

# Optimizing Parking at TXST: Identifying Ideal Locations and Smart Allocation Strategies

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## Research Question

- Which campus site provides the optimal location for a new parking facility to maximize benefits for dorm residents and the general student population?
- How can we develop an algorithm to match incoming students with vehicles to the best dorm locations, considering factors like parking proximity, available spaces, and individual preferences?

## Methodology

### Data Processing

- Scraped student housing data using Firecrawl API
- Obtained geo-coordinates via Google Maps API
- Created consolidated datasets for:
  - Student demographics and housing (n=13,069)
  - Dormitory locations (n=25)
  - Parking facilities (n=21)

### Spatial Analysis

- Applied KMeans clustering (k=5) on dorm coordinates
- Calculated student density distribution
- Mapped parking proximity using Haversine distance

### Desirability Scoring

Developed composite score:

$$Desirability = 0.4(normalized\_density) + 0.4(proximity\_score) + 0.2(1 - parking\_penalty)$$

### Optimization

- Generated parking recommendations based on:
  - Population clusters
  - Resource utilization
  - Spatial accessibility
- Validated using cross-reference analysis

### Dorm Allocation Algorithm

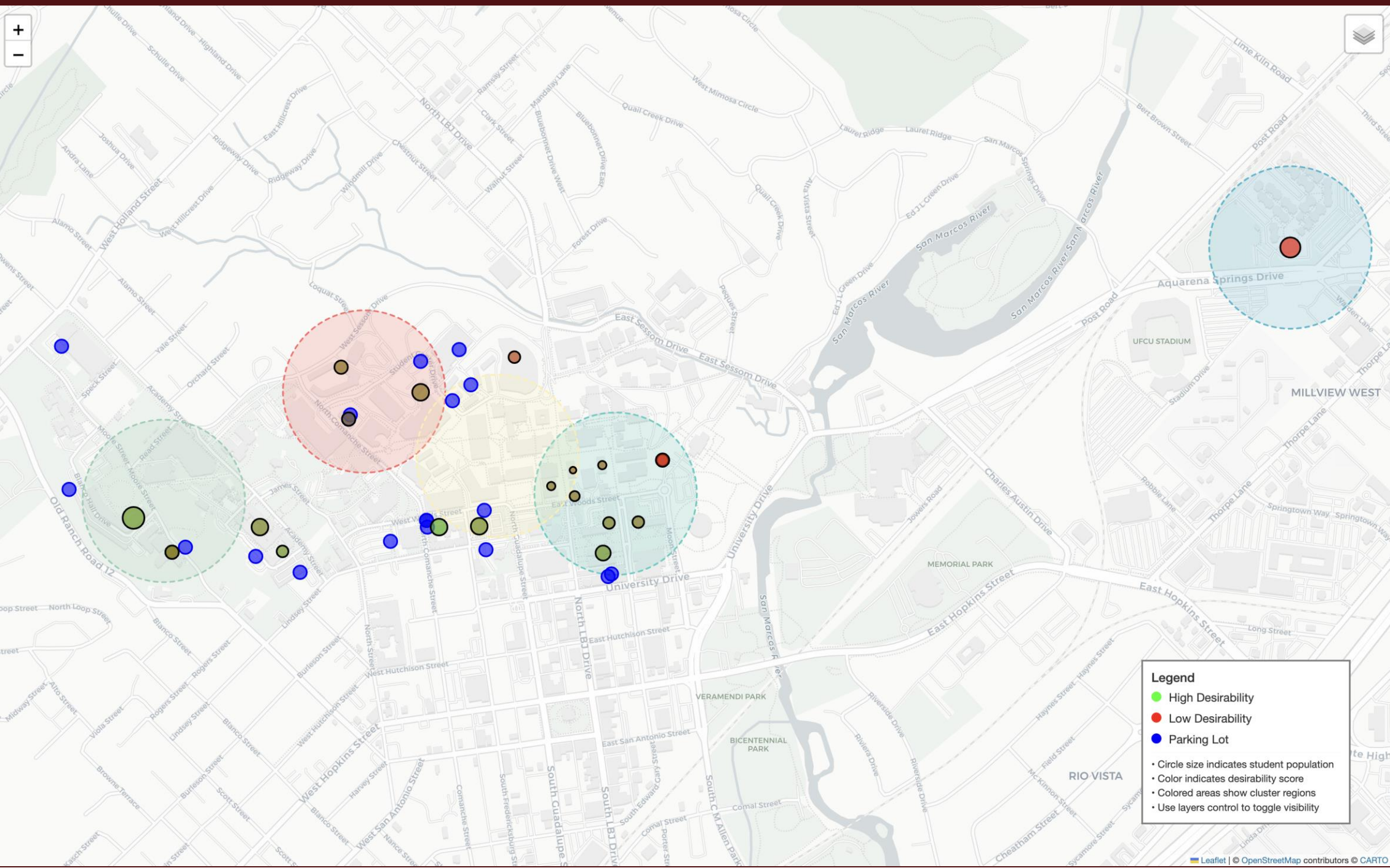
- Merged dormitory and parking lot datasets for a consolidated view.
- Calculated shared parking distribution based on dorm bed capacity for multi-dorm lots.
- Developed an algorithm to update vehicle-owning student count per dorm and adjust available parking in real time.

### Interpretation

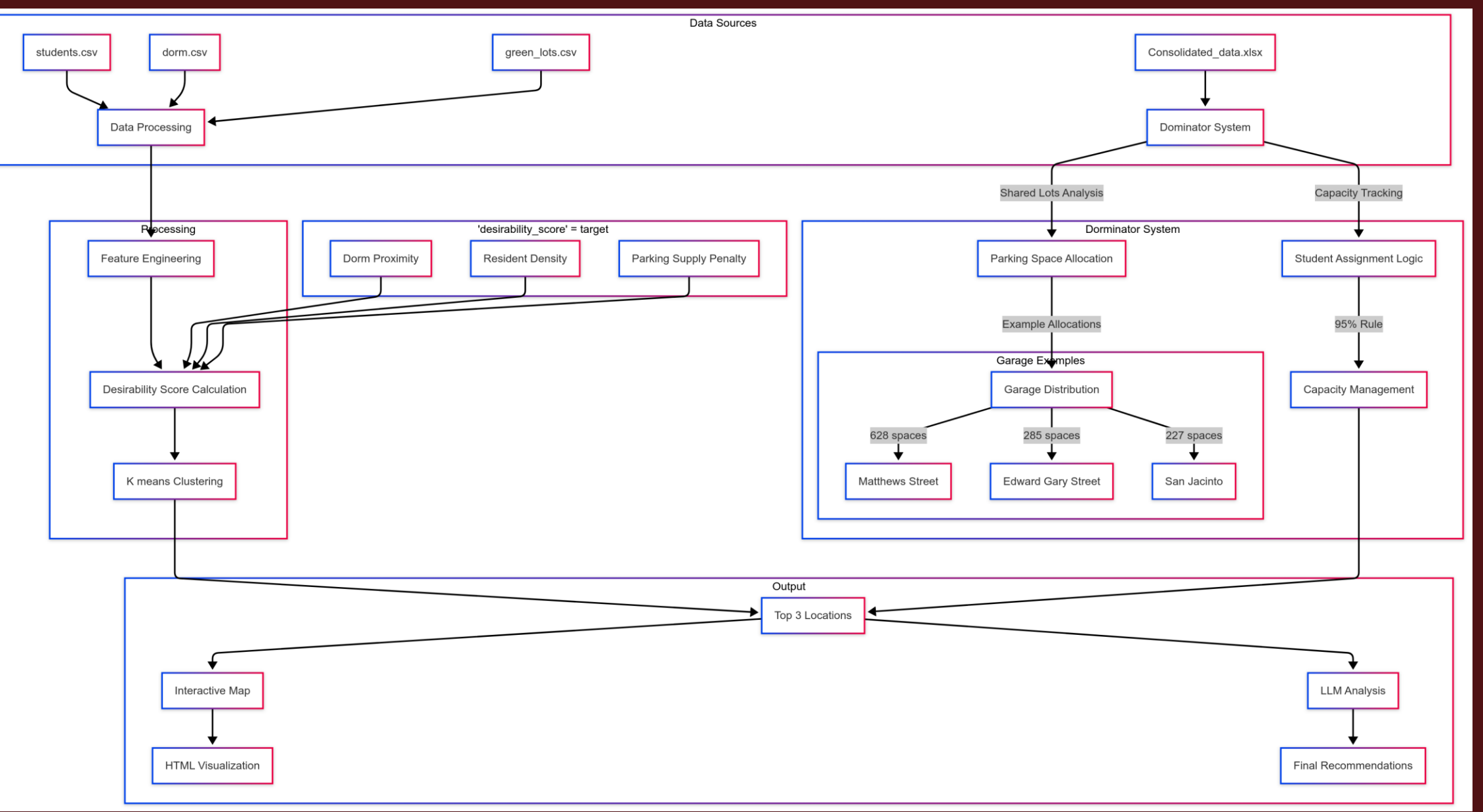
- Processed results through LLM for stakeholder-friendly insights
- Created interactive visualizations of recommendations
- Generated impact analysis for proposed locations

## Findings

- Parking supply at Texas State is not the issue; rather, the distribution of parking spots and accessibility is problematic.
- Perimeter permits are significantly oversold at 156.9%, with 10,438 permits issued for only 4,063 available spaces, while some other permit types are undersold, indicating an optimization potential.
- Dorms like Sayers, Falls, Blanco have great bed capacities and hold a huge student population but the available parking spaces are comparatively lesser.
- On the other hand, several residential parking spaces remain unused leading to problems in availability of parking spaces.

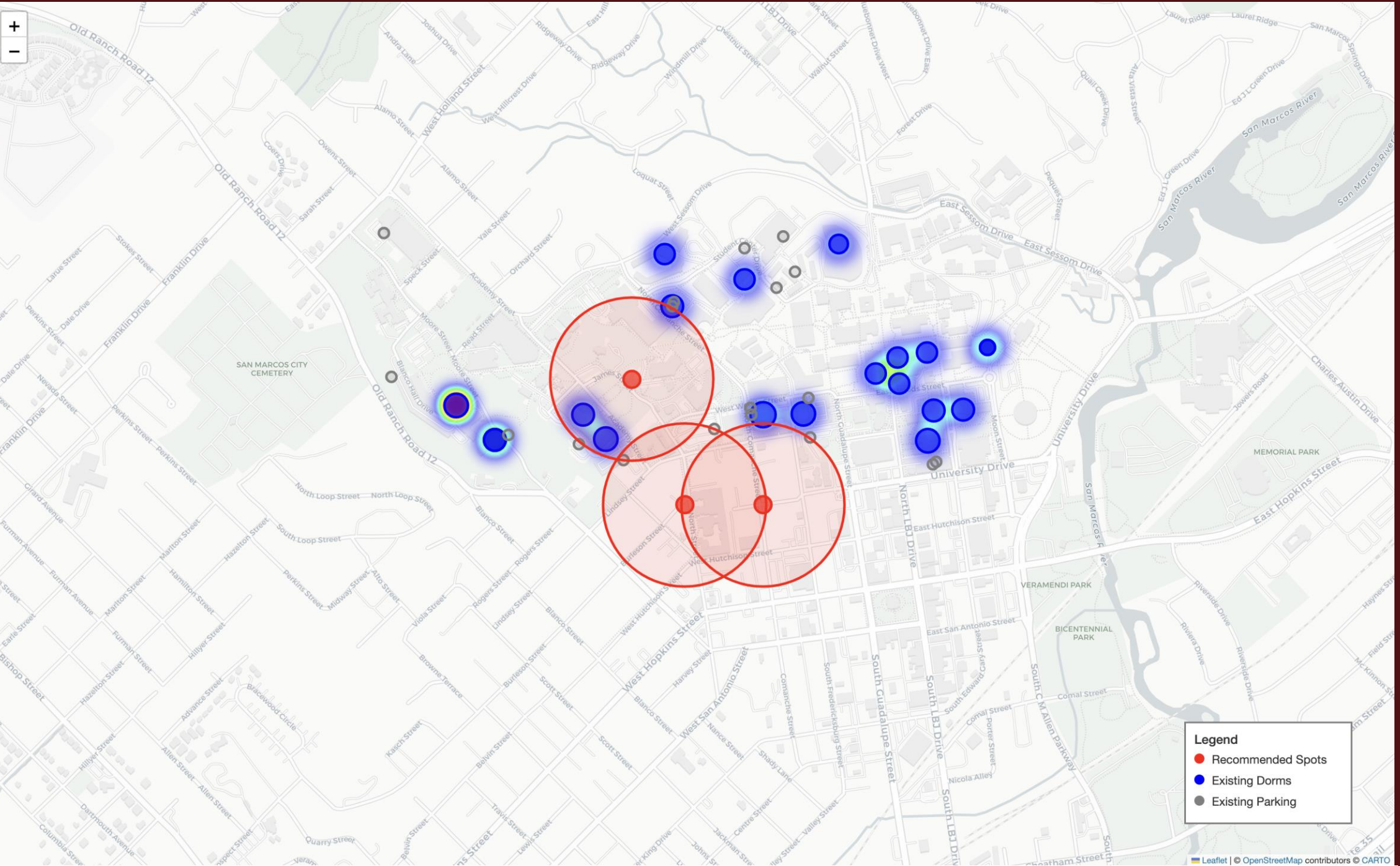
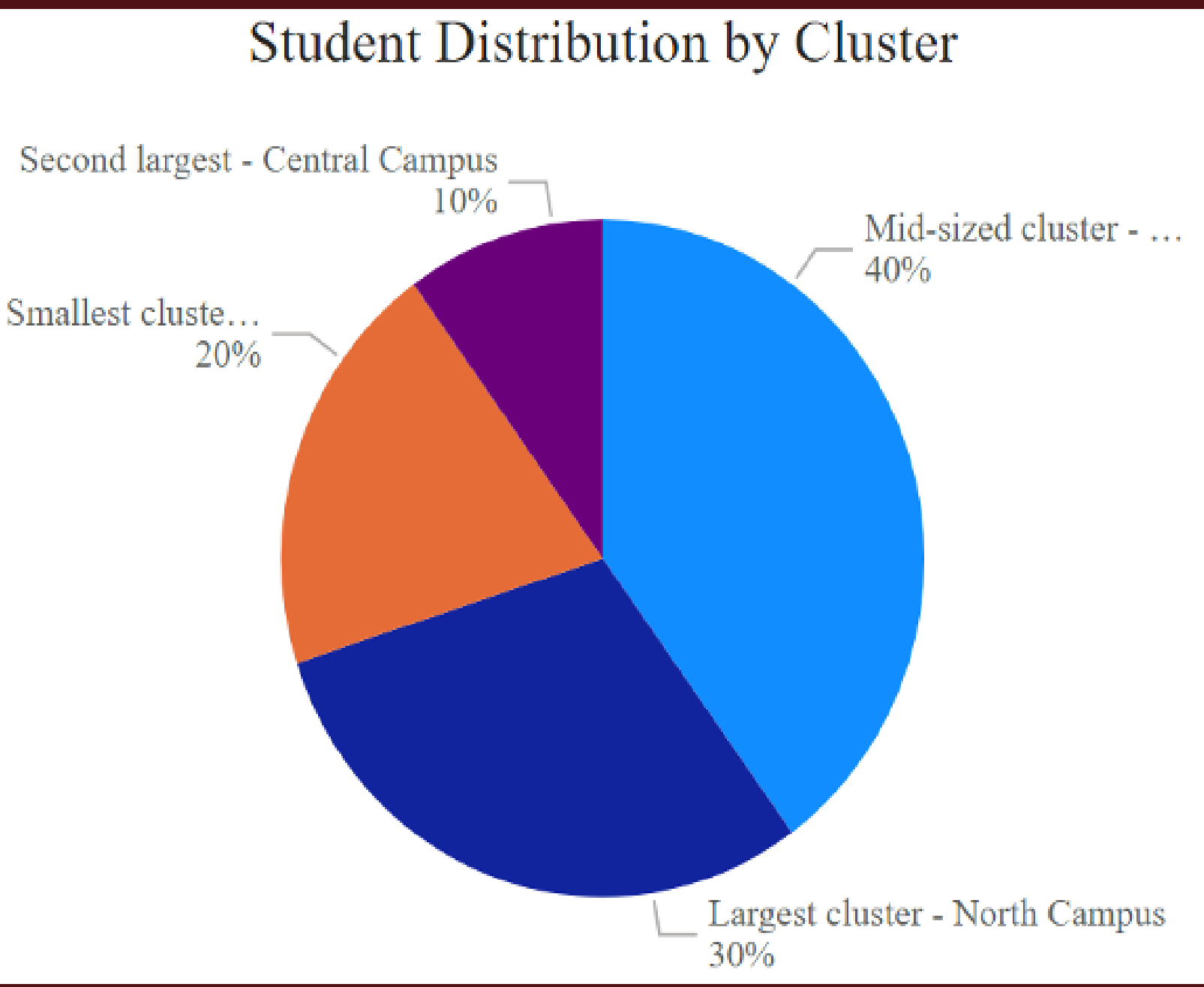


Map showing the clusters of dorms based on student population



## Results

- The algorithm helps create less crowd in busy areas with academic buildings by appropriately placing vehicle owning students in dorms with enough parking spaces.
- Can help observe the dorms with shared parking lots nearby and drive the vehicle owning students to those dorms.
- This creates lesser parking problems for dorm residents and helps manage parking availability for commuters and other permit owners as well.
- Blanco and Sterry Hall stand out as high-desirability dorms with severe parking shortages. Blanco’s desirability score (0.613) and Sterry Hall’s score (0.594) indicate strong demand, but their parking infrastructure is inadequate.



Map with 3 Recommended Parking Spaces for Expansion

```
Processing Student 1:
Assigned to San Marcos
Current state of San Marcos:
Beds: 1/417.0
Parking: 1.0/481

Processing Student 2:
Assigned to San Marcos
Current state of San Marcos:
Beds: 2/417.0
Parking: 2.0/481

Processing Student 3:
Assigned to San Marcos
Current state of San Marcos:
Beds: 3/417.0
Parking: 2.0/481

Final State:
dorm_name total_beds occupied_beds total_parking \ used_parking
0 San Marcos 417.0 3 481 0 2.0
1 Bexar 202.0 0 209 1 NaN
2 College Inn 200.0 0 30 2 0.0
3 San Jacinto 469.0 0 397 3 0.0
4 Lantana 239.0 0 132 4 0.0
5 Sterry 371.0 0 205 5 0.0
6 Butler 236.0 0 144 6 0.0
7 Tower 434.0 0 391 7 0.0
8 Jackson 425.0 0 257 8 0.0
9 Falls 286.0 0 81 9 0.0
10 Blanco 594.0 0 168 10 0.0
11 First Five Freedom 280.0 0 183 12 0.0
12 Elena Zamora O'Shea 318.0 0 200 13 0.0
13 Gallardia 306.0 0 192 14 0.0
14 CTO 306.0 0 192 15 0.0
15 Sayers 292.0 0 102 16 0.0
16 Cibola 501.0 0 22 17 NaN
17 Total NaN 0 3386
```

## Implications

- The university can implement our algorithm to appropriately match a student based on their vehicle owning status and other preferences.
- High-demand dorms like Blanco (1,556 students, 168 spaces) and San Jacinto (925 students, 397 spaces) have particularly low parking availability relative to student density. Blanco has a parking-to-student ratio of 0.11, while San Jacinto has a ratio of 0.43.

## References

- <https://public.tableau.com/app/profile/texas.state.institutional.research.qa/viz/shared/35794TZPQ>
- <https://www.parking.txst.edu/about/statistics.html>
- [https://github.com/Tar-ive/txst\\_open\\_datathon\\_2025](https://github.com/Tar-ive/txst_open_datathon_2025)
- <https://github.com/imraghavojha/dorminator>

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