library(ggplot2)

library(tidyquant)

library(readxl)

library(ExactCIdiff)

library(pairwiseCI)

library(plotrix)

#The negative quality metric is proportion of patients receiving low quality treatment. If a positive quality metric is used, the colors will need to be adjusted.

#Data should include 6 variables ("Facility", "Volume", "Open", "Close", "High", "Low")

# and sorted in acending order by "Open".

#Facility is the faciltiy ID.

#OpenVolume is the facility denominator at Open

#OpenEvents is the facility numerator at Open

#Open is the baseline period performance (%).

#CloseVolume is the facility denominator at Close

#CloseEvents is the facility numerator at Close

#Close is the follow-up period performance (%).

#High is the greater of Open and Close.

#Low is the lower of Open and Close.

#Reads in the data

url <- "http://med.stanford.edu/content/dam/sm/s-spire/documents/Delta-Plot-Demo-Data.xlt"

destfile <- "Delta\_Plot\_Demo\_Data.xls"

curl::curl\_download(url, destfile)

exampleData <- read\_excel(destfile)

#Removes facilities with <5 observations in either the baseline of follow-up period - this step is optional

aa<-exampleData$OpenVolume<5 | exampleData$CloseVolume<5

exampleData<-exampleData[-aa, ]

#Calculates and plots the 95% CI of change in proportion (Figure 1 in the paper)

exampleData$Change<-exampleData$Open - exampleData$Close

pihata <- exampleData$Open/100

pihatb <- exampleData$Close/100

n\_a <- exampleData$OpenVolume

n\_b <- exampleData$CloseVolume

se <- (pihata\*(1-pihata)/n\_a + pihatb\*(1-pihatb)/n\_b)^0.5

exampleData$LL<-pihata-pihatb-1.96\*se

exampleData$UL<-pihata-pihatb+1.96\*se

attach(exampleData)

exampleDataCIS<-exampleData[order(Change), ]

detach(exampleData)

exampleDataCIS$Facility2<-1:length(exampleDataCIS$Facility) #Used to sort the plot by magnitude of change, but alters the orginal facility ID numbers

ChangeinPerformance<-ggplot(exampleDataCIS) + geom\_point(aes(x = Facility2, y = Change, size = OpenVolume))+geom\_linerange(aes(x = Facility2,ymin=LL\*100, ymax=UL\*100)) +labs(title="95% CIs of Percent Change in Low Quality Care in Year 1 for Facilities")+ ylab("Percent (95% CI)of Patients Receiving Low Quality Treatment")+xlab("Facility ID")

ChangeinPerformance

#Plots initial performance in 120 facilities

InitialPerformance<-ggplot(exampleData) + geom\_point(aes(x = Facility, y = Open))+labs(title="Distributon of a Low Quality Care in Year 1 for 120 Facilities")+ ylab("Percent Patients Receiving Low Quality Treatment")

InitialPerformance

#Same plot as above but scaled by denominator OpenVolume. Could be scaled to closed volume if desired.

InitialPerformance<-ggplot(exampleData) + geom\_point(aes(x = Facility, y = Open, size = OpenVolume))+labs(title="Distributon of a Low Quality Care in Year 1 for 120 Facilities")+ ylab("Percent Patients Receiving Low Quality Treatment")

InitialPerformance

#Figure 2 Delta plot - note that in this case, lower is better (green)

exampleData$chg <- ifelse(Cl(exampleData) > Op(exampleData), "up", "dn")

exampleData$width <- exampleData$OpenVolume/mean(exampleData$OpenVolume)

exampleData$flat\_bar <- exampleData[, "High"] == exampleData[, "Low"]

deltaPlot <- ggplot(exampleData, aes(x=Facility))+geom\_linerange(aes(ymin=Low, ymax=High)) +theme\_bw() +

 labs(title="Distribution of Initial Performance (black dots), and 2-Year Improvements (Green) and Worsening (Red) of Low Quality Care for 120 Facilities")+ ylab("Percent Patients Receiving Low Quality Treatment")+xlab("Facility") +

 geom\_rect(aes(xmin = Facility - width/2 \* 0.9, xmax = Facility + width/2 \* 0.9, ymin = pmin(Open, Close), ymax = pmax(Open, Close), fill = chg) , linetype = 1) + guides(fill = FALSE, colour = FALSE) + scale\_fill\_manual(values = c("dn" = "darkgreen", "up" = "darkred"))

if (any(exampleData$flat\_bar)) deltaPlot <- deltaPlot + geom\_segment(data = exampleData[exampleData$flat\_bar,], aes(x = Facility - width / 2 \* 0.9, y = Close, yend = Close, xend = Facility + width / 2 \* 0.9))

deltaPlot+geom\_point(aes(x = Facility, y = Open, size = OpenVolume))#theme(legend.position="none")

#Figure 3 - Same as above but restricted to 62 faclities with >20 denominator cases

big<-exampleData$OpenVolume>20

table(big)

exampleData2<-exampleData[big,]

exampleData2$chg <- ifelse(Cl(exampleData2) > Op(exampleData2), "up", "dn")

exampleData2$width <- exampleData2$OpenVolume/mean(exampleData2$OpenVolume)

exampleData2$flat\_bar <- exampleData2[, "High"] == exampleData2[, "Low"]

deltaPlot <- ggplot(exampleData2, aes(x=Facility))+geom\_linerange(aes(ymin=Low, ymax=High)) +theme\_bw() +

 labs(title="Distribution of Initial Performance (black dots), and 2-Year Improvements (Green) and Worsening (Red) of Low Quality Care for 62 Facilities with >20 Denominators Cases in Year 1")+ ylab("Percent Patients Receiving Low Quality Treatment")+xlab("Facility") +

 geom\_rect(aes(xmin = Facility - width/2 \* 0.9, xmax = Facility + width/2 \* 0.9, ymin = pmin(Open, Close), ymax = pmax(Open, Close), fill = chg) , linetype = 1) + guides(fill = FALSE, colour = FALSE) + scale\_fill\_manual(values = c("dn" = "darkgreen", "up" = "darkred"))

if (any(exampleData2$flat\_bar)) deltaPlot <- deltaPlot + geom\_segment(data = exampleData2[exampleData2$flat\_bar,], aes(x = Facility - width / 2 \* 0.9, y = Close, yend = Close, xend = Facility + width / 2 \* 0.9))

deltaPlot+geom\_point(aes(x = Facility, y = Open, size = OpenVolume))#+ theme(legend.position="none")