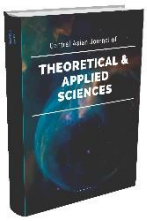

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Classification of Sarcastic and Non-Sarcastic Tweets Using Machine Learning

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Abstract: *When someone is being sarcastic, they are expressing their negative emotions through the use of positive or exaggerated positive language. A person's tone of voice and body language, such as eye rolling, hand gestures, etc., might give away their sarcasm. Without these non-verbal cues, such as tone of voice and body language, a human being would have a very difficult time detecting sarcasm in written data. These difficulties explain the growing interest in sarcasm detection of social media text, particularly tweets. Major difficulties arise from analysing the ever-increasing volume of tweets. We suggested a machine learning-based framework that can collect tweets in real time and analyse them with algorithms that can accurately detect sarcastic sentiment. We find that the analysis and processing time under an ML-based framework vastly surpasses the traditional methods and is better suited for continuously streaming tweets in real time.*

Keywords: *Classification of Sarcastic, Non-Sarcastic, Tweets, Machine Learning, Random Forest (RF) and Decision Tree (DT).*

INTRODUCTION

When someone is being sarcastic, they are expressing their negative emotions through the use of positive or exaggerated positive language [1]. A person's tone of voice and body language, such as eye rolling, hand gestures, etc., might give away their sarcasm [2]. Without these non-verbal cues, such as tone of voice and body language, a human being would have a very difficult time detecting sarcasm in written data. These difficulties explain the growing interest in sarcasm detection of social media text, particularly tweets. Major difficulties arise from analysing the ever-increasing volume of tweets. We suggested a machine learning-based framework that can collect tweets in real time and analyse them with algorithms that can accurately detect sarcastic sentiment. We find that the analysis and processing time under an ML-based framework vastly surpasses the traditional methods and is better suited for continuously streaming tweets in real time [3-7]. In our study, we evaluate the performance of two different prediction algorithms, Random Forest (RF) and Decision Tree (DT), on predicting sarcastic tweets. Machine learning, in the

context of statistics, is an application of AI in which previously acquired knowledge is leveraged via algorithms to analyse or aid in the analysis of statistical data [8-11]. Even though Machine Learning makes use of automated thought processes, it still necessitates human oversight. Machine learning relies heavily on generalisation to produce a model that can successfully apply learned rules to new data. Machine learning, a subfield of computer science that offers many methods for analysing data, is a comparatively recent development in the field [12-19]. Logistic regression and principal component analysis are two examples of procedures that are based on tried and true statistical methodologies, whereas others are not [20].

Most statistical methods are based on the principle of selecting one probabilistic model from a set of candidate models as providing the greatest fit to observed data [21]. Machine learning methods, in a similar vein, seek to identify models that provide the best fits for data (i.e., they find solutions to specific optimization problems), but these models are not limited to the probabilistic variety. As a result, machine learning approaches have an edge over statistical methods because the former don't need any prior probabilistic models [22-29]. While probabilistic models are used in some machine learning approaches, traditional statistical methods typically prove insufficient in the Big Data age to keep up with the growing complexity and variety of available data [30]. It may be challenging, if not impossible, to prescribe probabilistic models that relate variables from different data sources in a way that is both plausible and amenable to statistical analysis. Machine learning has the potential to offer a wider variety of adaptable alternative analytical methods that are better adapted to modern data sources [31-33]. The future demands of statistical agencies may be better served by machine learning techniques than by more conventional methods, hence these agencies should investigate the possibility of using machine learning [34-37].

Classes of Machine Learning

Among the two types of machine learning, supervised and unsupervised, supervised learning is more common. Comparing statistical methods of logistic regression and support vector machines (machine learning) The application of logistic regression to forecast future outcomes is a type of supervised machine learning. Logistic regression takes as input a set of observations for which values have been recorded on a response variable (0 or 1) and on a set of predictor variables (covariates). In the language of machine learning, this is known as "training data." A Bernoulli distribution (a family of probabilistic models) for the response variable and a linear relationship between the predictor variables and the logarithm of the posterior probability of the response are the two primary hypotheses [38-41]. Assuming that the units' responses are uncorrelated, we can use maximum likelihood to determine the most appropriate values for the coefficients (which parameterize the joint distribution) in this linear function. The "fitted" model is the one with the ideal coefficient values, and it can be used to "predict" the value of the response variable for a new unit (or "classify" the new unit as 0 or 1) when just the predictor values are available. One non-statistical supervised machine learning technique with the same purpose as the aforementioned logistic regression classifier is the Support Vector Machine (SVM). Discover the best-fitting SVM model for a given set of training data, and then employ that model to make classifications on unseen data. The distinction is that SVM uses a collection of hyperplanes defined by the predictor variables as its underlying models. Finding the hyperplane in predictor space that most effectively divides 0 response value units from 1 response value units is the optimization problem that must be solved. As a matter of probability theory, the optimum problem for logistic regression, SVM's optimum problem is based on geometry [42-49]. This summary also discusses other supervised machine learning approaches like decision trees, neural networks, and Bayesian networks. Unsupervised learning examples B [50]. The statistical method of principal component analysis against another method, cluster analysis (machine learning). In classical statistics, principal component analysis stands out as the primary example of an unsupervised machine learning technique [51-57]. PCA attempts to "summarise" data points in high-

dimensional space by locating orthogonal, one-dimensional subspaces along which most variation in the data points is captured [58-61]. The absence of a response variable in the current context is what "unsupervised" refers to [62-71]. Non-statistical unsupervised machine learning methods include cluster analysis and association analysis [72]. The former endeavours to ascertain the underlying clustering structure of a dataset, whereas the latter looks for commonalities between items [73].

Introduction of Project

Researchers in the field of natural language processing (NLP) have found an increase in interest in the detection of sarcasm in conversations as the popularity of informal threads on social media platforms has grown. Since sarcasm analysis is now essential for social media platforms, it has become the topic of much discussion [74-81]. One specific area of NLP analysis is the identification of sarcasm. Linguists have done substantial research on sarcasm because of the close relationship between the two. In recent decades, it's gained acclaim as a respected academic discipline. Researchers in information processing are increasingly interested in automatic sarcasm detection due to the popularity of social media and sentiment analysis. Sentiment analysis is a subset of text mining that focuses on identifying and extracting subjective information from a text [82-89]. The core concept is to determine the reader's emotional response to a piece of text through the use of machine learning methods. In order to understand people's subjective viewpoints, NLP frequently makes use of sentiment analysis [90-96]. However, if people utilise sarcasm in their words, the analysis will also be tainted. The capacity to recognise sarcasm is crucial for accurately understanding other people's motivations. Identifying sarcasm can be a challenging endeavour because it is heavily influenced by surrounding information and the speaker's or writer's tone. The capacity to detect sarcasm is crucial for accurately understanding people's motivations. Several NLP applications can benefit from incorporating sarcasm detection, such as market research, opinion mining, and data categorization [97-99]. The identification of sarcasm, however, is just as challenging as it relies heavily on factors such as context, past information, and the overall tone of the speaker or writer [100-101].

Some areas of natural language processing (NLP) are more narrowly focused than others; sarcasm detection, for example, is a subset of sentiment analysis in which the primary goal is to identify sarcasm rather than a broad range of emotions. The goal of this study is to determine whether or not a given text contains sarcasm [102-107]. The primary goal of this paper and the sarcasm detection method it presents is to differentiate between people's opinions (sentiments) on goods, politics, services, and people, which has various applications for businesses [108-111]. The ability to discern objective from subjective data is crucial. It aids in the production of organised knowledge, a vital piece of information for both automated and human decision-making processes. This project's goal is to analyse the sentiment of the text, comments, or reviews to clarify that meaning and enhance the general sentiment categorization of a massive amount of textual data gleaned from social media users by employing Machine Learning. Improved efficacy in identifying sarcasm [112-119]. Because they take into account a wider variety of characteristics than rule-based or Lexicon-based methods, machine learning-based systems can achieve greater precision and greater relevance in their output. This may be due to the fact that ML technologies are capable of taking into account a greater variety of data, down to the most minute nuances of behaviour patterns associated with a certain account [120-125].

System Study Feasibility Study

In this stage, the project's viability is evaluated, and a business proposal outlining the project's broad strokes and some preliminary cost estimates is presented [126-131]. A feasibility assessment of the proposed system is to be conducted during system analysis. This guarantees the suggested system won't cost the business too much. Feasibility analysis relies heavily on a thorough familiarity with the system's

most pressing needs [132-139]. The feasibility analysis probes the issue at hand and the stakeholders' information requirements [140]. Its goal is to calculate how much time and money will be needed to implement an information systems solution, how much good it will do, and whether or not it's even possible [141-144]. The analyst performing the study utilises a number of prominent data collection techniques, including but not limited to:

- Creating surveys for stakeholders like potential users of the information system and distributing them.
- Check in with the people who are currently making use of the system to see if they have any complaints or suggestions.
- Gathering, reviewing, and analysing all relevant existing system documentation, including but not limited to reports, diagrams, procedures, manuals, and other written materials.
- Work actions in the existing system are being modelled, observed, and simulated.

The purpose of the feasibility study is to investigate potential solutions to the organization's information systems issues, assess their viability, and then recommend the most promising one. A solution's viability is determined by analysing each of its constituent parts [145-151].

Economic Feasibility

The purpose of the analysis is to determine how much money the system will cost the company. The corporation can only devote so much money to the system's development phase. Every penny spent must make sense [152]. Due to the widespread availability of the underlying technology, the designed system was also cost-effective. The only things that needed to be bought were the ones that were personalised.

Technical Feasibility

The purpose of this research is to determine whether or not the technical specifications of the system are actually achievable. Any new system can't place an excessive strain on the current infrastructure. This will put a considerable strain on the accessible technological means. Therefore, the customer might expect a lot of pressure as a result [153-159]. The developed system should have low requirements, as adopting it will need few or no changes.

Social Feasibility

The study's focus is on gauging user satisfaction with the system. The user must be instructed in the proper use of the system as part of this process. The user should feel safe using the system and should not view it as a danger. Getting people to embrace a new system is entirely dependent on how well you introduce it to them and how well you ensure they understand how it works. As the system's end user, he has to feel more certain in his abilities before he can offer any constructive criticism, which is always appreciated.

Operational Feasibility

Whether or not the various parties involved can and are willing to use, support, and run the planned computer information system. Leadership, staff, consumers, and vendors are all considered stakeholders. Stakeholders care about systems that are simple to use, have low mistake rates, generate the needed data, and align with the aims of the organisation.

Existing System Random Forest (RF):

An ensemble learning method for classification, regression, and other tasks, random forests or random decision forests work by constructing a large number of decision trees during training and then producing the class that is the mode of the classes (classification) or the mean/average prediction (regression) of the

individual trees. To address decision trees' tendency to overfit their training set, random decision forests offer a viable alternative. While they are superior to decision trees, random forests are not as accurate as gradient-boosted trees. However, their efficiency can be hampered by particular aspects of the data. Commonly used in many machine learning applications, decision trees are a powerful tool. Because it is invariant under scaling and various other transformations of feature values, is robust to the inclusion of irrelevant features, and produces inspectable models, tree learning "come[s] closest to meeting the requirements for serving as an off-the-shelf procedure for data mining," say Hastie et al. But they are usually off the mark. Overfitting their training sets, i.e. having low bias but very high variance, is a common trait among trees that are allowed to grow very deep. Random forests are a method for reducing variation by averaging the output of numerous deep decision trees that were each trained using a subset of the same training data. This typically results in a significant improvement in the final model's performance, albeit at the cost of a slight rise in the bias and some loss of interpretability. Efforts made using a decision tree algorithm are similar to those of a forest. The efficiency of a single random tree can be increased by utilising the combined efforts of multiple trees. Forests approximate the results of K-fold cross-validation, but they aren't the same.

Decision Tree (DT):

A decision tree is a tool used to help make choices by creating a tree diagram of potential outcomes, costs, and benefits associated with those choices. That's one method to show off an algorithm using simple if/then logic. In the field of operations research, decision analysis is where you'll most often find the use of decision trees to assist figure out which course of action is most likely to result in success. Nonetheless, they are also widely used in the field of machine learning. Each internal node of a decision tree represents a "test" on an attribute (such as whether a coin is headed up or down), each branch reflects the result of the test, and each leaf node represents a class label (decision taken after computing all attributes). The branches off the main trunk stand for differentiating criteria. In decision analysis, where the expected values (or expected utility) of competing alternatives are computed, a decision tree and the closely related impact diagram are employed as visual and analytical decision assistance tools.

In the fields of operations research and operations management, decision trees are a common tool. If decisions must be made in real time with no recall and just partial information available, a probability model should be used instead of a decision tree as the best choice model or online selection model method. A decision tree can also be used to describe the conditions under which a probability is calculated. Undergraduates in business, health economics, and public health programmes learn how to use decision analytic techniques like decision trees, influence diagrams, utility functions, and more. Both of these are commonplace in the fields of operations research and science.

UML Diagrams Use case Diagram

Dependencies and associations between a set of Use Cases and the Actors involved in the process can be depicted visually using a Use Case Diagram. Use Case Diagrams are a tool that can help you better communicate with your customers and the people who will be using your system in the future to determine what capabilities your system must have. Use Case Diagrams outline the desired functionality of a system but do not and cannot include its implementation details (figure 1).

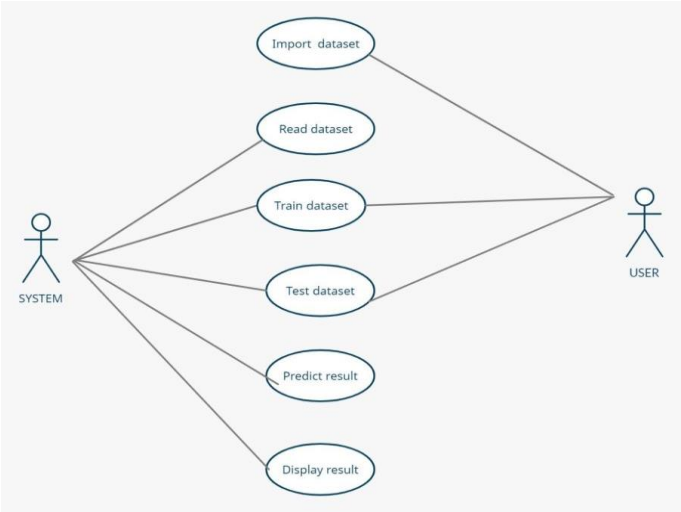

Figure 1: UML Diagrams Use case Diagram

Almost every project incorporates the use of use cases. Together, you can better reveal needs and organise the project. It is recommended that the majority of use cases be identified early in a project's lifecycle, but additional ones may become apparent as development proceeds.

Class Diagram

In object-oriented modelling, the Class Diagram serves as the fundamental building component. It's a tool for systematic and comprehensive model translation, utilised for conceptually modelling applications at a high level of abstraction. Data modelling is another application of class diagrams. In a class diagram, each class represents a key component of the application as well as an interaction between those components and the objects that will be written into the application. Boxes with three sides are used to represent these classes in class diagrams (figures 2 and 3).

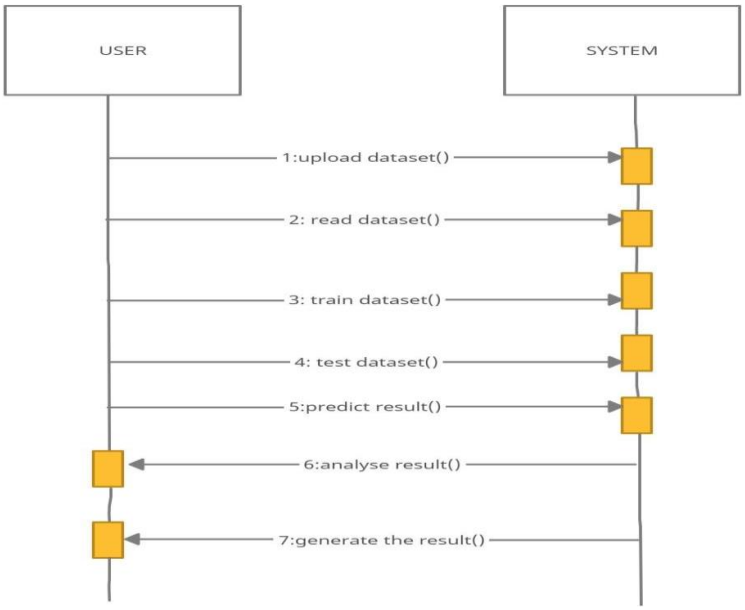

Figure 2: Sequence Diagrams

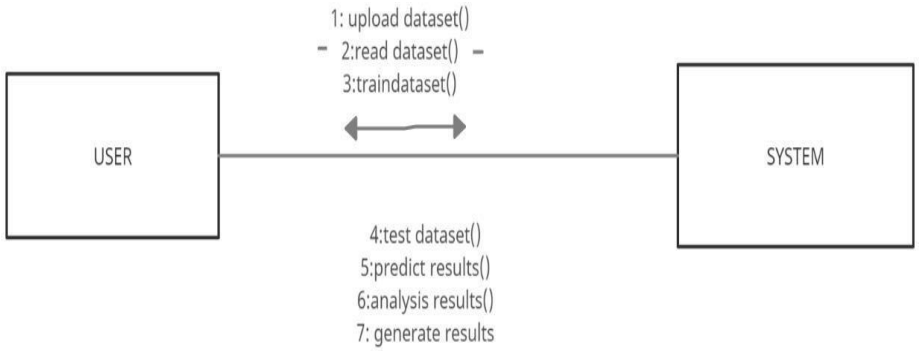

Figure 3: Collaboration Diagram

Database Design

Designing a database entails creating a comprehensive data model. To establish a database, this data model includes all the necessary logical and physical design decisions and physical storage characteristics. Each entity in a fully attributed data model has its own set of specific attributes. Many distinct facets of designing a database system can be included under the umbrella term "database design." It is best understood as the reasoning behind the foundational data structures that hold the data. Tables and views are the building blocks of the relational database paradigm. Entities and relationships in an object database have one-to-one correspondence with object classes and named relationships. However, the word database design can also refer to the process of creating the database management system's whole database application, including not just the fundamental data structures but also the forms and queries utilised by users (DBMS). There are various standard procedures a database designer will follow while creating a new database.

The preceding step can be further subdivided into two within the relational model: (1) determining the grouping of information within the system, or what are the basic objects about which information is being stored; and (2) determining the relationships between these groups of information, or objects. With an Object database, this is not a necessary procedure. Therefore, the data to be maintained in the database is typically determined in conjunction with a specialist in the field who is aware of what information must be kept in the system. Eliciting the necessary information from persons with domain knowledge is a skillful procedure that is typically part of requirements analysis and calls for the expertise of the database designer. This is because experts in the field aren't used to thinking in terms of discrete data items, therefore they have trouble articulating their database system requirements. The information that has to be saved can be specified by the requirements.

Data Dictionary

All databases should have a data dictionary. Metadata is the data about data, including information about the database itself. All of the adbms-required descriptions of the databases themselves can be found in the data dictionary. The data dictionary is typically an operational part of the DBMS. Each time a database is accessed, the DBMS looks up relevant information in the data dictionary. With numerous people working on the same database, it might be difficult to communicate exactly what information goes into which fields. Therefore, a data dictionary is a helpful accessory for preserving data uniformity. There is currently no accepted template for constructing a data dictionary. There is diversity in metadata between tables.

System Implementation

System elements at the lowest level in the system hierarchy are produced by the implementation process (system breakdown structure). Components of the system can be created, acquired, or repurposed.

Forming, removing, connecting, and polishing are all examples of hardware fabrication processes; developing and testing software are examples of software realisation processes; and operational procedure development is an example of an operational process. The goal of the implementation is to develop (or manufacture) a system component that meets the specifications laid forth for it in the component's design. The element is built using standard industry methods and equipment. This phase connects the steps of defining the system to the phase of integrating it. The phase of a project known as "System Implementation" is where the theoretical design is made into a functional system. The user's trust in the new system's ability to perform successfully and efficiently is the most important part of this process. The current system took a very long time to complete. The Python programming language was used in the creation of the suggested system. Because of the current setup, the communication process takes a very lengthy time. However, the final product is a user-friendly system that provides them with a graphical user interface and menus to navigate. The final step in any project is to have it installed on the required system after the code has been written and tested. The goal is to generate the executable and then run it. The code is retested in the production environment.

System Testing

Finding flaws is why we conduct testing. When testing, it's important to look for any and all potential points of failure. It's a method for verifying the operation of individual parts, assemblies, and even final products. Software testing is the practise of putting a programme through its paces to make sure it won't crash in an unacceptable way, as well as that it satisfies all of the requirements and user expectations set forth for it. The range of examinations available is broad. There are various kinds of tests, and each one caters to a different need.

Types of Tests

In order to ensure that the core programme logic is working as intended and that inputs produce legitimate outputs, unit testing requires the creation of test cases to verify this. It is important to test all possible paths of execution, both inside and outside of the main programme. Unit testing is the process of evaluating the functionality of the application's software in discrete parts. It's done after each component is finished but before they're integrated. To perform these invasive tests on a structure, one must have prior knowledge of its build. When testing a particular business process, application, or system configuration, unit tests run fundamental tests at the component level. Each possible branch of a business process can be tested individually to confirm it conforms to the published specifications and produces the desired results. The purpose of integration testing is to ensure that all parts of an application can be operated together smoothly. During testing, the focus is on the most fundamental results of screens and fields rather than on how they look. Even if all of the components passed their respective unit tests, that doesn't mean the whole thing is right and consistent unless it's been put though an integration test. The goal of integration testing is to find issues that occur when different parts are put together. Functional testing is a method of systematically proving that the system performs as expected in accordance with the business and technical specifications, the system documentation, and the user guides.

Open CV

Intel created the Open CV collection of functions for real-time computer vision, and Willogarage is now an official contributor and maintainer. Under the terms of the open-source BSD licence, its use is without cost. Five hundred plus optimised algorithms can be found in the collection. Forty thousand people throughout the world use it regularly. The applications span from innovative robotics and mine inspection to interactive art. Given that the library is mostly written in C, it may be easily ported to many platforms, including Digital Signal Processors. A number of language wrappers, including C, Python, Ruby, and Java (with Java CV), have been created to facilitate wider usage. The most up-to-date releases have C++

interfaces. As its name suggests, it is primarily concerned with processing images in real time. Open CV may be used on multiple operating systems thanks to its portable library format. Open CV has been hailed as the premier open-source computer vision library by programmers and academics alike.

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Prerequisites

To succeed, you need to know the fundamentals of computer programming. Possessing even a little competence in any programming language is an asset. Pandas relies heavily on NumPy's features. Before continuing with this tutorial, you should read our introduction to NumPy. The open-source Python Library Pandas provides access to its potent data structures and associated tools for data manipulation and analysis at scale. The term "Pandas" comes from the field of Econometrics known as "Panel Data." When programmer Wes McKinney found himself in need of high-performance, versatile tools for data processing, he began work on pandas in 2008. Python was commonly used for data munching and preprocessing prior to the release of Pandas. Few insights on the data were gained from it. The pandas were able to find a solution to this issue. When working with data of any kind, Pandas simplifies the process by allowing us to perform the five standard processes of processing and analysis: loading, preparing, manipulating, modelling, and analysing. The academic and business worlds, as well as the domains of finance, economics, Statistics, analytics, etc., all make use of Python with Pandas.

Standard Python distribution doesn’t come bundled with the Pandas module.

NumPy

NumPy, short for "Numerical Python," is a set of procedures and objects for working with multidimensional arrays. NumPy is used for performing arithmetic and logical operations on arrays. The fundamentals of NumPy, including its framework and operating system, are covered in this tutorial. Array indexing, functions, and other related topics are also covered. Also included is a primer on using Matplotlib. All of this is made clear using illustrative examples.

Audience

A primer on the fundamentals and capabilities of NumPy, this resource is intended for newcomers to the language. They will find it very helpful for creating algorithms. Following the completion of this guide, you should be at an intermediate level of expertise.

Prerequisites

You should be familiar with some of the common terms used in the field of computer programming. Having a familiarity with Python or any other programming language is an advantage. It's a Python package called NumPy. Mathematical Python is what it means. It's a collection of array-processing routines and multidimensional array objects housed in a library. Before there was NumPy, there was Jim

Hugunin's Numeric. Numarray, another package, was created as well, and it has a few extra features. NumPy was developed by Travis Oliphant in 2005, when he took the Numeric package and added certain features from the Numarray package. This open-source endeavour has received significant help from a large number of people.

NumPy – A Replacement for MatLab

SciPy (Scientific Python) and Matplot lib are two popular companion packages to NumPy (plotting library). This duo is frequently employed as an alternative to the well-known technical computing environment known as MatLab. But nowadays, Python is considered a more up-to-date and comprehensive alternative to MatLab. NumPy also has the benefit of being open source. The NumPy module is not included in the standard Python distribution. NumPy may be installed in a fraction of the time by utilising pip, Python's standard package manager (figure 4). NumPy is best enabled by installing a binary package tailored to your operating system. These executables provide access to the entire SciPy suite (including NumPy, SciPy, matplotlib, IPython, SymPy and nose packages and core Python).

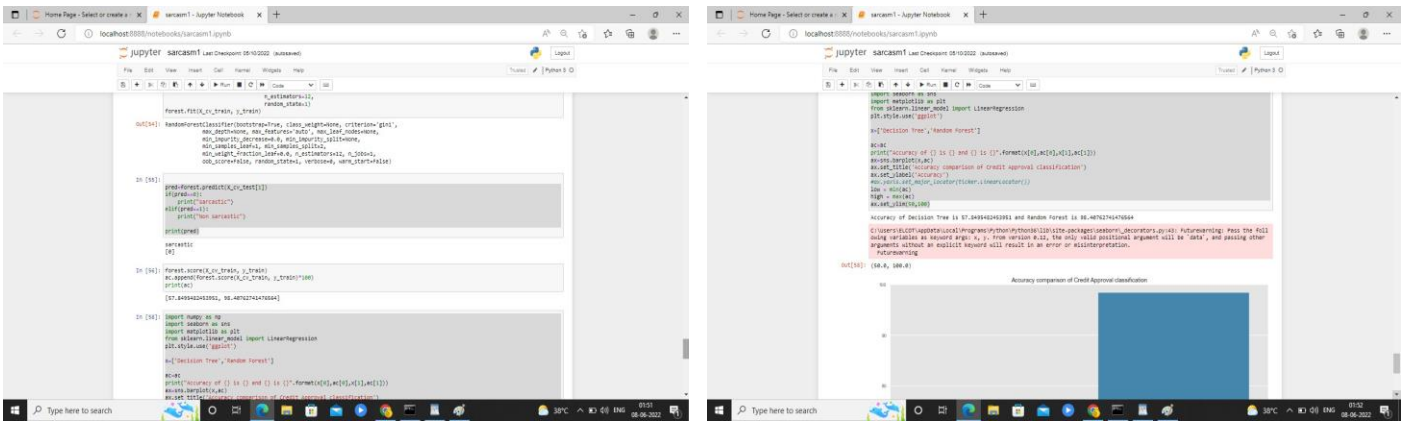

Figure 4: Model Outputs

Conclusion

Due to the ambiguity and complexity of sarcasm, it is one of the interesting subjects in sentiment analysis. It's a lot of work to improve the dataset's sarcasm detection. Scholars are interested in sarcasm detection studies in part because of this difficulty. To determine online sarcasm detection, we collect data and then, using a number of machine learning algorithms, provide a detailed representation of the Learning Model, which has the effect of producing more trustworthy and accurate results. Analyzing how people feel about particular things is the focus of a growing academic topic known variously as sentiment analysis or opinion mining. In this work, we address a fundamental shortcoming of sentiment analysis: the need to classify sentiments according to their polarity. Better pre-processing and text mining methods, such as emoji and slang detection, are provided as means of improving existing caustic comment detection algorithms. Assigning a sarcastic or nonsarcastic label to a tweet. Although a number of methods are employed, this study focuses on a classification algorithm and makes a number of suggestions for enhancing its performance that will lead to greater accuracy. The project derived analytical views from a social media dataset and filtered out or reversed analysed sarcastic tweets to comprehensively classify the given information. The model has been frequently tested, and it has the potential to collect tweets in real-time by filtering them using hashtags and then classifying them on the fly.

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