610 Final project

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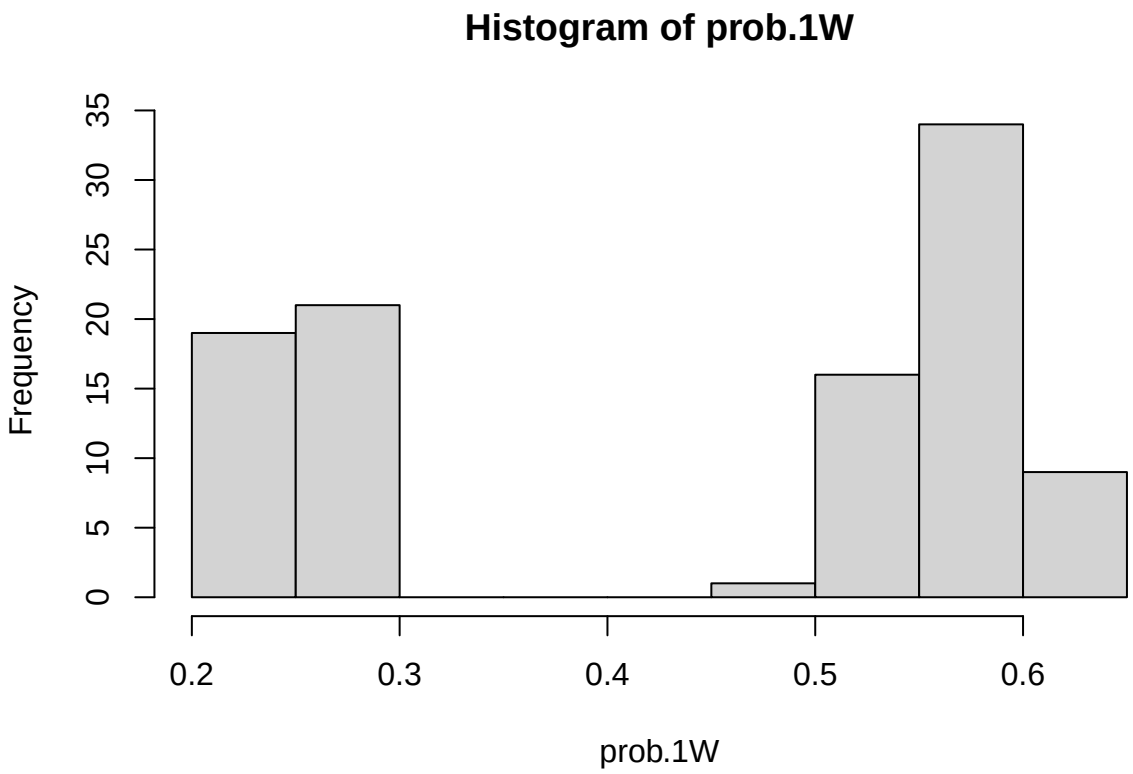
Alona

```
# 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
```

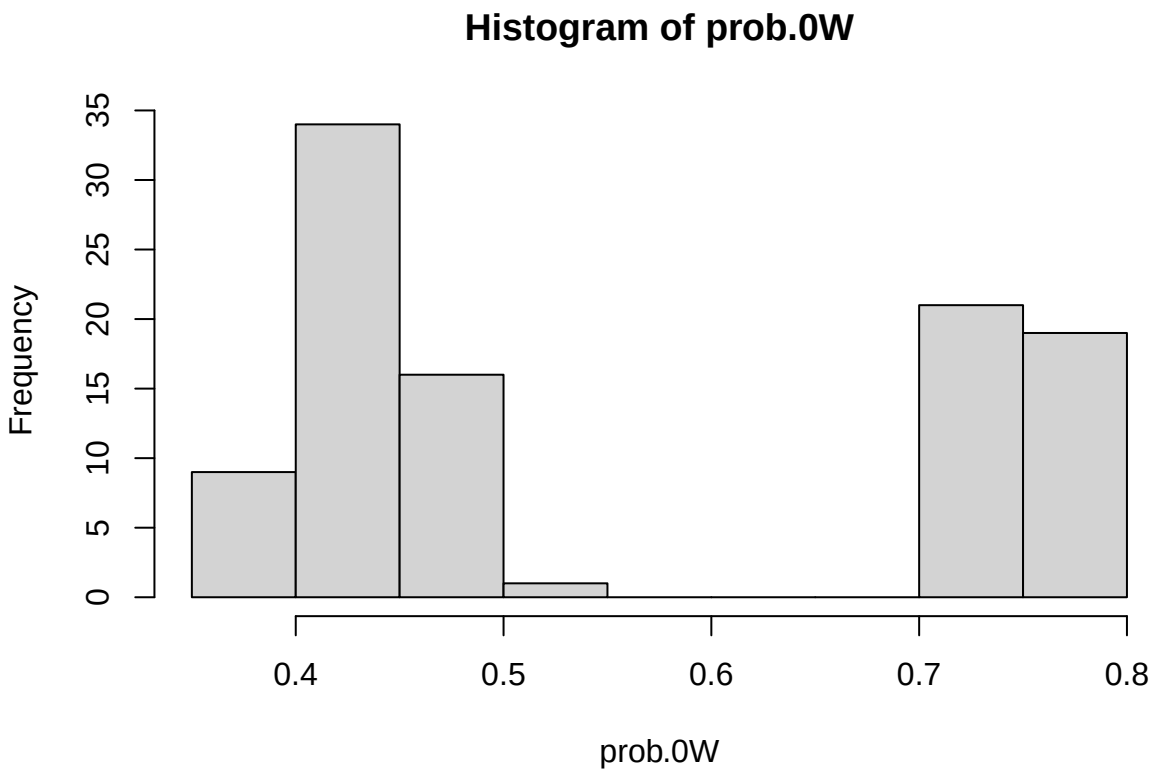
```
# IPTW estimator
prob.AW.reg <- glm(A ~ W11 + W12 + W13 + W14, family="binomial", data=ObsData)
prob.1W <- predict(prob.AW.reg, type= "response")
prob.0W <- 1 - prob.1W

hist(prob.1W)
```




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

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.2216  0.2516  0.5358  0.4400  0.5727  0.6226
```

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



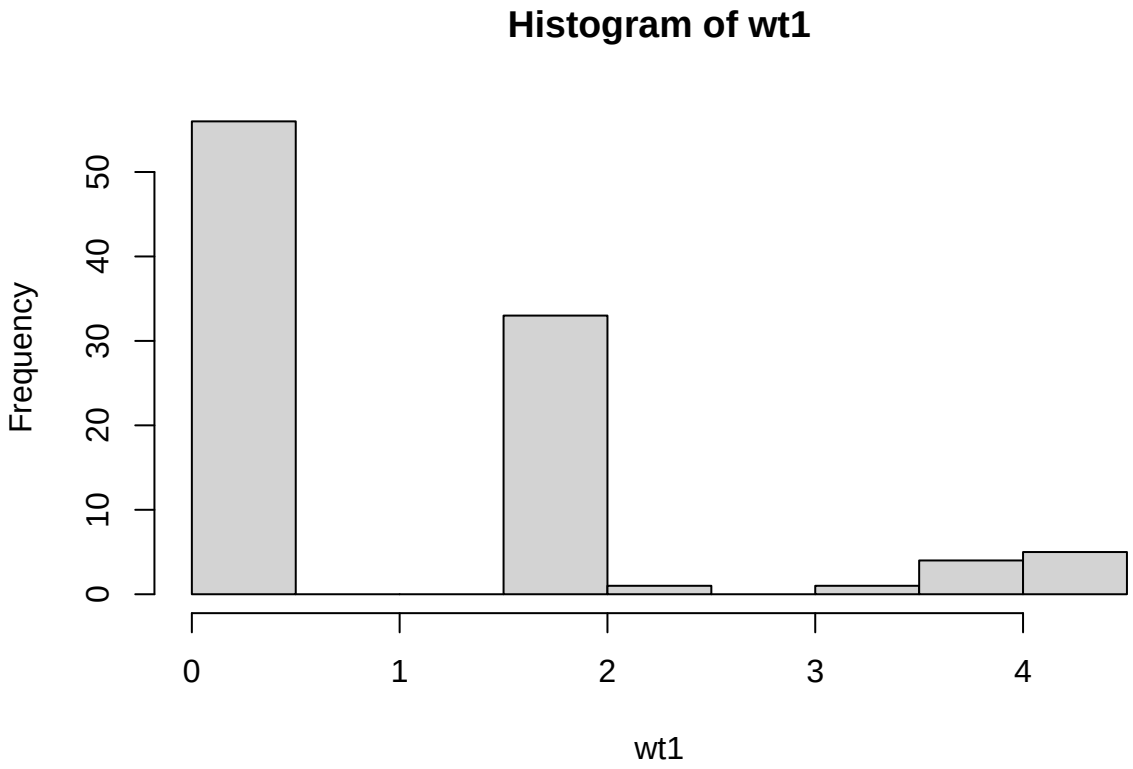

```
summary(prob.0W)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.3774  0.4273  0.4642  0.5600  0.7484  0.7784
```

```
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   1.766   4.452
```

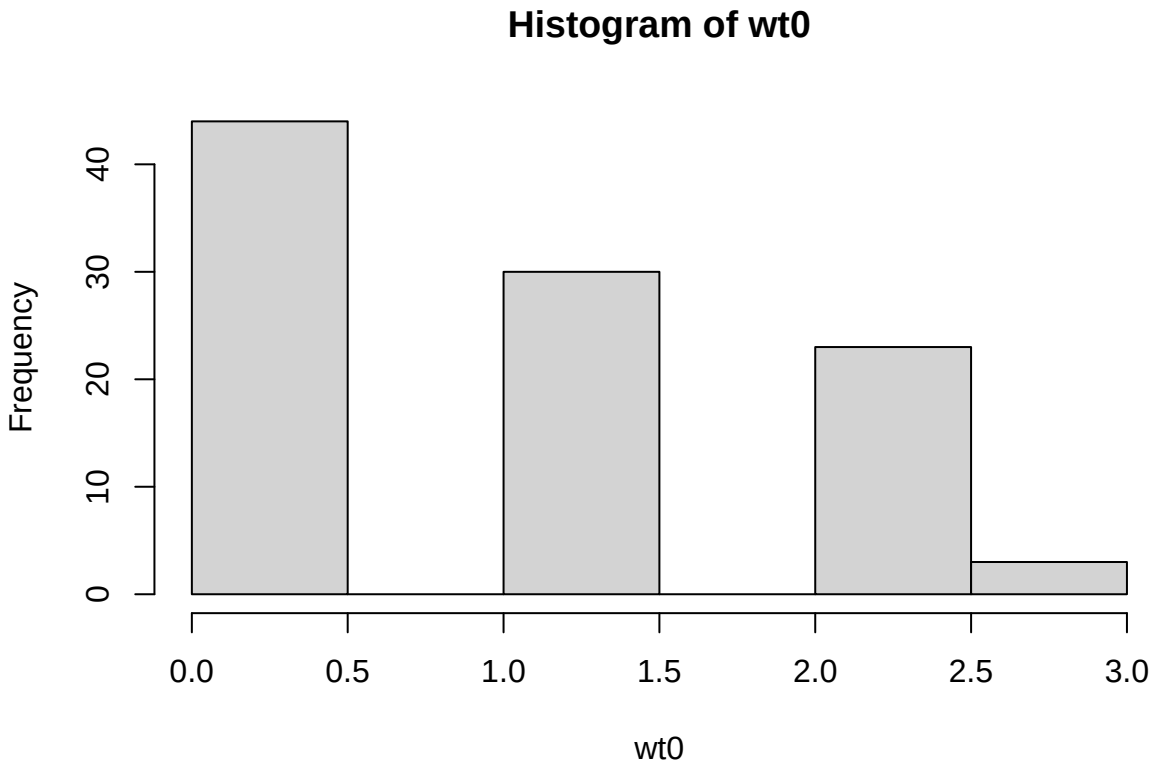
```
hist(wt1)
```




```
summary(wt0)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   0.000   1.312   0.998   2.074   2.594
```

```
hist(wt0)
```




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

```
## [1] -0.003532538
```

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

```
## [1] -0.00916455
```

```
# 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$A <- 1
X0$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              0.1258137 0.00000000
## SL.glm.interaction_All 0.2489844 0.05671778
## SL.step_All             0.1227187 0.00000000
## SL.randomForest_All     0.1115945 0.38472470
## SL.step.forward_All     0.1199469 0.00000000
## SL.stepAIC_All          0.1111990 0.00000000
## SL.mean_All             0.1078519 0.55855752
```

```
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    0.8866605    0.8866605    0.8366287
## 96  0    0.8498628    0.8240960    0.8498628
## 97  1    0.9310495    0.9310495    0.8681761
## 98  0    0.9275870    0.9260481    0.9275870
## 99  1    0.9310495    0.9310495    0.9329104
## 100 0    0.9056576    0.9114285    0.9056576
```

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

```
## [1] 0.01058352
```

```
## 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 8.414013e-24    0
## SL.step_All             8.414013e-24    0
## SL.randomForest_All     2.615260e-03    0
## SL.step.forward_All     8.414013e-24    0
## SL.stepAIC_All          8.414013e-24    0
## SL.mean_All             2.493086e-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
## -0.0691249
```

```
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
## -1.071629e-16
```

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

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

```
## [1]  0.01058352 -0.12000000 -0.56000000
```

```
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 0.11150 0.025165 9.3013e-03 0.33135
##             Discrete SL 0.11675 0.026154 1.5956e-02 0.33684
##              SL.glm_All 0.12055 0.025972 3.1452e-03 0.33644
##  SL.glm.interaction_All 0.27756 0.043707 4.9304e-32 0.64316
##             SL.step_All 0.12126 0.026261 4.3443e-03 0.33329
##     SL.randomForest_All 0.10853 0.024454 5.1776e-03 0.33684
##     SL.step.forward_All 0.11641 0.026792 4.3443e-03 0.33329
##          SL.stepAIC_All 0.10750 0.025261 1.5956e-02 0.32687
##             SL.mean_All 0.10750 0.025261 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              0.1215762 0.0000000
## SL.glm.interaction_All 0.2591733 0.0000000
## SL.step_All             0.1209773 0.0000000
## SL.randomForest_All     0.1126710 0.4844898
## SL.step.forward_All     0.1214698 0.0000000
## SL.stepAIC_All          0.1118354 0.5155102
## SL.mean_All             0.1118354 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             0.11051509 0.0000000
## SL.glm.interaction_All 0.24777496 0.0000000
## SL.step_All            0.11329319 0.0000000
## SL.randomForest_All    0.09977725 0.4024222
## SL.step.forward_All    0.11035896 0.0000000
## SL.stepAIC_All         0.09517965 0.0000000
## SL.mean_All            0.09517965 0.5975778
##
## $`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             0.11953045 0.0000000
## SL.glm.interaction_All 0.26315789 0.0000000
## SL.step_All            0.11633190 0.0000000
## SL.randomForest_All    0.09535163 0.7085178
## SL.step.forward_All    0.11116131 0.0000000
## SL.stepAIC_All         0.10478580 0.0000000
## SL.mean_All            0.10408584 0.2914822
##
## $`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             0.1247512 0.00000000
## SL.glm.interaction_All 0.2495917 0.03462923
## SL.step_All            0.1237026 0.00000000
## SL.randomForest_All    0.1169836 0.42148232
## SL.step.forward_All    0.1228748 0.00000000
## SL.stepAIC_All         0.1140220 0.54388846
## SL.mean_All            0.1140220 0.00000000
##
```

```
## $`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             0.1149861 0.1439543
## SL.glm.interaction_All 0.3118483 0.0000000
## SL.step_All            0.1196941 0.0000000
## SL.randomForest_All    0.1162921 0.3654175
## SL.step.forward_All    0.1206846 0.0000000
## SL.stepAIC_All         0.1118890 0.4906282
## SL.mean_All            0.1118890 0.0000000
##
## $`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             0.1304755 0.000000
## SL.glm.interaction_All 0.2995354 0.000000
## SL.step_All            0.1292679 0.000000
## SL.randomForest_All    0.1214743 0.368775
## SL.step.forward_All    0.1356974 0.000000
## SL.stepAIC_All         0.1201722 0.000000
## SL.mean_All            0.1142949 0.631225
##
## $`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             0.1314494 0.00000000
## SL.glm.interaction_All 0.2549001 0.05715279
## SL.step_All            0.1325885 0.00000000
## SL.randomForest_All    0.1172753 0.35688209
## SL.step.forward_All    0.1321304 0.00000000
## SL.stepAIC_All         0.1160471 0.00000000
## SL.mean_All            0.1124670 0.58596512
##
```

```
## $`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             0.10797413 0.0000000
## SL.glm.interaction_All 0.25798143 0.0000000
## SL.step_All            0.10469531 0.0000000
## SL.randomForest_All    0.09364398 0.5553373
## SL.step.forward_All    0.10469531 0.0000000
## SL.stepAIC_All         0.09829996 0.0000000
## SL.mean_All            0.09631953 0.4446627
##
## $`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             0.1215047 0.0000000
## SL.glm.interaction_All 0.2422032 0.1013251
## SL.step_All            0.1268170 0.0000000
## SL.randomForest_All    0.1078500 0.5406656
## SL.step.forward_All    0.1267616 0.0000000
## SL.stepAIC_All         0.1143228 0.3580093
## SL.mean_All            0.1143228 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             0.1255001 0.00000000
## SL.glm.interaction_All 0.1897605 0.09829639
## SL.step_All            0.1222297 0.00000000
## SL.randomForest_All    0.1074756 0.31146351
## SL.step.forward_All    0.1172202 0.00000000
## SL.stepAIC_All         0.1134086 0.00000000
## SL.mean_All            0.1051820 0.59024010
##
```

```
## $`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             0.1184500 0.0000000
## SL.glm.interaction_All 0.2857255 0.0000000
## SL.step_All            0.1223834 0.0000000
## SL.randomForest_All    0.1069366 0.4377032
## SL.step.forward_All    0.1124989 0.0000000
## SL.stepAIC_All         0.1072178 0.0000000
## SL.mean_All            0.1046196 0.5622968
##
## $`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             0.1132673 0.178561377
## SL.glm.interaction_All 0.2662470 0.009550496
## SL.step_All            0.1165690 0.000000000
## SL.randomForest_All    0.1191917 0.100028405
## SL.step.forward_All    0.1124363 0.000000000
## SL.stepAIC_All         0.1052006 0.711859722
## SL.mean_All            0.1052006 0.000000000
##
## $`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             0.1280690 0.000000
## SL.glm.interaction_All 0.2526316 0.000000
## SL.step_All            0.1286402 0.000000
## SL.randomForest_All    0.1081923 0.566777
## SL.step.forward_All    0.1153312 0.000000
## SL.stepAIC_All         0.1116910 0.433223
## SL.mean_All            0.1116910 0.000000
##
```

```
## $`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             0.1173494 0.0000000
## SL.glm.interaction_All 0.2259799 0.1276789
## SL.step_All            0.1152775 0.0000000
## SL.randomForest_All    0.1184940 0.0000000
## SL.step.forward_All    0.1061866 0.0000000
## SL.stepAIC_All         0.1045631 0.8723211
## SL.mean_All            0.1045631 0.0000000
##
## $`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             0.1299857 0.0000000
## SL.glm.interaction_All 0.2679915 0.0000000
## SL.step_All            0.1323620 0.0000000
## SL.randomForest_All    0.1143697 0.4534637
## SL.step.forward_All    0.1275906 0.0000000
## SL.stepAIC_All         0.1181686 0.0000000
## SL.mean_All            0.1118354 0.5465363
##
## $`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             0.1264514 0.00000000
## SL.glm.interaction_All 0.2053207 0.08755636
## SL.step_All            0.1131484 0.00000000
## SL.randomForest_All    0.1168374 0.13990731
## SL.step.forward_All    0.1104736 0.00000000
## SL.stepAIC_All         0.1047326 0.77253634
## SL.mean_All            0.1047326 0.00000000
##
```

```
## $`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             0.1299339 0.0000000
## SL.glm.interaction_All 0.2367349 0.1200620
## SL.step_All            0.1304075 0.0000000
## SL.randomForest_All    0.1195651 0.1021222
## SL.step.forward_All    0.1138641 0.0000000
## SL.stepAIC_All         0.1056121 0.7778158
## SL.mean_All            0.1056121 0.0000000
##
## $`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             0.1280355 0.00000000
## SL.glm.interaction_All 0.2148670 0.04455746
## SL.step_All            0.1340232 0.00000000
## SL.randomForest_All    0.1069784 0.37341203
## SL.step.forward_All    0.1334494 0.00000000
## SL.stepAIC_All         0.1056395 0.00000000
## SL.mean_All            0.1040951 0.58203051
##
## $`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             0.1228646 0.0000000
## SL.glm.interaction_All 0.2480133 0.0000000
## SL.step_All            0.1223337 0.0000000
## SL.randomForest_All    0.1082115 0.5927172
## SL.step.forward_All    0.1225197 0.0000000
## SL.stepAIC_All         0.1118261 0.4072828
## SL.mean_All            0.1118261 0.0000000
##
```

```
## $`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             0.1214648 0.03117103
## SL.glm.interaction_All 0.2603479 0.00000000
## SL.step_All            0.1254899 0.00000000
## SL.randomForest_All    0.1153083 0.43728147
## SL.step.forward_All    0.1266755 0.00000000
## SL.stepAIC_All         0.1124042 0.53154750
## SL.mean_All            0.1124042 0.00000000
```

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

```
##    SL.glm_All SL.glm.interaction_All SL.step_All SL.randomForest_All
## 1  0.00000000            0.000000000           0           0.4844898
## 2  0.00000000            0.000000000           0           0.4024222
## 3  0.00000000            0.000000000           0           0.7085178
## 4  0.00000000            0.034629229           0           0.4214823
## 5  0.14395430            0.000000000           0           0.3654175
## 6  0.00000000            0.000000000           0           0.3687750
## 7  0.00000000            0.057152791           0           0.3568821
## 8  0.00000000            0.000000000           0           0.5553373
## 9  0.00000000            0.101325133           0           0.5406656
## 10 0.00000000            0.098296391           0           0.3114635
## 11 0.00000000            0.000000000           0           0.4377032
## 12 0.17856138            0.009550496           0           0.1000284
## 13 0.00000000            0.000000000           0           0.5667770
## 14 0.00000000            0.127678929           0           0.0000000
## 15 0.00000000            0.000000000           0           0.4534637
## 16 0.00000000            0.087556355           0           0.1399073
## 17 0.00000000            0.120062033           0           0.1021222
## 18 0.00000000            0.044557463           0           0.3734120
## 19 0.00000000            0.000000000           0           0.5927172
## 20 0.03117103            0.000000000           0           0.4372815
##    SL.step.forward_All SL.stepAIC_All SL.mean_All
## 1                    0      0.5155102   0.0000000
## 2                    0      0.0000000   0.5975778
## 3                    0      0.0000000   0.2914822
## 4                    0      0.5438885   0.0000000
## 5                    0      0.4906282   0.0000000
## 6                    0      0.0000000   0.6312250
## 7                    0      0.0000000   0.5859651
## 8                    0      0.0000000   0.4446627
## 9                    0      0.3580093   0.0000000
## 10                   0      0.0000000   0.5902401
## 11                   0      0.0000000   0.5622968
## 12                   0      0.7118597   0.0000000
```

```
## 13                  0       0.4332230   0.0000000
## 14                  0       0.8723211   0.0000000
## 15                  0       0.0000000   0.5465363
## 16                  0       0.7725363   0.0000000
## 17                  0       0.7778158   0.0000000
## 18                  0       0.0000000   0.5820305
## 19                  0       0.4072828   0.0000000
## 20                  0       0.5315475   0.0000000
```