AST 309L Fall 2008: Scalo

Review sheet for fifth (and last) exam

Outline of topics and readings; suggested
end-of-chapter questions; sample exam questions.

TOPIC 1. Convergence of intelligence

Textbook sec. 6.5 Human evolution.

The primary thing to look for are the most important developments that the authors list, and that I listed in lecture, that may have led to the development of our kind(s) of intelligence.

You should know roughly how long ago the following occurred: modern humans; hominids; great apes; prosimians. What is the characteristic most associated with Homo habilis? Homo erectus?

12.2 Intelligence

Convergence or string of fluky events? That is the (main) question. You should be able to argue it either way.

---> Material already completed in lecture. In addition to the material in the book (mostly encephalization quotient trends), we discussed the genome-perspective on convergence of intelligence. Since this is not in the text, a two-page summary will be made available as a handout (and online).

TOPIC 2. SETI searches

Textbook 12.3 Searching for intelligence, pp. 410-425. (SETI)

You should be familiar with: Search strategies, proposed encoding and signaling techniques, bandwidth, "magic frequencies," ongoing SETI programs. SETI programs past and present: You should know something about Ozma, Ohio State "wow signal," Phoenix, SERENDIP, SETI@home, Allen Telescope Array, and optical SETI in general (but no specific programs). You don't need to know any numbers related to these programs.

---> We will finish this up at beginning of Tuesday's lecture.

A full pdf of the lecture material on SETI is available at the course website (put there Monday). Note that there is much overlap with the textbook, but some extras too. An example is the discussion of "interference" or "noise" which is not in the textbook; and remember that I

NOT ON EXAM: 12.4 (UFOs) read on your own if interested--too difficult to include on an exam. I suggest you at least skim to understand the authors' general opinion or conclusion.

TOPIC 3. Interstellar travel and the Fermi paradox

Textbook 13.1, 13.2, 13.3; pp. 438-466.

(Lots of pages, but only need basic ideas and conclusions)

---> I will try to cram much of this into the last 2/3 of Tuesday's lecture.

13.1 (Why interstellar travel is so difficult) 438-444
13.2 (Designing interstellar spacecraft) 444-455
13.3 (The Fermi Paradox) 456-466.
OMIT sec. 13.4.

A few terms you should know: possible fuel sources—chemical, fission, fusion, matter-antimatter; Project Orion, Project Daedalus, Von Neuman probe, Bracewell probe; Bussard ramjet, laser sail design, mass-to-fuel ratio, Fermi paradox, Galactic colonization, the coral model, …

You don't have to know any past space mission names, like Pioneers or Voyagers.

I will not ask you to reproduce any of the calculations presented in this chapter; in particular, don't worry about using "the rocket equation." However you *should* know the meaning and significance of the "mass ratio;" a simple question on this is given below.

When prepared, you should be able to answer (quickly, in a reply that anyone could understand) questions like: What is the relation between the Fermi paradox and interstellar travel? You will have to clearly explain the "Fermi paradox" first.

Not on the exam: the "Epilogue," which is a summary of prospects for life in our Galaxy, and a discussion of the implications of extraterrestrial life and intelligence on human perspectives and on the nature of human life in general. However I do suggest you read it if you are interested in a broad perspective on the topics we have covered.

Roughly half the questions on the exam will be about SETI, the rest split between intelligence and interstellar travel, plus a few on the Fermi paradox.

End of chapter questions:
Ch.6. RQ 18, 19, 21; Would you believe it? 31; Short Answer 45.
Ch.12 RQ 2, 3, 6, 9, 10; QQ 28-32.
Ch.13 RQ 6, 7, 8, 10-16; QQ 13, 37, 38.

Some sample questions:
1. The most rapid major evolutionary change in the history of the Earth was probably
a. branching of the different hominids. b. cultural evolution.
c. the Cambrian explosion. d. the transition following "Snowball Earth."

The last time I used this question, a remarkably small 14% of the class got it correct. Yet it has such an obvious answer that I think it is an example of the kinds of questions that have given many students problems. Just stop and think about it for a minute, don't simply react.

2. According to biochemical differences and fossil evidence the family hominidae (i.e. the hominids, which includes the Australophithicus and Homo lines) and the apes probably split off from a common ancestor about
a. 1 Myr ago. **b**. 6 Myr ago. c. 20 Myr ago. d. 100 Myr ago.
[Look in your textbook.]

3. One result that might indicate contingency of intelligence (i.e. not convergence) is
a. Similarity of memorization and categorization strategies in very different human cultures, but not in other animals.
b. There is evidence for human-specific mutations in genes that code for traits (like brain size) related to intelligence.
c. Among animals, intelligence, such as elementary mathematical ability, only developed once on Earth (humans).
[This might require that you attended class in order to clearly eliminate one of these choices.]

4. Which of the following is probably true about the encephalization quotient "EQ"?
a. It correlates well with IQ scores in humans.
b. The highest individual EQs are actually found among crows.
c. A few million years ago dolphin EQs were larger than any primate EQ.
d. EQ correlates with brain folding, metabolic rate, and measures of socialization, suggesting that this single number might capture several important factors involved in intelligence.

5. Which effect most limits our ability to detect ETI signals at very small frequencies (large wavelengths)?
a. receiver (or quantum) noise
b. radiation from supernova remnants throughout our galaxy ("galactic noise")
c. absorption by interstellar dust grains
d. the cosmic microwave background radiation

6. Observed from a distant star, leakage radiation from the earth would display a regular pattern because
a until recently, most television stations were in operation only a small fraction of the time.
b. television transmissions occur only in a certain range of frequencies.
c. the earth rotates on its axis.
d. the Doppler effect would reflect the earth's revolution around the sun.
[We spent a quarter of a lecture going over leakage radiation.]

7. The Lagrange points might be a good place to search for alien artifacts because
a. they would require the challenge of traveling to the outer solar system to find them.
b. they would require the challenge of traveling to our Moon.
c. we know exactly where they are.
d. their position in the sky does not change with time.
[Try the book if you don't know the answer.]

8. A disadvantage of a targeted SETI search, compared to a sky survey, is that it would
a. not have time to detect more complex signals
b. be less capable of detecting short-duration signals.
c. be less capable of detecting long-duration signals.
d. miss nearly all of the potential stars that might be broadcasting signals.
[This is a particularly easy question if you understand this material.]

9. Of the following, which is the most efficient fuel reaction (i.e. converts the largest fraction of the fuel mass into energy)?
a. chemically burning hydrogen and oxygen together.
b. nuclear fission
c. combining matter and anti-matter
d. nuclear fusion

10. A major difficulty with the Bussard ramjet could be overcome if
a. the density of hydrogen gas along the travel route was much larger than average.
b. some way could be found to accelerate the ship during the initial stage.
c. the technology to build magnetic shielding were available.
d. a technique could be found for containing matter and antimatter.

11. A major problem with laser sail proposals for travel between the stars is:
a. The shielding of the sails from interstellar particles requires excessive mass for the sail..
b. The ship could not slow down unless there was a laser already in place at the destination.
c. Even in principal (e.g. with a perfect, infinitely powerful laser), this method could not attain a significant fraction of the speed of light because the light intensity decreases with distance.
d. The fuel that the laser would have to ignite is far too massive.

12. Why can't an explanation like "Maybe aliens are just not interested in colonization of the Galaxy" explain the Fermi paradox?
a. It overlooks the problem with energy requirements for star travel.
b. It neglects the possibility of self-reproducing machines used as space probes.
c. It would have to apply universally to a very large number of civilizations.
d. If they weren’t interested in colonization, how could they be considered intelligent?