PART B: Experimenting with genetic algorithms and evolved creatures

Hyper-parameter exploration

The Hyper-parameters that I have changed to see the effect on evolution are the Mutation rate and amount, the Population Size, The Fitness Function, and Parent Selection. Firstly, the Mutation rate and amount are doubled for every generation, and the mean fitness is considered. The Population Size for five groups of creatures was used. 20, 50, 100, 150, and 200 are the number of creatures in each population size. The Fitness function is modified by changing the gene count for every run. The Parents are randomly selected from the fits map, where five groups of parents are selected and run for each generation.

I have chosen Time to be the number of generations where each generation has a different number of creatures present. The groups are 20,50,100,150, and 200, respectively. The evolution speed is considered for every hyperparameter changed during every generation. The results are then tabulated and presented in the form of line graphs. However, the Population Size is represented as a Scatter Map to present clear data without null values.

Changed Mutation Rate and Amount

Time[Number of generations]	2	4	8	16	32
20	27.913	28.982	25.162	29.596	28.762
50	10.541	10.363	10.843	10.578	9.189
100	4.111	4.794	5.222	5.086	4.022
150	2.67	2.604	2.736	2.636	2.692
200	2.744	1.415	2.572	2.598	2.511

Fig1.1 Table showing the evolution rates for different rates for every generation

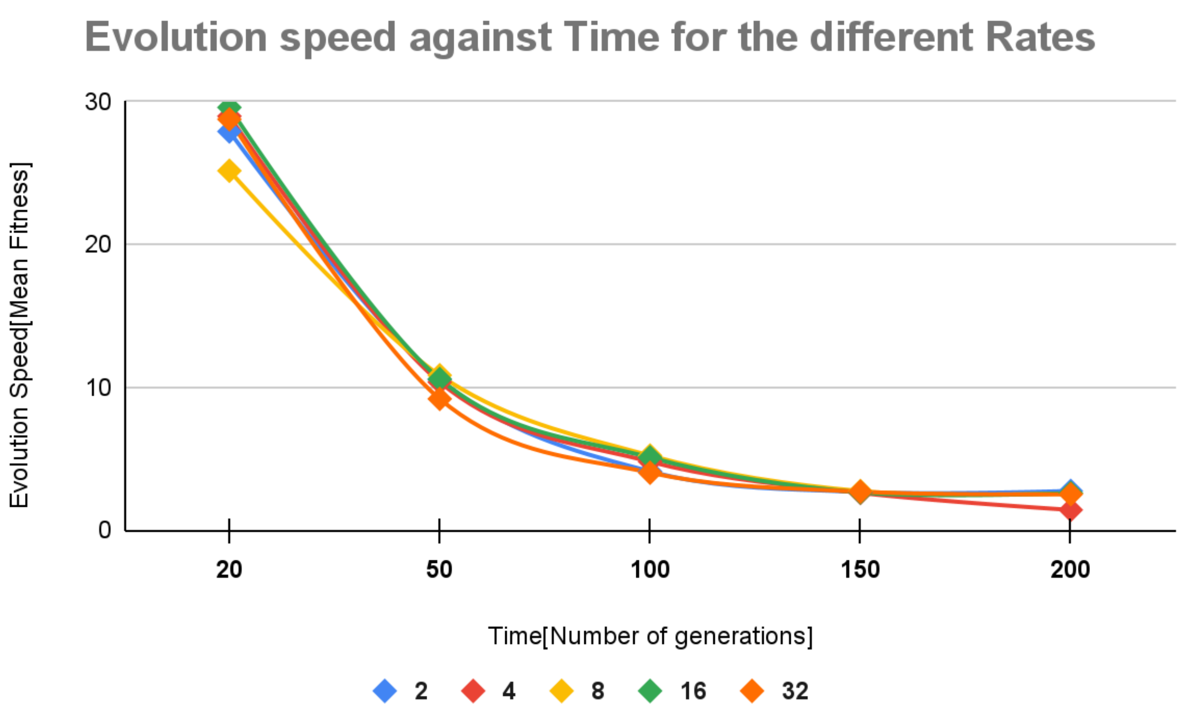


Fig1.2

As seen in Fig 1.2, the line graph shows that the higher the rate of mutation, the lower the evolution speed when the number of generations increases over time. At a mutation rate of 32.0, the evolution speed is the lowest among all the other rates as it has the lowest evolution speed for every generation. This could be because good genes were mutated out in the process of evolution, causing creatures that were produced at a higher mutation rate to have the lowest evolution speed.

Changed Population Size

Time[Number of generations]	20	50	100	150	200
20	29.056	Null	Null	Null	Null
50	Null	12.083	Null	Null	Null
100	Null	Null	5.16	Null	Null
150	Null	Null	Null	3.951	Null
200	Null	Null	Null	Null	2.632

Fig1.3 Table showing the evolution rates for different Population Size for every generation

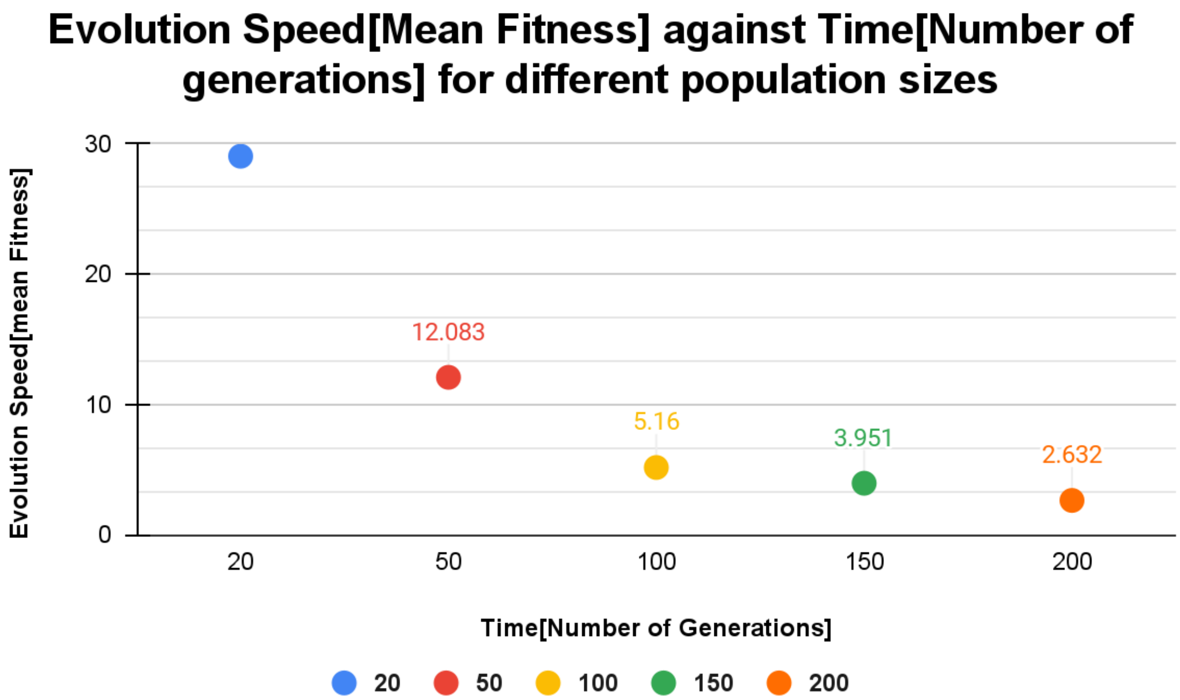


Fig1.4

As seen in Fig1.3 and Fig 1.4, the lower the population size, the faster the evolution speed. This is so because when the pool size is smaller, it is highly likely that we can choose two fittest parents who have the best genes to create offsprings that can move faster and travel longer distances. When the population size increase, there is less likely that the parents we choose may not have the best genes available for us to create offsprings that are more agile.

Changed Fitness Function

Time[Number of generations]	3	4	5	6	7
20	27.913	30.453	31.543	31.023	31.542
50	10.541	12.675	13.234	13.654	13.027
100	4.111	5.324	5.783	5.564	5.982
150	2.67	3.567	4.562	5.324	5.552
200	2.744	4.654	4.843	4.589	4.897

Fig1.5 Table showing the evolution rates for different Gene Count for every generation

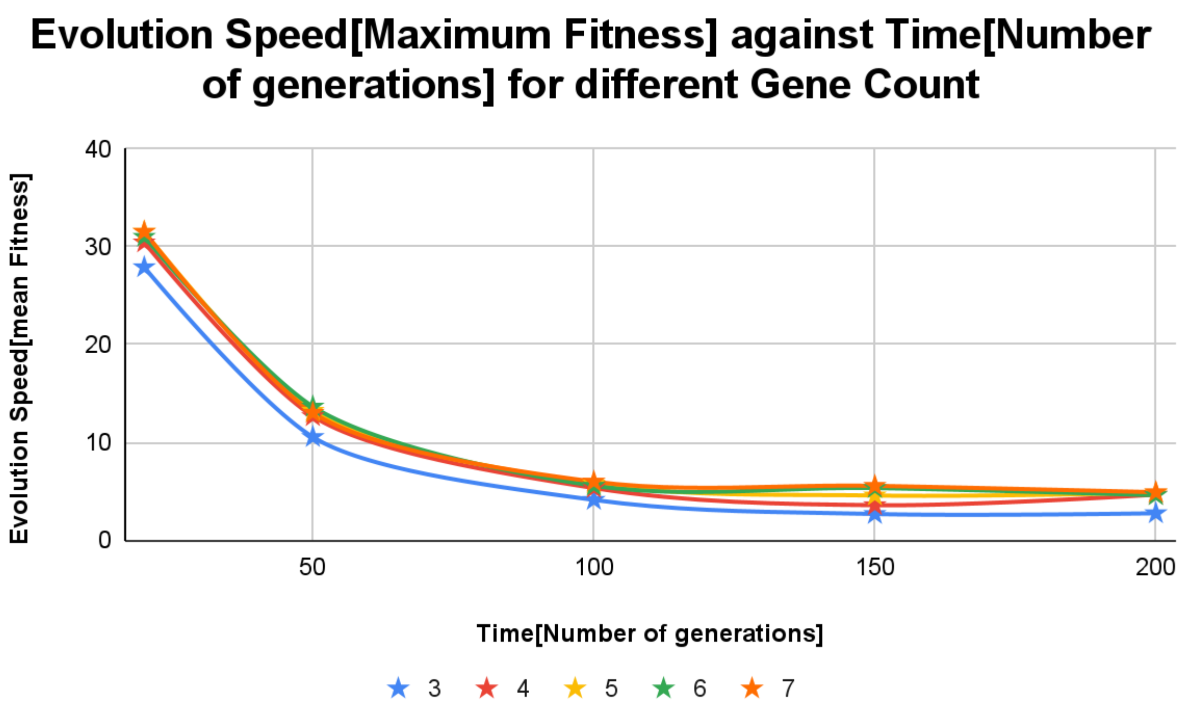


Fig1.6

As seen in Fig 1.5 and Fig1.6, the higher the gene count, the faster the evolution rate. The higher the gene count, the larger the space available for the mutation rate to work on. With more genes, there is a higher chance for the system to identify favorable genes and mutate them out to pass them onto the next generation, thus increasing the evolution speed and creating more flexible and agile offspring.

Changed Parents Selection

Time[Number of generations]	1 & 2	3 & 4	5 & 6	7 & 8	9 & 10
20	29.056	29.993	29.854	28.543	29.289
50	12.083	10.381	11.421	12.456	12.543
100	5.16	3.979	5.323	6.542	5.202
150	3.951	5.254	6.134	5.421	6.321
200	2.632	5.008	5.451	5.046	5.553

Fig1.7 Table showing the evolution rates for different Parent selections for every generation

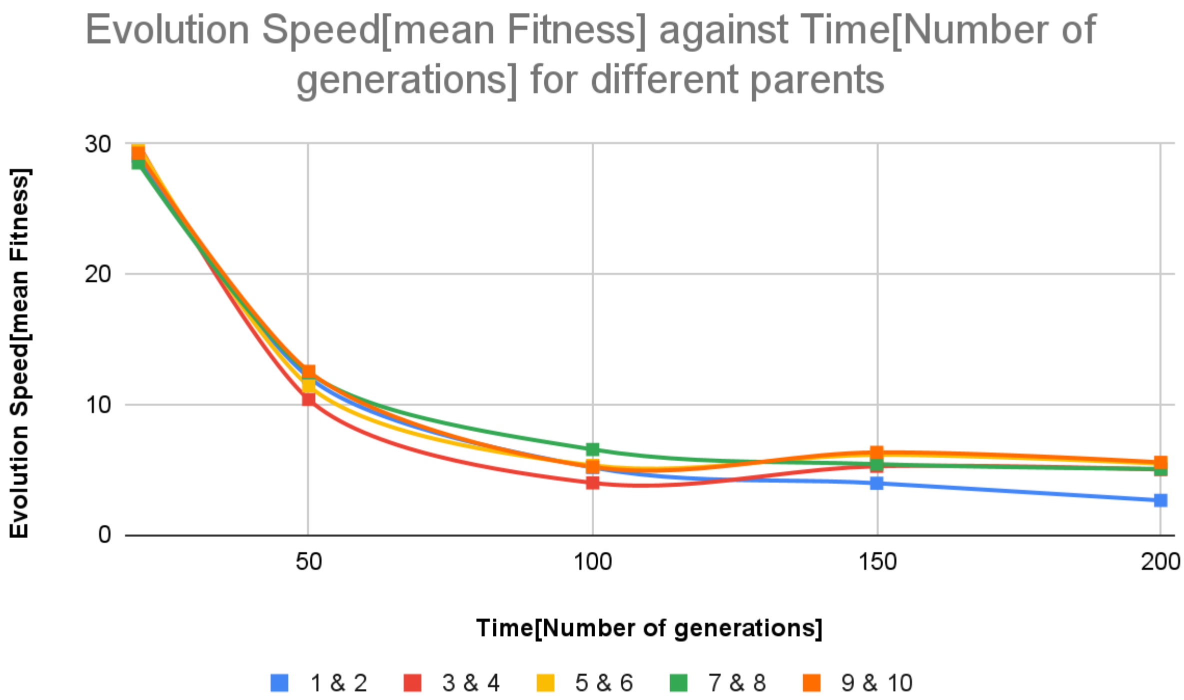


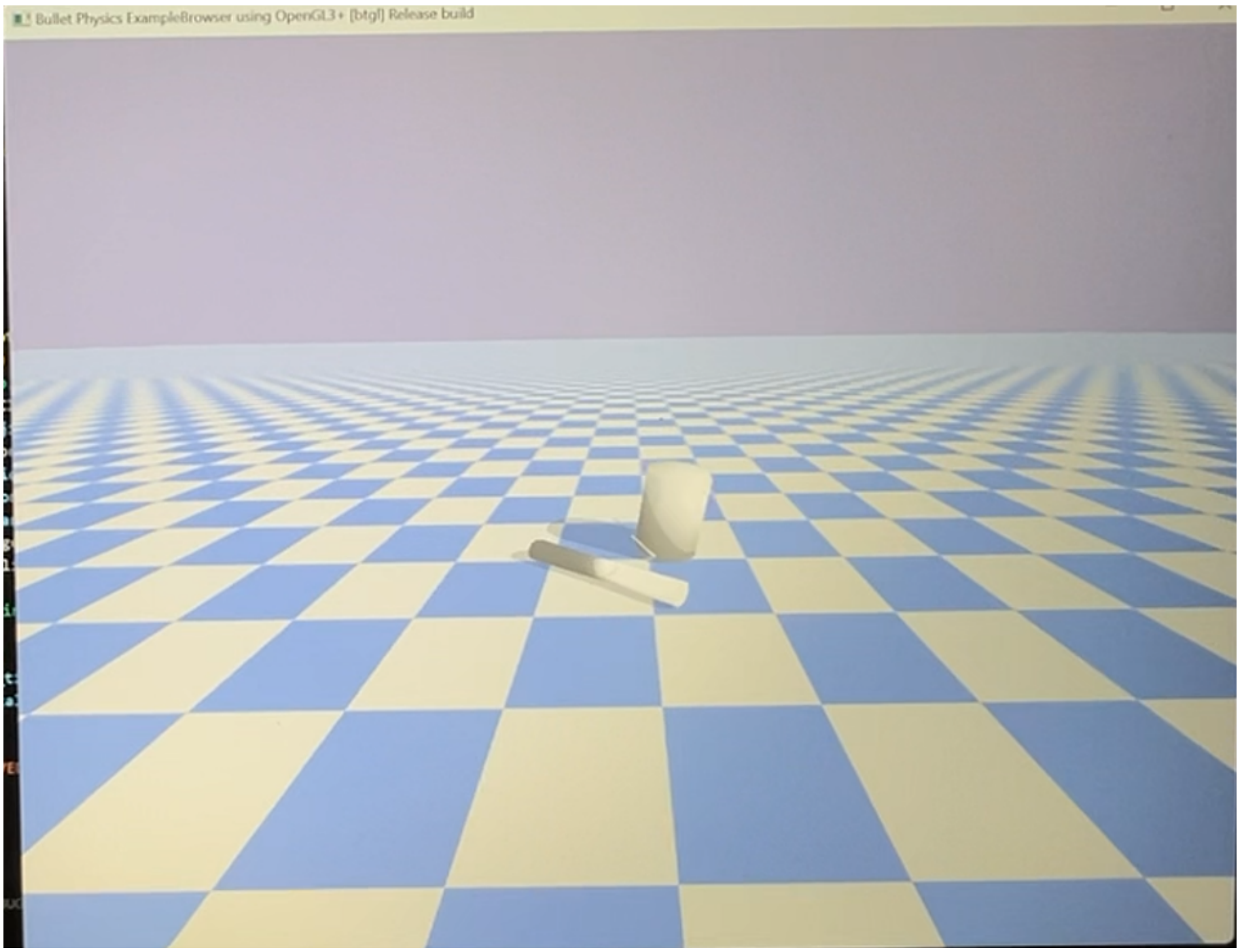
Fig1.8

Figures 1.7 and 1.8 show that parent groups 3 and 4 have the lowest evolution rate over time. The parent groups selected after parent groups 3 and 4 have a higher evolution rate. This may be the result of random selection affecting the evolution rate. In this case, the parents are randomly selected, with some having favorable genes while others may not. Over time, parents with more favorable genes are selected randomly, and more favorable genes are passed down to the next generation, creating offspring with a higher evolution rate.

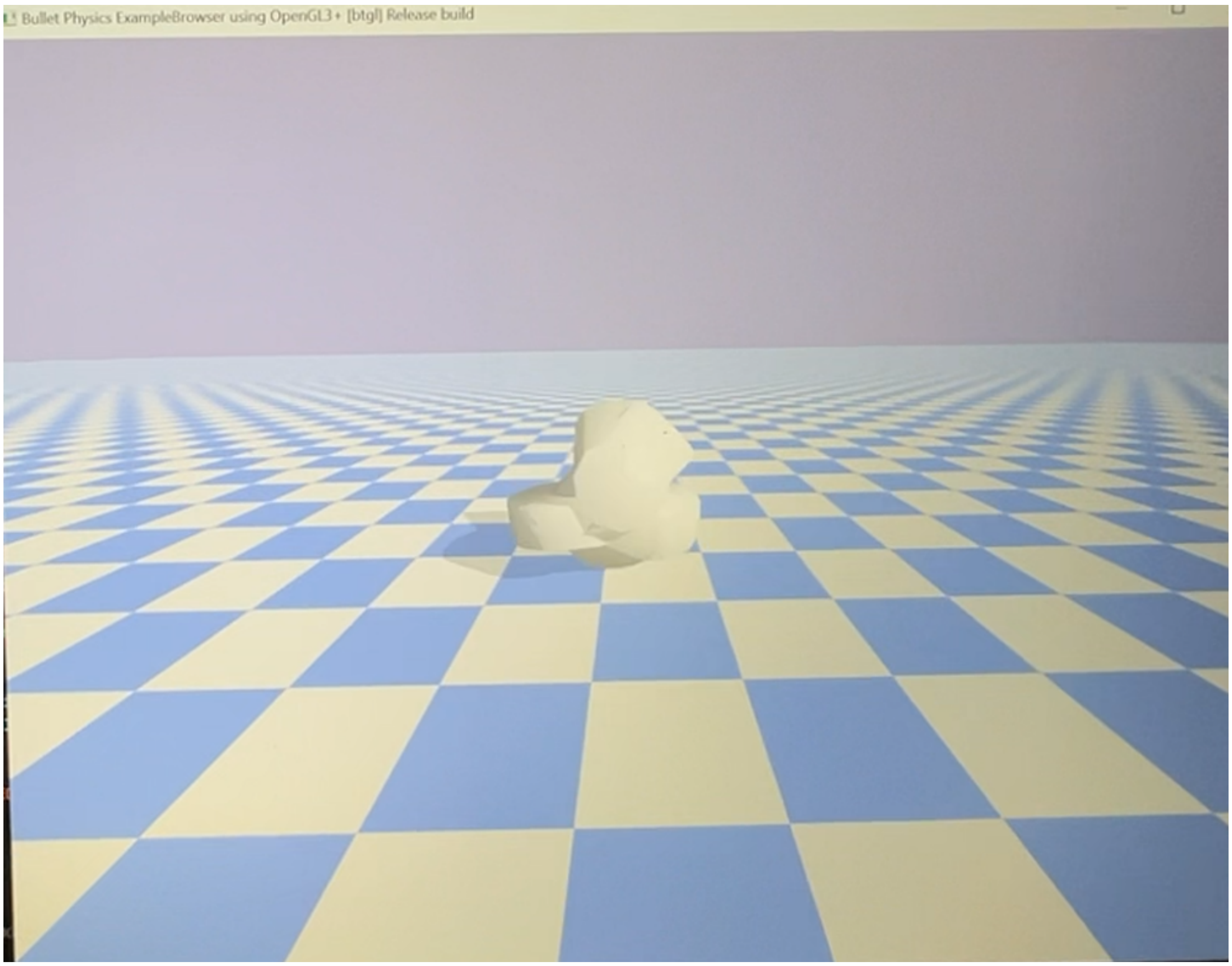
Experiment with the encoding scheme

In the Encoding Scheme, the settings changed: the Link length and radius, the Mass, and the Joints length and axis. The parameters used were 20, 50, 100, and 200, respectively, and then observed how the creatures changed physically over time.

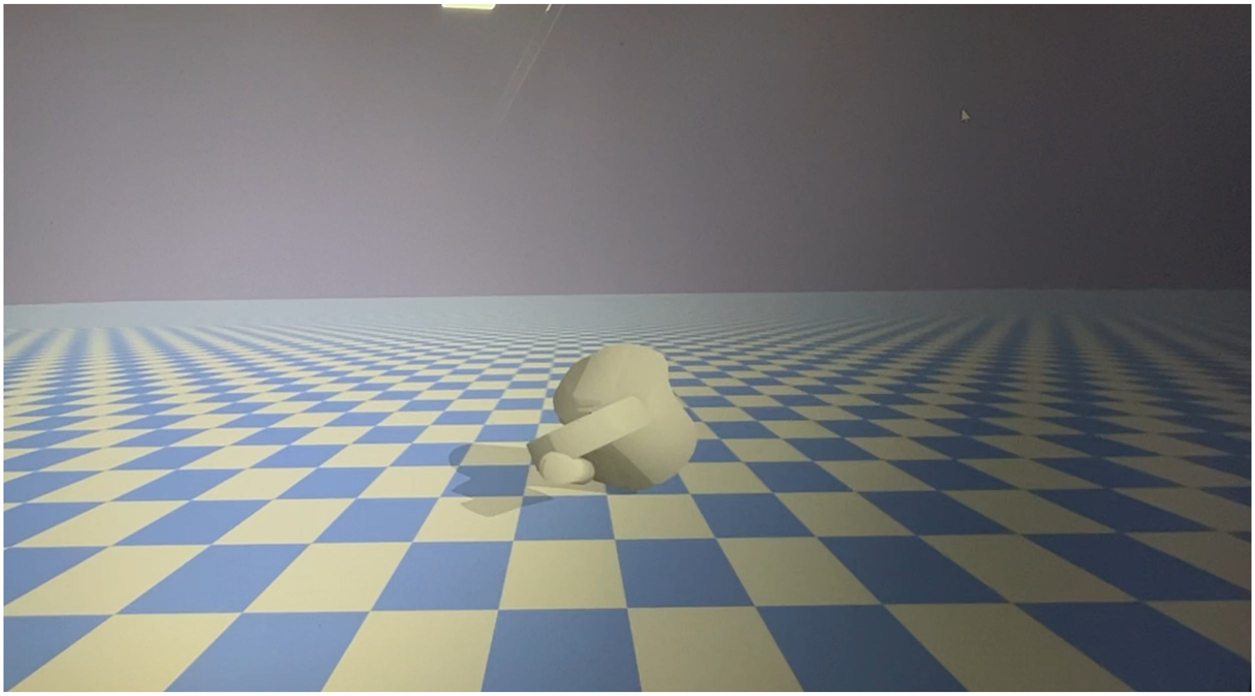
Creature 1[Link length and radius = 20]



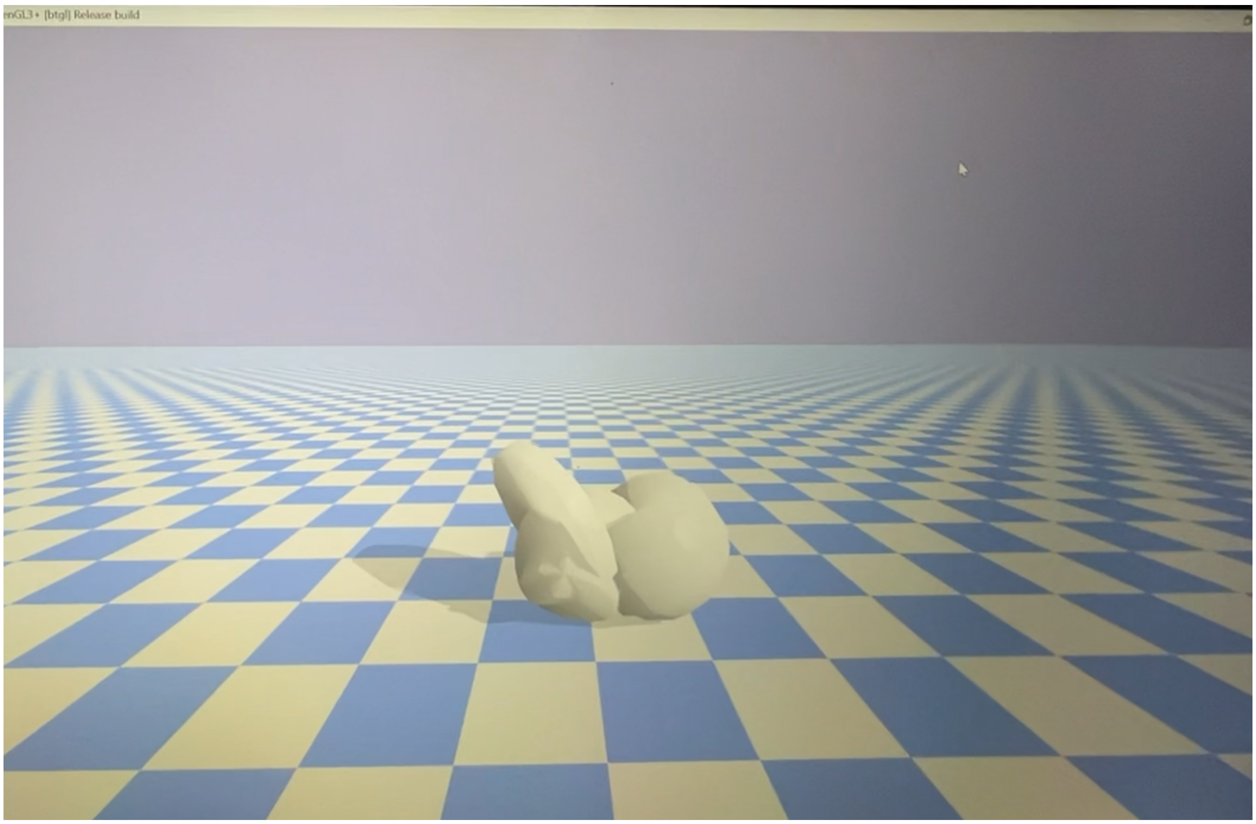
Creature 2[Link length and radius = 50]



Creature 3[Link length and radius = 100]

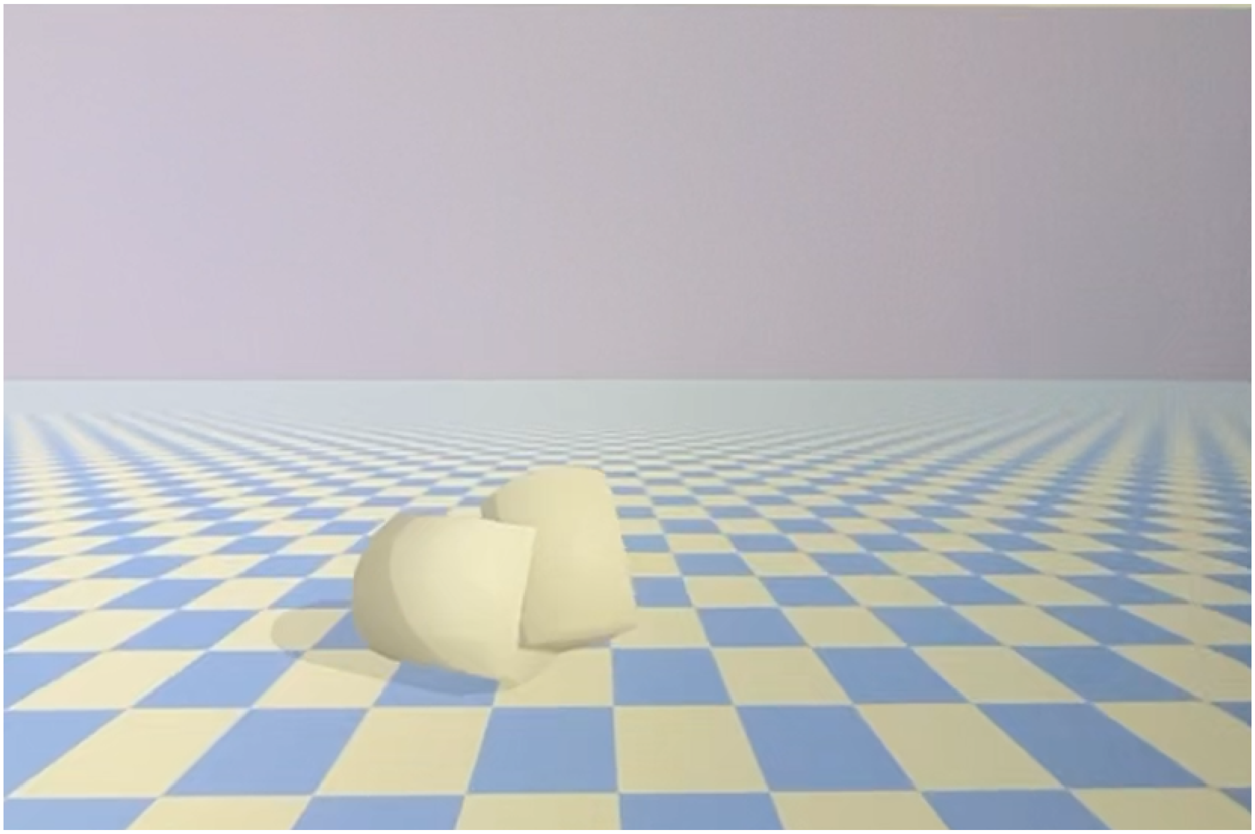


Creature 4[Link length and radius = 200]

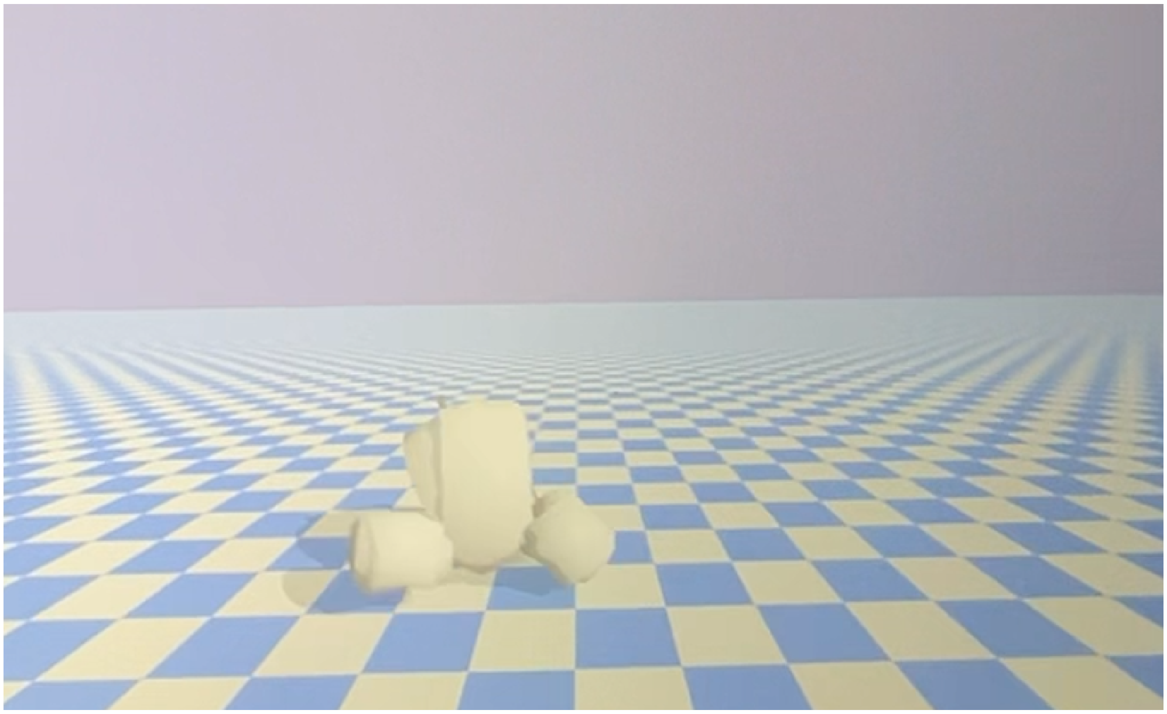


For creatures 1 to 4, the link length and link radius are given extreme parameters to observe how the length and radius affect the creatures. Firstly, creature 1 has the highest speed and can travel longer distances than the other three. The shorter the link length and radius, the faster the creature is. This could be because, with a larger radius, creatures with larger surface areas are created, causing the movement of the creatures to be restricted and become slower than before.

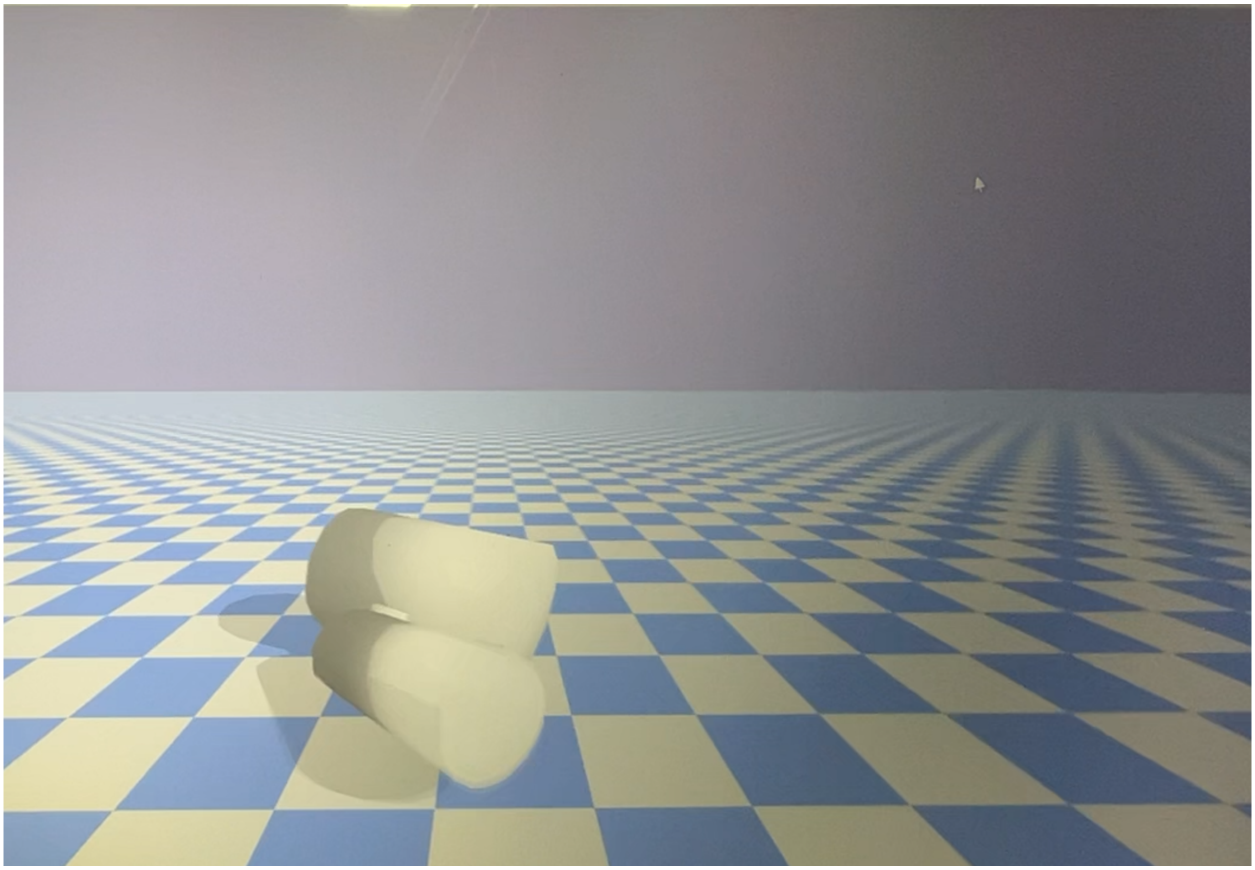
Creature 5[Mass = 20]



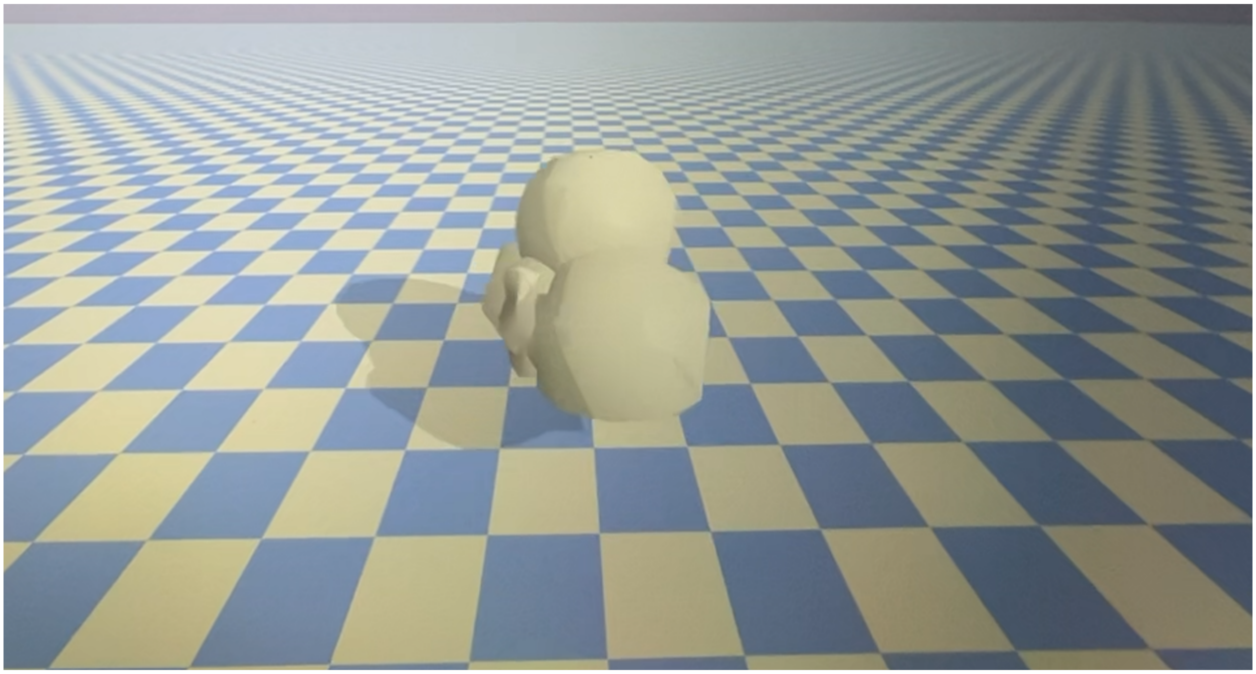
Creature 6[Mass = 50]



Creature 7[Mass = 100]

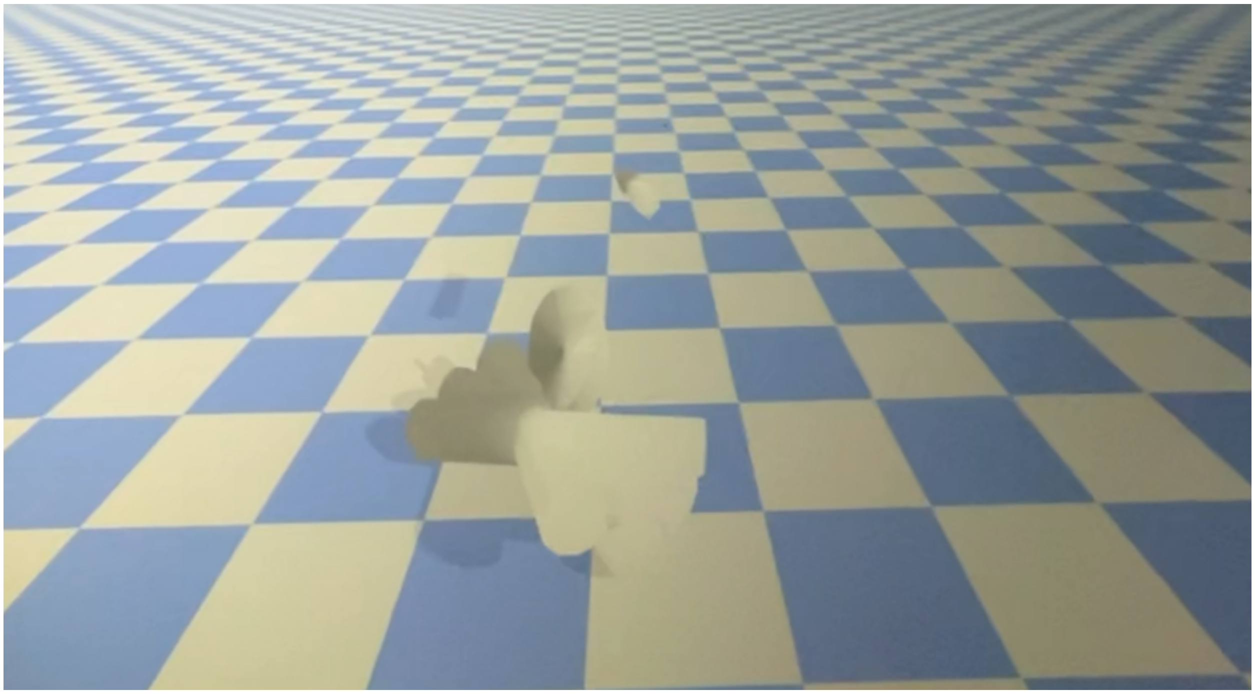


Creature 8[Mass = 200]

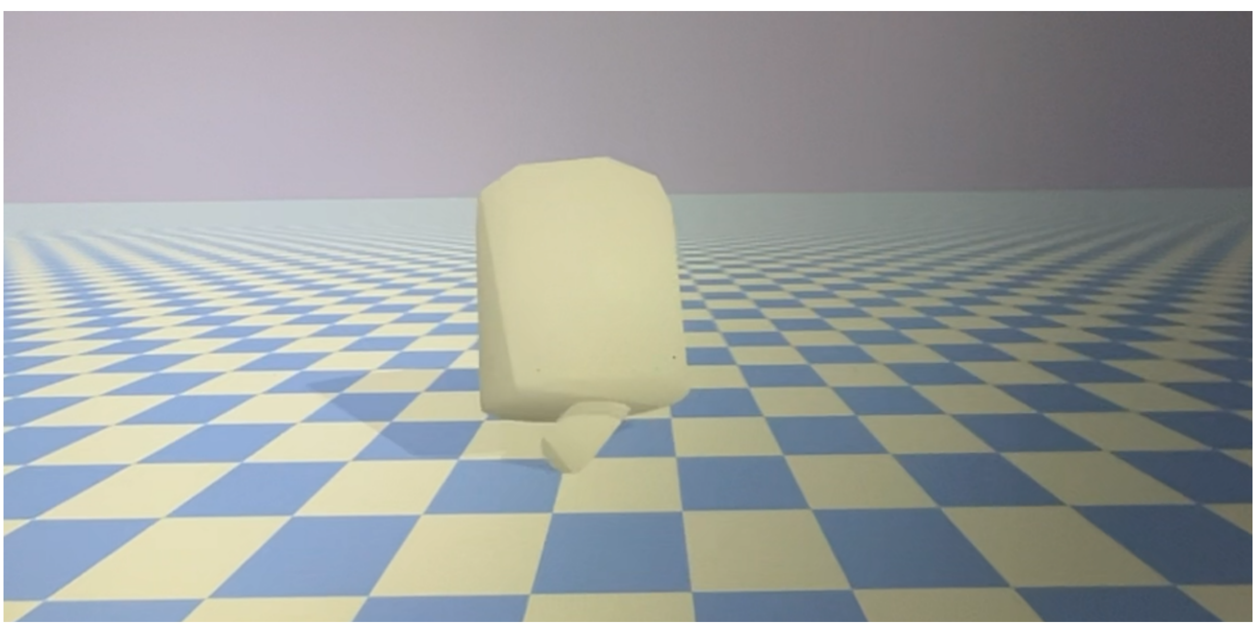


From creatures 5 to 8, the mass of the creatures is changed. The higher the mass of the creature, the lower the speed of the creature and, therefore, the lesser the distance traveled by the creature. With a higher mass and a smaller joint length, the creatures cannot move further and can only spin themselves in one place. This is so because the joints of the creatures are too short to support the movement of heavy creatures with a large mass.

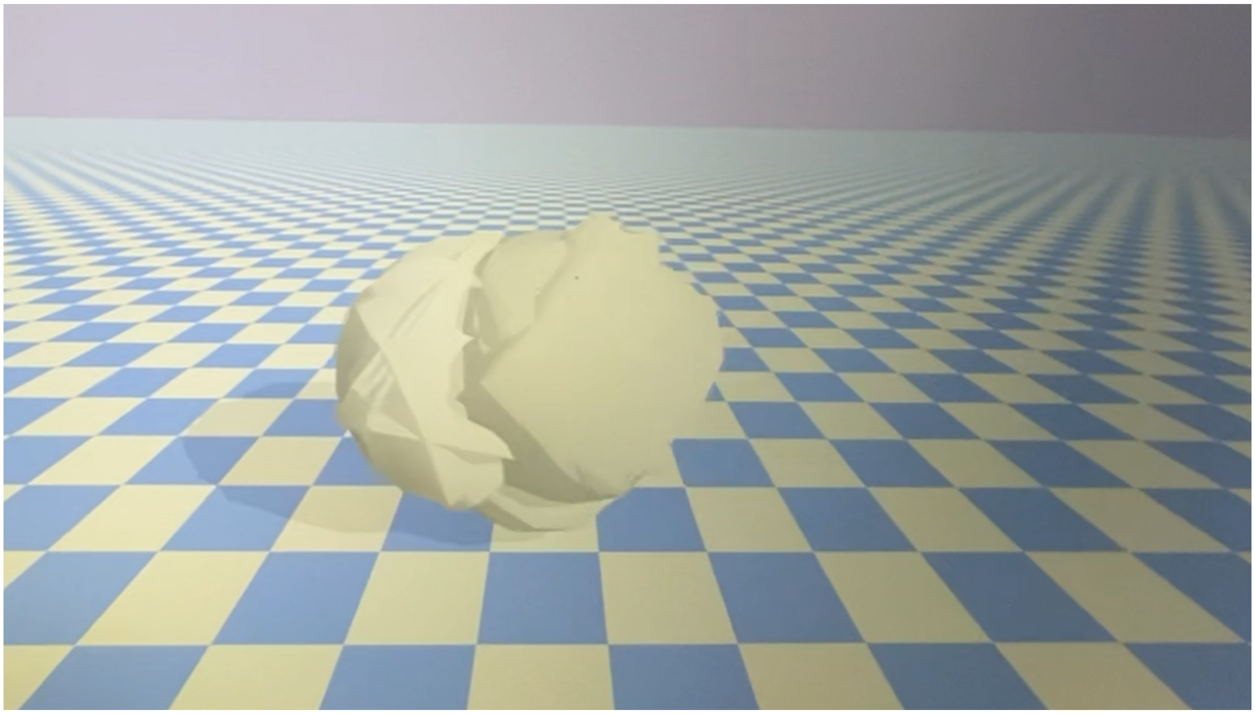
Creature 9[Joints = 20]



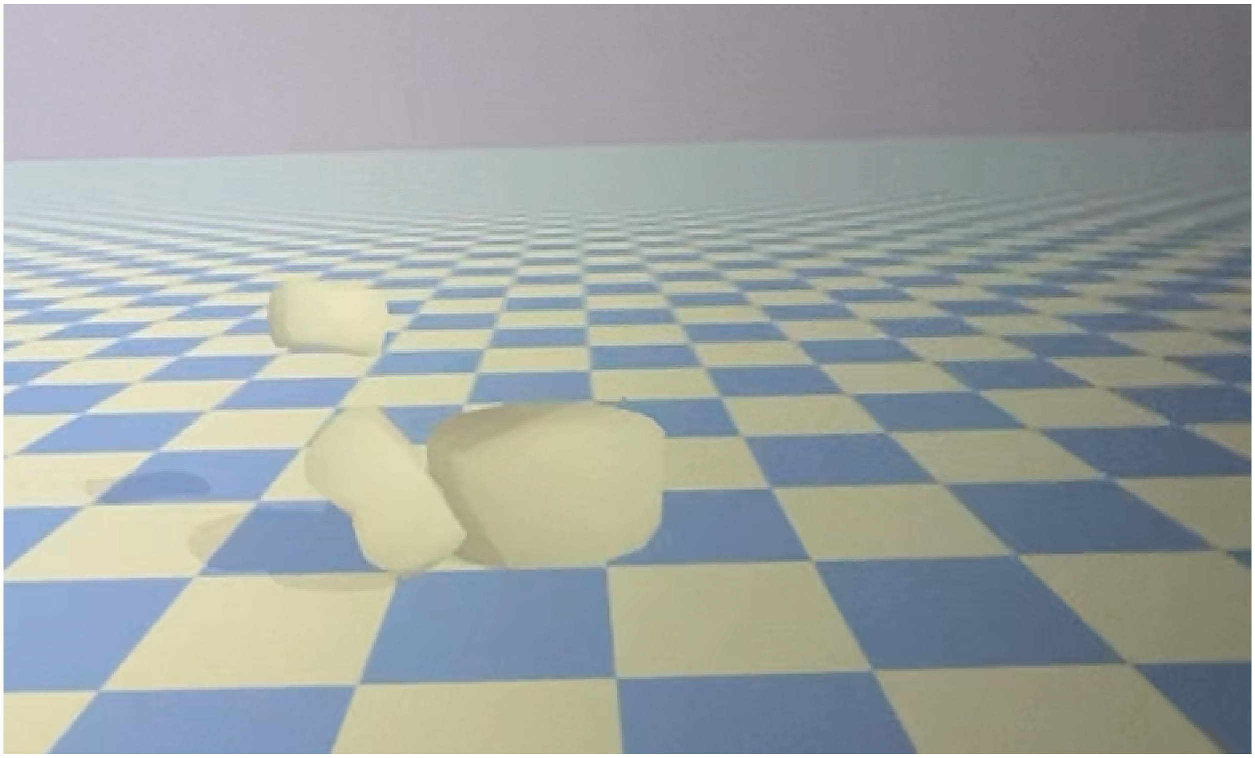
Creature 10[Joints = 50]



Creature 11[Joints = 100]



Creature 12[Joints = 200]



For creatures 9 to 12, the joint length and link values were changed. The higher the joint length and link values, the further the distance the creatures could travel. The creatures started to display a walking behavior where they could move around with the help of stronger and longer joints. Creatures are also created in different shapes where the joints resemble a star shape mostly.

Word count: 779 words