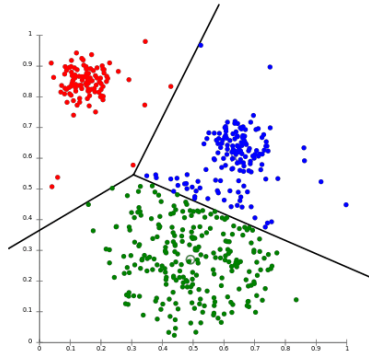


Visualizing the Future Prospect of Electric Vehicle (EV)





A K-means Clustering-based Spatial Analysis of Electric Vehicle Charging Stations (EVCS) in Boston, MA

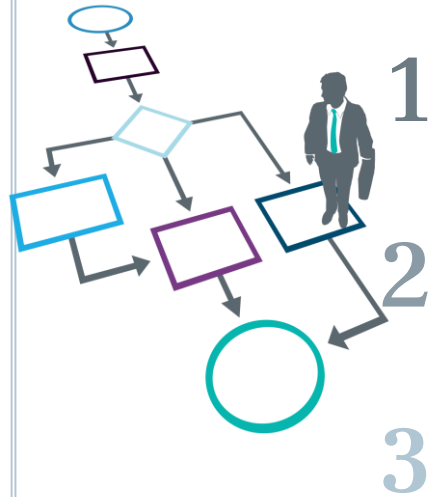
Wang Xi

BIG CONCEPT

A proper EVCS should be
located very carefully to
maximize EV usage.



Project Workflow



1 Data Acquisition

2 Methodology—K-means Spatial Analysis

3 Data Visualization—Map Clustering

A Gentle Introduction to dataset

1. `elec_car_station_data` - the geolocation of the electric car charging stations json data (the whole United States).
2. `evcs` - electric vehicle charging station pandas dataframe (the whole United States).
3. `evcs_boston` - the electric vehicle charging station location in Boston, MA.
4. `evcs_boston_map` - the visualization map of the electric vehicle charging station location in Boston, MA.
5. `evcs_venues` - the nearby venues characteristics of EVCS in Boston, MA.
6. `evcs_onehot` - the dummies dataframe of EVCS in Boston, MA.
7. `evcs_grouped` - EVCS grouped by neighborhood and taken the mean of the frequency of occurrence of each category in Boston, MA.
8. `num_top_venues` - the number of top visiting venues near EVCS in Boston, MA.
9. `evcs_venues_sorted` - EVCS nearby venues sorted by from the 1st most common venue to the 10th most common venue in Boston, MA.
10. `evcs_merged` - EVCS dataframe merged with EVCS nearby venues sorted by from the 1st most common venue to the 10th most common venue in Boston, MA.
11. `map_clusters` - the visualization map of the electric vehicle charging station clusters by using K-means clustering methodology in Boston, MA.





json data

```
[2]: with open('nrel-station_elec_equipments_mv.json') as json_data:
      elec_car_station_data = json.load(json_data)
      elec_car_station_data

[2]: {'type': 'FeatureCollection',
      'totalFeatures': 26537,
      'features': [{'type': 'Feature',
                    'id': 'station_elec_equipments_mv.fid-12dd6121_16dfb743c61_-6d13',
                    'geometry': {'type': 'Point', 'coordinates': [-121.4926, 38.5783882]},
                    'geometry_name': 'the_geom',
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                                  'fuel_type_code': 'ELEC',
                                  'status_code': 'AVBL',
                                  'street_address': '1815 L St',
                                  'city': 'Sacramento',
                                  'st_prv_code': 'CA',
                                  'zip': '95814',
                                  'station_phone': '888-758-4389 916-264-5011',
                                  'access_days_time': 'Garage business hours; pay lot',
                                  'groups_with_access_code': 'Public',
                                  'cards_accepted': None,
                                  'longitude': -121.4926,
                                  'latitude': 38.5783882}},
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                    'geometry_name': 'the_geom',
                    'properties': {'station_name': 'LADWP - Truesdale Center',
                                  'fuel_type_code': 'ELEC',
                                  'status_code': 'AVBL',
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                                  'city': 'Sun Valley',
                                  'st_prv_code': 'CA',
                                  'zip': '91352',
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                                  'access_days_time': None,
                                  'groups_with_access_code': 'Private - Government only',
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                                  'latitude': 34.249396)},
                  {'type': 'Feature',
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                    'geometry_name': 'the_geom',
                    'properties': {'station_name': 'Southern California Edison - Rosemead Office Building 1',
                                  'fuel_type_code': 'ELEC',
                                  'status_code': 'AVBL',
                                  'street_address': '2244 Walnut Grove Ave',
                                  'city': 'Rosemead',
                                  'st_prv_code': 'CA',
                                  'zip': '91770'}
```

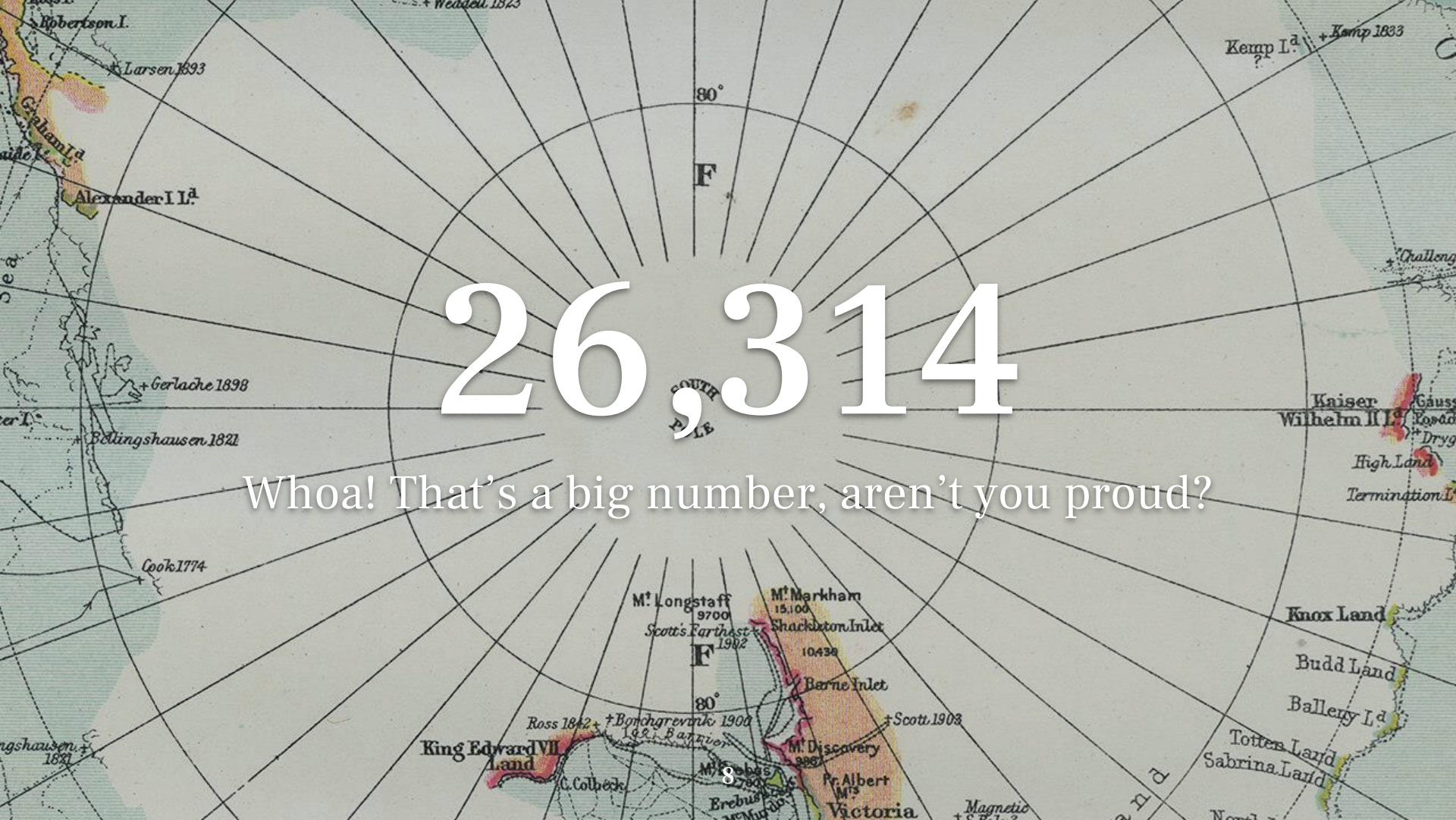
Dataframe with All EVCS Data in U.S.



```
[8]: evcs.head()
```

[8]:	State	City	Status	Station Name	Street Address	Access Time	Group	Longitude	Latitude
0	CA	Sacramento	AVBL	City of Sacramento - Capitol Parking Garage	1015 L St	Garage business hours; pay lot	Public	-121.492600	38.578380
1	CA	Sun Valley	AVBL	LADWP - Truesdale Center	11791 Truesdale St	None Private - Government only		-118.387136	34.249396
2	CA	Rosemead	AVBL	Southern California Edison - Rosemead Office B...	2244 Walnut Grove Ave	Employee use only	Private	-118.081014	34.050745
3	CA	Los Angeles	AVBL	Los Angeles Convention Center	1201 S Figueroa St	24 hours daily; pay lot	Public	-118.268762	34.040570
4	CA	Los Angeles	AVBL	LADWP - John Ferraro Building	111 N Hope St	24 hours daily	Public	-118.249800	34.057922



A polar projection map of Antarctica, showing the continent and surrounding islands. The map includes latitude and longitude lines, with 80° marked on both the vertical and horizontal axes. Various geographical features are labeled, including islands like Alexander I. L., Bellingshausen I., and numerous mountains and inlets. The number 26,314 is prominently displayed in the center of the map, overlaid on the continent. The text 'SOUTH POLE' is visible just below the number.

26,314

Whoa! That's a big number, aren't you proud?

Boston, MA



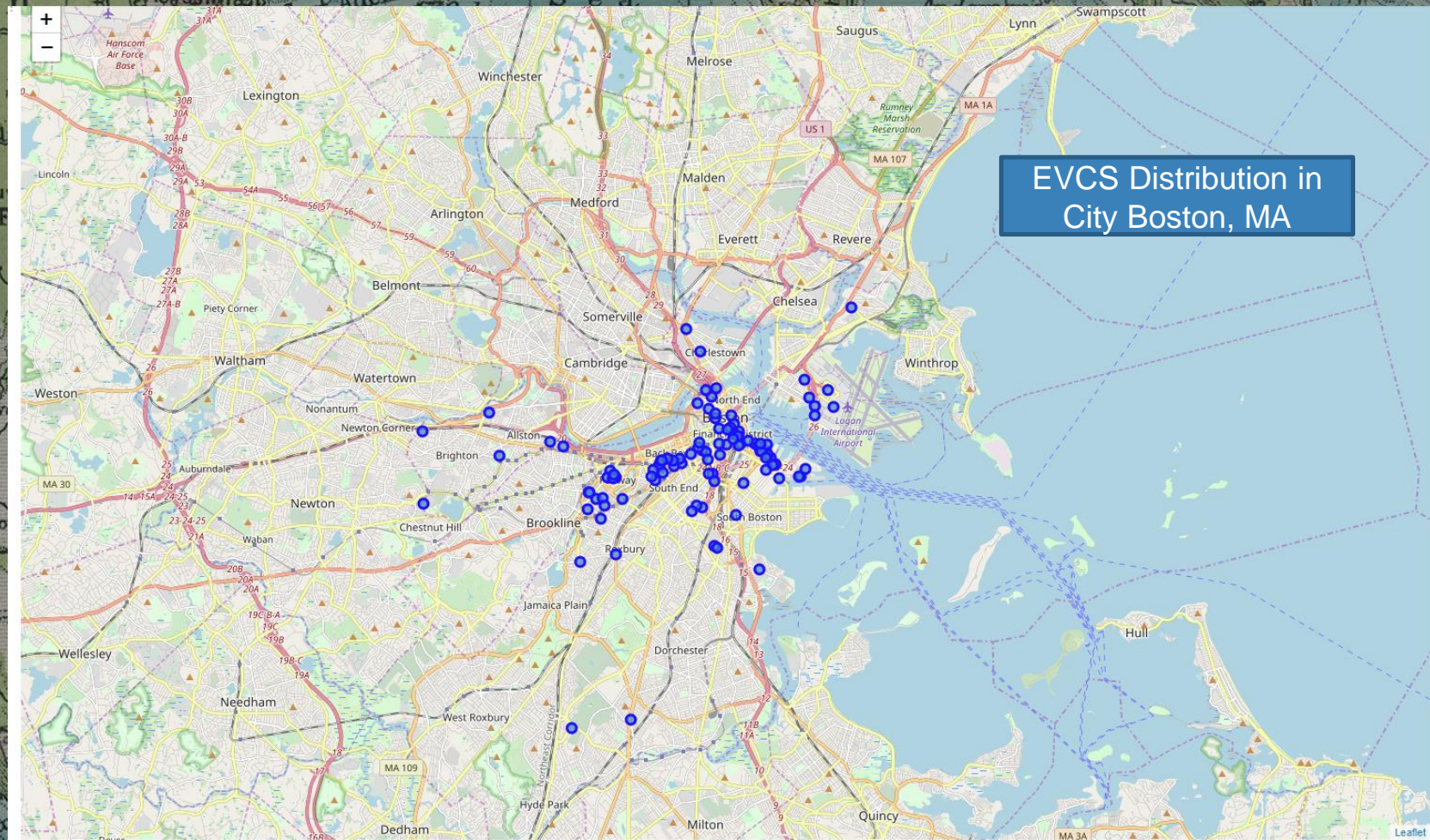
```
[9]: evcs_boston = evcs[evcs['City'] == 'Boston'].reset_index(drop=True)
evcs_boston.head()
```

[9]:	State	City	Status	Station Name	Street Address	Access Time	Group	Longitude	Latitude
0	MA	Boston	AVBL	SEAPORT GARAGE	1 Seaport Ln	24 hours daily	Public	-71.041742	42.349316
1	MA	Boston	AVBL	CLARENDON GROUP	265 Franklin St	24 hours daily	Public	-71.053321	42.356527
2	MA	Boston	AVBL	PRUDENTIAL CTR	800 Boylston St	24 hours daily	Public	-71.082497	42.347275
3	MA	Boston	AVBL	State Street Garage	75 State St	24 hours daily; pay lot	Public	-71.055089	42.358449
4	MA	Boston	AVBL	State Street Financial Center Parking	1 Lincoln St	24 hours daily	Public	-71.057957	42.352954

```
[10]: evcs_boston.shape
```

```
[10]: (107, 9)
```

Let's visualize City of Boston, MA.



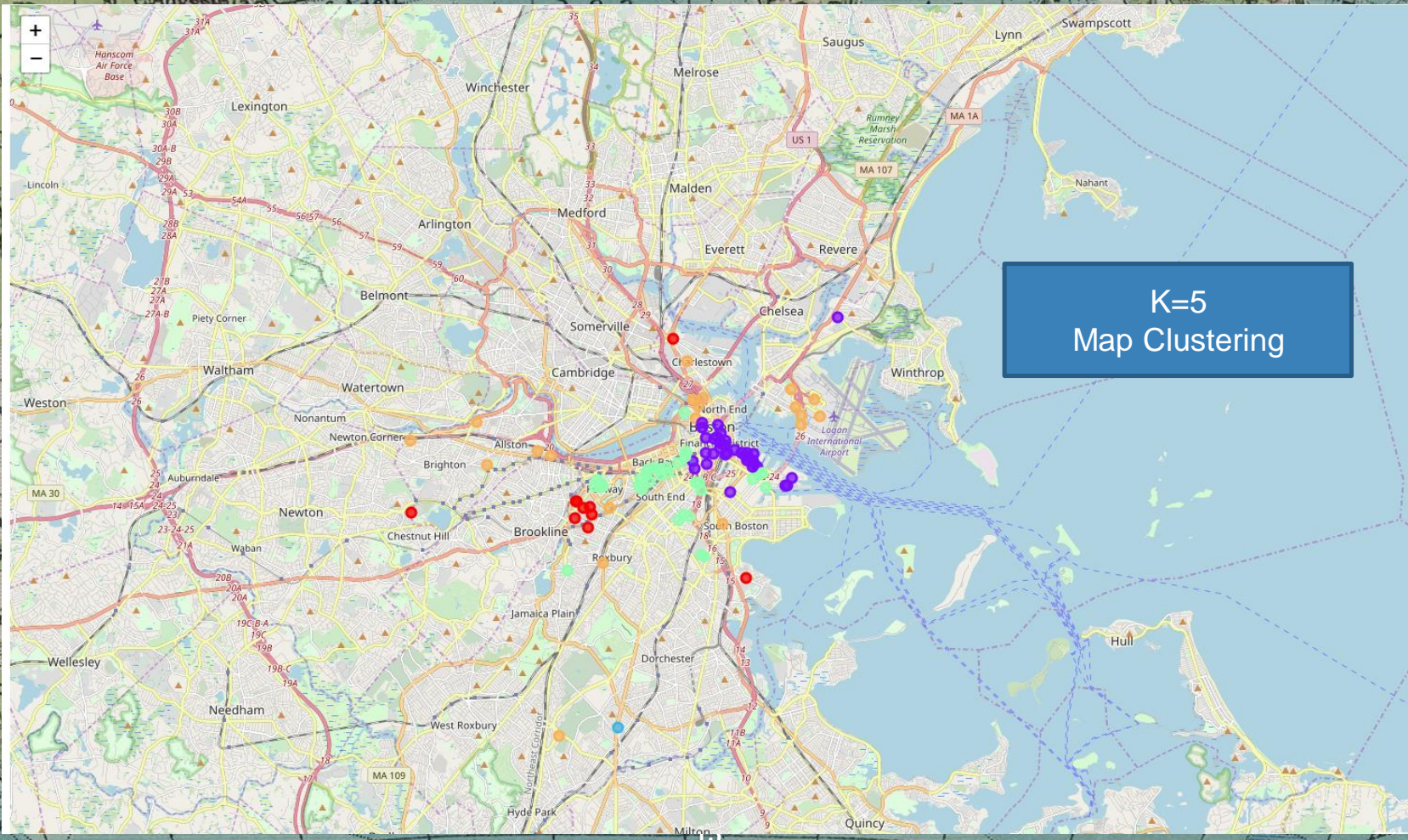
	Station Name	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	10 St. James Ave. / 75 Arlington ST	Spa	Hotel	Sandwich Place	American Restaurant	Seafood Restaurant	Theater	Gym	Gym / Fitness Center	Italian Restaurant	Jewelry Store
1	100 CLARENDON	American Restaurant	Spa	Gym	Seafood Restaurant	Gym / Fitness Center	Hotel	Sandwich Place	Italian Restaurant	Department Store	Cosmetics Shop
2	100 High Street	Coffee Shop	Sandwich Place	Italian Restaurant	Café	Falafel Restaurant	American Restaurant	Park	New American Restaurant	Hotel	Burger Joint
3	100 Northern	Hotel	Italian Restaurant	Steakhouse	Seafood Restaurant	Park	Mediterranean Restaurant	Taco Place	Gym	Coffee Shop	Salad Place
4	101 SEAPORT	Italian Restaurant	Coffee Shop	Asian Restaurant	Hotel	Steakhouse	Seafood Restaurant	Gym	Bakery	Mediterranean Restaurant	Salad Place

Combined Two Tables

	State	City	Status	Station Name	Street Address	Access Time	Group	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	MA	Boston	AVBL	SEAPORT GARAGE	Seaport Ln	24 hours daily	Public	-71.041742	42.349316	1	Seafood Restaurant	Coffee Shop	Bar	Hotel	Italian Restaurant	Steakhouse	Donut Shop	American Restaurant	Park	Taco Place
1	MA	Boston	AVBL	CLARENDON GROUP	265 Franklin St	24 hours daily	Public	-71.053321	42.356527	1	Coffee Shop	Hotel	Seafood Restaurant	Bakery	American Restaurant	Historic Site	Sandwich Place	Salad Place	Park	Italian Restaurant
2	MA	Boston	AVBL	PRUDENTIAL CTR	800 Boylston St	24 hours daily	Public	-71.082497	42.347275	3	Hotel	Italian Restaurant	Seafood Restaurant	Coffee Shop	American Restaurant	Bar	Ice Cream Shop	Dessert Shop	Gym / Fitness Center	Spa
3	MA	Boston	AVBL	State Street Garage	75 State St	24 hours daily; pay lot	Public	-71.055089	42.358449	1	Seafood Restaurant	Historic Site	Coffee Shop	Park	American Restaurant	Bakery	Hotel	Salad Place	Italian Restaurant	Sandwich Place
4	MA	Boston	AVBL	State Street Financial Center Parking	1 Lincoln St	24 hours daily	Public	-71.057957	42.352954	1	Coffee Shop	Sandwich Place	Asian Restaurant	Chinese Restaurant	Bakery	Café	Gym / Fitness Center	Sushi Restaurant	Gym	Italian Restaurant

“

*K-Means tries to minimize
the intra-cluster distances
and maximize the inter-
cluster distances.*



Cluster 1



10 Venues

Cluster 1 (red point on the map)

```
evcs_merged.loc[evcs_merged['Cluster Labels'] == 0, evcs_merged.columns[[3] + list(range(5, evcs_merged.shape[1]))]]
```

	Station Name	Access Time	Group	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
9	LONGWOOD GARAGE	24 hours daily	Public	-71.105662	42.338179	0	Café	American Restaurant	Coffee Shop	Falafel Restaurant	Sandwich Place	Gastropub	Pharmacy	Park	Bus Stop	Burrito Place
23	BRIGHAM CIRCLE	24 hours daily	Public	-71.103849	42.332801	0	Café	Sandwich Place	Pizza Place	Sushi Restaurant	Gastropub	Caribbean Restaurant	New American Restaurant	Greek Restaurant	Grocery Store	Pub
34	Medical, Academic, and Scientific Community Or...	24 hours daily	Public	-71.108312	42.340042	0	Café	Coffee Shop	Donut Shop	Fast Food Restaurant	Pharmacy	American Restaurant	Sandwich Place	Metro Station	Falafel Restaurant	Shipping Store
43	BOSTON COLLEGE	24 hours daily	Public	-71.168664	42.337087	0	ATM	Café	Mexican Restaurant	Donut Shop	Shipping Store	Bus Stop	Bus Station	Ice Cream Shop	Costume Shop	Concert Hall
44	BWH-SFRGARAGE	24 hours daily	Public	-71.108562	42.335386	0	Café	American Restaurant	Sandwich Place	Falafel Restaurant	Bus Stop	Sushi Restaurant	Coffee Shop	Ice Cream Shop	Bar	Pharmacy
54	HARVARD MEDICAL	24 hours daily	Public	-71.103142	42.338445	0	Café	Coffee Shop	Sandwich Place	Falafel Restaurant	Fast Food Restaurant	Italian Restaurant	Park	Burrito Place	Shipping Store	Donut Shop
76	DoubleTree Club by Hilton Boston-Bayside - Tes...	24 hours daily; for Tesla use only; for custom...	Public	-71.045934	42.319148	0	Coffee Shop	Bank	Harbor / Marina	Grocery Store	Liquor Store	Café	Breakfast Spot	Bike Rental / Bike Share	Hotel	Antique Shop
85	Harvard Medical School	None	Private	-71.102475	42.336489	0	Café	Italian Restaurant	American Restaurant	Gym	Sushi Restaurant	Sandwich Place	Coffee Shop	Falafel Restaurant	Ice Cream Shop	Bar
89	MASCO E.V.E.	24 hours daily	Public	-71.108014	42.339954	0	Café	Coffee Shop	Donut Shop	Falafel Restaurant	Sandwich Place	Pharmacy	American Restaurant	Fast Food Restaurant	Italian Restaurant	Bank
104	SCHRAFFTS CENTE	24 hours daily	Public	-71.072489	42.384195	0	Gym / Fitness Center	Café	Bus Stop	Electronics Store	Gym	Bus Station	Art Gallery	Baseball Field	Theater	Auto Workshop

Cluster 2



35 Venues

Cluster 2 (purple point on the map)

```
[32]: evcs_merged.loc[evcs_merged['Cluster Labels'] == 1, evcs_merged.columns[3] + list(range(5, evcs_merged.shape[1]))]
```

[32]:

	Station Name	Access Time	Group	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	SEAPORT GARAGE	24 hours daily	Public	-71.041742	42.349316	1	Seafood Restaurant	Coffee Shop	Bar	Hotel	Italian Restaurant	Steakhouse	Donut Shop		Park	Taco Place
1	CLARENDON GROUP	24 hours daily	Public	-71.053321	42.356527	1	Coffee Shop	Hotel	Seafood Restaurant	Bakery	American Restaurant	Historic Site	Sandwich Place	Salad Place	Park	Italian Restaurant
3	State Street Garage	24 hours daily; pay lot	Public	-71.055089	42.358449	1	Seafood Restaurant	Historic Site	Coffee Shop	Park	American Restaurant	Bakery	Hotel	Salad Place	Italian Restaurant	Sandwich Place
4	State Street Financial Center Parking	24 hours daily	Public	-71.057957	42.352954	1	Coffee Shop	Sandwich Place	Asian Restaurant	Chinese Restaurant	Bakery	Café	Gym / Fitness Center	Sushi Restaurant	Gym	Italian Restaurant
5	GARAGE AT PO SQ	24 hours daily	Public	-71.055596	42.356276	1	Sandwich Place	Coffee Shop	Historic Site	Hotel	Italian Restaurant	New American Restaurant	American Restaurant	Salad Place	Seafood Restaurant	Park
12	Standard Parking	Garage business hours	Public	-71.062137	42.359957	1	Coffee Shop	Historic Site	American Restaurant	Seafood Restaurant	Hotel	Sandwich Place	New American Restaurant	Cocktail Bar	Salad Place	Restaurant
16	ATLANTIC WHARF	24 hours daily	Public	-71.052761	42.353325	1	Coffee Shop	Italian Restaurant	Hotel	Sandwich Place	French Restaurant	Bar	Salad Place	Cocktail Bar	Asian Restaurant	Park
21	UDR	24 hours daily	Public	-71.043399	42.351138	1	Italian Restaurant	Steakhouse	Coffee Shop	Hotel	Seafood Restaurant	Park	Bar	Asian Restaurant	Taco Place	Bakery
22	FEDERAL RESERVE	24 hours daily	Public	-71.053416	42.352676	1	Sandwich Place	Coffee Shop	Italian Restaurant	Hotel	Asian Restaurant	Bar	French Restaurant	Seafood Restaurant	Pizza Place	Dive Bar
24	PILGRIM PARKING	24 hours daily	Public	-71.060194	42.350088	1	Asian Restaurant	Chinese Restaurant	Bakery	Coffee Shop	Sushi Restaurant	Sandwich Place	Theater	Gym	Performing Arts Venue	Café
25	50 POST OFFICE	24 hours daily	Public	-71.055247	42.355712	1	Sandwich Place	Coffee Shop	Italian Restaurant	Historic Site	American Restaurant	Hotel	Park	Burger Joint	New American Restaurant	Sushi Restaurant
26	CHARGE STATION	24 hours daily	Public	-71.012355	42.389934	1	Rental Car Location	Hotel	Gym	Coffee Shop	Cosmetics Shop	Chinese Restaurant	Café	Sandwich Place	Fast Food Restaurant	Food
28	125 HIGH ST	24 hours daily	Public	-71.053601	42.355197	1	Coffee Shop	Sandwich Place	Hotel	Italian Restaurant	American Restaurant	Lounge	Burger Joint	Bar	Sushi Restaurant	Seafood Restaurant
29	100 High Street	MO: 12:00am-12:00am TU: 12:00am-12:00am WE: ...	Public	-71.055401	42.354474	1	Coffee Shop	Sandwich Place	Italian Restaurant	Café	Falafel Restaurant	American Restaurant	Park	New American Restaurant	Hotel	Burger Joint
32	101 SEAPORT	24 hours daily	Public	-71.045350	42.351169	1	Italian Restaurant	Coffee Shop	Asian Restaurant	Hotel	Steakhouse	Seafood Restaurant	Gym	Bakery	Mediterranean Restaurant	Salad Place
33	SEAPORT GARAGE	24 hours daily	Public	-71.042713	42.350046	1	Seafood Restaurant	Coffee Shop	Bar	Hotel	Italian Restaurant	Steakhouse	Donut Shop	American Restaurant	Park	Taco Place

Cluster 3



1 Venues

Cluster 3 (blue point on the map)¶

```
evcs_merged.loc[evcs_merged['Cluster Labels'] == 2, evcs_merged.columns[[3] + list(range(5, evcs_merged.shape[1]))]]
```

	Station Name	Access Time	Group	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
62	RCC CAR CHARGE	24 hours daily	Public	-71.093021	42.278609	2	Ice Cream Shop	Moving Target	Liquor Store	Park	Zoo Exhibit	Donut Shop	Dive Bar	Doctor's Office	Dog Run	Duty-free Shop

Cluster 4



41 Venues

Cluster 4 (brilliant green point on the map)

```
evcs_merged.loc[evcs_merged["Cluster Labels"] == 3, evcs_merged.columns[[3] + list(range(5, evcs_merged.shape[1]))]]
```

	Station Name	Access Time	Group	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
2	PRUDENTIAL CTR	24 hours daily	Public	-71.082497	42.347275	3	Hotel	Italian Restaurant	Seafood Restaurant	Coffee Shop	American Restaurant	Bar	Ice Cream Shop	Dessert Shop	Gym / Fitness Center	Spa
6	RES INN FENWAY	24 hours daily	Public	-71.100562	42.345877	3	American Restaurant	Lounge	Sports Bar	Mexican Restaurant	Thai Restaurant	Café	Donut Shop	Pizza Place	Coffee Shop	Hotel
7	TRILOGY	24 hours daily	Public	-71.101413	42.344161	3	Sports Bar	American Restaurant	Thai Restaurant	Lounge	Pizza Place	Mexican Restaurant	Café	Greek Restaurant	Baseball Field	Liquor Store
8	TRILOGY	24 hours daily	Public	-71.098469	42.344070	3	Sports Bar	American Restaurant	Thai Restaurant	Lounge	Pizza Place	Mexican Restaurant	Café	Greek Restaurant	Baseball Field	Liquor Store
10	PRUDENTIAL CTR	24 hours daily	Public	-71.082532	42.347152	3	Hotel	Italian Restaurant	Seafood Restaurant	Coffee Shop	American Restaurant	Bar	Ice Cream Shop	Dessert Shop	Gym / Fitness Center	Spa
11	601 Congress Street	MO: Not Specified; TU: Not Specified; WE: Not ...	Public	-71.039867	42.347527	3	Seafood Restaurant	Donut Shop	American Restaurant	Music Venue	Harbor / Marina	Steakhouse	Deli / Bodega	Café	Sandwich Place	Hotel
13	WHOLE FOODS MKT	24 hours daily	Public	-71.062833	42.345169	3	Grocery Store	Art Gallery	Pizza Place	Dog Run	Chinese Restaurant	Italian Restaurant	Japanese Restaurant	Hotel	Thrift / Vintage Store	Pharmacy
19	TRANSCOMM	24 hours daily	Public	-71.066885	42.336015	3	Sandwich Place	Donut Shop	Mediterranean Restaurant	Flower Shop	Department Store	Tapas Restaurant	Bakery	Café	Southern / Soul Food Restaurant	Miscellaneous Shop
20	TRANSCOMM	24 hours daily	Public	-71.066898	42.336521	3	Sandwich Place	Donut Shop	Mediterranean Restaurant	Flower Shop	Department Store	Tapas Restaurant	Bakery	Café	Southern / Soul Food Restaurant	Miscellaneous Shop
30	Midtown Hotel	MO: Not Specified; TU: Not Specified; WE: Not ...	Public	-71.083958	42.343261	3	Coffee Shop	Sushi Restaurant	American Restaurant	Pizza Place	Bakery	Bar	Concert Hall	Middle Eastern Restaurant	Bookstore	Grocery Store
31	The Lenox Hotel Watt Station	24 hours daily	Public	-71.079376	42.349218	3	Hotel	Sporting Goods Shop	Coffee Shop	American Restaurant	Clothing Store	Seafood Restaurant	Italian Restaurant	Ice Cream Shop	Cosmetics Shop	New American Restaurant
39	VAN NESS	24 hours daily	Public	-71.099183	42.344212	3	Sports Bar	Lounge	American Restaurant	Pizza Place	Café	Thai Restaurant	Furniture / Home Store	Liquor Store	Donut Shop	Hotel
40	VAN NESS	24 hours daily	Public	-71.099419	42.344030	3	Sports Bar	Lounge	American Restaurant	Pizza Place	Café	Thai Restaurant	Furniture / Home Store	Liquor Store	Donut Shop	Hotel
41	VAN NESS	24 hours daily	Public	-71.098925	42.344133	3	Sports Bar	Lounge	American Restaurant	Pizza Place	Café	Thai Restaurant	Furniture / Home Store	Liquor Store	Donut Shop	Hotel

Cluster 5



20 Venues

Cluster 5 (brown point on the map)

```
evcs_merged.loc[evcs_merged['Cluster Labels'] == 4, evcs_merged.columns[3:] = list(range(4, evcs_merged.shape[1]))]
```

	Station Name	Street Address	Access Time	Group	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
14	CHARLES RIVER	899-925 Commonwealth Avenue	24 hours daily	Public	-71.117506	42.352459	4	Pizza Place	Coffee Shop	Burger Joint	Chinese Restaurant	Thai Restaurant	Gym / Fitness Center	Yoga Studio	Donut Shop	College Cafeteria	Nightclub
15	CHARLES RIVER	161-179 Ashford St	24 hours daily	Public	-71.122325	42.353708	4	Pizza Place	Coffee Shop	Burger Joint	Chinese Restaurant	Thai Restaurant	Gym / Fitness Center	Yoga Studio	Donut Shop	College Cafeteria	Nightclub
17	MASSPORT	Airport Road - Arrival Level	24 hours daily	Public	-71.020897	42.367584	4	Donut Shop	Coffee Shop	Rental Car Location	Airport Lounge	Harbor / Marina	Seafood Restaurant	Hotel	American Restaurant	Park	Airport Service
18	MASSPORT	Logan Airport Terminal B	24 hours daily	Public	-71.018645	42.363092	4	Donut Shop	Coffee Shop	Rental Car Location	Airport Lounge	Harbor / Marina	Seafood Restaurant	Hotel	American Restaurant	Park	Airport Service
27	XL Hybrids Inc	145 Newton St	Employee use only	Private	-71.169102	42.356504	4	Park	Hotpot Restaurant	Baseball Field	Skating Rink	Harbor / Marina	Toll Plaza	Convenience Store	Discount Store	Event Space	Ethiopian Restaurant
38	CAMELOT COURT	10 Camelot Ct	24 hours daily	Public	-71.140868	42.350007	4	Pizza Place	Donut Shop	Gastropub	Liquor Store	Bar	Burmese Restaurant	Dog Run	Chinese Restaurant	Japanese Restaurant	Bubble Tea Shop
42	JACKSON UE	1542R Columbus Ave	24 hours daily	Public	-71.098236	42.323381	4	Park	Pizza Place	Metro Station	Mobile Phone Shop	Donut Shop	Plaza	Snack Place	Paella Restaurant	Chinese Restaurant	Sandwich Place
48	LEVEL P3	1 Nashua St	24 hours daily	Public	-71.063294	42.365955	4	Donut Shop	Pizza Place	Italian Restaurant	Coffee Shop	Bar	Hotel	Sports Bar	Brewery	Sandwich Place	Park
51	North Station Garage	121 Nashua St	Garage business hours; pay lot	Public	-71.065477	42.367580	4	Donut Shop	Science Museum	Bar	Park	Pizza Place	Sports Bar	Coffee Shop	Sporting Goods Shop	Gym	Liquor Store
52	Longfellow Garage	60 Staniford St	Garage business hours; pay lot	Public	-71.064251	42.362557	4	Pizza Place	Sandwich Place	American Restaurant	Hotel	Bar	Coffee Shop	Café	Mexican Restaurant	Donut Shop	Museum
63	Millennium Tower Boston	1 Franklin Street	MON: 24 hours TUE: 24 hours WED: 24 hours ...	Public	-71.067386	42.378045	4	Coffee Shop	Convenience Store	Pizza Place	Gastropub	Park	Pool	Café	Shopping Mall	Donut Shop	Pet Store
64	MFA	20 Museum Rd	24 hours daily	Public	-71.096006	42.338270	4	Art Museum	Art Gallery	Sandwich Place	Coffee Shop	Donut Shop	Grocery Store	Café	Bakery	Baseball Field	Mexican Restaurant
70	RELATED BEAL	105 Beverly Street	24 hours daily	Public	-71.061459	42.368122	4	Bar	Pizza Place	Donut Shop	Italian Restaurant	Hotel	Park	Gym / Fitness Center	Gastropub	Brewery	Scenic Lookout
72	TD BANK	950 American Legion Hwy	24 hours daily	Public	-71.114361	42.276355	4	Latin American Restaurant	Pharmacy	Convenience Store	Supermarket	Liquor Store	Buffet	Discount Store	Gym / Fitness Center	Mexican Restaurant	Video Store
87	MASSPORT	1 Harborside Dr	24 hours daily	Public	-71.025706	42.363421	4	Donut Shop	Coffee Shop	Rental Car Location	Airport Lounge	Harbor / Marina	Seafood Restaurant	Hotel	American Restaurant	Park	Airport Service
92	PORTSIDE	40 East Pier Drive	24 hours daily	Public	-71.054316	42.333964	4	Pizza Place	Italian Restaurant	Sandwich Place	Laundromat	Dive Bar	Grocery Store	Gym	Gym / Fitness Center	Liquor Store	Chinese Restaurant

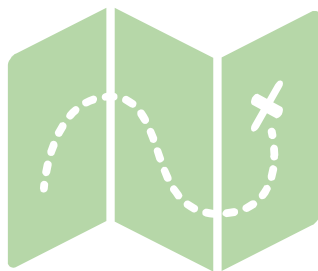


The Elbow Method

The elbow point is determined where the rate of decrease sharply shifts.

It is the right K for clustering.





THANKS!