Electric Vehicle Single-Charge Range Prediction

for EV makers and adopters

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Problem formulation:

from technical specs of an EV predict its driving range on a single charge

Why?

use case examples

EV producers

Task
For a market research department to assess the performance of a new model concept agains competitors.

Conventional Solution
Order evaluation of performance from the technical department

With our Service
Quickly prototype new concepts with instant results on their range performance based on technical and user specs.

EV fleet users (e.g. Taxi companies)

Task
Decide on the type of cars to include in the fleet. Compare different car configurations in terms of performance.

Conventional Solution
Research the market for specific models matching their requirements and assess their performance.

With our Service
Estimate the approximate performance of the car with necessary specs to evaluate the fleet structure before exploring specific options.

The Data

EDA & Feature Selection

```
0    brand                       478 non-null    object
1    model                       477 non-null    object
2    top_speed_kmh               478 non-null    int64
3    battery_capacity_kWh        478 non-null    float64
4    battery_type                478 non-null    object
5    number_of_cells             276 non-null    float64
6    torque_nm                   471 non-null    float64
7    efficiency_wh_per_km        478 non-null    int64
8    range_km                    478 non-null    int64
9    acceleration_0_100_s        478 non-null    float64
10   fast_charging_power_kw_dc   477 non-null    float64
11   fast_charge_port            477 non-null    object
12   towing_capacity_kg          452 non-null    float64
13   cargo_volume_l              477 non-null    object
14   seats                       478 non-null    int64
15   drivetrain                  478 non-null    object
16   segment                     478 non-null    object
17   length_mm                   478 non-null    int64
18   width_mm                    478 non-null    int64
19   height_mm                   478 non-null    int64
20   car_body_type               478 non-null    object
21   source_url                  478 non-null    object
```

Size: 470 records after preprocessing

Range by Drivetrain Type

Correlation Heatmap of EV Data

Range by Body Type
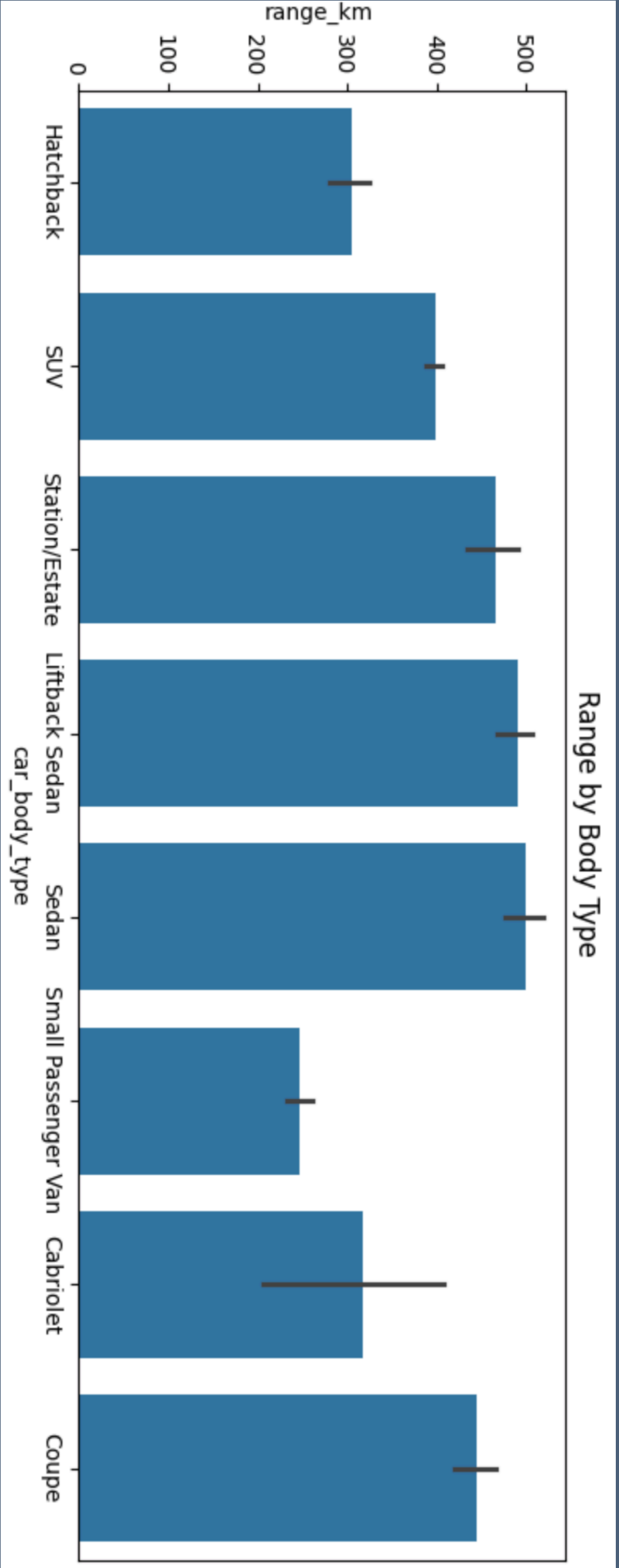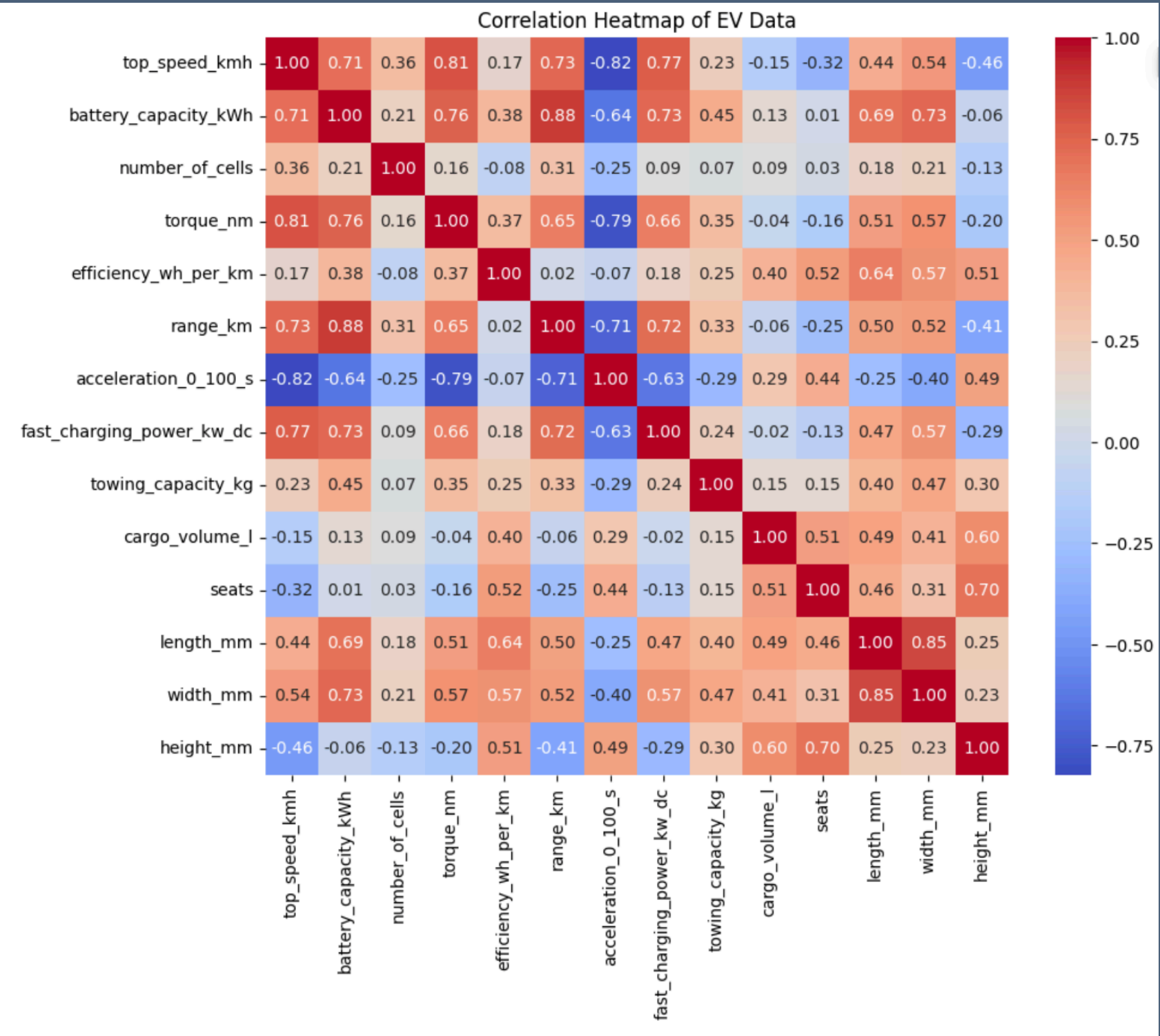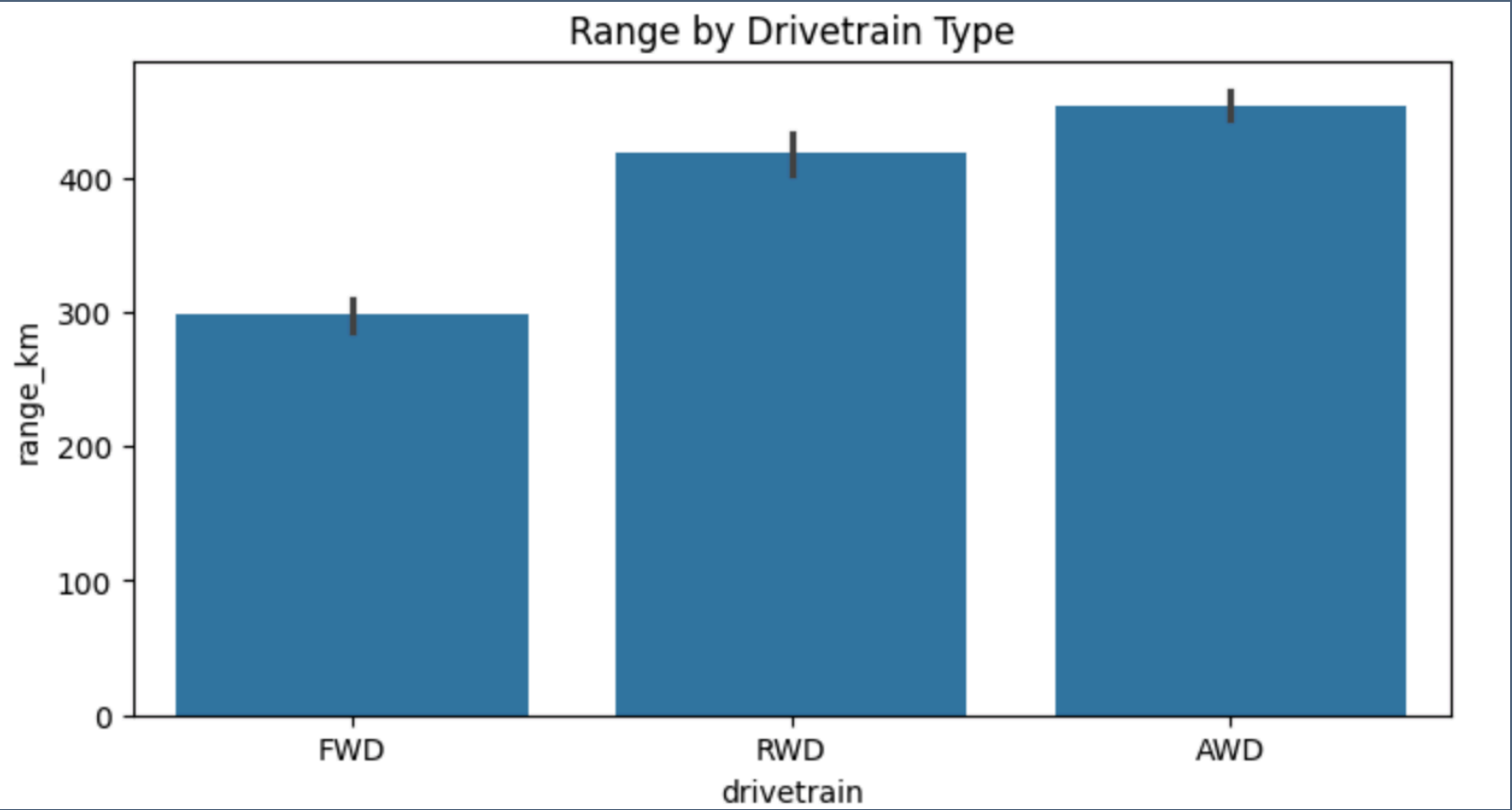
The Model

ANN design

Input Layer: 15 neurons (after one-hot encoding)

Hidden Architecture: 2-layer feedforward network

Hidden Layer 1: 32 neurons with ReLU activation + Dropout (0.2)

Hidden Layer 2: 16 neurons with ReLU activation + Dropout (0.15)

Output Layer: 1 neuron with linear activation (regression output)

Note: the dataset is fairly small — 470 records, meaning that a deep heavy-weight network is excessive given tightly limited computational resources

Regression-Specific Design

- **Linear output activation:** allows unbounded continuous predictions

- **Single output neuron:** predicts one continuous value (range_km)

- **Mean Squared Error loss function:** assessing deviation from the real target value

Evaluation Metric:

- **Mean Absolute Error:** easy to interpret

- **Mean Absolute Percentage Error:** percentage error compared to target size

The Prototype
links & demo

GitHub repository:

https://github.com/kshashkov/ev_range_prediction

Prototype on GitHub pages:

https://kshashkov.github.io/ev_range_prediction/application/

⚡ **Electric Vehicle Range Predictor**

AI-Powered Range Estimation Using Neural Networks

🧠 **Model Training**

✓ Model ready! Enter vehicle specifications to predict range.

✓ Loading training data - 470 samples loaded

✓ Preprocessing features - 14 features, 376 train samples

✓ Building neural network - 1025 parameters

✓ Training model - Training completed successfully

100%

Epoch	Loss	Val Loss	MAE
200	4610.83	761.45	53.38

🚗 **Vehicle Specifications**

Top Speed (km/h)

180

Battery Capacity (kWh)

75

Torque (Nm)

450

Acceleration 0-100 km/h (s)

6,5

Fast Charging Power (kW DC)

120

Fast Charge Port

CCS

📊 **Prediction Result**

Estimated Range

394

kilometers on a single charge