * spirit (heart, etc): super-natural order

Liang Zhao (趙亮), Dr. Informatics

<https://aw.gsais.kyoto-u.ac.jp>

Research: life and wisdom, network algorithms

Machine learning and application, future AI

[1] Erwin Schrödinger, What is life? 1944.

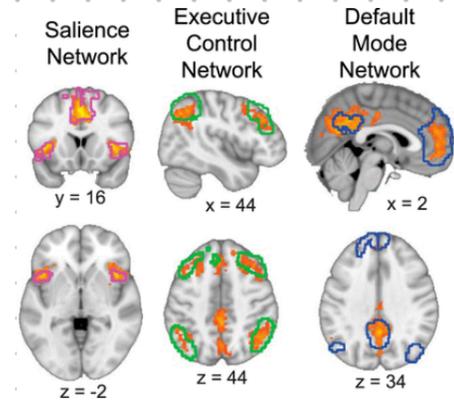
[2] Yuval Noah Harari, Sapiens: a brief history of humankind, 2011.

[3] Max Tegmark, Life 3.0, 2017.

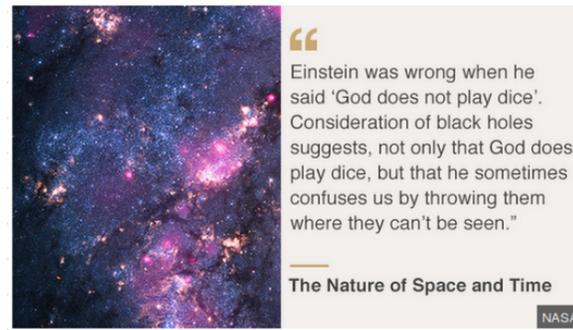
[4] 趙亮, (第12章)情報乱雑さで生きること考えてみる, 実践する総合生存学, 池田編著, 京都大学学術出版社, 2021.

Definition of wisdom

- * Learning and thinking (Confucius)
- * listening, reflection, cultivation (Buddhism)
- * (Western philosophy)



<http://www.patriotinstitute.org/end-second-american-era>



<https://www.bbc.co.uk/news/amp/uk-43396627>



Tim Cook, "Graduates, be fearless!"
https://twitter.com/tim_cook/status/995702835462529025

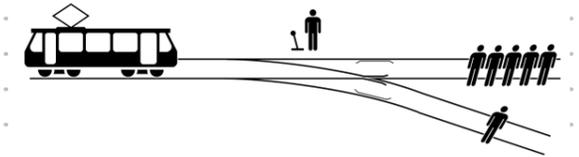
Configuration and strength ^[60]				
Versions	Hardware	Elo rating	Date	Results
AlphaGo Fan	176 GPUs, ^[51] distributed	3,144 ^[50]	Oct 2015	5:0 against Fan Hui
AlphaGo Lee	48 TPUs, ^[51] distributed	3,739 ^[50]	Mar 2016	4:1 against Lee Sedol
AlphaGo Master	4 TPUs, ^[51] single machine	4,858 ^[50]	May 2017	60:0 against professional players; Future of Go Summit
AlphaGo Zero (40 block)	4 TPUs, ^[51] single machine	5,185 ^[50]	Oct 2017	100:0 against AlphaGo Lee 89:11 against AlphaGo Master
AlphaZero (20 block)	4 TPUs, single machine	5,018 ^[61]	Dec 2017	60:40 against AlphaGo Zero (20 block)

<https://en.wikipedia.org/wiki/AlphaGo>

Ex. AlphaGo uses (machine) learning and random algorithm (Monte Carlo method)

Wisdom = Learning + Random selecting

Learning: deterministic actions, e.g., cognition, memory, calculation, inference etc.
Random selecting: nondeterministic actions, e.g., freedom, random, mutation, creating, etc.



<https://commons.wikimedia.org/w/index.php?curid=52237245>

Zhao L., Li W. (2020) "Choose for No Choose"—Random-Selecting Option for the Trolley Problem in Autonomous Driving. In: Zhang J., Dresner M., Zhang R., Hua G., Shang X. (eds) LISS2019.

Evidences from neuroscience

- * Salience Network -> deterministic actions
- * Default Mode Network -> nondeterministic actions
- * Executive Control Network -> control
- * Both S.N. and D.M.N work -> strong creativity

Young et al., Dynamic Shifts in Large-Scale Brain Network Balance As a Function of Arousal, J. Neurosci. 37 (2), 281-290 (2017)

My research interests

- * Use entropy to explain order and disorder
- * Learning (e.g., how network and society emerge)
- * Random selecting (Psychology, AI ethics, creativity)
- * Use algorithm to implement future wisdom
- * Other topics related to AI, life, humanity, and wisdom



joint work with S. Yang, H. Liu, D. Ke, X. Lyu, X. Liang, L. Zhang

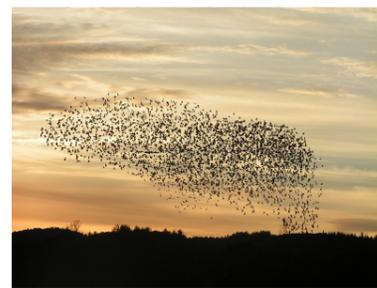
Free Energy Principle (Friston 2006)

- * Hypothesis: brain is a Bayesian brain
- * A = event to infer, B = observation
- * P(A) => preconception, prior, belief, etc
- * Brain learns by calculating the difference between P(A|B) and P(A)
- * Then observes and learns more by active inference.

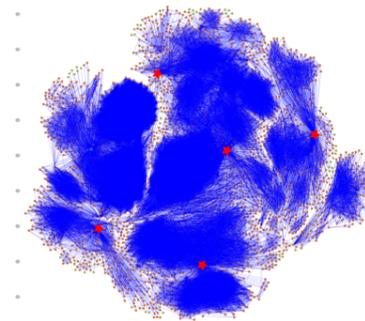
Bayes' theorem (Bayes, 1763)

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

機能	論文
鏡視	Brown & Friston (2012)
眼球運動	Friston, Adams et al. (2012), Parr & Friston (2018)
アフォーダンス	Friston, Shiner et al. (2012)
知覚推論	Friston & Kiehl (2009), 5
注意	Feldman & Friston (2010)
身体化による認知	Friston (2011)
動作認識	Donnarumma, Costantini et al. (2017)
運動制御	Friston, Daunizeau et al. (2010)
最適制御	Friston, Samothracis et al. (2012)
強化学習	Friston, Daunizeau et al. (2009)
迷路学習	Friston, FitzGerald et al. (2016)
モチベーションによる制御	Pezzulo, Rigoli et al. (2018)
気分	Clark, Watson et al. (2018)
愛着	Cittern, Nothe et al. (2018)
自閉症	Friston, Lawson et al. (2013), Quattrucci & Friston (2014)
サヴァン症候群	Friston (2010)
計算論的精神医学	Friston, Stephan et al. (2014)
価値	Friston, Schwartenbeck et al. (2013)
洞察	Friston, Lin et al. (2017)
行動計画	Kaplan & Friston (2018)
意思決定	Schwartenbeck, FitzGerald et al. (2013), Schwartenbeck, FitzGerald et al. (2015)
自己組織化	Palacios, Razi et al. (2017)
ホメオスタシスの制御	Pezzulo et al. (2015)
アロスタシス	Stephan, Manjaly et al. (2016)
自律神経制御	Seth & Friston (2016)
ドーパミンの役割	Friston, Schwartenbeck et al. (2014)
コリン作動性神経調節物質の役割	Moran, Campo et al. (2013)

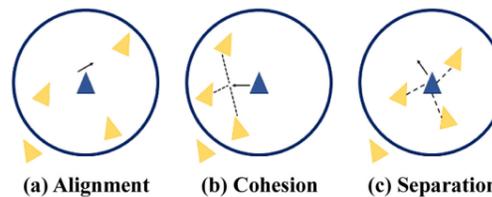


https://en.wikipedia.org/wiki/Swarm_behaviour



Application in complex network

Zhao L., Peng T. (2020) An Allometric Scaling for the Number of Representative Nodes in Social Networks. In: Masuda N., Goh K.I., Jia T., Yamanoi J., Sayama H. (eds) Proceedings of NetSci-X 2020



<https://www.sciencedirect.com/science/article/abs/pii/S2210650217301700>

Boids (Reynolds'86): self organization in nature
=> Can be used to explain the orders in human society.
e.g., observation from Shared Leadership studies (Xu C.)

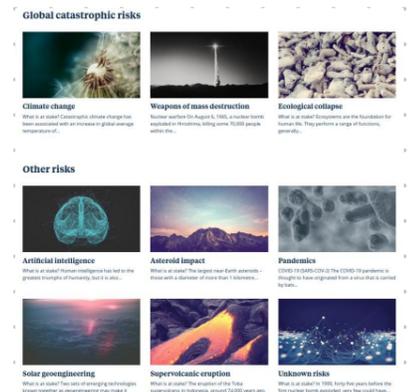


Generating Sansui arts by PGGAN (2018)

乾敏郎 (2019) 解説 自由エネルギー原理
—環境との相即不離の主観理論—
Cognitive Studies, 26 (3), p368 (Sep 2019)

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Research: life and wisdom, network algorithms
Machine learning and application, future AI

Future AI and human society



<https://globalchallenges.org/global-risks/>