### OPTIMIZED STRATIFICATION PROJECT – (7/22/18)

Dr. Jack K. Rasmus-Vorrath

### Section 1.Descriptive Statistics

The variable of interest is ‘INVENTORY’.

The number of units in the population is 9762.

> nrow(df)

[1] 9762

The population total is 1754954823.

> sum(df$inventory)

[1] 1754954823

The population standard deviation is 1573358.

> sd(df$inventory)

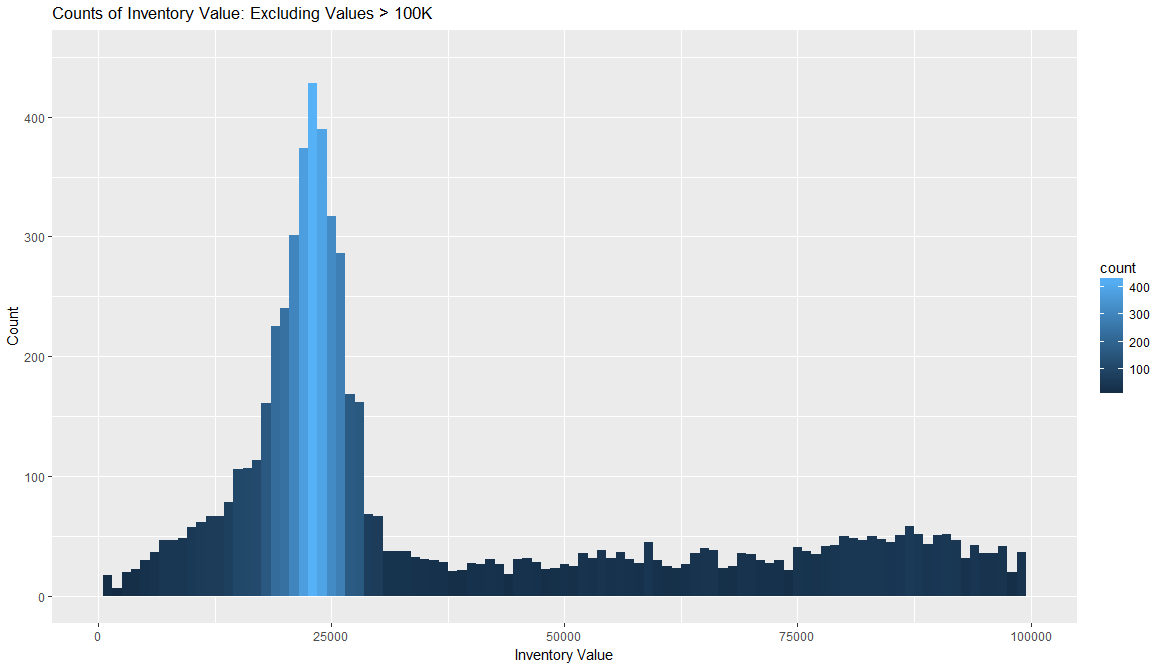
[1] 1573358

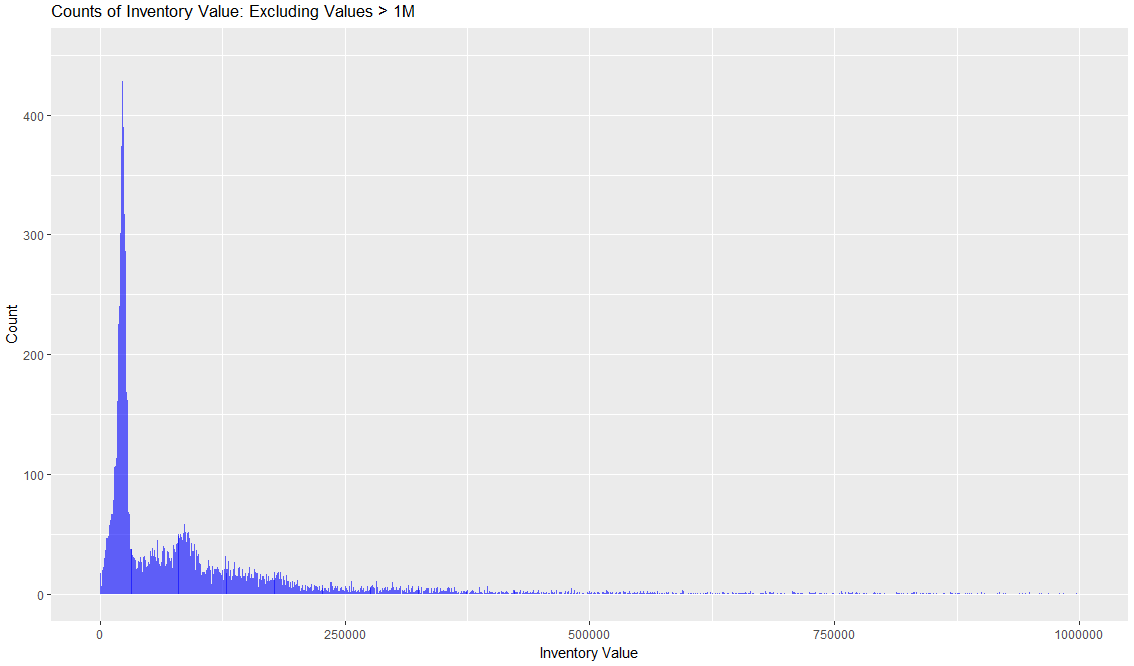
The population mean is 179774.1.

> mean(df$inventory)

[1] 179774.1

Histograms of the variable of interest are shown below:





### Section 2. Stratification Using Sales(Inventory)

2.1 Description of the process followed in forming sampling strata for the population using the Inventory variable:

* + Description of the number and range of values chosen for the certainty stratum and the criteria used for including units in the certainty stratum.

Particularly when dealing with severely right-skewed data, best analytic practices suggest **assigning the highest-valued records to the certainty stratum** to minimize sampling variance. Cf. <https://enablement.acl.com/helpdocs/analytics/13/user-guide/en-us/Content/da_sampling_data/classical_variables_sampling.htm#navlink-5>.

Deciding how many of the highest-valued records to assign was determined according to a custom-made optimization wrapper function designed to minimize the overall coefficient of variation (relative root mean squared error) produced when applying the generalized Lavallee-Hidiroglou stratification method for skewed populations.

Cf. **Lavallée, P., and Hidiroglou, M. (1988). On the stratification of skewed populations. Survey Methodology, 14, 33-43.**

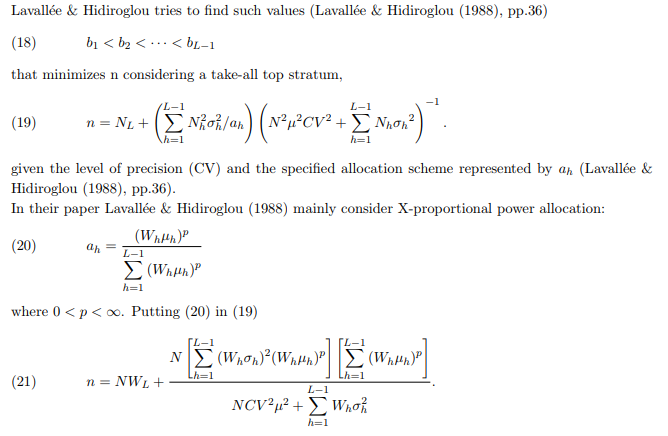
The Lavallee-Hidiroglou stratification method is implemented using the strat.LH() function from the ‘Stratification’ R package. The function implements Kozak’s Random Search method.

Cf. **Kozak, M. (2004). Optimal Stratification Using Random Search Method in Agricultural Surveys, Statistics in Transition, 6, 5, 797-806.**

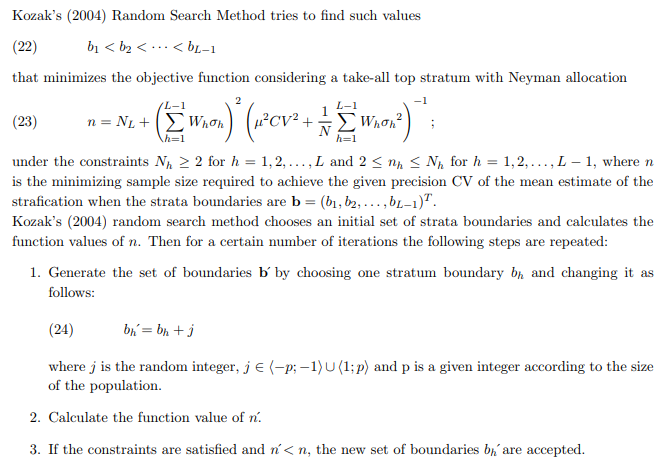
For an explanation of Lavallee-Hidiroglou stratification and Kozak’s Random Search method,

Cf. **Sebnem, Er. (2011). Computational Methods for Optimum Stratification: A Review, Int. Statistical Inst.: Proc. 58th World Statistical Congress, 2011, Dublin (Session STS058).**

As shown in Sebnem (2011), the Lavallee-Hidiroglou stratification method works as follows:



As shown in Sebnem (2011), Kozak’s Random Search method works as follows:



The custom wrapper function (written in R) iterated through several sizes of highest-valued certainty strata before arriving at an optimum of **110 records** with the highest inventory value. Their values **ranged from 1372514.04 to the maximum 105379553.91**.

* + Description of the process for deciding on the number of non-certainty strata.

The same custom wrapper function served to jointly optimize the number of non-certainty strata, arriving at the number **10**.

* + Table showing a row for each stratum, with the stratum number, number of units, and range of values.

The optimal configuration of highest-valued records and number of non-certainty strata is shown below, with stratum numbers, number of units (Nh) and their respective ranges of values (bh):

> print(Optim\_Config)

Given arguments:

x = df$inventory

n = 500, Ls = 10, takenone = 0, takeall = 0

allocation: q1 = 0.5, q2 = 0, q3 = 0.5

model = none

algo = Kozak: minsol = 1000, idopti = nh, minNh = 2, maxiter = 10000,

maxstep = 100, maxstill = 500, rep = 5, trymany = TRUE

Strata information:

| type rh | bh E(Y) Var(Y) Nh nh fh

stratum 1 | take-some 1 | 36703.82 21229.61 41103797 4346 79 0.02

stratum 2 | take-some 1 | 71986.24 55039.89 99472460 1054 30 0.03

stratum 3 | take-some 1 | 106848.40 88032.43 79086957 1334 33 0.02

stratum 4 | take-some 1 | 151201.78 128117.76 158852979 852 30 0.04

stratum 5 | take-some 1 | 210748.83 176507.24 257069766 730 33 0.05

stratum 6 | take-some 1 | 295186.09 251081.23 612253308 416 29 0.07

stratum 7 | take-some 1 | 413551.11 343819.24 1063090418 361 33 0.09

stratum 8 | take-some 1 | 614205.40 499757.45 3131901977 248 39 0.16

stratum 9 | take-some 1 | 974662.93 756680.65 8825392705 176 47 0.27

stratum 10 | take-some 1 | 105379553.90 1193526.37 9217654279 135 37 0.27

| certain 1 | - 5476606.91 - 110 110 1.00

Total 9762 500 0.05

Total sample size: 500

Anticipated population mean: 179774.1

Anticipated CV: 0.003779453

Note: CV=RRMSE (Relative Root Mean Squared Error) because takenone=0.

2.2 Neyman allocation of units to a stratified sample of size 500.

The Neyman allocation of sample strata followed the procedure shown below. The sample sizes come from the ‘nh’ vector of the ‘Optim\_Config’ object returned by the stratification::strata.LH() function. The size of the certainty stratum is appended before performing the sampling procedure.

> #adjusted Neyman Allocation, assuming values provided by the LH optimization

> Ney\_Alloc\_3 <- append(Optim\_Config$nh, 110)

>

> #Set Random Sampling Seed

> set.seed(232)

>

> #Sampling using Neyman Allocation

> Ney\_Samp\_12 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_3, method="srswor")

>

> #Drop duplicated column

> Ney\_Samp\_12 <- Ney\_Samp\_12[, !duplicated(colnames(Ney\_Samp\_12))]

>

> #Rename ID column to match original data frame, for merging

> colnames(Ney\_Samp\_12)[2] <- "coID"

> Ney\_Samp\_12\_merged <- merge(x = df, y = Ney\_Samp\_12)

>

> #sort by Stratum

> Ney\_Samp\_12\_merged <- Ney\_Samp\_12\_merged[order(Ney\_Samp\_12\_merged$Stratum),]

2.3 Selection of 5 stratified samples using Neyman allocation.

After preparing the population data frame (as shown below), the procedure above was used to select the 5 samples used by the analysis.

> #Preparing the data frame#####################################################################################################

>

> #Identify boundary separating highest-valued certainty stratum from other strata

> options(digits=15)

> min(df[order(df$inventory, decreasing=T)[1:110],]$inventory)

[1] 1372514.035

> #Returns 1372514.035

>

> #Assign Strata

> df$Stratum <- NA

> df$Stratum[df$`inventory` < 36703.82] <- 1

> df$Stratum[(df$`inventory` < 71655.62) & (df$`inventory` >= 36703.82)] <- 2

> df$Stratum[(df$`inventory` < 106848.40) & (df$`inventory` >= 71655.62)] <- 3

> df$Stratum[(df$`inventory` < 151104.80) & (df$`inventory` >= 106848.40)] <- 4

> df$Stratum[(df$`inventory` < 209954.79) & (df$`inventory` >= 151104.80)] <- 5

> df$Stratum[(df$`inventory` < 295186.09) & (df$`inventory` >= 209954.79)] <- 6

> df$Stratum[(df$`inventory` < 413551.11) & (df$`inventory` >= 295186.09)] <- 7

> df$Stratum[(df$`inventory` < 614205.40) & (df$`inventory` >= 413551.11)] <- 8

> df$Stratum[(df$`inventory` < 974662.93) & (df$`inventory` >= 614205.40)] <- 9

> df$Stratum[(df$`inventory` < 1372514.04) & (df$`inventory` >= 974662.93)] <- 10

> df$Stratum[(df$`inventory` < 105379553.91) & (df$`inventory` >= 1372514.04)] <- 11

>

> #Check if any NAs in Stratum column

> any(is.na(df$Stratum))

[1] FALSE

>

> #Assign column for Finite Population Correction

> df$Num <- NA

> df$Num[df$Stratum == 1] <- 4346

> df$Num[df$Stratum == 2] <- 1047

> df$Num[df$Stratum == 3] <- 1341

> df$Num[df$Stratum == 4] <- 851

> df$Num[df$Stratum == 5] <- 723

> df$Num[df$Stratum == 6] <- 424

> df$Num[df$Stratum == 7] <- 361

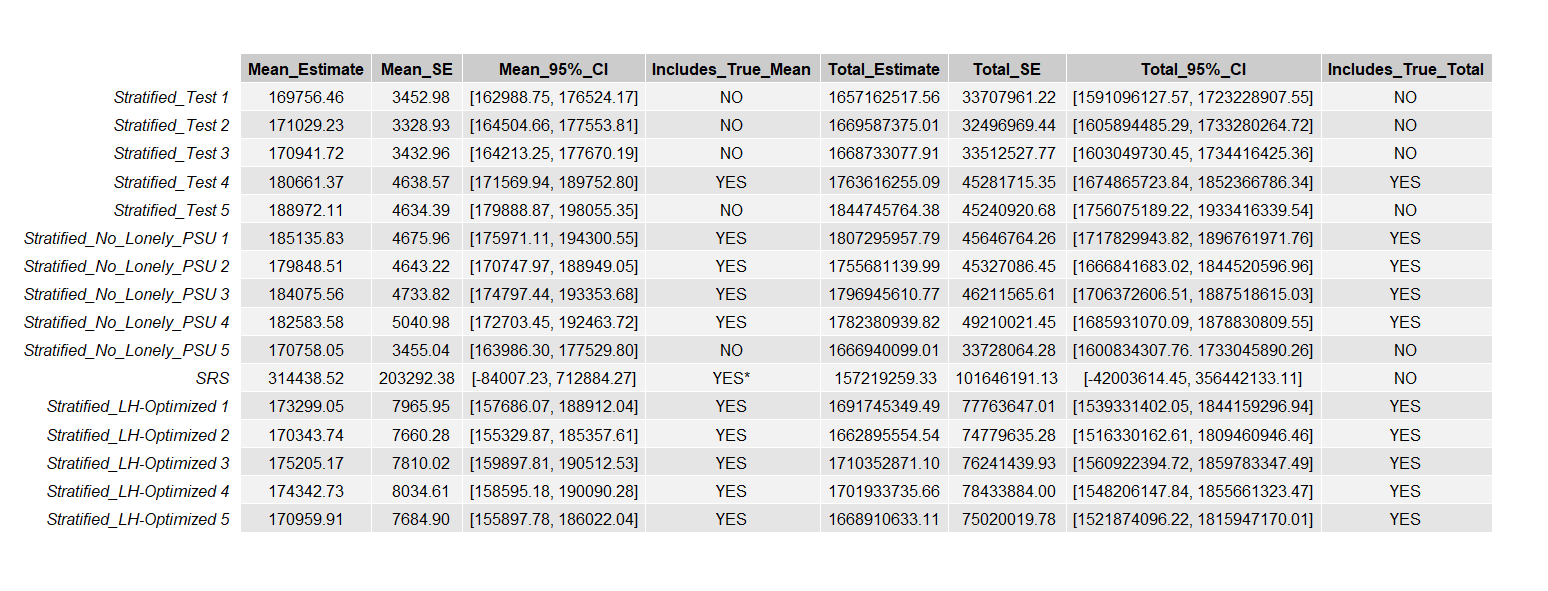
> df$Num[df$Stratum == 8] <- 248

> df$Num[df$Stratum == 9] <- 176

> df$Num[df$Stratum == 10] <- 135

> df$Num[df$Stratum == 11] <- 110

2.4 Estimations of Inventory for each sample: the population mean, the standard error of the mean, the 95% confidence interval for the mean, the population total, the standard error for the total, and the 95% confidence interval for the total.



A table showing the results of the analysis is shown above. The first 5 rows show the results of a stratified sampling procedure which used a ‘lonely PSU’ adjustment, allocating a single record to the highest-valued certainty stratum. The second set of 5 rows show the results of a stratified sampling procedure which did not employ a ‘lonely PSU’ adjustment, allocating two records to the highest-valued certainty stratum. The 11th row shows the results of an unstratified simple random sampling (SRS) procedure. Altogether, the first 11 rows represent a performance comparison to the results output by a stratified sampling design that employs the generalized Lavallee-Hidiroglou stratification method for skewed populations, allocating the 110 highest-valued records to the certainty stratum as determined by the optimization procedure. Although this strategy did result in broader confidence intervals and larger values of standard error (incurred by including more of the highly variant higher-valued records in the certainty stratum), it also resulted in a more accurate estimation, successfully including the population mean and total 100% of the time.

Using the generalized Lavallee-Hidiroglou stratification method for 5 sampling procedures, the mean of the estimate of mean, its standard error, as well as the mean of the estimate of total and its standard error are shown below:

> #Mean of the Total and Mean Estimates and their Standard Errors (across Samples assuming the Sizes allocated by LH Optimization)

>

> m.est\_of\_mean <- mean(173299.05, 170343.74, 175205.17, 174342.73, 170959.91)

> m.est\_of\_mean

[1] 173299.05

> m.est\_of\_mean\_SE <- mean(7965.95, 7660.28, 7810.02, 8034.61, 7684.90)

> m.est\_of\_mean\_SE

[1] 7965.95

> m.est\_of\_total <- mean(1691745349.49, 1662895554.54, 1710352871.10, 1701933735.66, 1668910633.11)

> m.est\_of\_total

[1] 1691745349.49

> m.est\_of\_total\_SE <- mean(77763647.01, 74779635.28, 76241439.93, 78433884.00, 75020019.78)

> m.est\_of\_total\_SE

[1] 77763647.01

2.5. Estimates of mean and total compared to the true values of mean and total.

When using the ‘lonely PSU’ adjustment (allocating a single record to the highest-valued certainty stratum), the confidence intervals of the estimations included the true values only 20% of the time.

When not using the ‘lonely PSU’ adjustment (allocating two records to the highest-valued certainty stratum), the confidence intervals of the estimations included the true values 80% of the time.

When applying optimized stratification using the generalized Lavallee-Hidiroglou method, (allocating 110 records to the highest-valued certainty stratum), the confidence intervals of the estimations included the true values 100% of the time.

2.6 Results of performing the analysis without stratification.

When no stratification procedure was applied, and a simple random sampling (SRS) of the population data was used, the confidence intervals of the estimations failed entirely to include the true values, capturing it 0%\* of the time. More precisely, the true mean was included by a completely uninformative confidence interval, ranging from [-84007.23, 712884.27]—when corrected for nonsensical values, [0, 712884.27]. Despite the similarly enormous confidence interval of the SRS estimate of total ([-42003614.45, 356442133.11], or [0, 356442133.11], it still failed to capture the true value.

#### Section 4. Conclusion

Stratification can greatly enhance the precision of one’s estimates. Dealing with highly skewed data presents particular challenges when determining the optimal partitioning of strata. Applications of the Lavallee-Hidiroglou method outperformed the cumulative root frequency method and geometric method when minimizing the overall coefficient of variation (relative root mean squared error) to obtain the most precise estimates. Wrapping the L-H function in a custom-written optimization function facilitated the process of identifying the most performant configuration of hyperparameters (including the number of records to include in the certainty stratum, and the number of strata to create). Although including the highest-valued records of this strongly right-skewed data in the certainty stratum resulted in larger standard error and broader confidence intervals than were obtained when limiting the number of these highly variant primary sampling units (PSUs), it also resulted in better estimations, capturing the true values of mean and total 100% of the time.

References

<https://www.r-project.ro/conference2016/presentations/Italy_Catanese1.pdf>

<https://www150.statcan.gc.ca/n1/pub/12-001-x/2011001/article/11447-eng.pdf>

<http://www.fao.org/docrep/009/a0198e/A0198E06.htm>

<https://enablement.acl.com/helpdocs/analytics/13/user-guide/en-us/Content/da_sampling_data/classical_variables_sampling.htm#navlink-5>

<https://www.researchgate.net/profile/M_Hidiroglou/publication/261873319_On_the_Stratification_of_Skewed_Populations/links/00b7d535b583baffae000000/On-the-Stratification-of-Skewed-Populations.pdf>

<https://www150.statcan.gc.ca/n1/en/pub/12-001-x/2004002/article/7749-eng.pdf?st=4wqQLPwS>

<http://2011.isiproceedings.org/papers/650214.pdf>

<https://pdfs.semanticscholar.org/3559/96951658d08596a44a63a36643b87937eec9.pdf>

Appendix. R Code

|  |
| --- |
|  |
|  |  |
|  | #IMPORTS################################################################## |
|  | library(readxl) |
|  | library(Hmisc) |
|  | library(plotrix) |
|  |  |
|  | library(ggplot2) |
|  |  |
|  | library(stratification) |
|  | library(sampling) |
|  | library(PracTools) |
|  | library(survey) |
|  |  |
|  | library(gridExtra) |
|  |  |
|  |  |
|  | #read individual sheet to dataframe object |
|  | df <- readxl::read\_excel('projectData.xlsx',sheet='projectData') |
|  | head(df) |
|  |  |
|  | #Summary Statistics######################################################## |
|  |  |
|  | summary(df) |
|  |  |
|  | nrow(df) |
|  | #Returns: 9762 |
|  |  |
|  | sum(df$inventory) |
|  | #Returns: 1754954823 |
|  |  |
|  | mean(df$inventory) |
|  | #Returns: 179774.1 |
|  |  |
|  | sd(df$inventory) |
|  | #Returns: 1573358 |
|  |  |
|  | plotrix::std.error(df$inventory) |
|  | #Returns: 15924.22 |
|  |  |
|  | Hmisc::describe(df) |
|  |  |
|  | #VISUALIZING VARIABLE OF INTEREST########################################### |
|  |  |
|  | #Histogram of inventory, excluding values above 100K |
|  | ggplot(df,aes(x=inventory)) + geom\_histogram(binwidth=1000,aes(fill=..count..)) + |
|  | xlab('Inventory Value') + ylab('Count') + ggtitle('Counts of Inventory Value: Excluding Values > 100K') + |
|  | xlim(c(0, 100000)) + ylim(c(0,450)) |
|  |  |
|  | #Histogram of inventory, excluding values above 1M |
|  | ggplot(df,aes(x=inventory)) + geom\_histogram(binwidth=1000,fill='blue',alpha=0.6) + |
|  | xlab('Inventory Value') + ylab('Count') + ggtitle('Counts of Inventory Value: Excluding Values > 1M') + |
|  | xlim(c(0, 1000000)) + ylim(c(0,450)) |
|  |  |
|  |  |
|  |  |
|  | ################################################################################################################################ |
|  |  |
|  | #Using highest valued Inventory records as the certainty stratum |
|  | # CF. https://enablement.acl.com/helpdocs/analytics/13/user-guide/en-us/Content/da\_sampling\_data/classical\_variables\_sampling.htm#navlink-5 |
|  |  |
|  | #NB: The stratification::strata.LH() function below accepts an index vector as input to the argument specifying the certainty stratum |
|  | cert\_vec <- list(top\_certainty\_vec <- c(which(df$inventory==max(df$inventory))), |
|  | top5\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:5],]$coID, |
|  | top10\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:10],]$coID, |
|  | top20\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:20],]$coID, |
|  | top50\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:50],]$coID, |
|  | top80\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:80],]$coID, |
|  | top90\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:90],]$coID, |
|  | top100\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:100],]$coID, |
|  | top110\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:110],]$coID, |
|  | top120\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:120],]$coID, |
|  | top150\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:150],]$coID, |
|  | top200\_certainty\_vec <- df[order(df$inventory, decreasing=T)[1:200],]$coID) |
|  |  |
|  | #NB: Must define cert\_vec in global environment before passing to minCV() function below. For common scoping issues: |
|  | # CF. https://stackoverflow.com/questions/28601959/error-object-not-found-in-nested-functions |
|  |  |
|  |  |
|  |  |
|  | #Generalized Lavallee-Hidiroglou Method -- applying Kozak's (2004) Algorithm############################################################ |
|  | # CF. https://www.rdocumentation.org/packages/stratification/versions/2.2-5/topics/strata.LH |
|  |  |
|  | #Function Optimizing the number of sampled strata and the best performing certainty stratum from the vector list above################## |
|  |  |
|  | #NB: Passing the vector c(0.5, 0, 0.5) to the 'alloc' argument of the stratification::strata.LH() function applies Neyman allocation |
|  | # Passing 'none' to the 'model' argument assumes that Y=X, i.e. that the variable being stratified is also the one being analyzed |
|  |  |
|  | minCV <- function(lo\_Ls, hi\_Ls, cert\_vec){ |
|  | CV.list<-numeric() |
|  | min.CV <- 999 |
|  | min.i <- 99 |
|  | min.j <- 99 |
|  |  |
|  | for (i in lo\_Ls:hi\_Ls){ |
|  | for (j in 1:length(cert\_vec)){ |
|  | k <- tryCatch(stratification::strata.LH(x=df$`inventory`, n=500, Ls=i, alloc=c(0.5,0,0.5), |
|  | certain=cert\_vec[j], model="none", algo="Kozak")$RRMSE, |
|  | warning=function(w){ |
|  | message("Warning: LH Algo failed. Some sampled strata < mininum Nh") |
|  | NA}) |
|  | if(is.na(k)){ |
|  | next |
|  | } |
|  | cat('Coefficient of Variation (RRMSE): ', k, '\n') |
|  | cat('Selected Number of Strata: ', i, '\n') |
|  | cat('Index of Certainty Stratum: ', j, '\n') |
|  |  |
|  | CV.list <- append(CV.list, k) |
|  | cat('All Coefficients of Variation: \n', CV.list, '\n') |
|  |  |
|  | min\_val <- min(CV.list, na.rm=TRUE) |
|  | if (min.CV > min\_val){ |
|  | min.CV <- min\_val |
|  | min.i <- i |
|  | min.j <- j |
|  | } |
|  | } |
|  | } |
|  | result\_list <- list('Minimum\_CV'=min.CV, 'Best\_LS'=min.i, 'Best\_CertStratum'=min.j) |
|  | return(result\_list) |
|  | } |
|  |  |
|  |  |
|  | #Implement Stratification Optimization######################################################################################## |
|  |  |
|  | best\_results <- minCV(5, 10, cert\_vec) |
|  | best\_results$Minimum\_CV |
|  | best\_results$Best\_LS |
|  | best\_results$Best\_CertStratum |
|  |  |
|  |  |
|  | #Best Stratification Configuration: Lavallee-Hidiroglou (1988) Method and Kozak's (2004) Algorithm############################ |
|  |  |
|  | Optim\_Config <- stratification::strata.LH(x=df$`inventory`, n=500, Ls=10, alloc=c(0.5,0,0.5), |
|  | certain=cert\_vec[9], model='none', algo='Kozak') |
|  |  |
|  | print(Optim\_Config) |
|  | plot(Optim\_Config) |
|  |  |
|  |  |
|  | #Performance Comparison: Gunning and Horgan (2004) Geometric Stratification Method |
|  |  |
|  | ############################################################################################################################# |
|  |  |
|  | Optim\_Geo <- stratification::strata.geo(x=df$`inventory`, n=500, Ls = 8, alloc = c(0.5, 0, 0.5), |
|  | certain=cert\_vec[9], model="none") |
|  |  |
|  | print(Optim\_Geo) |
|  | plot(Optim\_Geo) |
|  |  |
|  |  |
|  | ############################################################################################################################## |
|  |  |
|  | #Apply Optimum Stratification to Sampling and Estimation###################################################################### |
|  |  |
|  | #Preparing the data frame##################################################################################################### |
|  |  |
|  | #Identify boundary separating highest-valued certainty stratum from other strata |
|  | options(digits=15) |
|  | min(df[order(df$inventory, decreasing=T)[1:110],]$inventory) |
|  | #Returns 1372514.035 |
|  |  |
|  | #Assign Strata |
|  | df$Stratum <- NA |
|  | df$Stratum[df$`inventory` < 36703.82] <- 1 |
|  | df$Stratum[(df$`inventory` < 71655.62) & (df$`inventory` >= 36703.82)] <- 2 |
|  | df$Stratum[(df$`inventory` < 106848.40) & (df$`inventory` >= 71655.62)] <- 3 |
|  | df$Stratum[(df$`inventory` < 151104.80) & (df$`inventory` >= 106848.40)] <- 4 |
|  | df$Stratum[(df$`inventory` < 209954.79) & (df$`inventory` >= 151104.80)] <- 5 |
|  | df$Stratum[(df$`inventory` < 295186.09) & (df$`inventory` >= 209954.79)] <- 6 |
|  | df$Stratum[(df$`inventory` < 413551.11) & (df$`inventory` >= 295186.09)] <- 7 |
|  | df$Stratum[(df$`inventory` < 614205.40) & (df$`inventory` >= 413551.11)] <- 8 |
|  | df$Stratum[(df$`inventory` < 974662.93) & (df$`inventory` >= 614205.40)] <- 9 |
|  | df$Stratum[(df$`inventory` < 1372514.04) & (df$`inventory` >= 974662.93)] <- 10 |
|  | df$Stratum[(df$`inventory` < 105379553.91) & (df$`inventory` >= 1372514.04)] <- 11 |
|  |  |
|  | #Check if any NAs in Stratum column |
|  | any(is.na(df$Stratum)) |
|  |  |
|  | #Assign column for Finite Population Correction |
|  | df$Num <- NA |
|  | df$Num[df$Stratum == 1] <- 4346 |
|  | df$Num[df$Stratum == 2] <- 1047 |
|  | df$Num[df$Stratum == 3] <- 1341 |
|  | df$Num[df$Stratum == 4] <- 851 |
|  | df$Num[df$Stratum == 5] <- 723 |
|  | df$Num[df$Stratum == 6] <- 424 |
|  | df$Num[df$Stratum == 7] <- 361 |
|  | df$Num[df$Stratum == 8] <- 248 |
|  | df$Num[df$Stratum == 9] <- 176 |
|  | df$Num[df$Stratum == 10] <- 135 |
|  | df$Num[df$Stratum == 11] <- 110 |
|  |  |
|  | #Check if any NAs in df |
|  | any(is.na(df)) |
|  |  |
|  | #Specify vector of population stratum sizes, appending certainty stratum |
|  | Nh <- append(Optim\_Config$Nh, 110) |
|  |  |
|  | #Specify vector of population stratum standard deviations, appending 1 for certainty stratum |
|  | Sh <- append(sqrt(Optim\_Config$varh), 1) |
|  |  |
|  | #NB: Appending 1 as the certainty stratum standard deviation may result in an underestimation of variance for this severely right-skewed population. |
|  | # See results of sampling procedures #1-10 below, which serve as a performance comparison, assigning only 1 or 2 units to the 'certainty' stratum. |
|  | # The results of procedures #12-16 accept the stratum sample sizes determined by LH-Optimization, assigning all 110 highest-valued records to the 'certainty' stratum. |
|  |  |
|  |  |
|  | #Neyman Allocation to determine strata sizes in sample of size n = 500 |
|  | PracTools::strAlloc(n.tot=500, Nh=Nh, Sh=Sh, alloc='neyman') |
|  | #Returns sample stratum sizes of (100, 38, 43, 39, 41, 39, 43, 50, 60, 47, 0) |
|  |  |
|  | #Run the allocation again for a sample of size 499, reserving 1 unit for the certainty stratum |
|  | Nh <- Optim\_Config$Nh |
|  | Sh <- sqrt(Optim\_Config$varh) |
|  | PracTools::strAlloc(n.tot=499, Nh=Nh, Sh=Sh, alloc='neyman') |
|  | #Returns sample stratum sizes of (101, 37, 43, 39, 41, 38, 43, 50, 60, 47) |
|  |  |
|  | #Adjusted Neyman Allocation, including certainty stratum |
|  | Ney\_Alloc <- c(101, 37, 43, 39, 41, 38, 43, 50, 60, 47, 1) |
|  |  |
|  |  |
|  |  |
|  |  |
|  | ############################################################################################################################# |
|  |  |
|  | #PASS 1 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- IMPLEMENTING LONELY PSU ADJUSTMENT |
|  | ############################################################################################################################# |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(222) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_1 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_1 <- Ney\_Samp\_1[, !duplicated(colnames(Ney\_Samp\_1))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_1)[2] <- "coID" |
|  | Ney\_Samp\_1\_merged <- merge(x = df, y = Ney\_Samp\_1) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_1\_merged <- Ney\_Samp\_1\_merged[order(Ney\_Samp\_1\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_1 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_1\_merged, fpc = ~Num) |
|  |  |
|  | #Adjust for single-PSU certainty stratum |
|  | options(survey.lonely.psu = "certainty") |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_1) |
|  | #Returns: mean SE |
|  | # inventory 169756.4553944 3452.97697 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_1)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 162988.744885283 176524.165903571 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_1) |
|  | #Returns: total SE |
|  | # inventory 1657162517.56 33707961.22347 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_1)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1591096127.57013 1723228907.55066 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 1754954822.94687######### |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 2 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- IMPLEMENTING LONELY PSU ADJUSTMENT |
|  | ############################################################################################################################# |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(223) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_2 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_2 <- Ney\_Samp\_2[, !duplicated(colnames(Ney\_Samp\_2))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_2)[2] <- "coID" |
|  | Ney\_Samp\_2\_merged <- merge(x = df, y = Ney\_Samp\_2) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_2\_merged <- Ney\_Samp\_2\_merged[order(Ney\_Samp\_2\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_2 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_2\_merged, fpc = ~Num) |
|  |  |
|  | #Adjust for single-PSU certainty stratum |
|  | options(survey.lonely.psu = "certainty") |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_2) |
|  | #Returns: mean SE |
|  | # inventory 171029.233252 3328.92537 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_2)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 164504.659423391 177553.807080663 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_2) |
|  | #Returns: total SE |
|  | # inventory 1669587375.006 32496969.44308 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_2)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1605894485.29115 1733280264.72143 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 1754954822.94687################ |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 3 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- IMPLEMENTING LONELY PSU ADJUSTMENT |
|  | ############################################################################################################################# |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(224) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_3 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_3 <- Ney\_Samp\_3[, !duplicated(colnames(Ney\_Samp\_3))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_3)[2] <- "coID" |
|  | Ney\_Samp\_3\_merged <- merge(x = df, y = Ney\_Samp\_3) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_3\_merged <- Ney\_Samp\_3\_merged[order(Ney\_Samp\_3\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_3 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_3\_merged, fpc = ~Num) |
|  |  |
|  | #Adjust for single-PSU certainty stratum |
|  | options(survey.lonely.psu = "certainty") |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_3) |
|  | #Returns: mean SE |
|  | # inventory 170941.7207444 3432.95716 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_3)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 164213.248356339 177670.193132409 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_3) |
|  | #Returns: total SE |
|  | # inventory 1668733077.907 33512527.76587 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_3)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1603049730.45458 1734416425.35857 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 1754954822.94687################ |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 4 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- IMPLEMENTING LONELY PSU ADJUSTMENT |
|  | ############################################################################################################################# |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(225) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_4 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_4 <- Ney\_Samp\_4[, !duplicated(colnames(Ney\_Samp\_4))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_4)[2] <- "coID" |
|  | Ney\_Samp\_4\_merged <- merge(x = df, y = Ney\_Samp\_4) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_4\_merged <- Ney\_Samp\_4\_merged[order(Ney\_Samp\_4\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_4 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_4\_merged, fpc = ~Num) |
|  |  |
|  | #Adjust for single-PSU certainty stratum |
|  | options(survey.lonely.psu = "certainty") |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_4) |
|  | #Returns: mean SE |
|  | # inventory 180661.3660204 4638.56949 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_4)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 171569.936881626 189752.795159095 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_4) |
|  | #Returns: total SE |
|  | # inventory 1763616255.091 45281715.35415 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_4)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1674865723.83843 1852366786.34309 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################ |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 5 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- IMPLEMENTING LONELY PSU ADJUSTMENT |
|  | ############################################################################################################################# |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(226) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_5 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_5 <- Ney\_Samp\_5[, !duplicated(colnames(Ney\_Samp\_5))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_5)[2] <- "coID" |
|  | Ney\_Samp\_5\_merged <- merge(x = df, y = Ney\_Samp\_5) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_5\_merged <- Ney\_Samp\_5\_merged[order(Ney\_Samp\_5\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_5 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_5\_merged, fpc = ~Num) |
|  |  |
|  | #Adjust for single-PSU certainty stratum |
|  | options(survey.lonely.psu = "certainty") |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_5) |
|  | #Returns: mean SE |
|  | # inventory 188972.1127207 4634.39056 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_5)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # q inventory 179888.874126264 198055.351315211 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_5) |
|  | #Returns: total SE |
|  | # inventory 1844745764.38 45240920.6795 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_5)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1756075189.22059 1933416339.53909 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 1754954822.94687######### |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | ############################################################################################################################ |
|  |  |
|  | #PASS 6 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- NO LONELY PSU CERTAINTY STRATUM ADJUSTMENT |
|  | ############################################################################################################################ |
|  |  |
|  | #Run the allocation again for a sample of size 498, reserving 2 units for the certainty stratum |
|  | Nh <- Optim\_Config$Nh |
|  | Sh <- sqrt(Optim\_Config$varh) |
|  | PracTools::strAlloc(n.tot=498, Nh=Nh, Sh=Sh, alloc='neyman') |
|  | #returns sample stratum sizes of (101, 37, 43, 39, 41, 38, 42, 50, 60, 47) |
|  |  |
|  | #adjusted Neyman Allocation, including certainty stratum |
|  | Ney\_Alloc\_2 <- c(101, 37, 43, 39, 41, 38, 43, 50, 60, 47, 2) |
|  |  |
|  |  |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(227) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_6 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_2, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_6 <- Ney\_Samp\_6[, !duplicated(colnames(Ney\_Samp\_6))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_6)[2] <- "coID" |
|  | Ney\_Samp\_6\_merged <- merge(x = df, y = Ney\_Samp\_6) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_6\_merged <- Ney\_Samp\_6\_merged[order(Ney\_Samp\_6\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_6 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_6\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_6) |
|  | #Returns: mean SE |
|  | # inventory 185135.8284971 4675.96438 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_6)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 175971.106721974 194300.550272168 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_6) |
|  | #Returns: total SE |
|  | # inventory 1807295957.788 45646764.26414 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_6)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1717829943.81991 1896761971.7569 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 7 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- NO LONELY PSU CERTAINTY STRATUM ADJUSTMENT |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(228) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_7 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_2, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_7 <- Ney\_Samp\_7[, !duplicated(colnames(Ney\_Samp\_7))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_7)[2] <- "coID" |
|  | Ney\_Samp\_7\_merged <- merge(x = df, y = Ney\_Samp\_7) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_7\_merged <- Ney\_Samp\_7\_merged[order(Ney\_Samp\_7\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_7 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_7\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_7) |
|  | #Returns: mean SE |
|  | # inventory 179848.508501 4643.21721 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_7)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 170747.969987538 188949.047014456 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_7) |
|  | #Returns: total SE |
|  | # inventory 1755681139.987 45327086.45115 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_7)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1666841683.01835 1844520596.95512 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 8 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- NO LONELY PSU CERTAINTY STRATUM ADJUSTMENT |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(229) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_8 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_2, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_8 <- Ney\_Samp\_8[, !duplicated(colnames(Ney\_Samp\_8))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_8)[2] <- "coID" |
|  | Ney\_Samp\_8\_merged <- merge(x = df, y = Ney\_Samp\_8) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_8\_merged <- Ney\_Samp\_8\_merged[order(Ney\_Samp\_8\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_8 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_8\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_8) |
|  | #Returns: mean SE |
|  | # inventory 184075.5593905 4733.82151 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_8)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 174797.439716593 193353.679064313 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_8) |
|  | #Returns: total SE |
|  | # inventory 1796945610.77 46211565.60562 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_8)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1706372606.51338 1887518615.02582 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 9 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- NO LONELY PSU CERTAINTY STRATUM ADJUSTMENT |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(230) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_9 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_2, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_9 <- Ney\_Samp\_9[, !duplicated(colnames(Ney\_Samp\_9))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_9)[2] <- "coID" |
|  | Ney\_Samp\_9\_merged <- merge(x = df, y = Ney\_Samp\_9) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_9\_merged <- Ney\_Samp\_9\_merged[order(Ney\_Samp\_9\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_9 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_9\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_9) |
|  | #Returns: mean SE |
|  | # inventory 182583.5832636 5040.97741 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_9)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 172703.449097735 192463.717429423 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_9) |
|  | #Returns: total SE |
|  | # inventory 1782380939.819 49210021.45333 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_9)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1685931070.09209 1878830809.54603 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 10 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- NO LONELY PSU CERTAINTY STRATUM ADJUSTMENT |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(231) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_10 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_2, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_10 <- Ney\_Samp\_10[, !duplicated(colnames(Ney\_Samp\_10))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_10)[2] <- "coID" |
|  | Ney\_Samp\_10\_merged <- merge(x = df, y = Ney\_Samp\_10) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_10\_merged <- Ney\_Samp\_10\_merged[order(Ney\_Samp\_10\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_10 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_10\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_10) |
|  | #Returns: mean SE |
|  | # inventory 170758.0515275 3455.03629 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_10)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 163986.304831325 177529.798223672 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 179774.106017914########### |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_10) |
|  | #Returns: total SE |
|  | # inventory 1666940099.011 33728064.2754 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_10)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1600834307.7634 1733045890.25948 |
|  |  |
|  | #DOES NOT CONTAIN TRUE VALUE of 1754954822.94687############ |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | ############################################################################################################################# |
|  |  |
|  | #PASS 11: PERFORMANCE COMPARISON with UNSTRATIFIED SIMPLE RANDOM SAMPLING |
|  | ############################################################################################################################# |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(1) |
|  |  |
|  | #SRS of Size 500 |
|  | srs\_df <- df[sample(nrow(df), 500), ] |
|  |  |
|  | #SRS design object |
|  | mydesign\_srs <- survey::svydesign(id = ~1, data = srs\_df) |
|  |  |
|  | #SRS mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_srs) |
|  | #Returns: mean SE |
|  | # inventory 314438.5186579 203292.38226 |
|  |  |
|  | #confidence interval of SRS mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_srs)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory -84007.2288961298 712884.266211934 |
|  |  |
|  | #HUGE UNINFORMATIVE CONFIDENCE INTERVAL CONTAINS TRUE VALUE of 179774.106017914### |
|  |  |
|  | #SRS estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_srs) |
|  | #Returns: total SE |
|  | # inventory 157219259.329 101646191.1282 |
|  |  |
|  | #Confidence interval of SRS estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_srs)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory -42003614.4480649 356442133.105967 |
|  |  |
|  | #HUGE UNINFORMATIVE CONFIDENCE INTERVAL STILL DOES NOT CONTAIN TRUE VALUE of 1754954822.94687### |
|  |  |
|  |  |
|  |  |
|  |  |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #PASS 12 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- ASSUMING SAMPLE STRATUM SIZES ASSIGNED BY LH OPTIMIZATION |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #adjusted Neyman Allocation, assuming values provided by the LH optimization |
|  | Ney\_Alloc\_3 <- append(Optim\_Config$nh, 110) |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(232) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_12 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_3, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_12 <- Ney\_Samp\_12[, !duplicated(colnames(Ney\_Samp\_12))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_12)[2] <- "coID" |
|  | Ney\_Samp\_12\_merged <- merge(x = df, y = Ney\_Samp\_12) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_12\_merged <- Ney\_Samp\_12\_merged[order(Ney\_Samp\_12\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_12 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_12\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_12) |
|  | #Returns: mean SE |
|  | # inventory 173299.0523965 7965.95442 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_12)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 157686.068638111 188912.036154827 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_12) |
|  | #Returns: total SE |
|  | # inventory 1691745349.494 77763647.01153 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_12)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1539331402.04524 1844159296.94342 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 13 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- ASSUMING SAMPLE STRATUM SIZES ASSIGNED BY LH OPTIMIZATION |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #adjusted Neyman Allocation, assuming values provided by the LH optimization |
|  | Ney\_Alloc\_3 <- append(Optim\_Config$nh, 110) |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(233) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_13 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_3, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_13 <- Ney\_Samp\_13[, !duplicated(colnames(Ney\_Samp\_13))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_13)[2] <- "coID" |
|  | Ney\_Samp\_13\_merged <- merge(x = df, y = Ney\_Samp\_13) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_13\_merged <- Ney\_Samp\_13\_merged[order(Ney\_Samp\_13\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_13 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_13\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_13) |
|  | #Returns: mean SE |
|  | # inventory 170343.7363795 7660.27815 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_13)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 155329.867097901 185357.605661186 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_13) |
|  | #Returns: total SE |
|  | # inventory 1662895554.537 74779635.28079 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_13)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1516330162.60971 1809460946.4645 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 14 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- ASSUMING SAMPLE STRATUM SIZES ASSIGNED BY LH OPTIMIZATION |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #adjusted Neyman Allocation, assuming values provided by the LH optimization |
|  | Ney\_Alloc\_3 <- append(Optim\_Config$nh, 110) |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(234) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_14 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_3, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_14 <- Ney\_Samp\_14[, !duplicated(colnames(Ney\_Samp\_14))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_14)[2] <- "coID" |
|  | Ney\_Samp\_14\_merged <- merge(x = df, y = Ney\_Samp\_14) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_14\_merged <- Ney\_Samp\_14\_merged[order(Ney\_Samp\_14\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_14 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_14\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_14) |
|  | #Returns: mean SE |
|  | # inventory 175205.17016 7810.02253 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_14)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 159897.807284972 190512.533034961 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_14) |
|  | #Returns: total SE |
|  | # inventory 1710352871.102 76241439.92664 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_14)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1560922394.7159 1859783347.48729 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 15 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- ASSUMING SAMPLE STRATUM SIZES ASSIGNED BY LH OPTIMIZATION |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #adjusted Neyman Allocation, assuming values provided by the LH optimization |
|  | Ney\_Alloc\_3 <- append(Optim\_Config$nh, 110) |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(235) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_15 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_3, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_15 <- Ney\_Samp\_15[, !duplicated(colnames(Ney\_Samp\_15))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_15)[2] <- "coID" |
|  | Ney\_Samp\_15\_merged <- merge(x = df, y = Ney\_Samp\_15) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_15\_merged <- Ney\_Samp\_15\_merged[order(Ney\_Samp\_15\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_15 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_15\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_15) |
|  | #Returns: mean SE |
|  | # inventory 174342.7305529 8034.61217 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_15)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 158595.180070016 190090.281035698 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_15) |
|  | #Returns: total SE |
|  | # inventory 1701933735.657 78433884.00301 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_15)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1548206147.8435 1855661323.47048 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #PASS 16 OF STRATIFIED SAMPLING ESTIMATION of MEAN and TOTAL -- ASSUMING SAMPLE STRATUM SIZES ASSIGNED BY LH OPTIMIZATION |
|  | ############################################################################################################################ |
|  |  |
|  |  |
|  | #adjusted Neyman Allocation, assuming values provided by the LH optimization |
|  | Ney\_Alloc\_3 <- append(Optim\_Config$nh, 110) |
|  |  |
|  | #Set Random Sampling Seed |
|  | set.seed(236) |
|  |  |
|  | #Sampling using Neyman Allocation |
|  | Ney\_Samp\_16 <- sampling::strata(df, stratanames='Stratum', size=Ney\_Alloc\_3, method="srswor") |
|  |  |
|  | #Drop duplicated column |
|  | Ney\_Samp\_16 <- Ney\_Samp\_16[, !duplicated(colnames(Ney\_Samp\_16))] |
|  |  |
|  | #Rename ID column to match original data frame, for merging |
|  | colnames(Ney\_Samp\_16)[2] <- "coID" |
|  | Ney\_Samp\_16\_merged <- merge(x = df, y = Ney\_Samp\_16) |
|  |  |
|  | #sort by Stratum |
|  | Ney\_Samp\_16\_merged <- Ney\_Samp\_16\_merged[order(Ney\_Samp\_16\_merged$Stratum),] |
|  |  |
|  | #Neyman stratified design object |
|  | mydesign\_16 <- survey::svydesign(id = ~1, strata = ~Stratum, data = Ney\_Samp\_16\_merged, fpc = ~Num) |
|  |  |
|  | #Neyman stratified mean estimate and SE |
|  | survey::svymean(~`inventory`, design = mydesign\_16) |
|  | #Returns: mean SE |
|  | # inventory 170959.9091492 7684.90266 |
|  |  |
|  | #Confidence interval of the mean estimate |
|  | confint(survey::svymean(~`inventory`, design = mydesign\_16)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 155897.77670773 186022.04159064 |
|  |  |
|  | #CONTAINS TRUE VALUE of 179774.106017914################ |
|  |  |
|  | #Neyman stratified estimate of total and SE |
|  | survey::svytotal(~`inventory`, design = mydesign\_16) |
|  | #Returns: total SE |
|  | # inventory 1668910633.114 75020019.78265 |
|  |  |
|  | #Confidence interval of the estimate of total |
|  | confint(survey::svytotal(~`inventory`, design = mydesign\_16)) |
|  | #Returns: 2.5 % 97.5 % |
|  | # inventory 1521874096.22086 1815947170.00782 |
|  |  |
|  | #CONTAINS TRUE VALUE of 1754954822.94687################# |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | ################################################################################################################################ |
|  |  |
|  | #SUMMARY OF RESULTS############################################################################################################## |
|  |  |
|  | #Mean of the Total and Mean Estimates and their Standard Errors (across Samples assuming the Sizes allocated by LH Optimization) |
|  |  |
|  | m.est\_of\_mean <- mean(173299.05, 170343.74, 175205.17, 174342.73, 170959.91) |
|  | #Returns: 173299.05 |
|  |  |
|  | m.est\_of\_mean\_SE <- mean(7965.95, 7660.28, 7810.02, 8034.61, 7684.90) |
|  | #Returns: 7965.95 |
|  |  |
|  | m.est\_of\_total <- mean(1691745349.49, 1662895554.54, 1710352871.10, 1701933735.66, 1668910633.11) |
|  | #Returns: 1691745349.49 |
|  |  |
|  | m.est\_of\_total\_SE <- mean(77763647.01, 74779635.28, 76241439.93, 78433884.00, 75020019.78) |
|  | #Returns: 77763647.01 |
|  |  |
|  |  |
|  |  |
|  |  |
|  | #VISUALIZE TABLE OF RESULTS######################################################################################################################### |
|  |  |
|  | val\_df <- setNames(data.frame(matrix(ncol = 8, nrow = 16)), |
|  | c('Mean\_Estimate','Mean\_SE','Mean\_95%\_CI','Includes\_True\_Mean','Total\_Estimate','Total\_SE','Total\_95%\_CI','Includes\_True\_Total')) |
|  |  |
|  | rownames(val\_df) <- c(paste('Stratified\_Test',1:5), paste('Stratified\_No\_Lonely\_PSU',1:5), 'SRS', paste('Stratified\_LH-Optimized',1:5)) |
|  |  |
|  | val\_df[,1] <- c(169756.46, 171029.23, 170941.72, 180661.37, 188972.11, |
|  | 185135.83, 179848.51, 184075.56, 182583.58, 170758.05, |
|  | 314438.52, |
|  | 173299.05, 170343.74, 175205.17, 174342.73, 170959.91) |
|  |  |
|  | val\_df[,2] <- c(3452.98, 3328.93, 3432.96, 4638.57, 4634.39, |
|  | 4675.96, 4643.22, 4733.82, 5040.98, 3455.04, |
|  | 203292.38, |
|  | 7965.95, 7660.28, 7810.02, 8034.61, 7684.90) |
|  |  |
|  | val\_df[,3] <- c('[162988.75, 176524.17]','[164504.66, 177553.81]','[164213.25, 177670.19]','[171569.94, 189752.80]','[179888.87, 198055.35]', |
|  | '[175971.11, 194300.55]','[170747.97, 188949.05]','[174797.44, 193353.68]','[172703.45, 192463.72]','[163986.30, 177529.80]', |
|  | '[-84007.23, 712884.27]', |
|  | '[157686.07, 188912.04]','[155329.87, 185357.61]','[159897.81, 190512.53]','[158595.18, 190090.28]','[155897.78, 186022.04]') |
|  |  |
|  | val\_df[,4] <- c('NO','NO','NO','YES','NO', |
|  | 'YES','YES','YES','YES','NO', |
|  | 'YES\*', |
|  | 'YES','YES','YES','YES','YES') |
|  |  |
|  | val\_df[,5] <- c(1657162517.56, 1669587375.01, 1668733077.91, 1763616255.09, 1844745764.38, |
|  | 1807295957.79, 1755681139.99, 1796945610.77, 1782380939.82, 1666940099.01, |
|  | 157219259.33, |
|  | 1691745349.49, 1662895554.54, 1710352871.10, 1701933735.66, 1668910633.11) |
|  |  |
|  | val\_df[,6] <- c(33707961.22, 32496969.44, 33512527.77, 45281715.35, 45240920.68, |
|  | 45646764.26, 45327086.45, 46211565.61, 49210021.45, 33728064.28, |
|  | 101646191.13, |
|  | 77763647.01, 74779635.28, 76241439.93, 78433884.00, 75020019.78) |
|  |  |
|  | val\_df[,7] <- c('[1591096127.57, 1723228907.55]','[1605894485.29, 1733280264.72]','[1603049730.45, 1734416425.36]','[1674865723.84, 1852366786.34]','[1756075189.22, 1933416339.54]', |
|  | '[1717829943.82, 1896761971.76]','[1666841683.02, 1844520596.96]','[1706372606.51, 1887518615.03]','[1685931070.09, 1878830809.55]','[1600834307.76. 1733045890.26]', |
|  | '[-42003614.45, 356442133.11]', |
|  | '[1539331402.05, 1844159296.94]','[1516330162.61, 1809460946.46]','[1560922394.72, 1859783347.49]','[1548206147.84, 1855661323.47]','[1521874096.22, 1815947170.01]') |
|  |  |
|  | val\_df[,8] <- c('NO','NO','NO','YES','NO', |
|  | 'YES','YES','YES','YES','NO', |
|  | 'NO', |
|  | 'YES','YES','YES','YES','YES') |
|  |  |
|  |  |
|  | val\_tbl <- tableGrob(val\_df) |
|  |  |
|  | grid.arrange(val\_tbl) |