MULTI AGENT AND AGENT SYSTEMS
**PROJECT PROPOSAL: BAKERY SIMULATION**

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Overview
The project simulates how a bakery works. The bakery offers a number of different products. It has numerous customers and delivers products via a number of trucks. There are 3 types of customers. Some customers (mainly sales shops, supermarkets) order between 50% and 100% of their demand at end of the day before delivery (next day orders). The remaining demand is ordered on the same day as delivery. Some customers (elderly homes, hospitals, canteens) order all their demand once a day for next day delivery. Some customers (catering services, clubs, associations, etc. organising special events) order their demand several days ahead of delivery. To guarantee freshness, products can only be produced on the day of delivery.

Stages
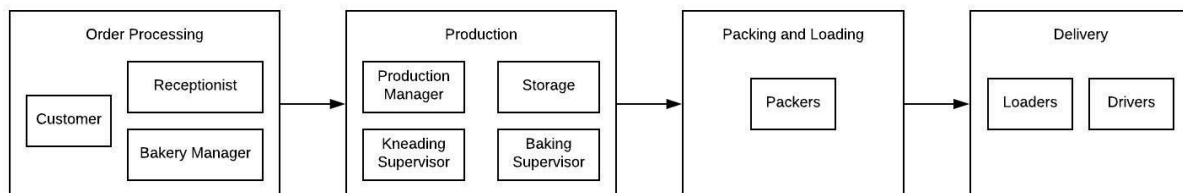
There are 4 stages in the simulation:
1. Order processing stage
   In the order processing stage, the Agent Receptionist (AR) takes an order from the Agent Customer (AC). Then it forwards the order to the Agent Bakery Manager (ABM). ABM checks the schedule and give the confirmation to the receptionist. If the schedule allows, it give a 'yes' and AR offers the price to AC. AC then either refuse or accept the offer. If AC agrees to continue the order, ABM will arrange the order to the schedule otherwise it removes the order.

2. Production stage (00.00 - 12.00)
   One day before the production should start, ABM gives the list of orders to Agent Production Manager (APM). APM gives order to Agent Storage (AS) to checks the storage and buy the ingredients if necessary. At the beginning of the day (00.00) APM commands the Agent Kneading Supervisor (AKS) to start kneading. AKS hold the whole schedule for one day. AKS has a vector of objects (Kneading Machine) and distribute tasks to each of them. Everytime there is an empty Kneading Machine, it asks AS to give the ingredients based on the schedule.

All doughs are returned to AKS and rest there for a while. After resting, AKS delivers the dough to Agent Baking Supervisor (ABS). Similar as AKS, ABS has a vector of objects (Oven). All product fresh from the oven will rest at ABS and then be returned to APM.

3. Packing
   Agent Packers (AP) received the list of orders for the day at the beginning of the day (00.00) from ABM. AP gives notice to APM whether it is ready to pack. APM then delivers the product to AP. AP packs everything and wait until all products from the same customer are ready before delivering it to the next stage. Packages for same customer are collected into a bundle.

4. Delivery stage
   Agent Loading (AL) considers the time of desired delivery, the delivery location, and the size of the truck while loading the package. Agent Drivers (AD) received the list of orders for the day at the beginning of the day (00.00) from ABM. It creates the best route (distance, time) to deliver the package.

UML Diagram
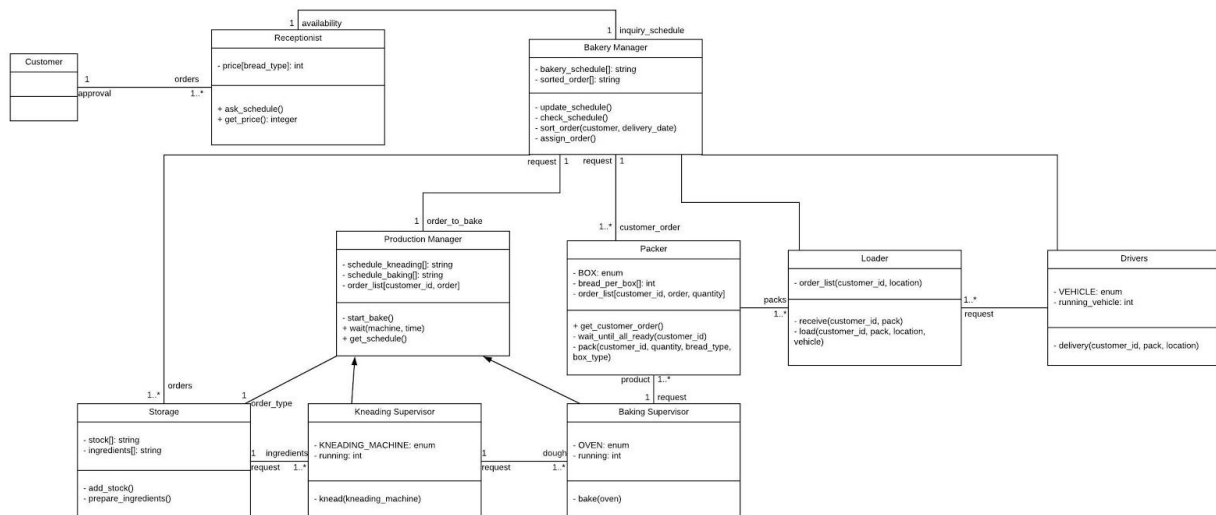
Agents: all are built during startup.
- Customer
  - Starting point, all orders are generated in a list
  - Further improvement, a customer can input the order manually based on the product list.
- Receptionist
  - The agent holds the price for each product.
  - It forwards the order to Bakery Manager for every orders to make sure if the order is feasible.
  - First frontier of bakery to communicate with the customer.

- Bakery Manager
  - The agent holds the working time of each object bakery has (kneading machine, oven, and truck).
  - Based on the input (order), the agent arrange the order whether they will be made a day before or on the day of the delivery date.
- Production Manager
  - The agent takes one day schedule and arrange the task hourly based on the delivery date (and hour).
  - The agent manages the production stage and is responsible to communicate with other stages.
- Kneading Supervisor
  - The agent works under the production manager.
  - It receives the one day schedule (hour based) from the production manager and distributes the task to each kneading machine.
  - It rests the dough from kneading machine before giving it to the baking supervisor.
- Storage
  - The agent makes sure that the ingredients are enough for production process.
  - It gathers all ingredients for one time kneading (based on the order and kneading machine size) and deliver it to kneading supervisor based on request.
- Baking Supervisor
  - It receives the one day schedule (hour based) from the production manager, and distributes the task to each oven.
  - It lets the fresh-from-the-oven product cool down before giving it to the packing.
- Packer
  - It waits until all product from the same customer ready and bundles the packages.
- Loaders
  - It loads bundles of package from the packer to the truck.
  - It arranges the bundles based on the distance. The shortest distances will be the nearest to the door.
- Drivers
  - It holds a list of driver.
  - Each driver is assigned to a truck.
  - The agent calculate the best route to deliver the package.

Order Aggregation:
- Bakery Manager
  Class Scheduler:
        Map<Date, Customer> schedule = new HashMap<Date, Customer>()

  Class Customer:
        String customer_id

List[Float] location #[latitude, longitude]
List[Order] orders
Time delivery_time

Class Order:
String order_type
Int quantity

Class Time:
Date date
Int hour

Class Date:
Int month
Int day

- Production Manager
Map<Int, Order> schedule = new HashMap<Int, Order>() #hour: order

MESSAGES
Approval: Integer
Order Processor Agent →Customer Agent
The Order Processor Agent will check the schedule before accepting the customer order. If the schedule is open, the Order Processor Agent will give price as message. If the order is not feasible, the Order Processor Agent will return null. This message is only one order.

Order: String <customer_id;product_type;quantity;delivery_date;location>
Customer Agent →Order Processor Agent
The Customer Agent gives order by this format. If there are more than one product type, the customers need to make another order.

Inquiry_Schedule: String <customer_id;product_type;quantity;delivery_date;location>
Order Processor Agent →Schedule Holder
The Order Processor Agent acts as a receptionist and check the schedule of the bakery to the Schedule Holder Agent. Schedule Holder Agent will then estimate the time to start baking based on the input. This agent holds a rough schedule of each station agent (baking, packing, etc), which is whether the day is full or not (working hours is 8 hours).

Availability: Boolean
Schedule Holder →Order Processor
The Schedule Holder will return True if the order is possible and False if not.

Orders: String <product_type;quantity>
Schedule Holder →Storage
Schedule Holder will send the Storage Agent the list of orders that will be baked few days later.
The Storage will then check its stock. If it is empty, it will buy them.

Order_Type: String <customer_id;product_type;quantity>
Baking Manager →Storage
When Baking Manager is ready to bake, the Baking Manager tell the Storage to gather the
necessary ingredients.

Ingredients: String <customer_id;product_type;quantity>
Storage →Kneading Station
After requested by Kneading Station, Storage Agent will give the Kneading Station Agent a lump
of ingredients to produce a product type in a specific amount.