

Specifications

15. November 2019

1 Preface

2 Goal

The goal is a software which performs image classification and is able to switch between deploy platforms and working modes. It also should have a GUI to control the software and to show the results.

3 Product use

Image classification

4 Acceptance criteria

4.1 Must

AC30 Different operating modes

The software has three modes. One mode for high performance, one for low power consumption and one for high energy efficiency.

AC50 Performance and power consumption prediction

The software can predict the performance with a certain powerconsumption an also the powerconsumption for a certain performance.

MAC010 : Image classification

MAC020 : Running NN on heterogenous platforms, CPU and FPGA
MAC030 : Different operating modes
MAC040 : GUI for interacting with software
MAC050 : Performance/power prediction

4.2 Can

KAC060 : Training a nn for classification
KAC070 : Illustration of a topology of the nn
KAC080 : Object detection
KAC090 : Choosing between different models
KAC100 : Creating new models
KAC110 : Voting of multiple nn
KAC120 : Using video for classification
KAC130 : Using camera for classification input
KAC140 : Running NN on GPU

5 Functional Requirements Must

MFR025 : Dispatching the calculation process defined from the mode
MFR030 : Support CPU for calculation
MFR031 : Support FPGA for calculation
MFR040 : Communication between Host-PC and platform
MFR041 : Send image for classification
MFR042 : Receive result
MFR050 : GUI
MFR060 : Showing results

- MFR010 Use neural network for image classification**
A neural network should be used in order to classify images based on what is shown on them. For each image a list of possible classes it could belong to along with degree of confidence should be given as output.
- MFR011 Deploy pre-trained neural network with the corresponding layers**
A pre-trained neural network should be deployed to with all the corresponding layers in order to fulfill MFR010.
- MFR020 Have high performance operating mode**
An option to perform calculations fast with low regard for power consumption.
- MFR021 Have low power consumption operating mode**
An option to perform calculations with low power consumption and low regard for speed.
- MFR022 Have high energy efficiency operating mode**
An option to perform calculations at an adequate balance between speed and power consumption.
- MFR023 Calculator for power consumption**
Calculations for the possible power consumption running the image classifications would result in based on the neural network, platform and operating mode used.
- MFR024 Calculator for performance**
Calculations for the possible performance running the image classifications would result in based on the neural network, platform and operating mode used.
- FR070 Choosing image for classification**
Testet with: Implements:
The GUI has a button with an on click event which opens a file explorer. The explorer filters the files so that only files of the format .jpg, .png, .bmp are listed. That also are the only valid formats.
- FR080 Choosing platform/hardware**
Testet with: Implements:
The GUI has a dropdown which lists the devices on which the classification can be done. The devices which can be theoretically be accessed but aren't connected to the host pc or the communication with them doesn't work are grayed out.
- FR090 Choosing mode**
Testet with: Implements:
The GUI has dropdown which lists the modes (high performance mode, low power consumption mode and best energy efficiency mode). The power consumption in Watts and performance in FLOPs are also stated behind the mode names.

6 Functional Requirements Can

CFR012 Reading and parsing neural network configuration/weight file
Having the ability to import/export different (external) neural networks to use for the image classification.

FR100 Choosing between different models
Testet with: Implements:
The GUI has a button which opens the file explorer which filters for .txt files, there you choose the config file of the neural network with which you want to use. The program loads this config and parses it so it can be deployed. Possible models are GoogLeNet or AlexNet.

FR110 Train nn for classification of imageset (with transfer learning)
Testet with: Implements:
The user chooses a pretrained neural network and a new imageset and then can train the neural network on this new imageset with transfer learning.

KFR111 : Saving new trained nn (config an weights)
KFR112 : Choosing/Reading data set
KFR032 : Support GPU for calculation
KFR113 : Backpropagation
KFR114 : Choosing parameters like learning rate
KFR120 : Illustrating nn topology
KFR130 : Object detection algorithm
KFR131 : Showing detected object
KFR132 : Choosing between detection and classification mode
KFR140 : Creating new topology
KFR150 : Choosing between training and inference mode
KFR160 : Choosing video in format .avi
KFR161 : Apply classification for a certain amount of frames
KFR170 : Connect with camera
KFR171 : Receive video stream from camera
KFR180 : Detecting object
KFR181 : Drawing bounding box

7 Productdata

- PD010 Images for classification**
The user can choose images of the format .jpg, .png, .bmp. The images are chosen by the user with the file explorer.
- PD020 Config/weight file of pretrained model**
It is a .cfg file. In the beginning are hyperparameters described with the format *name = value*. Then the layers are described in their order with the following format
[kind of layer]
list of parameters in the format *name = value*
- PD030 Labeled image set for classification training**
The dataset is chosen by the user. The dataset is a directory with images and the name of the image is the label.
- PD040 Labeled set of images for object detection training**
It is a .txt file and a directory with images. The images are labeled with their name. The bounding box for each image are described in the .txt file, in the format *imagename, x,y,width,height*. (X,Y) are the coordinates in pixel of the left bottom corner, the width and height are in pixel.

8 Demarcation

- D010 : No real time / no performance optimization
D020 : No mobile support
D030 : No neural network size optimization
D040 : No low-level (Assembler) optimization

9 Non-functional requirements

- NF10

10 Test cases

T010	Use neural network for image classification State: A image is given as an input. Action: Calculations are performed on hand of the image and a neural network. Reaction: A list of possible classes the given image could belong to along with degree of confidence for each class are given as output.
T011	Deploy pre-trained neural network with the corresponding layers State: There is a neural network (already trained). Action: Calculations are performed cased on a given image and the given neural network. Reaction: A list of possible classes the given image could belong to along with degree of confidence for each class are given as output.
T012	Reading and parsing neural network configuration/weight file
T012.1	State: The user is on the page to select a neural network to use for the image classification. Action: The user selects the option to import a neural network. Reaction: The file explorer opens.
T012.2	State: The file explorer is open Action: The user selects an neural network to import Reaction: The file explorer closes and neural network is imported and selected for the classification calculations.
T020	Have high performance operating mode State: The user is ready to start the calculations. Action: The user chooses to perform the calculations in high performance operating mode. Reaction: The calculations run considerably faster than in the other possible modes with the same conditions.
T021	Have low power consumption operating mode State: The user is ready to start the calculations. Action: The user chooses to perform the calculations in low power consumption operating mode. Reaction: The calculations run with considerably lower power consumption than with the other possible modes in the same conditions.
T022	Have high energy efficiency operating mode State: The user is ready to start the calculations. Action: The user chooses to perform the calculations in high energy efficiency operating mode. Reaction: The calculations run with regard to balance between power consumption and speed. 7
T070	Choosing image for classification
T070.1	State: The user is on the page for image classification Action: The user clicks on the button „Choose image“. Reaction: The file explorer opens with the filter for .png, .jpg, .bmp
T070.2	State: The file explorer is open Action: The user selects an image with a valid format Reaction: The file explorer closes and image is as preview shown

11 System models

11.1 Scenarios

11.2 Usecases

11.3 GUI

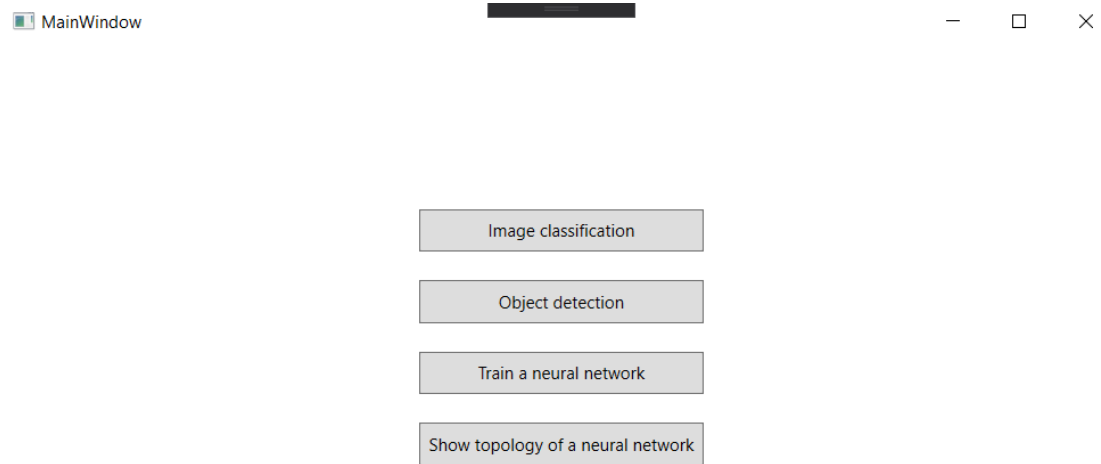


Abbildung 1: Main page of our software

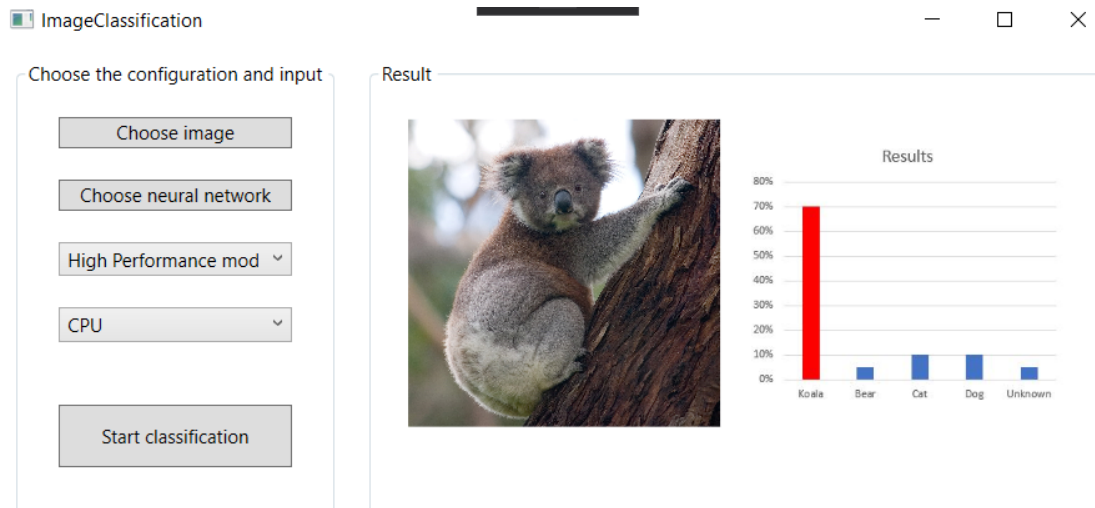


Abbildung 2: Image classification page of our software

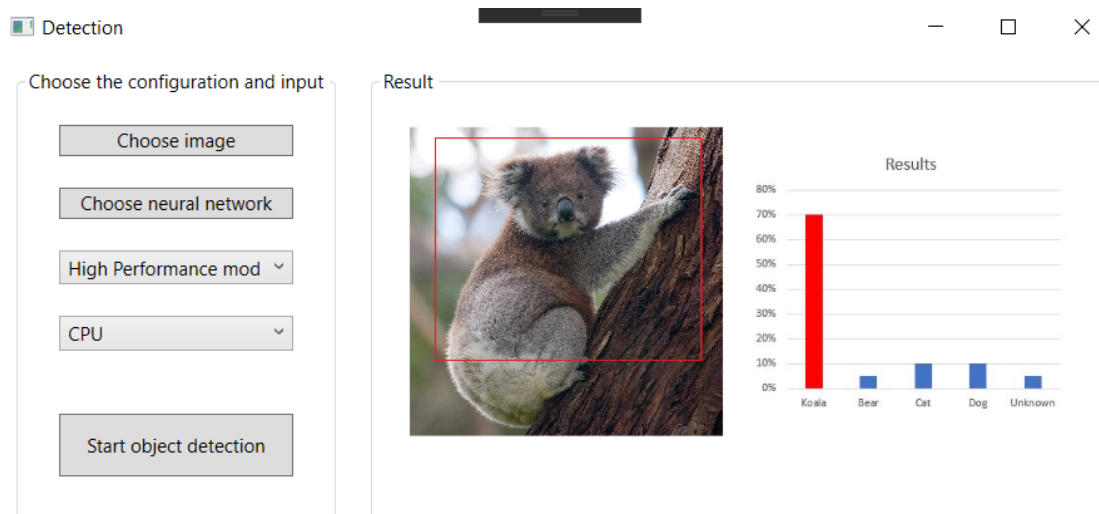


Abbildung 3: Object detection page of our software

Glossar

image a two dimensional matrix of red,green,blue (RGB) values that can be visualized as each cell represents a single pixel on the monitor. (ex.: a photo).

neural network a network or a circuit of neuron used for information processing inspired by the way biological neural systems process data.

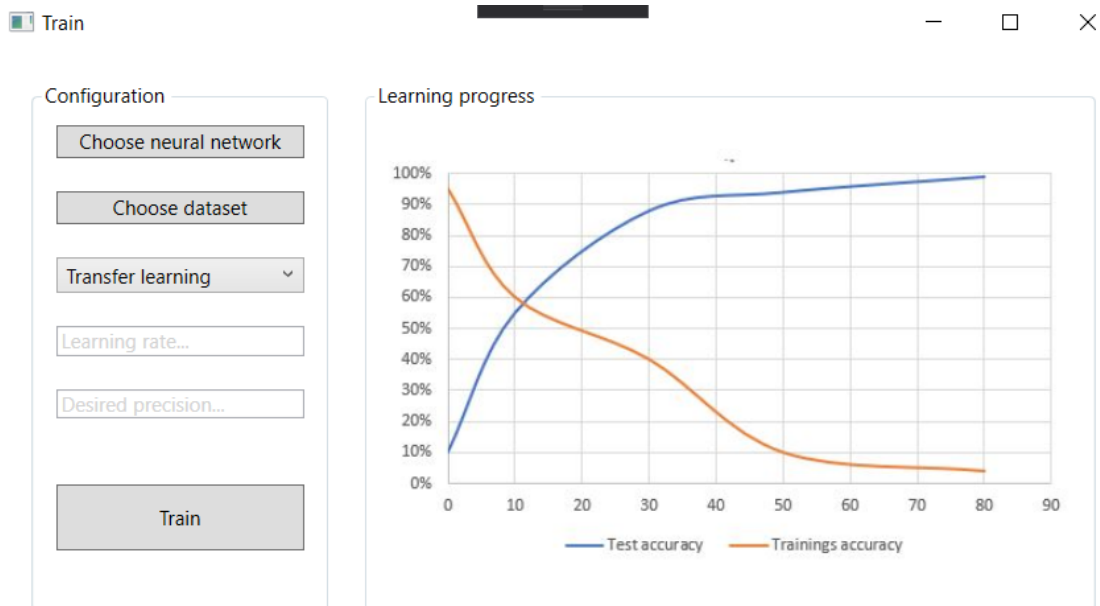


Abbildung 4: Training page of our software

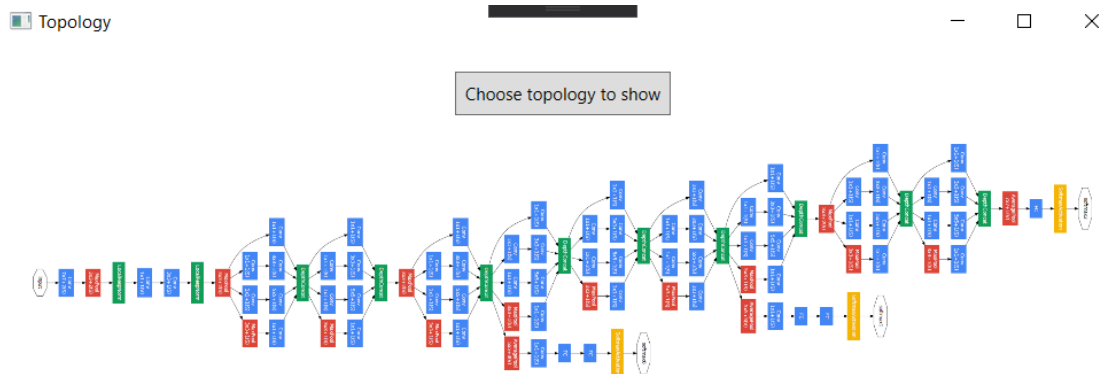


Abbildung 5: Page which shows the topology of a selected NN of our software