Alexandria University
Faculty of Engineering
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OOP Lab 5

Report

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Problem Statement:

A simulation program to simulate an assembly line that produces different products consists of different processing machines Ms that are responsible for processing the product at different stages and queue Qs to handle product movement between different processing stages as a queuing network.

Features in the program:

- Build the production line by:
  - graphically add Qs.
  - graphically add Ms.
  - connect Qs and Ms via UI arbitrarily.
- Simulate the production line.
- Save memento and replay it.

Required steps to run the program:

1. Extract the compressed program folder.
2. For back-end part:
   - Open the **Simulation_Backend** folder using IntelliJ IDE (recommended) or any other java IDE or open it by simply running the pom.xml file.
   - Run the **LastAssignmentApplication** on: src/main/java/com.example.demo.
3. For front-end part:
   - You should have NodeJS and Angular-CLI if you haven't downloaded them.
   - Open the **Simulation_Frontend** folder using VS code IDE (recommended) then copy this to your terminal npm install and press Enter.
   - Copy this to your terminal ng serve and press Enter. Then the Simulation program is going to run on localhost:4200 copy it to your MS edge end press Enter, the interface of the program is going to show up and enjoy 😊. (You can replace MS edge by Chrome but first you have to open launch.json in the **Simulation_Frontend** from inside the VS code IDE and replace the 2 msedge written in the page by pwa-chrome and chrome **respectively.)**
   - **Note:** it's better to open the **tsconfig.json** then replace the assignment of strict to false instead of true to avoid any unwanted errors.

User guide:

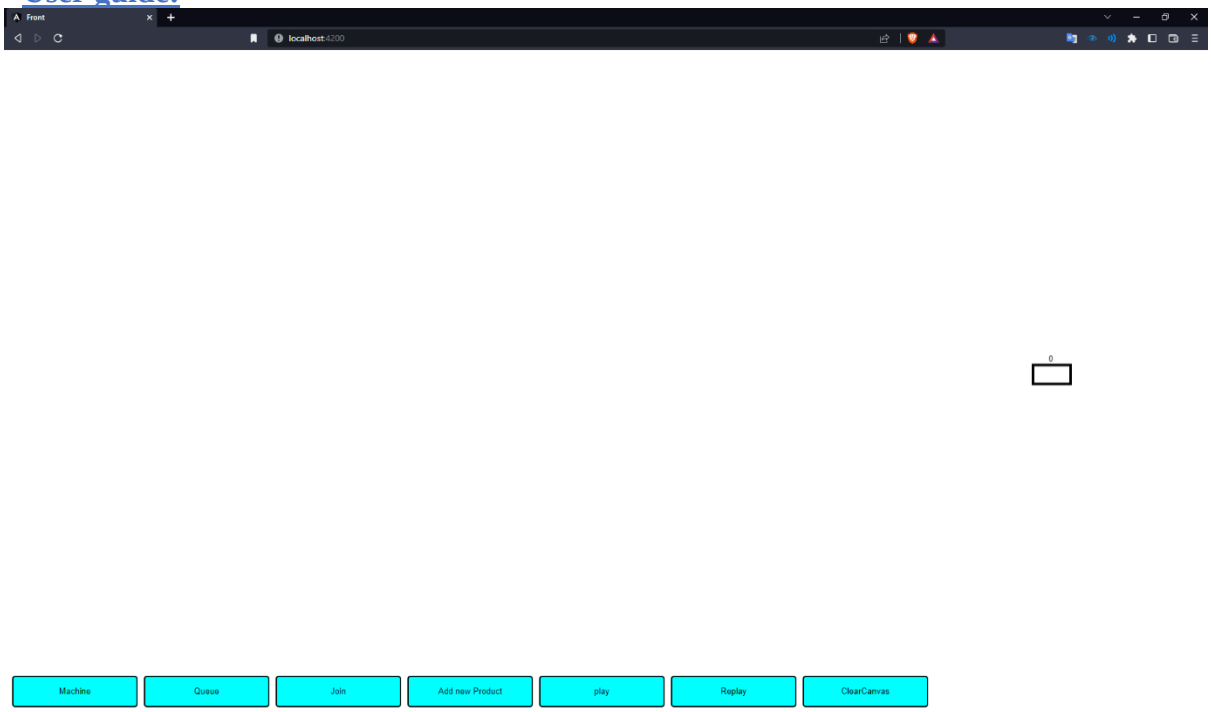


Figure 0-1: Start-Screen

In Fig 0-1: you can see the start screen of the program; you can see that by default Q0 is there.

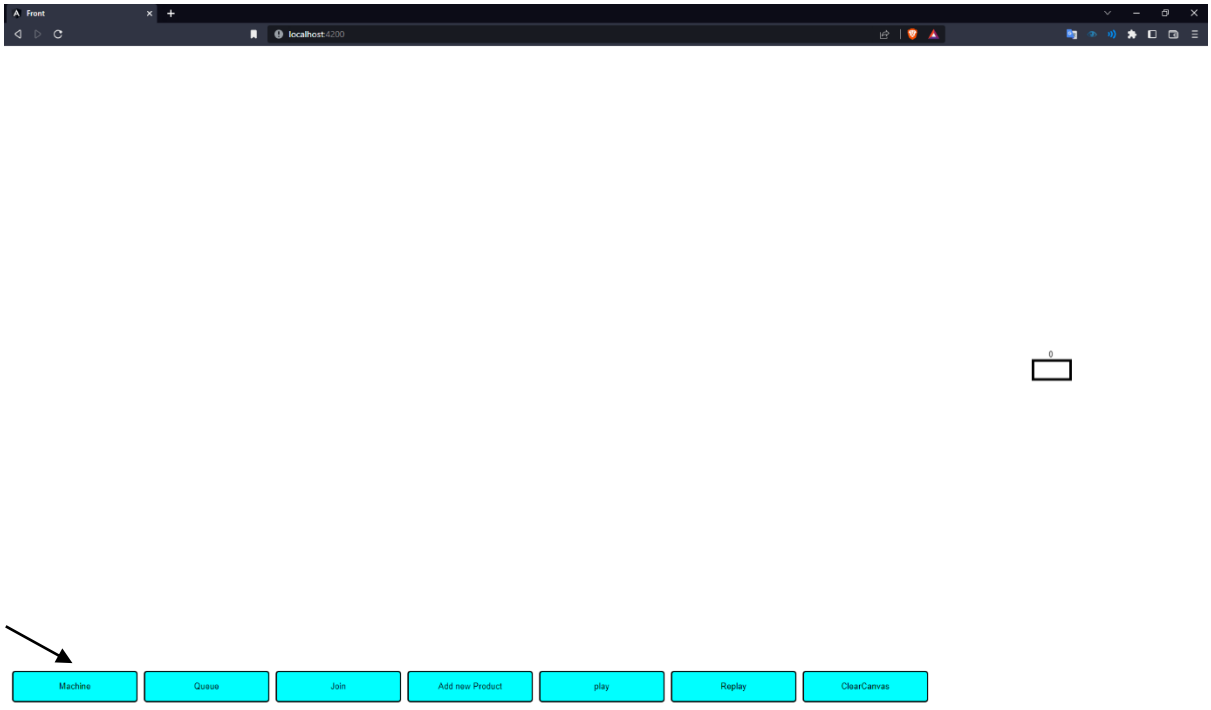


Figure 0-2: Machine command

In Fig 0-2: you can see the arrow referring to the Machine command which will insert a Machine like the following Fig:

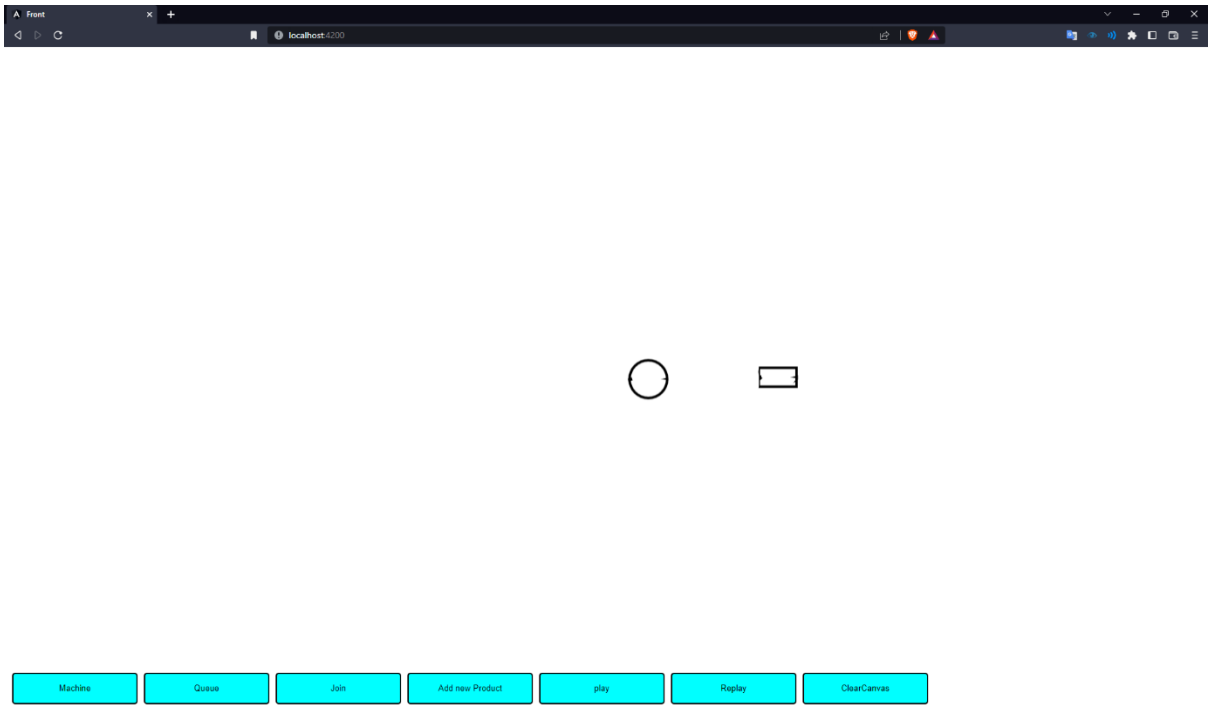


Figure 0-3: New Method

Figure 0-4: Queue command

In Fig 0-4: you can see the arrow referring to the Queue command which will insert a Queue like the following Fig:

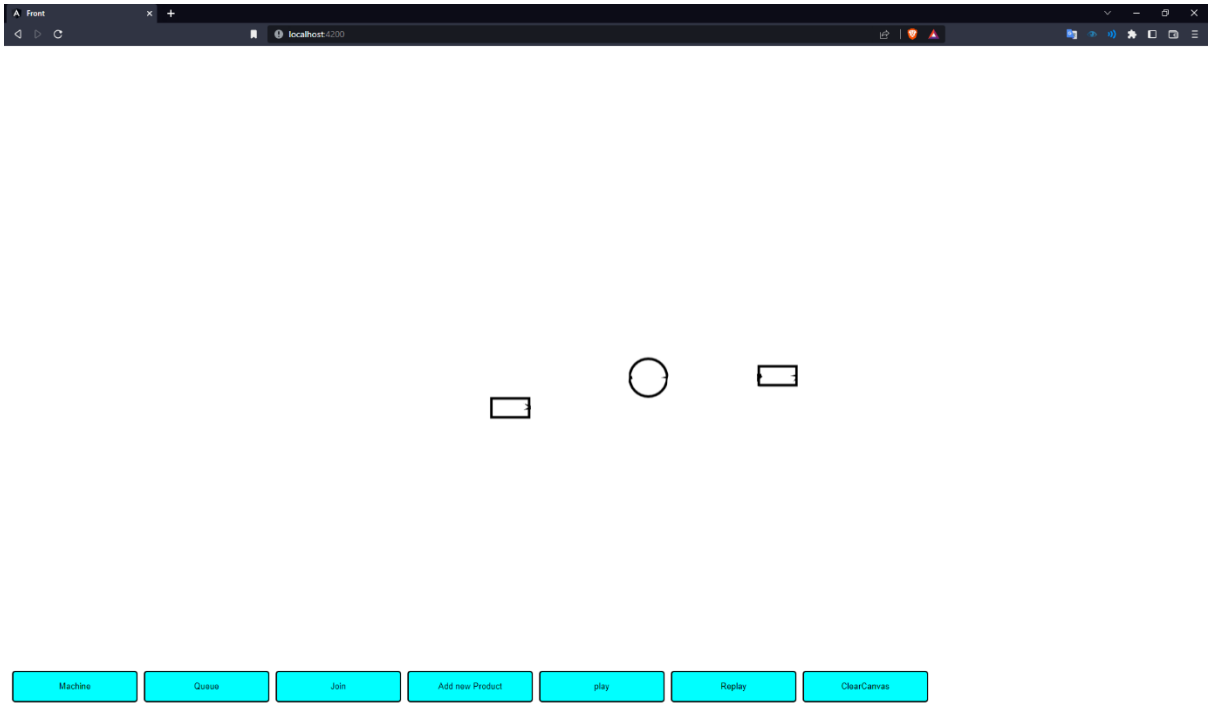


Figure 0-5: New Queue

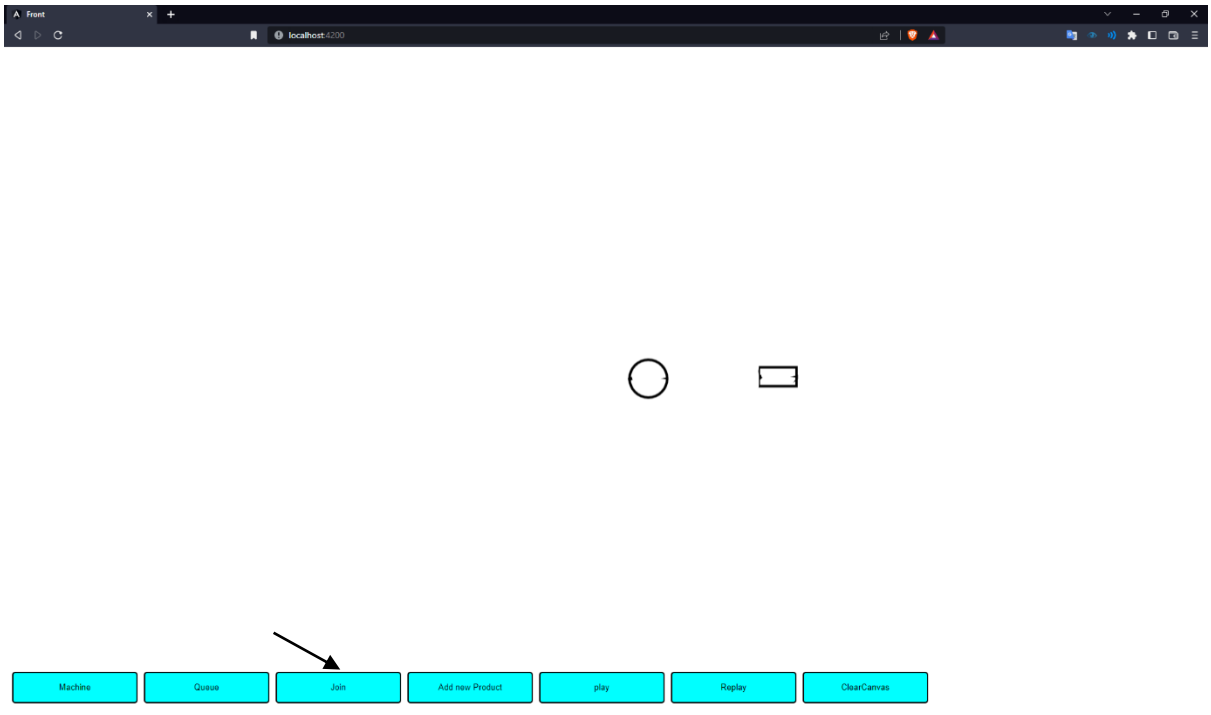


Figure 0-6: Join Command

In Fig 0-6: you can see the arrow referring to the Join command which will Join the two selected component like the following Fig:

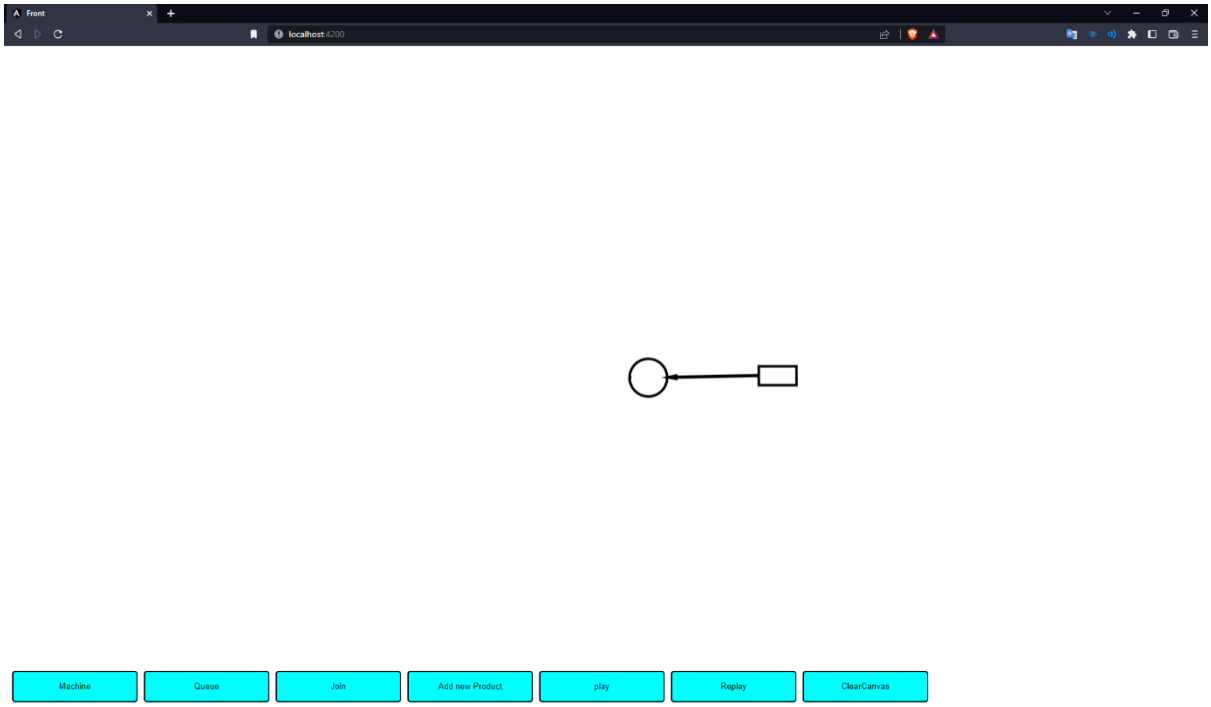


Figure 0-7: New Link

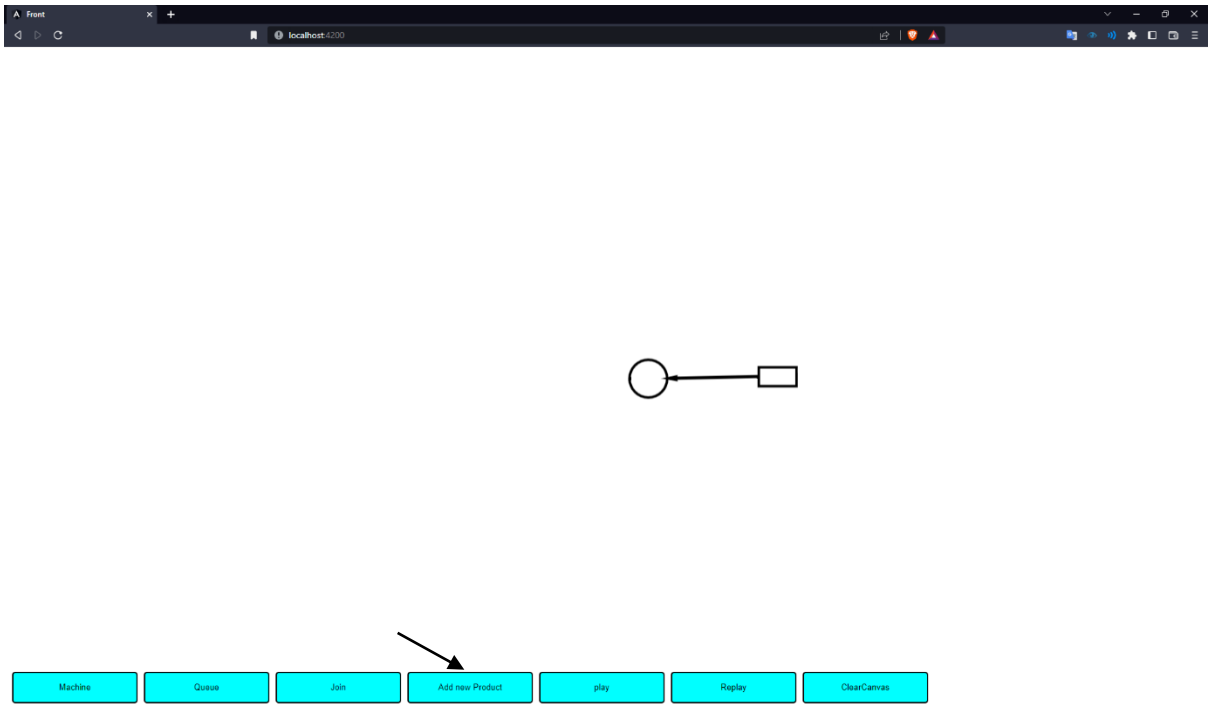


Figure 0-8: Add New Product Command

In Fig 0-8: you can see the arrow referring to the Add new product command which will Add a new product to Q0 like the following Fig:

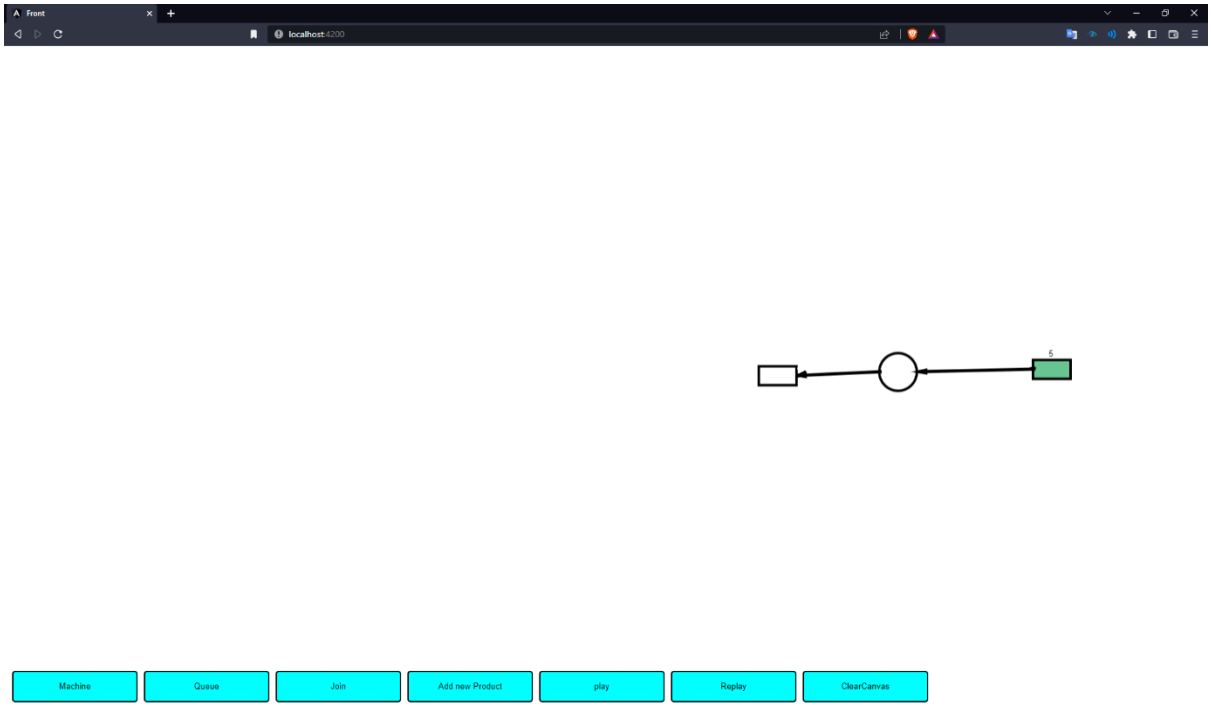


Figure 0-9: New Products

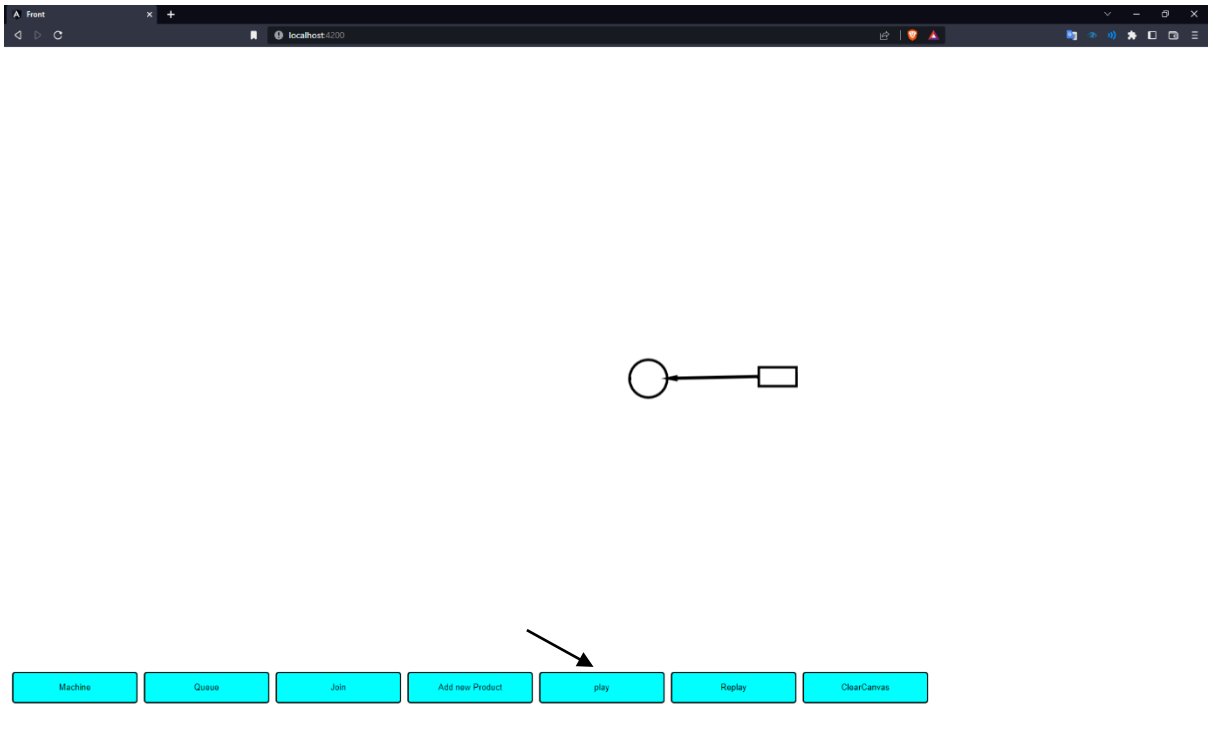


Figure 0-10: Play Command

In Fig 0-10: you can see the arrow referring to the play command which will start the simulation of the product like the following Fig:

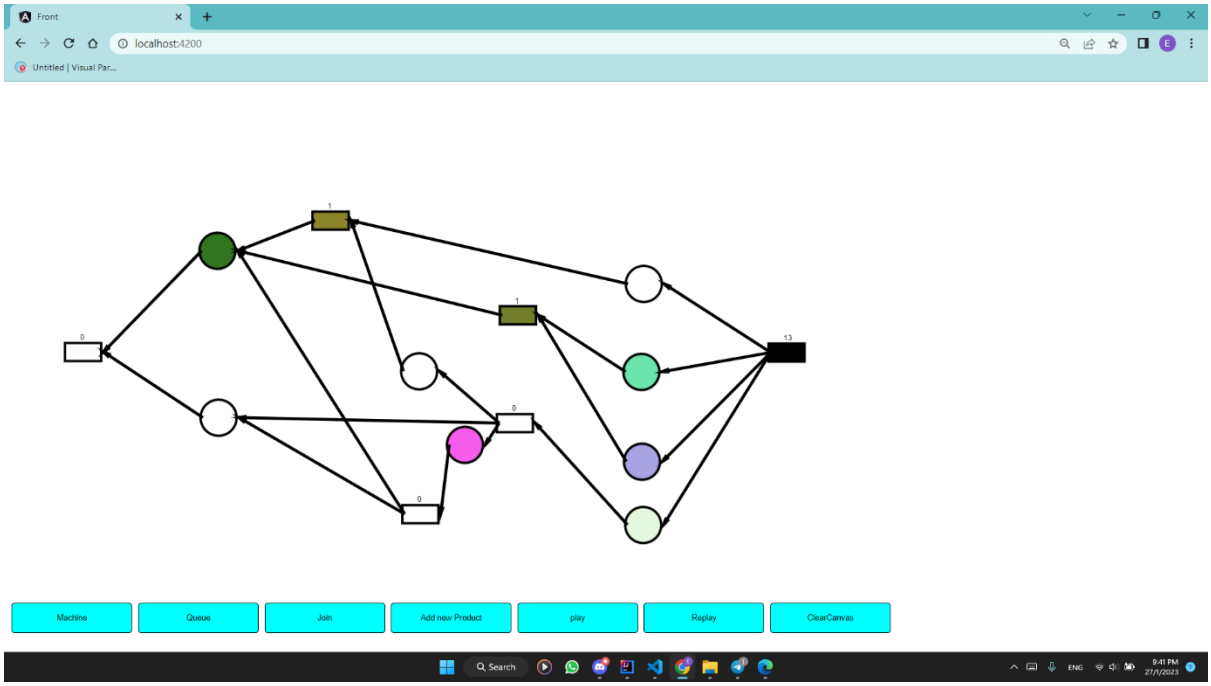


Figure 0-11: Simulation-Screen

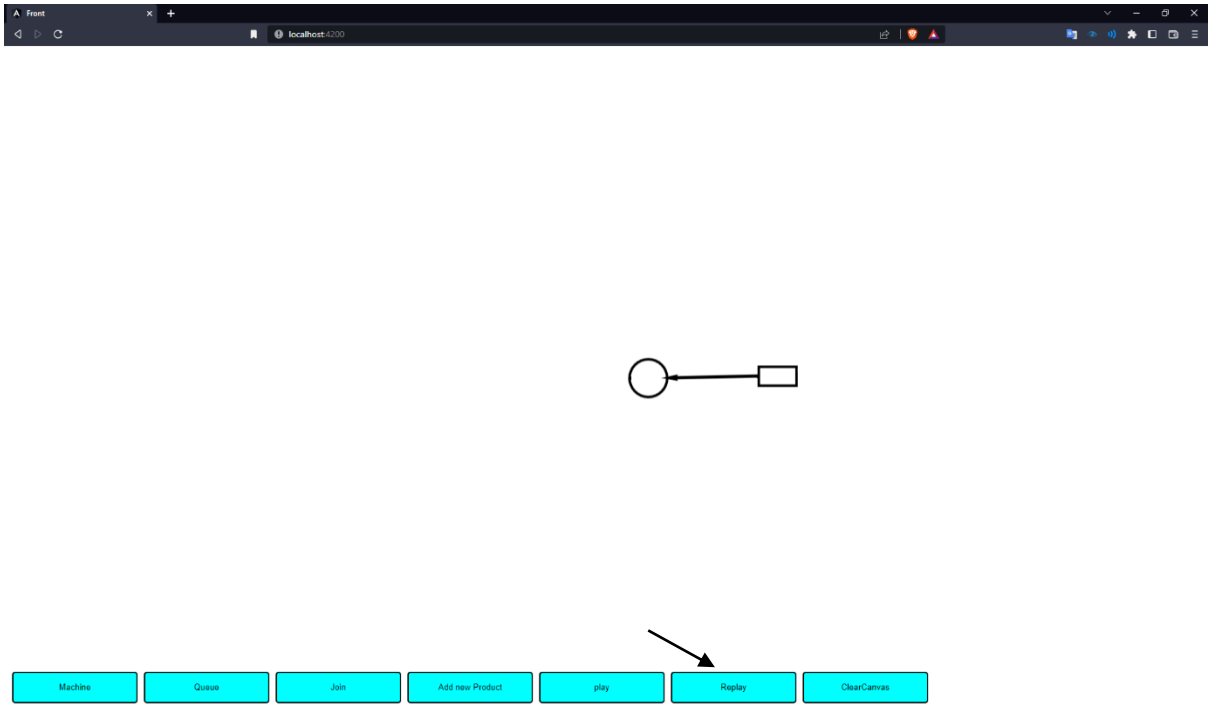


Figure 0-12: Replay Command

In Fig 0-12: you can see the arrow referring to the replay command which will replay the simulation of the product from the beginning.

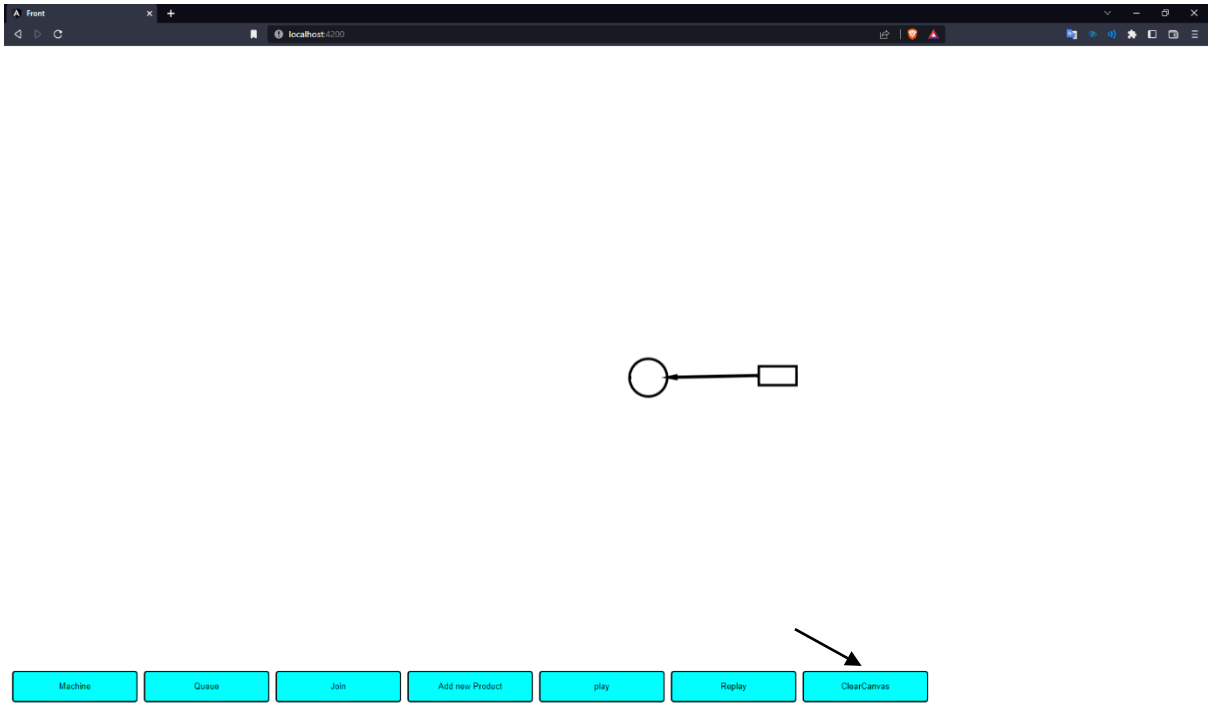


Figure 0-13: Clear Canvas Command

In Fig 0-13: you can see the arrow referring to the Clear Canvas command which will clear the screen and return to the starting screen like the following Fig:

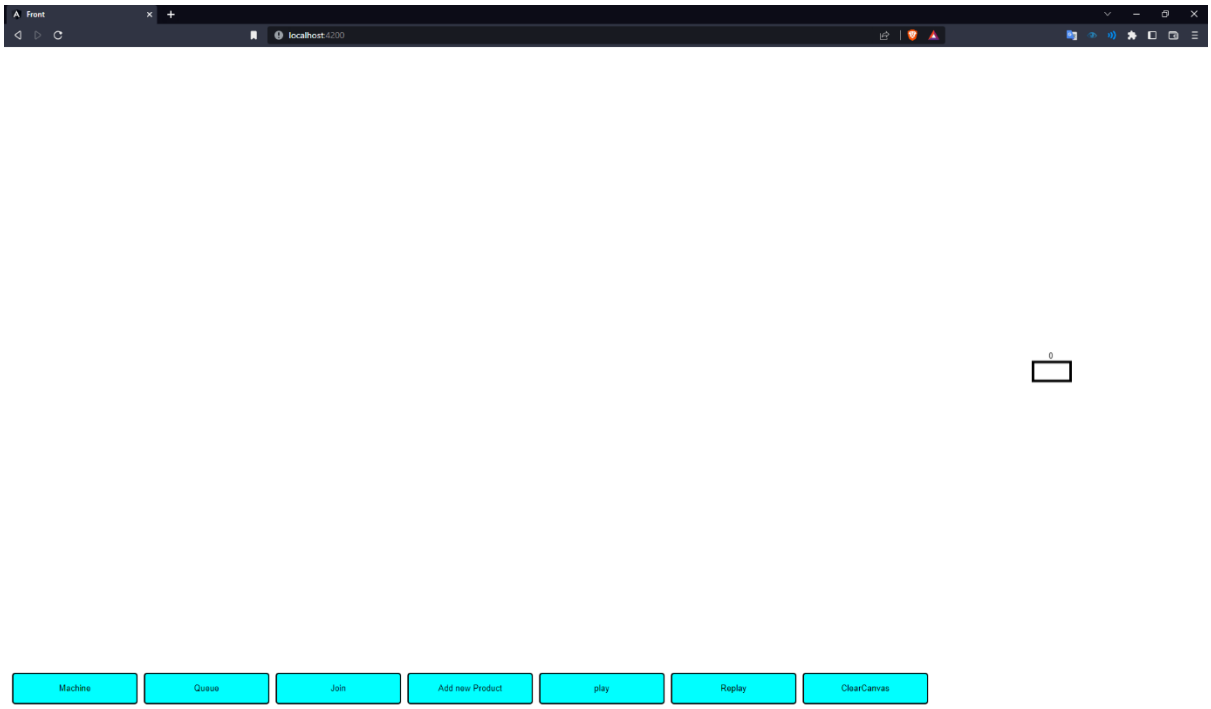
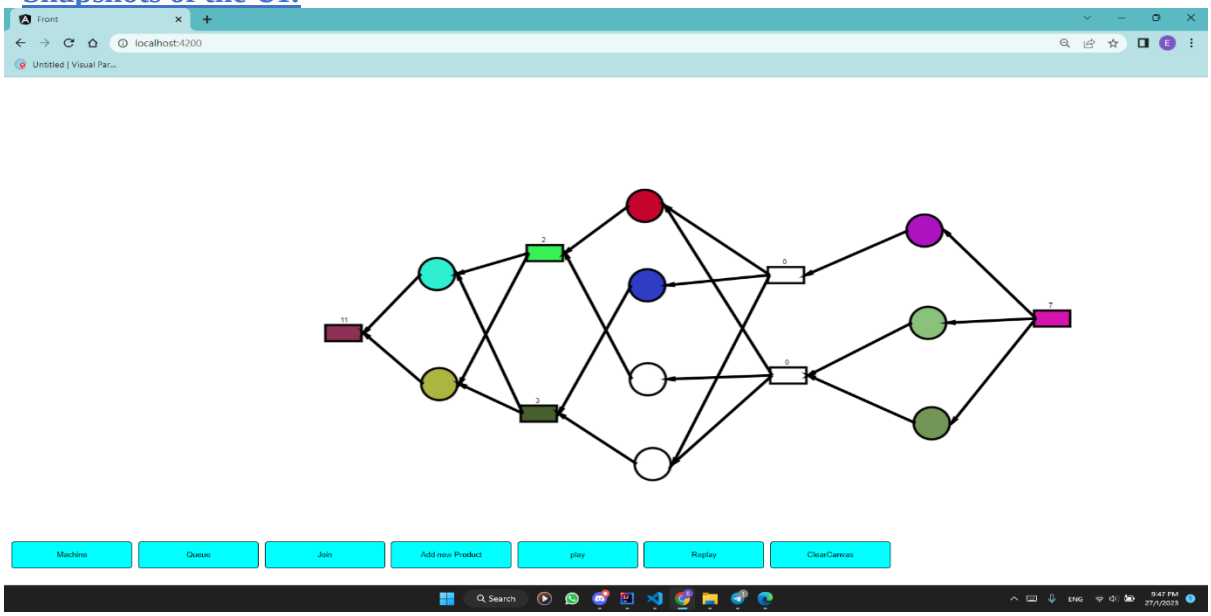
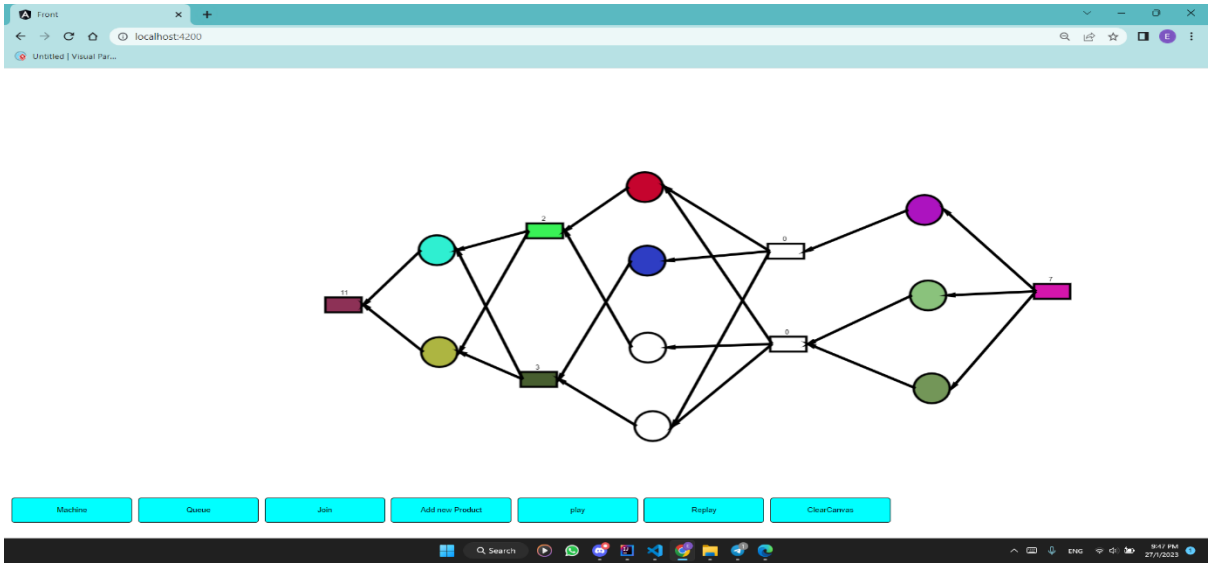
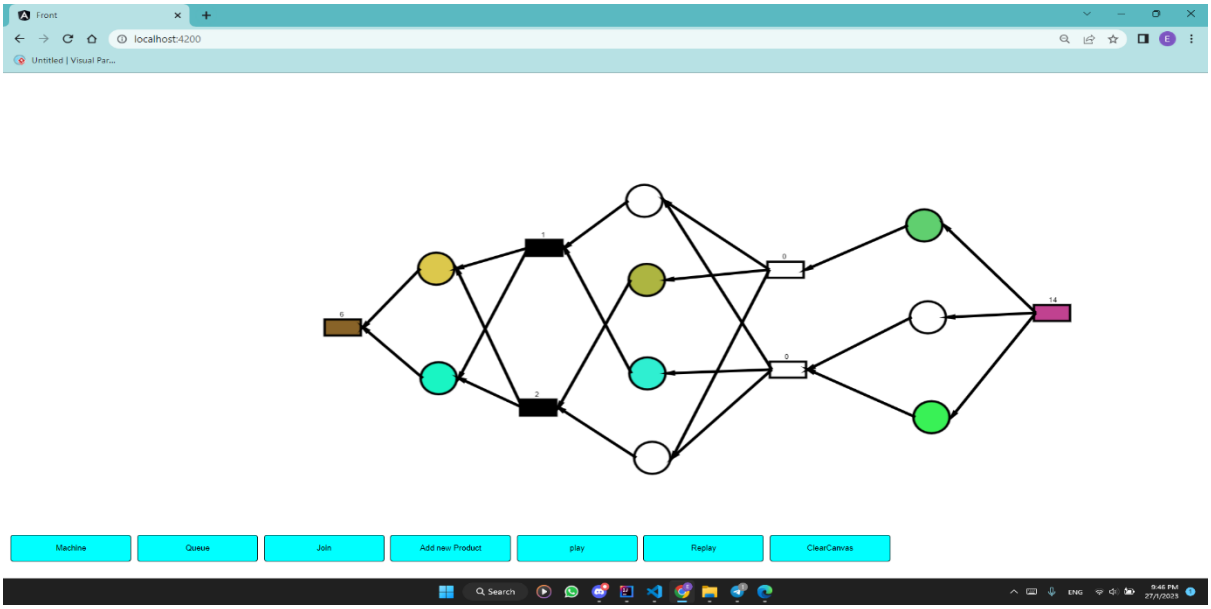


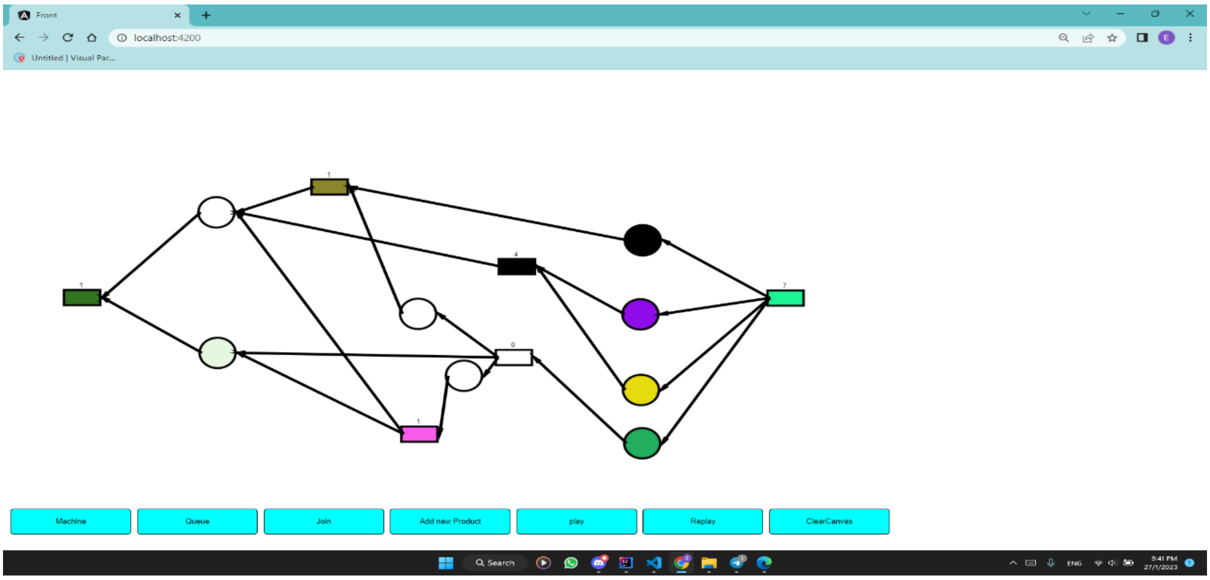
Figure 0-14: The Cleared Screen

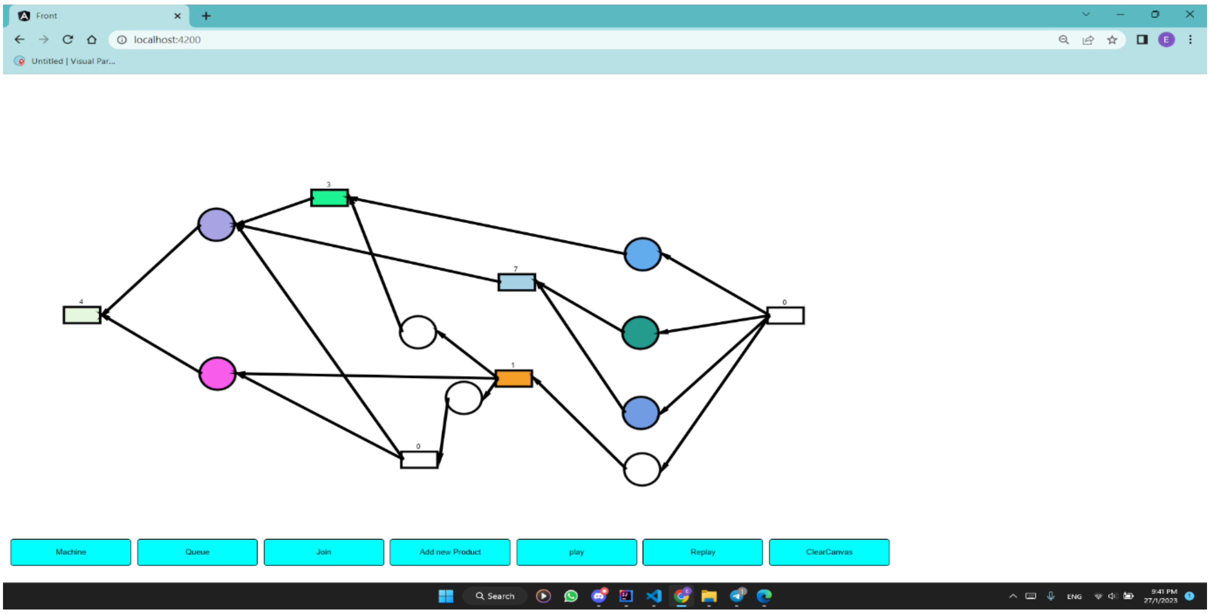
Snapshots of the UI:

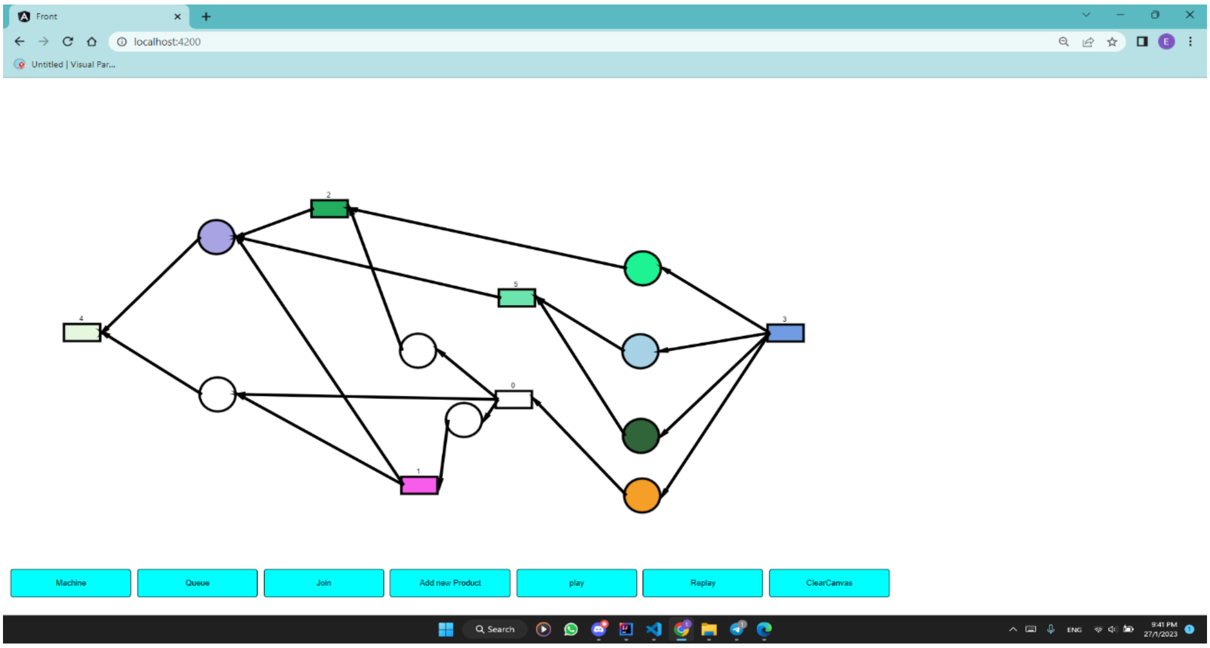




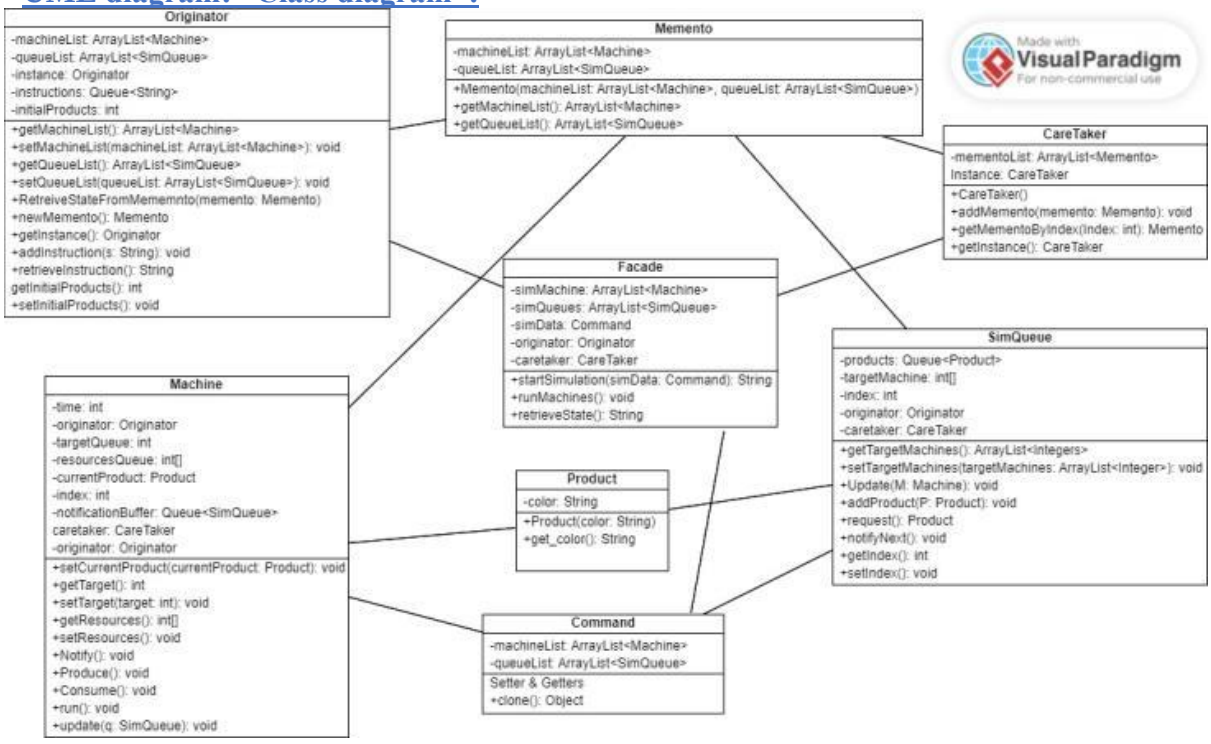



Front
localhost:4200
Untitled | Visual Par...
Machine
Queue
Join
Add new Product
play
Replay
ClearCanvas
Search


Front
localhost:4200
Untitled | Visual Par...
Machine
Queue
Join
Add new Product
play
Replay
ClearCanvas
Search


Front
localhost:4200
Untitled | Visual Par...
Machine
Queue
Join
Add new Product
play
Replay
ClearCanvas
Search

UML diagram: “Class diagram”:



How the design patterns are applied:

- Producer consumer + Observer:

Each machine can act as both producer and consumer, so whenever the producer puts a product in the queue it instructs the queue to notify all the machines that are going to be consuming from it, then it returns to its own operation.

If the machine was busy at the time, it keeps the notification in a buffer to respond to it when it finishes its current process even if some other machine responds to the queue and takes the product from it.

If that happens it will simply check if it still has a product to be consumed, if not then it waits for a notification. In this situation the queues act as subject and the consuming machines act as observers

- Memento:

we used snapshot design pattern to store the machines and queues in an Originator Object and CareTaker class to store several mementos of objects in an ArrayList.

- Façade:

The facade class communicates with all classes in order to begin the simulation, once the simulation has begun, each machine starts its own thread and begins the process.

The class initializes the originator for the snapshot design pattern and readies the machines and queues.

- Singelton:

the originator class is a singleton class.

Snapshots of the design pattern:

- Memento:

```
package com.example.demo.SnapShot;

import com.example.demo.Machine;
import com.example.demo.SimQueue;
import java.util.ArrayList;

6 usages  Random *
public class Memento {
    2 usages
    private ArrayList<Machine> machineList;
    2 usages
    private ArrayList<SimQueue> queueList;

    1 usage  Random
    public Memento(ArrayList<Machine> machineList, ArrayList<SimQueue> queueList) {
        this.machineList = machineList;
        this.queueList = queueList;
    }
    Random
    public ArrayList<Machine> getMachineList() { return machineList; }

    Random
    public ArrayList<SimQueue> getQueueList() { return queueList; }
}
```

```
import com.example.demo.Machine;
import com.example.demo.SimQueue;
import org.springframework.stereotype.Component;
import java.util.ArrayList;
import java.util.LinkedList;
import java.util.Queue;

14 usages  Random *
@Component
public class Originator {
    1 usage
    private static final Originator instance = new Originator();
    1 usage  new *
    private Originator(){}
    3 usages  new *
    public static Originator getInstance(){return instance;}
    5 usages
    private ArrayList<Machine> machineList;
    5 usages
    private ArrayList<SimQueue> queueList;
    2 usages
    private Queue<String> instructions = new LinkedList<>();
    2 usages
    private int initialProducts;
    1 usage  Random
    public ArrayList<Machine> getMachineList() { return machineList; }
    1 usage  Random
    public void setMachineList(ArrayList<Machine> machineList) { this.machineList = machineList; }
```

```
    public ArrayList<SimQueue> getQueueList() { return queueList; }
    1 usage  Random
    public void setQueueList(ArrayList<SimQueue> queueList) { this.queueList = queueList; }
    Random
    public void RetreiveStateFromMemento(Memento memento) {
        machineList = machineList;
        queueList = queueList;
    }
    1 usage  new *
    public Memento newMemento() { return new Memento(machineList,queueList);}
    6 usages  new *
    public void addInstruction(String s) { instructions.add(s); }
    1 usage  new *
    public String retrieveInstruction() { return instructions.poll(); }
    1 usage  new *
    public int getInitialProducts() { return initialProducts;}
    1 usage  new *
    public void setInitialProducts(int initialProducts) { this.initialProducts = initialProducts;}
}
```

```
import java.util.ArrayList;

12 usages  Random *
public class CareTaker {

    1 usage
    private static final CareTaker instance = new CareTaker();

    1 usage  new *
    private CareTaker(){}

    3 usages  new *
    public static CareTaker getInstance(){return instance;}

    2 usages
    private ArrayList<Memento> mementoList = new ArrayList<>();


    1 usage  Random
    public void addMemento(Memento memento) { mementoList.add(memento); }

    Random
    public Memento getMementoByIndex(int index) { return mementoList.get(index); }


}
```

- Producer-Consumer + Observer:

```
public class Machine implements Runnable{
    3 usages
    private int time;

    7 usages
    private int index;

    3 usages
    private Queue<SimQueue> notificationBuffer = new LinkedList<SimQueue>();

    5 usages
    private Originator originator = Originator.getInstance();
    1 usage
    private CareTaker caretaker = CareTaker.getInstance();
    6 usages
    private int targetQueue = -1;

    8 usages
    private Product currentProduct = null;

    Random
    public void setCurrentProduct(Product currentProduct) {
        this.currentProduct = currentProduct;
    }
```

```
public void produce() throws InterruptedException {
    if(targetQueue == -1)
        return;
    Thread.sleep(this.time);
    originator.addInstruction( s: "machine " + String.valueOf(index) +" #ffffff");
    SimQueue target = originator.getQueueList().get(targetQueue);
    target.addProduct(currentProduct);
    System.out.println("Machine " + this.index + " produced product of color " + currentProduct.getColor() + " and fed to queue " + this.targetQueue);
    target.notifyNext();
    currentProduct = null;
    this.consume();
}

2 usages   Random *
public void consume() throws InterruptedException {
    while(currentProduct == null) {
        while (this.notificationBuffer.isEmpty()){Thread.sleep( millis: 10);}
        SimQueue requester = notificationBuffer.poll();
        this.currentProduct = requester.request();
    }
    System.out.println("Machine " + this.index + " consumed product of color " + currentProduct.getColor() + " from a queue");
    originator.addInstruction( s: "machine " + String.valueOf(index) + " " + currentProduct.getColor());
    caretaker.addMemento(originator.newMemento());
    this.produce();
}
1 usage   new *
public void update(SimQueue q) {
    System.out.println("Machine " + this.index + "  is notified");
    this.notificationBuffer.add(q);
}
```

```java
@Override
public void run() {
    try {
        System.out.println("Starting machine " + this.index + " target is " + this.targetQueue);
        this.consume();
    } catch (InterruptedException e) {
        e.printStackTrace();
    }
}

new *
public int getTime() {
    return time;
}

new *
public void setTime(int time) {
    this.time = time;
}

new *
public int getTargetQueue() {
    return targetQueue;
}

new *
public void setTargetQueue(int targetQueue) {
    this.targetQueue = targetQueue;
}

1 usage  new *
public void setIndex(int index) {
    this.index = index;
}

Random *
public void setOriginator(Originator originator) {
    this.originator = originator;
}
}
```

Design decisions and assumptions:

- We used Angular for Front-End coding.
- We used Spring boot for the Back-end coding.
- In front End we have used:
    - npm i konva
    - npm i net -S
- The Color of the Queues is the color of the last product equipped.
- The production line must start with a Queue.
- The production line must end with a Queue.
- The terminal Queue must be the last Queue equipped.