MSE | MASTER OF SCIENCE IN ENGINEERING

University of Applied Sciences and Arts of Southern Switzerland

SUPSI

Topic Model 4

Design and Configuration of Automated Production Systems using Virtual Environments

Group
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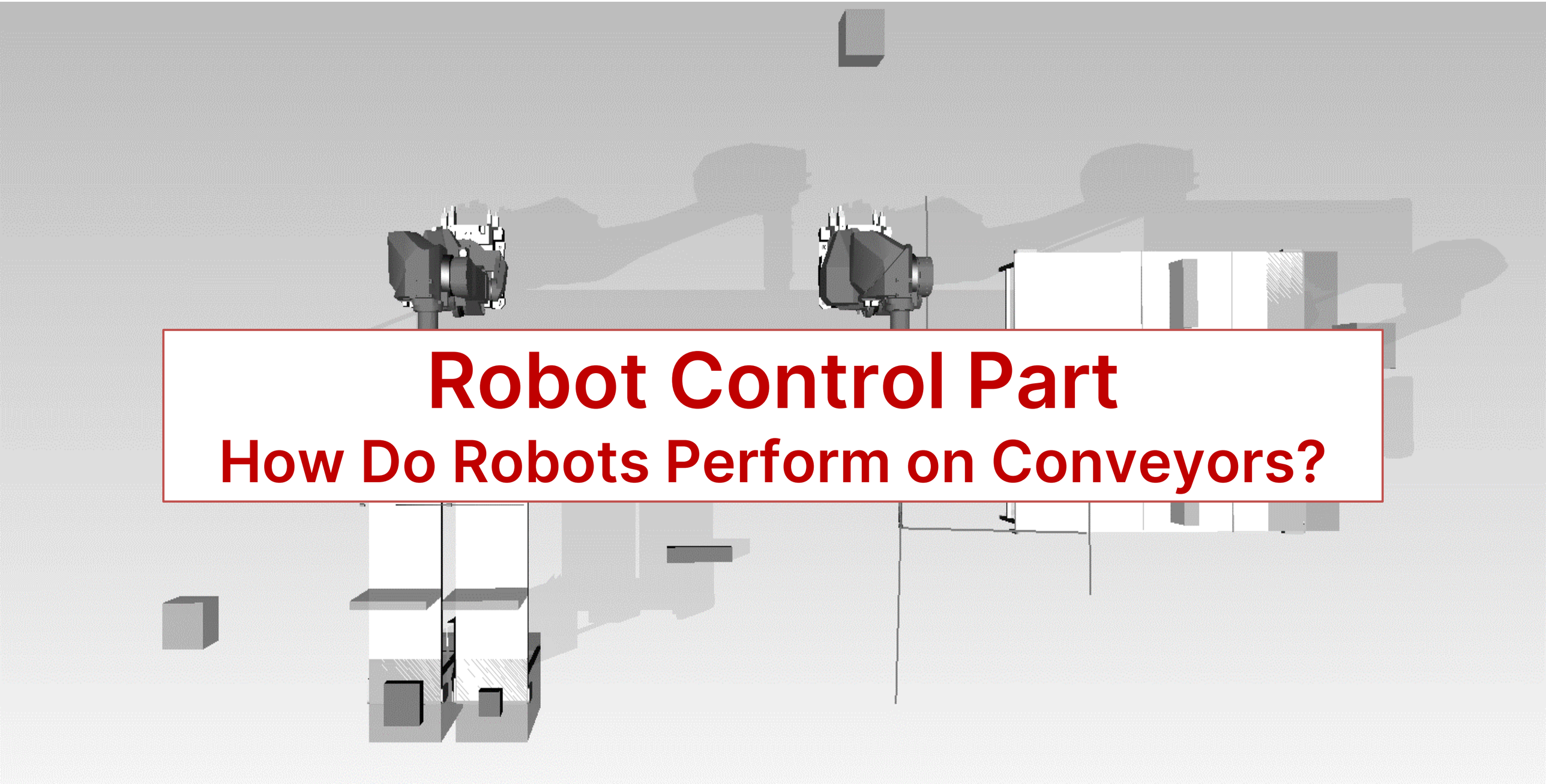


Robot Control Part

How Do Robots Perform on Conveyors?

Robot Control Part

PL1StateMacheine.java (R1)

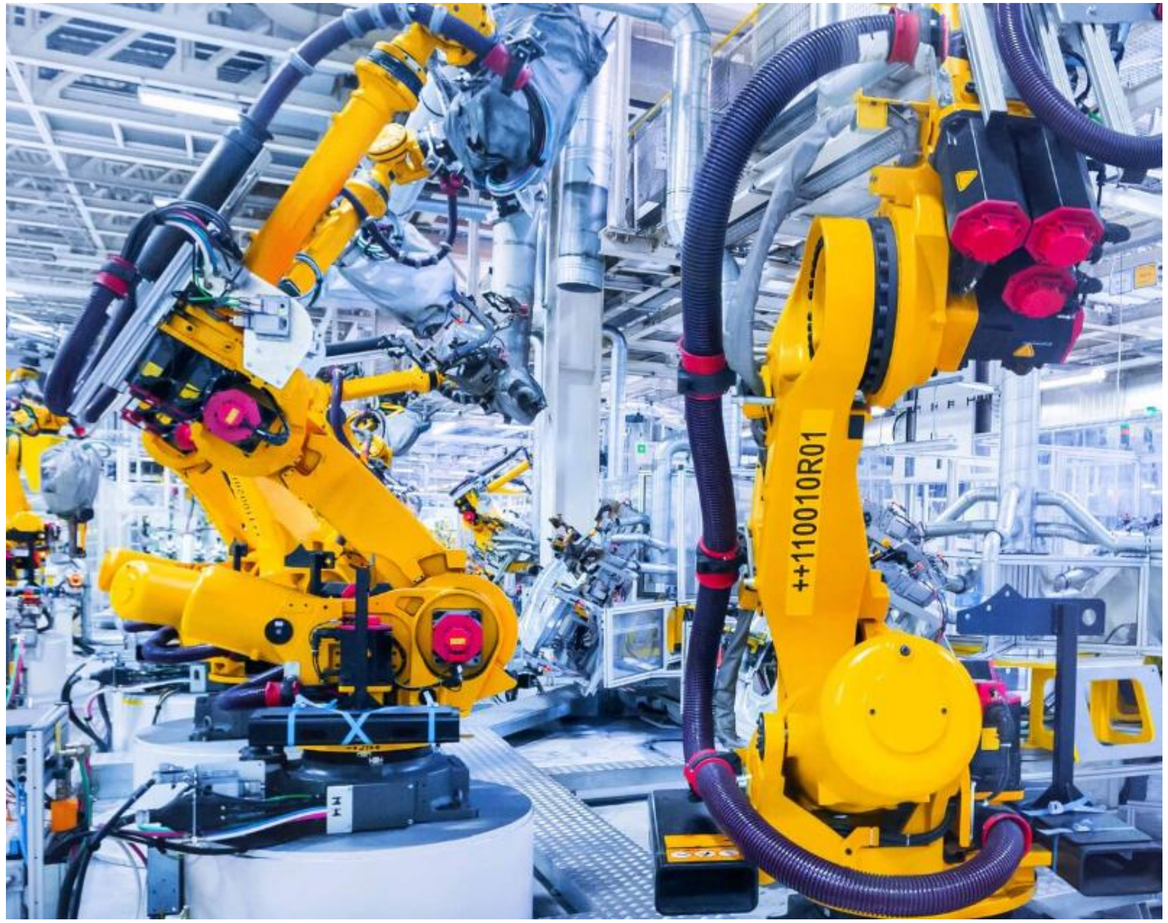
- Assign variant to box A in the order of 2V1, 1V2, and 2V3, then take B and C from conveyor B and C respectively to assemble V1 (ABB), V2 (ABC), and V3 (ACC).

PL1StateMacheine1.java (R2)

- Perform welding work for V1, V2, and V3.

PL1StateMacheine.java (R3)

- Perform product sorting, placing V1 and V2 on conveyor belt D and placing V3 on conveyor belt E.



Robot Control Part

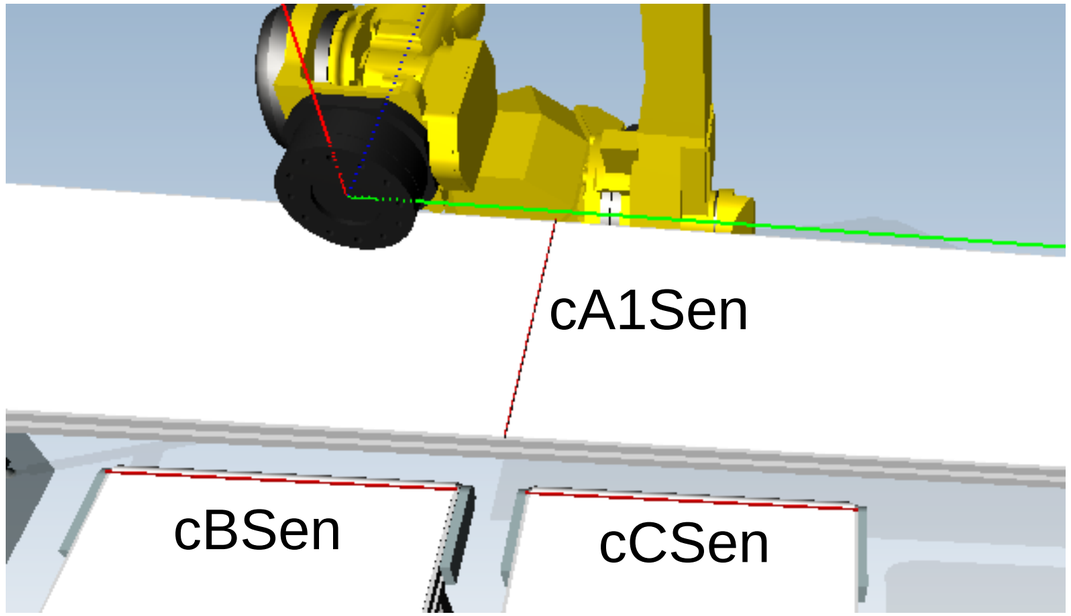
PL1StateMacheine.java (R1)

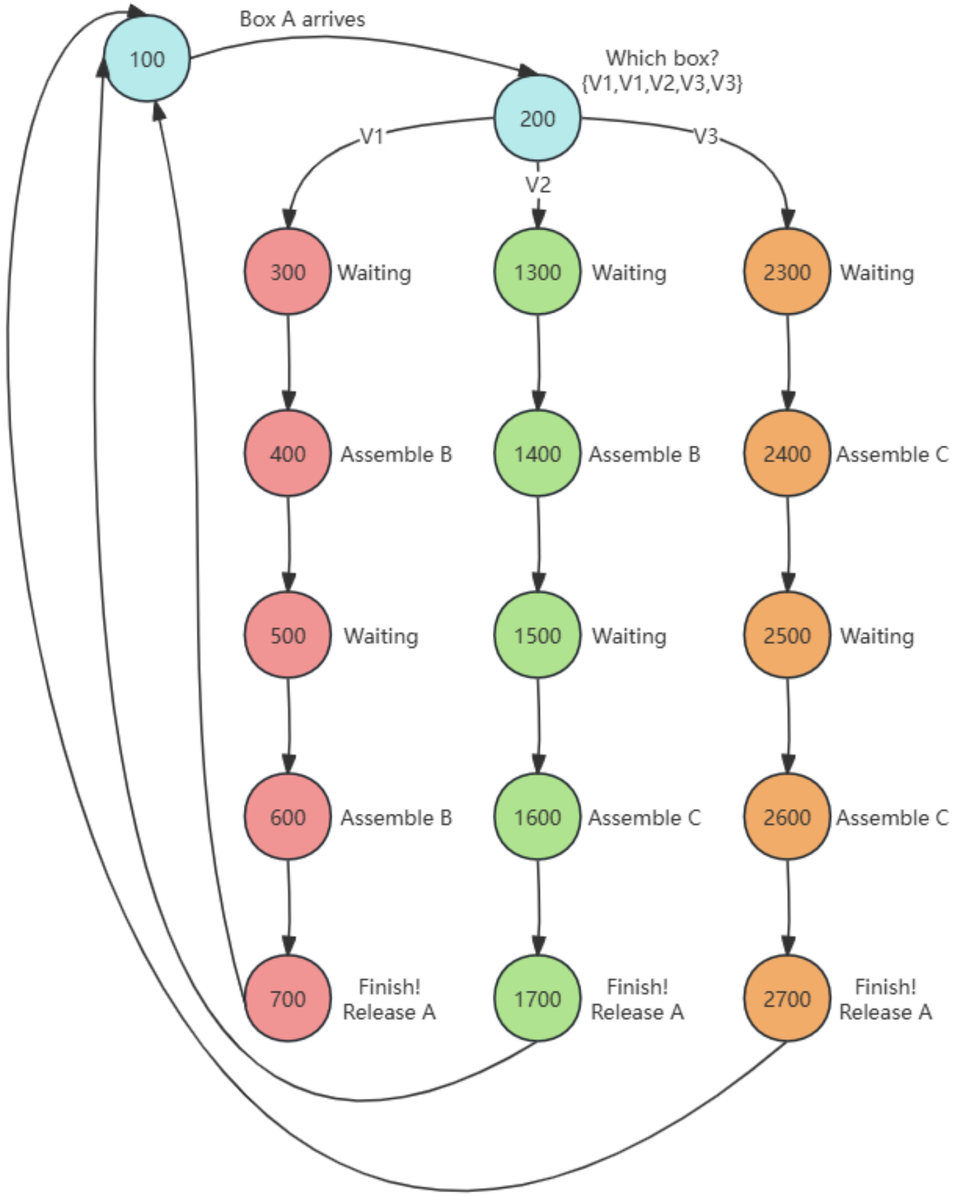
Three sensors

cA1Sen: Stop the box A, trigger R1 to get B/C

cBSen: Stop the box B, tell R1 B is ready.

cCSen: Stop the box C, tell R1 B is ready.





PL1StateMacheine.java (R1)

Challenge:

How to prevent a robot from overlapping with the first box when placing the second box?

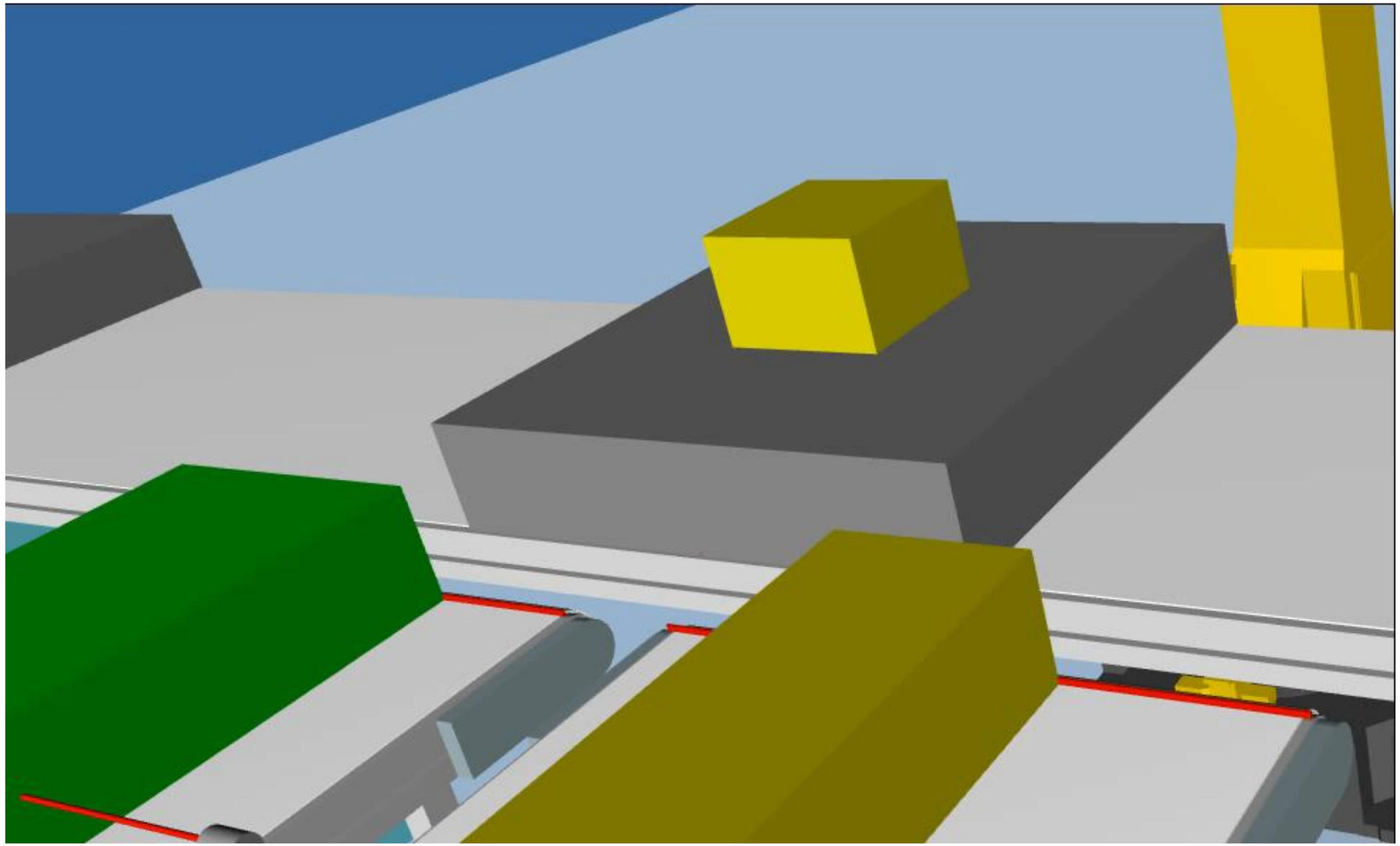
Solution:

'VxHeight' is a boolean variable used to control the height adjustment of the robot when placing the second box. Specifically, V1Height acts as a flag indicating whether a height adjustment is necessary to avoid overlap in V1.

```
public void state_500() {
    if (asmBFinished.readBoolean() && partB.read() != null) {
        V1Height.write(v: true);
        asmBFinished.write(v: false);
        box0nB = partB.readAndForget();
        switchState(s: 600);

    }
}

public void state_600() {
    executeAssemblyProcess(box1: box0nA, frameTransform: "CB.FB", box2: box0nB, conveyorCmd: cBCmd, asmFinishedVar: asmBFinished);
    switchState(s: 700);
}

public void state_700() {
    if (asmBFinished.readBoolean()) {
        asmBFinished.write(v: false);
        V1Height.write(v: false);
        releaseBoxA();
        switchState(s: 100);
    }
}
```

```
r1Cmd.moveLinear(t: driver.getFrameTransform(name: frameTransform), d: VR0B);
r1Cmd.moveLinear(t: BoxUtils.targetOffset(box: box1, offsetX: 0, offsetY: 0, offsetZ: 400, rX: 0, rY: 0, rZ: 0), d: VR0B);
if (V1Height.readBoolean() || V2Height.readBoolean() || V3Height.readBoolean()) {
    r1Cmd.moveLinear(t: BoxUtils.targetOffset(box: box1, offsetX: 0, offsetY: 0, BoxUtils.zSize(box: box2) * 3, rX: 0, rY: 0, rZ: 0), d: VR0B);
    box1.entity.setProperty(string: "boxU2", o: box2);
} else {
    r1Cmd.move(t: BoxUtils.targetTop(box: box1), wframe: box2.cF, l: 1000L);
    box1.entity.setProperty(string: "boxU1", o: box2);
}
r1Cmd.release();
```

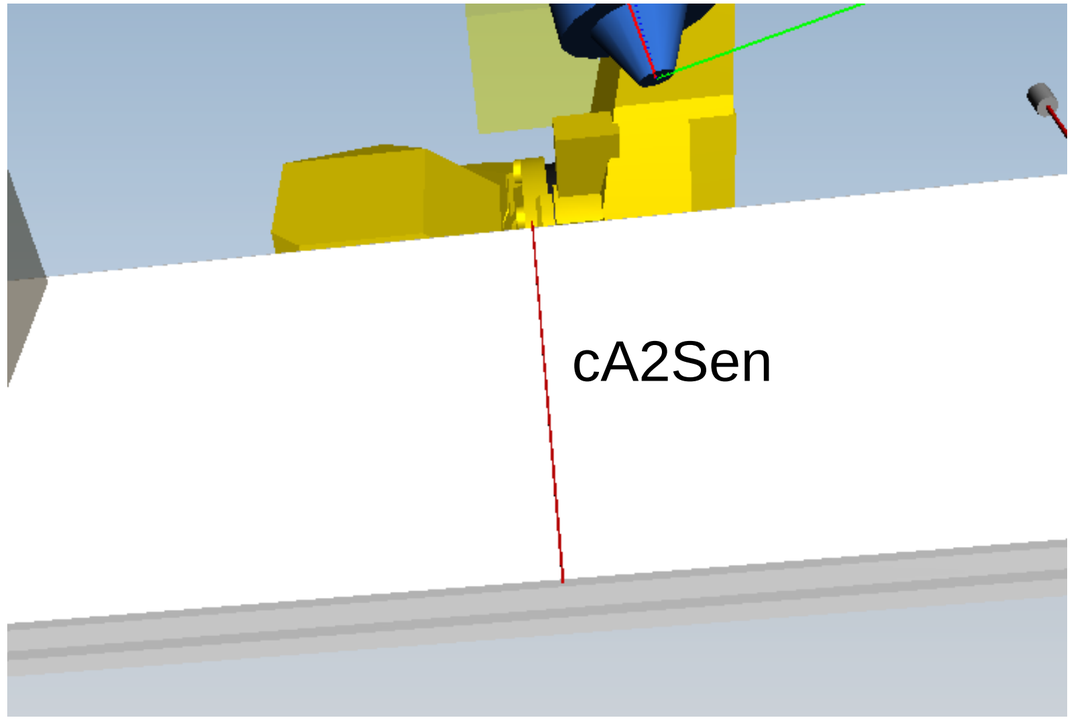
Robot Control Part

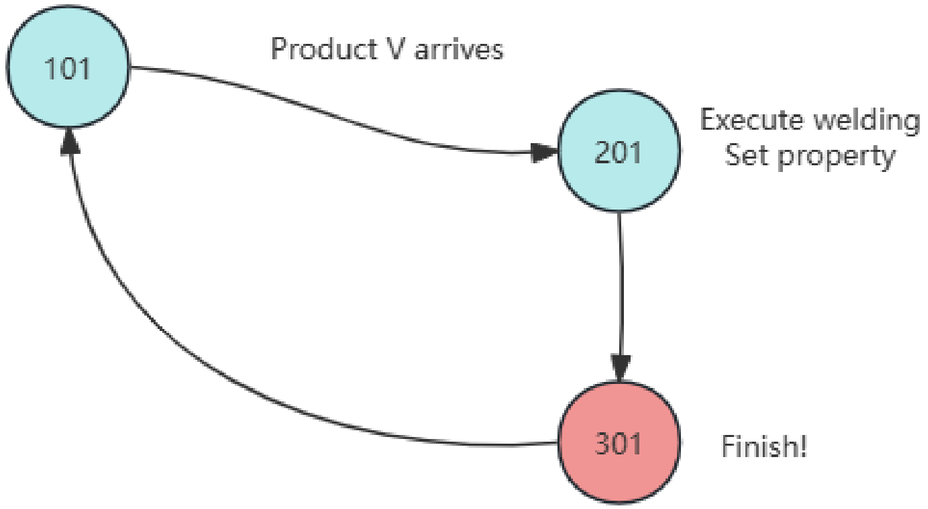


PL1StateMacheine1.java (R2)

One sensor

cA2Sen: Stop the Vx, trigger R2 to start welding.





PL1StateMacheine1.java (R2)

Challenge:

How to make the welding gun move naturally along the connected edges while in motion?

Solution:

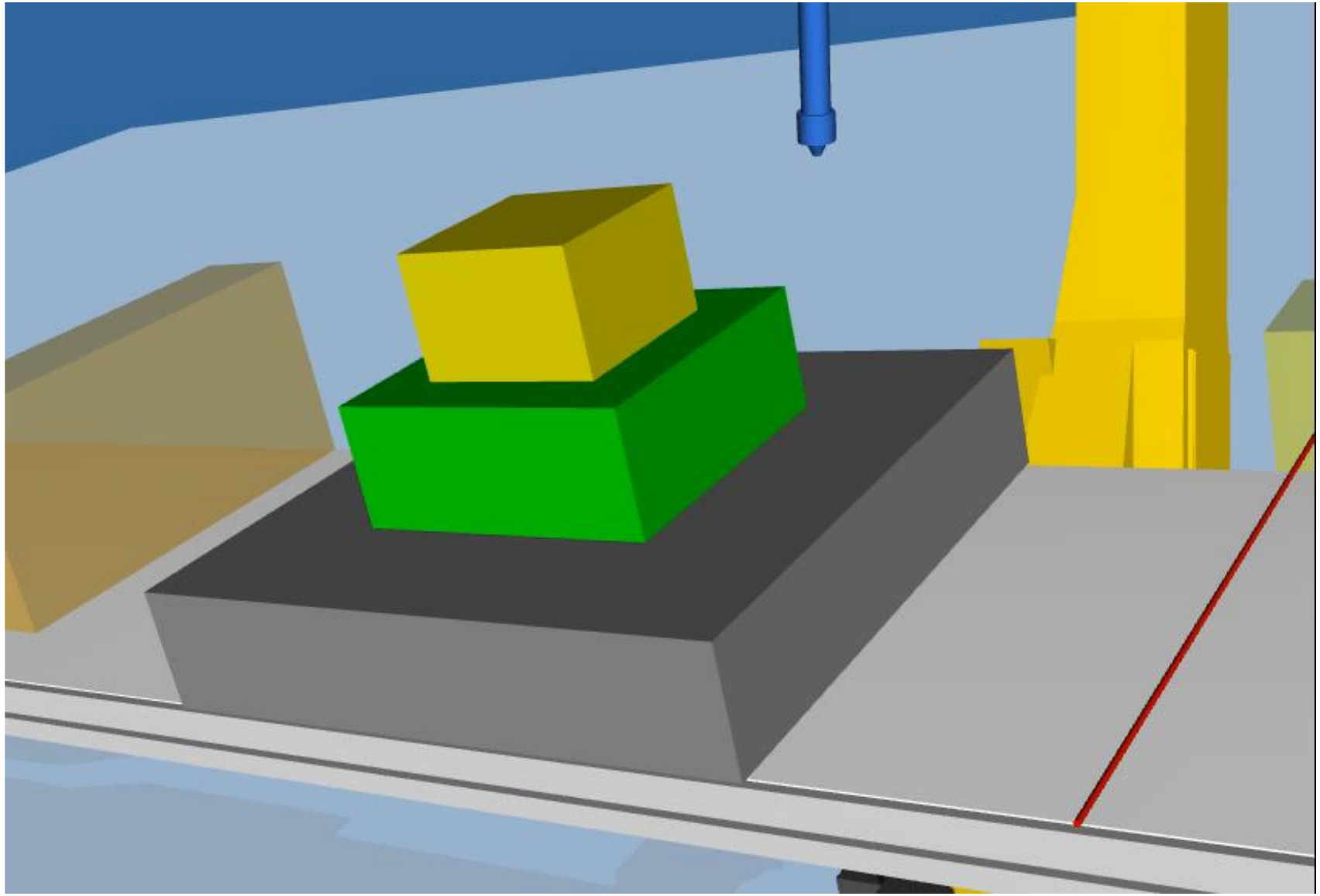
Adjust the welding gun direction only at turning points.

Don’t change the direction. Only linear move.

```
void weldingMove(ConveyorBox box) {

    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, BoxUtils.xSize(box) / 2, BoxUtils.ySize(box) / 2, offsetZ:0, rX: 0, rY: 45, rZ: 0), d: VR0B);
    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, BoxUtils.xSize(box) / 2, -BoxUtils.ySize(box) / 2, offsetZ:0, rX: 0, rY: 45, rZ: 0), d: VR0B);

    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, BoxUtils.xSize(box) / 2, -BoxUtils.ySize(box) / 2, offsetZ:0, rX: 45, rY: 0, rZ: -90), d: VR0B);
    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, -BoxUtils.xSize(box) / 2, -BoxUtils.ySize(box) / 2, offsetZ:0, rX: 45, rY: 0, rZ: -90), d: VR0B);

    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, -BoxUtils.xSize(box) / 2, -BoxUtils.ySize(box) / 2, offsetZ:0, rX: 0, rY: -45, rZ: 180), d: VR0B);
    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, -BoxUtils.xSize(box) / 2, BoxUtils.ySize(box) / 2, offsetZ:0, rX: 0, rY: -45, rZ: 180), d: VR0B);

    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, -BoxUtils.xSize(box) / 2, BoxUtils.ySize(box) / 2, offsetZ:0, rX: -45, rY: 0, rZ: 90), d: VR0B);
    r2Cmd.moveLinear(t: BoxUtils.targetOffset(box, BoxUtils.xSize(box) / 2, BoxUtils.ySize(box) / 2, offsetZ:0, rX: -45, rY: 0, rZ: 90), d: VR0B);

    r2Cmd.moveLinear(t: driver.getFrameTransform(name: "CA.FW"), d: VR0B);
}
```

Don’t move. Only adjust the direction.

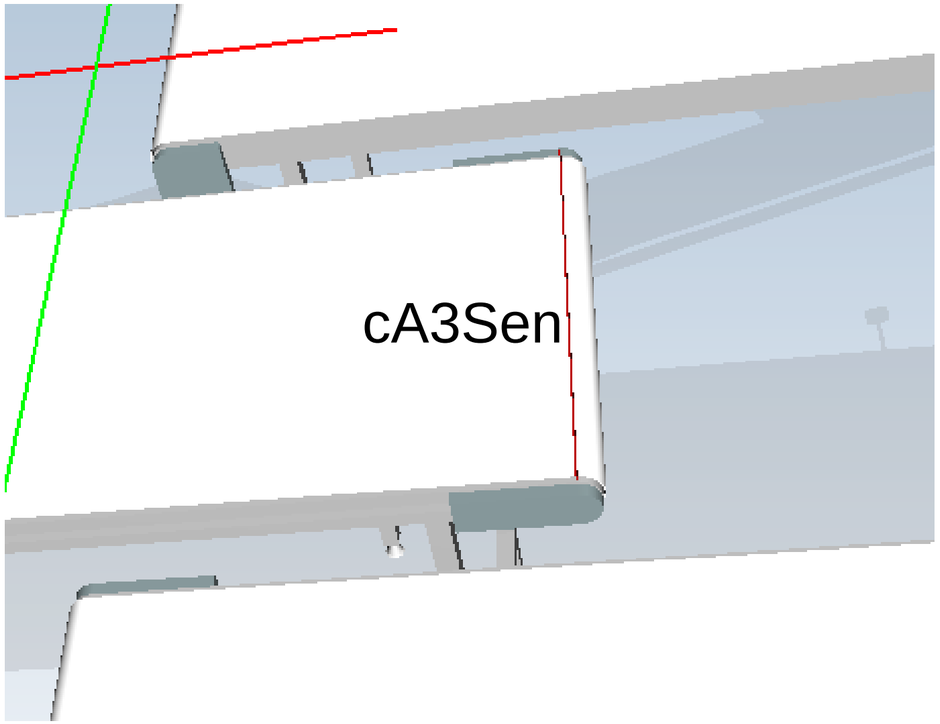
Robot Control Part

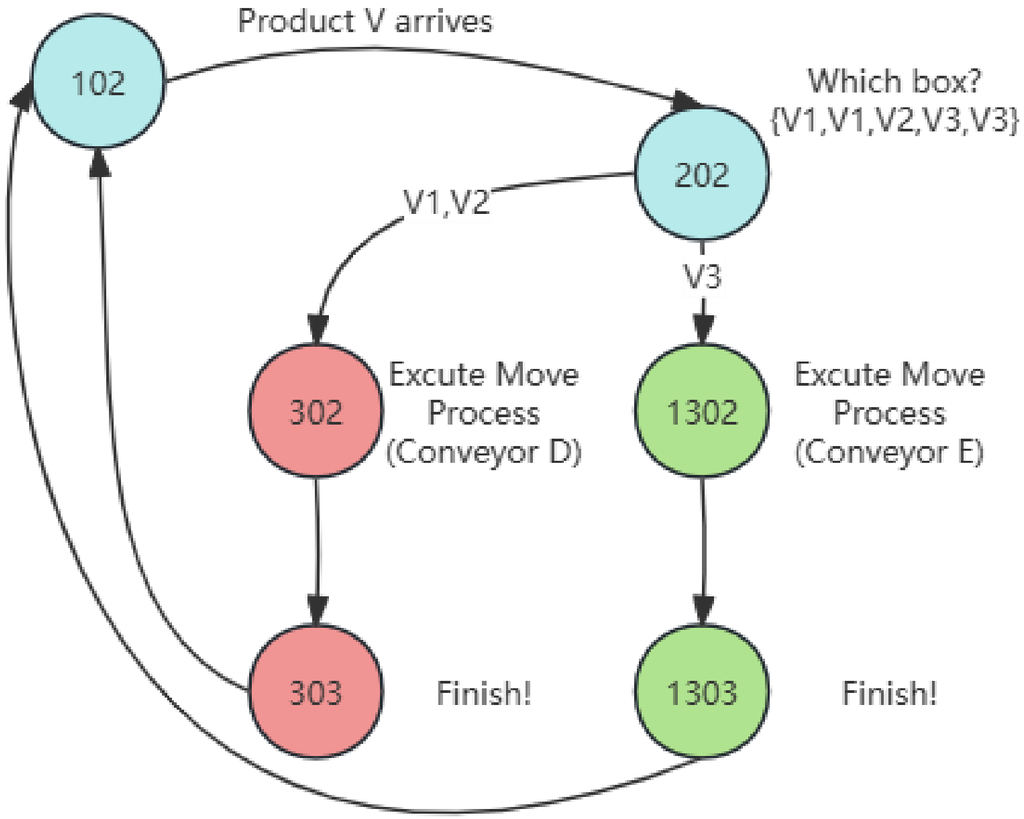


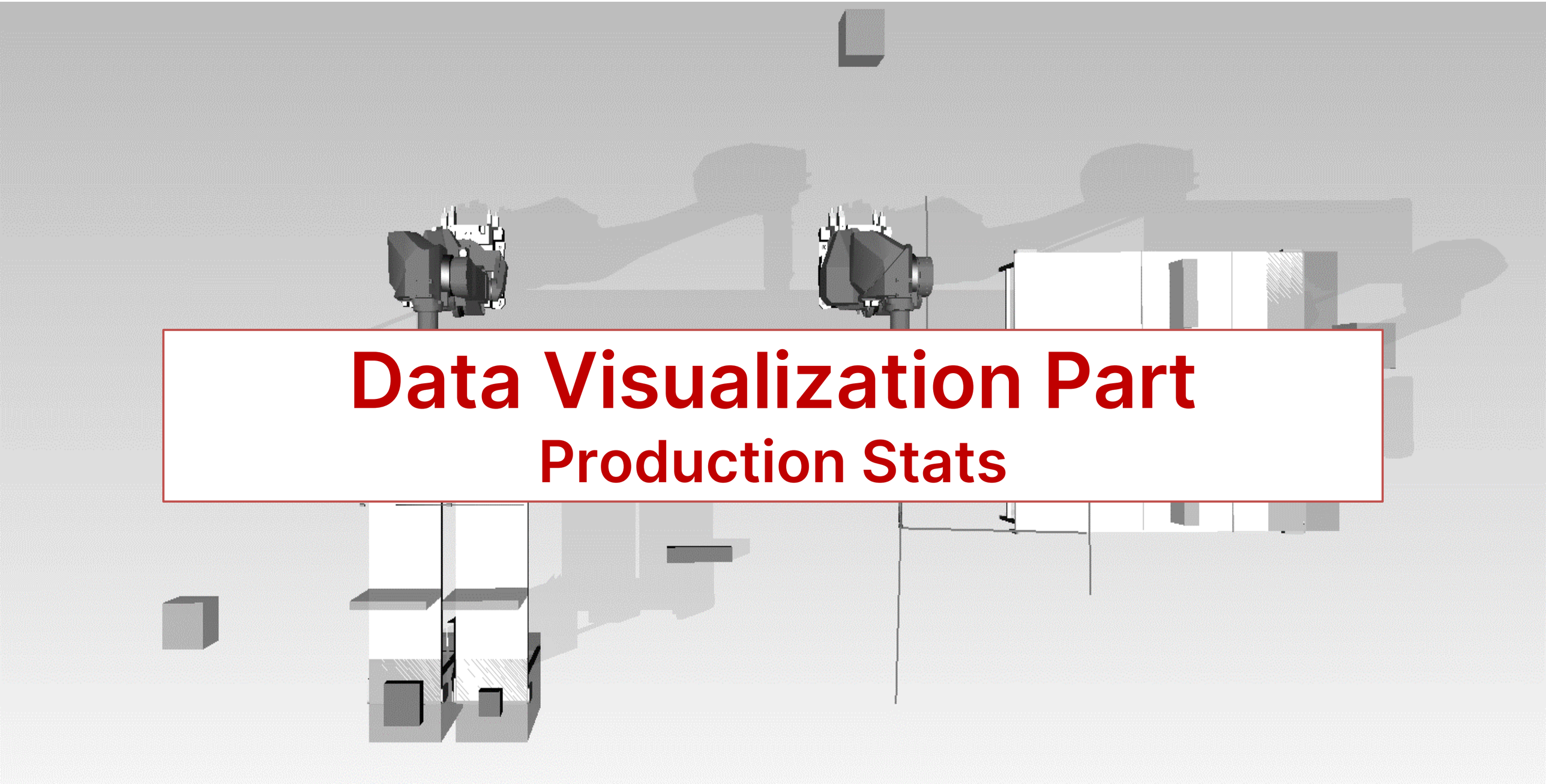
PL1StateMacheine2.java (R3)

One sensor

cA3Sen: Stop the Vx, trigger R3 to sort.





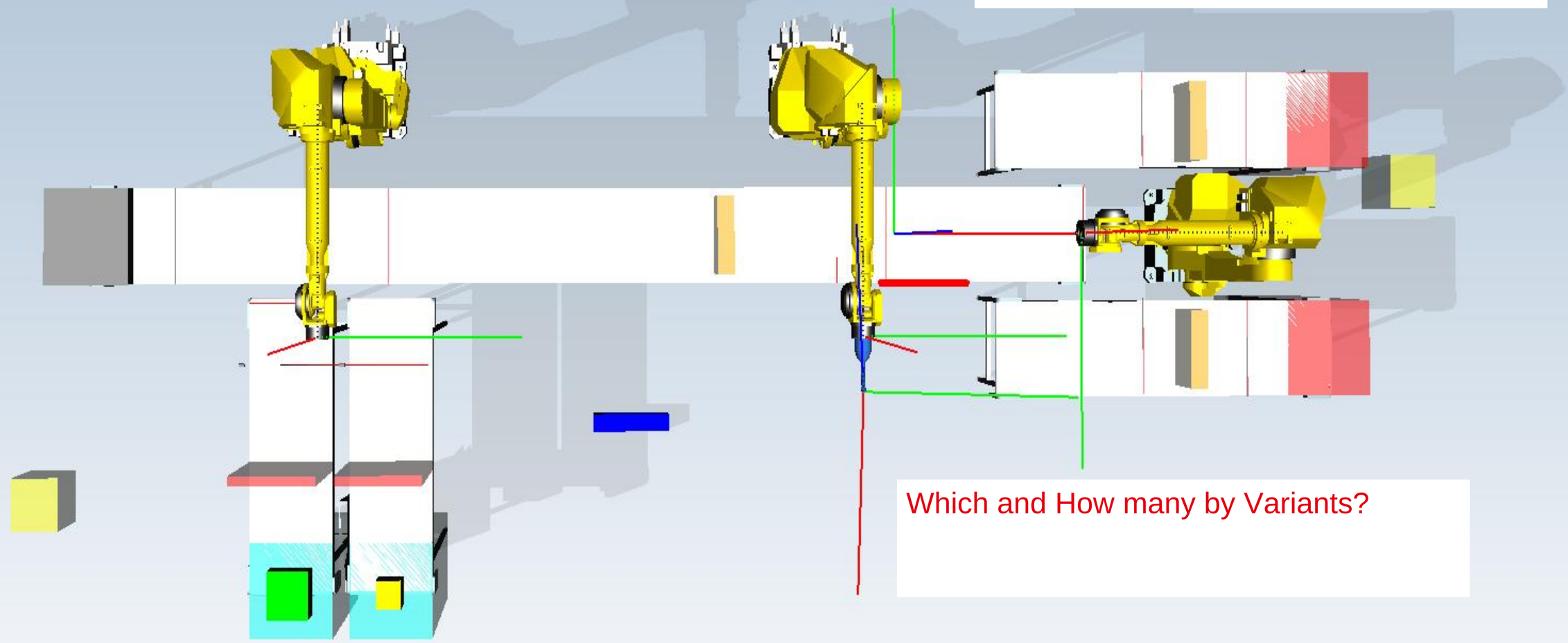


Data Visualization Part

Production Stats

How much parts are being produced?

How much parts are being scraped?

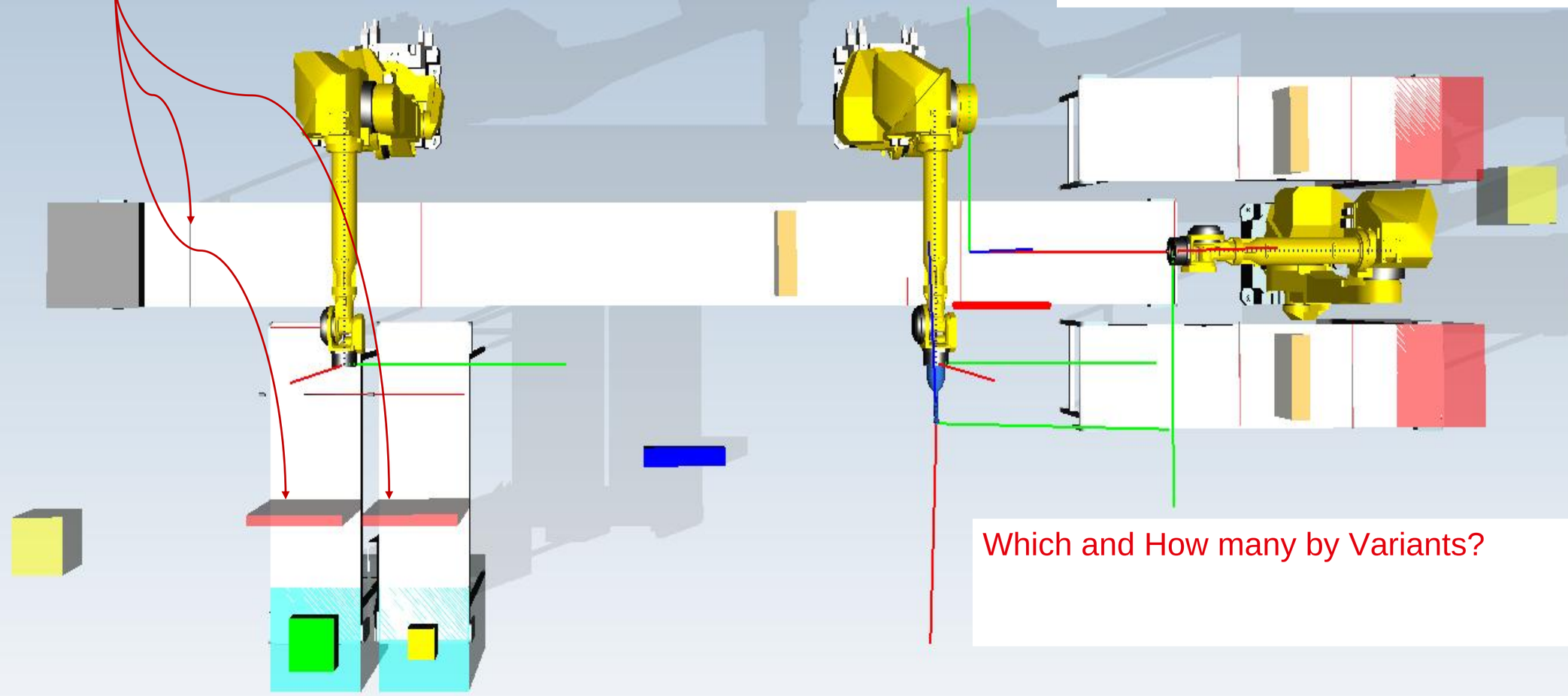


Which and How many by Variants?

How much parts are being produced?

- By counting the number of Parts A, B, C using Photocells on Conveyor A, B, and C

How much parts are being scraped?



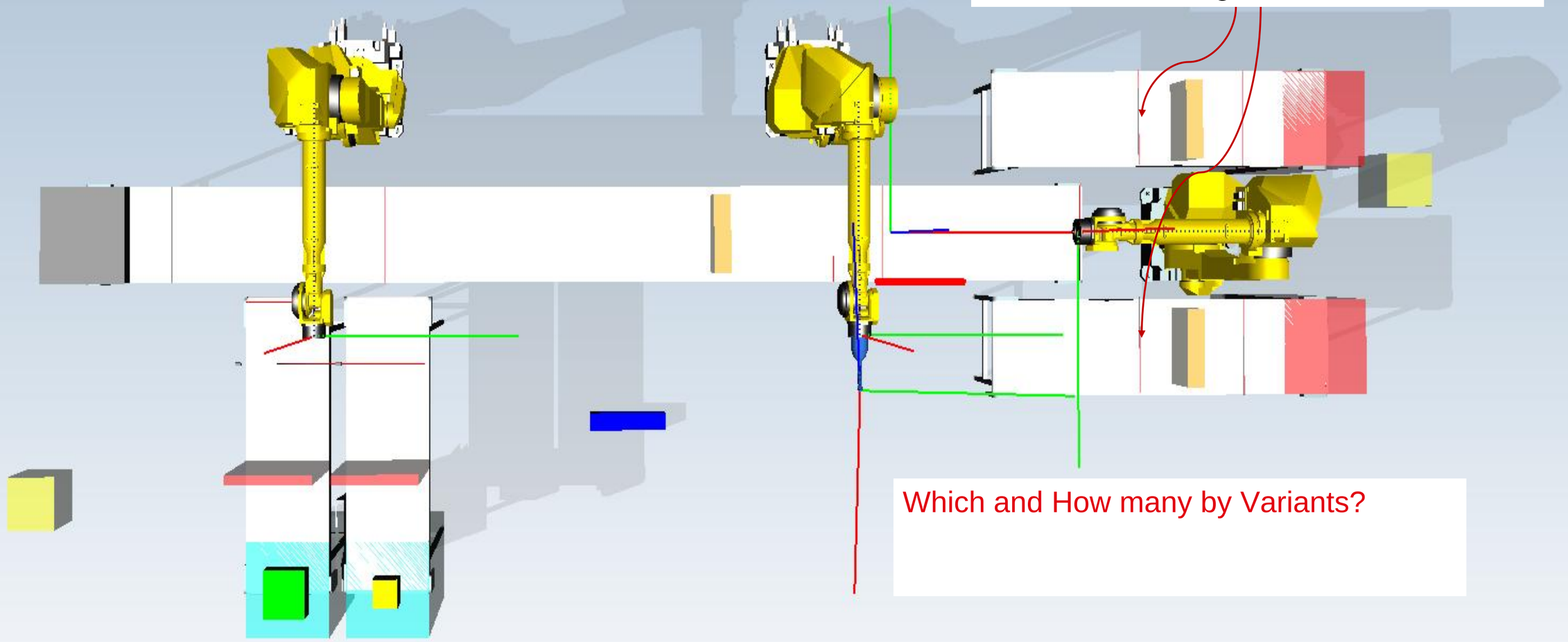
Which and How many by Variants?

How much parts are being produced?

- By counting the number of Parts A, B, C using Photocells on Conveyor A, B, and C

How much parts are being scraped?

- Counting the Parts being scrapped in 10minutes using Photocells



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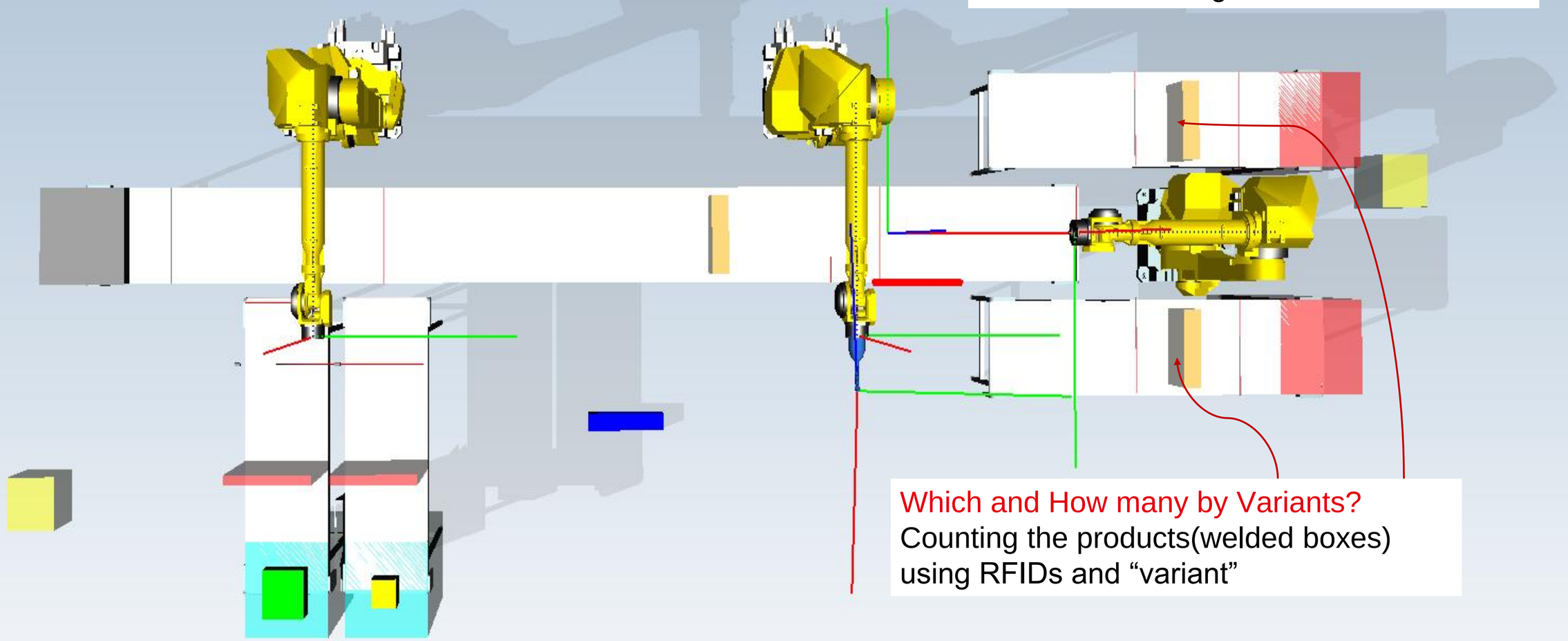
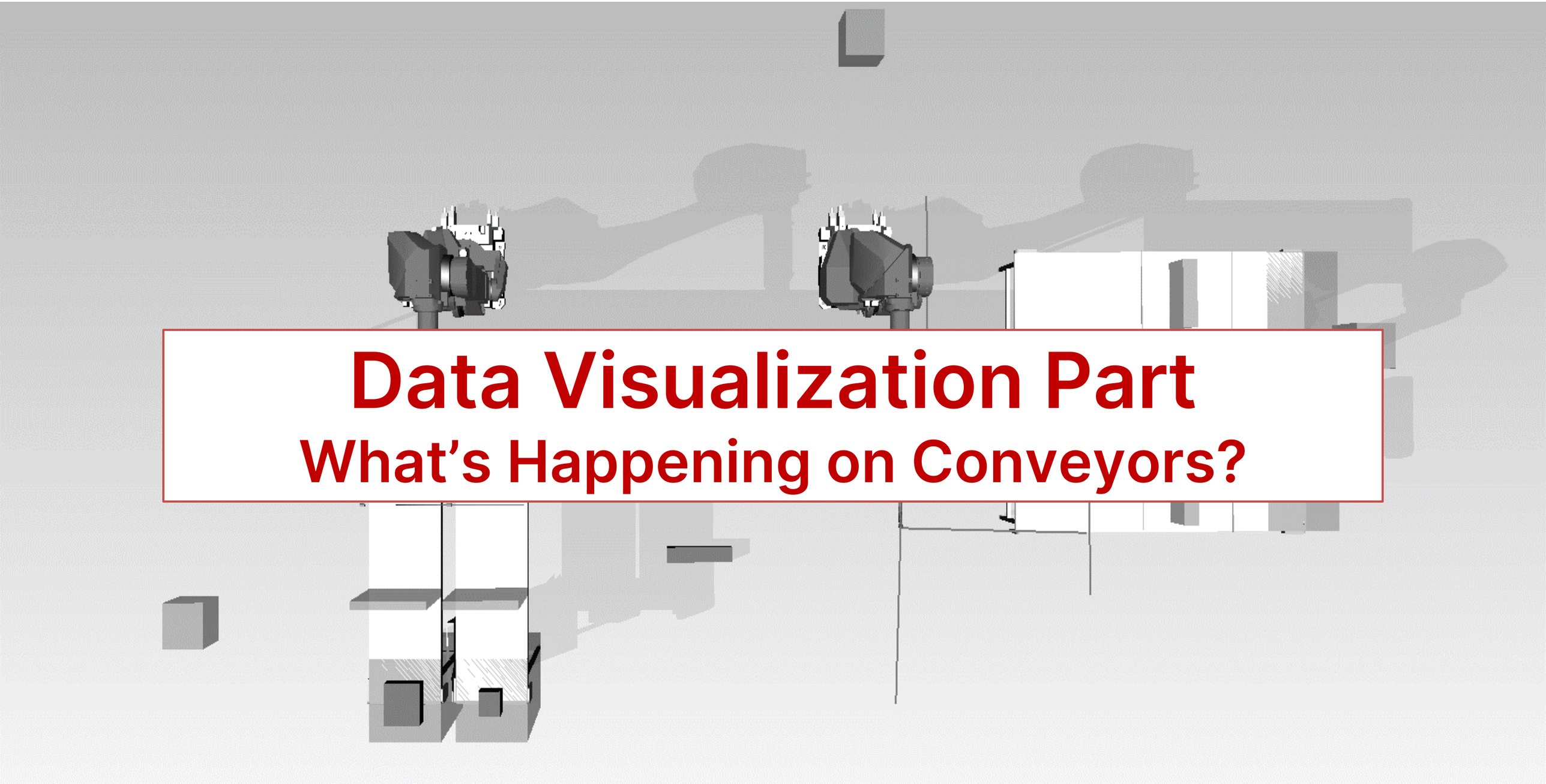


Which and How many by Variants?

Counting the products(welded boxes) using RFIDs and “variant”

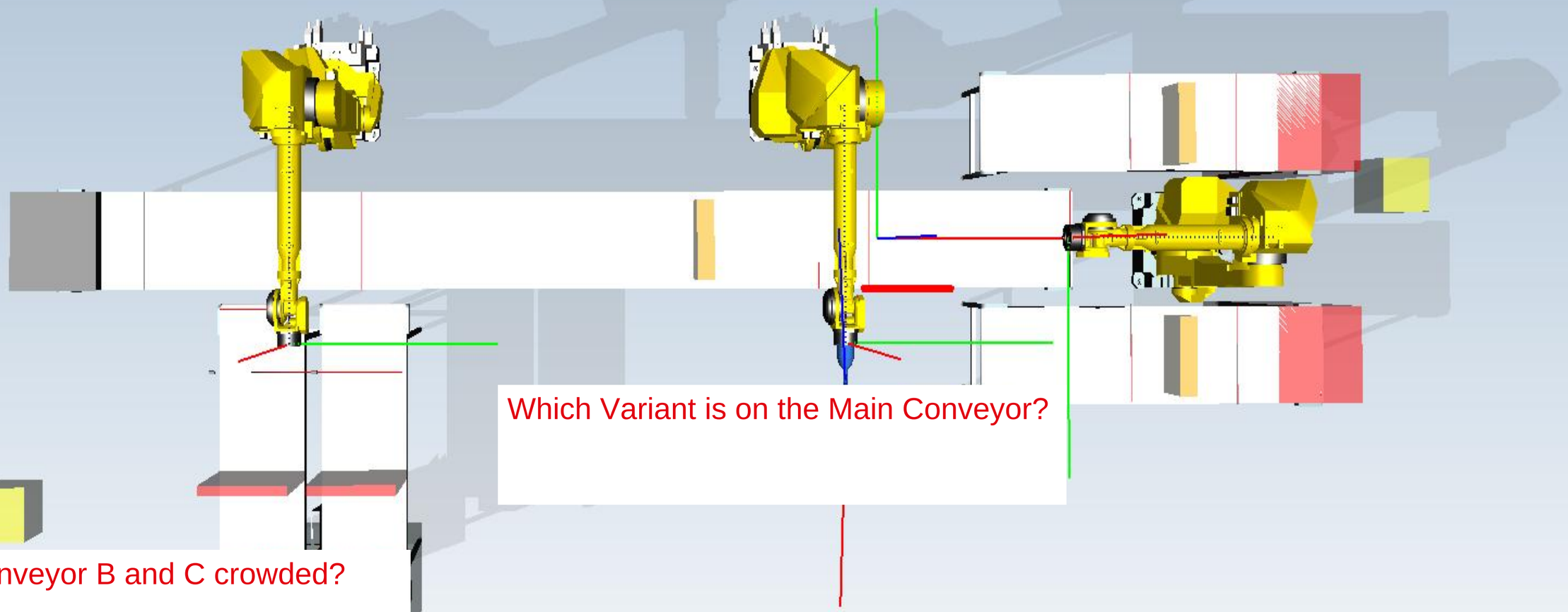


Data Visualization Part

What’s Happening on Conveyors?

How fast assembly is being done?

How fast Welding is being done?



Which Variant is on the Main Conveyor?

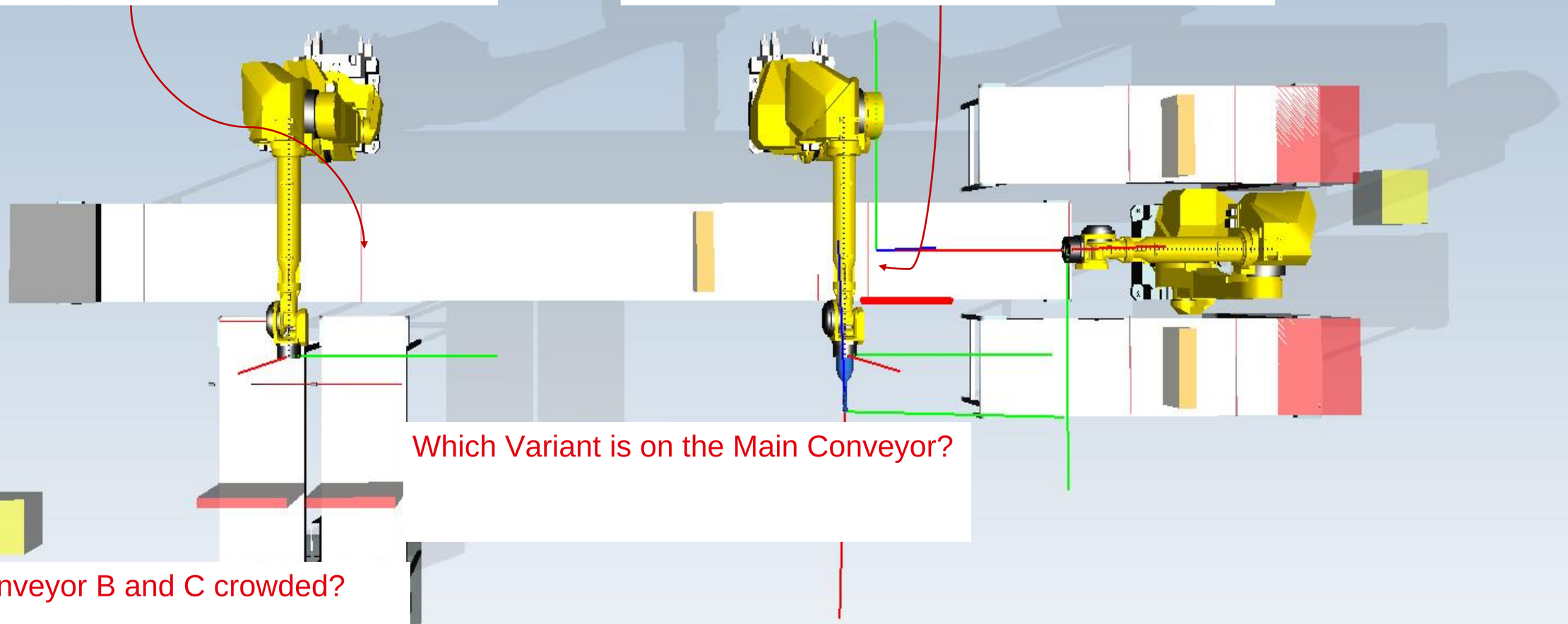
Are the Conveyor B and C crowded?

How fast assembly is being done?

- By counting the number of assembled Parts in 10 min using Photocells after R1

How fast Welding is being done?

- By counting the number of welded Parts in 10 min using Photocells after R1



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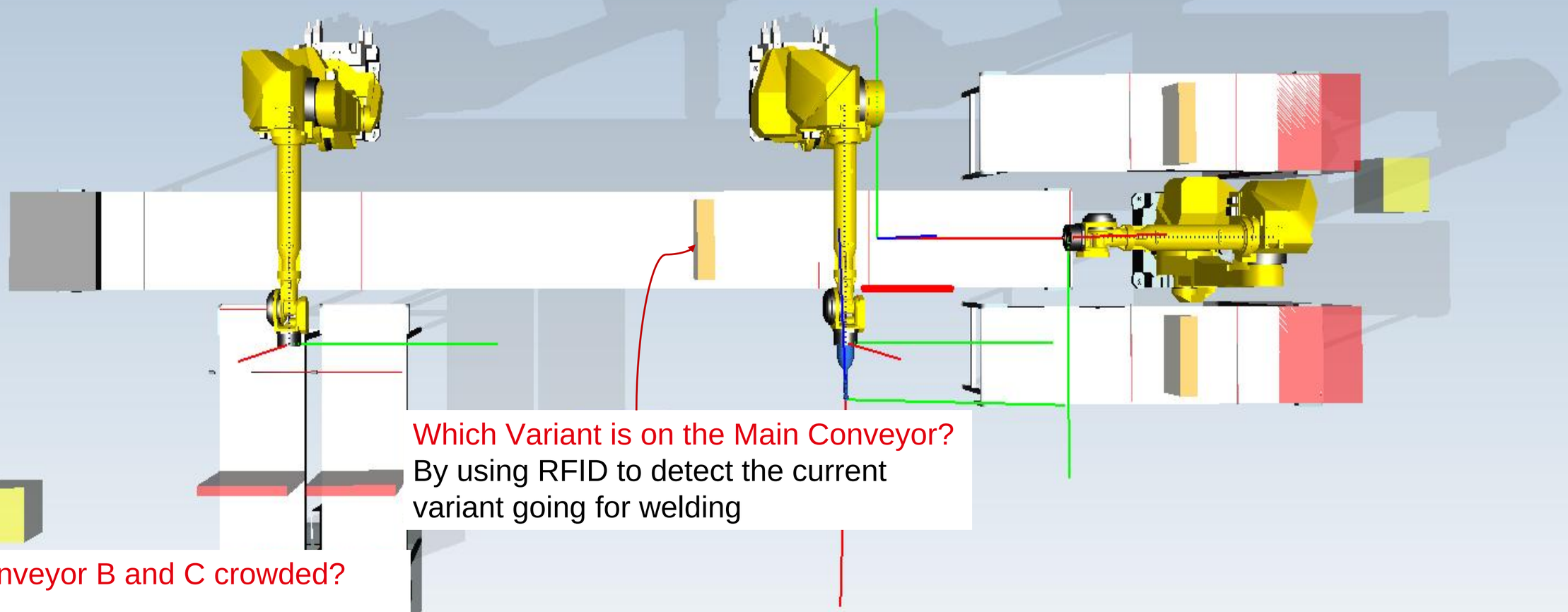


Which Variant is on the Main Conveyor?

By using RFID to detect the current variant going for welding

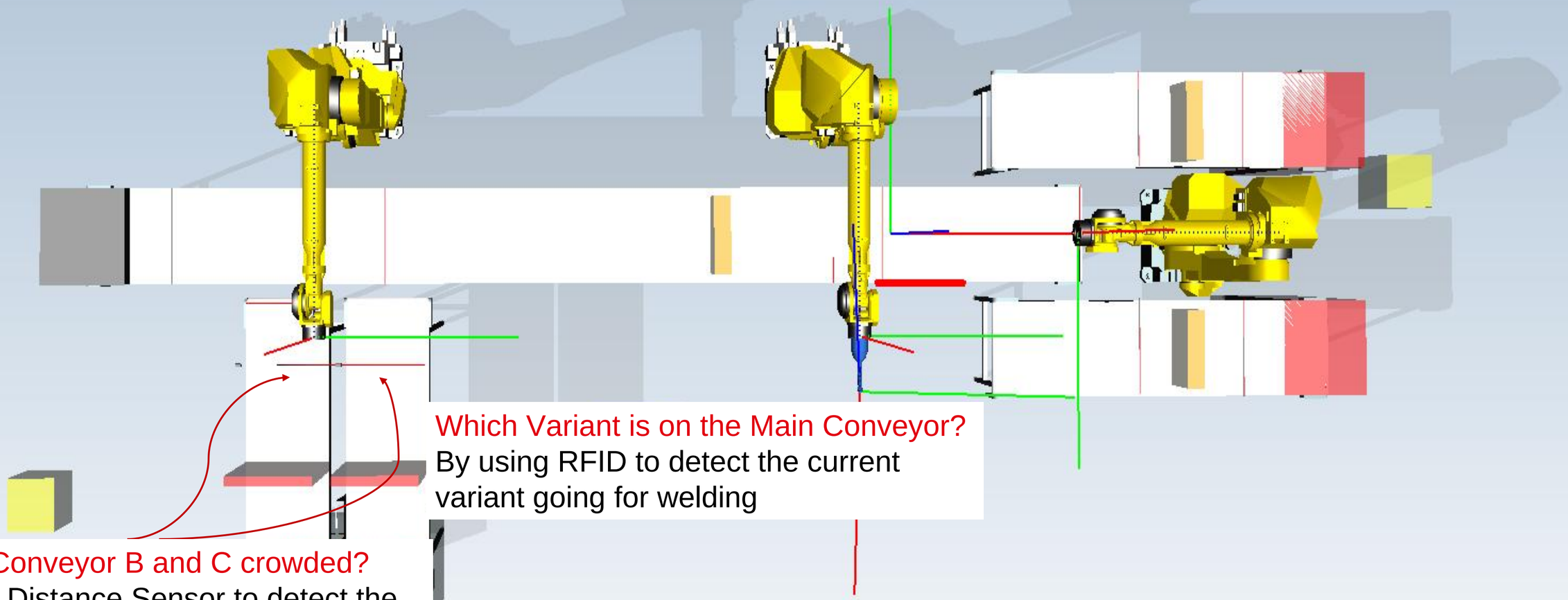
Are the Conveyor B and C crowded?

How fast assembly is being done?

- By counting the number of assembled Parts in 10 min using Photocells after R1

How fast Welding is being done?

- By counting the number of welded Parts in 10 min using Photocells after R1



Which Variant is on the Main Conveyor?

By using RFID to detect the current variant going for welding

Are the Conveyor B and C crowded?

By using Distance Sensor to detect the crowdedness on these Conveyors

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Data Visualization Part

Dashboard

Input Raw Materials Stats

Production Rate of PartA (Box/10min)

26

Production Rate of PartB (Box/10min)

26

Production Rate of PartC (Box/10min)

27

Crowded State(BoxB,BoxC)

_time	state
2024-06-10 21:56:31.171	Not Crowded (C)
2024-06-10 21:56:31.171	Crowded (B)

Assembly and Welding Stations

Assembly Rate of Boxes (Box/10min)

2

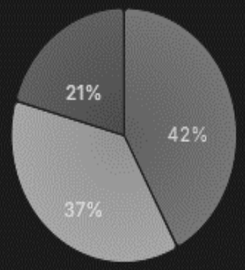
Variant for Welding on ConvA

Welding Rate of Boxes (Box/10min)

Product Amount in 10 mins

Scrap Station

Scrap Count by Variants



V1 V3 V2

ScrapingRate of ConvE Boxes (Box/10min)

10

ScrapingRate of ConvD Boxes (Box/10min)

16

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Data Visualization Part

Input Raw Materials Stats

Production Rate of PartA (Box/10min)

26

Production Rate of PartB (Box/10min)

26

Production Rate of PartC (Box/10min)

27

Crowded State(BoxB,BoxC)

_time	state
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2024-06-10 21:56:31.171	Crowded (B)

Assembly and Welding Stations

Assembly Rate of Boxes (Box/10min)

26

Variant for Welding on ConvA

V3

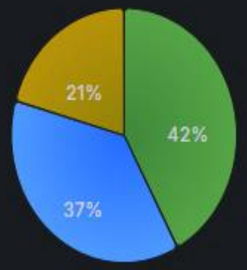
Welding Rate of Boxes (Box/10min)

26

Product Amount in 10 mins

Scrap Station

Scrap Count by Variants



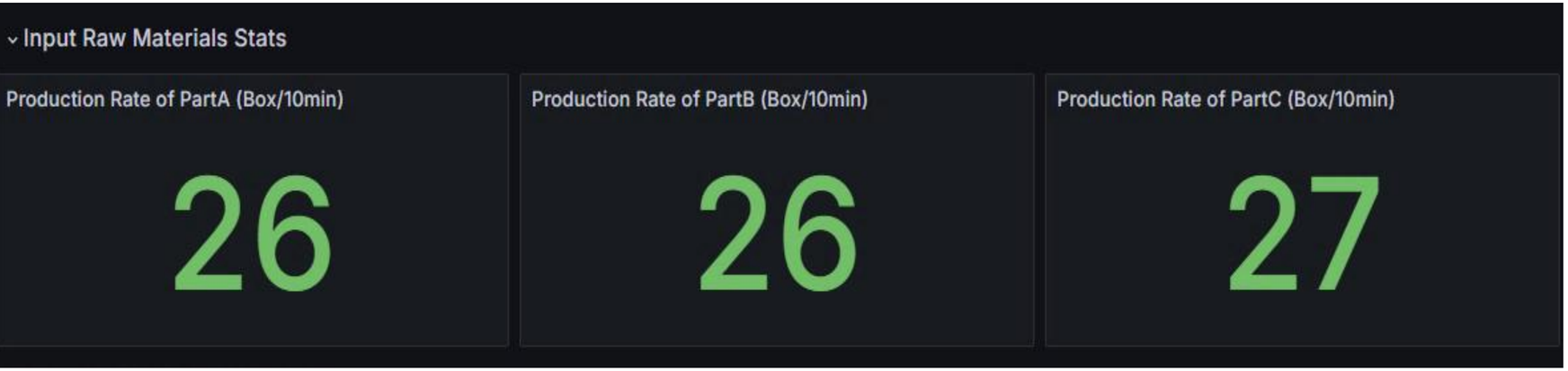
ScrapingRate of ConvE Boxes (Box/10min)

10

ScrapingRate of ConvD Boxes (Box/10min)

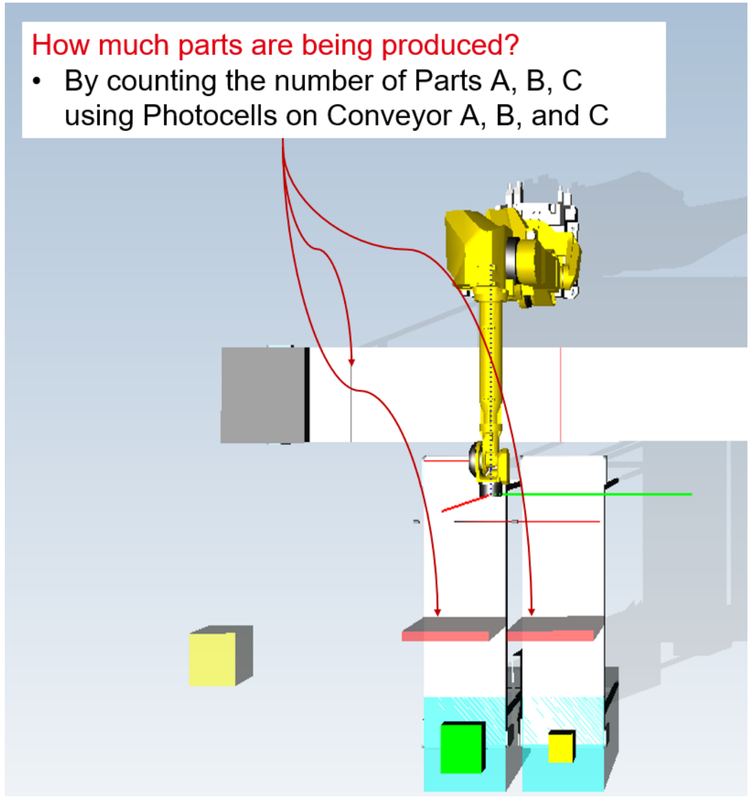
16

Data Visualization Part

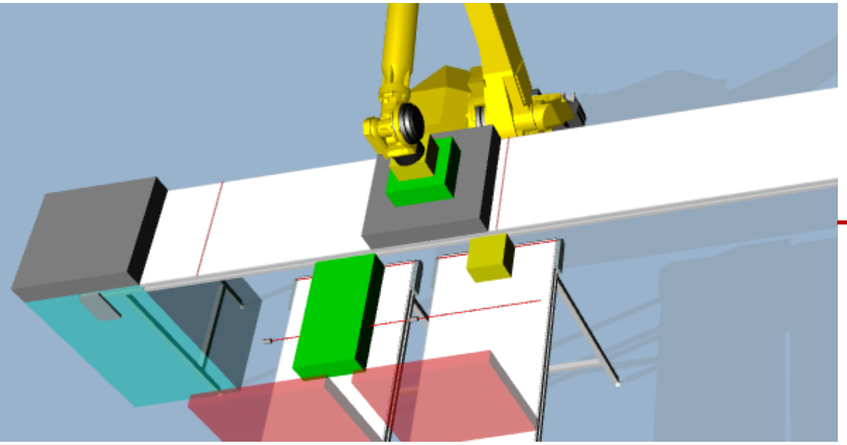


How much parts are being produced?

- By counting the number of Parts A, B, C using Photocells on Conveyor A, B, and C

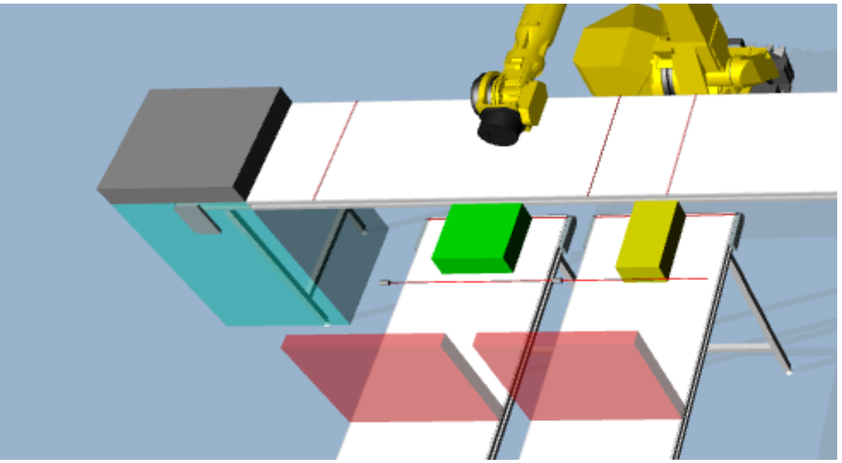


Data Visualization Part



Crowded State(BoxB,BoxC)

_time	state
2024-06-10 21:56:31.171	Not Crowded (C)
2024-06-10 21:56:31.171	Crowded (B)



Crowded State(BoxB,BoxC)

_time	state
2024-06-10 22:03:14.888	Not Crowded (C)
2024-06-10 22:03:14.888	Not Crowded (B)

Data Visualization Part

Input Raw Materials Stats

Production Rate of PartA (Box/10min)

26

Production Rate of PartB (Box/10min)

26

Production Rate of PartC (Box/10min)

27

Crowded State(BoxB,BoxC)

_time	state
2024-06-10 21:56:31.171	Not Crowded (C)
2024-06-10 21:56:31.171	Crowded (B)

Assembly and Welding Stations

Assembly Rate of Boxes (Box/10min)

26

Variant for Welding on ConvA

V3

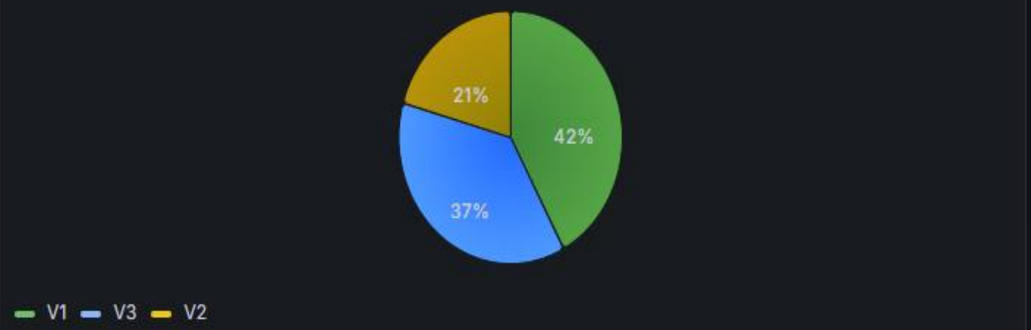
Welding Rate of Boxes (Box/10min)

26

Product Amount in 10 mins

Scrap Station

Scrap Count by Variants



ScrapingRate of ConvE Boxes (Box/10min)

10

ScrapingRate of ConvD Boxes (Box/10min)

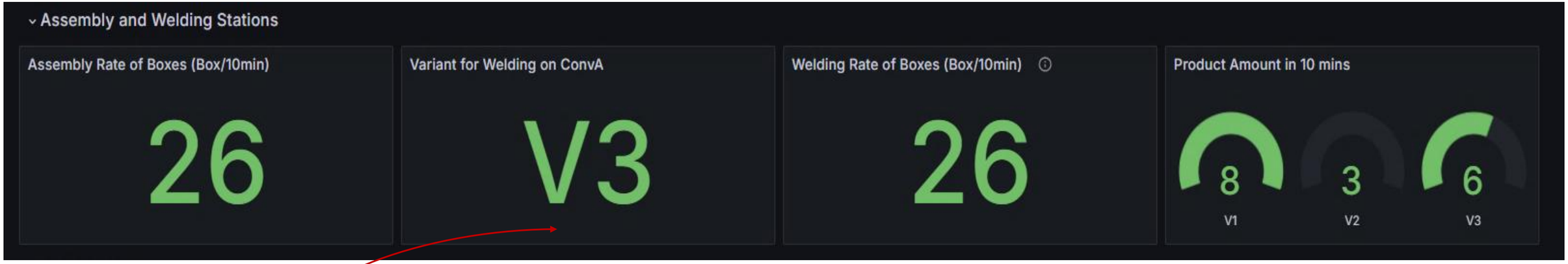
16

How fast assembly is being done?

- By counting the number of assembled Parts in 10 min using Photocells after R1

How fast Welding is being done?

- By counting the number of welded Parts in 10 min using Photocells after R1



Which Variant is on the Main Conveyor?

By using RFID to detect the current variant going for welding

Total Variants Produced in the last 10 minutes?

By using Distance Sensor to detect the crowdedness on these Conveyors

Data Visualization Part

Input Raw Materials Stats

Production Rate of PartA (Box/10min)

26

Production Rate of PartB (Box/10min)

26

Production Rate of PartC (Box/10min)

27

Crowded State(BoxB,BoxC)

_time	state
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Assembly and Welding Stations

Assembly Rate of Boxes (Box/10min)

26

Variant for Welding on ConvA

V3

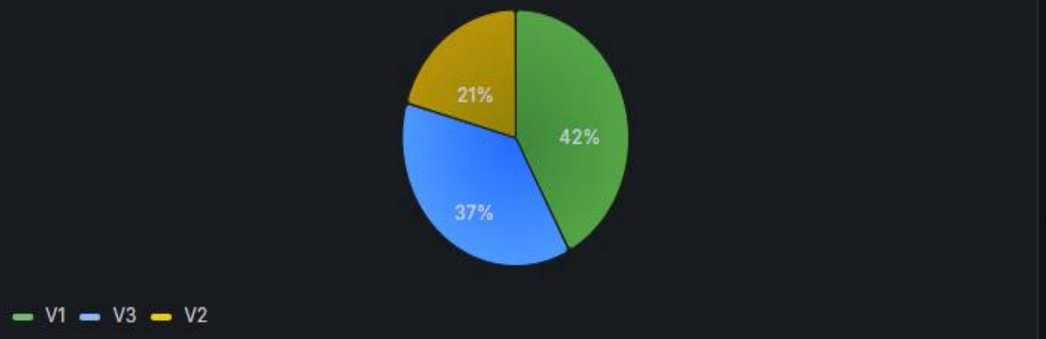
Welding Rate of Boxes (Box/10min)

26

Product Amount in 10 mins

Scrap Station

Scrap Count by Variants



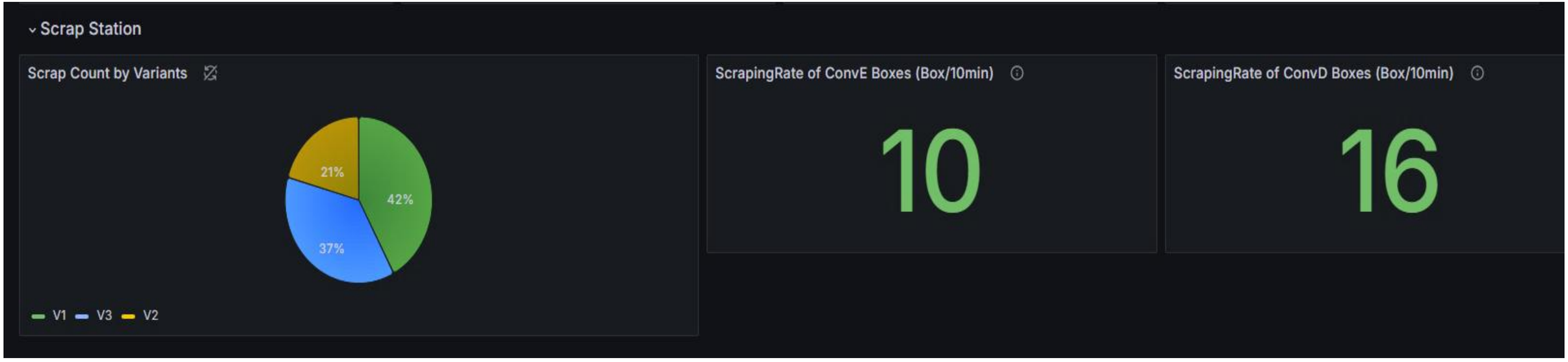
ScrapingRate of ConvE Boxes (Box/10min)

10

ScrapingRate of ConvD Boxes (Box/10min)

16

Data Visualization Part



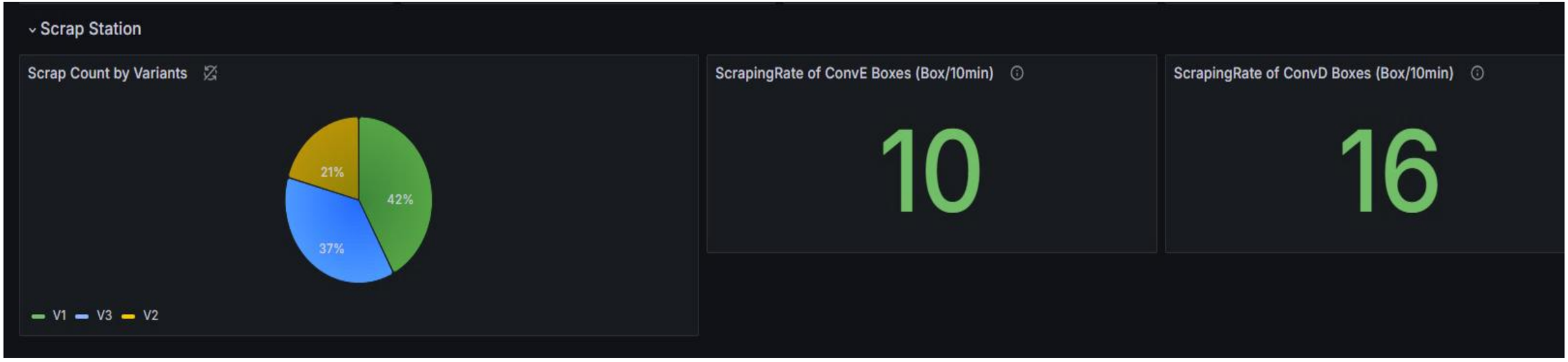
Data Visualization Part

Which and How many by Variants?

Counting the products(welded boxes) using RFIDs and “variant”

How much parts are being scraped?

- Counting the Parts being scrapped in 10minutes using Photocells



Data Visualization Part

Input Raw Materials Stats

Production Rate of PartA (Box/10min)

26

Production Rate of PartB (Box/10min)

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Production Rate of PartC (Box/10min)

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Crowded State(BoxB,BoxC)

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Assembly and Welding Stations

Assembly Rate of Boxes (Box/10min)

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Variant for Welding on ConvA

V3

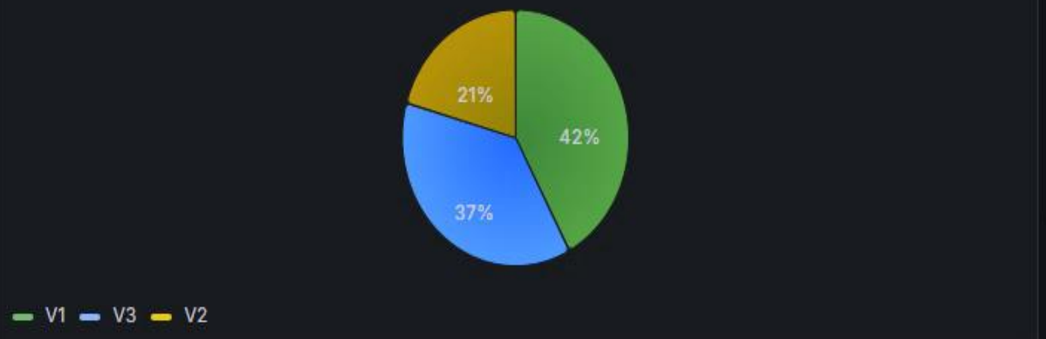
Welding Rate of Boxes (Box/10min)

26

Product Amount in 10 mins

Scrap Station

Scrap Count by Variants



ScrapingRate of ConvE Boxes (Box/10min)

10

ScrapingRate of ConvD Boxes (Box/10min)

16

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Thank you for your attention.