Mosses Classification Using Deep Learning

Carried out:

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CONTENTS

INTRODUCTION 01

- PROBLEM DEFINITION
- MOTIVATION

INTRODUCTION: PROBLEM DEFINITION

Mosses provide early warning of air pollution

INTRODUCTION: PROBLEM DEFINITION

Mosses species classification

Question is?

How can we identify a moss species out of 14500 other moss species?

Answer.....

INTRODUCTION: PROBLEM DEFINITION

Mosses species classification

To employ computers in this task we need:

1. **Data to learn from (must be clean data!)**
2. **Determine the machine learning techniques to be used.**
3. **Deploy the trained models on handy platforms**
   (e.g Web page - Android mobile APP).

MOSSES CLASSIFICATION USING DEEP LEARNING METHODOLOGY

02

- DATASET
- CLASSIFICATION MODEL
- ENVIRONMENT

CLASSIFICATION MODEL : MOSSES DATASET

Dataset was built from scratch using Bing Image Search API
[https://github.com/ahmedesolyman/moss-db/tree/master/dataset]

Microsoft Azure

Mosses used in the dataset

1. pleurozium_schreberi
2. Hylocomium_splendens
3. hypnum_cupressiforme
4. Pseudoscleropodium_purum
5. abietinella_abietina

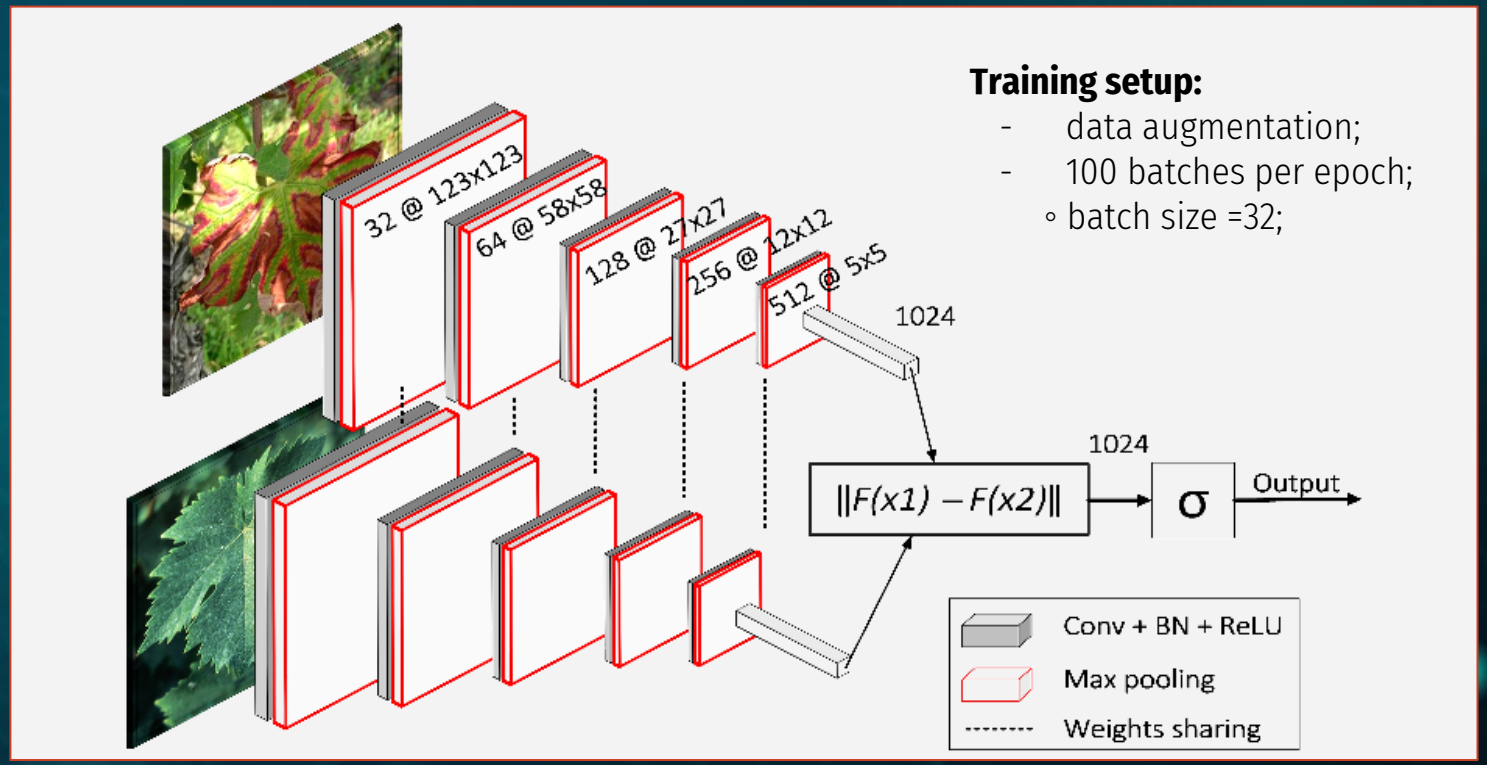
CLASSIFICATION PIPELINE:

Steps used in building the mosses classifier

Step 1: Train the Siamese Neural Network as a feature extractor .
Step 2: Transfer Learning (Combine Siamese feature extractor with additional layers for classification).

CLASSIFICATION MODEL:

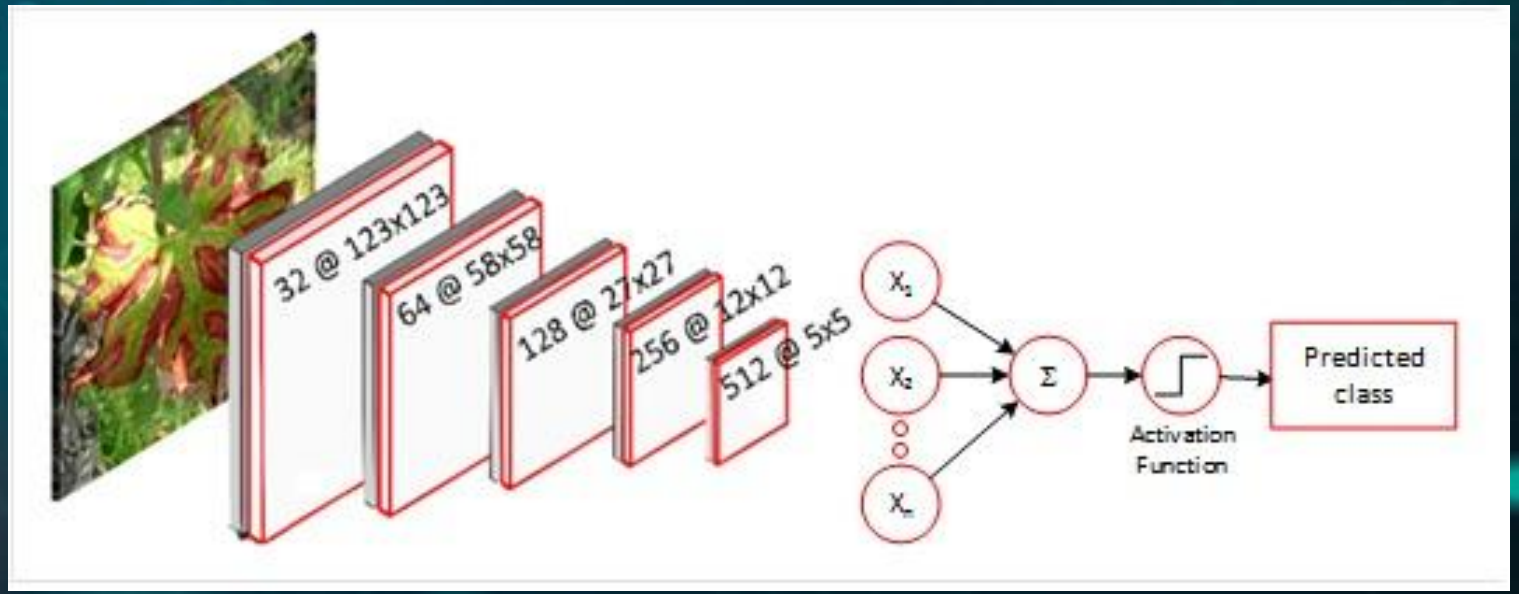
Step 1: Train the Siamese Neural Network as a feature Extractor



CLASSIFICATION MODEL:

Step 2: Transfer Learning (use on of twins to get embedding)

a. Made an architecture modification for the pre-trained **Siamese Neural Network**. (We use Multilayer Perceptron (MLP))

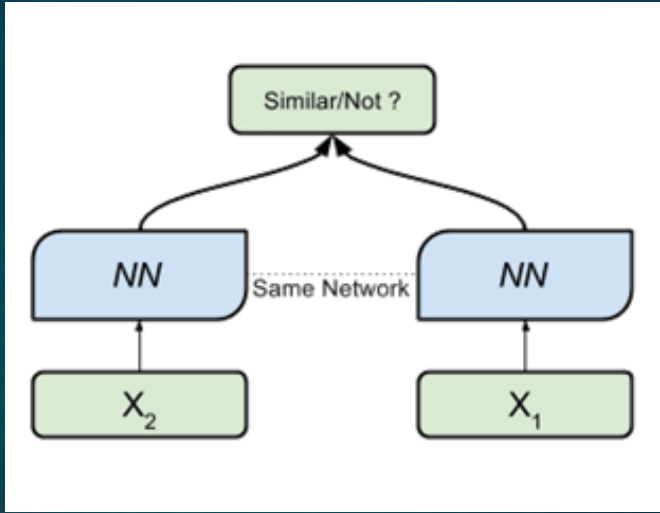


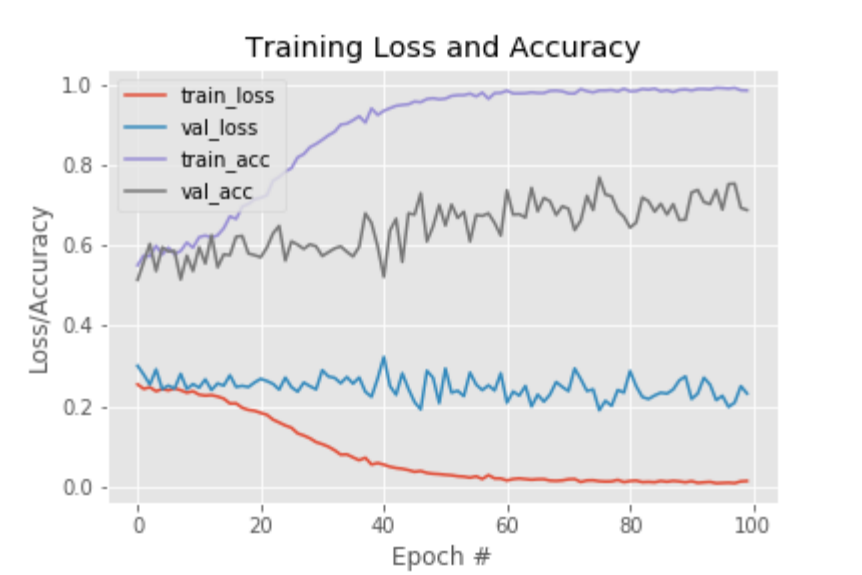
RESULTS , CONCLUSION & FUTURE WORK

03

- DATA VISUALIZATION
- CONFUSION MATRIX
- Results from JINR server web-page & Android mobile APP
- FUTURE WORK

Results: Siamese Network (Feature Extraction)





Loss function	Contrastive cosine
Dropout ratio	0.2
Training Accuracy	0.9716
Validation Accuracy	0.75

Results: Data Visualization (Siamese)

t-distributed Stochastic Neighbor Embedding (t-SNE)

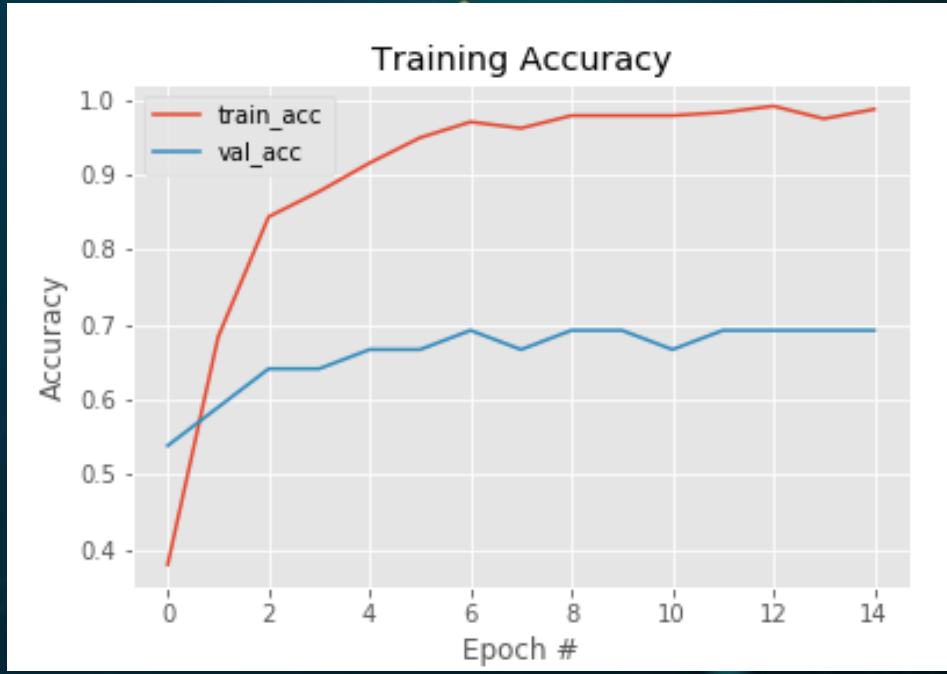
The t-distributed Stochastic Neighbor Embedding (t-SNE) is used to visualize the data extracted using 2D space.

There are five separated clusters one per each moss class. Although, there are a few points, which wrongly got into the different set.

Results: Transfer Learning

Feature extraction using Siames Network → `Moss_feature_extractor.h5` → Transfer Learning

Activation Function	ReLU (inner layers) Softmax (output layers)
Dropout ratio	0.2
Training Accuracy	0.9858
Validation Accuracy	0.70

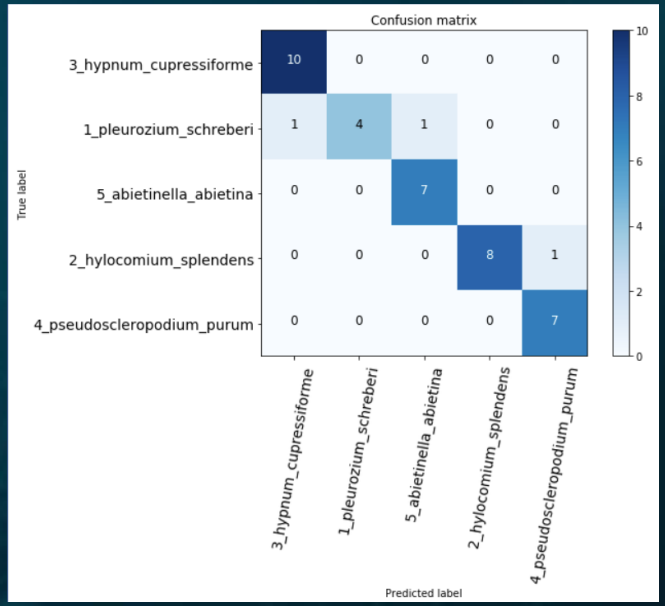


Results: Data Visualization (Transfer Learning)

CONFUSION MATRIX

This matrix shows how many Predicted class objects were recognized as True class objects

Applied on 276 Pictures



Results: Data Visualization

EXAMPLES OF THE INCORRECT PREDICTIONS

TRUE : 3_hypnum_cupressiforme
PREDICTED: 4_pseudoscleropodium_purum

TRUE : 1_pleurozium_schreberi
PREDICTED: 5_abietinella_abietina

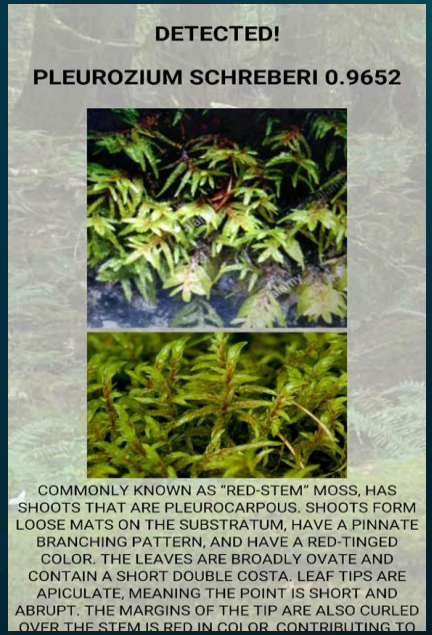
Results: Data Visualisation

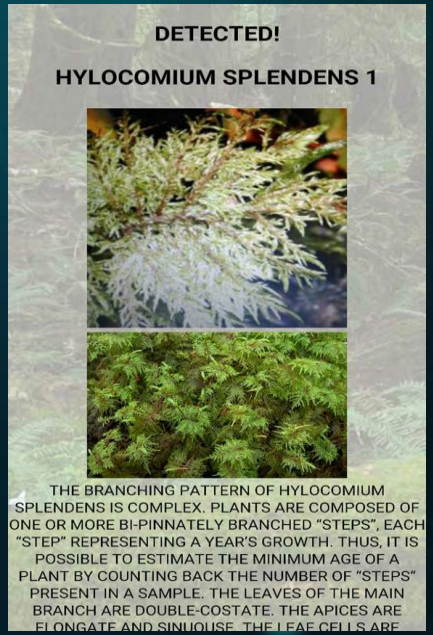
a- Results from JINR server web-page

(http://moss.jinr.ru/detect_mosses/)

Results: Data Visualisation

b- Results from (Moss ICP) Android mobile APP





Development Environment

Programming Language : Python
IDEs :Spyder / Jupyter / Colab
Frameworks :TensorFlow / Keras
Version Control :GitHub

Conclusion:

1. Database for mosses has been Established from scratch.
2. A new Deep Learning pipeline has been developed for identifying moss species from images using Siamese network and Transfer Learning **(novel work)**.
3. The model is finally deployed at (http://moss.jinr.ru/detect_mosses/)
4. The preliminary results show the system effectiveness with high training accuracy (98%) and high validation accuracy (80%).

Learning Outcomes and Acknowledgement

1. Theoretical introduction to deep learning: history, architectures, loss functions, different optimization techniques for loss functions, and regularization techniques.
2. Experimental introduction to Siamese network architecture for training feature extractor from small datasets, with application to images of diseased grapes, crops, and wheat.
3. Experimental introduction to Transfer Learning to combine pre-trained network with additional trainable layer(s), and application to the above dataset.
4. Practice on automated preparation of datasets from the web using Bing API in Python, with application to five different species of Mosses (novel work).

Learning Outcomes

5. Practice on classifying objects from video streams.
6. Developing new deep learning pipeline for identifying moss species from images using Siamese network and Transfer Learning (novel work). The model is finally deployed at (http://moss.jinr.ru/detect_mosses/) and preliminary results show competency.
7. Practice and training on different high performance computing technologies and hands-on practice on JINR`s supercomputer:
    a. OpenMP: parallel processing framework on a single node CPU.
    b. CUDA: parallel processing library on Nvidia`s Graphical Processing Units (GPUs).
    c. MPI: distributed processing framework on a cluster of nodes (distributed CPUs and memories).
    d. MKL: high performance and efficient mathematical library by Intel.

Learning Outcomes

Special thanks to the supervising team at Prof. Ososkov's lab. They were very kind and cooperative throughout the three weeks. We are very impressed and pleased by their generous giving.

FUTURE WORK:

Group	1. Establish Database for crops in Egypt like cotton, mango,..etc. 2. Develop Deep Learning pipeline for identifying crop species and its diseases using an alike pipeline.
Ahmed	1. Finalize the the part of object recognition using deep learning to complete the motion control algorithms in my research of teleoperated robot programming and trajectory planning. 2. A QUAD copter may be used and programmed to gather live videos and images to prepare high quality dataset and do surveillance on crops in Egypt; along the time.

FUTURE WORK:

Asem	1. Develop a cloud-based application for data collection by the agricultural community to generate a huge dataset of annotated images of various crops with different diseases in Egypt. 2. Develop similar ML pipelines to learn from this big data.
Nermen	1. Designing and manufacturing Unmanned Ground Vehicle (UGV) that will be used to collect crops images like (Potatoes, Beans, mosses, …) from farms to prepare effective dataset. 2. Investigate the effectiveness of other types of DLNN on increase the reliability, and repeatability on moss or crops classification. 3. Build a real-time condition monitoring system on crops diseases as well as deposition of pollutants in different places through mosses.

THANKS!

Do you have any questions?

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