Astronomy 330

This class (Lecture 18):
Origin of Intelligence
Tanya Spektor
Kyla Bachtell

Next Class:

Cultural Evolution
Jack Holzman
Steven Kallal

Music: *Aliens Exist* – Blink 182

Extra-Credit?

- The famous amateur astronomer David Levy (ever heard of the Shoemaker-Levy comet?) will be giving a talk on campus tonight.
  - Shakespeare as a Skywatcher: Joining Astronomy with English Literature (Beckman at 7:30pm)
- Go and write a 1-2 page **typed** report that includes:
  1) Summary of the cool ideas
  2) What aspect did you find really interesting?
  3) Relate somehow to class topics.
- Turn in to your class by April 3rd, then you can earn up to 0.5% on your final grade!

Paper Rough Draft

- Worth 2% of your grade, but really worth more.
- Due on or before April 10th!
- Should include most of the details of the final paper.
- Will be looking for scope, ease-of-read, scientific reasoning, **proper citation**, and general style.
- 8 to 10 pages double-spaced 12-point font, not including references.
- ***Mars is a planet without an overzealous monkey population (Holt et al. 2000; James & Mann 2006; Walker 20007).***

HW #6

- Andrew Xie: http://www.freedomofinfo.org/evidence1.html
- Gretchen Bromann: http://www.ufoevidence.org/documents/doc616.htm
- Dave Luedtke: http://www.unexplainable.net/artman/publish/article_2553.shtml

Presentations

- **Tanya Spektor:** Area 51
- **Kyla Bachtell:** Wormholes

Outline

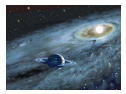
- What is intelligence?
- Development of intelligence.
- Brains. Brains.
- The rise of the primates!

Drake Equation

Frank Drake

That's 2.9 life systems/decade







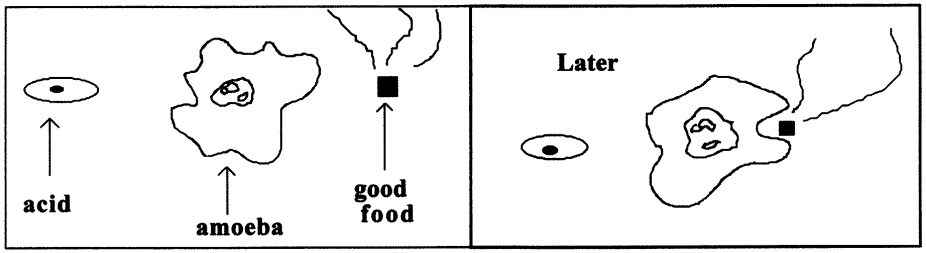

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# of advanced civilizations we can contact in our Galaxy today	Star formation rate	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
	19 stars/ yr	0.4 systems/ star	1.25 x 0.07 = 0.0875 planets/ system	0.44 life/ planet	intel./ life	comm./ intel.	yrs/ comm.

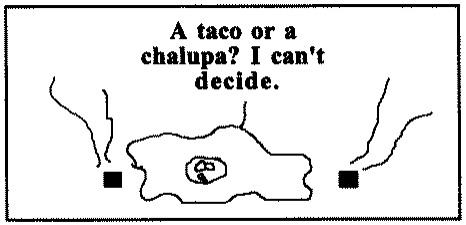
Evolution of Intelligence

- 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?

An Amoeba Distinguishes

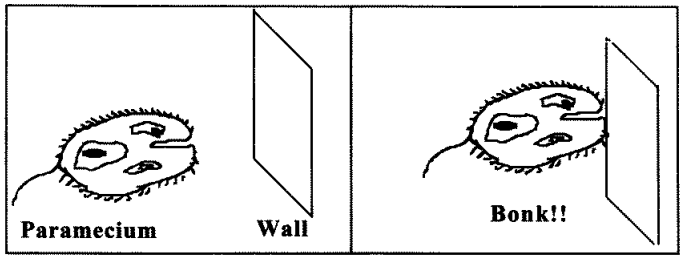


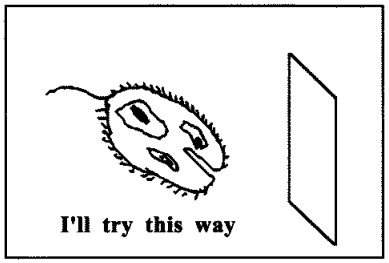
- Has a model of its environment.
- What if two pieces of food are placed nearby?



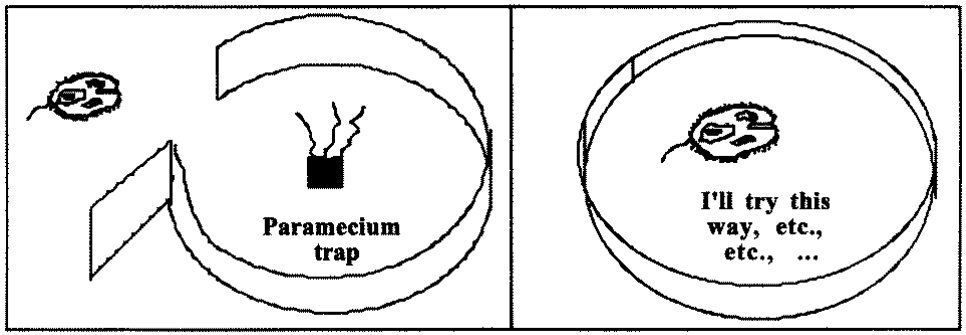
The Intelligent Paramecium?

- 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.

Evolution of Intelligence

- A general definition is "the ability to model the world, including the organism's own self".
- But even single-celled animals seem to be able to do that to some degree.
- Can think of intelligence as a continuum, not a unique aspect of humans.
- Why then, does there seem to be a gap between us and the rest of life on Earth?

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.

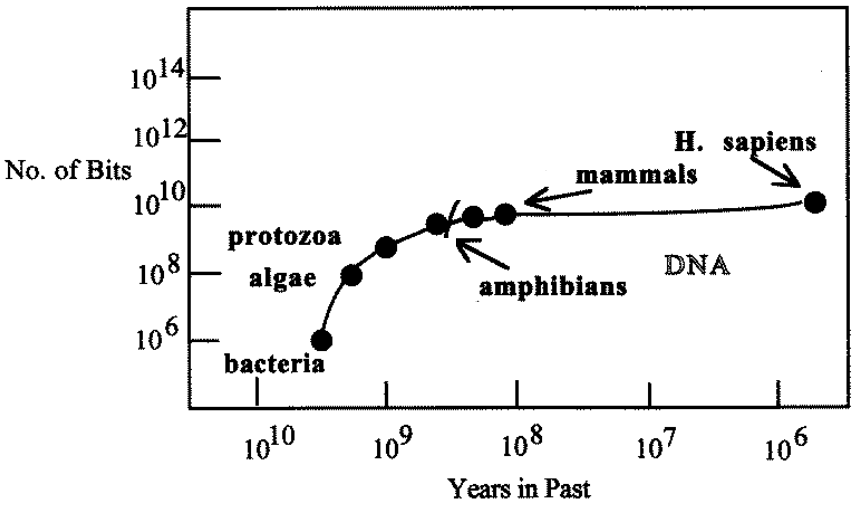
Spottet Dolphins sounds
http://neptune.atlantis-intl.com/dolphins/sounds.html

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 (3×10^9) bases x 2 bits per base = 6×10^9 bits (~750 Mbytes), like 4000 books of 500 pages.

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 seems to actually code proteins, then humans have 1.2×10^8 bits (15 MB), or 800 books
  - For some organism the "junk DNA" is significant: Newts and lilies would have more than 10^{11} bits (12.5 GB).

http://www.eeingeorgia.org/eic/images/landfill.jpg

Caveats

- 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.

http://www.eeingeorgia.org/eic/images/landfill.jpg

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.

Limited Pockets in Genes

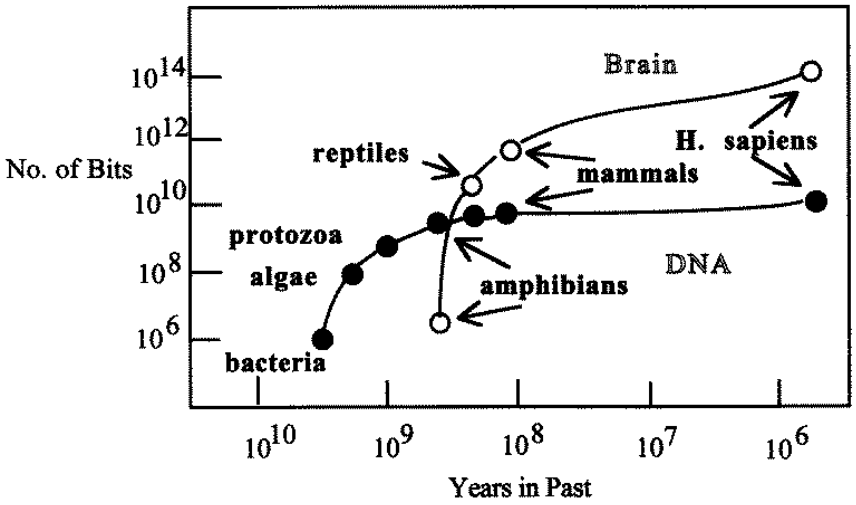
- What did life do?
- Evolution devised a new way (extra-genetic) to store information.
- Life developed a nervous system and brains. More bits of storage that are R/W. We can learn!

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 (12.5 Terabytes)

Development of Intelligence



Intelligence

- It seems that intelligence is 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.

http://www.cartoonstock.com/lowres/shr0945l.jpg

Intelligence

- 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

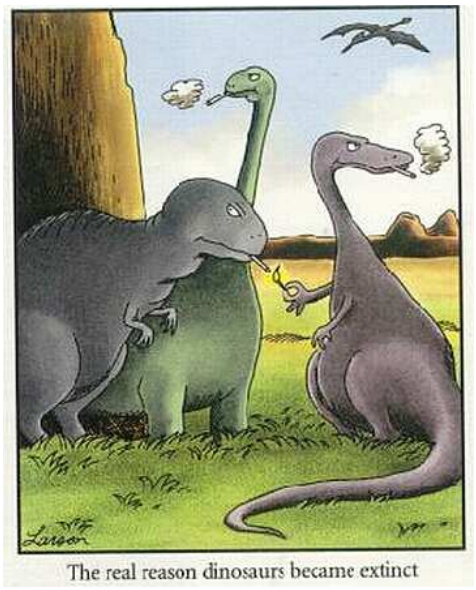
Human-Level Intelligence

- Our species is the only one on Earth to have developed a technological civilization.
- How likely is that to happen on other planets?

Human-Level Intelligence

- Actually the development of humans is still controversial, even among anthropologists. New fossils are appearing that change our understanding.
- Mammals first appeared on the fossil stage about 200 Myrs ago, but were minor players until about 65 Myrs ago.

Less Credible Theories



http://www.boundaryschools.com/fws/snidsmk.htm

Primates

- Main characteristics:
  - Flat fingernails
  - Eyes in front of face
  - No sharp teeth or claws
  - Some have large brain-to-body rations, but most do not.
  - Primarily adapted to life in trees

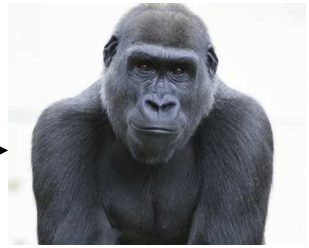
http://saldf.stanford.edu/Projects.htm

Primates

- Basically, with **one** large exception, primates have not been very successful.

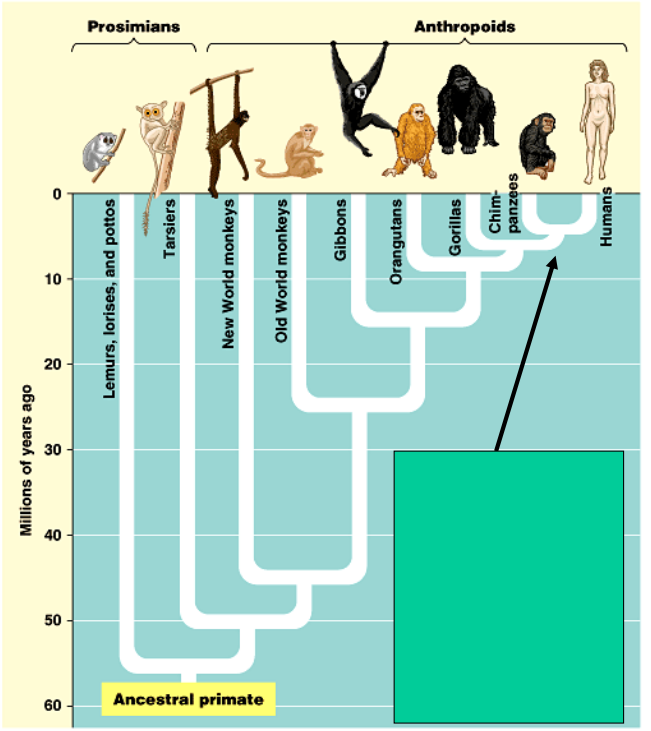
That one

Not that one



Family Tree?

- General trend of adaptation to tree life.
- From toe claws to gripping with large toes or fingers (thumbs).
  - This allowed for tool use.
- From nocturnal to daylight.
- More vision– a rounded face with forward eyes and color vision.
- These mutations were random.



The Last 5 Myrs

Sapiens that had larger brain volume and probably language.

Went extinct 28000 yrs ago.

May or may not be related to us.

Ancestors

- Overall, the evolution leading to H. sapiens was not a smooth and steady path.
- At some points there were 4-6 distinct hominid species living.
- Modern humans emerged from a situation with many variant species adapting to fill different environmental niches.
- Only one path lead to much larger brains, and we do not truly understand what environmental factor favored it.