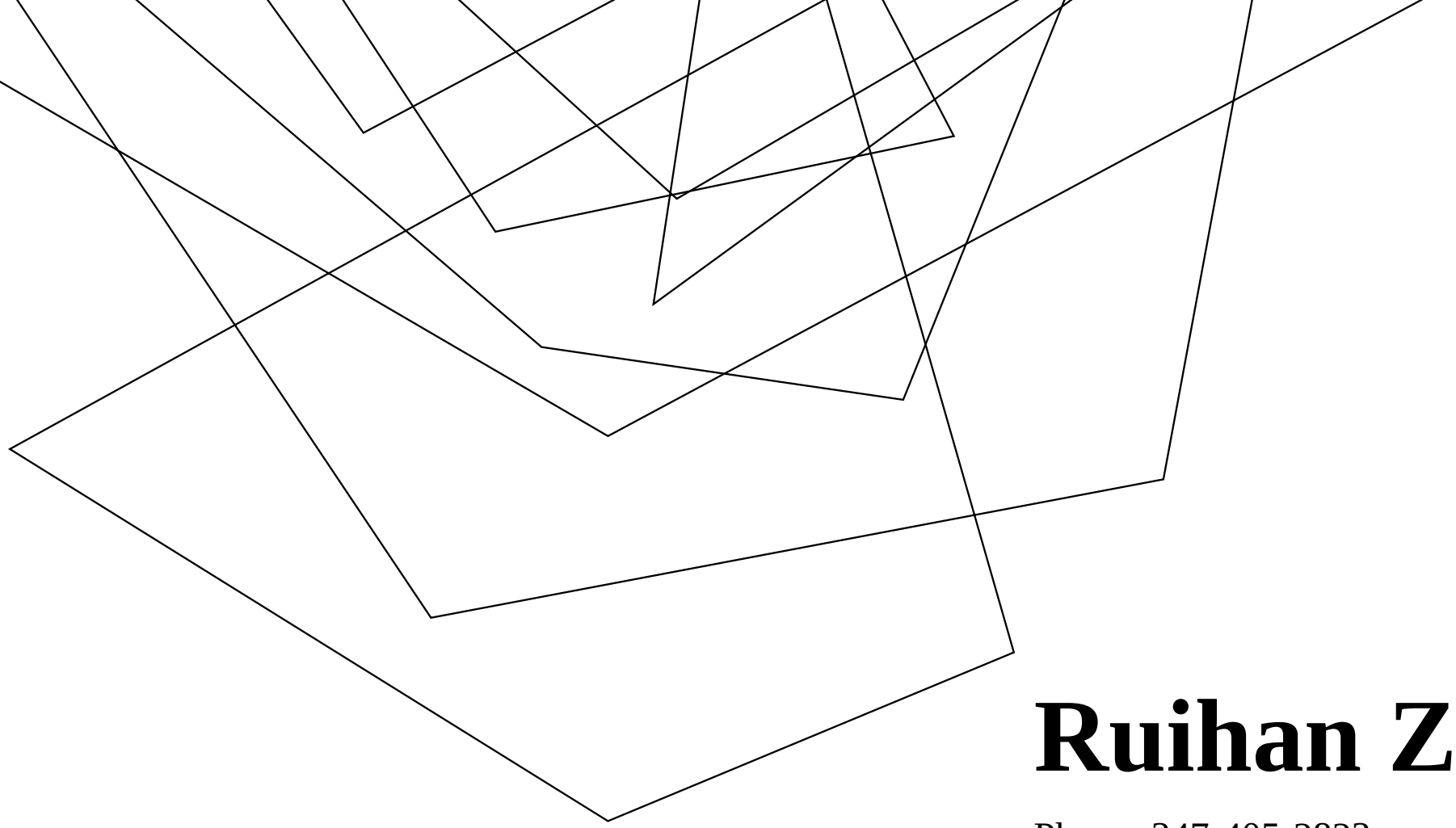

Ruihan Zhu

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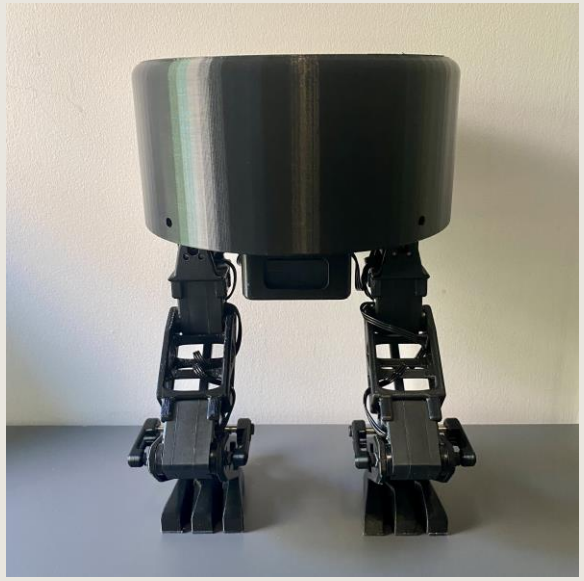
Profile: www.linkedin.com/in/ruihan714

Education

- **Columbia University (CU)**, New York, NY (Sep 2022 until now)
  Master of Science in Mechanical Engineering
  Concentration in Robotics and Control

- **University of Washington (UW)**, Seattle, WA (Sep 2017 - Jun 2021)
  Bachelor of Science in Mechanical Engineering
  Concentration in Mechatronics, Minor in Mathematics.



Robotics Studio

(Columbia University)

Aim:

Design and construct an legged robot using up to eight motors in total and embedded control program. Develop a locomotion pattern that makes the robot walk.

Result:

Designed and 3D printed a biped walking robot controlled by an embedded control program, and it can walk 2.5 cm/s.

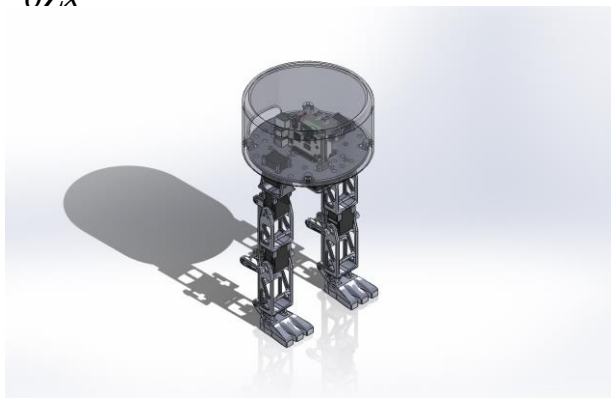
Tools:

SolidWorks, Python (PyBullet), Raspberry Pi, 3D printing

Journey Video Link: https://youtu.be/mzutKupubok

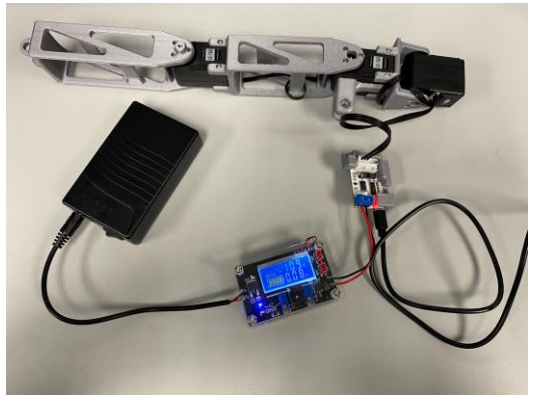
CAD Model and Manufacture

Designed a biped walking robot with a CAD model.
3D printed all parts and assemble the prototype with electronics.
Tested the motion and extreme position of a single leg.
Video link:
https://youtube.com/playlist?list=PLRk1L8o740uLq5HIrg78cxN640DTgj0Zx



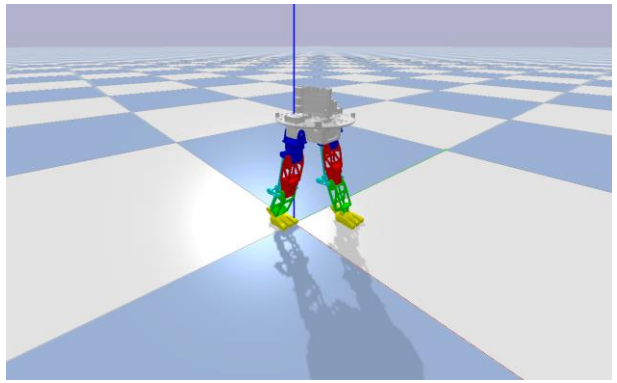
Locomotion Pattern

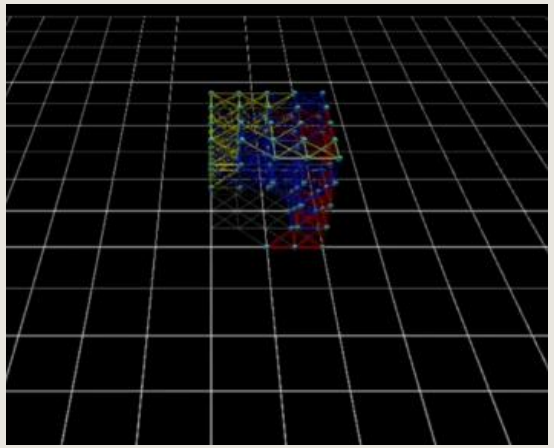
Developed and implemented a locomotion pattern to achieve walking of the robot using central pattern generators. The general repetitive locomotion pattern used on the robot is periodic gait and manually optimizing the parameters.



Simulation (Future expectation)

Converted the CAD model to URDF file and modeled the robot in PyBullet.
Utilized evolutionary algorithms to find a better locomotion pattern, but the outcome was not satisfactory.
Expected a better result using Reinforcement Learning.





Evolving Soft Robots

(Columbia University)

Aim:

Utilized evolutionary computation to evolve the locomotion pattern of soft robots with varying morphologies.

Result:

Developed a physics simulator to simulate soft robots. Evolved a soft robot with a locomotion pattern that can move 0.203 m/s and 0.146 maximum size per cycle.

Tools:

Python (VPython)

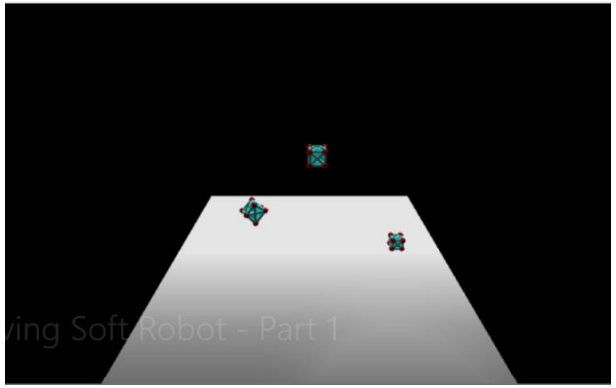
Video Link: https://youtu.be/FYMlVDjxCRY

Physics Simulator

Developed a physics simulator using a mass and spring system to simulate soft robots. This simulator simulates gravity, spring force, and restoration force. Time step of one frame of motion is 0.0005.

Video Link:

https://youtu.be/DW1ca1YNpr8



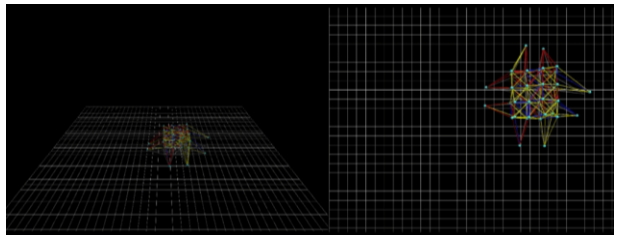
Fixed Morphology

Evolved a locomotion pattern of a soft robot with a fixed morphology using evolutionary computation, by adjusting the material parameter of the springs.

Result in a speed of 0.245 m/s, 0.35 maximum size per cycle.

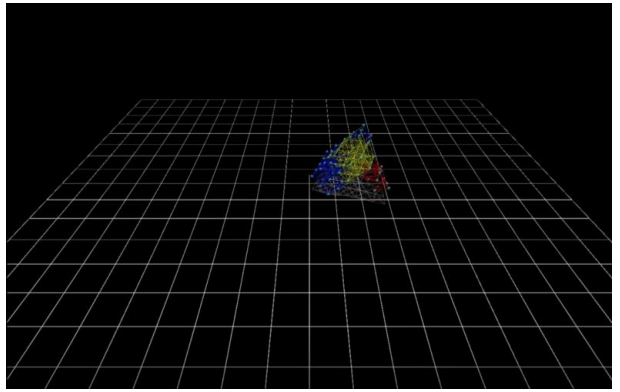
Video link:

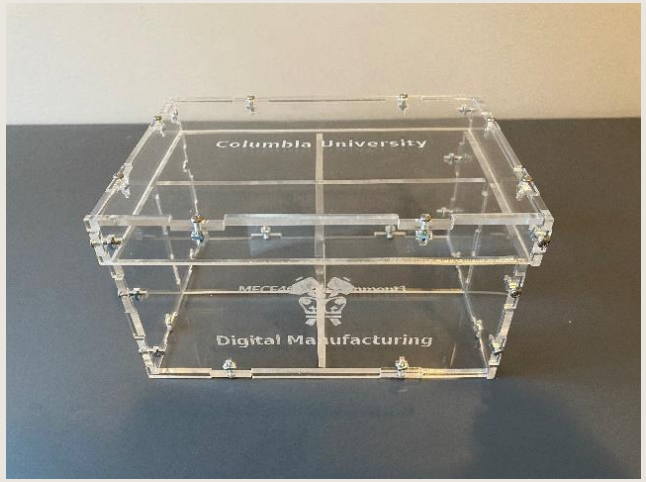
https://youtu.be/NrJHyycGrkM



Variable morphology

Evolved a locomotion pattern of a soft robot with a variable morphology using evolutionary computation by the same method on the left, expect it add a change by removing springs and masses from a base body.





Digital Manufacturing: Laser Cut Desk Organizer

(Columbia University)

Aim:

Developed a program to generate parts for a customized small acrylic desk organizer. Use laser cut to manufacture the design and assemble it.

Result:

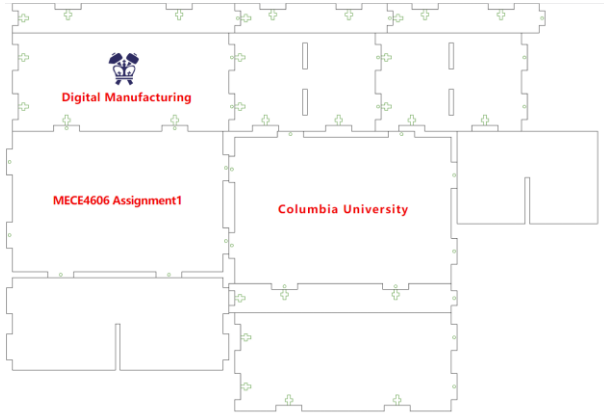
The program can output flat pattern of the organizer with different custom inputs. Two samples were made by laser cutting.

Tools:

Python, Laser cutter

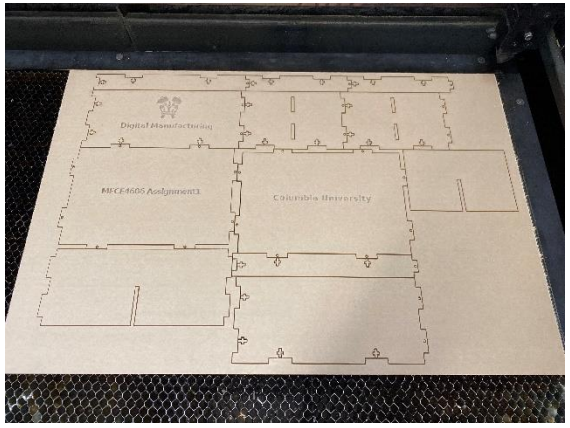
Output Flat Pattern

Based on the input parameters, the program can generate an output flat pattern of SVG file that can be used on a laser cutter for manufacturing. Custom input contains length, width, height of the box, divider position, and text on top and bottom of the box.



Laser Cutting

With the SVG file generated by the program, I manufactured and assembled two sample desk organizers. The design implements DFA to ensure the organizer can be successfully assembled.



Digital Manufacturing: Desk and Chair Design

(Columbia University)

Aim:

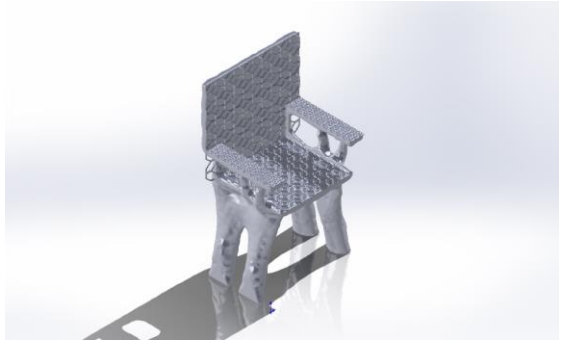
Propose an optimal design for a desk that is 30” high, 24” deep, and 60” wide, and design a chair with a back, suitable for seating an adult weighing up to 150 Kg using topology optimization.

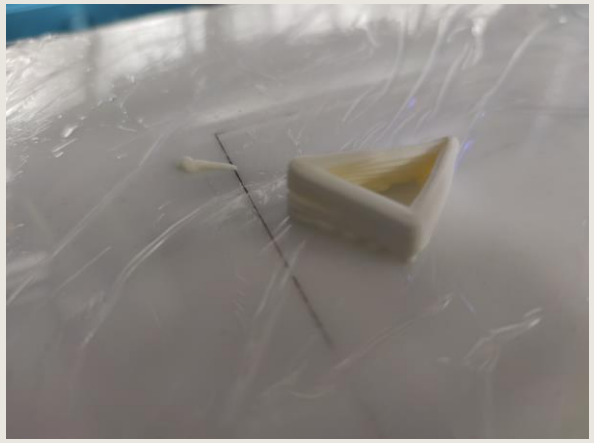
Result:

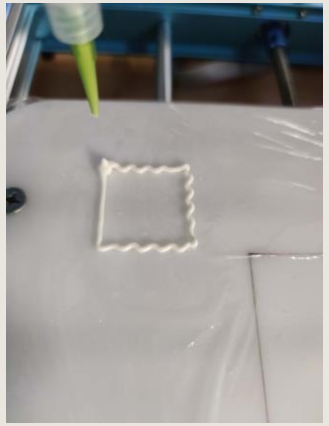
Designed a desk and chair that meets the initial goal with a lattice structure.

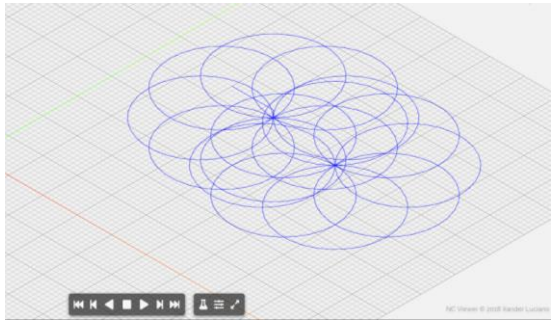
Tools:

SolidWorks, nTopology









Digital Manufacturing: Food Printing

(Columbia University)

Aim:

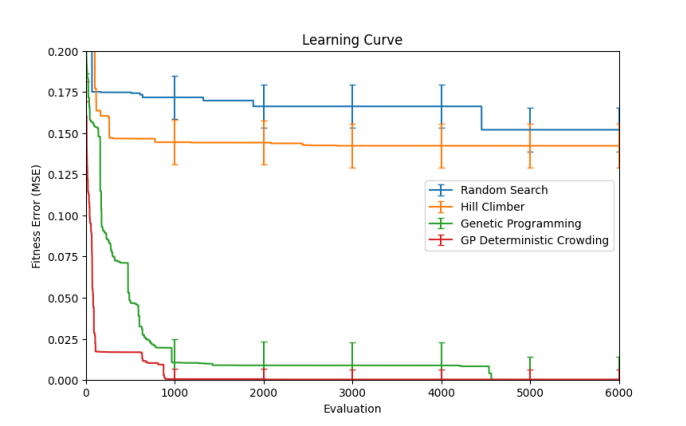
Develop a source code that generated the G-code to fabricate a 3D structure using food material.

Result:

Used 3D printing to fabricate a square, twisted triangle, and an intricate shape with cream cheese.

Tools:

Python, G-code, 3D printing



Symbolic Regression

(Columbia University)

Aim:

Use genetic programming to perform symbolic regression that can find the symbolic algebraic expression of the form y=f(x) with a set of (x, y) data.

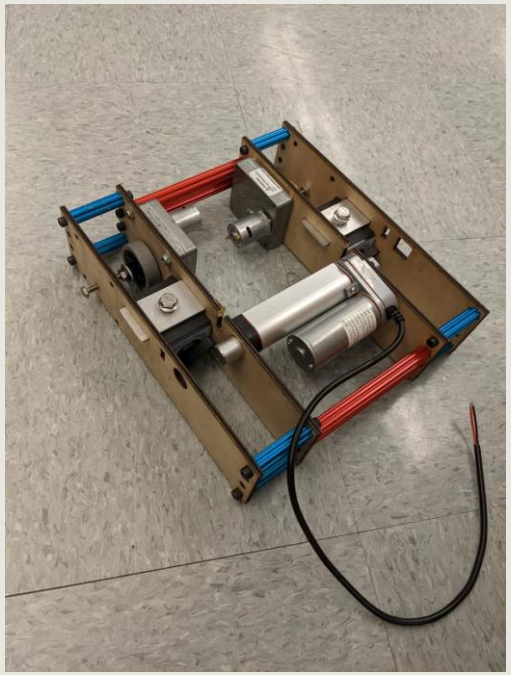
Result:

Successfully found an expression that has 0.0000001437 mean squared error with the given true dataset.

Tools:

Python

Video Link: https://youtu.be/mtXlYVkfNXY



Wall-climbing Robot

(University of Washington)

Aim:

Design and construct a wall-climbing robot for in-tank work. The design should be able to attach, detach on the wall, counter gravity, and move on the vertical wall.

Result:

Designed and manufactured a prototype that can attach, detach on the wall, counter gravity, move on the vertical wall, and can carry a 2 lb. payload.

Tools:

SolidWorks, Python

Contribution

Took on the leadership role for the chassis part team, making plans, assigning work, and tracking the process.

Contributed to the magnetism, control, and power portions of the project in collaboration with team members.