Benjamin Fields
CS 575 – Parallel Programming
Project 4 – Functional Decomposition
May 17, 2017

1. Choice Quantity - FIRES

For this project, I chose to model an additional environmental factor of fires. In real life, the probability of a fire increases with less precipitation, high temperatures, and lots of fuel (grain). Each of these factors were included in this simulation and thus it was a perfect match. To properly simulate the number of fires during each month, at each time step the amount of rain, temperature, and height of grain were all measured. The number of fires was then calculated by the following equation:

Number of Fires = [Temperature (C) + (Grain Height(centimeters)/3) – precipitation (centimeters)]/2

This equation uses the fact that the number of fires is highly dependent on the temperature and precipitation while the amount of grass only slightly impacts the number of fires. Once the number of fires is known the rest of the environment can react to the fires. The two factors that are impacted by the fires are the grain height and the number of deer. For the grain height, every fire that occurs in each month reduces the height by .5 inches. For the deer, if there are 9 or more fires in a month then one deer runs away and must find a new home elsewhere ☺.

2. Table of Simulation Results

Month	Precipitation (cm)	Temperature (C)	Grain Height (cm)	Deer Count	Fire Count
1	0	-17.7778	0	2	0
2	29.0594	-3.40706	0.160711	1	0
3	25.967	10.8421	4.283	0	0
4	31.328	15.8029	4.57737	1	0
5	31.094	17.0551	3.41915	2	0
6	17.501	22.6451	0.879552	1	3
7	11.8952	17.9658	0	0	3
8	2.79151	15.0069	0	1	6
9	0	13.3624	0	0	6
10	0	10.2948	0	1	5
11	9.18078	-0.536864	0	0	0
12	7.75224	3.2568	11.9791	1	0
13	16.6934	2.84843	27.3453	2	0
14	30.5709	7.28243	39.8226	3	0
15	34.8226	5.61657	52.9491	4	0
16	33.6168	17.6411	47.934	5	0
17	29.7045	22.4393	41.5845	6	4
18	23.9927	21.2373	28.8867	7	5
19	7.01421	15.8361	13.8264	8	9

20	4.55651	22.2335	0	6	11
21	0	13.9781	0	4	6
22	1.2248	11.6061	0	3	5
23	5.6702	3.57864	0.687728	2	0
24	16.2062	0.711952	9.49763	1	0
25	16.8254	0.616199	19.5051	2	0
26	28.5357	4.90082	36.8432	3	0
27	34.0233	12.301	35.4841	4	0
28	30.5795	15.8044	30.7019	5	0
29	27.8307	17.6309	24.4239	6	0
30	23.7244	20.1305	16.8109	7	2
31	8.51047	19.445	5.38979	6	8
32	4.26414	23.1764	0	5	10
33	0	10.1229	0	3	5
34	1.49184	5.22886	0	2	1
35	9.24909	1.33035	6.09543	1	0
36	11.3057	-2.56736	7.86202	2	0
37	19.3146	-1.80107	10.7437	3	0
38	27.8069	-3.29719	9.82235	4	0
39	31.384	9.18822	14.0143	3	0
40	29.6377	13.714	11.4254	4	0
41	25.618	19.0036	6.36657	5	0
42	16.9884	22.8858	0.0168685	4	4
43	15.6637	21.9329	0	3	3
44	8.23251	17.2117	0	2	4
45	4.19292	13.2191	0	1	4
46	0	6.983	0	0	3
47	7.45642	0.0460095	2.78116	1	0
48	10.3645	4.69132	15.7964	2	0
49	16.0898	1.41833	26.4608	3	0
50	25.2186	4.53565	42.9643	4	0
51	30.0322	5.95744	56.1346	5	0
52	30.4906	17.1907	49.8856	6	2
53	26.4386	14.9426	40.2963	7	2
54	22.0614	17.7639	28.93	8	4
55	13.5193	23.5538	13.6901	9	9
56	0.460438	20.6825	0	7	12
57	1.97222	15.7559	0	5	6

58	0.132361	9.74448	0	4	4
59	4.73977	0.930019	0	3	0
60	14.0655	-1.33873	1.8242	2	0
61	23.8977	-4.95745	0.439187	1	0
62	26.7154	-2.59047	3.24653	0	0
63	30.3023	4.10349	22.7499	1	0
64	32.0992	11.5562	25.1616	2	0
65	28.6553	15.1466	23.1104	3	0
66	21.2485	21.4606	19.3021	4	3
67	15.4525	25.3953	10.4121	5	8
68	0.426731	21.7949	0	4	12
69	0	18.3588	0	2	9
70	0.719311	4.9804	0	0	2
71	3.99994	3.98093	7.38246	1	0
72	13.4748	-2.47098	9.57399	2	0

Table 1: State of each factor at each month.

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3. Graph of Simulation Results

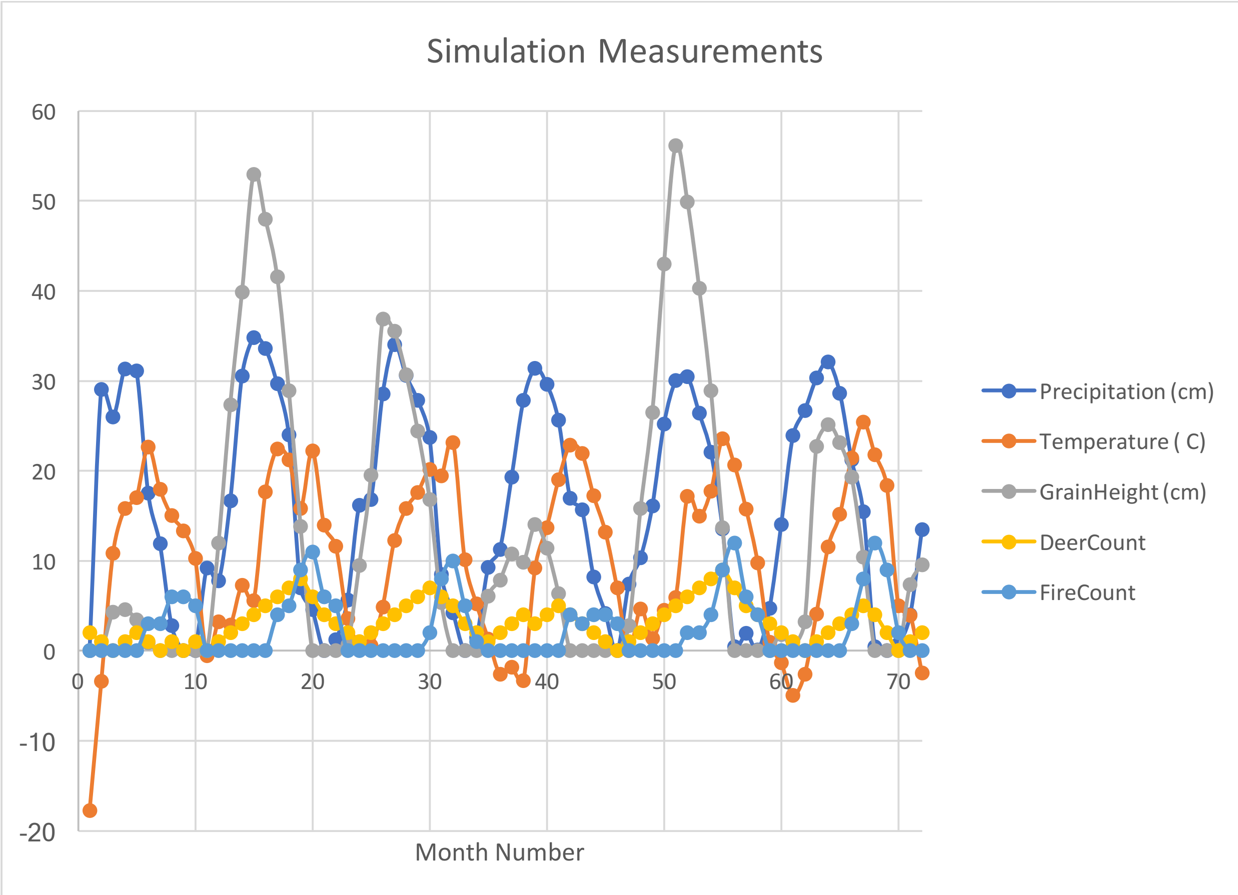

Figure 1: Plot of Simulation state at each month.

4. Patterns in Graph and Variables

In Figure 1, as seen in the previous section, there are some clear patterns for each of the variables. For variables such as Precipitation and Temperature there is a regular sinusoidal pattern that continues through the months and the other factors have no effect on the outcome of these variables. In the case of Grain Height, Deer Count, and Fire Count we begin to see some clear trends in how each factor impacts the environment as well as other factors. If we look at grain height we know that the grain will increase with good temperatures, sufficient precipitation, limited fires, and not too many deer. This pattern holds as when observing month 16 we can see the grain hit a peak. This peak is the result of high precipitation, optimal temperatures, no fires, and a limited number of deer. The grain height quickly decreases once the temperature increases, precipitation decreases, there are too many deer and there are multiple fires. In the case of deer, we can see similar trends. If we observe month 19 we see that the deer population hit a peak. The conditions in month 19 show that leading up to this point the grain levels were very high and the number of fires were limited, thus leading to growth in the population. However, once the population became large enough, grain levels fell

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and with the combination of more fires the population of deer quickly dropped confirming the relationships between factors. Finally, by observing the number of fires we can see a clear relationship between the temperature, precipitation and grain height. In month 20 the number of fires was at a high. By observing the state of the environment at that point we can see that the months leading up to that had very high temperatures, decreasing precipitation, and lots of grass. This behavior matches our expectations given the real-world behavior of fires and the behavior of fires as defined by the equations. Previously we stated that the number of fires is highly dependent on the temperatures and precipitation. If we observe the values of fires in relation to temperature we can see that when the temperature is increasing, the number of fires increases. Similarly, when the precipitation levels are high the number of fires is limited. After observing these patterns, we can conclude that the simulation matches expectations and changes with the states correctly.