Google Data Analytics Bike Sharing Capstone Project

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7/19/2021

Introduction

The following case study is a Capstone project requirement for the Google Data Analytics Professional Certificate. The case study is based on bike share data generated by fictional company Cyclistic.

Scenario

In 2016, Cyclistic launched a successful bike-share offering. Since then, the program has grown to a fleet of 5,824 bicycles that are geotracked and locked into a network of 692 stations across Chicago. The bikes can be unlocked from one station and returned to any other station in the system anytime. Until now, Cyclistic's marketing strategy relied on building general awareness and appealing to broad consumer segments. One approach that helped make these things possible was the flexibility of its pricing plans: single-ride passes, full-day passes, and annual memberships. Customers who purchase single-ride or full-day passes are referred to as casual riders. Customers who purchase annual memberships are Cyclistic members.

Cyclistic's Director of Marketing believes the company's future success depends on maximizing the number of annual memberships. Therefore, the goal of the case study is to understand how casual riders and annual members use Cyclistic's bikes differently. From these insights, a new marketing strategy will be designed to hopefully convert causal riders to annual members.

Data source

While Cyclistic is a fictional company, the real world data used for the case study is from an actual company named Divy. The data has been made available by Motivate International Inc. and can be found here:

https://divvy-tripdata.s3.amazonaws.com/index.html

Load libriaries

It will be necessary to load the following libraries into R in order import, clean, wrangle and visualize the data.

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.3     v dplyr   1.0.7
## v tidyr   1.1.3     v stringr 1.4.0
## v readr   2.0.1     v forcats 0.5.1
```

```
## -- Conflicts ---------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(janitor)
```

```
##
## Attaching package: 'janitor'
```

```
## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```
library(lubridate)
```

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

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

```
library(ggplot2)
library(readxl)
library(data.table)
```

```
##
## Attaching package: 'data.table'
```

```
## The following objects are masked from 'package:lubridate':
##
##     hour, isoweek, mday, minute, month, quarter, second, wday, week,
##     yday, year
```

```
## The following objects are masked from 'package:dplyr':
##
##     between, first, last
```

```
## The following object is masked from 'package:purrr':
##
##     transpose
```

Load CSV files into R

The following code will import each month's trip data into its own dataframe

```
apr20 <- read_csv("202004-divvy-tripdata.csv")
```

```
## Rows: 84776 Columns: 13
```

```
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
may20 <- read_csv("202005-divvy-tripdata.csv")
```

```
## Rows: 200274 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
jun20 <- read_csv("202006-divvy-tripdata.csv")
```

```
## Rows: 343005 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
jul20 <- read_csv("202007-divvy-tripdata.csv")
```

```
## Rows: 551480 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
aug20 <- read_csv("202008-divvy-tripdata.csv")
```

```
## Rows: 622361 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
sep20 <- read_csv("202009-divvy-tripdata.csv")
```

```
## Rows: 532958 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
oct20 <- read_csv("202010-divvy-tripdata.csv")
```

```
## Rows: 388653 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
nov20 <- read_csv("202011-divvy-tripdata.csv")
```

```
## Rows: 259716 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (7): ride_id, rideable_type, started_at, ended_at, start_station_name, e...
## dbl (6): start_station_id, end_station_id, start_lat, start_lng, end_lat, en...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
dec20 <- read_csv("202012-divvy-tripdata.csv")
```

```
## Rows: 131573 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (9): ride_id, rideable_type, started_at, ended_at, start_station_name, s...
## dbl (4): start_lat, start_lng, end_lat, end_lng

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
jan21 <- read_csv("202101-divvy-tripdata.csv")
```

```
## Rows: 96834 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (9): ride_id, rideable_type, started_at, ended_at, start_station_name, s...
## dbl (4): start_lat, start_lng, end_lat, end_lng

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
feb21 <- read_csv("202102-divvy-tripdata.csv")
```

```
## Rows: 49622 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (9): ride_id, rideable_type, started_at, ended_at, start_station_name, s...
## dbl (4): start_lat, start_lng, end_lat, end_lng

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
mar21 <- read_csv("202103-divvy-tripdata.csv")
```

```
## Rows: 228496 Columns: 13

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (9): ride_id, rideable_type, started_at, ended_at, start_station_name, s...
## dbl (4): start_lat, start_lng, end_lat, end_lng

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

Clean and wrangle data

After importing all individual months of data, it was necessary to check to see if the data is in consistent format.

```
compare_df_cols_same(apr20, may20, jun20, jul20, aug20, sep20, oct20, nov20, dec20, jan21, feb21, mar21)
```

```
##        column_name     ..1     ..2     ..3     ..4     ..5     ..6     ..7
## 1   end_station_id numeric numeric numeric numeric numeric numeric numeric
## 2 start_station_id numeric numeric numeric numeric numeric numeric numeric
##       ..8       ..9      ..10      ..11      ..12
## 1 numeric character character character character
## 2 numeric character character character character
```

```
## [1] FALSE
```

start_station_id and end_station_id in dec20, jan21, feb21 and mar21 need to be adjusted from character types to numeric types.

```
dec20 <- dec20 %>%
  mutate(start_station_id = as.numeric(start_station_id),
         end_station_id = as.numeric(end_station_id))
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
jan21 <- jan21 %>%
  mutate(start_station_id = as.numeric(start_station_id),
         end_station_id = as.numeric(end_station_id))
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
feb21 <- feb21 %>%
  mutate(start_station_id = as.numeric(start_station_id),
         end_station_id = as.numeric(end_station_id))
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
mar21 <- mar21 %>%
  mutate(start_station_id = as.numeric(start_station_id),
         end_station_id = as.numeric(end_station_id))
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

Recheck to see if all individual months of data are consistent now.

```
compare_df_cols_same(apr20, may20, jun20, jul20, aug20, sep20, oct20, nov20, dec20, jan21, feb21, mar21
```

```
## [1] TRUE
```

Now that all individual months of data are in consistent format, combined all months into one single dataframe and use glimpse to get a quick understanding of the data structure.

```
all_trips <- bind_rows(apr20, may20, jun20, jul20, aug20, sep20, oct20, nov20, dec20, jan21, feb21, mar
```

```
glimpse(all_trips)
```

```
## Rows: 3,489,748
## Columns: 13
## $ ride_id            <chr> "A847FADBBC638E45", "5405B80E996FF60D", "5DD24A79A4~
## $ rideable_type      <chr> "docked_bike", "docked_bike", "docked_bike", "docke~
## $ started_at         <chr> "4/26/2020 17:45", "4/17/2020 17:08", "4/1/2020 17:~
## $ ended_at           <chr> "4/26/2020 18:12", "4/17/2020 17:17", "4/1/2020 18:~
## $ start_station_name <chr> "Eckhart Park", "Drake Ave & Fullerton Ave", "McClu~
## $ start_station_id   <dbl> 86, 503, 142, 216, 125, 173, 35, 434, 627, 377, 508~
## $ end_station_name   <chr> "Lincoln Ave & Diversey Pkwy", "Kosciuszko Park", "~
## $ end_station_id     <dbl> 152, 499, 255, 657, 323, 35, 635, 382, 359, 508, 37~
## $ start_lat          <dbl> 41.8964, 41.9244, 41.8945, 41.9030, 41.8902, 41.896~
## $ start_lng          <dbl> -87.6610, -87.7154, -87.6179, -87.6975, -87.6262, -~
## $ end_lat            <dbl> 41.9322, 41.9306, 41.8679, 41.8992, 41.9695, 41.892~
## $ end_lng            <dbl> -87.6586, -87.7238, -87.6230, -87.6722, -87.6547, -~
## $ member_casual      <chr> "member", "member", "member", "member", "casual", "~
```

The data can be cleaned up a bit, removed start_lat, start_lng, end_lat, end_lng as these columns are not necessary for our specific analysis. Also rename some columns to make more clear/descriptive

```
all_trips_v1 <- all_trips %>%
  select(-c(start_lat, start_lng, end_lat, end_lng)) %>%
  rename(ride_type = rideable_type,
         start_time = started_at,
         end_time = ended_at,
         customer_type = member_casual)

glimpse(all_trips_v1)
```

```
## Rows: 3,489,748
## Columns: 9
## $ ride_id            <chr> "A847FADBBC638E45", "5405B80E996FF60D", "5DD24A79A4~
## $ ride_type          <chr> "docked_bike", "docked_bike", "docked_bike", "docke~
## $ start_time         <chr> "4/26/2020 17:45", "4/17/2020 17:08", "4/1/2020 17:~
## $ end_time           <chr> "4/26/2020 18:12", "4/17/2020 17:17", "4/1/2020 18:~
## $ start_station_name <chr> "Eckhart Park", "Drake Ave & Fullerton Ave", "McClu~
## $ start_station_id   <dbl> 86, 503, 142, 216, 125, 173, 35, 434, 627, 377, 508~
## $ end_station_name   <chr> "Lincoln Ave & Diversey Pkwy", "Kosciuszko Park", "~
## $ end_station_id     <dbl> 152, 499, 255, 657, 323, 35, 635, 382, 359, 508, 37~
## $ customer_type      <chr> "member", "member", "member", "member", "casual", "~
```

I realize start_time and end_time are character types, these columns should be in date-time format to allow for ride length analysis

```
all_trips_v2 <- all_trips_v1 %>%
  mutate(start_time = mdy_hm(start_time),
         end_time = mdy_hm(end_time))
```

Now we are able to add ride_length_minutes, month_year, day_of_week and time columns which can be used to expand on our analysis. The time column needs to be converted to a character vector first and then back to POSIXct format.

```
all_trips_v3 <- all_trips_v2 %>%
  mutate(ride_length_minutes = as.numeric(end_time - start_time) / 60,
         month_year = format(as.Date(start_time), '%b_%y'),
         day_of_week = lubridate::wday(start_time, label = TRUE, abbr = FALSE))

all_trips_v3$time <- format(all_trips_v3$start_time, format = "%H:%M")
all_trips_v3$time <- as.POSIXct(all_trips_v3$time, format = "%H:%M")

all_trips_v3$month_year <- ordered(all_trips_v3$month_year, levels=c("Apr_20", "May_20", "Jun_20", "Jul

glimpse(all_trips_v3)
```

```
## Rows: 3,489,748
## Columns: 13
## $ ride_id             <chr> "A847FADBBC638E45", "5405B80E996FF60D", "5DD24A79A~
## $ ride_type           <chr> "docked_bike", "docked_bike", "docked_bike", "dock~
## $ start_time          <dttm> 2020-04-26 17:45:00, 2020-04-17 17:08:00, 2020-04~
## $ end_time            <dttm> 2020-04-26 18:12:00, 2020-04-17 17:17:00, 2020-04~
## $ start_station_name  <chr> "Eckhart Park", "Drake Ave & Fullerton Ave", "McCl~
## $ start_station_id    <dbl> 86, 503, 142, 216, 125, 173, 35, 434, 627, 377, 50~
## $ end_station_name    <chr> "Lincoln Ave & Diversey Pkwy", "Kosciuszko Park", ~
## $ end_station_id      <dbl> 152, 499, 255, 657, 323, 35, 635, 382, 359, 508, 3~
## $ customer_type       <chr> "member", "member", "member", "member", "casual", ~
## $ ride_length_minutes <dbl> 27, 9, 14, 12, 53, 6, 5, 76, 5, 17, 24, 5, 9, 4, 2~
## $ month_year          <ord> Apr_20, Apr_20, Apr_20, Apr_20, Apr_20, Apr_20, Ap~
## $ day_of_week         <ord> Sunday, Friday, Wednesday, Tuesday, Saturday, Thur~
## $ time                <dttm> 2021-08-22 17:45:00, 2021-08-22 17:08:00, 2021-08~
```

Check for inconsistencies in the data again

```
summary(all_trips_v3)
```

```
##    ride_id           ride_type           start_time
##  Length:3489748     Length:3489748     Min.   :2020-04-01 00:00:00
##  Class :character   Class :character   1st Qu.:2020-07-14 19:38:00
##  Mode  :character   Mode  :character   Median :2020-08-29 14:50:00
##                                        Mean   :2020-09-10 01:21:16
##                                        3rd Qu.:2020-10-20 18:14:00
##                                        Max.   :2021-03-31 23:59:00
##
##     end_time                    start_station_name start_station_id
```

```
##  Min.   :2020-04-01 00:10:00   Length:3489748     Min.   :    2
##  1st Qu.:2020-07-14 20:13:00   Class :character   1st Qu.:  109
##  Median :2020-08-29 15:21:00   Mode  :character   Median :  212
##  Mean   :2020-09-10 01:46:02                      Mean   : 1016
##  3rd Qu.:2020-10-20 18:28:00                      3rd Qu.:  332
##  Max.   :2021-04-06 11:00:00                      Max.   :20258
##                                                   NA's   :388463
##  end_station_name   end_station_id   customer_type      ride_length_minutes
##  Length:3489748     Min.   :    2   Length:3489748     Min.   :-29050.00
##  Class :character   1st Qu.:  110   Class :character   1st Qu.:     8.00
##  Mode  :character   Median :  213   Mode  :character   Median :    15.00
##                     Mean   : 1016                      Mean   :    24.77
##                     3rd Qu.:  332                      3rd Qu.:    27.00
##                     Max.   :20258                      Max.   : 58720.00
##                     NA's   :404359
##    month_year        day_of_week          time
##  Aug_20 :622361   Sunday   :529117   Min.   :2021-08-22 00:00:00
##  Jul_20 :551480   Monday   :419556   1st Qu.:2021-08-22 11:51:00
##  Sep_20 :532958   Tuesday  :431292   Median :2021-08-22 15:25:00
##  Oct_20 :388653   Wednesday:464804   Mean   :2021-08-22 14:48:06
##  Jun_20 :343005   Thursday :467993   3rd Qu.:2021-08-22 18:08:00
##  Nov_20 :259716   Friday   :516802   Max.   :2021-08-22 23:59:00
##  (Other):791575   Saturday :660184
```

```
unique(all_trips_v3$end_station_name)
```

```
##   [1] "Lincoln Ave & Diversey Pkwy"
##   [2] "Kosciuszko Park"
##   [3] "Indiana Ave & Roosevelt Rd"
##   [4] "Wood St & Augusta Blvd"
##   [5] "Sheridan Rd & Lawrence Ave"
##   [6] "Streeter Dr & Grand Ave"
##   [7] "Fairbanks St & Superior St"
##   [8] "Western Ave & Congress Pkwy"
##   [9] "Larrabee St & Division St"
##  [10] "Central Park Ave & North Ave"
##  [11] "Western Ave & Walton St"
##  [12] "Damen Ave & Chicago Ave"
##  [13] "Ashland Ave & Division St"
##  [14] "Michigan Ave & 8th St"
##  [15] "Sheffield Ave & Kingsbury St"
##  [16] "Clark St & Lincoln Ave"
##  [17] "Leavitt St & Archer Ave"
##  [18] "Southport Ave & Wrightwood Ave"
##  [19] "Aberdeen St & Randolph St"
##  [20] "Cornell Dr & Hayes Dr"
##  [21] "Southport Ave & Waveland Ave"
##  [22] "900 W Harrison St"
##  [23] "Ravenswood Ave & Lawrence Ave"
##  [24] "Evanston Civic Center"
##  [25] "Lincoln Ave & Fullerton Ave"
##  [26] "Clinton St & Lake St"
##  [27] "Buckingham Fountain"
##  [28] "Aberdeen St & Monroe St"
```

```
##  [29] "Loomis St & Jackson Blvd"
##  [30] "Larrabee St & Webster Ave"
##  [31] "Pine Grove Ave & Irving Park Rd"
##  [32] "Wolcott Ave & Polk St"
##  [33] "Leavitt St & Chicago Ave"
##  [34] "Racine Ave & Randolph St"
##  [35] "Rush St & Superior St"
##  [36] "Ashland Ave & Wellington Ave"
##  [37] "Michigan Ave & Lake St"
##  [38] "Wabash Ave & Roosevelt Rd"
##  [39] "Halsted St & Archer Ave"
##  [40] "Halsted St & 35th St"
##  [41] "Broadway & Barry Ave"
##  [42] "Wilton Ave & Diversey Pkwy"
##  [43] "Clark St & Drummond Pl"
##  [44] "Lake Shore Dr & Wellington Ave"
##  [45] "Halsted St & Wrightwood Ave"
##  [46] "Kingsbury St & Kinzie St"
##  [47] "Fairbanks Ct & Grand Ave"
##  [48] "Morgan St & Lake St"
##  [49] "Dearborn St & Erie St"
##  [50] "St. Clair St & Erie St"
##  [51] "Kedzie Ave & Bryn Mawr Ave"
##  [52] "Clarendon Ave & Leland Ave"
##  [53] "Broadway & Belmont Ave"
##  [54] "Western Ave & Granville Ave"
##  [55] "Wilton Ave & Belmont Ave"
##  [56] "Clinton St & Washington Blvd"
##  [57] "Carpenter St & Huron St"
##  [58] "Mies van der Rohe Way & Chicago Ave"
##  [59] "California Ave & Byron St"
##  [60] "LaSalle Dr & Huron St"
##  [61] "Clark St & Wrightwood Ave"
##  [62] "Leavitt St & North Ave"
##  [63] "Washtenaw Ave & Lawrence Ave"
##  [64] "Ritchie Ct & Banks St"
##  [65] "Museum of Science and Industry"
##  [66] "Damen Ave & Charleston St"
##  [67] "Blue Island Ave & 18th St"
##  [68] "Noble St & Milwaukee Ave"
##  [69] "Clinton St & Madison St"
##  [70] "Ellis Ave & 53rd St"
##  [71] "Milwaukee Ave & Wabansia Ave"
##  [72] "State St & Randolph St"
##  [73] "Michigan Ave & Madison St"
##  [74] "Clark St & Ida B Wells Dr"
##  [75] "Ashland Ave & Chicago Ave"
##  [76] "Ashland Ave & Grace St"
##  [77] "Broadway & Ridge Ave"
##  [78] "Peoria St & Jackson Blvd"
##  [79] "Greenview Ave & Jarvis Ave"
##  [80] "Chicago Ave & Washington St"
##  [81] "Wolcott (Ravenswood) Ave & Montrose Ave"
##  [82] "Lincoln Ave & Winona St"
```

```
##  [83] "Clark St & Elm St"
##  [84] "Lake Shore Dr & North Blvd"
##  [85] "Oakley Ave & Touhy Ave"
##  [86] "Broadway & Cornelia Ave"
##  [87] "Kedzie Ave & Milwaukee Ave"
##  [88] "Wells St & Concord Ln"
##  [89] "Sheffield Ave & Wellington Ave"
##  [90] "Cottage Grove Ave & Oakwood Blvd"
##  [91] "Millennium Park"
##  [92] "Lake Shore Dr & Monroe St"
##  [93] "Damen Ave & Cortland St"
##  [94] "Wood St & Milwaukee Ave"
##  [95] "Cannon Dr & Fullerton Ave"
##  [96] "Lincoln Park Conservatory"
##  [97] "Lake Shore Dr & Belmont Ave"
##  [98] "Shields Ave & 31st St"
##  [99] "Ogden Ave & Race Ave"
## [100] "Troy St & North Ave"
## [101] "Milwaukee Ave & Rockwell St"
## [102] "Wells St & Hubbard St"
## [103] "Broadway & Waveland Ave"
## [104] "Green St & Madison St"
## [105] "Sedgwick St & North Ave"
## [106] "Clark St & Randolph St"
## [107] "Damen Ave & Foster Ave"
## [108] "Sacramento Blvd & Franklin Blvd"
## [109] "Cityfront Plaza Dr & Pioneer Ct"
## [110] "Blackstone Ave & Hyde Park Blvd"
## [111] "Federal St & Polk St"
## [112] "Western Blvd & 48th Pl"
## [113] "Paulina St & 18th St"
## [114] "Dearborn St & Monroe St"
## [115] "California Ave & 23rd Pl"
## [116] "Michigan Ave & 14th St"
## [117] "LaSalle St & Illinois St"
## [118] "Halsted St & 18th St"
## [119] "Eckhart Park"
## [120] "Wolcott Ave & Fargo Ave"
## [121] "Elmwood Ave & Austin St"
## [122] "Clark St & Jarvis Ave"
## [123] "Stetson Ave & South Water St"
## [124] "Southport Ave & Belmont Ave"
## [125] "Lincoln Ave & Sunnyside Ave"
## [126] "Damen Ave & Pierce Ave"
## [127] "Clark St & Lunt Ave"
## [128] "Artesian Ave & Hubbard St"
## [129] "Wells St & Walton St"
## [130] "State St & 29th St"
## [131] "Western Ave & Division St"
## [132] "Racine Ave & Belmont Ave"
## [133] "Daley Center Plaza"
## [134] "Ada St & Washington Blvd"
## [135] "Commercial Ave & 83rd St"
## [136] "Marine Dr & Ainslie St"
```

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## [137] "McClurg Ct & Illinois St"
## [138] "Wells St & Polk St"
## [139] "Clark St & Berwyn Ave"
## [140] "Wells St & Huron St"
## [141] "Lincoln Ave & Addison St"
## [142] "Stockton Dr & Wrightwood Ave"
## [143] "Wells St & Evergreen Ave"
## [144] "Leavitt St & Armitage Ave"
## [145] "Clark St & North Ave"
## [146] "Kedzie Ave & Chicago Ave"
## [147] "Marshfield Ave & Cortland St"
## [148] "Sedgwick St & Huron St"
## [149] "Ashland Ave & Wrightwood Ave"
## [150] "Larrabee St & Menomonee St"
## [151] "Wood St & Chicago Ave (*)"
## [152] "Desplaines St & Kinzie St"
## [153] "Cottage Grove Ave & 47th St"
## [154] "Calumet Ave & 35th St"
## [155] "MLK Jr Dr & Pershing Rd"
## [156] "Oakley Ave & Irving Park Rd"
## [157] "Albany Ave & Montrose Ave"
## [158] "McClurg Ct & Erie St"
## [159] "Sedgwick St & Schiller St"
## [160] "Lake Shore Dr & Diversey Pkwy"
## [161] "Paulina Ave & North Ave"
## [162] "Michigan Ave & Pearson St"
## [163] "Indiana Ave & 26th St"
## [164] "Burling St (Halsted) & Diversey Pkwy (Temp)"
## [165] "Southport Ave & Wellington Ave"
## [166] "State St & Kinzie St"
## [167] "Sheffield Ave & Fullerton Ave"
## [168] "Cottage Grove Ave & 51st St"
## [169] "Clifton Ave & Armitage Ave"
## [170] "Orleans St & Elm St"
## [171] "Clark St & Wellington Ave"
## [172] "Ashland Ave & 13th St"
## [173] "Campbell Ave & North Ave"
## [174] "Halsted St & 21st St"
## [175] "Bissell St & Armitage Ave"
## [176] "Halsted St & Dickens Ave"
## [177] "Kedzie Ave & Palmer Ct"
## [178] "Damen Ave & Grand Ave"
## [179] "Green St & Randolph St"
## [180] "Franklin St & Illinois St"
## [181] "Field Blvd & South Water St"
## [182] "Lake Park Ave & 56th St"
## [183] "Spaulding Ave & Division St"
## [184] "Clark St & Grace St"
## [185] "Michigan Ave & Oak St"
## [186] "Canal St & Madison St"
## [187] "Field Museum"
## [188] "California Ave & Fletcher St"
## [189] "Leavitt St & Division St (*)"
## [190] "Warren Park East"
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## [191] "Morgan Ave & 14th Pl"
## [192] "Wabash Ave & 16th St"
## [193] "State St & 19th St"
## [194] "Calumet Ave & 18th St"
## [195] "University Ave & 57th St"
## [196] "Wood St & Taylor St"
## [197] "Ogden Ave & Roosevelt Rd"
## [198] "Orleans St & Merchandise Mart Plaza"
## [199] "Dayton St & North Ave"
## [200] "Calumet Ave & 51st St"
## [201] "Dearborn Pkwy & Delaware Pl"
## [202] "Sheffield Ave & Willow St"
## [203] "Clybourn Ave & Division St"
## [204] "Southport Ave & Irving Park Rd"
## [205] "Elizabeth (May) St & Fulton St"
## [206] "Sheridan Rd & Irving Park Rd"
## [207] "State St & 33rd St"
## [208] "California Ave & North Ave"
## [209] "Spaulding Ave & Armitage Ave"
## [210] "Clark St & Chicago Ave"
## [211] "Morgan St & 18th St"
## [212] "Glenwood Ave & Touhy Ave"
## [213] "Wells St & Elm St"
## [214] "63rd St Beach"
## [215] "Southport Ave & Clybourn Ave"
## [216] "Clark St & Bryn Mawr Ave"
## [217] "Broadway & Wilson Ave"
## [218] "Wabash Ave & Cermak Rd"
## [219] "Racine Ave & 18th St"
## [220] "Ashland Ave & Grand Ave"
## [221] "Central Ave & Madison St"
## [222] "Sawyer Ave & Irving Park Rd"
## [223] "Michigan Ave & Jackson Blvd"
## [224] "Sheridan Rd & Montrose Ave"
## [225] "California Ave & Francis Pl (Temp)"
## [226] "Clark St & Lake St"
## [227] "Fairfield Ave & Roosevelt Rd"
## [228] "Rhodes Ave & 32nd St"
## [229] "Clinton St & Roosevelt Rd"
## [230] "Canal St & Adams St"
## [231] "Ravenswood Ave & Berteau Ave"
## [232] "Rush St & Cedar St"
## [233] "Racine Ave & 15th St"
## [234] "Sheridan Rd & Loyola Ave"
## [235] "California Ave & 21st St"
## [236] "Western Ave & 28th St"
## [237] "Ellis Ave & 58th St"
## [238] "Desplaines St & Randolph St"
## [239] "Milwaukee Ave & Grand Ave"
## [240] "Prairie Ave & 43rd St"
## [241] "Clark St & Newport St"
## [242] "Sedgwick St & Webster Ave"
## [243] "Monticello Ave & Irving Park Rd"
## [244] "State St & Harrison St"
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## [245] "Pine Grove Ave & Waveland Ave"
## [246] "Wabash Ave & Adams St"
## [247] "Winthrop Ave & Lawrence Ave"
## [248] "Wacker Dr & Washington St"
## [249] "Michigan Ave & Washington St"
## [250] "Aberdeen St & Jackson Blvd"
## [251] "Broadway & Argyle St"
## [252] "Franklin St & Chicago Ave"
## [253] "Clinton St & Jackson Blvd"
## [254] "Clarendon Ave & Junior Ter"
## [255] "Loomis St & Lexington St"
## [256] "Throop (Loomis) St & Taylor St"
## [257] "Hermitage Ave & Polk St"
## [258] "Francisco Ave & Foster Ave"
## [259] "Ellis Ave & 83rd St"
## [260] "Cottage Grove Ave & 78th St"
## [261] "Rush St & Hubbard St"
## [262] "Damen Ave & Sunnyside Ave"
## [263] "Christiana Ave & Lawrence Ave"
## [264] "Greenview Ave & Fullerton Ave"
## [265] "Laflin St & Cullerton St"
## [266] "Cottage Grove Ave & 63rd St"
## [267] "St. Louis Ave & Balmoral Ave"
## [268] "LaSalle St & Jackson Blvd"
## [269] "Sheffield Ave & Waveland Ave"
## [270] "Ashland Ave & Archer Ave"
## [271] "Lakeview Ave & Fullerton Pkwy"
## [272] "Ravenswood Ave & Irving Park Rd"
## [273] "MLK Jr Dr & 29th St"
## [274] "Franklin St & Lake St"
## [275] "Milwaukee Ave & Cuyler Ave"
## [276] "Clark St & Schiller St"
## [277] "Lincoln Ave & Roscoe St"
## [278] "Sheridan Rd & Noyes St (NU)"
## [279] "Lake Shore Dr & Ohio St"
## [280] "Damen Ave & Division St"
## [281] "Dorchester Ave & 49th St"
## [282] "Humboldt Blvd & Armitage Ave"
## [283] "South Shore Dr & 71st St"
## [284] "Western Ave & 21st St"
## [285] "HUBBARD ST BIKE CHECKING (LBS-WH-TEST)"
## [286] "Orleans St & Chestnut St (NEXT Apts)"
## [287] "California Ave & Altgeld St"
## [288] "LaSalle St & Washington St"
## [289] "MLK Jr Dr & 63rd St"
## [290] "Mies van der Rohe Way & Chestnut St"
## [291] "State St & Pearson St"
## [292] "Wabash Ave & Grand Ave"
## [293] "Dearborn St & Adams St"
## [294] "Clarendon Ave & Gordon Ter"
## [295] "Loomis St & Archer Ave"
## [296] "Clark St & Winnemac Ave"
## [297] "Richmond St & Diversey Ave"
## [298] "Halsted St & Maxwell St"
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## [299] "California Ave & Cortez St"
## [300] "Clark St & Armitage Ave"
## [301] "Southport Ave & Clark St"
## [302] "Michigan Ave & 18th St"
## [303] "Sheffield Ave & Webster Ave"
## [304] "Southport Ave & Roscoe St"
## [305] "Dearborn St & Van Buren St"
## [306] "Clark St & Leland Ave"
## [307] "Kingsbury St & Erie St"
## [308] "Clark St & Schreiber Ave"
## [309] "California Ave & Montrose Ave"
## [310] "Clark St & Touhy Ave"
## [311] "Sheffield Ave & Wrightwood Ave"
## [312] "Michigan Ave & Ida B Wells Dr"
## [313] "Halsted St & Roscoe St"
## [314] "Halsted St & Clybourn Ave"
## [315] "Damen Ave & Pershing Rd"
## [316] "Columbus Dr & Randolph St"
## [317] "Western Ave & Roscoe St"
## [318] "Drake Ave & Fullerton Ave"
## [319] "Leavitt St & Addison St"
## [320] "Broadway & Granville Ave"
## [321] "Damen Ave & Melrose Ave"
## [322] "Archer (Damen) Ave & 37th St"
## [323] "Halsted St & Polk St"
## [324] "Ogden Ave & Congress Pkwy"
## [325] "Wallace St & 35th St"
## [326] "Ogden Ave & Chicago Ave"
## [327] "Theater on the Lake"
## [328] "Logan Blvd & Elston Ave"
## [329] "Kimbark Ave & 53rd St"
## [330] "Halsted St & Willow St"
## [331] "Ashland Ave & Blackhawk St"
## [332] "Chicago Ave & Sheridan Rd"
## [333] "Broadway & Thorndale Ave"
## [334] "Calumet Ave & 33rd St"
## [335] "Broadway & Sheridan Rd"
## [336] "Winchester (Ravenswood) Ave & Balmoral Ave"
## [337] "Benson Ave & Church St"
## [338] "Franklin St & Jackson Blvd"
## [339] "Central Park Ave & Elbridge Ave"
## [340] "Kimball Ave & Belmont Ave"
## [341] "Austin Blvd & Lake St"
## [342] "Sheridan Rd & Buena Ave"
## [343] "Ashland Ave & Belle Plaine Ave"
## [344] "Eastlake Ter & Rogers Ave"
## [345] "Lincoln Ave & Waveland Ave"
## [346] "Lakefront Trail & Bryn Mawr Ave"
## [347] "Canal St & Monroe St"
## [348] "Clark St & 9th St (AMLI)"
## [349] "Franklin St & Monroe St"
## [350] "Paulina St & Flournoy St"
## [351] "Kilbourn Ave & Milwaukee Ave"
## [352] "Woodlawn Ave & 55th St"
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## [353] "Larrabee St & Kingsbury St"
## [354] "Ellis Ave & 60th St"
## [355] "Broadway & Berwyn Ave"
## [356] "Clark St & Montrose Ave"
## [357] "Seeley Ave & Roscoe St"
## [358] "Racine Ave & Fullerton Ave"
## [359] NA
## [360] "Damen Ave & Cullerton St"
## [361] "Damen Ave & Madison St"
## [362] "Clark St & Columbia Ave"
## [363] "Damen Ave & Clybourn Ave"
## [364] "May St & Taylor St"
## [365] "Walsh Park"
## [366] "Conservatory Dr & Lake St"
## [367] "Kedzie Ave & Foster Ave"
## [368] "Adler Planetarium"
## [369] "Desplaines St & Jackson Blvd"
## [370] "Harper Ave & 59th St"
## [371] "Kedzie Ave & Leland Ave"
## [372] "Troy St & Elston Ave"
## [373] "Sheridan Rd & Columbia Ave"
## [374] "Larrabee St & Armitage Ave"
## [375] "Kedzie Ave & Lake St"
## [376] "California Ave & Division St"
## [377] "Larrabee St & Oak St"
## [378] "California Ave & Milwaukee Ave"
## [379] "Shore Dr & 55th St"
## [380] "Morgan St & 31st St"
## [381] "Lincoln Ave & Belmont Ave"
## [382] "Damen Ave & Wellington Ave"
## [383] "Albany Ave & Bloomingdale Ave"
## [384] "Larrabee St & North Ave"
## [385] "Avers Ave & Belmont Ave"
## [386] "Wentworth Ave & Cermak Rd (Temp)"
## [387] "Lake Park Ave & 47th St"
## [388] "Glenwood Ave & Morse Ave"
## [389] "Western Ave & Leland Ave"
## [390] "Greenwood Ave & 47th St"
## [391] "Paulina St & Howard St"
## [392] "Damen Ave & Leland Ave"
## [393] "Greenview Ave & Diversey Pkwy"
## [394] "Normal Ave & Archer Ave"
## [395] "Sangamon St & Washington Blvd"
## [396] "Jefferson St & Monroe St"
## [397] "Orleans St & Hubbard St"
## [398] "Leavitt St & Lawrence Ave"
## [399] "Talman Ave & Addison St"
## [400] "Latrobe Ave & Chicago Ave"
## [401] "Warren Park West"
## [402] "Racine Ave & Congress Pkwy"
## [403] "Rockwell St & Eastwood Ave"
## [404] "Western Ave & Monroe St"
## [405] "Wabash Ave & 9th St"
## [406] "State St & 35th St"
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## [407] "Western Ave & Winnebago Ave"
## [408] "Ellis Ave & 55th St"
## [409] "Racine Ave & Washington Blvd (*)"
## [410] "Cottage Grove Ave & 43rd St"
## [411] "Halsted St & 63rd St"
## [412] "Maplewood Ave & Peterson Ave"
## [413] "Fort Dearborn Dr & 31st St"
## [414] "Canal St & Harrison St"
## [415] "Halsted St & 47th Pl"
## [416] "Honore St & Division St"
## [417] "Franklin St & Adams St (Temp)"
## [418] "Lincoln Ave & Belle Plaine Ave"
## [419] "Clinton St & Tilden St"
## [420] "Racine Ave & Wrightwood Ave"
## [421] "Wabash Ave & Wacker Pl"
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## [423] "Chicago Ave & Dempster St"
## [424] "Clark St & Elmdale Ave"
## [425] "2112 W Peterson Ave"
## [426] "LaSalle St & Adams St"
## [427] "Western Ave & Lunt Ave"
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## [429] "Wood St & Hubbard St"
## [430] "Drake Ave & Addison St"
## [431] "Canal St & Taylor St"
## [432] "Delano Ct & Roosevelt Rd"
## [433] "Stave St & Armitage Ave"
## [434] "Paulina St & Montrose Ave"
## [435] "Cornell Ave & Hyde Park Blvd"
## [436] "Bosworth Ave & Howard St"
## [437] "Millard Ave & 26th St"
## [438] "Prairie Ave & Garfield Blvd"
## [439] "Pulaski Rd & Eddy St (Temp)"
## [440] "Elston Ave & Wabansia Ave"
## [441] "Damen Ave & Thomas St (Augusta Blvd)"
## [442] "Wentworth Ave & 63rd St"
## [443] "Campbell Ave & Montrose Ave"
## [444] "Smith Park (*)"
## [445] "State St & Pershing Rd"
## [446] "Central Park Ave & 24th St"
## [447] "Woodlawn Ave & Lake Park Ave"
## [448] "Ashland Ave & Augusta Blvd"
## [449] "Sheridan Rd & Greenleaf Ave"
## [450] "Keystone Ave & Montrose Ave"
## [451] "Cicero Ave & Quincy St"
## [452] "Cherry Ave & Blackhawk St"
## [453] "McCormick Place"
## [454] "Campbell Ave & Fullerton Ave"
## [455] "State St & Van Buren St"
## [456] "Western Ave & Fillmore St (*)"
## [457] "Phillips Ave & 79th St"
## [458] "Wentworth Ave & 24th St (Temp)"
## [459] "Indiana Ave & 31st St"
## [460] "Hoyne Ave & 47th St"
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## [461] "Ashland Ave & Lake St"
## [462] "Morgan St & Polk St"
## [463] "Wentworth Ave & 35th St"
## [464] "Claremont Ave & Hirsch St"
## [465] "Ashland Ave & McDowell Ave"
## [466] "Lake Park Ave & 35th St"
## [467] "Valli Produce - Evanston Plaza"
## [468] "Budlong Woods Library"
## [469] "Racine Ave & Garfield Blvd"
## [470] "Jeffery Blvd & 71st St"
## [471] "Halsted St & North Branch St"
## [472] "Ashland Ave & Garfield Blvd"
## [473] "Seeley Ave & Garfield Blvd"
## [474] "Manor Ave & Leland Ave"
## [475] "Clinton St & 18th St"
## [476] "Kildare Ave & Montrose Ave"
## [477] "Stony Island Ave & 64th St"
## [478] "Central Park Ave & Ogden Ave"
## [479] "Evans Ave & 75th St"
## [480] "MLK Jr Dr & 83rd St"
## [481] "Jeffery Blvd & 67th St"
## [482] "Halsted St & 59th St"
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## [489] "Emerald Ave & 28th St"
## [490] "Morgan St & Pershing Rd"
## [491] "Shedd Aquarium"
## [492] "Ashland Ave & Pershing Rd"
## [493] "Racine Ave & 13th St"
## [494] "Financial Pl & Ida B Wells Dr"
## [495] "Malcolm X College"
## [496] "Stony Island Ave & 82nd St"
## [497] "Keystone Ave & Fullerton Ave"
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## [506] "Ridge Blvd & Howard St"
## [507] "Princeton Ave & 47th St"
## [508] "Indiana Ave & 40th St"
## [509] "Union Ave & Root St"
## [510] "Winchester Ave & Elston Ave"
## [511] "Central Ave & Harrison St"
## [512] "MLK Jr Dr & 47th St"
## [513] "Halsted St & Roosevelt Rd"
## [514] "Halsted St & 56th St"
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## [515] "Dorchester Ave & 63rd St"
## [516] "Canal St & Jackson Blvd"
## [517] "Albany Ave & 26th St"
## [518] "Austin Blvd & Madison St"
## [519] "DuSable Museum"
## [520] "Leavitt St & Belmont Ave (*)"
## [521] "Yates Blvd & 75th St"
## [522] "Central St Metra"
## [523] "Central St & Girard Ave"
## [524] "Stony Island Ave & 71st St"
## [525] "Damen Ave & Walnut (Lake) St (*)"
## [526] "Cottage Grove Ave & 71st St"
## [527] "Avondale Ave & Irving Park Rd"
## [528] "Calumet Ave & 71st St"
## [529] "Bernard St & Elston Ave"
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## [551] "Kedzie Ave & 21st St"
## [552] "South Chicago Ave & 83rd St"
## [553] "Central Park Ave & Bloomingdale Ave"
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## [555] "Clinton St & Polk St"
## [556] "Drake Ave & Montrose Ave"
## [557] "Stony Island Ave & 75th St"
## [558] "Damen Ave & 59th St"
## [559] "Jeffery Blvd & 76th St"
## [560] "Marshfield Ave & 44th St"
## [561] "University Library (NU)"
## [562] "Laramie Ave & Madison St"
## [563] "Kedzie Ave & Roosevelt Rd"
## [564] "Princeton Ave & Garfield Blvd"
## [565] "Woodlawn Ave & 75th St"
## [566] "Stony Island Ave & South Chicago Ave"
## [567] "State St & 76th St"
## [568] "Eggleston Ave & 69th St (*)"
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## [569] "Kostner Ave & Adams St"
## [570] "Vernon Ave & 79th St"
## [571] "Damen Ave & 51st St"
## [572] "Stony Island Ave & 67th St"
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## [575] "Eberhart Ave & 61st St"
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## [578] "Pulaski Rd & Congress Pkwy"
## [579] "Perry Ave & 69th St"
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## [581] "Central Ave & Lake St"
## [582] "Karlov Ave & Madison St"
## [583] "Central Ave & Chicago Ave"
## [584] "Throop St & 52nd St"
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## [592] "Cicero Ave & Flournoy St"
## [593] "Rhodes Ave & 71st St"
## [594] "Phillips Ave & 83rd St"
## [595] "Vincennes Ave & 75th St"
## [596] "Elizabeth St & 59th St"
## [597] "Greenwood Ave & 79th St"
## [598] "Rainbow Beach"
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## [600] "Halsted St & 69th St"
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## [603] "Montrose Harbor"
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## [605] "Marshfield Ave & 59th St"
## [606] "Burnham Harbor"
## [607] "Elizabeth St & 47th St"
## [608] "Lakefront Trail & Wilson Ave"
## [609] "Kenton Ave & Madison St"
## [610] "Stewart Ave & 63rd St (*)"
## [611] "Bennett Ave & 79th St"
## [612] "Shields Ave & 43rd St"
## [613] "Wentworth Ave & Cermak Rd"
## [614] "Leavitt St & Belmont Ave"
## [615] "Western Ave & Fillmore St"
## [616] "Wood St & Chicago Ave"
## [617] "Stewart Ave & 63rd St"
## [618] "Racine Ave & Washington Blvd"
## [619] "Eggleston Ave & 69th St"
## [620] "South Chicago Ave & Elliot Ave"
## [621] "Damen Ave & Walnut (Lake) St"
## [622] "Halsted St & 78th St"
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## [623] "Leavitt St & Division St"
## [624] "Smith Park"
## [625] "Ashland Ave & 78th St"
## [626] "Stewart Ave & 83rd St"
## [627] "Ashland Ave & 73rd St"
## [628] "Halsted St & 73rd St"
## [629] "hubbard_test_lws"
## [630] "WATSON TESTING - DIVVY"
## [631] "Eberhart Ave & 91st St"
## [632] "Marquette Ave & 89th St"
## [633] "Loomis Blvd & 84th St"
## [634] "W Oakdale Ave & N Broadway"
## [635] "Dauphin Ave & 103rd St"
## [636] "Elizabeth St & 92nd St"
## [637] "Houston Ave & 92nd St"
## [638] "Oglesby Ave & 100th St"
## [639] "W Armitage Ave & N Sheffield Ave"
## [640] "Prospect Sq & 91st St"
## [641] "Indiana Ave & 103rd St"
## [642] "Summit Ave & 86th St"
## [643] "State St & 95th St"
## [644] "Baltimore Ave & 87th St"
## [645] "East End Ave & 87th St"
## [646] "Halsted St & 96th St"
## [647] "Cottage Grove Ave & 111th Pl"
## [648] "Ashland Ave & 74th St"
## [649] "Wentworth Ave & 104th St"
## [650] "Burling St & Diversey Pkwy"
## [651] "Eggleston Ave & 92nd St"
## [652] "Michigan Ave & 114th St"
## [653] "Big Marsh Park"
## [654] "State St & 123rd St"
## [655] "Dauphin Ave & 87th St"
## [656] "Jeffery Blvd & 91st St"
## [657] "Halsted St & 111th St"
## [658] "Major Taylor Trail & 115th St"
## [659] "Greenwood Ave & 91st St"
## [660] "Stony Island Ave & 90th St"
## [661] "Throop St & Taylor St"
## [662] "Halsted St & 104th St"
## [663] "Ewing Ave & Burnham Greenway"
## [664] "Wood St & Taylor St (Temp)"
## [665] "Greenwood Ave & 97th St"
## [666] "Constance Ave & 95th St"
## [667] "Torrence Ave & 106th St"
## [668] "Avenue O & 134th St"
## [669] "Vernon Ave & 107th St"
## [670] "Burnham Greenway & 105th St"
## [671] "Walden Pkwy & 100th St"
## [672] "Clyde Ave & 87th St"
## [673] "Eberhart Ave & 131st St"
## [674] "St. Louis Ave & Fullerton Ave"
## [675] "Major Taylor Trail & 124th St"
## [676] "Avenue O & 118th St"
```

```
## [677] "Homewood Ave & 115th St"
## [678] "Bradley Park"
## [679] "Western Ave & 111th St"
## [680] "New St & Illinois St"
## [681] "Commercial Ave & 130th St"
## [682] "Hale Ave & 107th St"
## [683] "Lawndale Ave & 111th St"
## [684] "Ada St & 113th St"
## [685] "Vincennes Ave & 104th St"
## [686] "Western Ave & 104th St"
## [687] "Torrence Ave & 126th Pl"
## [688] "Hegewisch Metra Station"
## [689] "Base - 2132 W Hubbard Warehouse"
## [690] "N Green St & W Lake St"
## [691] "W Washington Blvd & N Peoria St"
## [692] "N Carpenter St & W Lake St"
## [693] "Dodge Ave & Main St"
## [694] "Broadway & Wilson - Truman College Vaccination Site"
## [695] "Western & 28th - Velasquez Institute Vaccination Site"
## [696] "Avenue L & 114th St"
## [697] "Malcolm X College Vaccination Site"
## [698] "N Sheffield Ave & W Wellington Ave"
## [699] "N Paulina St & Lincoln Ave"
## [700] "N Damen Ave & W Wabansia St"
## [701] "N Southport Ave & W Newport Ave"
## [702] "N Hampden Ct & W Diversey Ave"
## [703] "Damen Ave & Wabansia Ave"
## [704] "Chicago State University"
## [705] "Kedzie Ave & 110th St"
## [706] "Halsted & 63rd - Kennedy-King Vaccination Site"
## [707] "S Wentworth Ave & W 111th St"
```

It is apparent that there are negative ride lengths and that some company "test" sites which should be removed

```
all_trips_v4 <- all_trips_v3[all_trips_v3$ride_length_minutes > 0,]

all_trips_v5 <- all_trips_v4[!((all_trips_v4$start_station_name %like% "TEST" | all_trips_v4$start_stati
```

Conduct some descriptive analysis by customer type

```
all_trips_grouped_summary <- all_trips_v5 %>%
  group_by(customer_type) %>%
  summarize(number_of_rides = n(),
            total_minutes = sum(ride_length_minutes),
            min_ride_length = min(ride_length_minutes),
            max_ride_length = max(ride_length_minutes),
            mean_ride_length = mean(ride_length_minutes),
            median_ride_length = median(ride_length_minutes)) %>%
  mutate(percentage_of_rides = prop.table(number_of_rides) * 100,
         percentage_of_ride_length = prop.table(total_minutes) * 100)
```

```
View(all_trips_grouped_summary)
```

Explore the distribution of rides based on customer_type and days_of_week

```
days_of_week_distribution  <- all_trips_v5 %>%
  group_by(customer_type, day_of_week) %>%
  summarize(number_of_rides = n(),
            mean_ride_length = mean(ride_length_minutes),
            median_ride_length = median(ride_length_minutes))
```

```
## `summarise()` has grouped output by 'customer_type'. You can override using the `.groups` argument.
```

```
View(days_of_week_distribution)
```

Check to see the trip distribution by ride_type

```
ride_type_summary <- all_trips_v5 %>%
  group_by(ride_type) %>%
  summarise(number_of_rides = n()) %>%
  mutate(percentage_of_rides = prop.table(number_of_rides) * 100)

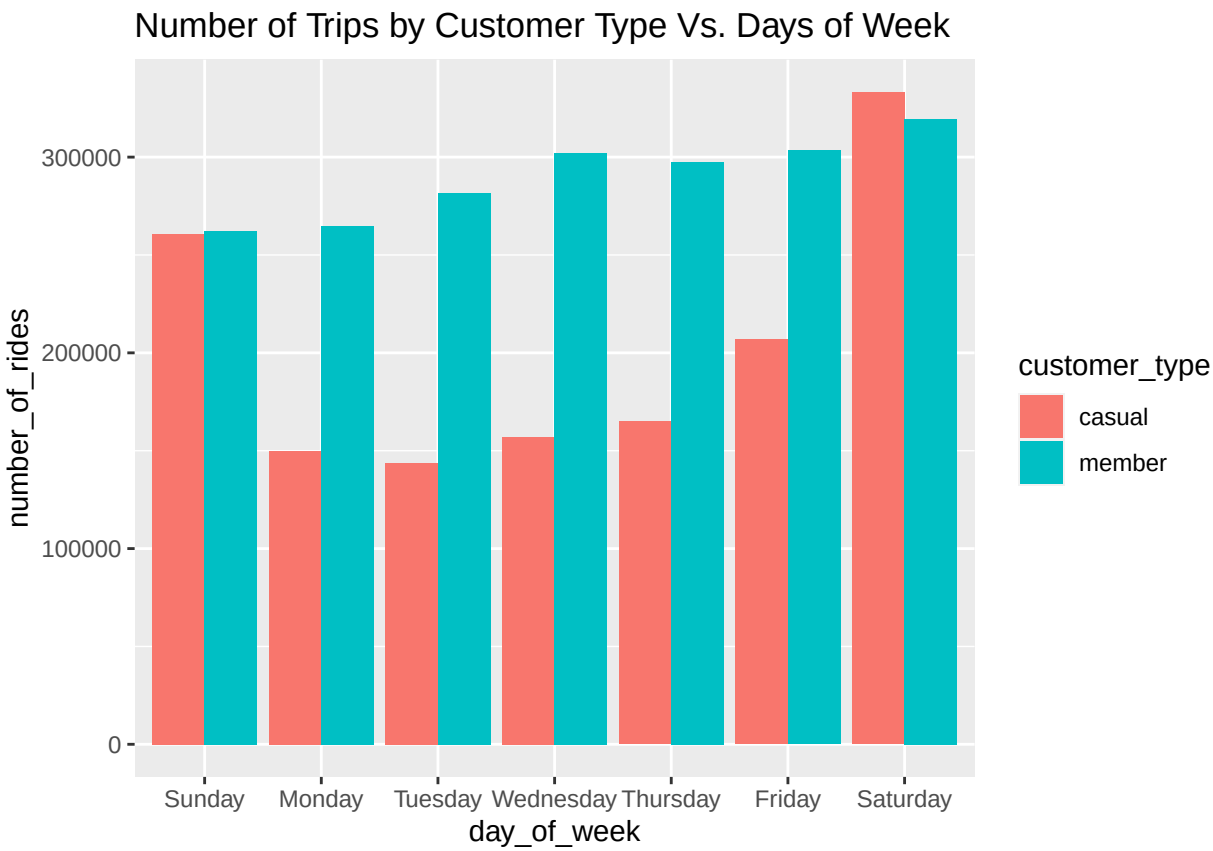
View(ride_type_summary)
```

Data visualization

Visualize number of trips by customer type vs different days of the week

```
all_trips_v5 %>%
  group_by(customer_type, day_of_week) %>%
  summarise(number_of_rides = n()) %>%
  arrange(customer_type, day_of_week) %>%
  ggplot(aes(x = day_of_week, y = number_of_rides, fill = customer_type))  +
  labs(title = "Number of Trips by Customer Type Vs. Days of Week") +
  scale_y_continuous(labels = function(x) format(x, scientific = FALSE)) +
  geom_col(position = "dodge")
```

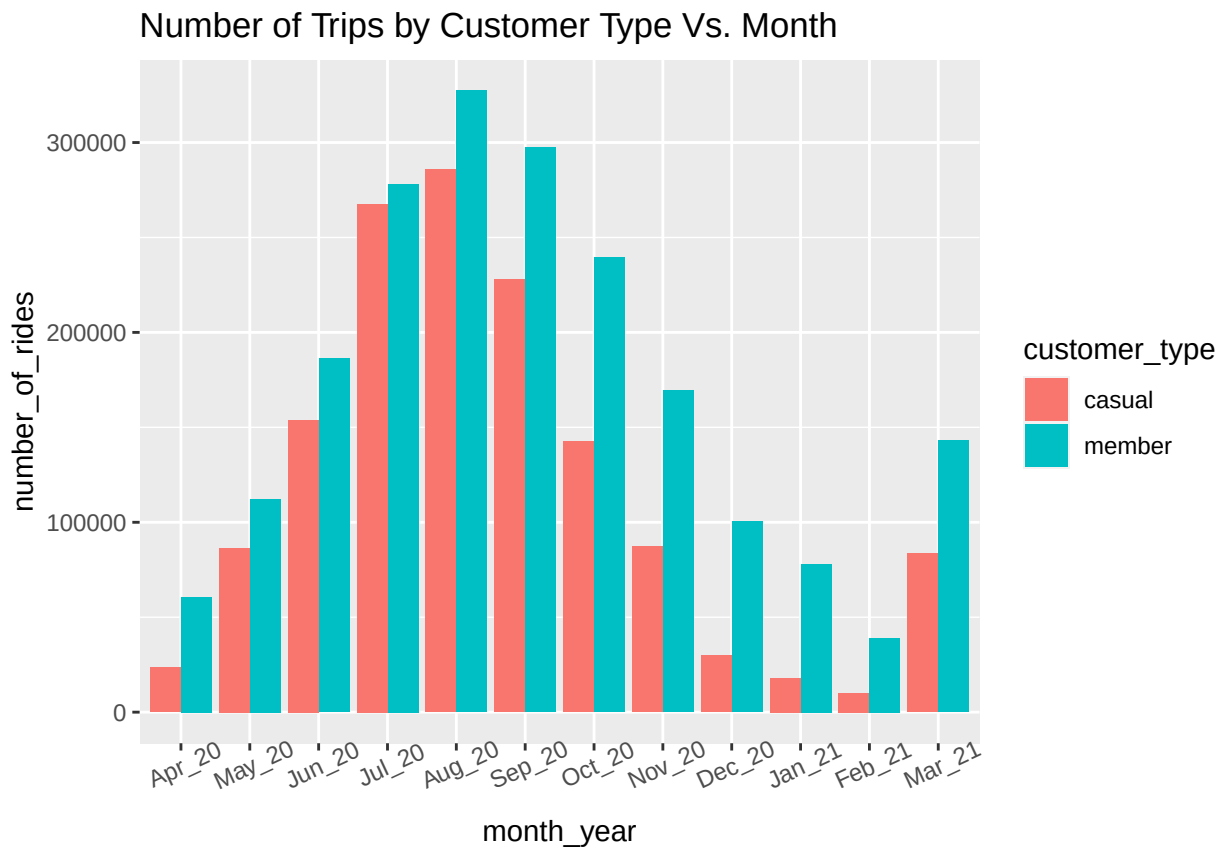
```
## `summarise()` has grouped output by 'customer_type'. You can override using the `.groups` argument.
```



Visualize number of trips by customer type vs. month

```
all_trips_v5 %>%
  group_by(customer_type, month_year) %>%
  summarise(number_of_rides = n()) %>%
  arrange(customer_type, month_year) %>%
  ggplot(aes(x = month_year, y = number_of_rides, fill = customer_type))  +
  labs(title = "Number of Trips by Customer Type Vs. Month") +
  scale_y_continuous(labels = function(x) format(x, scientific = FALSE)) +
  geom_col(position = "dodge") +
  theme(axis.text.x = element_text(angle = 25))
```

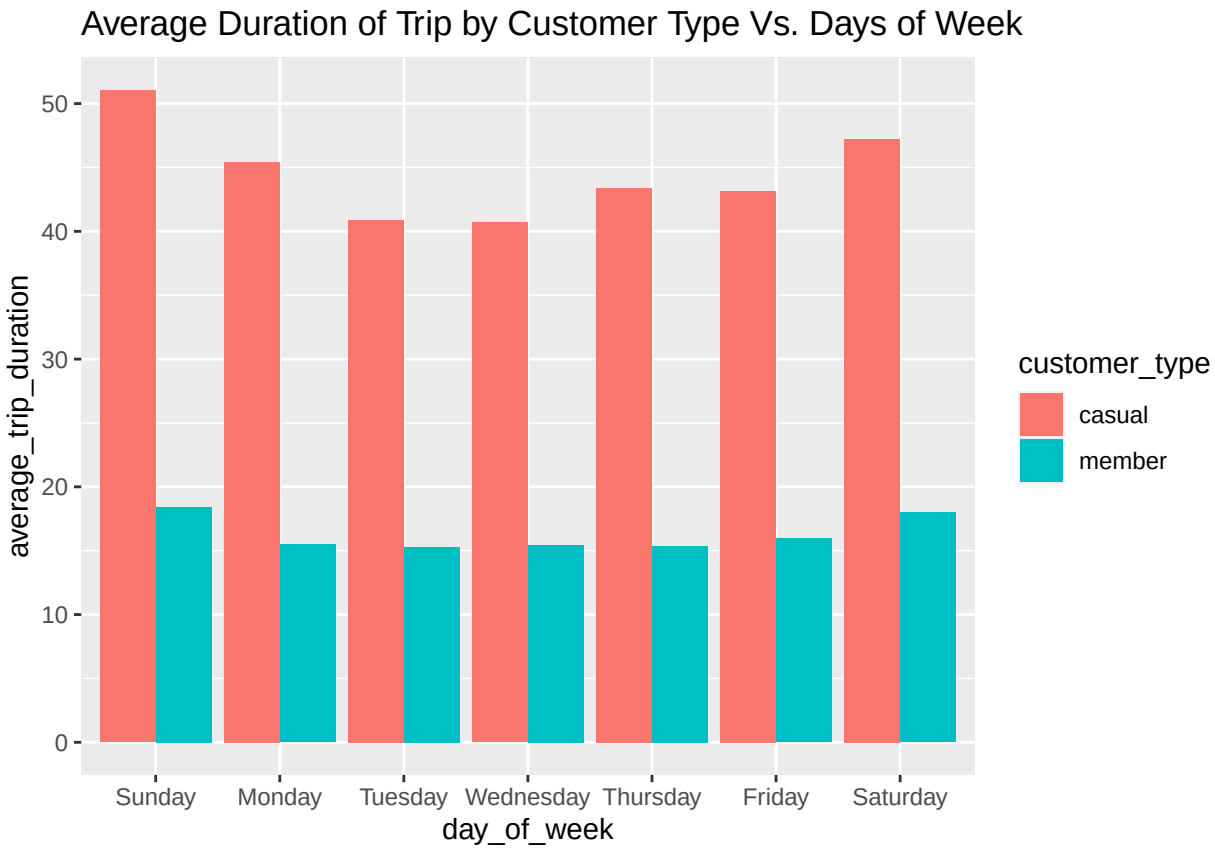
```
## `summarise()` has grouped output by 'customer_type'. You can override using the `.groups` argument.
```



Visualize average trip time by customer type vs days of the week

```
all_trips_v5 %>%
  group_by(customer_type, day_of_week) %>%
  summarise(average_trip_duration = mean(ride_length_minutes)) %>%
  arrange(customer_type, day_of_week) %>%
  ggplot(aes(x = day_of_week, y = average_trip_duration, fill = customer_type))  +
  labs(title = "Average Duration of Trip by Customer Type Vs. Days of Week") +
  geom_col(position = "dodge")
```

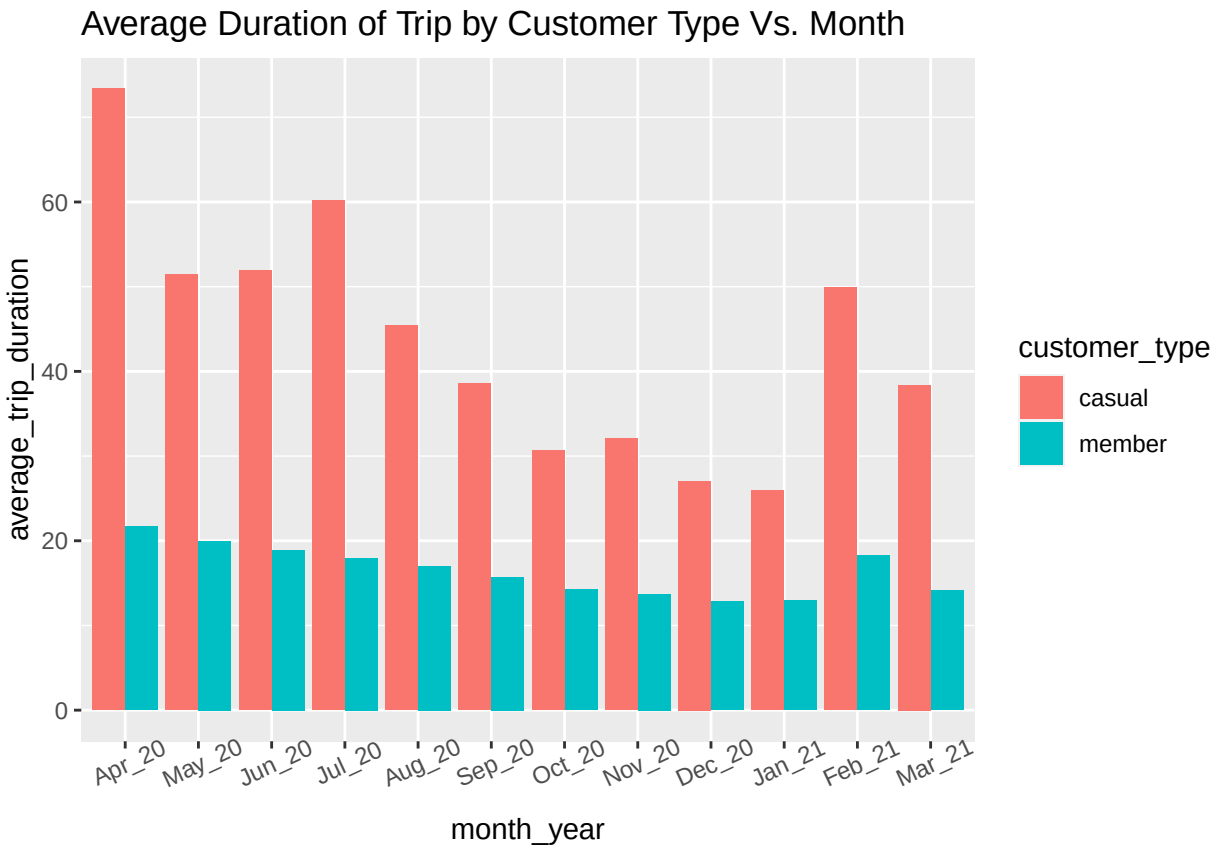
```
## `summarise()` has grouped output by 'customer_type'. You can override using the `.groups` argument.
```



Visualize average trip time by customer type vs month

```
all_trips_v5 %>%
  group_by(customer_type, month_year) %>%
  summarise(average_trip_duration = mean(ride_length_minutes)) %>%
  arrange(customer_type, month_year) %>%
  ggplot(aes(x = month_year, y  = average_trip_duration, fill = customer_type))  +
  labs(title = "Average Duration of Trip by Customer Type Vs. Month") +
  geom_col(position = "dodge") +
  theme(axis.text.x = element_text(angle = 25))
```

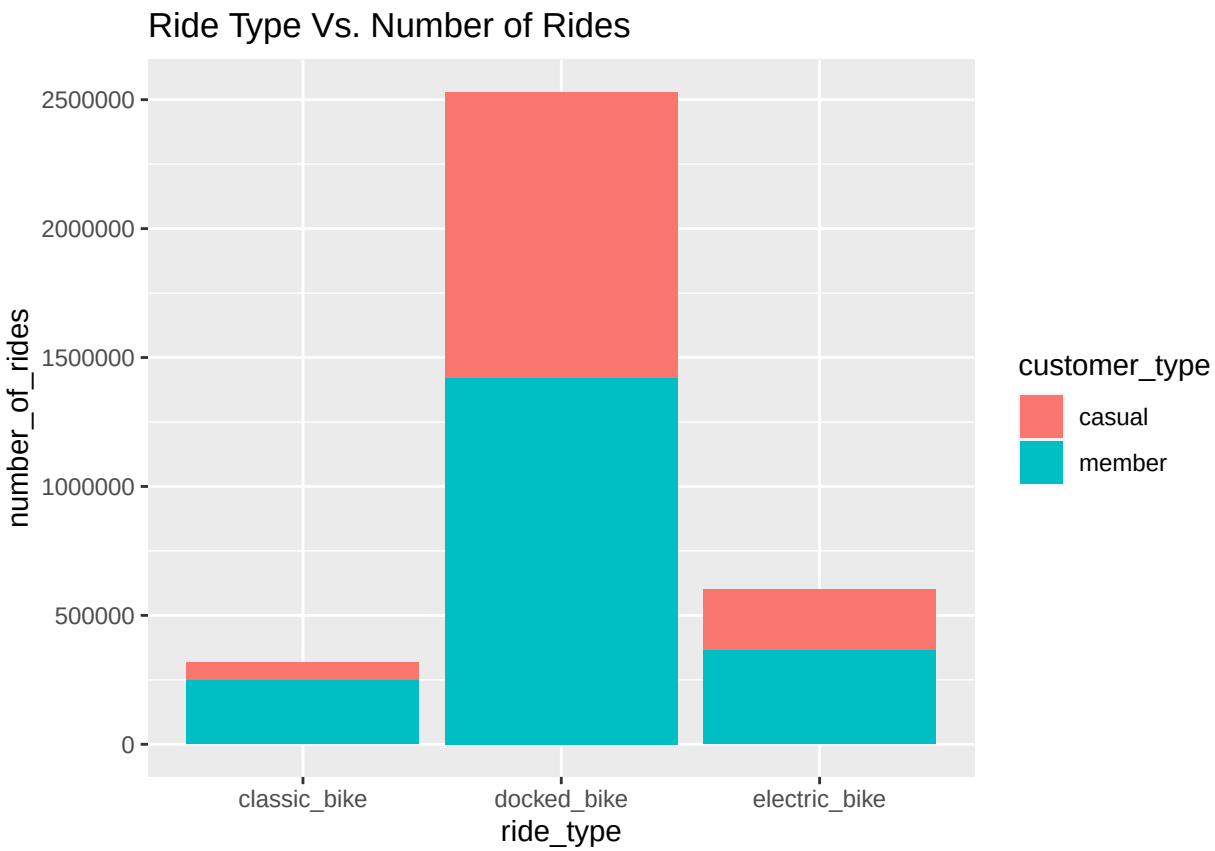
```
## `summarise()` has grouped output by 'customer_type'. You can override using the `.groups` argument.
```



Visualize the number of rides by ride type

```
all_trips_v5 %>%
  group_by(ride_type, customer_type) %>%
  summarise(number_of_rides = n()) %>%
  ggplot(aes(x = ride_type, y = number_of_rides, fill = customer_type))  +
  geom_bar(stat = "identity") +
  labs(title = "Ride Type Vs. Number of Rides")
```

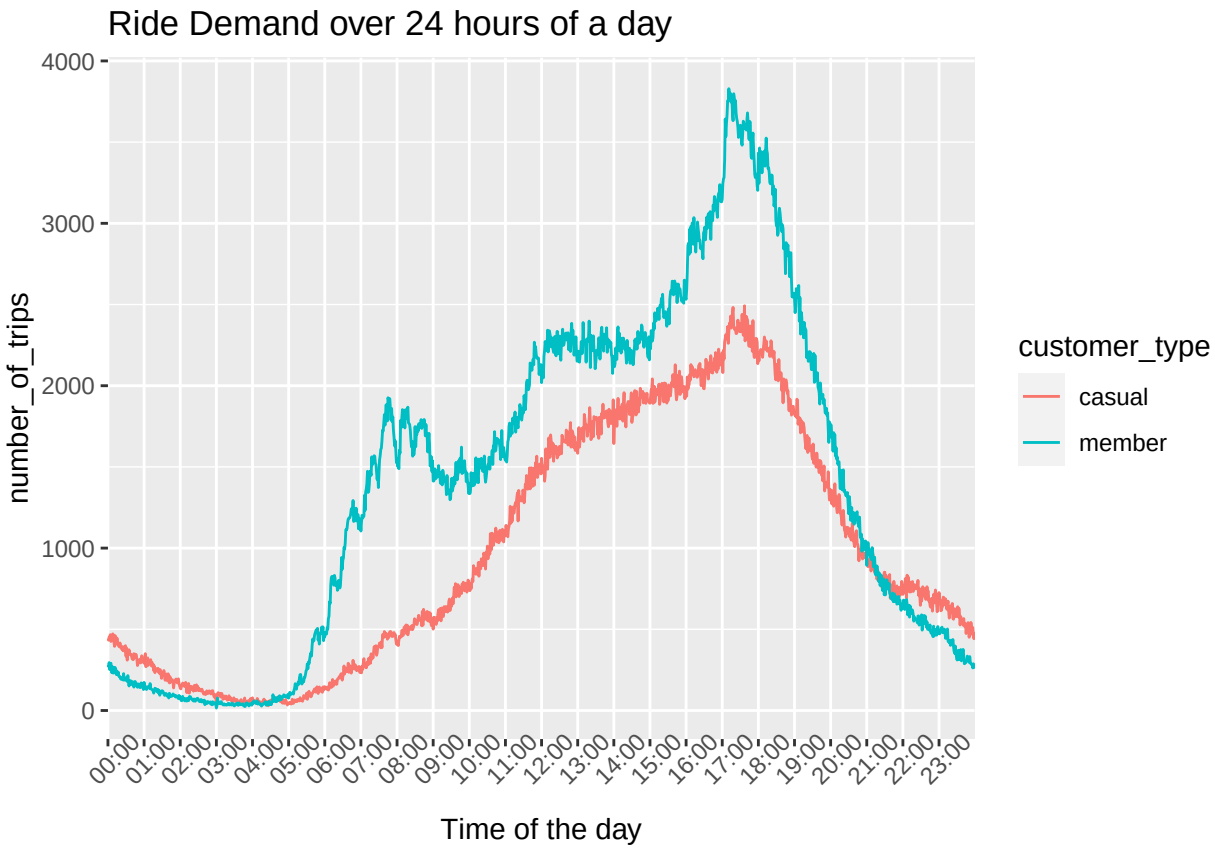
```
## `summarise()` has grouped output by 'ride_type'. You can override using the `.groups` argument.
```



Visualize ride demand over the time of day

```
all_trips_v5 %>%
  group_by(customer_type, time) %>%
  summarise(number_of_trips = n()) %>%
  ggplot(aes(x = time, y = number_of_trips, color = customer_type, group = customer_type)) +
  geom_line() +
  scale_x_datetime(date_breaks = "1 hour", minor_breaks = NULL,
                   date_labels = "%H:%M", expand = c(0,0)) +
  theme(axis.text.x = element_text(angle = 45)) +
  labs(title ="Ride Demand over 24 hours of a day", x = "Time of the day")
```

```
## `summarise()` has grouped output by 'customer_type'. You can override using the `.groups` argument.
```



Key takeaways

- Overall, member riders made up approximately 59% of the total number of rides and casual riders made up the remaining 41% of rides taken between April 2020 and March 2021.
- Although member riders accounted for a greater number of rides, casual riders took significantly longer rides on average. Casual riders accounted for approximately 66% of the total trip duration compared to member riders who accounted for 34% of total trip duration. In addition, casual riders had a mean ride length of 45 minutes and a median ride length of 21 minutes compared to member riders who had a mean ride length of 16 minutes and a median ride length of 12 minutes.
- Member riders seem to take rides fairly consistently throughout each day of the week while casual riders utilize the bike share service more often on weekends.
- Not surprisingly, the number of rides for both member and casual riders is higher in warmer months (June, July, August, September, October) compared to the colder months (November, December, January, February).
- The average trip duration for casual riders is typically twice as long as member riders no matter what the day of the week is.
- Member riders had a similar ride duration no matter what month it was while casual riders took longer rides on average in February, April, May, June, July and August.
- While customers have the option of using a classic bike, docked bike or electric bike, the overwhelming majority of rides (73%) are taken on a docked bike.

- Member ridership seems to be significant around 7am-9am and 5pm-7pm, seemingly tying into people arriving and leaving work. Casual ridership increases throughout the day and peaks around 5pm-6pm.

Without knowledge of the current pricing between single-rides, day passes and annual memberships it is dificult to propose an optomized cost structure. However, some general recomendations can be made:

- Casual riders use the bike share service more often on the weekends and in the afternoon. Offering casual riders discounts between Monday-Friday may increase ridership on those days. In addition, offering early bird specials or discounts in off-peak hours may also increase casual ridership.
- Offering casual riders a discounted annual membership may incentivize casual riders to make the switch over to becoming members.
- Also, it may be beneficial to transition the single-ride pass and day pass structure to a pay-per-minute or similar time sensitive pricing strategy since casual riders take significantly longer rides than member riders.