

# 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

- Scrapped 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:

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

### Optimization

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

### Dorm Allocation Algorithm

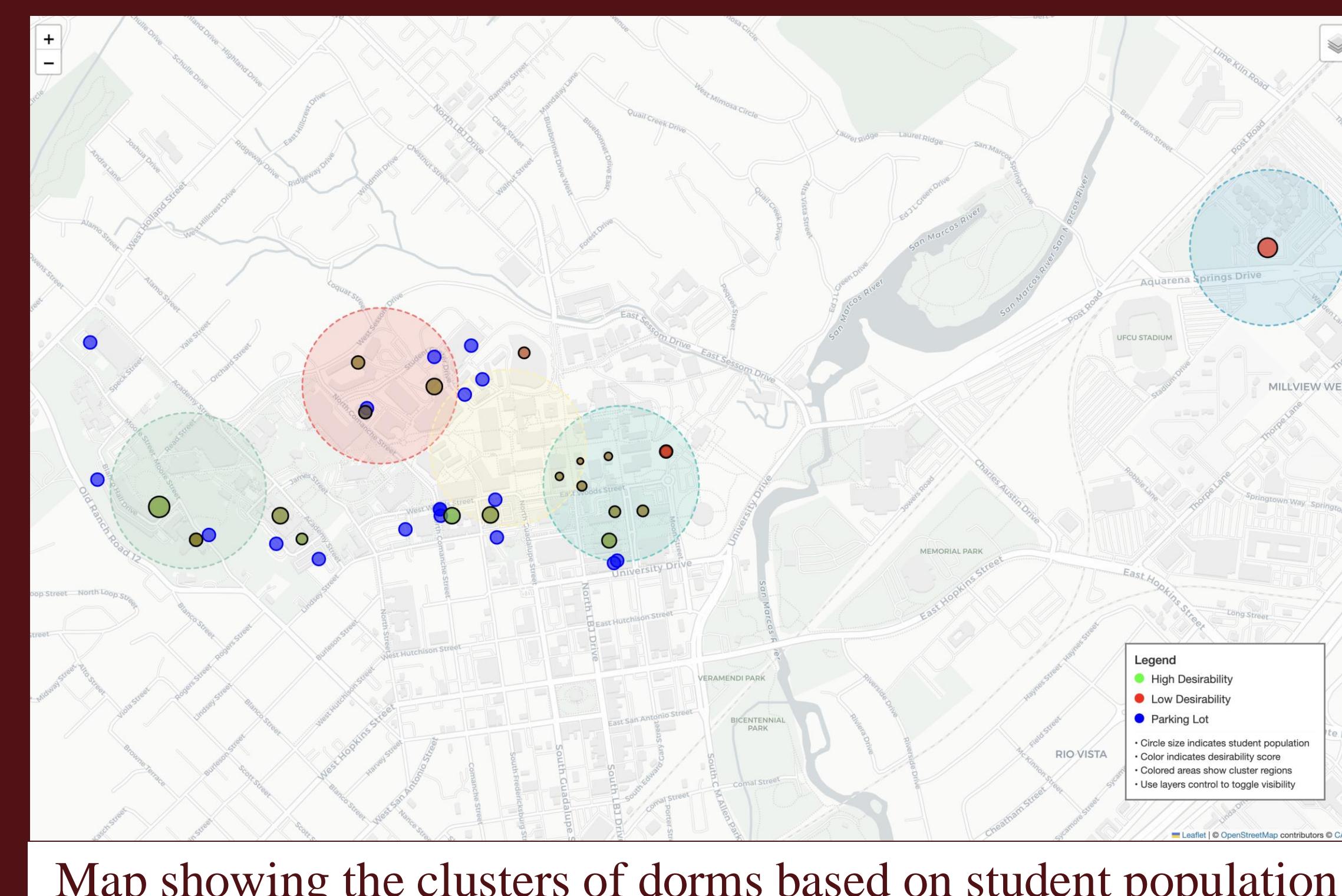
- Merged dormitory and parking lot datasets for a consolidated view.
- Calculated shared parking distribution based on dorm bed capacity for multi-dorm lots.
- Developed an algorithm to update vehicle-owning student count per dorm and adjust available parking in real time.

### Interpretation

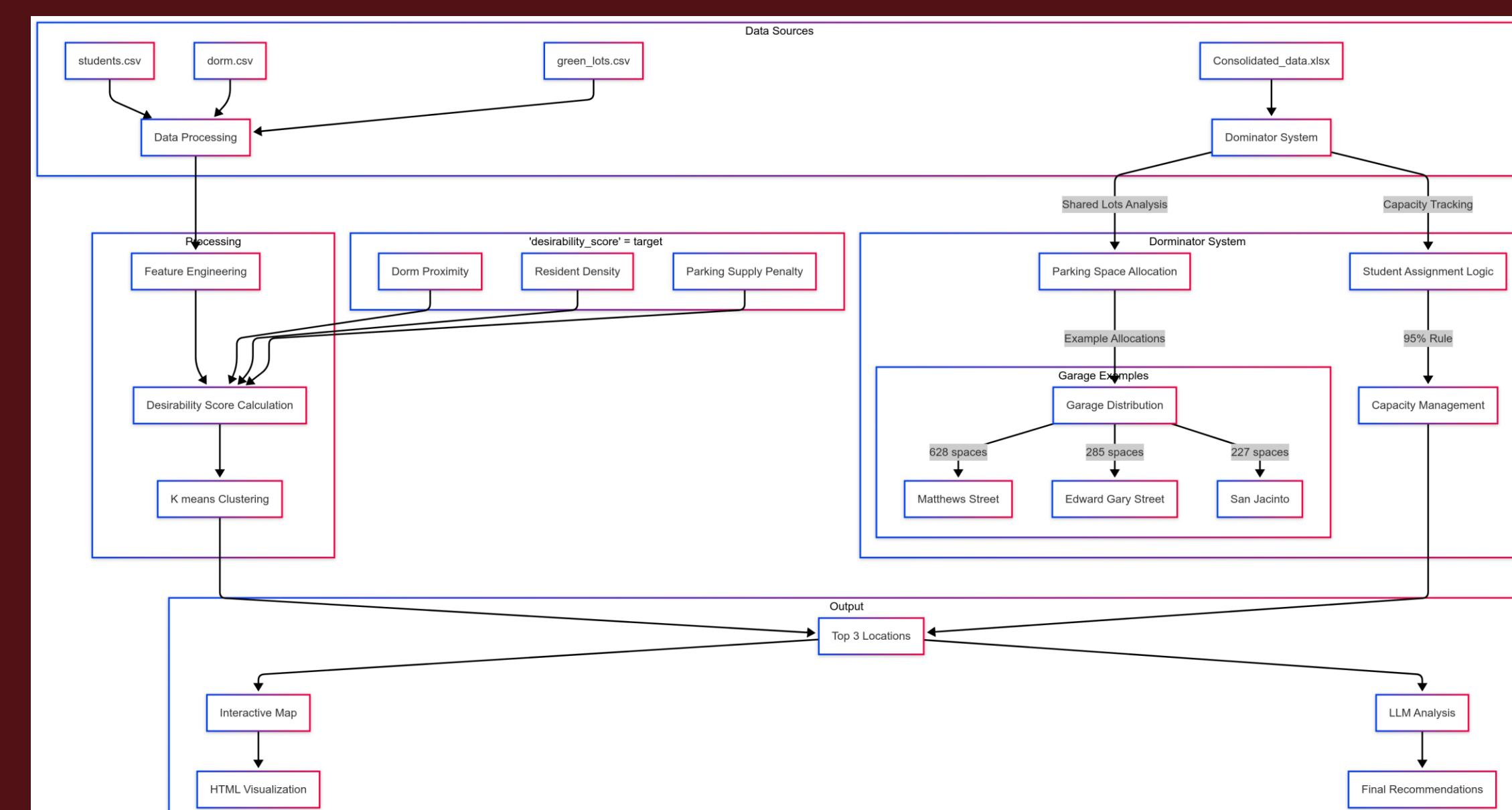
- Processed results through LLM for stakeholder-friendly insights
- Created interactive visualizations of recommendations
- Generated impact analysis for proposed locations

## 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.

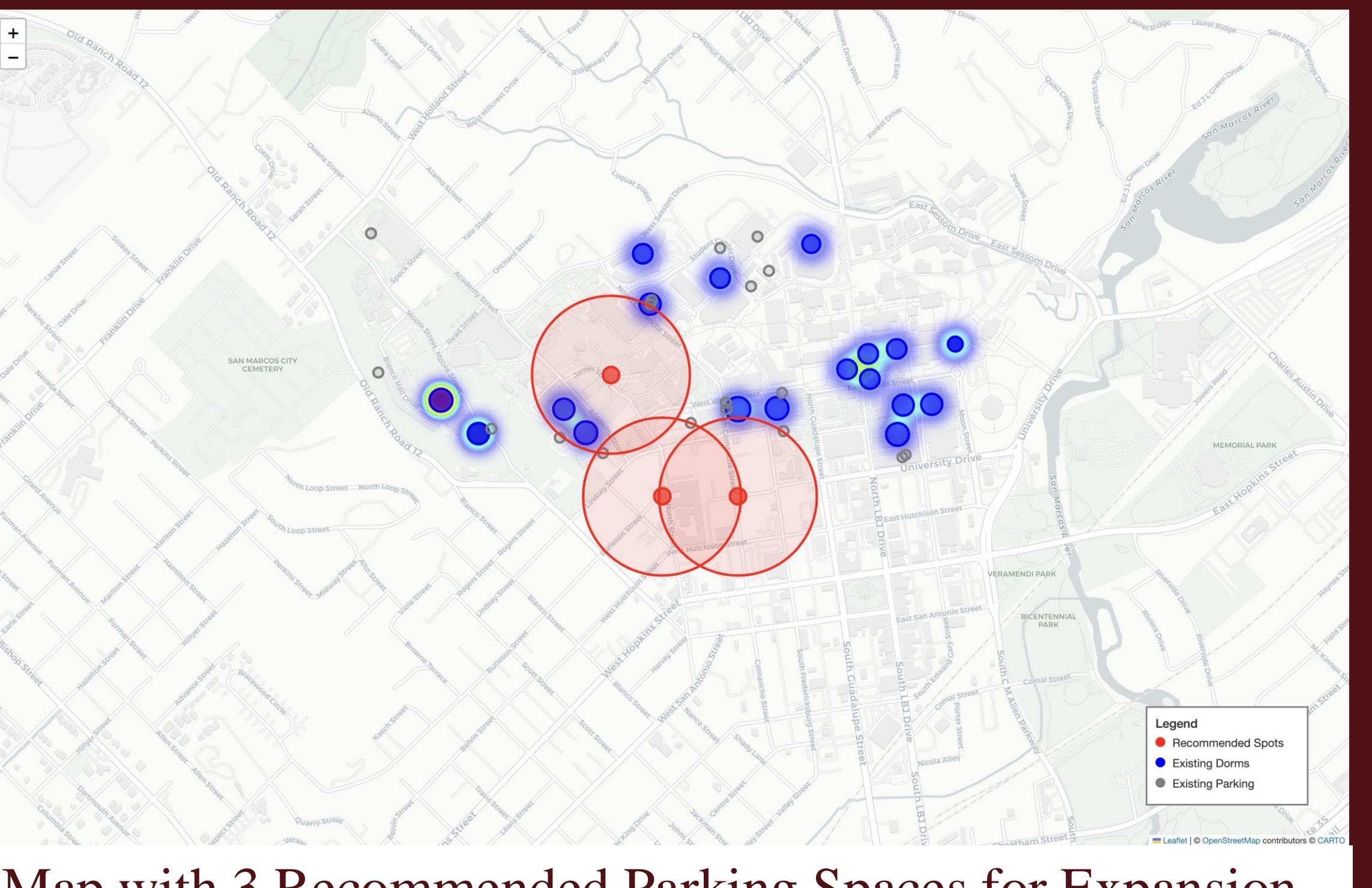
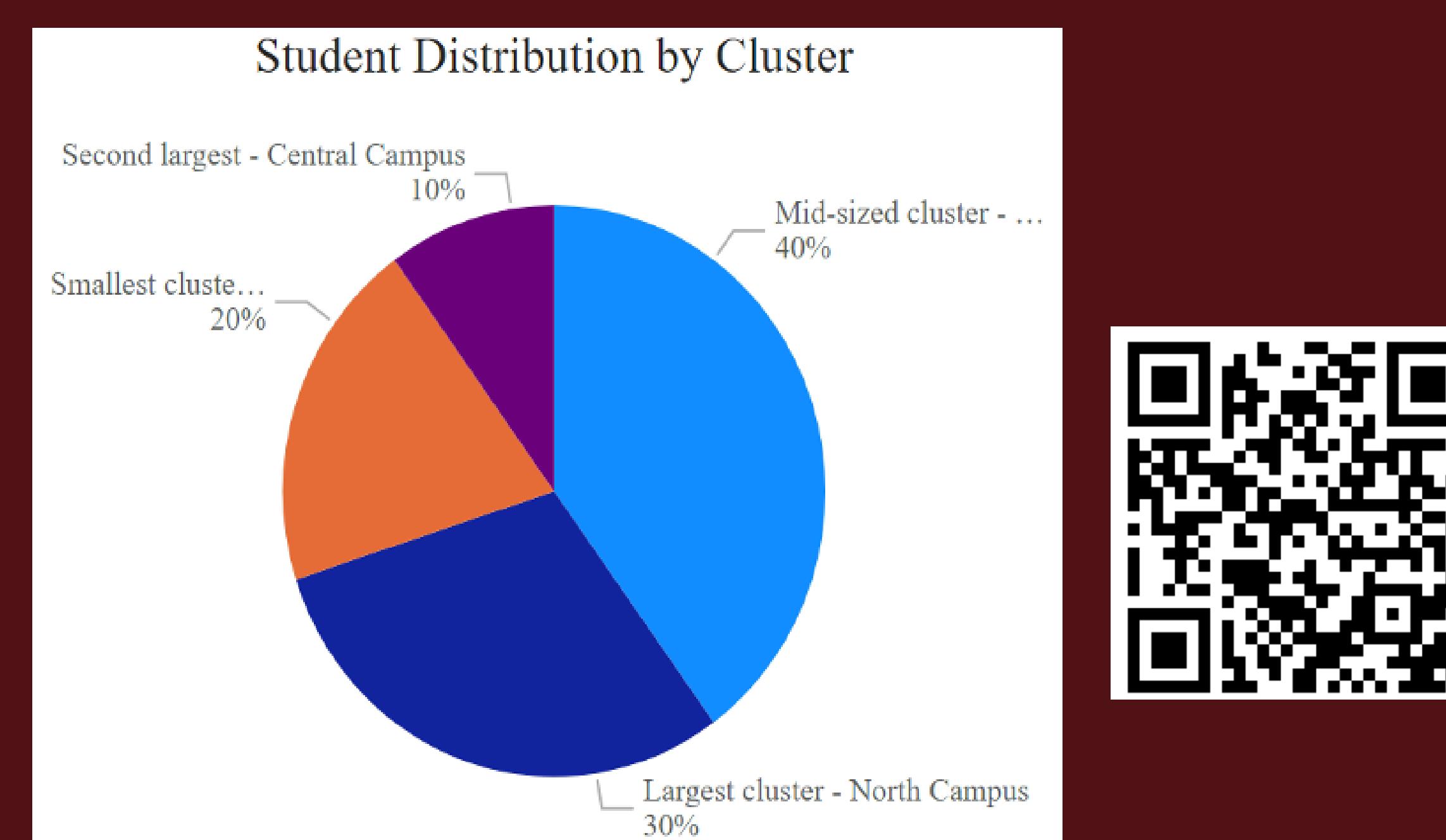


Map showing the clusters of dorms based on student population



## 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

	dorm_name	total_beds	occupied_beds	total_parking	\	used_parking
0	San Marcos	417.0	0	481	0	2.0
1	Bexar	202.0	0	209	1	NaN
2	College Inn	280.0	0	30	2	0.0
3	San Jacinto	469.0	0	397	3	0.8
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	423.0	0	257	8	0.0
9	Falls	235.0	0	81	9	0.0
10	Blanco	594.0	0	168	11	0.0
11	First Five Freedom	280.0	0	183	12	0.0
12	Elena Zamora O'Shea	318.0	0	290	13	0.8
13	Gallardia	306.0	0	192	14	0.0
14	CTQ	306.0	0	192	15	0.0
15	Sayers	292.0	0	182	16	0.0
16	Cibolo	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/Tarive/txst\\_open\\_datathon\\_2025](https://github.com/Tarive/txst_open_datathon_2025)
- <https://github.com/imraghavojha/dominator>