Census vs Study Diversity Indices

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Setup

Importing data

```
library(grid)
library(plyr)
library(dplyr)
```

```
##
## Attaching package: ’dplyr’
```

```
## The following objects are masked from ’package:plyr’:
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

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

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

```
library(ggplot2)
library(gridExtra)
```

```
## Warning: package ’gridExtra’ was built under R version 4.3.1
```

```
##
## Attaching package: ’gridExtra’
```

```
## The following object is masked from ’package:dplyr’:
##
##     combine
```

```r
df_COGS2 <- read.csv("C:\\Users\\danie\\Documents\\Joshi Lab Materials\\3 Studies Dataset\\Dataset Merg
df_COGS2 <- df_COGS2[df_COGS2$cStudy == "COGS2", ]
nrow(df_COGS2)
```

```
## [1] 2477
```

```r
head(df_COGS2)
```

```
##           X cStudy cAge cDiagnosis cEnrollmentDateYear cGender cRace
## 33535 34651  COGS2   25       CTRL          2010-07-07       M    AS
## 33536 34652  COGS2   43         SZ          2010-07-14       M    CA
## 33537 34653  COGS2   44       CTRL          2010-07-15       M    AA
## 33538 34654  COGS2   50         SZ          2010-07-16       M    CA
## 33539 34655  COGS2   49       CTRL          2010-07-19       M    CA
## 33540 34656  COGS2   43         SZ          2010-07-20       M    AA
##       cHispanicorLatino cLocationInstitution cLocationCity cLocationState
## 33535                No                 UCSD     San Diego             CA
## 33536               Yes                 UCSD     San Diego             CA
## 33537                No                 UCSD     San Diego             CA
## 33538                No                 UCSD     San Diego             CA
## 33539                No                 UCSD     San Diego             CA
## 33540                No                 UCSD     San Diego             CA
##       cLocationCounty cDiagnosis2 cDiagnosis3 cDiagnosis4
## 33535       San Diego          CS          CS          CS
## 33536       San Diego          SZ      SZSAFD      SZSAFD
## 33537       San Diego          CS          CS          CS
## 33538       San Diego          SZ      SZSAFD      SZSAFD
## 33539       San Diego          CS          CS          CS
## 33540       San Diego          SZ      SZSAFD      SZSAFD
```

```r
# adding year column
df_COGS2$cEnrollmentYear <- as.numeric(substr(df_COGS2$cEnrollmentDateYear,
    1, 4))
head(df_COGS2)
```

```
##           X cStudy cAge cDiagnosis cEnrollmentDateYear cGender cRace
## 33535 34651  COGS2   25       CTRL          2010-07-07       M    AS
## 33536 34652  COGS2   43         SZ          2010-07-14       M    CA
## 33537 34653  COGS2   44       CTRL          2010-07-15       M    AA
## 33538 34654  COGS2   50         SZ          2010-07-16       M    CA
## 33539 34655  COGS2   49       CTRL          2010-07-19       M    CA
## 33540 34656  COGS2   43         SZ          2010-07-20       M    AA
##       cHispanicorLatino cLocationInstitution cLocationCity cLocationState
## 33535                No                 UCSD     San Diego             CA
## 33536               Yes                 UCSD     San Diego             CA
## 33537                No                 UCSD     San Diego             CA
## 33538                No                 UCSD     San Diego             CA
## 33539                No                 UCSD     San Diego             CA
## 33540                No                 UCSD     San Diego             CA
##       cLocationCounty cDiagnosis2 cDiagnosis3 cDiagnosis4 cEnrollmentYear
## 33535       San Diego          CS          CS          CS            2010
## 33536       San Diego          SZ      SZSAFD      SZSAFD            2010
## 33537       San Diego          CS          CS          CS            2010
## 33538       San Diego          SZ      SZSAFD      SZSAFD            2010
## 33539       San Diego          CS          CS          CS            2010
## 33540       San Diego          SZ      SZSAFD      SZSAFD            2010
```

```
unique(df_COGS2$cRace)
```

```
## [1] "AS"  "CA"  "AA"  "MR"  "NH"  "AE"  "UNK"
```

```
# re-encoding OT/UNK/MR into one group
df_COGS2$cRace2 <- df_COGS2$cRace
df_COGS2$cRace2[df_COGS2$cRace2 %in% c("OT", "OT/UNK", "MR",
    "UNK")] <- "OT/MR"
nrow(df_COGS2)
```

```
## [1] 2477
```

Helper function: Diversity Index

```
mult_ent <- function(race_prop_vec) {

    tot <- 0

    for (i in 1:length(race_prop_vec)) {
        if (race_prop_vec[i] != 0) {
            tot <- tot + race_prop_vec[i] * log(1/race_prop_vec[i])
        }
    }
    return(tot)
}
```

COGS2 Analysis + Plots

COGS2: Aggregate and By-City DI

Aggregate DI

```
pdf("Census_vs_Study_div_index.pdf")
head(df_COGS2)
```

```
##           X cStudy cAge cDiagnosis cEnrollmentDateYear cGender cRace
## 33535 34651  COGS2   25       CTRL          2010-07-07       M    AS
## 33536 34652  COGS2   43         SZ          2010-07-14       M    CA
## 33537 34653  COGS2   44       CTRL          2010-07-15       M    AA
## 33538 34654  COGS2   50         SZ          2010-07-16       M    CA
## 33539 34655  COGS2   49       CTRL          2010-07-19       M    CA
## 33540 34656  COGS2   43         SZ          2010-07-20       M    AA
##       cHispanicorLatino cLocationInstitution cLocationCity cLocationState
## 33535                No                 UCSD     San Diego             CA
## 33536               Yes                 UCSD     San Diego             CA
## 33537                No                 UCSD     San Diego             CA
## 33538                No                 UCSD     San Diego             CA
## 33539                No                 UCSD     San Diego             CA
## 33540                No                 UCSD     San Diego             CA
##       cLocationCounty cDiagnosis2 cDiagnosis3 cDiagnosis4 cEnrollmentYear
## 33535       San Diego          CS          CS          CS            2010
## 33536       San Diego          SZ      SZSAFD      SZSAFD            2010
## 33537       San Diego          CS          CS          CS            2010
## 33538       San Diego          SZ      SZSAFD      SZSAFD            2010
## 33539       San Diego          CS          CS          CS            2010
## 33540       San Diego          SZ      SZSAFD      SZSAFD            2010
##       cRace2
## 33535     AS
## 33536     CA
## 33537     AA
## 33538     CA
## 33539     CA
## 33540     AA
```

```
group_ct <- plyr::count(df_COGS2, c("cRace2", "cGender", "cHispanicorLatino"))
group_ct$prop <- group_ct$freq/nrow(df_COGS2)
prop_vec <- group_ct$prop
prop_vec
```

```
##  [1] 0.1142511102 0.0052482842 0.1978199435 0.0080742834 0.0004037142
##  [6] 0.0004037142 0.0028259992 0.0012111425 0.0234154219 0.0306822769
## [11] 0.0004037142 0.1699636657 0.0246265644 0.2587807832 0.0395639887
## [16] 0.0036334275 0.0004037142 0.0064594267 0.0004037142 0.0278562778
## [21] 0.0238191361 0.0335082761 0.0262414211
```

```
agg_m_ent <- mult_ent(prop_vec)
agg_m_ent
```

```
## [1] 2.19125
```

```
agg_df <- data.frame(City = "COGS2 Aggregate", mult_ent = agg_m_ent)

# same thing but without SD
no_sd <- df_COGS2[df_COGS2$cLocationCity != "San Diego", ]
group_ct <- plyr::count(no_sd, c("cRace2", "cGender", "cHispanicorLatino"))
group_ct$prop <- group_ct$freq/nrow(no_sd)
prop_vec <- group_ct$prop
prop_vec
```

```
##  [1] 0.1309836928 0.0057864282 0.2225144661 0.0105207785 0.0005260389
##  [6] 0.0021041557 0.0005260389 0.0215675960 0.0315623356 0.0005260389
## [11] 0.1657022620 0.0252498685 0.2467122567 0.0441872699 0.0031562336
## [16] 0.0005260389 0.0063124671 0.0005260389 0.0215675960 0.0105207785
## [21] 0.0352446081 0.0136770121
```

```
agg_m_ent_nosd <- mult_ent(prop_vec)
agg_m_ent_nosd
```

```
## [1] 2.1343
```

```
agg_df_nosd <- data.frame(City = "COGS2 No SD", mult_ent = agg_m_ent_nosd)
```

By-City DI

```
cities <- unique(df_COGS2$cLocationCity)
n <- length(cities)
df_di <- data.frame(City = rep("", n), mult_ent = rep(0, n))
head(df_di)
```

```
##   City mult_ent
## 1             0
## 2             0
## 3             0
## 4             0
## 5             0
```

```
for (i in 1:length(cities)) {
    df_sub <- df_COGS2[df_COGS2$cLocationCity == cities[i], ]

    group_ct <- plyr::count(df_sub, c("cRace2", "cGender", "cHispanicorLatino"))
    group_ct$prop <- group_ct$freq/nrow(df_sub)

    prop_vec <- group_ct$prop
    m_ent <- mult_ent(prop_vec)

    df_di[i, 1] <- cities[i]
    df_di[i, 2] <- m_ent
}
head(df_di)
```

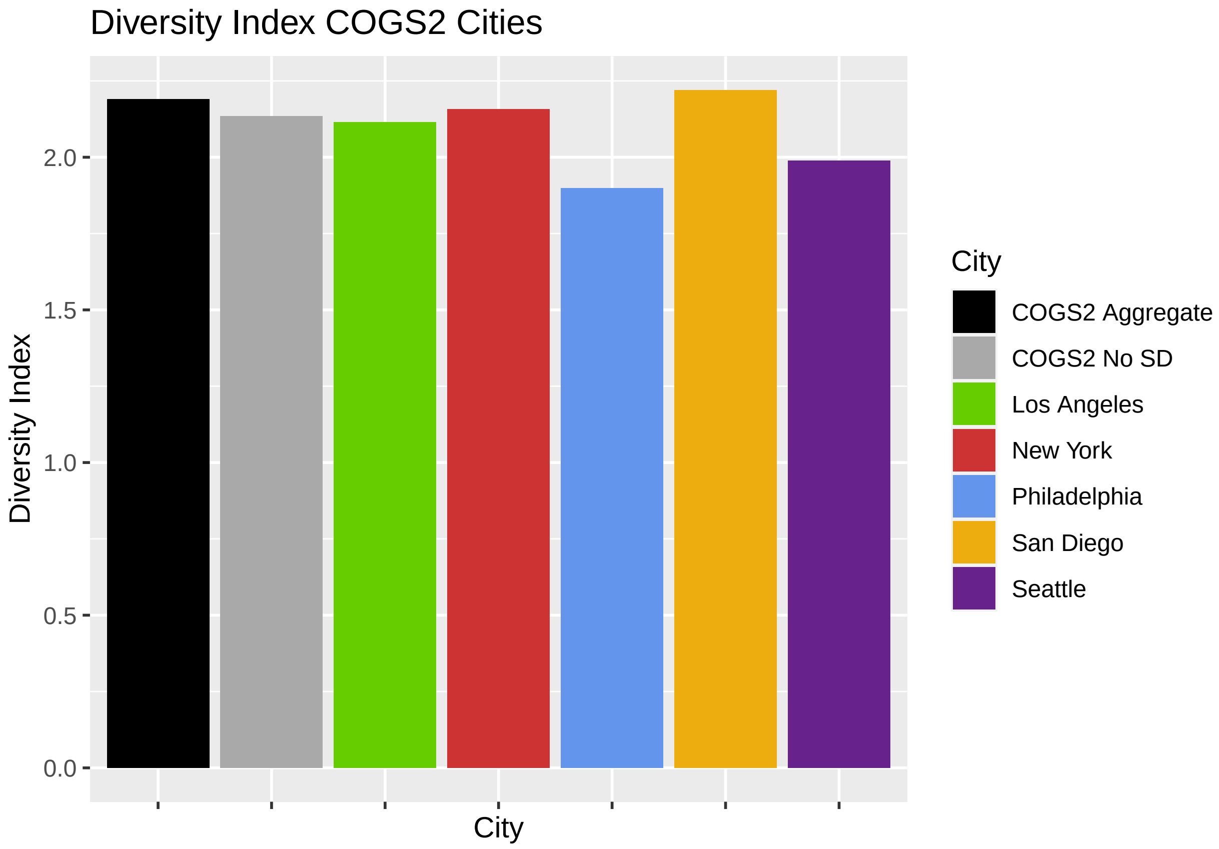
```
##           City mult_ent
## 1    San Diego 2.219907
## 2  Los Angeles 2.114581
## 3     New York 2.158019
## 4 Philadelphia 1.899062
## 5      Seattle 1.988777
```

```
df_di <- rbind(df_di, agg_df, agg_df_nosd)
df_di
```

```
##              City mult_ent
## 1       San Diego 2.219907
## 2     Los Angeles 2.114581
## 3        New York 2.158019
## 4    Philadelphia 1.899062
## 5         Seattle 1.988777
## 6 COGS2 Aggregate 2.191250
## 7     COGS2 No SD 2.134300
```

Barplot comparing results

```
my_cols <- c("black", "darkgray", "chartreuse3", "brown3", "cornflowerblue",
    "darkgoldenrod2", "darkorchid4")

cogs2_bar <- ggplot(data = df_di, aes(x = City, y = mult_ent,
    fill = City)) + geom_bar(stat = "identity", position = position_dodge()) +
    ylab("Diversity Index") + ggtitle("Diversity Index COGS2 Cities") +
    theme(axis.text.x = element_blank()) + scale_fill_manual(values = my_cols)
cogs2_bar
```



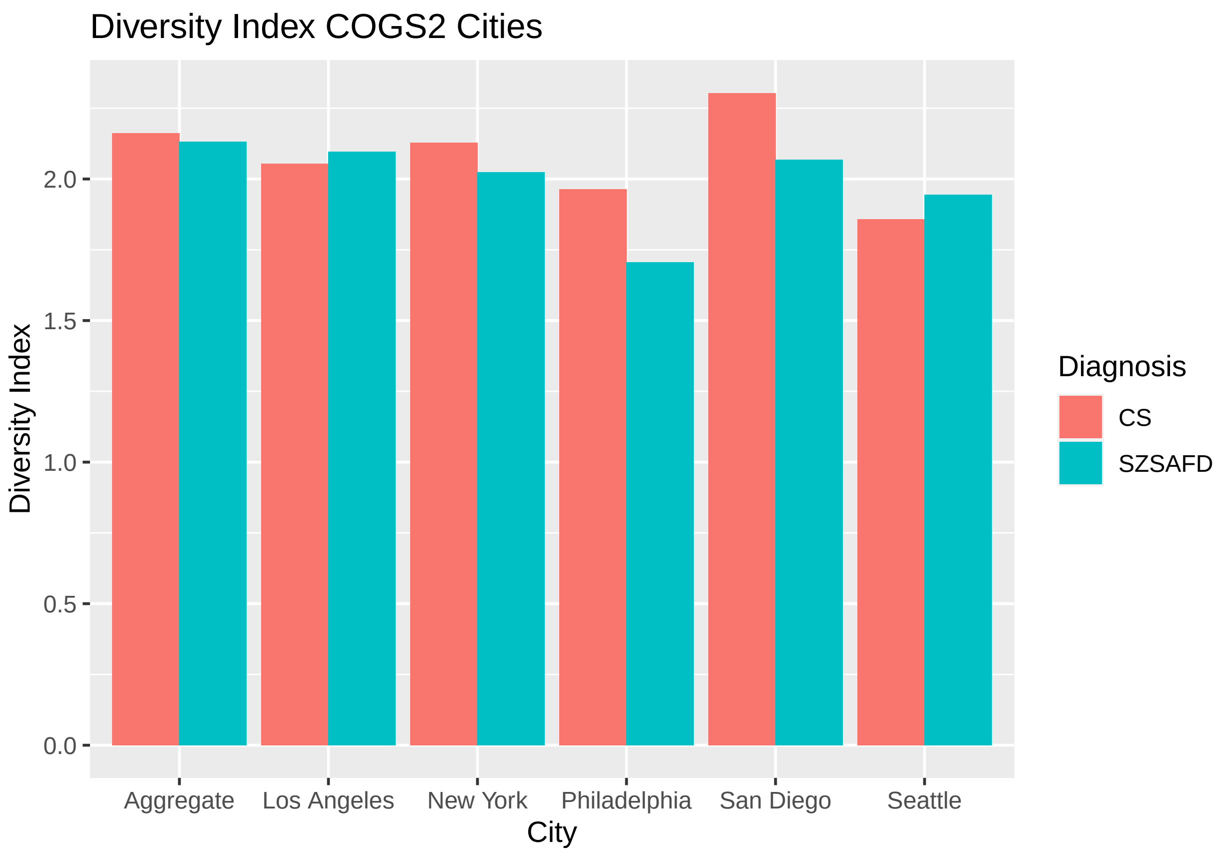
COGS2: CS and SZSAFD split

```
diagnoses <- c("CS", "SZSAFD")
cities2 <- c(cities, "Aggregate")
n <- 2 * length(cities2)
```

```
df_di2 <- data.frame(City = rep("", n), Diagnosis = rep("", n),
    mult_ent = rep(0, n))
n_track <- 1
for (d in 1:length(diagnoses)) {
    for (j in 1:length(cities2)) {
        if (cities2[j] != "Aggregate") {
            df_sub <- df_COGS2[df_COGS2$cDiagnosis3 == diagnoses[d] &
                df_COGS2$cLocationCity == cities2[j], ]
        } else {
            df_sub <- df_COGS2[df_COGS2$cDiagnosis3 == diagnoses[d],
                ]
        }

        # if the dataframe is empty, skip this iteration
        if (nrow(df_sub) == 0) {
            df_di2[n_track, 1] <- cities2[j]
            df_di2[n_track, 2] <- diagnoses[d]
            df_di2[n_track, 3] <- -99  # code for no data
            n_track <- n_track + 1
            next
        }

        group_ct <- plyr::count(df_sub, c("cRace2", "cGender",
            "cHispanicorLatino"))
        group_ct$prop <- group_ct$freq/nrow(df_sub)

        prop_vec <- group_ct$prop
        m_ent <- mult_ent(prop_vec)

        df_di2[n_track, 1] <- cities2[j]
        df_di2[n_track, 2] <- diagnoses[d]
        df_di2[n_track, 3] <- m_ent
        n_track <- n_track + 1
    }
}

# View(df_di2)
```

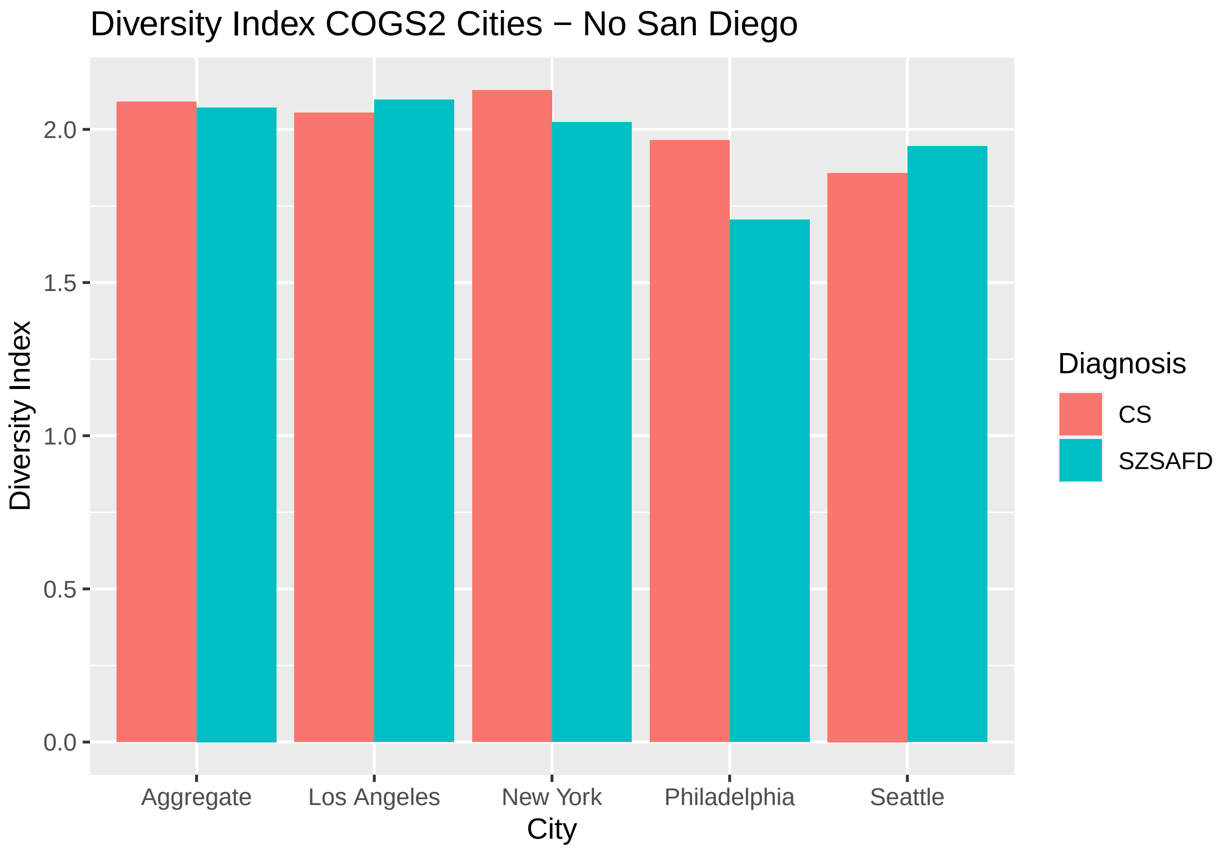
Barplot

```
bar2_COGS2 <- ggplot(data = df_di2, aes(x = City, y = mult_ent,
    fill = Diagnosis)) + geom_bar(stat = "identity", position = position_dodge()) +
    ylab("Diversity Index") + ggtitle("Diversity Index COGS2 Cities")
bar2_COGS2
```



Same thing but without San Diego

```
cities3 <- cities2[-1]

n <- 2 * length(cities3)

df_di3 <- data.frame(City = rep("", n), Diagnosis = rep("", n),
    mult_ent = rep(0, n))
n_track <- 1
for (d in 1:length(diagnoses)) {
    for (j in 1:length(cities3)) {
        if (cities3[j] != "Aggregate") {
            df_sub <- no_sd[no_sd$cDiagnosis3 == diagnoses[d] &
                no_sd$cLocationCity == cities3[j], ]
        } else {
            df_sub <- no_sd[no_sd$cDiagnosis3 == diagnoses[d],
                ]
        }

        # if the dataframe is empty, skip this iteration
        if (nrow(df_sub) == 0) {
            df_di3[n_track, 1] <- cities3[j]
            df_di3[n_track, 2] <- diagnoses[d]
            df_di3[n_track, 3] <- -99  # code for no data
            n_track <- n_track + 1
            next
        }

        group_ct <- plyr::count(df_sub, c("cRace2", "cGender",
            "cHispanicorLatino"))
        group_ct$prop <- group_ct$freq/nrow(df_sub)

        prop_vec <- group_ct$prop
        m_ent <- mult_ent(prop_vec)

        df_di3[n_track, 1] <- cities3[j]
        df_di3[n_track, 2] <- diagnoses[d]
        df_di3[n_track, 3] <- m_ent
        n_track <- n_track + 1
    }
}

bar3_COGS2 <- ggplot(data = df_di3, aes(x = City, y = mult_ent,
    fill = Diagnosis)) + geom_bar(stat = "identity", position = position_dodge()) +
    ylab("Diversity Index") + ggtitle("Diversity Index COGS2 Cities - No San Diego")
bar3_COGS2
```



```
plyr::count(df_COGS2, "cLocationCity")  # losing 576 samples by ignoring SD
```

```
##   cLocationCity freq
## 1   Los Angeles  481
## 2      New York  466
## 3  Philadelphia  480
## 4     San Diego  576
## 5       Seattle  474
```

ACS Analysis

Importing and checking data

```
df_acs <- read.csv("C:\\Users\\danie\\Documents\\Joshi Lab Materials\\acs_cogs2_1014.csv")
unique(df_acs$CITY)  # all cities except SD
```

```
## [1] 3730 4610 5330 6430
```

```
head(df_acs)
```

```
##   YEAR SAMPLE SERIAL CBSERIAL HHWT      CLUSTER CITY CITYPOP STRATA GQ PERNUM
## 1 2010 201001  70099      255   64 2.010001e+12 3730   37971 541806  1      1
## 2 2010 201001  70111      385   53 2.010001e+12 3730   37971 542406  3      1
## 3 2010 201001  70116      449   82 2.010001e+12 3730   37971 541106  1      1
## 4 2010 201001  70116      449   82 2.010001e+12 3730   37971 541106  1      2
## 5 2010 201001  70116      449   82 2.010001e+12 3730   37971 541106  1      3
## 6 2010 201001  70122      550   67 2.010001e+12 3730   37971 541006  1      1
##   PERWT SEX AGE RACE RACED HISPAN HISPAND
## 1    64   2  71    2   200      0       0
## 2    53   1  58    1   100      0       0
## 3    82   2  38    1   100      0       0
## 4    82   1  36    1   100      0       0
## 5    91   2   3    1   100      0       0
## 6    68   2  53    1   100      0       0
```

```
# no missing data
sum(complete.cases(df_acs)) == nrow(df_acs)
```

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

Encoding new race categories, binarizing hispan category

```
df_acs$Race2 <- rep(0, nrow(df_acs))
df_acs$Hispan2 <- rep(0, nrow(df_acs))

sum(df_acs$HISPAN == 9)  # everyone reported a hispanic status
```

```
## [1] 0
```

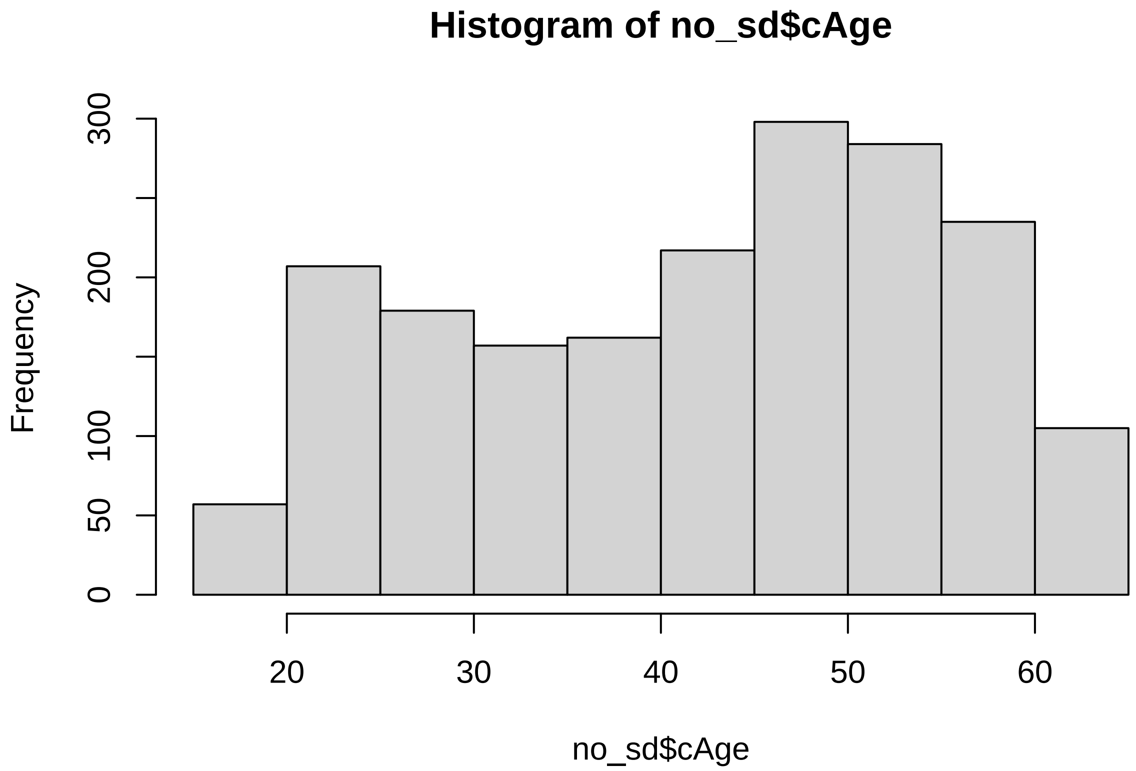
```
df_acs$Hispan2 <- as.numeric(df_acs$HISPAN != 0)  # 0 for not hispanic or latino, else 1

PI_raced <- c(680:699)  # PI races

df_acs$Race2[df_acs$RACE == 1] <- 1  # White
df_acs$Race2[df_acs$RACE == 2] <- 2  # Black
df_acs$Race2[df_acs$RACE == 3] <- 3  # American Indian or Alaska Native
df_acs$Race2[df_acs$RACE %in% 4:6 & !(df_acs$RACED %in% PI_raced)] <- 4  # Asian
df_acs$Race2[df_acs$RACE == 6 & df_acs$RACED %in% PI_raced] <- 5  # Pacific Islander (or Native Hawaiia
df_acs$Race2[df_acs$RACE %in% 7:9] <- 6  # Mixed/Other
```

Comparing ACS age ranges to COGS2 age ranges

```
# Getting the counts from no_sd
city_sam_sizes <- plyr::count(no_sd, "cLocationCity")
city_sam_sizes
```

```
##   cLocationCity freq
## 1   Los Angeles  481
## 2      New York  466
## 3  Philadelphia  480
## 4       Seattle  474
```

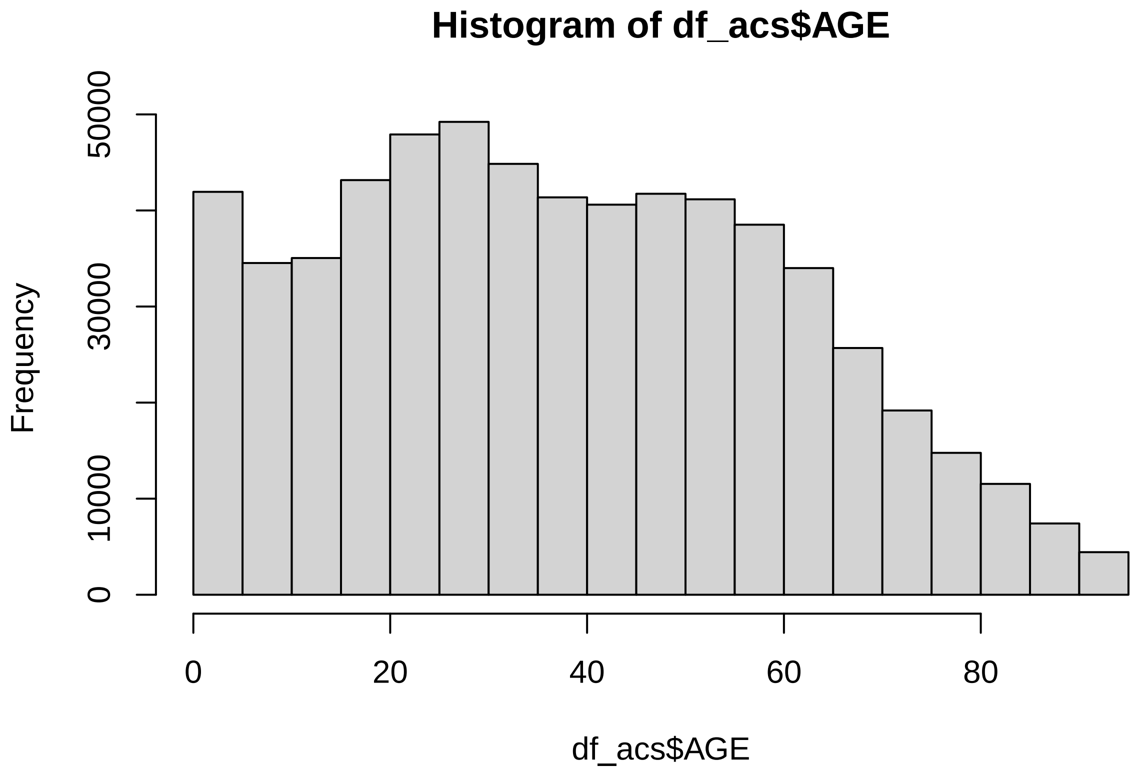
```
# age range of COGS2 was 18-65
hist(no_sd$cAge)
```



```
summary(no_sd$cAge)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   18.00   31.00   45.00   42.66   53.00   65.00
```

```
# age range of the ipums sample: 0-95
hist(df_acs$AGE)
```



```
summary(df_acs$AGE)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00   20.00   37.00   38.54   56.00   95.00
```

```
# solution: truncate the acs dataframe by the age in COGS2
acs1865 <- df_acs[df_acs$AGE >= 18 & df_acs$AGE <= 65, ]
(nrow(df_acs) - nrow(acs1865))/nrow(df_acs) * 100  # lost 34% of the rows
```

```
## [1] 34.01336
```

Calculating diversity index for ACS sample

```
# effective total population note: due to truncation, city
# pop is no longer relevant

# empty dataframe to hold results
acs_di <- data.frame(CITY = rep("", 4), DI = rep(0, 4))

cogs_cities_acs <- unique(acs1865$CITY)
cogs_cities_acs2 <- c(-1, cogs_cities_acs)  # -1 is surrogate for aggregate
```

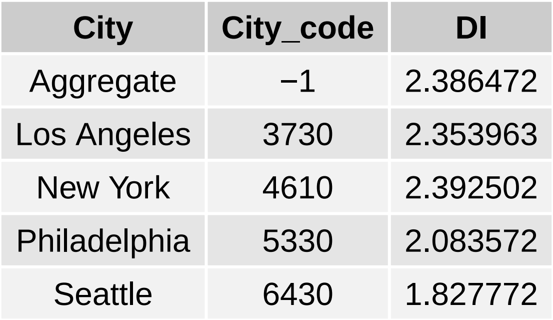
```r
for (i in 1:length(cogs_cities_acs2)) {
    if (cogs_cities_acs2[i] != -1) {
        df_sub <- acs1865[acs1865$CITY == cogs_cities_acs2[i],
            ]
    } else {
        df_sub <- acs1865
    }

    # total effective population for that city need to use
    # this cuz subset by age
    tot <- sum(df_sub$PERWT)

    weighted_cts <- plyr::count(df_sub, c("Race2", "Hispan2",
        "SEX"), wt_var = "PERWT")

    props <- weighted_cts$freq/tot
    acs_di[i, 1] <- cogs_cities_acs2[i]
    acs_di[i, 2] <- mult_ent(props)
}

# View(acs_di)

fac_test <- factor(acs_di$CITY)
levels(fac_test) <- c("Aggregate", "Los Angeles", "New York",
    "Philadelphia", "Seattle")
fac_test
```

```
## [1] Aggregate    Los Angeles  New York     Philadelphia Seattle
## Levels: Aggregate Los Angeles New York Philadelphia Seattle
```

```r
acs_di$City <- fac_test
acs_di <- acs_di[, c("City", "CITY", "DI")]
colnames(acs_di)[2] <- "City_code"

knitr::kable(acs_di)
```

City	City_code	DI
Aggregate	-1	2.386472
Los Angeles	3730	2.353963
New York	4610	2.392502
Philadelphia	5330	2.083572
Seattle	6430	1.827772

```r
grid.newpage()
grid.table(acs_di, rows = NULL)
```



City	City_code	DI
Aggregate	−1	2.386472
Los Angeles	3730	2.353963
New York	4610	2.392502
Philadelphia	5330	2.083572
Seattle	6430	1.827772

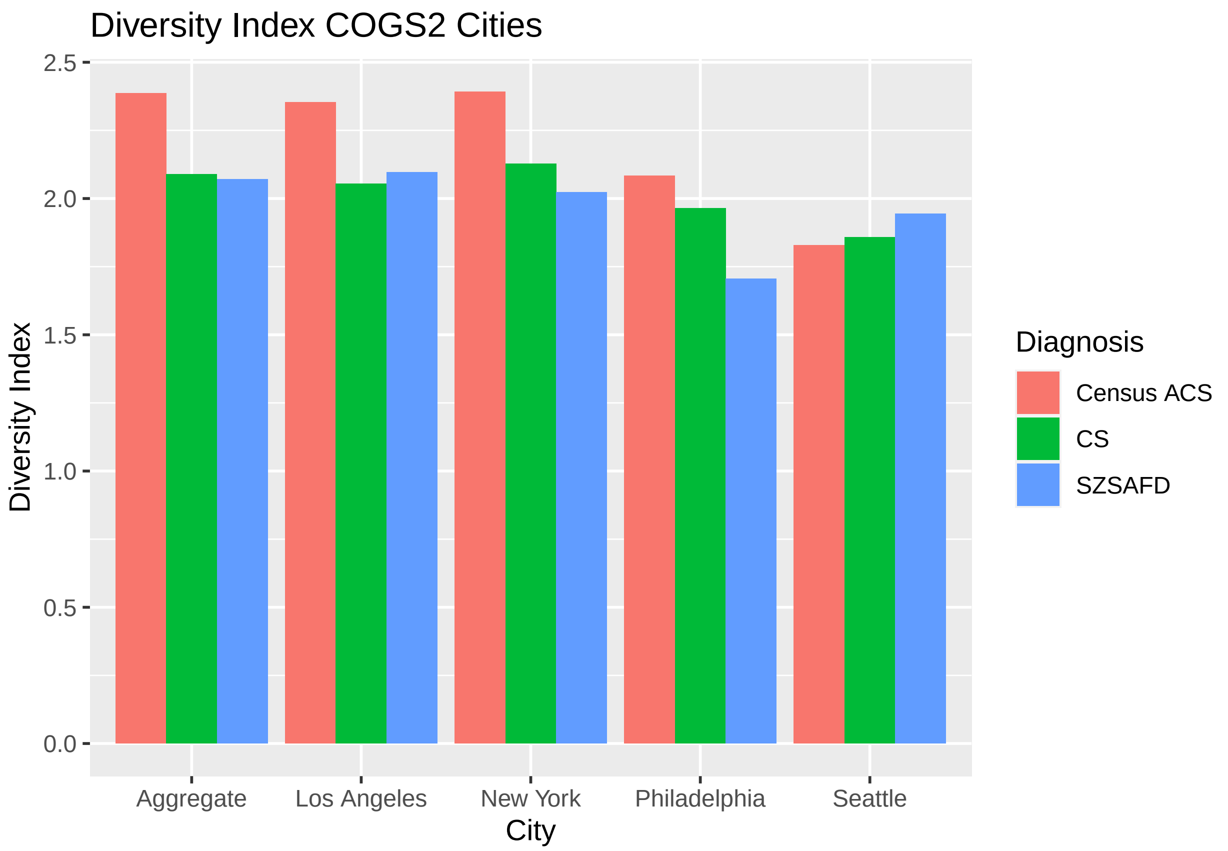
```
# showing populations
pop_counts <- plyr::count(acs1865, "CITY", "PERWT")
pop_counts$City <- c("Los Angeles", "New York", "Philadelphia",
    "Seattle")
pop_counts[, c("City", "CITY", "freq")]
```

```
##           City CITY     freq
## 1  Los Angeles 3730 13007366
## 2     New York 4610 27946386
## 3 Philadelphia 5330  5126426
## 4      Seattle 6430  2367072
```

```
# LA and NY have highest counts
```

Analysis: Comparing ACS DI to study DI

```
# putting the dataframes on top of each other
cs_cogs2 <- df_di3[df_di3$Diagnosis == "CS", ]
szsafd_cogs2 <- df_di3[df_di3$Diagnosis == "SZSAFD", ]
acs_di$Diagnosis <- "Census ACS"
colnames(cs_cogs2)[3] = colnames(szsafd_cogs2)[3] = "DI"
di_collection <- rbind(acs_di[, c(1, 4, 3)], cs_cogs2, szsafd_cogs2)
di_collection <- di_collection[order(di_collection$City), ]
# View(di_collection)

# barplot of the dataframe
di_bars <- ggplot(data = di_collection, aes(x = City, y = DI,
    fill = Diagnosis)) + geom_bar(stat = "identity", position = position_dodge()) +
    ylab("Diversity Index") + ggtitle("Diversity Index COGS2 Cities")

di_bars
```



Hypothesis Testing: Monte-Carlo Simulation

Getting sample sizes

```
# by-city and diagnosis sample sizes
city_diag_sam_sizes <- plyr::count(no_sd, c("cLocationCity",
    "cDiagnosis4"))
city_diag_sam_sizes
```

```
##   cLocationCity cDiagnosis4 freq
## 1   Los Angeles          CS  217
## 2   Los Angeles      SZSAFD  264
## 3      New York          CS  196
## 4      New York      SZSAFD  270
## 5  Philadelphia          CS  207
## 6  Philadelphia      SZSAFD  273
## 7       Seattle          CS  221
## 8       Seattle      SZSAFD  253
```

```
# by-diagnosis sample size (aggregate)
city_diag_agg_sam_size <- plyr::count(no_sd, "cDiagnosis4")
city_diag_agg_sam_size
```

```
##   cDiagnosis4 freq
## 1          CS  841
## 2      SZSAFD 1060
```

Simulation Methodology

Methodology: 1) Follow same for loop structure as in generation of diversity index 2) After generating the proportions vector for use in the DI calculation: - Randomly sample n from the rows of the weighted_cts data frame - Choose n based on what COGS2's counts for CS or SZSAFD within the city of interest - Then re-generate diversity index 3) Store results in a matrix - 1 row per city per diagnosis - 10 rows total (include the aggregate) - 1000 columns

Generating the Results Matrix

```
city_diag_sam_sizes
```

```
##   cLocationCity cDiagnosis4 freq
## 1   Los Angeles          CS  217
## 2   Los Angeles      SZSAFD  264
## 3      New York          CS  196
## 4      New York      SZSAFD  270
## 5  Philadelphia          CS  207
## 6  Philadelphia      SZSAFD  273
## 7       Seattle          CS  221
## 8       Seattle      SZSAFD  253
```

```
city_diag_agg_sam_size
```

```
##   cDiagnosis4 freq
## 1          CS  841
## 2      SZSAFD 1060
```

```
agg_info <- data.frame(cLocationCity = "Aggregate", cDiagnosis4 = c("CS",
    "SZSAFD"), freq = city_diag_agg_sam_size$freq)
city_ns <- rbind(city_diag_sam_sizes, agg_info)
city_ns
```

```
##    cLocationCity cDiagnosis4 freq
## 1    Los Angeles          CS  217
## 2    Los Angeles      SZSAFD  264
## 3       New York          CS  196
## 4       New York      SZSAFD  270
## 5   Philadelphia          CS  207
## 6   Philadelphia      SZSAFD  273
## 7        Seattle          CS  221
## 8        Seattle      SZSAFD  253
## 9      Aggregate          CS  841
## 10     Aggregate      SZSAFD 1060
```

```
city_ns
```

```
##    cLocationCity cDiagnosis4 freq
## 1    Los Angeles          CS  217
## 2    Los Angeles      SZSAFD  264
## 3       New York          CS  196
## 4       New York      SZSAFD  270
## 5   Philadelphia          CS  207
## 6   Philadelphia      SZSAFD  273
## 7        Seattle          CS  221
## 8        Seattle      SZSAFD  253
## 9      Aggregate          CS  841
## 10     Aggregate      SZSAFD 1060
```

```
N_sim <- 1000
sim_mat <- matrix(0, nrow = 10, ncol = N_sim)

# Same for-loop structure as before
n_track <- 1

for (i in 1:length(cogs_cities_acs2)) {
    for (d in 1:length(diagnoses)) {

        if (cogs_cities_acs2[i] != -1) {
            df_sub <- acs1865[acs1865$CITY == cogs_cities_acs2[i],
                ]
            # total effective population for that city need
            # to use this cuz subset by age
            tot <- sum(df_sub$PERWT)

            weighted_cts <- plyr::count(df_sub, c("Race2", "Hispan2",
                "SEX"), wt_var = "PERWT")

            props <- weighted_cts$freq/tot

            # begin random sampling

            for (N in 1:N_sim) {
                row_samples <- sample(1:nrow(weighted_cts), size = city_ns$freq[i],
                  p = props, replace = TRUE)

                # generate proportions for the 24 groups
                row_sam_cts <- plyr::count(row_samples)
                prop_for_DI <- row_sam_cts$freq/sum(row_sam_cts$freq)

                # generate diversity index
                DI_sam <- mult_ent(prop_for_DI)

                # store in matrix
                sim_mat[n_track, N] <- DI_sam
            }
        } else {
            df_sub <- acs1865

            # Get counts of each combination, but per city
            weighted_cts <- plyr::count(df_sub, c("Race2", "Hispan2",
                "SEX", "CITY"), wt_var = "PERWT")

            # Generate within-city totals
            tots <- plyr::count(df_sub, "CITY", wt_var = "PERWT")

            # Generate proportions of each combination
            # within each city
            weighted_cts$props <- rep(0, nrow(weighted_cts))

            for (r in 1:nrow(weighted_cts)) {
                weighted_cts$props[r] <- weighted_cts$freq[r]/tots$freq[tots$CITY ==
                  weighted_cts$CITY[r]]
            }

            for (N in 1:N_sim) {

                # splitting the weighted_cts into 1 df for
                # each city
                df_LA <- weighted_cts[weighted_cts$CITY == 3730,
                  ]
                df_NY <- weighted_cts[weighted_cts$CITY == 4610,
                  ]
                df_Ph <- weighted_cts[weighted_cts$CITY == 5330,
                  ]
                df_Se <- weighted_cts[weighted_cts$CITY == 6430,
                  ]

                rownames(df_LA) <- NULL
                rownames(df_NY) <- NULL
                rownames(df_Ph) <- NULL
                rownames(df_Se) <- NULL

                # sample sizes
                ss <- city_ns$freq[city_ns$cDiagnosis4 == diagnoses[d]][1:4]

                row_samples <- c(sample(1:nrow(df_LA), size = ss[1],
                  p = df_LA$props, replace = TRUE), sample(1:nrow(df_NY),
                  size = ss[2], p = df_NY$props, replace = TRUE),
                  sample(1:nrow(df_Ph), size = ss[3], p = df_Ph$props,
                    replace = TRUE), sample(1:nrow(df_Se), size = ss[4],
                    p = df_Se$props, replace = TRUE))

                # generate proportions for the 24 groups
                row_sam_cts <- plyr::count(row_samples)
                prop_for_DI <- row_sam_cts$freq/sum(row_sam_cts$freq)

                # generate diversity index
                DI_sam <- mult_ent(prop_for_DI)

                # store in matrix
                sim_mat[n_track, N] <- DI_sam
            }
        }

        n_track <- n_track + 1
    }
}

acs_di$Percent_Max_DI <- acs_di$DI/log(24)
sim_res <- data.frame(city = rep(cogs_cities_acs2, rep(2, 5)),
    sim_means = apply(sim_mat, 1, mean))
sim_res
```

```
##    city sim_means
## 1    -1  2.300741
## 2    -1  2.306645
## 3  3730  2.314841
## 4  3730  2.317142
## 5  4610  2.349159
## 6  4610  2.348143
## 7  5330  2.047882
## 8  5330  2.050623
## 9  6430  1.783065
## 10 6430  1.783436
```

```
city_ns
```

```
##    cLocationCity cDiagnosis4 freq
## 1    Los Angeles          CS  217
## 2    Los Angeles      SZSAFD  264
## 3       New York          CS  196
## 4       New York      SZSAFD  270
## 5   Philadelphia          CS  207
## 6   Philadelphia      SZSAFD  273
## 7        Seattle          CS  221
## 8        Seattle      SZSAFD  253
## 9      Aggregate          CS  841
## 10     Aggregate      SZSAFD 1060
```

Calculating the 95% CI

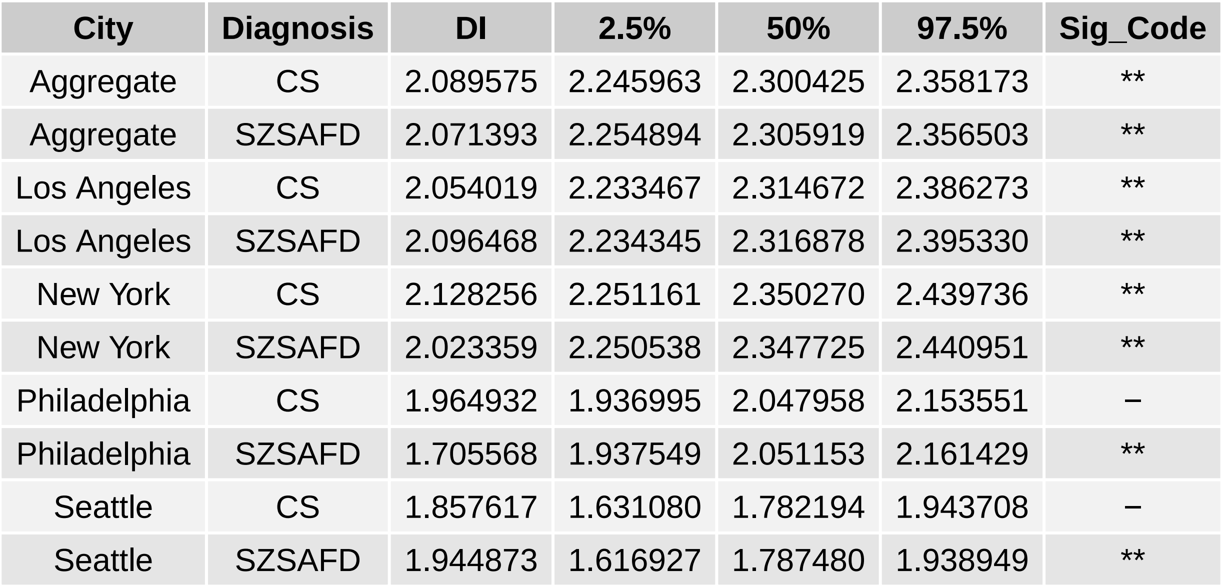
```
CI_df <- as.data.frame(t(apply(sim_mat, MARGIN = 1, FUN = quantile,
    prob = c(0.025, 0.5, 0.975), simplify = TRUE)))
CI_df
```

```
##        2.5%      50%    97.5%
## 1  2.245963 2.300425 2.358173
## 2  2.254894 2.305919 2.356503
## 3  2.233467 2.314672 2.386273
## 4  2.234345 2.316878 2.395330
## 5  2.251161 2.350270 2.439736
## 6  2.250538 2.347725 2.440951
## 7  1.936995 2.047958 2.153551
## 8  1.937549 2.051153 2.161429
## 9  1.631080 1.782194 1.943708
## 10 1.616927 1.787480 1.938949
```

```
di_cogs2 <- di_collection[di_collection$Diagnosis != "Census ACS",
    ]
rownames(di_cogs2) <- NULL
di_sig <- cbind(di_cogs2, CI_df)
di_sig$Significant <- di_sig$DI < di_sig$`2.5%` | di_sig$DI >
    di_sig$`97.5%`
di_sig$Sig_Code <- ifelse(di_sig$Significant, "**", "-")
# View(di_sig)

knitr::kable(di_sig)
```

City	Diagnosis	DI	2.5%	50%	97.5%	Significant	Sig_Code
Aggregate	CS	2.089575	2.245963	2.300425	2.358173	TRUE	**
Aggregate	SZSAFD	2.071393	2.254894	2.305919	2.356503	TRUE	**
Los Angeles	CS	2.054019	2.233467	2.314672	2.386273	TRUE	**
Los Angeles	SZSAFD	2.096468	2.234345	2.316878	2.395330	TRUE	**
New York	CS	2.128256	2.251161	2.350270	2.439736	TRUE	**
New York	SZSAFD	2.023359	2.250538	2.347725	2.440951	TRUE	**
Philadelphia	CS	1.964932	1.936995	2.047958	2.153551	FALSE	-
Philadelphia	SZSAFD	1.705568	1.937549	2.051153	2.161429	TRUE	**
Seattle	CS	1.857617	1.631080	1.782194	1.943708	FALSE	-
Seattle	SZSAFD	1.944873	1.616927	1.787480	1.938949	TRUE	**

```
grid.newpage()
grid.table(di_sig[, -7], rows = NULL)
```



City	Diagnosis	DI	2.5%	50%	97.5%	Sig_Code
Aggregate	CS	2.089575	2.245963	2.300425	2.358173	**
Aggregate	SZSAFD	2.071393	2.254894	2.305919	2.356503	**
Los Angeles	CS	2.054019	2.233467	2.314672	2.386273	**
Los Angeles	SZSAFD	2.096468	2.234345	2.316878	2.395330	**
New York	CS	2.128256	2.251161	2.350270	2.439736	**
New York	SZSAFD	2.023359	2.250538	2.347725	2.440951	**
Philadelphia	CS	1.964932	1.936995	2.047958	2.153551	–
Philadelphia	SZSAFD	1.705568	1.937549	2.051153	2.161429	**
Seattle	CS	1.857617	1.631080	1.782194	1.943708	–
Seattle	SZSAFD	1.944873	1.616927	1.787480	1.938949	**

Barplot of results

```
library(ggsignif)
```

```
## Warning: package 'ggsignif' was built under R version 4.3.1
```

```
census_medians <- di_sig[, c("City", "Diagnosis", "50%")]
census_medians$Diagnosis <- paste(census_medians$Diagnosis, "ACS")
census_medians
```

```
##            City  Diagnosis      50%
## 1     Aggregate     CS ACS 2.300425
## 2     Aggregate SZSAFD ACS 2.305919
## 3   Los Angeles     CS ACS 2.314672
## 4   Los Angeles SZSAFD ACS 2.316878
## 5      New York     CS ACS 2.350270
## 6      New York SZSAFD ACS 2.347725
## 7  Philadelphia     CS ACS 2.047958
## 8  Philadelphia SZSAFD ACS 2.051153
## 9       Seattle     CS ACS 1.782194
## 10      Seattle SZSAFD ACS 1.787480
```

```
head(census_medians)
```

```
##          City  Diagnosis      50%
## 1   Aggregate     CS ACS 2.300425
## 2   Aggregate SZSAFD ACS 2.305919
## 3 Los Angeles     CS ACS 2.314672
## 4 Los Angeles SZSAFD ACS 2.316878
## 5    New York     CS ACS 2.350270
## 6    New York SZSAFD ACS 2.347725
```

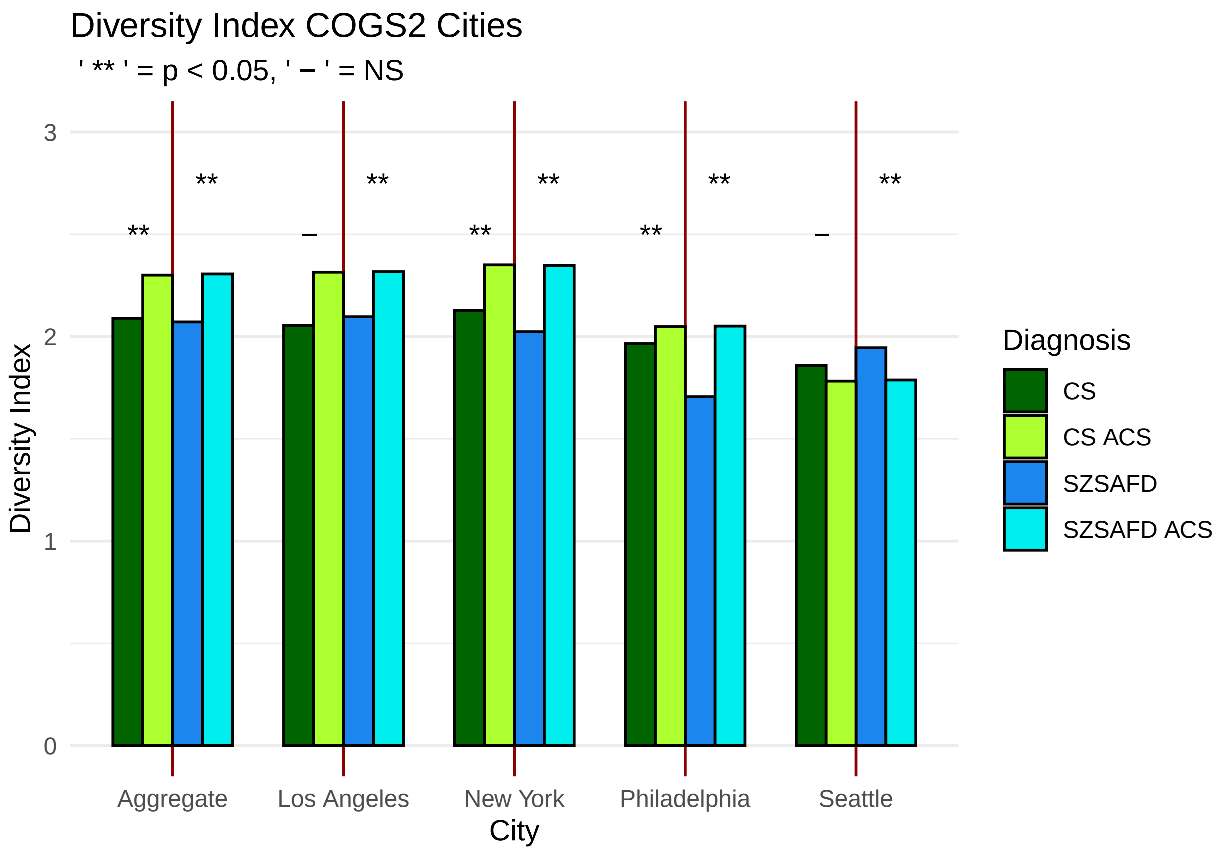
```
colnames(census_medians)[3] <- "DI"

head(di_sig)
```

```
##          City Diagnosis       DI     2.5%      50%    97.5% Significant
## 1   Aggregate        CS 2.089575 2.245963 2.300425 2.358173        TRUE
## 2   Aggregate    SZSAFD 2.071393 2.254894 2.305919 2.356503        TRUE
## 3 Los Angeles        CS 2.054019 2.233467 2.314672 2.386273        TRUE
## 4 Los Angeles    SZSAFD 2.096468 2.234345 2.316878 2.395330        TRUE
## 5    New York        CS 2.128256 2.251161 2.350270 2.439736        TRUE
## 6    New York    SZSAFD 2.023359 2.250538 2.347725 2.440951        TRUE
##   Sig_Code
## 1       **
## 2       **
## 3       **
## 4       **
## 5       **
## 6       **
```

```
di_sig_plot <- rbind(di_sig[, 1:3], census_medians)
di_sig_plot
```

```
##            City  Diagnosis       DI
## 1     Aggregate         CS 2.089575
## 2     Aggregate     SZSAFD 2.071393
## 3   Los Angeles         CS 2.054019
## 4   Los Angeles     SZSAFD 2.096468
## 5      New York         CS 2.128256
## 6      New York     SZSAFD 2.023359
## 7  Philadelphia         CS 1.964932
## 8  Philadelphia     SZSAFD 1.705568
## 9       Seattle         CS 1.857617
## 10      Seattle     SZSAFD 1.944873
## 11    Aggregate     CS ACS 2.300425
## 12    Aggregate SZSAFD ACS 2.305919
## 13  Los Angeles     CS ACS 2.314672
## 14  Los Angeles SZSAFD ACS 2.316878
## 15     New York     CS ACS 2.350270
## 16     New York SZSAFD ACS 2.347725
## 17 Philadelphia     CS ACS 2.047958
## 18 Philadelphia SZSAFD ACS 2.051153
## 19      Seattle     CS ACS 1.782194
## 20      Seattle SZSAFD ACS 1.787480
```

```r
hyp_test <- ggplot(data = di_sig_plot, aes(City, DI)) + geom_bar(aes(fill = Diagnosis),
    width = 0.7, stat = "identity", position = position_dodge(),
    color = "black") + ylim(0, 3) + ylab("Diversity Index") +
    ggtitle("Diversity Index COGS2 Cities") + theme_minimal() +
    theme(panel.grid.major.x = element_line(color = "darkred"))
# panel.grid.minor.x = element_line(color = 'grey68'))

cslabel.df <- data.frame(City = 0.8 + 0:4, DI = rep(2.5, 5))

szsafdlabel.df <- data.frame(City = 1.2 + 0:4, DI = rep(2.75,
    5))

my_colors <- c("darkgreen", "greenyellow", "dodgerblue2", "cyan2")

# hyp_test + scale_fill_brewer(palette='Blues') +
# geom_text(data = cslabel.df, label = c('**', '-', '**',
# '**', '-')) + geom_text(data= szsafdlabel.df, label =
# c('**', '**', '**', '**', '**'))
hyp_test + scale_fill_manual(values = my_colors) + geom_text(data = cslabel.df,
    label = c("**", "-", "**", "**", "-")) + geom_text(data = szsafdlabel.df,
    label = c("**", "**", "**", "**", "**")) + labs(subtitle = " ' ** ' = p < 0.05, ' - ' = NS")
```



```r
dev.off()
```

```
## pdf
##     3
```