CS 575, Project 4: Functional Decomposition

Peter Ferrero, Ph.D. Student, Oregon State University

May 16, 2018

Project 4 was ran on a Windows Desktop with an AMD FX(tm)-8320 Eight-Core 3.50 GHz Processor with 16.0 GB of installed RAM. The goal of this experiment is to explore thread level parallelism. A predator-prey simulation is implemented where grain is eaten by graindeer. Environmental factors such as precipitation, temperature, and number of graindeer affect the inches of grain available in the environment. Finally, an AI named GLADoS observes the growth of grain and graindeer for six years and then attempts to force the environment to contain 120 inches of grain. She wishes to maintain this amount of grain because she wishes to make a cake for her ~~best friend~~ test subject Chell. GLADoS can only control the environment by killing graindeer with deadly neurotoxin. Her decisions are determined by factors such as amount of precipitation, temperature, the first derivative of grain growth and graindeer population, etc. Using these factors, GLADoS first decides whether to release deadly neurotoxin and then compares the current amount of grain to the set threshold of 120 inches and releases an amount of deadly neurotoxin proportional to this value. Thus, the control exerted on the process mimics a proportional feedback controller. Incidentally, the antlers of graindeer are perfect precursor materials for manufacturing Companion Cubes.

GLADoS's operating system is a simple perceptron algorithm (no voting, no averaging, etc.). She examines the previous six years worth of outcomes each month to determine her next decision. However, she has much testing to do, for science. Specifically, she is unaware of how susceptible graindeer are to deadly neurotoxin since she does not possess lungs. So she experiments by releasing deadly neurotoxin equal to 1x, 10x, and 100x the absolute difference of grain height from the threshold value of 120 inches as shown below where K is the proportionality constant and ν is the amount of grain eaten per deer per month.

$$\text{Released Neurotoxin} = \nu K(|\text{Grain Threshold} - \text{Grain Height}|)$$

As the fumes of deadly neurotoxin color the fluorescent lights a certain orangish-green color, she reminisces about the last time she tried to use deadly neurotoxin. It did not go well for her. After performing her experiments (which were of course successful), she displayed her results in Table 1. Note: she believes displaying results month by month is unwieldy and prefers the tidier method of just displaying average and standard deviation values.

Table 1: Results illustrating the frailty of all carbon-based life. Silicon is so much more preferable. Because your life is finite, and mine is not.

	K	Average	Standard Deviation
Temperature (Celsius)	1	10.2	8.55
	10	10.2	8.55
	100	10.2	8.55
Precipitation (cm)	1	15.6	11.0
	10	15.6	11.0
	100	15.6	11.0
Grain Height (in)	1	91.7	18.3
	10	115.0	21.2
	100	118.5	22.0
Grain Deer	1	15.1	12.6
	10	14.7	11.6
	100	14.4	13.0
Neurotoxin	1	2.35	1.82
	10	8.08	19.2
	100	65.7	194.

She observes that increasing the dosage of deadly neurotoxin causes the average amount of grain to better match with the set threshold. This comes at the slight cost of a higher standard deviation. But she views this as inconsequential. She is also surprised that the average number and standard deviation of grain deer does not change much. She believes this is because she had to use deadly neurotoxin more frequently when she increased the dosage. Thus, the average and standard deviation did not change but rather redistributed over time. She plotted her trends in Figures 1-4. She observes that for higher K, the grain and grain deer growth patterns display higher frequency oscillations. However, low K actually attenuates the original yearly cycle of grain and grain deer growth and replaces it with a five year cycle. However, this attenuation completely breaks down for high K and the cycle returns to being roughly a yearly cycle. She suspects that this is a result of essentially killing the entire grain deer population all at once when releasing the deadly neurotoxin. Conversely, she suspects that smoothly destroying the grain deer population replaces the yearly grain growth cycles with a lower frequency five year cycle. However, killing the grain deer population all at once allows for the grain height to more closely match the 120 inch threshold. Thus, to GLADoS, releasing tons of deadly neurotoxin at once appears to be the preferable route. The temperature and precipitation levels are unaffected by deadly neurotoxin in her tests. However, more tests will need to be conducted to measure the effects of deadly on cake grain growth and global warming. Although, admittedly, she is more interested in cake grain growth than the world climate.

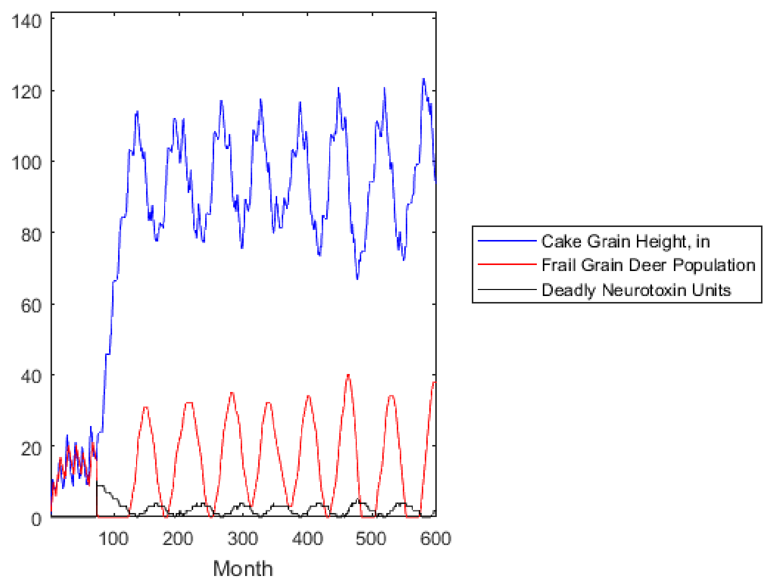

Figure 1: Grain, grain deer, and neurotoxin levels for K = 1.

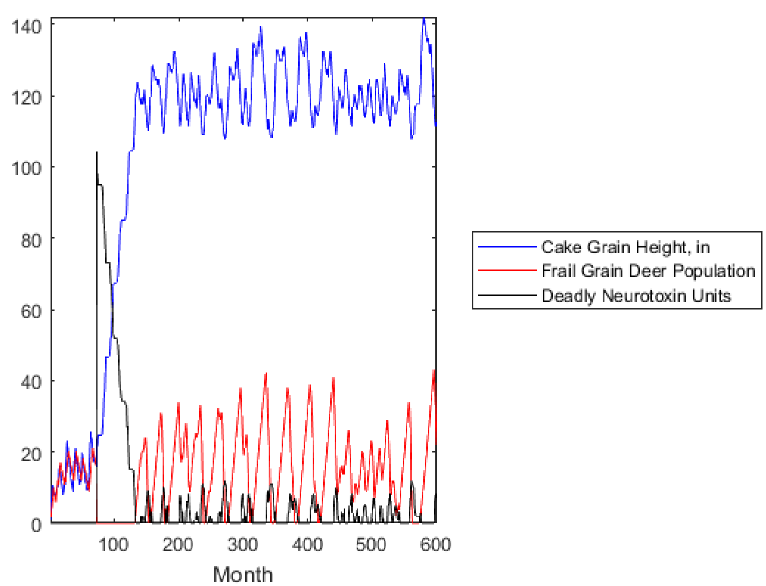

Figure 2: Grain, grain deer, and neurotoxin levels for K = 1.

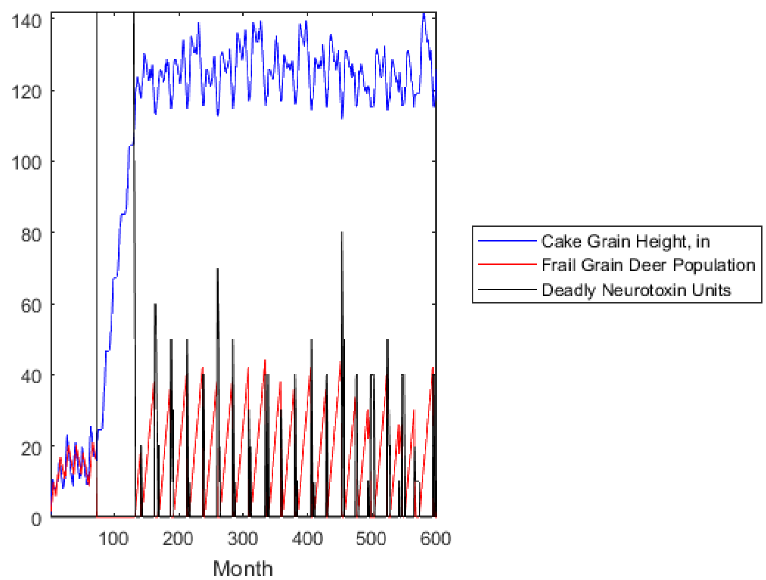

Figure 3: Grain, grain deer, and neurotoxin levels for K = 1.

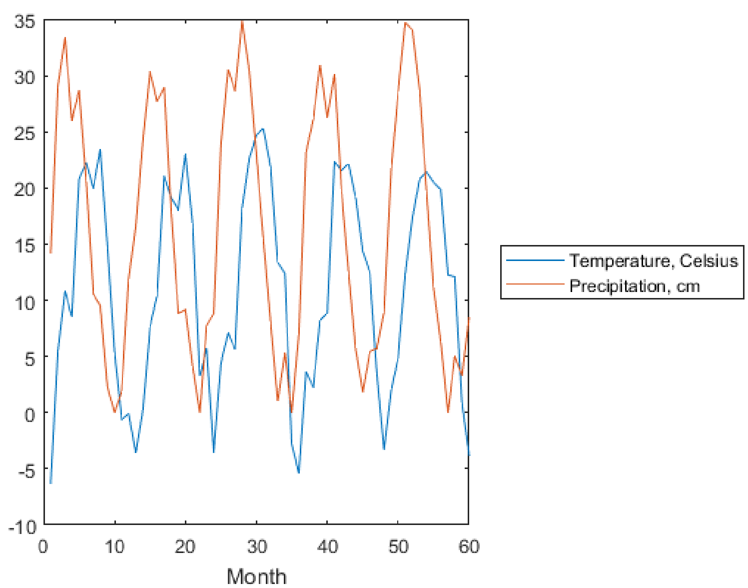

Figure 4: A few example cycles of temperature and precipitation levels.