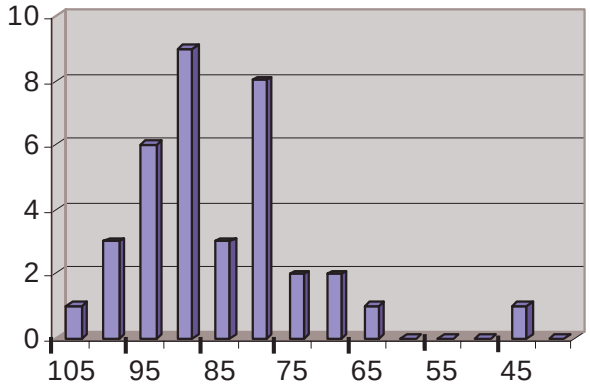
Midterm

If the midterm (avg of 84) was the only grade for this class:

A+ >100
A > 89
A - > 85
B+ > 80
B > 75
B- > 70
C+ > 60
D+ > 40



Astronomy 230

Section 1– MWF 1400-1450
106 B1 Eng Hall

This Class (Lecture 24):

Origin of Intelligence

Tony Sergenti
Terry Timmons

HW #5 Due on Oct 29th!

Next Class:

Origin of Intelligence

Music: *Where is Everybody?* – NIN

Outline

- What is intelligence?
- Development of intelligence.

Drake Equation







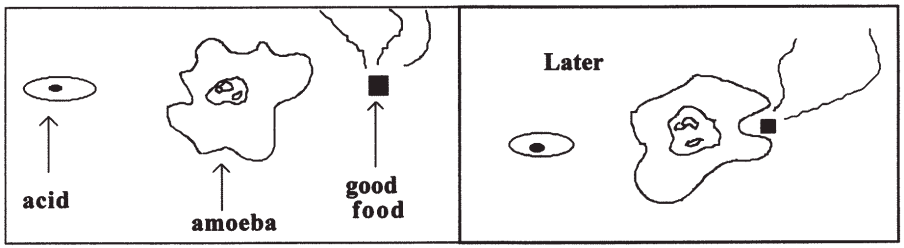

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

N	R_*	f_p	n_e	f_l	f_i	f_c	L
# of advanced civilizations we can contact	Rate of star formation	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that commun-icate	Lifetime of advanced civilizations
	25 stars/ yr	**0.34** systems /star	**.396** life planets /system	**0.54** life /planet			**= 1.8** Evolved Life /year

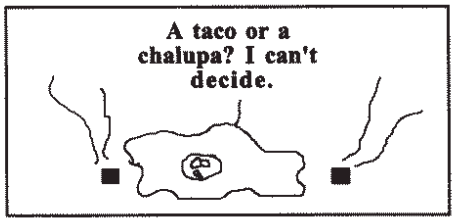
Evolution of Intelligence

- Through diversity, evolution has resulted in an increase in the complexity of organisms on Earth.
- Can we associate complexity with intelligence?
- If intelligence is an advantageous trait, it is plausible that intelligence would increase over time.
- But, what is intelligence?
- A general definition is “the ability to model the world, including the organism’s own self.”

An Amoeba Distinguishes

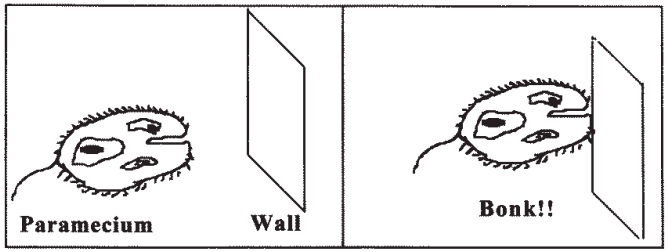


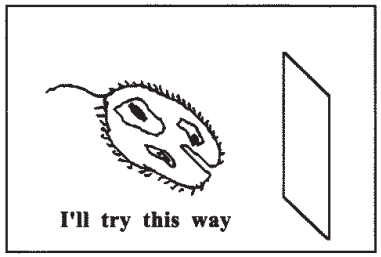
- Has a model of its environment.
- What if two pieces of food are placed nearby?



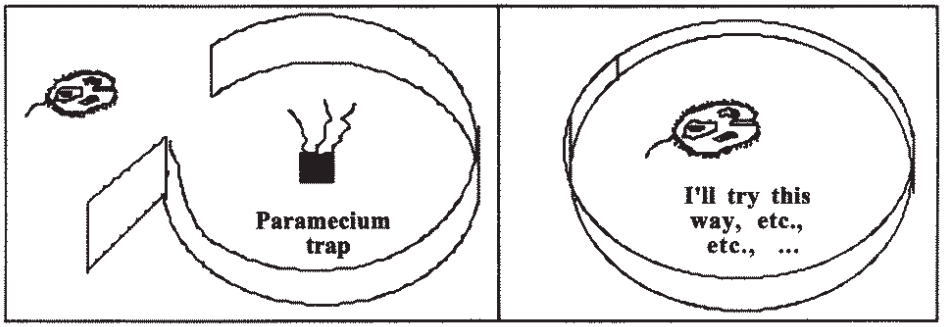
The Intelligent Paramecium?

- Still one celled, but more complex.
- Has a kind of primitive memory.





Intelligence Breakdown



- Doesn’t realize to give up.
- Smarter than the amoeba, but no genius.
- With complexity does come some intelligence.
- There seems to be a continuum of intelligence.

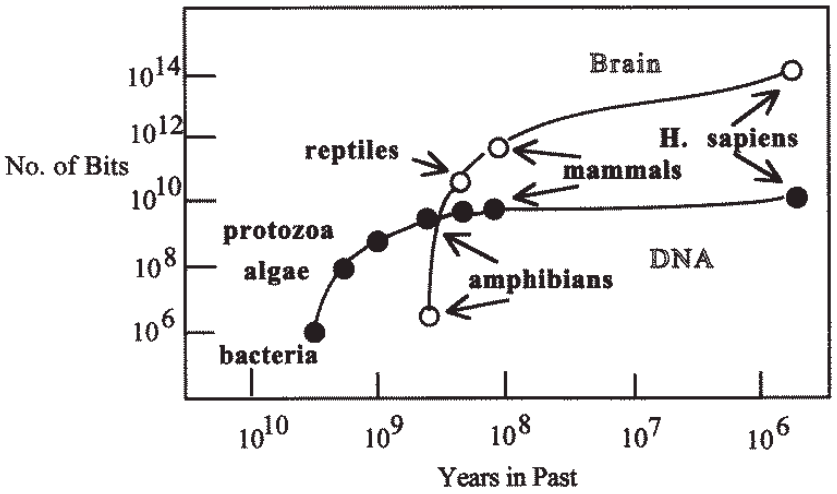
Origin of Human Intelligence

- If we view intelligence as a continuum, then we are not essentially different than other organisms.
- Still need a quantitative measure of intelligence.
- Intelligence could be defined by the amount of information stored in the organism. DNA storage.
- We'll use bits of information
  - Yes = 1
  - No = 0
- Each DNA base has 2 bits of information– 4 options.
- Each codon has 3 bases or 6 bits (3 x 2)
- Humans have (3 x 10^9) bases x 2 bits per base = 6 x 10^9 bits, like 4000, 500 page books.

Spottet Dolphins sounds

http://neptune.atlantis-intl.com/dolphins/sounds.html

Development of Intelligence



Caveats

- Existence of large amount of junk DNA makes it problematic to measure intelligence by number of DNA possibilities
  - Only about 2% of human DNA actually codes proteins, then humans have 1.2 x 10^8 bits, or 800 books
  - For some organism the junk DNA is significant: Newts and lilies would have more than 10^{11} bits.
- Keep in mind that less intelligent organism did not disappear, so there is no trend for organisms to get smarter.
- The diversity of life with time led to some species with intelligence.

Limited Pockets in Genes

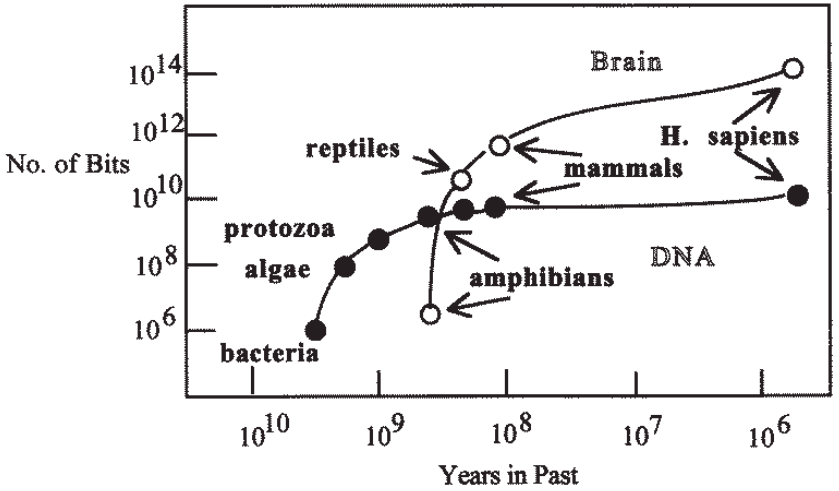
- There are limits to how much info genes can store.
- If you try to store too much info, mutations can wipe you out.
- For eukaryotes, the error rate is about 10^{-9}, limiting the amount of storage to about 10^{10} bits.
- What did life do?
- Evolution devised a new way (extra-genetic) to store information.
- Life developed a nervous system and brains. More bits of storage that are R/W. We can learn!

Info Storage in Brains?

- Information storage in DNA is straightforward, but in the brain?
- There are 10^{11} nerve cells (called neurons) in a human brain, but they do not work in binary form, more analog-based.
- And they are interconnected– a neuron can be connected (with synapses) to 10^3 other neurons.

- An impulse triggers a chain of neurons to "fire" causing a reaction. So, really the information is stored in synapses. $10^{11} \times 10^3 = 10^{14}$ bits

Development of Intelligence



Intelligence

- It seems that intelligence <u>is</u> a desirable trait.
- And we can argue for a rough connection between the rise of complexity and intelligence.
- Increased diversity is the key. With more organisms of all types, a more intelligent species is reasonable.
- Still, the point of the Drake equation is to find civilizations with which to communicate, so we need to think about developing human-like or better, intelligence.

http://www.newenglandfilm.com/news/archives/03march/reviews.htm