Homework 1

Submission 1, Spring 2026

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```
options(repos = c(CRAN = "https://cloud.r-project.org"))

if (!require("pacman")) install.packages("pacman")
```

```
Loading required package: pacman
```

```
pacman::p_load(tidyverse, ggplot2, dplyr, lubridate, stringr, readxl, data.table, gdata, scal

source("..//functions-1.R")
```

```
data.2014 <- read.csv('../data/output/data-2014.csv')
data.2015 <- read.csv('../data/output/data-2015.csv')
data.2016 <- read.csv('../data/output/data-2016.csv')
data.2017 <- read.csv('../data/output/data-2017.csv')
data.2018 <- read.csv('../data/output/data-2018.csv')
data.2019 <- read.csv('../data/output/data-2019.csv')
```

```
data.full <- rbind(data.2014, data.2015, data.2016, data.2017, data.2018, data.2019)

glimpse(data.full)
```

```
Rows: 449,046
Columns: 61
$ contractid          <chr> "H0022", "H0022", "H0022", "H0022", "H0022", "H002~
$ planid              <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 3, 4,~
$ fips                <int> 39023, 39035, 39051, 39055, 39057, 39085, 39093, 3~
$ year.x              <int> 2014, 2014, 2014, 2014, 2014, 2014, 2014, 2014, 20~
$ n_nonmiss           <int> 6, 8, 7, 0, 6, 8, 8, 7, 8, 6, 4, 7, 12, 12, 12, 12~
$ avg_enrollment      <dbl> 72.00000, 330.12500, 24.57143, NA, 120.83333, 41.5~
```

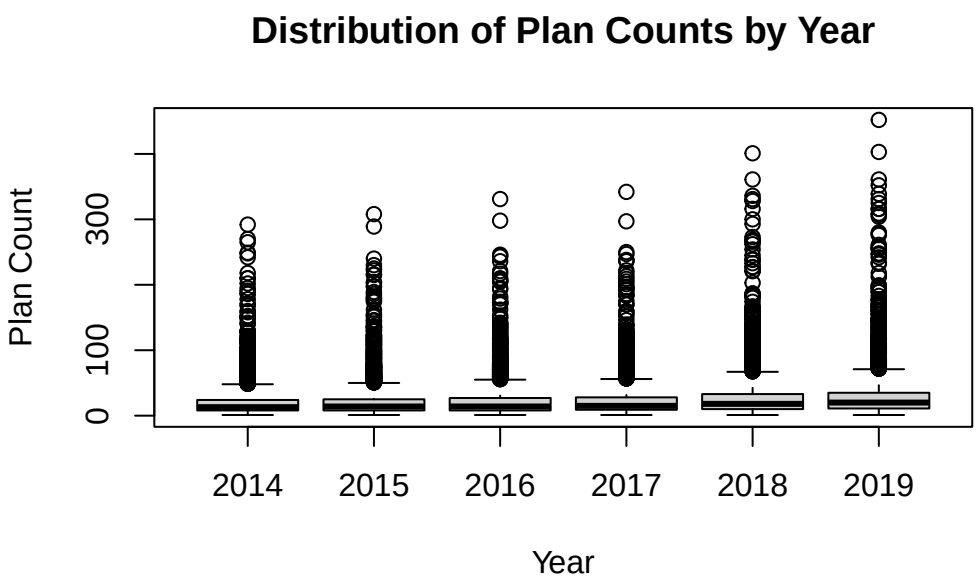
```
$ sd_enrollment       <dbl> 7.2111026, 10.6158574, 1.8126539, NA, 15.7659972, ~
$ min_enrollment      <int> 60, 309, 23, NA, 90, 39, 29, 299, 24, 431, 11, 71,~
$ max_enrollment      <int> 81, 344, 28, NA, 135, 44, 43, 440, 26, 713, 12, 85~
$ first_enrollment    <int> 60, 309, 24, NA, 90, 41, 29, 299, 24, 431, 11, 71,~
$ last_enrollment     <int> 81, 344, 24, NA, 135, 44, 43, 440, 24, 713, 12, 82~
$ state               <chr> "OH", "OH", "OH", "OH", "OH", "OH", "OH", "OH", "O~
$ county              <chr> "Clark", "Cuyahoga", "Fulton", "Geauga", "Greene",~
$ org_type            <chr> "Demo", "Demo", "Demo", "Demo", "Demo", "Demo", "D~
$ plan_type           <chr> "Medicare-Medicaid Plan HMO/HMOPOS", "Medicare-
Med~
$ partd               <chr> "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "~
$ snp                 <chr> "No", "No", "No", "No", "No", "No", "No", "No", "N~
$ eghp                <chr> "No", "No", "No", "No", "No", "No", "No", "No", "N~
$ org_name            <chr> "BUCKEYE COMMUNITY HEALTH PLAN, INC.", "BUCKEYE CO~
$ org_marketing_name  <chr> "Buckeye Health Plan - MyCare Ohio", "Buckeye Heal~
$ plan_name           <chr> "Buckeye Community Health Plan - MyCareOhio (Medic~
$ parent_org          <chr> "Centene Corporation", "Centene Corporation", "Cen~
$ contract_date       <chr> "05/01/2014 0:00:00", "05/01/2014 0:00:00", "05/01~
$ state_long          <chr> "ohio", "ohio", "ohio", "ohio", "ohio", "ohio", "o~
$ county_long         <chr> "Clark", "Cuyahoga", "Fulton", "Geauga", "Greene",~
$ year.y              <int> 2014, 2014, 2014, 2014, 2014, 2014, 2014, 2014, 20~
$ n_elig              <int> 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12~
$ n_enrol             <int> 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12~
$ avg_eligibles       <dbl> 28454.167, 239039.917, 7940.667, 17845.250, 27621.~
$ sd_eligibles        <dbl> 189.188138, 1269.732574, 90.744730, 190.812676, 24~
$ min_eligibles       <int> 28186, 237409, 7818, 17551, 27276, 46128, 56725, 7~
$ max_eligibles       <int> 28802, 241155, 8081, 18136, 28054, 47183, 58358, 7~
$ first_eligibles     <int> 28186, 237565, 7818, 17551, 27276, 46128, 56725, 7~
$ last_eligibles      <int> 28802, 241155, 8081, 18136, 28054, 47183, 58358, 7~
$ avg_enrolled        <dbl> 13405.2500, 92824.3333, 2445.5833, 6246.0000, 1050~
$ sd_enrolled         <dbl> 140.73064, 2245.45967, 56.73136, 187.22908, 138.86~
$ min_enrolled        <int> 13200, 88467, 2340, 5894, 10298, 17006, 17843, 284~
$ max_enrolled        <int> 13585, 94709, 2508, 6412, 10707, 18076, 19238, 302~
$ first_enrolled      <int> 13200, 88467, 2340, 5894, 10298, 17006, 17843, 284~
$ last_enrolled       <int> 13585, 94709, 2501, 6408, 10707, 18076, 19238, 302~
$ ssa                 <int> 36110, 36170, 36260, 36280, 36290, 36440, 36480, 3~
$ ncount              <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,~
$ state_name          <chr> "ohio", "ohio", "ohio", "ohio", "ohio", "ohio", "o~
$ premium             <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 16~
$ premium_partc       <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 1,~
$ premium_partd_basic <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 15~
$ premium_partd_supp  <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 0,~
$ premium_partd_total <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 15~
```

```
$ partd_deductible    <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 31~
$ year.x.x            <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 20~
$ riskscore_partc     <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 0.~
$ payment_partc       <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 68~
$ rebate_partc        <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 44~
$ year.y.y            <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 20~
$ payment_partd       <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 61~
$ directsubsidy_partd <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 35~
$ reinsurance_partd   <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 16~
$ costsharing_partd   <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 8.~
$ riskscore_partd     <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 0.~
$ basic_premium       <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 0,~
$ bid                 <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 82~
```

Problem 1

```
plan_counts <- data.full %>% group_by(fips) %>% count(county, year.x, name = "plan_count")
```

```
boxplot(plan_count ~ year.x, data = plan_counts,
        xlab = "Year",
        ylab = "Plan Count",
        main = "Distribution of Plan Counts by Year")
```

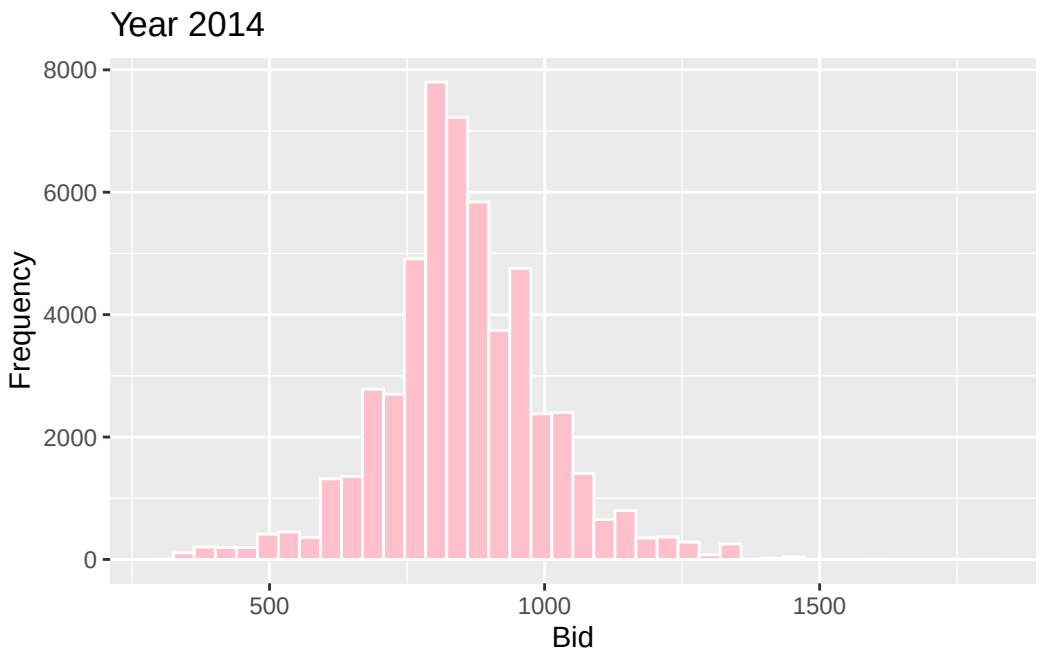


Problem 2

```r
data.full <- data.full %>% mutate (basic_premium = case_when(
        rebate_partc > 0 ~ 0,
        partd == "No" & !is.na(premium) & is.na(premium_partc) ~ premium,
        TRUE ~ premium_partc
      ),
      bid = case_when(
        rebate_partc == 0 & basic_premium > 0 ~ (payment_partc + basic_premium) / riskscore_p
        rebate_partc > 0  | basic_premium == 0 ~  payment_partc / riskscore_partc,
        TRUE ~ NA_real_
      )
    )
```

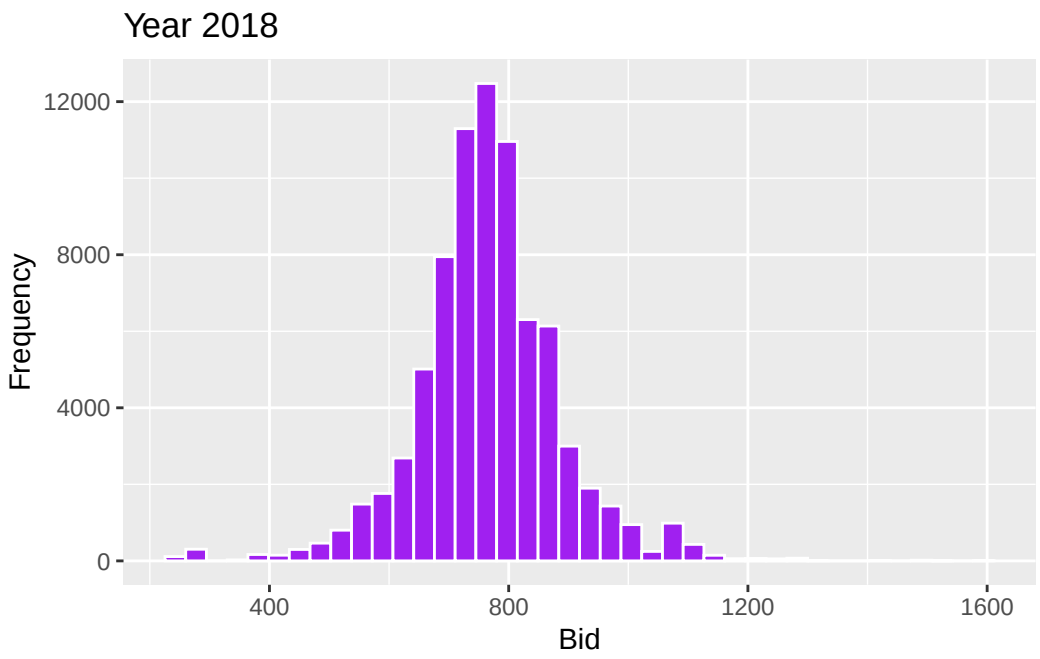
```r
data.full %>%
  filter(year.x == 2014) %>%
  ggplot(aes(x = bid)) +
  geom_histogram(bins = 40, fill = "pink", color = "white")+
  labs(
    x = "Bid",
    y = "Frequency",
    title = "Year 2014"
  )
```

```
Warning: Removed 8956 rows containing non-finite values (`stat_bin()`).
```



```
data.full %>%
  filter(year.x == 2018) %>%
  ggplot(aes(x = bid)) +
  geom_histogram(bins = 40, fill = "purple", color = "white")+
  labs(
    x = "Bid",
    y = "Frequency",
    title = "Year 2018"
  )
```

```
Warning: Removed 8094 rows containing non-finite values (`stat_bin()`).
```



Problem 3

```
hhi_data <- data.full %>%
  mutate(share = avg_enrollment / avg_enrolled) %>%
  group_by(fips, year.x) %>%
  summarise(HHI = sum(share^2, na.rm = TRUE), .groups = "drop") %>%
  group_by(year.x) %>%
  summarise(mean_HHI = mean(HHI, na.rm = TRUE), .groups = "drop")
```

```r
hhi_data
```

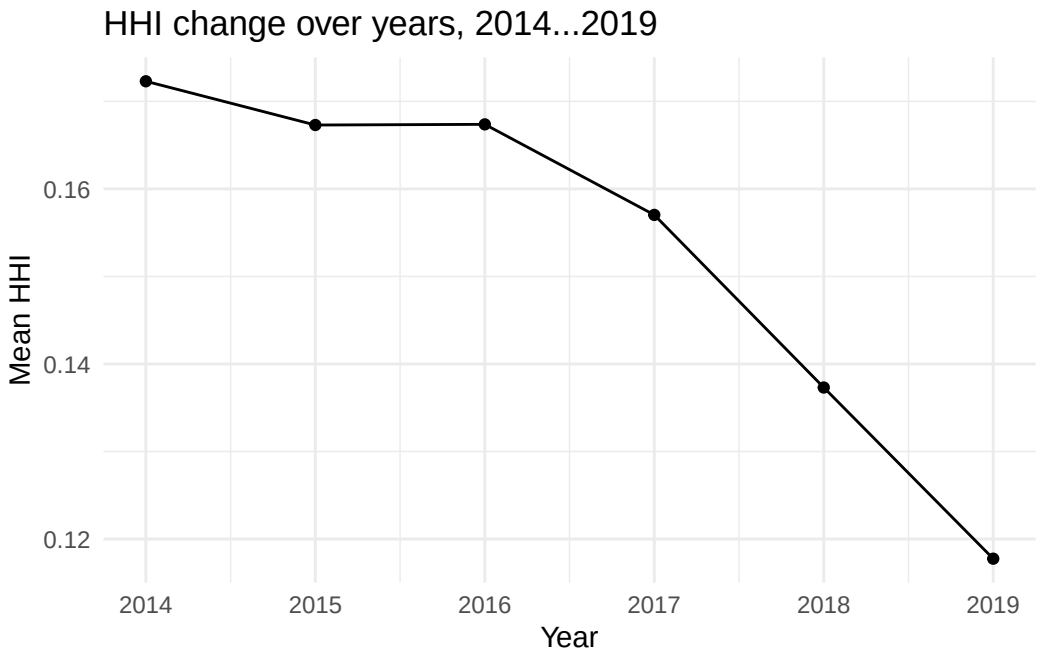
```
# A tibble: 6 x 2
  year.x mean_HHI
   <int>    <dbl>
1   2014    0.172
2   2015    0.167
3   2016    0.167
4   2017    0.157
5   2018    0.137
6   2019    0.118
```

```r
ggplot(hhi_data, aes(x = year.x, y = mean_HHI)) + geom_line() + geom_point() + theme_minimal
    x = "Year",
    y = "Mean HHI",
    title = "HHI change over years, 2014-2019"
  )
```

```
Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>
```

```
Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>
```

```
Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <e2>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <80>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'HHI change over years, 2014-2019' in 'mbcsToSbcs': dot
substituted for <93>
```



Problem 4

```
ma_share_yearly <- data.full %>%
  mutate(ma_share = avg_enrolled / avg_eligibles) %>%
  group_by(year.x) %>%
  summarise(mean_share = mean(ma_share, na.rm = TRUE), .groups = "drop")
```

```
ggplot(ma_share_yearly, aes(x = year.x, y = mean_share)) +
  geom_line() +
  geom_point() +
  theme_minimal() +
  labs(
    x = "Year",
    y = "Average MA Share",
    title = "Average Medicare Advantage Share, 2014-2019"
  )
```

```
Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>
```

```
Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
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conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>
```
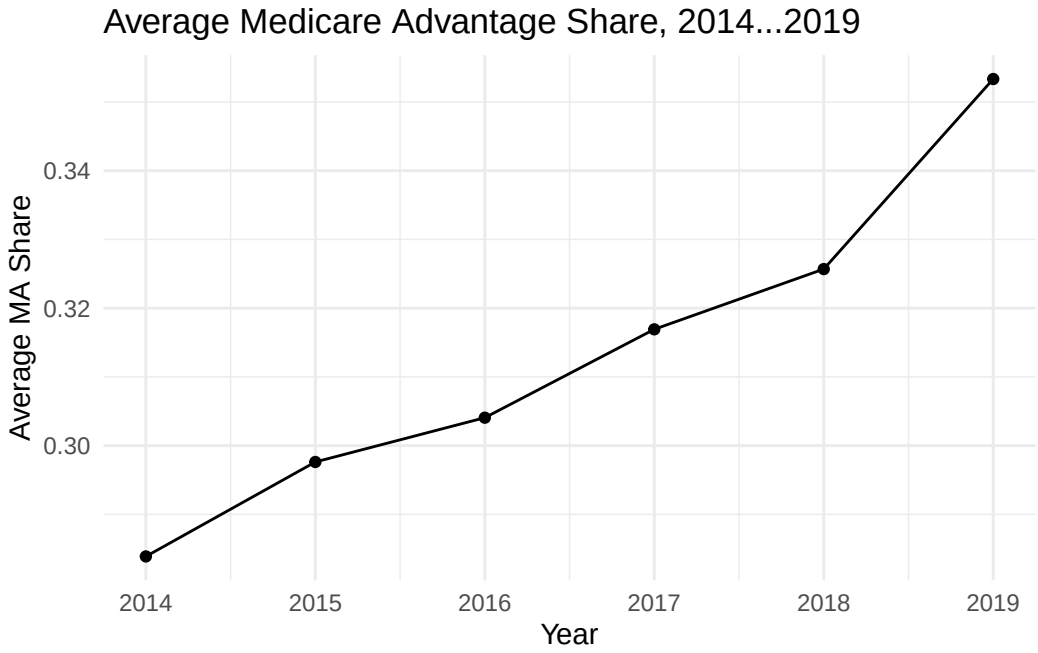

```
Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <e2>
```

```
Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <80>
```

```
Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on 'Average Medicare Advantage Share, 2014-2019' in
'mbcsToSbcs': dot substituted for <93>
```



Estimate ATEs

Problem 5

```
data.full.2018 <- data.full %>% filter(year.x == 2018)
```

```
colnames(data.full.2018)
```

```
 [1] "contractid"          "planid"              "fips"
 [4] "year.x"              "n_nonmiss"           "avg_enrollment"
 [7] "sd_enrollment"       "min_enrollment"      "max_enrollment"
[10] "first_enrollment"    "last_enrollment"     "state"
[13] "county"              "org_type"            "plan_type"
[16] "partd"               "snp"                 "eghp"
[19] "org_name"            "org_marketing_name"  "plan_name"
```

```
[22] "parent_org"          "contract_date"       "state_long"
[25] "county_long"         "year.y"              "n_elig"
[28] "n_enrol"             "avg_eligibles"       "sd_eligibles"
[31] "min_eligibles"       "max_eligibles"       "first_eligibles"
[34] "last_eligibles"      "avg_enrolled"        "sd_enrolled"
[37] "min_enrolled"        "max_enrolled"        "first_enrolled"
[40] "last_enrolled"       "ssa"                 "ncount"
[43] "state_name"          "premium"             "premium_partc"
[46] "premium_partd_basic" "premium_partd_supp"  "premium_partd_total"
[49] "partd_deductible"    "year.x.x"            "riskscore_partc"
[52] "payment_partc"       "rebate_partc"        "year.y.y"
[55] "payment_partd"       "directsubsidy_partd" "reinsurance_partd"
[58] "costsharing_partd"   "riskscore_partd"     "basic_premium"
[61] "bid"
```

```
hhi_data_2018 <- data.full.2018 %>%
  mutate(share = avg_enrollment / avg_enrolled) %>%
  group_by(fips, year.x) %>%
  mutate(HHI = sum(share^2, na.rm = TRUE)) %>%
  ungroup()
```

```
hhi_data_33 <- quantile(hhi_data_2018$HHI, 0.33, na.rm = TRUE)
hhi_data_66 <- quantile(hhi_data_2018$HHI, 0.66, na.rm = TRUE)
```

```
hhi_high <- hhi_data_2018 %>% filter(hhi_data_2018$HHI >= hhi_data_66)
hhi_low <- hhi_data_2018 %>% filter(hhi_data_2018$HHI <= hhi_data_33)
```

```
avg_high <- hhi_high %>% summarise(avg_66 = mean(bid, na.rm = TRUE))
avg_low <- hhi_low %>% summarise(avg_33 = mean(bid, na.rm = TRUE))

cat("Average Bid in Uncompetitive Markets:", avg_high$avg_66, "\n")
```

```
Average Bid in Uncompetitive Markets: 770.536
```

```
cat("Average Bid in Competitive Markets:", avg_low$avg_33, "\n")
```

```
Average Bid in Competitive Markets: 767.0241
```

Problem 6

```r
data.2018.ffs <- read.csv('../data/output/data-2018-ffs.csv')
```

```r
data.2018.ffs <- data.2018.ffs %>% mutate(ffs_quartile = ntile(avg_ffscost, 4))
```

```r
results <- lapply(1:4, function(q) {
  treatment <- data.2018.ffs %>%
    filter(ffs_quartile == q) %>%
    summarise(avg_bid_treat = mean(bid, na.rm = TRUE))

  control <- data.2018.ffs %>%
    filter(ffs_quartile != q) %>%
    summarise(avg_bid_control = mean(bid, na.rm = TRUE))

  data.frame(
    quartile = q,
    avg_bid_treat = treatment$avg_bid_treat,
    avg_bid_control = control$avg_bid_control
  )
})

results_table <- do.call(rbind, results)

print(results_table)
```

```
  quartile avg_bid_treat avg_bid_control
1        1      778.7275        761.3458
2        2      769.9289        764.2578
3        3      758.0963        768.2317
4        4      756.0814        768.8580
```

Problem 7

```r
options(repos = c(CRAN = "https://cloud.r-project.org"))
install.packages("Matching")
```

```r
ate_results <- lapply(1:4, function(q) {

dat_q <- data.2018.ffs %>%
    mutate(
      treat = ifelse(ffs_quartile == q, 1, 0),
```

```
      outcome = bid,
      covar = avg_ffscost
    )

dat_q <- dat_q %>%
  filter(!is.na(outcome), !is.na(treat), !is.na(covar))

nn <- Matching::Match(
    Y = dat_q$outcome,
    Tr = dat_q$treat,
    X = dat_q$covar,
    M = 1,
    Weight = 1,
    estimand = "ATE",
    ties=FALSE
  )

  data.frame(
    quartile = q,
    ATE = nn$est
  )
})

ate_table <- do.call(rbind, ate_results)

print(ate_table)
```

```
names(ate_table) <- c("quartile", "ate_inv_var")
saveRDS(ate_table, "ate_table_1.rds")
```

```
my_data <- readRDS("ate_table_1.rds")
knitr::kable(my_data)
```

quartile	ate_inv_var
1	-97.08781
2	14.60799
3	41.16648
4	-27.29791

```r
ate_results <- lapply(1:4, function(q) {

dat_q <- data.2018.ffs %>%
    mutate(
      treat = ifelse(ffs_quartile == q, 1, 0),
      outcome = bid,
      covar = avg_ffscost
    )

dat_q <- dat_q %>%
  filter(!is.na(outcome), !is.na(treat), !is.na(covar))

nn2 <- Matching::Match(
    Y = dat_q$outcome,
    Tr = dat_q$treat,
    X = dat_q$covar,
    M = 1,
    Weight = 2,
    estimand = "ATE",
    ties=FALSE
  )

  data.frame(
    quartile = q,
    ATE = nn2$est
  )
})

ate_table <- do.call(rbind, ate_results)

print(ate_table)
```

```r
names(ate_table) <- c("quartile", "ate_mahalanobis ")
saveRDS(ate_table, "ate_table_2.rds")
```

```r
my_data <- readRDS("ate_table_2.rds")
knitr::kable(my_data)
```

quartile	ate_mahalanobis
1	-96.95895

quartile	ate_mahalanobis
2	14.90622
3	41.28525
4	-27.85682

```
ate_results <- lapply(1:4, function(q) {

dat_q <- data.2018.ffs %>%
    mutate(
      treat = ifelse(ffs_quartile == q, 1, 0),
      outcome = bid,
      covar = avg_ffscost
    )

dat_q <- dat_q %>%
  filter(!is.na(outcome), !is.na(treat), !is.na(covar))

logit.model <- glm(treat ~ covar, family = binomial, data = dat_q)
dat_q$ps <- fitted(logit.model)

dat_q <- dat_q %>%
    mutate(ipw = case_when( treat == 1 ~ 1/ps, treat == 0 ~ 1/(1 - ps) ))

mean.w1 <- dat_q %>% filter(treat == 1) %>% summarize(mean_y = weighted.mean(outcome, ipw))

mean.w0 <- dat_q %>% filter(treat == 0) %>% summarize(mean_y = weighted.mean(outcome, ipw))

ate_ipw <- mean.w1$mean_y - mean.w0$mean_y

    data.frame(
    quartile = q,
    ATE = ate_ipw
  )

})

ate_table <- do.call(rbind, ate_results)

print(ate_table)
```

```r
names(ate_table) <- c("quartile", "ate_ipw")
saveRDS(ate_table, "ate_table_3.rds")
```

```r
my_data <- readRDS("ate_table_3.rds")
knitr::kable(my_data)
```

quartile	ate_ipw
1	17.255246
2	3.416613
3	-9.398434
4	-12.843000

```r
ate_results <- lapply(1:4, function(q) {

dat_q <- data.2018.ffs %>%
    mutate(
      treat = ifelse(ffs_quartile == q, 1, 0),
      outcome = bid,
      covar = avg_ffscost
    )

dat_q <- dat_q %>%
  filter(!is.na(outcome), !is.na(treat), !is.na(covar))

reg1.dat <- dat_q %>% filter(treat==1)
reg1 <- lm(outcome ~ covar, data=reg1.dat)

reg0.dat <- dat_q %>% filter(treat==0)
reg0 <- lm(outcome ~ covar, data=reg0.dat)

pred1 <- predict(reg1,new=dat_q)
pred0 <- predict(reg0,new=dat_q)

ate <- mean(pred1-pred0)

    data.frame(
    quartile = q,
    ATE = ate
  )
```

```
})

ate_table <- do.call(rbind, ate_results)

print(ate_table)
```

```
names(ate_table) <- c("quartile", "ate_simple_lr")
saveRDS(ate_table, "ate_table_4.rds")
```

```
my_data <- readRDS("ate_table_4.rds")
knitr::kable(my_data)
```

quartile	ate_simple_lr
1	-9.1913192
2	-0.1601797
3	-7.4778456
4	-3.3832612

Problem 8. ATE calculated with inverse variance distance and Mahalanobis distance are identical, while the ones calculated with IPW and simple linear regression differ vastly. IPW particularly says the algorithm didn't converge.

Problem 9. We will use my favorite simple linear regression on total Medicare beneficiaries alongside the FFS quartile.

```
ate_results <- lapply(1:4, function(q) {

  dat_q <- data.2018.ffs %>%
    mutate(
      treat = ifelse(ffs_quartile == q, 1, 0),
      outcome = bid,
      covar1 = avg_ffscost,
      covar2 = n_enrol
    ) %>%
    filter(!is.na(outcome), !is.na(covar1), !is.na(covar2))

  reg1 <- lm(outcome ~ covar1 + covar2, data = dat_q %>% filter(treat == 1))
  reg0 <- lm(outcome ~ covar1 + covar2, data = dat_q %>% filter(treat == 0))

  pred1 <- predict(reg1, newdata = dat_q)
```

```
  pred0 <- predict(reg0, newdata = dat_q)

  ate <- mean(pred1 - pred0)

  data.frame(
    quartile = q,
    ATE = ate
  )
})

ate_table <- do.call(rbind, ate_results)
print(ate_table)
```

```
names(ate_table) <- c("quartile", "ate_total_beneficiaries")
saveRDS(ate_table, "ate_table_5.rds")
```

```
my_data <- readRDS("ate_table_5.rds")
knitr::kable(my_data)
```

quartile	ate_total_beneficiaries
1	-9.4984154
2	-0.1257976
3	-7.3484978
4	-2.7936440

It still leads to comparable or identical result when regression was run without total number of Medicare beneficiaries as a covariate.

Problem 10

My experience was fulfilling working with these large data chunks; it really completed my prior experiences. One thing I learned is that my code runs much cleaner and is easier to navigate, as I built most of it from class notes, my concepts, and simple structural logic, rather than using LLMs that I genuinely use strictly for my personal use. One thing that surprised me was how strenuous data management could be when I had to change file names and column ranges while creating cumulative data files for each year, and generalizable RegEx expressions couldn't be deployed.