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**Article Title**: **Enhancing Secure Communication in VANETs with Blockchain and Privacy using PSOACO Algorithm**

# Enhancing Secure Communication in VANETs with Blockchain and Privacy using PSOACO Algorithm

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## ABSTRACT

This study explores the optimization of shortest paths in intelligent transportation systems using a hybrid Particle Swarm Optimization and Ant Colony Optimization (PSOACO) algorithm. The study focuses on improving traffic flow efficiency and minimizing travel time by finding the most optimal routes for vehicles. Utilizing simulations and algorithmic analysis, the PSOACO algorithm is evaluated for its effectiveness in guiding vehicles through complex traffic networks. The results demonstrate significant improvements in route planning and traffic coordination, showcasing the potential of hybrid optimization techniques in enhancing intelligent transportation systems' performance. This study contributes to the advancement of efficient routing strategies, critical for managing traffic congestion and improving overall transportation system efficiency.

**Keywords:** Shortest path, Hybrid PSOACO Algorithm, Optimization, Intelligent transportation systems, Traffic flow efficiency.

## 1 Introduction

The Introduction to the work "Enhancing Secure Communication in VANETs through Blockchain-Based Anonymous Authentication and Integrity Preservation using PSOACO Algorithm" sets the context for addressing critical challenges in modern transportation systems. With the rise of intelligent transportation systems (ITS), efficient traffic management and secure communication are paramount for ensuring smooth and safe mobility. Traditional VANETs face vulnerabilities such as privacy concerns, inefficient traffic coordination, and data integrity risks, highlighting the need for innovative solutions

The work's focus is on leveraging emerging technologies like blockchain and optimization algorithms to tackle these challenges. Blockchain technology offers decentralized and tamper-resistant data storage, making it ideal for ensuring secure and anonymous authentication in VANETs. By implementing blockchain-based authentication mechanisms, the work aims to enhance trust and privacy among vehicles while preserving data integrity

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The utilization of the hybrid Particle Swarm Optimization and Ant Colony Optimization (PSOACO) algorithm further enhances the work's capabilities. This algorithm, known for its ability to find optimal routes in complex networks, is applied to optimize shortest paths in intelligent transportation systems. By efficiently routing vehicles, the PSOACO algorithm contributes to reducing travel time, minimizing congestion, and improving traffic flow efficiency.

Through simulations and algorithmic analysis, the work evaluates the effectiveness of the PSOACO algorithm in guiding vehicles through dynamic traffic networks. The expected outcomes include significant improvements in route planning, traffic coordination, and overall system performance. These advancements not only benefit individual vehicles by reducing travel time but also contribute to the broader goal of creating smarter, safer, and more efficient transportation networks.

## 2 Existing System

The existing system is to leverage blockchain technology, decentralized traffic coordination, and anonymized communication to address challenges in traditional Vehicular Ad-hoc Networks (VANETs). This includes enhancing security, privacy, traffic efficiency, and coordination among vehicles, while also exploring the integration of technologies like IoT, fog/edge computing, machine learning, and data analytics to optimize traffic management and communication in real-world transportation scenarios.

### 2.1 Existing System Architecture

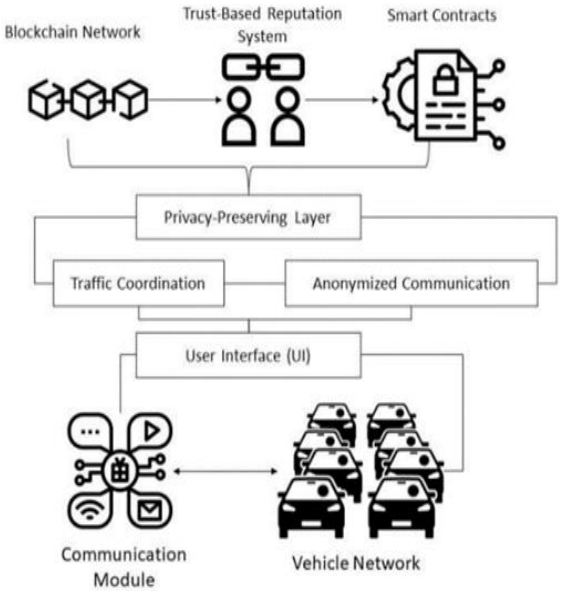


**Figure 1:** *Existing System Architecture*

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**Blockchain Network**: The system's foundation is a distributed network of nodes (vehicles), each maintaining a copy of the Blockchain and participating in the consensus process.

**Trust-Based Reputation System:** Each vehicle has a trust calculation module that computes and updates trust scores based on interactions and behaviours. These scores are broadcast and recorded on the Blockchain.

**Smart Contracts:** Deployed on the Blockchain, smart contracts automate traffic management tasks like intersection coordination and congestion control based on predefined conditions.

**Privacy-Preserving Layer:** Advanced cryptographic techniques ensure anonymous vehicle communication, including secure data sharing, encryption, and decryption.

**User Interface (UI):** Vehicles feature an intuitive UI for drivers to access traffic information and receive real-time updates, displaying data derived from the Blockchain and smart contracts.

**Communication Module:** Equipped with cryptographic keys, vehicles use communication modules for secure interactions, ensuring encryption and decryption for data exchange.

### 2.2 Drawbacks

- Complexity
- Scalability
- Cost
- Security Risks

## 3 Proposed System

The proposed system focuses on optimizing the hybrid Particle Swarm Optimization and Ant Colony Optimization (PSOACO) algorithm for efficient routing in intelligent transportation systems. Through simulations, it aims to minimize travel time and enhance traffic flow coordination in complex road networks.

The goal is to develop robust routing strategies to manage traffic congestion, reduce fuel consumption, and improve overall transportation system efficiency. This initiative addresses critical challenges posed by urbanization and rising vehicular traffic, contributing to sustainable urban mobility and enhancing the performance and reliability of intelligent transportation systems.

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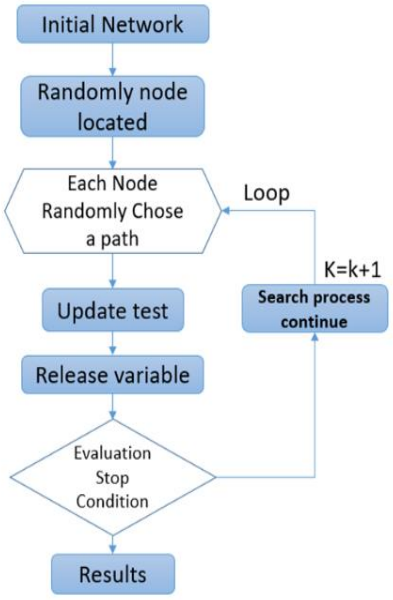


**Figure 2:** *Flow chart for PSOACO method*

**Initial Network:** At the start, the network is established with a predefined set of nodes placed randomly across the network space.

**Randomly Located Nodes:** Nodes are positioned without any specific pattern or order, simulating real-world randomness in node distribution.

**Each Node Chooses a Path Randomly:** Each node independently selects a path from its current position to a destination, simulating decentralized decision-making.

**Loop:** The process enters a loop to iterate through the steps until a termination condition is met, typically to achieve convergence or a specific solution quality.

**Update Test:** This step likely involves evaluating the current state of the network, such as assessing path lengths, congestion levels, or other performance metrics.

**Search Process Incrementation (K=k+1):** A variable, often denoted as K, is incremented to track the number of iterations or search process steps completed.

**Continue:** The loop continues, returning to the path selection step (Step 3), allowing nodes to reassess and potentially change their chosen paths based on the current network state.

**Release Variable:** This step might involve releasing resources or resetting certain variables within the algorithm to prepare for the next iteration.

**Evaluation Stop Condition:** The loop terminates when a predefined condition is met, such as reaching a specified number of iterations, achieving a target solution quality, or satisfying convergence criteria.

**Results:** Once the loop ends, the algorithm outputs the results, which could include optimal paths, network performance metrics, or other relevant data for analysis and decision-making.

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In network optimization, nodes are initially scattered randomly across the network. They independently choose paths, a process repeated in a loop with iterative updates. Evaluation criteria guide the refinement of path choices until a termination condition is satisfied. This decentralized approach fosters adaptability and efficiency in route selection. The algorithm's performance hinges on variable management and continuous evaluation, ensuring optimal paths are determined. This process, combining randomness with iterative refinement, mirrors real-world complexities in network routing and decision-making. The final results showcase a network structure finely tuned for efficient data transmission and resource utilization.

### 3.1 Block-Diagram

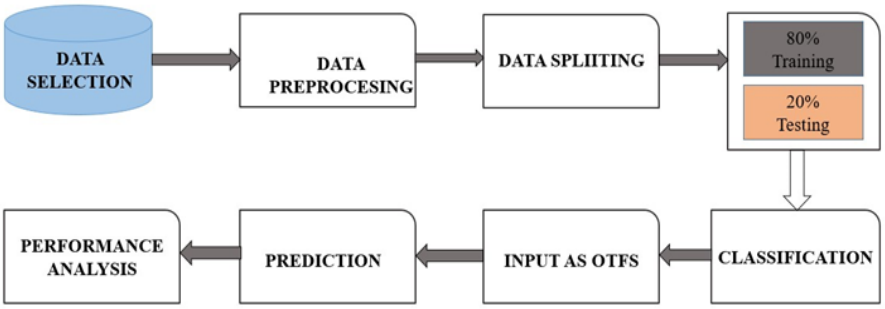


**Figure 3:** *Block Diagram of Proposed System*

- **Data Selection:** Relevant datasets like traffic patterns and vehicle movements are chosen from public repositories or collected through sensors.
- **Data Preprocessing:** Data is cleaned, scaled, and encoded to prepare it for analysis, including handling missing values and outliers.
- **Data Splitting:** The dataset is divided into training and testing sets, ensuring unbiased model evaluation.
- **Training Model:** Machine learning models are trained using the training data, optimizing their performance through hyper parameter tuning.
- **Classification:** Trained models classify data, such as predicting traffic congestion or identifying hazards.
- **Prediction:** Predictive modelling forecasts future events, like traffic patterns or road conditions.
- **Performance Evaluation:** Model performance is assessed using metrics like accuracy and precision, validating its effectiveness in real-world scenarios.

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By following these stages of operation, the proposed method can effectively leverage data-driven approaches to enhance traffic coordination, optimize resource allocation, and improve the overall efficiency and safety of B-VANETs.

### 3.2 Implementation

Implementing Blockchain-Enhanced Vehicular Ad-hoc Networks (B-VANETs) with decentralized traffic coordination and anonymized communication involves several steps and considerations. Here's a high-level overview of the implementation process:

- **Environment Setup:** Prepare the development tools and programming languages needed for B-VANET.
- **Blockchain Infrastructure:** Deploy and configure blockchain nodes and smart contracts.
- **Decentralized Traffic Coordination:** Use smart contracts for traffic management tasks and route optimization.
- **Anonymized Communication:** Develop encryption techniques for secure and private vehicle communication.
- **Hybrid PSO-ACO Algorithm:** Implement the PSO-ACO algorithm for efficient traffic flow.
- **Integration with SDN:** Connect B-VANET with Software-Defined Networking for dynamic management.
- **Data Selection and Preprocessing:** Choose relevant datasets and clean them for analysis.
- **Model Training and Classification:** Train machine learning models to classify traffic conditions.
- **Performance Evaluation:** Assess system performance using accuracy and latency metrics.
- **Testing and Validation:** Test extensively and validate system functionality and security.
- **Deployment:** Deploy the B-VANET system in real or simulated environments and monitor its performance.

## 4 Performance Metrics

Performance measures are used to evaluate the network performance of the proposed model. this work uses accuracy, precision, recall, and f1-score as performance measures, which are formulated.

**a) Accuracy**

Measures the overall correctness of recognized signs or gestures compared to the ground truth.

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$$Accuracy = \frac{\text{Number of correctly predicted instances}}{\text{Total number of instances}}$$

**b) Precision**

Precision signifies the proportion of correctly recognized signs among all recognized signs.

$$\text{Precision} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$$

**c) Recall**

Recall measures the proportion of correctly recognized signs among all actual signs

$$Recall = \frac{\text{True Positives}}{\text{True Positives+False Negatives}}$$

**d) F1-Score**

This harmonic mean of precision and recall provides a balanced measure of a model's performance.

$$F1 - Score = 2X\frac{\text{Precision}\times\text{Recall}}{\text{Precision+Recall}}$$

## 5 Results

### 5.1 Open Navigator

- Open the code file using an integrated development environment (IDE) or a text editor.
- Compile or interpret the code based on the programming language used.
- Execute the code to perform tasks such as data processing, model training, or system simulation.

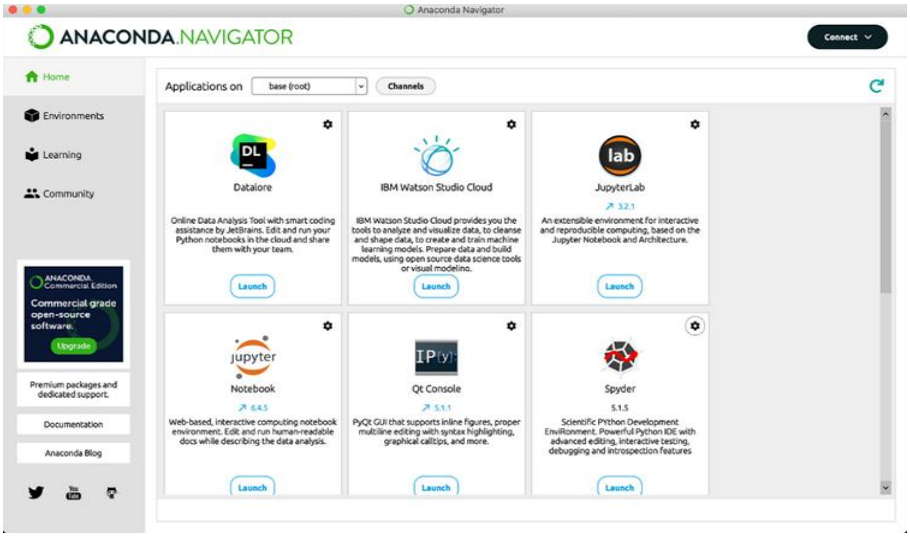


**Figure 4:** *Spyder IDE in Anaconda software*

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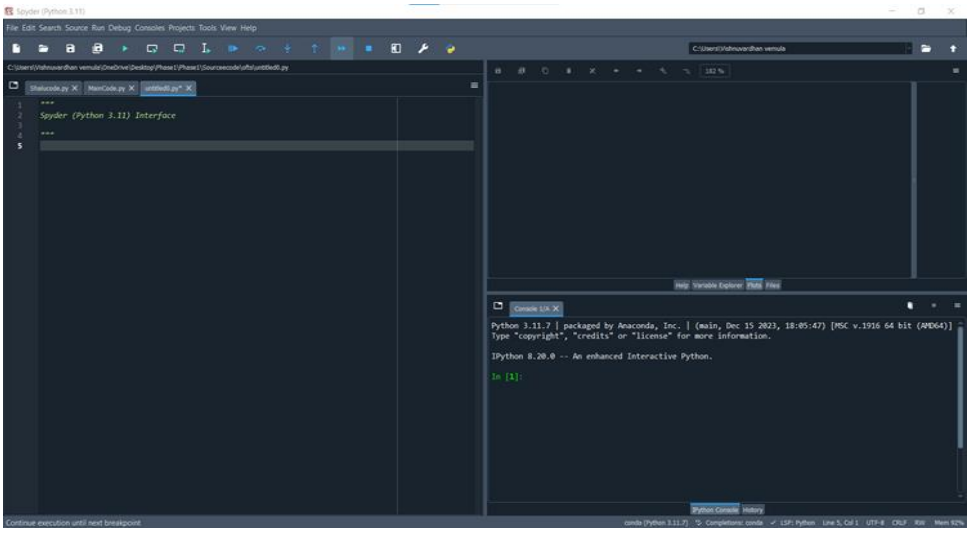

**Figure 5:** *Spyder (Python 3.11) Interface*

## 5.2 Data Selection

- Choose relevant datasets for analysis and modelling.
- Ensure the datasets are in a suitable format for processing.

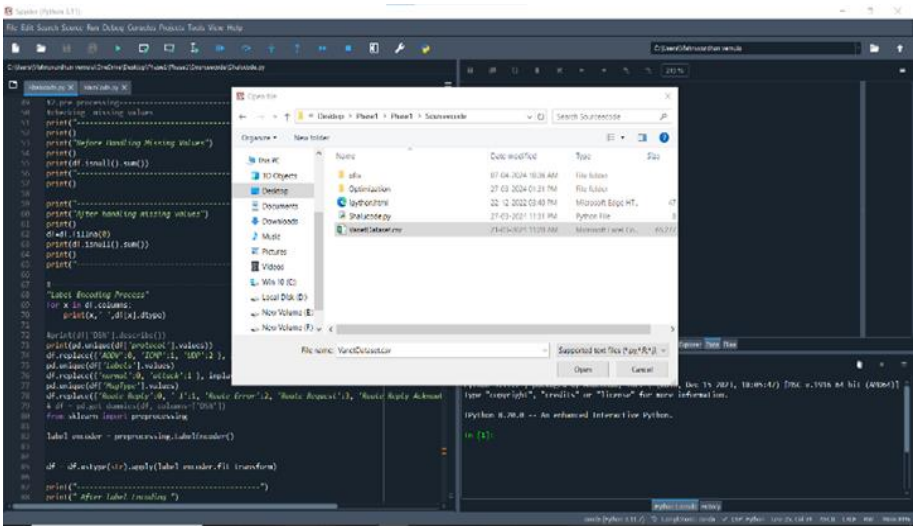

**Figure 6:** *Choose relevant dataset*

## 5.3 Run the Code

Execute the code to observe its functionality and output.

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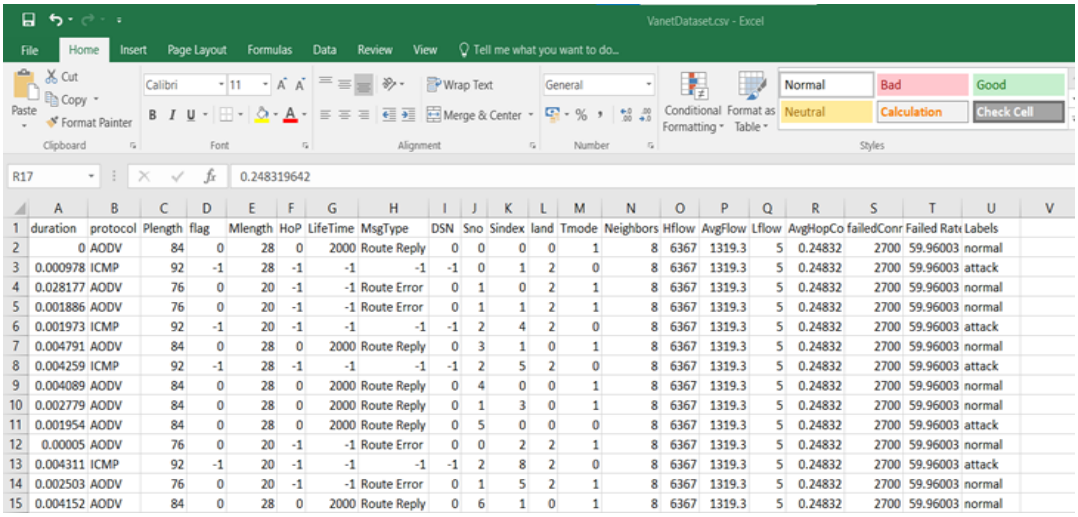

VanetDataset.csv - Excel

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | duration | protocol | Plength | flag | Mlength | HoP | LifeTime | MsgType | DSN | Sno | Sindex | land | Tmode | Neighbors | Hflow | AvgFlow | Lflow | AvgHopCo | failedConr | Failed Rate | Labels | |
| 2 | 0 | AODV | 84 | 0 | 28 | 0 | 2000 | Route Reply | 0 | 0 | 0 | 0 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 3 | 0.000978 | ICMP | 92 | -1 | 28 | -1 | -1 | -1 | -1 | 0 | 1 | 2 | 0 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | attack | |
| 4 | 0.028177 | AODV | 76 | 0 | 20 | -1 | -1 | Route Error | 0 | 1 | 0 | 2 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 5 | 0.001886 | AODV | 76 | 0 | 20 | -1 | -1 | Route Error | 0 | 1 | 1 | 2 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 6 | 0.001973 | ICMP | 92 | -1 | 20 | -1 | -1 | -1 | -1 | 2 | 4 | 2 | 0 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | attack | |
| 7 | 0.004791 | AODV | 84 | 0 | 28 | 0 | 2000 | Route Reply | 0 | 3 | 1 | 0 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 8 | 0.004259 | ICMP | 92 | -1 | 28 | -1 | -1 | -1 | -1 | 2 | 5 | 2 | 0 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | attack | |
| 9 | 0.004089 | AODV | 84 | 0 | 28 | 0 | 2000 | Route Reply | 0 | 4 | 0 | 0 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 10 | 0.002779 | AODV | 84 | 0 | 28 | 0 | 2000 | Route Reply | 0 | 1 | 3 | 0 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 11 | 0.001954 | AODV | 84 | 0 | 28 | 0 | 2000 | Route Reply | 0 | 5 | 0 | 0 | 0 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | attack | |
| 12 | 0.00005 | AODV | 76 | 0 | 20 | -1 | -1 | Route Error | 0 | 0 | 2 | 2 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 13 | 0.004311 | ICMP | 92 | -1 | 20 | -1 | -1 | -1 | -1 | 2 | 8 | 2 | 0 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | attack | |
| 14 | 0.002503 | AODV | 76 | 0 | 20 | -1 | -1 | Route Error | 0 | 1 | 5 | 2 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |
| 15 | 0.004152 | AODV | 84 | 0 | 28 | 0 | 2000 | Route Reply | 0 | 6 | 1 | 0 | 1 | 8 | 6367 | 1319.3 | 5 | 0.24832 | 2700 | 59.96003 | normal | |

**Figure 7:** *Dataset in excel sheet*

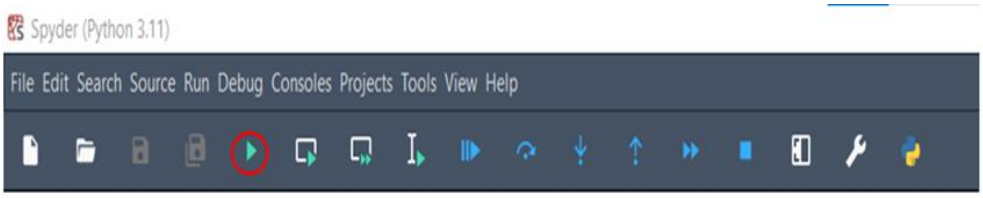


**Figure 8:** *Run the code*

### 5.4 Build Network

- By using network we can create source & destination nodes.
- In the above green node is source and red node is destination node.

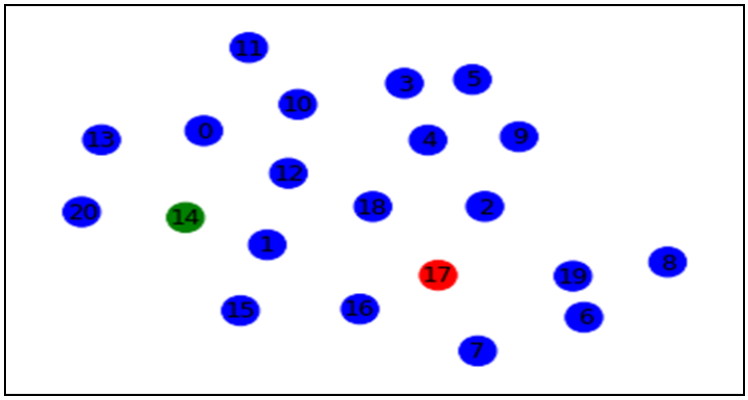


**Figure 9:** *Network Building*

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The above figure with three different circles on a white background. The green circle has the number "14" it is a source node, and the red circle has the number "17" which is the destination node.

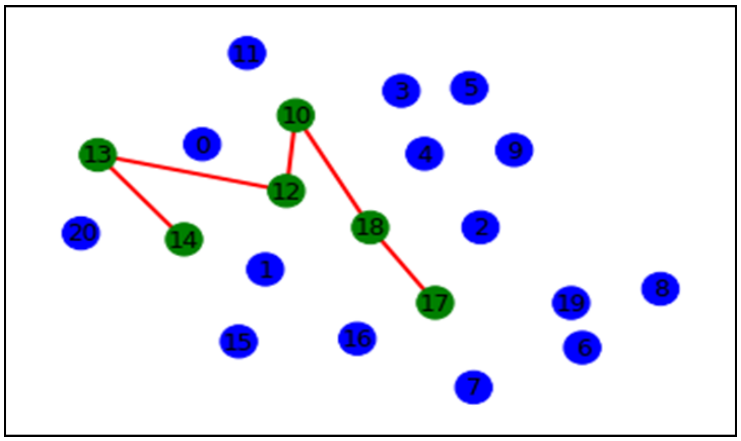


**Figure 10:** *Best Path from Source to Destination Node*

The above figure appears to be finding the smallest path in a larger network “14” is a source node and “17” is a destination node, it is connected by the red line.

### 5.5 Handling user Input

- If the code requires user input, provide the necessary data or parameters as required.
- Follow any prompts or instructions provided within the code for user interaction.

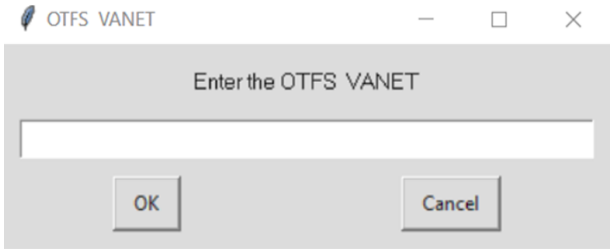


**Figure 11:** *User input*

The above figure gives input as an OTFS to predict vehicle is an attack or non-attack

### 5.6 Attack / Non-Attack Detection

- Use the processed input "OTFS" as input to the system's attack detection mechanism.
- Determine whether the input represents an attack or a non-attack scenario based on predefined criteria or machine learning models.

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*5.6.1 Sample Output-1*

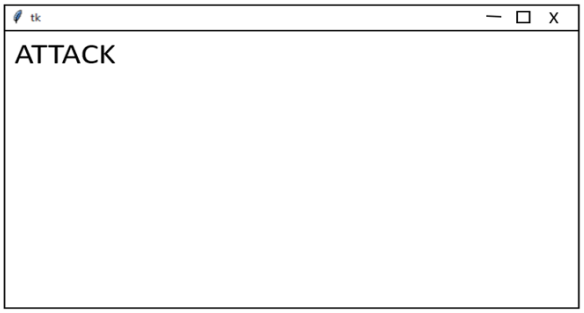


**Figure 12:** *Output as Attack*

The Tkinter popup window displays an attack message triggered by the input from the OTFS system. The message indicates that the vehicle has been attacked, highlighting a potential security breach or malicious activity within the vehicular network. This notification serves as a warning to alert system operators or users about the security threat, prompting immediate action to investigate and mitigate the attack. Such visual cues are essential for real-time monitoring and response in ensuring the safety and integrity of the vehicular communication environment.

*5.6.2 Sample Output-2*

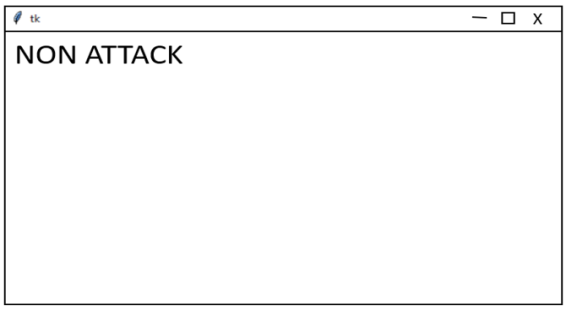


**Figure 14:** *Output as Non-Attack*

The Tkinter popup window displays a non-attack message triggered by the input from the OTFS system, indicating that the vehicle has not been attacked. This message provides reassurance regarding the security status of the vehicle, affirming that no malicious activities or security breaches have occurred within the vehicular network. Such notifications play a crucial role in maintaining user confidence and ensuring the reliability of the system. They contribute to effective monitoring and management of security incidents, allowing for prompt response and mitigation measures when genuine threats are detected.

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## 6 Application and Advantages

### 6.1 Applications

- Emergency Vehicle Coordination
- Wrong way driver warning
- Supply Chain Management
- Environmental Monitoring

### 6.2 Advantages

There are some advantages of this Work.

- Increases communication time
- Incident management
- Quick response
- Reliability and Resilience

## 7 Conclusion and Future Scope

### 7.1 Conclusion

By using a hybrid PSOACO algorithm and integrating blockchain technology, this study significantly improved route planning and traffic coordination in intelligent transportation systems. The simulations and algorithmic analysis demonstrated the effectiveness of the PSOACO algorithm in optimizing routes, reducing congestion, and enhancing traffic flow efficiency. The system architecture, with its components like blockchain networks and trust-based reputation systems, addressed existing drawbacks such as complexity and security risks. Moving forward, further study can focus on refining the system, exploring new optimization algorithms, and addressing evolving challenges in transportation systems. The ultimate goal is to create smarter, safer, and more efficient transportation networks for sustainable urban mobility. This study lays a solid foundation for future developments in intelligent transportation systems and optimization techniques.

### 7.2 Future Scope

Future study can make this system better by finding smarter ways to plan routes and manage traffic using new technologies like AI and edge computing. We also need to make sure our system can handle bigger networks and different situations smoothly. Keeping our data safe and protecting privacy is very important too. Improving how people interact with our system and using real-time data to manage traffic better are also areas to explore. Working together with companies and government can help us put these ideas into action, making transportation systems smarter and more efficient for everyone.

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