

# SYN GARDENS by Ziming, Andrea, Maithili, Lucretia

## Proposal

Our project started last week with a lot of information about complex systems of AI and all of its components. At the end we focused on an exercise, developing a proposal for an AI system for a MDEF student in 2044 living in a Solar Punk world.

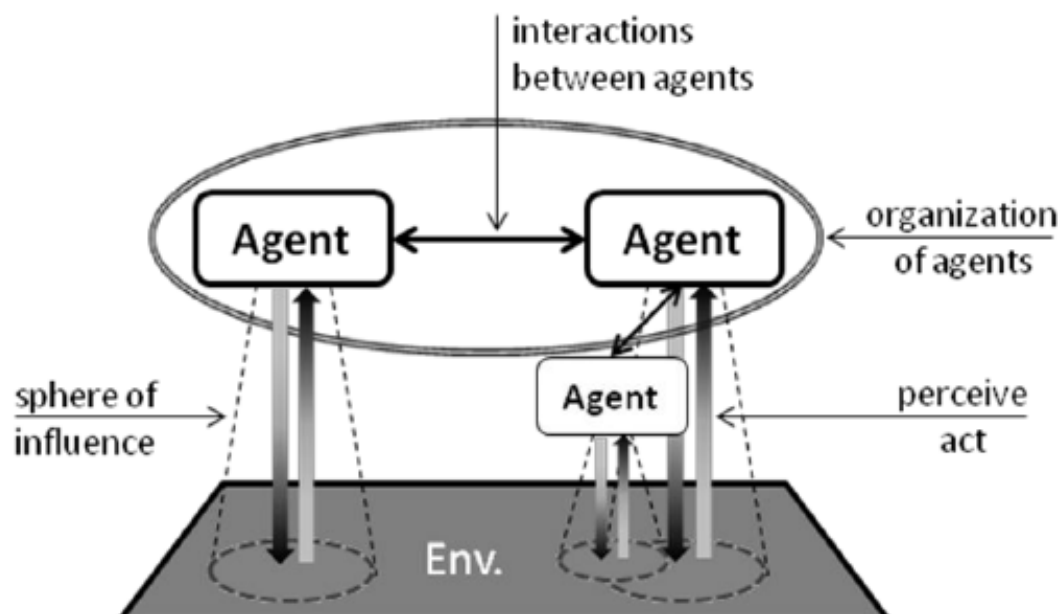
We wanted to develop a system where MDEF students could more easily get a snack during a short break in class than we can now. So instead of going to a supermarket (like Mercadona) they could go to one of many community gardens and pick a fruit or vegetable for a snack for free. The idea was to develop a plant monitoring, resource management, and mapping system that would integrate concepts from *The Honorable Harvest* into a suggestion system that would tell a student where they could go and what and how much they could take.

Hypothesis / value proposition statement	
CONCEPT NAME	Syn-Garden
IF WE USE [input data]	Nutrition data, plant/fruit recognition, plant health
TO [AI capability]	To suggest and analyze nutrition benefits of fruits and vegetables based on mood input, and optimize growing environments for plants in the garden
WE CAN HELP [person from IAAC community]	IAAC student who looks for lunch solution (also include people in El Poblenou district)
WITH A BETTER WAY TO [task]	Build a self sufficient community garden with healthy and ecological food choice
THEN THEY WILL BE ABLE TO [gain vs. pain]	Contribute to environmental well-being as well as personal well-being
SO THAT [value for person and/or society]	To construct a community Garden with multi AI Agents to integrate well-being in city life and build a balance relationship among technology, community and nature

## Multi Agent Systems

We were confused about how to develop this system. The concept for the project was complex and had quite a few components to figure out. We discussed it with Pau and he suggested we research the concept of Multi Agent Systems which might help us address the complexity of our proposal.

Pau suggested we research Multi Agent Systems (MAS) as a potential method of proposing the accomplishment of our goals. We discovered that MAS is a structure of an AI System where AI 'agents' work together to perform a complex task.



Each agent of the multi agent system is equipped with doing specific tasks autonomously, while being a part of a shared environment. Each agent can communicate, share information and alter the structure of other agents in the environment. Multi agent systems also have the ability to store memory and reconfigure the ways complex tasks are performed.

MAS can be of two types - centralized and decentralized. Each type has its benefits and drawbacks. The centralized system relies on a global network of agents that can share massive amounts of information and has the ability to process complex tasks. However, if one agent fails, the entire system collapses. The decentralized system, on the other hand, focuses on specific types of tasks

and can only share limited resources, but has a more robust structure as failure of a single agent does not affect the rest.

For our project, we proposed to use the decentralized multi agent system. We discussed multiple approaches of integrating MAS in our project but eventually decided to assign different processes to different agents. Since an important part of our proposal is using principles of the 'Honourable Harvest ', we proposed using it as a base for the shared environment that all the agents could work within. However, after discussing with Pau, we realized adding ethics to an environment was not possible, instead we would have to assign the principles to a separate agent. We further detailed out the proposal with flow charts to further understand the details.

## Chat-GPT Inspiration

Our vision was better than before, but it was difficult to clearly define our systems. We used the Chat-GPT tool, just to try to have a more clear understanding about what our systems could be. We wrote a prompt that talks about our concept.

“A community garden where the people could have fruit and vegetables for free and they could take the fruit and vegetables related to their feelings/wellness in the moment, so while you could have fruit and vegetables for free you could have a specific fruit for increasing your mental and body wellness.”

Chat-GPT gave us this project outline, The Garden of Well-Being.

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#### **\*\*Scenario: The Garden of Well-Being\*\***

*Imagine living in a \*solar punk\* city, where community urban gardens not only grow fruits and vegetables, but also serve as central hubs for the physical and mental well-being of the community. In this city, residents can access natural produce for free without the fear of depleting resources, thanks to an intelligent management system that balances the supply with the nutritional needs of the population.*

#### **### \*\*System Components:\*\***

##### **1. \*\*Community Garden with Biological Agents and Environmental Sensors\*\***

- The garden is equipped with sensors that monitor plant growth conditions, soil health, humidity levels, and other ecological variables. These sensors are connected to a central system that regulates the availability of fruits and vegetables, ensuring that crops are neither over-harvested nor depleted.
- Each plant is "tagged" with biological information such as vitamins, minerals, and other nutrients, making it possible to know exactly what the garden offers at any given time.

##### **2. \*\*Facial Recognition Camera with AI\*\***

- As users enter the garden or approach a designated harvesting area, they are monitored by an integrated camera that assesses their physical condition through facial recognition and analysis of bodily signals (such as fatigue, stress, or mental strain).
- The AI system analyzes the user's face in real time to detect potential nutritional deficiencies or signs of stress. For example, if the user shows signs of low energy (often caused by a deficiency in vitamins or sugars), or if they appear stressed or anxious, the system will suggest foods that could help improve their condition.

##### **3. \*\*Personalized Nutritional Advice\*\***

- Based on the information gathered from the camera and sensors, the AI suggests a specific fruit or vegetable that could address the user's nutritional needs. If the user needs more vitamin C, for instance, they might be directed to an apple or an orange. If the user appears stressed, the system could recommend foods that help boost serotonin production, such as tomatoes rich in lycopene, known to promote mental well-being.
- The AI not only recommends what to eat but also provides information on the psychological and physical benefits of each food item: "This red apple will help rejuvenate your energy levels, thanks to its high natural sugar content and vitamin C, ideal for combating mental fatigue."

##### **4. \*\*Resource Management System\*\***

- The community garden is managed by a system of intelligent agents that ensures individuals only collect what they need, avoiding waste. These agents can, for example, monitor the number of people in a specific area of the garden and ensure that harvest zones are not overcrowded.
- At the same time, the system ensures that no one takes more than they need, establishing personalized daily collection limits for each user based on their nutritional needs, physical and mental conditions.

##### **5. \*\*Mental Well-being and Social Integration\*\***

- The garden is not just a place for harvesting. It is also a social and therapeutic space where users are encouraged to participate in activities such as outdoor meditation, walking among the plants, or joining communal gardening groups. A virtual agent (an AI "companion") suggests relaxation activities or breathing exercises based on the user's emotional and physical state.

- *The garden also fosters social integration, where people can share their well-being experiences and contribute to harvesting together, creating a sense of community and connection with others.*

#### ### **Technologies Used:**

- **AI for Well-being and Nutrition**: Advanced facial analysis systems (e.g., *Deep Learning*) to detect emotions, stress, and nutritional deficiencies. Recommendation algorithms suggest personalized foods.
- **IoT and Environmental Sensors**: Sensors to monitor climate, plant health, and gather data on environmental well-being. These sensors communicate with the central system, which regulates fruit and vegetable availability.
- **Augmented Reality (AR)**: Users can use AR devices to receive real-time information on the benefits of each food and exercises to do while walking in the garden. They can also scan plants to learn about their history and healing properties.

#### ### **Sustainability and Inclusivity:**

*In a **solar punk** context, access to healthy food is completely free and based on a collective sharing model, without waste. The system is also committed to educating users about sustainability, teaching them to harvest responsibly and respect the natural cycles of the garden. Collaboration among residents is encouraged, with recipe exchanges, advice-sharing, and stories of well-being.*

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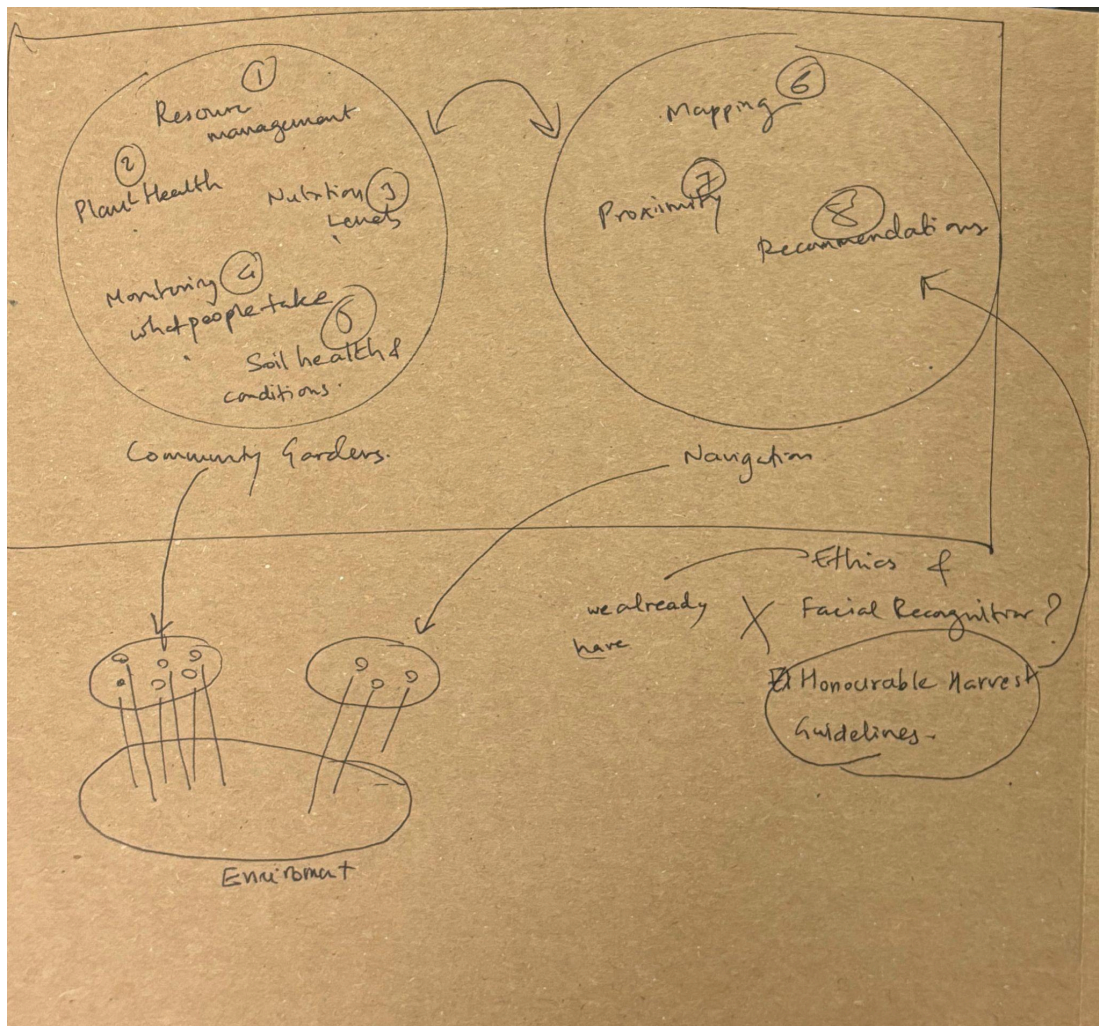
#### ### **Conclusion**

*The "Garden of Well-Being" is a perfect example of how a **Multi-Agent System** can integrate biological needs with the mental and physical well-being of users. The combination of artificial intelligence, environmental sensors, and a sustainable community garden not only improves urban life quality but also fosters a lifestyle that balances technology, nature, and community in perfect harmony with the **solar punk** spirit.*

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Though the ChatGPT response was a good framework, we realized that it still included some elements that were against our ethics. For example, the use of facial recognition to deduce our health concerns seemed to give too much access to our body health. We decided against using that piece of it. Additionally, it glossed over some pieces like "Augmented Reality" didn't feel necessary for our project and complicated it too much.

We used this prompt to come up with a more clear idea of how our system might work.



## Bias and Ethical Issues

Like any system built by or involving humans, our AI system will have bias and ethical concerns. Here are some of our summarized thoughts on the topics.

One initial part of our proposal was to use an emotion recognition system to determine what someone entering the garden was feeling. Using this kind of information, our system would be able to suggest which fruit or vegetable might improve their mood. However, through discussion within our group, we decided the ethical concerns and inherent bias within a system like this didn't sit well with

us. We decided that instead a user could choose what emotion they were feeling and that the system could make suggestions based on that input rather than any biometric information.

Another thing we decided to remove from our original system was the idea of monitoring how much an individual took. We decided instead to propose monitoring the plants rather than the humans interacting with them. This way, we wouldn't penalize or monitor human behavior, which could introduce many ethical concerns and even bias with facial recognition systems such as those described below.

#### Facial Recognition

- Race
- Gender
- Age
- Limited emotion recognition

Removing these pieces of the system would reduce the bias our system had. Additionally, we want to suggest that if we truly are living in an enlightened Solar Punk world, perhaps policing an individual's behavior would be unnecessary because the values of *The Honorable Harvest* would already be integrated into how society functions.

Despite removing the facial recognition component, there are still biases in our system and some ethical concerns.

- Nutrition Content may be inaccurate which may bias certain suggestions to happen more than others
- Assumptions that all people need similar nutrient intake misses nuance of individuality
- By considering some foods "healthy" while others are considered "bad" there is potential to perpetuate an individual's complicated relationships with food

We wanted to make sure our system would be encoded with an ethical code of its own. While the AI System would still be a product of human creation and have all of the biases humans have, the ideal would be to elevate it above base human instincts by encoding it with some of the better ethical codes humans have come up with.

Ethics we will encode:

- The Honorable Harvest
  - *Never take the first. Never take the last.*
  - *Harvest in a way that minimizes harm.*
  - *Take only what you need and leave some for others.*
  - *Use everything that you take.*
  - *Take only that which is given to you.*
  - *Share it, as the Earth has shared with you.*
  - *Be grateful.*
  - *Reciprocate the gift.*
  - *Sustain the ones who sustain you, and the Earth will last forever.*
- Waste Reduction - monitoring and predicting ripeness to suggest optimal times and quantities to harvest

## Proposal Details

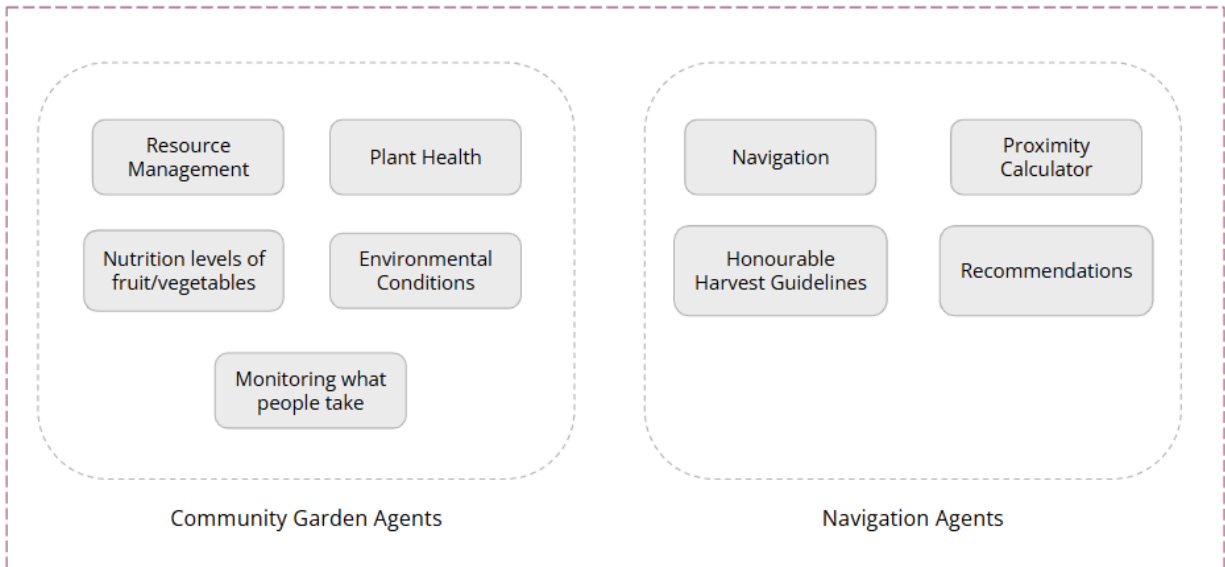
In a solar punk future, a large network of community gardens surround IAAC  
The gardens grow fruits and vegetables that the local people may take for free  
An AI system monitors the supply of resources:

- Mapping available resources based on proximity
- Predicting future resource availability to reduce waste or over-harvesting
- Providing anticipated nutritional information
- Suggesting what and how much each person can take to maintain a balanced supply for ethical and sustainable prosperity

After we analyzed the Multi Agent System composition, we detailed out the proposal with flowcharts to understand the role of different agents.

The project consists of two main categories which will each have multiple agents performing different tasks -





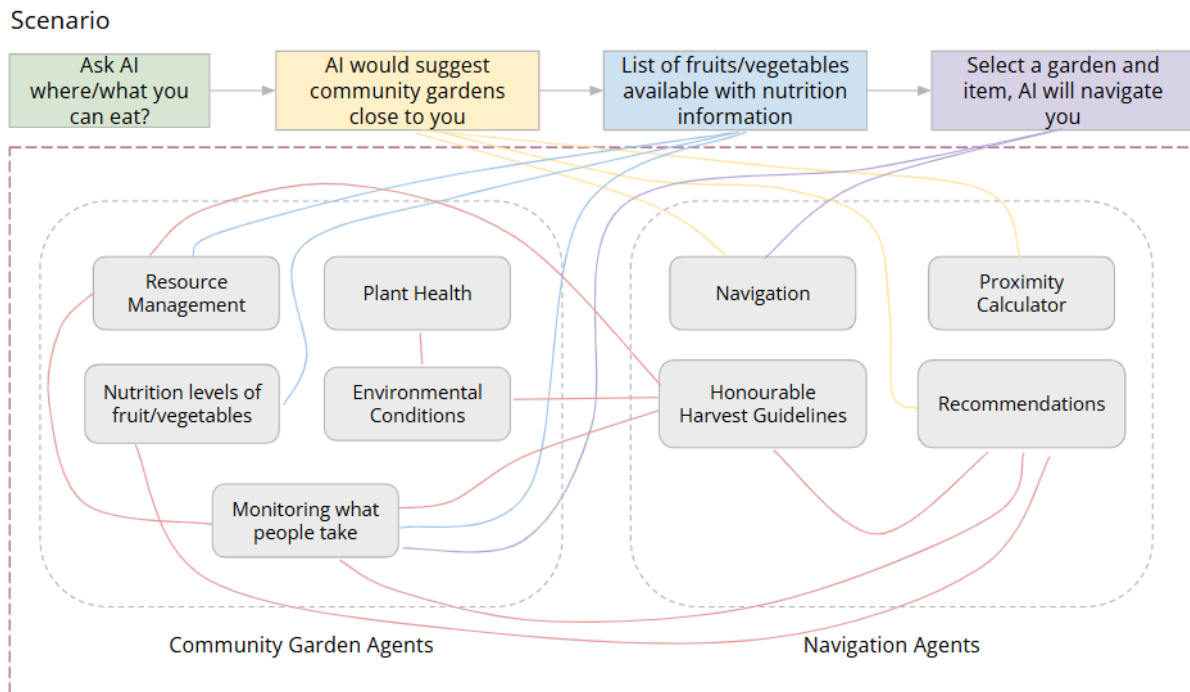
## 1. Community Garden

- a. **Resource Management Agent** : Will ensure stocktaking of resources in each community garden and update when required
- b. **Nutrition Level Agent** : Gathers information about nutrition levels for all resources available with access to different external tools.
- c. **Agent that monitor what people take from the garden using a camera**
- d. **Environmental Monitoring Agent** : Collects data of the conditions in the garden like soil fertility, humidity, temperature, etc.
- e. **Plant Health Monitoring Agent** : Keeps an eye on all plants and their growth to ensure their wellbeing. Works in conjunction with the environmental agent to predict the harvest for the following seasons and suggests improvements based on the data collected.

## 2. Navigation

- a. **Navigation**: to guide the user to find the closest garden with available resources to take.
- b. **Proximity Calculator**: to predict the approximate harvest of plants and fruits in the garden.
- c. **Honorable Harvest Guideline**: Based on the ethics of the Honorable Harvest, suggest the best amount for users to take of the fruits and plants in order to balance the growing environment in the garden.

- d. **Recommendation:** Recommend and optimize the best garden for the user to go, according to monitor what people had already taken, and recommend users based on the nutrition value.



After establishing the tasks for each agent, we compared the user interface with which agents will be working together to complete specific tasks. This flowchart is how we imagine the system to work. If you were a user, these are the steps you would follow to get a desired answer -

1. Ask the AI where and what you could eat during your lunch?
2. **Agents engaged : Navigation + Proximity Calculator + Recommendations**

Working together, you would get a list of community gardens near you that you could visit within your given time.

3. Once you decide which community garden you would like to visit, it will provide you with a list of resources available along with the nutritional information..

4. **Agents engaged : Resource management + Nutritional Information + Monitoring what people take**

Working together to provide a list of fruits and vegetables available with nutritional information for you to choose from.

5. Once you choose a garden and the item , it will navigate you using maps,

6. **Agents engaged : Navigation + Monitoring what people take**

Would not only guide you but also update information based on which fruits/vegetables you take.

7. Apart from these outputs, we also imagine internal communication between different agents. The red lines in the flowchart are indicating which agents would mutually interact with each other and update information based on external inputs.

For making our model training we use **datasets**:

Speaking about datasets that we would use for this project were super diverse due to all the different processes. However, found relevant datasets we could use for specific tasks and to train specific models. We made a list of the datasets we found -

Name	Link	Source	Notes
Embrapa ADD 256 (Embrapa Apples by Drones Detection Dataset)	<a href="https://paperswithcode.com/dataset/embrapa-add-256">https://paperswithcode.com/dataset/embrapa-add-256</a>	<a href="https://paperswithcode.com">paperswithcode.com</a>	Apple Identification from above
MinneApple	<a href="https://paperswithcode.com/dataset/minneapolis-apple">https://paperswithcode.com/dataset/minneapolis-apple</a>	<a href="https://paperswithcode.com">paperswithcode.com</a>	Apple Classification
tomato detection (A dataset of tomato fruits images for object detection in the	<a href="https://paperswithcode.com/dataset/tomato-detection">https://paperswithcode.com/dataset/tomato-detection</a>	<a href="https://paperswithcode.com">paperswithcode.com</a>	Tomato Classification in factories

complex lighting environment of plant factories)			
DeepHS Fruit v2	<a href="https://paperswithcode.com/dataset/deephhs-fruit-v2">https://paperswithcode.com/dataset/deephhs-fruit-v2</a>	<a href="https://paperswithcode.com">paperswithcode.com</a>	Avocados, Kiwis, Persimmons, Papayas, Mango
ACFR Orchard Fruit Dataset	<a href="https://paperswithcode.com/dataset/acfr-orchard-fruit-dataset">https://paperswithcode.com/dataset/acfr-orchard-fruit-dataset</a>		Various kind of fruit in Australia
Tomato Ripeness Detection	<a href="https://www.kaggle.com/datasets/nexuswh/tomatod">https://www.kaggle.com/datasets/nexuswh/tomatod</a>	<a href="https://www.kaggle.com/datasets?search=fruit+ripeness">https://www.kaggle.com/datasets?search=fruit+ripeness</a>	Identifying stages of ripeness in tomatoes
3D Facial Expressions Recognition Data	<a href="https://paperswithcode.com/dataset/4458-people-3d-facial-expressions-recognition">https://paperswithcode.com/dataset/4458-people-3d-facial-expressions-recognition</a>		Asian (Chinese), Black, Caucasian; gender distribution: male, female; age distribution: ranging from teenager to the elderly, the middle-aged and young people are the majorities
fruit-SALAD	<a href="https://paperswithcode.com/dataset/fruit-salad">fruit-SALAD Dataset   Papers With Code</a>	<a href="https://paperswithcode.com">http://paperswithcode.com</a>	fruit-SALAD is a synthetic image dataset with 10,000 generated images of fruit depictions. This combined semantic category and style benchmark comprises 100 instances each of 10 easily recognizable fruit categories and 10 easy distinguishable styles.
VegFru	<a href="https://paperswithcode.com/dataset/vegfru">https://paperswithcode.com/dataset/vegfru</a>		VegFru categorizes vegetables and fruits according to their eating characteristics, and each image contains at least one edible part of vegetables or fruits with the same cooking usage.
Fruits and Vegetables - Nutritional Values	<a href="https://www.kaggle.com/datasets/yoyoyloy/fruits-and-vegetables-nutritional-values">https://www.kaggle.com/datasets/yoyoyloy/fruits-and-vegetables-nutritional-values</a>		Nutritional values of fruits and vegetables, like protein, fat, fiber, sugars.
Food and vegetable nutrition dataset	<a href="https://www.kaggle.com/datasets/cid007/food-and-vegetable-nutrition-dataset">https://www.kaggle.com/datasets/cid007/food-and-vegetable-nutrition-dataset</a>		Nutritional values of fruits and vegetables, like protein, fat, fiber, sugars.
Apple Quality	<a href="https://www.kaggle.com/datasets/nelgiryewithana/apple-quality">https://www.kaggle.com/datasets/nelgiryewithana/apple-quality</a>		This dataset contains information about various attributes of a set of fruits, providing insights into their characteristics. The dataset includes

			details such as fruit ID, size, weight, sweetness, crunchiness, juiciness, ripeness, acidity, and quality.
Composition of Foods Raw, Processed 🍉🍌🍍🍇	<a href="https://www.kaggle.com/datasets/mahdiehhajian/composition-of-foods-raw-processed">https://www.kaggle.com/datasets/mahdiehhajian/composition-of-foods-raw-processed</a>		Composition of Raw, Processed, Prepared Foods USDA National Nutrient
	<a href="#">USDA food and nutrition label data with extracts</a>		USDA FoodData Central database: <a href="https://fdc.nal.usda.gov/download-datasets.html">https://fdc.nal.usda.gov/download-datasets.html</a> , this constellation of tables is centered on the food table. That table identifies foods broadly classed as Standard like what you might find in the periphery of the store, or Branded which typically occupies the center aisles. Each Standard Reference food identifier points to exactly one food label, where each label (in the set of all labels) is a set of entity attribute value (EAV) triples comprised of FoodId NutrientId and Quantity per hectogram
Ripe Strawberry Identification	<a href="https://huggingface.co/datasets/TrainingDataPro/ripe-strawberries-detection">https://huggingface.co/datasets/TrainingDataPro/ripe-strawberries-detection</a>		Identifies ripe strawberries
Plant Health Data	<a href="https://www.kaggle.com/datasets/ziya07/plant-health-data">https://www.kaggle.com/datasets/ziya07/plant-health-data</a>		Image based classification and identification of plant health
Food Nutrition Levels	<a href="https://huggingface.co/datasets/HC-85/food-nutritional-values">https://huggingface.co/datasets/HC-85/food-nutritional-values</a>		Information about the nutritional levels of different foods
fruit and vegetable classification	<a href="https://www.kaggle.com/code/abdelrahman16/fruit-and-vegetable-classification">https://www.kaggle.com/code/abdelrahman16/fruit-and-vegetable-classification</a>		
Food recommendation based on emotion	<a href="https://www.kaggle.com/datasets/nikhilmaton/food-recommendation-based-emotion">https://www.kaggle.com/datasets/nikhilmaton/food-recommendation-based-emotion</a>		

## Demo

For the Demo, we wanted to create a single simple piece of this complex, Multi Agent System.

### Model APIs and structure

<https://colab.research.google.com/drive/1M8xVhJB0inBO3mYiR6OVa2nTBvC9QAQI?usp=sharing>

We used two models, meta-llama-3-8b-instruct and llava-13b.

1. Using meta-llama-3-8b-instruct we come up with a list of potentially available fruits and vegetables in Barcelona community gardens.
  - a. Suggested prompt structure:
    - i. *"I am feeling [insert emotional state], what items grown in a community garden in Barcelona, Spain should I eat to help my mood?"*
    - b. The LLM will output a complex list of potential fruits and vegetables with a description of their nutrient benefits.
2. Feed the answer back into the meta-llama-3-8b-instruct to simplify the result to a simple list of the fruits and vegetable
3. Feed the answer into the llava-13b model along with a picture of a plant with fruits or vegetables and ask if any of the suggested food is available in the photo

This is only a small piece of the complex system that we have proposed, but it demonstrates the capabilities of LLMs and is a simple proof-of-concept for our proposed project.



## Input Images



## Demo Videos

The videos are also available in our submission folder, but links to them can be found here as well.

[Demo\\_Oranges.mov](#)

[Demo\\_FailureToIdentifyRipeness.mov](#)

[Demo\\_Cucumbers.mov](#)

## Reflections

Throughout this process, we learned a lot, discussed a lot, and we were left with some confusion and questions as we learned more and discovered more about what we don't know.

In conversation with Pau, we realized that our idea didn't necessarily actually require an AI system. This kind of project could actually be done fairly easily

using existing technologies (i.e. sensors, navigation maps, databases, etc.) which challenged us to find the parts of the project that we could use an AI system for. We decided that monitoring the plants would be the most straightforward part where we could use AI. This is why our demo addressed that part of the proposal.

We struggled with defining our proposal clearly and had some different ideas about how the system would be used. These challenges led us to talk about changing our project a few times. We proposed different, more simple projects, but ultimately decided to follow through with the original idea, but to only do a simple demo rather than trying to understand the whole system.

We talked a lot about the ethics of monitoring who takes what and how much from the garden and additionally discussed the ethical concerns surrounding using emotion reading facial recognition. We decided to remove these elements from our proposal and to focus instead on envisioning a solar punk world where capitalism is no longer the dominant system and individual responsibility and accountability is baked into the culture of our network of community gardens and those who access them.

Pau's suggestion about the Multi Agent System helped us to sort out our complex idea of the function of community gardens. Different AI agents collaborate with each other in different tasks to construct a more complete AI in order to achieve a communicative system for an optimized calculation.

During our presentation, we were asked who would own and operate the garden monitoring system. In an ideal situation, the solar punk future that we are dreaming of, ownership would be less significant than stewardship. Who would tend the AI garden of our system is perhaps more the question we would need to answer. Our proposal is that it would be a distributed system where each garden will have its own infrastructure that a volunteer or collective of volunteers tend. The infrastructure could then work together, through the help of more volunteers and interested people. This system would not be for profit, it would promote balanced food distribution and shared community. Caring for the earth and plants as well as our fellow humans. What a world to live in.

Our proposed system is very speculative, this imagined solar punk world sadly does not yet exist in Barcelona or even within the subculture just surrounding



IAAC. We as a society still value money and profit over collective ownership, still push responsibility onto others rather than taking it for ourselves and trusting those around us to do the same. The small piece of this AI system we developed still consumes massive amounts of resources, some of which could go directly into nurturing the plants in our proposed community gardens. So, what we learned is, that like everything, it is complex. The AI system itself is complex, the societal change that would need to take place is complex, and the ethics of monitoring people, using massive amounts of resources and exploiting the earth and other humans for the good of some, is a complex and challenging question to answer.