Copy of Source

May 26, 2024

[2]:
```python
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

[ ]:
```
!sudo apt update
!apt-get install openjdk-8-jdk-headless -qq > /dev/null
!tar xf /content/drive/MyDrive/Colab_Notebooks/spark-3.5.1-bin-hadoop3.tgz
!pip install -q findspark
!pip install pyspark
!mv spark-3.5.1-bin-hadoop3 /content/
```

[ ]:
```python
import os
os.environ["JAVA_HOME"] = "/usr/lib/jvm/java-8-openjdk-amd64"
os.environ["SPARK_HOME"] = "/content/spark-3.5.1-bin-hadoop3"
```

[ ]:
```python
import findspark
findspark.init()
findspark.find()
import pyspark as spark
print(spark.__version__)
```

[ ]:
```python
from pyspark.sql import SparkSession, DataFrame, functions as F, Column
from pyspark.sql.functions import to_date, col, lag, asc, round
from pyspark.sql import SparkSession, DataFrame
from pyspark.ml.feature import VectorAssembler, StringIndexer, OneHotEncoder,␣
  ↪StandardScaler
from pyspark.ml.clustering import KMeans
from pyspark.sql.window import Window
from pyspark.ml.regression import LinearRegression
from pyspark.ml.linalg import Vectors, VectorUDT
from pyspark.sql.types import FloatType
from pyspark.ml.classification import MultilayerPerceptronClassifier,␣
  ↪RandomForestClassifier, LinearSVC, OneVsRest
from pyspark.ml.evaluation import MulticlassClassificationEvaluator
from pyspark.ml import Pipeline
from pyspark.ml.recommendation import ALS
from pyspark.ml.evaluation import RegressionEvaluator
from pyspark.context import SparkContext, SparkConf
import numpy as np
import matplotlib.pyplot as plt
```

[ ]:

```
spark = SparkSession.builder \
    .appName("Final") \
    .config("spark.executor.memory", "8g") \
    .config("spark.driver.memory", "8g") \
    .getOrCreate()
```

1 Task 1

[ ]:

```
data = '/content/drive/MyDrive/Colab_Notebooks/mnist_mini.csv'
df = spark.read.csv(data, header=False, inferSchema=True)
df.show()
```

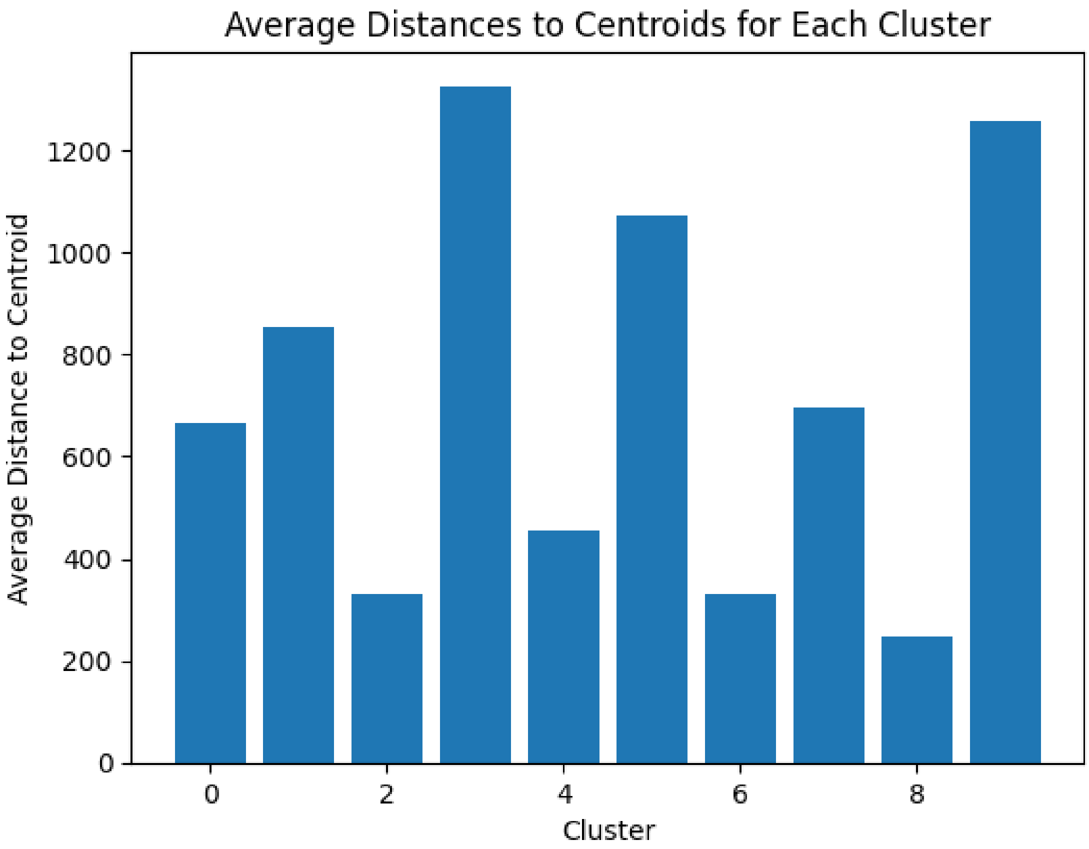
[ ]:

```
class Clustering:
    def __init__(self, spark: SparkSession, data_path: str):
        self.spark = spark
        self.df = self.prepare_data(data_path)

    def prepare_data(self, data_path: str, weighted_indices: list = [],␣
 ↪weight_factor: int = 100) -> DataFrame:
        df = self.spark.read.csv(data_path, header=False, inferSchema=True)
        df = df.withColumnRenamed("_c0", "label")

        if weighted_indices:
            df = df.withColumn(
                "weight",
                F.when(F.col("label").isin(weighted_indices), weight_factor)
                .otherwise(1)
                .cast("double"),
            )
        else:
            df = df.withColumn("weight", F.lit(1.0))

        assembler = VectorAssembler(
            inputCols=df.columns[1:-1], outputCol="features"  # Exclude label␣
 ↪and weight
        )
        df = assembler.transform(df)

        scaler = StandardScaler(
            inputCol="features", outputCol="scaledFeatures", withStd=True,␣
 ↪withMean=False
```

```
        )
        scalerModel = scaler.fit(df)
        df = scalerModel.transform(df)
        return df

    def cluster(self, k: int, seed: int = 42):
        kmeans = KMeans(
            featuresCol="scaledFeatures", k=k, seed=seed, weightCol="weight"
        )
        model = kmeans.fit(self.df)
        return model, model.transform(self.df).select("label", "prediction",␣
↪"scaledFeatures")

    def calculate_average_distances(self, model, transformed_df: DataFrame) ->␣
↪list:
        avg_distances = []
        for cluster in range(k):
            cluster_data = (
                transformed_df.filter(F.col("prediction") == cluster)
                .select("scaledFeatures")
                .rdd.map(lambda row: Vectors.dense(row["scaledFeatures"]))
                .collect()
            )
            centroid = Vectors.dense(model.clusterCenters()[cluster])
            distances = [Vectors.squared_distance(point, centroid) for point in␣
↪cluster_data]
            avg_dist = sum(distances) / len(distances)
            avg_distances.append(avg_dist)
        return avg_distances

    def visualize_distances(self, avg_distances: list):
        plt.bar(range(len(avg_distances)), avg_distances)
        plt.xlabel("Cluster")
        plt.ylabel("Average Distance to Centroid")
        plt.title("Average Distances to Centroids for Each Cluster")
        plt.show()
```

[ ]:

```
clusterer = Clustering(spark, data)
weighted_indices = [0, 1, 2, 3, 4, 7, 8, 11, 18, 61]
k = 10

model, transformed_df = clusterer.cluster(k)
avg_distances = clusterer.calculate_average_distances(model, transformed_df)
clusterer.visualize_distances(avg_distances)
```



##Task 2

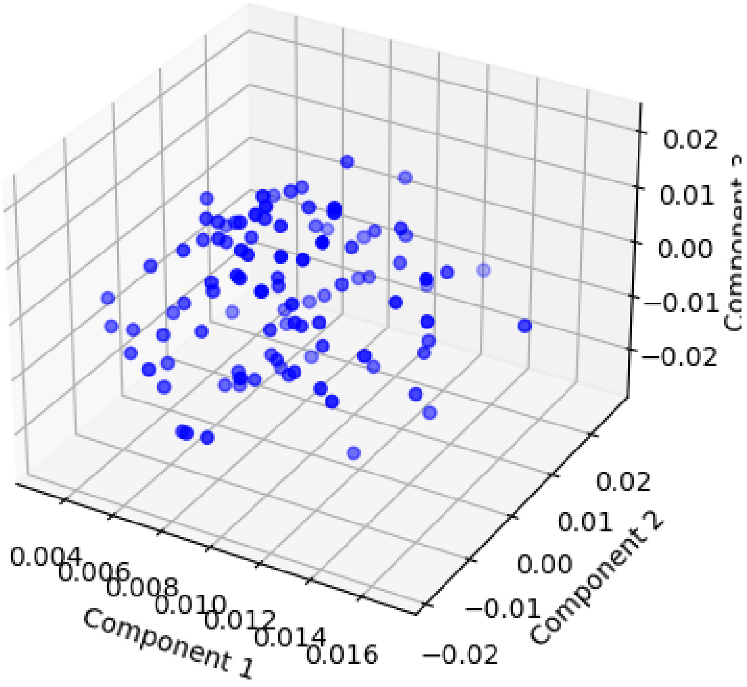
```
[ ]: import random
     from pyspark.mllib.linalg.distributed import RowMatrix, IndexedRow,␣
      ↪IndexedRowMatrix
     from pyspark.ml.linalg import DenseMatrix
```

```
[ ]: class SVDReducer:
         def __init__(self, file_path, label_col="_c0", n_components=3,␣
      ↪sample_size=100):
             self.file_path = file_path
             self.n_components = n_components
             self.sample_size = sample_size
             self.spark = SparkSession.builder.appName("DimensionalityReducer").
      ↪getOrCreate()
             self.data = None
             self.reduced_data = None
             self.label_with_index = None
```

```
    def load_data(self):
        self.data = self.spark.read.csv(self.file_path, header=False,␣
↪inferSchema=True)


    def preprocess_data(self):
        data_with_index = self.data.rdd\
                    .map(lambda x: (x[0],\
                                    Vectors.dense([float(it) for it in x[1:
↪]])))\
                    .zipWithIndex()\
                    .map(lambda x: (x[1], x[0][0], x[0][1]))\
                    .toDF(["id", "label", "features"])
        self.label_with_index = data_with_index.select("id", "label")

        feature_with_index = data_with_index.select("id", "features").rdd\
                    .map(lambda row: IndexedRow(row["id"], row["features"].
↪tolist()))

        return feature_with_index


    def cal_SVD(self, indexed_row_rdd, r=3):
        index_row_matrix = IndexedRowMatrix(indexed_row_rdd)
        svd = index_row_matrix.computeSVD(r, True)
        U = svd.U.rows.collect()
        S = svd.s.toArray()
        V = svd.V
        return U, S, V

    def reduce_dimensionality(self):
        indexed_row_rdd = self.preprocess_data()
        U, S, V = self.cal_SVD(indexed_row_rdd)
        self.reduced_data = np.array([u.vector.toArray()[:self.n_components]␣
↪for u in U])

    def get_random_samples(self):
        if self.reduced_data is None:
            raise ValueError("No reduced data available. Run␣
↪reduce_dimensionality first.")

        indices = np.random.choice(len(self.reduced_data), size=self.
↪sample_size, replace=False)
        return self.reduced_data[indices]

    def plot_samples(self, samples):
        fig = plt.figure()
        ax = fig.add_subplot(111, projection='3d')
        ax.scatter(samples[:, 0], samples[:, 1], samples[:, 2], c='b',␣
 ↪marker='o')
        ax.set_xlabel('Component 1')
        ax.set_ylabel('Component 2')
        ax.set_zlabel('Component 3')
        plt.show()


    def run(self):
        self.load_data()
        self.reduce_dimensionality()
        samples = self.get_random_samples()
        self.plot_samples(samples)
```

[ ]:

```
input_file = "/content/drive/MyDrive/Colab_Notebooks/mnist_mini.csv"

reducer = SVDReducer(input_file)
reducer.run()
```



2 Task 3

```
[ ]: class CollaborativeFiltering:
         def __init__(self, data_path, rank_range):
             self.spark = SparkSession.builder.appName("CollaborativeFiltering").
      ↪getOrCreate()
             self.data_path = data_path
             self.rank_range = rank_range
             self.data = None
             self.train_data = None
             self.test_data = None
             self.model = None

         def load_data(self):
             print("Loading data...")
             self.data = self.spark.read.csv(self.data_path, header=True,␣
      ↪inferSchema=True)

         def preprocess_data(self, train_fraction=0.7):
             print("Splitting data into training and test sets...")
             (self.train_data, self.test_data) = self.data.
      ↪randomSplit([train_fraction, 1 - train_fraction])
             print(f"Training data count: {self.train_data.count()}, Test data count:
      ↪ {self.test_data.count()}")

         def build_model(self, rank, maxIter=10, regParam=0.1):
             print(f"Building model with rank: {rank}...")
             als = ALS(maxIter=maxIter, regParam=regParam, rank=rank,␣
      ↪userCol="user", itemCol="item", ratingCol="rating", coldStartStrategy="drop")
             self.model = als.fit(self.train_data)

         def evaluate_model(self):
             print("Evaluating model...")
             predictions = self.model.transform(self.test_data)
             evaluator = RegressionEvaluator(metricName="mse", labelCol="rating",␣
      ↪predictionCol="prediction")
             mse = evaluator.evaluate(predictions)
             print(f"Evaluation completed with MSE: {mse}")
             return mse

         def run(self):
             self.load_data()
             self.preprocess_data()
             mse_values = []
             for rank in self.rank_range:
                 self.build_model(rank=rank)
                 mse = self.evaluate_model()
```

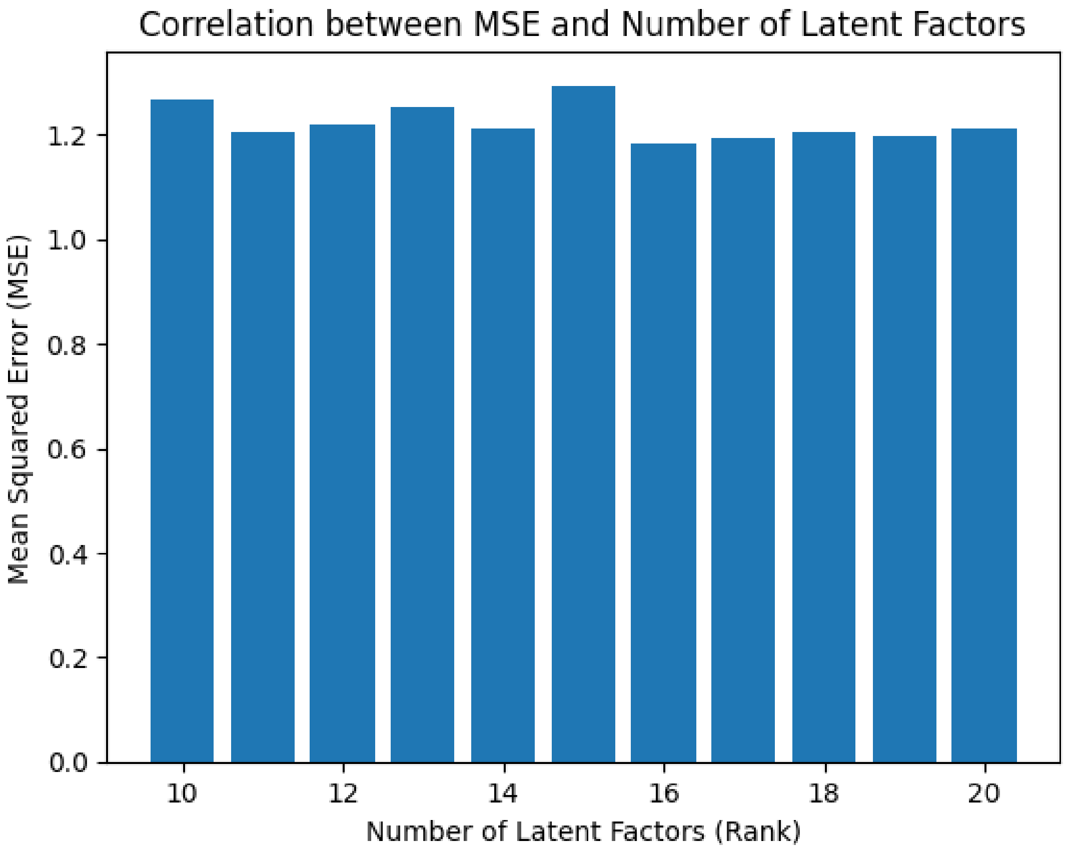
```
            mse_values.append(mse)
            print(f"Rank: {rank}, MSE: {mse}")
        self.visualize_results(self.rank_range, mse_values)

    def visualize_results(self, rank_range, mse_values):
        plt.bar(rank_range, mse_values)
        plt.xlabel('Number of Latent Factors (Rank)')
        plt.ylabel('Mean Squared Error (MSE)')
        plt.title('Correlation between MSE and Number of Latent Factors')
        plt.show()
```

[ ]:

```
data_path = '/content/drive/MyDrive/Colab_Notebooks/ratings2k.csv'
rank_range = range(10, 21)
recommender = CollaborativeFiltering(data_path, rank_range)
recommender.run()
```

```
Loading data…
Splitting data into training and test sets…
Training data count: 1669, Test data count: 696
Building model with rank: 10…
Evaluating model…
Evaluation completed with MSE: 1.2662359635411782
Rank: 10, MSE: 1.2662359635411782
Building model with rank: 11…
Evaluating model…
Evaluation completed with MSE: 1.2048789544703244
Rank: 11, MSE: 1.2048789544703244
Building model with rank: 12…
Evaluating model…
Evaluation completed with MSE: 1.217901262169418
Rank: 12, MSE: 1.217901262169418
Building model with rank: 13…
Evaluating model…
Evaluation completed with MSE: 1.252243742051413
Rank: 13, MSE: 1.252243742051413
Building model with rank: 14…
Evaluating model…
Evaluation completed with MSE: 1.2130647516116528
Rank: 14, MSE: 1.2130647516116528
Building model with rank: 15…
Evaluating model…
Evaluation completed with MSE: 1.2940607885065865
Rank: 15, MSE: 1.2940607885065865
Building model with rank: 16…
Evaluating model…
Evaluation completed with MSE: 1.1815590065721802
Rank: 16, MSE: 1.1815590065721802
```

```
Building model with rank: 17…
Evaluating model…
Evaluation completed with MSE: 1.1945136199450292
Rank: 17, MSE: 1.1945136199450292
Building model with rank: 18…
Evaluating model…
Evaluation completed with MSE: 1.2030410327675085
Rank: 18, MSE: 1.2030410327675085
Building model with rank: 19…
Evaluating model…
Evaluation completed with MSE: 1.1982754119045977
Rank: 19, MSE: 1.1982754119045977
Building model with rank: 20…
Evaluating model…
Evaluation completed with MSE: 1.2105606743846473
Rank: 20, MSE: 1.2105606743846473
```



3 Task 4

```
[ ]: class StockDataProcessor:
         def __init__(self):
             self.spark = SparkSession.builder\
                                          .
      ↪appName("StockPriceFluctuationRangePrediction")\
                                          .getOrCreate()
             self.df = None

         def load_data(self, file_path):
             self.df = self.spark.read.csv(file_path, header=True, inferSchema=True)
             ## Change suitablely default formate datetime for dataset
             self.df = self.df.withColumn("Ngay", to_date(col("Ngay"), "dd/MM/yyy"))
             ## Change stock price column to be numerical
             self.df = self.df.withColumn("HVN", col("HVN").cast("float"))
             ## Sort dates in ascending order
             self.df = self.df.orderBy(asc("Ngay"))
             return self.df

         def prepare_data(self, dataset):
             prepared_dataset = None
             windowSpec = Window.orderBy("Ngay")
             ## Create fluctuation column
             dataset = dataset.withColumn('fluctuation', (col('HVN') - lag('HVN', 1).
      ↪over(windowSpec)) \
                                                                / lag('HVN', 1).
      ↪over(windowSpec))
             dataset = dataset.na.fill({'fluctuation': 0})

             ## Get ranges of 5 previous dates
             for i in range(1, 6):
                 dataset = dataset.withColumn(f'ranges_of_{i}_prev_dates',␣
      ↪lag('fluctuation', i).over(windowSpec))
             dataset = dataset.dropna()

             ## Combine ranges of 5 previous dates to one column
             assembler = VectorAssembler(inputCols=[f'ranges_of_{i}_prev_dates' for␣
      ↪i in range(1, 6)], outputCol='features')
             prepared_dataset = assembler.transform(dataset).select('Ngay',␣
      ↪'features', col('fluctuation').alias('label'))

             return prepared_dataset

         def split_data(self):
             train_data = self.df.filter(self.df['Ngay'] <= '2022-06-30')
             test_data = self.df.filter(self.df['Ngay'] > '2022-06-30')
```

```
        return train_data, test_data
```

```
[ ]: processor = StockDataProcessor()
     df = processor.load_data("/content/drive/MyDrive/Colab_Notebooks/stockHVN2022.
      ↪csv")
     train_data, test_data = processor.split_data()
     processor.prepare_data(train_data).take(5)
```

```
[ ]: [Row(Ngay=datetime.date(2022, 1, 11), features=DenseVector([0.0243, -0.0088,
     -0.0108, -0.0086, 0.0]), label=-0.006465582799399054),
      Row(Ngay=datetime.date(2022, 1, 12), features=DenseVector([-0.0065, 0.0243,
     -0.0088, -0.0108, -0.0086]), label=-0.004338328738870972),
      Row(Ngay=datetime.date(2022, 1, 13), features=DenseVector([-0.0043, -0.0065,
     0.0243, -0.0088, -0.0108]), label=-0.013071944855602494),
      Row(Ngay=datetime.date(2022, 1, 14), features=DenseVector([-0.0131, -0.0043,
     -0.0065, 0.0243, -0.0088]), label=0.002207556081734901),
      Row(Ngay=datetime.date(2022, 1, 17), features=DenseVector([0.0022, -0.0131,
     -0.0043, -0.0065, 0.0243]), label=0.008810521976604648)]
```

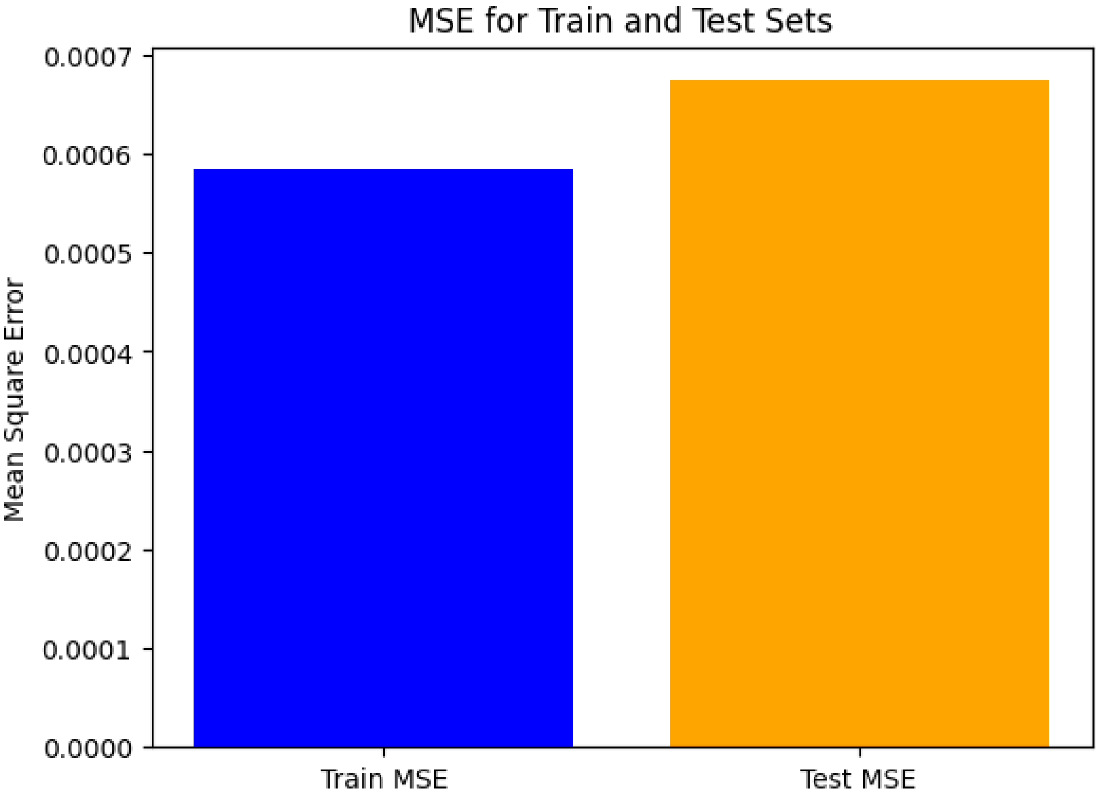
```
[ ]: class StockFlucModel:
         def __init__(self, train_data, test_data):
             self.train_data = train_data
             self.test_data = test_data
             self.model = None
             self.evaluator = RegressionEvaluator(metricName="mse")

         def train_model(self):
             lr = LinearRegression(featuresCol='features', labelCol='label')
             self.model = lr.fit(self.train_data)
             return self.model

         def evaluate_model(self):
             train_predictions = self.model.transform(self.train_data)
             test_predictions = self.model.transform(self.test_data)
             train_mse = self.evaluator.evaluate(train_predictions)
             test_mse = self.evaluator.evaluate(test_predictions)
             return train_mse, test_mse

         def predict(self):
             predictions = self.model.transform(self.test_data)
             return predictions.select('prediction')

         def plot_mse(self, train_mse, test_mse):
             plt.bar(['Train MSE', 'Test MSE'], [train_mse, test_mse],␣
      ↪color=['blue', 'orange'])
             plt.ylabel('Mean Square Error')
             plt.title('MSE for Train and Test Sets')
```

```
        plt.show()
```

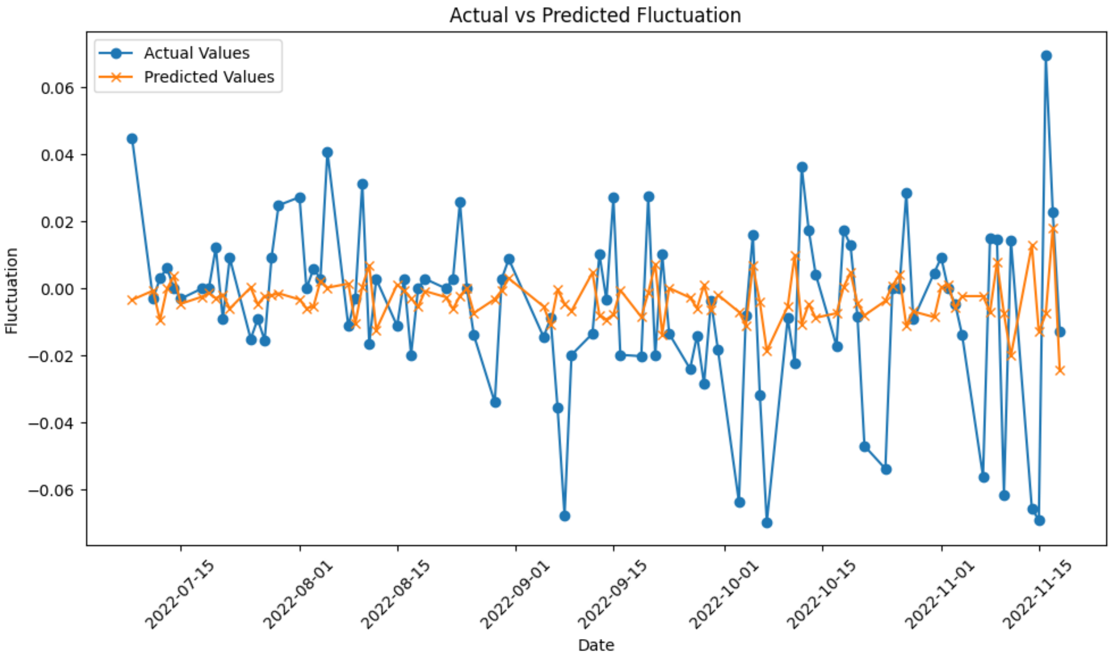
[ ]:

```
def main():
    ## Load and prepare data
    processor = StockDataProcessor()
    data = processor.load_data('/content/drive/MyDrive/Colab_Notebooks/
 ↪stockHVN2022.csv')

    print("Samples of dataset: ")
    data.show(5)
    print("The number of rows of dataset: ", data.count())
    print("Columns of dataset: ")
    data.printSchema()

    train_data, test_data = processor.split_data()
    prepared_train_data = processor.prepare_data(train_data)
    prepared_test_data = processor.prepare_data(test_data)

    ## Create, train, evaluate and visulize results of model
    model = StockFlucModel(prepared_train_data, prepared_test_data)
    model.train_model()
    train_mse, test_mse = model.evaluate_model()
    model.plot_mse(train_mse, test_mse)

    # Predict on the test set
    predictions = model.predict()
    predictions.show(5)

    # Collect actual and predicted values along with dates
    actual_values = [row['label'] for row in prepared_test_data.collect()]
    predicted_values = [row['prediction'] for row in predictions.collect()]
    dates = [row['Ngay'] for row in prepared_test_data.collect()]

    # Plot actual and predicted values
    plt.figure(figsize=(10, 6))
    plt.plot(dates, actual_values, label='Actual Values', marker='o')
    plt.plot(dates, predicted_values, label='Predicted Values', marker='x')
    plt.xlabel('Date')
    plt.ylabel('Fluctuation')
    plt.title('Actual vs Predicted Fluctuation')
    plt.legend()
    plt.xticks(rotation=45)
    plt.tight_layout()
    plt.show()

if __name__ == "__main__":
    main()
```

```
Samples of dataset:
+----------+-----+
|      Ngay|  HVN|
+----------+-----+
|2022-01-04| 23.3|
|2022-01-05| 23.1|
|2022-01-06|22.85|
|2022-01-07|22.65|
|2022-01-10| 23.2|
+----------+-----+
only showing top 5 rows

The number of rows of dataset:  219
Columns of dataset:
root
 |-- Ngay: date (nullable = true)
 |-- HVN: float (nullable = true)
```



```
+--------------------+
|          prediction|
+--------------------+
|-0.00337246015779…|
|-6.40023528657115E-4|
|-0.00951425708381701|
|-5.47631591134960…|
|0.003675510125960…|
+--------------------+
only showing top 5 rows
```



4 Task 5

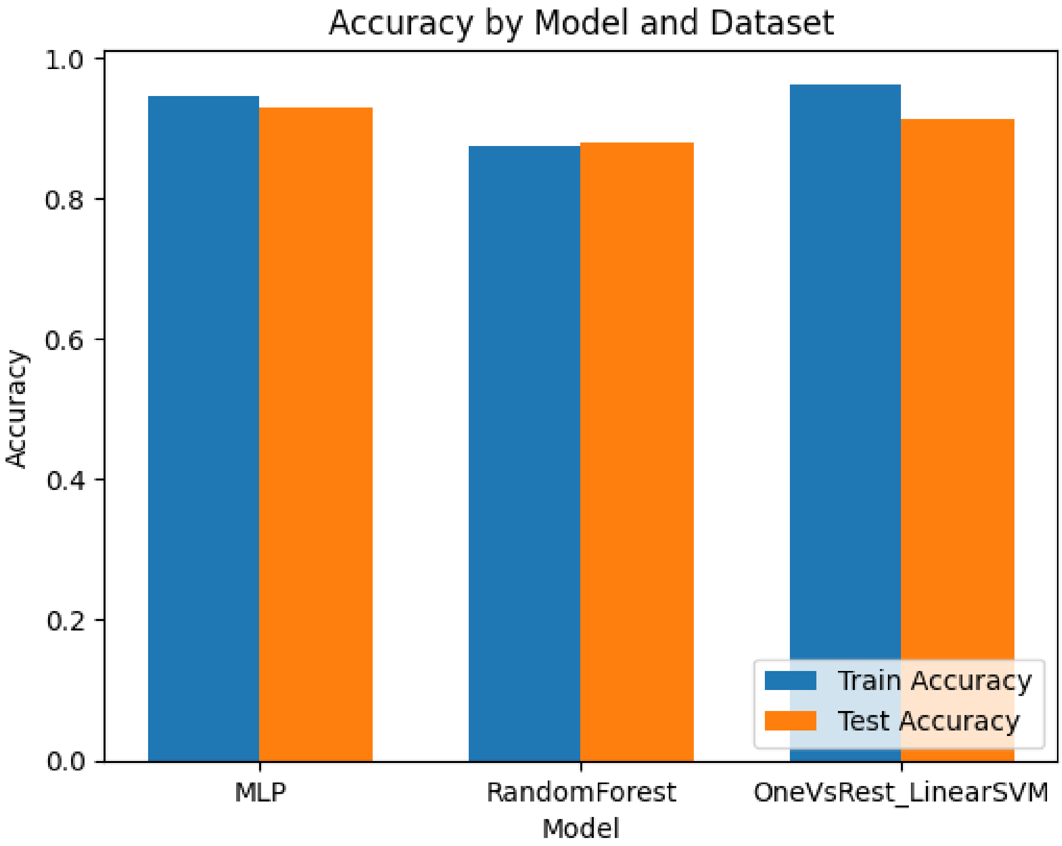
[ ]:

```
class MultiClassClassification:
    def __init__(self, input_path):
        self.spark = SparkSession.builder \
            .appName("MultiClassClassification") \
            .config("spark.driver.memory", "8g") \
            .config("spark.executor.memory", "8g") \
            .getOrCreate()
        self.data = self.spark.read.csv(input_path, header=False,␣
 ↪inferSchema=True)
        self.rename_columns()
        self.train_data, self.test_data = None, None

    def rename_columns(self):
        # Efficiently rename columns
```

```python
        new_column_names = ["label"] + [f"pixel{i}" for i in range(784)]
        self.data = self.data.toDF(*new_column_names)

    def preprocess_data(self):
        feature_cols = [f"pixel{i}" for i in range(784)]
        assembler = VectorAssembler(inputCols=feature_cols, outputCol="features")
        assembled_data = assembler.transform(self.data).select("label", "features")
        self.train_data, self.test_data = assembled_data.randomSplit([0.8, 0.2], seed=1234)

    def train_evaluate(self, model):
        model = model.fit(self.train_data)
        predictions_train = model.transform(self.train_data)
        predictions_test = model.transform(self.test_data)

        evaluator = MulticlassClassificationEvaluator(labelCol="label", predictionCol="prediction", metricName="accuracy")
        accuracy_train = evaluator.evaluate(predictions_train)
        accuracy_test = evaluator.evaluate(predictions_test)

        return accuracy_train, accuracy_test

    def run_classifiers(self):
        results = {}

        # Multi-layer Perceptron
        layers = [784, 128, 64, 10]
        mlp = MultilayerPerceptronClassifier(layers=layers, labelCol="label", featuresCol="features", maxIter=100)
        results['MLP'] = self.train_evaluate(mlp)

        # Random Forest
        rf = RandomForestClassifier(labelCol="label", featuresCol="features", numTrees=100)
        results['RandomForest'] = self.train_evaluate(rf)

        # One-vs-Rest with Linear SVM
        lsvc = LinearSVC(labelCol="label", featuresCol="features", maxIter=100)
        ovr = OneVsRest(classifier=lsvc)
        results['OneVsRest_LinearSVM'] = self.train_evaluate(ovr)

        return results

    def plot_results(self, results):
        models = list(results.keys())
        accuracies_train = [results[model][0] for model in models]
        accuracies_test = [results[model][1] for model in models]

        x = range(len(models))

        fig, ax = plt.subplots()
        bar_width = 0.35

        bars1 = ax.bar(x, accuracies_train, bar_width, label='Train Accuracy')
        bars2 = ax.bar([p + bar_width for p in x], accuracies_test, bar_width,␣
 ↪label='Test Accuracy')

        ax.set_xlabel('Model')
        ax.set_ylabel('Accuracy')
        ax.set_title('Accuracy by Model and Dataset')
        ax.set_xticks([p + bar_width / 2 for p in x])
        ax.set_xticklabels(models)
        ax.legend(loc='lower right')

        plt.show()
```

[ ]:

```
classification = MultiClassClassification("/content/drive/MyDrive/
 ↪Colab_Notebooks/mnist_mini.csv")
classification.preprocess_data()
results = classification.run_classifiers()
classification.plot_results(results)
```



```
[1]: !jupyter nbconvert --to html "/content/drive/MyDrive/Colab_Notebooks/Source.
     ↪ipynb"
```

```
[NbConvertApp] WARNING | pattern
'/content/drive/MyDrive/Colab_Notebooks/Source.ipynb' matched no files
This application is used to convert notebook files (*.ipynb)
        to various other formats.

        WARNING: THE COMMANDLINE INTERFACE MAY CHANGE IN FUTURE RELEASES.

Options
=======
The options below are convenience aliases to configurable class-options,
as listed in the "Equivalent to" description-line of the aliases.
To see all configurable class-options for some <cmd>, use:
    <cmd> --help-all

--debug
    set log level to logging.DEBUG (maximize logging output)
    Equivalent to: [--Application.log_level=10]
```

```
--show-config
    Show the application's configuration (human-readable format)
    Equivalent to: [--Application.show_config=True]
--show-config-json
    Show the application's configuration (json format)
    Equivalent to: [--Application.show_config_json=True]
--generate-config
    generate default config file
    Equivalent to: [--JupyterApp.generate_config=True]
-y
    Answer yes to any questions instead of prompting.
    Equivalent to: [--JupyterApp.answer_yes=True]
--execute
    Execute the notebook prior to export.
    Equivalent to: [--ExecutePreprocessor.enabled=True]
--allow-errors
    Continue notebook execution even if one of the cells throws an error and
include the error message in the cell output (the default behaviour is to abort
conversion). This flag is only relevant if '--execute' was specified, too.
    Equivalent to: [--ExecutePreprocessor.allow_errors=True]
--stdin
    read a single notebook file from stdin. Write the resulting notebook with
default basename 'notebook.*'
    Equivalent to: [--NbConvertApp.from_stdin=True]
--stdout
    Write notebook output to stdout instead of files.
    Equivalent to: [--NbConvertApp.writer_class=StdoutWriter]
--inplace
    Run nbconvert in place, overwriting the existing notebook (only
            relevant when converting to notebook format)
    Equivalent to: [--NbConvertApp.use_output_suffix=False
--NbConvertApp.export_format=notebook --FilesWriter.build_directory=]
--clear-output
    Clear output of current file and save in place,
            overwriting the existing notebook.
    Equivalent to: [--NbConvertApp.use_output_suffix=False
--NbConvertApp.export_format=notebook --FilesWriter.build_directory=
--ClearOutputPreprocessor.enabled=True]
--no-prompt
    Exclude input and output prompts from converted document.
    Equivalent to: [--TemplateExporter.exclude_input_prompt=True
--TemplateExporter.exclude_output_prompt=True]
--no-input
    Exclude input cells and output prompts from converted document.
            This mode is ideal for generating code-free reports.
    Equivalent to: [--TemplateExporter.exclude_output_prompt=True
--TemplateExporter.exclude_input=True
--TemplateExporter.exclude_input_prompt=True]
```

```
--allow-chromium-download
    Whether to allow downloading chromium if no suitable version is found on the
system.
    Equivalent to: [--WebPDFExporter.allow_chromium_download=True]
--disable-chromium-sandbox
    Disable chromium security sandbox when converting to PDF..
    Equivalent to: [--WebPDFExporter.disable_sandbox=True]
--show-input
    Shows code input. This flag is only useful for dejavu users.
    Equivalent to: [--TemplateExporter.exclude_input=False]
--embed-images
    Embed the images as base64 dataurls in the output. This flag is only useful
for the HTML/WebPDF/Slides exports.
    Equivalent to: [--HTMLExporter.embed_images=True]
--sanitize-html
    Whether the HTML in Markdown cells and cell outputs should be sanitized..
    Equivalent to: [--HTMLExporter.sanitize_html=True]
--log-level=<Enum>
    Set the log level by value or name.
    Choices: any of [0, 10, 20, 30, 40, 50, 'DEBUG', 'INFO', 'WARN', 'ERROR',
'CRITICAL']
    Default: 30
    Equivalent to: [--Application.log_level]
--config=<Unicode>
    Full path of a config file.
    Default: ''
    Equivalent to: [--JupyterApp.config_file]
--to=<Unicode>
    The export format to be used, either one of the built-in formats
            ['asciidoc', 'custom', 'html', 'latex', 'markdown', 'notebook',
'pdf', 'python', 'rst', 'script', 'slides', 'webpdf']
            or a dotted object name that represents the import path for an
            ``Exporter`` class
    Default: ''
    Equivalent to: [--NbConvertApp.export_format]
--template=<Unicode>
    Name of the template to use
    Default: ''
    Equivalent to: [--TemplateExporter.template_name]
--template-file=<Unicode>
    Name of the template file to use
    Default: None
    Equivalent to: [--TemplateExporter.template_file]
--theme=<Unicode>
    Template specific theme(e.g. the name of a JupyterLab CSS theme distributed
    as prebuilt extension for the lab template)
    Default: 'light'
    Equivalent to: [--HTMLExporter.theme]
```

```
--sanitize_html=<Bool>
    Whether the HTML in Markdown cells and cell outputs should be sanitized.This
    should be set to True by nbviewer or similar tools.
    Default: False
    Equivalent to: [--HTMLExporter.sanitize_html]
--writer=<DottedObjectName>
    Writer class used to write the
                                        results of the conversion
    Default: 'FilesWriter'
    Equivalent to: [--NbConvertApp.writer_class]
--post=<DottedOrNone>
    PostProcessor class used to write the
                                        results of the conversion
    Default: ''
    Equivalent to: [--NbConvertApp.postprocessor_class]
--output=<Unicode>
    overwrite base name use for output files.
                can only be used when converting one notebook at a time.
    Default: ''
    Equivalent to: [--NbConvertApp.output_base]
--output-dir=<Unicode>
    Directory to write output(s) to. Defaults
                                  to output to the directory of each notebook.
To recover
                                  previous default behaviour (outputting to the
current
                                  working directory) use . as the flag value.
    Default: ''
    Equivalent to: [--FilesWriter.build_directory]
--reveal-prefix=<Unicode>
    The URL prefix for reveal.js (version 3.x).
            This defaults to the reveal CDN, but can be any url pointing to a
copy
            of reveal.js.
            For speaker notes to work, this must be a relative path to a local
            copy of reveal.js: e.g., "reveal.js".
            If a relative path is given, it must be a subdirectory of the
            current directory (from which the server is run).
            See the usage documentation
            (https://nbconvert.readthedocs.io/en/latest/usage.html#reveal-js-
html-slideshow)
            for more details.
    Default: ''
    Equivalent to: [--SlidesExporter.reveal_url_prefix]
--nbformat=<Enum>
    The nbformat version to write.
            Use this to downgrade notebooks.
    Choices: any of [1, 2, 3, 4]
    Default: 4
    Equivalent to: [--NotebookExporter.nbformat_version]

Examples
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    The simplest way to use nbconvert is

            > jupyter nbconvert mynotebook.ipynb --to html

            Options include ['asciidoc', 'custom', 'html', 'latex', 'markdown',
'notebook', 'pdf', 'python', 'rst', 'script', 'slides', 'webpdf'].

            > jupyter nbconvert --to latex mynotebook.ipynb

            Both HTML and LaTeX support multiple output templates. LaTeX
includes
            'base', 'article' and 'report'.  HTML includes 'basic', 'lab' and
            'classic'. You can specify the flavor of the format used.

            > jupyter nbconvert --to html --template lab mynotebook.ipynb

            You can also pipe the output to stdout, rather than a file

            > jupyter nbconvert mynotebook.ipynb --stdout

            PDF is generated via latex

            > jupyter nbconvert mynotebook.ipynb --to pdf

            You can get (and serve) a Reveal.js-powered slideshow

            > jupyter nbconvert myslides.ipynb --to slides --post serve

            Multiple notebooks can be given at the command line in a couple of
            different ways:

            > jupyter nbconvert notebook*.ipynb
            > jupyter nbconvert notebook1.ipynb notebook2.ipynb

            or you can specify the notebooks list in a config file, containing::

                c.NbConvertApp.notebooks = ["my_notebook.ipynb"]

            > jupyter nbconvert --config mycfg.py

To see all available configurables, use `--help-all`.
```