An Automated Tool for

Carpool Matching by Preferences

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Agenda

Motivation

Problem

Literature Review Take Aways

Spring/22 Student Profile

Design

Implementation

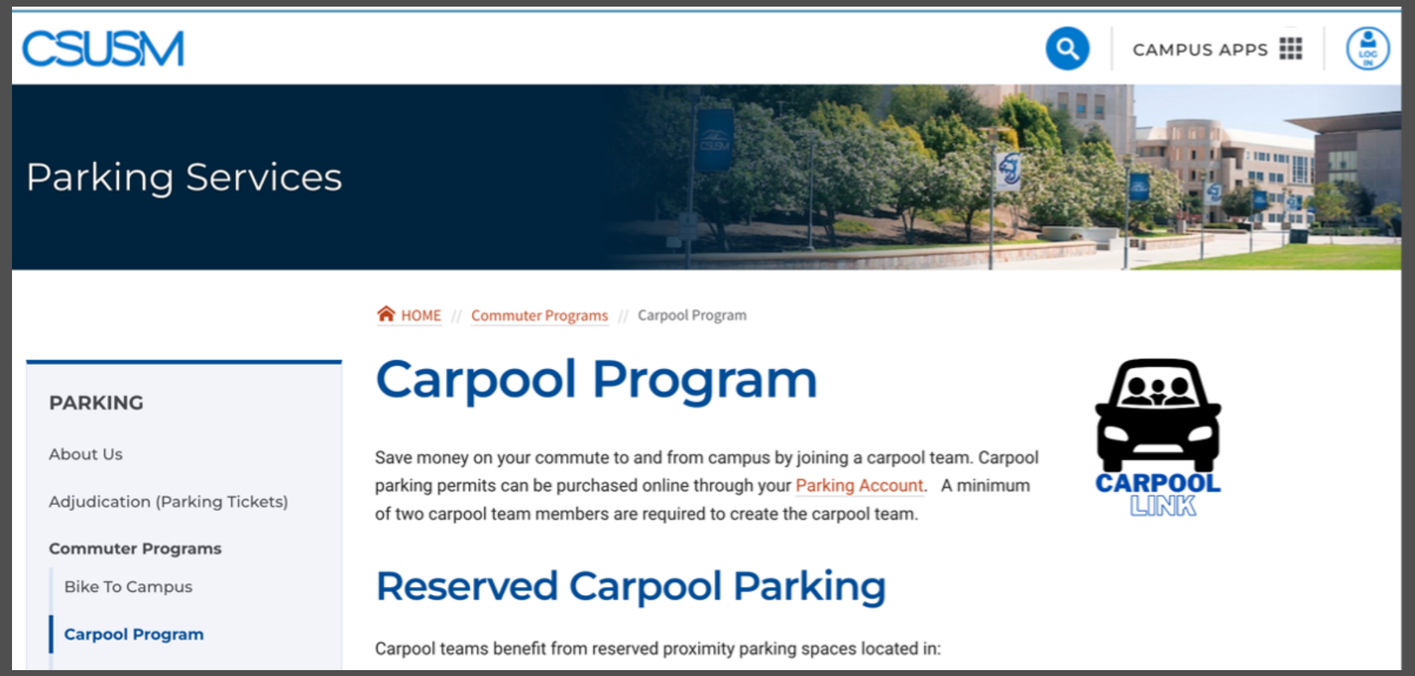
Results

"Sorry I haven't been coming to class, but if I don't find a ride I cannot come. It's too expensive.”

CS211 Student during Spring/22

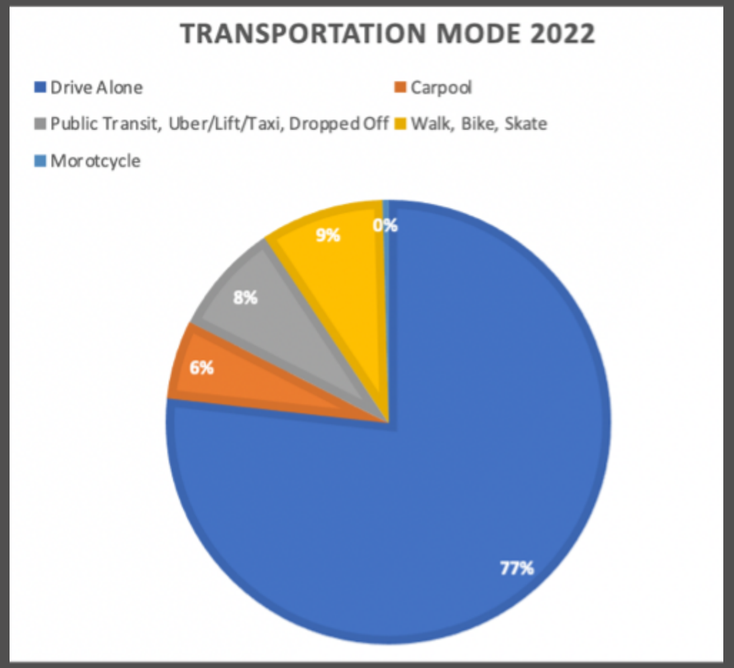
Ineffective Existing CSUSM Carpool Program

- CSUSM > Commuter Programs > Carpool Program > Carpool link to fill up a form
- Manual sorting and matching process
- Low uptake: from 10,292 students enrolled for in person classes, only 35 applied



Carpool Potential

How many students that drive alone could be carpooling to school?



Transportation Survey

18.7% of drive alone students need help finding carpool partners

Prospective Carpoolers

Of 10,292 students (in person classes), 77% drive alone (7,925 students) but **1,482** need help finding partners

Literature Review

Social Sciences

- Societal benefits: reduction on traffic, emissions, fuel consumption
- Individual benefits: accessibility, convenience, cost savings
- Psychological barriers: trust, reliability, discomfort, perceived security, difficulty in finding matches
- 40% interest in enjoyable solutions: 24% choses interesting people, after 41% cost savings

Computer Science

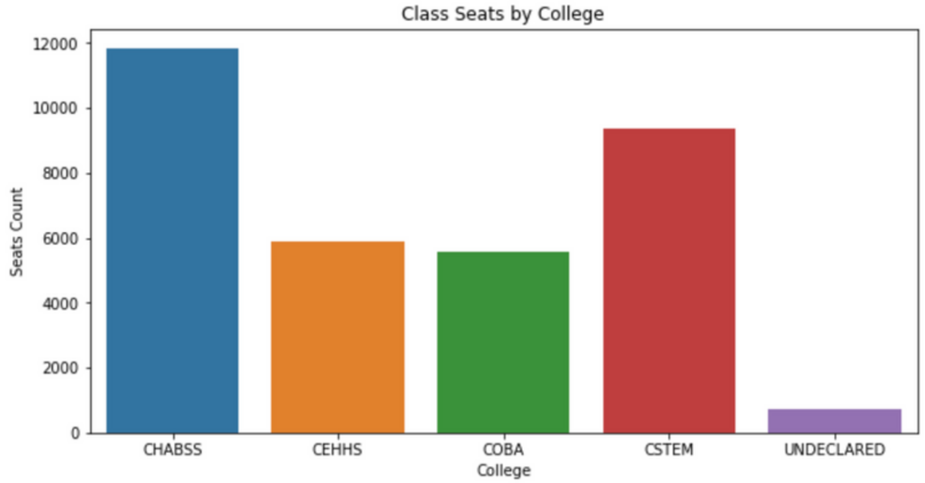
- NP-hard Problem
- Carpooling Problem Variations: ridesharing, long-term carpooling, vanpooling
- Solutions using exact and heuristic algorithms with focus on minimizing the total cost, distance, and time. Only 20% mention preferences or profile matching
- Few researches use real data, none has a varied schedule for a long-term carpool

Spring/22 Student Profile

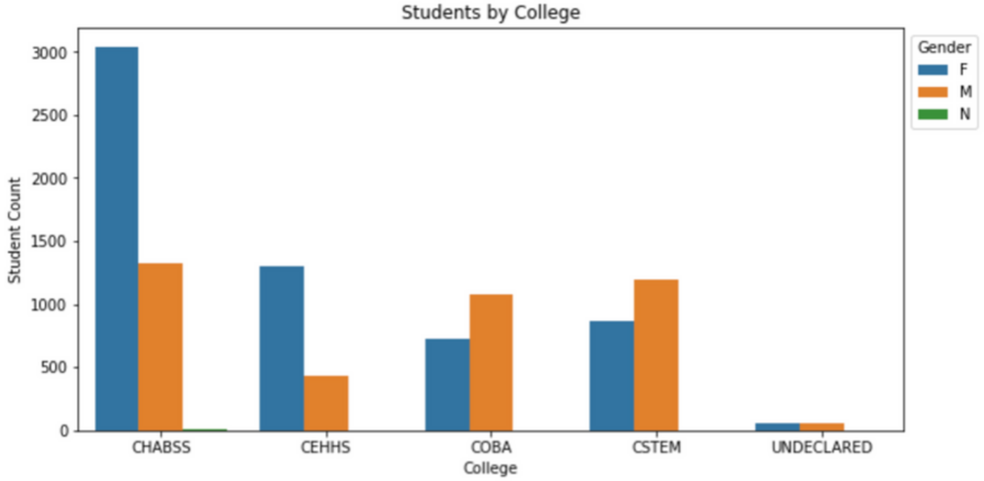
Students enrolled on in person classes

Who are they? What do they do?

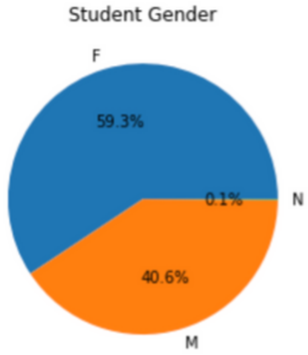
- Original Data



- Extracted Data



- 33,417 entries
- 306 classes
- 86 sessions
- 12 different meeting patterns
- 10,292 students



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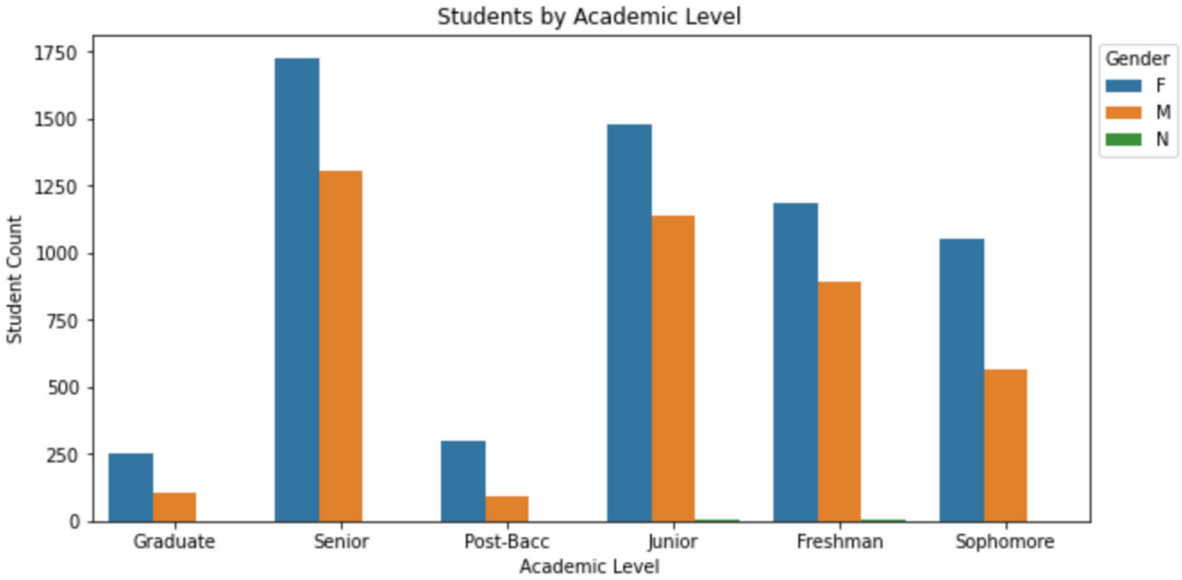
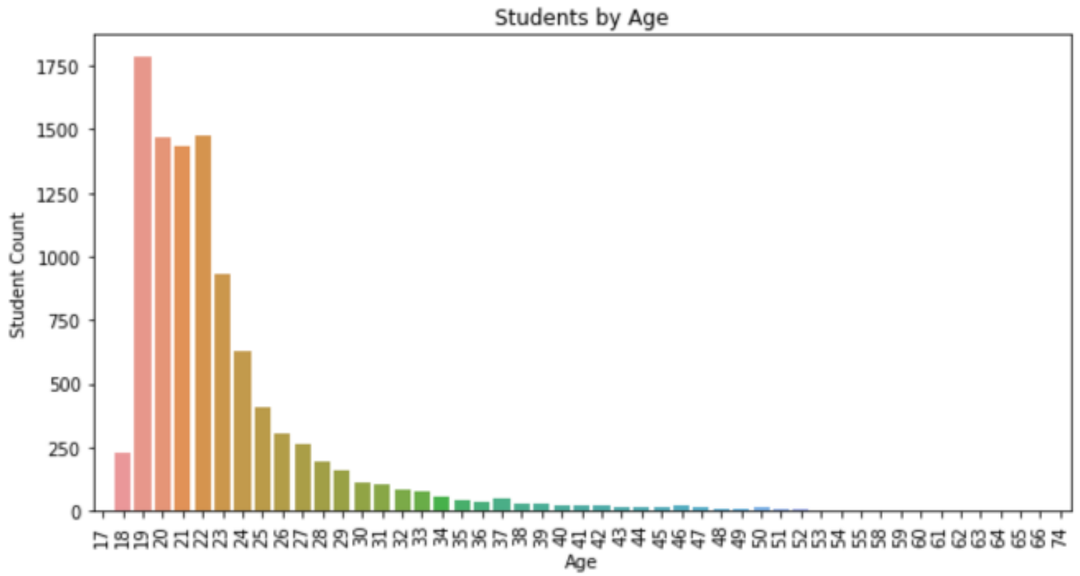
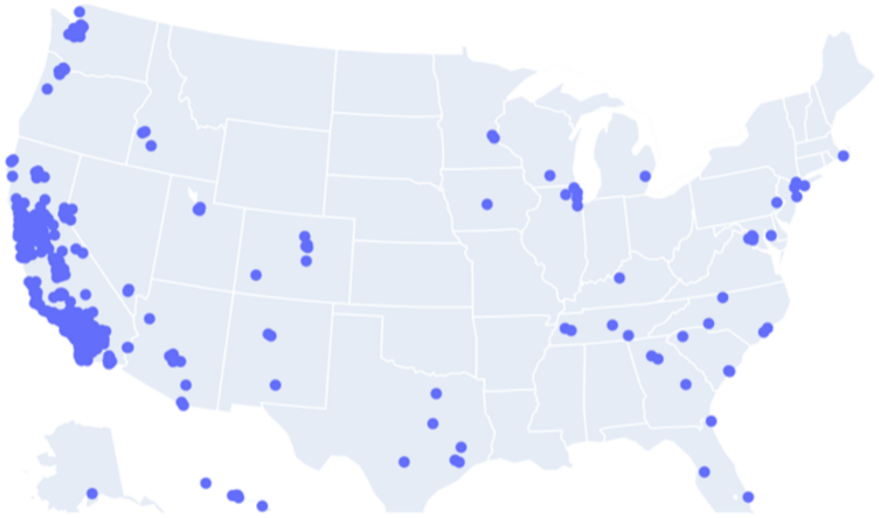


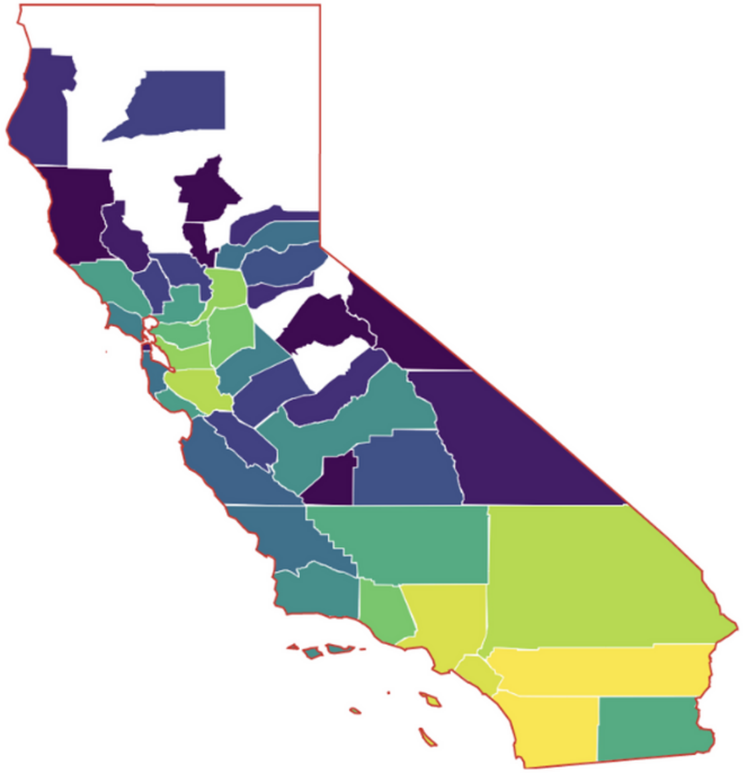


Where do they come from?

CSUSM Spring 2022 Student Location

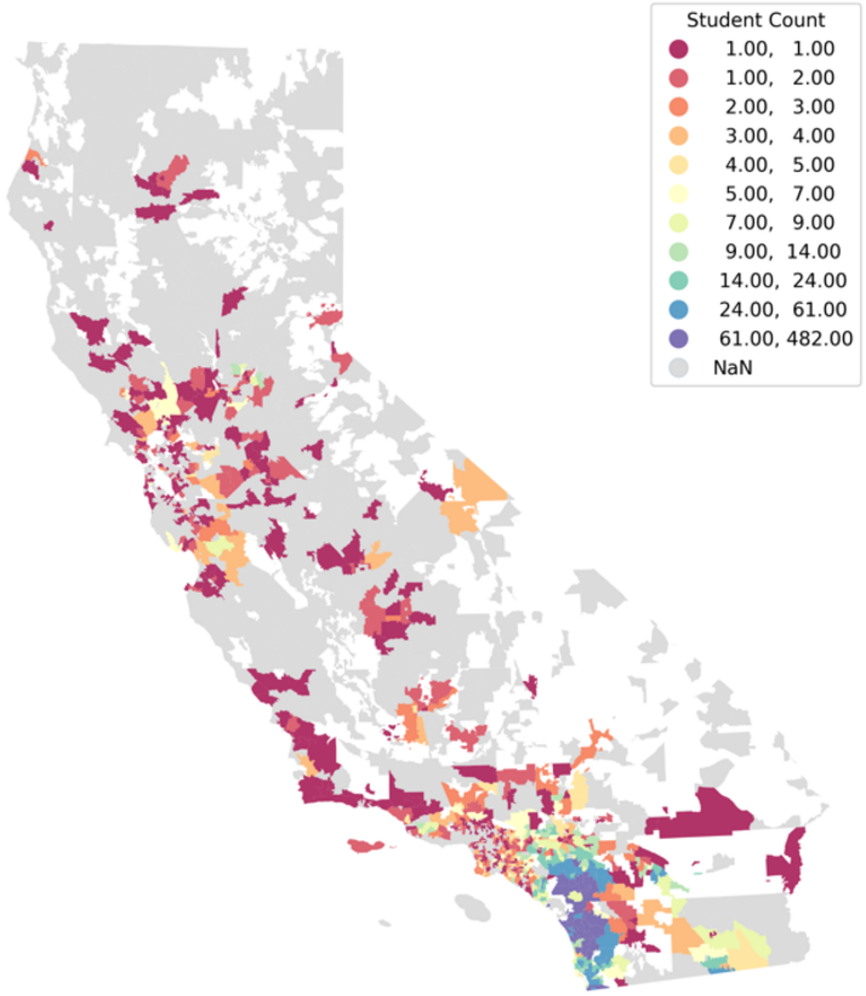


CSUSM Spring 2022 Students by County

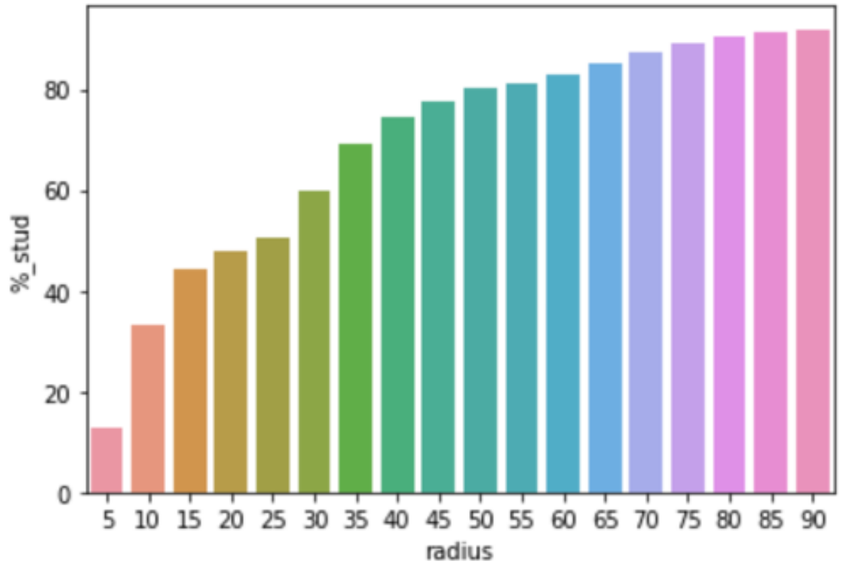


Where do they come from?

Spring/22 CSUSM Students by Zip Code



Spring/22 CSUSM Students Count within Radius Disttance from campus



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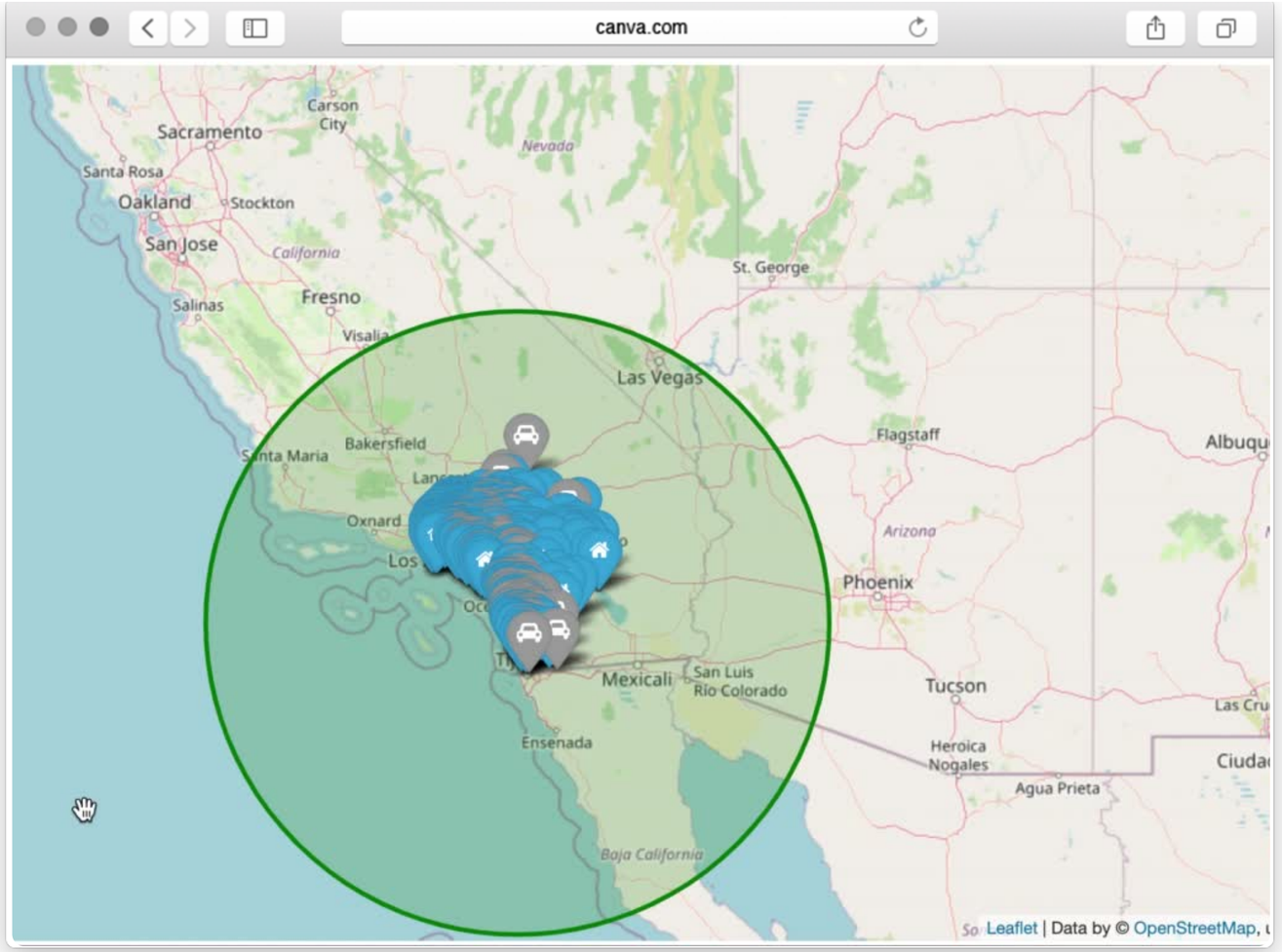


Our Solution

Requirements

What information we need from students to create the matches

Constraints

Location
Schedule
Role
Available Seats

Preferences

Same Gender
Same Age Group
Same Status
Non-Smoker Ride-mate

...

Compatibility Score

Equation

$$CS = \sum b \cdot w^A \cdot w^B$$

Base Value b

- 1 : features with the same characteristic
- 0 : feature with opposite characteristics but not choses as preference by any user
- -1 : features with opposite characteristic and chosen as a preferenceby any user

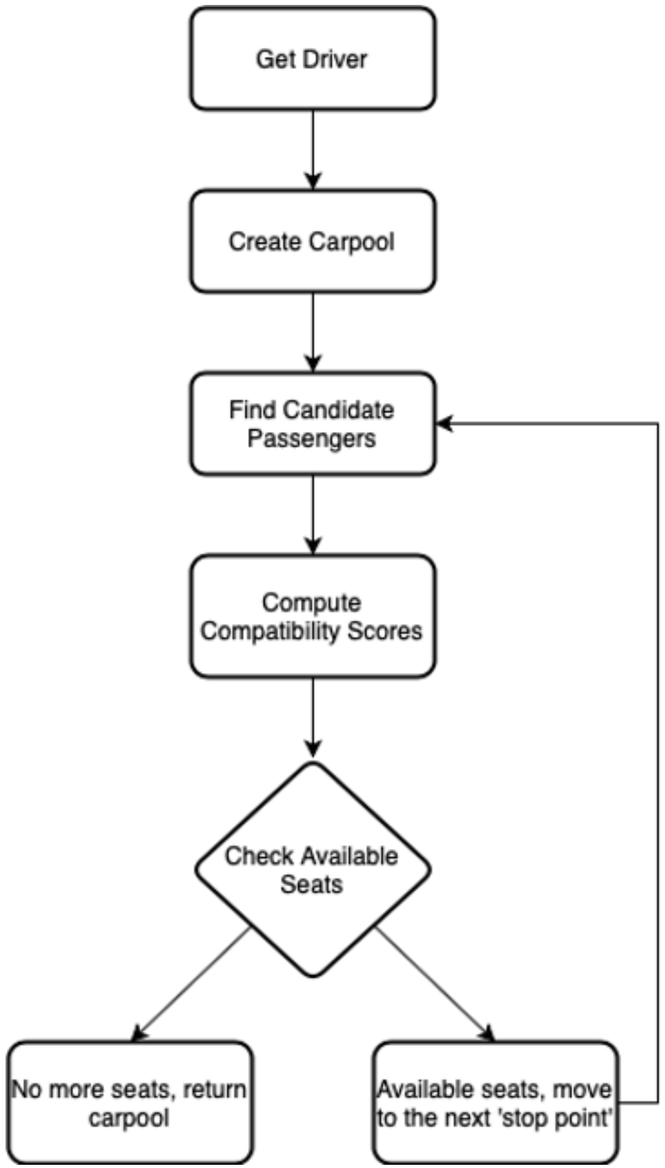
Weight w

- Factor = 2 (system defined)

Example

	STUDENT A		STUDENT B					
FEATURE	**Characteristic**	**Preference**	**Characteristic**	**Preference**	**b**	**w^A**	**w^B**	**Total**
NON-SMOKER	✓	✓	✓	✓	1	2	2	4
GENDER	Female		Female	✓	1		2	2
AGE GROUP	Under 25		Under 25		1			1
STATUS	Undergrad		Grad		0			0
COLLEGE	CSTEM		CEHHS		0			0
				FINAL COMPATIBILITY SCORE				**7**

Final score range [-17, 17]



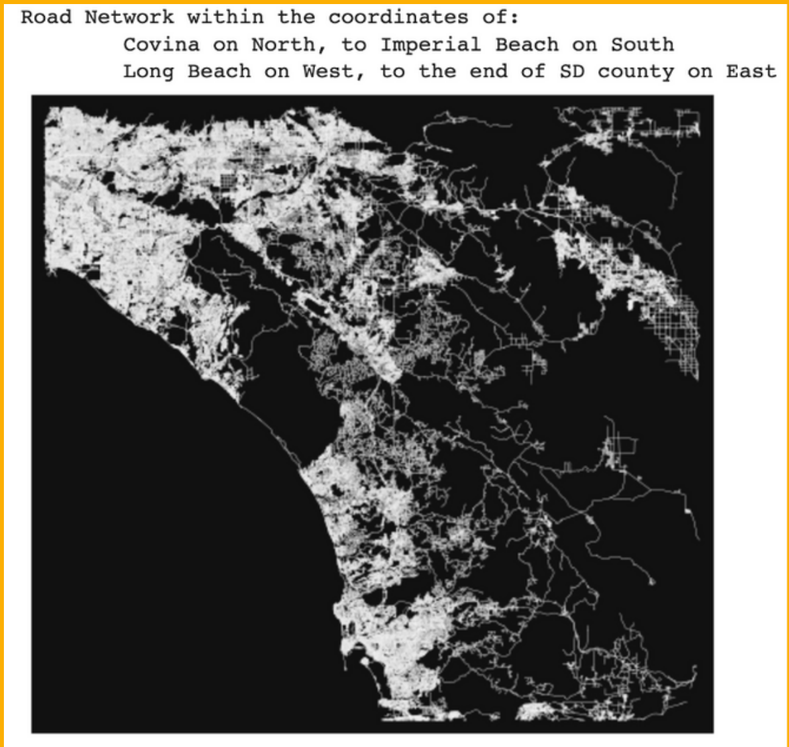
Process Flow

How the carpools are created

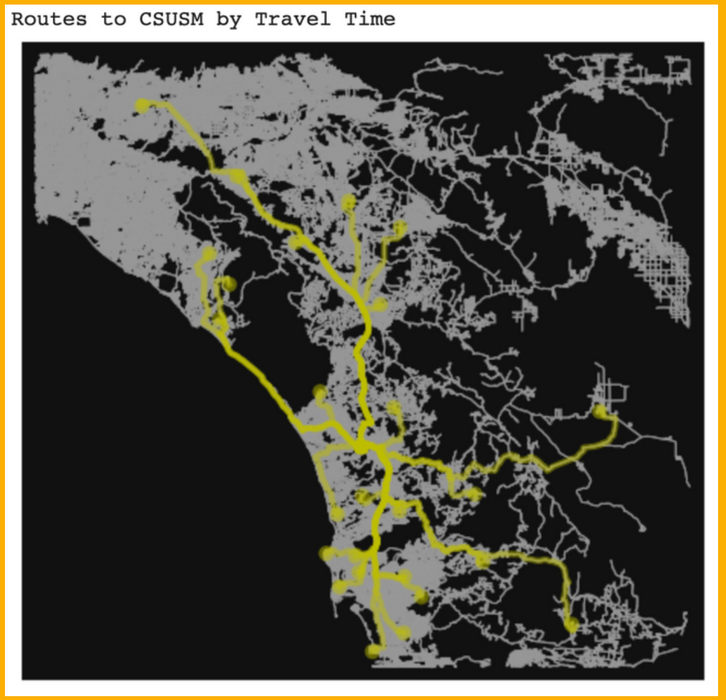
1. Select a driver from the pool
2. Create a carpool
3. Find candidates around this location
4. Compute the compatibility score
5. Select higher score candidates to fill up the seats
6. If there are available seats, go to the next location and repeat the process from # 3
7. Else, save the carpool, and select another driver to restart the process

Pre-processed Routes

Save computing by time fetching pre-processed routes from the database



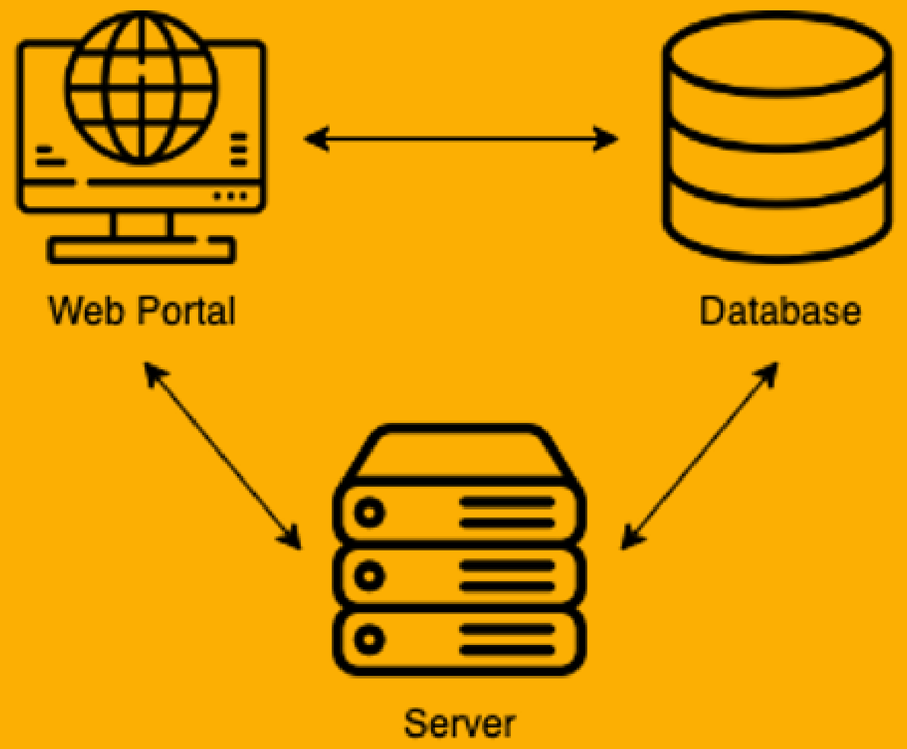
Origin	Travel Time	Travel Distance
Imperial_Beach	00:46:07	46.04 miles
San_Clemente	00:43:04	42.05 miles
Perris	00:51:56	52.27 miles
Lake_Elsinore	00:46:53	48.27 miles
Temecula	00:32:22	32.55 miles
Valley_Center	00:19:50	15.39 miles
Camp_Pendleton	00:20:25	15.99 miles
Murieta	00:52:35	52.39 miles
Poway	00:20:18	17.69 miles
Clairemont	00:29:31	28.31 miles
La_Mesa	00:34:06	34.71 miles
Chula_vista	00:41:35	42.36 miles
Hemet	00:49:38	49.26 miles
Spring_Valley	00:40:58	40.07 miles
Carmel_Valley	00:25:06	18.76 miles
La_Jolla	00:35:00	28.06 miles
Linda_Vista	00:29:26	29.59 miles
Point_Loma	00:35:26	34.10 miles
Black_Mountain	00:21:14	17.62 miles
Corona	01:01:39	65.63 miles
Lake_Forest	00:55:45	56.12 miles
Covina	01:26:29	90.57 miles
Alpine	00:47:54	41.53 miles
Campo	01:17:21	70.75 miles
Ramona	00:41:41	30.06 miles
Borrego_Springs	01:36:25	70.52 miles



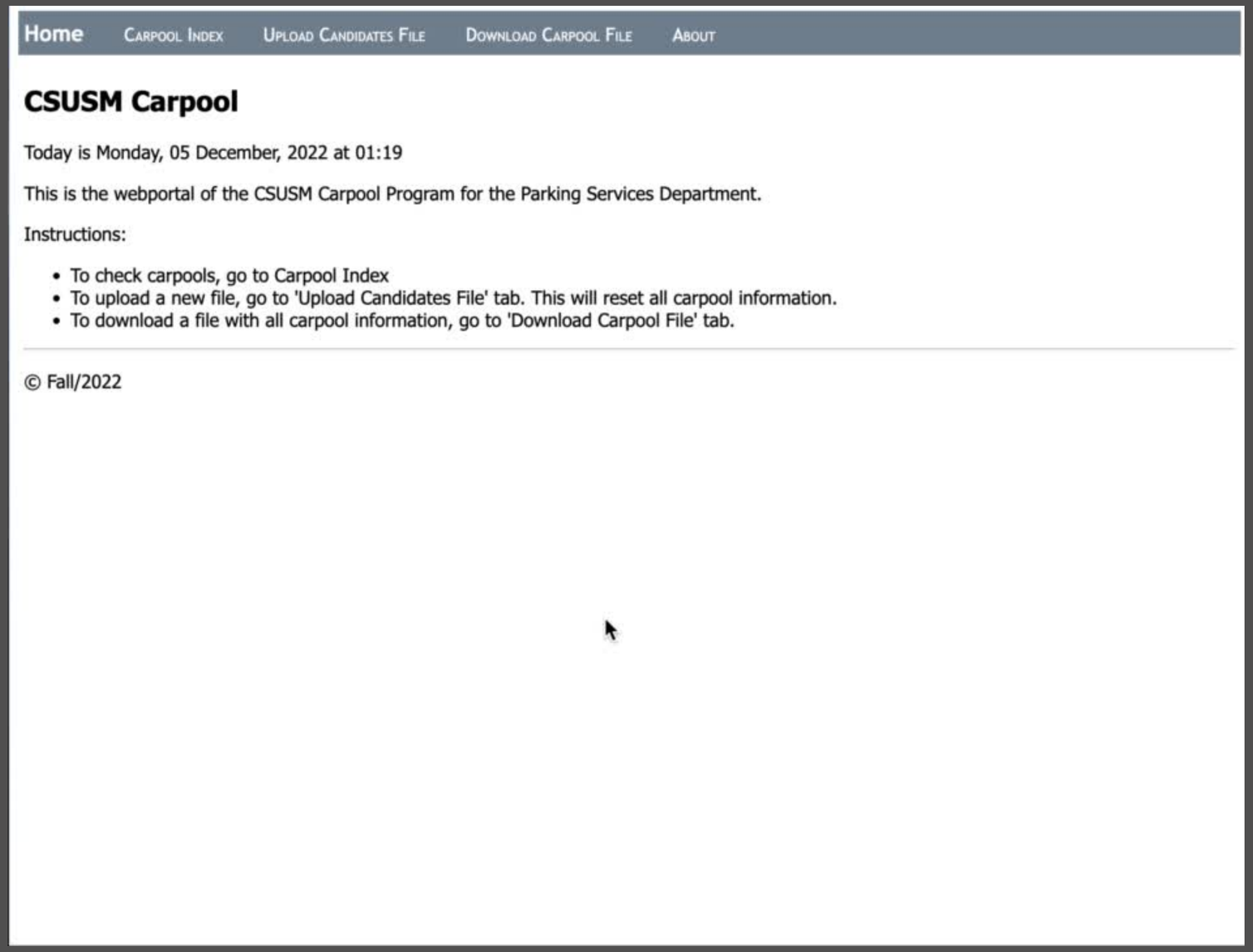
Implementation

Client-Server Architecture

- Web Portal: user interaction, upload/download files
- Database: routes, candidates, and carpools information
- Server: data processing and control



Web Portal


Home
Carpool Index
Upload Candidates File
Download Carpool File
About
CSUSM Carpool
Today is Monday, 05 December, 2022 at 01:19
This is the webportal of the CSUSM Carpool Program for the Parking Services Department.
Instructions:
To check carpools, go to Carpool Index
To upload a new file, go to 'Upload Candidates File' tab. This will reset all carpool information.
To download a file with all carpool information, go to 'Download Carpool File' tab.
© Fall/2022

Experiments and Results

Radius (miles)	Carpools	Total Unmatched		Total Matched		Time (sec)
0	650	448	30%	1052	70%	59
1	653	440	29%	1060	71%	56
2	676	408	27%	1092	73%	64
3	678	349	23%	1151	77%	53
4	697	315	21%	1185	79%	49
5	702	296	20%	1204	80%	49

1

Radius search

From 0 to 5 miles

Weekday Schedule

All week, group days, single days

2

Dataset Size	Carpools	Total Unmatched		Total Matched		Time (sec)
2500	632	419	17%	2081	83%	57
2000	496	381	19%	1619	81%	41
1500	357	369	25%	1131	75%	33
1000	231	288	29%	712	71%	25
500	114	173	35%	327	65%	14
400	94	146	37%	254	64%	12
300	60	143	48%	157	52%	9
200	38	104	52%	96	48%	6
100	16	60	60%	40	40%	3

Experiments and Results

Dataset Size	Carpools Created	Total Unmatched		Total Matched		Time (sec)
2500	1216	392	16%	2108	84%	93
2000	951	336	17%	1664	83%	75
1500	702	295	20%	1205	80%	54
1000	466	228	23%	772	77%	47
500	215	139	28%	361	72%	21
400	169	126	32%	274	69%	17
300	109	125	42%	175	58%	13
200	66	92	46%	108	54%	9
100	29	51	51%	49	49%	4

3

Multiple Options for Passengers

Keeping them in the pool

Time Constraint Relaxation

Interval of 30 min

4

Dataset Size	Carpools Created	Total Unmatched		Total Matched		Time (sec)
2500	1227	375	15%	2125	85%	126
2000	998	229	15%	1701	85%	85
1500	698	263	18%	1237	82%	61
1000	470	189	19%	811	81%	43
500	234	129	26%	371	74%	27
400	192	104	26%	296	74%	24
300	121	98	33%	202	67%	14
200	82	67	34%	133	67%	19
100	33	48	48%	52	52%	5

Thank you