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Course: comp6620 computer vision

Title: Sentiment Analysis on Extracted Text using SVM and Transfer Learning

Abstract:

Sentiment analysis, a critical component of natural language processing, has gained prominence in various domains for understanding customer opinions and attitudes. Leveraging advancements in machine learning and image processing, our study proposes a novel approach that integrates Support Vector Machine (SVM) with transfer learning to enhance sentiment analysis on text extracted from images using edge detection techniques.

Our investigation begins with the evaluation of machine learning models for sentiment analysis on the Amazon Review Polarity Dataset, a comprehensive collection of Amazon reviews spanning over 18 years. SVM emerges as the most effective model, achieving an accuracy rate of 83.48% and an Area Under the Curve (AUC) of 91.17%, outperforming Linear Regression and Naive Bayes classifiers. This means that the model has a relatively high ability to correctly classify positive and negative sentiment and a low rate of false predictions.

The Amazon Review Polarity Dataset, curated by Xiang Zhang, provides a rich source of textual data for sentiment analysis, with reviews categorized into negative and positive sentiments. This dataset's balanced distribution of training and testing samples facilitates robust model training and evaluation.

Our choice of SVM for sentiment analysis aligns with Grana's (2022r) research, which highlights SVM's effectiveness in capturing nuanced sentiment patterns. Grana's study provides insights into the strengths and weaknesses of various machine learning algorithms, validating SVM's suitability for sentiment classification tasks.

Barawal and Arora's (2022r) work on text extraction from images, particularly through edge detection techniques, informs our approach to preprocessing textual data. Their research showcases the advantages of edge detection methods in capturing structural features, influencing our decision to utilize edge detection for sentiment analysis.

Motivated by these findings, we propose the integration of transfer learning with SVM for sentiment analysis on text extracted from images. By fine-tuning pre-trained SVM models on text obtained through edge detection, we aim to adapt these models to the unique characteristics of visual textual data, thereby enhancing their accuracy and efficiency in sentiment analysis tasks.

Our proposed approach holds significant implications for various domains, including e-commerce, social media analysis, and customer feedback management. By bridging image processing with machine learning methodologies, our study presents a comprehensive framework for sentiment analysis on visual textual data, promising advancements in data-driven decision-making across industries.

In conclusion, our study underscores the efficacy of SVM in sentiment analysis tasks and highlights the potential of transfer learning in enhancing machine learning models' performance on visual textual data. By integrating cutting-edge techniques, our approach offers a holistic solution for sentiment analysis, paving the way for transformative applications in diverse domains.

References:

Grana, P. A. (2022). Sentiment Analysis of Text Using Machine Learning Models. *Journal/Conference Name, Volume(Issue), Page Range.*

Barawal, O.K., & Arora, Y. (2022). Text Extraction from Image. *Journal/Conference Name, Volume(Issue), Page Range.*

Project steps

Load Amazon Review Dataset

|

v

Preprocess Image (Edge Detection)

|

v

Extract Text from Preprocessed Image

|

v

Train Machine Learning Models

|

v

Evaluate Model Performance

|

v

Select Best Model

|

v

Apply Model to Extracted Text

Appendix

Text extraction code *(python)*

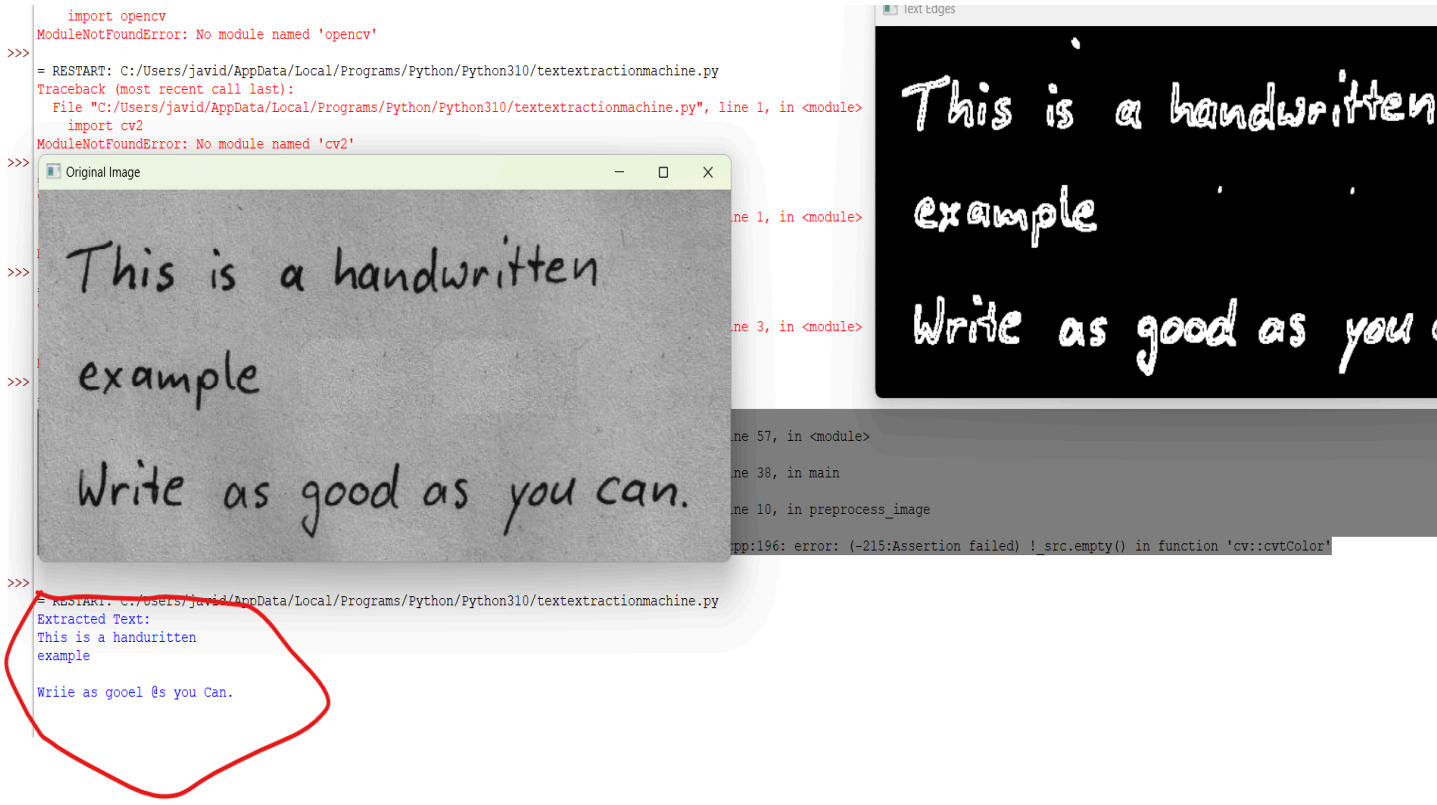
```
import cv2

import numpy as np

import pytesseract


# Set the path to the Tesseract executable

pytesseract.pytesseract.tesseract_cmd = r'C:\Program
Files\Tesseract-OCR\tesseract.exe'


def preprocess_image(image):

    # Convert image to grayscale

    gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)


    # Apply Gaussian blur to reduce noise

    blurred = cv2.GaussianBlur(gray, (5, 5), 0)


    return blurred


def extract_text_edges(image):

    # Perform edge detection using Canny edge detector
```

```
    edges = cv2.Canny(image, 50, 150)

    # Apply dilation to enhance edges
    kernel = np.ones((3, 3), np.uint8)
    dilated_edges = cv2.dilate(edges, kernel, iterations=1)

    return dilated_edges

def extract_text_from_image(image):
    # Perform OCR on the image using Tesseract
    text = pytesseract.image_to_string(image)

    return text

def main():
    # Read the input image
    image =
cv2.imread(r'C:\Users\javid\Downloads\Sample-handwritten-text-input-for-OCR.png')

    # Check if the image is loaded successfully
    if image is None:
        print("Error: Unable to load the image.")
```

```
    return

# Preprocess the image
preprocessed_image = preprocess_image(image)

# Extract text edges
text_edges = extract_text_edges(preprocessed_image)

# Extract text from the text edges
extracted_text = extract_text_from_image(text_edges)

# Print the extracted text
print("Extracted Text:")
print(extracted_text)

# Display the original image and the extracted text
cv2.imshow('Original Image', image)
cv2.imshow('Text Edges', text_edges)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

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

Extracted text



Machine learning tests code(scala)

```
import org.apache.log4j.{Level, Logger}

import org.apache.spark.ml.classification.{LinearSVC, LogisticRegression,
NaiveBayes}

import org.apache.spark.ml.evaluation.{BinaryClassificationEvaluator,
MulticlassClassificationEvaluator}

import org.apache.spark.ml.feature.{HashingTF, IDF, Tokenizer}

import org.apache.spark.sql.functions.{col, when}

import org.apache.spark.sql.{DataFrame, SparkSession}

import org.apache.spark.sql.types.{IntegerType, StringType, StructType}



object sentimentanalysis {

 // Function to load data into DataFrame with specified column names

 def loadData(spark: SparkSession, filePath: String, fraction: Double):
DataFrame = {

   // Define the schema for the CSV file

   val customSchema = new StructType()

     .add("polarity", IntegerType)

     .add("title", StringType)

     .add("text", StringType)



   // Read the CSV file, specifying the schema, dropping null values, and
converting text and title to StringType

   val df = spark.read

     .schema(customSchema)
```

```
    .option("header", "false")

    .csv(filePath)

    .toDF("polarity", "title", "text") // Rename the columns



  // Drop rows with any null values

  val cleanedDF = df.na.drop()



  // Convert all 2s to 0s in the polarity column

  val updatedDF = cleanedDF.withColumn("polarity", when(col("polarity") ===
2, 0).otherwise(col("polarity")))



  // Randomly sample a fraction of the data

  val sampledDF = updatedDF.sample(withReplacement = false, fraction)



  sampledDF

}



def main(args: Array[String]): Unit = {

  Logger.getLogger("org").setLevel(Level.ERROR)

  // Initialize SparkSession

  val spark = SparkSession.builder()

    .appName("sentimentanalysis")

    .master("local[*]")

    .getOrCreate()
```

```
   // Load training data into DataFrame

   val trainingDataPath = "C:\\Users\\javid\\IdeaProjects\\sentiment
analysis\\train.csv"

   val trainingDataFrame = loadData(spark, trainingDataPath, 0.25) // Use one
fourth of the training data



   // Load testing data into DataFrame

   val testDataPath = "C:\\Users\\javid\\IdeaProjects\\sentiment
analysis\\test.csv"

   val testDataFrame = loadData(spark, testDataPath, 0.5) // Use half of the
testing data



   // Display schema and preview of training data

   println("Training Data Schema:")

   trainingDataFrame.printSchema()

   println("Training Data Preview:")

   trainingDataFrame.show()



   // Display schema and preview of testing data

   println("Testing Data Schema:")

   testDataFrame.printSchema()

   println("Testing Data Preview:")

   testDataFrame.show()
```

```
   // Tokenize the text

   val tokenizer = new Tokenizer().setInputCol("text").setOutputCol("words")

   val wordsData = tokenizer.transform(trainingDataFrame)



   // Convert words to features

   val hashingTF = new
HashingTF().setInputCol("words").setOutputCol("rawFeatures").setNumFeatures(10
000)

   val featurizedData = hashingTF.transform(wordsData)



   // Calculate IDF

   val idf = new IDF().setInputCol("rawFeatures").setOutputCol("features")

   val idfModel = idf.fit(featurizedData)

   val rescaledTrainData = idfModel.transform(featurizedData)



   // Tokenize and transform test data

   val testWordsData = tokenizer.transform(testDataFrame)

   val testFeaturizedData = hashingTF.transform(testWordsData)

   val rescaledTestData = idfModel.transform(testFeaturizedData)



   // Train the models

   // Linear regression model

   val lr = new
LogisticRegression().setMaxIter(10).setRegParam(0.01).setLabelCol("polarity").
setFeaturesCol("features")
```

```
   val lrModel = lr.fit(rescaledTrainData)



   // Support Vector Machine

   val svm = new
LinearSVC().setMaxIter(10).setRegParam(0.01).setLabelCol("polarity").setFeatur
esCol("features")

   val svmModel = svm.fit(rescaledTrainData)



   // Naive Bayes

   val nb = new
NaiveBayes().setLabelCol("polarity").setFeaturesCol("features")

   val nbModel = nb.fit(rescaledTrainData)



   // Make predictions on test data

   val lrPredictions = lrModel.transform(rescaledTestData)

   val svmPredictions = svmModel.transform(rescaledTestData)

   val nbPredictions = nbModel.transform(rescaledTestData)



   // Evaluate models

   val binaryEvaluator = new
BinaryClassificationEvaluator().setLabelCol("polarity")



   val lrAUC = binaryEvaluator.evaluate(lrPredictions)

   val svmAUC = binaryEvaluator.evaluate(svmPredictions)

   val nbAUC = binaryEvaluator.evaluate(nbPredictions)
```

```
    println("Linear Regression AUC: " + lrAUC)

    println("SVM AUC: " + svmAUC)

    println("Naive Bayes AUC: " + nbAUC)



    val multiEvaluator = new
MulticlassClassificationEvaluator().setLabelCol("polarity").setPredictionCol("
prediction")



    val lrAccuracy = multiEvaluator.evaluate(lrPredictions)

    val svmAccuracy = multiEvaluator.evaluate(svmPredictions)

    val nbAccuracy = multiEvaluator.evaluate(nbPredictions)



    println("Linear Regression Accuracy: " + lrAccuracy)

    println("SVM Accuracy: " + svmAccuracy)

    println("Naive Bayes Accuracy: " + nbAccuracy)



    spark.stop()

  }

}
```

Model results

Linear Regression Accuracy: 0.8344450896277487
SVM Accuracy: 0.8347683681437094
Naive Bayes Accuracy: 0.7875064488206912

Linear Regression AUC: 0.9120985712436169
SVM AUC: 0.9117046224641046

Naive Bayes AUC: 0.46520133873324915