AquaDiva
collaborative research center 1076

A Deep Learning-based approach for Banana Leaf Diseases Classification

Jihene Amara[1], Bassem Bouaziz[1], **Alsayed Algergawy[2]**

[1]Institute of computer science and Multimedia, University of Sfax, Tunisia
[2]Institute for Computer Science, Friedrich-Schiller University of Jena, Germany

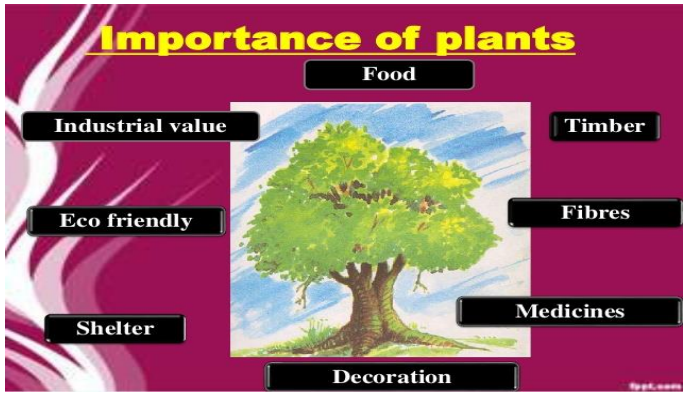
2nd BigDS Workshop, March 7th 2017

DFG Deutsche Forschungsgemeinschaft

seit 1558

Motivation

- Plants provide us with food, fiber, shelter, medicine, and fuel
- The basic food for all organisms is produced by green plants
- In the process of food production, oxygen is released. This oxygen, which we obtain from the air we breathe, is essential to life.
- The only source of food and oxygen are plants; no animal alone can supply these.
- Shelter, in the form of wood for houses; and clothing, in the form of cotton fibers, are obvious uses of plant materials



Motivation

AquaDiva collaborative research center 1076

- Modern technologies have given human society the ability to produce enough food to meet the demand for more than 7 billion people
- However, food security remains threaten by a number of factors: **climate change, decline in pollinators, plant diseases**
- Plant diseases are not only a thread to a global scale, but can also have catastrophic consequences for smallholder farmers
- In the developing countries, more than 80% of the agricultural products are generated by these smallholder farmers
- Loss of more than 50% of crops due to pests and diseases

DFG Deutsche Forschungsgemeinschaft

seit 1558

Motivation

AquaDiva collaborative research center 1076

- Disease fungi take their energy from the plants on which they live.
- They are responsible for a great deal of damage and are characterized by wilting, scabs, moldy coatings, rusts, blotches and rotted tissue.

Anthracnose
Generally found in the eastern part of the U.S., anthracnose infected plants develop dark lesions on stems, leaves or fruit

Early Blight
Appears on lower, older leaves as small brown spots with concentric rings that form a "bull's eye" pattern.

Leaf Spot
Infected plants have brown or black water-soaked spots on the foliage, sometimes with a yellow halo, usually uniform in size.

https://www.planetnatural.com/pest-problem-solver/plant-disease/

DFG Deutsche Forschungsgemeinschaft

seit 1558

Motivation

AquaDiva
collaborative research center 1076

- A plant **disease** is described as :
  - Abnormal condition that alters the appearance or function of a plant.
  - A physiological process that affects some or all plant functions.

- Damage the crop
- Reduce the quantity and quality of yield
- Increase the cost of production
- **Continuous monitoring of an expert is too expensive and time consuming**

Bacterial disease

Fungal disease

Viral disease

?

DFG Deutsche Forschungsgemeinschaft

seit 1558

Motivation

AquaDiva
collaborative research center 1076

- Identifying a disease correctly when it first appears is a crucial step for efficient disease management
- With the advanced of HD Camera,
- High performance processors
- Image processing and learning techniques

- **Develop and implement a deep learning approach for plant disease classification**

DFG Deutsche Forschungsgemeinschaft

seit 1558

Outline

AquaDiva
collaborative research center 1076

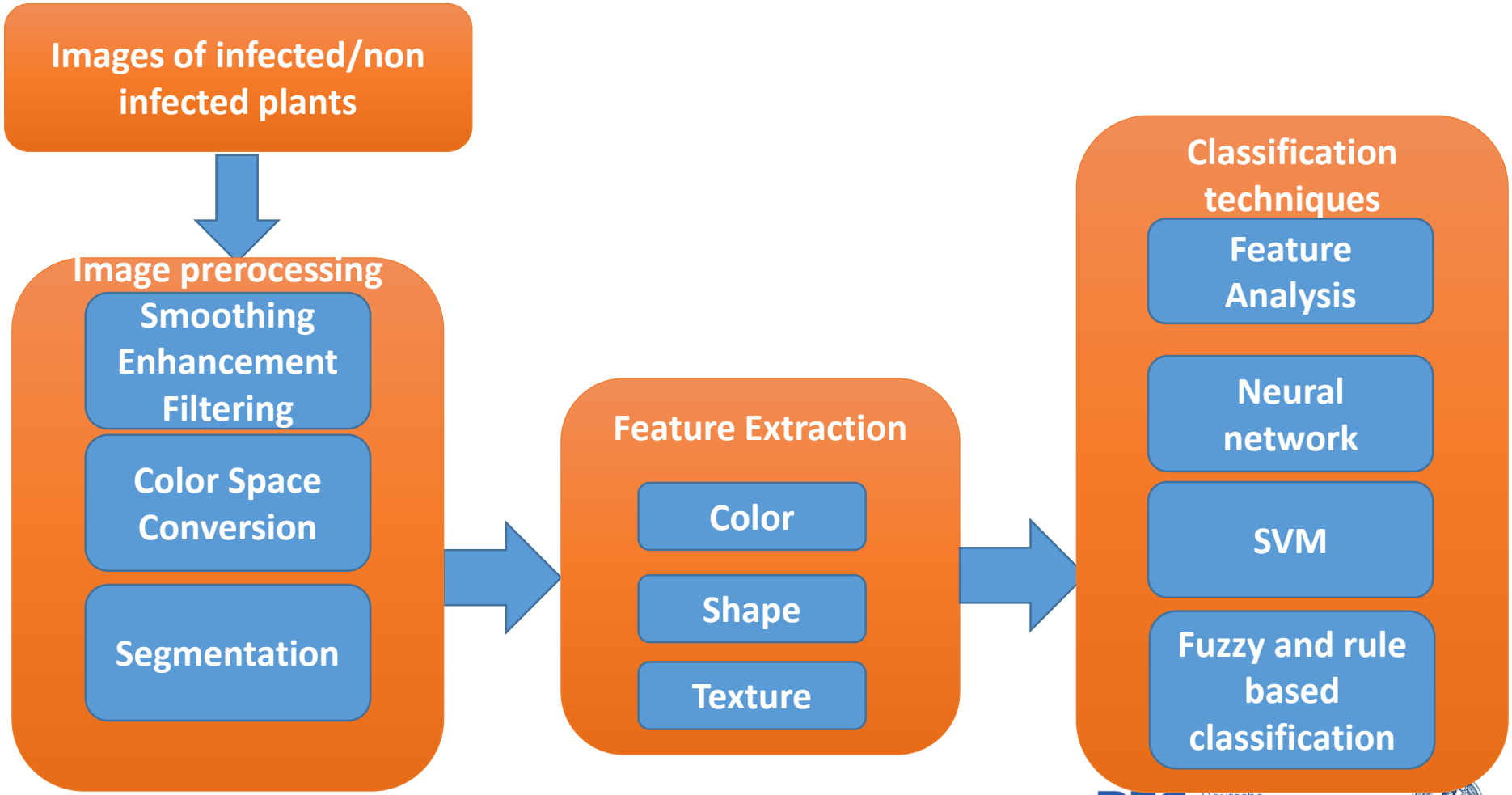
- Motivation & Introduction
- Plant disease identification steps
- Proposed system
- Experimental results

DFG Deutsche Forschungsgemeinschaft

seit 1558

Plant disease identification: General steps

AquaDiva
collaborative research center 1076



DFG Deutsche Forschungsgemeinschaft

seit 1558

Limitations

- Fails in case of image with complex background, size and orientation
- Illumination conditions : Most of these methods will fail to extract the leaf from its background
- Color based methods and thresholding techniques may affect the disease identification in case of symptoms with not well defined edges and fade into healthy tissue

Limitations

- Methods relying on hand-crafted features such as color histograms, texture features and shape features do not generalize well.
  - Large amount of data could contain significant varieties.
  - Most of the diseases produce **heterogeneous symptoms**
  - Detect the disease effectively under difficult conditions of **illumination**, complex **background**, different **resolutions**, **size**, **pose** and **orientation**

Example of symptoms with no clear edges.

Example of a leaf image with specular reflections and several light/shadow transitions.

Variation in symptoms of Southern corn leaf blight disease

Outline

AquaDiva
collaborative research center 1076

- Motivation & Introduction
- Plant disease identification steps
- Proposed system
- Experimental results

DFG Deutsche Forschungsgemeinschaft

seit 1558

Banana leaves diseases

Black Sigatoka

Banana Speckle

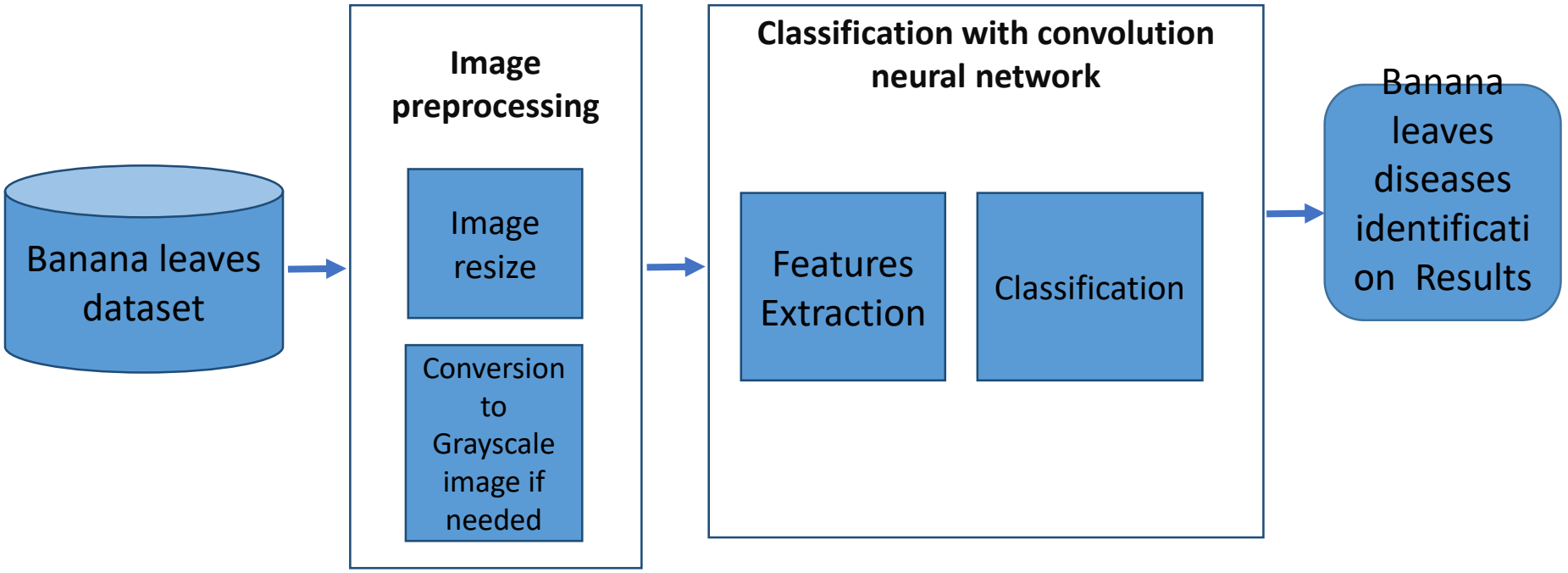
A new database developed by Hughes and Salathe (2015)
more than 50,000 images of healthy and diseased plants are being made available (https://www.plantvillage.org/)

The use of **Deep Convolution Neural Network** for object detection and classification has led to significant gain in accuracy.

Application of CNN for plant diseases classification to :

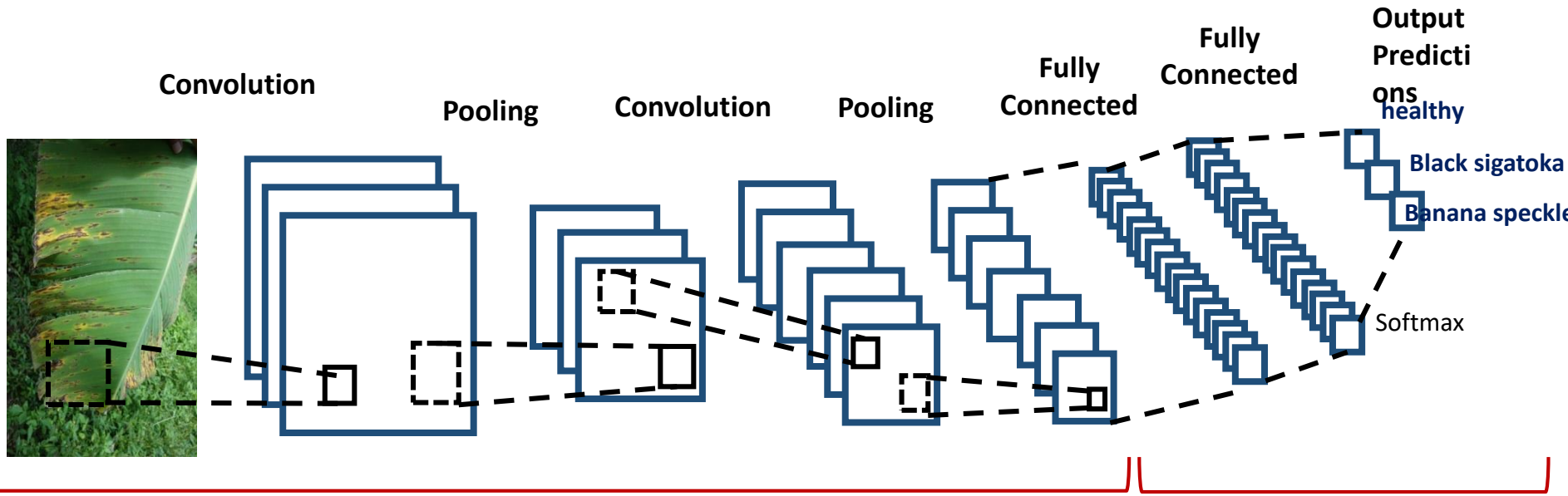
- Get promising results
- Avoid the hand-crafted features
- Stand on self-taught features reducing consequently the dependency to their extraction techniques

Proposed method



Proposed method

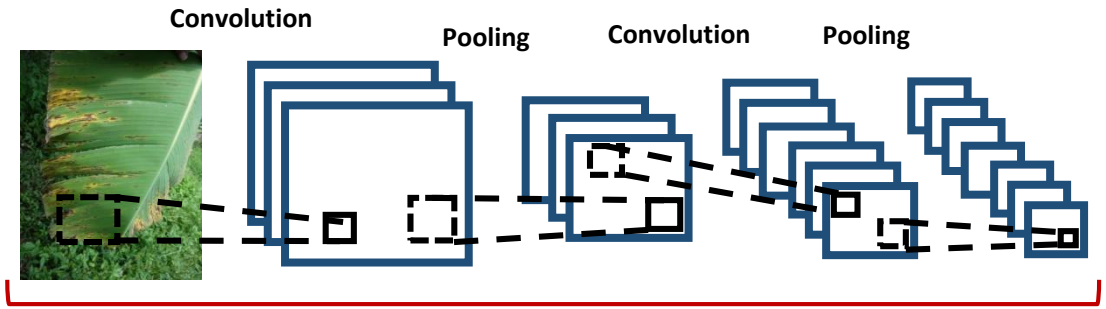
AquaDiva
collaborative research center 1076



DFG Deutsche Forschungsgemeinschaft

seit 1558

Feature Extraction model



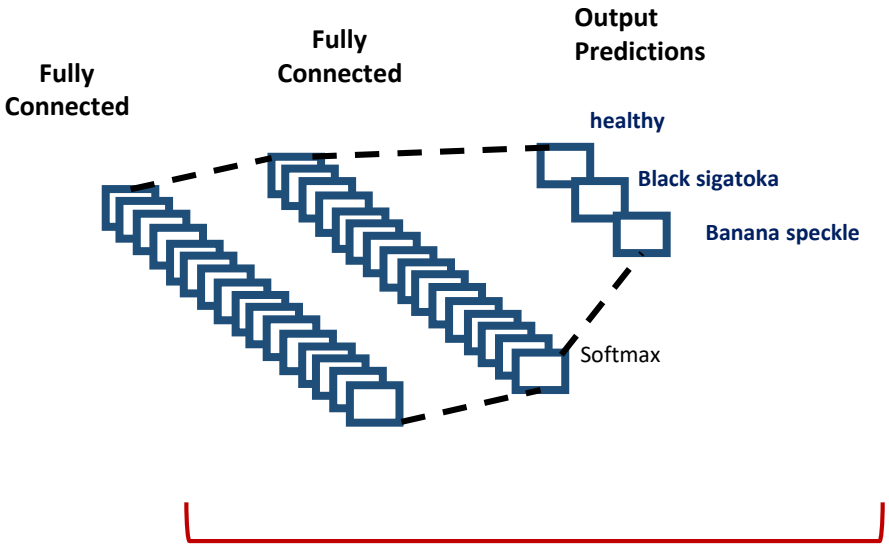
$$M_i = b_i + \sum_k W_{ik} \star X_k$$

where $\star$ is the convolution operator, X_k is the k^{th} input channel, W_{ik} is the sub kernel of that channel and b_i is a bias term.

Max-pooling map : A layer of sub-sampling reduces the size of the convolution maps, and introduces invariance to (low) rotations and translations that can appear in the input.

Rectified nonlinear activation functions (ReLU) -> f(x)=max(0, x) where x is the input to a neuron

Classification Model



$$y_c = \varsigma(\mathbf{z})_c = \frac{e^{z_c}}{\sum_{d=1}^{C} e^{z_d}} \quad for\ c = 1 \cdots C$$

The softmax function ς takes as input a C-dimensional vector Z and outputs a C-dimensional vector y of real values between 0 and 1.

Outline

AquaDiva
collaborative research center 1076

- Motivation & Introduction
- Plant disease identification steps
- Proposed system
- Experimental results

DFG Deutsche Forschungsgemeinschaft

seit 1558

Experimental results

AquaDiva
collaborative research center 1076

Three annotated class for banana image leaf (**https://www.plantvillage.org/**)

Healthy (1643)

Black sigatoka (725)

black speckle (1332)

Experimental results

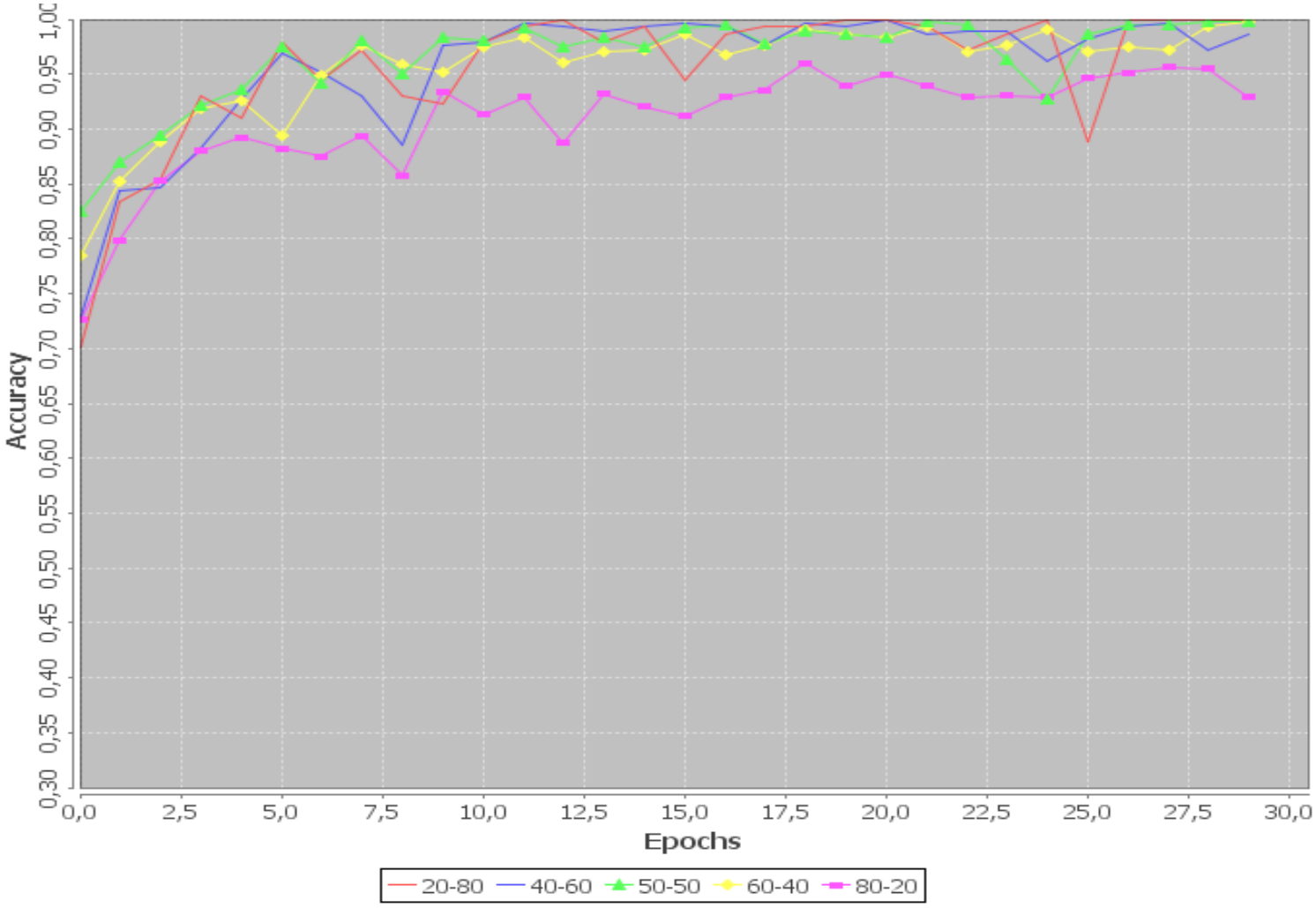
AquaDiva
collaborative research center 1076

		Color				Gray Scale			
Train	**Test**	**Accuracy**	**Precision**	**Recall**	**F1score**	**Accuracy**	**Precision**	**Recall**	**F1score**
20%	80%	0.9861	0.9867	0.986	0.9864	0.9444	0.9479	0.9444	0.9462
40%	60%	0.9861	0.9865	0.9859	0.9863	0.9757	0.9764	0.975	0.976
50%	50%	0.9972	0.9970	0.9972	0.9971	0.8528	0.889	0.8527	0.8705
60%	40%	0.9676	0.969	0.9677	0.9683	0.9282	0.9314	0.9283	0.9298
80%	20%	0.9288	0.9299	0.9288	0.9294	0.8594	0.8678	0.8594	0.8636

DFG Deutsche Forschungsgemeinschaft

Experimental results

AquaDiva
collaborative research center 1076



DFG Deutsche Forschungsgemeinschaft

seit 1558

Conclusion

AquaDiva
collaborative research center 1076

- Agriculture suffers from a severe problem, plant diseases, which reduces the production and quality of yield.
- The shortage of diagnostics tools in underdeveloped countries has a devastating impact on its development and quality of life.
- We present an approach based on convolution neural network to identify and classify two famous banana diseases which are banana sigatoka and banana speckle in real scene and under challenging conditions such as illumination, complex background, different images resolution, size, pose and orientation.

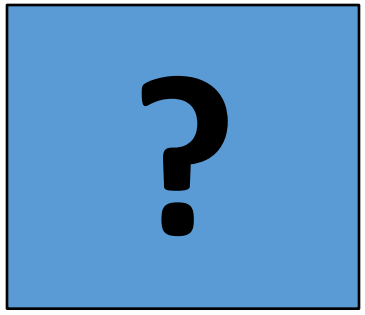
DFG Deutsche Forschungsgemeinschaft

Conclusion

- After several experimentations our system was able to find good classification results.
- We intend in our future work to test more banana and plants diseases with our model. Besides, we will target the **automatically severity estimation** of the detected disease since it is an important problem that can help the farmers in deciding how to intervene to stop the disease.

AquaDiva
collaborative research center 1076

Thank you for your attention

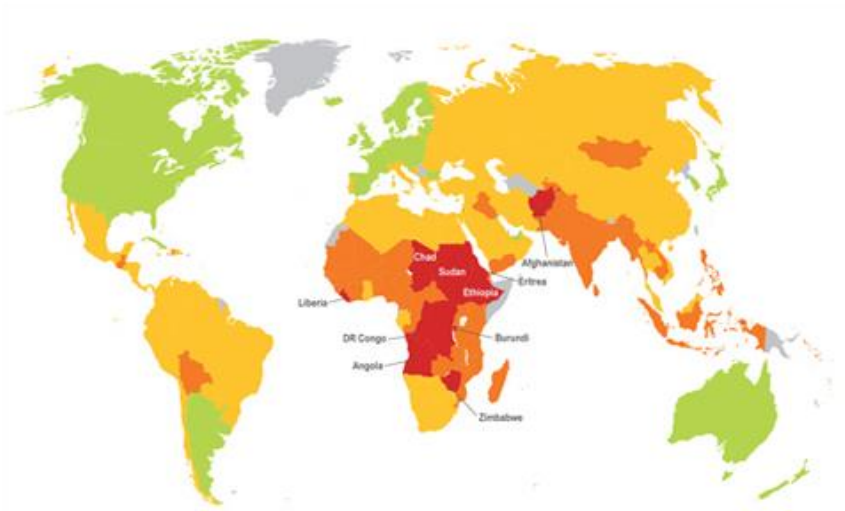


DFG Deutsche Forschungsgemeinschaft

seit 1558

Motivation

AquaDiva
collaborative research center 1076



Legend	
Extreme risk	
High risk	
Medium risk	
Low risk	
No Data	

Rank	Country	Rating
1	Afghanistan	Extreme
2	DR Congo	Extreme
3	Burundi	Extreme
4	Eritrea	Extreme
5	Sudan	Extreme

Rank	Country	Rating
6	Ethiopia	Extreme
7	Angola	Extreme
8	Liberia	Extreme
9	Chad	Extreme
10	Zimbabwe	Extreme

Food Security.

Food Security Risk Index 2010

- The WHO defines three facets of food security:
  - food availability (= sufficient quantities)
  - food access (= sufficient resources)
  - food use (=appropriate use based on knowledge of basic nutrition and care)
- The FAO adds a fourth facet: the stability of the first three dimensions of food security over time

http://www.libelium.com/food_sustainability_monitoring_sensor_network/

DFG Deutsche Forschungsgemeinschaft

seit 1558