Class 17: Mini Project

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Getting Started

```
# 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                   95446                    Sonoma    Sonoma
2 2021-01-05                   96014                  Siskiyou  Siskiyou
3 2021-01-05                   96087                    Shasta    Shasta
4 2021-01-05                   96008                    Shasta    Shasta
5 2021-01-05                   95410                 Mendocino Mendocino
6 2021-01-05                   95527                   Trinity   Trinity
  vaccine_equity_metric_quartile                vem_source
1                              2 Healthy Places Index Score
2                              2    CDPH-Derived ZCTA Score
3                              2    CDPH-Derived ZCTA Score
4                             NA            No VEM Assigned
5                              3    CDPH-Derived ZCTA Score
6                              2    CDPH-Derived ZCTA Score
  age12_plus_population age5_plus_population tot_population
1                4840.7                 5057           5168
2                 135.0                  135            135
3                 513.9                  544            544
4                1125.3                 1164             NA
5                 926.3                  988            997
6                 476.6                  485            499
  persons_fully_vaccinated persons_partially_vaccinated
1                       NA                           NA
2                       NA                           NA
3                       NA                           NA
```

```
4                       NA                           NA
5                       NA                           NA
6                       NA                           NA
  percent_of_population_fully_vaccinated
1                                     NA
2                                     NA
3                                     NA
4                                     NA
5                                     NA
6                                     NA
  percent_of_population_partially_vaccinated
1                                         NA
2                                         NA
3                                         NA
4                                         NA
5                                         NA
6                                         NA
  percent_of_population_with_1_plus_dose booster_recip_count
1                                     NA                  NA
2                                     NA                  NA
3                                     NA                  NA
4                                     NA                  NA
5                                     NA                  NA
6                                     NA                  NA
  bivalent_dose_recip_count eligible_recipient_count
1                        NA                       0
2                        NA                       0
3                        NA                       2
4                        NA                       2
5                        NA                       0
6                        NA                       0
                                                                    redacted
1 Information redacted in accordance with CA state privacy requirements
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?

The column vax$persons_fully_vaccinated details the total number of fully vaccinated individuals.

Q2. What column details the Zip code tabulation area?

vax$zip_code_tabulation area

Q3. What is the earliest date in this dataset?

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

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

The earliest date is 2021-01-05.

Q4. What is the latest date in this dataset?

```
head(sort(vax$as_of_date, decreasing = TRUE))
```

```
[1] "2023-02-28" "2023-02-28" "2023-02-28" "2023-02-28" "2023-02-28"
[6] "2023-02-28"
```

The latest date is 2023-02-28.

Let's call the `skim()` function from the skimr package to take an overview look at the dataset:

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

Table 1: Data summary

Name	vax
Number of rows	199332
Number of columns	18
Column type frequency:	
character	5
numeric	13
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	113	0
local_health_jurisdiction	0	1	0	15	565	62	0
county	0	1	0	15	565	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	1817.38	90001	92257.75	93658.50	95380.50	97635.0	
vaccine_equity_metric_quartile	9831	0.95	2.44	1.11	1	1.00	2.00	3.00	4.0	
age12_plus_population	0	1.00	18895.04	18993.87	0	1346.95	13685.50	31756.25	88556.7	
age5_plus_population	0	1.00	20875.22	21105.97	0	1460.50	15364.00	34877.00	101902.0	
tot_population	9718	0.95	23372.72	22628.51	12	2126.00	18714.00	38168.00	111165.0	
persons_fully_vaccinated	16525	0.92	13962.38	15054.09	11	930.00	8566.00	23302.00	87566.0	
persons_partially_vaccinated	16525	0.92	1701.64	2030.18	11	165.00	1196.00	2535.00	39913.0	
percent_of_population_fully_vaccinated	20825	0.90	0.57	0.25	0	0.42	0.60	0.74	1.0	
percent_of_population_partially_vaccinated	20825	0.90	0.08	0.09	0	0.05	0.06	0.08	1.0	
percent_of_population_with_1_plus_dose	21859	0.89	0.63	0.24	0	0.49	0.67	0.81	1.0	
booster_recip_count	72872	0.63	5837.31	7165.81	11	297.00	2748.00	9438.25	59553.0	
bivalent_dose_recip_count	158664	0.20	2924.93	3583.45	11	190.00	1418.00	4626.25	27458.0	
eligible_recipient_count	0	1.00	12801.84	14908.33	0	504.00	6338.00	21973.00	87234.0	

Q5. How many numeric columns are in this dataset?

There are 13 numeric columns.

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

```
n.missing <- sum(is.na(vax$persons_fully_vaccinated))
n.missing
```

```
[1] 16525
```

There are 16525 NA values in vax$persons_fully_vaccinated.

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

```
signif(n.missing/nrow(vax), 2) * 100
```

```
[1] 8.3
```

8.3% of vax$persons_fully_vaccinated are missing.

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

Some data may be missing from smaller counties that have not updated their information.

Working with Dates

The `as_of_date` column contains dates in Year-Month-Day format. We can use the **lubridate** package to handle working with dates and times more efficiently.

```
# install.packages("lubridate")
library(lubridate)
```

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

```
The following objects are masked from 'package:base':

    date, intersect, setdiff, union
```

We can check today's date

```
today()
```

```
[1] "2023-03-07"
```

We can do math with dates:

```
today() - ymd("2021-01-05")
```

```
Time difference of 791 days
```

```
today() - ymd("2000-09-16")
```

```
Time difference of 8207 days
```

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

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

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

```
Time difference of 7 days
```

7 days have passed

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

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

```
[1] 113
```

There are 113 unique dates in the dataset.

Working with ZIP Codes

The numeric columns of `vax$zip_code_tabulation_area` are ZIP codes. We can use teh **zipcodeR** package to make it easier to work with the codes. Let's find the centroid of the La JOlla 92037 ZIP code.

```
# install.packages("zipcodeR")
library(zipcodeR)
```

```
geocode_zip('92037')
```

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

We can calculate the distance between centroids of any two ZIP codes in miles.

```
zip_distance('92037', '92109')
```

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

We can pull the census data about ZIP code areas (including median household income etc)

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

```
# A tibble: 2 x 24
  zipcode zipcode_~1 major~2 post_~3 common_c~4 county state   lat   lng timez~5
  <chr>   <chr>      <chr>   <chr>       <blob> <chr>  <chr> <dbl> <dbl> <chr>
1 92037   Standard   La Jol~ La Jol~ <raw 20 B> San D~ CA     32.8 -117. Pacific
2 92109   Standard   San Di~ San Di~ <raw 21 B> San D~ CA     32.8 -117. Pacific
# ... with 14 more variables: 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>, and abbreviated variable names
#   1: zipcode_type, 2: major_city, 3: post_office_city, ...
```

```
# Pull data for all ZIP codes in the dataset
zipdata <- reverse_zipcode( vax$zip_code_tabulation_area )
```

Focus on the San Diego area

We can focus down to the San Diego County area and restrict ourselves to `vax$county == "San Diego"` entries. We'll do this first with base R and secondly with **dplyr** package.

```
# Subset to San Diego county only areas
sd <- vax[vax$county == "San Diego", ]
head(sd)
```

```
    as_of_date zip_code_tabulation_area local_health_jurisdiction    county
365 2021-01-05                   92040                San Diego San Diego
389 2021-01-05                   92154                San Diego San Diego
391 2021-01-05                   92122                San Diego San Diego
393 2021-01-05                   92120                San Diego San Diego
396 2021-01-05                   92115                San Diego San Diego
398 2021-01-05                   92114                San Diego San Diego
    vaccine_equity_metric_quartile                vem_source
365                              3 Healthy Places Index Score
389                              2 Healthy Places Index Score
391                              4 Healthy Places Index Score
393                              4 Healthy Places Index Score
396                              2 Healthy Places Index Score
398                              2 Healthy Places Index Score
    age12_plus_population age5_plus_population tot_population
365               39405.0                42833          46306
389               76365.2                82971          88979
391               44091.1                45951          48071
393               26372.9                28414          30550
396               56152.4                60409          64343
398               59050.7                64945          68851
    persons_fully_vaccinated persons_partially_vaccinated
365                       14                          585
389                       16                         1397
391                       19                         1249
393                       25                          906
396                       28                          874
398                       12                         1213
    percent_of_population_fully_vaccinated
365                               0.000302
389                               0.000180
391                               0.000395
393                               0.000818
396                               0.000435
398                               0.000174
    percent_of_population_partially_vaccinated
365                                   0.012633
389                                   0.015700
```

```
391                                    0.025982
393                                    0.029656
396                                    0.013583
398                                    0.017618
    percent_of_population_with_1_plus_dose booster_recip_count
365                                0.012935                  NA
389                                0.015880                  NA
391                                0.026377                  NA
393                                0.030474                  NA
396                                0.014018                  NA
398                                0.017792                  NA
    bivalent_dose_recip_count eligible_recipient_count
365                        NA                       14
389                        NA                       16
391                        NA                       19
393                        NA                       25
396                        NA                       28
398                        NA                       12
                                                                    redacted
365 Information redacted in accordance with CA state privacy requirements
389 Information redacted in accordance with CA state privacy requirements
391 Information redacted in accordance with CA state privacy requirements
393 Information redacted in accordance with CA state privacy requirements
396 Information redacted in accordance with CA state privacy requirements
398 Information redacted in accordance with CA state privacy requirements
```

Let's look at the **dplyr** code:

```
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
```

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

```
[1] 12091
```

Using **dplyr** is more convenient when we subset across multiple criteria, i.e. all SD areas with a pop of over 10,000.

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

Q11. How many distinct zip codes are listed for San Diego County?

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

```
[1] 107
```

There are 107 distinct zip codes.

Q12. What San Diego County Zip code area has the largest 12 + Population in this dataset?

```
maxElement <- which.max(sd$age12_plus_population)
sd$zip_code_tabulation_area[maxElement]
```

```
[1] 92154
```

The zip code area with the largest 12+ population in the dataset is 92154.

Use dplyr to select all San Diego "county" entries on "as_of_date" "2023-02-28" and use this for the following questions.

```
sd.feb <-  filter(vax, county == "San Diego" &
           as_of_date == "2023-02-28")
head(sd.feb)
```

```
  as_of_date zip_code_tabulation_area local_health_jurisdiction    county
1 2023-02-28                   91980                San Diego San Diego
2 2023-02-28                   91963                San Diego San Diego
3 2023-02-28                   92173                San Diego San Diego
4 2023-02-28                   92154                San Diego San Diego
5 2023-02-28                   92078                San Diego San Diego
6 2023-02-28                   92123                San Diego San Diego
  vaccine_equity_metric_quartile               vem_source
1                             NA           No VEM Assigned
2                              2   CDPH-Derived ZCTA Score
3                              1 Healthy Places Index Score
4                              2 Healthy Places Index Score
5                              3 Healthy Places Index Score
6                              3 Healthy Places Index Score
  age12_plus_population age5_plus_population tot_population
1                   0.0                    0             NA
2                1010.3                 1089           1182
3               25332.5                28487          31000
4               76365.2                82971          88979
5               41789.5                47476          50510
6               28353.3                30426          32473
  persons_fully_vaccinated persons_partially_vaccinated
1                     1968                         672
2                     1204                         175
3                    56448                       37233
4                    87566                       19638
5                    36673                        2992
6                    29884                        3737
  percent_of_population_fully_vaccinated
1                               1.000000
2                               1.000000
3                               1.000000
4                               0.984120
5                               0.726054
6                               0.920272
  percent_of_population_partially_vaccinated
1                                   1.000000
2                                   0.148054
3                                   1.000000
4                                   0.220704
5                                   0.059236
6                                   0.115080
  percent_of_population_with_1_plus_dose booster_recip_count
```

```
1                                    NA                863
2                               1.00000                584
3                               1.00000              27100
4                               1.00000              48030
5                               0.78529              23557
6                               1.00000              19673
  bivalent_dose_recip_count eligible_recipient_count redacted
1                       198                    1962       No
2                       135                    1202       No
3                      6603                   56212       No
4                     12970                   87234       No
5                      9495                   36526       No
6                      7561                   29717       No
```

Q13. What is the overall average "Percent of Population Fully Vaccinated" value for all San Diego "County" as of "2023-02-28"?

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

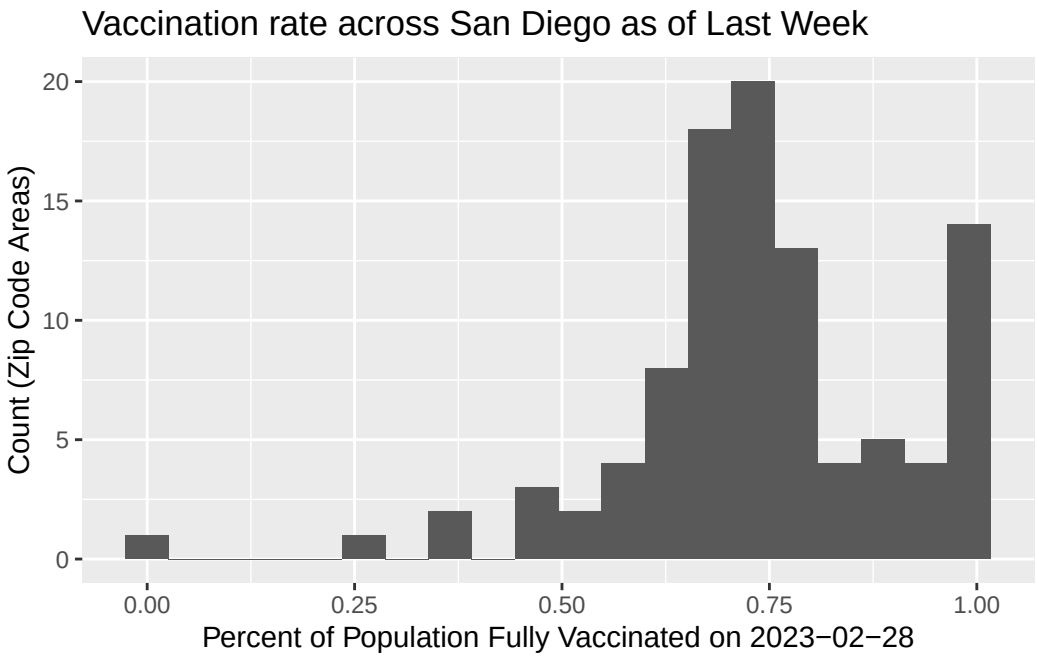
```
[1] 0.7400878
```

The average of the sd.feb$percent_of_population_fully_vaccinated is 0.74, or 74%.

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 "2023-02-28"?

```
library(ggplot2)
ggplot(sd.feb,
       aes(percent_of_population_fully_vaccinated)) +
  geom_histogram(bins = 20) +
  labs(title = "Vaccination rate across San Diego as of Last Week",
         x = "Percent of Population Fully Vaccinated on 2023-02-28",
         y = "Count (Zip Code Areas)")
```

```
Warning: Removed 8 rows containing non-finite values (`stat_bin()`).
```



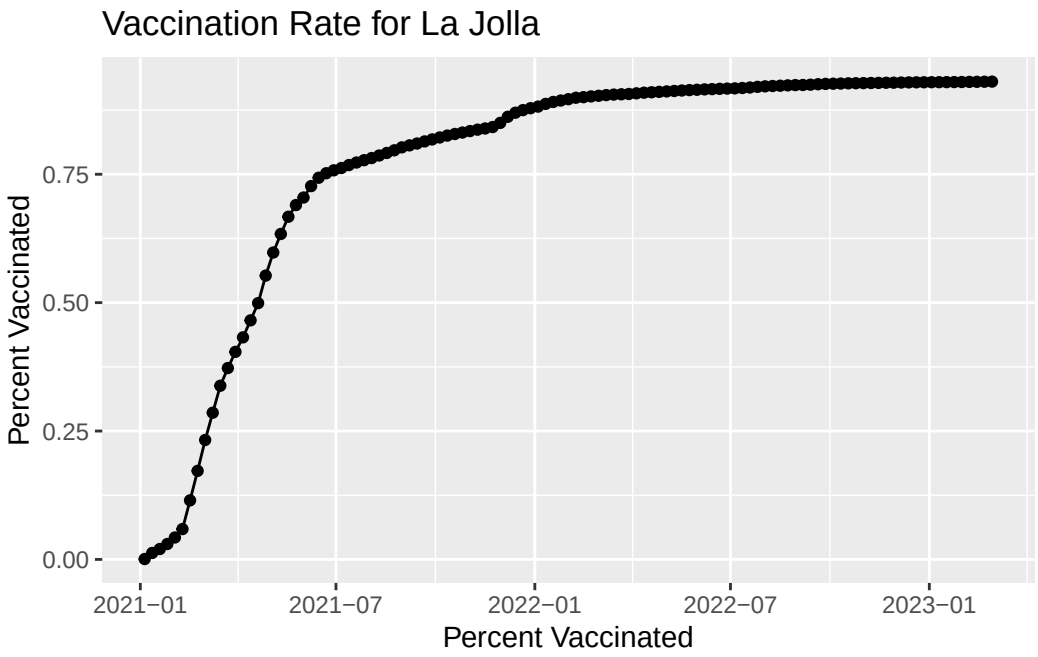
Focus on UCSD/La Jolla

```
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:

```
vaxplot <- ggplot(ucsd) +
  aes(as_of_date, percent_of_population_fully_vaccinated) +
  geom_point() +
  geom_line() +
  labs(title = "Vaccination Rate for La Jolla", x= "Percent Vaccinated", y="Percent Vaccin
vaxplot
```



Comparing to 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 as_of_date "2022-02-22".

```
# Subset to all CA areas with a population as large as 92037
vax.36 <- filter(vax, age5_plus_population > 36144 &
                 as_of_date == "2023-02-28")

head(vax.36)
```

```
  as_of_date zip_code_tabulation_area local_health_jurisdiction      county
1 2023-02-28                   93257                     Tulare      Tulare
2 2023-02-28                   93535              Los Angeles Los Angeles
3 2023-02-28                   91367              Los Angeles Los Angeles
4 2023-02-28                   90025              Los Angeles Los Angeles
5 2023-02-28                   90024              Los Angeles Los Angeles
6 2023-02-28                   90031              Los Angeles Los Angeles
  vaccine_equity_metric_quartile                vem_source
1                              1 Healthy Places Index Score
2                              1 Healthy Places Index Score
3                              3 Healthy Places Index Score
```

```
4                           4 Healthy Places Index Score
5                           3 Healthy Places Index Score
6                           1 Healthy Places Index Score
  age12_plus_population age5_plus_population tot_population
1               61519.8                70784          76519
2               59042.7                68471          74264
3               40437.4                43398          45970
4               42803.2                44982          46883
5               48841.8                50198          51627
6               34503.3                37735          39916
  persons_fully_vaccinated persons_partially_vaccinated
1                    45104                         5629
2                    45338                         4907
3                    33648                         2948
4                    36156                         4530
5                    28005                         5788
6                    29270                         3186
  percent_of_population_fully_vaccinated
1                               0.589448
2                               0.610498
3                               0.731956
4                               0.771196
5                               0.542449
6                               0.733290
  percent_of_population_partially_vaccinated
1                                   0.073563
2                                   0.066075
3                                   0.064129
4                                   0.096624
5                                   0.112112
6                                   0.079818
  percent_of_population_with_1_plus_dose booster_recip_count
1                               0.663011               22106
2                               0.676573               21799
3                               0.796085               22052
4                               0.867820               25207
5                               0.654561               19239
6                               0.813108               17344
  bivalent_dose_recip_count eligible_recipient_count redacted
1                      4981                    45046       No
2                      6754                    45247       No
3                      9234                    33544       No
4                     12099                    35980       No
```

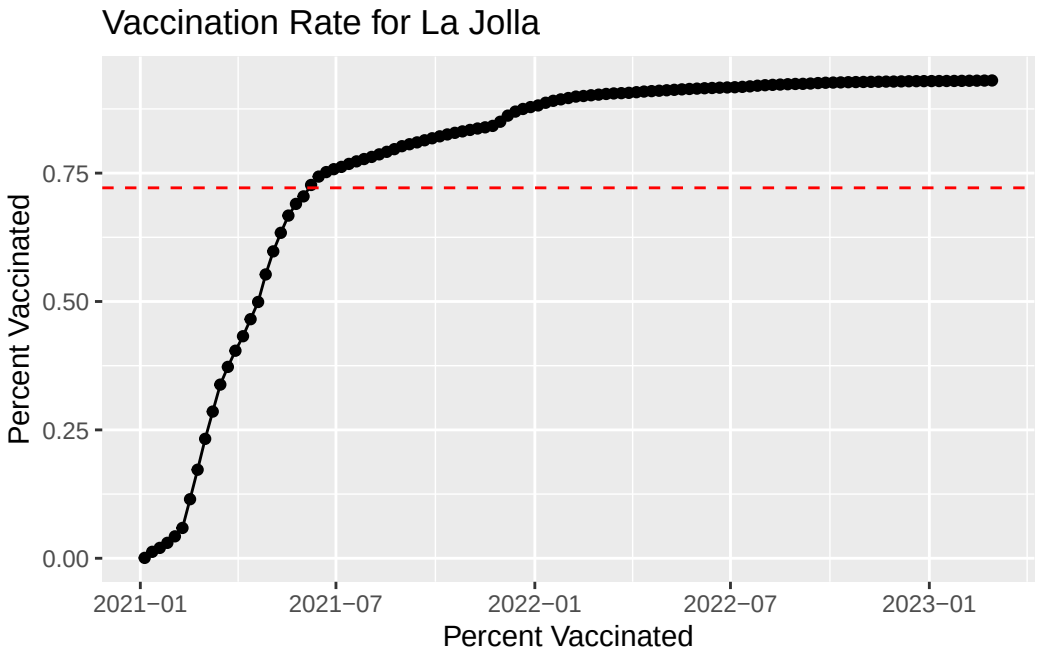
```
5                      8578                    27934       No
6                      6076                    29213       No
```

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 "2022-11-15". Add this as a straight horizontal line to your plot from above with the geom_hline() function?

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

```
[1] 0.7213331
```

```
vaxplot + geom_hline(yintercept=meanvax, color = "red", linetype = 2)
```



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 "2022-11-15"?

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

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.3804  0.6457  0.7181  0.7213  0.7907  1.0000
```

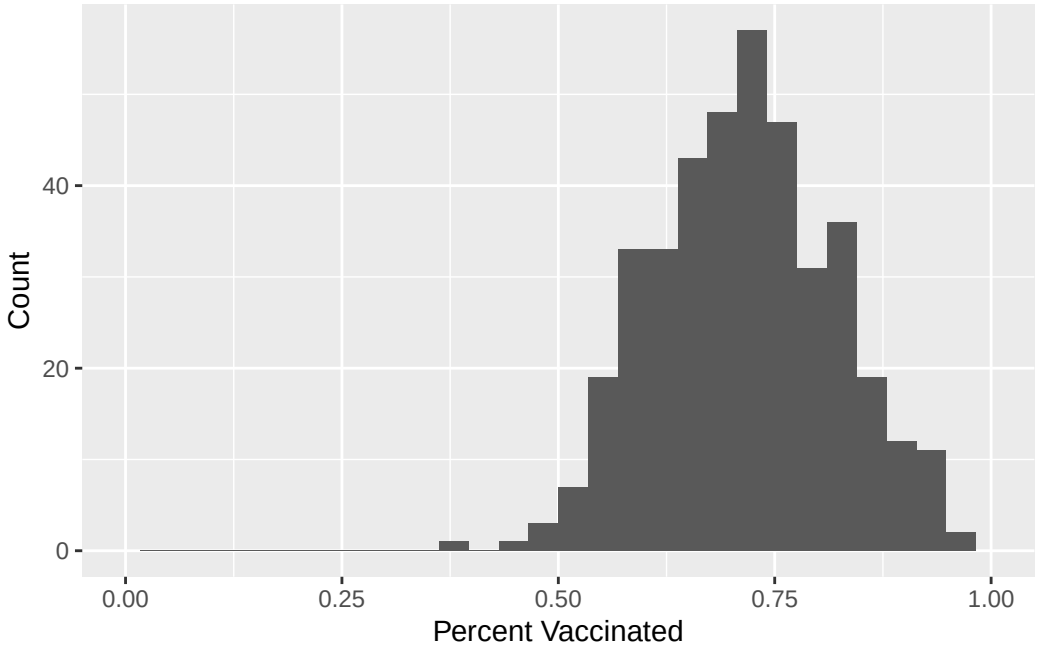
The min is 0.3804, first qu is 0.6457, median is 0.7181, 3rd qu is 0.7907, and max of 1.000.

Q18. Using ggplot generate a histogram of this data.

```
ggplot(vax.36) +
    aes(percent_of_population_fully_vaccinated) +
    geom_histogram() +
    xlim(c(0,1)) +
    xlab("Percent Vaccinated") +
    ylab("Count")
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```
Warning: Removed 2 rows containing missing values (`geom_bar()`).
```



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

```
x <- filter(vax.36, zip_code_tabulation_area %in% c("92109", "92040"))
x$percent_of_population_fully_vaccinated
```

```
[1] 0.694572 0.550296
```

```
# vax %>% filter(as_of_date == "2023-02-28") %>%
#  filter(zip_code_tabulation_area=="92040") %>%
#  select(percent_of_population_fully_vaccinated)
```

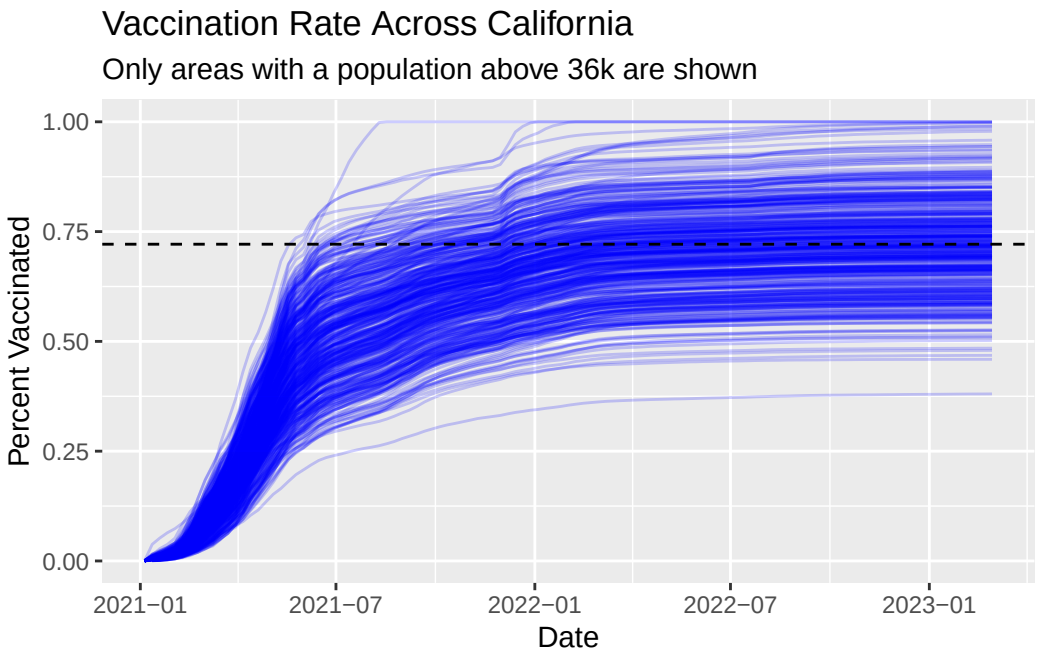
The ZIP codes areas are below the calculated average value.

> Q20. Finally make a time course plot 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 = 0.7213, linetype=2)
```

```
Warning: Removed 183 rows containing missing values (`geom_line()`).
```


Vaccination Rate Across California
Only areas with a population above 36k are shown
Percent Vaccinated
1.00
0.75
0.50
0.25
0.00
2021−01
2021−07
2022−01
2022−07
2023−01
Date