User Manual
DLV Software (Version 0.1)

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This document provides instructions on how to install and use the software DLV (abbreviated for Deep Learning Verifier) version 0.1.

NB: The document will be updated. Please come back and check to see more details.

1 Installation

The software is dependent on the following packages:

- Python 2.7, which is the shipped version in Mac OSX version 10.11.5.
- Theano, version 0.8.2, which can be installed with the following command:

```
pip install Theano
```

- Keras, which can be installed with the following command:

```
pip install keras
```

The software may require other python libraries such as opencv, numpy, math, etc.

2 Usage

The following command can be used to call the program:

```
python main.py
```

Please use the file "configuration.py" to set the parameters for the system to run. More instructions on how to adapt the parameters will be given in Section **??**.

3 Neural Network Models

The software has been configured to work with four neural network models. For the first three models, one may either train a model first and then verify or verify a pre-trained model included in the package without training. For the last model, one can only work with a pre-trained model downloaded from internet (link provided below): it is impractical to train the model since there is no data available for training and the training may take months of time.

3.1 A Classification Network for A Pre-defined 2D Curve

The network structure and the parameters for training can be found in file "twoD-curve_network.py".

3.2 A Classification Network for MNIST Handwritten Dataset

The source file for training the network is downloaded from the following link:

https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

3.3 A Classification Network for CIFAR-10 Small Image Dataset

The source file for training the network is downloaded from the following link:

https://github.com/fchollet/keras/blob/master/examples/cifar10_cnn.py

3.4 A Classification Network for ImageNet Dataset

One needs to download the VGG16 pre-trained model from the following link

https://gist.github.com/baraldilorenzo/07d7802847aaad0a35d3

Moreover, the images need to be in the directory networks/imageNet/, and change the corresponding paths in networks/imageNet_network.py

4 Parameters

In this section, we explain how to adapt the parameters for experiments.

task defines the task for execution. In current release, there is only one option.

task = "safety_check"

dataset defines which neural network to work with. One of the following lines should be included and other three lines are commented out by prefixing a symbol #.

dataset = "twoDcurve"
dataset = "mnist"
dataset = "cifar10"
dataset = "imageNet"

experimental_config defines whether to choose the default experimental setting specified in the file "usual_configuration.py". One of the following lines should be included and the other commented out.

experimental_config = True
experimental_config = False

whichMode defines the execution mode: "train" means that the neural network will be trained first and then be verified; "read" means to verify directly the pre-trained neural network. The trained model is stored in their individual directories, e.g., networks/mnist/ for MNIST dataset and networks/cifar10/ for CIFAR-10 dataset. One of the following lines should be included and the other commented out.

whichMode = "read"
whichMode = "train"

dataProcessing defines how to process examples: "single" means that only the example whose index is specified in the parameter *startIndexOfImage* will be processed; "batch" means that a set of *n* examples will be processed, starting from the example whose index is specified in the parameter *startIndexOfImage*. The number *n* is specified in parameter *dataProcessingBatchNum*. One of the following lines should be included and the other commented out.

dataProcessing = "single"
dataProcessing = "batch"

dataProcessingBatchNum defines the number of examples to be processed in a single execution of the program if *dataProcessing* is set to be "batch".

dataProcessingBatchNum = 200

span defines the size of a span for manipulation in a dimension. Together with the parameter *numSpan*, it defines the size of a dimension to work with. Please refer to the paper for the detailed explanation of this parameter.

span = 255/float(255)

numSpan defines the number of spans to be considered for defining the size of a dimension.

numSpan = 1.0

featureDims defines the number of dimensions for a feature.

featureDims = 5

startIndexOfImage defines the index of an example from the test data set. For MNIST data set, it is in [0,9999].

startIndexOfImage = 197

startLayer defines the first layer to start verifying. Note that, for both MNIST, CIFAR-10, and ImageNet networks, *startLayer* = 0 suggests the first hidden layer.

startLayer = 0

maxLayer defines the deepest layer to verify until.

maxLayer = 0

numOfFeatures defines the number of features to be considered when verifying a layer.

numOfFeatures = 40

checkingMode defines how to verify layer by layer: for “specificLayer”, it directly verifies the one specified in *maxLayer*; for “stepwise”, it starts from the layer *startLayer* and work layer by layer until completing the *maxLayer*.

checkingMode = “specificLayer”
checkingMode = “stepwise”