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Applied  
Data Science  
Capstone  
Project

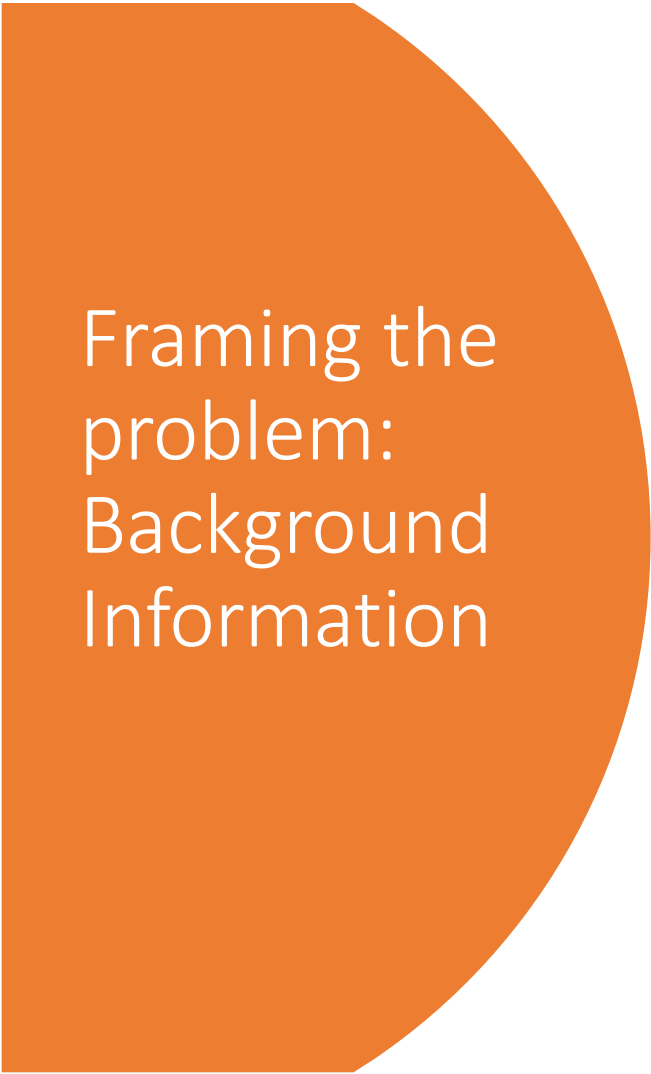
# **An Analysis of Healthcare In the City of Seattle, Washington**

**Jeffrey Guest  
June 27, 2020**



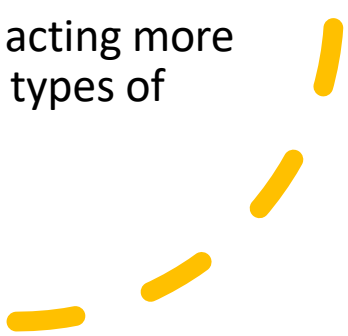
# Applied Data Science Capstone Project Overview

- **For the first week, the final deliverables of the project will be:**
  - A description of the problem and a discussion of the background. (15 marks)
  - A description of the data and how it will be used to solve the problem. (15 marks)
- **For the second week, the final deliverables of the project will be:**
  - A link to your Notebook on your Github repository, showing your code. (15 marks)
  - A full report consisting of all of the following components (15 marks):
    - 1) Introduction where you discuss the business problem and who would be interested in this project.
    - 2) Data where you describe the data that will be used to solve the problem and the source of the data.
    - 3) Methodology section which represents the main component of the report where you discuss and describe any exploratory data analysis that you did, any inferential statistical testing that you performed, if any, and what machine learnings were used and why.
    - 4) Results section where you discuss the results.
    - 5) Discussion section where you discuss any observations you noted and any recommendations you can make based on the results.
    - 6) Conclusion section where you conclude the report
  - Your choice of a presentation or blogpost. (10 marks)

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## Framing the problem: Background Information

### A Changing Healthcare Landscape:

- Healthcare delivery models are undergoing substantial changes
  - Patients increasingly responsible for making financial decisions about their own health care
    - Individuals responsible for larger portions of healthcare costs
    - Those seeking health services are acting more and more like consumers of other types of goods and services
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## Intended Audience and Potential Impact

### Healthcare Thought Leadership:

- Serves as a data science exercise that demonstrates insight and understanding about health resources in a major metropolitan area:
  - More informed decisions about resource distribution and payment methodologies
  - Healthcare accessibility
- Audience targets:
  - Healthcare provider administrators
  - Government health policy leaders
  - Health payors (health insurers)
  - Healthcare consumers



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## Problem Statement

## Major Project Aims:

- Understand some key elements about health service locations.
- Visualize data around healthcare Length of Stay and Charge data from a State-level Department of Health.
- Demonstrate data science comprehension
  - Use of Python
  - Associated Libraries
  - Data visualization
  - Clustering techniques



## Data Background

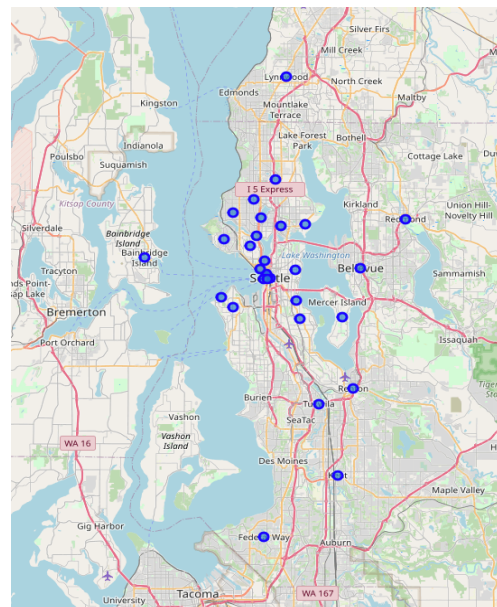
### High-level description of project data:

- Using Foursquare, the data for this project used a very high-level keyword description of “healthcare”.
- Folium package used to provide a mapping, visual representations of similar clusters of healthcare venues using a k-means algorithm approach.
- Washington Department of Health Data and Descriptive Statistics related to:
  - Hospital Volume Data
  - Length of Stay
  - Payor charge behavior



# Project Methodology

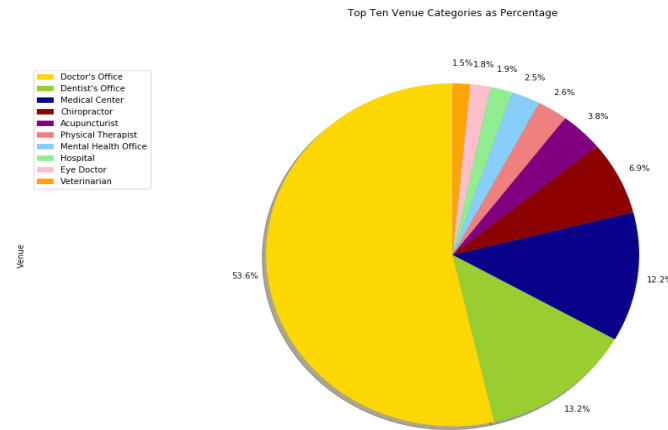
- Folium mapping by neighborhood of Seattle, WA:



	Zip Code	Neighborhood	Latitude	Longitude
0	98003	Federal Way, WA	47.313494	-122.339310
1	98005	Bellevue, WA	47.614422	-122.192337
2	98037	Lynnwood, WA	47.827866	-122.305393
3	98040	Mercer Island, WA	47.560207	-122.220142
4	98052	Redmond, WA	47.669414	-122.123877
5	98055	Renton, WA	47.479908	-122.203450
6	98101	Seattle, WA	47.603832	-122.330062
7	98101	Downtown Seattle, WA	47.604872	-122.333458
8	98102	Capital Hill Seattle, WA	47.608263	-122.335190
9	98103	Greenwood, WA	47.690981	-122.354877

# Project Methodology

- Healthcare venue analysis:



- Top 10 healthcare venue categories considered using pie-chart
- Doctor's and Dentist offices vastly most common
- 29 total categories in all:
  - Many with only 1 or 2 instances



# Project Methodology

- K-Means venue analysis:

- One hot encoding with Top 5 Analysis by neighborhood:

	Neighborhood	Acupuncturist	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Dentist's Office	Doctor's Office	Emergency Room	...	Me
0	Federal Way, WA	0	0	0	0	0	0	0	0	0	0	...
1	Federal Way, WA	0	0	0	0	0	0	0	1	0	0	...
2	Federal Way, WA	0	0	0	0	0	0	0	1	0	0	...
3	Federal Way, WA	0	0	0	0	0	0	1	0	0	0	...

```

---- Alki Beach, WA----
venue freq
0 Doctor's Office 0.5
1 Alternative Healer 0.5
2 Acupuncturist 0.0
3 Massage Studio 0.0
4 Urgent Care Center 0.0

```

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---- Bainbridge Island, WA----
venue freq
0 Doctor's Office 0.67
1 Dentist's Office 0.14
2 Acupuncturist 0.10
3 Chiropractor 0.05
4 Medical Center 0.05

```

```

---- Ballard, WA----
venue freq
0 Dentist's Office 0.75
1 Massage Studio 0.25
2 Acupuncturist 0.00
3 Marijuana Dispensary 0.00
4 Urgent Care Center 0.00

```

- Utilize K = 5 for clusters:

Zip Code	Neighborhood	Latitude	Longitude	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 98003	Federal Way, WA	47.313494	-122.339310	4	Dentist's Office	Doctor's Office	Acupuncturist	Chiropractor	Daycare	Medical Center	Eye Doctor	Hospital Ward	Alternative Healer	Assisted Living
1 98005	Bellevue, WA	47.614422	-122.192337	2	Doctor's Office	Dentist's Office	Chiropractor	Medical Center	Physical Therapist	Veterinarian	Hospital	Urgent Care Center	Medical Lab	Mental Health Office
2 98037	Lynnwood, WA	47.827866	-122.305393	4	Dentist's Office	Veterinarian	Doctor's Office	Chiropractor	Acupuncturist	Optical Shop	Office	Alternative Healer	Assisted Living	Building
3 98040	Mercer Island, WA	47.560207	-122.220142	1	Dentist's Office	Veterinarian	Hospital Ward	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Doctor's Office	Emergency Room
4 98052	Redmond, WA	47.669414	-122.123877	4	Dentist's Office	Physical Therapist	Doctor's Office	Veterinarian	Medical Center	Chiropractor	Acupuncturist	Eye Doctor	Optical Shop	Hospital

# Project Methodology

- Washington State -  
Department of Health Data:
  - Discharges by Payor and key census data
  - 2019 Calendar year

Fields Name	Description
Hospital_name	Name of the facility
Type	Type of facility – Includes Acute care, urgent care, skilled nursing facility, etc.
Lic	State Healthcare License Number
Payername	
Discharges	Total number of discharged patients for period
Total_days	Pateint days in hospital as defined under the two midnight rule
Total_charges	Total amount charged for the care received
Mean_LOS	Length of stay, rounded to nearest integer value. The Length of stay is the total number of days divided by the total number of discharges
Mean_charge_per_discharge	Total charges divided by the number of discharges
Mean_Charge_per_Day	Total charges divided the number of patient days
Casemix_index	An adjustment factor based on the relative population sickness being treated at the facility. Charge metrics are divided by this factor. If the factor is less than one the Charge metric will increase, if the factor is greater than one the metric will decrease.
Casemix_adjusted Charge per Disch	Calculated charge based on casemix index as described above.

# Primary Data Analysis Results

## Census Dataframe:

- Recalculation by facility using “groupby” method and “value\_counts()”.
- Sorting by Charges per Discharge or Charges per Day to determine lowest Charge facilities results in list of facilities with very few overall Discharges.

	Discharges	Total_days	Total_charges	Charges_per_disch	Charges_per_day
Hospital_name					
East Adams Rural Healthcare	6	8	26492.00	4415.33	3311.50
Garfield County Public Hospital District	14	88	70473.00	5033.79	800.83
Odessa Memorial Healthcare Center	38	98	268151.98	7056.63	2736.24
Columbia Basin Hosp	260	732	1943316.14	7474.29	2654.80
Cascade Med Ctr	116	306	1052800.58	9075.87	3440.52

- Updated methodology to make comparison by largest volume by discharge.

# Primary Data Analysis Results

## K-Means Cluster Results:

### Cluster 1:

	Neighborhood	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	Greenwood, WA	Doctor's Office	Medical Center	Physical Therapist	Dentist's Office	Veterinarian	Chiropractor	Building	Massage Studio	Maternity Clinic	Acupuncturist
10	Fremont Seattle, WA	Doctor's Office	Acupuncturist	Medical Center	Chiropractor	Physical Therapist	Dentist's Office	Mental Health Office	Health & Beauty Service	Alternative Healer	Marijuana Dispensary
12	Seattle Chinatown - International District, WA	Doctor's Office	Chiropractor	Dentist's Office	Mental Health Office	Medical Center	Veterinarian	Hospital	Alternative Healer	Assisted Living	Building
13	Pioneer Square, WA	Doctor's Office	Chiropractor	Dentist's Office	Medical Center	Mental Health Office	Physical Therapist	Eye Doctor	Acupuncturist	Health & Beauty Service	Medical Lab
14	University District, WA	Doctor's Office	Dentist's Office	Medical Center	Chiropractor	Acupuncturist	Physical Therapist	Hospital	Marijuana Dispensary	Medical Lab	Mental Health Office
15	Laurelhurst, WA	Hospital	Doctor's Office	Medical Center	Hospital Ward	Laboratory	Medical Lab	Emergency Room	Eye Doctor	Alternative Healer	Assisted Living
17	South Lake Union, WA	Doctor's Office	Dentist's Office	Chiropractor	Medical Lab	Medical Center	Eye Doctor	Veterinarian	Hospital	Office	Alternative Healer
18	Queen Anne, WA	Doctor's Office	Dentist's Office	Chiropractor	Acupuncturist	Physical Therapist	Eye Doctor	Hospital Ward	Alternative Healer	Assisted Living	Building
24	Balltown, WA	Doctor's Office	Dentist's Office	Chiropractor	Medical Center	Mental Health Office	Eye Doctor	Veterinarian	Alternative Healer	Acupuncturist	Marijuana Dispensary
28	Kent, WA	Dentist's Office	Doctor's Office	Medical Center	Laboratory	Chiropractor	Hospital Ward	Alternative Healer	Assisted Living	Building	Daycare
29	Tukwila, WA	Doctor's Office	Dentist's Office	Chiropractor	Mental Health Office	Eye Doctor	Urgent Care Center	Veterinarian	Hospital	Alternative Healer	Assisted Living

### Cluster 2:

	Neighborhood	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
3	Mercer Island, WA	Dentist's Office	Veterinarian	Hospital Ward	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Doctor's Office	Emergency Room
16	Ballard, WA	Dentist's Office	Massage Studio	Veterinarian	Hospital Ward	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Doctor's Office
27	Magnolia Seattle, WA	Dentist's Office	Veterinarian	Hospital Ward	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Doctor's Office	Emergency Room

### Cluster 3:

	Neighborhood	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
1	Bellevue, WA	Doctor's Office	Dentist's Office	Chiropractor	Medical Center	Physical Therapist	Veterinarian	Hospital	Urgent Care Center	Medical Lab	Mental Health Office
6	Seattle, WA	Doctor's Office	Medical Center	Veterinarian	Hospital Ward	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Dentist's Office
7	Downtown Seattle, WA	Doctor's Office	Medical Center	Office	Veterinarian	Hospital	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare
8	Capital Hill Seattle, WA	Doctor's Office	Medical Center	Optical Shop	Veterinarian	Hospital	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare
19	Bainbridge Island, WA	Doctor's Office	Dentist's Office	Acupuncturist	Chiropractor	Medical Center	Hospital Ward	Alternative Healer	Assisted Living	Building	Daycare
21	West Seattle, WA	Doctor's Office	Dentist's Office	Acupuncturist	Medical Center	Chiropractor	Medical Lab	Alternative Healer	Physical Therapist	Hospital	Assisted Living
22	Alki Beach, WA	Alternative Healer	Doctor's Office	Veterinarian	Hospital Ward	Assisted Living	Building	Chiropractor	Daycare	Dentist's Office	Emergency Room

### K-Means Cluster Results:

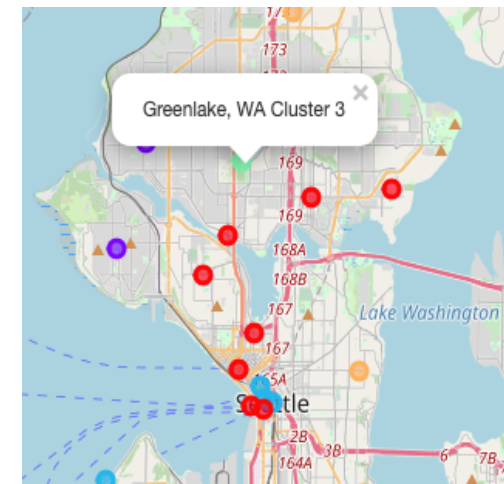
Cluster 4:

11	Overnight, WA	Physician Therapist	Hospital	Veterinarian	Hospital Work	Alternative Health	Assisted Living	Outpatient	Clinical Research	Pharmacy	Dentist's Office
	Neighborhood	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

Cluster 5:

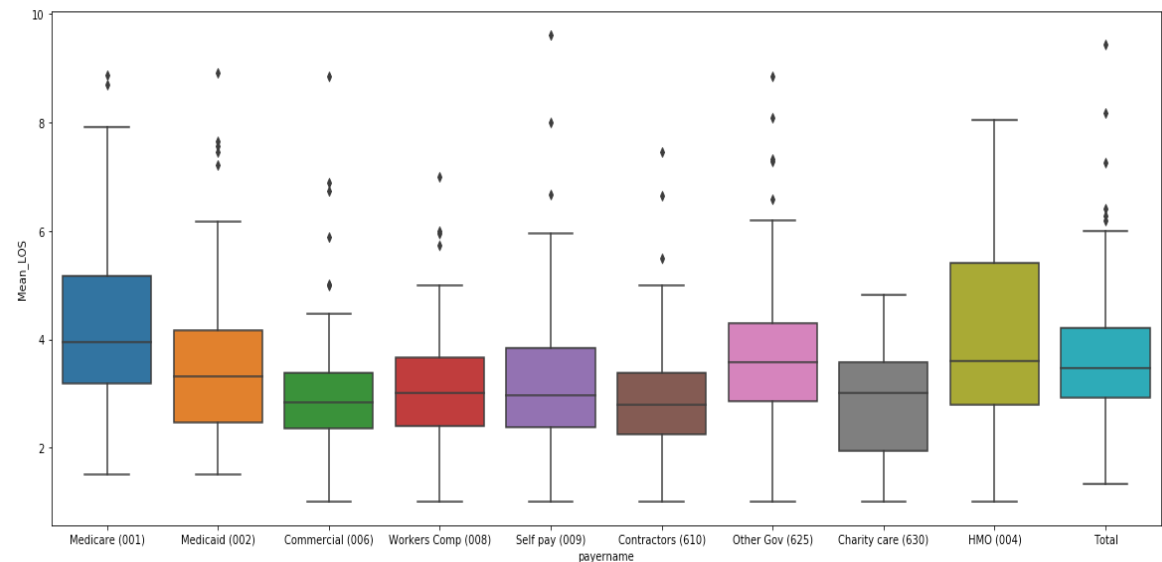
0	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
1	Federal Way, WA	Dentist's Office	Doctor's Office	Acupuncturist	Chiropractor	Daycare	Medical Center	Eye Doctor	Hospital Ward	Alternative Healer	Assisted Living
2	Lynnwood, WA	Dentist's Office	Veterinarian	Doctor's Office	Chiropractor	Acupuncturist	Optical Shop	Office	Alternative Healer	Assisted Living	Building
4	Redmond, WA	Dentist's Office	Physical Therapist	Doctor's Office	Veterinarian	Medical Center	Chiropractor	Acupuncturist	Eye Doctor	Optical Shop	Hospital
5	Renton, WA	Dentist's Office	Chiropractor	Mental Health Office	Medical Lab	Veterinarian	Alternative Healer	Alternative Healer	Doctor's Office	Hospital	Assisted Living
10	Monte Vista, WA	Dentist's Office	Acupuncturist	Mental Health Office	Mental Health Office	Hospital Ward	Assisted Living	Building	Assisted Living	Doctor's Office	Assisted Living
18	Columbia City, WA	Dentist's Office	Acupuncturist	Medical Center	Doctor's Office	Maternity Clinic	Office	Financial or Legal Service	Alternative Healer	Assisted Living	Assisted Living
19	Northgate, WA	Dentist's Office	Chiropractor	Mental Health Office	Mental Health Office	Doctor's Office	Veterinarian	Alternative Healer	Assisted Living	Acupuncturist	Medical Lab
26	Mount Baker Seattle, WA	Physical Therapist	Dentist's Office	Veterinarian	Hospital Ward	Alternative Healer	Assisted Living	Building	Chiropractor	Daycare	Doctor's Office

- Key Differences in Clustering based on "lower-level" Most Common Venues
- Foursquare venue criteria unspecific and potentially duplicative



# Primary Data Analysis Results

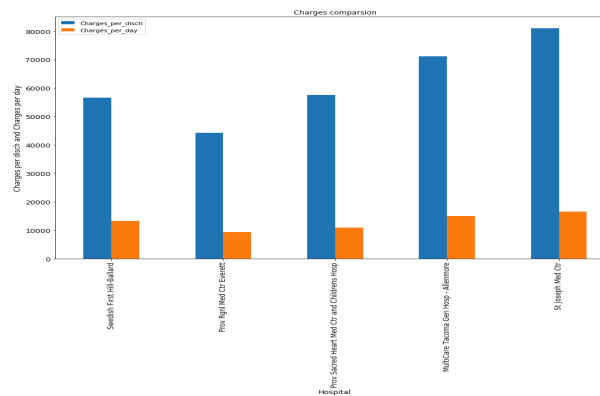
## Length of Stay Analysis:



- Comparison metrics by payor
- Commercial boxplot interquartile range significantly tighter than for government payer.

# Primary Data Analysis Results

## Largest Volume Discharge Acute-care Facility Comparison:



Overall, it appears that Providence Sacred Heart balances charges per discharge and charges per day the best of these top 5 hospitals by discharge volume

Hospital_name	Discharges	Total_days	Total_charges	Charges_per_disch	Charges_per_day
Swedish First Hill-Ballard	79548	340442	4509615860.90	56690.50	13246.36
Prov Rgnl Med Ctr Everett	67052	315352	2965003123.14	44219.46	9402.20
Prov Sacred Heart Med Ctr and Childrens Hosp	62680	330946	3605333668.00	57519.68	10894.02
MultiCare Tacoma Gen Hosp - Allenmore	47902	227652	3411209439.04	71212.26	14984.32
St Joseph Med Ctr	46938	229790	3802601730.90	81013.29	16548.16