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MAIS 202 Project Proposal

1. Choice of datasets
    - Garbage Classification (12 classes) (kaggle.com)
        - 12 classes, which will let us choose which category of garbage we want to implement:
            - Paper, cardboard, biological, metal, plastic, green-glass, brown-glass, white-glass, clothes, shoes, batteries, and trash.
        - Clear images, well distinguished between classes
        - Most images close to garbage images
2. Methodology
    - Data Preprocessing
        - Check for any inconsistencies or missing data
        - Lower the resolution of the images to ensure compatibility with the camera module (680 x 480 VGA)
        - Split the dataset into training and testing sets
        - Augment the data to increase the amount of data and help the model generalize better (rotate, zoom in, etc)
    - Machine Learning Model
        - Objective: predict the category of garbage based on provided images
        - Convolutional Neural Networks (CNNs)
            - Pros:
                - CNNs are specifically designed for image classification tasks and for automatically learning hierarchical features from images
                - CNNs exploit the local spatial correlations present in images
            - Cons:
                - Computationally intensive, may require powerful resources
                - Prone to overfitting
        - Alternative : Support Vector Machines (SVM)
            - Effective in high dimensional data like images, memory efficient
            - /Requires manual feature extraction, which can be complex and time-consuming for image data.
            - CNN outperform SVMs on image classification tasks, especially if data augmentation techniques are used, to increase size of training sets
    - Evaluation Metric
        - Confusion matrix:
            - Display the number of true positive, true negative, false positive, and false negative predictions for each class.

- Accuracy:
  - Measure the overall correctness of the model's predictions.
  - Accuracy= (TP+TN) / (TP+TN+FP+FN)
- Precision-recall:
  - Precision = TP / (TP+FP)
  - Recall = TP / (TP+FN)
  - offer a more nuanced view of model performance, especially in situations where class imbalance exists.
- Logistic loss:
  - Measures the discrepancy between the predicted probability distribution and the actual distribution of the data.
    - $Cross - EntropyLoss = -\frac{1}{N}\sum_{i=1}^{N} y_i \log(p_i) + (1 - y_i) \log(1 - p_i)$
    - Where y_i is the true label (0 or 1) and p_i is the predicted probability for instance i.

3. Application
   - Hardware project with Arduino
   - Components needed: Arduino Wifi board, camera module OV7670, servo motors, ultrasonic sensor, power supply modules, breadboard, cables
   - Once the user disposes waste, the ultrasonic sensor detects it, and activates the camera, then the image is sent to the backend server that runs the machine learning model. The predicted category is sent back to Arduino. The machine then directs the trash to its specific bin.

Bibliography:

OpenAI. (2023). *ChatGPT.* (Sept 17, 2023 version) [Large language model]. https://chat.openai.com/chat