2020 Comau MDP Project – Robotic 3D Tetris

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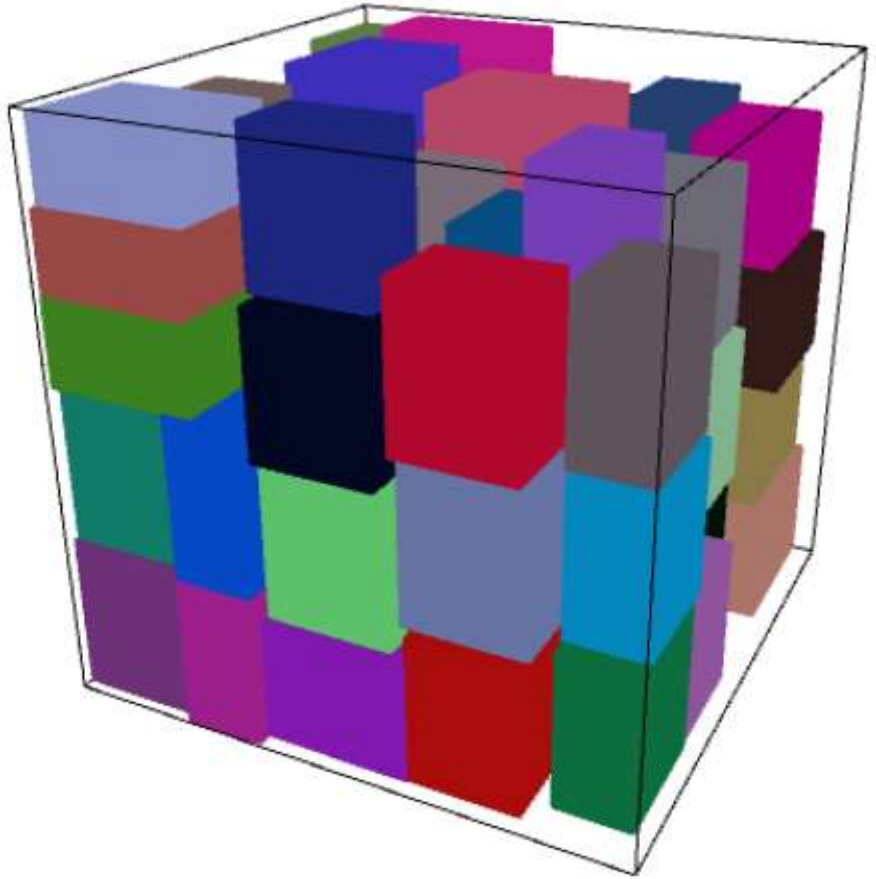
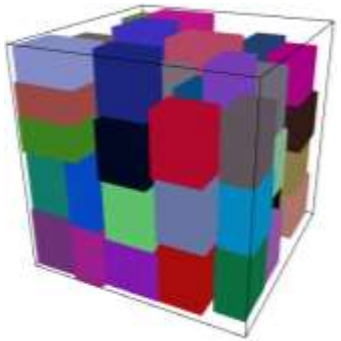
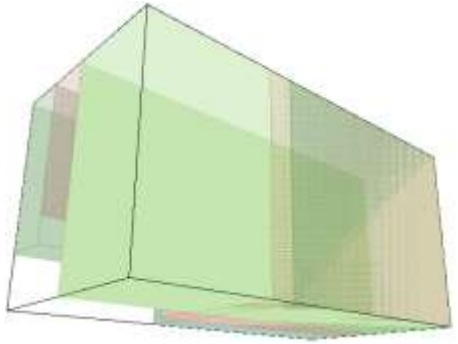
Sponsor Mentor: *Joshua Graff*



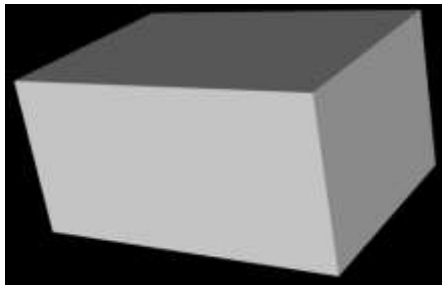
This presentation covers the Comau 2020 MDP project: Robotic 3D Tetris.



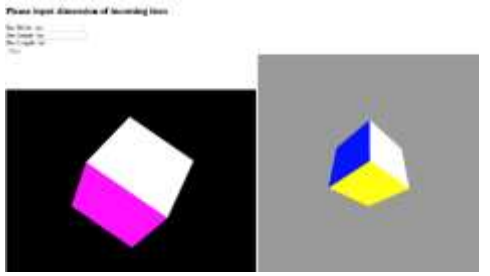
Project Overview



Our Solutions



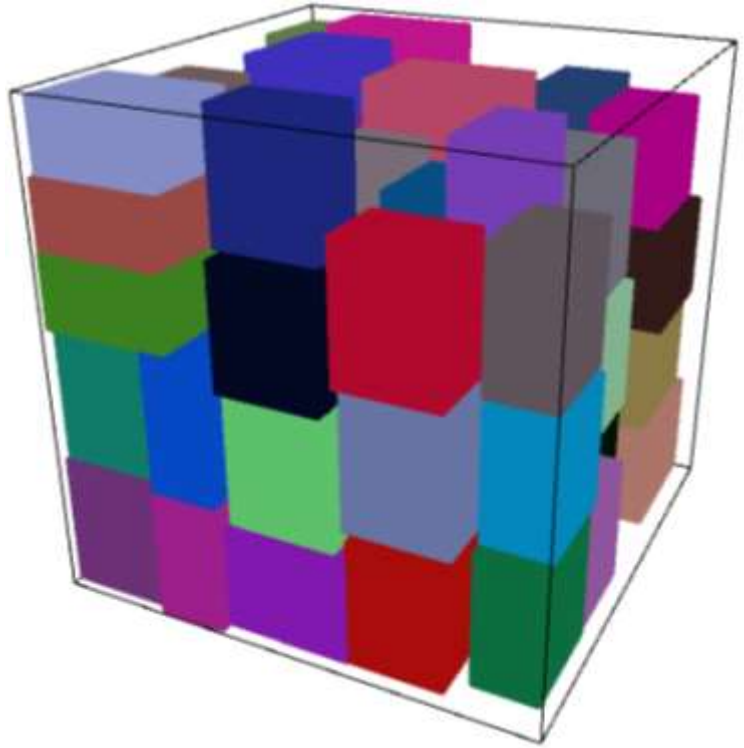
Results



Next Steps

Our project measures the dimensions of an incoming item and determines the optimal location for it within a container.

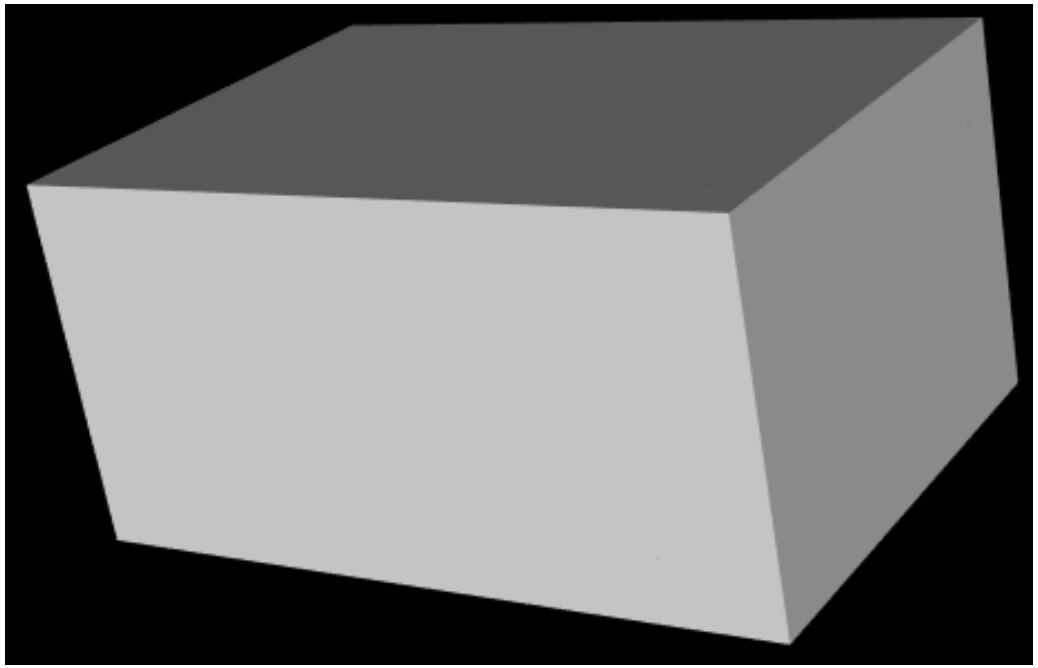
Point cloud of an incoming item



GUI visualization of a packed container

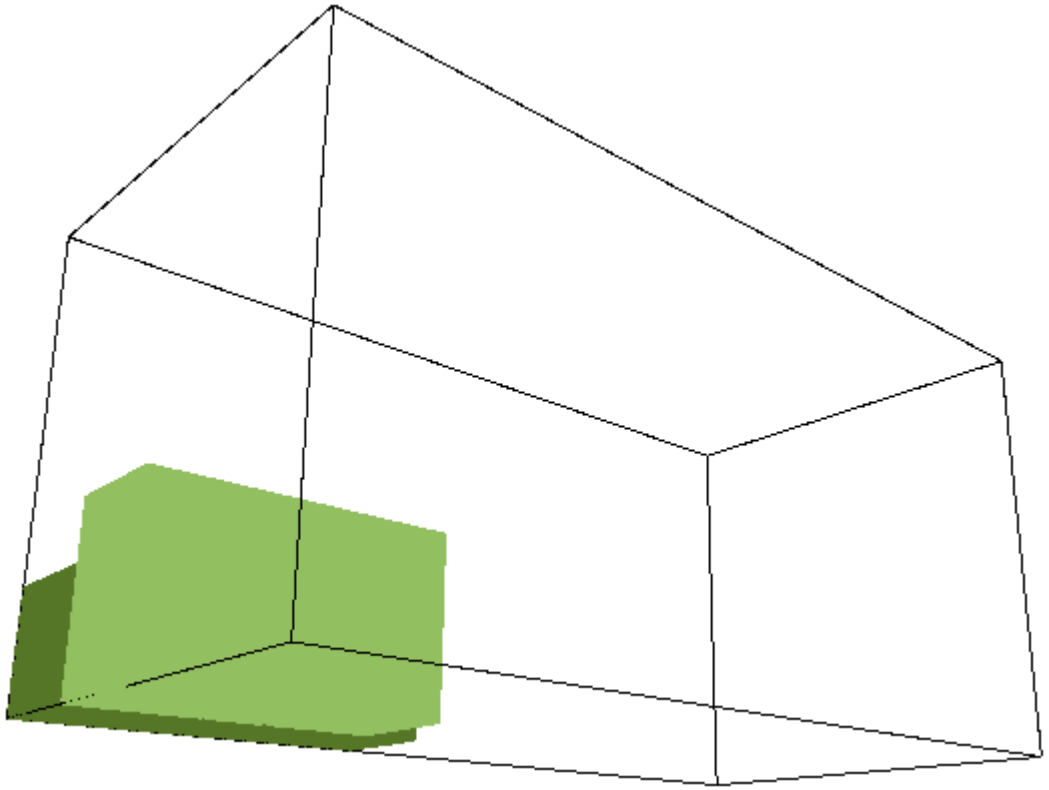
Our system measures incoming items by merging two point clouds and creating a minimal oriented bounding box.

Point cloud of the incoming item

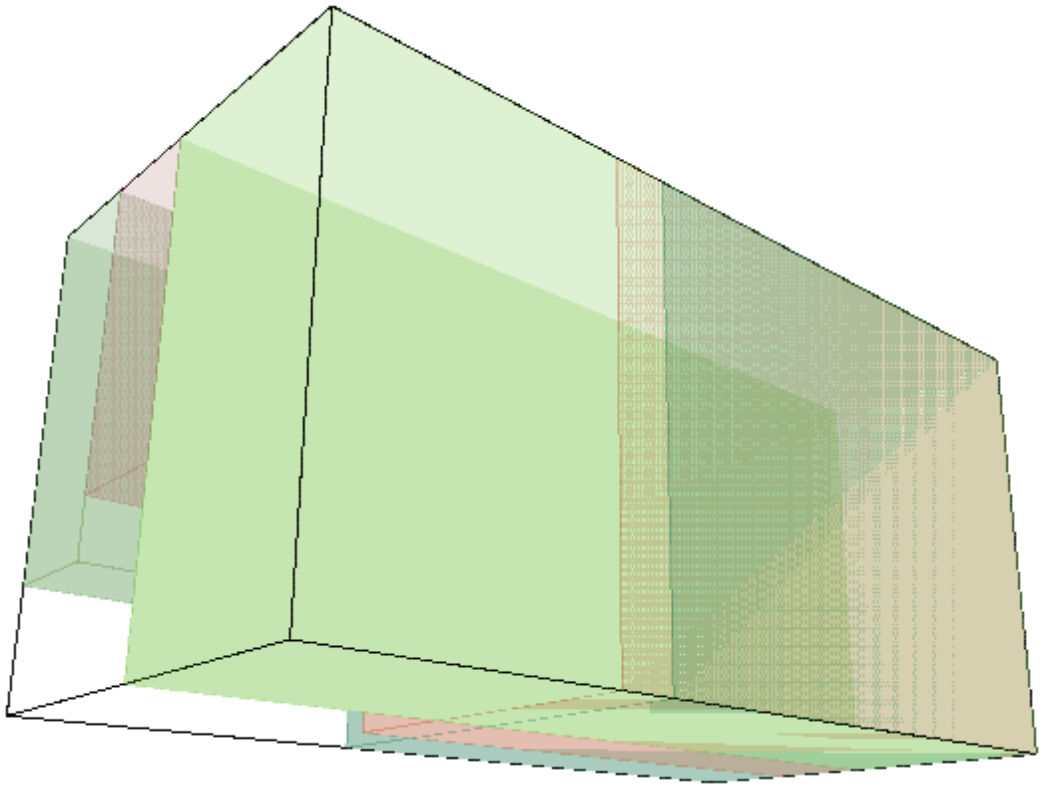


The generated bounding box for the item

Our system packs items into the container using a modified version of the Online Bin Packing Heuristic.

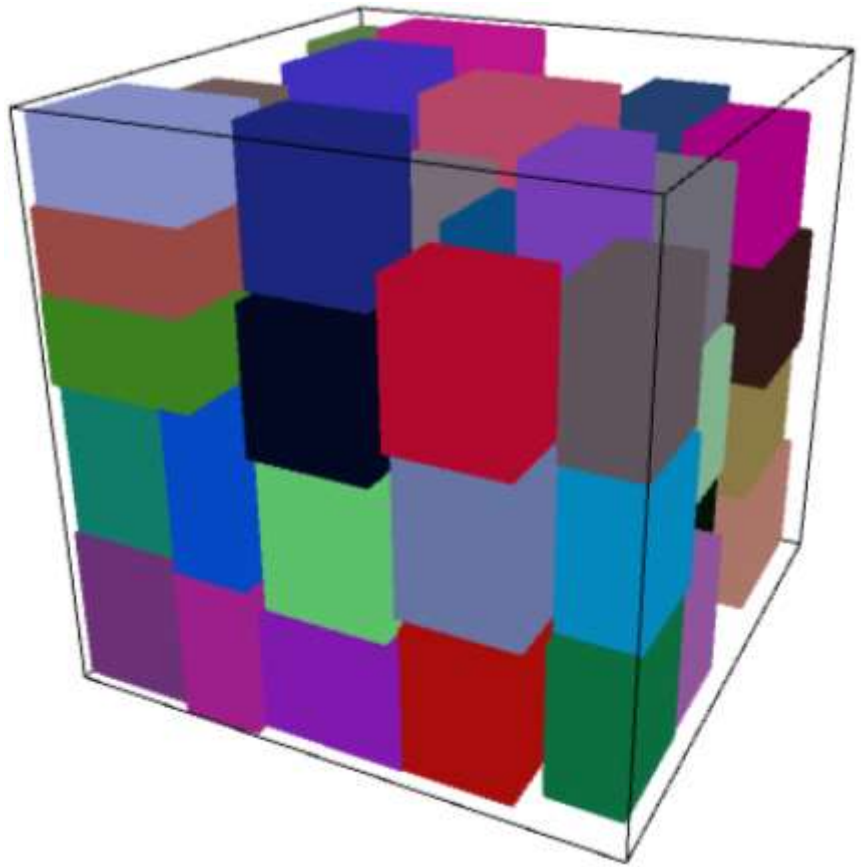


Two items placed in a container



The corresponding Empty Maximal Spaces for the items

Our system displays data via two programs: a bin packing visualizer and a data and parameters interface.



The bin packing visualization

```
Starting packing server
Packing server started
Connected to visualization GUI
Received message "Visualization GUI connected"
Enter bin dimensions:
        Width:  100
        Height: 100
        Depth:  100
New item placed
        Dimensions:
                Width:  30
                Height: 18
                Depth:  12
        Location:
                X: 0
                Y: 0
                Z: 12
Starting segmentation server
Segmentation server started
Waiting for next object
New object detected
Object dimensions:
        Width:  42.0094
        Height: 19.7191
        Depth:  39.155
Waiting for next object
```

The data and parameter interface

The various components of our system communicate via the TCP/IP communication protocol.

```
Start server

42.009388 19.719147 39.154961
Response sent

39.922001 45.582371 9.877568
Response sent

16.761137 38.411480 13.888736
Response sent

27.698500 23.869852 31.443544
Response sent

18.239223 25.670046 47.611488
Response sent
```

A sample TCP/IP server

```
42.009388 19.719147 39.154961
Dimensions sent
Server received dimensions

39.922001 45.582371 9.877568
Dimensions sent
Server received dimensions

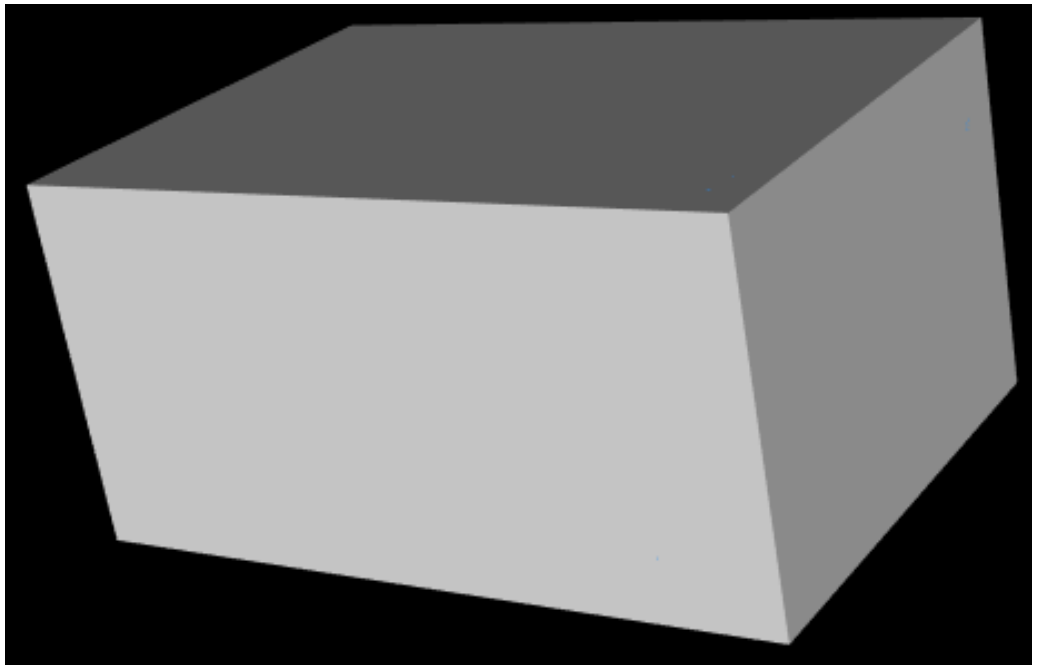
16.761137 38.411480 13.888736
Dimensions sent
Server received dimensions

27.698500 23.869852 31.443544
Dimensions sent
Server received dimensions

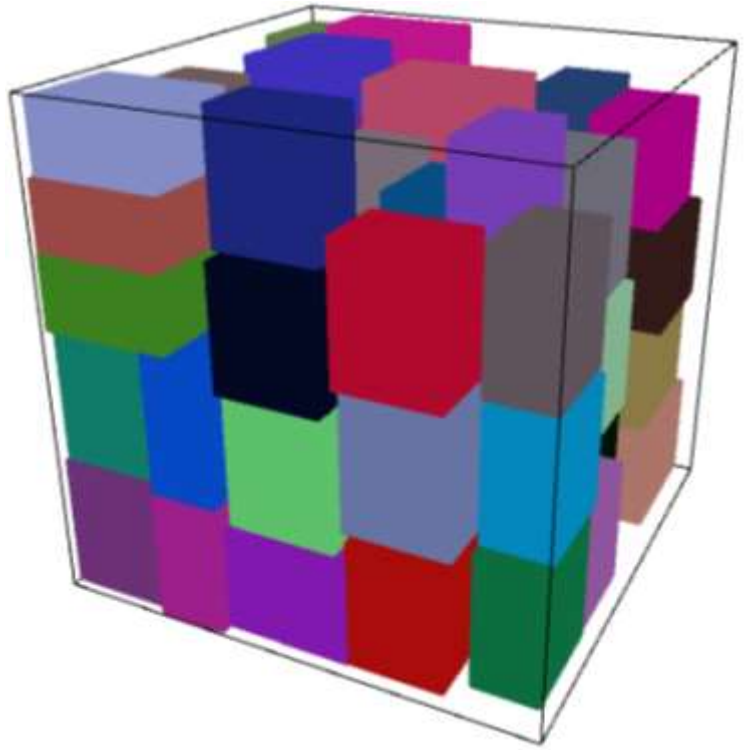
18.239223 25.670046 47.611488
Dimensions sent
Server received dimensions
```

A sample TCP/IP client

Our system’s components met or made very good progress towards our original goals.



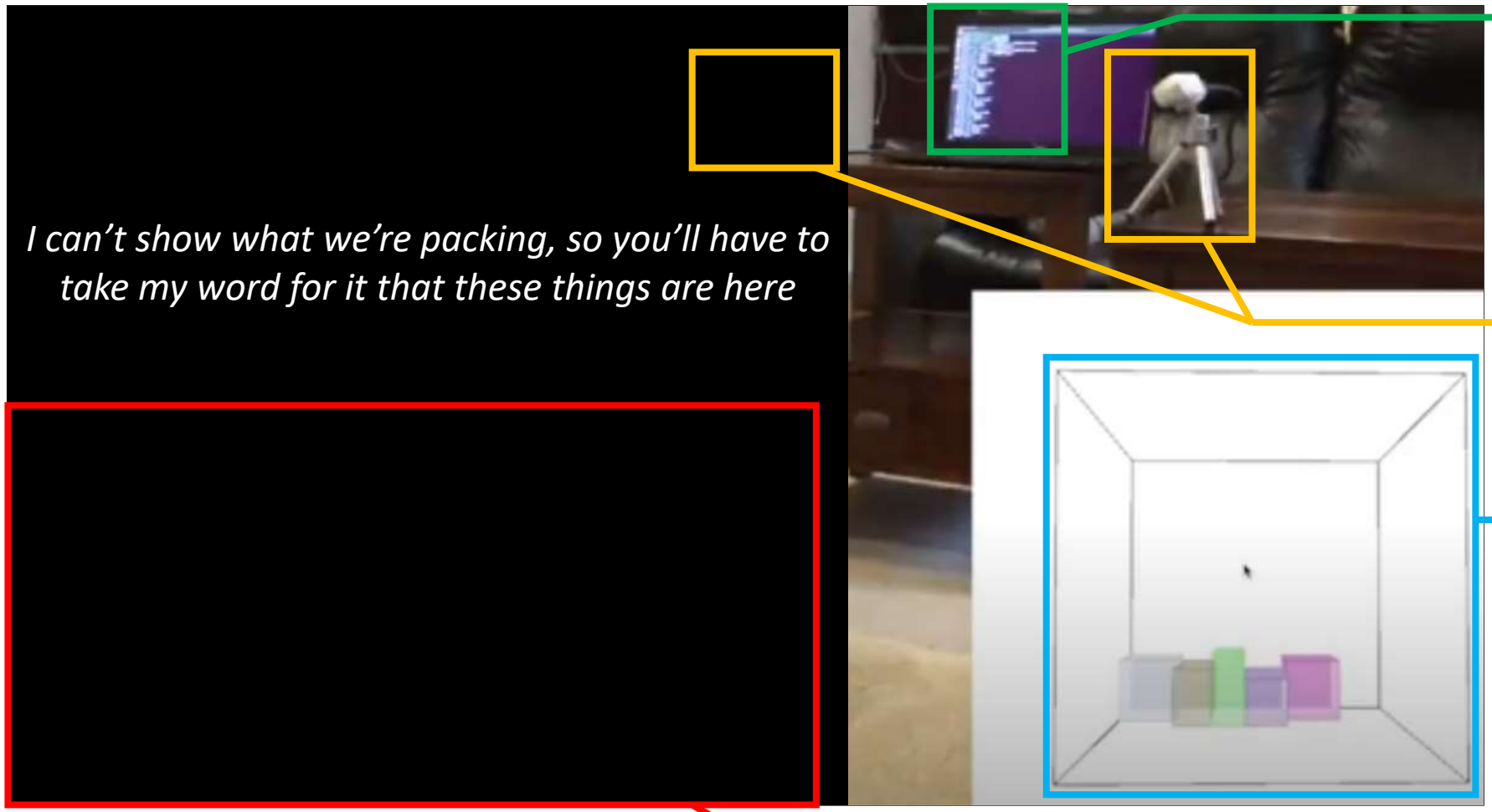
Our segmentation algorithm measures items within a 2.5% margin of error



Our bin packing algorithm fills at most 75% of the container

Our system worked as a whole and met our desired cycle time.

I can't show what we're packing, so you'll have to take my word for it that these things are here



Segmentation computer

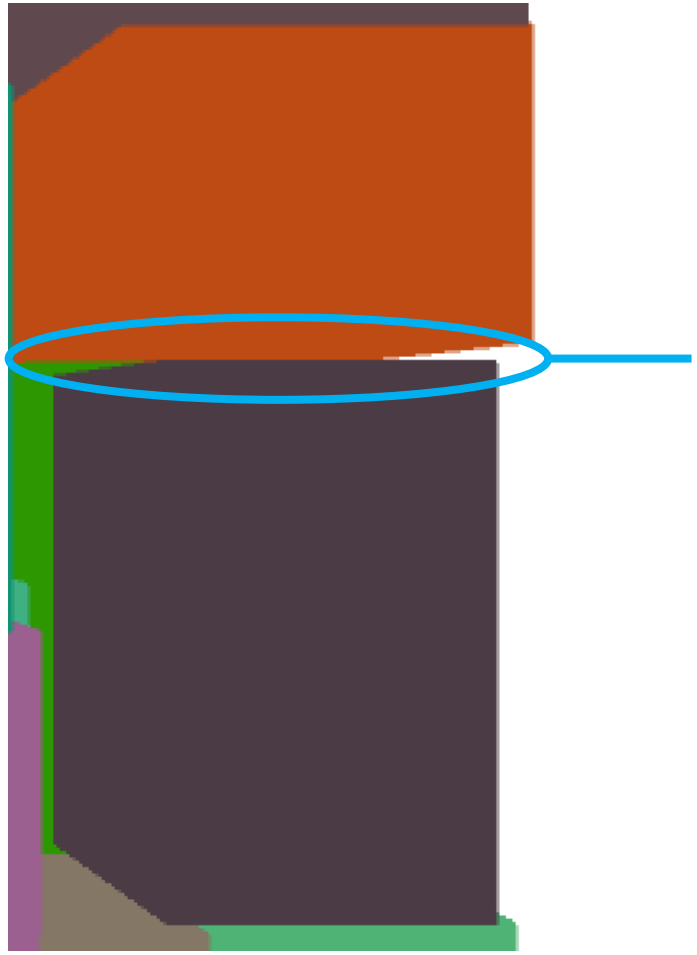
Depth cameras

GUI (Bin packing visualizer)

Item staging area

Not shown: Bin packing computer

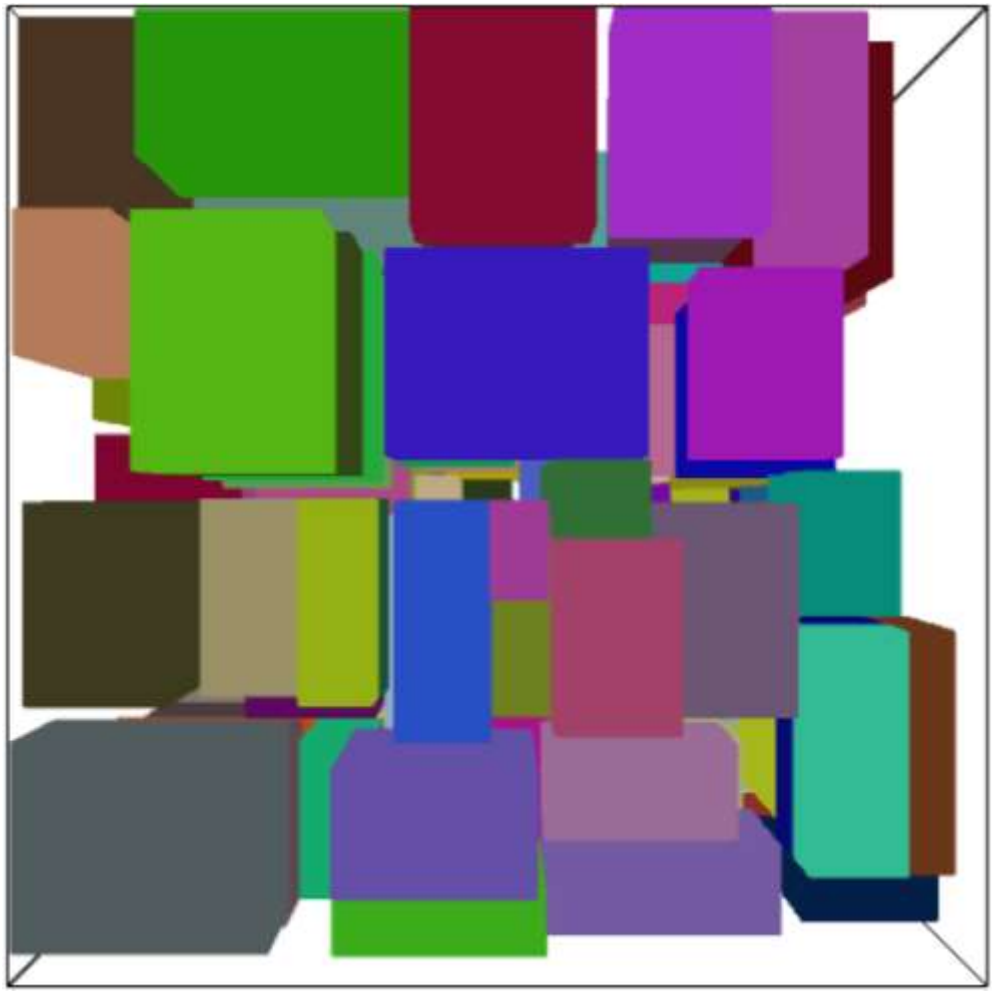
More realistic item modeling & simulation would help our algorithms and the system as a whole better reflect reality.



An excerpt of the left view of our best packing case

Note the empty spaces between the items

The bin packing algorithm could be improved by cutting down on the empty spaces between items.



A top view of our best packing case

Combining the GUI's components into a single program would increase ease of use.

```
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Waiting for next object
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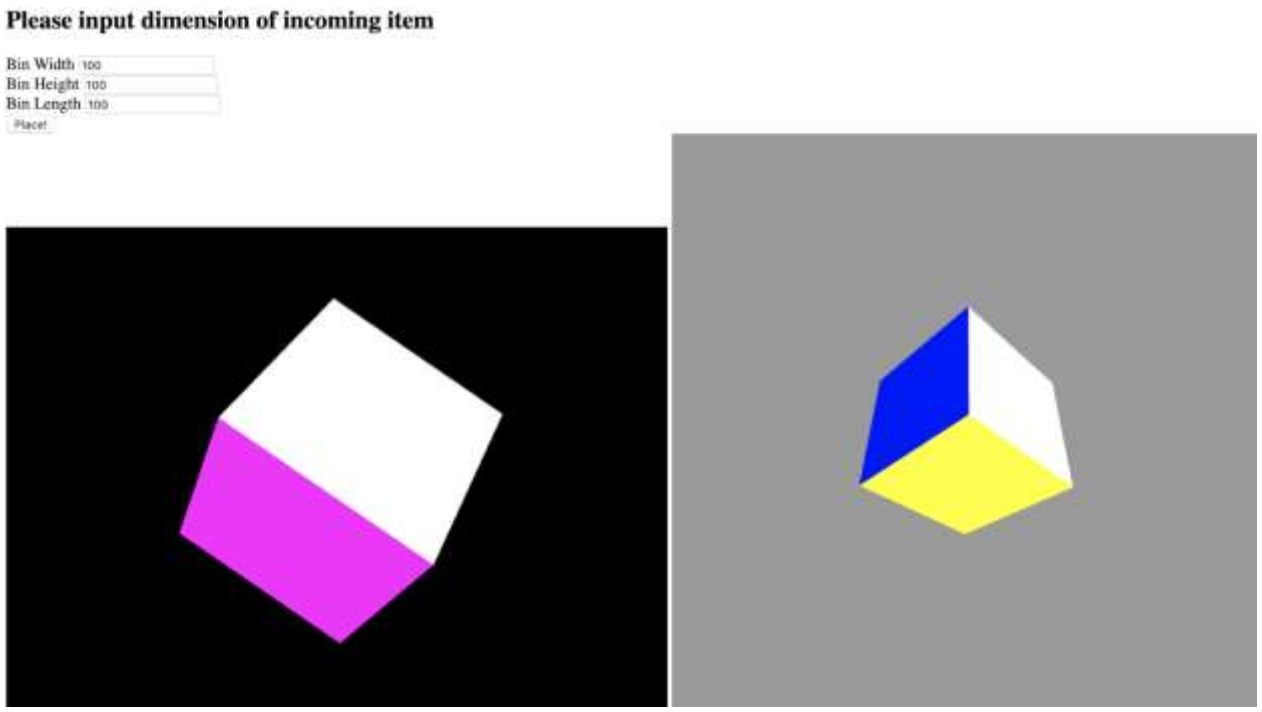
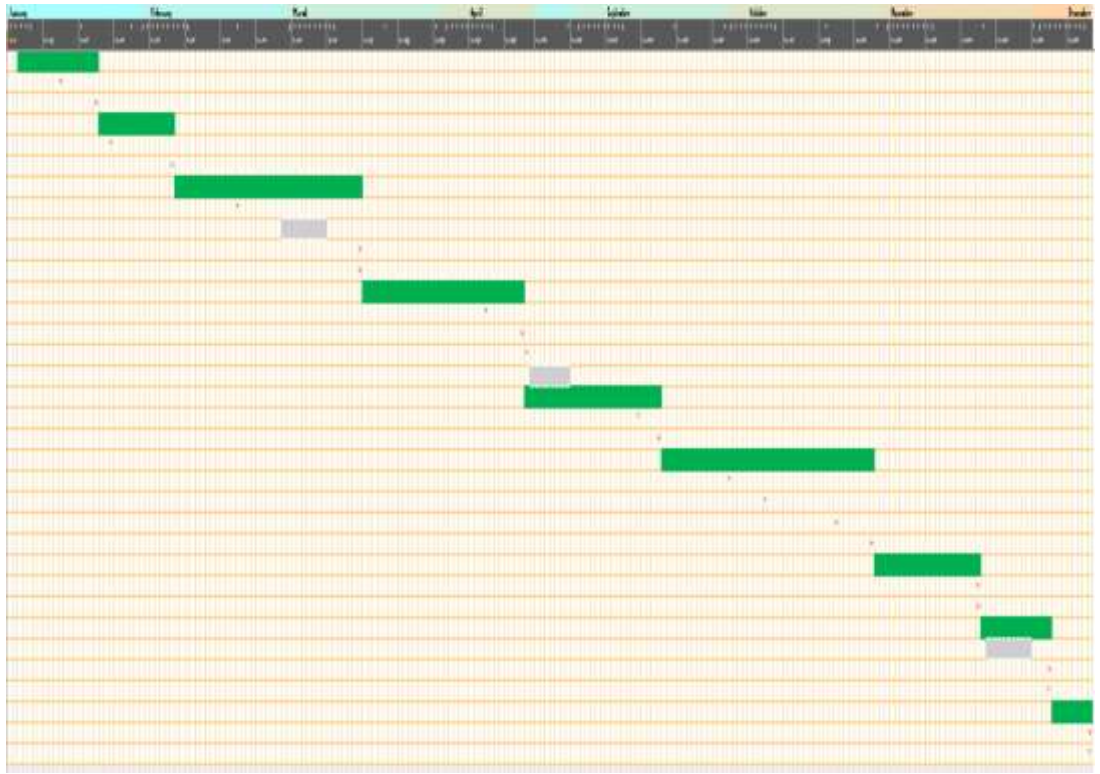
Our current data and parameter interface



An early prototype of our GUI

In summary, our project successfully solved the problem we were presented with, but can still be improved.

- We met our goal for accurately measuring items
- Our bin packing algorithm fills 75% of the container (our goal was 85%)
- Our GUI is functional but could be a bit clearer



Questions?