Class 17: Vaccination Rate Mini-Project

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Background

As we approach a period of travel and larger gatherings, let's have a look at vaccination rates across the State.

We will take data from the CA.gov site here: https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data-by-zip-code.

```
# Import vaccination data
vax <- read.csv("covid19vaccinesbyzipcode_test.csv")
head(vax)
```

```
##   as_of_date zip_code_tabulation_area local_health_jurisdiction    county
## 1 2021-01-05                    92804                    Orange    Orange
## 2 2021-01-05                    92626                    Orange    Orange
## 3 2021-01-05                    92250                  Imperial  Imperial
## 4 2021-01-05                    92637                    Orange    Orange
## 5 2021-01-05                    92155                 San Diego San Diego
## 6 2021-01-05                    92259                  Imperial  Imperial
##   vaccine_equity_metric_quartile                 vem_source
## 1                              2 Healthy Places Index Score
## 2                              3 Healthy Places Index Score
## 3                              1 Healthy Places Index Score
## 4                              3 Healthy Places Index Score
## 5                             NA            No VEM Assigned
## 6                              1    CDPH-Derived ZCTA Score
##   age12_plus_population age5_plus_population persons_fully_vaccinated
## 1               76455.9                84200                       19
## 2               44238.8                47883                       NA
## 3                7098.5                 8026                       NA
## 4               16027.4                16053                       NA
## 5                 456.0                  456                       NA
## 6                 119.0                  121                       NA
##   persons_partially_vaccinated percent_of_population_fully_vaccinated
## 1                         1282                               0.000226
## 2                           NA                                     NA
## 3                           NA                                     NA
## 4                           NA                                     NA
## 5                           NA                                     NA
## 6                           NA                                     NA
##   percent_of_population_partially_vaccinated
## 1                                   0.015226
## 2                                         NA
## 3                                         NA
## 4                                         NA
## 5                                         NA
## 6                                         NA
##   percent_of_population_with_1_plus_dose
## 1                               0.015452
## 2                                     NA
## 3                                     NA
## 4                                     NA
## 5                                     NA
## 6                                     NA
##                                                                 redacted
## 1                                                                     No
## 2 Information redacted in accordance with CA state privacy requirements
## 3 Information redacted in accordance with CA state privacy requirements
## 4 Information redacted in accordance with CA state privacy requirements
## 5 Information redacted in accordance with CA state privacy requirements
## 6 Information redacted in accordance with CA state privacy requirements
```

Q1. What column details the total number of people fully vaccinated?

Answer: The column "persons fully vaccinated" details the total number of people fully vaccinated.

Q2. What column details the ZIP code tabulation area?

Answer: The column "zip code tabulation area" details the ZIP code tabulation area.

Q3. What is the earliest date in this dataset?

```
head(vax$as_of_date)
```

```
## [1] "2021-01-05" "2021-01-05" "2021-01-05" "2021-01-05" "2021-01-05"
## [6] "2021-01-05"
```

Answer: The earliest date in this dataset is 2021-01-05.

Q4. What is the latest date in this dataset?

```
tail(vax$as_of_date)
```

```
## [1] "2021-11-16" "2021-11-16" "2021-11-16" "2021-11-16" "2021-11-16"
## [6] "2021-11-16"
```

Answer: The latest date in this dataset is 2021-11-16.

Let's call the 'skim()' function from the **skimr** package to get a quick overview of this dataset.

```
library(skimr)
skimr::skim(vax)
```

Table 1: Data summary

Name	vax
Number of rows	81144
Number of columns	14
Column type frequency:	
character	5
numeric	9
Group variables	None

Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
as_of_date	0	1	10	10	0	46	0
local_health_jurisdiction	0	1	0	15	230	62	0
county	0	1	0	15	230	59	0
vem_source	0	1	15	26	0	3	0
redacted	0	1	2	69	0	2	0

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
zip_code_tabulation_area	0	1.00	93665.11	1817.39	90001	92257.75	93658.50	95380.50	97635.0	
vaccine_equity_metric_quartile	4002	0.95	2.44	1.11	1	1.00	2.00	3.00	4.0	
age12_plus_population	0	1.00	18895.04	18993.94	0	1346.95	13685.10	31756.12	88556.7	
age5_plus_population	0	1.00	20875.24	21106.05	0	1460.50	15364.00	34877.00	101902.0	
persons_fully_vaccinated	8256	0.90	9456.49	11498.25	11	506.00	4105.00	15859.00	71078.0	
persons_partially_vaccinated	8256	0.90	1900.61	2113.07	11	200.00	1271.00	2893.00	20185.0	
percent_of_population_fully_vaccinated	8256	0.90	0.42	0.27	0	0.19	0.44	0.62	1.0	
percent_of_population_partially_vaccinated	8256	0.90	0.10	0.10	0	0.06	0.07	0.11	1.0	
percent_of_population_with_1_plus_dose	8256	0.90	0.50	0.26	0	0.30	0.53	0.70	1.0	

Q5. How many numeric columns are in this dataset?

Answer: There are 9 numeric columns in this dataset.

Q6. Note that there are "missing values" in the dataset. How many NA values are there in the persons_fully_vaccinated column?

Answer: There are 8,256 NA values in the person_fully_vaccinated column.

Q7. What percent of persons_fully_vaccinated values are missing (to 2 significant figures)?

```
sum(is.na(vax$persons_fully_vaccinated)) / nrow(vax)
```

```
## [1] 0.101745
```

Answer: 10.17% of persons_fully_vaccinated values are missing.

> **Q8**. [Optional] Why might this data be missing?

Answer: Optional.

Working with Dates

We will use the **lubridate** package to make life a lot easier when dealing with dates and times.

```
library(lubridate)
```

```
## Warning: package 'lubridate' was built under R version 4.1.2
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
today()
```

```
## [1] "2021-11-23"
```

Here we make our 'as_of_date' column lubridate format…

```
# Specify that we are using the year-month-day format
vax$as_of_date <- ymd(vax$as_of_date)
```

Now I can do useful math with dates more easily.

```
today()-vax$as_of_date[1]
```

```
## Time difference of 322 days
```

```
vax$as_of_date[nrow(vax)]-vax$as_of_date[1]
```

```
## Time difference of 315 days
```

> **Q9**. How many days have passed since the last update of the dataset?

```
today()-vax$as_of_date[nrow(vax)]
```

```
## Time difference of 7 days
```

Answer: It has been 7 days since the last entry.

> **Q10**. How many unique dates are in the dataset (i.e. how many different dates are detailed)?

```
length(unique(vax$as_of_date))
```

```
## [1] 46
```

Answer: There are 46 unique dates in the dataset.

Working with ZIP Codes

```
library(zipcodeR)
```

```
## Warning: package 'zipcodeR' was built under R version 4.1.2
```

```
# Find centroid of La Jolla 92037 ZIP code area
geocode_zip('92037')
```

```
## # A tibble: 1 x 3
##   zipcode   lat   lng
##   <chr>   <dbl> <dbl>
## 1 92037    32.8 -117.
```

```
# Calculate distance between centroids of any two ZIP codes
zip_distance('92037', '92109')
```

```
##   zipcode_a zipcode_b distance
## 1     92037     92109     2.33
```

More usefully, we can pull census data about ZIP code areas (including median household income, etc.).

```
reverse_zipcode(c('92037', '92109'))
```

```
## # A tibble: 2 x 24
##   zipcode zipcode_type major_city post_office_city common_city_list county state
##   <chr>   <chr>        <chr>      <chr>                      <blob> <chr>  <chr>
## 1 92037   Standard     La Jolla   La Jolla, CA           <raw 20 B> San D~ CA
## 2 92109   Standard     San Diego  San Diego, CA          <raw 21 B> San D~ CA
## # ... with 17 more variables: lat <dbl>, lng <dbl>, timezone <chr>,
## #   radius_in_miles <dbl>, area_code_list <blob>, population <int>,
## #   population_density <dbl>, land_area_in_sqmi <dbl>,
## #   water_area_in_sqmi <dbl>, housing_units <int>,
## #   occupied_housing_units <int>, median_home_value <int>,
## #   median_household_income <int>, bounds_west <dbl>, bounds_east <dbl>,
## #   bounds_north <dbl>, bounds_south <dbl>
```

We can use this reverse_zipcode() to pull census data later on for any or all ZIP code areas we might be interested in.

Focus on San Diego Area

```
table(vax$county)
```

```
## 
##                          Alameda          Alpine          Amador           Butte 
##              230            2254              46             552             828 
##        Calaveras          Colusa    Contra Costa       Del Norte       El Dorado 
##              828             322            1978             184            1012 
##           Fresno           Glenn        Humboldt        Imperial            Inyo 
##             2530             276            1610             690             460 
##             Kern           Kings            Lake          Lassen     Los Angeles 
##             2254             322             644             598           13340 
##           Madera           Marin        Mariposa       Mendocino          Merced 
##              552            1288             368            1196             874 
##            Modoc            Mono        Monterey            Napa          Nevada 
##              506             322            1288             460             552 
##           Orange          Placer          Plumas       Riverside      Sacramento 
##             4048            1334             736            3220            2484 
##       San Benito  San Bernardino       San Diego   San Francisco     San Joaquin 
##              184            4094            4922            1242            1472 
##  San Luis Obispo       San Mateo   Santa Barbara     Santa Clara      Santa Cruz 
##             1012            1334            1058            2668             782 
##           Shasta          Sierra        Siskiyou          Solano          Sonoma 
##             1196             322             966             690            1656 
##       Stanislaus          Sutter          Tehama         Trinity          Tulare 
##             1104             414             598             598            1518 
##         Tuolumne         Ventura            Yolo            Yuba 
##              598            1242             782             506
```

We will subset with base R.

```
inds <- vax$county=="San Diego"
head(vax[inds,])
```

```
##    as_of_date zip_code_tabulation_area local_health_jurisdiction    county
## 5  2021-01-05                    92155                 San Diego San Diego
## 14 2021-01-05                    92147                 San Diego San Diego
## 16 2021-01-05                    92124                 San Diego San Diego
## 24 2021-01-05                    92145                 San Diego San Diego
## 34 2021-01-05                    91935                 San Diego San Diego
## 36 2021-01-05                    92102                 San Diego San Diego
##    vaccine_equity_metric_quartile                 vem_source
## 5                              NA            No VEM Assigned
## 14                             NA            No VEM Assigned
## 16                              3 Healthy Places Index Score
## 24                             NA            No VEM Assigned
## 34                              3 Healthy Places Index Score
## 36                              1 Healthy Places Index Score
##    age12_plus_population age5_plus_population persons_fully_vaccinated
## 5                  456.0                  456                       NA
## 14                 518.0                  518                       NA
## 16               25422.4                29040                       29
## 24                1603.5                 1821                       NA
## 34                7390.0                 8101                       NA
## 36               37042.3                41033                       29
##    persons_partially_vaccinated percent_of_population_fully_vaccinated
## 5                            NA                                     NA
## 14                           NA                                     NA
## 16                          573                               0.000999
## 24                           NA                                     NA
## 34                           NA                                     NA
## 36                         1495                               0.000707
##    percent_of_population_partially_vaccinated
## 5                                          NA
## 14                                         NA
## 16                                   0.019731
## 24                                         NA
## 34                                         NA
## 36                                   0.036434
##    percent_of_population_with_1_plus_dose
## 5                                      NA
## 14                                     NA
## 16                               0.020730
## 24                                     NA
## 34                                     NA
## 36                               0.037141
##                                                                  redacted
## 5  Information redacted in accordance with CA state privacy requirements
## 14 Information redacted in accordance with CA state privacy requirements
## 16                                                                     No
## 24 Information redacted in accordance with CA state privacy requirements
## 34 Information redacted in accordance with CA state privacy requirements
## 36                                                                     No
```

But let's use the **dplyr** package and its **filter()** function.

```
library(dplyr)
```

```
## 
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
## 
##     filter, lag
```

```
## The following objects are masked from 'package:base':
## 
##     intersect, setdiff, setequal, union
```

```r
sd <- filter(vax, county=="San Diego")

nrow(sd)
```

```
## [1] 4922
```

Using **dplyr** is more convenient when we are subsetting across multiple criteria. For example:

```r
sd.10 <- filter(vax, county=="San Diego" & age5_plus_population>10000)
```

> **Q11**. How many distinct ZIP codes are listed for San Diego County?

```r
length(unique(sd$zip_code_tabulation_area))
```

```
## [1] 107
```

Answer: There are 107 distinct ZIP codes listed for San Diego County.

> **Q12**. What San Diego County ZIP code area has the largest 12+ population in this dataset?

```r
which.max(sd$age12_plus_population)
```

```
## [1] 23
```

```r
sd$zip_code_tabulation_area[23]
```

```
## [1] 92154
```

Answer: The San Diego County ZIP code area of 92154 has the largest 12+ population in this dataset.

Using **dplyr**, select all San Diego "county" entries on "as_of_date" "2021-11-09".

```r
sd.11.09 <- filter(vax, county=="San Diego" & as_of_date=="2021-11-09")
```

> **Q13**. What is the overall average "Percent of Population Fully Vaccinated" value for all San Diego "County" as of "2021-11-09"?

```r
mean(sd.11.09$percent_of_population_fully_vaccinated, na.rm=TRUE)
```

```
## [1] 0.6727567
```

Answer: The overall average "Percent of Population Fully Vaccinated" value is 67.27567%.

We can look at the 6-number summary.

```r
summary(sd.11.09$percent_of_population_fully_vaccinated)
```

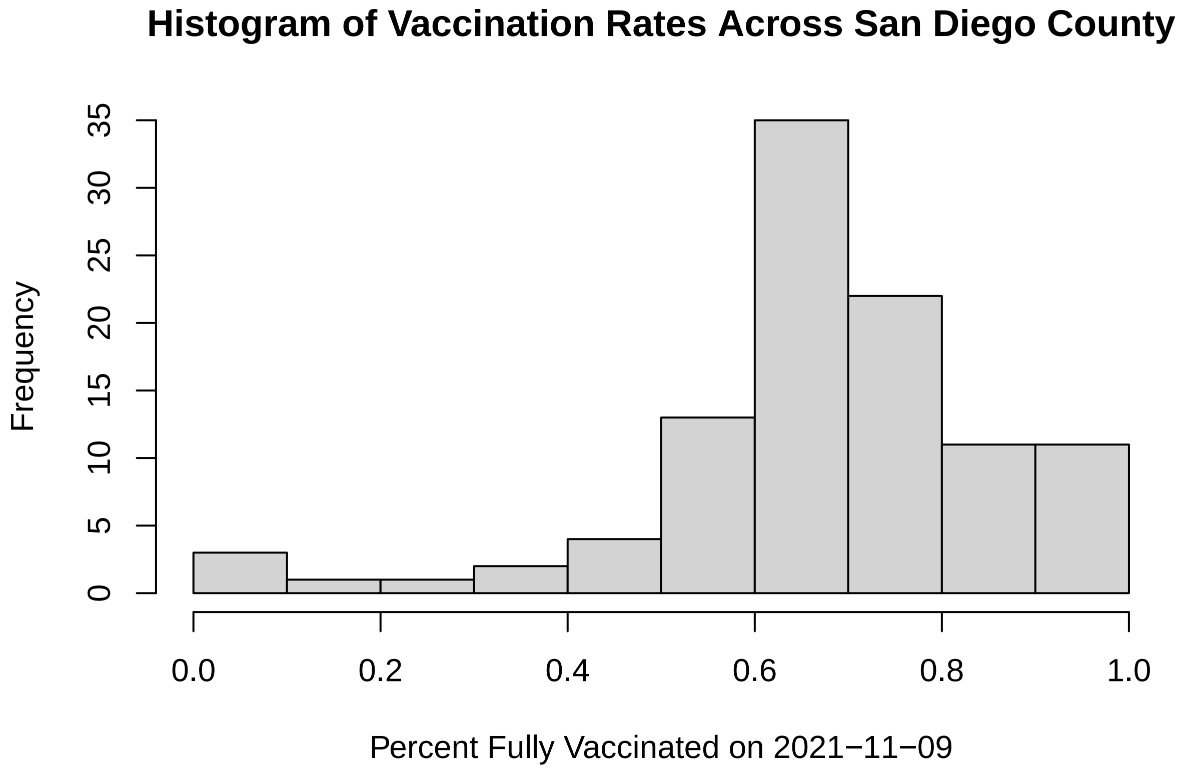
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's 
## 0.01017 0.60776 0.67700 0.67276 0.76164 1.00000       4
```

> **Q14**. Using either ggplot or base R graphics, make a summary figure that shows the distribution of Percent of Population Fully Vaccinated values as of “2021-11-09”.

Answer:

Using base R plots

```
hist(sd.11.09$percent_of_population_fully_vaccinated,
     main="Histogram of Vaccination Rates Across San Diego County",
     xlab="Percent Fully Vaccinated on 2021-11-09",
     ylab="Frequency")
```

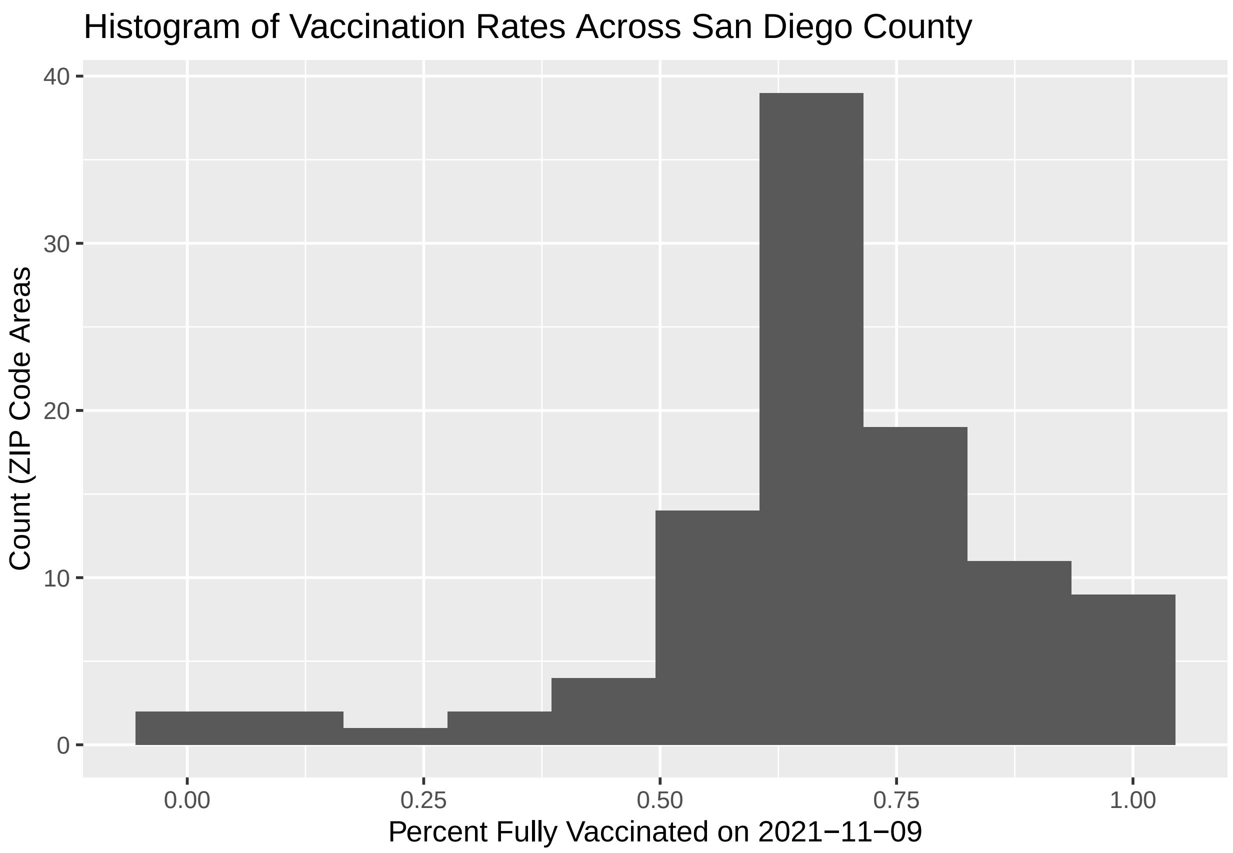


Using ggplot

```
library(ggplot2)

ggplot(sd.11.09) +
  aes(percent_of_population_fully_vaccinated) +
  geom_histogram(bins=10) +
  labs(x="Percent Fully Vaccinated on 2021-11-09", y="Count (ZIP Code Areas",
       title="Histogram of Vaccination Rates Across San Diego County")
```

```
## Warning: Removed 4 rows containing non-finite values (stat_bin).
```



Focus on UCSD/La Jolla

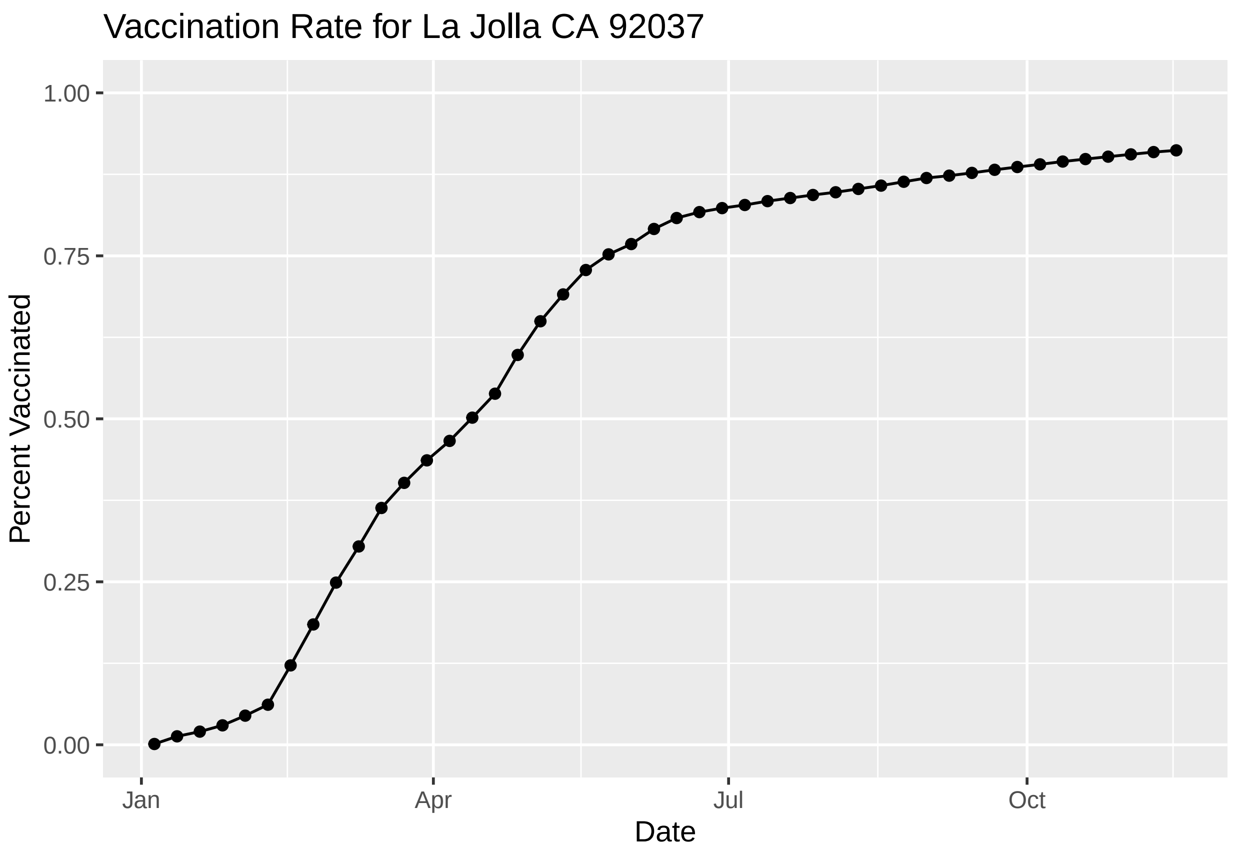
```
ucsd <- filter(sd, zip_code_tabulation_area=="92037")
ucsd[1,]$age5_plus_population
```

```
## [1] 36144
```

> **Q15**. Using **ggplot**, make a graph of the vaccination rate time course for the 92037 ZIP code area.

Answer:

```
ggplot(ucsd) +
  aes(as_of_date,percent_of_population_fully_vaccinated) +
  geom_point() +
  geom_line(group=1) +
  ylim(c(0,1)) +
  labs(x="Date", y="Percent Vaccinated",
       title="Vaccination Rate for La Jolla CA 92037")
```



Comparing 92037 to Other Similar Sized Areas?

Let's return to the full dataset and look across every ZIP code area with a population at least as large as that of 92037 on "2021-11-16".

```
# Subset to all CA areas with a population as large as 92037
vax.36 <- filter(vax, age5_plus_population>36144 & as_of_date=="2021-11-16")
head(vax.36)
```

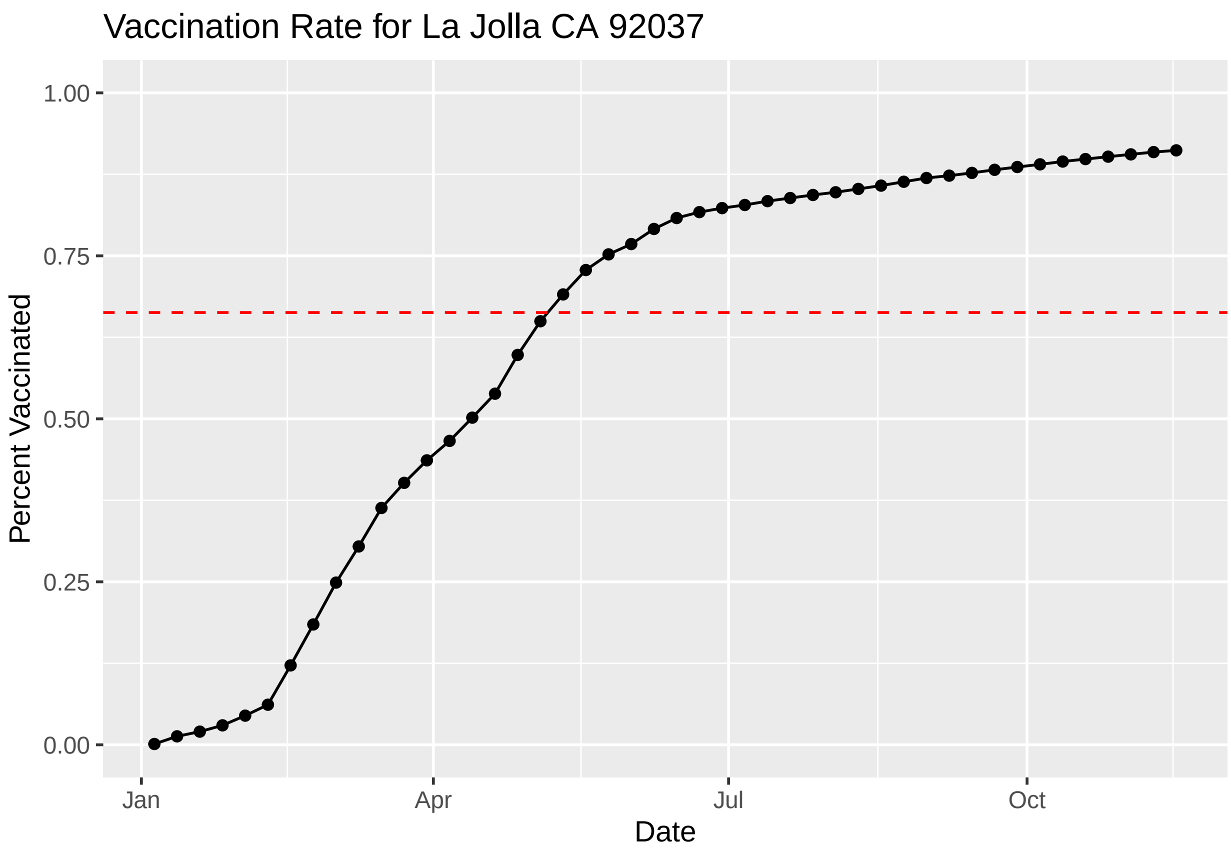
```
##   as_of_date zip_code_tabulation_area local_health_jurisdiction         county
## 1 2021-11-16                    92833                    Orange         Orange
## 2 2021-11-16                    92234                 Riverside      Riverside
## 3 2021-11-16                    92507                 Riverside      Riverside
## 4 2021-11-16                    92555                 Riverside      Riverside
## 5 2021-11-16                    92345            San Bernardino San Bernardino
## 6 2021-11-16                    91306               Los Angeles    Los Angeles
##   vaccine_equity_metric_quartile                 vem_source
## 1                              3 Healthy Places Index Score
## 2                              1 Healthy Places Index Score
## 3                              1 Healthy Places Index Score
## 4                              2 Healthy Places Index Score
## 5                              1 Healthy Places Index Score
## 6                              2 Healthy Places Index Score
##   age12_plus_population age5_plus_population persons_fully_vaccinated
## 1                 43985.4                   48623                      34668
## 2                 46401.1                   51202                      34191
## 3                 51432.5                   55253                      31704
## 4                 36725.7                   41446                      23776
## 5                 66047.5                   75539                      35332
## 6                 42671.1                   46573                      31858
##   persons_partially_vaccinated percent_of_population_fully_vaccinated
## 1                         3377                               0.712996
## 2                         3966                               0.667767
## 3                         3434                               0.573797
## 4                         2424                               0.573662
## 5                         4428                               0.467732
## 6                         3372                               0.684044
##   percent_of_population_partially_vaccinated
## 1                                   0.069453
## 2                                   0.077458
## 3                                   0.062150
## 4                                   0.058486
## 5                                   0.058619
## 6                                   0.072402
##   percent_of_population_with_1_plus_dose redacted
## 1                               0.782449       No
## 2                               0.745225       No
## 3                               0.635947       No
## 4                               0.632148       No
## 5                               0.526351       No
## 6                               0.756446       No
```

Q16. Calculate the mean "Percent of Population Fully Vaccinated" for ZIP code areas with a population as large as 92037 (La Jolla) as_of_date "2021-11-16". Add this as a straight horizontal line to your plot from above with the geom_hline() function.

```
vaccination.36 <- mean(vax.36$percent_of_population_fully_vaccinated)
```

Answer:

```
ggplot(ucsd) +
  aes(as_of_date,percent_of_population_fully_vaccinated) +
  geom_point() +
  geom_line(group=1) +
  ylim(c(0,1)) +
  labs(x="Date", y="Percent Vaccinated",
       title="Vaccination Rate for La Jolla CA 92037") +
  geom_hline(yintercept=vaccination.36, color="red", linetype="dashed")
```



Q17. What is the 6 number summary (Min, 1st Qu., Median, Mean, 3rd Qu., and Max) of the “Percent of Population Fully Vaccinated” values for ZIP code areas with a population as large as 92037 (La Jolla) as_of_date “2021-11-16”?

Answer:

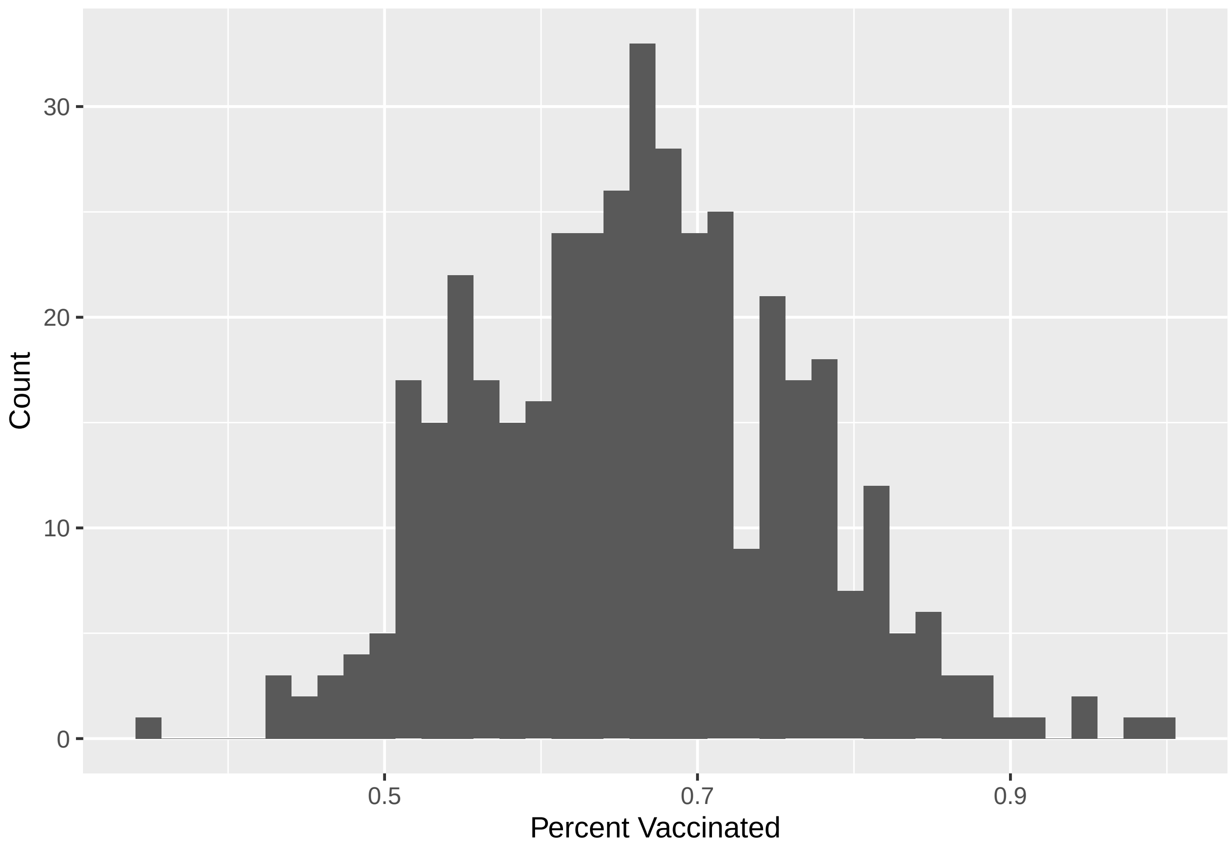
```
summary(vax.36$percent_of_population_fully_vaccinated)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##  0.3519  0.5891  0.6649  0.6630  0.7286  1.0000
```

Q18. Using ggplot, generate a histogram of this data.

Answer:

```
ggplot(vax.36) +
  aes(percent_of_population_fully_vaccinated) +
  geom_histogram(bins=40) +
  labs(x="Percent Vaccinated", y="Count")
```



Q19. Is the 92109 and 92040 ZIP code areas above or below the average value you calculated for all these above?

```
vax %>% filter(as_of_date=="2021-11-16") %>%
  filter(zip_code_tabulation_area=="92109") %>%
  select(percent_of_population_fully_vaccinated)
```

```
##   percent_of_population_fully_vaccinated
## 1                               0.687763
```

```
vax %>% filter(as_of_date=="2021-11-16") %>%
  filter(zip_code_tabulation_area=="92040") %>%
  select(percent_of_population_fully_vaccinated)
```

```
##   percent_of_population_fully_vaccinated
## 1                               0.520463
```

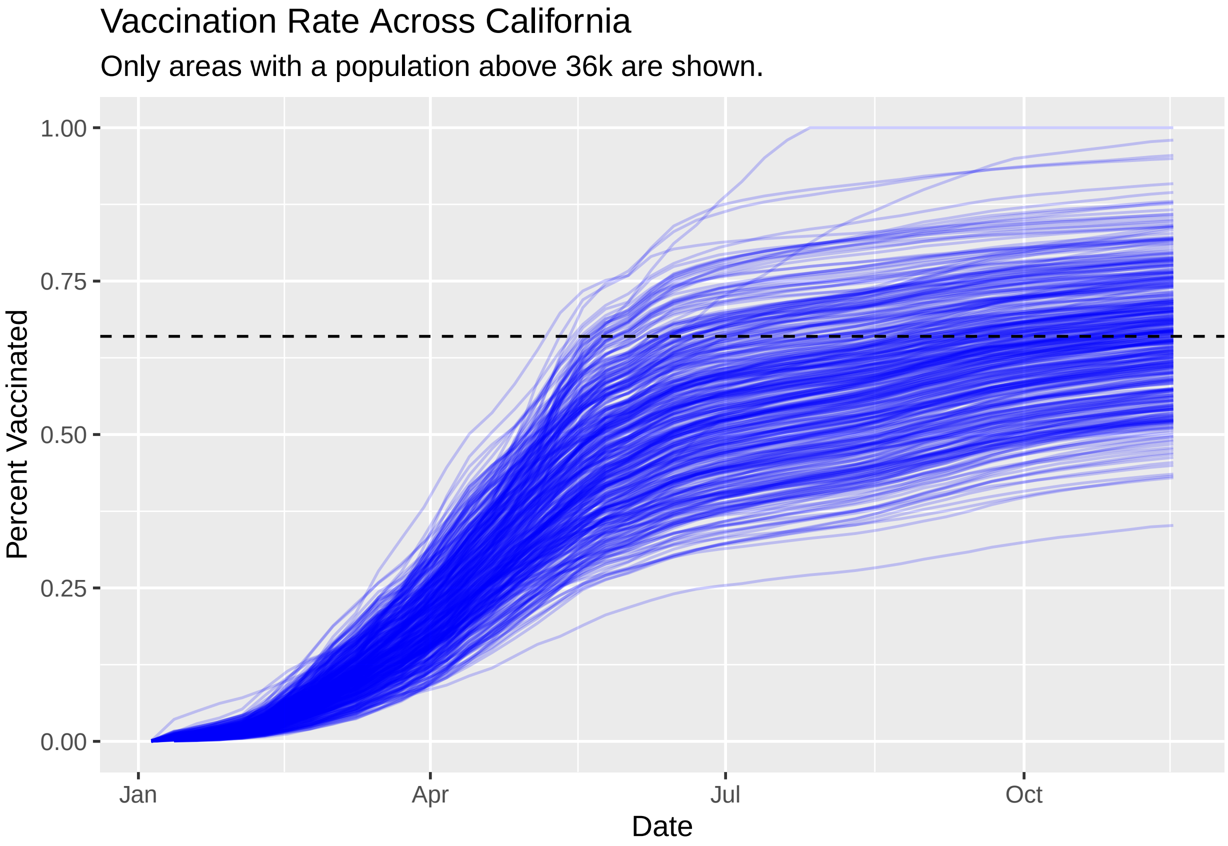
Answer: The 92109 ZIP code area is above the average value of 0.6630 I calculated for all these above. However, the 92040 ZIP code area is below the average value.

Q20. Finally make a time course of vaccination progress for all areas in the full dataset with a age5_plus_population > 36144.

```
vax.36.all <- filter(vax, age5_plus_population>36144)

ggplot(vax.36.all) +
  aes(as_of_date, percent_of_population_fully_vaccinated, group=zip_code_tabulation_area) +
  geom_line(alpha=0.2, color="blue") +
  ylim(c(0,1)) +
  labs(x="Date", y="Percent Vaccinated",
       title="Vaccination Rate Across California",
       subtitle="Only areas with a population above 36k are shown.") +
  geom_hline(yintercept=0.66, linetype="dashed")
```

```
## Warning: Removed 180 row(s) containing missing values (geom_path).
```



**Q21*. How do you feel about traveling for Thanksgiving and meeting for in-person class next week?

Answer: Considering the trend of rising cases in the U.S. as well as other countries and the lower-than-expected vaccination rates analyzed through this activity, I feel apprehensive about traveling for Thanksgiving and meeting for in-person class next week.