LYU1802
BotanWiki

Wong Tsz Hin 1155079510
Yan Chi Shing 1155078689

Supervised by Prof. Lyu Rung Tsong Michael
Motivation

Beautiful campus

With high variety of plants
Significance

- For botanists, reduce their workload massive data → quick recognition
- For public, countryside to check the plant
- Offline, stable performance in rural area
- Education purpose for students or children
We would like to build an **offline** leaf recognition mobile application, a **sustainable platform** about plants recognition.
Technology Overview

- OpenCV and keras
- TensorFlow
- Android Studio
- Gitlab
Timeline

**Preparation Work**
1. Target Setup
2. Interview with Curator David Lau
3. Begin Data collection

**Prototyping**
1. PyTorch: ResNet (~70%)
2. Get familiar with TensorFlow
3. Get familiar with Android App: Live Recognising

**Enhancement**
1. Data Augmentation
2. MobileNet (More than 90%)
3. 1st Version of Mobile Applicaiton: Dr.Leaf

**Presentation and Demonstration**
Knowledge on recognizing plants by leaf

To recognize a plant in a scientific way,

- Growing habit, habitat
- Stem and branches
- Flower
- Fruit
- Leaf

Difficult to classify with leaves only.
Classification Problem

Classify by comparing the features
Neural Network
Convolutional Neural Network

Image Matrix

Kernel Matrix

Output Matrix
Convolutional Neural Network

![Convolutional Neural Network Diagram](image)
Convolutional Neural Network
Data Preparation

- Take Photos
- Divide into single leaf set and multiple leaves set
Data Preparation

Single Leaf Dataset

![Graph showing the amount of photos for different leaf species](cg00000.png)

- Anacardium occidentale
- Anacardium occidentale variegated
- Campsiandra grandiflora
- Campsiandra japonica
- Cinnamomum album
- Cinnamomum hookerianum
- Ficus altissima
- Hibiscus rosa
- Magnolia chelsea
- Podocarpus macrophyllus
- Syzygium lancea

![Leaf images](cg00001.png, cg00002.png, cg00003.png, cg00004.png, cg00005.png, cg00006.png, cg00007.png, cg00008.png)
Data Preparation

Multiple Leaves Dataset

<table>
<thead>
<tr>
<th>Name</th>
<th>Amount of Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anacardia heterophylla</td>
<td></td>
</tr>
<tr>
<td>Aralia spinosa</td>
<td></td>
</tr>
<tr>
<td>Callicarpa americana</td>
<td></td>
</tr>
<tr>
<td>Ceanothuseurus</td>
<td></td>
</tr>
<tr>
<td>Cinnamomum album</td>
<td></td>
</tr>
<tr>
<td>Fuchsia alata</td>
<td></td>
</tr>
<tr>
<td>Hebe pinguinfolia</td>
<td></td>
</tr>
<tr>
<td>Hibiscus rosa-sinensis</td>
<td></td>
</tr>
<tr>
<td>Magnolia davidiana</td>
<td></td>
</tr>
<tr>
<td>Podocarpus m.</td>
<td></td>
</tr>
<tr>
<td>Streptocarpus</td>
<td></td>
</tr>
</tbody>
</table>

Images:
- cg00001.png
- cg00002.png
- cg00006.png
- cg00007.png
- cg00011.png
- cg00012.png
Data Preparation

Mixed Leaves Dataset

<table>
<thead>
<tr>
<th>Name</th>
<th>Amount of photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Araucaria heterophylla</td>
<td>300</td>
</tr>
<tr>
<td>Bauhinia variegata</td>
<td>400</td>
</tr>
<tr>
<td>Cathaya grantii</td>
<td>350</td>
</tr>
<tr>
<td>Cinnamomum album</td>
<td>450</td>
</tr>
<tr>
<td>Croton angulatus</td>
<td>500</td>
</tr>
<tr>
<td>Dracaena fascicularis</td>
<td>320</td>
</tr>
<tr>
<td>Hambroa Chungii</td>
<td>400</td>
</tr>
<tr>
<td>Macrostephanum truncatum</td>
<td>550</td>
</tr>
<tr>
<td>Podocarpus quinquefolius</td>
<td>420</td>
</tr>
<tr>
<td>Strobilanthes kunstiana</td>
<td>380</td>
</tr>
</tbody>
</table>

Images of leaves for verification.
Data Preparation

- Augmentation (Geometric Transformation)
  - Flipping
  - Rotation
  - Random Crop
  - Shearing
Data Preparation

Augmented Single Leaf Dataset

<table>
<thead>
<tr>
<th>Name</th>
<th>Amount of photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternaria heliantha</td>
<td>644</td>
</tr>
<tr>
<td>barbatana spinosa</td>
<td>644</td>
</tr>
<tr>
<td>Cornelia graminifolia</td>
<td>644</td>
</tr>
<tr>
<td>camellia japonica</td>
<td>644</td>
</tr>
<tr>
<td>campanulrum</td>
<td>644</td>
</tr>
<tr>
<td>ficus elastica</td>
<td>644</td>
</tr>
<tr>
<td>hibiscus rosa-sinensis</td>
<td>644</td>
</tr>
<tr>
<td>macrophylla glomerata</td>
<td>644</td>
</tr>
<tr>
<td>podocarpus n.</td>
<td>644</td>
</tr>
<tr>
<td>sterculia lanceolata</td>
<td>644</td>
</tr>
</tbody>
</table>

Images:
- mc_0_258.jpg
- mc_0_277.jpg
- mc_0_326.jpg
- mc_0_334.jpg
- mc_0_390.jpg
- mc_0_392.jpg
Data Preparation

Augmented Multiple Leaves Dataset

![Bar chart showing the amount of photos for different plant species.](fa_0_192.jpg)

- Atouca_hel...: 1250
- bauhinia_purpurea: 1000
- camellia_sinensis: 750
- crassula_ovi...: 500
- fuchsia_ar...: 250
- hibiscus_ros...: 250
- nolina_ch...: 250
- palacanthus_m...: 250
- atouca_junc...: 250

![Images of green leaves from different species.](fa_0_242.jpg)

- fa_0_196.jpg
- fa_0_249.jpg
- fa_0_326.jpg
- fa_0_327.jpg
Data Preparation
Concern

- Development Cycle
- Portability
- Speed
MobileNet
MobileNet

Depthwise convolution

Input Image
(W_in * H_in * Nch)

Nch
Kernell
(k * k)

Depthwise_out
(W_out * H_out * Nch)

1

1

2

2

... ...

... ...

Nch

Nch

Pointwise convolution

Nk
Kernel Map
(1 * 1 * Nk)

Output Image
(W_out * H_out * Nk)
<table>
<thead>
<tr>
<th></th>
<th>Original</th>
<th>Augmented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Leaf</td>
<td>95.6%</td>
<td>96.8%</td>
</tr>
<tr>
<td>Multiple Leaves</td>
<td>97.9%</td>
<td>98.5%</td>
</tr>
<tr>
<td>Mixed Leaves</td>
<td>97.3%</td>
<td>97.2%</td>
</tr>
</tbody>
</table>
Mobile Application
Research On Current Market
## Highlight 1 - Online Database

<table>
<thead>
<tr>
<th>Application</th>
<th>Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>PlantSnap</td>
<td>585,000 species, with 90% [1] of accuracy</td>
</tr>
<tr>
<td>PictureThis</td>
<td>4,000 species, with 98% [2] of accuracy</td>
</tr>
<tr>
<td>Pl@ntNet</td>
<td>7657 species of plants in USA [3]</td>
</tr>
</tbody>
</table>

[1] Statistical data such as the size of database and accuracy of identification mentioned in official website, [https://www.plantsnap.com/](https://www.plantsnap.com/)

[2] Statistical data such as the size of database and accuracy of identification mentioned in official website, [http://www.xingseapp.com/](http://www.xingseapp.com/)

[3] Statistical data such as the size of database and accuracy of identification mentioned in official website, [https://identify.plantnet-project.org/](https://identify.plantnet-project.org/)
Highlight 2 - Assistance of Recognition

User can choose the part showing photo

User can take photo with the focus area.
User have to input the name and search the details of the plant.
Dr. Leaf
Dr.Leaf

STEP 1
Take a photo of the leaf

STEP 2
Classify it!

85%

Camellia granthamiana Sealy
大麗山茶

Home / Pre-FactSheet
/ Camellia granthamiana Sealy 大麗山茶
Design Specification
Architecture Design

User Interact with mobile application

Local

Room (SQLite)

Query

Response

Photo Taking

AI Recognition

Built-in GoogleMap(Location Display)

Open

Google Map (Live tracking)

Back

Web Browser (Plant Detail)

Open

Back
All functions share the same database.
Two-Step Recognition with 97.2% accuracy
**STEP 1**
Take a photo of the leaf

**STEP 2**
Classify it!

85%
Dr. Leaf

CAMELLIA GRANTHAMIANA
大隱山茶
Score: 56.8%

STERCULIA LANCOGLATA
酸葉婆
Score: 21.6%
Camelia granthamiana Sealy

Home / Pro-Factsheet
CAMELIA GRANTHAMIANA SEALY 大苞山茶
Dr. Leaf

CAMELLIA GRANTHAMIANA
大葉山茶
Score: 56.8%

STERCULIA LANCEOLATA
飯漏婆
Score: 21.6%
Look up all the plants in map
Look up all the plants in list
Functionality

Recognition

Navigation

Look up plants in CUHK

Check out plants detail
Evaluation
User Interface

Rely on WIMP (Windows, Icons, Menus and Pointing Device)

Pros:

● Flow is clear
● Easy to follow

Cons:

● Old style
● Not attractive
# Testing - Functional

<table>
<thead>
<tr>
<th>Function</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open camera</td>
<td>Pass</td>
</tr>
<tr>
<td>Recognition</td>
<td>Pass</td>
</tr>
<tr>
<td>Website button</td>
<td>Pass</td>
</tr>
<tr>
<td>Location button</td>
<td>Pass</td>
</tr>
</tbody>
</table>

![Image of app interface with results]

**Dr. Leaf**

- **CAMELLIA GRANTHAMIANA**
  - Score: 56.8%

- **STERCULIA LANCEOLATA**
  - Score: 21.6%

- **HANDROANTHUS CHRYSANTHUS**
  - Score: 85%

- **HIBISCUS ROSA-SINENSIS**
  - Score: 90%
Testing - UI

Only testing in emulator is not enough.

Momery resource problem.
Evolvability

- Modularity
- Keep database record
- GitLab version control
- Resouce file system in android studio
Evolvability - Modularity
Evolvability - Keep database record

```json
{
  "formatVersion": 1,
  "database": {
    "version": 3,
    "identityHash": "ff414d2037da9108e2fa40b6be767a95",
    "entities": [
      {
        "tableName": "plant_table",
        "createSql": "CREATE TABLE IF NOT EXISTS `${TABLE_NAME}` (`code` TEXT NOT NULL, `name` TEXT NOT NULL),
        "fields": [
          {
            "fieldPath": "plantCode",
            "columnName": "code",
            "affinity": "TEXT",
            "notNull": true
          },
          {
            "fieldPath": "nameEng",
            "columnName": "nameEng",
            "affinity": "TEXT",
            "notNull": false
          },
          {
            "fieldPath": "nameChi",
            "columnName": "nameChi",
            "affinity": "TEXT"
          }
        ]
      }
    ]
  }
}
```
<table>
<thead>
<tr>
<th>Date</th>
<th>Number of Commits</th>
<th>Commit Message</th>
<th>Author</th>
<th>Date of Authoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 Nov, 2018</td>
<td>3</td>
<td>Add photo visibility</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fixed Incorrect textview init in MainActivity</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show Result in Another Activity: ClassifyReult</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td>13 Nov, 2018</td>
<td>7</td>
<td>Finished Basic Photo Taking &amp; Classification Function</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Add the cue by comment in the particular file</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MV</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Add Picture files</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Init file &amp; fix forcibly quit app by changing byte to float in Android-xxx-xxx...</td>
<td>edw4r</td>
<td>2 weeks ago</td>
</tr>
</tbody>
</table>
Evolvability - Resource Control

**STEP 1**
Take a photo of the leaf.

**STEP 2**
Classify it!

Edit translations for all locales in the translations editor.

```xml
<resources>
  <string name="app_name">Dr. Leaf</string>
  <string name="title_activity_specific_plant_result">SpecificPlantResult</string>
  <string name="action_settings">Settings</string>
  <string name="title_activity_room_testing">roomTesting</string>
  <string name="title_activity_plants_maps">Map</string>
</resources>
```
Limitation and Difficulties

- No existing tree database
- web-crawling is not realistic
Limitation and Difficulties

- Only leaf is not enough
- Tree features varies in different habitats
Future Development
AI Model

- More features
- More Species
Mobile app

- Add more function
- Improve UI/UX
- More testing

[1] Picture is retrieved from https://material.io/
[2] Picture is retrieved from https://giphy.com/gifs/weather-11youGHnnqd8yc/links
Thank You
Q & A