Optimization scheduling simulation for an Electric Vehicle(EV) Charging Station

A mathematical approach to jointly optimize EV charging station allocation and workforce scheduling using Vehicle-to-Everything (V2X) data systems.

Group-13

Rising EV Demand

Growing EV adoption creates huge pressure on urban infrastructure.

Allocation Challenge

Need real-time solutions for where and how to allocate charging stations.

Workforce Optimization

Human resources must be optimized for maintenance and support.

V2X Systems

Live data flows between EVs and infrastructure enable smart management.

Problem Statement

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EV Charging Station Allocation

Optimize placement and availability of charging points.

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Workforce Scheduling

Efficiently manage human resources for maintenance and support.

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V2X Data Integration

Utilize real-time vehicle data for dynamic optimization.

Relevance & Applications

Urban Smart Cities

Integrate with city-wide infrastructure planning and management systems.

EV Fleet Logistics

Optimize charging for delivery companies and transportation services.

Grid-level Energy Optimization

Balance power distribution across charging network.

Service & HR Planning

Streamline workforce management for EV infrastructure.

Core Mathematical Model

Goal: Maximize Station Availability

We define availability as the ratio of free capacity to total capacity.

$$A_j = \frac{\texttt{station.capacity}(j) - \texttt{station.occupied}(j)}{\texttt{station.capacity}(j)}$$

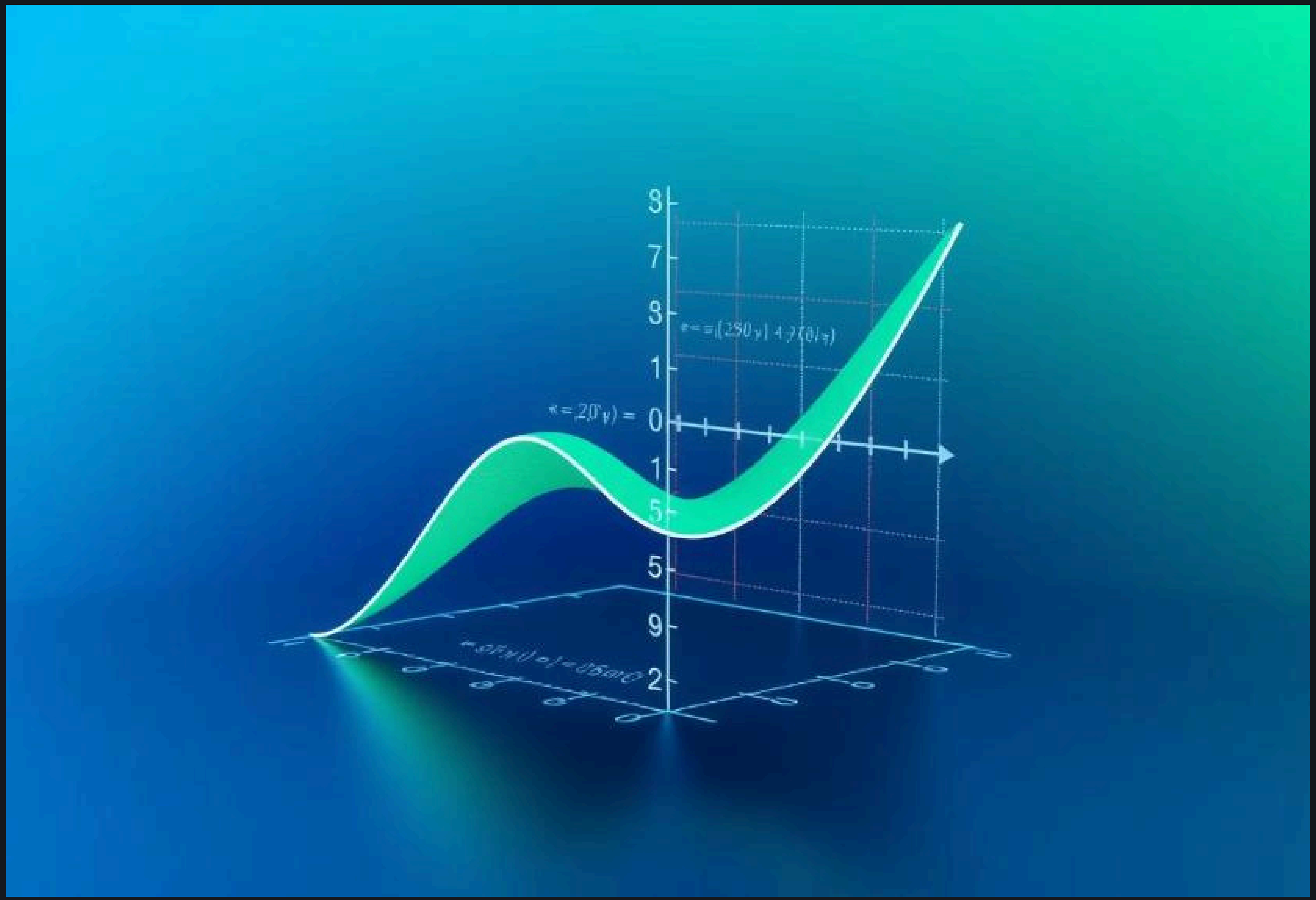
x_ij → Binary decision variable: 1 if car i is allocated to station j, else 0

Objective Function

$$\max \sum_{i=1}^{\texttt{numCars}} \sum_{j=1}^{\texttt{numStations}} A_j \cdot x_{ij}$$

Intution

- Assign cars to more available stations
- Avoid overloading any single station
- Keep system adaptive to incoming vehicles



Constraints

One Station Per Car

Each vehicle can be assigned to at most one charging station.

$$\sum_{j=1}^{\texttt{numStations}} x_{ij} \leq 1 \quad \forall i = 1, 2, \ldots, \texttt{numCars}$$

Distance Constraint

Vehicles can only reach stations within their range.

r_i = min(charge_i × mileage_i, maxDist_i)

Station Capacity

Total assignments cannot exceed available capacity.

$$\sum_{i=1}^{\texttt{numCars}} x_{ij} + \texttt{station.occupied}(j) \leq \texttt{station.capacity}(j)$$

Graph Theory & Pathfinding

Network Construction

Each station represents a node in our network.

Edge Definition

Edges represent paths based on distance between stations.

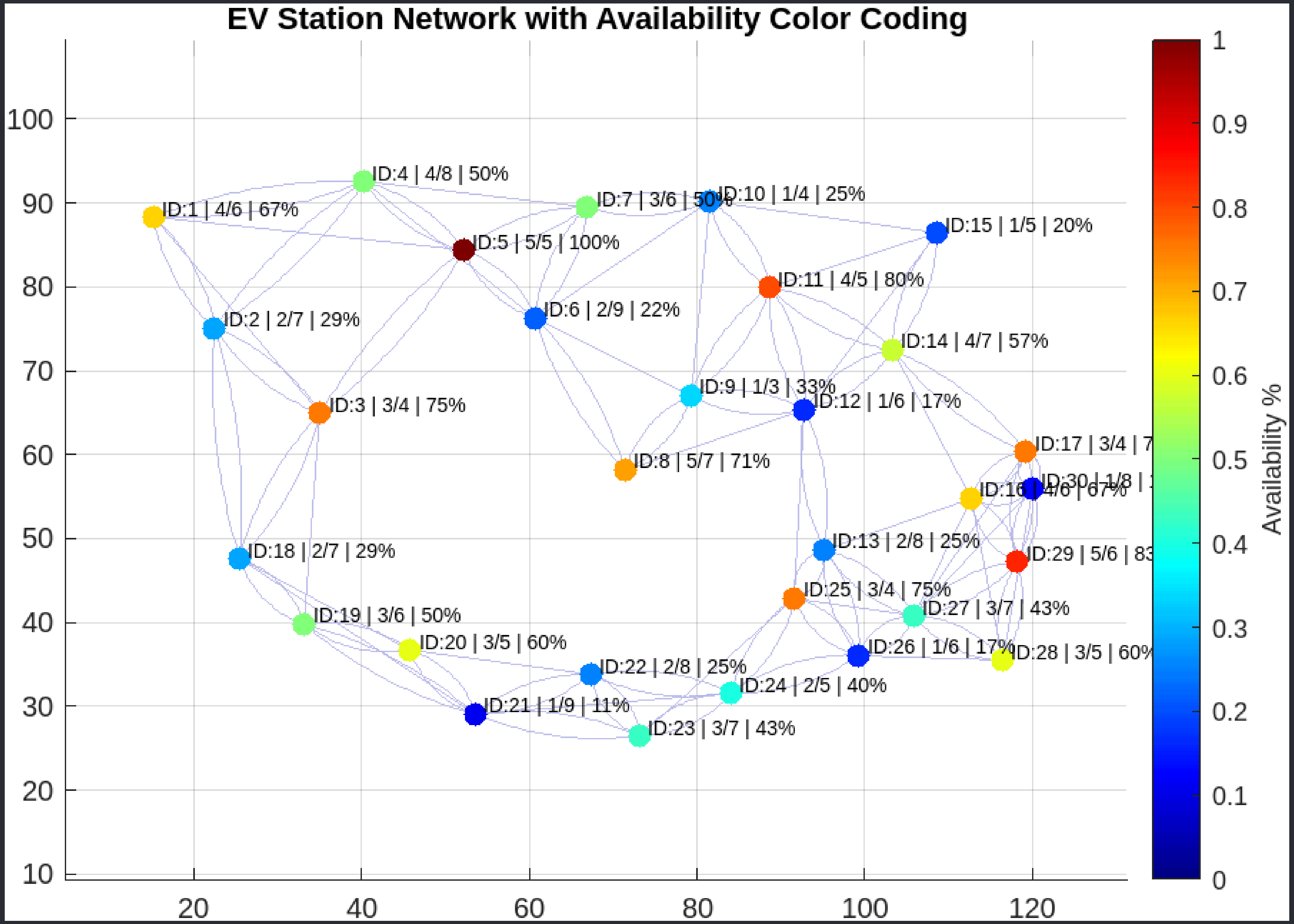
Graph Properties

Sparse but connected graph based on Euclidean distances.

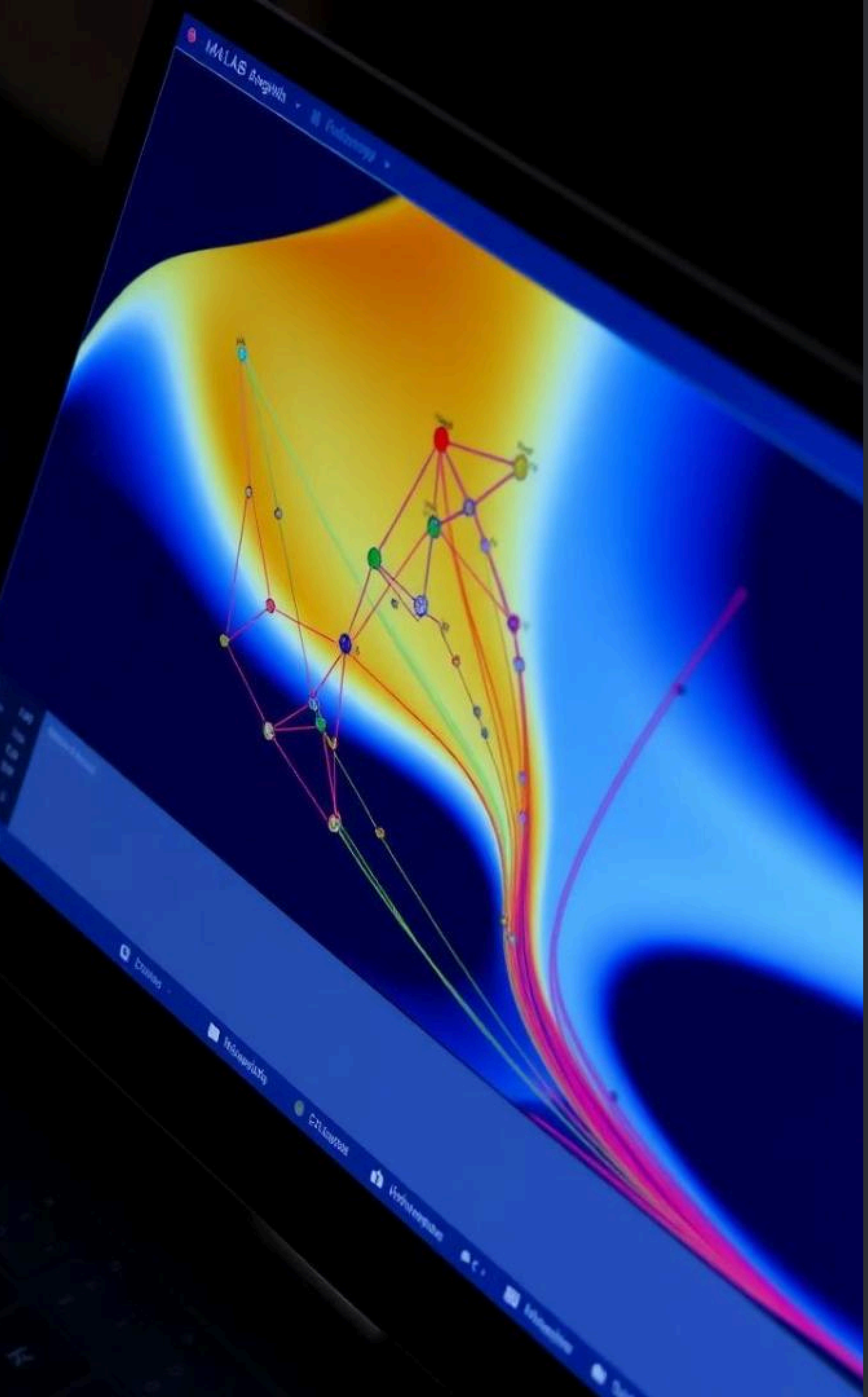
Dijkstra's Algorithm

Used for finding optimal shortest paths between stations.

MATLAB Simulation



Idealistic Grid Network

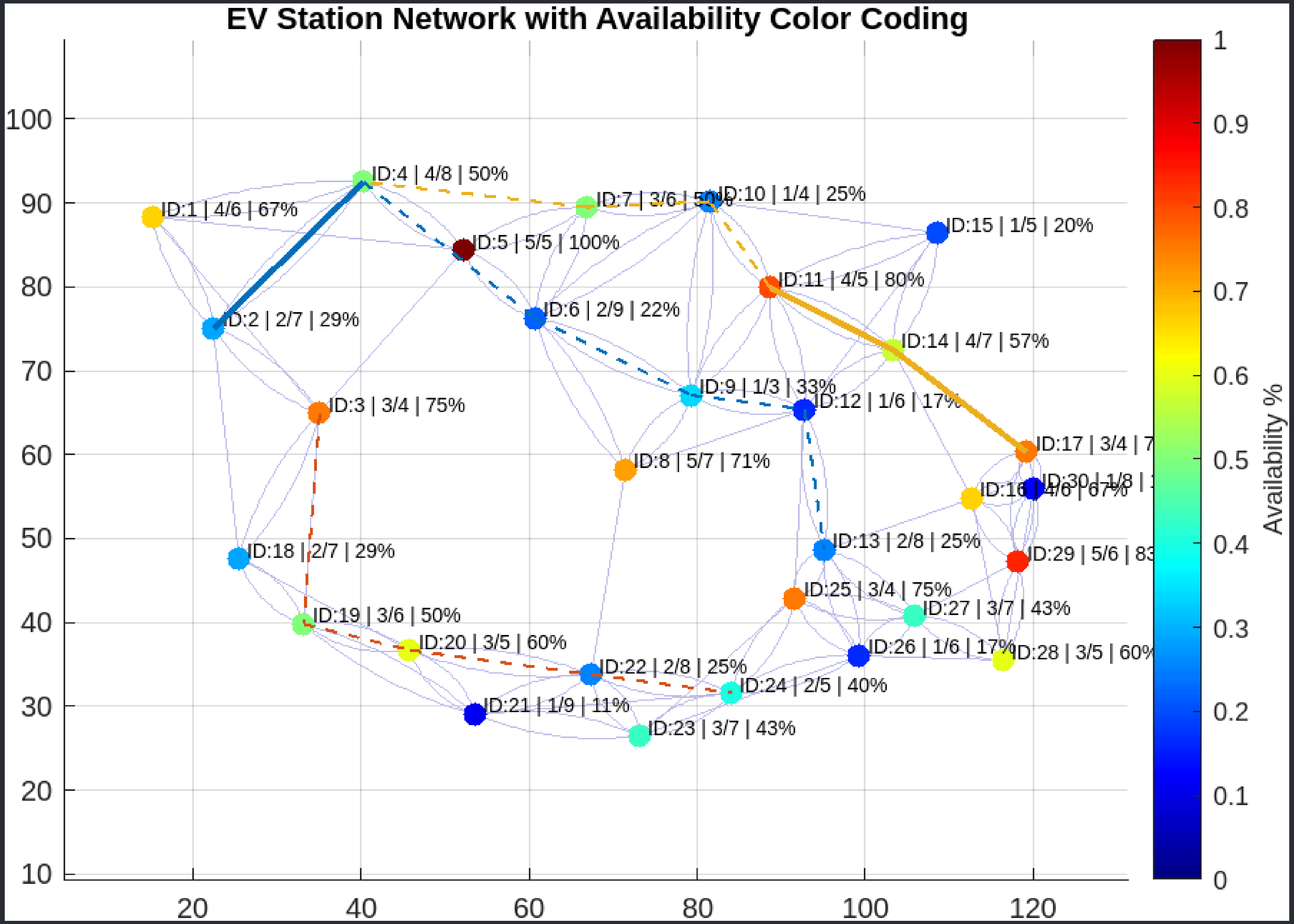


MATLAB Simulation

Input Data

Car	From	To	Charge	Mileage	Max Dist
1	2	13	25	35	37 km
2	3	24	54	45	17 km
3	17	4	25	35	700 km

MATLAB Simulation



Results

- Car 1 → Station 5
- Car 2 → Not reachable
- Car 3 → Station 11

Future Work & Conclusion

Next Steps

- Live traffic and grid integration via APIs
- Worker skill levels and training scheduling
- Stochastic uncertainty modeling

Summary

Our MILP model integrates EV-V2X data with workforce scheduling.

The system optimizes both charging infrastructure and human resources.

This framework is simulation-tested and ready for real-world applications.

Thank you!

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