Science & Science Fiction

Major Question 4:
Are we alone in the universe?

Today…

Final remarks about sentient machines;

Conditions necessary for intelligent life

- **Quiz 4 today**
  - **Ch. 4 + lectures on Artificial Intelligence**
  - **Given on Canvas, 50 points possible**
- **Exploration Paper 4 due Friday, Nov. 10**
  - **Topics on Extraterrestrial Intelligence**
  - **Details on Canvas**

Announcements for Monday, November 6

- Quiz 5 next Monday, November 13
  - Ch. 5 + lectures this week
  - Given on Canvas, 25 points possible

Next week…

Deep Learning
(“bottom-up” approach)

Simulated neural networks

Learns from many examples

Last time…
Two general approaches to Machine Learning

Bayesian Method
(“top-down” approach)

Formulate hypothesis; make prediction

Revise hypothesis; minimize prediction error

Learns quickly from few examples

Two general approaches to Machine Learning

Chappie

Directed by Neill Blomkamp

Columbia Pictures (2015)

Machine Learning

If machines do become conscious, could they be trained to work as gangsters?

If robots become conscious, how should we behave toward them?

Moral and ethical implications…

Bicentennial Man

Directed by Chris Columbus

Columbia Pictures (1999)

If machines do become conscious, will there be moral implications for our behavior toward them?

Could robot abuse lead to a robot rebellion?

Visit YouTube:

"Atlas The Next Generation Robot – harassed with hockey stick!"

https://www.youtube.com/watch?v=E0Rc9CzVRuQ

Moral and ethical implications…

Geoffrey Hinton speaks on *60 Minutes* about AI

Visit YouTube:

"Godfather of AI" Geoffrey Hinton: The 60 Minutes Interview"

https://www.youtube.com/watch?v=qrvK_KuIeJk

The future of AI?

Two possibilities for an answer…

A. Solve the problem of consciousness (which hasn't been done yet)

B. Hope (or fear) that consciousness might be an emergent property of sufficiently complex systems.

Closing remarks on Major Question 3: Can a machine become self-aware?

Are we alone in the universe?

(The search for extraterrestrial intelligence)

- Chapter 5 in the text
- Lecture material this week

Today…
Major Question 4

Some related questions…

- **Who** wants to know and is willing to provide funding?
  - Government agency?
  - Private initiative?

Q4: Are we alone in the universe?
(the search for extraterrestrial intelligence)

Some related questions…

- **What should we look for?**
  - **Life as we know it?**
  - **Something completely different?**

Q4: Are we alone in the universe?
(the search for extraterrestrial intelligence)

Some related questions…

- **Where** should we look?
  - Finding planets in other star systems
  - Conditions necessary for life

Q4: Are we alone in the universe?
(the search for extraterrestrial intelligence)

Some related questions…

- **How should we go about the search?**
  - Human spaceflight or robotic probes
  - Stay home and listen (radio signals)
  - Wait for *them* to come and visit us

Q4: Are we alone in the universe?
(the search for extraterrestrial intelligence)

Some related questions…

- **When** did the systematic search begin?
  - How long have we been searching?
  - Have we found anything yet?

Q4: Are we alone in the universe?
(the search for extraterrestrial intelligence)

- **How do we decide what to look for?**
  - **Why do we only search for life *as we know it*?**
  - **What conditions are necessary for life *as we know it* to exist?**
- **How do we begin the search?**

Systematically searching for signs of extraterrestrial intelligence…

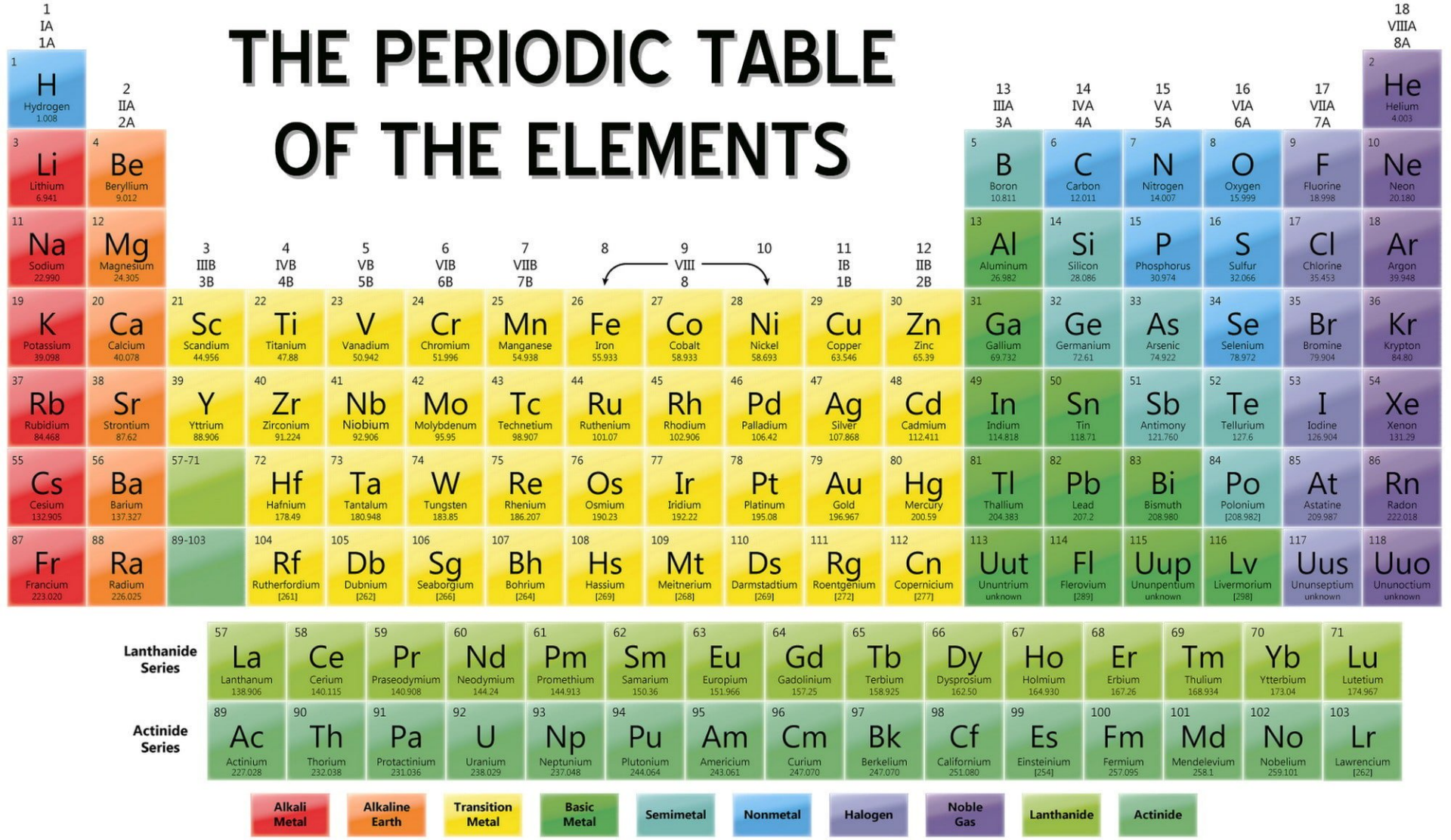
Star Trek (original series)
"The Devil in the Dark"

Written by Joseph Pevney

Paramount (1967)

(total run time approximately 0:10:26)

The search for extraterrestrial intelligence…
Why only look for life *as we know it*?



Why not life based on Silicon instead of Carbon?

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- Silicon has **same crystal structure** as one of the forms of Carbon
  - Solid Silicon is “diamond cubic”
- How does SiO_2 compare to CO_2?
  - CO_2 is a **gas** at room temperature
  - SiO_2 is **solid** at room temperature

Why only search for life *as we know it*?
Why not life based on Silicon instead of Carbon?

Alien

Directed by Ridley Scott

20th Century Fox (1979)

Images in *Alien* (1979) inspired by *Star Trek* episode: “The Devil in the Dark” (1967)

- Questions raised in *Alien*…
  - Who should be in charge, government or private industry?
  - What should we look (or listen) for?
  - How do we go about searching?
    - Go “out there” and explore
    - Broadcast our presence from home
    - Stay home and look or listen

Systematically searching for signs of extraterrestrial intelligence…

- **How many privately-funded space agencies existed in 1979?**
  - **Zero!**
- **How many exist today?**
  - ***Space-X*** **(Elon Musk)**
  - ***Blue Origin*** **(Jeff Bezos)**
  - ***Virgin Galactic*** **(Sir Richard Branson)**
  - ***Starliner*** **(Boeing)**

Space exploration:
Government agency or private industry?

Predicted number of radio-communicating civilizations in the galaxy:

$$N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

R^* = rate of star formation in the galaxy
f_p = fraction of stars with planets
n_e = number of Earth-type planets per star
f_l = fraction of planets capable of supporting life
f_i = fraction of habitable planets with intelligent life
f_c = fraction of intelligent civilizations w/ radio com.
L = lifetime of typical radio-communicating species

Systematically searching for signs of extraterrestrial intelligence…
The Drake Equation and the SETI Project (1960)

Drake Equation

$$N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

Assumptions made (1960) to justify the SETI Project:

R^* = rate of star formation in the galaxy = 10 per year
f_p = fraction of stars with planets (<1)
n_e = number of Earth-type planets per star (>1)
f_l = fract'n of planets capable of supporting life (=1)
f_i = fract'n of habitable planets w/ intelligent life (=1)
f_c = fract'n of intelligent civ. w/ radio com. (=1)
L = lifetime of radio-communicating species (= 10^4 y)

Systematically searching for signs of extraterrestrial intelligence…
The Drake Equation and the SETI Project (1960)

Three standard methods plus one brand new one:

1. **Transit method** (periodic dips in light intensity)
2. **Doppler spectroscopy** (red-shift or blue-shift in wavelengths of light, due to motion of star)
3. **Wobble method** (shift in position in the sky)
4. **Direct photography** (image of actual planet)

Next time…
Finding planets in other star systems