

# ***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\\_KuleJk](https://www.youtube.com/watch?v=qrvK_KuleJk)**

**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*?**

# THE PERIODIC TABLE OF THE ELEMENTS

<h1>THE PERIODIC TABLE OF THE ELEMENTS</h1>																							
1 1A 1A H Hydrogen 1.008																	18 VIII 8A He Helium 4.003						
3 Li Lithium 6.941	2 IIA 2A Be Beryllium 9.012																	13 IIIA 3A B Boron 10.811	14 IVA 4A C Carbon 12.011	15 VA 5A N Nitrogen 14.007	16 VIA 6A O Oxygen 15.999	17 VIIA 7A F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B Sc Scandium 44.956	4 IVB 4B Ti Titanium 47.88	5 VB 5B V Vanadium 50.942	6 VIB 6B Cr Chromium 51.996	7 VIIB 7B Mn Manganese 54.938	8 VIII 8 Fe Iron 55.933	9 VIII 8 Co Cobalt 58.933	10 VIII 8 Ni Nickel 58.693	11 IB 1B Cu Copper 63.546	12 IIB 2B Zn Zinc 65.39	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948						
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.80						
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29						
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018						
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown						
		57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967							
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]							
		Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide												

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  $\text{SiO}_2$  compare to  $\text{CO}_2$ ?
  - $\text{CO}_2$  is a **gas** at room temperature
  - $\text{SiO}_2$  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  
20<sup>th</sup> 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:**

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

**$R^*$  = 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