Project 4: Functional Decomposition ("Grainville")

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CS575: Parallel Programming

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Abstract

CONTENTS

1 SYSTEM SPECS

The computer used for running these experiments is A lenovo with i7 (Intel(R) Core(TM) i7-3537U CPU @ 2.00GHz) with 8 GB of ram.

```
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                4
On-line CPU(s) list:   0-3
Thread(s) per core:    2
Core(s) per socket:    2
Socket(s):             1
NUMA node(s):          1
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 58
Model name:            Intel(R) Core(TM) i7-3537U CPU @ 2.00GHz
Stepping:              9
CPU MHz:               2793.686
CPU max MHz:           3100.0000
CPU min MHz:           800.0000
BogoMIPS:              4988.73
Virtualization:        VT-x
L1d cache:             32K
L1i cache:             32K
L2 cache:              256K
L3 cache:              4096K
NUMA node0 CPU(s):     0-3
```

2 APPROACH

This program takes advantage of 5 agents:

1) **Grain:** The grain is the primary food source for the Deer and Noah.
2) **Deer:** The deer is the primary consumer of grain and food for the wolves and Noah
3) **Wolf:** The wolves are primary consumers of the deer flesh, but that does not stop a hungry Noah from eating them.
4) **Noah:** That is right! Noah eats everything and anyone, relentlessly. He is trying to survive the life on Arc ... or fishing boat.
5) **Weather:** Weather dictates the birth and growth rate of the grain, deer and wolves.

Here is the prologue to the story:

Story time!

So God said to Noah, I am going to put an end to all people, for the earth is filled with some wicked stuff because of them! I am surely going to destroy both them and the earth because ... it's more dramatic that way!

Go build an arc and take a pair of each animal (don't forget the Dodo They look like birds, but they can't fly ... I guess chickens too).

- "But god Jesus was good at carpeting, not me " said Noah to God

- Not with the whole "ow your son this and that" again replied God; Just build a canoe or a small fishing boat would do, I'll shrink everything!

So Noah built the boat, but God got busy with planning his next religion and forgot to shrink the animals. Noah decided to teach God a lesson, and only brought ¡Some random value¿ of grain, ¡Some random value¿ Deers and ¡Some random value¿ Wolves to his boat.

Here is what happened next according to Noah's Diary:

Furthermore, we are using barriers in order to synchronize the timing of all agents for the time of the day.

```
#pragma omp barrier
```

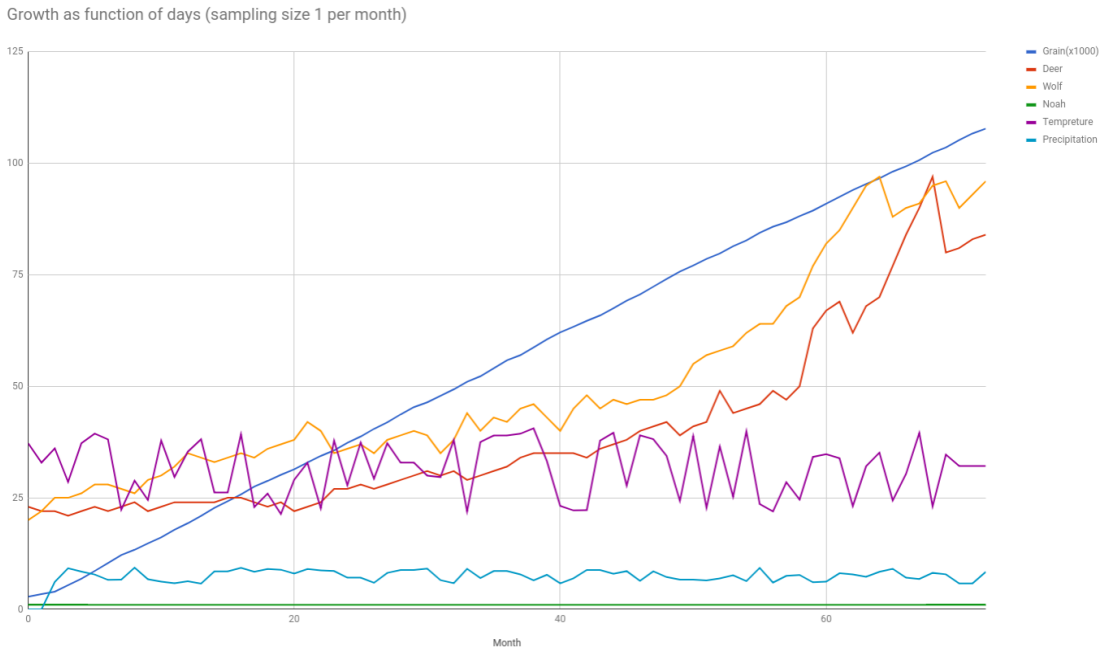
Furthermore, we are taking advantage of mutexes in order to make sure multiple threads are not reading and writing at the same time.

```
omp_set_lock(&GrainLock);
omp_set_lock(&DeerLock);
omp_set_lock(&WolfLock);
```

3 Performance

The program performed well. The 4 threads running took 0.763680 seconds in order to finish the task for the span of time of events. The Grain, dear and wolf population was recorded and analyzed.

4 Analysis of results



Here is the results of the experiment with regards to growth of different agents. In this graph we have plotted the Grain, Deer, Wolf, Noah Temperature and precipitation. We can see some interesting patterns emerging from our simulation. The table indicates how different agents interact with one another. Each agent affects the dynamics of growth rate of other agents. We can see the Deers were the most successful agent and

Noah managed to survive with about 96 hungry wolves. We can see that the drop in population of wolves is immediately after a drop in population of dear. This information could be found in table 1 and 2 (due to size of the table I had to break them into to 2).

We can see an interesting trend here. The weather and precipitation directly affects the growth of the grain and we can see that as the grain growth changes, the population of the Deer and wold increases too. To make things even more interesting, we can see that there even is a clear connection between some of the rises and drops in the table between temperature, Deer population and wolf population.

Table 1
Table of all values - 1

Day\Type	Grain(x1000)	Deer	Wolf	Noah	Temperature	Precipitation
0	2.827	23	20	1	37.230049	6.162022
1	3.421	22	22	1	32.891357	9.196632
2	3.958	22	25	1	36.098083	6.162022
3	5.428	21	25	1	28.56599	9.196632
4	6.871	22	26	1	37.236984	8.45144
5	8.587	23	28	1	39.404358	7.801332
6	10.366	22	28	1	38.090965	6.587852
7	12.166	23	27	1	22.315104	6.665993
8	13.354	24	26	1	28.844234	9.344496
9	14.791	22	29	1	24.506765	6.727283
10	16.111	23	30	1	37.829651	6.202617
11	17.824	24	32	1	29.673693	5.835857
12	19.3	24	35	1	35.345829	6.307928
13	20.959	24	34	1	38.120483	5.775053
14	22.759	24	33	1	26.173595	8.489885
15	24.22	25	34	1	26.173595	8.489885
16	25.768	25	35	1	39.25042	9.29844
17	27.535	24	34	1	22.90329	8.404635
18	28.795	23	36	1	25.960556	9.033603
19	30.148	24	37	1	21.370667	8.878954
20	31.384	22	38	1	29.046192	8.00299
21	32.914	23	42	1	32.861305	9.036688
22	34.39	24	40	1	22.637333	8.716507
23	35.641	27	35	1	37.831253	8.576881
24	37.345	27	36	1	27.802753	7.097451
25	38.752	28	37	1	37.393124	7.10096
26	40.462	27	35	1	29.26009	5.9354
27	41.935	28	38	1	37.230049	8.156489
28	43.705	29	39	1	32.891357	8.823891
29	45.334	30	40	1	32.891357	8.823891
30	46.411	31	39	1	29.969854	9.133294
31	47.869	30	35	1	29.641083	6.536581
32	49.33	31	38	1	37.966003	5.851738
33	51.034	29	44	1	21.935852	9.077493
34	52.261	30	40	1	37.525948	6.982221
35	54.031	31	43	1	38.96188	8.565676

Table 2
Table of all values - 2

Day\Type	Grain(x1000)	Deer	Wolf	Noah	Temperature	Precipitation
36	55.834	32	42	1	38.96188	8.565676
37	56.986	34	45	1	39.366032	7.830615
38	58.735	35	46	1	40.586067	6.478723
39	60.517	35	43	1	33.242653	7.734827
40	62.092	35	40	1	23.181883	5.806905
41	63.37	35	45	1	22.164841	6.945792
42	64.69	34	48	1	22.225452	8.819691
43	65.899	36	45	1	37.846565	8.819691
44	67.483	37	47	1	39.604183	7.96985
45	69.22	38	46	1	27.727674	8.55858
46	70.6	40	47	1	39.029438	6.364076
47	72.343	41	47	1	38.163704	8.519251
48	74.059	42	48	1	34.389847	7.225714
49	75.739	39	50	1	24.308846	6.646685
50	77.092	41	55	1	38.85323	6.646685
51	78.574	42	57	1	22.745148	6.47771
52	79.783	49	58	1	36.489014	6.934333
53	81.415	44	59	1	25.249437	7.624264
54	82.72	45	62	1	39.895252	6.303597
55	84.448	46	64	1	23.610626	9.28079
56	85.798	49	64	1	21.951658	5.976183
57	86.8	47	68	1	28.483971	7.488007
58	88.162	50	70	1	24.58979	7.69978
59	89.404	63	77	1	34.171646	6.047124
60	90.949	67	82	1	34.791935	6.191214
61	92.497	69	85	1	33.878498	8.084033
62	94.018	62	90	1	23.141356	7.832711
63	95.368	68	95	1	32.06702	7.290003
64	96.616	70	97	1	35.133221	8.410533
65	98.143	77	88	1	24.41641	9.077431
66	99.343	84	90	1	30.338007	7.106639
67	100.726	90	91	1	39.541424	6.800861
68	102.382	97	95	1	23.101294	8.1551
69	103.561	80	96	1	34.682961	7.84786
70	105.241	81	90	1	32.112694	5.786648
71	106.699	83	93	1	32.112694	5.786648
72	107.798	84	96	1	32.112694	8.404635

We can see the numbers and values associated with the graphs in these two tables.

5 Conclusion

As the story is concerned, Noah had a very successful trip! he managed to end up with 106360 grains, 82 Deers and 69 Wolves! We can see that It is possible to simultaneously run several threads with different instructions and behaviors. use of mutex, and proper data sharing and timing practices help us to create such a simulation and analyze the produced data.