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Experiment No-1

Title

Installation of Anaconda and introduction to Tenserflow and Keras.

Objectives:

At the end of this practical session, student will be able to setup an environment for developing Deep Learning models.

Theory:

A. Anaconda

Anaconda is a free and open-source distribution of the Python for scientific computing (data science, machine learning applications, large-scale data processing), that aims to simplify package management and deployment. In it, Package versions are managed by the package management system conda. The Anaconda distribution includes more than 1500 popular data-science packages.

Anaconda distribution comes with Anaconda Navigator, which is alternative to the command line interface (CLI), Anaconda Navigator is a desktop graphical User Interface (GUI) that allows users to launch applications & manage conda packages, environments & channels without using CLI commands. Navigator can search for packages on Anaconda Cloud or in a local Anaconda Repository, install them in an environment, run the packages & update them. It is available for windows, macOs & Linux.

B. Tenserflow

Tenserflow is an end-to-end open source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, and community.

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resources that lets developers to build and deploy ML powered applications easily. It has an open source software library used for numerical computations using data flow graphs. Nodes in graph represents computations or operations while edges represents data or tensors. Tenserflow takes 2 steps for building a graph based model.

1. Specify the operation and data to develop a static graph.
2. Execute the graph to get the final result.

C. Keras

Keras is a deep-learning framework for Python that provides a convinient way to define and train any kind of deep-learning model.

Key features:

- It allows the same code to run seamlessly on CPU or GPU.
- It has a user-friendly API that makes it easy to quickly prototype deep-learning models.
- It has built-in support for convolutional networks (for computer vision), recurrent networks (for sequence processing), and any combination of both.
- It supports arbitrary network architectures: multi-input or multi-output models, layer sharing, model sharing and so on.

Keras provides high-level building blocks for developing deep-learning models but it doesn't handle low-level operations such as tensor manipulation & differentiation. So keras relies on a specialized, well-optimized tensor library to do tensor manipulation, serving as the backend engine of Keras.

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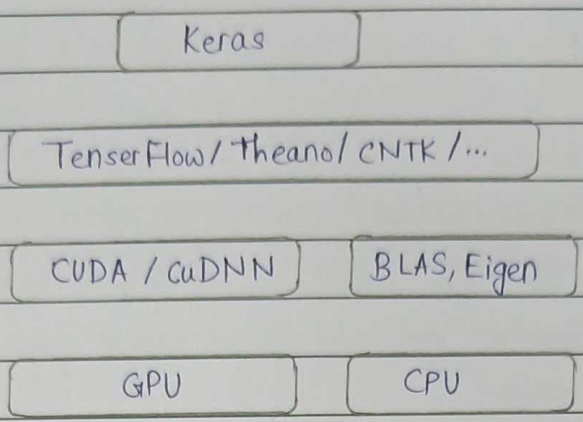

Keyword: Anaconda, Tenserflow, Keras

Procedure:

1. Install Anaconda on your machine
2. Create new environment in anaconda using anaconda navigator.
3. Install a tenserflow library in that environment.
4. Develop following graph using tenserflow.
5. Execute graph using tf. Session().
6. Install Keras library in same environment.
7. Import keras and execute cell in jupyter notebook.

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Experiment No - 2

Title

Design and develop a shallow neural network to classify fashion products from Fashion MNIST Dataset.

Objective

At the end of this practical, we will be abel to develop a shallow neural network using Keras after designing a neural network for digit classification.

Keras workflow for building model is as follows:

1. Define your training data: input and actual output

Keras comes with many preloaded dataset like CIFAR10, CIFAR100, IMDB Movie reviews, and MNIST database of handwritten digits. These datasets provide training and testing set for classification task. We can load these dataset using load_data() for training and testing purpose. If we have our own dataset then it can also be given to a neural network after preprocessing.

2. Define a network of layers (or model) that maps your inputs to your targets.

A model is the core data structure of Keras. It represents a way to organize layers. The simplest type of model is the sequential model. It is a linear stack of layers. Sequential model can be defined as: model = Sequential(). Layers in model can be added in stack using model.add(). In layers some data goes in, and it comes out in a more useful form. These layers in Keras like Dense, Dropout, Flatten, Conv1D, Conv2D, MaxPooling1D, RNN, SimpleRNN, CRV, and Embedding.

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3. Configure the learning process by choosing a loss function, an optimizer, and some metrics to monitor.

Once model definition looks good, its learning process need to be configured for training. Configuration generally includes three components: loss function, Optimizer function and metrics.

Loss function measures the performance of training data. It guides model to right direction. Optimizer function provides a mechanism through which the network will update itself based on the data it sees and its loss function. Metrics generally concentrates on accuracy. It measures fraction of correctly classified things.

4. Iterate on your training data by calling the fit() method of your model.

1. Draw a batch of training samples x and corresponding targets y.
2. Run the network on x (a step called the forward pass) to obtain predictions y-pred.
3. Compute the loss of the network on the batch that is measure of the mismatch between y-pred & y.
4. Update all weights of the network in a way that slightly reduces the loss on this batch.

Evaluation of model is done on testing data with evaluate().
It returns loss and accuracy over testing set.

Keyword:
Shallow Neural Network
ML, Keras.

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Procedure:

1. Design a shallow neural network for classifying fashion product available in fashion MNIST dataset.
2. Load MNIST dataset and get training and testing images.
3. Create a model that maps your inputs to your targets.
4. Configure the learning process by choosing a loss function, an optimizer, and some metrics to monitor.
5. Iterate on your training data by calling the fit() method on your model.
6. Evaluate model on testing data to check model's accuracy.

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Experiment No - 3

Title :

Design and develop a deep feed forward neural network to classify fashion products from Fashion MNIST dataset.

Objective:

We will be able to develop a deep neural network using Keras after designing a neural network for digit classification.

Theory :

A. introduction :

With classical ML approaches, it can be very difficult to extract high-level, abstract features from raw data due to variation in different factors. e.g. speaker's accent in audio data, position of cat in images. Deep learning solves this central problems in representation learning by introducing representations that are expressed in terms of other, simpler representations. Deep learning allows the computer to build complex concepts out of simpler concepts with the help of hierarchical layered representation as shown. This shows how a deep learning system can represent the concept of an image of a person by combining simpler concepts, such as corners and contours, which are in turn defined in terms of edges.

B. Learning in Deep Learning Models:

Learning means finding a set of values for the weights of all layers in a network, such that the network will correctly map example inputs to their associated targets. To control the

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output of a neural network, you need to be able to measure how far this output is from what you expected. This is the job of the loss function of the network, also called the objective function.

The fundamental trick in deep learning is to use this score as a feedback signal to adjust the value of the weights a little, in a direction that will lower the loss score for the current example. The working of deep learning model is summarized.

C. Building Deep learning mode in Keras.

The quintessential example of a deep learning model is the feedforward deep network or multilayer perception (MLP). A multilayer perception is just a mathematical function mapping some set of input values to output values.

Models in Keras are defined as sequence of layers.

Keywords: Deep Neural Network, ML, Keras

Procedure:

1. Design a deep neural network for classifying fashion product's MNIST dataset.
2. Load dataset & get training & testing images.
3. Create model that you designed for mapping inputs to target output.
4. Configure choosing process by choosing loss function, optimized & some metrics to monitor.
5. Iterate on your training data by calling fit() method.
6. Evaluate model on testing data to check model's accuracy.

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Experiment No - 4

Title:

Identifying effect of different hyperparameters and parameters on neural network in optimization task.

Objective:

At the end of practical, we will be able to optimize a deep neural network by tuning different hyperparameter after building deep learning model.

Theory:

1. Manually setting values

In this method, we have to set hyperparameter values manually. Based on output we have to update the hyperparameter values for next run. In keras, epochs and batch size are set as an argument to model.fit(). While other hyperparameters are set with optimizers module, e.g. setting hyperparameter for SGD optimizer can be done as follows:

sgd = optimizers.SGD (lr = 0.01, decay = 1e-6, momentum = 0.9, nesterov = True.

2. Grid Search method

Grid search is a traditional way to perform hyperparameter optimization. It works by searching exhaustively through a specified subset of hyperparameters. Using sklearn's GridSearchCV, we first define our grid of parameters to search over and then run the grid search.

3. Random Search method.

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Random search searches the specified subset of hyperparameters randomly instead of exhaustively. The major benefit being decreased processing time. There is a tradeoff to decreased processing time, however, It did not guarantee to find the optimal combination of hyperparameters. Sklearn's RandomizedSearchCV provides searching space in random search.

Keyword:
Deep learning model, Neural Network, Keras.

Procedures:
1. Develop a deep learning model using Keras library.
2. Manually setting values:
   a. Set different hyperparameter with some values.
   b. Identify effect of different hyperparameter values on neural network.
   c. Display hyperparameters that provides accurate result.
3. Using grid search method
   a. Define a grid to specify search space for different hyperparameter.
   b. Display the best set of hyperparameter to get accurate result.

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Experiment No-5

Title

Design and develop a model for predicting house prices.

Objective:

We will be able to predict the house prices with regression based Deep learning Model.

Theory:

1. Regression:

Regression is a method of modeling a target value based on independent predictors. This method is mostly used for forecasting and finding out cause and effect relationship between variables. It consists of predicting a continuous value instead of a discrete lable: For Instance, predicting the temperature tomorrow, given meteorological data; or predicting the time that a software project will take to complete, given its specification.

2. K-cross validation:

A neural network is evaluated by adjusting its parameters. For this dataset, is divided into a training set and a validation set. But, with a few datapoints in dataset, the validation set would end up being very small. As a consequence, the validation scores might change a lot depending on which data points you chose to use for validation and which you chose for training. This would prevent you from reliably evaluating your model. The best practice in such situation is to use K-fold cross-validation as shown.

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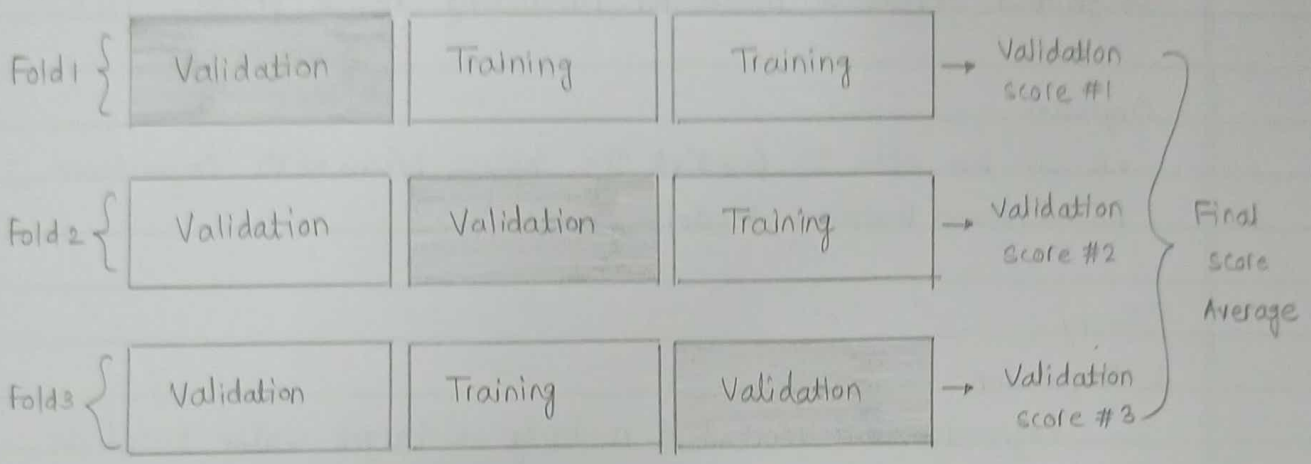
Fold 1
Validation
Training
Training
Validation score #1
Fold 2
Validation
Validation
Training
Validation score #2
Fold 3
Validation
Training
Validation
Validation score #3
Final score Average

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It consists of spilling the available data into K partitions (typically K=4 or 5), instantiating K identical models, and training each one on K-1 partitions while evaluating on the remaining partition.

The validation score for the model used is then the average of the K validation scores obtained.

Keyword :

Regression, K-fold validation.

Procedure :

1. Load boston housing price dataset from Keras databases
2. Prepare the data by normalizing the input features.
3. Design the network for predicting house prices.
4. Build the network neural.
5. Validate approach using K-fold validation.
6. Build the history of successive mean K-fold validation.
7. Plot validation scores.

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Experiment No. - 6

Title:

Design and develop a convolutional network for image classification.

Objective:

We will be abel to classify objects in different classes using convolutional neural network (CNN / ConNet).

Theory:

Convolutional neural network are a specialized kind of neural network for processing data that has a known, grid-like topology. Examples include time-series data, which can be thought of as a 1D grid taking samples at regular time intervals, and image data which can be thought of as a 2D grid of pixels.

It includes two types of layers namely convolutional layer and pooling layer. Primary purpose of convolution layer in CNN is to extract features from the input image by applying convolution operation. It is a point wise multiplication of image part and sliding window (convocute/kernel) over an image. The response is called as feature map or activation map or convoled features. It learns spatial hierarchies of patterns and these patterns are invarient - The pooling layer progressively reduces the size of representation to reduce the amount of parameters and computation in the network.

It also helps to consider the important features for object classification and discard the remaining.

stride is another important property with convolution operation. It represents distance between two successive sliding

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windows over the image. Default it is set to one. But, it is also possible to have stried convolutions where kernel convolutions with a stride higher than 1.

Convolutions operate over 3D tensors. Two spatial (Height and width) and one depth axis (also called as channels). In case of RGB image of size 1200 x 870, input size will be either (1200, 870, 3) or (3, 1200, 870)

Keyword:
Convolutional Neural Network, Object classification.

Procedure:
1. Load CIFAR-10 dataset
2. Preprocess the image
   a. Normalize the input image
   b. Convert actual output to one hot encoding.
3. Design your CNN model.
4. Build model and optimize during different hyperparameter.
5. Track history of training and validation
6. Plot graph.

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Experiment No-7

Title

Using pre-trained convolutional neural network for image classification

Objectives:

We will be able to classify objects in different classes by using pre-tained convolutional neural network.

Theory:

A pretrained network is a saved network that was previously trained on a large dataset, typically on a large-scale image-classification task. If this original dataset is large enough and general enough, then the spatial hierarchy of features learned by the pre-trained network can effectively act as a generic model of the visual world, and hence its features can prove useful for many different computer vision problems, even though these new problems may involve completely different classes than those of the original task. For instance, you might train a network on ImageNet (where classes are mostly animals and everyday objects) and then response this trained network for something as remote as identifying furniture items in images. Such portability of learned features across different problems is a key advantage of deep learning compared to many older, shallow-learning approaches, and it makes deep learning very effective for small-data problems. There are two ways to use a Pretrained network

1) Feature extraction
2) Fine-tuning.

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Feature extraction consists of using the representations learned by a previous network to extract interesting features from new samples. These features are then run through a new classifier, which is trained from scratch.

Fine-tuning consists of unfreezing a few of the top layers of a frozen model base used or feature extraction, and jointly training both the newly added part of the model and these top layers. This is called fine-tuning.

Keyword:

CNN, Pre-trained model.

Procedure:

1. Instantiate the VGG16 convolutional base.
2. Extract features using the pretrained convolutional base.
3. Define and train the densely connected classifier
4. Plot the results.

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Experiment No - 8

Title:

Design and develop a model for identifying sentiment of twitter dataset.

Objective:

We will be able to classify reviews in different sentiment classes using sequential model.

Theory:

Text data is the sequential data and can be understood as either a sequence of characters or a sequence of words. Recurrent neural networks or RNNs are a family of neural networks used for processing sequential data. It is specialized for processing a sequence of values $x_1, x_2, \ldots, x_t$ at timestamp 1, 2, ---, t timestamp. For sequential data processing, it shares parameters across different parts of a model. Parameter sharing makes it possible to extend and apply the model to examples of different forms (different lengths) and generalize across them.

Deep learning models do not take input as a raw text. They only work with numeric tensors. So text need to be converted into vector. Vectorizing text is the process of transforming text into numeric tensors. The different units into which you can break down text (words, characters, or n-grams) is called as Token. Tokenization process develop tokens from text. All text-vectorization process consist of applying some tokenization scheme and then associating numeric vectors with

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generated tokens.

Sentiment analysis consists of determining whether a comment expresses positive or negative sentiment. IDBM is benchmark database for sentiment analysis. It is database of movie reviews.

Sentiment analysis model takes these reviews and classify these in positive or negative class based on sentiment.

Keyword:
Sequential Model,
Sentiment Analysis.

Procedure:
1. Load twitter Dataset
2. Preprocess the input data
3. Define your model with embedding layer and simple RNN.
4. Train and evaluate your model.
5. Plot the result.

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Experiment No - 9

Title :

Design and develop a model for classifying news articles.

Objective:

We will be able to develop a model to classify the input text in multiple classes.

Keyword:

LSTM,

Natural Language Model.

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Experiment No - 10

Title:

Deployment of deep learning model for serving.

Objective:

We will be able to take a keras model and deploy it as a REST API for serving.

Theory:

A) Configuring Environment:

Keras need to be configured and installed on machine along with flask. Flask is a Python web framework. It is used to build API endpoint.

B) Building your Keras REST API

Keras REST API is self-contained in a single file named run_keras_server.py. All the installation is placed in a single file for simplicity.

C) It will have three following functionalities:

a) load-model

b) prepare-image

c) predict.

c) Launch the service

First call the load-model which loads Keras model from disk. The call to load-model is a blocking operation and prevents the web service from starting until the model is fully loaded.

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D) starting your Keras Rest API

Start REST API with command: python run_keras_server.py. After starting this server use the address http://127.0.0.1/<port-number>/predict to access the /predict endpoint via your browser. But it will provide error: a "Method Not Allowed" error. This error is due to the fact that browser is performing a GET request, but /predict only accepts a POST.

E) Using cURL to test the Keras REST API.

When testing and debugging your Keras REST API use cURL.

F) Consuming the Keras REST API programmatically.

We submit data to your Keras REST API and then consuming the returned predictions in some manner - this requires we programmatically handle the response from our server.

Keyword:

Serving model, REST API, cURL, FLASK.

Procedure:

1. Train your model and save it hard disk with network and weight.
2. Create environment by installing flask.
3. Build keras rest API.
4. Launch the service.
5. Start Keras rest API
6. Using cURL check predictions

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