610 Final project

Ariane Stark, Minsu Kim, Diezhang Wu, Alona Muzikansky

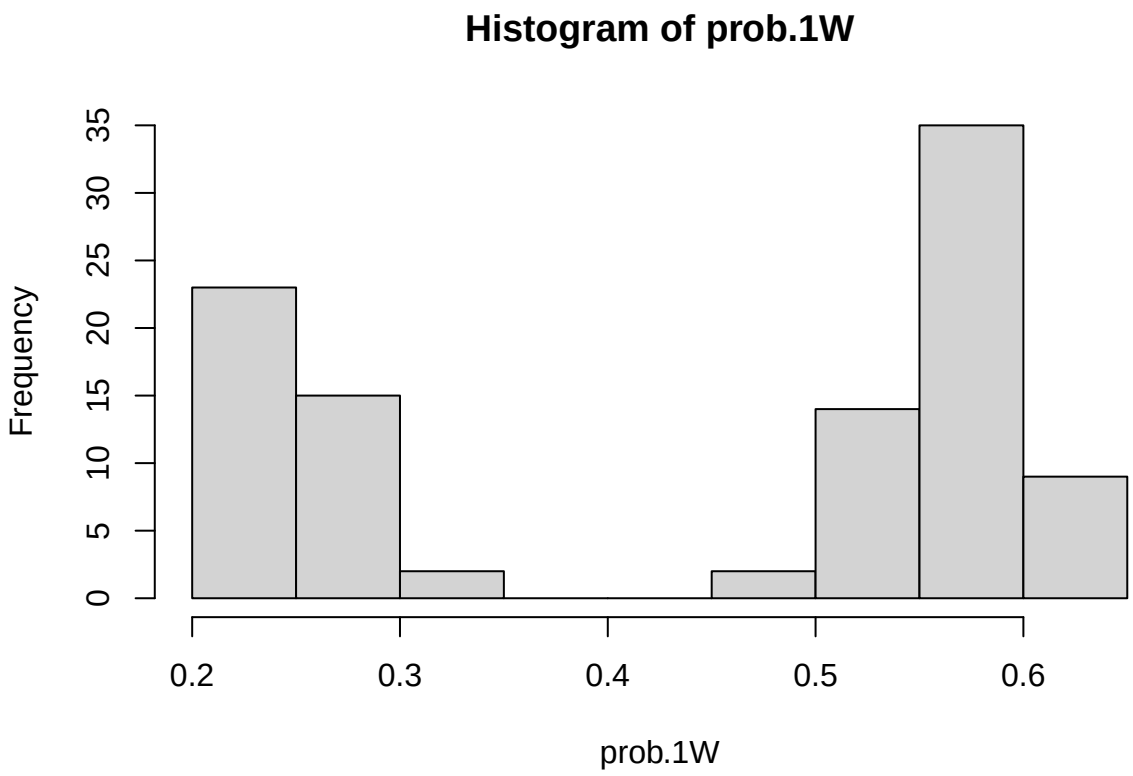
11/6/2021

Alona

```
# simple substitution estimator (a.k.a. parameteric G-computation)
txt <- ObsData
control <- ObsData

txt$A <- 1
control$A <- 0

g.comp.reg <- glm(Y ~ W11 + W12 + W13 + W14 + W2 + A, family="binomial", data=ObsData)
pred.txt <- predict(g.comp.reg, newdata = txt, type = "response")
pred.control <- predict(g.comp.reg, newdata = control, type = "response")
psi.hat <- mean(pred.txt - pred.control)
psi.hat
```

```
## [1] 0.01454638
```

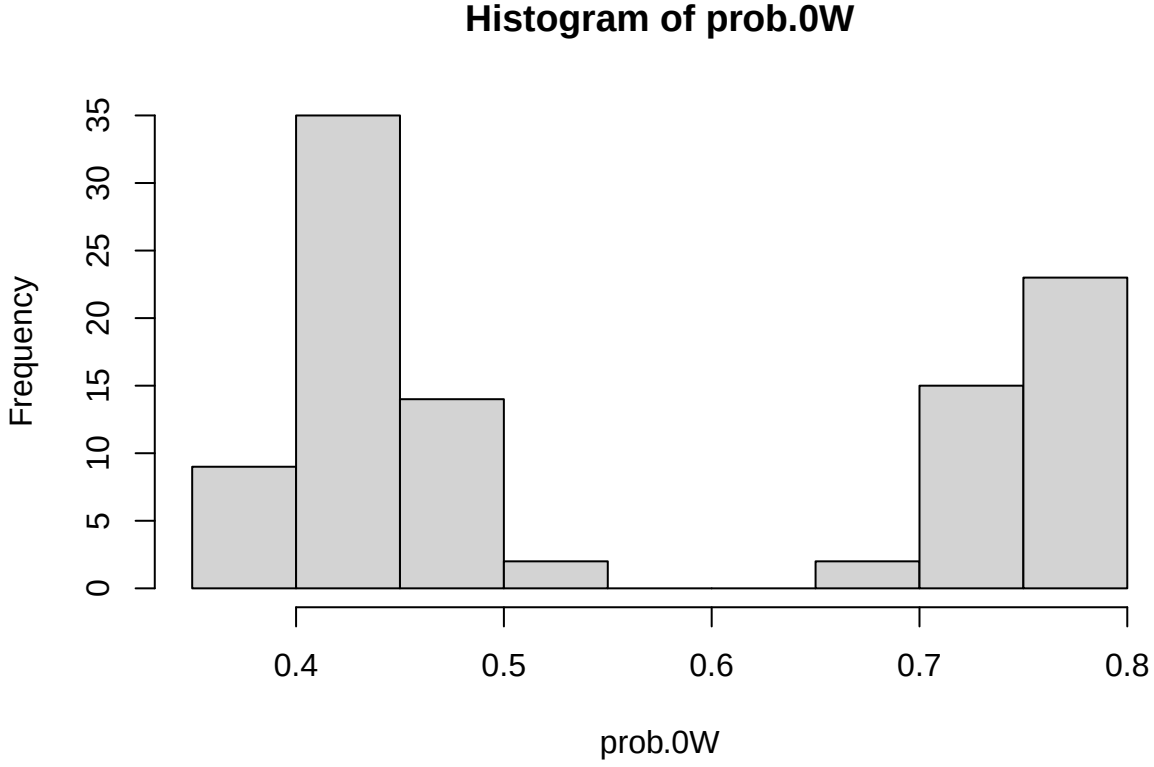
```
# IPTW estimator
prob.AW.reg <- glm(A ~ W11 + W12 + W13 + W14 + W2, family="binomial", data=ObsData)
prob.1W <- predict(prob.AW.reg, type= "response")
prob.0W <- 1 - prob.1W

hist(prob.1W)
```




```
summary(prob.1W)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.2096  0.2530  0.5406  0.4400  0.5739  0.6228
```

```
hist(prob.0W)
```



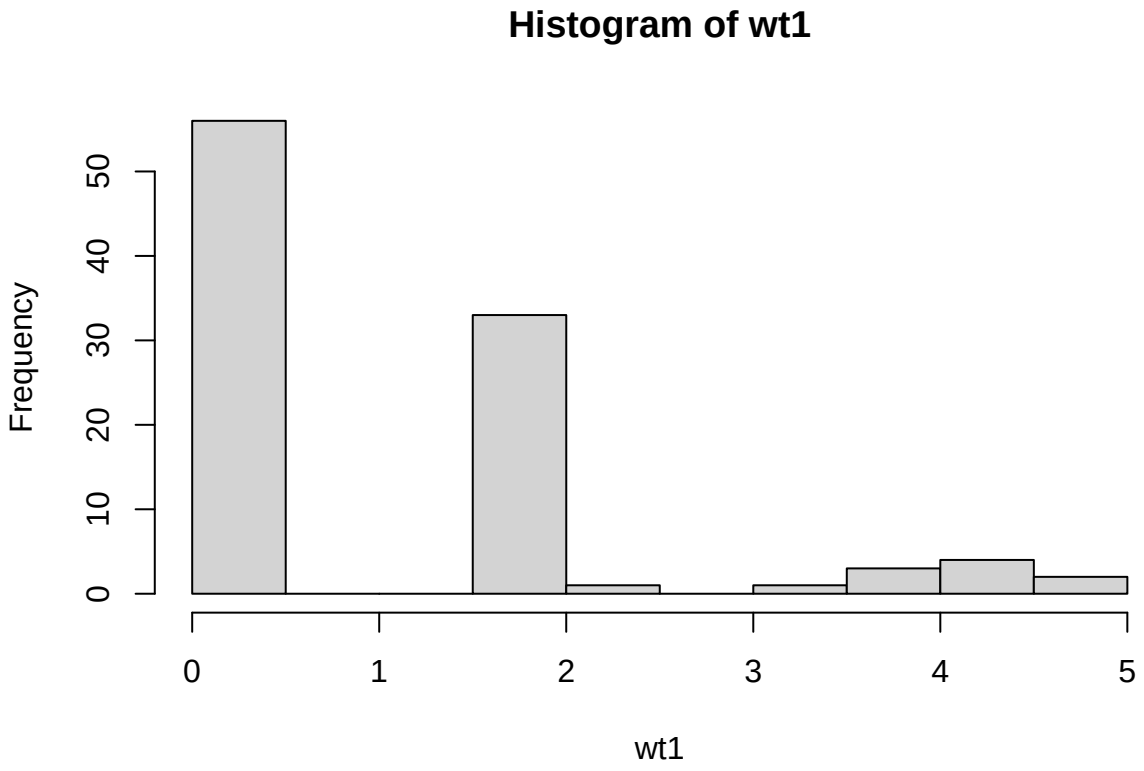
```
summary(prob.0W)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.3772  0.4261  0.4594  0.5600  0.7470  0.7904
```

```
wt1 <- as.numeric(ObsData$A==1)/prob.1W
wt0 <- as.numeric(ObsData$A==0)/prob.0W
summary(wt1)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   0.000   0.000   1.004   1.760   4.771
```

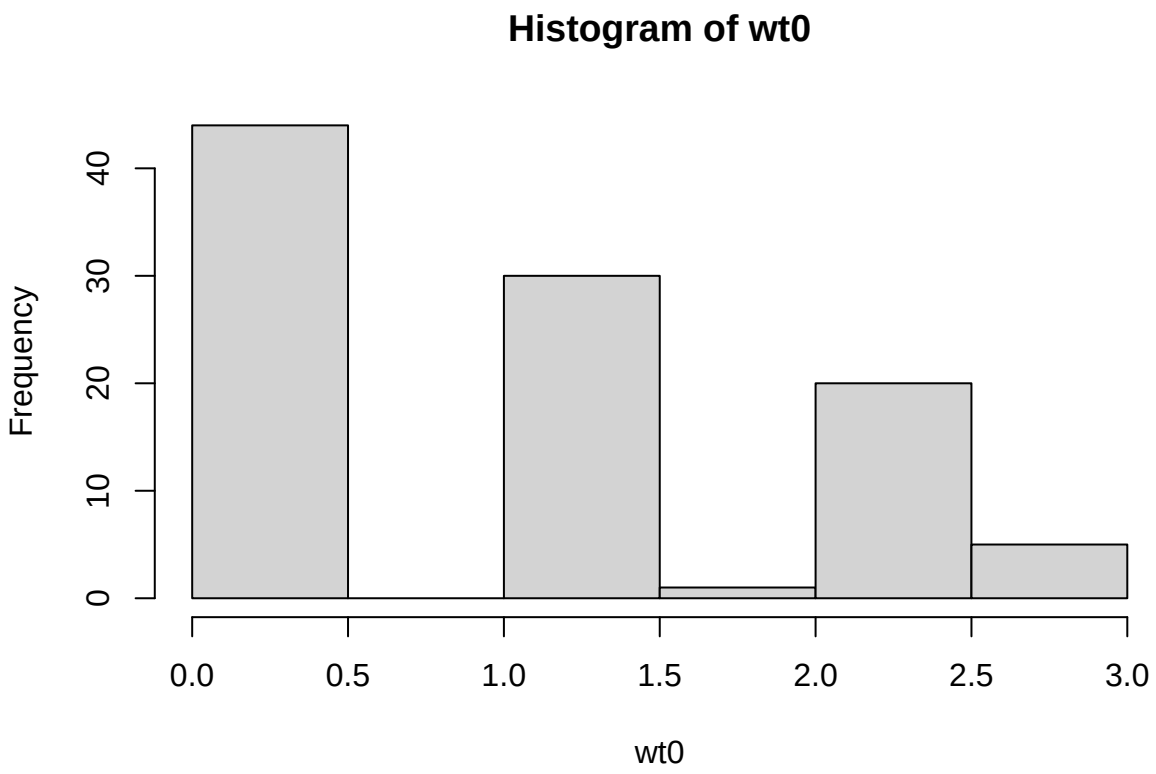
```
hist(wt1)
```




```
summary(wt0)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   0.000   1.313   0.999   1.994   2.651
```

```
hist(wt0)
```




```
psi.iptw <- mean(wt1*ObsData$Y) - mean(wt0*ObsData$Y)
psi.iptw
```

```
## [1] -0.007883951
```

```
# Modified HT
psi.ht <- mean(wt1*ObsData$Y)/mean(wt1) - mean(wt0*ObsData$Y)/mean(wt0)
psi.ht
```

```
## [1] -0.01201499
```

```
# Unadjusted estimator
wt1.ua <- as.numeric(ObsData$A==1)/mean(ObsData$A == 1)
wt0.ua <- as.numeric(ObsData$A==0)/mean(ObsData$A == 0)
psi.unadj <- mean(wt1.ua*ObsData$Y) - mean(wt0.ua*ObsData$Y)
psi.unadj
```

```
## [1] -0.02922078
```

```
# TMLE estimator
```

SS, IPTW and TMLE estimator with super learner

```
library("SuperLearner")
SL.library<- c('SL.glm', 'SL.glm.interaction', "SL.step",
               "SL.randomForest","SL.step.forward","SL.stepAIC","SL.mean")

X <- subset(ObsData, select = c(A, W11, W12, W13, W14, W2))

## SS
X1 <- X0 <- X
X1$A <- 1
```

```r
X0$A <- 0

SL.outcome <- SuperLearner(Y = ObsData$Y, X = X, family = "binomial", SL.library = SL.library)
SL.outcome
```

```
##
## Call:
## SuperLearner(Y = ObsData$Y, X = X, family = "binomial", SL.library = SL.library)
##
##
##
##                              Risk     Coef
## SL.glm_All              0.1184962 0.000000
## SL.glm.interaction_All 0.2797439 0.000000
## SL.step_All             0.1199257 0.000000
## SL.randomForest_All     0.1108811 0.434656
## SL.step.forward_All     0.1120397 0.000000
## SL.stepAIC_All          0.1073827 0.565344
## SL.mean_All             0.1073827 0.000000
```

```r
expY.givenAW <- predict(SL.outcome, newdata=X)$pred
expY.given1W <- predict(SL.outcome, newdata=X1)$pred
expY.given0W <- predict(SL.outcome, newdata=X0)$pred

tail(data.frame(A=ObsData$A, expY.givenAW, expY.given1W, expY.given0W))
```

```
##     A expY.givenAW expY.given1W expY.given0W
## 95  1    0.8904317    0.8904317    0.8778267
## 96  0    0.8495741    0.8026312    0.8495741
## 97  1    0.9308547    0.9308547    0.9234656
## 98  0    0.9273775    0.9212923    0.9273775
## 99  1    0.9291161    0.9291161    0.9321587
## 100 0    0.8978209    0.9039061    0.8978209
```

```r
PsiHat.SS<-mean(expY.given1W - expY.given0W)
PsiHat.SS
```

```
## [1] 0.002890462
```

```r
## IPTW with TLME
SL.exposure<- SuperLearner(Y=ObsData$A, X=X[,-ncol(X)], SL.library=SL.library, family="binomial")
SL.exposure
```

```
##
## Call:
## SuperLearner(Y = ObsData$A, X = X[, -ncol(X)], family = "binomial", SL.library = SL.library)
##
##
##
##                                Risk Coef
## SL.glm_All              8.414013e-24    1
## SL.glm.interaction_All 8.414014e-24    0
## SL.step_All             8.414013e-24    0
## SL.randomForest_All     2.955280e-03    0
## SL.step.forward_All     8.414013e-24    0
## SL.stepAIC_All          8.414013e-24    0
```

```
## SL.mean_All            2.525926e-01    0
```

```
probA1.givenW<- SL.exposure$SL.predict
# above is equivalent to
# check <- predict(SL.exposure, newdata=X)$pred
# sum(probA1.givenW != check)
probA0.givenW<- 1- probA1.givenW


H.AW<- as.numeric(ObsData$A==1)/probA1.givenW - as.numeric(ObsData$A==0)/probA0.givenW
# also want to evaluate the clever covariates at A=1 and A=0 for all participants
H.1W<- 1/probA1.givenW
H.0W<- -1/probA0.givenW
tail(data.frame(ObsData$A, H.AW, H.1W, H.0W))
```

```
##     ObsData.A H.AW         H.1W          H.0W
## 95          1    1            1 -344746785117
## 96          0   -1 344744197867            -1
## 97          1    1            1 -344746785117
## 98          0   -1 344744197852            -1
## 99          1    1            1 -344746785117
## 100         0   -1 344744197866            -1
```

```
PsiHat.IPTW <-mean( H.AW*ObsData$Y)
PsiHat.IPTW
```

```
## [1] -0.12
```

```
## TMLE estimator
logitUpdate<- glm(ObsData$Y ~ -1 +offset(qlogis(expY.givenAW)) + H.AW, family='binomial')
epsilon <- logitUpdate$coef
epsilon
```

```
##        H.AW
## -0.07320994
```

```
expY.givenAW.star<- plogis(qlogis(expY.givenAW)+ epsilon*H.AW)
expY.given1W.star<- plogis(qlogis(expY.given1W)+ epsilon*H.1W)
expY.given0W.star<- plogis(qlogis(expY.given0W)+ epsilon*H.0W)
coef(glm(ObsData$Y ~ -1 +offset(qlogis(expY.givenAW.star)) + H.AW, family=binomial))
```

```
##          H.AW
## -4.071122e-16
```

```
PsiHat.TMLE <- mean(expY.given1W.star - expY.given0W.star)

c(PsiHat.SS, PsiHat.IPTW, PsiHat.TMLE)
```

```
## [1]  0.002890462 -0.120000000 -0.560000000
```

```
CV.SL.out<- CV.SuperLearner(Y=ObsData$Y, X=X, V = 20, SL.library=SL.library, family='binomial')
summary(CV.SL.out)
```

```
##
## Call:
## CV.SuperLearner(Y = ObsData$Y, X = X, V = 20, family = "binomial", SL.library = SL.library)
##
##
## Risk is based on: Mean Squared Error
```

```
##
## All risk estimates are based on V =  20
##
##               Algorithm     Ave       se        Min     Max
##           Super Learner 0.11190 0.025359 7.1910e-03 0.35441
##             Discrete SL 0.12102 0.025589 1.5956e-02 0.37489
##              SL.glm_All 0.11681 0.025212 2.6669e-03 0.37404
##  SL.glm.interaction_All 0.25431 0.042453 4.9304e-32 0.60000
##             SL.step_All 0.11852 0.025859 4.6238e-03 0.37333
##     SL.randomForest_All 0.11088 0.024489 1.3742e-03 0.37489
##     SL.step.forward_All 0.12086 0.027043 5.4675e-03 0.36161
##          SL.stepAIC_All 0.10793 0.025361 1.5956e-02 0.32687
##             SL.mean_All 0.10793 0.025361 1.5956e-02 0.32687
```

```
CV.SL.out$AllSL
```

```
## $`1`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                             Risk      Coef
## SL.glm_All             0.1147698 0.0000000
## SL.glm.interaction_All 0.2990297 0.0000000
## SL.step_All            0.1158926 0.0000000
## SL.randomForest_All    0.1074224 0.4710353
## SL.step.forward_All    0.1124124 0.0000000
## SL.stepAIC_All         0.1058760 0.5289647
## SL.mean_All            0.1058760 0.0000000
##
## $`2`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                             Risk      Coef
## SL.glm_All             0.1162058 0.0000000
## SL.glm.interaction_All 0.2486879 0.0000000
## SL.step_All            0.1204573 0.0000000
## SL.randomForest_All    0.1037323 0.5315549
## SL.step.forward_All    0.1177351 0.0000000
## SL.stepAIC_All         0.1108064 0.0000000
## SL.mean_All            0.1051348 0.4684451
##
## $`3`
##
## Call:
```

```
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1279710 0.0000000
## SL.glm.interaction_All 0.3301831 0.0000000
## SL.step_All            0.1268885 0.0000000
## SL.randomForest_All    0.1188007 0.3883643
## SL.step.forward_All    0.1257496 0.0000000
## SL.stepAIC_All         0.1160356 0.0000000
## SL.mean_All            0.1124042 0.6116357
##
## $`4`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1272123 0.0000000
## SL.glm.interaction_All 0.2946103 0.0000000
## SL.step_All            0.1317725 0.0000000
## SL.randomForest_All    0.1172183 0.4602303
## SL.step.forward_All    0.1323879 0.0000000
## SL.stepAIC_All         0.1176587 0.0000000
## SL.mean_All            0.1149545 0.5397697
##
## $`5`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk       Coef
## SL.glm_All             0.1253331 0.00000000
## SL.glm.interaction_All 0.2951980 0.02218734
## SL.step_All            0.1249333 0.00000000
## SL.randomForest_All    0.1169556 0.40969031
## SL.step.forward_All    0.1177713 0.00000000
## SL.stepAIC_All         0.1180376 0.00000000
## SL.mean_All            0.1136511 0.56812235
##
## $`6`
##
## Call:
```

```
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk     Coef
## SL.glm_All             0.11209913 0.000000
## SL.glm.interaction_All 0.21331906 0.000000
## SL.step_All            0.11373404 0.000000
## SL.randomForest_All    0.09024195 0.604479
## SL.step.forward_All    0.11074347 0.000000
## SL.stepAIC_All         0.09975164 0.000000
## SL.mean_All            0.09522973 0.395521
##
## $`7`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1245178 0.0000000
## SL.glm.interaction_All 0.2753962 0.0000000
## SL.step_All            0.1170592 0.0000000
## SL.randomForest_All    0.1138565 0.2904781
## SL.step.forward_All    0.1100400 0.0000000
## SL.stepAIC_All         0.1052006 0.7095219
## SL.mean_All            0.1052006 0.0000000
##
## $`8`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk        Coef
## SL.glm_All             0.1255487 0.000000000
## SL.glm.interaction_All 0.2327898 0.006221423
## SL.step_All            0.1251791 0.000000000
## SL.randomForest_All    0.1117011 0.506196396
## SL.step.forward_All    0.1226562 0.000000000
## SL.stepAIC_All         0.1124227 0.487582181
## SL.mean_All            0.1124227 0.000000000
##
## $`9`
##
## Call:
```

```
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1379288 0.0000000
## SL.glm.interaction_All 0.3030651 0.0000000
## SL.step_All            0.1375810 0.0000000
## SL.randomForest_All    0.1076430 0.6007781
## SL.step.forward_All    0.1374887 0.0000000
## SL.stepAIC_All         0.1133181 0.3992219
## SL.mean_All            0.1133181 0.0000000
##
## $`10`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1262690 0.0000000
## SL.glm.interaction_All 0.2685087 0.0000000
## SL.step_All            0.1280276 0.0000000
## SL.randomForest_All    0.1154600 0.4358084
## SL.step.forward_All    0.1290233 0.0000000
## SL.stepAIC_All         0.1118168 0.5641916
## SL.mean_All            0.1118168 0.0000000
##
## $`11`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                               Risk       Coef
## SL.glm_All             0.10885084 0.00000000
## SL.glm.interaction_All 0.25263158 0.05974298
## SL.step_All            0.10702469 0.00000000
## SL.randomForest_All    0.11240063 0.00000000
## SL.step.forward_All    0.09896112 0.00000000
## SL.stepAIC_All         0.09569487 0.00000000
## SL.mean_All            0.09569487 0.94025702
##
## $`12`
##
## Call:
```

```
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk       Coef
## SL.glm_All             0.1161836 0.09383864
## SL.glm.interaction_All 0.2836667 0.00000000
## SL.step_All            0.1204619 0.00000000
## SL.randomForest_All    0.1174906 0.19016300
## SL.step.forward_All    0.1085525 0.00000000
## SL.stepAIC_All         0.1050783 0.71599837
## SL.mean_All            0.1050783 0.00000000
##
## $`13`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk     Coef
## SL.glm_All             0.1278612 0.000000
## SL.glm.interaction_All 0.2672018 0.000000
## SL.step_All            0.1334167 0.000000
## SL.randomForest_All    0.1200051 0.397522
## SL.step.forward_All    0.1323532 0.000000
## SL.stepAIC_All         0.1174576 0.000000
## SL.mean_All            0.1140405 0.602478
##
## $`14`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk       Coef
## SL.glm_All             0.1228814 0.00000000
## SL.glm.interaction_All 0.2335785 0.03775388
## SL.step_All            0.1133933 0.00000000
## SL.randomForest_All    0.1041591 0.42862147
## SL.step.forward_All    0.1133933 0.00000000
## SL.stepAIC_All         0.1144541 0.00000000
## SL.mean_All            0.1032341 0.53362465
##
## $`15`
##
## Call:
```

```
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk       Coef
## SL.glm_All             0.1221760 0.03495652
## SL.glm.interaction_All 0.2812392 0.00000000
## SL.step_All            0.1259103 0.00000000
## SL.randomForest_All    0.1182459 0.40623314
## SL.step.forward_All    0.1277901 0.00000000
## SL.stepAIC_All         0.1134532 0.55881034
## SL.mean_All            0.1134532 0.00000000
##
## $`16`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1159463 0.0000000
## SL.glm.interaction_All 0.2423495 0.0000000
## SL.step_All            0.1197851 0.0000000
## SL.randomForest_All    0.1030970 0.5300566
## SL.step.forward_All    0.1103901 0.0000000
## SL.stepAIC_All         0.1041609 0.4699434
## SL.mean_All            0.1041609 0.0000000
##
## $`17`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk      Coef
## SL.glm_All             0.1251813 0.0000000
## SL.glm.interaction_All 0.2783939 0.0000000
## SL.step_All            0.1290222 0.0000000
## SL.randomForest_All    0.1187805 0.3956532
## SL.step.forward_All    0.1265823 0.0000000
## SL.stepAIC_All         0.1168111 0.0000000
## SL.mean_All            0.1126679 0.6043468
##
## $`18`
##
## Call:
```

```
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                             Risk       Coef
## SL.glm_All             0.1216218 0.00000000
## SL.glm.interaction_All 0.2233736 0.01723967
## SL.step_All            0.1267452 0.00000000
## SL.randomForest_All    0.1081214 0.56920712
## SL.step.forward_All    0.1301612 0.00000000
## SL.stepAIC_All         0.1122877 0.41355321
## SL.mean_All            0.1122877 0.00000000
##
## $`19`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                             Risk     Coef
## SL.glm_All             0.1299974 0.000000
## SL.glm.interaction_All 0.2463785 0.000000
## SL.step_All            0.1302651 0.000000
## SL.randomForest_All    0.1154049 0.445998
## SL.step.forward_All    0.1306953 0.000000
## SL.stepAIC_All         0.1124134 0.554002
## SL.mean_All            0.1124134 0.000000
##
## $`20`
##
## Call:
## SuperLearner(Y = cvOutcome, X = cvLearn, newX = cvValid, family = family,
##     SL.library = SL.library, method = method, id = cvId, verbose = verbose,
##     control = control, cvControl = valid[[2]], obsWeights = cvObsWeights,
##     env = env)
##
##
##                              Risk       Coef
## SL.glm_All             0.11706070 0.00000000
## SL.glm.interaction_All 0.23181094 0.03884836
## SL.step_All            0.10591569 0.00000000
## SL.randomForest_All    0.09836078 0.39016440
## SL.step.forward_All    0.10719754 0.00000000
## SL.stepAIC_All         0.09569487 0.00000000
## SL.mean_All            0.09569487 0.57098723
```

```
CV.SL.out$coef
```

```
##    SL.glm_All SL.glm.interaction_All SL.step_All SL.randomForest_All
## 1  0.00000000            0.000000000           0           0.4710353
```

```
## 2  0.00000000            0.000000000           0           0.5315549
## 3  0.00000000            0.000000000           0           0.3883643
## 4  0.00000000            0.000000000           0           0.4602303
## 5  0.00000000            0.022187337           0           0.4096903
## 6  0.00000000            0.000000000           0           0.6044790
## 7  0.00000000            0.000000000           0           0.2904781
## 8  0.00000000            0.006221423           0           0.5061964
## 9  0.00000000            0.000000000           0           0.6007781
## 10 0.00000000            0.000000000           0           0.4358084
## 11 0.00000000            0.059742984           0           0.0000000
## 12 0.09383864            0.000000000           0           0.1901630
## 13 0.00000000            0.000000000           0           0.3975220
## 14 0.00000000            0.037753878           0           0.4286215
## 15 0.03495652            0.000000000           0           0.4062331
## 16 0.00000000            0.000000000           0           0.5300566
## 17 0.00000000            0.000000000           0           0.3956532
## 18 0.00000000            0.017239672           0           0.5692071
## 19 0.00000000            0.000000000           0           0.4459980
## 20 0.00000000            0.038848361           0           0.3901644
##    SL.step.forward_All SL.stepAIC_All SL.mean_All
## 1                    0      0.5289647   0.0000000
## 2                    0      0.0000000   0.4684451
## 3                    0      0.0000000   0.6116357
## 4                    0      0.0000000   0.5397697
## 5                    0      0.0000000   0.5681224
## 6                    0      0.0000000   0.3955210
## 7                    0      0.7095219   0.0000000
## 8                    0      0.4875822   0.0000000
## 9                    0      0.3992219   0.0000000
## 10                   0      0.5641916   0.0000000
## 11                   0      0.0000000   0.9402570
## 12                   0      0.7159984   0.0000000
## 13                   0      0.0000000   0.6024780
## 14                   0      0.0000000   0.5336246
## 15                   0      0.5588103   0.0000000
## 16                   0      0.4699434   0.0000000
## 17                   0      0.0000000   0.6043468
## 18                   0      0.4135532   0.0000000
## 19                   0      0.5540020   0.0000000
## 20                   0      0.0000000   0.5709872
```