

Summer Intensive Training Program Report 2022



Machine Learning and Deep Learning

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Preface and Acknowledgement

The Report is about my Summer Internship of one month, conducted at the National Institute of Technology, Warangal. The Internship is on Machine Learning and Deep Learning. This Report contains all learnings related to Real-world examples with Machine Learning and Deep Learning. We have covered an ample number of Real-Life Problems to understand the Algorithms and their applications.

It contains the Basic Knowledge of Python Language, Important Libraries used in Machine Learning, Basics of Machine Learning, Algorithms of different Machine Learning Techniques, Neural Networks, and Deep Learning Techniques, and various applications of Deep Neural Networks.

I am highly thankful to the Institute and Professors, who have helped me as a guide, throughout the Internship.

“Engineering is the approximation of error.”

Contents:

- ☐ Python for Machine Learning (Basic)
- ☐ Python for Machine Learning (Advance)
- ☐ Methods of ML (Supervised & Unsupervised Learning)
- ☐ Linear Regression using Least Square Method
- ☐ Linear Regression using Gradient Descent Method
- ☐ Multiple Linear Regression
- ☐ Logistic Regression
- ☐ K – Means Clustering Algorithm
- ☐ Support Vector Machine (SVM)
- ☐ Artificial Neural Network (ANN)
- ☐ Convolutional Neural Network (CNN)
- ☐ Image Processing
- ☐ Image & Video Detection
- ☐ Generative Adversarial Networks (GANs)
- ☐ Recurrent Neural Network (RNN)

1: Python for Machine Learning (Basic)

Topics Covered:

- Python Variables, Data Types (Lists, Tuples, Sets, Dictionaries), Operators
- Flow of Control
- Iterations in Python
- Important Examples:
 1. International Morse Code
 2. Caesar Cipher Method

2: Python for Machine Learning (Advance)

Topics Covered:

- Functions in Python
- NumPy Library in Python
- Pandas Library in Python
- Matplotlib Library in Python
- Self-Exploration: ScikitLearn and Seaborn Libraries

3: Linear Regression using Least Square Method

Topics Covered:

- Supervised Machine Learning Method
- Introduction to Linear Regression
- GATE score – Academic Progress Example
- Least Square Technique (Mathematical View)
- Quality of Prediction
 1. Correlation Coefficient
 2. SSE and SST
 3. Coefficient of Determination
- Modelling using Inbuilt Functions
- Hours vs Marks Example
- Ice Cream Sale Example
- Using Large Datasets: Weather Prediction using Weather History Dataset
- Analysis on Covid 19 Dataset (Large Sample)

4: Linear Regression using Gradient Descent Method

Topics Covered:

- Basic Meaning of Optimization
- What is Mean Square Error?
- Gradient Descent Algorithm
- An Example on Gradient Descent Algorithm
- Area and Price Example with Gradient Descent Algorithm
- Analysis on 'Years of Experience' vs Salary Dataset
- Analysis on Onion Price Dataset
- Applying gradient Descent Method on a Non-Linear Function (x^2-2x+2)
- Analyzing Himmel-Blau's Function

5: Multiple Linear Regression

Topics Covered:

- Brief understanding on Data Preprocessing
- Mathematics Behind Multiple Linear Regression
- Sales Prediction Example
- An Introduction with statsmodels Library in Python
- Multicollinearity in Multiple Linear Regression
- Variance Inflation Factor (VIF)
- Using Data Preprocessing: Analysis on Profit of 1000 Companies Dataset
- Analysis on Large Datasets:
 1. Salary Prediction based on Age and Years of Experience
 2. Sales Prediction based on Advertisement Data
- A Special Case of Multiple Linear Regression: Polynomial Regression
- An Example of Polynomial Regression

6: Logistic Regression

Topics Covered:

- How Logistic Regression is different from Linear Regression?
- Binary Logistic Regression
- Some Probability Terms: Odds and Evens of an event
- Mathematics behind Logistic Regression: Sigmoid Function
- An Example on Prediction of Purchasing based on Advertisement Data (Mathematical Way)
- Diabetes Prediction using Mathematical Formulae
- Diabetes Prediction using Predefined Logistic Regression Model
- Breast Cancer Analysis using Predefined Logistic Regression Model
- A Small Project on Handwritten Digit Recognition

7: K - Means Clustering Algorithm

Topics Covered:

- Unsupervised Machine Learning Method
- Cluster and Centroid of a Dataset
- Working of K - means Clustering:
 1. Elbow Point
 2. Measuring Distance (Various Methods)
 3. Grouping
 4. Repositioning Centroids
 5. Convergence
- An Introduction with Color Quantization
- Analysis on ODI Cricketers Dataset

8: Performing Different Analysis on Large Datasets using K - Means Clustering

Topics Covered:

- A quick review on K – Means Clustering Algorithm
- An Example on 1D Dataset
- Breast Cancer Analysis using Predefined using K – Means Clustering algorithm
- A Small Project on Image Size Reduction using K – Means Clustering Algorithm

9: Support Vector Machine (SVM)

Topics Covered:

- What is a Feature Vector?
- A Basic Introduction with Decision Surfaces
- Linear Discriminant Function
- Concept of Hyperplane in Linear Classifier
- Algebraic Expression for the width of a Margin
- Handling Non-Linear Separable Data
- Non-Linear Support Vector Machine: Feature Space
- Kernel Function and Mercer's Condition

10: Artificial Neural Network (ANN)

Topics Covered:

- What is Deep Learning and its Applications?
- Deep Learning vs Machine Learning
- An Introduction with Biological Neuron and resemblance between Biological and Artificial Neurons
- Important terms:
 1. Activation Function
 2. Weights and Bias
 3. Input Layer, Hidden Layer, and Output Layer
- Working of an Artificial Neuron: Forward and Backward Propagation
- Performing Forward and Backward Pass using Hand Calculation
- A Basic Example with ANN using Mathematical Functions
- Applying ANN on Iris Multivariate Dataset (Recognizing Species using Petal and Sepal - length and width)
- Performing ANN on XOR Gate Table

11: Convolutional Neural Network (CNN)

Topics Covered:

- Disadvantages of ANN for image classification
- What is Deep Neural Network?
- What are Convolution and Stride?
- Understanding Convolution Concept by Koala's Example (Human recognition)
- 1D and 2D Convolution Operation with Features
- Filters are nothing but the Feature Detectors!
- ReLu and Pooling:
 1. AveragePool
 2. MaxPool
- Importance of Padding
- Performing CNN on (227x227x3) Data gives (4096x1x1) input layer for classification
- SoftMax Function in Fully Connected Layer
- Brain Image conversion using CNN for Pneumonia Detection
- Convolutions on RGB images
- Finding Accuracy Terms using Actual and Predicted Normal and Actual and Predicted Abnormal
- Classic Networks:
 1. LeNet - 5
 2. Alexnet

3.VGG – 16

4.ResNet

- Using Google Collab
- Performing Various Filters using Google Collab on an image

12: Image Processing (using CNN)

Topics Covered:

- Introduction with OpenCV Library
- Changing Color Pixels of an Image
- Performing Transformations on Image:
 1. Geometrical Transformations
 - 1.1 Translation
 - 1.2 Rotation
 - 1.3 Image Scaling
 2. Affine Transformation
 3. Projective Transformation
- Extracting Sobel Edges in an Image
- Image Blurring

13. Face Detection & Face Blurring in Images (Applications of CNN-1)

Topics Covered:

- Using OpenCV Haarcascades Modules
- Detection of Face in an Image
- Detecting Faces in Group Photo
- Classifying Faces from given Image
- Blurring the Detected Faces
- Blanking Faces in an Image

14. Face Detection using Webcam (Application of CNN-2)

Topics Covered:

- Working of the Model: How to Capture Videos and imported through OpenCV
- Introducing the OpenCV object to Capture Frames: VideoCapture()
- Using facecascade Classifier in Face Detection
- Detecting Faces in Video Frames
- Performing Blurring and Blanking Operations on Faces in Webcam
- Handling with the crashing of Python IDE while using OpenCV: Introducing cv2.destroyAllWindows()
- Creating a Program to Detect Faces using Webcam
- Improving the Accuracy using faceCascade method

15. Generative Adversarial Networks (GANs)

A Special Lecture by Dr. Swagatam Das, Associate Professor and Head

Electronics and Communication Sciences Unit
(Indian Statistical Institute)

Topics Covered:

- Machine Learning as a Function/Mapping: An Introduction
- Deep Learning: An Introduction
- Two Deep Inference Models:
 1. Discriminative Model
 2. Generative Model
- Generative Adversarial Networks: History and Overview
- Probabilistic Generative Models & Density Estimation
- Implicit Generative Models
- Implementing Transform Function with a Neural Network
- What is a Generator?: Structure of its Network
- What is a Discriminator?: Structure of its Network
- Introduction to Generating Negative Examples
- Algorithm:
 1. Initializing Generator and Discriminator
 2. Training Generator and Discriminator
 - 2.1 Two-Player Game

2.2 Learning to Generate Handwritten Digits based on Epochs

- GANs Sample Applications
 1. BigGAN
 2. CycleGAN
 3. Neural Photo Editor
 4. Pix2Pix
- How do GANs Bring Old photos to Life?: An Small Introduction

16. Recurrent Neural Network (RNN)

Topics Covered:

- What is Sequential Data?
- An Introduction with LSTM: Long Short Term Memory
- Structure of an LSTM
- Mathematics behind working of LSTM
- Important Terminologies:
 1. Input Gate
 2. Forget Gate
 3. Output Gate
 4. LSTM Block
 5. Timestamp
- What is RNN? Use of LSTM in RNN
- Recurrent Neural Network vs Feed-Forward Neural Network
- Structure of an RNN Network
- Working of RNN Network
- An Analysis on Application of RNN: Stock Prediction Model (using 47 years Dataset)
- Challenges in Predicting Live Stock Values
- Revisit on the Machine Learning and Deep Learning Techniques

Project Work Done on Final Week: Face Recognition Attendance System

Language Used: Python

IDE/Platform Used: Jupyter Notebook and Spyder

Neural Network Used: Convolutional Neural Network

Approach Used for Detection: HOG + Linear SVM Face Detector Method (CNN)

Important Dependencies used:

1. Numpy
2. OpenCV
3. C-make
4. Dlib Library
5. Face Recognition Module

Working Steps of the Program:

1. Importing Images from the Dataset
2. Compute Encodings of the Faces Detected
3. Training and Testing the Model using the encodings
(Perform in the Dlib Library)
4. Capturing Faces using Webcam and creating Frames
5. Matching Faces using the encoding values.
6. Marking Attendance of the Detected Face.

References:

1. Machine Learning is Fun! Part 4: Modern Face Recognition using Deep Learning, by Adam Geitgey
2. Face Recognition with OpenCV, Python, and Deep Learning, by Adrien Rosebrock
3. Face Detection with dlib (HOG and CNN), by Adrien Rosebrock
4. A Face Recognition Library using Convolutional Neural Networks, Paperwork by Leonardo Blanger (URI University, Erechim - Brazil) and Alison R. Panisson (Pontifical University of Rio Grande do Sul, Porto Alegre - Brazil)
5. An Improved face recognition algorithm and its application in the attendance management system, by Serign Modou Bah and Fang Ming