435 - Project PLANTS

UMD Plant Identification - Dr. Purtilo

DEPARTMENT OF COMPUTER SCIENCE

Ryan Ding, Andrew Le, Omar Malash, Nhat Nguyen, Scottie Tran, Clark Wishard, Jiayi Wu

Problem Definition

Our team was tasked with creating a web-based plant identification feature for the Roots and Routes project using a phone camera to identify plants on the UMD campus.

Problem Impact

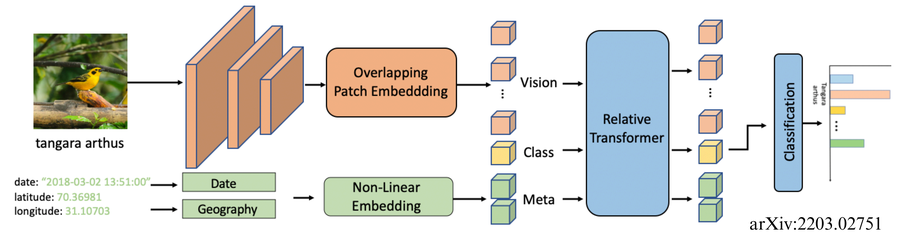
Help people connect and learn more about UMD's plant life and landscape by classifying and interacting with them.

Design Calculations

- Input images are resized to **384×384 pixels** before going into the model.
- **MetaFormer predicts the top 5 plants**, each with a confidence score (0-100%) using softmax.
- Added location-based filtering: **only shows plants within 25 meters of the user.**
- Plants **outside 25 meters get a 0% score** and are removed from results.
- **Predictions are limited to the UMD Arboretum** to keep accuracy high.
- Since the **UMD plant list and MetaFormer data don't always match** (due to cultivars with the same genus/species), we built a matching system.
- This system **cross-checks** predictions **with nearby plants** and picks **the right cultivar** based on location.

Joint Approach Scheme

Main Approach: AI



arXiv:2203.02751

How it works

- Why MetaFormer: Runner-up in 2021 iNaturalist competition
- Training data: 2021 iNaturalist Mini dataset
  - Per species: 50 images for training, 10 for validation
  - Additional species: Scraped from iNaturalist (not in original dataset)
  - Total: **382/460 valid unique campus species**, mostly woody plants
    - The remaining species are not wild and thus cannot be scraped.
- Model: **Transfer learning** on MetaFormer (18 epochs)
- Validation accuracy: **72%**

Future plans

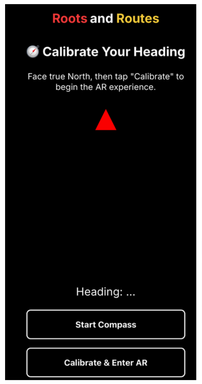
- Add more plants via a UMD Arboretum-specific album
- Leverage MetaFormer's metadata capability for UMD improvements
- Continually update model as better architectures release and benchmark

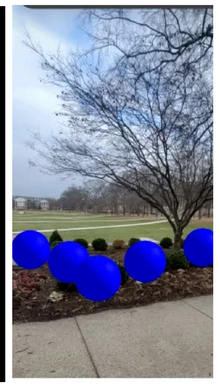
DEMO

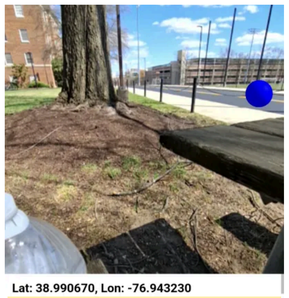
Backup: AR

How it works

1. **Tracks user's GPS** location (updates when moves +2m)
2. Get **nearby plants within 7m radius** from UMD Arboretum
3. Use AR.js to:
   a. **Calibrate heading** (iPhone)
   b. **Display** nearby plant markers, info when clicking on markers







DEMO

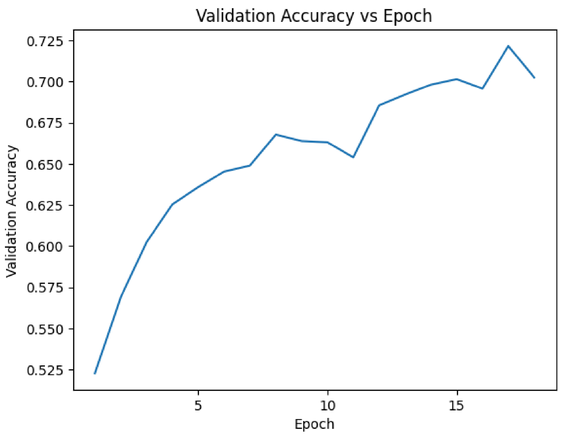
Limitation: Marker Drift

Phones have a **3–5m location error**, so AR markers aren't always precise. We tested:

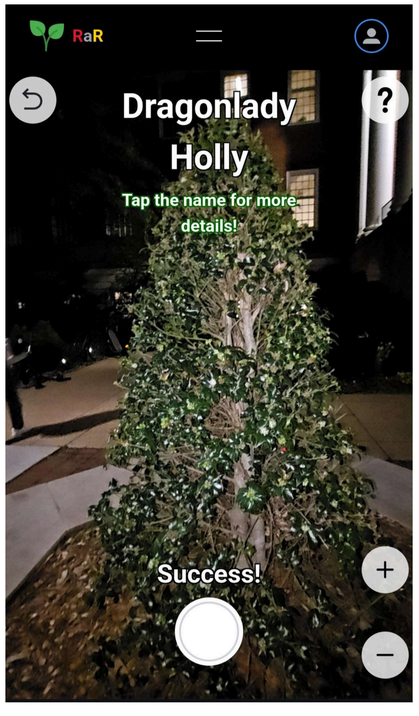
1. SLAM (Simultaneous Localization and Mapping) with phone's **IMU and gyroscope sensors**, but without an absolute reference, it can't place 3D markers. **Calibration also varies by device**.
2. VPS (Visual Positioning System) using **pre-scanned locations**, but it's too **costly and time-consuming.**

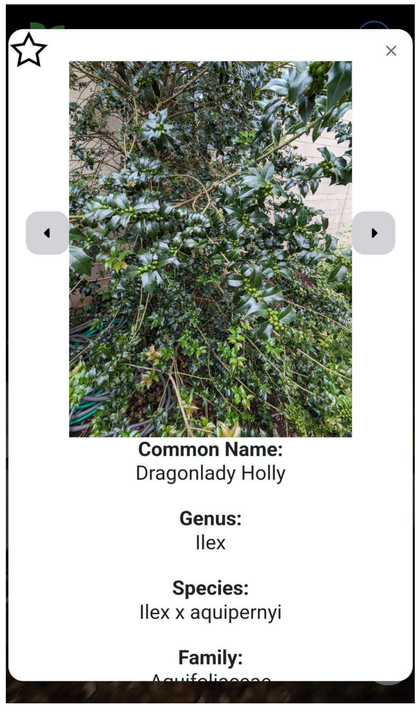
Analysis & Results

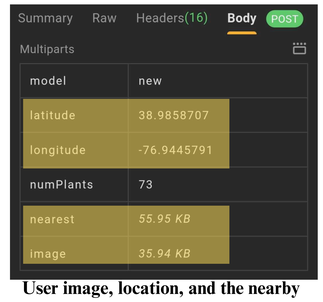
	AI	AR
iPhone & Andrioids	Process image and display prediction: • iPhones ~ 2 seconds • Android ~ varied from 2 up to 8 seconds	Works on both but • iPhones needs True North Calibration • iPhones has better location tracking and has less drift but still within 1-5m range
Weak Wifi/Data	**Weak Wi-Fi does not affect** the MetaFormer model's inference **speed**, but it **increases the time** required to send input data to the server and receive predictions back	**Weaker wifi** leads to **weaker geolocation tracking**, especially when loading +10 3D markers



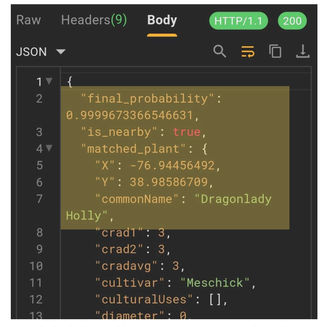
- Trained MetaFormer using the Adam optimizer with an initial learning rate of 1e-3.
- Model **accuracy plateaued at epoch 18**.
- **Overfitting hasn't been addressed yet** — planned for future work.







User image, location, and the nearby plants are sent to the server



Model predictions are returned and displayed to the user.