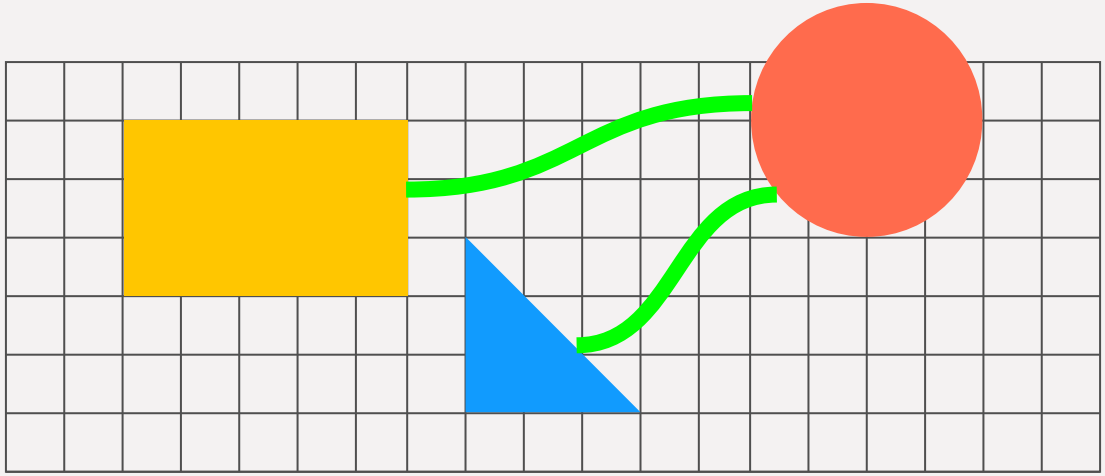
Dirac Assembly Simulation



Meet the team

Team Lead:

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Members:

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Kate Li
➔ 1st year BS CS

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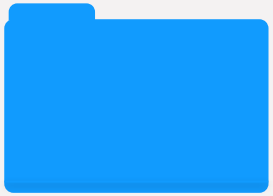
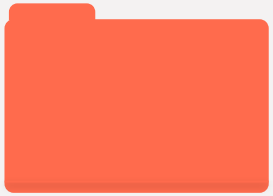
➔ 2nd year BS CS

Agenda

Problem & Scope



Process



Algorithm Overview

Achievements & Next Steps

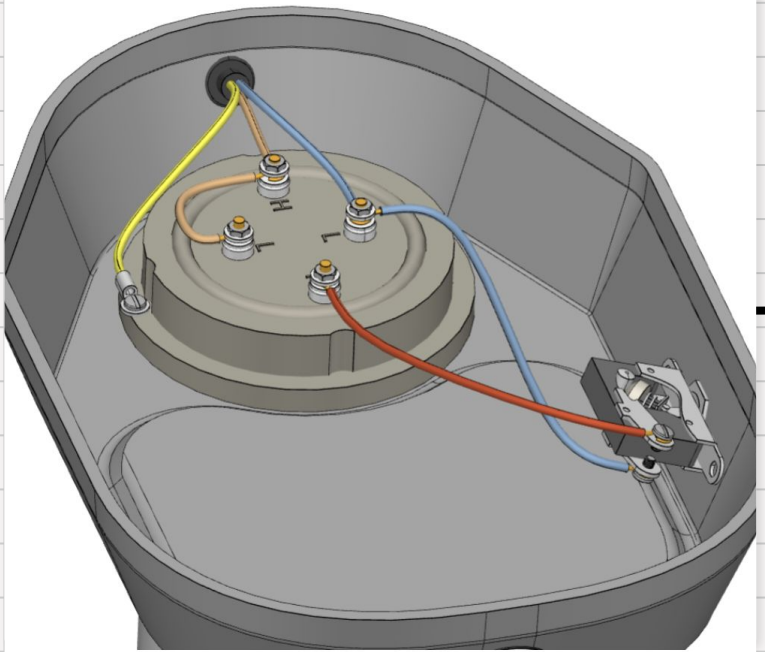
Problem Statement

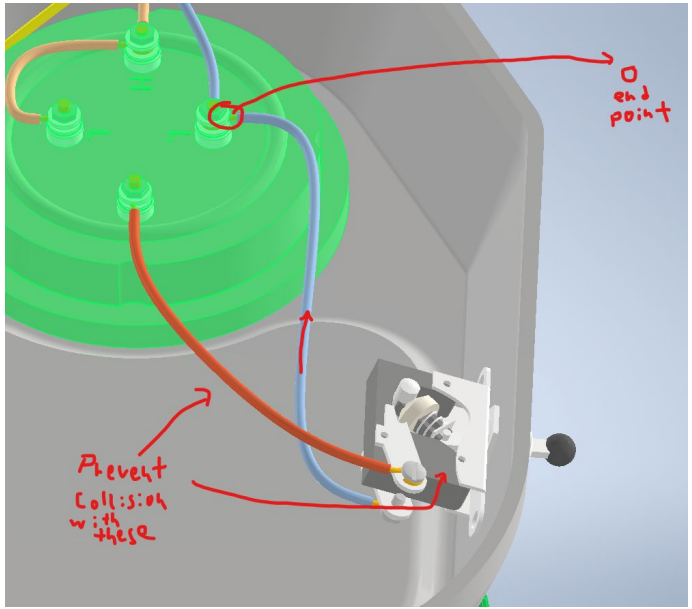
- Simulate the **installation and removal of a flexible wire** in a 3D electrical cabinet model
- Ensure the wire's motion accounts for real-world constraints like **collisions and bending** behavior
- Reflect the wire's **physical properties**, including tension, elasticity, and minimum bend radius

Scope

- Focus on simulating the **flexible properties** of the wire realistically in 3D space
- Account for **obstacles or collisions** during installation and removal
- Provide a **clear, optimal path** for wire placement based on its physical behavior and spatial constraints

Process





Timeline

Date	Topic	Take-Home Work
Monday Oct 21	Kickoff with Dirac project sponsor	• Familiarize ourselves with 3D model of coffee machine • Research tools for 3D model manipulation
Friday Nov 1	Discussed 3D model; curated list of questions for sponsor	• Continue researching tools and familiarizing ourselves with 3D model
Thursday Nov 7	Met with sponsor to go over critical questions and further discuss problem statement	• Review 3D model
Friday Nov 8	Went over 3D model as a group and discussed in regard to questions answered by sponsor	• Come up with 2 algorithm / tool ideas and be ready to share

Timeline

Date	Topic	Take-Home Work
Friday Nov **15**	Shared potential algorithms / tools for manipulating 3D model; determined which tools to start with	• Prepare code for removing wires from coffee machine
Friday Nov **22**	Reviewed code samples and debugged to account for wire blockage	• Prepare code for animating algorithm
Friday Nov **29**	Discussed animation updates and planned for showcase presentation	• Finalize deliverables • Prepare for showcase
Wednesday Dec **4**	Product @ GT Showcase presentation	• Send deliverables to Dirac project sponsor

The Algorithm

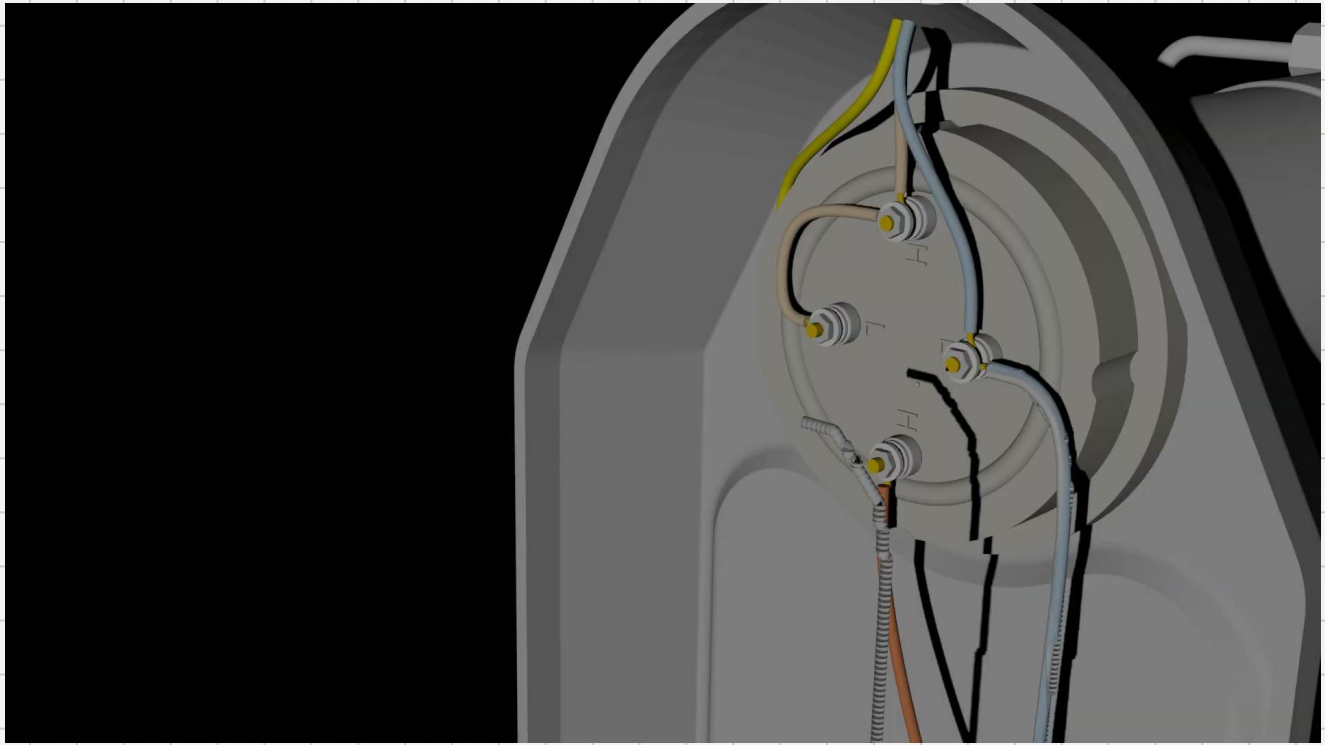
Blender Python API (bpy) pathfinding script

- Uses the **A* pathfinding-based algorithm** to navigate 3D space without collisions
- Tries to find such a path in a 3D environment and visualizes it on spheres
- The purpose is to identify the most effective and efficient way to remove the wires. It supplements this with **Blender's collision detection and object manipulation**, to add visual feedback using the script.

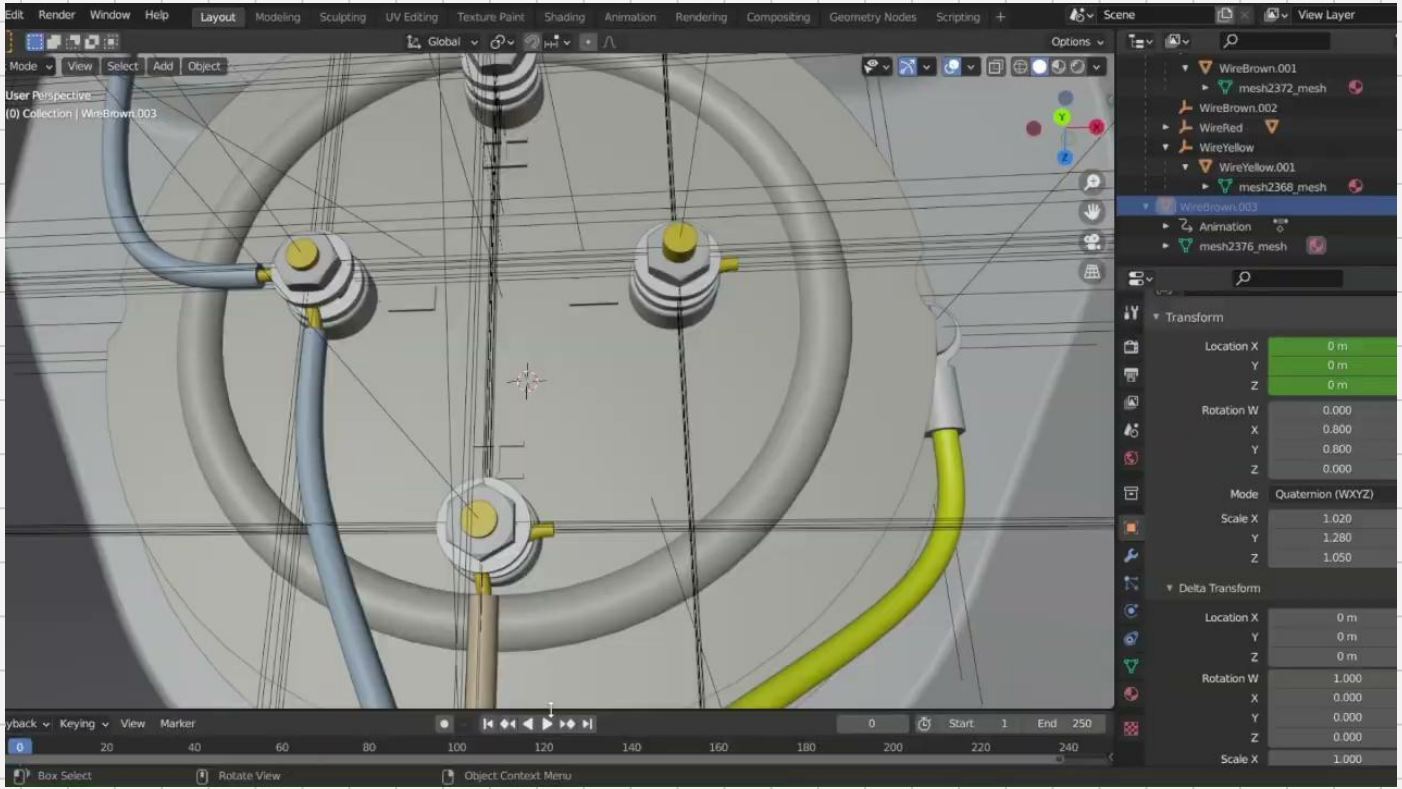
Some tools we tested:

- A*
- PythonOCC and Breadth-First Search Travel
- Unity ML-Agents for RL training and NVIDIA Isaac Gym

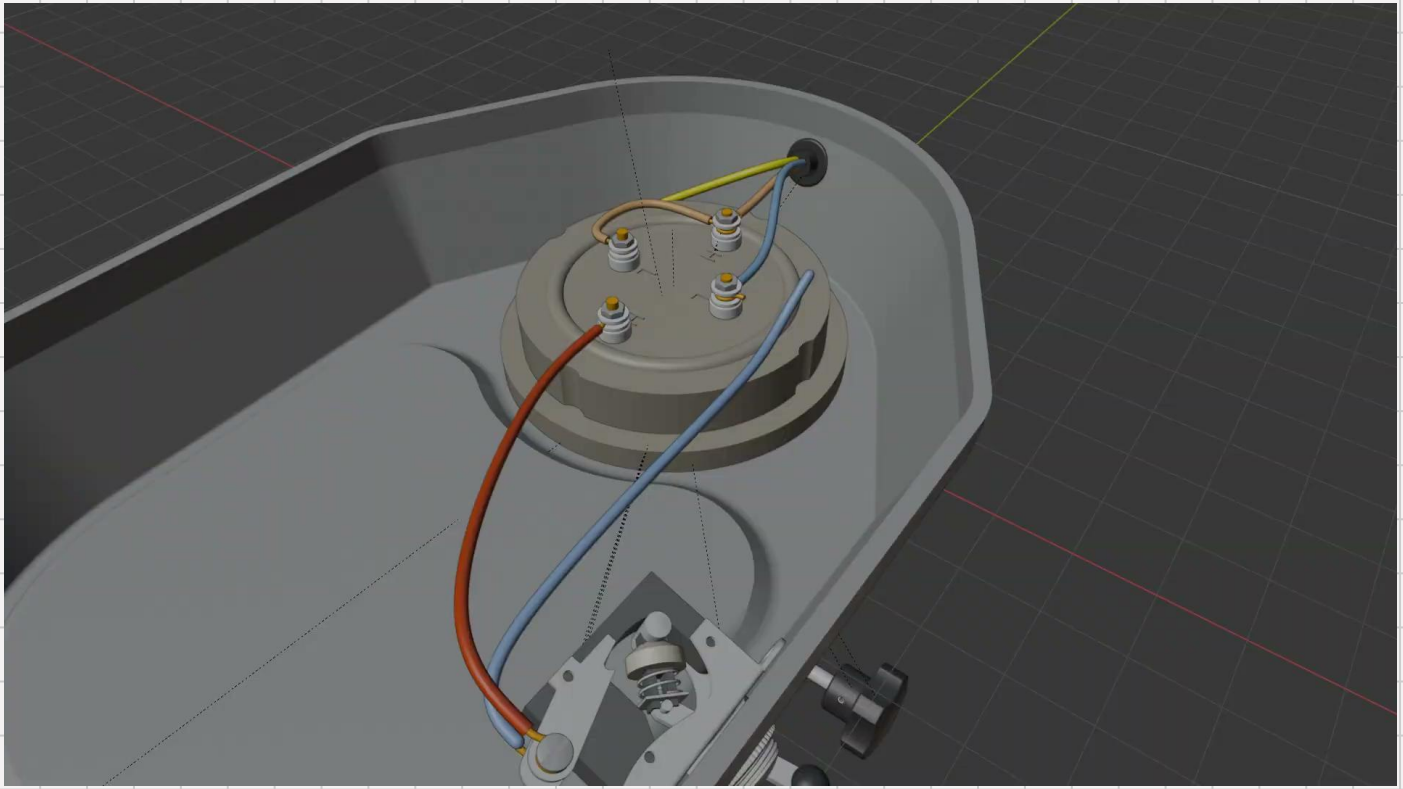
The Animation with FreeCAD



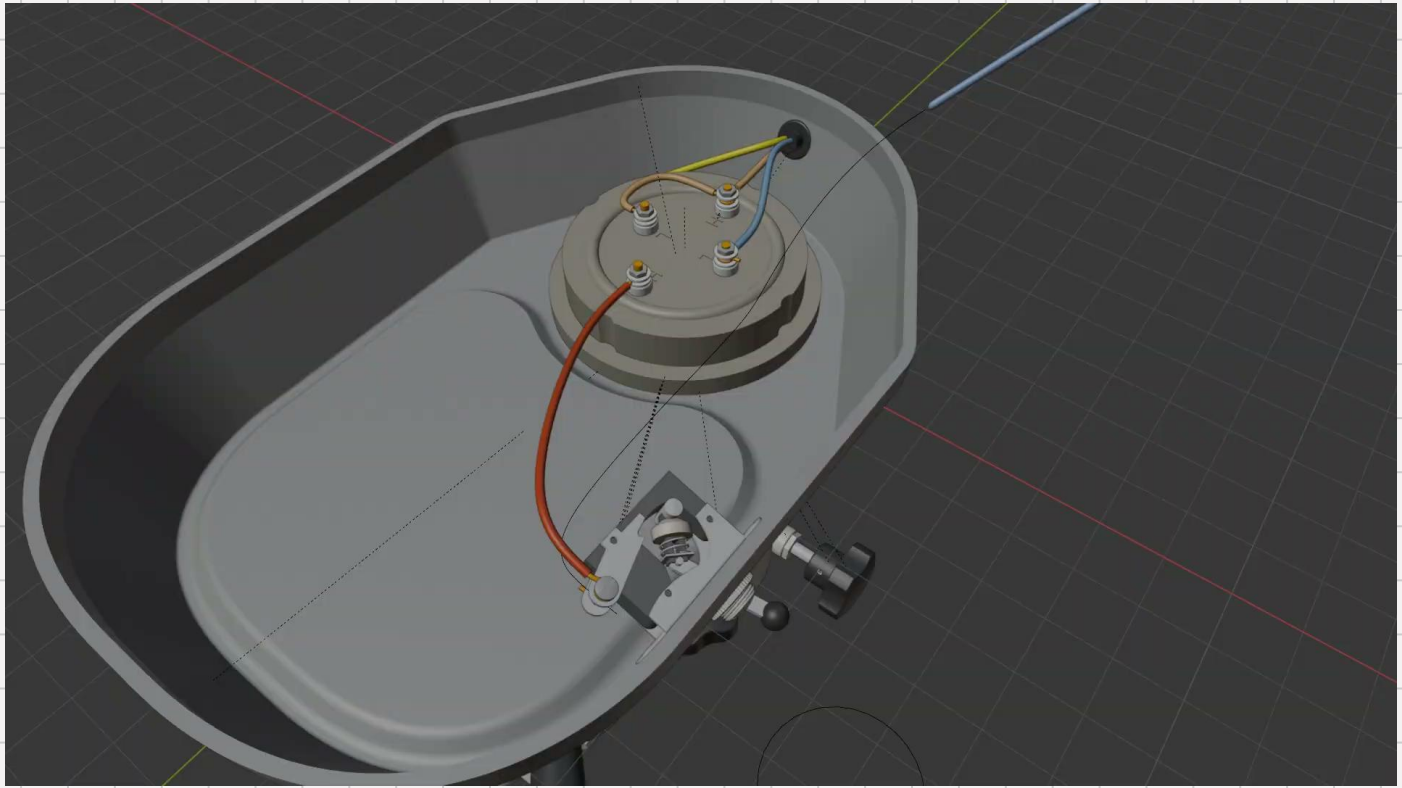
The Animation - Test with Blender



The Animation - Wire Removal



The Animation - Wire Installation



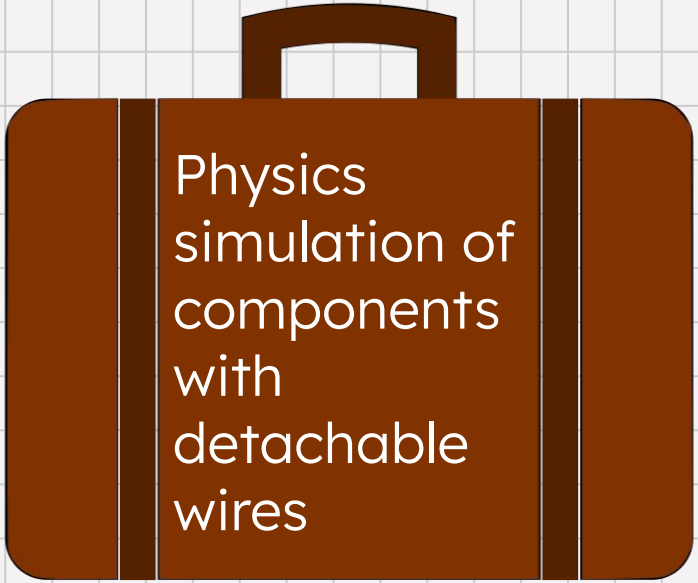
Accomplishments

- Learned how to manipulate 3D objects via CAD files in Python
- Tested multiple types of platforms for animation
- Tested multiple types of algorithms to figure which is the most effective and most efficient

Future Goals

- Improve algorithm & animation to unhook the wire from copper hook
- Tailor the algorithm to a more complex model
- Try to implement either PythonOCC or machine learning to further improve the algorithm

Business Value



Thank you!

We appreciate the support of Product@GT and our Dirac Project Sponsors, Jerrod Heiser and Filip Aronshtein.