Data Lake Documentation

ICCS - NTUA

Introduction

In this document we will explore the architecture of the Data Lake of our project and the ways that we can use it to safely store the data of every use case. We will see ways that we can experiment with the API it provides locally and how to contribute to its betterment.

Contents

Data Lake Abstract Architecture

Postgres

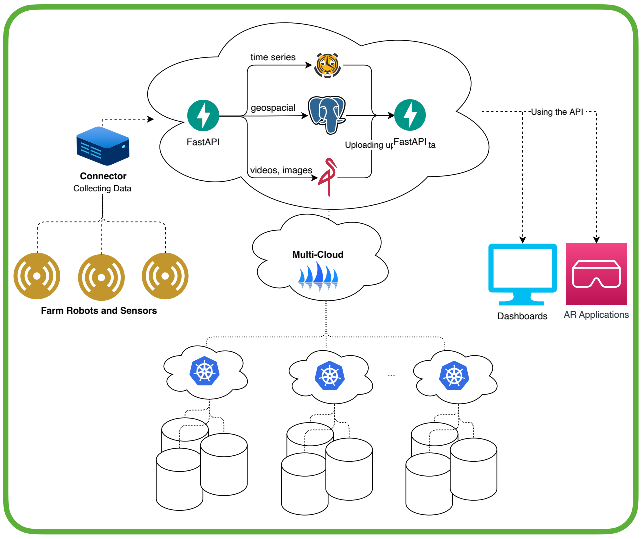
PostgreSQL is a powerful, open-source relational database management system. It is known for its robustness, reliability, and support for advanced data types and performance optimization features.

MinIO

MinIO is an open-source, high-performance, distributed object storage system. It is designed to store unstructured data such as photos, videos

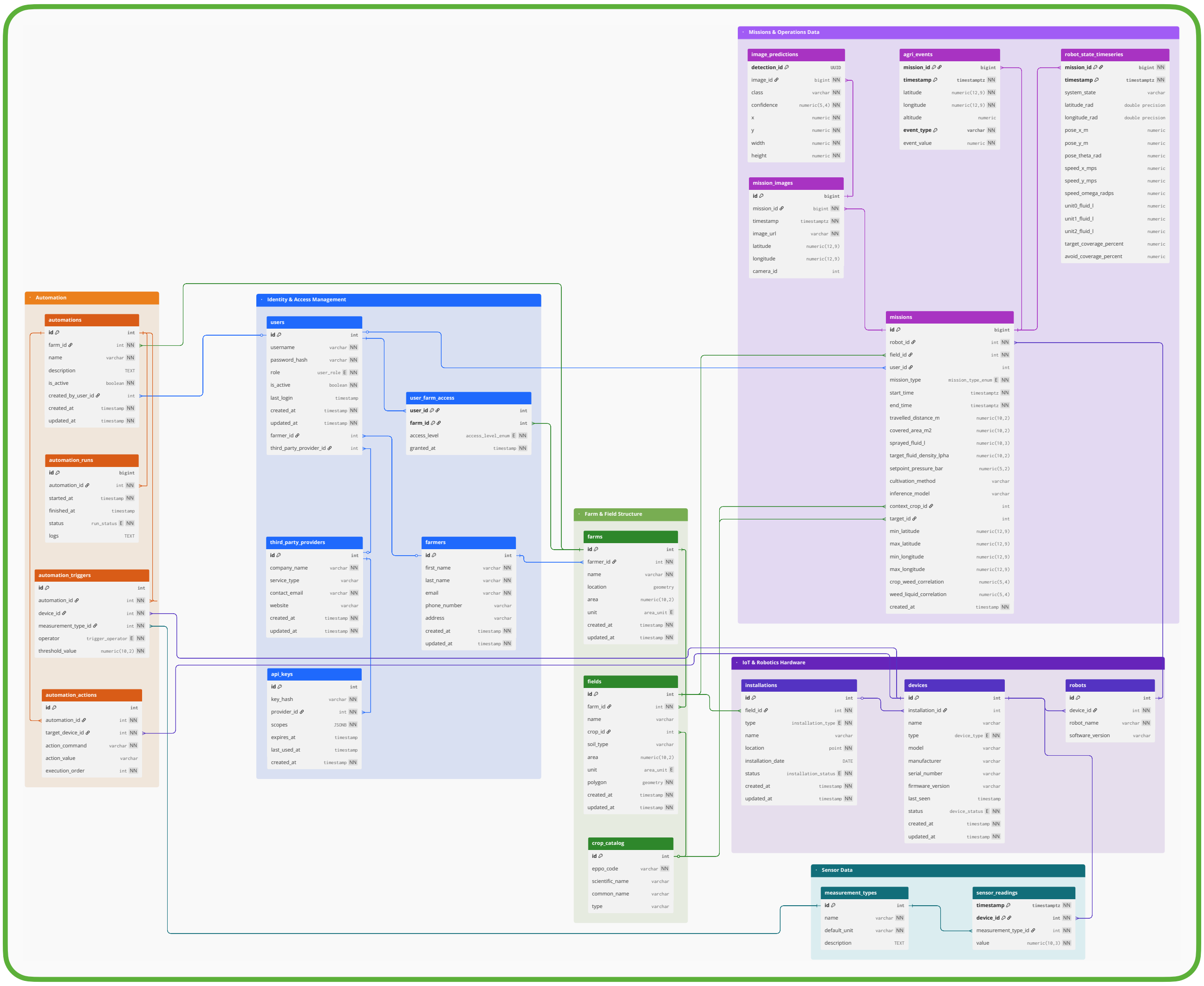
The API

To communicate with the Data Lake we have set up an API using FastAPI.



Our data lake uses PostgreSQL to save relational data and MinIO to save objects (like photos), and FastAPI to ingest and serve information.

Relational Schema



Automation

automations		
id 🔑	int	
farm_id 🔗	int	NN
name	varchar	NN
description	TEXT	
is_active	boolean	NN
created_by_user_id 🔗	int	
created_at	timestamp	NN
updated_at	timestamp	NN

automation_runs		
id 🔑	bigint	
automation_id 🔗	int	NN
started_at	timestamp	NN
finished_at	timestamp	
status	run_status E	NN
logs	TEXT	

automation_triggers		
id 🔑	int	
automation_id 🔗	int	NN
device_id 🔗	int	NN
measurement_type_id 🔗	int	NN
operator	trigger_operator E	NN
threshold_value	numeric(10,2)	NN

automation_actions		
id 🔑	int	
automation_id 🔗	int	NN
target_device_id 🔗	int	NN
action_command	varchar	NN
action_value	varchar	
execution_order	int	NN

Identity & Access Management

users		
id 🔑	int	
username	varchar	NN
password_hash	varchar	NN
role	user_role E	NN
is_active	boolean	NN
last_login	timestamp	
created_at	timestamp	NN
updated_at	timestamp	NN
farmer_id 🔗	int	
third_party_provider_id 🔗	int	

user_farm_access		
user_id 🔑 🔗	int	
farm_id 🔑 🔗	int	
access_level	access_level_enum E	NN
granted_at	timestamp	NN

third_party_providers		
id 🔑	int	
company_name	varchar	NN
service_type	varchar	
contact_email	varchar	NN
website	varchar	
created_at	timestamp	NN
updated_at	timestamp	NN

farmers		
id 🔑	int	
first_name	varchar	NN
last_name	varchar	NN
email	varchar	NN
phone_number	varchar	
address	varchar	
created_at	timestamp	NN
updated_at	timestamp	NN

api_keys		
id 🔑	int	
key_hash	varchar	NN
provider_id 🔗	int	NN
scopes	JSONB	NN
expires_at	timestamp	
last_used_at	timestamp	
created_at	timestamp	NN

Farm & Field Structure

farms		
id 🔑	int	
farmer_id 🔗	int	NN
name	varchar	NN
location	geometry	
area	numeric(10,2)	
unit	area_unit E	
created_at	timestamp	NN
updated_at	timestamp	NN

fields		
id 🔑	int	
farm_id 🔗	int	NN
name	varchar	
crop_id 🔗	int	
soil_type	varchar	
area	numeric(10,2)	
unit	area_unit E	
polygon	geometry	NN
created_at	timestamp	NN
updated_at	timestamp	NN

crop_catalog		
id 🔑	int	
eppo_code	varchar	NN
scientific_name	varchar	
common_name	varchar	
type	varchar	

Missions & Operations Data

image_predictions		
detection_id 🔑	UUID	
image_id 🔗	bigint	NN
class	varchar	NN
confidence	numeric(5,4)	NN
x	numeric	NN
y	numeric	NN
width	numeric	NN
height	numeric	NN

agri_events		
mission_id 🔑 🔗	bigint	
timestamp 🔑	timestamptz	NN
latitude	numeric(12,9)	NN
longitude	numeric(12,9)	NN
altitude	numeric	
event_type 🔑	varchar	NN
event_value	numeric	NN

robot_state_timeseries		
mission_id 🔑 🔗	bigint	NN
timestamp 🔑	timestamptz	NN
system_state	varchar	
latitude_rad	double precision	
longitude_rad	double precision	
pose_x_m	numeric	
pose_y_m	numeric	
pose_theta_rad	numeric	
speed_x_mps	numeric	
speed_y_mps	numeric	
speed_omega_radps	numeric	
unit0_fluid_l	numeric	
unit1_fluid_l	numeric	
unit2_fluid_l	numeric	
target_coverage_percent	numeric	
avoid_coverage_percent	numeric	

mission_images		
id 🔑	bigint	
mission_id 🔗	bigint	NN
timestamp	timestamptz	NN
image_url	varchar	NN
latitude	numeric(12,9)	
longitude	numeric(12,9)	
camera_id	int	

missions		
id 🔑	bigint	
robot_id 🔗	int	NN
field_id 🔗	int	NN
user_id 🔗	int	
mission_type	mission_type_enum E	NN
start_time	timestamptz	NN
end_time	timestamptz	NN
travelled_distance_m	numeric(10,2)	
covered_area_m2	numeric(10,2)	
sprayed_fluid_l	numeric(10,3)	
target_fluid_density_lpha	numeric(10,2)	
setpoint_pressure_bar	numeric(5,2)	
cultivation_method	varchar	
inference_model	varchar	
context_crop_id 🔗	int	
target_id 🔗	int	
min_latitude	numeric(12,9)	
max_latitude	numeric(12,9)	
min_longitude	numeric(12,9)	
max_longitude	numeric(12,9)	
crop_weed_correlation	numeric(5,4)	
weed_liquid_correlation	numeric(5,4)	
created_at	timestamp	NN

IoT & Robotics Hardware

installations		
id 🔑	int	
field_id 🔗	int	NN
type	installation_type E	NN
name	varchar	
location	point	NN
installation_date	DATE	
status	installation_status E	NN
created_at	timestamp	NN
updated_at	timestamp	NN

devices		
id 🔑	int	
installation_id 🔗	int	
name	varchar	
type	device_type E	NN
model	varchar	
manufacturer	varchar	
serial_number	varchar	
firmware_version	varchar	
last_seen	timestamp	
status	device_status E	NN
created_at	timestamp	NN
updated_at	timestamp	NN

robots		
id 🔑	int	
device_id 🔗	int	NN
robot_name	varchar	NN
software_version	varchar	

Sensor Data

measurement_types		
id 🔑	int	
name	varchar	NN
default_unit	varchar	NN
description	TEXT	

sensor_readings		
timestamp 🔑	timestamptz	NN
device_id 🔑 🔗	int	NN
measurement_type_id 🔗	int	NN
value	numeric(10,3)	NN

Additional Information

- You can view the schema here
- Details about the DB can be found here

The API

Local experimentation with the API

To start experimenting with the api. You can visit https://github.com/iloudaros/agribot-data and follow the instructions to create a local instance of it, using minikube.

In case you encounter a 404 error with the link above, chances are you are not listed as a contributor at the repository, please send an email to iloudaros@microlab.ntua.gr and we will sort it out.

Pilot Case 1 - Weed identification and spot spraying

AUA

[not enough information yet]

Pilot Case 2 - Robotic spraying of weeds in potato and volunteer potatoes

Ecorobotix

Objective

To ingest a complete mission summary from an Ecorobotix system. This involves combining data from two separate JSON files (`mission_data.json` and `mission_metadata.json`) into a single API call to create a new record in the missions table.

Source Files

- `data_samples/UC2/Ecorobotix/mission_data.json`: Contains the core operational data of the mission.

- `data_samples/UC2/Ecorobotix/mission_metadata.json`: Contains supplementary metadata and boundary information.

Data Mapping and Pre-processing

JSON Field	Example Value	Pre-processing step	API Body field	Database Column
start_time_ms	1747408062392	Convert ms epoch to ISO 8601	start_time	start_time
end_time_ms	1747408439367	Convert ms epoch to ISO 8601	end_time	end_time
robot_id	"erxbot-1910"	Look up id from robots table	robot_id	robot_id
field_name	"26"	Look up id from fields table	field_id	field_id
context_eppo	"DAUCA"	Look up id from crop_catalog table	context_crop_id	context_crop_id
target_eppo	"WEED"	Look up id from crop_catalog table	target_id	target_id
travelled_distance_m	418.86887	Direct mapping	travelled_distance_m	travelled_distance_m
covered_area_m2	2574.026	Direct mapping	covered_area_m2	covered_area_m2
sprayed_fluid_l	5.3678803	Direct mapping	sprayed_fluid_l	sprayed_fluid_l

JSON Field	Example Value	Pre-processing step	API Body field	Database Column
max_lat	46.96215985	Direct mapping	max_latitude	max_latitude
min_lat	46.95933422	Direct mapping	min_latitude	min_latitude
max_long	7.14054517	Direct mapping	max_longitude	max_longitude
min_long	7.13690217	Direct mapping	min_longitude	min_longitude
crop_weed_correlation	0.62	Direct mapping	crop_weed_correlation	crop_weed_correlation
weed_liquid_correlation	0.74	Direct mapping	weed_liquid_correlation	weed_liquid_correlation

Affected DB Tables

This use case primarily creates a record in the missions table but relies on several other tables for foreign key lookups.

Table Name	Role in this Use Case
missions	**Primary Storage:** A new row is created here containing the combined and processed data from the API call.
users	**Authentication:** The API request must be authenticated, and the user_id of the authenticated user is stored in the new missions record.
robots	**Foreign Key Lookup:** Used to convert the robot name (e.g., "erxbot-1910") into its integer primary key (robot_id).
fields	**Foreign Key Lookup:** Used to convert the field name (e.g., "26") into its integer primary key (field_id).
crop_catalog	**Foreign Key Lookup:** Used to convert EPPO codes (e.g., "DAUCA", "WEED") into their integer primary keys (context_crop_id, target_id).

API Endpoint

```
POST /api/v1/missions/
```

This endpoint creates a new mission summary. It requires authentication and expects a request body conforming to the MissionCreate model.

Examples

curl Example

```
curl -X POST "http://127.0.0.1:8080/api/v1/missions/" \
-H "Authorization: Bearer $TOKEN" \
-H "Content-Type: application/json" \
-d '{
    "robot_id": 1,
    "field_id": 1,
    "mission_type": "spraying",
    "start_time": "2025-05-18T10:07:42.392Z",
    "end_time": "2025-05-18T10:13:59.367Z",
    "travelled_distance_m": 418.87,
    "covered_area_m2": 2574.03,
    "sprayed_fluid_l": 5.368,
    "target_fluid_density_lpha": 200.0,
    "setpoint_pressure_bar": 3.0,
    "cultivation_method": "RIDGES",
    "inference_model": "DAUCA/8",
    "context_crop_id": 1,
    "target_id": 3,
    "min_latitude": 46.95933422,
    "max_latitude": 46.96215985,
    "min_longitude": 7.13690217,
    "max_longitude": 7.14054517,
    "crop_weed_correlation": 0.62,
    "weed_liquid_correlation": 0.74
}'
```

python Example

```python
import requests
import json
from datetime import datetime, timezone

# --- Configuration ---
API_BASE_URL = "http://127.0.0.1:8080"
# Replace with a valid token obtained from the /token endpoint
ACCESS_TOKEN = "YOUR_JWT_ACCESS_TOKEN"
HEADERS = {
    "Authorization": f"Bearer {ACCESS_TOKEN}",
    "Content-Type": "application/json"
}

# --- Pre-processing & Lookups (Simulated) ---
# In a real application, these values would be fetched from your database.
# For this example, we'll use the IDs created by the db/seeds.sql script.
robot_id_map = {"erxbot-1910": 1}
field_id_map = {"26": 1}
crop_id_map = {"DAUCA": 1, "WEED": 3}


def ingest_ecorobotix_mission(mission_data_path, metadata_path):
    """
    Loads, combines, processes, and ingests an Ecorobotix mission.
    """
    print("1. Loading source JSON files...")
    with open(mission_data_path, 'r') as f:
        mission_data = json.load(f)
    with open(metadata_path, 'r') as f:
        metadata = json.load(f)

    print("2. Processing and combining data...")
    try:
        # Combine data from both files into a single payload
        payload = {
            # Perform ID lookups
            "robot_id": robot_id_map.get(mission_data["robot_id"]),
            "field_id": field_id_map.get(mission_data["field_name"]),
            "context_crop_id": crop_id_map.get(mission_data["context_eppo"]),
            "target_id": crop_id_map.get(mission_data["target_eppo"]),

            # Convert timestamps from milliseconds to ISO 8601 UTC format
            "start_time": datetime.fromtimestamp(mission_data["start_time_ms"] / 1000,
tz=timezone.utc).isoformat(),
            "end_time": datetime.fromtimestamp(mission_data["end_time_ms"] / 1000,
tz=timezone.utc).isoformat(),

            # Map fields directly
            "mission_type": "spraying", # Assuming based on context
            "travelled_distance_m": mission_data["travelled_distance_m"],
            "covered_area_m2": mission_data["covered_area_m2"],
            "sprayed_fluid_l": mission_data["sprayed_fluid_l"],
            "target_fluid_density_lpha": mission_data["target_fluid_surface_density_lpha"],
            "setpoint_pressure_bar": mission_data["setpoint_pressure_bar"],
            "cultivation_method": mission_data["cultivation_method"],
            "inference_model": mission_data["inference_model"],
            "min_latitude": metadata["min_lat"],
            "max_latitude": metadata["max_lat"],
            "min_longitude": metadata["min_long"],
            "max_longitude": metadata["max_long"],
            "crop_weed_correlation": metadata["crop_weed_correlation"],
            "weed_liquid_correlation": metadata["weed_liquid_correlation"]
        }
    except KeyError as e:
        print(f"ERROR: A required key is missing from the source files: {e}")
        return

    print("3. Posting data to the API...")
    try:
        response = requests.post(f"{API_BASE_URL}/api/v1/missions/", headers=HEADERS, json=payload)
        response.raise_for_status() # Raise an exception for bad status codes (4xx or 5xx)
        print("✅ Success! Mission created.")
        print("Response:", json.dumps(response.json(), indent=2))
    except requests.exceptions.RequestException as e:
        print(f"❌ API call failed: {e}")
        if e.response:
            print("Error details:", e.response.text)


if __name__ == "__main__":
    if ACCESS_TOKEN == "YOUR_JWT_ACCESS_TOKEN":
        print("Please update the ACCESS_TOKEN variable in the script before running.")
    else:
        ingest_ecorobotix_mission(
            'data_samples/UC2/Ecorobotix/mission_data.json',
            'data_samples/UC2/Ecorobotix/mission_metadata.json'
        )
```

Pilot Case 3 - Robotic fertilization management for leafy vegetables in open field conditions

POLIBA

Objective

To ingest a batch of time-series event data from a CSV file. This data represents discrete events recorded during a mission, such as weed detection counts at specific geographic coordinates. This data is appended to an existing mission.

Source Files

- `data_samples/UC3 & UC4/sample_file_uc3_uc4.csv`: A CSV file where each row contains a timestamp, geographic coordinates, and a numeric value.

Data Mapping and Pre-processing

The raw CSV data must be parsed and structured into a JSON payload that matches the API's AgriEvent model. This is a batch operation; many CSV rows are sent in a single API call.

A crucial pre-processing step is to define an event_type. Since the CSV file only contains raw numbers, we must give them context. For this use case, we will define the type as “detection-count”.

JSON Field	Example Value	Pre-processing step	API Body field	Database Column
Column 1	1631269580.973	Convert Unix epoch to ISO 8601	timestamp	timestamp
Column 2	40.45422209	Direct mapping (as float)	latitude	latitude
Column 3	17.90726559	Direct mapping (as float)	longitude	longitude
Column 4	87.025999	Direct mapping (as float)	altitude	altitude
Column 5	6	Direct mapping (as float/int)	event_value	event_value
(N/A)	(N/A)	Define a string literal	event_type	event_type

Affected DB Tables

This use case adds new rows to the agri_events table.

Table Name	Role in this Use Case
agri_events	**Primary Storage:** One or more new rows are created here, one for each event sent in the batch.
missions	**Foreign Key Prerequisite:** The mission_id in the API path must correspond to an existing record in this table. This operation does not create a new mission; it only adds data to one.
users	**Authentication:** The request must be authenticated by a valid user token.

API Endpoint

```
POST /api/v1/missions/{mission_id}/agri_events
```

This endpoint accepts a list of AgriEvent objects in the request body and associates them with the mission_id specified in the URL path.

Examples

curl Example

```
curl -X POST "http://127.0.0.1:8080/api/v1/missions/1/agri_events" \
-H "Authorization: Bearer $TOKEN" \
-H "Content-Type: application/json" \
-d '[
  {
    "timestamp": "2021-09-10T10:26:20.973Z",
    "latitude": 40.4542221,
    "longitude": 17.9072656,
    "altitude": 87.026,
    "event_type": "detection_count",
    "event_value": 6
  },
  {
    "timestamp": "2021-09-10T10:26:21.974Z",
    "latitude": 40.4542220,
    "longitude": 17.9072655,
    "altitude": 87.018,
    "event_type": "detection_count",
    "event_value": 9
  }
]'
```

python Example

```python
import requests
import json
import csv
from datetime import datetime, timezone

# --- Configuration ---
API_BASE_URL = "http://127.0.0.1:8080"
# Replace with a valid token obtained from the /token endpoint
ACCESS_TOKEN = "YOUR_JWT_ACCESS_TOKEN"
HEADERS = {
    "Authorization": f"Bearer {ACCESS_TOKEN}",
    "Content-Type": "application/json"
}
# The ID of the mission to which we are adding events
TARGET_MISSION_ID = 1


def ingest_agri_events(csv_file_path, mission_id):
    """
    Reads event data from a CSV, processes it, and sends it to the API
    as a single batch.
    """
    print(f"1. Reading data from source file: {csv_file_path}")
    agri_events = []

    try:
        with open(csv_file_path, 'r') as f:
            reader = csv.reader(f)
            for row in reader:
                # Create one AgriEvent object per row
                event = {
                    "timestamp": datetime.fromtimestamp(float(row[0]), tz=timezone.utc).isoformat(),
                    "latitude": float(row[1]),
                    "longitude": float(row[2]),
                    "altitude": float(row[3]),
                    "event_type": "detection_count", # Assigning a type to the value
                    "event_value": float(row[4])
                }
                agri_events.append(event)
    except FileNotFoundError:
        print(f"❌ ERROR: The file was not found at {csv_file_path}")
        return
    except (ValueError, IndexError) as e:
        print(f"❌ ERROR: Could not process a row in the CSV file. Check data format. Error: {e}")
        return

    if not agri_events:
        print("No events found in the file. Nothing to send.")
        return

    print(f"2. Processed {len(agri_events)} events. Posting batch to mission ID {mission_id}...")
    try:
        api_url = f"{API_BASE_URL}/api/v1/missions/{mission_id}/agri_events"
        response = requests.post(api_url, headers=HEADERS, json=agri_events)
        response.raise_for_status()

        print("✅ Success! Batch of agri-events added.")
        print("Response:", json.dumps(response.json(), indent=2))

    except requests.exceptions.RequestException as e:
        print(f"❌ API call failed: {e}")
        if e.response:
            print("Error details:", e.response.text)


if __name__ == "__main__":
    if ACCESS_TOKEN == "YOUR_JWT_ACCESS_TOKEN":
        print("Please update the ACCESS_TOKEN variable in the script before running.")
    else:
        ingest_agri_events(
            'data_samples/UC3 & UC4/sample_file_uc3_uc4.csv',
            TARGET_MISSION_ID
        )
```

Pilot Case 4 - Robotic technologies for crop monitoring and management in soilless tomato cultivation

POLIBA

[same as 3]

Pilot Case 5 - Robotic harvesting in orchards

KUL

Objective

To ingest a batch of object detection predictions (e.g., detected fruit) from a JSON file and associate them with a specific image from a mission.

Prerequisite

Before predictions can be added, the image they correspond to must already exist in the database. This is typically done by making a POST request to the /api/v1/missions/{mission_id}/images endpoint. This call uploads the image file, creates a record in the mission_images table, and returns the unique image_id needed for this use case.

Source Files

- `data_samples/UC5 &UC6/EUT/thinning_output.json`: A JSON file containing an array of detected objects, each with bounding box coordinates, a class label, and a confidence score.

Data Mapping and Pre-processing

The API endpoint expects a direct list of prediction objects. The source JSON file contains a top-level object with a predictions key, so the value of this key (the list) must be extracted to become the request body.

A key detail is the mapping of the class field. Since class is a reserved keyword in Python, the API model uses the alias class_name.

JSON Field	Example Value	Pre-processing step	API Body field	Database Column
detection_id	"1274...c010"	Direct mapping (as UUID)	detection_id	detection_id
class	"fruit"	Direct mapping (via Pydantic alias)	class_name	class
confidence	0.96	Direct mapping (as float)	confidence	confidence
x	631.5	Direct mapping (as float)	x	x
y	1306.5	Direct mapping (as float)	y	y
width	95	Direct mapping (as float)	width	width
height	91	Direct mapping (as float)	height	height
class_id	0	Field is ignored by the API	(N/A)	(N/A)

Affected DB Tables

This use case adds new rows to the image_predictions table.

Table Name	Role in this Use Case
image_predictions	**Primary Storage:** One new row is created here for each prediction object sent in the batch.
mission_images	**Foreign Key Prerequisite:** The image_id in the API path must correspond to an existing record in this table. This operation links the predictions to a specific image.
users	**Authentication:** The request must be authenticated by a valid user token.

API Endpoint

```
POST /api/v1/images/{image_id}/predictions
```

This endpoint accepts a list of ImagePrediction objects in the request body and associates them with the image_id specified in the URL path.Examples

Examples

curl Example

```
curl -X POST "http://127.0.0.1:8080/api/v1/images/1/predictions" \
-H "Authorization: Bearer $TOKEN" \
-H "Content-Type: application/json" \
-d '[
 {
   "detection_id": "1274ddba-ac61-47c4-a30c-b64eaf8cc010",
   "class": "fruit",
   "confidence": 0.96,
   "x": 631.5,
   "y": 1306.5,
   "width": 95,
   "height": 91
 },
 {
   "detection_id": "b9e14d91-8407-4e0e-8a2d-b4093b48cf82",
   "class": "fruit",
   "confidence": 0.944,
   "x": 988,
   "y": 1819.5,
   "width": 70,
   "height": 65
 }
]'
```

python Example

```
import requests
import json
from datetime import datetime, timezone

# Configuration based on your README and Makefile
API_BASE = "http://127.0.0.1:8080/api/v1"
USERNAME = "testuser"
PASSWORD = "testpassword"

def get_auth_token():
    """Authenticates with the API and returns a Bearer token."""
    url = f"{API_BASE}/token"
    # OAuth2 expects form-data, not JSON
    payload = {
        "username": USERNAME,
        "password": PASSWORD
    }

    print(f"🔑 Authenticating as '{USERNAME}'...")
    try:import requests
import json
from datetime import datetime, timezone

# Configuration based on your README and Makefile
API_BASE = "http://127.0.0.1:8080/api/v1"
USERNAME = "testuser"
PASSWORD = "testpassword"

def get_auth_token():
    """Authenticates with the API and returns a Bearer token."""
    url = f"{API_BASE}/token"
    # OAuth2 expects form-data, not JSON
    payload = {
        "username": USERNAME,
        "password": PASSWORD
    }

    print(f"🔑 Authenticating as '{USERNAME}'...")
    try:
        response = requests.post(url, data=payload)
        response.raise_for_status()
        token = response.json().get("access_token")
        print("✅ Authentication successful.")
        return token
    except requests.exceptions.RequestException as e:
        print(f"❌ Login failed: {e}")
        if response.text:
            print(f"Server response: {response.text}")
        exit(1)

def create_mission(token):
```

```python
def ingest_image_predictions(image_id, predictions_path):
    """
    Loads prediction data from a JSON file and sends it to the API.
    """
    print(f"2. Loading predictions for image ID {image_id} from {predictions_path}...")
    try:
        with open(predictions_path, 'r') as f:
            # Extract the list from the "predictions" key
            predictions_payload = json.load(f).get("predictions", [])
    except FileNotFoundError:
        print(f"❌ ERROR: The file was not found at {predictions_path}")
        return

    if not predictions_payload:
        print("No predictions found in the file. Nothing to send.")
        return

    print(f"3. Processed {len(predictions_payload)} predictions. Posting batch...")
    try:
        api_url = f"{API_BASE_URL}/api/v1/images/{image_id}/predictions"
        # The json parameter automatically sets the Content-Type header
        response = requests.post(api_url, headers={"Authorization": HEADERS["Authorization"]},
json=predictions_payload)
        response.raise_for_status()

        print("✅ Success! Batch of predictions added.")
        print("Response:", json.dumps(response.json(), indent=2))

    except requests.exceptions.RequestException as e:
        print(f"❌ API call failed: {e}")
        if e.response:
            print("Error details:", e.response.text)


if __name__ == "__main__":
    if ACCESS_TOKEN == "YOUR_JWT_ACCESS_TOKEN":
        print("Please update the ACCESS_TOKEN variable in the script before running.")
    else:
        # Step 1: Fulfill the prerequisite by uploading an image
        new_image_id = upload_dummy_image(TARGET_MISSION_ID)

        # Step 2: If the image was created successfully, add predictions to it
        if new_image_id:
            ingest_image_predictions(
                new_image_id,
                'data_samples/UC5 &UC6/EUT/thinning_output.json'
            )
```

Pilot Case 6 - Robotic pruning and thinning with XR in orchards

KUL

```python
import requests
import json
from datetime import datetime, timezone

# Configuration based on your README and Makefile
API_BASE = "http://127.0.0.1:8080/api/v1"
USERNAME = "testuser"
PASSWORD = "testpassword"

def get_auth_token():
    """Authenticates with the API and returns a Bearer token."""
    url = f"{API_BASE}/token"
    # OAuth2 expects form-data, not JSON
    payload = {
        "username": USERNAME,
        "password": PASSWORD
    }

    print(f"🔑 Authenticating as '{USERNAME}'...")
    try:
        response = requests.post(url, data=payload)
        response.raise_for_status()
        token = response.json().get("access_token")
        print("✅ Authentication successful.")
        return token
    except requests.exceptions.RequestException as e:
        print(f"❌ Login failed: {e}")
        if response.text:
            print(f"Server response: {response.text}")
        exit(1)

def create_mission(token):
    """Sends a POST request to create a new mission."""
    url = f"{API_BASE}/missions/"

    headers = {
        "Authorization": f"Bearer {token}",
        "Content-Type": "application/json"
    }

    # Data structure matching app.models.schemas.MissionCreate
    # robot_id=1 and field_id=1 exist in your db/seeds.sql
    mission_payload = {
        "robot_id": 1,
        "field_id": 1,
        "mission_type": "thinning",
        "start_time": datetime.now(timezone.utc).isoformat(),
        "end_time": datetime.now(timezone.utc).isoformat(),
        "travelled_distance_m": 150.5,
        "covered_area_m2": 500.0,
        "sprayed_fluid_l": 0.0, # Weeding mission, no fluid
        "cultivation_method": "MECHANICAL",
        "crop_weed_correlation": 0.85
    }

    print("\n🚀 Sending POST request to create mission...")
    print(f"Payload: {json.dumps(mission_payload, indent=2)}")

    try:
        response = requests.post(url, headers=headers, json=mission_payload)
        response.raise_for_status()

        data = response.json()
        print(f"\n✅ Mission Created Successfully!")
        print(f"Mission ID: {data.get('id')}")
        print(f"Mission Type: {data.get('mission_type')}")
    except requests.exceptions.RequestException as e:
        print(f"❌ Creation failed: {e}")
        print(f"Server response: {response.text}")

if __name__ == "__main__":
    access_token = get_auth_token()
    create_mission(access_token)
```