Assigned 2 February 2021 Due 11:00am Eastern Time, 4 February 2021

COMPSCI 390A: Homework 1

Instructions. You may discuss this assignment with other students. However, you must write your answers independently. You may use the internet to look up material, but do not search for answers to the questions directly. You are encouraged to begin by reading all of the questions.

Submit your answers in one .pdf file using Gradescope. Make sure to tag each page corresponding to the question it is answering. Note that you do not need to tag the page the question is on. If you are not currently added to the course COMPSCI 390A on Gradescope, send an email to Cooper (csigrist@umass.edu) or Scott (sjordan@cs.umass.edu) asking to be added to the course. In the email, make sure to include the email that you use to log in to Moodle. Additionally, you should add your student ID to your Gradescope profile so we can correctly transfer your grades from Gradescope.

1. **[50 Points]** Our intelligence is the result of at least two forms of computation: evolution to create the brain, and subsequently learning to allow the brain to adapt to the environment based on its experiences. We live in an interesting time – a time when the computational power of computers is surpassing the computation power of the human brain. The computational power of the human brain has been estimated to be around 10^{13}–10^{17} *floating point operations per second* (FLOPS or flop/s) while the supercomputer *Fugaku* has roughly 44^{17} FLOPS.[1] While this gives some hope that we may see *artificial general intelligence* (AGI) soon, it is worth thinking through these computational arguments in more detail.

   Specifically, this comparison focuses on the computation needed to simulate the brain, which excludes the computational work performed by evolution to create the brain. One might argue that intelligence is primarily a result of learning after birth, not evolution, and so the computational work of evolution can be ignored. However, this is clearly false, with nature providing many examples of animals with exceptional levels of intelligence shortly after birth. For example, wildebeests can identify and follow their mother shortly after birth[1] and iguanas can flee from snakes shortly after hatching.[2] Hence, evolution is responsible for a significant amount of intelligence.

   To complete the comparison of the computational power used by nature to create your brain in its current state to the computational power of modern computers, estimate the amount of computational power used by evolution. You may create your own units to perform this comparison (e.g., the number of simulated cell-seconds). Try to make your estimate as accurate as possible, but we of course expect error in these computations.

   Write 500–1000 words describing your unit of measurement, your computation of the computational power of biological evolution, and the final number that you find. You are free to set the scope of this assessment. For example, it is up to you whether you will include the possibility of evolution running and failing to produce intelligent animals many times (on other worlds) before it succeeds on Earth in the estimate of how much computation was used to create your genome.

2. **[25 Points]** Write 250–500 words explaining why your answer to Question 1 suggests that AGI may be difficult to create within the next century (describe how you extrapolate the increase in the power of computers over time, and how you relate your unit of computation in Question 1 to the computational power of computers).

3. **[25 Points]** Write 250–500 words explaining why your answer to Question 1 is compatible with the view that AGI may be likely within the next 20 years.