Plant Disease Identification AI App Testing

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Project Introduction

FarmAssistX

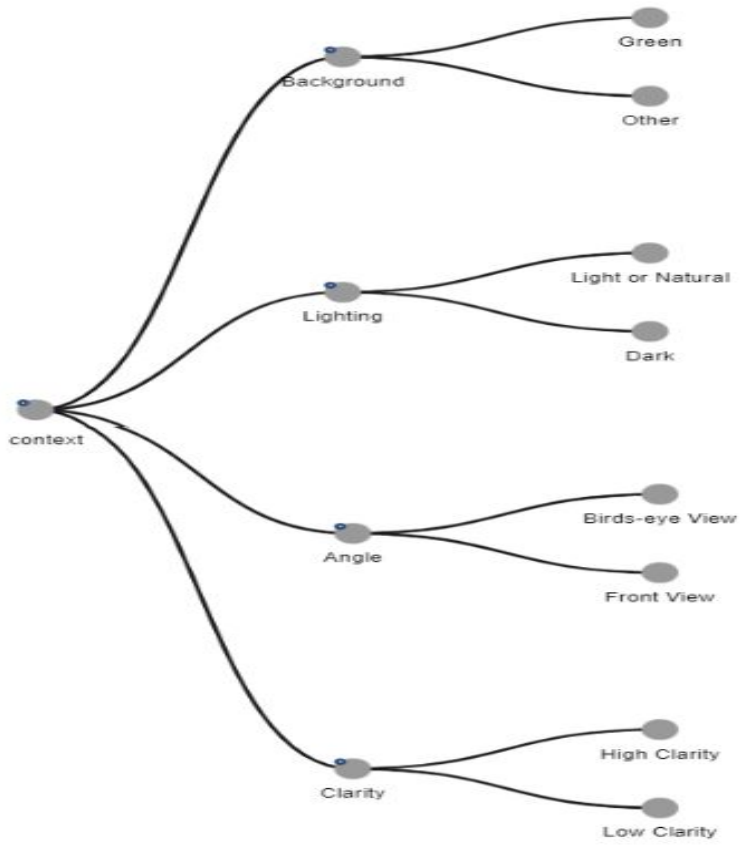
DoctorP

PlantDiseaseIdentifier

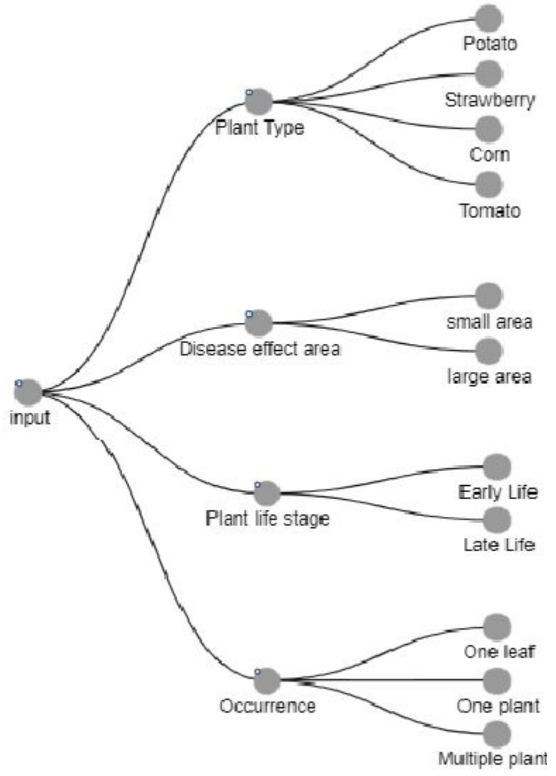
SickPlantDiseaseIdentifier

Our Feature:
Our apps use AI to detect the plant disease when given an image of the plant
While there are numerous diseases, we decided to focus on specific diseases for the following plants:
Tomato, Potato, Strawberry, Corn

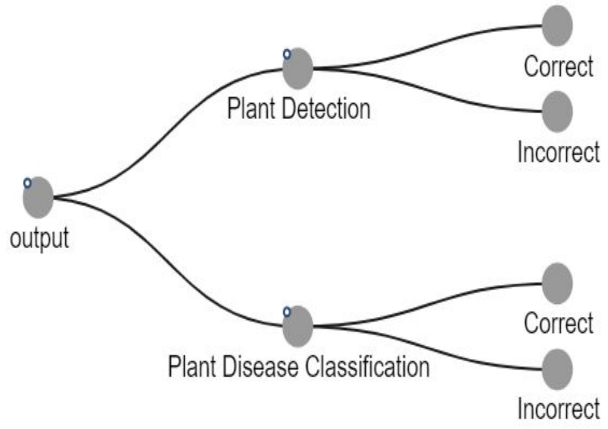
Context Model



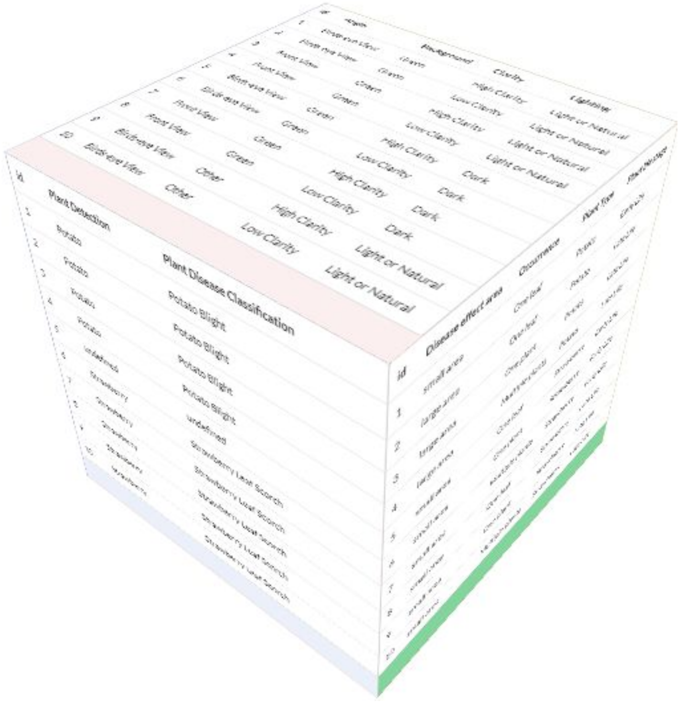
Input Model


input
Plant Type
Potato
Strawberry
Corn
Tomato
Disease effect area
small area
large area
Plant life stage
Early Life
Late Life
Occurrence
One leaf
One plant
Multiple plant

Output Model



3D Classification Decision Table



Id	Angle	Background	Clarity	Lighting
1	Bird-eye View	Green	High Clarity	Light or Natural
2	Bird-eye View	Green	Low Clarity	Light or Natural
3	Front View	Green	High Clarity	Light or Natural
4	Front View	Green	Low Clarity	Light or Natural
5	Bird-eye View	Green	High Clarity	Dark
6	Bird-eye View	Green	Low Clarity	Dark
7	Front View	Green	High Clarity	Dark
8	Front View	Green	Low Clarity	Dark
9	Bird-eye View	Other	High Clarity	Light or Natural
10	Bird-eye View	Other	Low Clarity	Light or Natural

Id	Plant Detection	Plant Disease Classification
1	Potato	Potato Blight
2	Potato	Potato Blight
3	Potato	Potato Blight
4	Potato	Potato Blight
5	undefined	undefined
6	Strawberry	Strawberry Leaf Scorch
7	Strawberry	Strawberry Leaf Scorch
8	Strawberry	Strawberry Leaf Scorch
9	Strawberry	Strawberry Leaf Scorch
10	Strawberry	Strawberry Leaf Scorch

Id	Disease effect area	Occurrence	Plant Type	[illegible]
1	small area	One leaf	Potato	[illegible]
2	large area	One leaf	Potato	[illegible]
3	large area	One plant	Potato	[illegible]
4	large area	Multiple plants	Potato	[illegible]
5	small area	One leaf	Strawberry	[illegible]
6	small area	One plant	Strawberry	[illegible]
7	small area	Multiple plants	Strawberry	[illegible]
8	small area	One leaf	Strawberry	[illegible]
9	small area	One leaf	Strawberry	[illegible]
10	small area	Multiple plants	[illegible]	[illegible]

Project AI Test Design, Test Cases/Data

2.4.1 Context Spanning Table

ID	Angle	Background	Clarity	Lighting
C1	Birds-Eye View	Green	High	Light
C2	Birds-Eye View	Other	High	Light
C3	Front View	Green	High	Light
C4	Front View	Other	High	Light
C5	Front View	Other	High	Dark
C6	Front View	Other	Low	Light
C7	Front View	Other	Low	Dark

2.4.2 Input Spanning Table

ID	Plant Type	Disease effect area	Occurrence	Life Stage
I1	-	-	No Plant	-
I2			One plant	Early Life
I3	Potato	One Spot	One leaf	Late Life
I4	Tomato	One Spot	One plant	Late Life
I5	Potato	Multiple Spots	One leaf	Late Life
I6	Potato	Multiple Spots	One plant	Late Life
I7	Strawberry	Multiple Spots	One leaf	Late Life
I8	Strawberry	Multiple Spots	One plant	Late Life
I9	Corn	Multiple Spots	One leaf	Late Life

I10	Corn	Multiple Spots	One plant	Late Life
I11	Tomato	Multiple Spots	One leaf	Late Life
I12	Tomato	Multiple Spots	One plant	Late Life

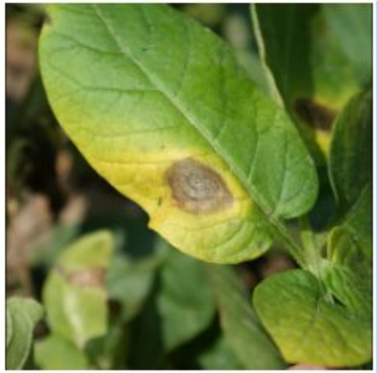
2.4.3 Output Spanning Table

ID	Plant Detection	Plant Disease Classification
O1	Correct	Correct
O2	Correct	Wrong
O3	Wrong	Wrong

2.4.4 Test Case Design

ID	Context Spanning Tree	Input Spanning Tree	Output Spanning Tree
T1	C1	I6	O1
T2	C7	I6	O1
T3	C4	I6	O1
T4	C5	I6	O1
T5	C4	I8	O1
T6	C6	I8	O1
T7	C3	I9	O1
T8	C4	I9	O1
T9	C2	I12	O1
T10	C4	I12	O1
T11	C4	I1	O1
T12	C4	I2	O1
T13	C4	I3	O1

T14	C4	I4	O1
T15	C4	I5	O1
T16	C4	I6	O1
T17	C4	I7	O1
T18	C4	I8	O1
T19	C4	I9	O1
T20	C4	I10	O1
T21	C4	I11	O1
T22	C4	I12	O1
T23	C2	I5	O1
T24	C2	I6	O1
T25	C2	I7	O1
T26	C2	I8	O1
T27	C2	I9	O1
T28	C2	I10	O1
T29	C2	I11	O1
T30	C2	I12	O1

Test Case ID	T13			
Test Case Description	Potato blight, one singular spot on leaf, front view, high clarity and light			
App Name	FarmAssistX	Sick Plant Disease Identifier	PlantDiseaseIndentifier	PictureThis
Test Case Input				
Performed By	Tejas Kulkarni	Nathan Kim	Mitchell Sayer	Umesh Singh
Execution Date	10/22/2023	10/22/2023	10/22/2023	10/22/2023
Expected Result	Potato Blight	Potato Early Blight (Fungi)	Potato Leaf - Blight	Potato Blight
Actual Result	Healthy	Groundcherry Fungi (Most Likely)	Potato - Blight	This plant has Potato Blight!
Test Case Result	Fail	Pass	Pass	Pass

Test complexity and coverage

- **Test Complexity:**

  Test complexity based on 3D AI decision table
  Test complexity: W*L*H
  → 48 Input rows
  → 48 Output rows
  → 16 Context rows
  → 48*48*16 = 36864

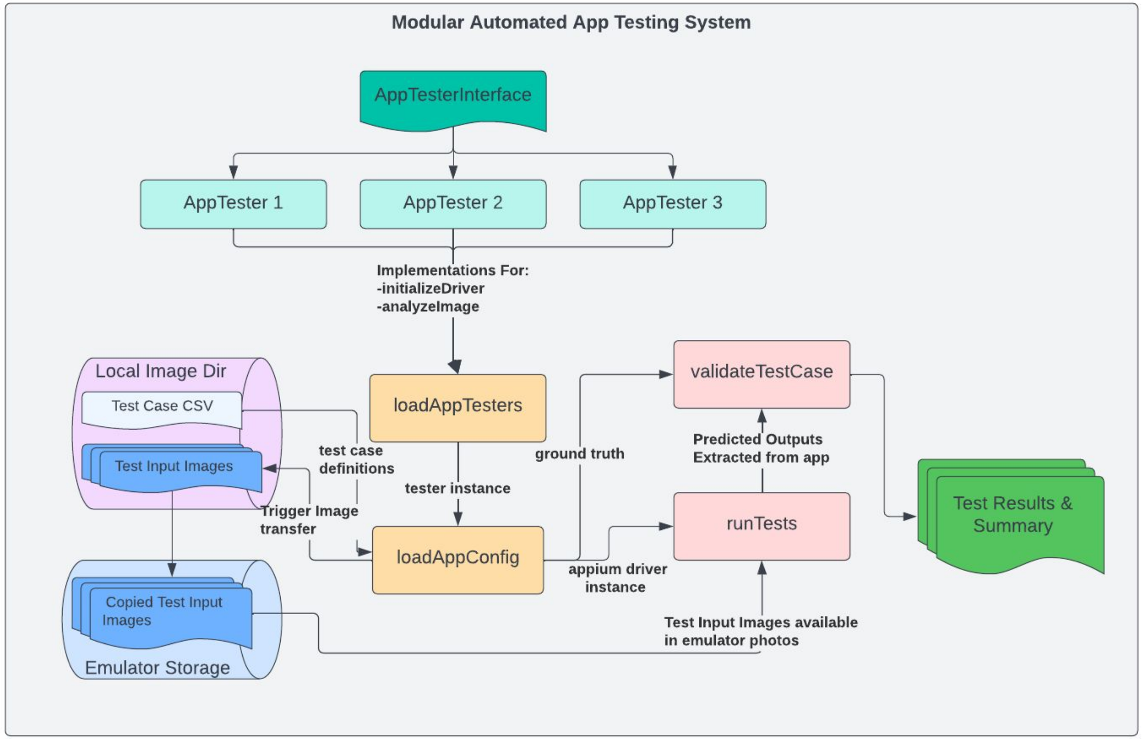
- **Test Coverage:**
  - The input category partitions, output category partitions, and the context category partitions were evaluated and tested.

Test report and coverage

- **Test Report:**
  - Execution:
    - The criteria for pass/fail criteria was clearly established
    - Python scripts were written to load and evaluate images (test cases)
    - Our group loaded our scripts into Appium and executed the test cases
    - Results were evaluated using our specified testing criteria (slide 4)
- **Test Coverage:**
  - The input category partitions, output category partitions, and the context category partitions were evaluated and tested.

Test Automation System

Designed and implemented modular automated testing system.



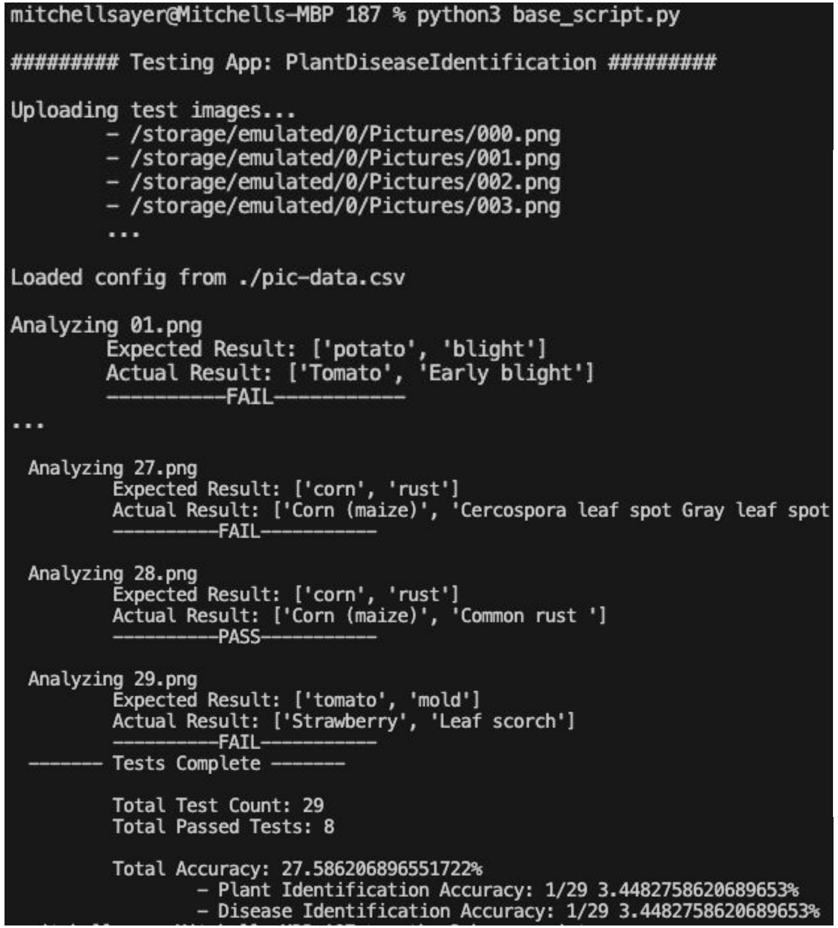
System Features:

- Enables systematic automated testing of multiple APK files
- Simple interface for integrating new applications
- Automatic configuration of submodules
- Automated test reporting
- CSV configuration file defines mapping of input image files -> expected prediction values for each test case
- Automatically parses input image files and pushes them to the Android Emulator file system

New AppTester modules must implement:

- initializeDriver: instantiates appium web driver & connects to server
- analyzeImage: given an index in the sorted input image list, this function interacts with the app and extracts predicted plant and disease values

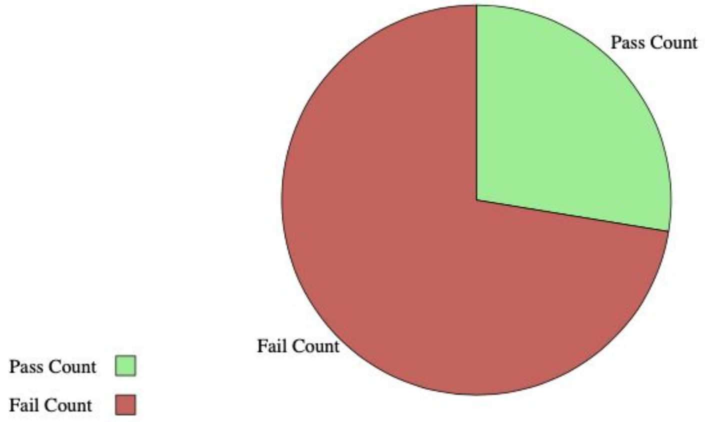
Test Automation System Output



```
mitchellsayer@Mitchells-MBP 187 % python3 base_script.py

######### Testing App: PlantDiseaseIdentification #########

Uploading test images...
        - /storage/emulated/0/Pictures/000.png
        - /storage/emulated/0/Pictures/001.png
        - /storage/emulated/0/Pictures/002.png
        - /storage/emulated/0/Pictures/003.png
        ...

Loaded config from ./pic-data.csv

Analyzing 01.png
        Expected Result: ['potato', 'blight']
        Actual Result: ['Tomato', 'Early blight']
        -----------FAIL------------
...

 Analyzing 27.png
        Expected Result: ['corn', 'rust']
        Actual Result: ['Corn (maize)', 'Cercospora leaf spot Gray leaf spot
        ----------FAIL-----------

 Analyzing 28.png
        Expected Result: ['corn', 'rust']
        Actual Result: ['Corn (maize)', 'Common rust ']
        ----------PASS-----------

 Analyzing 29.png
        Expected Result: ['tomato', 'mold']
        Actual Result: ['Strawberry', 'Leaf scorch']
        ----------FAIL-----------
 ------- Tests Complete -------

        Total Test Count: 29
        Total Passed Tests: 8

        Total Accuracy: 27.586206896551722%
                - Plant Identification Accuracy: 1/29 3.4482758620689653%
                - Disease Identification Accuracy: 1/29 3.4482758620689653%
```

Automation Test Report: PlantDiseaseIdentification

Number of Test Cases	Passed Cases Count	Failed Cases Count	Pass Rate	Fail Rate
29	8	21	27.59%	72.41%



Automated Testing System Demo Video

Observed Bugs

Background

Sick Plant Disease Identifier and Plant Disease Identifier failed this. The app needs to make some changes in regards to how it detects the plant itself. Having a background that looks similar to the plant (green color) can throw the detection off.

Lighting

Both Sick Plant Disease Identifier and Plant Disease Identifier failed 2 test cases in this category once again. The PictureThis apps failed 1 test case. Apps need to be able to detect plants and their diseases in various types of lighting situations, both Light and Dark. For the most part, situations where the lighting was dark seemed to give the message that no plant was detected, or that the plant had turned dark due to some disease.

Disease Effect Area

Both FarmAssistX and PictureThis have 1 failed test case. This is extremely good and goes to show that the passing apps have trained for plants with even a small speck of indication of disease.