Smart Cycle

FYP Project Demo

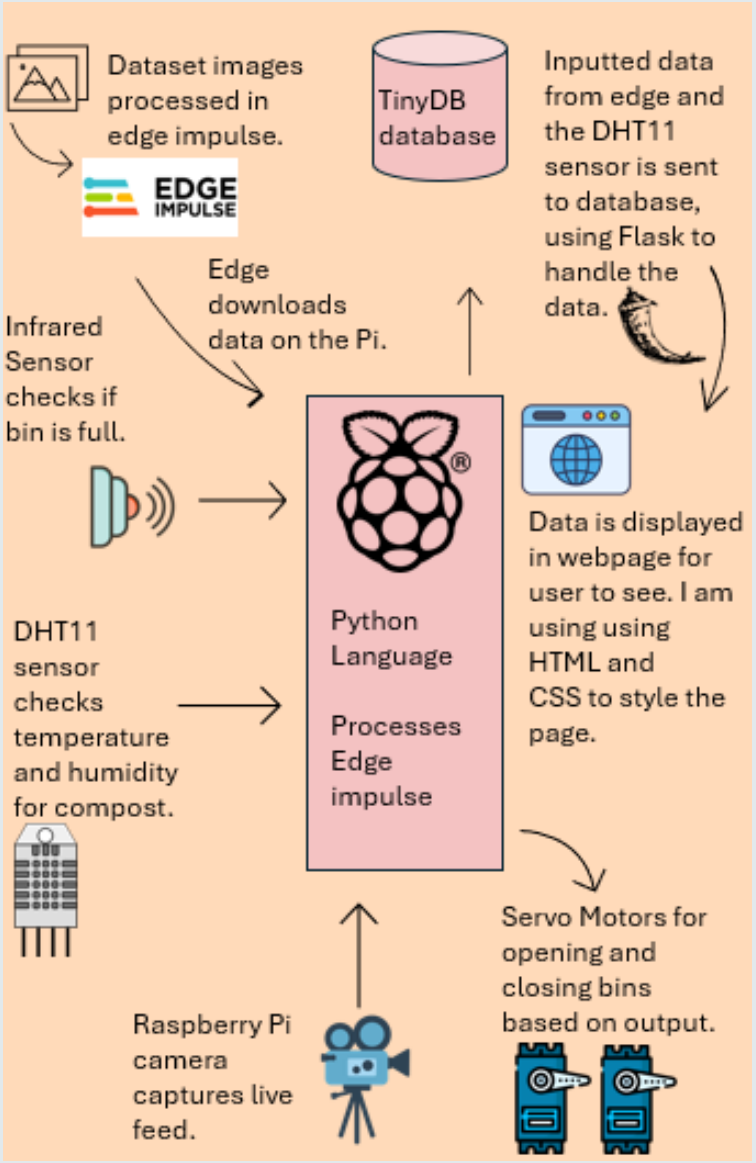
Ciara Crowe

Supervisor: Niall O’Keefe

Introduction

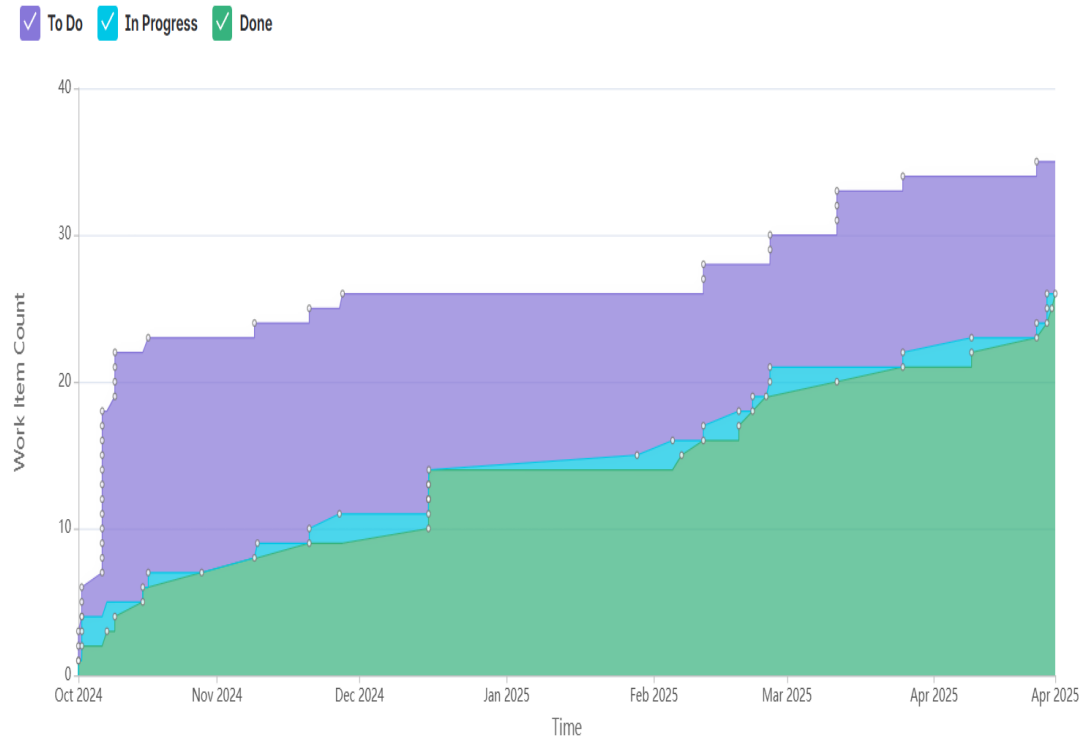
Waste detection project which uses computer vision to classify objects into waste and compost.
Edge Impulse – Uploaded data, applied image classification and object detection. Deployed locally to Raspberry Pi.
Servo Motors, Infrared Sensor and DHT11 Sensor. Data saved in TinyDB.
Data is displayed on webpage. Flask, HTML and CSS

Architectural Diagram



Project Management JIRA

- Sprints
- Failures
- Epics
- Backlog



Research

- Raspberry Pi
- Setting up OS – sd card/pi imager
- Connections to other peripherals
- Computer Vision
- Edge Impulse
- Dataset
- Object Detection (bounding boxes)
- Model evaluation

Technical Content

- Python, HTML and CSS
- Raspberry Pi
- Edge Impulse – computer vison platform
- Servo Motors
- Infrared Sensor
- DHT11 Sensor
- TinyDB
- Flask

Edge Impulse

- Locally deployed my edge impulse model to my raspberry pi – Edge impulse CLI impulse runner.
- Used CompostNet dataset
- Two classes waste and recycling
- Uses FOMO and MobileNetV2 0.35

F1 SCORE
72.4%

Confusion matrix (validation set)

	BACKGROUND	COMPOST	RECYCLING
BACKGROUND	100.0%	0.0%	0.0%
COMPOST	10.5%	89.5%	0%
RECYCLING	25%	0%	75%
F1 SCORE	1.00	0.82	0.69

```
process = subprocess.Popen(
    ['edge-impulse-linux-runner'],
    stdout=subprocess.PIPE,
    stderr=subprocess.PIPE,
    text=True
)
```

```
while True:
    line = process.stdout.readline()

    print(line.strip())

    match = re.search(r'(\[.*\])', line)
    if match:
        try:
            detections = json.loads(match.group(1))

            read_motor_time = time.time()

            for obj in detections:
                label = obj.get("label")
```

Servo Motors and IR Sensor

- When a detection is made a servo motor rotates depending on what class is detected.
- If the bin is full a high is detected which stops the motors from opening and closing.

```
RECYCLING_PIN = 24
COMPOST_PIN = 16
```

```
GPIO.setup(RECYCLING_PIN, GPIO.OUT)
GPIO.setup(COMPOST_PIN, GPIO.OUT)
```

```
pwm_recycling = GPIO.PWM(RECYCLING_PIN, 50)
pwm_compost = GPIO.PWM(COMPOST_PIN, 50)
```

```
def open_bin(pwm):
    if is_bin_full():
        print('Bin is full')
        db.insert({
            "type": "Detection",
            "action": "Bin is full",
            "time": time.time()
        })
        return
    time.sleep(0.1)
    print("Opening bin")
    pwm.ChangeDutyCycle(5.0)
    time.sleep(3)
    print("Holding bin")

    print("Closing bin")
    pwm.ChangeDutyCycle(7.5)
    time.sleep(3)
    pwm.ChangeDutyCycle(0)
```

DHT11 Sensor

- Temperature and Humidity readings
- Runs every minute

- Not reading properly when connected alongside other functions.

```
DHT_PIN = 26
```

```
sensor = dht11.DHT11(pin=DHT_PIN)
```

```
def temp_humidity():
    result = sensor.read()
    temperature = result.temperature
    humidity = result.humidity
    print(f"Temperature: {temperature}°C, Humidity: {humidity}%")

    db.insert({
        "type": "Temperature and Humidity",
        "temperature": temperature,
        "humidity": humidity,
        "action": f"Temperature: {temperature}°C, Humidity: {humidity}%",
        "time": time.time()
    })
```

```
if time.time() - read_dht_time >= 60:
    temp_humidity()
    read_dht_time = time.time()
```

Dataset

- TinyDB – NoSQL
- Lightweight
- JSON

```python
class ProjectBinDatabase:
    def __init__(self, db_path="/home/ciara/Documents/FinalYrPro/db.json"):
        self.db = TinyDB(db_path)

    def detection(self, data):
        self.db.insert(data)

    def get_detections(self):
        return self.db.all()
```

Flask

- Lightweight python web framework to handle requests between database and webpage.
- Used routing to route to different pages
- Called my functions defined in database to retrieve data.

```
app = Flask(__name__)
db = ProjectBinDatabase("/home/ciara/Documents/FinalYrPro/db.json")


@app.route('/')
def home():
    return render_template('home.html')

@app.route('/data')
def data():
    data = db.get_detections()
    return render_template('data.html', data=data)

@app.route('/live')
def live():
    return redirect("http://192.168.178.155:4912/")
```

Threading

- I wanted flask to run with my backend
- Threading – runs multiple processes at the same time
- Created a new thread and called the function.

```
flash_thread = threading.Thread(target=run_flask)
flash_thread.start()
```

HTML & CSS

- Structure and styling
- Jinja2

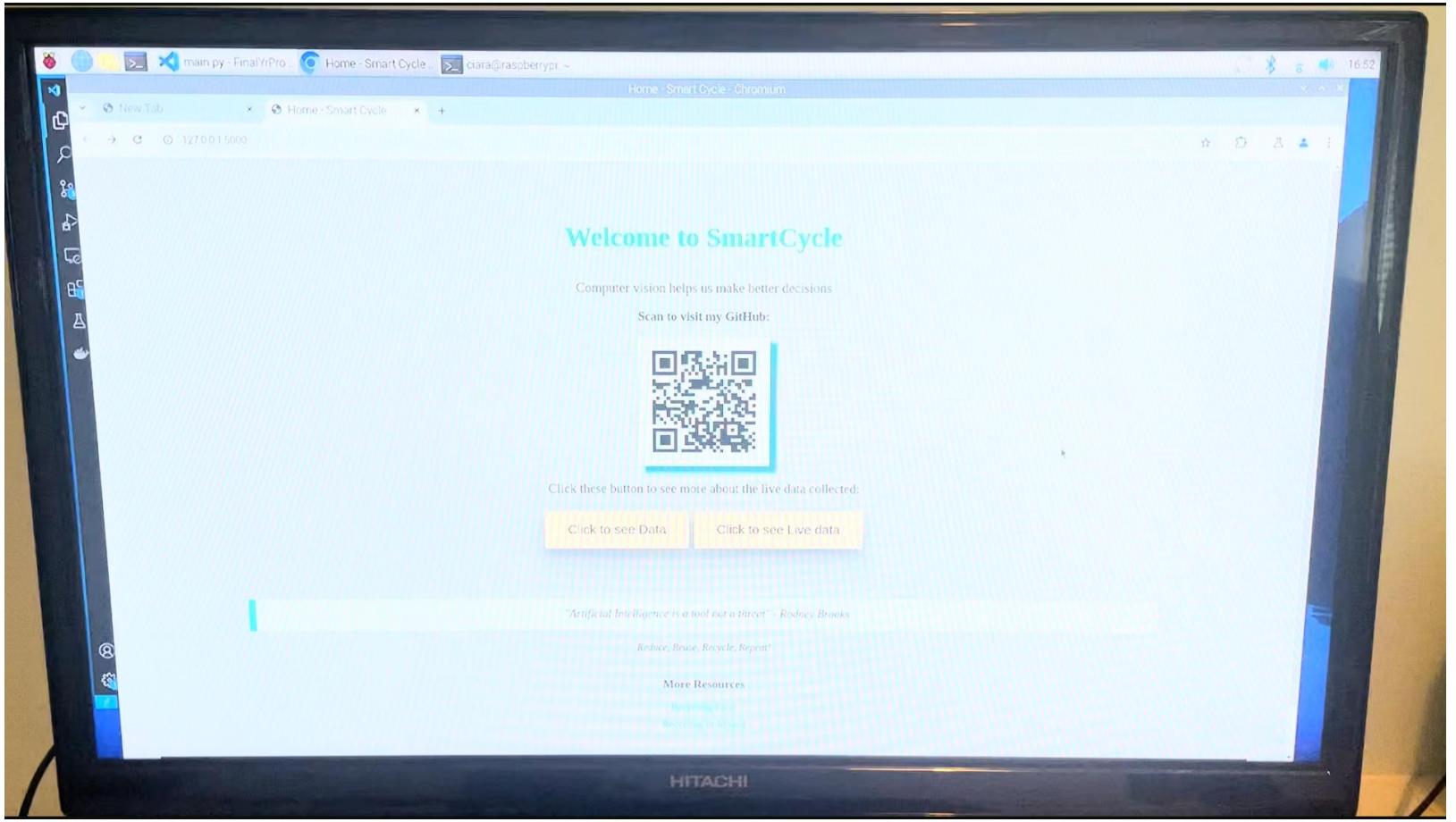
```
{% for item in data %}
<tr>
    <td>{{ loop.index }}</td>
    <td>{{ item['type'] }}</td>
    <td>{{ item['action'] }}</td>
    <td>{{ item['time']  | datetimeformat}}</td>
</tr>
{% endfor %}
```

```
body {
    font-family: 'Papyrus', fantasy;
    background-color: #D3D3D3;
    text-align: center;
    padding: 50px;
}

h1 {
    color: #20B2AA;
    margin-bottom: 40px;
}

table {
    width: 80%;
    margin: auto;
    border-spacing: 0;
    box-shadow: 10px 10px 5px rgb(0, 128, 128);
    background: white;
    border-radius: 8px;
}
```

Video


Home - Smart Cycle - Chromium
Welcome to SmartCycle
Computer vision helps us make better decisions
Scan to visit my GitHub:
Click these button to see more about the live data collected:
Click to see Data
Click to see Live data
"Artificial Intelligence is a tool not a threat" - Rodney Brooks
Reduce, Reuse, Recycle, Repeat!
More Resources
HITACHI

Future Improvements

Add more data

Add more classes

Check out my Github

- https://github.com/CiaraC03/FinalYrProject