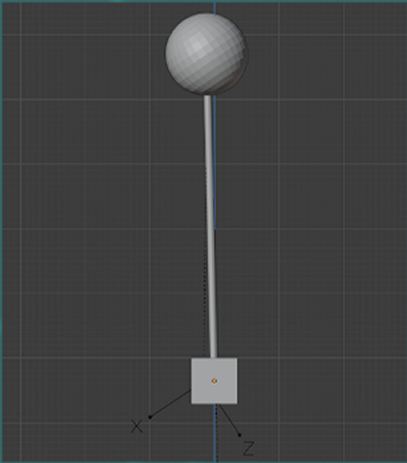


# Virtual Chaos

This project intends to examine the value of implementing dynamic systems such as the double pendulum into environments like Blender, what that might look like, and how that would affect types of simulations.



To determine how programs like Blender handle chaotic motion in rigid bodies, a rigid body simulation was built. Using the preexisting settings found in Blender, a simple pendulum with rigid body physics was made, and tested to see if chaotic motion was possible.

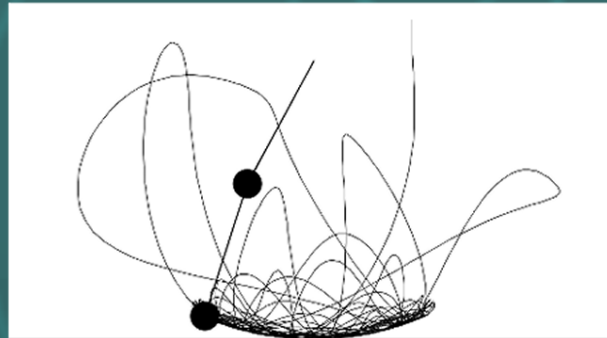


ideal result      actual result with Blender

Since Blender's physics cannot be modified in the program itself, the Bullet physics library that Blender runs on will be used to make the pendulum work, as this allows for more focus on the algorithms that demonstrate chaotic behavior.



A prototype double pendulum in Processing was investigated before any progress was made with the Bullet library. Double pendulums are more commonly used as a demonstration of chaotic behavior as well, so it seemed reasonable to use those instead of a pendulum with a single weight.



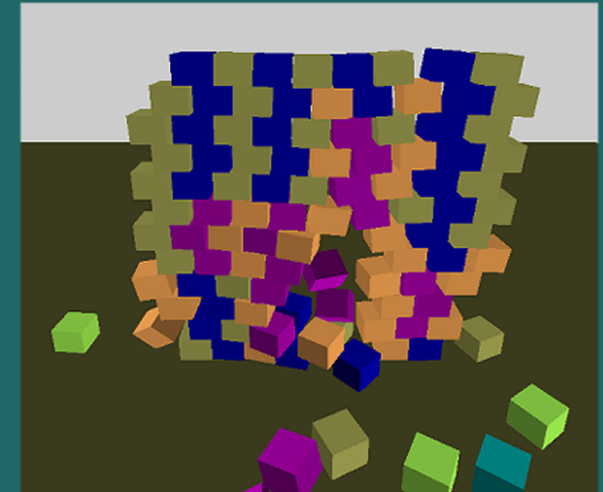
The double pendulum uses code from thecodingtrain.com to demonstrate chaotic motion.

```

float num1 = -g * (2 * m1 + m2) * sin(a1);
float num2 = -m2 * g * sin(a1-2*a2);
float num3 = -2*sin(a1-a2)*m2;
float num4 = a2_v*a2_v*r2+a1_v*a1_v*r1*cos(a1-a2);
float den = r1 * (2*m1+m2-m2*cos(2*a1-2*a2));
float a1_a = (num1 + num2 + num3*num4) / den;

num1 = 2 * sin(a1-a2);
num2 = (a1_v*a1_v*r1*(m1+m2));
num3 = g * (m1 + m2) * cos(a1);
num4 = a2_v*a2_v*r2*m2*cos(a1-a2);
den = r2 * (2*m1+m2-m2*cos(2*a1-2*a2));
float a2_a = (num1*(num2+num3+num4)) / den;
    
```

This code uses the mass of the two weights of a double pendulum and the angle of the weights to determine their acceleration, producing a chaotic result.



(image from [https://commons.wikimedia.org/wiki/File:Bullet\\_Wall.png](https://commons.wikimedia.org/wiki/File:Bullet_Wall.png))

After the prototype has been experimented with, the actual physics library will be used. The Bullet double pendulum uses actual rigid body physics, so the results will most likely vary. The results will be compared to each other, then the behavior of real double pendulums, and if one or both of them do not resemble real results, they will be modified.

## references

Daniel Shiffman. (2018). Double Pendulum Coding Challenge #93 — Coding Train. [Online]. Available: <https://thecodingtrain.com/CodingChallenges/093-double-pendulum.html> (visited on Mar 9, 2021).