**Arab Academy for Science and Technology and Maritime Transport**

**College of Computing and Information Technology**

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| **Course** | Digital Image Processing (CS455) |
| **Lecturer** | Dr. Radwa Fathalla |
| **TA** | Mahmoud ElMorshedy |

# 12th Project – Plant Leaf Classification

Design a program for the automated segmentation and classification of plant leaves. The program's input is a plant leaf image, and the output should consist of 1) A binary image with only the plant leaf object, and 2) The class of the plant leaf image. The ten plant classes are depicted below:

*Alstonia Scholaris*

*Arjun*

*Basil*

*Chinar*

*Jamun*

*Jatropha*

*Lemon*

*Mango*

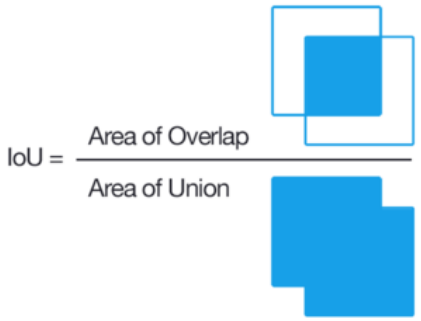
*Pomegranate*

*Pongamia Pinnata*

The project is divided into two phases:

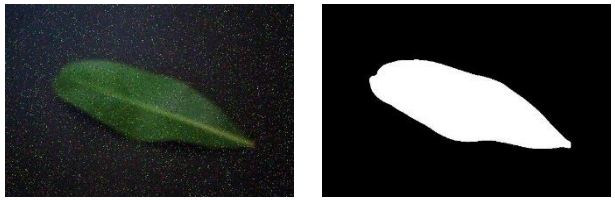
## Phase-1:

- In this phase you are required to **segment** all images in the given dataset. You will find the dataset in a zip file named **"_Output.zip"** on your Google Classroom.
- The images in the given dataset are low contrasted images and have some salt and pepper noise. So, to segment the images you need to do some **preprocessing**, you may need to:
  - Adjust the contrast of the image.
  - Remove the salt and pepper noise.
  - Extract the plant leaf region using Thresholding or any other segmentation technique.
  - Use morphological operations (Erosion, Dilation, Opening, Closing, …) to further improve the segmentation result.
- To assess your segmentation result, you will need to measure the **average Intersection of Union (IoU or *Jaccard index*)** between your segmentation output and the ground truth segmentations provided in the zip file named **"_Ground_Truth.zip"**.
  - The Jaccard index is a value between [0-1] (the higher the better matching) https://www.mathworks.com/help/images/ref/jaccard.html. The Jaccard index is calculated between two images (the output binary image and its corresponding ground truth image). We do this for all images in the dataset and calculate the average Jaccard index, which indicates the overall segmentation accuracy of your program.

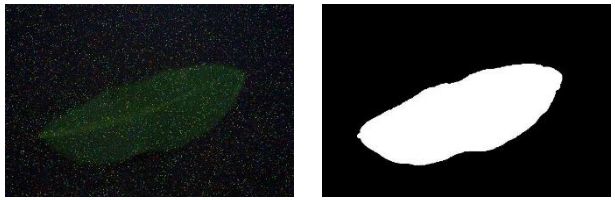



Examples for inputs and ground truth outputs are shown below:

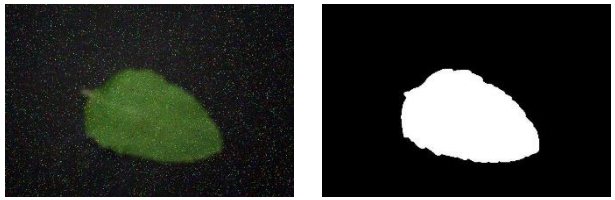
Alstonia Scholaris



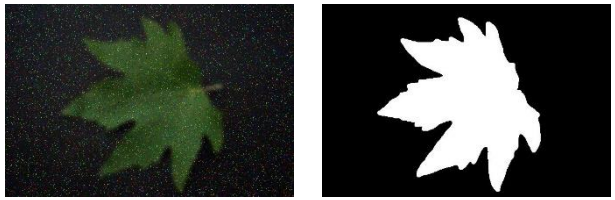
Arjun



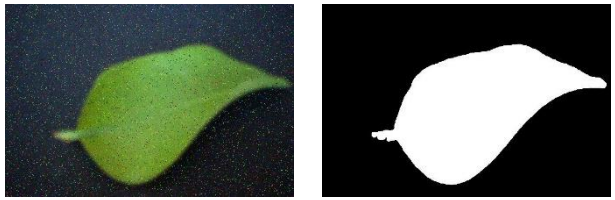
Basil



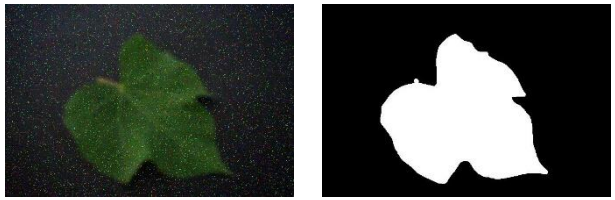
Chinar



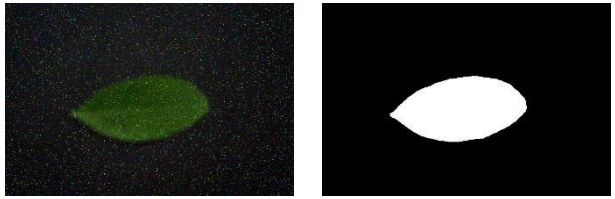
Jamun



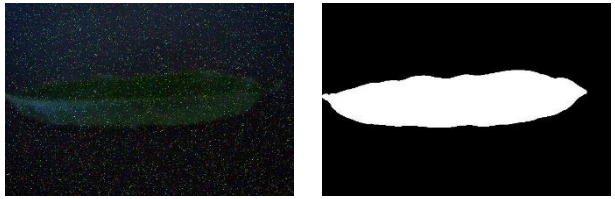
Jatropha



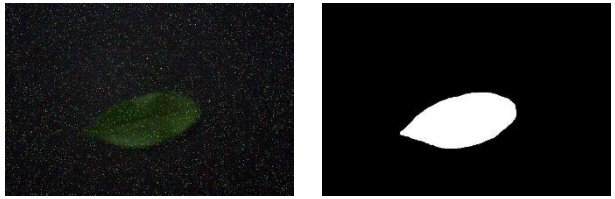
Lemon



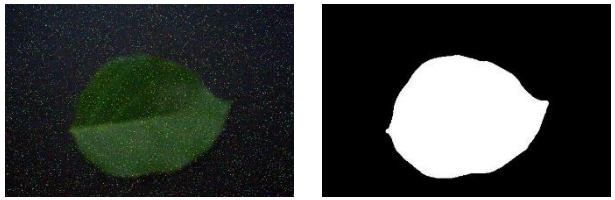
Mango



Pomegranate



Pongamia Pinnata



## Phase-2:

- This phase takes the output segmented binary images and **extract** some meaningful features for each image. For features you may extract:
  - Boundary Features (e.g., Fourier Descriptors)
  - Region Features (e.g., Area, Perimeter, Circularity, Convexity, Compactness, Moments, …etc.)
    - [See regionprops function in Matlab: https://www.mathworks.com/help/images/ref/regionprops.html]
- The extracted features for all images in the dataset should be inserted into a **features table** where the records correspond to the images and the columns correspond to the extracted features.
- This features table is then divided into training and test sets.
- Finally, we train some **classifier** on the training set and evaluate its accuracy on the test set. (You can use the Classification Learner app in the Image Processing Toolbox in Matlab).
- The output for this phase should be 1) a **trained classifier** model with its **accuracy** figure on the test set, and 2) the **predicted class** for a given input image using the trained classifier.

## Rubric and Instructions:

### Phase-1: [10 Marks, Included in the 12th. *The other 10 Marks of the 12th are on the assigned sheets*.]

- [3 Marks] Preprocessing (Image denoising, Contrast enhancement, Image Sharpening).
- [4 Marks] Image Segmentation (The segmented binary image processed with Morphological operation, if needed).
- [3 Marks] Report. The report should include:
  - Source code snippets with a brief explanation of each function used.
  - The output image after each change in the image until the final segmented binary image.

### Phase-2: [10 Marks, Coursework Marks]

- [2 Marks] Features extraction.
- [2 Marks] Features table.
- [2 Marks] Classifier training and testing.
- [2 Marks] Classifier evaluation (accuracy figures).
- [2 Marks] Report. Complete the report with:
  - Source code snippets for phase-2 with a brief explanation of each function used.
  - The trained classifier accuracy figures.

*You may work in pairs.*
*Phase-1 should be submitted on the 13th week and Phase-2 on the 15th week. (See deadline on Classroom).*