**Title Page:**

# Tracking of Moving Objects for Vehicles Classification in Traffic using Novel Deep Sort Algorithm over Decision Tree Algorithm with Improved Accuracy

K. Siva Naga Manoj Kumar[1], N. Deepa[2]

K. Siva Naga Manoj Kumar[1]
Research Scholar,
Department of Computer Science and Engineering,
Saveetha School of Engineering,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University, Chennai, Tamil Nadu, India. Pincode: 602105
kattekotakumar1630.sse@saveetha.com

N. Deepa[2]
Research Guide, Corresponding Author
Department of Computer Science and Engineering,
Saveetha School of Engineering,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University, Chennai, Tamil Nadu, India. Pincode: 602105
ndeepa.sse@saveetha.com

**Keywords:** Decision Tree, Deep learning, Machine learning, Novel Deep Sort, Object Detection, Traffic, Vehicle.

## ABSTRACT

**Aim:** The proposed work focuses on extracting the accurate tracking of moving objects for Vehicles Classification in Traffic using Novel Deep Sort (NDS) over Decision Tree (DT) Algorithm. **Materials and Methods:** Tracking of Moving Objects for Vehicles Classification in Traffic. classification of vehicles is performed by Novel Deep Sort (N=24) of sample size and Decision tree algorithm of sample size (N=24), obtained by G power of 80%. **Results**: Novel Deep Sort has the accuracy of 88.54% which is relatively higher than Decision Tree which has accuracy of 83.79% and it shows that there is statistical significance difference between the Novel Deep Sort algorithm with Decision Tree with p=0.030 ($p<0.05$) . **Conclusion**: Novel Deep Sort has higher accuracy of 88.54% in classification of vehicles Decision Tree algorithm of accuracy 83.79%.

**Keywords:** Decision Tree, Deep learning, Machine learning, Novel Deep Sort, Object detection, Traffic, Vehicle.

## INTRODUCTION

A subset of machine learning known as deep learning is focused on deep neural networks, or neural networks with several learning layers (Zomaya 2023; Shlezinger et al. n.d.). Its ability to extract intricate representations and structures from large datasets allows it to produce precise forecasts and classifications. Various artificial intelligence applications, picture and audio recognition (Javed et al. 2022) , and natural language processing are among the applications. Inaccuracy in tracking moving objects for traffic vehicle classification (L. Chen, Pelger, and Zhu 2023). It improves vehicle classification accuracy and traffic monitoring for applications like adaptive traffic signal control and law enforcement, allowing for the management of traffic congestion (Zuo et al. 2022) the capacity to monitor and classify cars in traffic is necessary for enhancing the timing of traffic signals, implementing regulations, enhancing urban planning, guaranteeing road safety, and supporting security-related initiatives, surveillance, pollution control, and the development of autonomous vehicles. It is essential to many different fields and helps to build intelligent, safer, and more effective transportation systems (Yang et al. 2022).

In the research of Tracking of Moving Objects for Vehicle,different paper which performed research on tracking of moving objects for vehicle in traffic are found in IEEE xplore, ScienceDirect and springer. 762 journals are found form IEEE Xplore digital library, 4826

articles from science direct, 17665 articles articles from Springer. Research work (Zuo et al. 2022) contains 129 more citations and is about the advances technologies like intrusive sensing, video processing and machine learning is crucial for timely maintenance and public safety. The article (Nabati and Qi 2021) contains more citations 212. The article provides the combining motion detection and key frame selection to enhance vehicle video analysis in IoT-enabled intelligent transportation systems.Article (K. Qian et al. 2021) contains more citations 87 times and is about the Vehicle detection with visual sensors like lidar and camera is one of the critical functions. The article (Z. Qian, Jabbar, and Li 2022) contains more citations 86 times and it's about the enhanced lightweight YOLOv5 method for vehicle detection and to improve detection accuracy. The article (Y. Chen et al. 2021) this paper provides a survey of deep learning techniques for vehicle detection.

In the research paper of An Improved YOLOv2 for Vehicle Detection which as low accuracy while tracking of moving objects in traffic (Diwan, Anirudh, and Tembhurne 2022) A Novel Approach Integrating Novel Deep Sort and Decision Tree Algorithm introduces a method to address the task of tracking and categorizing moving vehicles in challenging traffic conditions By combining the strengths of the Novel Deep Sort and Decision Tree algorithm this study aims to achieve levels of accuracy in vehicle classification (Jagannathan et al. 2021). The Novel Deep Sort , known for its ability to identify data patterns, is seamlessly integrated with the interpretability and rule based decision making capabilities of Decision Trees resulting in a framework that effectively handles real world traffic complexities (Q. Zhang et al. 2023) This research holds implications for optimizing traffic monitoring and management systems ultimately improving safety and efficiency in transportation. The proposed work focuses on extracting the accurate tracking of moving objects for Vehicles Classification in Traffic using Novel Deep Sort (NDS) over Decision Tree (DT) Algorithm (Yu et al. 2022)**.**

## MATERIALS AND METHODS

Research work took place within the well-equipped AR and VR lab at the Saveetha School of Engineering, part of the Saveetha Institute of Medical and Technical Sciences (Diwan, Anirudh, and Tembhurne 2022) where the lab is equipped with a high configuration system to conduct study and get the result. Number of groups considered for the review were two with a sample size of 24. The calculation obtained 80% of G-power value with 0.05 alpha value and 0.8 beta value with 95% confidence interval (Li et al. 2022).

Dataset used in this proposed work is Vehicle Recognition in videos file dataset . This dataset is downloaded from Kaggle. The file dataset which is 2GB size which is a traffic CCTV videos.The video contains vehicles. Since ,the proposed work is about the recognition of moving

objects in traffic, the dataset used is mp4 file with some vehicles.The algorithm which is proposed in this paper is implemented with dataset and compares the result with the comparison algorithm (Aboah 2021).

Google collab is one of the products from google.its runs on the cloud. Python code can be executed in google collab without any setup. this actually stores the code that runs on Google Drive. Google collab has pre installed libraries and provides real time collaboration.Google Collab is available for free and gives you access to a specific amount of CPU and GPU power to run your code. Google Colab integrates with Google Drive, so you can easily save and load data and notebooks from your Google Drive account.

**Novel Deep Sort Algorithm**

The Novel Deep Sort algorithm detects moving objects, sample preparation group 1. Using the combination of deep learning techniques, Novel Deep Sort generates complex structures that accurately identify automobile visual behavior. For accurately tracking and categorizing cars in dynamic traffic situations, Novel Deep Sort is a great tool.Smart traffic surveillance systems benefit greatly from Novel Deep Sort capacity to manage obstructions, enhance online learning, and give re-identification, all of which increase the accuracy of multi-object tracking.In dynamic traffic settings, Novel Deep Sort excels at Novel Deep Sort precisely tracking and classifying cars. Novel Deep Sortenhances the precision of vehicle direction.s re-identification capability makes it an essential part of modern traffic management systems.These characteristics come together to offer a complete solution for accurate and instantaneous monitoring in traffic scenarios. proposed algorithm pseudocode of Novel Deep Sort shown in Table 1 (Min, Oh, and Song 2021)**.**

**Decision Tree Algorithm**

The Decision Tree method is essential for improving accuracy when tracking moving objects in real time for vehicle classifying in traffic, sample preparation group 2. Machine learning models that are flexible and easy to understand, decision trees work well for classification applications. Decision Trees can be taught to evaluate features taken from tracked vehicles and make defensible categorization decisions in the context of traffic surveillance. These trees are composed of leaf nodes that indicate the vehicle class, and nodes that represent features, tests and paths that represent potential outcomes. Decision trees facilitate decision-making transparency and offer insightful information about the variables affecting vehicle classification. Decision Tree algorithms' increased accuracy leads to more dependable and efficient tracking in traffic situations, which promotes developments in intelligent transportation systems and

improves overall safety and efficiency on the roads. proposed algorithm pseudocode of decision tree shown in Table 2 (Y. Zhang et al. 2022).

**Statistical Analysis**

IBM SPSS with version 27.0 Statistical software was used to analyze the standard error mean, mean, standard deviation value. Video frame as independent values. Input video data which is recorded video, Frame id as dependent variables and analysis of T-test is conducted in this research work (Guo, Qi, and Wu 2021)**.**

**RESULTS**

The pseudocode of Novel Deep Sort can be found in table 1. The required libraries are imported from training with the dataset ,a data set is divided into two sets of models for testing and training ,and those are assigned to different function to calculate accuracy.

The pseudocode of decision tree can be found in table 2. The required libraries are imported from training with the dataset, a data set is divided into two sets of models for testing and training ,and those are assigned to different function to calculate accuracy.

In table 3 ,the video dataset table accuracy is represented for both Novel Deep Sort and decision tree .

Table 4 represents the N (24), mean (88.54), std.Deviation(2.395), std.error mean values (0.489) for the Novel Deep Sort and N (24), mean (83.79), std.Deviation(2.859), std.error mean values (0.584) for decision tree.

The T-test results for the statistical independence sample are shown in Table 5. With a p-value of 0.030 ($p<0.005$), the mean difference, standard error difference, and 95% confidence interval indicate a statistically significant difference between the Novel Deep Sort and decision tree.

Figure 1 Represents Line Graph for Accuracy values for N=24 iterations for Novel Deep Sort algorithm. X-axis:iterations, Y-axis:Accuracy values.

Figure 2 Represents Line Graph for Accuracy values for N=24 iterations for Decision Tree . X-axis:iterations, Y-axis:Accuracy values.

Figure 3 Represents Line Graph for Accuracy values for N=24 iterations for both DeepSort and Decision Tree. X-axis:iterations, Y-axis:Accuracy values. The Blue line indicates the Novel Deep Sort algorithm and Red line indicates the Decision Tree algorithm. By the above graph Novel Deep Sort have higher Accuracy then Decision Tree.
Figure 4 is a bar graph which represents the T-test results for the Novel Deep Sort and decision tree. It clearly shows that the accuracy rate of Novel Deep Sort has higher accuracy than the decision tree.

**DISCUSSION**

Analyzing the results of an independent T-test,significance is determined. 0.030 is the significance value which is lesser than 0.05 which is significant and Novel Deep Sort accuracy is 88.54 which is greater than the accuracy of the decision tree which is 83.79 and the difference between the two groups is significant.

In the recent survey, the Novel Deep Sort algorithm has been found to have more promising accuracy than the other real world algorithms (Aboah 2021). The present framework will combine the two datasets with the data collected from the users and found that the Novel Deep Sort has provided the best accuracy (Al-qaness et al. 2021). Proposed Novel Deep Sort algorithm has been significantly faster than the other gradient boosting methods and has more precise accuracy by all means (Butilă and Boboc 2022). The results can be developed by implementing new features and picking the best data set. Some of the researchers have proposed the Novel Deep Sort algorithm in some of their research articles and concluded that the Novel Deep Sort algorithm has provided better results than the other Machine Learning algorithms (Jagannathan et al. 2021). Some of the articles have proposed the Decision tree SVM algorithm to classify the vehicles in traffic and found it had provided better accuracy in some cases than our proposed Novel Deep Sort algorithm (Jagannathan et al. 2021)). In some research surveys some of the researchers have implemented the SVM algorithm to provide future tracking of Moving Objects for Vehicles Classification in Traffic and found out that it provided more accurate results than our Novel Deep Sort algorithm (Abid, Khan, and Iqbal 2020).

Specifically, the study looks at tracking moving objects for vehicle classification in traffic utilizing Novel Deep Sort over Decision Tree Algorithm with enhanced accuracy. One of the study's influences is the way Novel Deep Sort captures changing patterns of traffic. As busy areas or sudden changes in vehicle movement patterns may have an impact on Novel Deep Sort effectiveness, limitations may include difficulties managing blocks and complicated traffic

circumstances. Future research will examine advanced fusion methods, including combining Novel Deep Sort with other machine learning algorithms, to improve vehicle categorization accuracy under various traffic scenarios.

## CONCLUSION

To improve the accuracy of the tracking and classification of moving vehicles in traffic performed by the Novel Deep Sort algorithm and Decision Tree algorithm with multiple dataset comparing two algorithms the accuracy rate of Novel Deep Sort is 88.54 which is higher than the Decision Tree 83.79. Novel Deep Sort performance is more compared to the Decision Tree and classification is higher in Novel Deep Sort than Decision Tree.

## DECLARATIONS

### Conflict of Interest

No conflict of interest in this manuscript.

### Authors Contributions

Author MK was involved in methodology, text analysis and writing the manuscript. Author ND was involved in review and editing, supervision and validation.


### Acknowledgements

The authors would like to express their gratitude towards Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (Formerly known as Saveetha University) for providing the necessary infrastructure to carry out this work successfully.

**Funding:** We thank the following organizations for providing financial support that enabled us to complete the study.

1. Cyclotron Technologies,Chennai
2. Saveetha University
3. Saveetha Institute of Medical and Technical Sciences
4. Saveetha School of Engineering

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## TABLES AND FIGURES

**Table 1.** Novel Deep Sort Pseudo code. Transformers play a key role in Novel Deep Sort. It analyzes the vehicles in traffic.

| |
|---|
| **Input:** Video Dataset |
| **Output:** Accuracy (%) |
| **Step 1:**<br>● data collection<br>● video dataset<br>● data processing |
| **Step 2:**<br>**Object Detection:**<br>Utilize a pre-trained object detection model to identify and locate vehicles in each frame of the video. |
| **Step 3:**<br>**Feature Extraction:**<br>Extract deep appearance features for each detected vehicle, using a pre-trained feature extraction model. |
| **Step 4:**<br>**Data Association:**<br>Perform data association to link detections across frames, associating features with tracked objects using methods like the Hungarian algorithm. |
| **Step 5:**<br>**Object Tracking :**<br>Implement object tracking which predicts the next state of each tracked object and updates it based on the associated features. |
| **Step 6:**<br>**Vehicle Classification :**<br>Optionally, integrate a classifier or decision rules to classify vehicles based on their features. |

**Table 2.** Decision Tree  Pseudo code. Transformers play a key role in Decision Tree . It  analyzes the vehicles in traffic

| |
|---|
| **Input:** Video dataset |
| **Output:** Accuracy (%) |
| **Step 1**<br>**Data Collection and Labeling:**<br>● Collect a labeled dataset with features extracted from tracked vehicles in traffic, including attributes like size, speed, and color.<br>● Label each example with the corresponding vehicle class. |
| **Step 2**<br>**Data Preprocessing:**<br>Preprocess the dataset by handling missing values, normalizing numeric features, and encoding categorical variables if needed. |
| **Step 3**<br>**Train Decision Tree:**<br>Train a Decision Tree classifier using the preprocessed dataset. |
| **Step 4**<br>**Evaluate Decision Tree**:<br>Assess the performance of the Decision Tree on a testing set to calculate accuracy and other relevant metrics. |
| **Step 5**<br>**Integration with Object Tracking:**<br>Integrate the trained Decision Tree classifier with the object tracking system to classify vehicles in real-time |
| **Step 6**<br>**Visualization:**<br>Optionally, visualize the results by displaying tracked objects along with their assigned classifications. |

**Table 3.** With N=24 sample size ,video data input is taken, the accuracy rate is calculated in every for Novel Deep Sort and decision tree .the Novel Deep Sort has more accuracy compared to decision tree

| S.No | Novel Deep Sort Accuracy (%) | Decision Tree Accuracy (%) |
|---|---|---|
| 1 | 89 | 85 |
| 2 | 88 | 82 |
| 3 | 86 | 85 |
| 4 | 88 | 82 |
| 5 | 86 | 82 |
| 6 | 88 | 85 |
| 7 | 89 | 85 |
| 8 | 89 | 80 |
| 9 | 90 | 87 |
| 10 | 96 | 88 |
| 11 | 88 | 80 |
| 12 | 87 | 80 |
| 13 | 95 | 80 |
| 14 | 88 | 86 |
| 15 | 88 | 88 |
| 16 | 86 | 87 |
| 17 | 87 | 86 |
| 18 | 88 | 86 |
| 19 | 87 | 85 |
| 20 | 89 | 86 |
| 21 | 88 | 85 |
| 22 | 87 | 80 |
| 23 | 89 | 81 |
| 24 | 89 | 80 |

**Table 4.** Statistics for independent samples comparing Novel Deep Sort with Decision Tree Algorithm. In Novel Deep Sort , the mean accuracy is 88.54, whereas in DT it is 83.79. Novel Deep Sort has a standard deviation of 2.395 and DT has a standard deviation of 2.859. Standard error mean for Novel Deep Sort 0.489 is and DT 0.584.

| **Group Statistics** | | | | | |
|---|---|---|---|---|---|
| | **Algorithm** | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
| **Accuracy** | **NDS** | 24 | 88.54 | 2.395 | 0.489 |
| | **DT** | 24 | 83.79 | 2.859 | 0.584 |

**Table 5.** T-Test for Statistical Independent Samples comparing Novel Deep Sort with Decision Tree Algorithm, 95% Confidence Interval. It shows that there is statistical significance difference between the Novel Deep Sort algorithm and Decision Tree with p=0.030 (p<0.05).

| Independent Samples Test | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Accuracy | Equal variances assumed | 5.925 | .019 | 6.239 | 46 | .030 | 4.750 | .761 | 3.218 | 6.282 |
| | Equal variances not assumed | | | 6.239 | 44.632 | .031 | 4.750 | .761 | 3.216 | 6.284 |

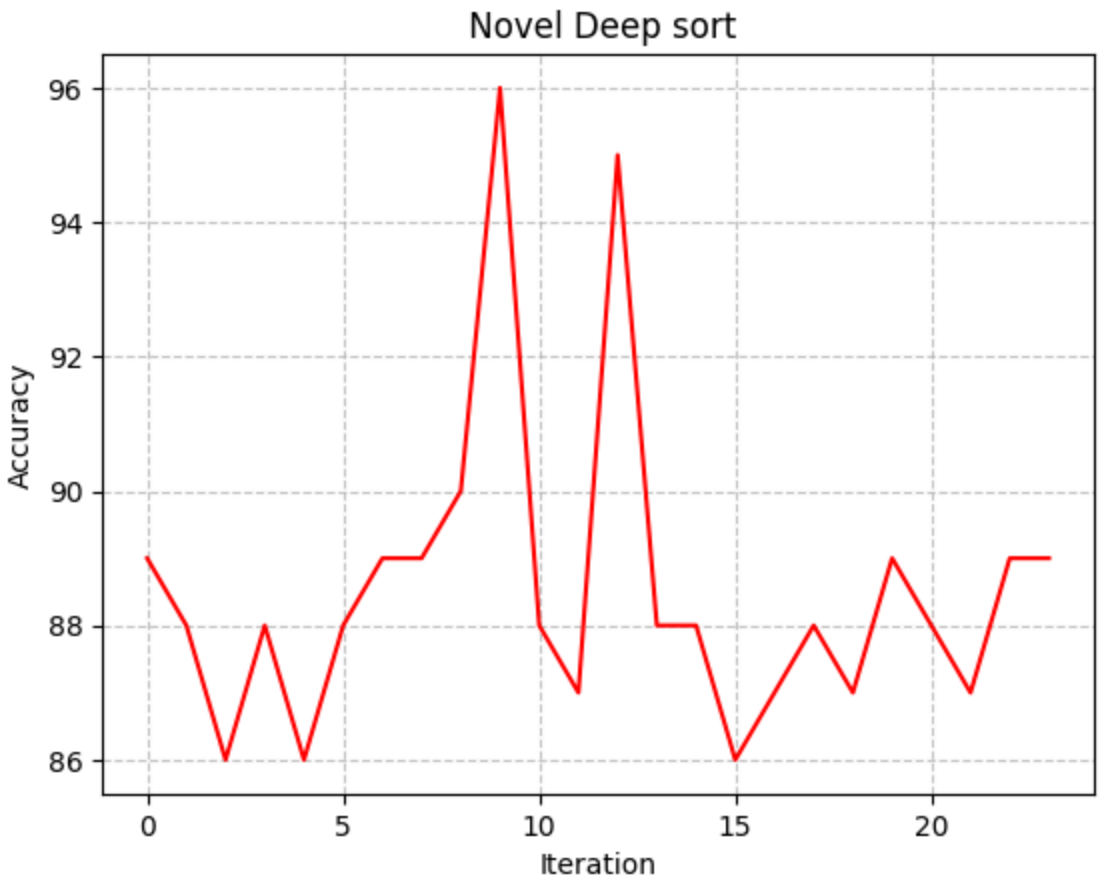


**Fig. 1.** Line Graph for Accuracy values for N=24 iterations for Novel Deep Sort Model. X-axis:iterations, Y-axis:Accuracy values.

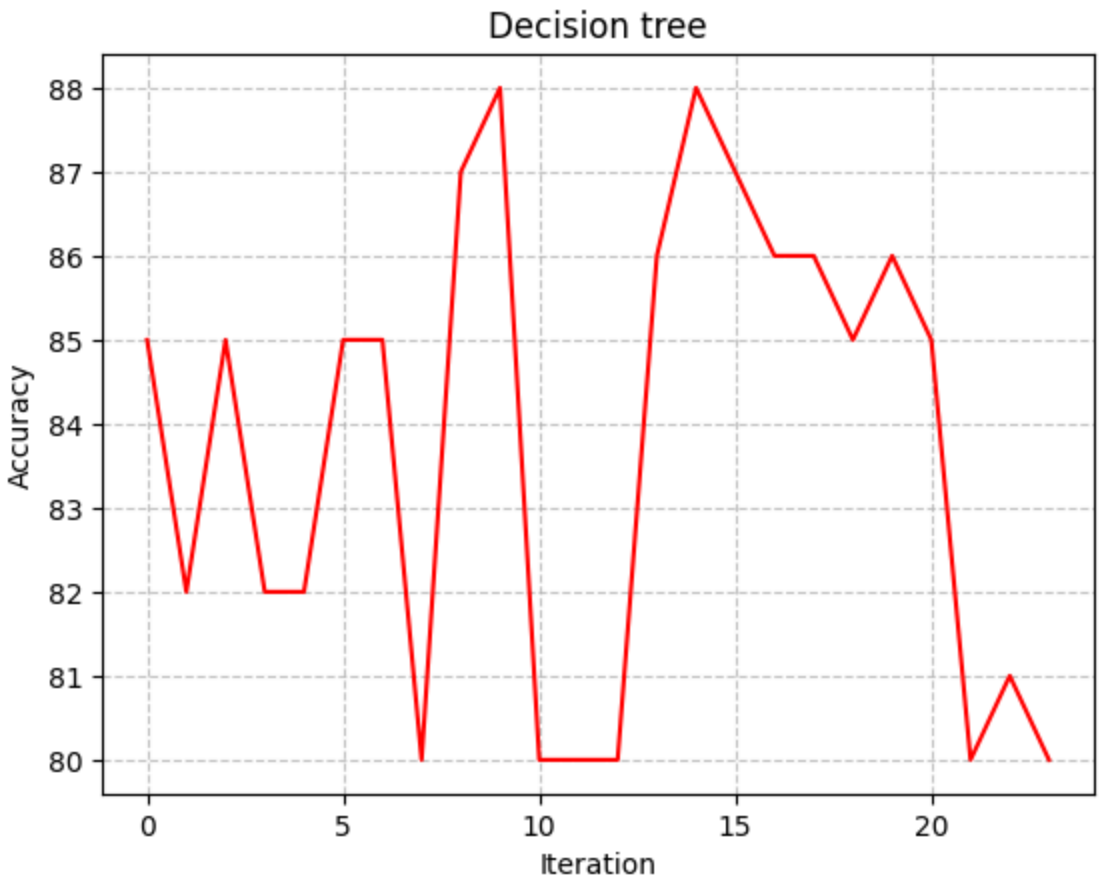


**Fig. 2.** Line Graph for Accuracy values for N=24 iterations for Decision Tree X-axis:iterations, Y-axis:Accuracy values.

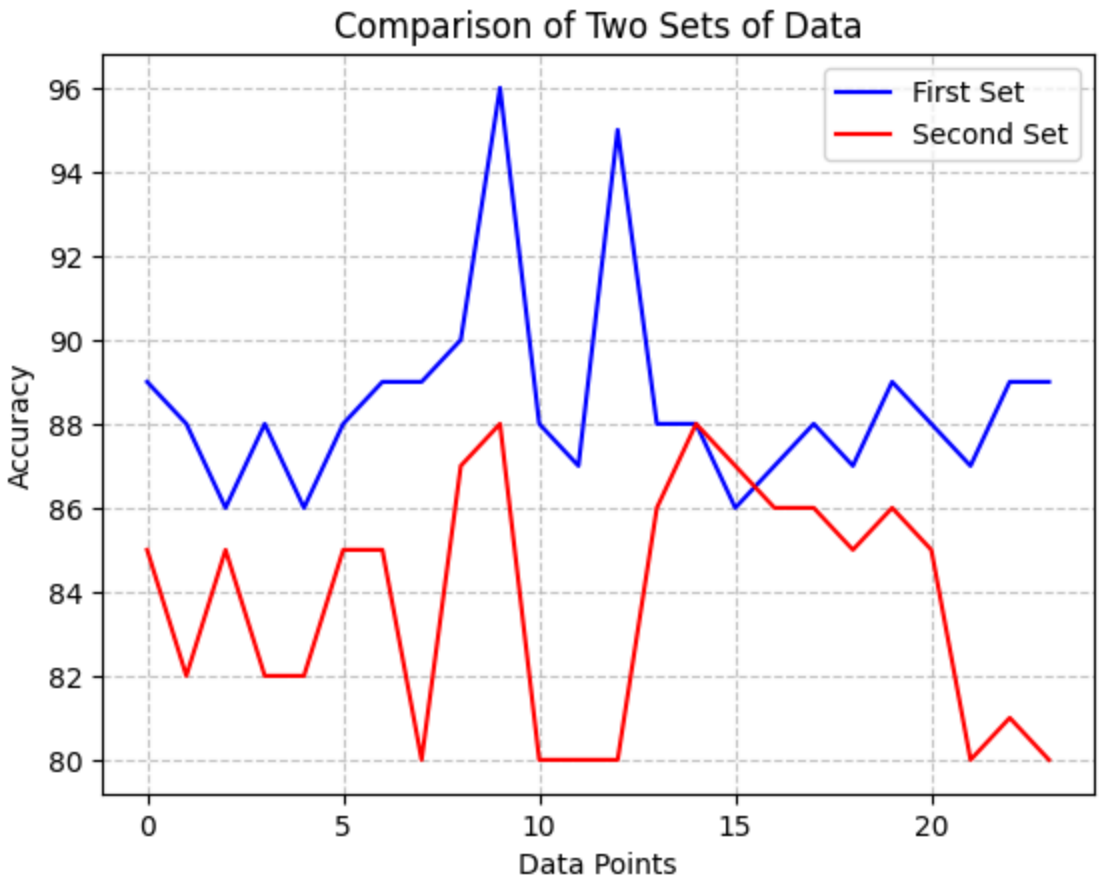


**Fig. 3.** Line Graph for Accuracy values for N=24 iterations for both DeepSort and Decision Tree. X-axis:iterations, Y-axis:Accuracy values. The Blue line indicates Novel Deep Sort algorithm and the Red line indicates the Decision Tree algorithm. By the above graph Novel Deep Sort have higher Accuracy then Decision Tree.

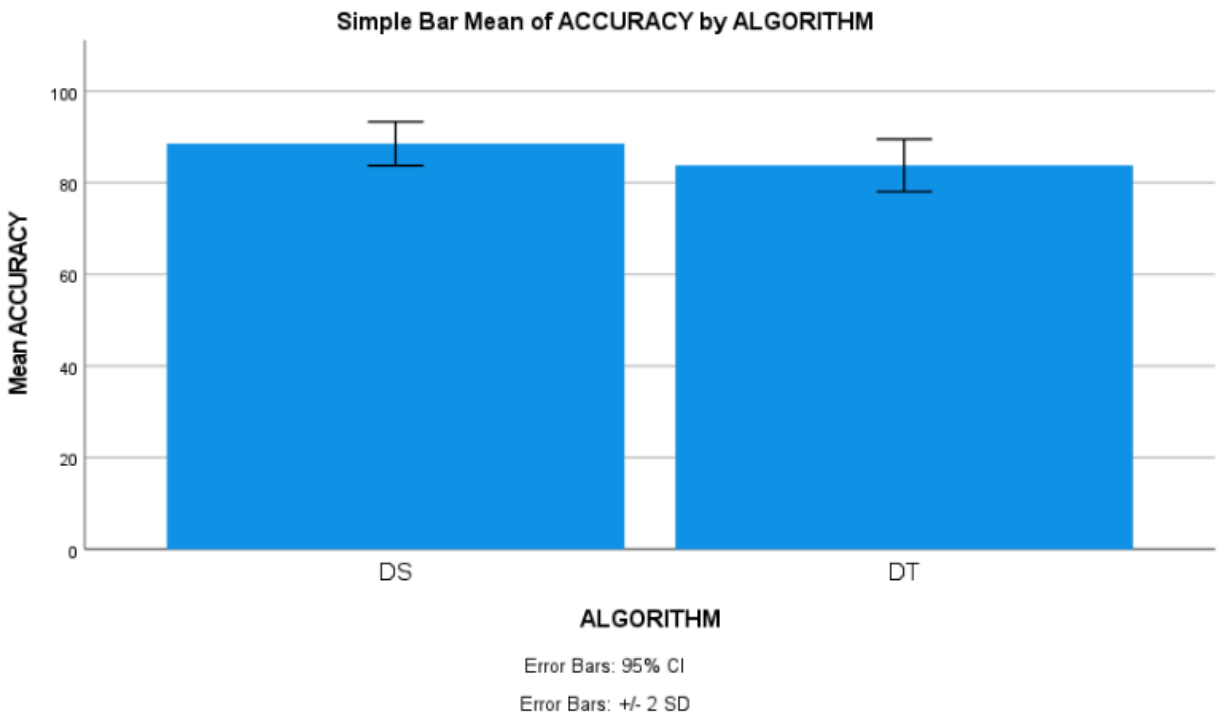


**Fig. 4.** The mean accuracy comparison between Novel Deep Sort and decision tree algorithm shows that Novel Deep Sort has a higher mean accuracy of 88.54, compared to the 83.79 of decision tree . The standard deviation of Novel Deep Sort is also lower than that of the decision tree algorithm. On the X-axis: Novel Deep Sort vs. decision tree algorithm, and on the Y-axis: Mean Accuracy. The error bar is represented by ± 2 SD