Section 5.5.1 - Acoustic Fire Extinguisher

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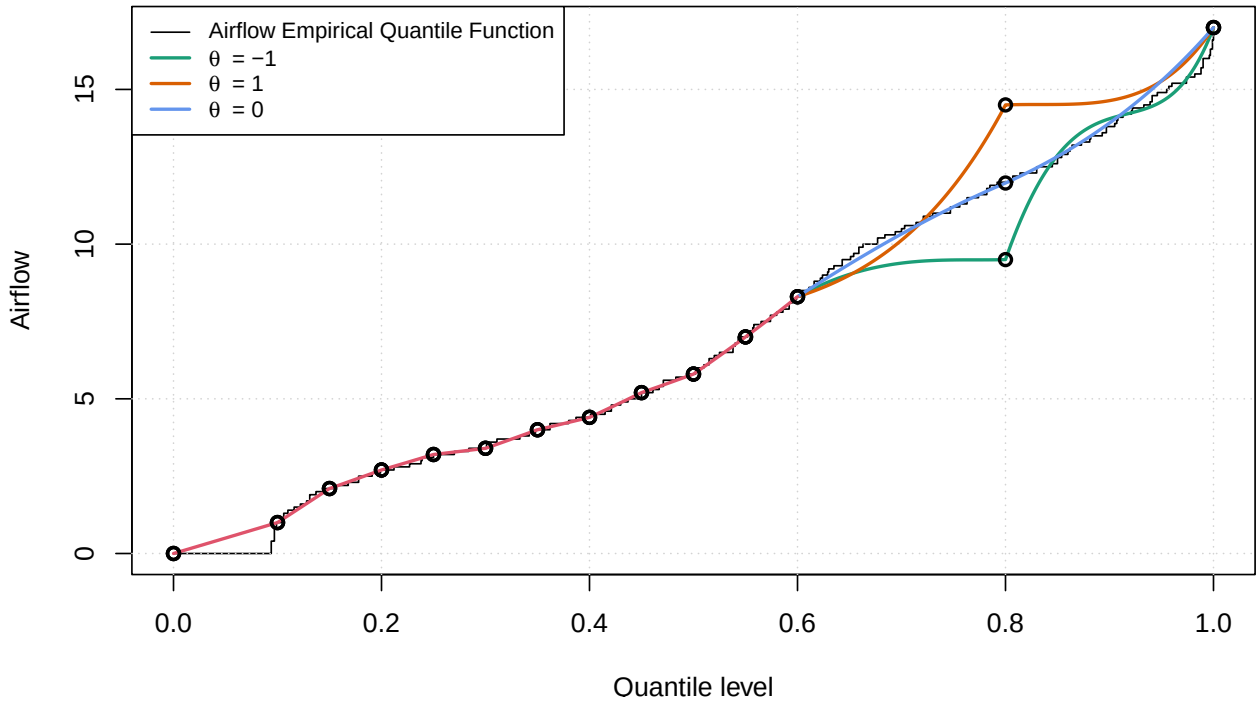
```
# Loading the data

load(file="../../useCases/acousticFireExtinguisher/data/AFE_data.RData")
load(file="results/AFE_pertRes.RData")
```

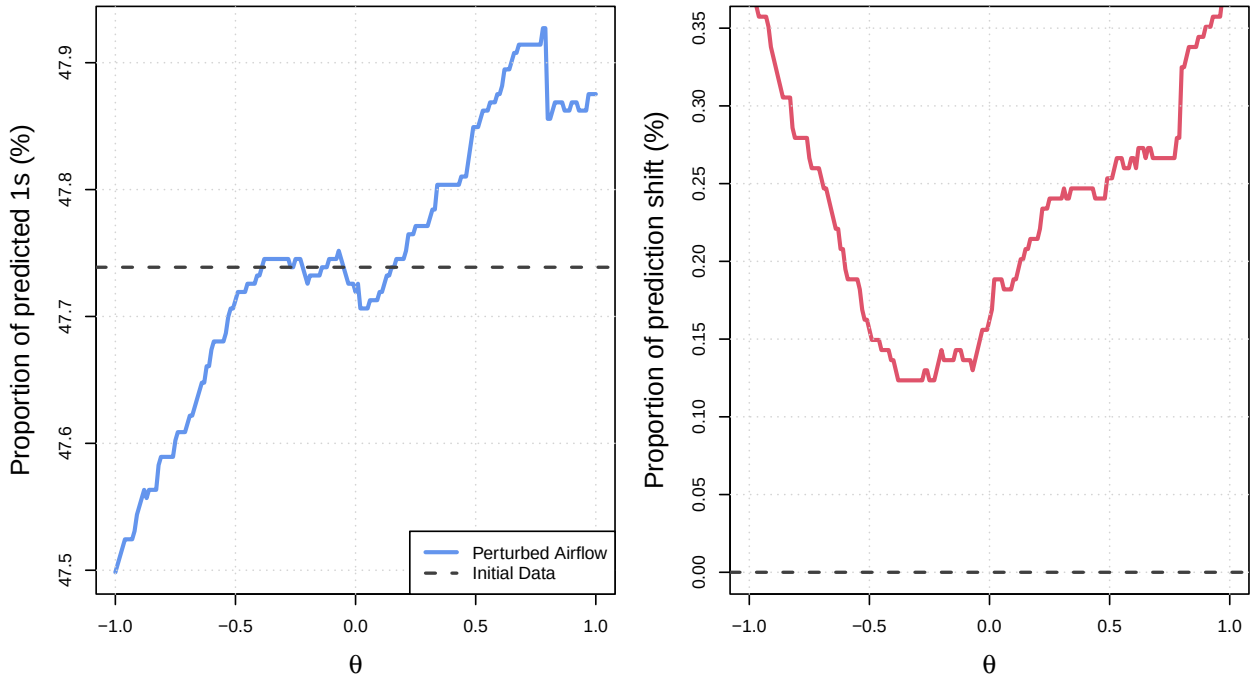
```
#Data Prep
y.pert=fire.rob$pred.pert[,-1]
x.dist=fire.rob$dist.pert[,-1]
pred.change=t(apply(y.pert, 1, function(x) x!=fire.rob$Y.init))

#Colors

coul <- brewer.pal(6, "Dark2")

coul[3]="cornflowerblue"

#Perts
minPert<-fire.rob$res.pert[[1]]
midPert<-fire.rob$res.pert[[100]]
maxPert<-fire.rob$res.pert[[201]]

seq_pert=seq(0,1,0.001)

minPert.Y<-interpretability:::evaluate.qcwProj(minPert, seq_pert)
midPert.Y<-interpretability:::evaluate.qcwProj(midPert, seq_pert)
maxPert.Y<-interpretability:::evaluate.qcwProj(maxPert, seq_pert)

minPert.interpol.x<-sort(unique(as.numeric(minPert$intervals[,c(1,2)])))
minPert.interpol.y<-sort(unique(as.numeric(minPert$intervals[,c(3,4)])))
minPert.interpol.y<-(minPert.interpol.y-1)*((minPert$max.P-minPert$min.P)/2)+minPert$max.P

midPert.interpol.x<-sort(unique(as.numeric(midPert$intervals[,c(1,2)])))
midPert.interpol.y<-sort(unique(as.numeric(midPert$intervals[,c(3,4)])))
midPert.interpol.y<-(midPert.interpol.y-1)*((midPert$max.P-midPert$min.P)/2)+midPert$max.P

maxPert.interpol.x<-sort(unique(as.numeric(maxPert$intervals[,c(1,2)])))
maxPert.interpol.y<-sort(unique(as.numeric(maxPert$intervals[,c(3,4)])))
maxPert.interpol.y<-(maxPert.interpol.y-1)*((maxPert$max.P-maxPert$min.P)/2)+maxPert$max.P
```

```
par(mar=c(3.8,4,1,1))

equiv=seq_pert<=0.6
```

```
equiv_min=seq_pert<=0.65
equiv_post=seq_pert>=0.94

supPose_min=seq_pert>=0.8 & seq_pert<=0.94
supPose_max=seq_pert>=0.65 & seq_pert<=0.8

plot(seq_pert, quantile(fire.nn[,4], seq_pert, type=1), type='s', lwd=1,
     xlab="Quantile level",
     ylab="Airflow")
grid()
lines(seq_pert[!equiv], minPert.Y[!equiv], col=coul[1], lwd=2)
lines(seq_pert[!equiv], maxPert.Y[!equiv], col=coul[2], lwd=2)
lines(seq_pert[!equiv], midPert.Y[!equiv], col=coul[3], lwd=2)
lines(seq_pert[equiv], minPert.Y[equiv], col=2, lwd=2)

points(minPert.interpol.x, minPert.interpol.y, pch=1, lwd=2)
points(maxPert.interpol.x, maxPert.interpol.y, pch=1, lwd=2)
points(midPert.interpol.x, midPert.interpol.y, pch=1, lwd=2)

legend("topleft",
         col=c(1, coul[1:3]),
         lty=rep(1,4),
         lwd=c(1,2,2,2),
         legend=c("Airflow Empirical Quantile Function",
                  expression(theta~" = -1"),
                  expression(theta~" = 1"),
                  expression(theta~" = 0")),
       cex=0.8,
       bg="white")
```

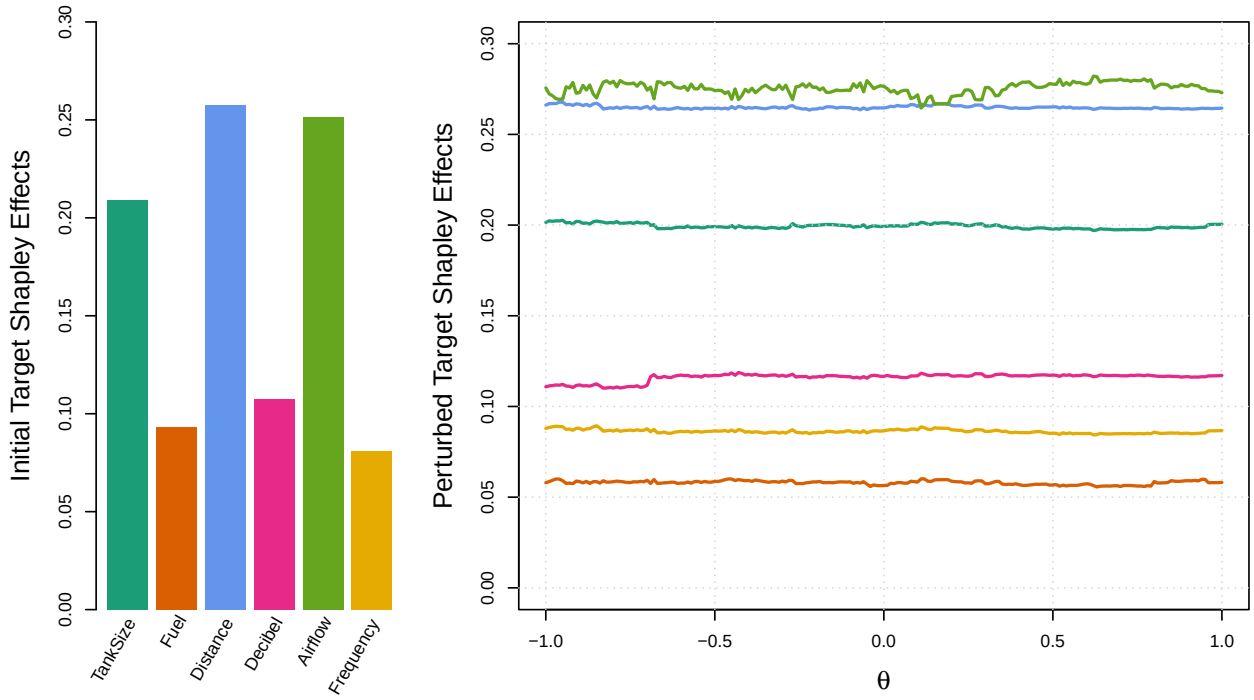


```
par(mar=c(5,4.5,1,1))
layout(matrix(c(1,1,1,2,2,2,
                1,1,1,2,2,2,
                1,1,1,2,2,2), nrow=3, ncol=6, byrow=T))
plot(fire.rob$theta[,1], fire.rob$global.pert*mean(fire.rob$Y.init)*100, type='l',
     ylab="Proportion of predicted 1s (%)",
     xlab=expression(theta),
     col="cornflowerblue", lwd=2.5,
     cex.lab=1.5)
grid()
abline(h=mean(fire.rob$Y.init)*100, lty=2, lwd=2, col="gray25")
legend("bottomright",
       col=c("cornflowerblue", "gray25"),
       lty=c(1,2),
       lwd=c(2.5,2),
       legend=c("Perturbed Airflow", "Initial Data"),
       cex=1,
       bg="white")

plot(fire.rob$theta[,1], rowMeans(pred.change)*100, type="l",
     ylab="Proportion of prediction shift (%)",
     xlab=expression(theta),
     col=2,
     lwd=2.5,
     ylim=c(0,0.35),
     cex.lab=1.5)
grid()
abline(h=0,lty=2, lwd=2, col="gray25")
```




```
layout(matrix(c(1,1,2,2,2,2,
                1,1,2,2,2,2,
                1,1,2,2,2,2), nrow=3, ncol=6, byrow=T))
```

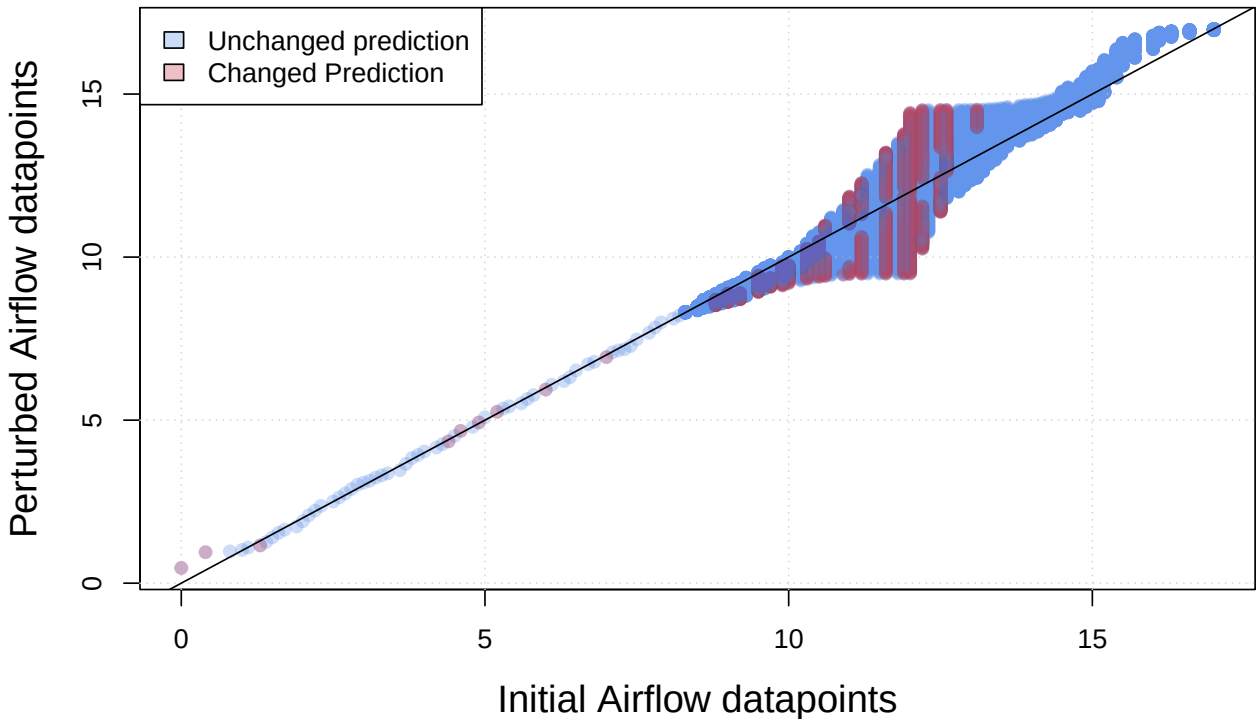
```r
a=barplot(height=c(baseline.shap$Shap),
        names=rownames(baseline.shap$Shap),
        col=coul,
        ylim=c(0,0.3),
        ylab="Initial Target Shapley Effects",
        cex.lab=1.5,
        cex.names=1,
        xaxt="n",
        border=F)
 text(a, par("usr")[3], labels = rownames(baseline.shap$Shap), srt = 60, adj = c(1.1,1.1), xpd = TRUE, c


plot(res.shap[,1], res.shap[,2], type='l', col=coul[1], ylim=c(0,0.3), lwd=2,
     ylab="Perturbed Target Shapley Effects",
     xlab=expression(theta),
     cex.lab=1.5)
grid()
lines(res.shap[,1], res.shap[,3], col=coul[2], lwd=2)
lines(res.shap[,1], res.shap[,4], col=coul[3], lwd=2)
lines(res.shap[,1], res.shap[,5], col=coul[4], lwd=2)
lines(res.shap[,1], res.shap[,6], col=coul[5], lwd=2)
lines(res.shap[,1], res.shap[,7], col=coul[6], lwd=2)
```




```r
y.pert=fire.rob$pred.pert[,-1]

x.pert=fire.rob$dist.pert[,-1]
x.init=fire.rob$dist.pert[,-1]

set.seed(12345)
n_sub=nrow(x.pert)
subs_pert=sample(1:nrow(x.pert),n_sub)
```

```
X.pert=matrix(NA, nrow=n_sub, ncol=ncol(x.pert))
X.init=matrix(NA, nrow=n_sub, ncol=ncol(x.init))
isPert=matrix(NA, nrow=n_sub, ncol=ncol(x.init))

for(i in 1:nrow(x.pert)){
  X.pert[i,]=fire.rob$pert.data[[i]][,4]
  X.init[i,]=fire.nn[,4]
  isPert[i,]=y.pert[i,]==fire.rob$Y.init
}

X.pert=as.vector(X.pert)
X.init=as.vector(X.init)
isPert=as.vector(isPert)

X.init.Paspert=X.init[isPert]
X.init.pert=X.init[!isPert]
X.pert.Paspert=X.pert[isPert]
X.pert.pert=X.pert[!isPert]

X.Paspert=data.frame("X.init"=X.init.Paspert, "X.pert"=X.pert.Paspert)
X.Pert<-data.frame("X.init"=X.init.pert, "X.pert"=X.pert.pert)

X.Paspert = X.Paspert[!duplicated.data.frame(X.Paspert),]
X.Pert = X.Pert[!duplicated.data.frame(X.Pert),]
```

```
par(mar=c(4,4.5,0.5,1))
plot(X.Paspert$X.init, X.Paspert$X.pert, col=rgb(0.392,0.585,0.929,0.3), pch=19,
     xlab="Initial Airflow datapoints",
     ylab="Perturbed Airflow datapoints",cex.lab=1.4)
grid()
points(X.Pert$X.init, X.Pert$X.pert, col=rgb(.796,.255,.329,0.3), pch=19, cex=1)
points(X.Paspert$X.init, X.Paspert$X.pert, col=rgb(0.392,0.585,0.929,0.018), pch=19, cex=1)
abline(a=0,b=1, lwd=1, lty=1, col=1)
legend("topleft",
       fill=c(rgb(0.392,0.585,0.929,1/3), rgb(.796,.255,.329,1/3)),
       legend=c("Unchanged prediction","Changed Prediction"),
       cex=1,
       bg="white")
```


Unchanged prediction
Changed Prediction
Perturbed Airflow datapoints
Initial Airflow datapoints
0
5
10
15