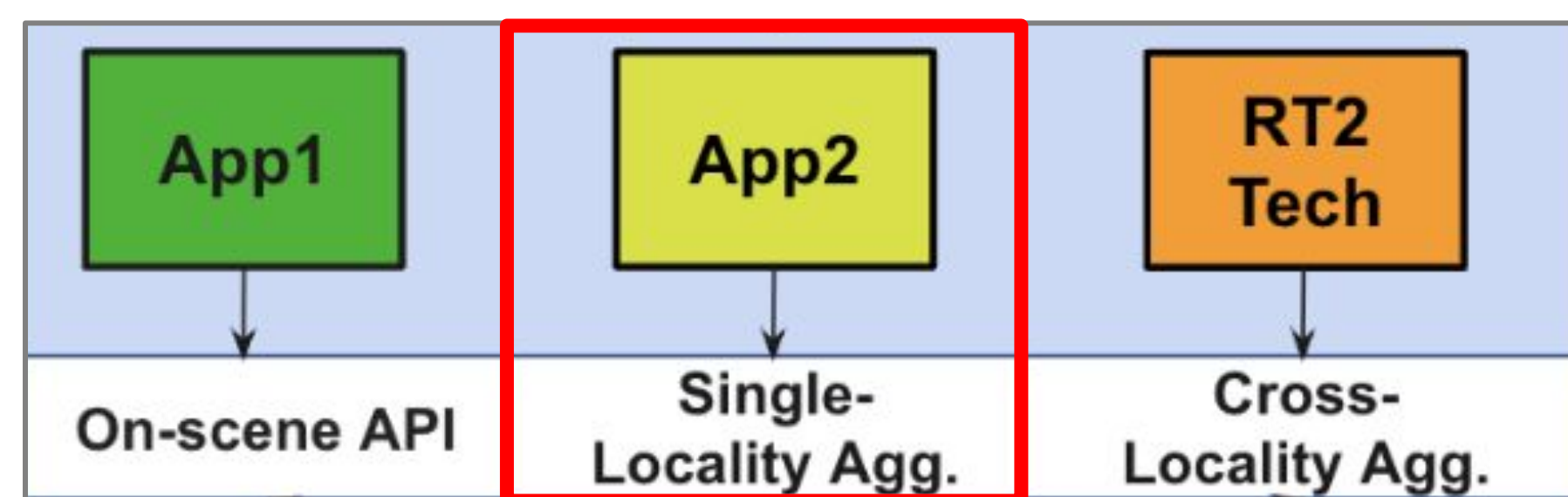




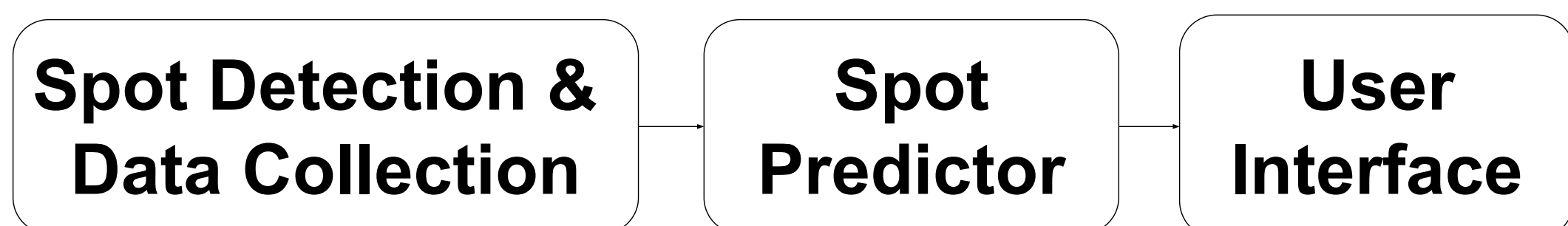
Introduction

CityOS is a privacy-first infrastructure enabling real-time urban data collection using differential privacy. Benefits preserve utility without compromising privacy.

- On-Scene: Real-time data untracked
- **Single-Locality Aggregation: localized continuous statistics**
- Cross-Locality Aggregation: citywide statistics



System Architecture



Camera Detection

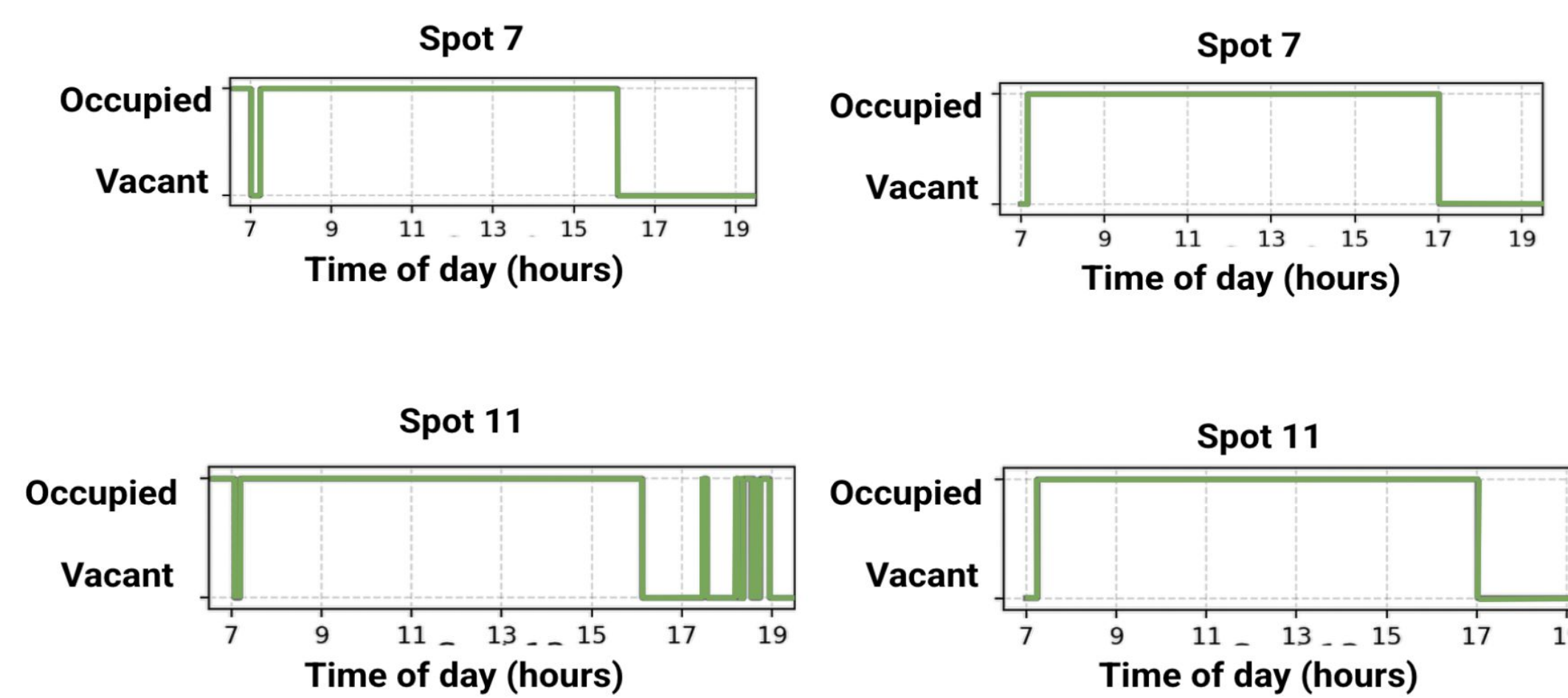
- We created a custom annotation tool to manually label each parking spot as free or occupied.
- Roboflow was also used to speed up and manage large-scale image labelling.
- A custom YOLO (You Only Look Once) classifier was trained on labelled images to detect if a spot was free or occupied.
- We logged each spot's status every 1 minute and collected data for over 60 days building a large time-series dataset for prediction.



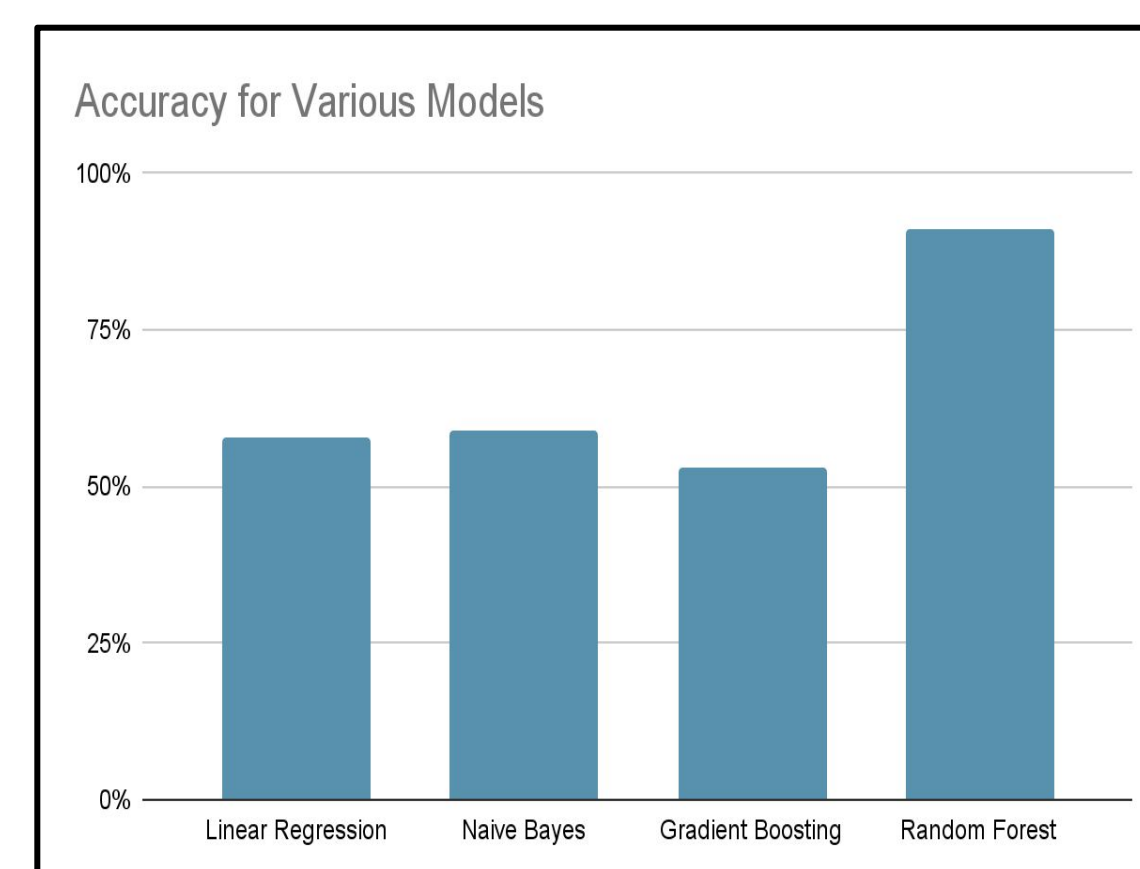
Prediction Model

- Random Forest Model: After experimenting with a vast number of hyperparameters, we found that decision trees trained on parking data (SpotID, Day, Hour, Minute) with optimized hyperparameters (n_estimators=200, max_depth=20, class_weight=balanced) for binary classification of spot availability, was optimal.
- Each tree predicts Free (0) or Occupied (1) and returns confidence scores from probability distributions

Predicted (left) vs Actual (right) Occupancy



Results



- Extensive experimentation with many different models
- Random Forest had the best performance handling non-linear temporal patterns and categorical features.

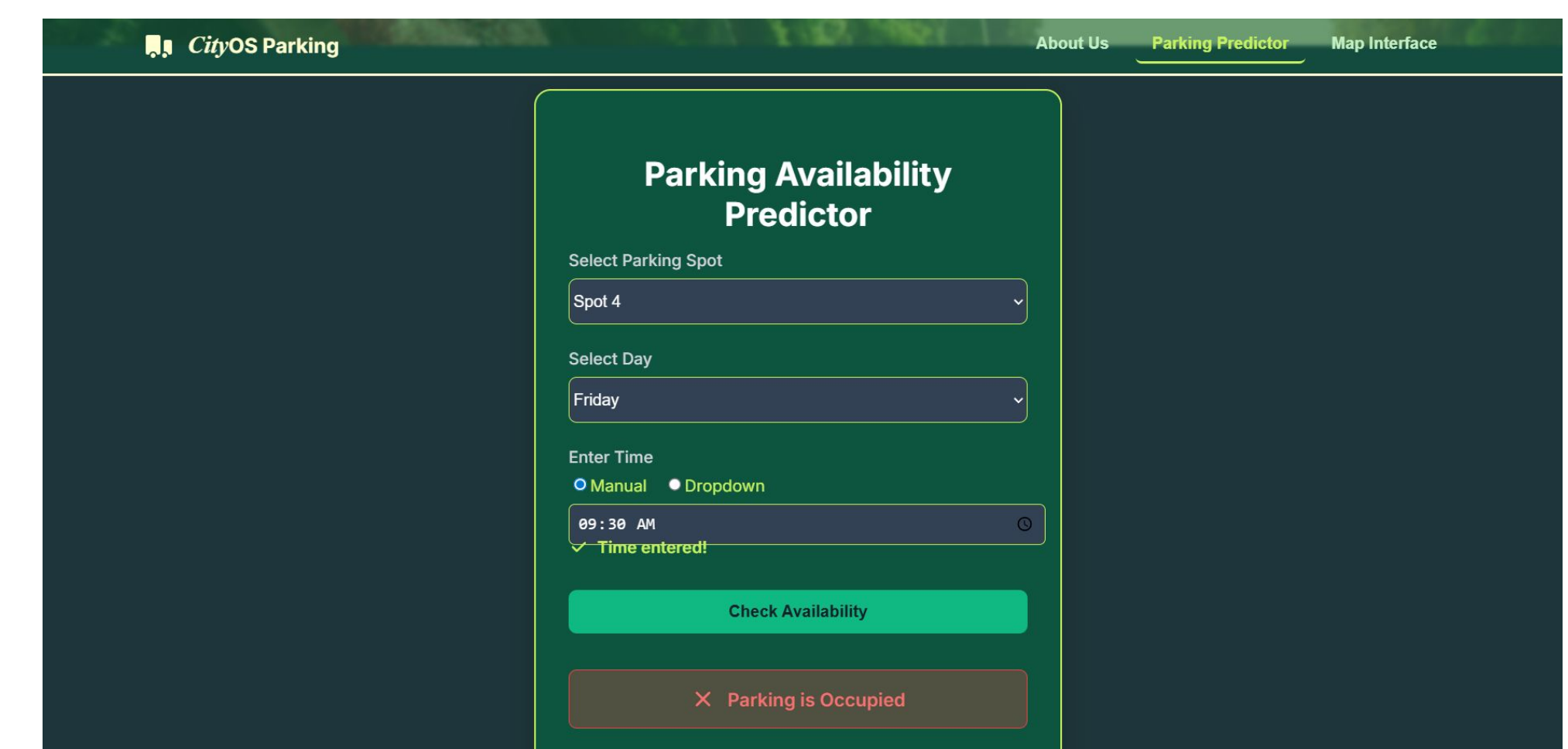
- Both ‘Free’ and ‘Occupied’ classes achieved 0.98 precision, recall and F1 scores. showing excellent classification results.

	Precision	Recall	F1 Score
Free (0)	0.98	0.98	0.98
Occupied (1)	0.98	0.98	0.98

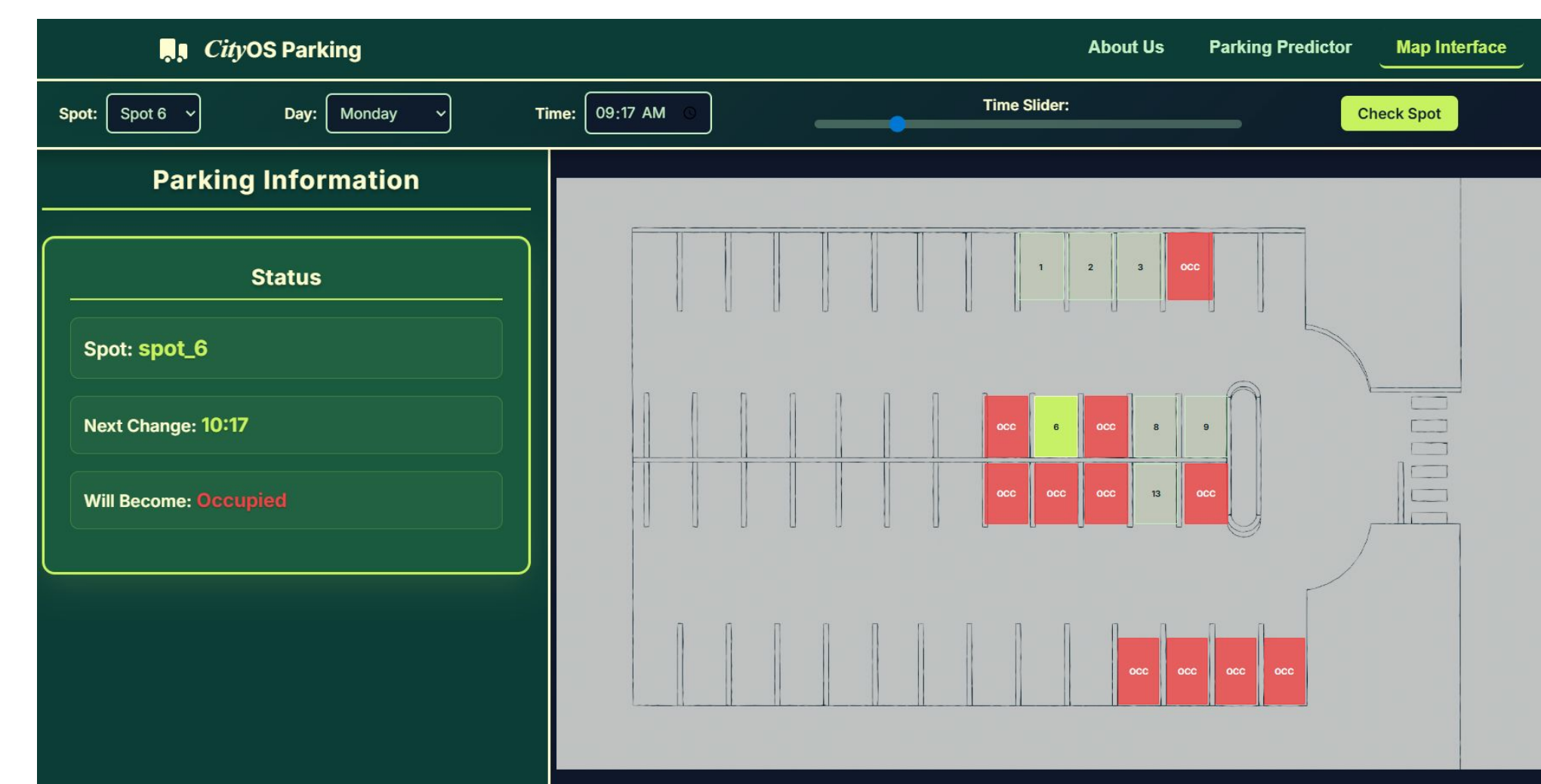
User Interface

The UI connects with the prediction model. These are the of the main functions of our two interfaces:

- **Single Spot Interface:**
 - Enter Day, Time, SpotID
 - Returns Occupancy (Free or Occupied)



- **Parking Lot Interface:**
 - Enter Day and Time
 - Time can be selected via dropdown, text, or time slider
 - Returns every spot's occupancy
 - Selecting a spot returns the next change in occupancy



Future Plans

- Using our parking app to analyze API 2's privacy infrastructure
- Create iOS/Android apps with push notifications for spot availability and navigation to available spots