

# Project #4

## Functional Decomposition ("Grainville")

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## 1. Own-Choice Quantity

I chose to add tigers into the simulation. Tiger eats deer and deer eats grain, so number of tiger controls the growth of the grain indirectly. The way I set the number of tiger controlling the number of deer is a little unrealistic. I set one tiger eats 0.5 deer per month, which means two tigers will decrease the number of deer by 1, but one tiger won't affect deer's number.

Also, I set a threshold at the number of deer. If the number of deer is smaller than 5, the number of tigers will fight for the food, which causes the number of tiger decrease by 2. If the number of deer is larger than 5, and the remaining number of deer in this month (including calculation for the deer eaten by tiger in this month) is larger than 2, the number of tiger will be increased by 1, otherwise it will be decreased by 1.

## 2. Performance Results

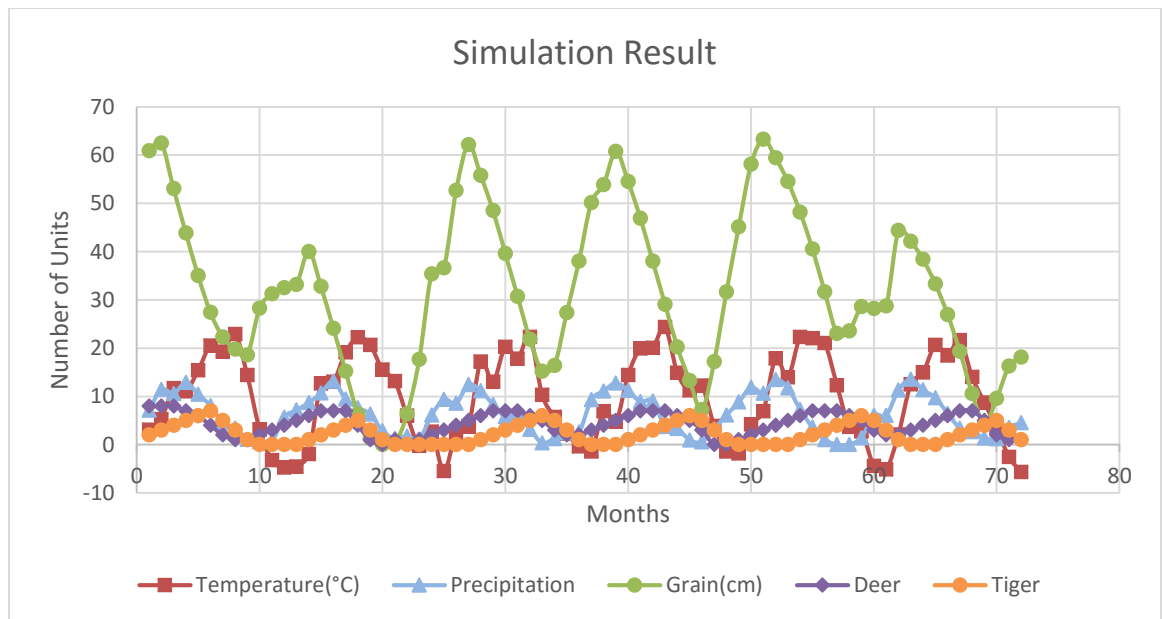
The following table shows the result I got from the simulation. I set the original grain height to 20 inch, original number of deer to 7, and the original number of tiger to 1.

Date	Temperature(°C)	Precipitation	Grain(cm)	Deer	Tiger
2016/1	3.047354	7.130446	60.86903	8	2
2016/2	5.288804	11.4364	62.51296	8	3
2016/3	11.69809	10.58576	53.08227	8	4
2016/4	11.04491	12.86847	43.84998	7	5
2016/5	15.38757	10.45852	35.00289	6	6
2016/6	20.48137	8.068398	27.38311	4	7
2016/7	19.23012	4.500689	22.30393	2	5
2016/8	22.88152	3.42214	19.76393	1	3
2016/9	14.38367	1.073633	18.56061	1	1
2016/10	3.142039	0.632321	28.29454	2	0
2016/11	-3.23118	0.728906	31.25966	3	0
2016/12	-4.76327	5.663794	32.49002	4	0
2017/1	-4.54719	7.156692	33.18461	5	0
2017/2	-1.97018	8.677876	40.01153	6	1
2017/3	12.66784	10.66858	32.76652	7	2
2017/4	13.01946	13.152	24.11589	7	3
2017/5	19.1083	9.426767	15.22694	7	4
2017/6	22.26087	7.650064	6.336958	4	5
2017/7	20.66121	6.338185	1.257124	1	3
2017/8	15.55137	2.842791	0.017303	0	1

2017/9	13.17293	1.2841	0.194765	1	0
2017/10	6.015663	1.770563	6.393612	0	0
2017/11	-0.26435	1.167192	17.68362	1	0
2017/12	2.686653	6.123193	35.38011	2	0
2018/1	-5.51301	9.350223	36.59564	3	0
2018/2	2.432094	8.586864	52.655	4	0
2018/3	3.704387	12.44846	62.14818	5	0
2018/4	17.21169	11.19113	55.80548	6	1
2018/5	13.0142	8.322733	48.49851	7	2
2018/6	20.26253	5.805298	39.60877	7	3
2018/7	17.82451	6.329622	30.72296	7	4
2018/8	22.32572	3.161039	21.83298	6	5
2018/9	10.28317	0.363486	15.23618	5	6
2018/10	5.737644	1.24544	16.41248	3	5
2018/11	2.282541	2.428254	27.31756	2	3
2018/12	-0.38133	2.604208	38.03509	2	1
2019/1	-1.42542	9.280254	50.15971	3	0
2019/2	6.930033	11.12645	53.86005	4	0
2019/3	4.727493	12.74969	60.75079	5	0
2019/4	14.43109	11.21175	54.49422	6	1
2019/5	19.94409	8.906537	46.87462	7	2
2019/6	20.06701	9.073215	37.98497	7	3
2019/7	24.3903	3.768434	29.09497	7	4
2019/8	14.84528	3.330849	20.26378	6	5
2019/9	11.2131	0.951124	13.28909	5	6
2019/10	12.1961	0.559006	7.260758	3	5
2019/11	3.891082	3.192064	17.18823	0	3
2019/12	-1.40407	6.142966	31.65142	0	1
2020/1	-1.86099	8.811981	45.13962	1	0
2020/2	4.190131	11.88653	58.08373	2	0
2020/3	6.929686	10.65886	63.26093	3	0
2020/4	17.87857	13.47607	59.45394	4	0
2020/5	13.94185	11.76689	54.50762	5	0
2020/6	22.30007	7.280728	48.15764	6	1
2020/7	22.06136	3.571323	40.53767	7	2
2020/8	21.03454	0.987191	31.64773	7	3
2020/9	12.28725	0	23.03493	7	4
2020/10	3.65238	0	23.5745	6	5
2020/11	2.770413	1.423364	28.62927	5	6
2020/12	-4.40354	6.074303	28.21307	3	5
2021/1	-5.14172	6.057216	28.76096	2	3
2021/2	2.092637	11.28454	44.35598	2	1
2021/3	12.51036	13.53557	42.14732	3	0

2021/4	14.92516	11.32831	38.39846	4	0
2021/5	20.63197	9.717295	33.31863	5	0
2021/6	18.44541	6.481961	26.9708	6	1
2021/7	21.67127	3.424736	19.35084	7	2
2021/8	13.99441	2.685954	10.57223	7	3
2021/9	8.714377	1.378326	4.303932	5	4
2021/10	3.392033	1.184731	9.550107	2	5
2021/11	-2.58419	3.557775	16.29893	1	3
2021/12	-5.70441	4.53334	18.12784	1	1

The graph created from the form listed above is shown below. The explanation is in the next section. In the graph, I change the grain height unit from inch to centimeter, and I change the temperature unit from °F to °C. Due to the paper size limitation, a bigger graph is put in the appendix after the main report.



### 3. Patterns & Explanation

As it shows in the graph, the temperature drops down every winter and the precipitation drops down every summer. The grain grows at every spring. After the grain grows, the number of deer grows. After the growing of number of number of deer, the number of tiger increases. These make senses since this is exactly how one species reacts with another.

Also, as the number of deer growing, the height of grain decreases since deer needs more food. As the number of tiger growing, the number of deer decreases since tiger needs more food. Then if there are not enough deer, the number of tiger decreases.

Taking one year for example:

2018/1	-5.51301	9.350223	36.59564	3	0
2018/2	2.432094	8.586864	52.655	4	0
2018/3	3.704387	12.44846	62.14818	5	0
2018/4	17.21169	11.19113	55.80548	6	1
2018/5	13.0142	8.322733	48.49851	7	2
2018/6	20.26253	5.805298	39.60877	7	3
2018/7	17.82451	6.329622	30.72296	7	4
2018/8	22.32572	3.161039	21.83298	6	5
2018/9	10.28317	0.363486	15.23618	5	6
2018/10	5.737644	1.24544	16.41248	3	5
2018/11	2.282541	2.428254	27.31756	2	3
2018/12	-0.38133	2.604208	38.03509	2	1

At the beginning of 2018, there are not enough deer so the tiger doesn't show up, and the grain grows. When the number of deer meets 5, the height of grain begins decreasing, and at the same time, tiger begins showing up. Once number of tiger is larger than 2, the number of deer meets a short term of balance but the number of tiger keep increasing. During this period of time, the height of grain keeps decreasing due to large number of deer. When there are a lot tigers, deer can no longer keep in balance, and the number begin to decrease. At this time, the height of grain's decreasing tendency slows down. After this, the number of tiger decreases since there are not enough food for them, and when the number of deer decreased to 3, the height of grain begins increasing again. All of these fits the pattern mentioned above and they kind of fit the nature rules.

4. Appendix

