

## Astronomy 330



This class (Lecture 20):  
Cultural Evolution  
Kevin Homann

Next Class:  
Worldview  
Margaret Sharp

HW #8 due Thursday

Music: *E.T. – Katie Perry*

## Paper Rough Draft



Mars is a planet with an overzealous monkey population (Holt et al. 2000; James & Mann 2006; Walker 2007; Wikipedia: Mars).

– *I expect to see a few refs per page!*

- Holt, W., Smith, E., Rowe, T., & Jones, A. B. 2000, The Astronomical Almanac for the Year 1994, Vol. 2 (2nd ed.; Washington, DC: GPO)
- Smith, A. B., Thomas, J. R., Major, W., & Peebles, P. J. E. 2006, Astrophysics Journal, 450, 12
- Wikipedia: Mars, <http://en.wikipedia.org/wiki/Mars>, Accessed: March 25, 2011, Updated: March 24, 2010

## Paper Rough Draft



- Worth 1% of your grade, but really worth more.
- **Due on or before April 14<sup>th</sup> (week from Thursday)!**
  - Beginning of class, else considered late.
- Should pretty much be the final paper.
- Will be looking for scope, ease-of-read, scientific reasoning, **proper citation**, and general style.
- 6 to 8 pages double-spaced 12-point font, not including references.

## Presentations



- Kevin Homann  
[The search for extraterrestrial life](#)

# Outline



- Will a civilization develop that has the appropriate **technology** and **worldview**?
- ET needs to think that aliens are out there with which to communicate.

# Drake Equation

Frank Drake



That's 2.8 intelligent systems/century



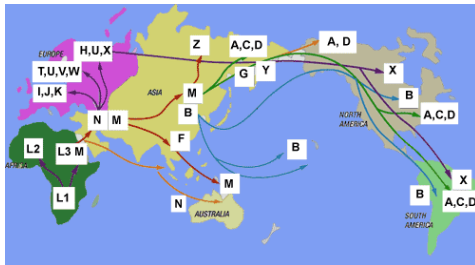
$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# 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
	15 stars/yr	0.65 systems/star	1.3 x 0.1 = 0.13 planets/system	0.125 life/planet	0.175 intel./life	comm./intel.	yrs/comm.

# Backdrop of Civilization



- Origin of modern H. sapiens is disputed, but the genetic and linguistic evidence points toward a spread of humans across Eurasia then the Americas.
- We share a common gene pool, but genetic drifts and selection for local environments created genetic differences among groups.
- These differences have little to do with the concept of race, which has been showed by genetic studies to be a meaningless concept.
- The greatest genetic and linguistic variations are found in Africa, supporting the “out of Africa” idea.



[http://en.wikipedia.org/wiki/File:Migration\\_map4.png](http://en.wikipedia.org/wiki/File:Migration_map4.png)

# Cultural Evolution



- Once humans spread across the globe, the primary method for evolutionary change shifted from biological to cultural evolution.
- Anatomically modern H. sapiens evolved 100,000 yrs ago, but the first modern behavior did not appear until 40,000 yrs ago– e.g. cave painting.
- Regardless, there has not been any significant biological evolution for the last 40,000 yrs– e.g. brain increase.



[http://www.codcottage.freemove.co.uk/images/hand\\_castillo\\_spain.jpg](http://www.codcottage.freemove.co.uk/images/hand_castillo_spain.jpg)

## Cultural Evolution



- The rest is cultural– from hunter-gathers to cell-phone-users.
- Cultural evolution was fast.
- Is cultural evolution needed for ET? Why would a ET culture try to communicate with us?
  - Capability (suitable technology) and interest (worldview?).



## Hunting and Gathering



- Until 10,000 years ago, H. Sapiens functioned completely as hunter-gathers.
- Small nomadic tribes with few possessions.
- Except for shortages, a fair and easy life
  - No midterms/finals
  - Only working about 4 hours a day
  - But, no way to create surpluses or free members for other roles.
  - When things go bad, they really go bad.



[http://www.cnn.com/WORLD/9511/safrica\\_bushmen/](http://www.cnn.com/WORLD/9511/safrica_bushmen/)



## Agriculture



- Tribal societies– 100s of people into villages
- Due to agriculture, larger and larger communities and new societal organizations.
- Began about 10,000 yrs ago, around the dead sea.
  - Mixed hunting with harvesting of wild wheat and barley.
  - Storage, planting, and seed selection.
  - Mutant varieties took over and hunting decreased.
  - 1000 years later, animal domestication.

<http://www.ffa.org/media/comm/index.html>



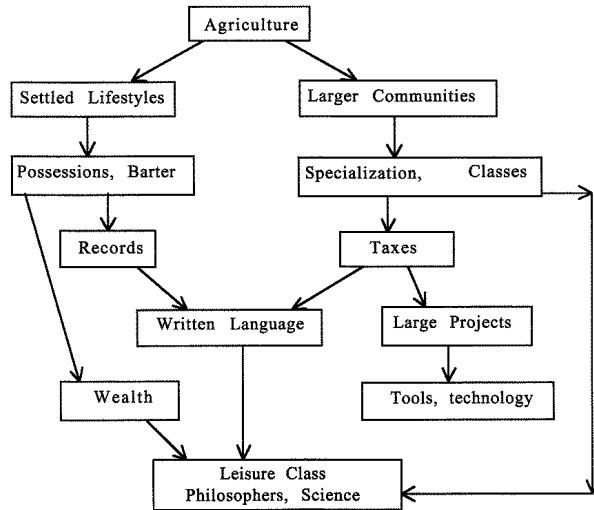
## Agriculture



- Provided long-term settlements for cultural evolution, information, tools, and energy sources.
- At first purely agriculture communities are hard:
  - A lot more work
  - Usually dietary deficiencies

<http://www.ffa.org/media/comm/index.html>

# The Importance of Agriculture



# Question



What cultural break-through eventually allowed for professional scientist, like Astronomy professors?

- a) Telescopes
- b) Religion
- c) The spoken word
- d) Agriculture
- e) Monkeys

# Language and Information



- Limited size for brain, due to birth canal size, so limited bits of info.
- Need to develop **extra-somatic** (outside the body) information storage techniques.
- First method to store information from another person was spoken language.
- Crucial development.



[http://muslimhiphop.com/index.php?p=Popular\\_Alternative\\_Genres/Spoken\\_Word](http://muslimhiphop.com/index.php?p=Popular_Alternative_Genres/Spoken_Word)  
<http://beyonrace.com/articles/news/2228-henry-rolls-to-bring-spoken-word-tour-to-us>  
<http://www.musicikedirt.com/2008/12/05/the-art-of-the-spoken-word-compilation/>

# Language and Dis-Information



- But the origins of language are not well understood– no fossils.
- Probably in hunting parties for large prey.
- The control of the tongue is through the hypoglossal canal (hole) in the skull. In humans it is twice as large as chimps.
- First arose about 400,000 yrs ago in Australopithecines.

Hypoglossal Nerve



<http://members.aol.com/paroleinfo/PRESSURE.HTM>

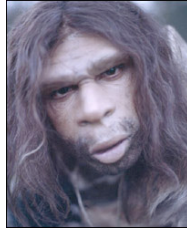
<http://imc.gsm.com/integrated/haonline/haonline/ha/imgs/00000/3000/600/3604.jpg>



# The Language Gene?



- FOXP2 was identified recently.
  - A severe speech and language disorder that affects almost half the members of a large family.
  - They are unable to produce the fine movements with the tongue and lips that are necessary to speak clearly.
- Human FOXP2 differs from chimp FOXP2 by only two amino acids, mouse by only 3, and zebra finch by only 7.
- Recent research shows that Neanderthal version is identical to ours. Maybe speech happened soon after chimp/hominid split?

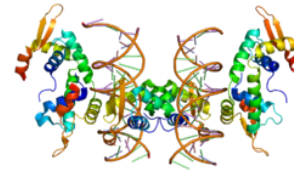


[http://news.bbc.co.uk/1/hi/health/newsid\\_6146000/6146908.stm](http://news.bbc.co.uk/1/hi/health/newsid_6146000/6146908.stm)

# The Language Gene?



- FOXP2 also plays a role in songbirds
- In Zebra Finches a reduced FOXP2 results in incomplete and inaccurate song imitation.



# Writing



- Oral language is clearly limited.
- Development of written language provided a powerful, new source of info storage.
- Earliest appearance was in Sumer– present day Iraq (8500 BCE).



MS 3008  
Account of commodities, Sumer, ca. 3200 BC.  
The earliest continuous writing known

<http://www.nb.no/baser/schoyen/4/4.4/441.html>

# Writing: The Beginning of History



- Probably started from economic need– barter or receipts.
- Common by 3000 BCE.
- Written records of taxes and a ruling class– the rise of civilization.
- Move from symbols to syllabic language developed by 1500 BCE.



MS 3008  
Account of commodities, Sumer, ca. 3200 BC.  
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<http://www.nb.no/baser/schoyen/4/4.4/441.html>

## Question



Language and writing are examples of

- a) culture.
- b) the FOXP2 gene.
- c) extra-somatic storage.
- d) how daddy went to jail.
- e) early government.

## Extrasomatic Storage Leaps



- Printing press (1456) – number of books jumped from 10,000 to 10 million in 50 yrs.
- Telegraph (1844)
- Radio (1895)
- Television (1936)
- Computers (1950s)
- Internet (1970s)
  - Huge extrasomatic storage: Well above brain storage



Does all of this increase the “intelligence” of our species?

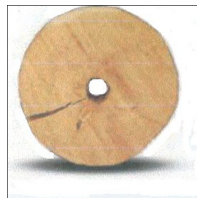


## From Rocks to Metal



- Stone tools (silicates) started with *H. habilis* about 2 Myrs ago.
- Agriculture developed at the end of the stone age.
- First pottery (still silicates) around 7000 BCE.
- First metal (copper) in 6500 BCE, mostly ornamentation.
- The wheel was invented in 6500 BCE.

<http://www.angelfire.com/country/veneti/images/OldestWheel.jpg>

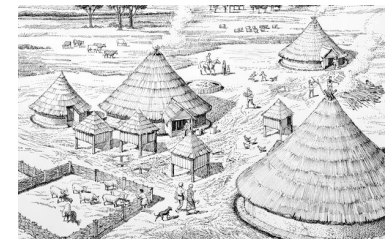


## From Rocks to Metal



- Copper tools in 4000 BCE.
- Animal drawn vehicles & sailboats in 3300 BCE.
- Bronze (copper and tin) tools in 2800-1000 BCE (the Bronze age).
- Iron first showed up in 1500 BCE.

[http://www.museumoflondon.org.uk/MOLsite/learning/who\\_are\\_you/teachers/images/citizenship/iron\\_age\\_settlement\\_no192.jpg](http://www.museumoflondon.org.uk/MOLsite/learning/who_are_you/teachers/images/citizenship/iron_age_settlement_no192.jpg)



## From Rocks, to Metal, to Rocks

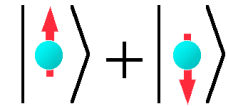
- Next real step was developing energy sources.
- The industrial revolution.
- Modern technology based on electronics, crucial to our ability to communicate with ET.



<http://www.learnhistory.org.uk/cpp/industrial-revolution-children-labor.jpg>

## From Rocks, to Metal, to Rocks

- Transistor in 1948.
- Microchip in 1959.
- We went back to rocks— silicon!  
We are arguably in the “silicon age”.
- This implies knowledge of electromagnetisms and quantum mechanics.



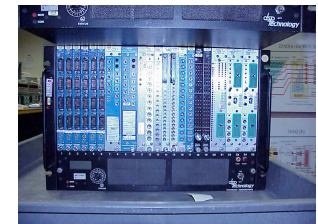
## Question

Which of the following is **not** an example of an extrasomatic storage technique?

- a) Brain synapses
- b) Wikipedia
- c) Printing press
- d) Language
- e) None of the above.

## Cultural Evolution

- What do we mean by cultural evolution?
- Is that like evolution's natural selection?
- Since technology has developed out of it, we can conclude that technology was a desirable trait that is likely to develop on any planet with competition between cultures.



## Cultural Evolution



- Or can we?
- If so, then would have to say that cultural evolution follows a punctuated equilibrium model.
- Or, episodic progress with long periods of dark ages.
- Like species, the fate of civilizations has been extinction, but their technology was adopted by others (cultural diffusion).

## Evolution?



- The main point is how likely is it that technological civilizations exist on other planets?
- Hard to determine from Earth data, but there are some points:
  - Agriculture arose independently in Mexico and probably China, Andes (potatoes), and eastern US (sunflowers).
  - Written language independently in Sumer, China, and the Americas, maybe India and Egypt.
  - But, the wheel was not invented outside of Sumer– were examples of toys in South Americas
  - For recent developments, the world was in too much contact to distinguish.

## Questions: Variations of Civilization



- What if the Americas had invented gunpowder?
- What if the Americas had large animals of burden?
- What if the germs of Europe were less dangerous than the germs of the Americas?
- Similar examples of cultural devastation in the Pacific Islands.
- Often cultures are wiped out from *Guns, Germs, and Steel* (by Jared Diamond)– manifestations of geography.

## Technology Development



- Our sample of one makes it difficult to determine if technological development (to communication ability) is a fundamental step from intelligence.
- Does it depend on the planet– water/desert dominated?
- How would metal poor planets develop?
- Does the competition of civilizations matter?
- Is there a dependence on psychology of the intelligence life?

## Technology

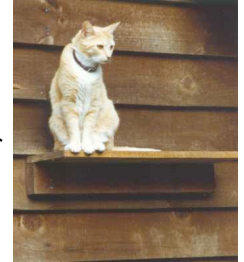


- Cultural evolution was fast.
- Especially after agriculture freed civilizations.
- Development of language.
- Increase of extra-somatic storage.
- We're living in a silicon age.
- Does the development of technology also include a correct worldview?

## Next Step



- Besides needing technology, intelligent life must have a **want** to communicate with extraterrestrial life.
- That means that it **MUST** believe in the possibility of other life.
- Requires civilization to undergo three steps:
  1. A correct appreciation of the size and nature of the Universe
  2. A realization of their place in the Universe
  3. A belief that the odds for life are reasonable. The beings of Q'earth must have taken their Q'astro 330 class and came up with a good number of communicable civilizations in the Q'drake equation.



<http://www.bybeeweb.com/cats/amelia-step.jpg>

## Big Questions



- Our capacity for interstellar communication arose at the same time as our interest in it. Coincidence?
- Can a society have a highly developed technology with an incorrect astronomy?
- What if the skies were constantly cloudy?
- What if their solar system had no other planets?
- What if they lived in a molecular cloud?
- What if they lived in a huge cluster of galaxies?

## Copernican Revolutions



1. We are not the center of the Solar System.
2. We are not the center of the Galaxy.
3. We are not the center of the Universe.



## Our First View



- The first concepts of the Universe were Earth-centered.
- How did we come to this point– Astro 330?
- First recorded cosmology was from the Babylonians.
  - The Universe is a large oyster, and we are inside.
  - But other aspects of their astronomy was advanced.
  - Regularity of astronomy for crop planting, harvesting, and accurate calendars back to the 3800 BC.



<http://www.internationalenglish.co.uk/courses.htm>

## Our First View



- The Mayans computed the length of year to within a few seconds (0.001%).
- So early humans had a weird mixture of precise calendar astronomy with primitive concept of the Universe and mythological systems incorporating magic.



<http://www.mayasites.com/equinox.html>



<http://ephemeris.com/history/mayan-calendar.jpg>

## Greek Astronomy



- Greeks were excellent Astronomers
  - Cataloged star positions & brightness.
  - Systematic, quantitative observations.
  - Natural philosophers.
- They observed that the stars, Sun, and planets revolved around the Earth.
- So Earth is center of Universe- **geocentric cosmology** (mostly from Plato and Aristotle).
- Even though other philosophers (Aristarchus) argued for a heliocentric cosmology.



## Power of Ignorance



- Geocentric model was absorbed by Christianity.
- If Geocentric, then of course no ET life.
- St. Augustine (420 AD) incorporated Neo-Platonism. He listed science as a temptation to avoid: “a mere itch to experience and find out”
- Also said, “Nor do I care to know the course of the stars.”



[http://www.fholocaustmuseum.org/history\\_wing/assets/room1/St\\_Augustine.jpg](http://www.fholocaustmuseum.org/history_wing/assets/room1/St_Augustine.jpg)



## Power of Ignorance



- The European worldview degenerated for years.
- No one in Europe mentioned the supernova of 1054 (Crab Nebula), unlike China or Americas. People were afraid to notice it and be described as a heretic.
- Could an ET civilization reach technology with that sort of attitude?

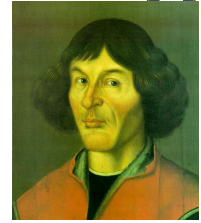
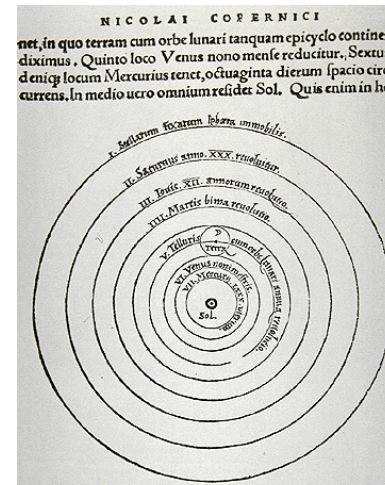
<http://www.pbs.org/deepspace/timeline/t114.html>



<http://www.godandscience.org/images/crabnebula.jpg>

<http://www.tulane.edu/~dannysouthwest.html>

## Copernicus (1540) resurrected the heliocentric model



- If Earth moves, then stars have to be very far away.
- Was rejected on theological and philosophical grounds.
- 1616, the Catholic Church listed it as heresy.



## Giordano Bruno



- Took this one step further.
- Thought that the stars were all little Suns.
- Possibly with planets of their own.
- Maybe life on those other planets.
- Maybe more advanced than those on Earth.



## Giordano Bruno



- These are some of the reasons why he was tortured then burned at the stake around 1600.
- One of his crimes of heresy: "Claiming the existence of a plurality of worlds and their eternity."
- He became a martyr for free-thought in the 19<sup>th</sup> century.



## Copernicus (1540) Heliocentric Model



BUT, keep in mind that the geocentric model was still valid. Both models explained the observed motion.

Heliocentric is NOT obvious!

IT was determined a philosophical argument for 50 years! New observations from Galileo finished the argument,

