

Astronomy 330



This class (Lecture 19):
Cultural Evolution

Next Class:
Evolution of World View

Exam 2 is next Thursday!

Music: *Space Oddity* – David Bowie

Apr 2, 2009

Astronomy 330 Spring 2009

Outline



- What is f_i ?
- From intelligence to communication
- Will a civilization develop that has the appropriate **technology** and **worldview**?
- Requires knowledge of quantum mechanics and astronomy.

Exam 2



- Exam 2 is coming up– April 9th!
- Will be similar to Exam 1 (class voted for 40 questions again).
- Cover from last exam up to Thursday's lecture.
- Again, 1 sheet of notes will be allowed.

Drake Equation

Frank Drake



That's 1.4 life systems/decade



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

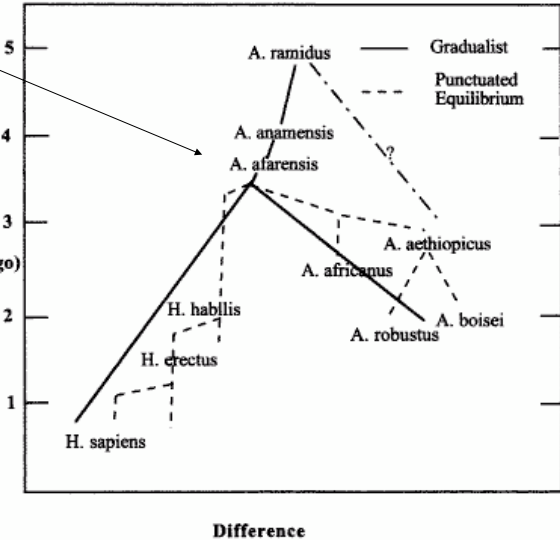
# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that communicate	Lifetime of advanced civilizations
	20 stars/yr	0.12 systems/star	$1.25 \times 0.12 = 0.15$ planets/system	0.4 life/planet	intel./life	comm./intel.	yrs/comm.

Path to Intelligence



- Path to intelligence is not obvious, nor likely to happen the same way twice.
- On this planet it took ~4 billion years.
- Diversity is the key...
- The direct path to hominid evolution is interesting and controversial.

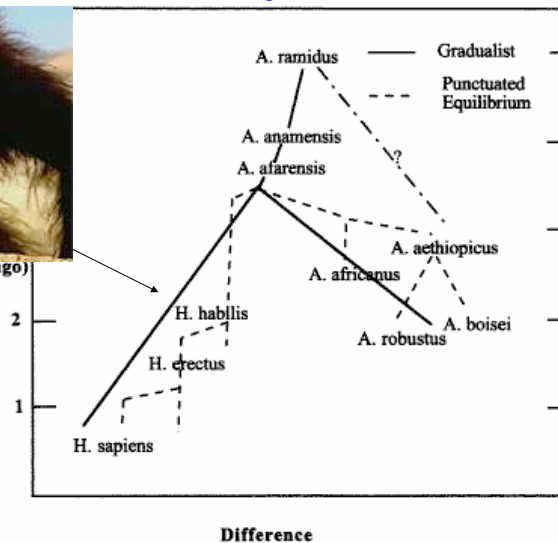
The Last 5 Myrs



The Last 5 Myrs



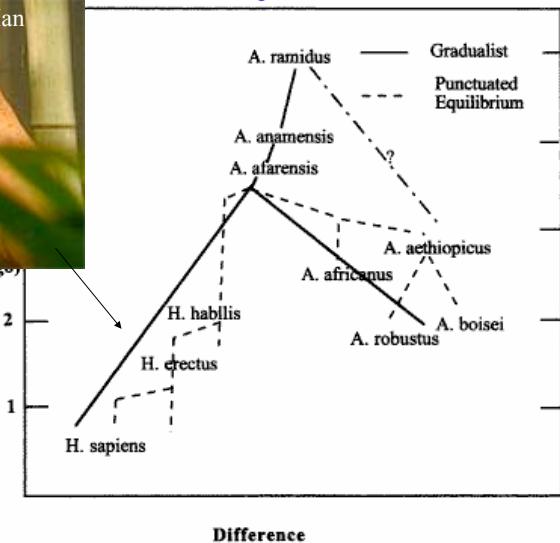
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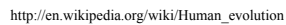
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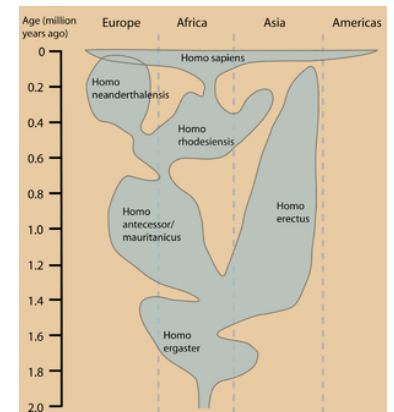
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- At some points there were 4 distinct hominid species living.



- Only one path lead to much larger brains, and we do not truly understand what environmental factor favored it.
- It seems likely that something like this will happen on other planet with enough time.



Question



Overall, the evolution of H. Sapiens was

- a) a smooth and direct path.
- b) simple and inevitable, after the extinction of the dinosaurs
- c) depended only upon the local environment in Africa.
- d) an awkward path of evolution with many surprises.
- e) likely orchestrated by aliens.

f; Considerations



- Complexity leads to intelligence, but complexity seems to require a benign environment. Harsher environments tend to have simpler organisms.
- Perhaps life may exist on harsh planets, but more intelligent life?

f; Considerations



- Remember, human intelligence took 4.5 billion years.
- Systems very near the center of the galaxy are more likely to be hit with supernovae event in that time.
- 4.5 Byrs is about half the age of our Galaxy. Were we fast or slow? Fast: severely limits ETs. Slow: there can be multiple ETs.

f; Considerations

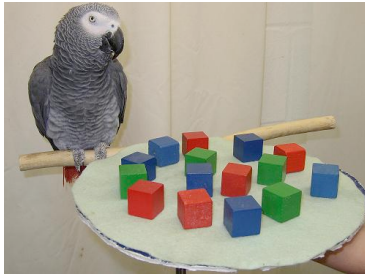


- Intelligent life is a very recent development on Earth with the emergence of the primates, hominids, and H. sapiens.
- Everyone agrees that this particular evolution will not occur on other planets.
- But, will the characteristics of H. sapiens be common to human-like intelligence?
 - Manipulative organs– hands
 - Walking upright?
 - Is tool use and larger brains associated with walking upright?
 - Pair bonding?
 - Human brains quadruple in size after birth compared to other primates which double.

f_i Considerations



- How unique is our intelligence?
- Teaching sign language to chimps and gorillas have shown they are more intelligent than we thought.
- Don't forget Alex the parrot!



Alex (1976 - September 6, 2007)



Dr. Patterson persuades Koko not to smoke. "Kitten hates it, Koko!"

f_i Considerations



- Whales and dolphins are speculated to be of high intelligence, but communicating is difficult.
- With all of this in hand, we are ready to make the next estimate in the Drake equation.
- This term is only intelligent life that can communicate abstract thought to each other, not technological able to communicate.



What is f_i



- What is the fraction of life that forms human or better intelligence in less than about 4.5 billion years?
- If you think that it always does, then $f_i = 100\%$
- If you think that it is a statistical fluke or required supernatural invention then you could use 1/billion or $10^{-7}\%$.
- Anywhere in between is fair game.