

Alzheimers Disease Brain Blood Samples

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This analysis is done using the NCBI gene expression samples taken from a study that used the middle temporal gyrus side of the brain of frozen samples taken from Alzheimer's patients that totalled 78 samples of control and repeat microarray gene expression results. The file was able to be downloaded and unzipped complete with the platform gene symbol ID already attached. A separate file of the meta information that includes the age, gender, tissue type and disease as Alzheimer's Disease (AD) or control was made from the Series information for each sample. The age range for these samples of healthy and AD patients is from 70-95 years of age.

This study can be linked to with all the sample and meta information at:

<https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE109887> The link to the 41 mb text file of series of samples with ID that is too large for github, or my github account type is:

ftp://ftp.ncbi.nlm.nih.gov/geo/series/GSE109nnn/GSE109887/matrix/GSE109887_series_matrix.txt.gz

Open the original Sample ID values text file and write out as a csv file.

```
alz <- read.delim('GSE109887_series_matrix.txt', sep='\t', header=TRUE,
na.strings=c('', ' '), comment.char='!')
```

```
write.csv(alz, 'alzheimersamples.csv', row.names=FALSE)
```

```
head(alz)
```

```
## ID_REF GSM2973262 GSM2973263 GSM2973264 GSM2973265 GSM2973266 GSM2973267
## 1 7A5 6.436441 6.500922 6.513507 6.480839 6.478978 6.509372
## 2 A1BG 6.736136 6.649034 6.612224 6.559642 6.574546 6.471425
## 3 A1CF 6.545395 6.479783 6.588104 6.482503 6.466453 6.442931
## 4 A26C3 6.529725 6.504956 6.531813 6.549229 6.458589 6.602654
## 5 A2BP1 6.773307 7.675723 7.159857 7.334894 7.928057 7.427863
## 6 A2M 11.253437 10.758069 10.790378 11.280206 10.550165 11.015546
## GSM2973268 GSM2973269 GSM2973270 GSM2973271 GSM2973272 GSM2973273
GSM2973274
## 1 6.558079 6.539648 6.476178 6.384209 6.474428 6.506147
6.547314
## 2 6.601043 6.680376 6.619720 6.695035 6.636312 6.549436
6.631196
## 3 6.448482 6.511453 6.537003 6.485914 6.481272 6.470623
6.556559
## 4 6.551262 6.618060 6.473897 6.475091 6.494137 6.539573
```

6.504725						
## 5	7.753590	7.542770	6.962004	7.844319	7.045881	8.032980
7.021767						
## 6	10.374510	10.232084	11.219453	10.558733	11.928947	10.029828
11.261613						
##	GSM2973275	GSM2973276	GSM2973277	GSM2973278	GSM2973279	GSM2973280
GSM2973281						
## 1	6.482653	6.431043	6.467538	6.496945	6.455699	6.533167
6.502415						
## 2	6.637651	6.610124	6.629145	6.633296	6.574900	6.686115
6.594453						
## 3	6.500758	6.521914	6.561131	6.483240	6.495440	6.545356
6.540573						
## 4	6.574710	6.434496	6.499997	6.456096	6.506443	6.601116
6.455450						
## 5	7.237758	7.626402	7.702040	7.108037	8.086046	7.320380
7.262326						
## 6	10.869890	10.028131	10.710539	10.902636	10.507890	10.889177
10.479438						
##	GSM2973282	GSM2973283	GSM2973284	GSM2973285	GSM2973286	GSM2973287
GSM2973288						
## 1	6.444786	6.501353	6.477281	6.544612	6.400074	6.520184
6.539472						
## 2	6.571460	6.662062	6.610356	6.586472	6.590251	6.587090
6.597562						
## 3	6.462481	6.499808	6.487859	6.539648	6.521903	6.523406
6.469701						
## 4	6.449598	6.531614	6.493402	6.426615	6.542165	6.577142
6.421726						
## 5	7.229908	7.817468	7.986829	8.202127	7.727549	7.299809
8.396471						
## 6	10.736578	10.754942	9.644938	10.630864	9.750951	11.035407
10.141873						
##	GSM2973289	GSM2973290	GSM2973291	GSM2973292	GSM2973293	GSM2973294
GSM2973295						
## 1	6.424923	6.474643	6.589264	6.445287	6.529792	6.537969
6.459321						
## 2	6.680176	6.550771	6.679956	6.569058	6.675714	6.579930
6.559305						
## 3	6.530320	6.473031	6.517640	6.506745	6.516516	6.464695
6.556136						
## 4	6.533016	6.370309	6.488512	6.445287	6.455889	6.412834
6.477753						
## 5	8.017758	8.169229	8.477709	7.172333	7.303684	8.116424
8.008762						
## 6	10.213843	10.347774	10.304462	9.771581	11.610263	10.145408
9.672881						
##	GSM2973296	GSM2973297	GSM2973298	GSM2973299	GSM2973300	GSM2973301
GSM2973302						
## 1	6.418835	6.503889	6.485979	6.485081	6.530189	6.450836

6.489789						
## 2	6.616573	6.893967	6.556532	6.569898	6.896213	6.618346
6.637531						
## 3	6.481994	6.476141	6.525448	6.504118	6.471415	6.439531
6.522903						
## 4	6.443488	6.490153	6.502554	6.540274	6.610700	6.443019
6.483445						
## 5	7.650064	7.083986	7.212323	7.138866	6.818649	7.580220
6.876141						
## 6	11.445590	10.917707	10.639809	10.877692	11.223275	9.632867
10.446053						
##	GSM2973303	GSM2973304	GSM2973305	GSM2973306	GSM2973307	GSM2973308
GSM2973309						
## 1	6.450708	6.461540	6.470023	6.446682	6.580688	6.506489
6.335251						
## 2	6.593549	6.678117	6.591719	6.636234	6.648021	6.622491
6.577416						
## 3	6.503260	6.528314	6.487072	6.525948	6.540932	6.499622
6.479403						
## 4	6.592281	6.483814	6.582309	6.535979	6.521488	6.538749
6.492057						
## 5	7.380896	6.899655	8.136078	7.597110	7.000424	8.066728
6.978048						
## 6	11.354353	10.837673	9.561554	10.928431	10.706460	10.236279
10.857606						
##	GSM2973310	GSM2973311	GSM2973312	GSM2973313	GSM2973314	GSM2973315
GSM2973316						
## 1	6.435910	6.383139	6.504311	6.442846	6.495440	6.423849
6.439607						
## 2	6.715207	6.776508	6.606429	6.632080	6.614676	6.610304
6.641509						
## 3	6.589606	6.485514	6.522903	6.514882	6.493620	6.504014
6.494156						
## 4	6.473449	6.466644	6.498143	6.367646	6.512105	6.483955
6.578028						
## 5	6.770394	8.196010	8.175675	8.239208	7.745435	7.878781
8.135434						
## 6	11.231447	10.371160	9.715824	9.869439	10.131814	10.695212
10.372269						
##	GSM2973317	GSM2973318	GSM2973319	GSM2973320	GSM2973321	GSM2973322
GSM2973323						
## 1	6.476767	6.432943	6.567727	6.590029	6.518445	6.402109
6.462368						
## 2	6.647461	6.583375	6.641342	6.559408	6.603364	6.667564
6.643683						
## 3	6.522168	6.490471	6.612509	6.502178	6.495266	6.483240
6.539573						
## 4	6.577480	6.422356	6.485102	6.515997	6.489093	6.380886
6.519553						
## 5	7.967045	7.416130	7.679170	8.173208	7.996740	7.893309

```

8.566021
## 6 10.452866 10.354096 10.449631 9.839133 9.939212 10.397824
10.141047
## GSM2973324 GSM2973325 GSM2973326 GSM2973327 GSM2973328 GSM2973329
GSM2973330
## 1 6.429510 6.461409 6.404062 6.527984 6.519651 6.447827
6.462642
## 2 6.610161 6.570311 6.587222 6.672783 6.565616 6.645337
6.667337
## 3 6.473020 6.468053 6.550716 6.533538 6.514122 6.499146
6.540705
## 4 6.397061 6.451695 6.484181 6.441520 6.464654 6.473196
6.557970
## 5 8.215478 8.026517 7.850848 8.178894 7.749528 8.342166
8.141308
## 6 9.837524 10.109630 11.115016 9.570170 11.066659 9.929106
9.642897
## GSM2973331 GSM2973332 GSM2973333 GSM2973334 GSM2973335 GSM2973336
GSM2973337
## 1 6.536339 6.506450 6.429433 6.427672 6.488852 6.503583
6.508713
## 2 6.551605 6.557762 6.600702 6.648831 6.660864 6.617121
6.541810
## 3 6.491767 6.479403 6.535446 6.487697 6.515856 6.546361
6.457605
## 4 6.505190 6.585256 6.594342 6.523304 6.526753 6.492019
6.623703
## 5 8.334120 8.201316 7.891050 8.061283 7.794727 7.156839
6.903667
## 6 10.061636 11.116617 10.779104 10.415084 10.889901 11.026483
10.926880
## GSM2973338 GSM2973339
## 1 6.442999 6.465497
## 2 6.547078 6.611912
## 3 6.469584 6.521874
## 4 6.467831 6.453058
## 5 8.187274 7.777883
## 6 9.636975 10.613131

```

Lets read in the meta information for age, gender, and disease type as AD or control.

```

meta <- read.csv('AlzheimerAgeGenderTissueSamplesMeta.csv', sep=',',
                 header=TRUE, na.strings=c('', ' '))

```

```
head(meta)
```

```

## sampleID          GSM2973262
## 1 gender              M
## 2 age                91
## 3 disease            AD
## 4 tissue brain, middle temporal gyrus blood

```

##	GSM2973263	GSM2973264
## 1	M	F
## 2	87	82
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973265	GSM2973266
## 1	F	M
## 2	73	94
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973267	GSM2973268
## 1	M	F
## 2	72	90
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973269	GSM2973270
## 1	F	F
## 2	86	87
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973271	GSM2973272
## 1	M	M
## 2	92	81
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973273	GSM2973274
## 1	M	F
## 2	87	92
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973275	GSM2973276
## 1	F	M
## 2	95	75
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973277	GSM2973278
## 1	F	M
## 2	87	95
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973279	GSM2973280
## 1	M	F
## 2	90	77
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973281	GSM2973282
## 1	F	M
## 2	84	85
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood

##	GSM2973283	GSM2973284
## 1	M	F
## 2	89	89
## 3	control	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973285	GSM2973286
## 1	F	F
## 2	82	78
## 3	control	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973287	GSM2973288
## 1	M	F
## 2	70	86
## 3	AD	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973289	GSM2973290
## 1	F	F
## 2	75	94
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973291	GSM2973292
## 1	M	M
## 2	82	82
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973293	GSM2973294
## 1	M	F
## 2	73	77
## 3	control	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973295	GSM2973296
## 1	M	M
## 2	85	92
## 3	AD	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973297	GSM2973298
## 1	F	F
## 2	84	87
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973299	GSM2973300
## 1	M	F
## 2	86	92
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973301	GSM2973302
## 1	M	F
## 2	92	90
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood

##	GSM2973303	GSM2973304
## 1	F	F
## 2	82	82
## 3	AD	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973305	GSM2973306
## 1	F	M
## 2	89	90
## 3	AD	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973307	GSM2973308
## 1	M	M
## 2	87	78
## 3	AD	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973309	GSM2973310
## 1	F	F
## 2	88	86
## 3	AD	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973311	GSM2973312
## 1	F	M
## 2	88	86
## 3	control	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973313	GSM2973314
## 1	F	F
## 2	92	81
## 3	control	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973315	GSM2973316
## 1	M	F
## 2	82	92
## 3	AD	control
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973317	GSM2973318
## 1	F	M
## 2	81	89
## 3	control	AD
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973319	GSM2973320
## 1	F	M
## 2	85	94
## 3	AD	control
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	
##	GSM2973321	GSM2973322
## 1	F	F
## 2	85	82
## 3	control	control
## 4 brain, middle temporal gyrus blood	brain, middle temporal gyrus blood	

##	GSM2973323	GSM2973324
## 1	M	F
## 2	81	77
## 3	control	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973325	GSM2973326
## 1	F	M
## 2	81	79
## 3	control	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973327	GSM2973328
## 1	M	F
## 2	78	78
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973329	GSM2973330
## 1	M	M
## 2	79	86
## 3	control	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973331	GSM2973332
## 1	M	M
## 2	91	82
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973333	GSM2973334
## 1	M	F
## 2	84	91
## 3	AD	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973335	GSM2973336
## 1	F	M
## 2	87	86
## 3	control	AD
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973337	GSM2973338
## 1	M	M
## 2	88	81
## 3	AD	control
## 4	brain, middle temporal gyrus blood	brain, middle temporal gyrus blood
##	GSM2973339	
## 1	F	
## 2	85	
## 3	AD	
## 4	brain, middle temporal gyrus blood	

Transpose the meta to fields instead of rows

```
meta1 <- as.data.frame(t(meta))
names <- as.character(meta$sampleID)
```



```
colnames(meta1) <- names
meta2 <- meta1[-1,]
head(meta2)
```

```
##           gender age disease                                tissue
## GSM2973262      M  91      AD brain, middle temporal gyrus blood
## GSM2973263      M  87      AD brain, middle temporal gyrus blood
## GSM2973264      F  82      AD brain, middle temporal gyrus blood
## GSM2973265      F  73      AD brain, middle temporal gyrus blood
## GSM2973266      M  94      AD brain, middle temporal gyrus blood
## GSM2973267      M  72      AD brain, middle temporal gyrus blood
```

Separate the data into gender and control or AD data sets respectively in each gender and for both genders.

Data tables of males and females for meta only:

```
row.names(alz) <- alz$ID_REF
alz1 <- alz[,-1]

row.names(meta) <- meta$sampleID
Meta <- meta[,-1]

names <- row.names(Meta)
Meta1 <- as.data.frame(t(Meta))
colnames(Meta1) <- names

fem <- grep('F', Meta1$gender)
mal <- grep('M', Meta1$gender)

Fem <- Meta1[fem,]
Mal <- Meta1[mal,]

Fem$sampleID <- as.factor(row.names(Fem))
Mal$sampleID <- as.factor(row.names(Mal))
```

Display the fields of these gender specific tables by meta information:

```
colnames(Fem)

## [1] "gender"    "age"       "disease"   "tissue"    "sampleID"

colnames(Mal)

## [1] "gender"    "age"       "disease"   "tissue"    "sampleID"
```

The same indices of each row name is the same as the alz1, alzheimer table colnames indices. So, use those same female and male indices values from the regex commands to separate the alzheimer table into male and female tables.

```
Females <- alz1[,fem]
Males <- alz1[,mal]
```

Data tables of control or AD for males and for females for meta only:

```
femControl <- grep('control', Fem$disease)
malControl <- grep('control', Mal$disease)

femAD <- grep('AD', Fem$disease)
malAD <- grep('AD', Mal$disease)

FemCtrl <- Fem[femControl,]
MalCtrl <- Mal[malControl,]

FemAD <- Fem[femAD,]
MalAD <- Mal[malAD,]
```

Display the AD or Control tables by gender for meta information:

```
colnames(FemCtrl)
## [1] "gender" "age" "disease" "tissue" "sampleID"

colnames(FemAD)
## [1] "gender" "age" "disease" "tissue" "sampleID"

colnames(MalCtrl)
## [1] "gender" "age" "disease" "tissue" "sampleID"

colnames(MalAD)
## [1] "gender" "age" "disease" "tissue" "sampleID"
```

Now use that same index information within each gender table derived from the alzheimer gene expression data:

```
Females_AD <- Fem[femAD,]
Females_control <- Fem[femControl,]

males_AD <- Mal[malAD,]
males_control <- Mal[malControl,]
```

Write these last tables to csv file:

```
write.csv(Females_AD, 'females_Alzheimers.csv', row.names=TRUE)
write.csv(Females_control, 'females_healthy_control.csv', row.names=TRUE)
write.csv(males_AD, 'males_Alzheimers.csv', row.names=TRUE)
write.csv(males_control, 'males_healthy_control.csv', row.names=TRUE)
```

What is the age range on these samples of healthy controls and AD patients?

```

age1 <- range(as.numeric(as.character(FemAD$age)))
age2 <- range(as.numeric(as.character(FemCtrl$age)))
age3 <- range(as.numeric(as.character(MalAD$age)))
age4 <- range(as.numeric(as.character(MalCtrl$age)))

char <- c('The minimum age: ', 'The maximum age: ')

AD_fem <- paste0(char,age1, sep='')
AD_mal <- paste0(char,age3, sep='')
ctrl_fem <- paste0(char,age2, sep='')
ctrl_mal <- paste0(char, age4, sep='')

adf <- c('Alzheimer females: ')
adm <- c('Alzheimer males: ')
cf <- c('healthy females: ')
cm <- c('healthy males: ')

ranges <- c(adf,AD_fem, adm, AD_mal, cf, ctrl_fem, cm, ctrl_mal)
ranges

## [1] "Alzheimer females: " "The minimum age: 73" "The maximum age: 95"
## [4] "Alzheimer males: " "The minimum age: 70" "The maximum age: 95"
## [7] "healthy females: " "The minimum age: 77" "The maximum age: 92"
## [10] "healthy males: " "The minimum age: 73" "The maximum age: 94"

```

The age range in all of this data for these healthy and AD patients is age 70 to age 95 years of age. Just useful to know when cross comparing blood microarray samples across the females from our overweight females using epigallocatechin (EGCG) in their 40s, the males from Russia who are also in their 40s with or without myocardial infarction (MI), the hemochromatosis (iron toxicity) males and females averaging their 40s in years of age with or without iron toxicity, and the flu vaccinated blood samples of males and females also in their 40s with or without antibiotic treatment combined with flu vaccination.

Lets do some data analysis of the means and fold change between the groups to create some additional statistical information on these Alzheimers blood samples and healthy controls of elderly patients. We will use dplyr for this and plot with ggplot2 later.

```
library(dplyr)
```

First lets look at the control and the AD tables within the gender specific tables: Females_AD, Females_control, males_AD, males_control. Get the means of each gene and compare into one table. This and these tables of data were already cleaned to only have one gene per row, due to not having to merge the platform fields to the series table and duplicate genes for missing data in the additional rows like previous studies mentioned earlier required.

Get the row means of each table and add to each table.

```

names <- row.names(Females_AD)
Females_AD1 <- rowMeans(Females_AD)

```

```

#colnames(Females_AD1) <- 'fem_AD_Mean'

Females_control1 <- rowMeans(Females_control)
#colnames(Females_control1) <- 'fem_ctrl_Mean'

males_AD1 <- rowMeans(males_AD)
#colnames(males_AD1) <- 'mal_AD_Mean'

males_control1 <- rowMeans(males_control)
#colnames(males_control1) <- 'mal_ctrl_Mean'

means <- cbind(Females_AD1, Females_control1, males_AD1, males_control1)
Means <- as.data.frame(means)
colnames(Means) <- paste(colnames(Means), '_Mean', sep='')
str(Means)

## 'data.frame':    31700 obs. of  4 variables:
## $ Females_AD1_Mean      : num  6.48 6.63 6.52 6.51 7.42 ...
## $ Females_control1_Mean: num  6.47 6.65 6.5 6.48 7.97 ...
## $ males_AD1_Mean        : num  6.48 6.6 6.5 6.51 7.51 ...
## $ males_control1_Mean   : num  6.48 6.62 6.51 6.5 8.01 ...

```

Now for the fold change values between the Means of the female control and AD patients, then for the male control and AD patients.

```

names <- row.names(Means)
FC_females <- Means %>% mutate(FC_fem_ctrl_AD =
                                Females_AD1_Mean/Females_control1_Mean)
str(FC_females)

## 'data.frame':    31700 obs. of  5 variables:
## $ Females_AD1_Mean      : num  6.48 6.63 6.52 6.51 7.42 ...
## $ Females_control1_Mean: num  6.47 6.65 6.5 6.48 7.97 ...
## $ males_AD1_Mean        : num  6.48 6.6 6.5 6.51 7.51 ...
## $ males_control1_Mean   : num  6.48 6.62 6.51 6.5 8.01 ...
## $ FC_fem_ctrl_AD        : num  1.001 0.998 1.004 1.005 0.931 ...

row.names(FC_females) <- names

names <- row.names(FC_females)
FC_both <- FC_females %>% mutate(FC_male_ctrl_AD =
                                males_AD1_Mean/males_control1_Mean)
row.names(FC_both) <- names
str(FC_both)

## 'data.frame':    31700 obs. of  6 variables:
## $ Females_AD1_Mean      : num  6.48 6.63 6.52 6.51 7.42 ...
## $ Females_control1_Mean: num  6.47 6.65 6.5 6.48 7.97 ...
## $ males_AD1_Mean        : num  6.48 6.6 6.5 6.51 7.51 ...
## $ males_control1_Mean   : num  6.48 6.62 6.51 6.5 8.01 ...

```

```
## $ FC_fem_ctrl_AD      : num  1.001 0.998 1.004 1.005 0.931 ...
## $ FC_male_ctrl_AD     : num  0.999 0.997 0.999 1.002 0.938 ...

write.csv(FC_both, 'FC_both.csv', row.names=TRUE)
```

Combine the data of the samples with IDs in the alz1 table with the stats.

```
both <- cbind(FC_both, alz1)

Both <- round(both, 3)

write.csv(Both, 'Both.csv', row.names=TRUE)
```

Top 100 genes Most expressed in fold change for females with AD:

```
top100_fem <- Both[order(Both$FC_fem_ctrl_AD, decreasing=TRUE)[0:100],]
a <- row.names(top100_fem)
a
```

## [1]	"SLC5A3"	"LOC339879"	"DDIT4L"	"SLC6A12"	"SLC7A2"
## [6]	"SFMBT2"	"LOC727908"	"CHST6"	"TEAD2"	"GPER"
## [11]	"FLJ38717"	"FCGBP"	"HEY2"	"ITPRIPL2"	"SIPA1"
## [16]	"DDX27"	"RAPGEF3"	"C15ORF52"	"CALD1"	"ITSN1"
## [21]	"AEBP1"	"PLXNB1"	"HS.37648"	"LOC100129828"	"NBPF8"
## [26]	"GSDMD"	"ITPKB"	"PTH1R"	"SYTL4"	"MYOT"
## [31]	"TMEM137"	"FAM65C"	"FZD9"	"VCAN"	
	"ZCCHC24"				
## [36]	"HS.505676"	"HS.534061"	"LOC100133019"	"LRRC32"	"AHNAK"
## [41]	"LYL1"	"NOTCH1"	"APLNR"	"HS.379253"	"PTRF"
## [46]	"RPPH1"	"C10RF110"	"INPPL1"	"LOC649841"	"DLC1"
## [51]	"ITGB5"	"RASL12"	"AKR1C3"	"FOXC1"	
	"LOC100132532"				
## [56]	"RAB13"	"WSCD1"	"LOC643287"	"ACACB"	"CUEDC1"
## [61]	"INPP5D"	"LOC100129681"	"LOC642031"	"TNFRSF1B"	"CFLAR"
## [66]	"FXYS5"	"LOC100131541"	"PDGFRB"	"RAXL1"	"ANGPT2"
## [71]	"LOC100131277"	"SLC15A3"	"FLNC"	"LOC648921"	"NACC2"
## [76]	"RUNDC2C"	"UBXN2A"	"VIL2"	"ZNF786"	
	"DCLRE1C"				
## [81]	"FLJ46906"	"HS.143018"	"LOC727948"	"HS.193767"	"LRCH4"
## [86]	"MT1H"	"SCRIB"	"KIF1C"	"LASS1"	
	"LOC100130598"				
## [91]	"NDE1"	"RN7SK"	"ZNF621"	"C9ORF130"	"CAPS"
## [96]	"EML3"	"HS.576072"	"KCNJ10"	"LOC100131096"	
	"LOC653158"				

Top 100 genes most expressed in fold change for males with AD:

```
top100_male <- Both[order(Both$FC_male_ctrl_AD, decreasing=TRUE)[0:100],]
b <- row.names(top100_male)
b
```

##	[1]	"RGS1"	"SLC5A3"	"LOC649362"	"TTR"	"CD44"
##	[6]	"FCGBP"	"SLC7A2"	"C100RF10"	"EMP1"	"ITPRIP"
##	[11]	"DDIT4"	"PLXNB1"	"ITPKB"	"S100A8"	
		"SERPINA3"				
##	[16]	"TEAD2"	"ADAMTS1"	"CCL2"	"ZFP36"	"HEY2"
##	[21]	"PTH1R"	"CHST6"	"GFAP"	"HLA-DRA"	
		"SLC6A12"				
##	[26]	"ACACB"	"GPR4"	"SRGN"	"CD14"	"CDKN1A"
##	[31]	"LRRC32"	"FOS"	"HLA-DMB"	"KIAA1881"	
		"TNFRSF1B"				
##	[36]	"HLA-DMA"	"MS4A6A"	"RAB13"	"CALD1"	"RASL12"
##	[41]	"MT2A"	"SYTL4"	"AHNAK"	"CEBPD"	"FAM65C"
##	[46]	"TGFB1"	"TMC6"	"CAPS"	"DDIT4L"	"ID3"
##	[51]	"ITGB2"	"LCP1"	"RNU1G2"	"S1PR3"	"SIPA1"
##	[56]	"GADD45G"	"GSDMD"	"NUPR1"	"ANLN"	"GEM"
##	[61]	"PDGFRB"	"VCAN"	"AEBP1"	"CD163"	"KIF1C"
##	[66]	"LOC387763"	"RUNDC2C"	"ZFP36L1"	"CFLAR"	"CTGF"
##	[71]	"IL8"	"PDK4"	"PLIN2"	"SLC16A9"	"CSF1R"
##	[76]	"IL17RB"	"LOC100133692"	"LOC643287"	"SCIN"	"TAGLN"
##	[81]	"TMEM106A"	"ADM"	"EDN1"	"FOXC1"	
		"GADD45B"				
##	[86]	"HSPA1A"	"MT1M"	"APLNR"	"APOLD1"	"C7"
##	[91]	"HS.37648"	"IGFBP5"	"MYOT"	"RN7SK"	
		"C15ORF52"				
##	[96]	"GJA4"	"GPER"	"ITGB5"	"LEP"	"PLXDC2"

Bottom 100 genes that are least expressed in fold change in females with AD:

```
bottom100_fem <- Both[order(Both$FC_fem_ctrl_AD, decreasing=FALSE)[0:100],]
c <- row.names(bottom100_fem)
c
```

##	[1]	"SYT1"	"CHGB"	"PCSK1"	"VGF"	"MAL2"
##	[6]	"RGS4"	"GABRA1"	"NPTX2"	"SST"	"STAT4"
##	[11]	"C10RF173"	"CBLN4"	"DYNC1I1"	"STXBP1"	"GNG2"
##	[16]	"RGS7"	"TSPAN13"	"EFCBP1"	"NELL2"	"HPRT1"
##	[21]	"TAGLN3"	"DCLK1"	"ST6GALNAC5"	"GLRB"	"BEX5"
##	[26]	"DIRAS2"	"SYP"	"KIAA1107"	"PAK1"	"PTPRN"
##	[31]	"SERPINI1"	"ZCCHC12"	"NELL1"	"DACH2"	"ELMOD1"
##	[36]	"NECAB1"	"NEFM"	"PARM1"	"RTN1"	"VAMP2"
##	[41]	"ENC1"	"TMEM16C"	"CREG2"	"STX1A"	"SVOP"
##	[46]	"CAP2"	"SCG2"	"UCHL1"	"CALY"	
		"KIAA0748"				
##	[51]	"NAP1L3"	"RIMBP2"	"YWHAG"	"GABRG2"	
		"LOC100128403"				
##	[56]	"NAP1L2"	"NAP1L5"	"STMN2"	"ADCYAP1"	"SCN3B"
##	[61]	"GAD1"	"HS.390250"	"INA"	"SCN2B"	
		"GPRASP2"				
##	[66]	"ITFG1"	"SNX10"	"SV2B"	"ATP6V1G2"	"GABBR2"
##	[71]	"GAD2"	"HPCA"	"NUDT11"	"LPPR4"	

```

"TMEM155"
## [76] "CAMK1G"      "EPHA4"      "GABRA5"      "MYT1L"
"HS.553187"
## [81] "CDH13"       "VSNL1"      "XK"          "CKMT1A"
"HS.31961"
## [86] "PCSK1N"      "PRKCG"      "SYT13"       "NPY"         "PRKCB"
## [91] "RASL11B"     "SYN2"       "CADPS"       "TSPYL1"
"C12ORF53"
## [96] "HSPB3"       "MKL2"       "PPP3R1"      "SNCA"
"C2ORF80"

```

Bottom 100 genes that are least expressed in fold change in males with AD:

```

bottom100_male <- Both[order(Both$FC_male_ctrl_AD, decreasing=FALSE)[0:100],]
d <- row.names(bottom100_male)
d

```

```

## [1] "VGF"          "PCSK1"        "RGS4"         "CHGB"         "STAT4"
## [6] "GABRA1"       "ST6GALNAC5"  "ADCYAP1"      "MAL2"         "SYT1"
## [11] "CREG2"        "NPTX2"        "TMEM16C"      "CBLN4"         "SVOP"
## [16] "KIAA1107"     "RGS7"         "BEX5"         "C10RF173"      "NELL1"
## [21] "SST"          "PARM1"        "DYNC1I1"      "NAP1L5"        "NEFM"
## [26] "VAMP2"        "HS.390250"    "PTPRN"        "HSPB3"
"LOC100128403"
## [31] "STXBP1"       "ENC1"         "GAD2"         "PAK1"         "ANO3"
## [36] "INA"          "LOC387856"    "SLC30A3"      "STX1A"
"ZCCHC12"
## [41] "SCN2B"        "C2ORF80"      "CRYM"         "EPHA4"         "GLRB"
## [46] "HPRT1"        "KIAA0748"     "STMN2"        "C11ORF87"      "CAP2"
## [51] "GAD1"         "SNX10"        "EFCBP1"       "RPH3A"
"SERPINI1"
## [56] "DACH2"        "DCLK1"        "GPRASP2"      "SYP"
"TSpan13"
## [61] "VIP"          "C12ORF53"     "CALY"         "OLFM3"         "SV2B"
## [66] "COPG2IT1"     "DIRAS2"       "ELMOD1"       "NELL2"         "SCG2"
## [71] "SLC39A10"     "GABRG2"       "SLITRK4"      "TAGLN3"
"TMEM155"
## [76] "CKMT1B"       "CYP26B1"      "GABBR2"       "CPNE4"
"HS.553187"
## [81] "MFF"          "PRKCG"        "TUBB2A"       "ELAVL4"        "LRFN5"
## [86] "NCALD"        "RIMBP2"       "RTN1"         "SLC6A17"       "SYT13"
## [91] "YWHAE"        "CCKBR"        "FGF12"        "G3BP2"         "HOPX"
## [96] "NAP1L3"       "NMNAT2"       "ZNF365"       "C20ORF103"     "CADPS"

```

```

ab <- c(a,b)
topBoth <- unique(ab)

cd <- c(c,d)
bottomBoth <- unique(cd)

```

The unique top genes are:

topBoth

##	[1]	"SLC5A3"	"LOC339879"	"DDIT4L"	"SLC6A12"	"SLC7A2"
##	[6]	"SFMBT2"	"LOC727908"	"CHST6"	"TEAD2"	"GPER"
##	[11]	"FLJ38717"	"FCGBP"	"HEY2"	"ITPRIPL2"	"SIPA1"
##	[16]	"DDX27"	"RAPGEF3"	"C15ORF52"	"CALD1"	"ITSN1"
##	[21]	"AEBP1"	"PLXNB1"	"HS.37648"	"LOC100129828"	"NBPF8"
##	[26]	"GSDMD"	"ITPKB"	"PTH1R"	"SYTL4"	"MYOT"
##	[31]	"TMEM137"	"FAM65C"	"FZD9"	"VCAN"	
"ZCCHC24"						
##	[36]	"HS.505676"	"HS.534061"	"LOC100133019"	"LRRC32"	"AHNAK"
##	[41]	"LYL1"	"NOTCH1"	"APLNR"	"HS.379253"	"PTRF"
##	[46]	"RPPH1"	"C10RF110"	"INPL1"	"LOC649841"	"DLC1"
##	[51]	"ITGB5"	"RASL12"	"AKR1C3"	"FOXCI"	
"LOC100132532"						
##	[56]	"RAB13"	"WSCD1"	"LOC643287"	"ACACB"	"CUEDC1"
##	[61]	"INPP5D"	"LOC100129681"	"LOC642031"	"TNFRSF1B"	"CFLAR"
##	[66]	"FXVD5"	"LOC100131541"	"PDGFRB"	"RAXL1"	"ANGPT2"
##	[71]	"LOC100131277"	"SLC15A3"	"FLNC"	"LOC648921"	"NACC2"
##	[76]	"RUNDC2C"	"UBXN2A"	"VIL2"	"ZNF786"	
"DCLRE1C"						
##	[81]	"FLJ46906"	"HS.143018"	"LOC727948"	"HS.193767"	"LRCH4"
##	[86]	"MT1H"	"SCRIB"	"KIF1C"	"LASS1"	
"LOC100130598"						
##	[91]	"NDE1"	"RN7SK"	"ZNF621"	"C9ORF130"	"CAPS"
##	[96]	"EML3"	"HS.576072"	"KCNJ10"	"LOC100131096"	
"LOC653158"						
##	[101]	"RGS1"	"LOC649362"	"TTR"	"CD44"	
"C10ORF10"						
##	[106]	"EMP1"	"ITPRIP"	"DDIT4"	"S100A8"	
"SERPINA3"						
##	[111]	"ADAMTS1"	"CCL2"	"ZFP36"	"GFAP"	"HLA -
DRA"						
##	[116]	"GPR4"	"SRGN"	"CD14"	"CDKN1A"	"FOS"
##	[121]	"HLA-DMB"	"KIAA1881"	"HLA-DMA"	"MS4A6A"	"MT2A"
##	[126]	"CEBPD"	"TGFB1"	"TMC6"	"ID3"	"ITGB2"
##	[131]	"LCP1"	"RNU1G2"	"S1PR3"	"GADD45G"	"NUPR1"
##	[136]	"ANLN"	"GEM"	"CD163"	"LOC387763"	
"ZFP36L1"						
##	[141]	"CTGF"	"IL8"	"PDK4"	"PLIN2"	
"SLC16A9"						
##	[146]	"CSF1R"	"IL17RB"	"LOC100133692"	"SCIN"	"TAGLN"
##	[151]	"TMEM106A"	"ADM"	"EDN1"	"GADD45B"	"HSPA1A"
##	[156]	"MT1M"	"APOLD1"	"C7"	"IGFBP5"	"GJA4"
##	[161]	"LEP"	"PLXDC2"			

The unique bottom genes are:

bottomBoth

##	[1]	"SYT1"	"CHGB"	"PCSK1"	"VGF"	"MAL2"
##	[6]	"RGS4"	"GABRA1"	"NPTX2"	"SST"	"STAT4"
##	[11]	"C10RF173"	"CBLN4"	"DYNC1I1"	"STXBP1"	"GNG2"
##	[16]	"RGS7"	"TSPAN13"	"EFCBP1"	"NELL2"	"HPRT1"
##	[21]	"TAGLN3"	"DCLK1"	"ST6GALNAC5"	"GLRB"	"BEX5"
##	[26]	"DIRAS2"	"SYP"	"KIAA1107"	"PAK1"	"PTPRN"
##	[31]	"SERPINI1"	"ZCCHC12"	"NELL1"	"DACH2"	"ELMOD1"
##	[36]	"NECAB1"	"NEFM"	"PARM1"	"RTN1"	"VAMP2"
##	[41]	"ENC1"	"TMEM16C"	"CREG2"	"STX1A"	"SVOP"
##	[46]	"CAP2"	"SCG2"	"UCHL1"	"CALY"	
		"KIAA0748"				
##	[51]	"NAP1L3"	"RIMBP2"	"YWHAG"	"GABRG2"	
		"LOC100128403"				
##	[56]	"NAP1L2"	"NAP1L5"	"STMN2"	"ADCYAP1"	"SCN3B"
##	[61]	"GAD1"	"HS.390250"	"INA"	"SCN2B"	
		"GPRASP2"				
##	[66]	"ITFG1"	"SNX10"	"SV2B"	"ATP6V1G2"	"GABBR2"
##	[71]	"GAD2"	"HPCA"	"NUDT11"	"LPPR4"	
		"TMEM155"				
##	[76]	"CAMK1G"	"EPHA4"	"GABRA5"	"MYT1L"	
		"HS.553187"				
##	[81]	"CDH13"	"VSNL1"	"XK"	"CKMT1A"	
		"HS.31961"				
##	[86]	"PCSK1N"	"PRKCG"	"SYT13"	"NPY"	"PRKCB"
##	[91]	"RASL11B"	"SYN2"	"CADPS"	"TSPYL1"	
		"C12ORF53"				
##	[96]	"HSPB3"	"MKL2"	"PPP3R1"	"SNCA"	
		"C2ORF80"				
##	[101]	"ANO3"	"LOC387856"	"SLC30A3"	"CRYM"	
		"C11ORF87"				
##	[106]	"RPH3A"	"VIP"	"OLFM3"	"COPG2IT1"	
		"SLC39A10"				
##	[111]	"SLITRK4"	"CKMT1B"	"CYP26B1"	"CPNE4"	"MFF"
##	[116]	"TUBB2A"	"ELAVL4"	"LRFN5"	"NCALD"	
		"SLC6A17"				
##	[121]	"YWHAE"	"CCKBR"	"FGF12"	"G3BP2"	"HOPX"
##	[126]	"NMNAT2"	"ZNF365"	"C20ORF103"		

The top genes in common are those genes most expressed in fold change in females AND males who have Alzheimer:

```
A <- as.data.frame(a)
B <- as.data.frame(b)

topBoth <- merge(A,B,by.x='a', by.y='b')
topBoth$a
```

##	[1]	ACACB	AEBP1	AHNAK	APLNR	C15ORF52	CALD1	CAPS
##	[8]	CFLAR	CHST6	DDIT4L	FAM65C	FCGBP	FOXC1	GPB
##	[15]	GSDMD	HEY2	HS.37648	ITGB5	ITPKB	KIF1C	LOC643287

```
## [22] LRRC32      MYOT      PDGFRB    PLXNB1    PTH1R     RAB13     RASL12
## [29] RN7SK       RUNDC2C   SIPA1     SLC5A3    SLC6A12   SLC7A2    SYTL4
## [36] TEAD2      TNFRSF1B  VCAN
## 100 Levels: ACACB AEBP1 AHNAK AKR1C3 ANGPT2 APLNR C15ORF52 C10RF110 ...
ZNF786
```

The bottom genes in common are the least expressed genes in females AND males who have Alzheimer:

```
C <- as.data.frame(c)
D <- as.data.frame(d)

bottomBoth <- merge(C,D, by.x='c', by.y='d')
bottomBoth$c

## [1] ADCYAP1      BEX5         C12ORF53     C10RF173     C20RF80
## [6] CADPS        CALY         CAP2         CBLN4        CHGB
## [11] CREG2        DACH2        DCLK1        DIRAS2        DYNC1I1
## [16] EFCBP1       ELMOD1       ENC1         EPHA4        GABBR2
## [21] GABRA1       GABRG2       GAD1         GAD2         GLRB
## [26] GPRASP2      HPRT1        HS.390250    HS.553187    HSPB3
## [31] INA          KIAA0748     KIAA1107     LOC100128403 MAL2
## [36] NAP1L3       NAP1L5       NEFM         NELL1        NELL2
## [41] NPTX2        PAK1         PARM1        PCSK1        PRKCG
## [46] PTPRN        RGS4         RGS7         RIMBP2       RTN1
## [51] SCG2         SCN2B        SERPINI1     SNX10        SST
## [56] ST6GALNAC5   STAT4        STMN2        STX1A        STXBP1
## [61] SV2B         SVOP         SYP          SYT1         SYT13
## [66] TAGLN3       TMEM155      TMEM16C      TSPAN13      VAMP2
## [71] VGF          ZCCHC12
## 100 Levels: ADCYAP1 ATP6V1G2 BEX5 C12ORF53 C10RF173 C20RF80 CADPS ...
ZCCHC12
```

Lets look at three top expressed and three least expressed genes in common for females and males:

```
b3 <- as.character(bottomBoth$c[1:3])
t3 <- as.character(topBoth$a[1:3])

mix <- c(b3,t3)
mix

## [1] "ADCYAP1" "BEX5"      "C12ORF53" "ACACB"     "AEBP1"     "AHNAK"

Mix <- as.data.frame(mix)
mBoth <- Both
mBoth$gene <- row.names(mBoth)
MixBoth <- merge(Mix, mBoth, by.x='mix', by.y='gene')

toPlot <- MixBoth[,c(1,6,7)]
```

```

colnames(toPlot)[1] <- 'gene'
toPlot

##      gene FC_fem_ctrl_AD FC_male_ctrl_AD
## 1  ACACB      1.092      1.085
## 2 ADCYAP1      0.889      0.895
## 3  AEBP1      1.107      1.075
## 4  AHNAK      1.099      1.079
## 5   BEX5      0.877      0.907
## 6 C12ORF53     0.902      0.922

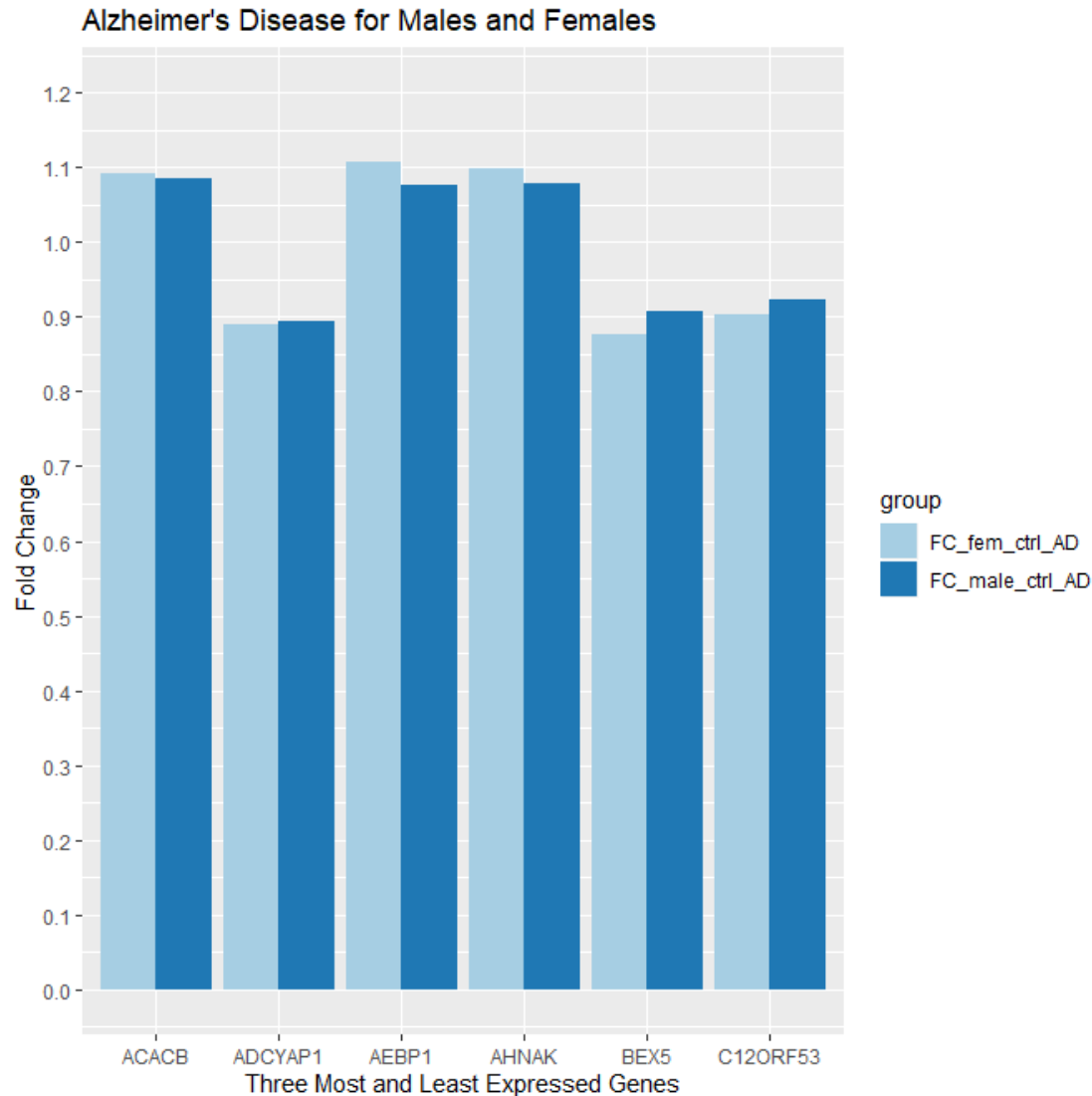
library(ggplot2)
library(tidyr)

to_plot <- gather(toPlot, 'group', 'foldChange', 2:3)
to_plot

##      gene      group foldChange
## 1  ACACB FC_fem_ctrl_AD      1.092
## 2 ADCYAP1 FC_fem_ctrl_AD      0.889
## 3  AEBP1 FC_fem_ctrl_AD      1.107
## 4  AHNAK FC_fem_ctrl_AD      1.099
## 5   BEX5 FC_fem_ctrl_AD      0.877
## 6 C12ORF53 FC_fem_ctrl_AD      0.902
## 7  ACACB FC_male_ctrl_AD      1.085
## 8 ADCYAP1 FC_male_ctrl_AD      0.895
## 9  AEBP1 FC_male_ctrl_AD      1.075
## 10 AHNAK FC_male_ctrl_AD      1.079
## 11  BEX5 FC_male_ctrl_AD      0.907
## 12 C12ORF53 FC_male_ctrl_AD      0.922

ggplot(data = to_plot, aes(x=gene, y=foldChange, fill=group)) +
  geom_bar(stat='identity', position=position_dodge()) +
  scale_y_continuous(breaks = seq(0, 1.2, by=.1), limits=c(0,1.2)) +
  scale_fill_brewer(palette='Paired') +
  ggtitle('Alzheimer\'s Disease for Males and Females') +
  ylab('Fold Change') +
  xlab('Three Most and Least Expressed Genes')

```



Some other data sets on diseases would be interesting to compare to this data on Alzheimer patients. The other data sets to compare this blood tissue type of microarray gene expression profiles are the: hemochromatosis (iron toxicity) from <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE121620>, epigallocatechin EGCG (green tea extract) use by overweight females in 40s found at <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE74560>, myocardial infarction MI (heart disease) in Russian males in 40s found at <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE141512>, antibiotic treatment in flu vaccinated patients of males and females between 18-45 years of age found at <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE120717> and <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE120719>, and an immunization blood sample data set that only has healthy donors blood six days after receiving the

tetanus-diphtheria toxoids and acellular pertussis found at <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE59697>.

Those data sets are needed for their stats with Fold Change values for each study respectively, except the tetanus shot because it is only healthy donor samples analyzing the tetanus-diphtheria toxoids as an antigen to test the B lymphocytes route in the plasma cells.

The females in the overweight study, the females in the flu study, and the females in the iron toxicity study could be cross compared to the females in this study on Alzheimer female patients. The males in the heart disease study, iron toxicity study, and flu study could be compared to the males in this Alzheimer study. And both genders from those studies could also be compared to both genders in this study.

The plan is to get the genes these studies all have in common and compare between the genders on fold change stats of those genes. That being iron toxicity fold change, and flu vaccinated fold change compared to added antibiotics (not compared to healthy non vaccinated patients) for comparison with Alzheimer patients. Overweight females using EGCG for weight loss is exclusive to the female comparisons, and the heart disease study was exclusive to male patients.

This study's data on fold change, means, and sample values is the **both.csv** file. The flu study had days 0,3,7, and 21 comparisons and both genders in the **FoldChange_All.csv** file for that study. The iron toxicity fold change stats is in the **all-fc-grops.csv** file for the hemochromatosis study on both genders. The overweight females using EGCG to diet with the included fold change values for those using EGCG or EGCG+vitamin C+fish oil is in the **foldChange_EGCG.csv** file. And the males who have heart disease of type MI is in the file **foldChange_MI_males.csv**. The tetanus immunization samples don't have the fold change because they are all healthy donors with no age data or gender data and taken 6 days after the tetanus shot, but it is useful to compare genes with healthy females and males in the healthy and control groups **tetanusImmunizationBlood.csv** is that file.

Lets read in those files with their respective and appropriately described names.

```
Alzheimer <- read.csv('both.csv', sep=',', header=T, na.strings=c('', ' '))
Heart_Disease_Males <- read.csv('foldChange_MI_males.csv', sep=',',
                                header=T, na.strings=c('', ' '))
TetanusImmunity <- read.csv('tetanusImmunizationBlood.csv', sep=',',
                             header=T, na.strings=c('', ' '))
Overweight_Females_EGCG <- read.csv('foldChange_EGCG.csv', sep=',',
                                     header=T, na.strings=c('', ' '))
flu_Vaccinated <- read.csv('FoldChange_All.csv', sep=',', header=T,
                           na.strings=c('', ' '))
iron_toxicity <- read.csv('all-fc-grops.csv', sep=',', header=T,
                          na.strings=c('', ' '))
```

Look at the column names and select the ones needed or that have fold change values to cross compare, or to compare means across samples as with the tetanus data set.

The Alzheimer column names are:

```
Alzheimer1 <- Alzheimer
colnames(Alzheimer1)[c(2:85)] <- paste('Alz_',
                                         colnames(Alzheimer1)[c(2:85)],
                                         sep='')
colnames(Alzheimer1)
```

## [1]	"X"	"Alz_Females_AD1_Mean"
## [3]	"Alz_Females_control1_Mean"	"Alz_males_AD1_Mean"
## [5]	"Alz_males_control1_Mean"	"Alz_FC_fem_ctrl_AD"
## [7]	"Alz_FC_male_ctrl_AD"	"Alz_GSM2973262"
## [9]	"Alz_GSM2973263"	"Alz_GSM2973264"
## [11]	"Alz_GSM2973265"	"Alz_GSM2973266"
## [13]	"Alz_GSM2973267"	"Alz_GSM2973268"
## [15]	"Alz_GSM2973269"	"Alz_GSM2973270"
## [17]	"Alz_GSM2973271"	"Alz_GSM2973272"
## [19]	"Alz_GSM2973273"	"Alz_GSM2973274"
## [21]	"Alz_GSM2973275"	"Alz_GSM2973276"
## [23]	"Alz_GSM2973277"	"Alz_GSM2973278"
## [25]	"Alz_GSM2973279"	"Alz_GSM2973280"
## [27]	"Alz_GSM2973281"	"Alz_GSM2973282"
## [29]	"Alz_GSM2973283"	"Alz_GSM2973284"
## [31]	"Alz_GSM2973285"	"Alz_GSM2973286"
## [33]	"Alz_GSM2973287"	"Alz_GSM2973288"
## [35]	"Alz_GSM2973289"	"Alz_GSM2973290"
## [37]	"Alz_GSM2973291"	"Alz_GSM2973292"
## [39]	"Alz_GSM2973293"	"Alz_GSM2973294"
## [41]	"Alz_GSM2973295"	"Alz_GSM2973296"
## [43]	"Alz_GSM2973297"	"Alz_GSM2973298"
## [45]	"Alz_GSM2973299"	"Alz_GSM2973300"
## [47]	"Alz_GSM2973301"	"Alz_GSM2973302"
## [49]	"Alz_GSM2973303"	"Alz_GSM2973304"
## [51]	"Alz_GSM2973305"	"Alz_GSM2973306"
## [53]	"Alz_GSM2973307"	"Alz_GSM2973308"
## [55]	"Alz_GSM2973309"	"Alz_GSM2973310"
## [57]	"Alz_GSM2973311"	"Alz_GSM2973312"
## [59]	"Alz_GSM2973313"	"Alz_GSM2973314"
## [61]	"Alz_GSM2973315"	"Alz_GSM2973316"
## [63]	"Alz_GSM2973317"	"Alz_GSM2973318"
## [65]	"Alz_GSM2973319"	"Alz_GSM2973320"
## [67]	"Alz_GSM2973321"	"Alz_GSM2973322"
## [69]	"Alz_GSM2973323"	"Alz_GSM2973324"
## [71]	"Alz_GSM2973325"	"Alz_GSM2973326"
## [73]	"Alz_GSM2973327"	"Alz_GSM2973328"
## [75]	"Alz_GSM2973329"	"Alz_GSM2973330"
## [77]	"Alz_GSM2973331"	"Alz_GSM2973332"
## [79]	"Alz_GSM2973333"	"Alz_GSM2973334"
## [81]	"Alz_GSM2973335"	"Alz_GSM2973336"

```
## [83] "Alz_GSM2973337"          "Alz_GSM2973338"
## [85] "Alz_GSM2973339"
```

The heart disease column names are:

```
Heart_Disease_Males1 <- Heart_Disease_Males
colnames(Heart_Disease_Males1)[c(4,6:11)] <- gsub('Male', 'MI_Male',
colnames(Heart_Disease_Males1)[c(4,6:11)])
Heart_Disease_Males1 <- Heart_Disease_Males1[, -1]
colnames(Heart_Disease_Males1)

## [1] "Symbol"          "FC_MI_males"
## [3] "HealthyMI_Male_Means" "MI_Male_Means"
## [5] "healthy_MI_Males_GSM4205364" "healthy_MI_Males_GSM4205363"
## [7] "healthy_MI_Males_GSM4205362" "healthy_MI_Males_GSM4205361"
## [9] "healthy_MI_Males_GSM4205360" "healthy_MI_Males_GSM4205359"
## [11] "MI_Males_GSM4205358" "MI_Males_GSM4205357"
## [13] "MI_Males_GSM4205356" "MI_Males_GSM4205355"
## [15] "MI_Males_GSM4205354" "MI_Males_GSM4205353"
```

The tetanus immunization after six days taken from their blood has the following column names:

```
colnames(TetanusImmunity)

## [1] "X"          "GENE_SYMBOL" "GSM1443061" "GSM1443062"
## [5] "GSM1443063" "GSM1443064" "GSM1443065" "GSM1443066"
## [9] "Tetanus_Means"

min(TetanusImmunity[,3:9])

## [1] 0.02

max(TetanusImmunity[,3:9])

## [1] 8508456098
```

Take the log2 scale of the tetanus data set to make the values the same scale as the flu vaccinated and other samples that used log2 scale.

```
TetanusImmunity1 <- log2(TetanusImmunity[,3:9]+1)#avoid negative values
TetanusImmunity1$GENE_SYMBOL <- TetanusImmunity$GENE_SYMBOL
min(TetanusImmunity1[,1:6])

## [1] 0.02856915

max(TetanusImmunity1[,1:6])

## [1] 32.98625

Tetanus_Immunity1 <- TetanusImmunity1[,c(8,7,1:6)]
colnames(Tetanus_Immunity1)[3:8] <- paste('tetanus_',
```

```

colnames(Tetanis_Immunity1)[3:8], sep='')
colnames(Tetanis_Immunity1)

## [1] "GENE_SYMBOL"          "Tetanis_Means"          "tetanis_GSM1443061"
## [4] "tetanis_GSM1443062"   "tetanis_GSM1443063"   "tetanis_GSM1443064"
## [7] "tetanis_GSM1443065"   "tetanis_GSM1443066"

```

The EGCG overweight females column names are:

```

Overweight_Females_EGCG1 <- Overweight_Females_EGCG
colnames(Overweight_Females_EGCG1)[9:36] <- paste('EGCG',
colnames(Overweight_Females_EGCG1[9:36]),
sep='_')
colnames(Overweight_Females_EGCG1)

## [1] "X"                "FC_egcg_quer"
## [3] "FC_egcg"          "DE_EGCG"
## [5] "DE_Quercentin"    "Pre_Means"
## [7] "Post_EGCG_Means"  "Post_EGCG_Quercentin_Means"
## [9] "EGCG_pre_GSM1923000" "EGCG_pre_GSM1923004"
## [11] "EGCG_pre_GSM1923010" "EGCG_pre_GSM1923012"
## [13] "EGCG_pre_GSM1923007" "EGCG_pre_GSM1923020"
## [15] "EGCG_pre_GSM192998" "EGCG_pre_GSM1922995"
## [17] "EGCG_pre_GSM1923002" "EGCG_pre_GSM1923008"
## [19] "EGCG_pre_GSM1923015" "EGCG_pre_GSM1923018"
## [21] "EGCG_pre_GSM1923022" "EGCG_pre_GSM1923017"
## [23] "EGCG_post_EG_GSM1923001" "EGCG_post_EG_GSM1923005"
## [25] "EGCG_post_EG_GSM1923011" "EGCG_post_EG_GSM1923013"
## [27] "EGCG_post_EG_GSM1923021" "EGCG_post_EG_GSM1923006"
## [29] "EGCG_post_EG_GSM1923014" "EGCG_post_EG_GSM192996"
## [31] "EGCG_post_EQ_GSM1923003" "EGCG_post_EQ_GSM1923009"
## [33] "EGCG_post_EQ_GSM1923016" "EGCG_post_EQ_GSM1923019"
## [35] "EGCG_post_EQ_GSM1923023" "EGCG_post_EQ_GSM192997"

```

The flu vaccinated (treated with antibiotics treatment or not as 't' or 'nt' respectively) for each of the initial day 0, day 3, day 7, and day 21 profiles from three treated and three not treated samples have the following column names:

```

flu_Vaccinated1 <- flu_Vaccinated
colnames(flu_Vaccinated1)[24:53] <-
paste('flu', colnames(flu_Vaccinated1)[24:53],
sep='_')
colnames(flu_Vaccinated1)

## [1] "Gene"
## [2] "FC_t1"
## [3] "FC_t3"
## [4] "FC_t7"
## [5] "FC_t21"
## [6] "FC_nt1"
## [7] "FC_nt3"

```



```

## [8] "FC_nt7"
## [9] "FC_nt21"
## [10] "FCB_1"
## [11] "FCB_3"
## [12] "FCB_7"
## [13] "FCB_21"
## [14] "T0_Mean"
## [15] "T1_Mean"
## [16] "T3_Mean"
## [17] "T7_Mean"
## [18] "T21_Mean"
## [19] "NT0_Mean"
## [20] "NT1_Mean"
## [21] "NT3_Mean"
## [22] "NT7_Mean"
## [23] "NT21_Mean"
## [24] "flu_GSM3409106_29_day_0"
## [25] "flu_GSM3409107_29_day_1"
## [26] "flu_GSM3409108_29_day_3"
## [27] "flu_GSM3409004_29_day_7"
## [28] "flu_GSM3409105_29_day_21_screening"
## [29] "flu_GSM3409006_30_.day_0"
## [30] "flu_GSM3409007_30_day_1"
## [31] "flu_GSM3409008_30_day_3"
## [32] "flu_GSM3409009_30_day_7"
## [33] "flu_GSM3409005_30_day_21_screening"
## [34] "flu_GSM3409013_05_.day_0"
## [35] "flu_GSM3409014_05_day_1"
## [36] "flu_GSM3409015_05_day_3"
## [37] "flu_GSM3409016_05_day_7"
## [38] "flu_GSM3409012_05_day_21_screening"
## [39] "flu_GSM3409161_33_day_0_no"
## [40] "flu_GSM3409162_33_day_1_no"
## [41] "flu_GSM3409163_33_day_3_no"
## [42] "flu_GSM3409111_33_.day_7_no"
## [43] "flu_GSM3409160_33_day_21_screening_no"
## [44] "flu_GSM3409124_36_day_0_no"
## [45] "flu_GSM3409125_36_day_1_no"
## [46] "flu_GSM3409126_36_day_3_no"
## [47] "flu_GSM3409127_36_day_7_no"
## [48] "flu_GSM3409123_36_day_21_screening_no"
## [49] "flu_GSM3409135_38_day_0_no"
## [50] "flu_GSM3409136_38_day_1_no"
## [51] "flu_GSM3409137_38_day_3_no"
## [52] "flu_GSM3409138_38_day_7_no"
## [53] "flu_GSM3409134_38_day_21_screening_no"

```

The iron toxicity study put the males and females into three groups of the genotypes associated with hemochromatosis or iron toxicity. It also included healthy males and females to compare to. The fold change values are for the groups each compared to the

healthy groups by gender by all three groups 'overall' and by each of the 3 groups separately. The iron toxicity column names are:

```
iron_toxicity1 <- iron_toxicity
colnames(iron_toxicity1)[c(2:9,12:43)] <-
paste('hemo_',colnames(iron_toxicity1)[c(2:9,12:43)],
      sep='')
colnames(iron_toxicity1)[10:11] <-
gsub('hemo','hemo_',colnames(iron_toxicity1)[10:11])

colnames(iron_toxicity1)

## [1] "X" "hemo_G1M_Mean"
## [3] "hemo_G2M_Mean" "hemo_G3M_Mean"
## [5] "hemo_G1F_Mean" "hemo_G2F_Mean"
## [7] "hemo_G3F_Mean" "hemo_healthyFemale_Mean"
## [9] "hemo_healthyMale_Mean" "hemo_Female_Mean"
## [11] "hemo_Male_Mean" "hemo_FC_1m"
## [13] "hemo_FC_2m" "hemo_FC_3m"
## [15] "hemo_FC_1F" "hemo_FC_2F"
## [17] "hemo_FC_3F" "hemo_FC_malesOverall"
## [19] "hemo_FC_femalesOverall" "hemo_GSM3440208"
## [21] "hemo_GSM3440209" "hemo_GSM3440210"
## [23] "hemo_GSM3440211" "hemo_GSM3440212"
## [25] "hemo_GSM3440213" "hemo_GSM3440214"
## [27] "hemo_GSM3440215" "hemo_GSM3440216"
## [29] "hemo_GSM3440217" "hemo_GSM3440218"
## [31] "hemo_GSM3440219" "hemo_GSM3440220"
## [33] "hemo_GSM3440221" "hemo_GSM3440222"
## [35] "hemo_GSM3440223" "hemo_GSM3440224"
## [37] "hemo_GSM3440225" "hemo_GSM3440226"
## [39] "hemo_GSM3440227" "hemo_GSM3440228"
## [41] "hemo_GSM3440229" "hemo_GSM3440230"
## [43] "hemo_GSM3440231"
```

The above tables that were just made that added the type of sample study to the NCBI GEO accession ID's and other fields missing table identifier type are now going to be merged and written to csv to use in other programs or purposes. It will also be added to Kaggle datasets.

```
K0 <- merge(Alzheimer1, Heart_Disease_Males1, by.x='X', by.y='Symbol')
K1 <- merge(Tetanus_Immunity1, K0, by.x='GENE_SYMBOL', by.y='X')
K2 <- merge(K1, flu_Vaccinated1, by.x='GENE_SYMBOL', by.y='Gene')
K3 <- merge(K2, Overweight_Females_EGCG1, by.x='GENE_SYMBOL', by.y='X')
K4 <- merge(K3, iron_toxicity1, by.x='GENE_SYMBOL', by.y='X')

GSM <- grep('GSM',colnames(K4))
all6samples <- K4[,GSM]
```

```

all6stats <- K4[, -GSM]
all6 <- cbind(all6stats, all6samples)
colnames(all6)

## [1] "GENE_SYMBOL"
## [2] "Tetanis_Means"
## [3] "Alz_Females_AD1_Mean"
## [4] "Alz_Females_control1_Mean"
## [5] "Alz_males_AD1_Mean"
## [6] "Alz_males_control1_Mean"
## [7] "Alz_FC_fem_ctrl_AD"
## [8] "Alz_FC_male_ctrl_AD"
## [9] "FC_MI_males"
## [10] "HealthyMI_Male_Means"
## [11] "MI_Male_Means"
## [12] "FC_t1"
## [13] "FC_t3"
## [14] "FC_t7"
## [15] "FC_t21"
## [16] "FC_nt1"
## [17] "FC_nt3"
## [18] "FC_nt7"
## [19] "FC_nt21"
## [20] "FCB_1"
## [21] "FCB_3"
## [22] "FCB_7"
## [23] "FCB_21"
## [24] "T0_Mean"
## [25] "T1_Mean"
## [26] "T3_Mean"
## [27] "T7_Mean"
## [28] "T21_Mean"
## [29] "NT0_Mean"
## [30] "NT1_Mean"
## [31] "NT3_Mean"
## [32] "NT7_Mean"
## [33] "NT21_Mean"
## [34] "FC_egcg_quer"
## [35] "FC_egcg"
## [36] "DE_EGCG"
## [37] "DE_Quercentin"
## [38] "Pre_Means"
## [39] "Post_EGCG_Means"
## [40] "Post_EGCG_Quercentin_Means"
## [41] "hemo_G1M_Mean"
## [42] "hemo_G2M_Mean"
## [43] "hemo_G3M_Mean"
## [44] "hemo_G1F_Mean"
## [45] "hemo_G2F_Mean"
## [46] "hemo_G3F_Mean"

```

```
## [47] "hemo_healthyFemale_Mean"
## [48] "hemo_healthyMale_Mean"
## [49] "hemo_Female_Mean"
## [50] "hemo_Male_Mean"
## [51] "hemo_FC_1m"
## [52] "hemo_FC_2m"
## [53] "hemo_FC_3m"
## [54] "hemo_FC_1F"
## [55] "hemo_FC_2F"
## [56] "hemo_FC_3F"
## [57] "hemo_FC_malesOverall"
## [58] "hemo_FC_femalesOverall"
## [59] "tetanis_GSM1443061"
## [60] "tetanis_GSM1443062"
## [61] "tetanis_GSM1443063"
## [62] "tetanis_GSM1443064"
## [63] "tetanis_GSM1443065"
## [64] "tetanis_GSM1443066"
## [65] "Alz_GSM2973262"
## [66] "Alz_GSM2973263"
## [67] "Alz_GSM2973264"
## [68] "Alz_GSM2973265"
## [69] "Alz_GSM2973266"
## [70] "Alz_GSM2973267"
## [71] "Alz_GSM2973268"
## [72] "Alz_GSM2973269"
## [73] "Alz_GSM2973270"
## [74] "Alz_GSM2973271"
## [75] "Alz_GSM2973272"
## [76] "Alz_GSM2973273"
## [77] "Alz_GSM2973274"
## [78] "Alz_GSM2973275"
## [79] "Alz_GSM2973276"
## [80] "Alz_GSM2973277"
## [81] "Alz_GSM2973278"
## [82] "Alz_GSM2973279"
## [83] "Alz_GSM2973280"
## [84] "Alz_GSM2973281"
## [85] "Alz_GSM2973282"
## [86] "Alz_GSM2973283"
## [87] "Alz_GSM2973284"
## [88] "Alz_GSM2973285"
## [89] "Alz_GSM2973286"
## [90] "Alz_GSM2973287"
## [91] "Alz_GSM2973288"
## [92] "Alz_GSM2973289"
## [93] "Alz_GSM2973290"
## [94] "Alz_GSM2973291"
## [95] "Alz_GSM2973292"
## [96] "Alz_GSM2973293"
```

```
## [97] "Alz_GSM2973294"
## [98] "Alz_GSM2973295"
## [99] "Alz_GSM2973296"
## [100] "Alz_GSM2973297"
## [101] "Alz_GSM2973298"
## [102] "Alz_GSM2973299"
## [103] "Alz_GSM2973300"
## [104] "Alz_GSM2973301"
## [105] "Alz_GSM2973302"
## [106] "Alz_GSM2973303"
## [107] "Alz_GSM2973304"
## [108] "Alz_GSM2973305"
## [109] "Alz_GSM2973306"
## [110] "Alz_GSM2973307"
## [111] "Alz_GSM2973308"
## [112] "Alz_GSM2973309"
## [113] "Alz_GSM2973310"
## [114] "Alz_GSM2973311"
## [115] "Alz_GSM2973312"
## [116] "Alz_GSM2973313"
## [117] "Alz_GSM2973314"
## [118] "Alz_GSM2973315"
## [119] "Alz_GSM2973316"
## [120] "Alz_GSM2973317"
## [121] "Alz_GSM2973318"
## [122] "Alz_GSM2973319"
## [123] "Alz_GSM2973320"
## [124] "Alz_GSM2973321"
## [125] "Alz_GSM2973322"
## [126] "Alz_GSM2973323"
## [127] "Alz_GSM2973324"
## [128] "Alz_GSM2973325"
## [129] "Alz_GSM2973326"
## [130] "Alz_GSM2973327"
## [131] "Alz_GSM2973328"
## [132] "Alz_GSM2973329"
## [133] "Alz_GSM2973330"
## [134] "Alz_GSM2973331"
## [135] "Alz_GSM2973332"
## [136] "Alz_GSM2973333"
## [137] "Alz_GSM2973334"
## [138] "Alz_GSM2973335"
## [139] "Alz_GSM2973336"
## [140] "Alz_GSM2973337"
## [141] "Alz_GSM2973338"
## [142] "Alz_GSM2973339"
## [143] "healthy_MI_Males_GSM4205364"
## [144] "healthy_MI_Males_GSM4205363"
## [145] "healthy_MI_Males_GSM4205362"
## [146] "healthy_MI_Males_GSM4205361"
```

```
## [147] "healthy_MI_Males_GSM4205360"
## [148] "healthy_MI_Males_GSM4205359"
## [149] "MI_Males_GSM4205358"
## [150] "MI_Males_GSM4205357"
## [151] "MI_Males_GSM4205356"
## [152] "MI_Males_GSM4205355"
## [153] "MI_Males_GSM4205354"
## [154] "MI_Males_GSM4205353"
## [155] "flu_GSM3409106_29_day_0"
## [156] "flu_GSM3409107_29_day_1"
## [157] "flu_GSM3409108_29_day_3"
## [158] "flu_GSM3409004_29_day_7"
## [159] "flu_GSM3409105_29_day_21_screening"
## [160] "flu_GSM3409006_30_day_0"
## [161] "flu_GSM3409007_30_day_1"
## [162] "flu_GSM3409008_30_day_3"
## [163] "flu_GSM3409009_30_day_7"
## [164] "flu_GSM3409005_30_day_21_screening"
## [165] "flu_GSM3409013_05_day_0"
## [166] "flu_GSM3409014_05_day_1"
## [167] "flu_GSM3409015_05_day_3"
## [168] "flu_GSM3409016_05_day_7"
## [169] "flu_GSM3409012_05_day_21_screening"
## [170] "flu_GSM3409161_33_day_0_no"
## [171] "flu_GSM3409162_33_day_1_no"
## [172] "flu_GSM3409163_33_day_3_no"
## [173] "flu_GSM3409111_33_day_7_no"
## [174] "flu_GSM3409160_33_day_21_screening_no"
## [175] "flu_GSM3409124_36_day_0_no"
## [176] "flu_GSM3409125_36_day_1_no"
## [177] "flu_GSM3409126_36_day_3_no"
## [178] "flu_GSM3409127_36_day_7_no"
## [179] "flu_GSM3409123_36_day_21_screening_no"
## [180] "flu_GSM3409135_38_day_0_no"
## [181] "flu_GSM3409136_38_day_1_no"
## [182] "flu_GSM3409137_38_day_3_no"
## [183] "flu_GSM3409138_38_day_7_no"
## [184] "flu_GSM3409134_38_day_21_screening_no"
## [185] "EGCG_pre_GSM1923000"
## [186] "EGCG_pre_GSM1923004"
## [187] "EGCG_pre_GSM1923010"
## [188] "EGCG_pre_GSM1923012"
## [189] "EGCG_pre_GSM1923007"
## [190] "EGCG_pre_GSM1923020"
## [191] "EGCG_pre_GSM192998"
## [192] "EGCG_pre_GSM1922995"
## [193] "EGCG_pre_GSM1923002"
## [194] "EGCG_pre_GSM1923008"
## [195] "EGCG_pre_GSM1923015"
## [196] "EGCG_pre_GSM1923018"
```

```

## [197] "EGCG_pre_GSM1923022"
## [198] "EGCG_pre_GSM1923017"
## [199] "EGCG_post_EG_GSM1923001"
## [200] "EGCG_post_EG_GSM1923005"
## [201] "EGCG_post_EG_GSM1923011"
## [202] "EGCG_post_EG_GSM1923013"
## [203] "EGCG_post_EG_GSM1923021"
## [204] "EGCG_post_EG_GSM1923006"
## [205] "EGCG_post_EG_GSM1923014"
## [206] "EGCG_post_EQ_GSM192996"
## [207] "EGCG_post_EQ_GSM1923003"
## [208] "EGCG_post_EQ_GSM1923009"
## [209] "EGCG_post_EQ_GSM1923016"
## [210] "EGCG_post_EQ_GSM1923019"
## [211] "EGCG_post_EQ_GSM1923023"
## [212] "EGCG_post_EQ_GSM192997"
## [213] "hemo_GSM3440208"
## [214] "hemo_GSM3440209"
## [215] "hemo_GSM3440210"
## [216] "hemo_GSM3440211"
## [217] "hemo_GSM3440212"
## [218] "hemo_GSM3440213"
## [219] "hemo_GSM3440214"
## [220] "hemo_GSM3440215"
## [221] "hemo_GSM3440216"
## [222] "hemo_GSM3440217"
## [223] "hemo_GSM3440218"
## [224] "hemo_GSM3440219"
## [225] "hemo_GSM3440220"
## [226] "hemo_GSM3440221"
## [227] "hemo_GSM3440222"
## [228] "hemo_GSM3440223"
## [229] "hemo_GSM3440224"
## [230] "hemo_GSM3440225"
## [231] "hemo_GSM3440226"
## [232] "hemo_GSM3440227"
## [233] "hemo_GSM3440228"
## [234] "hemo_GSM3440229"
## [235] "hemo_GSM3440230"
## [236] "hemo_GSM3440231"

write.csv(all6, 'all_6_studies.csv', row.names=FALSE)

```

In the interest of being interesting, these tables have all the original samples in each respective table for that disease group. There are some healthy samples in some such as healthy overweight females before taking EGCG, non-Alzheimer's males and females, healthy Russian males without heart disease, and healthy females and males who do not have iron toxicity relative to the iron toxicity study. There are some studies that do not

have healthy controls nor separation by gender such as the tetanis immunity and flu vaccinated samples.

Since the tetanis immunized samples don't have a control or healthy group to compare to which haven't been immunized, let us compare it to the samples of healthy overweight females, healthy Russian males, healthy females and males without iron toxicity, and flu vaccinated not treated with antibiotics and flu vaccinated treated with antibiotics. The values in the tetanis immunized samples have a very high range for some genes and doesn't get lower than 0.08 for any gene. We will compare the fields of each table that has the **mean** values across sample for each **gene** in that group by creating a table with those means.

```
tet_mean <- TetanisImmunity1[,c(7,8)] #gene and tetanis immunized mean
iron_mean <- iron_toxicity[,c(1,8:11)]#gene, healthy female, healthy male
# iron toxic females, iron toxic males
flu_7day <- flu_Vaccinated[,c(1,22,17)] #gene, not treated, treated
EGCG_females <- Overweight_Females_EGCG[,c(1,6:8)]#gene, pre,post EGCG,
# post EGCG+vitamin C+Fish Oil
MI_healthy_mean <- Heart_Disease_Males[,c(1,4,5)]#gene, healthy males,
# MI males
alz_means <- Alzheimer[,c(1:5)]#gene, female AD, female control, male AD,
# male control
```

Let us first compare the tetanis immunized to the healthy females no iron toxicity, healthy males no iron toxicity, overweight females EGCG, healthy males no MI, healthy AD females, and healthy AD males.

Gather only the healthy females and males of those studies.

```
healthy_iron <- iron_mean[,c(1:3)]
Healthy_EGCG_females <- EGCG_females #all are healthy
healthy_MI_males <- MI_healthy_mean[,1:2]
healthy_AD <- alz_means[,c(1,3,5)]

dim(healthy_iron)
## [1] 28433      3

colnames(healthy_iron)[2:3] <-
gsub('healthy','iron_healthy_',colnames(healthy_iron)[2:3])
colnames(healthy_iron)

## [1] "X"                  "iron_healthy_Female_Mean"
## [3] "iron_healthy_Male_Mean"

dim(Healthy_EGCG_females)
## [1] 22831      4
```



```

colnames(Healthy_EGCG_females)[2:4] <-
paste('overweight_females_', colnames(Healthy_EGCG_females)[2:4], sep='')
colnames(Healthy_EGCG_females)

## [1] "X"
## [2] "overweight_females_Pre_Means"
## [3] "overweight_females_Post_EGCG_Means"
## [4] "overweight_females_Post_EGCG_Quercentin_Means"

dim(healthy_MImales)

## [1] 30905      2

colnames(healthy_MImales)[2] <-
paste('MI_study_', colnames(healthy_MImales)[2], sep='')
colnames(healthy_MImales)

## [1] "X"                                "MI_study_HealthyMale_Means"

dim(healthy_AD)

## [1] 31700      3

colnames(healthy_AD)[2:3] <-
gsub('_control1_', '_no_AD_', colnames(healthy_AD)[2:3])
colnames(healthy_AD)

## [1] "X"                                "Females_no_AD_Mean" "males_no_AD_Mean"

dim(tet_mean)

## [1] 19749      2

colnames(tet_mean)

## [1] "Tetanis_Means" "GENE_SYMBOL"

```

The above tables all have a differing amount of genes in each table, so we need to merge the tables by genes in common to compare. The gene field is the 'X' field in these tables listed immediately above. We need to merge them all to the tetanis table, tet_mean, to compare with tetanis immunity gene expression values over 6 days.

```

healthy0 <- merge(tet_mean, healthy_iron, by.x='GENE_SYMBOL', by.y='X')
dim(healthy0)

## [1] 15059      4

healthy1 <- merge(healthy0, Healthy_EGCG_females, by.x='GENE_SYMBOL',
by.y='X')
dim(healthy1)

## [1] 14639      7

```

```
healthy2 <- merge(healthy1, healthy_MImales, by.x='GENE_SYMBOL', by.y='X')
dim(healthy2)
```

```
## [1] 14475      8
```

```
healthy3 <- merge(healthy2, healthy_AD, by.x='GENE_SYMBOL', by.y='X')
dim(healthy3)
```

```
## [1] 13193     10
```

```
colnames(healthy3)
```

```
## [1] "GENE_SYMBOL"
## [2] "Tetanis_Means"
## [3] "iron_healthy_Female_Mean"
## [4] "iron_healthy_Male_Mean"
## [5] "overweight_females_Pre_Means"
## [6] "overweight_females_Post_EGCG_Means"
## [7] "overweight_females_Post_EGCG_Quercentin_Means"
## [8] "MI_study_HealthyMale_Means"
## [9] "Females_no_AD_Mean"
## [10] "males_no_AD_Mean"
```

```
head(healthy3)
```

```
##  GENE_SYMBOL Tetanis_Means iron_healthy_Female_Mean
iron_healthy_Male_Mean
```

```
## 1      A1BG      22.5144403      4.816690
4.706227
```

```
## 2      A1CF      22.9031540      2.546950
2.229808
```

```
## 3      A2M      0.2789759      3.998705
4.323837
```

```
## 4     A2ML1      21.1270650      3.357760
3.048290
```

```
## 5      AAAS      24.6740221      5.287245
5.522265
```

```
## 6      AACS      21.2603715      5.471870
5.673802
```

```
##  overweight_females_Pre_Means overweight_females_Post_EGCG_Means
```

```
## 1      5.789      5.703
```

```
## 2      4.959      5.043
```

```
## 3      5.221      5.215
```

```
## 4      4.443      4.516
```

```
## 5      8.117      8.109
```

```
## 6      6.799      6.835
```

```
##  overweight_females_Post_EGCG_Quercentin_Means MI_study_HealthyMale_Means
```

```
## 1      5.697      5.653239
```

```
## 2      4.914      2.616675
```

```
## 3      5.236      3.568283
```

```
## 4      4.483      3.014349
```

## 5	8.128	7.043090
## 6	6.787	5.423620
## Females_no_AD_Mean	males_no_AD_Mean	
## 1	6.647	6.619
## 2	6.495	6.506
## 3	10.231	10.377
## 4	6.571	6.568
## 5	6.875	6.828
## 6	7.946	7.907

We need to use dplyr to analyze this data as is for the healthy samples compared to the tetanis samples.

```
library(dplyr)
```

Get the fold change 'FC' values for the between samples of genes using the healthy3 table.

```
FC0 <- healthy3 %>% mutate(FC_iron_fem =
Tetanis_Means/iron_healthy_Female_Mean)

FC1 <- FC0 %>% mutate(FC_iron_mal = Tetanis_Means/iron_healthy_Male_Mean)

FC2 <- FC1 %>% mutate(FC_heavy_fems_no_EGCG =
Tetanis_Means/overweight_females_Pre_Means)

FC3 <- FC2 %>% mutate(FC_heavy_fems_EGCG =
Tetanis_Means/overweight_females_Post_EGCG_Means)

FC4 <- FC3 %>% mutate(FC_heavy_fems_EGCG_plus =
Tetanis_Means/overweight_females_Post_EGCG_Quercentin_Means)

FC5 <- FC4 %>% mutate(FC_healthyMI_males =
Tetanis_Means/MI_study_HealthyMale_Means)

FC6 <- FC5 %>% mutate(FC_fems_noAD = Tetanis_Means/Females_no_AD_Mean)
FC7 <- FC6 %>% mutate(FC_mals_noAD = Tetanis_Means/males_no_AD_Mean)

healthy_tetanis_FCs <- FC7
dim(healthy_tetanis_FCs)

## [1] 13193    18

colnames(healthy_tetanis_FCs)

## [1] "GENE_SYMBOL"
## [2] "Tetanis_Means"
## [3] "iron_healthy_Female_Mean"
## [4] "iron_healthy_Male_Mean"
## [5] "overweight_females_Pre_Means"
## [6] "overweight_females_Post_EGCG_Means"
## [7] "overweight_females_Post_EGCG_Quercentin_Means"
```

```
## [8] "MI_study_HealthyMale_Means"
## [9] "Females_no_AD_Mean"
## [10] "males_no_AD_Mean"
## [11] "FC_iron_fem"
## [12] "FC_iron_mal"
## [13] "FC_heavy_fems_no_EGCG"
## [14] "FC_heavy_fems_EGCG"
## [15] "FC_heavy_fems_EGCG_plus"
## [16] "FC_healthyMI_males"
## [17] "FC_fems_noAD"
## [18] "FC_mals_noAD"
```

There are 13,193 genes to compare fold change values of tetanis immunized samples to the healthy control samples from the combined studies.

```
write.csv(healthy_tetanis_FCs, 'healthy_tetanis_FCs.csv', row.names=FALSE)
```

Now, compare the tetanis immunized to the flu vaccinated samples treated and not treated with antibiotics. The flu gene samples seemed to have the most changes in values after 7 days of receiving the flu immunization and the antibiotic or no antibiotic addition. This is why the flu immunizations for day 7 means were selected. Only the tet_mean and flu_7day tables will be used for genes in common as neither has the gender information attached.

```
dim(tet_mean);colnames(tet_mean)
## [1] 19749      2
## [1] "Tetanis_Means" "GENE_SYMBOL"
dim(flu_7day);colnames(flu_7day)
## [1] 20633      3
## [1] "Gene"      "NT7_Mean" "T7_Mean"
```

Merge these two tables of the tetanis and flu not treated (NT7 prefix) or treated (T7 prefix) means.

```
tet_flu_immune <- merge(tet_mean, flu_7day, by.x='GENE_SYMBOL', by.y='Gene')
dim(tet_flu_immune)
## [1] 17447      4
colnames(tet_flu_immune)
## [1] "GENE_SYMBOL" "Tetanis_Means" "NT7_Mean"      "T7_Mean"
```

Now for the fold change values between the Tetanis_Means and the flu immunization means with/without added antibiotics treatment, dplyr will be used to get that information.

```
tetanis_flu_FCs <- tet_flu_immune %>% mutate(FC_tet_flu_nt7 =
Tetanis_Means/NT7_Mean)
```

```

tetanis_flu_FCs1 <- tetanis_flu_FCs %>% mutate(FC_tet_flu_t7 =
Tetanis_Means/T7_Mean)

dim(tetanis_flu_FCs1)

## [1] 17447      6

colnames(tetanis_flu_FCs1)

## [1] "GENE_SYMBOL"      "Tetanis_Means"    "NT7_Mean"         "T7_Mean"
## [5] "FC_tet_flu_nt7"  "FC_tet_flu_t7"

head(tetanis_flu_FCs1)

##   GENE_SYMBOL Tetanis_Means NT7_Mean  T7_Mean FC_tet_flu_nt7 FC_tet_flu_t7
## 1      A1BG      22.5144403 4.237321 4.283943      5.31336641      5.25554149
## 2      A1CF      22.9031540 3.081198 3.188847      7.43319700      7.18226799
## 3     A2BP1       0.3968902 2.905718 3.187804      0.13658936      0.12450270
## 4     A2LD1       0.1132560 3.233051 4.178542      0.03503068      0.02710418
## 5      A2M       0.2789759 2.411421 3.146397      0.11568944      0.08866520
## 6     A2ML1      21.1270650 2.327324 2.872788      9.07783517      7.35420306

write.csv(tetanis_flu_FCs1, 'tetanis_flu_FCs.csv', row.names=FALSE)

```

Going to genecards.org I searched for Immune genes and found some genes that I want to analyze in this data set, tetanis_flu_FCs1, to see how immune cells being treated with the tetanis antibodies after six days and the separate study of flu immunized cells being treated with antibiotics after seven days, and not treated with antibiotics after 7 days. These genes are: * **CD4** (big autoimmune indicator in lupus) * **IL2** (produced by Produced by T-cells in response to antigenic or mitogenic...and other activities crucial to regulation of the immune response. Can stimulate B-cells, monocytes, lymphokine-activated... (UniProtKB/Swiss-Prot)) * **IFNG** (Produced by lymphocytes activated by specific antigens or mitogens. IFN-gamma, in addition to having antiviral activity, has important immunoregulatory functions. It is a potent activator of macrophages, it has antiproliferative effects on transformed cells and it can potentiate the antiviral and antitumor effects of the type I interferons.) * **IL10** (Major immune regulatory cytokine that acts on many cells of the immune system where it has profound anti-inflammatory functions, limiting excessive tissue disruption caused by inflammation.) * **IL6** (Cytokine with a wide variety of biological functions. It is a potent inducer of the acute phase response. Plays an essential role in the final differentiation of B-cells into Ig-secreting cells Involved in lymphocyte and monocyte differentiation. Acts on B-cells, T-cells, hepatocytes, hematopoietic progenitor cells and cells of the CNS. Required for the generation of T(H)17 cells. Also acts as a myokine. It is discharged into the bloodstream after muscle contraction and acts to increase the breakdown of fats and to improve insulin resistance. It induces myeloma and plasmacytoma growth and induces nerve cells differentiation.)

```

CD4 <- grep('^CD4$', tetanis_flu_FCs1$GENE_SYMBOL)
IL2 <- grep('^IL2$', tetanis_flu_FCs1$GENE_SYMBOL)
IFNG <- grep('^IFNG$', tetanis_flu_FCs1$GENE_SYMBOL)

```

```
IL10 <- grep('^IL10$', tetanis_flu_FCs1$GENE_SYMBOL)
IL6 <- grep('^IL6$', tetanis_flu_FCs1$GENE_SYMBOL)

tet_flu_immune_genes <- tetanis_flu_FCs1[c(CD4,IL2,IFNG,IL10,IL6),]
head(tet_flu_immune_genes)
```

	GENE_SYMBOL	Tetanis_Means	NT7_Mean	T7_Mean	FC_tet_flu_nt7
## 2945	CD4	26.2162826	4.443672	5.086368	5.8996883
## 7354	IL2	0.1720607	2.324467	3.035514	0.0740216
## 7237	IFNG	21.2490376	4.843903	4.516635	4.3867596
## 7308	IL10	18.5088908	2.852249	3.788690	6.4892270
## 7387	IL6	22.2122479	11.282219	3.585461	1.9687837

We need to tidy this data set for plotting with the tidyr and ggplot2 libraries.

```
library(tidyr)
library(ggplot2)
```

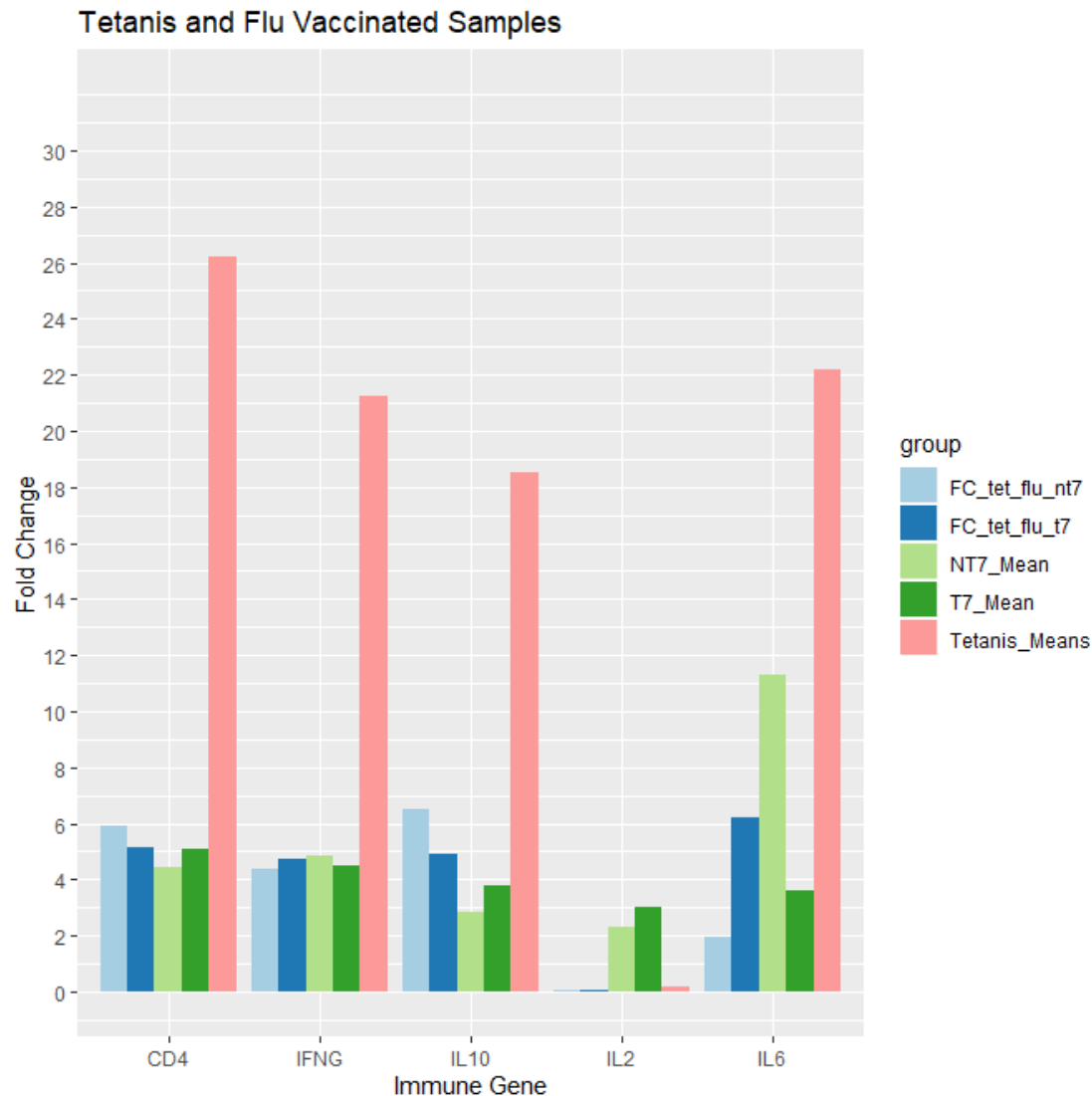
Tidy the table into a tibble

```
tet_flu_tidy <- gather(tet_flu_immune_genes, 'group', 'foldChange', 2:6)
tet_flu_tidy$foldChange <- round(tet_flu_tidy$foldChange, 3)
head(tet_flu_tidy)
```

	GENE_SYMBOL	group	foldChange
## 1	CD4	Tetanis_Means	26.216
## 2	IL2	Tetanis_Means	0.172
## 3	IFNG	Tetanis_Means	21.249
## 4	IL10	Tetanis_Means	18.509
## 5	IL6	Tetanis_Means	22.212
## 6	CD4	NT7_Mean	4.444

Plot the table or tibble of data above using bar plot to see how the gene expression values of immune genes compare.

```
ggplot(data = tet_flu_tidy, aes(x=GENE_SYMBOL, y=foldChange, fill=group)) +
  geom_bar(stat='identity', position=position_dodge()) +
  scale_y_continuous(breaks = seq(0, 30, by=2), limits=c(0,32)) +
  scale_fill_brewer(palette='Paired') +
  ggtitle('Tetanis and Flu Vaccinated Samples') +
  ylab('Fold Change') +
  xlab('Immune Gene')
```

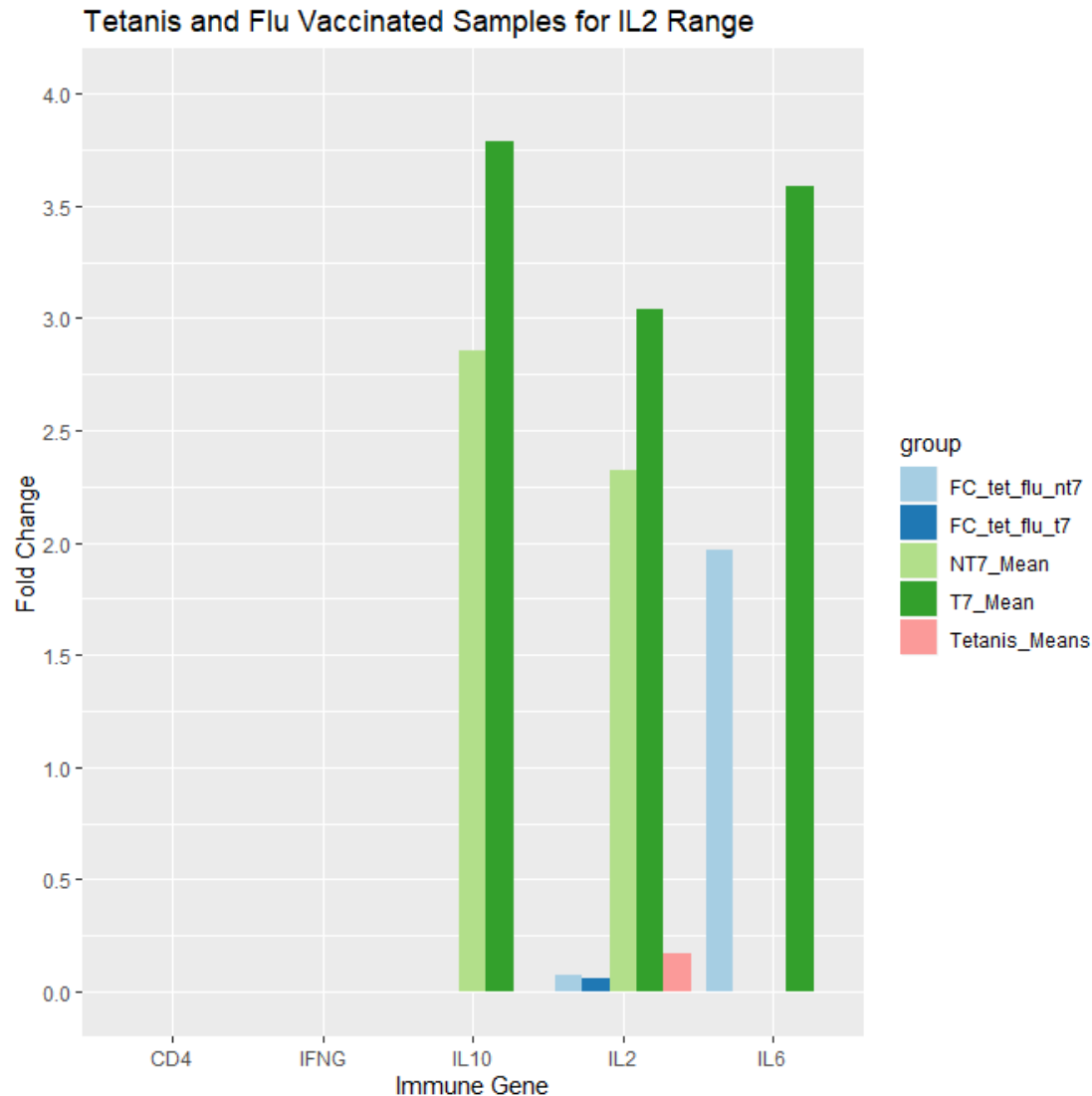


Now that we have a couple bar charts of these immune genes selected to compare across the fold change values and mean values of the tetanus and flu vaccinated samples that were and weren't treated with antibiotics, let's identify some conditions that stand out for gene expression values of the fold change values of tetanus to flu vaccinated.

It is apparently clear that the tetanus vaccinated mean values are highest in almost every immune gene above except for the IL2 gene which is produced by the T-cells and crucial to the immune response. There is a higher fold change in tetanus to flu without antibiotics than the fold change of tetanus to flu treated with antibiotics in the CD4, IL10, and IL2 genes, but the IFNG (antiviral properties) and IL6 genes have a lower fold change with the IL6 (increases break down of fats and insulin resistance) gene dramatically decreased.

From the above sample the IL2 gene is not visible, so we should scale it down knowing the other genes will be missing from the next plot.

```
ggplot(data = tet_flu_tidy, aes(x=GENE_SYMBOL, y=foldChange, fill=group)) +
  geom_bar(stat='identity', position=position_dodge()) +
  scale_y_continuous(breaks = seq(0, 4, by=.5), limits=c(0,4)) +
  scale_fill_brewer(palette='Paired') +
  ggtitle('Tetanis and Flu Vaccinated Samples for IL2 Range') +
  ylab('Fold Change') +
  xlab('Immune Gene')
```



What about comparing all the healthy female and male samples to the tetanis vaccinated samples and looking at those same immune genes, and doing the same for the flu samples? Would this show some interesting data? This table is the healthy_tetanis_FCs table.

```
colnames(healthy_tetanis_FCs)
```



```
## [1] "GENE_SYMBOL"
## [2] "Tetanis_Means"
## [3] "iron_healthy_Female_Mean"
## [4] "iron_healthy_Male_Mean"
## [5] "overweight_females_Pre_Means"
## [6] "overweight_females_Post_EGCG_Means"
## [7] "overweight_females_Post_EGCG_Quercentin_Means"
## [8] "MI_study_HealthyMale_Means"
## [9] "Females_no_AD_Mean"
## [10] "males_no_AD_Mean"
## [11] "FC_iron_fem"
## [12] "FC_iron_mal"
## [13] "FC_heavy_fems_no_EGCG"
## [14] "FC_heavy_fems_EGCG"
## [15] "FC_heavy_fems_EGCG_plus"
## [16] "FC_healthyMI_males"
## [17] "FC_fems_noAD"
## [18] "FC_mals_noAD"
```

Use dplyr to get gene means of all the sample means of healthy patients except the tetanis means. This will combine the mixed genders and ages of the healthy blood samples to compare with the tetanis vaccinated samples.

```
healthy <- healthy_tetanis_FCs[,c(1:10)]

CD4 <- grep('^CD4$', healthy$GENE_SYMBOL)
IL2 <- grep('^IL2$', healthy$GENE_SYMBOL)
IFNG <- grep('^IFNG$', healthy$GENE_SYMBOL)
IL10 <- grep('^IL10$', healthy$GENE_SYMBOL)
IL6 <- grep('^IL6$', healthy$GENE_SYMBOL)

healthy_ig <- healthy[,c(CD4,IL2,IFNG,IL10,IL6),]

healthy_ig$all_healthy_Means <- rowMeans(healthy_ig[3:10])
healthy_FC <- healthy_ig %>% mutate(FC_tet_healthy =
Tetanis_Means/all_healthy_Means)

healthy_tet_fc <- healthy_FC[,c(1,2,11,12)]
```

Tidy this table, healthy_tet_fc, into a tibble to plot a bar chart of the values.

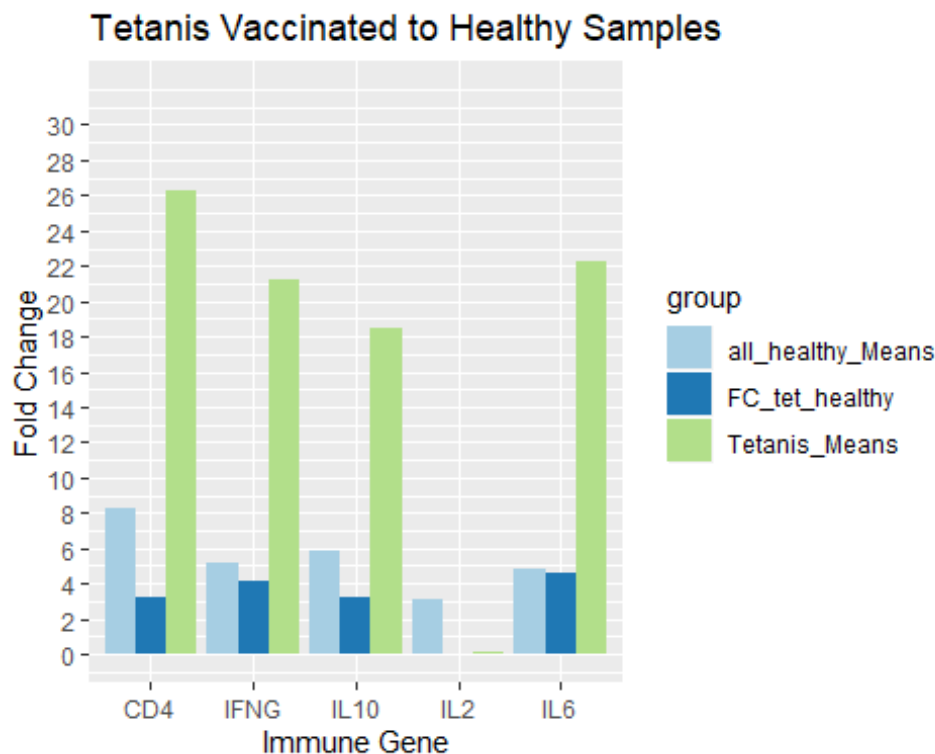
```
healthy_tet_fc_tidy <- gather(healthy_tet_fc, 'group', 'foldChange', 2:4)
healthy_tet_fc_tidy$foldChange <- round(healthy_tet_fc_tidy$foldChange, 3)
head(healthy_tet_fc_tidy)
```

##	GENE_SYMBOL	group	foldChange
## 1	CD4	Tetanis_Means	26.216
## 2	IL2	Tetanis_Means	0.172
## 3	IFNG	Tetanis_Means	21.249
## 4	IL10	Tetanis_Means	18.509

```
## 5      IL6      Tetanis_Means      22.212
## 6      CD4 all_healthy_Means      8.253
```

Now plot the results.

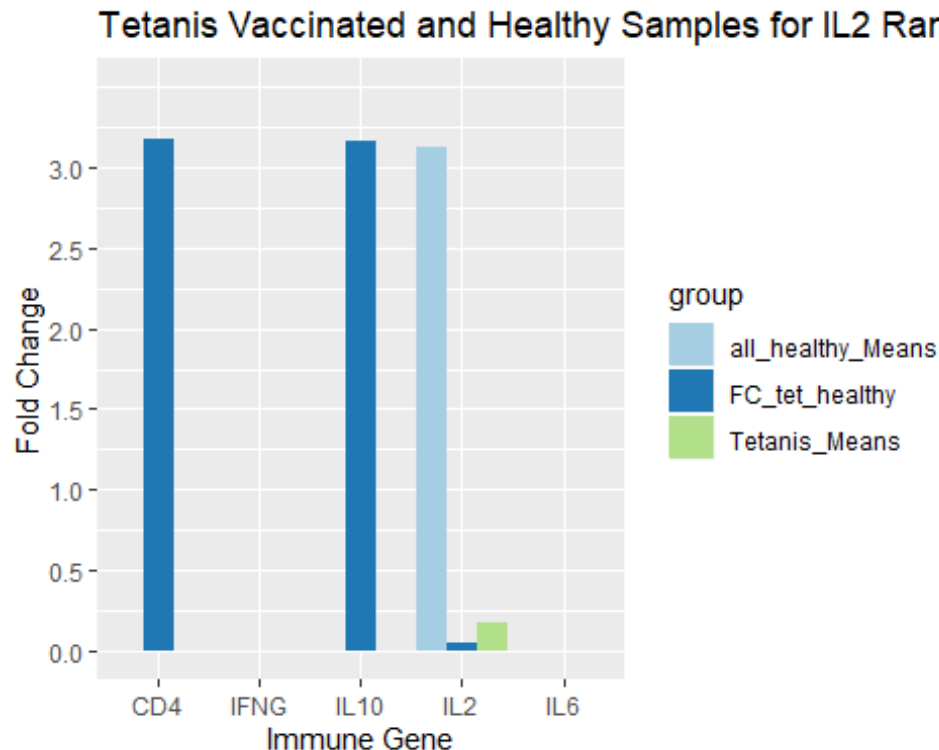
```
ggplot(data = healthy_tet_fc_tidy, aes(x=GENE_SYMBOL, y=foldChange,
fill=group)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 30, by=2), limits=c(0,32))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Tetanis Vaccinated to Healthy Samples')+
  ylab('Fold Change')+
  xlab('Immune Gene')
```



From the bar chart above, the Tetanis mean values are greatest (dramatically) in all immune genes selected except for the IL2 gene, as was the same for the tetanis to flu immunized samples. The fold change for tetanis vaccinated compared to healthy non-vaccinated samples show that Tetanis fold change values are all more than a 100% increase for these specific immune genes, except for the IL2 gene that will be shown in the plot below.

```
ggplot(data = healthy_tet_fc_tidy, aes(x=GENE_SYMBOL, y=foldChange,
fill=group)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 3, by=.5), limits=c(0,3.5))+
```

```
scale_fill_brewer(palette='Paired') +
ggtitle('Tetanus Vaccinated and Healthy Samples for IL2 Range') +
ylab('Fold Change') +
xlab('Immune Gene')
```



There are some more analytics or comparisons that can be done with this sort of data warehouse on gene expression values from blood in microarray medium. The flu vaccinated samples, flu_7day, could then be compared to these healthy samples in the healthy table. The EGCG effects on overweight females, the hemochromatosis patients' gene values can be compared to find how these specific immune genes compare to immunized flu and tetanus samples are a few other comparisons that can be made.

```
colnames(flu_7day)[2:3] <- paste('flu_', colnames(flu_7day)[2:3], sep='')
colnames(flu_7day)
```

```
## [1] "Gene" "flu_NT7_Mean" "flu_T7_Mean"
```

```
colnames(healthy)
```

```
## [1] "GENE_SYMBOL"
## [2] "Tetanus_Means"
## [3] "iron_healthy_Female_Mean"
## [4] "iron_healthy_Male_Mean"
## [5] "overweight_females_Pre_Means"
## [6] "overweight_females_Post_EGCG_Means"
```

```

## [7] "overweight_females_Post_EGCG_Quercentin_Means"
## [8] "MI_study_HealthyMale_Means"
## [9] "Females_no_AD_Mean"
## [10] "males_no_AD_Mean"

flu_healthy <- merge(flu_7day, healthy, by.x='Gene', by.y='GENE_SYMBOL')
colnames(flu_healthy)

## [1] "Gene"
## [2] "flu_NT7_Mean"
## [3] "flu_T7_Mean"
## [4] "Tetanis_Means"
## [5] "iron_healthy_Female_Mean"
## [6] "iron_healthy_Male_Mean"
## [7] "overweight_females_Pre_Means"
## [8] "overweight_females_Post_EGCG_Means"
## [9] "overweight_females_Post_EGCG_Quercentin_Means"
## [10] "MI_study_HealthyMale_Means"
## [11] "Females_no_AD_Mean"
## [12] "males_no_AD_Mean"

CD4 <- grep('^CD4$', flu_healthy$Gene)
IL2 <- grep('^IL2$', flu_healthy$Gene)
IFNG <- grep('^IFNG$', flu_healthy$Gene)
IL10 <- grep('^IL10$', flu_healthy$Gene)
IL6 <- grep('^IL6$', flu_healthy$Gene)

flu_healthy1 <- flu_healthy[c(CD4,IL2,IFNG,IL10,IL6),]
head(flu_healthy1)

##      Gene flu_NT7_Mean flu_T7_Mean Tetanis_Means iron_healthy_Female_Mean
## 1633  CD4      4.443672    5.086368    26.2162826      6.927265
## 5108  IL2      2.324467    3.035514     0.1720607      0.974014
## 5014 IFNG      4.843903    4.516635    21.2490376      3.724940
## 5068 IL10      2.852249    3.788690    18.5088908      3.144525
## 5137 IL6     11.282219    3.585461    22.2122479      3.760520
##      iron_healthy_Male_Mean overweight_females_Pre_Means
## 1633      7.269700      9.828
## 5108      1.253690      2.485
## 5014      3.830002      4.897
## 5068      2.871570      5.011
## 5137      3.863898      4.792
##      overweight_females_Post_EGCG_Means
## 1633      9.757
## 5108      2.549
## 5014      4.889
## 5068      5.043
## 5137      4.671
##      overweight_females_Post_EGCG_Quercentin_Means
## MI_study_HealthyMale_Means
## 1633      9.771

```

```

8.863609
## 5108                                2.575
2.271007
## 5014                                5.077
5.672044
## 5068                                4.856
3.693453
## 5137                                4.799
3.667605
##      Females_no_AD_Mean males_no_AD_Mean
## 1633             6.821             6.785
## 5108             6.457             6.471
## 5014             6.446             6.472
## 5068            11.122            11.133
## 5137             6.731             6.699

```

These are the fold change value comparisons to healthy mixed ages and gender samples. Where NT7 is not treated with antibiotics and T7 was treated for the flu fold change values only.

```

flu_healthy1$All_Healthy_Mean <- rowMeans(flu_healthy1[,5:12])
flu_healthy2 <- flu_healthy1 %>% mutate(FC_tet_healthy =
                                     Tetanis_Means/All_Healthy_Mean)
flu_healthy3 <- flu_healthy2 %>% mutate(FC_flu_NT7_healthy =
                                     flu_NT7_Mean/All_Healthy_Mean)
flu_healthy4 <- flu_healthy3 %>% mutate(FC_flu_T7_healthy =
                                     flu_T7_Mean/All_Healthy_Mean)
Flu_Healthy <- flu_healthy4[,c(1:4,13:16)]

```

Use tidy on this data.

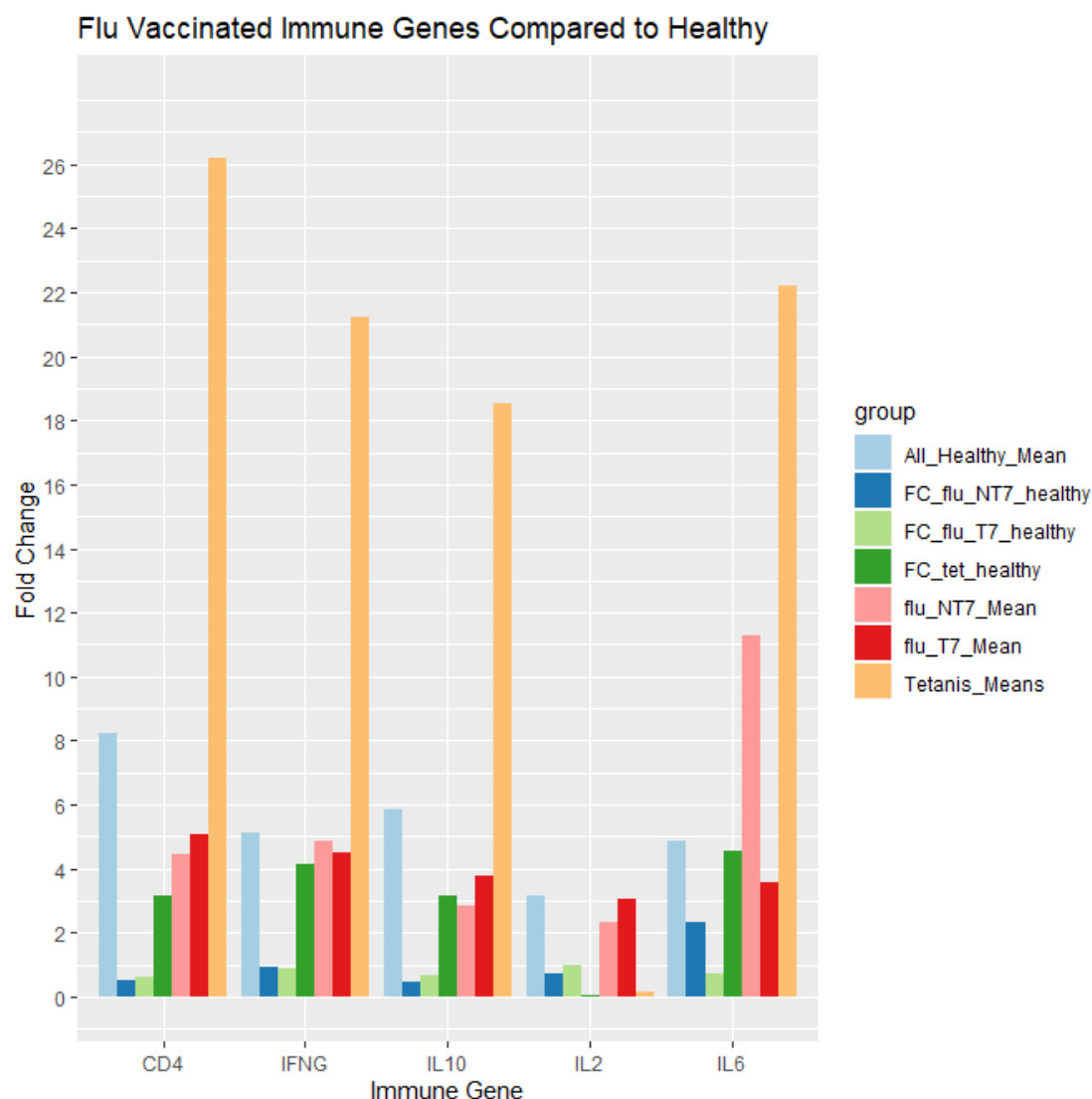
```

Flu_Healthy_tidy <- gather(Flu_Healthy, 'group', 'foldChange', 2:8)
Flu_Healthy_tidy$foldChange <- round(Flu_Healthy_tidy$foldChange, 3)
head(Flu_Healthy_tidy)

##   Gene      group foldChange
## 1  CD4 flu_NT7_Mean      4.444
## 2  IL2 flu_NT7_Mean      2.324
## 3 IFNG flu_NT7_Mean      4.844
## 4 IL10 flu_NT7_Mean      2.852
## 5  IL6 flu_NT7_Mean     11.282
## 6  CD4 flu_T7_Mean      5.086

ggplot(data = Flu_Healthy_tidy, aes(x=Gene, y=foldChange, fill=group)) +
  geom_bar(stat='identity', position=position_dodge()) +
  scale_y_continuous(breaks = seq(0, 27, by=2), limits=c(0,28)) +
  scale_fill_brewer(palette='Paired') +
  ggtitle('Flu Vaccinated Immune Genes Compared to Healthy') +
  ylab('Fold Change') +
  xlab('Immune Gene')

```



The above bar chart shows the Mean values for Tetanis and Flu vaccinated samples for these immune genes are higher than the mean values for these immune genes in non-vaccinated healthy samples of mixed genders and ages 18-95 years old.

The fold change values compared to healthy for the flu vaccinated and treated with antibiotics show these immune genes to be higher than the treated in only the IL10 and IL2 immune genes.

Again, IL2 is the only gene that the tetanis mean and fold change in gene expression values is not greater than the healthy mean values or the flu vaccinated mean values and fold change values compared to healthy gene expression means.

In the IL6 gene, the fold change value of the flu vaccinated not treated with antibiotics is more than double the fold change value of the flu vaccinated that was treated with

antibiotics. This could mean seven days after being treated with antibiotics when also being vaccinated for the flu, that the IL6 immune gene slows down expression values below the healthy levels.

It still remains to compare these samples of Alzheimer's Disease patients across samples of the healthy controls, and the same for the EGCG overweight female treatment, the heart disease males, iron toxicity males and females for the vaccinations. Since immune genes are a good way of telling how stressed a person's body is outside of what he or she can control this gives another option for analyzing health of a person to get vaccinated or when testing a new diet or discovering gene targets involved in an increased risk of death in heart disease or Alzheimer's disease.

What questions are you thinking about discovering given this data? Can you uncover what you know piled on top of what this data can explain for you to help answer the questions you have? If so, then play around with this data to answer those questions. If not, then go get more data or develop a different way to analyze this warehouse of data, then make note of any questions you have that you find interesting or curious and answer it with the data.

After letting this analysis sit for a while, let's get the data of all 236 samples of stats and study samples ready for machine learning with R and save for later using a classification variable that will give the study each sample was derived from. To do this we must first identify each sample from its respective study and retrieve the sample meta as healthy or treatment/disease type. This dataset is already in our environment from earlier if you saved your RStudio information or kept this file open the entire time while running the previous commands, `all6`, is the table to use. Otherwise it was written to csv as `'all_6_studies.csv'` to read in.

```
#Return the column names of all6  
colnames(all6)
```

```
## [1] "GENE_SYMBOL"  
## [2] "Tetanis_Means"  
## [3] "Alz_Females_AD1_Mean"  
## [4] "Alz_Females_control1_Mean"  
## [5] "Alz_males_AD1_Mean"  
## [6] "Alz_males_control1_Mean"  
## [7] "Alz_FC_fem_ctrl_AD"  
## [8] "Alz_FC_male_ctrl_AD"  
## [9] "FC_MI_males"  
## [10] "HealthyMI_Male_Means"  
## [11] "MI_Male_Means"  
## [12] "FC_t1"  
## [13] "FC_t3"  
## [14] "FC_t7"
```

```
## [15] "FC_t21"
## [16] "FC_nt1"
## [17] "FC_nt3"
## [18] "FC_nt7"
## [19] "FC_nt21"
## [20] "FCB_1"
## [21] "FCB_3"
## [22] "FCB_7"
## [23] "FCB_21"
## [24] "T0_Mean"
## [25] "T1_Mean"
## [26] "T3_Mean"
## [27] "T7_Mean"
## [28] "T21_Mean"
## [29] "NT0_Mean"
## [30] "NT1_Mean"
## [31] "NT3_Mean"
## [32] "NT7_Mean"
## [33] "NT21_Mean"
## [34] "FC_egcg_quer"
## [35] "FC_egcg"
## [36] "DE_EGCG"
## [37] "DE_Quercentin"
## [38] "Pre_Means"
## [39] "Post_EGCG_Means"
## [40] "Post_EGCG_Quercentin_Means"
## [41] "hemo_G1M_Mean"
## [42] "hemo_G2M_Mean"
## [43] "hemo_G3M_Mean"
## [44] "hemo_G1F_Mean"
## [45] "hemo_G2F_Mean"
## [46] "hemo_G3F_Mean"
## [47] "hemo_healthyFemale_Mean"
## [48] "hemo_healthyMale_Mean"
## [49] "hemo_Female_Mean"
## [50] "hemo_Male_Mean"
## [51] "hemo_FC_1m"
## [52] "hemo_FC_2m"
## [53] "hemo_FC_3m"
## [54] "hemo_FC_1F"
## [55] "hemo_FC_2F"
## [56] "hemo_FC_3F"
## [57] "hemo_FC_malesOverall"
## [58] "hemo_FC_femalesOverall"
## [59] "tetanis_GSM1443061"
## [60] "tetanis_GSM1443062"
## [61] "tetanis_GSM1443063"
## [62] "tetanis_GSM1443064"
## [63] "tetanis_GSM1443065"
## [64] "tetanis_GSM1443066"
```



```
## [65] "Alz_GSM2973262"
## [66] "Alz_GSM2973263"
## [67] "Alz_GSM2973264"
## [68] "Alz_GSM2973265"
## [69] "Alz_GSM2973266"
## [70] "Alz_GSM2973267"
## [71] "Alz_GSM2973268"
## [72] "Alz_GSM2973269"
## [73] "Alz_GSM2973270"
## [74] "Alz_GSM2973271"
## [75] "Alz_GSM2973272"
## [76] "Alz_GSM2973273"
## [77] "Alz_GSM2973274"
## [78] "Alz_GSM2973275"
## [79] "Alz_GSM2973276"
## [80] "Alz_GSM2973277"
## [81] "Alz_GSM2973278"
## [82] "Alz_GSM2973279"
## [83] "Alz_GSM2973280"
## [84] "Alz_GSM2973281"
## [85] "Alz_GSM2973282"
## [86] "Alz_GSM2973283"
## [87] "Alz_GSM2973284"
## [88] "Alz_GSM2973285"
## [89] "Alz_GSM2973286"
## [90] "Alz_GSM2973287"
## [91] "Alz_GSM2973288"
## [92] "Alz_GSM2973289"
## [93] "Alz_GSM2973290"
## [94] "Alz_GSM2973291"
## [95] "Alz_GSM2973292"
## [96] "Alz_GSM2973293"
## [97] "Alz_GSM2973294"
## [98] "Alz_GSM2973295"
## [99] "Alz_GSM2973296"
## [100] "Alz_GSM2973297"
## [101] "Alz_GSM2973298"
## [102] "Alz_GSM2973299"
## [103] "Alz_GSM2973300"
## [104] "Alz_GSM2973301"
## [105] "Alz_GSM2973302"
## [106] "Alz_GSM2973303"
## [107] "Alz_GSM2973304"
## [108] "Alz_GSM2973305"
## [109] "Alz_GSM2973306"
## [110] "Alz_GSM2973307"
## [111] "Alz_GSM2973308"
## [112] "Alz_GSM2973309"
## [113] "Alz_GSM2973310"
## [114] "Alz_GSM2973311"
```

```
## [115] "Alz_GSM2973312"
## [116] "Alz_GSM2973313"
## [117] "Alz_GSM2973314"
## [118] "Alz_GSM2973315"
## [119] "Alz_GSM2973316"
## [120] "Alz_GSM2973317"
## [121] "Alz_GSM2973318"
## [122] "Alz_GSM2973319"
## [123] "Alz_GSM2973320"
## [124] "Alz_GSM2973321"
## [125] "Alz_GSM2973322"
## [126] "Alz_GSM2973323"
## [127] "Alz_GSM2973324"
## [128] "Alz_GSM2973325"
## [129] "Alz_GSM2973326"
## [130] "Alz_GSM2973327"
## [131] "Alz_GSM2973328"
## [132] "Alz_GSM2973329"
## [133] "Alz_GSM2973330"
## [134] "Alz_GSM2973331"
## [135] "Alz_GSM2973332"
## [136] "Alz_GSM2973333"
## [137] "Alz_GSM2973334"
## [138] "Alz_GSM2973335"
## [139] "Alz_GSM2973336"
## [140] "Alz_GSM2973337"
## [141] "Alz_GSM2973338"
## [142] "Alz_GSM2973339"
## [143] "healthy_MI_Males_GSM4205364"
## [144] "healthy_MI_Males_GSM4205363"
## [145] "healthy_MI_Males_GSM4205362"
## [146] "healthy_MI_Males_GSM4205361"
## [147] "healthy_MI_Males_GSM4205360"
## [148] "healthy_MI_Males_GSM4205359"
## [149] "MI_Males_GSM4205358"
## [150] "MI_Males_GSM4205357"
## [151] "MI_Males_GSM4205356"
## [152] "MI_Males_GSM4205355"
## [153] "MI_Males_GSM4205354"
## [154] "MI_Males_GSM4205353"
## [155] "flu_GSM3409106_29_day_0"
## [156] "flu_GSM3409107_29_day_1"
## [157] "flu_GSM3409108_29_day_3"
## [158] "flu_GSM3409004_29_day_7"
## [159] "flu_GSM3409105_29_day_21_screening"
## [160] "flu_GSM3409006_30._day_0"
## [161] "flu_GSM3409007_30_day_1"
## [162] "flu_GSM3409008_30_day_3"
## [163] "flu_GSM3409009_30_day_7"
## [164] "flu_GSM3409005_30_day_21_screening"
```

```
## [165] "flu_GSM3409013_05_.day_0"
## [166] "flu_GSM3409014_05_day_1"
## [167] "flu_GSM3409015_05_day_3"
## [168] "flu_GSM3409016_05_day_7"
## [169] "flu_GSM3409012_05_day_21_screening"
## [170] "flu_GSM3409161_33_day_0_no"
## [171] "flu_GSM3409162_33_day_1_no"
## [172] "flu_GSM3409163_33_day_3_no"
## [173] "flu_GSM3409111_33_.day_7_no"
## [174] "flu_GSM3409160_33_day_21_screening_no"
## [175] "flu_GSM3409124_36_day_0_no"
## [176] "flu_GSM3409125_36_day_1_no"
## [177] "flu_GSM3409126_36_day_3_no"
## [178] "flu_GSM3409127_36_day_7_no"
## [179] "flu_GSM3409123_36_day_21_screening_no"
## [180] "flu_GSM3409135_38_day_0_no"
## [181] "flu_GSM3409136_38_day_1_no"
## [182] "flu_GSM3409137_38_day_3_no"
## [183] "flu_GSM3409138_38_day_7_no"
## [184] "flu_GSM3409134_38_day_21_screening_no"
## [185] "EGCG_pre_GSM1923000"
## [186] "EGCG_pre_GSM1923004"
## [187] "EGCG_pre_GSM1923010"
## [188] "EGCG_pre_GSM1923012"
## [189] "EGCG_pre_GSM1923007"
## [190] "EGCG_pre_GSM1923020"
## [191] "EGCG_pre_GSM192998"
## [192] "EGCG_pre_GSM1922995"
## [193] "EGCG_pre_GSM1923002"
## [194] "EGCG_pre_GSM1923008"
## [195] "EGCG_pre_GSM1923015"
## [196] "EGCG_pre_GSM1923018"
## [197] "EGCG_pre_GSM1923022"
## [198] "EGCG_pre_GSM1923017"
## [199] "EGCG_post_EG_GSM1923001"
## [200] "EGCG_post_EG_GSM1923005"
## [201] "EGCG_post_EG_GSM1923011"
## [202] "EGCG_post_EG_GSM1923013"
## [203] "EGCG_post_EG_GSM1923021"
## [204] "EGCG_post_EG_GSM1923006"
## [205] "EGCG_post_EG_GSM1923014"
## [206] "EGCG_post_EQ_GSM192996"
## [207] "EGCG_post_EQ_GSM1923003"
## [208] "EGCG_post_EQ_GSM1923009"
## [209] "EGCG_post_EQ_GSM1923016"
## [210] "EGCG_post_EQ_GSM1923019"
## [211] "EGCG_post_EQ_GSM1923023"
## [212] "EGCG_post_EQ_GSM192997"
## [213] "hemo_GSM3440208"
## [214] "hemo_GSM3440209"
```

```

## [215] "hemo_GSM3440210"
## [216] "hemo_GSM3440211"
## [217] "hemo_GSM3440212"
## [218] "hemo_GSM3440213"
## [219] "hemo_GSM3440214"
## [220] "hemo_GSM3440215"
## [221] "hemo_GSM3440216"
## [222] "hemo_GSM3440217"
## [223] "hemo_GSM3440218"
## [224] "hemo_GSM3440219"
## [225] "hemo_GSM3440220"
## [226] "hemo_GSM3440221"
## [227] "hemo_GSM3440222"
## [228] "hemo_GSM3440223"
## [229] "hemo_GSM3440224"
## [230] "hemo_GSM3440225"
## [231] "hemo_GSM3440226"
## [232] "hemo_GSM3440227"
## [233] "hemo_GSM3440228"
## [234] "hemo_GSM3440229"
## [235] "hemo_GSM3440230"
## [236] "hemo_GSM3440231"

```

The first 58 fields are the stat fields created for respective data sets and won't be included in the machine learning data set.

- The tetanis data sets didn't have any age or gender information provided and were all healthy so it will not need to be identified separately from healthy classification.
- The next samples are for Alzheimers, and these samples don't say the healthy or disease state, so they will need to have that information attached for **columns 65 to 142**.
- The MI samples as **columns 143 to 154** are already identified as healthy or MI.
- The flu samples are identified by flu as is with antibiotics or flu with out antibiotics from healthy donors in **columns 155 to 184**
- The EGCG samples are also identified already as using or not using EGCG in **columns 185 to 212** in the column name.
- The hemochromatosis columns in **213 to 236** need to be identified as healthy or disease.

I went through the subset tables in the Alzheimer and hemochromatosis gender and healthy tables to get the respective indices of the gender and healthy identified samples in this table. Revisiting the Flu+anti or not study, the day 0 is also the healthy state pre-vaccination that can be used as healthy blood , but without attached gender information. The flu+antibiotics gave antibiotics orally between day1 and day3

```

AD_healthy_male <-
c(74,76,82,86,94,96,99,102,123,126,129,130,132,133,134,141)
AD_healthy_female <-
c(72,87,88,89,91,97,100,114,116,119,120,124,125,127,128,138)
AD_male <-
c(65,66,69,70,75,79,81,85,90,95,98,104,109,110,111,115,118,121,135,136,139,140)
AD_female <-
c(67,68,71,73,77,78,80,83,84,92,93,101,103,105,106,107,108,112,113,117,122,131,137,142)
Hemo_healthy_female <- c(234,235)
Hemo_healthy_male <- c(231,232,233,236)
Hemo_disease_male <- c(213:218,220,221,223:226,230)
Hemo_disease_female <- c(219,222,227:229)
female_overweight <- c(185:198)
female_overweight_EGCG_treated <- c(199:205)
female_overweight_EGCG_Plus_treated <- c(206:212)
flu_healthy_control <- c(155,160,165,170,175,180)
flu_Plus_antibiotics_day1 <- c(156,161,166)
flu_Plus_antibiotics_day3 <- c(157,162,167)
flu_Plus_antibiotics_day7 <- c(158,163,168)
flu_Plus_antibiotics_day21 <- c(159,164,169)
flu_no_antibiotics_day1 <- c(171,176,181)
flu_no_antibiotics_day3 <- c(172,177,182)
flu_no_antibiotics_day7 <- c(173,178,183)
flu_no_antibiotics_day21 <- c(174,179,184)
MI_healthy_males <- c(143:148)
MI_males <- c(149:154)
tetanis_immunized <- c(59:64)

SamplesOnly <- all6[,c(1,AD_healthy_male,AD_healthy_female,AD_male,AD_female,
Hemo_healthy_female,Hemo_healthy_male,Hemo_disease_male,
Hemo_disease_female,
female_overweight,female_overweight_EGCG_treated,
female_overweight_EGCG_Plus_treated,
flu_healthy_control,flu_Plus_antibiotics_day1,
flu_Plus_antibiotics_day3,flu_Plus_antibiotics_day7,
flu_Plus_antibiotics_day21,flu_no_antibiotics_day1,
flu_no_antibiotics_day3,flu_no_antibiotics_day7,
flu_no_antibiotics_day21,MI_healthy_males,
MI_males,tetanis_immunized),]
row.names(SamplesOnly) <- SamplesOnly$GENE_SYMBOL
SamplesOnly2 <- SamplesOnly[, -1]

```

Now for making the class identifier as a vector to use in classifying these samples by type.

```

AD_hm <- rep('AD Healthy Male',length(AD_healthy_male))
AD_hf <- rep('AD Healthy Female', length(AD_healthy_female))
AD_m <- rep('AD Male', length(AD_male))

```

```

AD_f <- rep('AD Female', length(AD_female))
Hemo_hf <- rep('Hemo Healthy Female', length(Hemo_healthy_female))
Hemo_hm <- rep('Hemo Healthy Male', length(Hemo_healthy_male))
Hemo_m <- rep('Hemo Male', length(Hemo_disease_male))
Hemo_f <- rep('Hemo Female', length(Hemo_disease_female))
overweight_female <- rep('Overweight Female', length(female_overweight))
overweight_female_EGCG <- rep('Overweight Female EGCG Treated',
                              length(female_overweight_EGCG_treated))
overweight_female_EGCG_Plus <- rep('Overweight Female EGCG+fishOil+VitC',
                                   length(female_overweight_EGCG_Plus_treated))
flu_not_immunized_yet <- rep('Flu non immunized healthy',
                              length(flu_healthy_control))
flu_Plus_day1 <- rep('Flu Immunized Plus Antibiotics Day 1',
                    length(flu_Plus_antibiotics_day1))
flu_Plus_day3 <- rep('Flu Immunized Plus Antibiotics Day 3',
                    length(flu_Plus_antibiotics_day3))
flu_Plus_day7 <- rep('Flu Immunized Plus Antibiotics Day 7',
                    length(flu_Plus_antibiotics_day7))
flu_Plus_day21 <- rep('Flu Immunized Plus Antibiotics Day 21',
                     length(flu_Plus_antibiotics_day21))
flu_only_day1 <- rep('Flu Immunized Only Day 1',
                    length(flu_no_antibiotics_day1))
flu_only_day3 <- rep('Flu Immunized Only Day 3',
                    length(flu_no_antibiotics_day3))
flu_only_day7 <- rep('Flu Immunized Only Day 7',
                    length(flu_no_antibiotics_day7))
flu_only_day21 <- rep('Flu Immunized Only Day 21',
                     length(flu_no_antibiotics_day21))
MI_hm <- rep('MI Healthy Males', length(MI_healthy_males))
MI_m <- rep('MI Males', length(MI_males))
tet <- rep('Tetanis Immunized', length(tetanis_immunized))

ClassType <- as.data.frame(c(AD_hm, AD_hf, AD_m, AD_f, Hemo_hf, Hemo_hm,
                             Hemo_m, Hemo_f,
                             overweight_female, overweight_female_EGCG,
                             overweight_female_EGCG_Plus,
                             flu_not_immunized_yet, flu_Plus_day1, flu_Plus_day3,
                             flu_Plus_day7,
                             flu_Plus_day21, flu_only_day1, flu_only_day3, flu_only_day7,
                             flu_only_day21, MI_hm, MI_m, tet))
colnames(ClassType) <- 'Class_Type'
Class2 <- as.data.frame(t(ClassType))
colnames(Class2) <- colnames(SamplesOnly2)

t(Class2) #Compare the row names when transposed to the assigned Class_Type

##                               Class_Type
## Alz_GSM2973271                "AD Healthy Male"
## Alz_GSM2973273                "AD Healthy Male"

```

## Alz_GSM2973279	"AD Healthy Male"
## Alz_GSM2973283	"AD Healthy Male"
## Alz_GSM2973291	"AD Healthy Male"
## Alz_GSM2973293	"AD Healthy Male"
## Alz_GSM2973296	"AD Healthy Male"
## Alz_GSM2973299	"AD Healthy Male"
## Alz_GSM2973320	"AD Healthy Male"
## Alz_GSM2973323	"AD Healthy Male"
## Alz_GSM2973326	"AD Healthy Male"
## Alz_GSM2973327	"AD Healthy Male"
## Alz_GSM2973329	"AD Healthy Male"
## Alz_GSM2973330	"AD Healthy Male"
## Alz_GSM2973331	"AD Healthy Male"
## Alz_GSM2973338	"AD Healthy Male"
## Alz_GSM2973269	"AD Healthy Female"
## Alz_GSM2973284	"AD Healthy Female"
## Alz_GSM2973285	"AD Healthy Female"
## Alz_GSM2973286	"AD Healthy Female"
## Alz_GSM2973288	"AD Healthy Female"
## Alz_GSM2973294	"AD Healthy Female"
## Alz_GSM2973297	"AD Healthy Female"
## Alz_GSM2973311	"AD Healthy Female"
## Alz_GSM2973313	"AD Healthy Female"
## Alz_GSM2973316	"AD Healthy Female"
## Alz_GSM2973317	"AD Healthy Female"
## Alz_GSM2973321	"AD Healthy Female"
## Alz_GSM2973322	"AD Healthy Female"
## Alz_GSM2973324	"AD Healthy Female"
## Alz_GSM2973325	"AD Healthy Female"
## Alz_GSM2973335	"AD Healthy Female"
## Alz_GSM2973262	"AD Male"
## Alz_GSM2973263	"AD Male"
## Alz_GSM2973266	"AD Male"
## Alz_GSM2973267	"AD Male"
## Alz_GSM2973272	"AD Male"
## Alz_GSM2973276	"AD Male"
## Alz_GSM2973278	"AD Male"
## Alz_GSM2973282	"AD Male"
## Alz_GSM2973287	"AD Male"
## Alz_GSM2973292	"AD Male"
## Alz_GSM2973295	"AD Male"
## Alz_GSM2973301	"AD Male"
## Alz_GSM2973306	"AD Male"
## Alz_GSM2973307	"AD Male"
## Alz_GSM2973308	"AD Male"
## Alz_GSM2973312	"AD Male"
## Alz_GSM2973315	"AD Male"
## Alz_GSM2973318	"AD Male"
## Alz_GSM2973332	"AD Male"
## Alz_GSM2973333	"AD Male"

## Alz_GSM2973336	"AD Male"
## Alz_GSM2973337	"AD Male"
## Alz_GSM2973264	"AD Female"
## Alz_GSM2973265	"AD Female"
## Alz_GSM2973268	"AD Female"
## Alz_GSM2973270	"AD Female"
## Alz_GSM2973274	"AD Female"
## Alz_GSM2973275	"AD Female"
## Alz_GSM2973277	"AD Female"
## Alz_GSM2973280	"AD Female"
## Alz_GSM2973281	"AD Female"
## Alz_GSM2973289	"AD Female"
## Alz_GSM2973290	"AD Female"
## Alz_GSM2973298	"AD Female"
## Alz_GSM2973300	"AD Female"
## Alz_GSM2973302	"AD Female"
## Alz_GSM2973303	"AD Female"
## Alz_GSM2973304	"AD Female"
## Alz_GSM2973305	"AD Female"
## Alz_GSM2973309	"AD Female"
## Alz_GSM2973310	"AD Female"
## Alz_GSM2973314	"AD Female"
## Alz_GSM2973319	"AD Female"
## Alz_GSM2973328	"AD Female"
## Alz_GSM2973334	"AD Female"
## Alz_GSM2973339	"AD Female"
## hemo_GSM3440229	"Hemo Healthy Female"
## hemo_GSM3440230	"Hemo Healthy Female"
## hemo_GSM3440226	"Hemo Healthy Male"
## hemo_GSM3440227	"Hemo Healthy Male"
## hemo_GSM3440228	"Hemo Healthy Male"
## hemo_GSM3440231	"Hemo Healthy Male"
## hemo_GSM3440208	"Hemo Male"
## hemo_GSM3440209	"Hemo Male"
## hemo_GSM3440210	"Hemo Male"
## hemo_GSM3440211	"Hemo Male"
## hemo_GSM3440212	"Hemo Male"
## hemo_GSM3440213	"Hemo Male"
## hemo_GSM3440215	"Hemo Male"
## hemo_GSM3440216	"Hemo Male"
## hemo_GSM3440218	"Hemo Male"
## hemo_GSM3440219	"Hemo Male"
## hemo_GSM3440220	"Hemo Male"
## hemo_GSM3440221	"Hemo Male"
## hemo_GSM3440225	"Hemo Male"
## hemo_GSM3440214	"Hemo Female"
## hemo_GSM3440217	"Hemo Female"
## hemo_GSM3440222	"Hemo Female"
## hemo_GSM3440223	"Hemo Female"
## hemo_GSM3440224	"Hemo Female"

## EGCG_pre_GSM1923000	"Overweight Female"
## EGCG_pre_GSM1923004	"Overweight Female"
## EGCG_pre_GSM1923010	"Overweight Female"
## EGCG_pre_GSM1923012	"Overweight Female"
## EGCG_pre_GSM1923007	"Overweight Female"
## EGCG_pre_GSM1923020	"Overweight Female"
## EGCG_pre_GSM192998	"Overweight Female"
## EGCG_pre_GSM1922995	"Overweight Female"
## EGCG_pre_GSM1923002	"Overweight Female"
## EGCG_pre_GSM1923008	"Overweight Female"
## EGCG_pre_GSM1923015	"Overweight Female"
## EGCG_pre_GSM1923018	"Overweight Female"
## EGCG_pre_GSM1923022	"Overweight Female"
## EGCG_pre_GSM1923017	"Overweight Female"
## EGCG_post_EG_GSM1923001	"Overweight Female EGCG Treated"
## EGCG_post_EG_GSM1923005	"Overweight Female EGCG Treated"
## EGCG_post_EG_GSM1923011	"Overweight Female EGCG Treated"
## EGCG_post_EG_GSM1923013	"Overweight Female EGCG Treated"
## EGCG_post_EG_GSM1923021	"Overweight Female EGCG Treated"
## EGCG_post_EG_GSM1923006	"Overweight Female EGCG Treated"
## EGCG_post_EG_GSM1923014	"Overweight Female EGCG Treated"
## EGCG_post_EQ_GSM192996	"Overweight Female
EGCG+fishOil+VitC"	
## EGCG_post_EQ_GSM1923003	"Overweight Female
EGCG+fishOil+VitC"	
## EGCG_post_EQ_GSM1923009	"Overweight Female
EGCG+fishOil+VitC"	
## EGCG_post_EQ_GSM1923016	"Overweight Female
EGCG+fishOil+VitC"	
## EGCG_post_EQ_GSM1923019	"Overweight Female
EGCG+fishOil+VitC"	
## EGCG_post_EQ_GSM1923023	"Overweight Female
EGCG+fishOil+VitC"	
## EGCG_post_EQ_GSM192997	"Overweight Female
EGCG+fishOil+VitC"	
## flu_GSM3409106_29_day_0	"Flu non immunized healthy"
## flu_GSM3409006_30_.day_0	"Flu non immunized healthy"
## flu_GSM3409013_05_.day_0	"Flu non immunized healthy"
## flu_GSM3409161_33_day_0_no	"Flu non immunized healthy"
## flu_GSM3409124_36_day_0_no	"Flu non immunized healthy"
## flu_GSM3409135_38_day_0_no	"Flu non immunized healthy"
## flu_GSM3409107_29_day_1	"Flu Immunized Plus Antibiotics Day
1"	
## flu_GSM3409007_30_day_1	"Flu Immunized Plus Antibiotics Day
1"	
## flu_GSM3409014_05_day_1	"Flu Immunized Plus Antibiotics Day
1"	
## flu_GSM3409108_29_day_3	"Flu Immunized Plus Antibiotics Day
3"	
## flu_GSM3409008_30_day_3	"Flu Immunized Plus Antibiotics Day

3"	
## flu_GSM3409015_05_day_3	"Flu Immunized Plus Antibiotics Day
3"	
## flu_GSM3409004_29_day_7	"Flu Immunized Plus Antibiotics Day
7"	
## flu_GSM3409009_30_day_7	"Flu Immunized Plus Antibiotics Day
7"	
## flu_GSM3409016_05_day_7	"Flu Immunized Plus Antibiotics Day
7"	
## flu_GSM3409105_29_day_21_screening	"Flu Immunized Plus Antibiotics Day
21"	
## flu_GSM3409005_30_day_21_screening	"Flu Immunized Plus Antibiotics Day
21"	
## flu_GSM3409012_05_day_21_screening	"Flu Immunized Plus Antibiotics Day
21"	
## flu_GSM3409162_33_day_1_no	"Flu Immunized Only Day 1"
## flu_GSM3409125_36_day_1_no	"Flu Immunized Only Day 1"
## flu_GSM3409136_38_day_1_no	"Flu Immunized Only Day 1"
## flu_GSM3409163_33_day_3_no	"Flu Immunized Only Day 3"
## flu_GSM3409126_36_day_3_no	"Flu Immunized Only Day 3"
## flu_GSM3409137_38_day_3_no	"Flu Immunized Only Day 3"
## flu_GSM3409111_33._day_7_no	"Flu Immunized Only Day 7"
## flu_GSM3409127_36_day_7_no	"Flu Immunized Only Day 7"
## flu_GSM3409138_38_day_7_no	"Flu Immunized Only Day 7"
## flu_GSM3409160_33_day_21_screening_no	"Flu Immunized Only Day 21"
## flu_GSM3409123_36_day_21_screening_no	"Flu Immunized Only Day 21"
## flu_GSM3409134_38_day_21_screening_no	"Flu Immunized Only Day 21"
## healthy_MI_Males_GSM4205364	"MI Healthy Males"
## healthy_MI_Males_GSM4205363	"MI Healthy Males"
## healthy_MI_Males_GSM4205362	"MI Healthy Males"
## healthy_MI_Males_GSM4205361	"MI Healthy Males"
## healthy_MI_Males_GSM4205360	"MI Healthy Males"
## healthy_MI_Males_GSM4205359	"MI Healthy Males"
## MI_Males_GSM4205358	"MI Males"
## MI_Males_GSM4205357	"MI Males"
## MI_Males_GSM4205356	"MI Males"
## MI_Males_GSM4205355	"MI Males"
## MI_Males_GSM4205354	"MI Males"
## MI_Males_GSM4205353	"MI Males"
## tetanis_GSM1443061	"Tetanis Immunized"
## tetanis_GSM1443062	"Tetanis Immunized"
## tetanis_GSM1443063	"Tetanis Immunized"
## tetanis_GSM1443064	"Tetanis Immunized"
## tetanis_GSM1443065	"Tetanis Immunized"
## tetanis_GSM1443066	"Tetanis Immunized"

Replace the Samples GSM IDs with the class type labels.

```
SamplesOnly3 <- SamplesOnly2
colnames(SamplesOnly3) <- ClassType$Class_Type
```

```
write.csv(SamplesOnly3, 'Dracula.csv', row.names=TRUE)
```

```
dim(SamplesOnly3)
```

```
## [1] 12845    178
```

```
colnames(SamplesOnly3)
```

```
## [1] "AD Healthy Male"
## [2] "AD Healthy Male"
## [3] "AD Healthy Male"
## [4] "AD Healthy Male"
## [5] "AD Healthy Male"
## [6] "AD Healthy Male"
## [7] "AD Healthy Male"
## [8] "AD Healthy Male"
## [9] "AD Healthy Male"
## [10] "AD Healthy Male"
## [11] "AD Healthy Male"
## [12] "AD Healthy Male"
## [13] "AD Healthy Male"
## [14] "AD Healthy Male"
## [15] "AD Healthy Male"
## [16] "AD Healthy Male"
## [17] "AD Healthy Female"
## [18] "AD Healthy Female"
## [19] "AD Healthy Female"
## [20] "AD Healthy Female"
## [21] "AD Healthy Female"
## [22] "AD Healthy Female"
## [23] "AD Healthy Female"
## [24] "AD Healthy Female"
## [25] "AD Healthy Female"
## [26] "AD Healthy Female"
## [27] "AD Healthy Female"
## [28] "AD Healthy Female"
## [29] "AD Healthy Female"
## [30] "AD Healthy Female"
## [31] "AD Healthy Female"
## [32] "AD Healthy Female"
## [33] "AD Male"
## [34] "AD Male"
## [35] "AD Male"
## [36] "AD Male"
## [37] "AD Male"
## [38] "AD Male"
## [39] "AD Male"
## [40] "AD Male"
## [41] "AD Male"
## [42] "AD Male"
```

```
## [43] "AD Male"
## [44] "AD Male"
## [45] "AD Male"
## [46] "AD Male"
## [47] "AD Male"
## [48] "AD Male"
## [49] "AD Male"
## [50] "AD Male"
## [51] "AD Male"
## [52] "AD Male"
## [53] "AD Male"
## [54] "AD Male"
## [55] "AD Female"
## [56] "AD Female"
## [57] "AD Female"
## [58] "AD Female"
## [59] "AD Female"
## [60] "AD Female"
## [61] "AD Female"
## [62] "AD Female"
## [63] "AD Female"
## [64] "AD Female"
## [65] "AD Female"
## [66] "AD Female"
## [67] "AD Female"
## [68] "AD Female"
## [69] "AD Female"
## [70] "AD Female"
## [71] "AD Female"
## [72] "AD Female"
## [73] "AD Female"
## [74] "AD Female"
## [75] "AD Female"
## [76] "AD Female"
## [77] "AD Female"
## [78] "AD Female"
## [79] "Hemo Healthy Female"
## [80] "Hemo Healthy Female"
## [81] "Hemo Healthy Male"
## [82] "Hemo Healthy Male"
## [83] "Hemo Healthy Male"
## [84] "Hemo Healthy Male"
## [85] "Hemo Male"
## [86] "Hemo Male"
## [87] "Hemo Male"
## [88] "Hemo Male"
## [89] "Hemo Male"
## [90] "Hemo Male"
## [91] "Hemo Male"
## [92] "Hemo Male"
```

```
## [93] "Hemo Male"
## [94] "Hemo Male"
## [95] "Hemo Male"
## [96] "Hemo Male"
## [97] "Hemo Male"
## [98] "Hemo Female"
## [99] "Hemo Female"
## [100] "Hemo Female"
## [101] "Hemo Female"
## [102] "Hemo Female"
## [103] "Overweight Female"
## [104] "Overweight Female"
## [105] "Overweight Female"
## [106] "Overweight Female"
## [107] "Overweight Female"
## [108] "Overweight Female"
## [109] "Overweight Female"
## [110] "Overweight Female"
## [111] "Overweight Female"
## [112] "Overweight Female"
## [113] "Overweight Female"
## [114] "Overweight Female"
## [115] "Overweight Female"
## [116] "Overweight Female"
## [117] "Overweight Female EGCG Treated"
## [118] "Overweight Female EGCG Treated"
## [119] "Overweight Female EGCG Treated"
## [120] "Overweight Female EGCG Treated"
## [121] "Overweight Female EGCG Treated"
## [122] "Overweight Female EGCG Treated"
## [123] "Overweight Female EGCG Treated"
## [124] "Overweight Female EGCG+fishOil+VitC"
## [125] "Overweight Female EGCG+fishOil+VitC"
## [126] "Overweight Female EGCG+fishOil+VitC"
## [127] "Overweight Female EGCG+fishOil+VitC"
## [128] "Overweight Female EGCG+fishOil+VitC"
## [129] "Overweight Female EGCG+fishOil+VitC"
## [130] "Overweight Female EGCG+fishOil+VitC"
## [131] "Flu non immunized healthy"
## [132] "Flu non immunized healthy"
## [133] "Flu non immunized healthy"
## [134] "Flu non immunized healthy"
## [135] "Flu non immunized healthy"
## [136] "Flu non immunized healthy"
## [137] "Flu Immunized Plus Antibiotics Day 1"
## [138] "Flu Immunized Plus Antibiotics Day 1"
## [139] "Flu Immunized Plus Antibiotics Day 1"
## [140] "Flu Immunized Plus Antibiotics Day 3"
## [141] "Flu Immunized Plus Antibiotics Day 3"
## [142] "Flu Immunized Plus Antibiotics Day 3"
```

```
## [143] "Flu Immunized Plus Antibiotics Day 7"
## [144] "Flu Immunized Plus Antibiotics Day 7"
## [145] "Flu Immunized Plus Antibiotics Day 7"
## [146] "Flu Immunized Plus Antibiotics Day 21"
## [147] "Flu Immunized Plus Antibiotics Day 21"
## [148] "Flu Immunized Plus Antibiotics Day 21"
## [149] "Flu Immunized Only Day 1"
## [150] "Flu Immunized Only Day 1"
## [151] "Flu Immunized Only Day 1"
## [152] "Flu Immunized Only Day 3"
## [153] "Flu Immunized Only Day 3"
## [154] "Flu Immunized Only Day 3"
## [155] "Flu Immunized Only Day 7"
## [156] "Flu Immunized Only Day 7"
## [157] "Flu Immunized Only Day 7"
## [158] "Flu Immunized Only Day 21"
## [159] "Flu Immunized Only Day 21"
## [160] "Flu Immunized Only Day 21"
## [161] "MI Healthy Males"
## [162] "MI Healthy Males"
## [163] "MI Healthy Males"
## [164] "MI Healthy Males"
## [165] "MI Healthy Males"
## [166] "MI Healthy Males"
## [167] "MI Males"
## [168] "MI Males"
## [169] "MI Males"
## [170] "MI Males"
## [171] "MI Males"
## [172] "MI Males"
## [173] "Tetanis Immunized"
## [174] "Tetanis Immunized"
## [175] "Tetanis Immunized"
## [176] "Tetanis Immunized"
## [177] "Tetanis Immunized"
## [178] "Tetanis Immunized"
```

```
classNames <- colnames(SamplesOnly3)
```

The above data was written to file and almost machine learning ready, but it would be a wide matrix of 12,845 features of gene symbols and 178 rows of class if transposed as is. So it will be filtered to the top FC genes from all6 for Alzheimer females and bottom genes of the same. No particular reason the genes with the most change in Alzheimer's Disease for females was selected, but it is known the brain controls many functions and AD patients die slowly by having body functions shut off until sadly and ultimately they cannot swallow their own saliva or breathe (many clients have had loved ones die of AD whom were told by nurses and doctors that this is how they die—maybe a 3rd party fact).

```
AD_top125 <- all6[order(all6$Alz_FC_fem_ctrl_AD,
decreasing=TRUE)[1:125],c(1,7)]
```

```

AD_bottom125 <- all6[order(all6$Alz_FC_fem_ctrl_AD)[1:125],c(1,7)]
AD250 <- rbind(AD_top125,AD_bottom125)
SamplesOnly3$Gene <- row.names(SamplesOnly3)
SamplesOnly4 <- merge(AD250,SamplesOnly3, by.x='GENE_SYMBOL', by.y='Gene')
row.names(SamplesOnly4) <- SamplesOnly4$GENE_SYMBOL
Samples250 <- SamplesOnly4[, -c(1:2)]

ML_250 <- as.data.frame(t(Samples250))
ML_250$Class_Type <- classNames
row.names(ML_250) <- NULL
ML_ready_250 <- ML_250[,c(251,1:250)]
write.csv(ML_ready_250, 'ML_ready_250.csv', row.names=FALSE)

```

We can use this latest ML_ready_250, or machine learning ready table of 250 genes in common most/least expressed in AD females with the classifications (23) using a fast and relatively new ML software called H2O.

A note on H2O: it is faster than most machine learning data sets and is used as a better compression format for very large datasets, while being an extension to Principal Component Analysis (PCA) in extracting the PCAs with the most variance to analyze. These commands don't take very long to run.

[H2O tutorial](#) Installed [java for 64bit](#) when R didn't run

```

#install.packages('h2o')
library(h2o)

h2o.init(nthreads=-1, max_mem_size="2G")

## Connection successful!
##
## R is connected to the H2O cluster:
##   H2O cluster uptime:      12 minutes 19 seconds
##   H2O cluster timezone:    America/Los_Angeles
##   H2O data parsing timezone: UTC
##   H2O cluster version:     3.28.0.2
##   H2O cluster version age:  11 days
##   H2O cluster name:        H2O_started_from_R_m_wkq150
##   H2O cluster total nodes:  1
##   H2O cluster total memory: 2.00 GB
##   H2O cluster total cores:  2
##   H2O cluster allowed cores: 2
##   H2O cluster healthy:      TRUE
##   H2O Connection ip:        localhost
##   H2O Connection port:      54321
##   H2O Connection proxy:     NA
##   H2O Internal Security:    FALSE

```

```
##      H2O API Extensions:      Amazon S3, Algos, AutoML, Core V3,
TargetEncoder, Core V4
##      R Version:              R version 3.6.2 (2019-12-12)

h2o.removeAll() ## clean slate - just in case the cluster was already running

D = h2o.importFile(path = normalizePath("ML_ready_250.csv"))

##      |
|                                           | 0%
|
|=====| 100%

#h2o.summary(D) would print the summary stats of these 251 features

data = h2o.splitFrame(D, ratios=c(.7,.15),
                      destination_frames = c("train", "test", "valid"))
names(data) <- c('Train', 'Test', 'Valid')
```

multinomial model

```
m1 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
             x = colnames(data$Train)[2:251],
             y = 'Class_Type',
             family='multinomial',
             solver='L_BFGS')

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h2o.confusionMatrix(m1, valid=TRUE)

## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
##
##              AD Female AD Healthy Female AD Healthy Male AD
Male
## AD Female              0              1              0
0
## AD Healthy Female      0              0              3
0
## AD Healthy Male        1              0              0
0
## AD Male                3              0              0
1
## Flu Immunized Only Day 1 0              0              0
0
##
##              Flu Immunized Only Day 1 Flu Immunized Only Day
21
## AD Female              0
0
```


## AD Healthy Female	0		
0			
## AD Healthy Male	0		
0			
## AD Male	0		
0			
## Flu Immunized Only Day 1	0		
1			
##	Flu Immunized Only Day 3	Flu Immunized Only Day 7	
## AD Female	0	0	
## AD Healthy Female	0	0	
## AD Healthy Male	0	0	
## AD Male	0	0	
## Flu Immunized Only Day 1	0	0	
##	Flu Immunized Plus Antibiotics Day 1		
## AD Female	0		
## AD Healthy Female	0		
## AD Healthy Male	0		
## AD Male	0		
## Flu Immunized Only Day 1	0		
##	Flu Immunized Plus Antibiotics Day 21		
## AD Female	0		
## AD Healthy Female	0		
## AD Healthy Male	0		
## AD Male	0		
## Flu Immunized Only Day 1	0		
##	Flu Immunized Plus Antibiotics Day 3		
## AD Female	0		
## AD Healthy Female	0		
## AD Healthy Male	0		
## AD Male	0		
## Flu Immunized Only Day 1	0		
##	Flu Immunized Plus Antibiotics Day 7		
## AD Female	0		
## AD Healthy Female	0		
## AD Healthy Male	0		
## AD Male	0		
## Flu Immunized Only Day 1	0		
##	Flu non immunized healthy Hemo Female		
## AD Female	0	0	
## AD Healthy Female	0	0	
## AD Healthy Male	0	0	
## AD Male	0	0	
## Flu Immunized Only Day 1	0	0	
##	Hemo Healthy Female	Hemo Healthy Male	Hemo Male
## AD Female	0	0	0
## AD Healthy Female	0	0	0
## AD Healthy Male	0	0	0
## AD Male	0	0	0
## Flu Immunized Only Day 1	0	0	0

```

##          MI Healthy Males MI Males Overweight Female
## AD Female          0          0          0
## AD Healthy Female  0          0          0
## AD Healthy Male    0          0          0
## AD Male            0          0          0
## Flu Immunized Only Day 1 0          0          0
##          Overweight Female EGCG Treated
## AD Female          0
## AD Healthy Female  0
## AD Healthy Male    0
## AD Male            0
## Flu Immunized Only Day 1 0
##          Overweight Female EGCG+fishOil+VitC Tetanis
Immunized
## AD Female          0
0
## AD Healthy Female  0
0
## AD Healthy Male    0
0
## AD Male            0
0
## Flu Immunized Only Day 1 0
0
##          Error      Rate
## AD Female          1.0000 = 1 / 1
## AD Healthy Female  1.0000 = 3 / 3
## AD Healthy Male    1.0000 = 1 / 1
## AD Male            0.7500 = 3 / 4
## Flu Immunized Only Day 1 1.0000 = 1 / 1
##
## ---
##          AD Female AD Healthy Female AD Healthy
Male
## MI Males          0          0
0
## Overweight Female  0          0
0
## Overweight Female EGCG Treated 0          0
0
## Overweight Female EGCG+fishOil+VitC 0          0
0
## Tetanis Immunized  0          0
0
## Totals            4          1
3
##          AD Male Flu Immunized Only Day 1
## MI Males          0          0
## Overweight Female  0          0
## Overweight Female EGCG Treated 0          0

```

## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	1	0
## Flu Immunized Only Day 21		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
## Flu Immunized Only Day 3		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
## Flu Immunized Only Day 7		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
## Flu Immunized Plus Antibiotics Day 1		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
## Flu Immunized Plus Antibiotics Day 21		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
## Flu Immunized Plus Antibiotics Day 3		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
## Flu Immunized Plus Antibiotics Day 7		
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	

## Tetanis Immunized			0
## Totals			3
##	Flu non immunized healthy Hemo Female		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		0	0
##	Hemo Healthy Female Hemo Healthy Male		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		0	0
##	Hemo Male MI Healthy Males MI Males		
## MI Males	0	0	1
## Overweight Female	0	0	0
## Overweight Female EGCG Treated	0	0	0
## Overweight Female EGCG+fishOil+VitC	0	0	0
## Tetanis Immunized	0	0	0
## Totals	5	0	2
##	Overweight Female		
## MI Males	0		
## Overweight Female	3		
## Overweight Female EGCG Treated	2		
## Overweight Female EGCG+fishOil+VitC	1		
## Tetanis Immunized	0		
## Totals	6		
##	Overweight Female EGCG Treated		
## MI Males		0	
## Overweight Female		0	
## Overweight Female EGCG Treated		0	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		0	
##	Overweight Female EGCG+fishOil+VitC		
## MI Males		0	
## Overweight Female		1	
## Overweight Female EGCG Treated		0	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		1	
##	Tetanis Immunized Error Rate		
## MI Males	0 0.0000 =	0 / 1	
## Overweight Female	0 0.2500 =	1 / 4	
## Overweight Female EGCG Treated	0 1.0000 =	2 / 2	
## Overweight Female EGCG+fishOil+VitC	0 1.0000 =	1 / 1	

## Tetanis Immunized	1 0.0000 = 0 / 1
## Totals	1 0.7419 = 23 / 31

This model doesn't use regularization of the default by setting lambda=0, regularization generalizes better between the training set and test and validation set by reducing the over and under fit of model.

```
m2 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
             x = colnames(data$Train)[2:251],
             y = 'Class_Type',
             family='multinomial',
             solver='L_BFGS',
             lambda = 0)
```

```
## |
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|
|=====| 100%
```

Get confusion matrix in the training data.

```
h2o.confusionMatrix(m2, valid=FALSE)
```

```
## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
##
## AD Female AD Healthy Female AD Healthy Male AD
Male
## AD Female 19 0 0
0
## AD Healthy Female 0 11 0
0
## AD Healthy Male 0 0 12
0
## AD Male 0 0 0
16
## Flu Immunized Only Day 1 0 0 0
0
## Flu Immunized Only Day 1 Flu Immunized Only Day
21
## AD Female 0
0
## AD Healthy Female 0
0
## AD Healthy Male 0
0
## AD Male 0
0
## Flu Immunized Only Day 1 1
0
## Flu Immunized Only Day 3 Flu Immunized Only Day 7
## AD Female 0 0
## AD Healthy Female 0 0
```

## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## Flu Immunized Plus Antibiotics Day 1		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu Immunized Plus Antibiotics Day 21		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu Immunized Plus Antibiotics Day 3		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu Immunized Plus Antibiotics Day 7		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu non immunized healthy Hemo Female		
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## Hemo Healthy Female Hemo Healthy Male Hemo Male		
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## MI Healthy Males MI Males Overweight Female		
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## Overweight Female EGCG Treated		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	

```

## Flu Immunized Only Day 1 0
## Overweight Female EGCG+fishOil+VitC Tetanis
Immunized
## AD Female 0
0
## AD Healthy Female 0
0
## AD Healthy Male 0
0
## AD Male 0
0
## Flu Immunized Only Day 1 0
0
## Error Rate
## AD Female 0.0000 = 0 / 19
## AD Healthy Female 0.0000 = 0 / 11
## AD Healthy Male 0.0000 = 0 / 12
## AD Male 0.0000 = 0 / 16
## Flu Immunized Only Day 1 0.0000 = 0 / 1
##
## ---
## AD Female AD Healthy Female AD Healthy
Male
## MI Males 0 0
0
## Overweight Female 0 0
0
## Overweight Female EGCG Treated 0 0
0
## Overweight Female EGCG+fishOil+VitC 0 0
0
## Tetanis Immunized 0 0
0
## Totals 19 11
12
## AD Male Flu Immunized Only Day 1
## MI Males 0 0
## Overweight Female 0 0
## Overweight Female EGCG Treated 0 0
## Overweight Female EGCG+fishOil+VitC 0 0
## Tetanis Immunized 0 0
## Totals 16 1
## Flu Immunized Only Day 21
## MI Males 0
## Overweight Female 0
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized 0
## Totals 2
## Flu Immunized Only Day 3

```

## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	1	
##	Flu Immunized Only Day 7	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
##	Flu Immunized Plus Antibiotics Day 1	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
##	Flu Immunized Plus Antibiotics Day 21	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	1	
##	Flu Immunized Plus Antibiotics Day 3	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
##	Flu Immunized Plus Antibiotics Day 7	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	3	
##	Flu non immunized healthy Hemo Female	
## MI Males	0	0
## Overweight Female	0	0
## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	2	3
##	Hemo Healthy Female Hemo Healthy Male	
## MI Males	0	0


```

## Overweight Female                                0                0
## Overweight Female EGCG Treated                   0                0
## Overweight Female EGCG+fishOil+VitC              0                0
## Tetanis Immunized                                0                0
## Totals                                           2                3
##
## Hemo Male MI Healthy Males MI Males
## MI Males                                         0                0                5
## Overweight Female                               0                0                0
## Overweight Female EGCG Treated                  0                0                0
## Overweight Female EGCG+fishOil+VitC             0                0                0
## Tetanis Immunized                               0                0                0
## Totals                                           9                3                5
##
## Overweight Female
## MI Males                                         0
## Overweight Female                               9
## Overweight Female EGCG Treated                  0
## Overweight Female EGCG+fishOil+VitC             0
## Tetanis Immunized                               0
## Totals                                           9
##
## Overweight Female EGCG Treated
## MI Males                                         0
## Overweight Female                               0
## Overweight Female EGCG Treated                  5
## Overweight Female EGCG+fishOil+VitC             0
## Tetanis Immunized                               0
## Totals                                           5
##
## Overweight Female EGCG+fishOil+VitC
## MI Males                                         0
## Overweight Female                               0
## Overweight Female EGCG Treated                  0
## Overweight Female EGCG+fishOil+VitC             6
## Tetanis Immunized                               0
## Totals                                           6
##
## Tetanis Immunized Error Rate
## MI Males                                         0 0.0000 = 0 / 5
## Overweight Female                               0 0.0000 = 0 / 9
## Overweight Female EGCG Treated                  0 0.0000 = 0 / 5
## Overweight Female EGCG+fishOil+VitC             0 0.0000 = 0 / 6
## Tetanis Immunized                               3 0.0000 = 0 / 3
## Totals                                           3 0.0000 = 0 / 122

```

Get confusion matrix in the validation data.

```
h2o.confusionMatrix(m2, valid=TRUE)
```

```

## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
## AD Female AD Healthy Female AD Healthy Male AD
Male
## AD Female                                0                1                0
0

```

## AD Healthy Female	0	0	3
0			
## AD Healthy Male	1	0	0
0			
## AD Male	2	0	0
2			
## Flu Immunized Only Day 1	0	0	0
0			
##	Flu Immunized Only Day 1	Flu Immunized Only Day	
21			
## AD Female		0	
0			
## AD Healthy Female		0	
0			
## AD Healthy Male		0	
0			
## AD Male		0	
0			
## Flu Immunized Only Day 1		0	
0			
##	Flu Immunized Only Day 3	Flu Immunized Only Day 7	
## AD Female		0	0
## AD Healthy Female		0	0
## AD Healthy Male		0	0
## AD Male		0	0
## Flu Immunized Only Day 1		1	0
##	Flu Immunized Plus Antibiotics Day 1		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	
##	Flu Immunized Plus Antibiotics Day 21		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	
##	Flu Immunized Plus Antibiotics Day 3		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	
##	Flu Immunized Plus Antibiotics Day 7		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	

```

##          Flu non immunized healthy Hemo Female
## AD Female          0          0
## AD Healthy Female  0          0
## AD Healthy Male    0          0
## AD Male            0          0
## Flu Immunized Only Day 1 0          0
##          Hemo Healthy Female Hemo Healthy Male Hemo Male
## AD Female          0          0          0
## AD Healthy Female  0          0          0
## AD Healthy Male    0          0          0
## AD Male            0          0          0
## Flu Immunized Only Day 1 0          0          0
##          MI Healthy Males MI Males Overweight Female
## AD Female          0          0          0
## AD Healthy Female  0          0          0
## AD Healthy Male    0          0          0
## AD Male            0          0          0
## Flu Immunized Only Day 1 0          0          0
##          Overweight Female EGCG Treated
## AD Female          0
## AD Healthy Female  0
## AD Healthy Male    0
## AD Male            0
## Flu Immunized Only Day 1 0
##          Overweight Female EGCG+fishOil+VitC Tetanis
Immunized
## AD Female          0
0
## AD Healthy Female  0
0
## AD Healthy Male    0
0
## AD Male            0
0
## Flu Immunized Only Day 1 0
0
##          Error      Rate
## AD Female          1.0000 = 1 / 1
## AD Healthy Female  1.0000 = 3 / 3
## AD Healthy Male    1.0000 = 1 / 1
## AD Male            0.5000 = 2 / 4
## Flu Immunized Only Day 1 1.0000 = 1 / 1
##
## ---
##          AD Female AD Healthy Female AD Healthy
Male
## MI Males          0          0
0
## Overweight Female  0          0
0

```

## Overweight Female EGCG Treated	0	0
0		
## Overweight Female EGCG+fishOil+VitC	0	0
0		
## Tetanis Immunized	0	0
0		
## Totals	3	1
3		
##	AD Male Flu Immunized Only Day 1	
## MI Males	0	0
## Overweight Female	0	0
## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	2	0
##	Flu Immunized Only Day 21	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		0
##	Flu Immunized Only Day 3	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		2
##	Flu Immunized Only Day 7	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		2
##	Flu Immunized Plus Antibiotics Day 1	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		1
##	Flu Immunized Plus Antibiotics Day 21	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		0

##	Flu Immunized Plus Antibiotics Day 3		
## MI Males			0
## Overweight Female			0
## Overweight Female EGCG Treated			0
## Overweight Female EGCG+fishOil+VitC			0
## Tetanis Immunized			0
## Totals			1
##	Flu Immunized Plus Antibiotics Day 7		
## MI Males			0
## Overweight Female			0
## Overweight Female EGCG Treated			0
## Overweight Female EGCG+fishOil+VitC			0
## Tetanis Immunized			0
## Totals			1
##	Flu non immunized healthy Hemo Female		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		0	3
##	Hemo Healthy Female Hemo Healthy Male		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		0	0
##	Hemo Male MI Healthy Males MI Males		
## MI Males		0	1
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		2	1
##	Overweight Female		
## MI Males		0	
## Overweight Female		1	
## Overweight Female EGCG Treated		1	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		2	
##	Overweight Female EGCG Treated		
## MI Males		0	
## Overweight Female		1	
## Overweight Female EGCG Treated		1	
## Overweight Female EGCG+fishOil+VitC		1	
## Tetanis Immunized		0	
## Totals		3	
##	Overweight Female EGCG+fishOil+VitC		

```
## MI Males 0
## Overweight Female 2
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized 0
## Totals 2
##
## Tetanis Immunized Error Rate
## MI Males 0 0.0000 = 0 / 1
## Overweight Female 0 0.7500 = 3 / 4
## Overweight Female EGCG Treated 0 0.5000 = 1 / 2
## Overweight Female EGCG+fishOil+VitC 0 1.0000 = 1 / 1
## Tetanis Immunized 1 0.0000 = 0 / 1
## Totals 1 0.6774 = 21 / 31
```

```
m3 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
             x = colnames(data$Train)[2:251],
             y = 'Class_Type',
             family='multinomial',
             solver='L_BFGS',
             lambda = 0,
             keep_cross_validation_predictions = TRUE)
```

```
## |
|                                     | 0%
|
|=====| 100%
```

```
h2o.confusionMatrix(m3, valid=TRUE)
```

```
## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
```

```
## AD Female AD Healthy Female AD Healthy Male AD
```

```
Male
```

```
## AD Female 0 1 0
```

```
0
```

```
## AD Healthy Female 0 0 3
```

```
0
```

```
## AD Healthy Male 1 0 0
```

```
0
```

```
## AD Male 2 0 0
```

```
2
```

```
## Flu Immunized Only Day 1 0 0 0
```

```
0
```

```
## Flu Immunized Only Day 1 Flu Immunized Only Day
```

```
21
```

```
## AD Female 0
```

```
0
```

```
## AD Healthy Female 0
```

```
0
```

```
## AD Healthy Male 0
```

```
0
```

```
## AD Male 0
```

0				
## Flu Immunized Only Day 1	0			
0				
##	Flu Immunized Only Day 3	Flu Immunized Only Day 7		
## AD Female	0	0		
## AD Healthy Female	0	0		
## AD Healthy Male	0	0		
## AD Male	0	0		
## Flu Immunized Only Day 1	1	0		
##	Flu Immunized Plus Antibiotics Day 1			
## AD Female	0			
## AD Healthy Female	0			
## AD Healthy Male	0			
## AD Male	0			
## Flu Immunized Only Day 1	0			
##	Flu Immunized Plus Antibiotics Day 21			
## AD Female	0			
## AD Healthy Female	0			
## AD Healthy Male	0			
## AD Male	0			
## Flu Immunized Only Day 1	0			
##	Flu Immunized Plus Antibiotics Day 3			
## AD Female	0			
## AD Healthy Female	0			
## AD Healthy Male	0			
## AD Male	0			
## Flu Immunized Only Day 1	0			
##	Flu Immunized Plus Antibiotics Day 7			
## AD Female	0			
## AD Healthy Female	0			
## AD Healthy Male	0			
## AD Male	0			
## Flu Immunized Only Day 1	0			
##	Flu non immunized healthy Hemo Female			
## AD Female	0	0		
## AD Healthy Female	0	0		
## AD Healthy Male	0	0		
## AD Male	0	0		
## Flu Immunized Only Day 1	0	0		
##	Hemo Healthy Female	Hemo Healthy Male	Hemo Male	
## AD Female	0	0	0	
## AD Healthy Female	0	0	0	
## AD Healthy Male	0	0	0	
## AD Male	0	0	0	
## Flu Immunized Only Day 1	0	0	0	
##	MI Healthy Males	MI Males	Overweight Female	
## AD Female	0	0	0	
## AD Healthy Female	0	0	0	
## AD Healthy Male	0	0	0	
## AD Male	0	0	0	

```

## Flu Immunized Only Day 1      0      0      0
##                               Overweight Female EGCG Treated
## AD Female                      0
## AD Healthy Female              0
## AD Healthy Male               0
## AD Male                      0
## Flu Immunized Only Day 1      0
##                               Overweight Female EGCG+fishOil+VitC Tetanis
Immunized
## AD Female                      0
0
## AD Healthy Female              0
0
## AD Healthy Male               0
0
## AD Male                      0
0
## Flu Immunized Only Day 1      0
0
##                               Error      Rate
## AD Female                    1.0000 = 1 / 1
## AD Healthy Female            1.0000 = 3 / 3
## AD Healthy Male              1.0000 = 1 / 1
## AD Male                      0.5000 = 2 / 4
## Flu Immunized Only Day 1    1.0000 = 1 / 1
##
## ---
##                               AD Female AD Healthy Female AD Healthy
Male
## MI Males                      0                      0
0
## Overweight Female            0                      0
0
## Overweight Female EGCG Treated 0                      0
0
## Overweight Female EGCG+fishOil+VitC 0                      0
0
## Tetanis Immunized            0                      0
0
## Totals                       3                      1
3
##                               AD Male Flu Immunized Only Day 1
## MI Males                      0                      0
## Overweight Female            0                      0
## Overweight Female EGCG Treated 0                      0
## Overweight Female EGCG+fishOil+VitC 0                      0
## Tetanis Immunized            0                      0
## Totals                       2                      0
##                               Flu Immunized Only Day 21
## MI Males                      0

```


## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	0
## Flu Immunized Only Day 3	0
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	2
## Flu Immunized Only Day 7	0
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	2
## Flu Immunized Plus Antibiotics Day 1	0
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	1
## Flu Immunized Plus Antibiotics Day 21	0
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	0
## Flu Immunized Plus Antibiotics Day 3	0
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	1
## Flu Immunized Plus Antibiotics Day 7	0
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	1
## Flu non immunized healthy Hemo Female	0
## MI Males	0
## Overweight Female	0

## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	0	3
##	Hemo Healthy Female	Hemo Healthy Male
## MI Males	0	0
## Overweight Female	0	0
## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	0	0
##	Hemo Male MI Healthy Males	MI Males
## MI Males	0	1
## Overweight Female	0	0
## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	2	1
##	Overweight Female	
## MI Males	0	
## Overweight Female	1	
## Overweight Female EGCG Treated	1	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
##	Overweight Female EGCG Treated	
## MI Males	0	
## Overweight Female	1	
## Overweight Female EGCG Treated	1	
## Overweight Female EGCG+fishOil+VitC	1	
## Tetanis Immunized	0	
## Totals	3	
##	Overweight Female EGCG+fishOil+VitC	
## MI Males	0	
## Overweight Female	2	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
##	Tetanis Immunized	Error Rate
## MI Males	0	0.0000 = 0 / 1
## Overweight Female	0	0.7500 = 3 / 4
## Overweight Female EGCG Treated	0	0.5000 = 1 / 2
## Overweight Female EGCG+fishOil+VitC	0	1.0000 = 1 / 1
## Tetanis Immunized	1	0.0000 = 0 / 1
## Totals	1	0.6774 = 21 / 31

Binary ML ready data set

Lets go back to the ML_ready_250 data set and limit the classes to two, so that we can use binomial classification on Healthy or Disease. For this purpose the overweight females will be diseased because many health problems associated with being overweight.

```
ML_ready_250 <- read.csv('ML_ready_250.csv', sep=',', header=TRUE,
na.strings=c('', ' '))
ctrl <- grep('[hH]healthy', ML_ready_250$Class_Type)
healthy <- ML_ready_250[ctrl,]
disease <- ML_ready_250[-ctrl,]
disease$Class_Type <- 'Not Healthy or Treatment Control'
healthy$Class_Type <- 'Healthy Control'

ML_ready_250_binomial_class <- rbind(disease, healthy)
write.csv(ML_ready_250_binomial_class, 'ML_ready_250_binomial.csv',
row.names=FALSE)
```

Now, lets use H2O for binary classification and see results produced for the confusion matrix.

```
h2o.init(nthreads=-1, max_mem_size="2G")

## Connection successful!
##
## R is connected to the H2O cluster:
##   H2O cluster uptime:      12 minutes 32 seconds
##   H2O cluster timezone:    America/Los_Angeles
##   H2O data parsing timezone: UTC
##   H2O cluster version:     3.28.0.2
##   H2O cluster version age:  11 days
##   H2O cluster name:        H2O_started_from_R_m_wkq150
##   H2O cluster total nodes: 1
##   H2O cluster total memory: 2.00 GB
##   H2O cluster total cores: 2
##   H2O cluster allowed cores: 2
##   H2O cluster healthy:     TRUE
##   H2O Connection ip:       localhost
##   H2O Connection port:     54321
##   H2O Connection proxy:    NA
##   H2O Internal Security:   FALSE
##   H2O API Extensions:      Amazon S3, Algos, AutoML, Core V3,
TargetEncoder, Core V4
##   R Version:                R version 3.6.2 (2019-12-12)

h2o.removeAll() ## clean slate - just in case the cluster was already running

D = h2o.importFile(path = normalizePath("ML_ready_250_binomial.csv"))

## |
|
```

0%

```

|
|=====| 100%

data = h2o.splitFrame(D,ratios=c(.7,.15),
                      destination_frames = c("train","test","valid"))
names(data) <- c('Train','Test','Valid')

m4 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
             x = colnames(data$Train)[2:251],
             y = 'Class_Type',
             family='binomial',
             solver='L_BFGS',
             lambda = 0)

## |
|                                     | 0%
|
|==                                 | 3%
|
|=====| 100%

h2o.confusionMatrix(m4, valid=TRUE)

## Confusion Matrix (vertical: actual; across: predicted) for max f1 @
threshold = 3.82090888847217e-07:
##                                     Healthy Control
## Healthy Control                      6
## Not Healthy or Treatment Control      2
## Totals                              8
##                                     Not Healthy or Treatment Control   Error
## Healthy Control                      1 0.142857
## Not Healthy or Treatment Control     23 0.080000
## Totals                              24 0.093750
##                                     Rate
## Healthy Control                      =1/7
## Not Healthy or Treatment Control     =2/25
## Totals                              =3/32

```

With binary classification the error rate dropped from 80-90% on 23 classes to 29-30% on 2 classes.

Lets use some of the other machine classifiers on this data of binary values and the data of 23 classes.

```

library(caret)
library(randomForest)
library(MASS)
library(gbm)

```

```

set.seed(189678345)

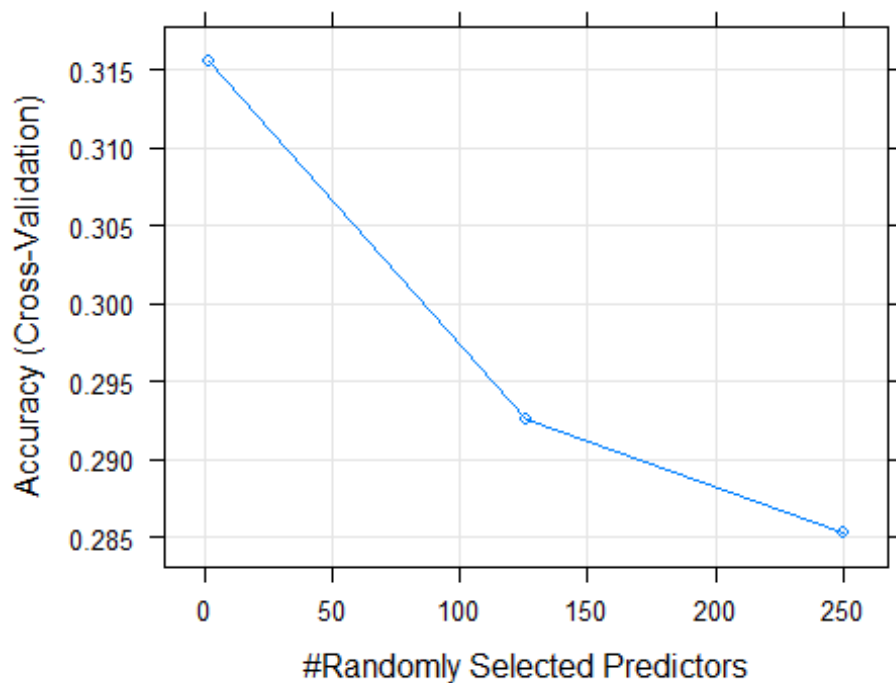
inTrain <- createDataPartition(y=ML_ready_250$Class_Type, p=0.7, list=FALSE)

trainingSet <- ML_ready_250[inTrain,]
testingSet <- ML_ready_250[-inTrain,]

Random Forest, cross-validation (cv) = 5

rfMod <- train(Class_Type~., method='rf', data=(trainingSet),
               trControl=trainControl(method='cv'), number=5)
plot(rfMod)

```

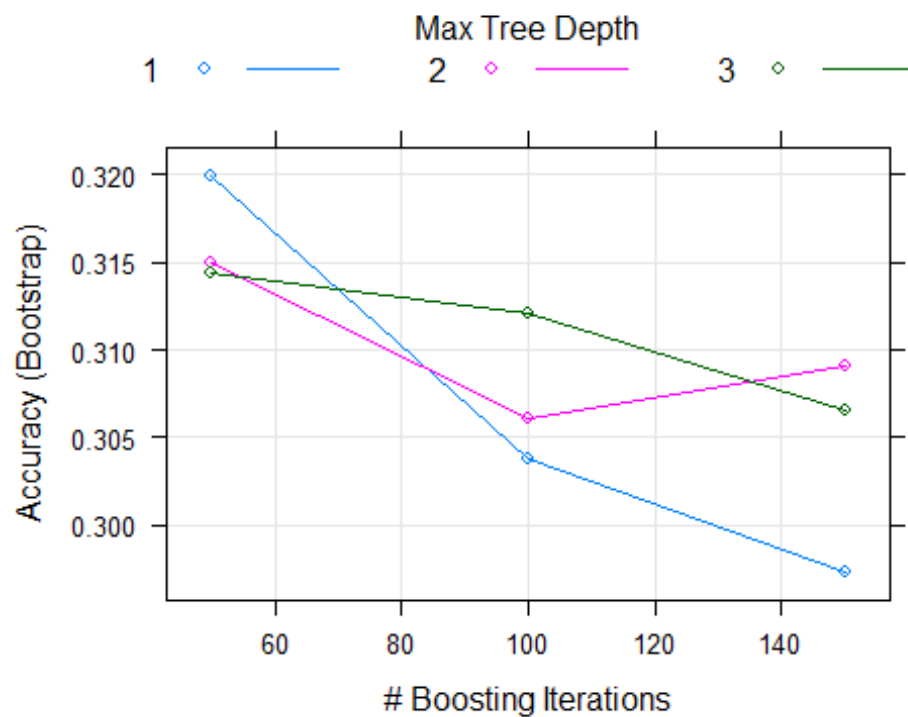


Generalized Boosted Model

```

gbmMod <- train(Class_Type~., method='gbm', data=trainingSet, verbose=FALSE )
plot(gbmMod)

```



Latent dirichlet allocation model

```
ldaMod <- train(Class_Type~., method='lda', data=trainingSet)
```

Run predictions on the testing set

```
predRF <- predict(rfMod, testingSet)
predGbm <- predict(gbmMod, testingSet)
predlda <- predict(ldaMod, testingSet)

predDF <- data.frame(predRF, predGbm, predlda, type=testingSet$Class_Type)
predDF
```

	predRF	predGbm
## 1	AD Healthy Female	AD Healthy Male
## 2	AD Male	AD Male
## 3	AD Healthy Female	AD Healthy Male
## 4	AD Healthy Male	AD Healthy Male
## 5	AD Healthy Male	AD Healthy Male
## 6	AD Healthy Female	AD Healthy Female
## 7	AD Healthy Female	AD Healthy Female
## 8	AD Healthy Female	AD Healthy Male
## 9	AD Healthy Female	AD Healthy Female
## 10	AD Female	AD Female
## 11	AD Healthy Male	AD Male
## 12	AD Healthy Male	AD Healthy Male
## 13	AD Male	AD Male

## 14	AD Female	AD Male
## 15	AD Male	AD Female
## 16	AD Male	AD Female
## 17	AD Male	AD Male
## 18	AD Female	AD Female
## 19	AD Healthy Female	AD Healthy Male
## 20	AD Male	AD Male
## 21	AD Female	AD Female
## 22	Hemo Male	Hemo Healthy Female
## 23	Hemo Male	Hemo Male
## 24	Hemo Male	Hemo Male
## 25	Hemo Male	Hemo Male
## 26	Hemo Male	Hemo Male
## 27	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 28	Overweight Female	Overweight Female
## 29	Overweight Female	Overweight Female EGCG+fishOil+VitC
## 30	Overweight Female	Overweight Female EGCG+fishOil+VitC
## 31	Overweight Female	Overweight Female
## 32	Overweight Female	Overweight Female EGCG Treated
## 33	Overweight Female	Overweight Female
## 34	Overweight Female	Overweight Female
## 35	Flu Immunized Only Day 1	Flu Immunized Only Day 3
## 36	MI Males	MI Males
## 37	MI Males	MI Males
## 38	Tetanis Immunized	Tetanis Immunized
##	predlda	type
## 1	AD Healthy Female	AD Healthy Male
## 2	AD Female	AD Healthy Male
## 3	AD Healthy Male	AD Healthy Male
## 4	AD Healthy Male	AD Healthy Male
## 5	AD Healthy Female	AD Healthy Female
## 6	AD Female	AD Healthy Female
## 7	AD Healthy Female	AD Healthy Female
## 8	AD Healthy Female	AD Healthy Female
## 9	AD Male	AD Male
## 10	AD Healthy Male	AD Male
## 11	AD Female	AD Male
## 12	AD Healthy Male	AD Male
## 13	AD Male	AD Male
## 14	AD Female	AD Male
## 15	AD Male	AD Female
## 16	AD Male	AD Female
## 17	AD Healthy Male	AD Female
## 18	AD Female	AD Female
## 19	AD Male	AD Female
## 20	AD Male	AD Female
## 21	AD Female	AD Female
## 22	Hemo Male	Hemo Healthy Male
## 23	Hemo Male	Hemo Male
## 24	Hemo Male	Hemo Male

## 25	Hemo Male	Hemo Male
## 26	Hemo Male	Hemo Female
## 27	Overweight Female EGCG Treated	Overweight Female
## 28	Overweight Female	Overweight Female
## 29	Overweight Female	Overweight Female
## 30	Overweight Female EGCG Treated	Overweight Female
## 31	Overweight Female	Overweight Female EGCG Treated
## 32	Overweight Female	Overweight Female EGCG Treated
## 33	Overweight Female	Overweight Female EGCG+fishOil+VitC
## 34	Overweight Female EGCG Treated	Overweight Female EGCG+fishOil+VitC
## 35	Flu Immunized Only Day 7	Flu non immunized healthy
## 36	MI Males	MI Healthy Males
## 37	MI Males	MI Males
## 38	Tetanis Immunized	Tetanis Immunized

Combined Models, similar to voting in ensemble methods of best algorithm score.

```
# CombinedModels <- train(type~., method='gam', data=predDF)
# CombinedPredictions <- predict(CombinedModels, predDF)
# CombinedPredictions
```

Some stats follow.

```
# sum <- sum(CombinedPredictions==testingSet$TYPE)
# length <- length(testingSet$TYPE)
# accuracy_CP1 <- sum/length
```

```
sum <- sum(predRF==testingSet$Class_Type)
length <- length(testingSet$Class_Type)
accuracy_rfMod <- (sum/length)
```

```
sum <- sum(predGbm==testingSet$Class_Type)
accuracy_gbmMod <- sum/length
```

```
sum <- sum(predlda==testingSet$Class_Type)
accuracy_ldaMod <- sum/length
```

```
#accuracy_CP1
accuracy_rfMod
```

```
## [1] 0.3947368
```

```
accuracy_gbmMod
```

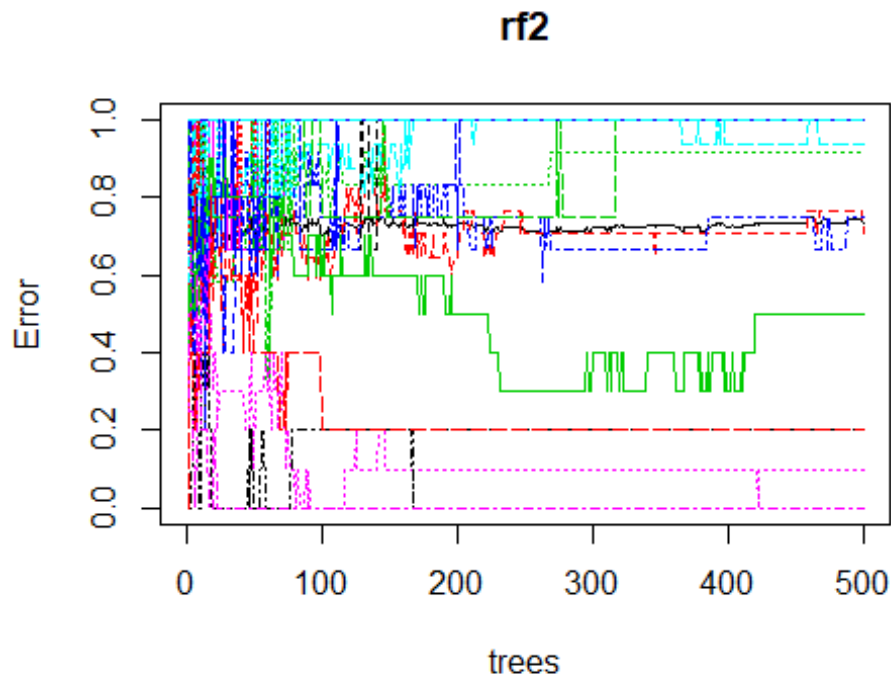
```
## [1] 0.5
```

```
accuracy_ldaMod
```

```
## [1] 0.4210526
```


The Random Forest algorithm, with differences by default than the random forest model in the caret package used previously.

```
rf2 <- randomForest(Class_Type~., data=trainingSet, method='class')
plot(rf2)
```



```
predRF2 <- predict(rf2, testingSet, type='class')
```

```
sum <- sum(predRF2==testingSet$Class_Type)
accuracy_RF2 <- sum/length
```

```
confusionMatrix(predRF2, testingSet$Class_Type)
```

```
## Confusion Matrix and Statistics
```

```
##
```

```
##
```

```
## Prediction
```

```
Reference
```

```
AD Female AD Healthy Female
```

```
## AD Female 3 0
```

```
## AD Healthy Female 0 3
```

```
## AD Healthy Male 1 1
```

```
## AD Male 3 0
```

```
## Flu Immunized Only Day 1 0 0
```

```
## Flu Immunized Only Day 21 0 0
```

```
## Flu Immunized Only Day 3 0 0
```

```
## Flu Immunized Only Day 7 0 0
```

```
## Flu Immunized Plus Antibiotics Day 1 0 0
```

##	Flu Immunized Plus Antibiotics Day 21	0	0
##	Flu Immunized Plus Antibiotics Day 3	0	0
##	Flu Immunized Plus Antibiotics Day 7	0	0
##	Flu non immunized healthy	0	0
##	Hemo Female	0	0
##	Hemo Healthy Female	0	0
##	Hemo Healthy Male	0	0
##	Hemo Male	0	0
##	MI Healthy Males	0	0
##	MI Males	0	0
##	Overweight Female	0	0
##	Overweight Female EGCG Treated	0	0
##	Overweight Female EGCG+fishOil+VitC	0	0
##	Tetanis Immunized	0	0

##		Reference	
##	Prediction	AD Healthy Male	AD Male
##	AD Female	0	2
##	AD Healthy Female	2	0
##	AD Healthy Male	1	4
##	AD Male	1	0
##	Flu Immunized Only Day 1	0	0
##	Flu Immunized Only Day 21	0	0
##	Flu Immunized Only Day 3	0	0
##	Flu Immunized Only Day 7	0	0
##	Flu Immunized Plus Antibiotics Day 1	0	0
##	Flu Immunized Plus Antibiotics Day 21	0	0
##	Flu Immunized Plus Antibiotics Day 3	0	0
##	Flu Immunized Plus Antibiotics Day 7	0	0
##	Flu non immunized healthy	0	0
##	Hemo Female	0	0
##	Hemo Healthy Female	0	0
##	Hemo Healthy Male	0	0
##	Hemo Male	0	0
##	MI Healthy Males	0	0
##	MI Males	0	0
##	Overweight Female	0	0
##	Overweight Female EGCG Treated	0	0
##	Overweight Female EGCG+fishOil+VitC	0	0
##	Tetanis Immunized	0	0

##		Reference
##	Prediction	Flu Immunized Only Day 1
##	AD Female	0
##	AD Healthy Female	0
##	AD Healthy Male	0
##	AD Male	0
##	Flu Immunized Only Day 1	0
##	Flu Immunized Only Day 21	0
##	Flu Immunized Only Day 3	0
##	Flu Immunized Only Day 7	0
##	Flu Immunized Plus Antibiotics Day 1	0

##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	Hemo Healthy Male	0
##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	0
##	Overweight Female EGCG Treated	0
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
	Reference	
##	Prediction	Flu Immunized Only Day 21
##	AD Female	0
##	AD Healthy Female	0
##	AD Healthy Male	0
##	AD Male	0
##	Flu Immunized Only Day 1	0
##	Flu Immunized Only Day 21	0
##	Flu Immunized Only Day 3	0
##	Flu Immunized Only Day 7	0
##	Flu Immunized Plus Antibiotics Day 1	0
##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	Hemo Healthy Male	0
##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	0
##	Overweight Female EGCG Treated	0
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
	Reference	
##	Prediction	Flu Immunized Only Day 3
##	AD Female	0
##	AD Healthy Female	0
##	AD Healthy Male	0
##	AD Male	0
##	Flu Immunized Only Day 1	0
##	Flu Immunized Only Day 21	0
##	Flu Immunized Only Day 3	0
##	Flu Immunized Only Day 7	0
##	Flu Immunized Plus Antibiotics Day 1	0

##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	Hemo Healthy Male	0
##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	0
##	Overweight Female EGCG Treated	0
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
	Reference	
##	Prediction	Flu Immunized Only Day 7
##	AD Female	0
##	AD Healthy Female	0
##	AD Healthy Male	0
##	AD Male	0
##	Flu Immunized Only Day 1	0
##	Flu Immunized Only Day 21	0
##	Flu Immunized Only Day 3	0
##	Flu Immunized Only Day 7	0
##	Flu Immunized Plus Antibiotics Day 1	0
##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	Hemo Healthy Male	0
##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	0
##	Overweight Female EGCG Treated	0
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
	Reference	
##	Prediction	Flu Immunized Plus Antibiotics Day
1		
##	AD Female	
0		
##	AD Healthy Female	
0		
##	AD Healthy Male	
0		
##	AD Male	
0		

```

## Flu Immunized Only Day 1
0
## Flu Immunized Only Day 21
0
## Flu Immunized Only Day 3
0
## Flu Immunized Only Day 7
0
## Flu Immunized Plus Antibiotics Day 1
0
## Flu Immunized Plus Antibiotics Day 21
0
## Flu Immunized Plus Antibiotics Day 3
0
## Flu Immunized Plus Antibiotics Day 7
0
## Flu non immunized healthy
0
## Hemo Female
0
## Hemo Healthy Female
0
## Hemo Healthy Male
0
## Hemo Male
0
## MI Healthy Males
0
## MI Males
0
## Overweight Female
0
## Overweight Female EGCG Treated
0
## Overweight Female EGCG+fishOil+VitC
0
## Tetanis Immunized
0
##
## Prediction
21
## AD Female
0
## AD Healthy Female
0
## AD Healthy Male
0
## AD Male
0
## Flu Immunized Only Day 1

```

Reference
Flu Immunized Plus Antibiotics Day

```

0
## Flu Immunized Only Day 21
0
## Flu Immunized Only Day 3
0
## Flu Immunized Only Day 7
0
## Flu Immunized Plus Antibiotics Day 1
0
## Flu Immunized Plus Antibiotics Day 21
0
## Flu Immunized Plus Antibiotics Day 3
0
## Flu Immunized Plus Antibiotics Day 7
0
## Flu non immunized healthy
0
## Hemo Female
0
## Hemo Healthy Female
0
## Hemo Healthy Male
0
## Hemo Male
0
## MI Healthy Males
0
## MI Males
0
## Overweight Female
0
## Overweight Female EGCG Treated
0
## Overweight Female EGCG+fishOil+VitC
0
## Tetanis Immunized
0
##
## Prediction
3
## AD Female
0
## AD Healthy Female
0
## AD Healthy Male
0
## AD Male
0
## Flu Immunized Only Day 1
0

```

Reference
Flu Immunized Plus Antibiotics Day

```

## Flu Immunized Only Day 21
0
## Flu Immunized Only Day 3
0
## Flu Immunized Only Day 7
0
## Flu Immunized Plus Antibiotics Day 1
0
## Flu Immunized Plus Antibiotics Day 21
0
## Flu Immunized Plus Antibiotics Day 3
0
## Flu Immunized Plus Antibiotics Day 7
0
## Flu non immunized healthy
0
## Hemo Female
0
## Hemo Healthy Female
0
## Hemo Healthy Male
0
## Hemo Male
0
## MI Healthy Males
0
## MI Males
0
## Overweight Female
0
## Overweight Female EGCG Treated
0
## Overweight Female EGCG+fishOil+VitC
0
## Tetanis Immunized
0
##
## Prediction
7
## AD Female
0
## AD Healthy Female
0
## AD Healthy Male
0
## AD Male
0
## Flu Immunized Only Day 1
0
## Flu Immunized Only Day 21
0

```

Reference
Flu Immunized Plus Antibiotics Day

0	
##	Flu Immunized Only Day 3
0	
##	Flu Immunized Only Day 7
0	
##	Flu Immunized Plus Antibiotics Day 1
0	
##	Flu Immunized Plus Antibiotics Day 21
0	
##	Flu Immunized Plus Antibiotics Day 3
0	
##	Flu Immunized Plus Antibiotics Day 7
0	
##	Flu non immunized healthy
0	
##	Hemo Female
0	
##	Hemo Healthy Female
0	
##	Hemo Healthy Male
0	
##	Hemo Male
0	
##	MI Healthy Males
0	
##	MI Males
0	
##	Overweight Female
0	
##	Overweight Female EGCG Treated
0	
##	Overweight Female EGCG+fishOil+VitC
0	
##	Tetanis Immunized
0	
##	
##	Prediction
Female	Reference
	Flu non immunized healthy Hemo
##	AD Female
0	0
##	AD Healthy Female
0	0
##	AD Healthy Male
0	0
##	AD Male
0	0
##	Flu Immunized Only Day 1
0	0
##	Flu Immunized Only Day 21
0	0

##	Flu Immunized Only Day 3	0
0		
##	Flu Immunized Only Day 7	1
0		
##	Flu Immunized Plus Antibiotics Day 1	0
0		
##	Flu Immunized Plus Antibiotics Day 21	0
0		
##	Flu Immunized Plus Antibiotics Day 3	0
0		
##	Flu Immunized Plus Antibiotics Day 7	0
0		
##	Flu non immunized healthy	0
0		
##	Hemo Female	0
0		
##	Hemo Healthy Female	0
0		
##	Hemo Healthy Male	0
0		
##	Hemo Male	0
1		
##	MI Healthy Males	0
0		
##	MI Males	0
0		
##	Overweight Female	0
0		
##	Overweight Female EGCG Treated	0
0		
##	Overweight Female EGCG+fishOil+VitC	0
0		
##	Tetanis Immunized	0
0		
##		
##	Reference	
##	Prediction	Hemo Healthy Female Hemo Healthy Male
##	AD Female	0
0		
##	AD Healthy Female	0
0		
##	AD Healthy Male	0
0		
##	AD Male	0
0		
##	Flu Immunized Only Day 1	0
0		
##	Flu Immunized Only Day 21	0
0		
##	Flu Immunized Only Day 3	0

0		
##	Flu Immunized Only Day 7	0
0		
##	Flu Immunized Plus Antibiotics Day 1	0
0		
##	Flu Immunized Plus Antibiotics Day 21	0
0		
##	Flu Immunized Plus Antibiotics Day 3	0
0		
##	Flu Immunized Plus Antibiotics Day 7	0
0		
##	Flu non immunized healthy	0
0		
##	Hemo Female	0
0		
##	Hemo Healthy Female	0
0		
##	Hemo Healthy Male	0
0		
##	Hemo Male	0
1		
##	MI Healthy Males	0
0		
##	MI Males	0
0		
##	Overweight Female	0
0		
##	Overweight Female EGCG Treated	0
0		
##	Overweight Female EGCG+fishOil+VitC	0
0		
##	Tetanis Immunized	0
0		
##		
##	Prediction	Reference
Males		Hemo Male MI Healthy Males MI
##	AD Female	0 0
0		
##	AD Healthy Female	0 0
0		
##	AD Healthy Male	0 0
0		
##	AD Male	0 0
0		
##	Flu Immunized Only Day 1	0 0
0		
##	Flu Immunized Only Day 21	0 0
0		
##	Flu Immunized Only Day 3	0 0
0		

##	Flu Immunized Only Day 7	0	0
0			
##	Flu Immunized Plus Antibiotics Day 1	0	0
0			
##	Flu Immunized Plus Antibiotics Day 21	0	0
0			
##	Flu Immunized Plus Antibiotics Day 3	0	0
0			
##	Flu Immunized Plus Antibiotics Day 7	0	0
0			
##	Flu non immunized healthy	0	0
0			
##	Hemo Female	0	0
0			
##	Hemo Healthy Female	0	0
0			
##	Hemo Healthy Male	0	0
0			
##	Hemo Male	3	0
0			
##	MI Healthy Males	0	0
0			
##	MI Males	0	1
1			
##	Overweight Female	0	0
0			
##	Overweight Female EGCG Treated	0	0
0			
##	Overweight Female EGCG+fishOil+VitC	0	0
0			
##	Tetanis Immunized	0	0
0			
##			
##	Prediction	Reference	
		Overweight Female	
##	AD Female		0
##	AD Healthy Female		0
##	AD Healthy Male		0
##	AD Male		0
##	Flu Immunized Only Day 1		0
##	Flu Immunized Only Day 21		0
##	Flu Immunized Only Day 3		0
##	Flu Immunized Only Day 7		0
##	Flu Immunized Plus Antibiotics Day 1		0
##	Flu Immunized Plus Antibiotics Day 21		0
##	Flu Immunized Plus Antibiotics Day 3		0
##	Flu Immunized Plus Antibiotics Day 7		0
##	Flu non immunized healthy		0
##	Hemo Female		0
##	Hemo Healthy Female		0
##	Hemo Healthy Male		0

##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	3
##	Overweight Female EGCG Treated	1
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
##	Prediction	Reference
##	AD Female	Overweight Female EGCG Treated
##	AD Healthy Female	0
##	AD Healthy Male	0
##	AD Male	0
##	Flu Immunized Only Day 1	0
##	Flu Immunized Only Day 21	0
##	Flu Immunized Only Day 3	0
##	Flu Immunized Only Day 7	0
##	Flu Immunized Plus Antibiotics Day 1	0
##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	Hemo Healthy Male	0
##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	2
##	Overweight Female EGCG Treated	0
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
##	Prediction	Reference
##	EGCG+fishOil+VitC	Overweight Female
##	AD Female	
##	AD Healthy Female	
##	AD Healthy Male	
##	AD Male	
##	Flu Immunized Only Day 1	
##	Flu Immunized Only Day 21	
##	Flu Immunized Only Day 3	
##	Flu Immunized Only Day 7	

##	Flu Immunized Plus Antibiotics Day 1	0
##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	Hemo Healthy Male	0
##	Hemo Male	0
##	MI Healthy Males	0
##	MI Males	0
##	Overweight Female	2
##	Overweight Female EGCG Treated	0
##	Overweight Female EGCG+fishOil+VitC	0
##	Tetanis Immunized	0
##		
##	Prediction	Reference
##	AD Female	Tetanis Immunized
##	AD Healthy Female	0
##	AD Healthy Male	0
##	AD Male	0
##	Flu Immunized Only Day 1	0
##	Flu Immunized Only Day 21	0
##	Flu Immunized Only Day 3	0
##	Flu Immunized Only Day 7	0
##	Flu Immunized Plus Antibiotics Day 1	0
##	Flu Immunized Plus Antibiotics Day 21	0
##	Flu Immunized Plus Antibiotics Day 3	0
##	Flu Immunized Plus Antibiotics Day 7	0
##	Flu non immunized healthy	0
##	Hemo Female	0
##	Hemo Healthy Female	0
##	HemoHealthy Male	0
##	Hemo Male	0

```

## MI Healthy Males 0
## MI Males 0
## Overweight Female 0
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized 1
##
## Overall Statistics
##
## Accuracy : 0.3947
## 95% CI : (0.2404, 0.5661)
## No Information Rate : 0.1842
## P-Value [Acc > NIR] : 0.001984
##
## Kappa : 0.322
##
## McNemar's Test P-Value : NA
##
## Statistics by Class:
##
## Class: AD Female Class: AD Healthy Female
## Sensitivity 0.42857 0.75000
## Specificity 0.93548 0.94118
## Pos Pred Value 0.60000 0.60000
## Neg Pred Value 0.87879 0.96970
## Prevalence 0.18421 0.10526
## Detection Rate 0.07895 0.07895
## Detection Prevalence 0.13158 0.13158
## Balanced Accuracy 0.68203 0.84559
##
## Class: AD Healthy Male Class: AD Male
## Sensitivity 0.25000 0.0000
## Specificity 0.82353 0.8750
## Pos Pred Value 0.14286 0.0000
## Neg Pred Value 0.90323 0.8235
## Prevalence 0.10526 0.1579
## Detection Rate 0.02632 0.0000
## Detection Prevalence 0.18421 0.1053
## Balanced Accuracy 0.53676 0.4375
##
## Class: Flu Immunized Only Day 1
## Sensitivity NA
## Specificity 1
## Pos Pred Value NA
## Neg Pred Value NA
## Prevalence 0
## Detection Rate 0
## Detection Prevalence 0
## Balanced Accuracy NA
##
## Class: Flu Immunized Only Day 21
## Sensitivity NA
## Specificity 1

```

```

## Pos Pred Value          NA
## Neg Pred Value          NA
## Prevalence               0
## Detection Rate           0
## Detection Prevalence     0
## Balanced Accuracy        NA
##          Class: Flu Immunized Only Day 3
## Sensitivity              NA
## Specificity              1
## Pos Pred Value          NA
## Neg Pred Value          NA
## Prevalence               0
## Detection Rate           0
## Detection Prevalence     0
## Balanced Accuracy        NA
##          Class: Flu Immunized Only Day 7
## Sensitivity              NA
## Specificity              0.97368
## Pos Pred Value          NA
## Neg Pred Value          NA
## Prevalence               0.00000
## Detection Rate           0.00000
## Detection Prevalence     0.02632
## Balanced Accuracy        NA
##          Class: Flu Immunized Plus Antibiotics Day 1
## Sensitivity              NA
## Specificity              1
## Pos Pred Value          NA
## Neg Pred Value          NA
## Prevalence               0
## Detection Rate           0
## Detection Prevalence     0
## Balanced Accuracy        NA
##          Class: Flu Immunized Plus Antibiotics Day 21
## Sensitivity              NA
## Specificity              1
## Pos Pred Value          NA
## Neg Pred Value          NA
## Prevalence               0
## Detection Rate           0
## Detection Prevalence     0
## Balanced Accuracy        NA
##          Class: Flu Immunized Plus Antibiotics Day 3
## Sensitivity              NA
## Specificity              1
## Pos Pred Value          NA
## Neg Pred Value          NA
## Prevalence               0
## Detection Rate           0
## Detection Prevalence     0

```

```

## Balanced Accuracy NA
## Class: Flu Immunized Plus Antibiotics Day 7
## Sensitivity NA
## Specificity 1
## Pos Pred Value NA
## Neg Pred Value NA
## Prevalence 0
## Detection Rate 0
## Detection Prevalence 0
## Balanced Accuracy NA
## Class: Flu non immunized healthy Class: Hemo Female
## Sensitivity 0.00000 0.00000
## Specificity 1.00000 1.00000
## Pos Pred Value NaN NaN
## Neg Pred Value 0.97368 0.97368
## Prevalence 0.02632 0.02632
## Detection Rate 0.00000 0.00000
## Detection Prevalence 0.00000 0.00000
## Balanced Accuracy 0.50000 0.50000
## Class: Hemo Healthy Female Class: Hemo Healthy Male
## Sensitivity NA 0.00000
## Specificity 1 1.00000
## Pos Pred Value NA NaN
## Neg Pred Value NA 0.97368
## Prevalence 0 0.02632
## Detection Rate 0 0.00000
## Detection Prevalence 0 0.00000
## Balanced Accuracy NA 0.50000
## Class: Hemo Male Class: MI Healthy Males Class: MI
Males
## Sensitivity 1.00000 0.00000
1.00000
## Specificity 0.94286 1.00000
0.97297
## Pos Pred Value 0.60000 NaN
0.50000
## Neg Pred Value 1.00000 0.97368
1.00000
## Prevalence 0.07895 0.02632
0.02632
## Detection Rate 0.07895 0.00000
0.02632
## Detection Prevalence 0.13158 0.00000
0.05263
## Balanced Accuracy 0.97143 0.50000
0.98649
## Class: Overweight Female
## Sensitivity 0.75000
## Specificity 0.88235
## Pos Pred Value 0.42857

```



```

## Neg Pred Value          0.96774
## Prevalence              0.10526
## Detection Rate          0.07895
## Detection Prevalence    0.18421
## Balanced Accuracy       0.81618
##
## Class: Overweight Female EGCG Treated
## Sensitivity              0.00000
## Specificity              0.97222
## Pos Pred Value          0.00000
## Neg Pred Value          0.94595
## Prevalence              0.05263
## Detection Rate          0.00000
## Detection Prevalence    0.02632
## Balanced Accuracy       0.48611
##
## Class: Overweight Female EGCG+fishOil+VitC
## Sensitivity              0.00000
## Specificity              1.00000
## Pos Pred Value          NaN
## Neg Pred Value          0.94737
## Prevalence              0.05263
## Detection Rate          0.00000
## Detection Prevalence    0.00000
## Balanced Accuracy       0.50000
##
## Class: Tetanis Immunized
## Sensitivity              1.00000
## Specificity              1.00000
## Pos Pred Value          1.00000
## Neg Pred Value          1.00000
## Prevalence              0.02632
## Detection Rate          0.02632
## Detection Prevalence    0.02632
## Balanced Accuracy       1.00000

```

```

predDF2 <- data.frame(predRF, predRF2, predlda, predGbm,
TYPE=testingSet$Class_Type)

```

```

# CombinedModels2 <- train(TYPE~., method='gam', data=predDF2)
# CombinedPredictions2 <- predict(CombinedModels2, predDF2)
# CombinedPredictions2

```

```

# sum <- sum(CombinedPredictions2==testingSet$TYPE)
# accuracy_CombinedPredictions2 <- sum/length

```

```

predDF3 <- data.frame(predRF, predRF2, predlda, predGbm,
TYPE=testingSet$Class_Type)

```

```

results <- c(round(accuracy_rfMod,2), round(accuracy_RF2,2),
             round(accuracy_ldaMod, 2), round(accuracy_gbmMod,2),
             round(100,2))

```

```

results <- as.factor(results)
results <- t(data.frame(results))
colnames(results) <- colnames(predDF3)
Results <- rbind(predDF3, results) #37X6
Results

```

	predRF	predRF2
##		
## 5	AD Healthy Female	AD Healthy Female
## 8	AD Male	AD Male
## 14	AD Healthy Female	AD Healthy Female
## 15	AD Healthy Male	AD Healthy Male
## 20	AD Healthy Male	AD Healthy Male
## 22	AD Healthy Female	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Female
## 35	AD Healthy Female	AD Healthy Male
## 44	AD Female	AD Healthy Male
## 47	AD Healthy Male	AD Healthy Male
## 48	AD Healthy Male	AD Healthy Male
## 49	AD Male	AD Female
## 50	AD Female	AD Female
## 55	AD Male	AD Female
## 60	AD Male	AD Male
## 61	AD Male	AD Male
## 63	AD Female	AD Female
## 65	AD Healthy Female	AD Healthy Male
## 66	AD Male	AD Male
## 73	AD Female	AD Female
## 82	Hemo Male	Hemo Male
## 89	Hemo Male	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female
## 116	Overweight Female	Overweight Female
## 118	Overweight Female	Overweight Female
## 123	Overweight Female	Overweight Female
## 125	Overweight Female	Overweight Female
## 129	Overweight Female	Overweight Female
## 135	Flu Immunized Only Day 1	Flu Immunized Only Day 7
## 163	MI Males	MI Males
## 170	MI Males	MI Males
## 173	Tetanis Immunized	Tetanis Immunized
## results	0.39	0.39
##	predlda	predGbm
## 5	AD Healthy Female	AD Healthy Male
## 8	AD Female	AD Male
## 14	AD Healthy Male	AD Healthy Male

## 15	AD Healthy Male	AD Healthy Male
## 20	AD Healthy Female	AD Healthy Male
## 22	AD Female	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Male
## 35	AD Male	AD Healthy Female
## 44	AD Healthy Male	AD Female
## 47	AD Female	AD Male
## 48	AD Healthy Male	AD Healthy Male
## 49	AD Male	AD Male
## 50	AD Female	AD Male
## 55	AD Male	AD Female
## 60	AD Male	AD Female
## 61	AD Healthy Male	AD Male
## 63	AD Female	AD Female
## 65	AD Male	AD Healthy Male
## 66	AD Male	AD Male
## 73	AD Female	AD Female
## 82	Hemo Male	Hemo Healthy Female
## 89	Hemo Male	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female EGCG+fishOil+VitC
## 116	Overweight Female EGCG Treated	Overweight Female EGCG+fishOil+VitC
## 118	Overweight Female	Overweight Female
## 123	Overweight Female	Overweight Female EGCG Treated
## 125	Overweight Female	Overweight Female
## 129	Overweight Female EGCG Treated	Overweight Female
## 135	Flu Immunized Only Day 7	Flu Immunized Only Day 3
## 163	MI Males	MI Males
## 170	MI Males	MI Males
## 173	Tetanis Immunized	Tetanis Immunized
## results	0.42	0.5
##	TYPE	
## 5	AD Healthy Male	
## 8	AD Healthy Male	
## 14	AD Healthy Male	
## 15	AD Healthy Male	
## 20	AD Healthy Female	
## 22	AD Healthy Female	
## 26	AD Healthy Female	
## 28	AD Healthy Female	
## 35	AD Male	
## 44	AD Male	
## 47	AD Male	
## 48	AD Male	
## 49	AD Male	

```

## 50                AD Male
## 55                AD Female
## 60                AD Female
## 61                AD Female
## 63                AD Female
## 65                AD Female
## 66                AD Female
## 73                AD Female
## 82                Hemo Healthy Male
## 89                Hemo Male
## 93                Hemo Male
## 94                Hemo Male
## 102               Hemo Female
## 106               Overweight Female
## 109               Overweight Female
## 114               Overweight Female
## 116               Overweight Female
## 118               Overweight Female EGCG Treated
## 123               Overweight Female EGCG Treated
## 125               Overweight Female EGCG+fishOil+VitC
## 129               Overweight Female EGCG+fishOil+VitC
## 135               Flu non immunized healthy
## 163               MI Healthy Males
## 170               MI Males
## 173               Tetanis Immunized
## results          100

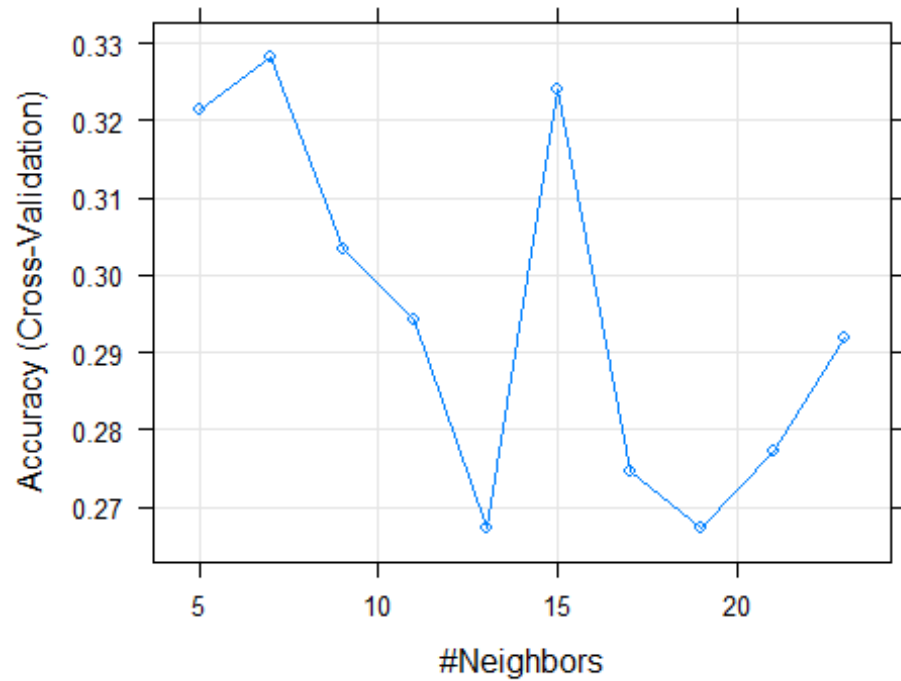
```

Try 'rpart', 'knn', 'glm',

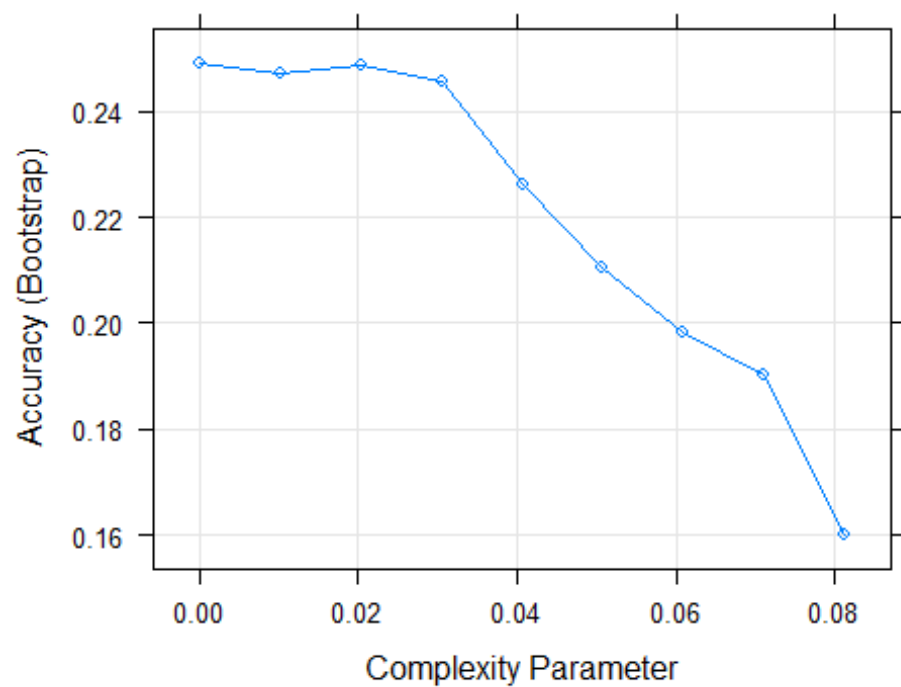
```

knnMod <- train(Class_Type ~ .,
                 method='knn', preProcess=c('center','scale'),
                 tuneLength=10, trControl=trainControl(method='cv'),
                 data=trainingSet)
plot(knnMod)

```



```
rpartMod <- train(Class_Type ~ ., method='rpart', tuneLength=9,  
data=trainingSet)  
plot(rpartMod)
```



```

# glmMod <- train(Class_Type ~ .,
#                  method='glm', data=trainingSet)

predKNN <- predict(knnMod, testingSet)
predRPART <- predict(rpartMod, testingSet)
#predGLM <- predict(glmMod, testingSet)

length=length(testingSet$Class_Type)

sumKNN <- sum(predKNN==testingSet$Class_Type)
sumRPart <- sum(predRPART==testingSet$Class_Type)
#sumGLM <- sum(predGLM==testingSet$TYPE)

accuracy_KNN <- sumKNN/length
accuracy_RPART <- sumRPart/length
#accuracy_GLM <- sumGLM/length

predDF3 <- data.frame(predDF2[,1:4],predKNN,predRPART,
                      TYPE=testingSet$Class_Type)

accuracy_KNN

## [1] 0.4210526

accuracy_RPART

## [1] 0.3157895

#accuracy_GLM

predDF3

##                predRF                predRF2
## 5      AD Healthy Female      AD Healthy Female
## 8                AD Male                AD Male
## 14     AD Healthy Female     AD Healthy Female
## 15          AD Healthy Male          AD Healthy Male
## 20          AD Healthy Male          AD Healthy Male
## 22     AD Healthy Female     AD Healthy Female
## 26     AD Healthy Female     AD Healthy Female
## 28     AD Healthy Female     AD Healthy Female
## 35     AD Healthy Female     AD Healthy Male
## 44                AD Female          AD Healthy Male
## 47          AD Healthy Male          AD Healthy Male
## 48          AD Healthy Male          AD Healthy Male
## 49                AD Male                AD Female
## 50          AD Female          AD Female
## 55                AD Male          AD Female
## 60                AD Male                AD Male
## 61                AD Male                AD Male
## 63                AD Female          AD Female
## 65     AD Healthy Female     AD Healthy Male

```

## 66	AD Male	AD Male
## 73	AD Female	AD Female
## 82	Hemo Male	Hemo Male
## 89	Hemo Male	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female
## 116	Overweight Female	Overweight Female
## 118	Overweight Female	Overweight Female
## 123	Overweight Female	Overweight Female
## 125	Overweight Female	Overweight Female
## 129	Overweight Female	Overweight Female
## 135	Flu Immunized Only Day 1	Flu Immunized Only Day 7
## 163	MI Males	MI Males
## 170	MI Males	MI Males
## 173	Tetanis Immunized	Tetanis Immunized
##	predlda	predGbm
## 5	AD Healthy Female	AD Healthy Male
## 8	AD Female	AD Male
## 14	AD Healthy Male	AD Healthy Male
## 15	AD Healthy Male	AD Healthy Male
## 20	AD Healthy Female	AD Healthy Male
## 22	AD Female	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Male
## 35	AD Male	AD Healthy Female
## 44	AD Healthy Male	AD Female
## 47	AD Female	AD Male
## 48	AD Healthy Male	AD Healthy Male
## 49	AD Male	AD Male
## 50	AD Female	AD Male
## 55	AD Male	AD Female
## 60	AD Male	AD Female
## 61	AD Healthy Male	AD Male
## 63	AD Female	AD Female
## 65	AD Male	AD Healthy Male
## 66	AD Male	AD Male
## 73	AD Female	AD Female
## 82	Hemo Male	Hemo Healthy Female
## 89	Hemo Male	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female EGCG+fishOil+VitC
## 116	Overweight Female EGCG Treated	Overweight Female EGCG+fishOil+VitC

## 118	Overweight Female	Overweight Female
## 123	Overweight Female	Overweight Female EGCG Treated
## 125	Overweight Female	Overweight Female
## 129	Overweight Female EGCG Treated	Overweight Female
## 135	Flu Immunized Only Day 7	Flu Immunized Only Day 3
## 163	MI Males	MI Males
## 170	MI Males	MI Males
## 173	Tetanis Immunized	Tetanis Immunized
##	predKNN	predRPART
## 5	AD Healthy Female	AD Healthy Female
## 8	AD Male	AD Female
## 14	AD Healthy Female	AD Healthy Male
## 15	AD Healthy Female	AD Healthy Female
## 20	AD Healthy Female	AD Female
## 22	AD Healthy Male	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Male
## 35	AD Healthy Male	AD Female
## 44	AD Healthy Male	AD Female
## 47	AD Healthy Male	AD Healthy Male
## 48	AD Healthy Female	AD Healthy Male
## 49	AD Male	AD Male
## 50	AD Female	AD Female
## 55	AD Male	AD Male
## 60	AD Female	AD Male
## 61	AD Male	AD Healthy Male
## 63	AD Female	AD Male
## 65	AD Healthy Female	AD Female
## 66	AD Female	AD Male
## 73	AD Female	AD Male
## 82	Hemo Male	Hemo Male
## 89	Hemo Female	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female EGCG Treated
## 116	Overweight Female	Overweight Female
## 118	Overweight Female	Overweight Female EGCG Treated
## 123	Overweight Female EGCG Treated	Overweight Female
## 125	Overweight Female	Overweight Female
## 129	Overweight Female	Overweight Female
## 135	Flu Immunized Only Day 21	Flu Immunized Only Day 1
## 163	MI Males	MI Healthy Males
## 170	MI Males	MI Healthy Males
## 173	Tetanis Immunized	MI Males
##	TYPE	
## 5	AD Healthy Male	
## 8	AD Healthy Male	


```

## 14          AD Healthy Male
## 15          AD Healthy Male
## 20          AD Healthy Female
## 22          AD Healthy Female
## 26          AD Healthy Female
## 28          AD Healthy Female
## 35          AD Male
## 44          AD Male
## 47          AD Male
## 48          AD Male
## 49          AD Male
## 50          AD Male
## 55          AD Female
## 60          AD Female
## 61          AD Female
## 63          AD Female
## 65          AD Female
## 66          AD Female
## 73          AD Female
## 82          Hemo Healthy Male
## 89          Hemo Male
## 93          Hemo Male
## 94          Hemo Male
## 102         Hemo Female
## 106         Overweight Female
## 109         Overweight Female
## 114         Overweight Female
## 116         Overweight Female
## 118         Overweight Female EGCG Treated
## 123         Overweight Female EGCG Treated
## 125 Overweight Female EGCG+fishOil+VitC
## 129 Overweight Female EGCG+fishOil+VitC
## 135         Flu non immunized healthy
## 163         MI Healthy Males
## 170         MI Males
## 173         Tetanis Immunized

# CombinedModels <- train(TYPE ~ ., method='gam', data=predDF3)
# CombinedPredictions2 <- predict(CombinedModels, predDF3)
#
# accuracy_CP2 <- sum(CombinedPredictions2==testingSet$TYPE)/length

predDF4 <- data.frame(predDF3[,1:6], TYPE=testingSet$Class_Type)
colnames(predDF4)

## [1] "predRF"      "predRF2"     "predlda"     "predGbm"     "predKNN"
##      "predRPART"
## [7] "TYPE"

```

```

results <- c(round(accuracy_rfMod,2), round(accuracy_RF2,2),
             round(accuracy_ldaMod, 2), round(accuracy_gbmMod,2),
             round(accuracy_KNN,2), round(accuracy_RPART,2),
             round(100,2))
results <- as.factor(results)
results <- t(data.frame(results))
colnames(results) <- colnames(predDF4)
Results <- rbind(predDF4, results)
Results

```

	predRF	predRF2
## 5	AD Healthy Female	AD Healthy Female
## 8	AD Male	AD Male
## 14	AD Healthy Female	AD Healthy Female
## 15	AD Healthy Male	AD Healthy Male
## 20	AD Healthy Male	AD Healthy Male
## 22	AD Healthy Female	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Female
## 35	AD Healthy Female	AD Healthy Male
## 44	AD Female	AD Healthy Male
## 47	AD Healthy Male	AD Healthy Male
## 48	AD Healthy Male	AD Healthy Male
## 49	AD Male	AD Female
## 50	AD Female	AD Female
## 55	AD Male	AD Female
## 60	AD Male	AD Male
## 61	AD Male	AD Male
## 63	AD Female	AD Female
## 65	AD Healthy Female	AD Healthy Male
## 66	AD Male	AD Male
## 73	AD Female	AD Female
## 82	Hemo Male	Hemo Male
## 89	Hemo Male	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female
## 116	Overweight Female	Overweight Female
## 118	Overweight Female	Overweight Female
## 123	Overweight Female	Overweight Female
## 125	Overweight Female	Overweight Female
## 129	Overweight Female	Overweight Female
## 135	Flu Immunized Only Day 1	Flu Immunized Only Day 7
## 163	MI Males	MI Males
## 170	MI Males	MI Males
## 173	Tetanis Immunized	Tetanis Immunized
## results	0.39	0.39

	predlda	predGbm
##		
## 5	AD Healthy Female	AD Healthy Male
## 8	AD Female	AD Male
## 14	AD Healthy Male	AD Healthy Male
## 15	AD Healthy Male	AD Healthy Male
## 20	AD Healthy Female	AD Healthy Male
## 22	AD Female	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Male
## 35	AD Male	AD Healthy Female
## 44	AD Healthy Male	AD Female
## 47	AD Female	AD Male
## 48	AD Healthy Male	AD Healthy Male
## 49	AD Male	AD Male
## 50	AD Female	AD Male
## 55	AD Male	AD Female
## 60	AD Male	AD Female
## 61	AD Healthy Male	AD Male
## 63	AD Female	AD Female
## 65	AD Male	AD Healthy Male
## 66	AD Male	AD Male
## 73	AD Female	AD Female
## 82	Hemo Male	Hemo Healthy Female
## 89	Hemo Male	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female EGCG+fishOil+VitC
## 116	Overweight Female EGCG Treated	Overweight Female EGCG+fishOil+VitC
## 118	Overweight Female	Overweight Female
## 123	Overweight Female	Overweight Female EGCG Treated
## 125	Overweight Female	Overweight Female
## 129	Overweight Female EGCG Treated	Overweight Female
## 135	Flu Immunized Only Day 7	Flu Immunized Only Day 3
## 163	MI Males	MI Males
## 170	MI Males	MI Males
## 173	Tetanis Immunized	Tetanis Immunized
## results	0.42	0.5
##	predKNN	predRPART
## 5	AD Healthy Female	AD Healthy Female
## 8	AD Male	AD Female
## 14	AD Healthy Female	AD Healthy Male
## 15	AD Healthy Female	AD Healthy Female
## 20	AD Healthy Female	AD Female
## 22	AD Healthy Male	AD Healthy Female
## 26	AD Healthy Female	AD Healthy Female
## 28	AD Healthy Female	AD Healthy Male
## 35	AD Healthy Male	AD Female

## 44	AD Healthy Male	AD Female
## 47	AD Healthy Male	AD Healthy Male
## 48	AD Healthy Female	AD Healthy Male
## 49	AD Male	AD Male
## 50	AD Female	AD Female
## 55	AD Male	AD Male
## 60	AD Female	AD Male
## 61	AD Male	AD Healthy Male
## 63	AD Female	AD Male
## 65	AD Healthy Female	AD Female
## 66	AD Female	AD Male
## 73	AD Female	AD Male
## 82	Hemo Male	Hemo Male
## 89	Hemo Female	Hemo Male
## 93	Hemo Male	Hemo Male
## 94	Hemo Male	Hemo Male
## 102	Hemo Male	Hemo Male
## 106	Overweight Female EGCG Treated	Overweight Female EGCG Treated
## 109	Overweight Female	Overweight Female
## 114	Overweight Female	Overweight Female EGCG Treated
## 116	Overweight Female	Overweight Female
## 118	Overweight Female	Overweight Female EGCG Treated
## 123	Overweight Female EGCG Treated	Overweight Female
## 125	Overweight Female	Overweight Female
## 129	Overweight Female	Overweight Female
## 135	Flu Immunized Only Day 21	Flu Immunized Only Day 1
## 163	MI Males	MI Healthy Males
## 170	MI Males	MI Healthy Males
## 173	Tetanus Immunized	MI Males
## results	0.42	0.32
##	TYPE	
## 5	AD Healthy Male	
## 8	AD Healthy Male	
## 14	AD Healthy Male	
## 15	AD Healthy Male	
## 20	AD Healthy Female	
## 22	AD Healthy Female	
## 26	AD Healthy Female	
## 28	AD Healthy Female	
## 35	AD Male	
## 44	AD Male	
## 47	AD Male	
## 48	AD Male	
## 49	AD Male	
## 50	AD Male	
## 55	AD Female	
## 60	AD Female	
## 61	AD Female	
## 63	AD Female	
## 65	AD Female	

```
## 66          AD Female
## 73          AD Female
## 82      Hemo Healthy Male
## 89          Hemo Male
## 93          Hemo Male
## 94          Hemo Male
## 102         Hemo Female
## 106      Overweight Female
## 109      Overweight Female
## 114      Overweight Female
## 116      Overweight Female
## 118      Overweight Female EGCG Treated
## 123      Overweight Female EGCG Treated
## 125      Overweight Female EGCG+fishOil+VitC
## 129      Overweight Female EGCG+fishOil+VitC
## 135          Flu non immunized healthy
## 163          MI Healthy Males
## 170          MI Males
## 173      Tetanis Immunized
## results                      100
```

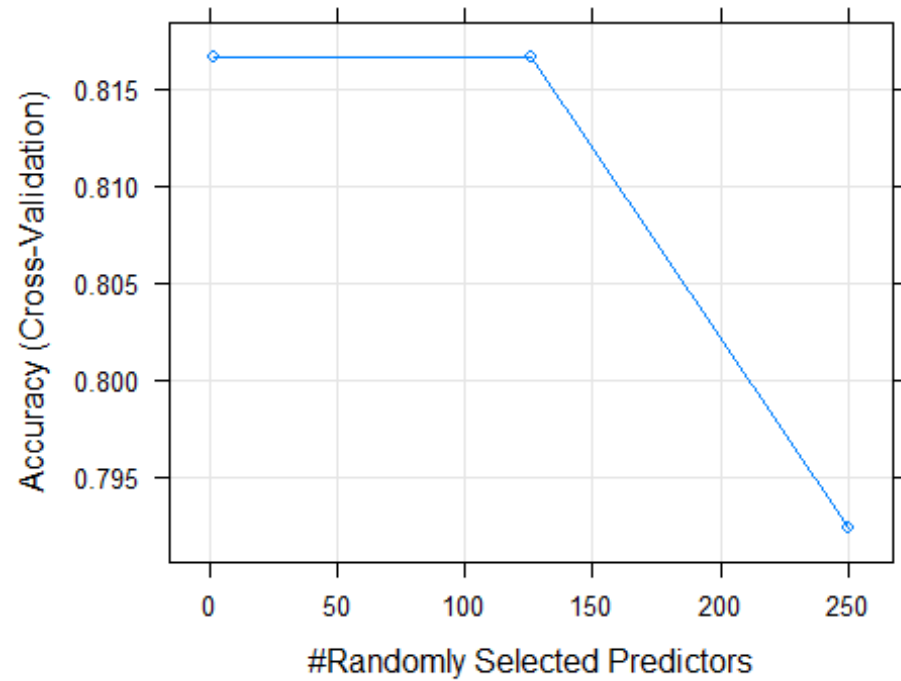
Now with the binary classification set, ML_ready_250_binomial_class. When predicting with 23 classes, the accuracy above isn't much better than half and some models couldn't be used like LDA.

```
inTrain <- createDataPartition(y=ML_ready_250_binomial_class$Class_Type,
p=0.7, list=FALSE)
```

```
trainingSet <- ML_ready_250_binomial_class[inTrain,]
testingSet <- ML_ready_250_binomial_class[-inTrain,]
```

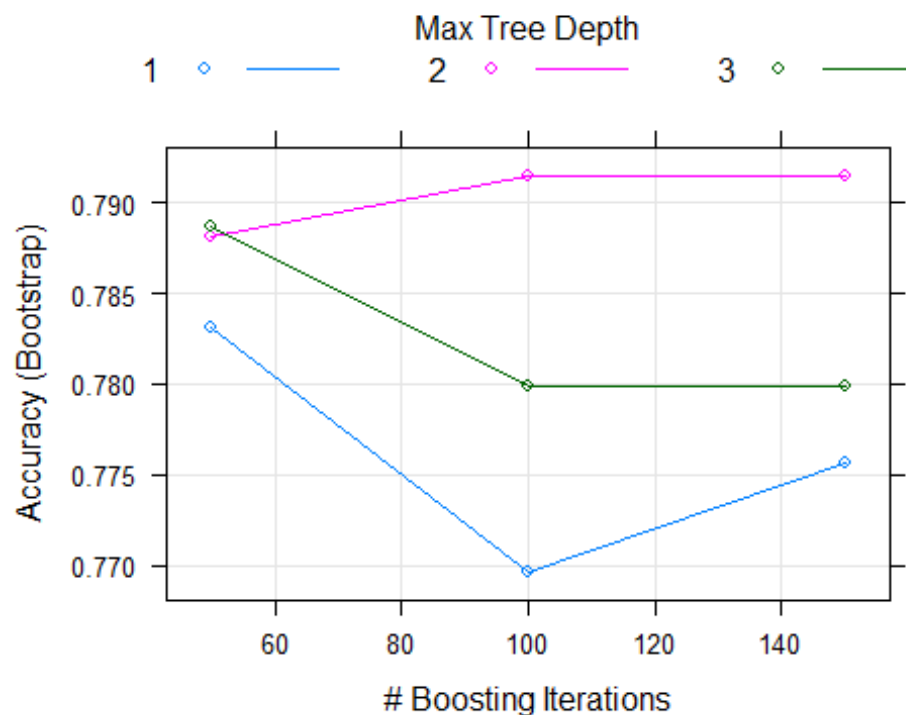
Random Forest, cross-validation (cv) = 5

```
rfMod <- train(Class_Type~., method='rf', data=(trainingSet),
               trControl=trainControl(method='cv'), number=5)
plot(rfMod)
```



Generalized Boosted Model

```
gbmMod <- train(Class_Type~., method='gbm', data=trainingSet, verbose=FALSE )  
plot(gbmMod)
```



Latent dirichlet allocation model

```
ldaMod <- train(Class_Type~., method='lda', data=trainingSet)
```

Run predictions on the testing set

```
predRF <- predict(rfMod, testingSet)
predGbm <- predict(gbmMod, testingSet)
predlda <- predict(ldaMod, testingSet)

predDF <- data.frame(predRF, predGbm, predlda, type=testingSet$Class_Type)
predDF
```

```
##               predRF               predGbm
## 1      Healthy Control      Healthy Control
## 2 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 3 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 4      Healthy Control      Healthy Control
## 5      Healthy Control      Healthy Control
## 6 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 7 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 8 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 9      Healthy Control      Healthy Control
## 10 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 11 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 12      Healthy Control      Healthy Control
## 13 Not Healthy or Treatment Control Not Healthy or Treatment Control
```

[illegible]

## 10	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 11	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 12	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 13		Healthy	Control	Not Healthy	or Treatment	Control
## 14	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 15	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 16	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 17	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 18	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 19	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 20	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 21	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 22	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 23	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 24	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 25	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 26	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 27	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 28	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 29	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 30	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 31		Healthy	Control	Not Healthy	or Treatment	Control
## 32	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 33		Healthy	Control	Not Healthy	or Treatment	Control
## 34	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 35		Healthy	Control	Not Healthy	or Treatment	Control
## 36	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 37	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 38	Not Healthy	or Treatment	Control	Not Healthy	or Treatment	Control
## 39	Not Healthy	or Treatment	Control		Healthy	Control
## 40		Healthy	Control		Healthy	Control
## 41		Healthy	Control		Healthy	Control
## 42	Not Healthy	or Treatment	Control		Healthy	Control
## 43		Healthy	Control		Healthy	Control
## 44		Healthy	Control		Healthy	Control
## 45	Not Healthy	or Treatment	Control		Healthy	Control
## 46	Not Healthy	or Treatment	Control		Healthy	Control
## 47		Healthy	Control		Healthy	Control
## 48	Not Healthy	or Treatment	Control		Healthy	Control
## 49	Not Healthy	or Treatment	Control		Healthy	Control
## 50	Not Healthy	or Treatment	Control		Healthy	Control
## 51	Not Healthy	or Treatment	Control		Healthy	Control
## 52	Not Healthy	or Treatment	Control		Healthy	Control
## 53		Healthy	Control		Healthy	Control

Combined Models, similar to voting in ensemble methods of best algorithm score.

```
# CombinedModels <- train(type~., method='gam', data=predDF)
# CombinedPredictions <- predict(CombinedModels, predDF)
# CombinedPredictions
```

Some stats follow.

```
# sum <- sum(CombinedPredictions==testingSet$TYPE)
# length <- length(testingSet$TYPE)
# accuracy_CP1 <- sum/length
```

```
sum <- sum(predRF==testingSet$Class_Type)
length <- length(testingSet$Class_Type)
accuracy_rfMod <- (sum/length)
```

```
sum <- sum(predGbm==testingSet$Class_Type)
accuracy_gbmMod <- sum/length
```

```
sum <- sum(predlda==testingSet$Class_Type)
accuracy_ldaMod <- sum/length
```

```
#accuracy_CP1
accuracy_rfMod
## [1] 0.754717
accuracy_gbmMod
## [1] 0.754717
accuracy_ldaMod
## [1] 0.7169811
```

The Random Forest algorithm, with differences by default than the random forest model in the caret package used previously.

```
# rf2 <- randomForest(Class_Type~., data=trainingSet)
#
# plot(rf2)
# predRF2 <- predict(rf2, testingSet, type='class')
#
# sum <- sum(predRF2==testingSet$Class_Type)
# accuracy_RF2 <- sum/length
#
# confusionMatrix(predRF2, testingSet$Class_Type)
predDF2 <- data.frame(predRF, predlda, predGbm, TYPE=testingSet$Class_Type)
# CombinedModels2 <- train(TYPE~., method='gam', data=predDF2)
# CombinedPredictions2 <- predict(CombinedModels2, predDF2)
# CombinedPredictions2
# sum <- sum(CombinedPredictions2==testingSet$TYPE)
# accuracy_CombinedPredictions2 <- sum/length
predDF3 <- data.frame(predRF, predlda, predGbm, TYPE=testingSet$Class_Type)
```

```
results <- c(round(accuracy_rfMod,2),
             round(accuracy_ldaMod, 2), round(accuracy_gbmMod,2),
             round(100,2))
```

```
results <- as.factor(results)
results <- t(data.frame(results))
colnames(results) <- colnames(predDF3)
Results <- rbind(predDF3, results)
Results
```

##		predRF		predlda
## 1	Healthy	Control	Not Healthy or Treatment	Control
## 2	Not Healthy or Treatment	Control	Healthy	Control
## 3	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 4	Healthy	Control	Not Healthy or Treatment	Control
## 5	Healthy	Control	Not Healthy or Treatment	Control
## 6	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 7	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 8	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 9	Healthy	Control	Healthy	Control
## 10	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 11	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 12	Healthy	Control	Not Healthy or Treatment	Control
## 13	Not Healthy or Treatment	Control	Healthy	Control
## 14	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 15	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 16	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 17	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 18	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 19	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 20	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 21	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 22	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 23	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 24	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 25	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 26	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 27	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 28	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 29	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 30	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 31	Not Healthy or Treatment	Control	Healthy	Control
## 32	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 33	Not Healthy or Treatment	Control	Healthy	Control
## 34	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 35	Not Healthy or Treatment	Control	Healthy	Control
## 36	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 37	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 38	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control

[illegible]

```

## 34      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 35      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 36      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 37      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 38      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 39      Not Healthy or Treatment Control      Healthy Control
## 40              Healthy Control      Healthy Control
## 41              Healthy Control      Healthy Control
## 42      Not Healthy or Treatment Control      Healthy Control
## 43              Healthy Control      Healthy Control
## 44              Healthy Control      Healthy Control
## 45      Not Healthy or Treatment Control      Healthy Control
## 46              Healthy Control      Healthy Control
## 47              Healthy Control      Healthy Control
## 48      Not Healthy or Treatment Control      Healthy Control
## 49      Not Healthy or Treatment Control      Healthy Control
## 50      Not Healthy or Treatment Control      Healthy Control
## 51      Not Healthy or Treatment Control      Healthy Control
## 52      Not Healthy or Treatment Control      Healthy Control
## 53              Healthy Control      Healthy Control
## results                                0.75                                100

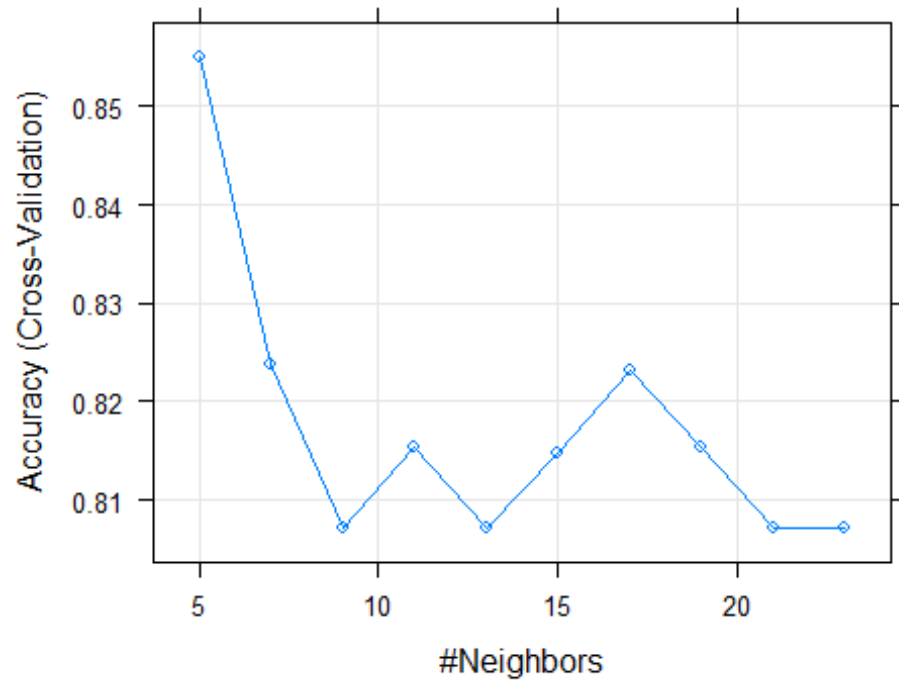
```

Try 'rpart', 'knn', 'glm',

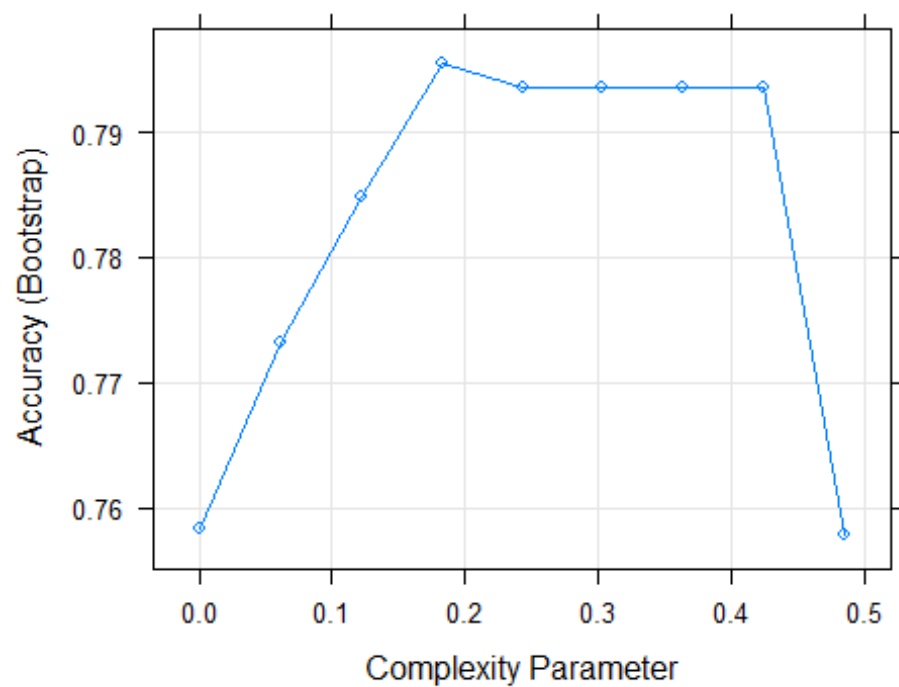
```

knnMod <- train(Class_Type ~ .,
                 method='knn', preProcess=c('center','scale'),
                 tuneLength=10, trControl=trainControl(method='cv'),
                 data=trainingSet)
plot(knnMod)

```



```
rpartMod <- train(Class_Type ~ ., method='rpart', tuneLength=9,  
data=trainingSet)  
plot(rpartMod)
```



```

# glmMod <- train(Class_Type ~ .,
#                  method='glm', data=trainingSet)

predKNN <- predict(knnMod, testingSet)
predRPART <- predict(rpartMod, testingSet)
#predGLM <- predict(glmMod, testingSet)

length=length(testingSet$Class_Type)

sumKNN <- sum(predKNN==testingSet$Class_Type)
sumRPART <- sum(predRPART==testingSet$Class_Type)
#sumGLM <- sum(predGLM==testingSet$TYPE)

accuracy_KNN <- sumKNN/length
accuracy_RPART <- sumRPART/length
#accuracy_GLM <- sumGLM/length

predDF3 <- data.frame(predDF2[,1:3],predKNN,predRPART,
                      TYPE=testingSet$Class_Type)

accuracy_KNN

## [1] 0.7169811

accuracy_RPART

## [1] 0.7735849

#accuracy_GLM

predDF3

##
##          predRF          predlda
## 1      Healthy Control Not Healthy or Treatment Control
## 2 Not Healthy or Treatment Control      Healthy Control
## 3 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 4      Healthy Control Not Healthy or Treatment Control
## 5      Healthy Control Not Healthy or Treatment Control
## 6 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 7 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 8 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 9      Healthy Control      Healthy Control
## 10 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 11 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 12      Healthy Control Not Healthy or Treatment Control
## 13 Not Healthy or Treatment Control      Healthy Control
## 14 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 15 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 16 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 17 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 18 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 19 Not Healthy or Treatment Control Not Healthy or Treatment Control

```

[illegible]

[illegible]

```

## 12          Healthy Control Not Healthy or Treatment Control
## 13 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 14 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 15 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 16 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 17 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 18 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 19 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 20 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 21 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 22 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 23 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 24 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 25 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 26 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 27 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 28 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 29 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 30 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 31 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 32 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 33 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 34 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 35 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 36 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 37 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 38 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 39 Not Healthy or Treatment Control          Healthy Control
## 40          Healthy Control          Healthy Control
## 41          Healthy Control          Healthy Control
## 42 Not Healthy or Treatment Control          Healthy Control
## 43          Healthy Control          Healthy Control
## 44          Healthy Control          Healthy Control
## 45 Not Healthy or Treatment Control          Healthy Control
## 46          Healthy Control          Healthy Control
## 47          Healthy Control          Healthy Control
## 48 Not Healthy or Treatment Control          Healthy Control
## 49 Not Healthy or Treatment Control          Healthy Control
## 50 Not Healthy or Treatment Control          Healthy Control
## 51 Not Healthy or Treatment Control          Healthy Control
## 52 Not Healthy or Treatment Control          Healthy Control
## 53 Not Healthy or Treatment Control          Healthy Control

```

```

# CombinedModels <- train(TYPE ~ ., method='gam', data=predDF3)
# CombinedPredictions2 <- predict(CombinedModels, predDF3)
#
# accuracy_CP2 <- sum(CombinedPredictions2==testingSet$TYPE)/length

```

```

predDF4 <- data.frame(predDF3[,1:5], TYPE=testingSet$Class_Type)
colnames(predDF4)

```

```
## [1] "predRF"      "predlda"      "predGbm"      "predKNN"      "predRPART" "TYPE"
```

```
results <- c(round(accuracy_rfMod,2),
             round(accuracy_ldaMod, 2), round(accuracy_gbmMod,2),
             round(accuracy_KNN,2), round(accuracy_RPART,2),
             round(100,2))
```

```
results <- as.factor(results)
```

```
results <- t(data.frame(results))
```

```
colnames(results) <- colnames(predDF4)
```

```
Results <- rbind(predDF4, results)
```

```
Results
```

##		predRF		predlda
## 1		Healthy	Control	Not Healthy or Treatment
## 2	Not Healthy or Treatment	Control		Healthy
## 3	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 4		Healthy	Control	Not Healthy or Treatment
## 5		Healthy	Control	Not Healthy or Treatment
## 6	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 7	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 8	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 9		Healthy	Control	Healthy
## 10	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 11	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 12		Healthy	Control	Not Healthy or Treatment
## 13	Not Healthy or Treatment	Control		Healthy
## 14	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 15	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 16	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 17	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 18	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 19	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 20	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 21	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 22	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 23	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 24	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 25	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 26	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 27	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 28	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 29	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 30	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 31	Not Healthy or Treatment	Control		Healthy
## 32	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 33	Not Healthy or Treatment	Control		Healthy
## 34	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 35	Not Healthy or Treatment	Control		Healthy
## 36	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control
## 37	Not Healthy or Treatment	Control	Not Healthy or Treatment	Control

[illegible]

[illegible]

```

## 28      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 29      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 30      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 31      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 32      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 33      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 34      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 35      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 36      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 37      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 38      Not Healthy or Treatment Control Not Healthy or Treatment Control
## 39      Not Healthy or Treatment Control      Healthy Control
## 40              Healthy Control      Healthy Control
## 41              Healthy Control      Healthy Control
## 42      Not Healthy or Treatment Control      Healthy Control
## 43              Healthy Control      Healthy Control
## 44              Healthy Control      Healthy Control
## 45      Not Healthy or Treatment Control      Healthy Control
## 46              Healthy Control      Healthy Control
## 47              Healthy Control      Healthy Control
## 48      Not Healthy or Treatment Control      Healthy Control
## 49      Not Healthy or Treatment Control      Healthy Control
## 50      Not Healthy or Treatment Control      Healthy Control
## 51      Not Healthy or Treatment Control      Healthy Control
## 52      Not Healthy or Treatment Control      Healthy Control
## 53      Not Healthy or Treatment Control      Healthy Control
## results                                0.77                                100

```

From the above, using the binary class system of predictions with various models, the accuracy jumped to 70-83% accuracy with Random Forest of the caret package as the Random Forest package failed for the structure of this binary data and was commented out. The next best model was glm or generalized linear machines with 81% accuracy.

I want to go back to the data on the hemochromatosis and compare to healthy and flu as well as tetanis vaccinated samples. Create a data set of the top 20 genes most and least expressed in hemochromatosis from the all_6_studies.csv, and the Dracula.csv better named sample types/classes, to create an ML ready data set of 20 genes to classify with H2O, random forests, glm, rpart, LDA, KNN, and so on as done above.

```

all <- read.csv('all_6_studies.csv', sep=',', header=T, na.strings=c('', ' '))
dracula <- read.csv('Dracula.csv', sep=',', header=T, na.strings=c('', ' '))

```

Sort the all table by hemochromatosis by hemo_FC_malesOverall and hemo_FC_femalesOverall.

```

hemoFCm <- all[order(all$hemo_FC_malesOverall, decreasing=TRUE)[1:20],]
hemoFCf <- all[order(all$hemo_FC_femalesOverall, decreasing=TRUE)[1:20],]
hemoFCmL <- all[order(all$hemo_FC_malesOverall)[1:20],]
hemoFCfL <- all[order(all$hemo_FC_femalesOverall)[1:20],]

Hemochromatosis <- rbind(hemoFCm,hemoFCf,hemoFCmL,hemoFCfL)
ironToxic <- Hemochromatosis[!duplicated(Hemochromatosis),]
ironToxic$GENE_SYMBOL

## [1] CEACAM8 CEACAM6 KRTAP2-1 UGT2B17 LTF OLFM4 RHD
## [8] DEFA6 MS4A3 ZBTB20 CYP4F2 IFIT1 MYH4 ATP6V1G3
## [15] CRYGB DEFB114 OR2F1 IFI44L ZNF208 RLN2 GLYATL2
## [22] ZNF430 HBZ LAIR2 SERPINB3 CENPK TAS2R50 TGIF2LY
## [29] PDE5A SLC12A1 RNASE3 TTTY11 OR2S2 LDHAL6A SRY
## [36] RAB40AL PCDH11Y MPRIP CFHR3 PSD3 IFNA4 HIST1H3B
## [43] OR7A17 SCEL ZNF99 UGT2B4 SLC01B1 PSG1 MSMB
## [50] IL2 TAS2R38 IFNA10 PRKAA2 KRT34 ZNF222 TBL1Y
## [57] SMR3A PRB4 RFPL3 CSN2 MRGPRX3 FABP7 HIST1H2BI
## [64] DDX3Y IQCF2 FM09P SMR3B DEFB125 KRT33B CLEC4M
## [71] LGALS13 HTN3 CYP2C19
## 12845 Levels: A1BG A1CF A2M A2ML1 AAAS AACS AADAC AADACL2 AADAT AAK1 AAMP
... ZZEF1

```

Combine the data.

```

IronDataGenes <- as.data.frame(unique(ironToxic$GENE_SYMBOL))
colnames(IronDataGenes) <- 'Gene'
IronData2 <- merge(IronDataGenes, dracula, by.x='Gene', by.y='X')
rownames(IronData2) <- IronDataGenes$Gene
IronData3 <- IronData2[, -1]
Class_Type <- gsub('-', '_', colnames(IronData3))
ClassType <- gsub('.[0-9]$', '', colnames(IronData3))
ClassType

## [1] "AD.Healthy.Male"
## [2] "AD.Healthy.Male"
## [3] "AD.Healthy.Male"
## [4] "AD.Healthy.Male"
## [5] "AD.Healthy.Male"
## [6] "AD.Healthy.Male"
## [7] "AD.Healthy.Male"
## [8] "AD.Healthy.Male"
## [9] "AD.Healthy.Male"
## [10] "AD.Healthy.Male"
## [11] "AD.Healthy.Male."
## [12] "AD.Healthy.Male."
## [13] "AD.Healthy.Male."
## [14] "AD.Healthy.Male."
## [15] "AD.Healthy.Male."
## [16] "AD.Healthy.Male."
## [17] "AD.Healthy.Female"

```

```
## [18] "AD.Healthy.Female"
## [19] "AD.Healthy.Female"
## [20] "AD.Healthy.Female"
## [21] "AD.Healthy.Female"
## [22] "AD.Healthy.Female"
## [23] "AD.Healthy.Female"
## [24] "AD.Healthy.Female"
## [25] "AD.Healthy.Female"
## [26] "AD.Healthy.Female"
## [27] "AD.Healthy.Female."
## [28] "AD.Healthy.Female."
## [29] "AD.Healthy.Female."
## [30] "AD.Healthy.Female."
## [31] "AD.Healthy.Female."
## [32] "AD.Healthy.Female."
## [33] "AD.Male"
## [34] "AD.Male"
## [35] "AD.Male"
## [36] "AD.Male"
## [37] "AD.Male"
## [38] "AD.Male"
## [39] "AD.Male"
## [40] "AD.Male"
## [41] "AD.Male"
## [42] "AD.Male"
## [43] "AD.Male."
## [44] "AD.Male."
## [45] "AD.Male."
## [46] "AD.Male."
## [47] "AD.Male."
## [48] "AD.Male."
## [49] "AD.Male."
## [50] "AD.Male."
## [51] "AD.Male."
## [52] "AD.Male."
## [53] "AD.Male."
## [54] "AD.Male."
## [55] "AD.Female"
## [56] "AD.Female"
## [57] "AD.Female"
## [58] "AD.Female"
## [59] "AD.Female"
## [60] "AD.Female"
## [61] "AD.Female"
## [62] "AD.Female"
## [63] "AD.Female"
## [64] "AD.Female"
## [65] "AD.Female."
## [66] "AD.Female."
## [67] "AD.Female."
```



```
## [68] "AD.Female."  
## [69] "AD.Female."  
## [70] "AD.Female."  
## [71] "AD.Female."  
## [72] "AD.Female."  
## [73] "AD.Female."  
## [74] "AD.Female."  
## [75] "AD.Female."  
## [76] "AD.Female."  
## [77] "AD.Female."  
## [78] "AD.Female."  
## [79] "Hemo.Healthy.Female"  
## [80] "Hemo.Healthy.Female"  
## [81] "Hemo.Healthy.Male"  
## [82] "Hemo.Healthy.Male"  
## [83] "Hemo.Healthy.Male"  
## [84] "Hemo.Healthy.Male"  
## [85] "Hemo.Male"  
## [86] "Hemo.Male"  
## [87] "Hemo.Male"  
## [88] "Hemo.Male"  
## [89] "Hemo.Male"  
## [90] "Hemo.Male"  
## [91] "Hemo.Male"  
## [92] "Hemo.Male"  
## [93] "Hemo.Male"  
## [94] "Hemo.Male"  
## [95] "Hemo.Male."  
## [96] "Hemo.Male."  
## [97] "Hemo.Male."  
## [98] "Hemo.Female"  
## [99] "Hemo.Female"  
## [100] "Hemo.Female"  
## [101] "Hemo.Female"  
## [102] "Hemo.Female"  
## [103] "Overweight.Female"  
## [104] "Overweight.Female"  
## [105] "Overweight.Female"  
## [106] "Overweight.Female"  
## [107] "Overweight.Female"  
## [108] "Overweight.Female"  
## [109] "Overweight.Female"  
## [110] "Overweight.Female"  
## [111] "Overweight.Female"  
## [112] "Overweight.Female"  
## [113] "Overweight.Female."  
## [114] "Overweight.Female."  
## [115] "Overweight.Female."  
## [116] "Overweight.Female."  
## [117] "Overweight.Female.EGCG.Treated"
```

```
## [118] "Overweight.Female.EGCG.Treated"
## [119] "Overweight.Female.EGCG.Treated"
## [120] "Overweight.Female.EGCG.Treated"
## [121] "Overweight.Female.EGCG.Treated"
## [122] "Overweight.Female.EGCG.Treated"
## [123] "Overweight.Female.EGCG.Treated"
## [124] "Overweight.Female.EGCG.fishOil.VitC"
## [125] "Overweight.Female.EGCG.fishOil.VitC"
## [126] "Overweight.Female.EGCG.fishOil.VitC"
## [127] "Overweight.Female.EGCG.fishOil.VitC"
## [128] "Overweight.Female.EGCG.fishOil.VitC"
## [129] "Overweight.Female.EGCG.fishOil.VitC"
## [130] "Overweight.Female.EGCG.fishOil.VitC"
## [131] "Flu.non.immunized.healthy"
## [132] "Flu.non.immunized.healthy"
## [133] "Flu.non.immunized.healthy"
## [134] "Flu.non.immunized.healthy"
## [135] "Flu.non.immunized.healthy"
## [136] "Flu.non.immunized.healthy"
## [137] "Flu.Immunized.Plus.Antibiotics.Day"
## [138] "Flu.Immunized.Plus.Antibiotics.Day.1"
## [139] "Flu.Immunized.Plus.Antibiotics.Day.1"
## [140] "Flu.Immunized.Plus.Antibiotics.Day"
## [141] "Flu.Immunized.Plus.Antibiotics.Day.3"
## [142] "Flu.Immunized.Plus.Antibiotics.Day.3"
## [143] "Flu.Immunized.Plus.Antibiotics.Day"
## [144] "Flu.Immunized.Plus.Antibiotics.Day.7"
## [145] "Flu.Immunized.Plus.Antibiotics.Day.7"
## [146] "Flu.Immunized.Plus.Antibiotics.Day."
## [147] "Flu.Immunized.Plus.Antibiotics.Day.21"
## [148] "Flu.Immunized.Plus.Antibiotics.Day.21"
## [149] "Flu.Immunized.Only.Day"
## [150] "Flu.Immunized.Only.Day.1"
## [151] "Flu.Immunized.Only.Day.1"
## [152] "Flu.Immunized.Only.Day"
## [153] "Flu.Immunized.Only.Day.3"
## [154] "Flu.Immunized.Only.Day.3"
## [155] "Flu.Immunized.Only.Day"
## [156] "Flu.Immunized.Only.Day.7"
## [157] "Flu.Immunized.Only.Day.7"
## [158] "Flu.Immunized.Only.Day."
## [159] "Flu.Immunized.Only.Day.21"
## [160] "Flu.Immunized.Only.Day.21"
## [161] "MI.Healthy.Males"
## [162] "MI.Healthy.Males"
## [163] "MI.Healthy.Males"
## [164] "MI.Healthy.Males"
## [165] "MI.Healthy.Males"
## [166] "MI.Healthy.Males"
## [167] "MI.Males"
```

```
## [168] "MI.Males"
## [169] "MI.Males"
## [170] "MI.Males"
## [171] "MI.Males"
## [172] "MI.Males"
## [173] "Tetanis.Immunized"
## [174] "Tetanis.Immunized"
## [175] "Tetanis.Immunized"
## [176] "Tetanis.Immunized"
## [177] "Tetanis.Immunized"
## [178] "Tetanis.Immunized"
```

```
ClassType2 <- ML_ready_250$Class_Type
compare <- cbind(as.data.frame(ClassType),as.data.frame(ClassType2))
compare
```

##	ClassType	
ClassType2		
## 1	AD.Healthy.Male	AD Healthy
Male		
## 2	AD.Healthy.Male	AD Healthy
Male		
## 3	AD.Healthy.Male	AD Healthy
Male		
## 4	AD.Healthy.Male	AD Healthy
Male		
## 5	AD.Healthy.Male	AD Healthy
Male		
## 6	AD.Healthy.Male	AD Healthy
Male		
## 7	AD.Healthy.Male	AD Healthy
Male		
## 8	AD.Healthy.Male	AD Healthy
Male		
## 9	AD.Healthy.Male	AD Healthy
Male		
## 10	AD.Healthy.Male	AD Healthy
Male		
## 11	AD.Healthy.Male.	AD Healthy
Male		
## 12	AD.Healthy.Male.	AD Healthy
Male		
## 13	AD.Healthy.Male.	AD Healthy
Male		
## 14	AD.Healthy.Male.	AD Healthy
Male		
## 15	AD.Healthy.Male.	AD Healthy
Male		
## 16	AD.Healthy.Male.	AD Healthy
Male		

## 17 Female	AD.Healthy.Female	AD Healthy
## 18 Female	AD.Healthy.Female	AD Healthy
## 19 Female	AD.Healthy.Female	AD Healthy
## 20 Female	AD.Healthy.Female	AD Healthy
## 21 Female	AD.Healthy.Female	AD Healthy
## 22 Female	AD.Healthy.Female	AD Healthy
## 23 Female	AD.Healthy.Female	AD Healthy
## 24 Female	AD.Healthy.Female	AD Healthy
## 25 Female	AD.Healthy.Female	AD Healthy
## 26 Female	AD.Healthy.Female	AD Healthy
## 27 Female	AD.Healthy.Female.	AD Healthy
## 28 Female	AD.Healthy.Female.	AD Healthy
## 29 Female	AD.Healthy.Female.	AD Healthy
## 30 Female	AD.Healthy.Female.	AD Healthy
## 31 Female	AD.Healthy.Female.	AD Healthy
## 32 Female	AD.Healthy.Female.	AD Healthy
## 33 Male	AD.Male	AD
## 34 Male	AD.Male	AD
## 35 Male	AD.Male	AD
## 36 Male	AD.Male	AD
## 37 Male	AD.Male	AD
## 38 Male	AD.Male	AD
## 39 Male	AD.Male	AD
## 40 Male	AD.Male	AD
## 41 Male	AD.Male	AD

## 42	AD.Male	AD
Male		
## 43	AD.Male.	AD
Male		
## 44	AD.Male.	AD
Male		
## 45	AD.Male.	AD
Male		
## 46	AD.Male.	AD
Male		
## 47	AD.Male.	AD
Male		
## 48	AD.Male.	AD
Male		
## 49	AD.Male.	AD
Male		
## 50	AD.Male.	AD
Male		
## 51	AD.Male.	AD
Male		
## 52	AD.Male.	AD
Male		
## 53	AD.Male.	AD
Male		
## 54	AD.Male.	AD
Male		
## 55	AD.Female	AD
Female		
## 56	AD.Female	AD
Female		
## 57	AD.Female	AD
Female		
## 58	AD.Female	AD
Female		
## 59	AD.Female	AD
Female		
## 60	AD.Female	AD
Female		
## 61	AD.Female	AD
Female		
## 62	AD.Female	AD
Female		
## 63	AD.Female	AD
Female		
## 64	AD.Female	AD
Female		
## 65	AD.Female.	AD
Female		
## 66	AD.Female.	AD
Female		

## 67 Female	AD.Female.	AD
## 68 Female	AD.Female.	AD
## 69 Female	AD.Female.	AD
## 70 Female	AD.Female.	AD
## 71 Female	AD.Female.	AD
## 72 Female	AD.Female.	AD
## 73 Female	AD.Female.	AD
## 74 Female	AD.Female.	AD
## 75 Female	AD.Female.	AD
## 76 Female	AD.Female.	AD
## 77 Female	AD.Female.	AD
## 78 Female	AD.Female.	AD
## 79 Female	Hemo.Healthy.Female	Hemo Healthy
## 80 Female	Hemo.Healthy.Female	Hemo Healthy
## 81 Male	Hemo.Healthy.Male	Hemo Healthy
## 82 Male	Hemo.Healthy.Male	Hemo Healthy
## 83 Male	Hemo.Healthy.Male	Hemo Healthy
## 84 Male	Hemo.Healthy.Male	Hemo Healthy
## 85 Male	Hemo.Male	Hemo
## 86 Male	Hemo.Male	Hemo
## 87 Male	Hemo.Male	Hemo
## 88 Male	Hemo.Male	Hemo
## 89 Male	Hemo.Male	Hemo
## 90 Male	Hemo.Male	Hemo
## 91 Male	Hemo.Male	Hemo

## 92	Hemo.Male	Hemo
Male		
## 93	Hemo.Male	Hemo
Male		
## 94	Hemo.Male	Hemo
Male		
## 95	Hemo.Male.	Hemo
Male		
## 96	Hemo.Male.	Hemo
Male		
## 97	Hemo.Male.	Hemo
Male		
## 98	Hemo.Female	Hemo
Female		
## 99	Hemo.Female	Hemo
Female		
## 100	Hemo.Female	Hemo
Female		
## 101	Hemo.Female	Hemo
Female		
## 102	Hemo.Female	Hemo
Female		
## 103	Overweight.Female	Overweight
Female		
## 104	Overweight.Female	Overweight
Female		
## 105	Overweight.Female	Overweight
Female		
## 106	Overweight.Female	Overweight
Female		
## 107	Overweight.Female	Overweight
Female		
## 108	Overweight.Female	Overweight
Female		
## 109	Overweight.Female	Overweight
Female		
## 110	Overweight.Female	Overweight
Female		
## 111	Overweight.Female	Overweight
Female		
## 112	Overweight.Female	Overweight
Female		
## 113	Overweight.Female.	Overweight
Female		
## 114	Overweight.Female.	Overweight
Female		
## 115	Overweight.Female.	Overweight
Female		
## 116	Overweight.Female.	Overweight
Female		

## 117 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 118 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 119 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 120 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 121 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 122 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 123 Treated	Overweight.Female.EGCG.Treated	Overweight Female EGCG
## 124	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 125	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 126	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 127	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 128	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 129	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 130	Overweight.Female.EGCG.fishOil.VitC EGCG+fishOil+VitC	Overweight Female
## 131 healthy	Flu.non.immunized.healthy	Flu non immunized
## 132 healthy	Flu.non.immunized.healthy	Flu non immunized
## 133 healthy	Flu.non.immunized.healthy	Flu non immunized
## 134 healthy	Flu.non.immunized.healthy	Flu non immunized
## 135 healthy	Flu.non.immunized.healthy	Flu non immunized
## 136 healthy	Flu.non.immunized.healthy	Flu non immunized
## 137 Day 1	Flu.Immunized.Plus.Antibiotics.Day	Flu Immunized Plus Antibiotics
## 138 Day 1	Flu.Immunized.Plus.Antibiotics.Day.1	Flu Immunized Plus Antibiotics
## 139 Day 1	Flu.Immunized.Plus.Antibiotics.Day.1	Flu Immunized Plus Antibiotics
## 140 Day 3	Flu.Immunized.Plus.Antibiotics.Day	Flu Immunized Plus Antibiotics
## 141 Day 3	Flu.Immunized.Plus.Antibiotics.Day.3	Flu Immunized Plus Antibiotics

## 142	Flu.Immunized.Plus.Antibiotics.Day.3	Flu Immunized Plus Antibiotics
Day 3		
## 143	Flu.Immunized.Plus.Antibiotics.Day	Flu Immunized Plus Antibiotics
Day 7		
## 144	Flu.Immunized.Plus.Antibiotics.Day.7	Flu Immunized Plus Antibiotics
Day 7		
## 145	Flu.Immunized.Plus.Antibiotics.Day.7	Flu Immunized Plus Antibiotics
Day 7		
## 146	Flu.Immunized.Plus.Antibiotics.Day.	Flu Immunized Plus Antibiotics
Day 21		
## 147	Flu.Immunized.Plus.Antibiotics.Day.21	Flu Immunized Plus Antibiotics
Day 21		
## 148	Flu.Immunized.Plus.Antibiotics.Day.21	Flu Immunized Plus Antibiotics
Day 21		
## 149	Flu.Immunized.Only.Day	Flu Immunized Only
Day 1		
## 150	Flu.Immunized.Only.Day.1	Flu Immunized Only
Day 1		
## 151	Flu.Immunized.Only.Day.1	Flu Immunized Only
Day 1		
## 152	Flu.Immunized.Only.Day	Flu Immunized Only
Day 3		
## 153	Flu.Immunized.Only.Day.3	Flu Immunized Only
Day 3		
## 154	Flu.Immunized.Only.Day.3	Flu Immunized Only
Day 3		
## 155	Flu.Immunized.Only.Day	Flu Immunized Only
Day 7		
## 156	Flu.Immunized.Only.Day.7	Flu Immunized Only
Day 7		
## 157	Flu.Immunized.Only.Day.7	Flu Immunized Only
Day 7		
## 158	Flu.Immunized.Only.Day.	Flu Immunized Only
Day 21		
## 159	Flu.Immunized.Only.Day.21	Flu Immunized Only
Day 21		
## 160	Flu.Immunized.Only.Day.21	Flu Immunized Only
Day 21		
## 161	MI.Healthy.Males	MI Healthy
Males		
## 162	MI.Healthy.Males	MI Healthy
Males		
## 163	MI.Healthy.Males	MI Healthy
Males		
## 164	MI.Healthy.Males	MI Healthy
Males		
## 165	MI.Healthy.Males	MI Healthy
Males		
## 166	MI.Healthy.Males	MI Healthy
Males		

```
## 167          MI.Males          MI
Males
## 168          MI.Males          MI
Males
## 169          MI.Males          MI
Males
## 170          MI.Males          MI
Males
## 171          MI.Males          MI
Males
## 172          MI.Males          MI
Males
## 173          Tetanis.Immunized    Tetanis
Immunized
## 174          Tetanis.Immunized    Tetanis
Immunized
## 175          Tetanis.Immunized    Tetanis
Immunized
## 176          Tetanis.Immunized    Tetanis
Immunized
## 177          Tetanis.Immunized    Tetanis
Immunized
## 178          Tetanis.Immunized    Tetanis
Immunized
```

#Same samples for the class type

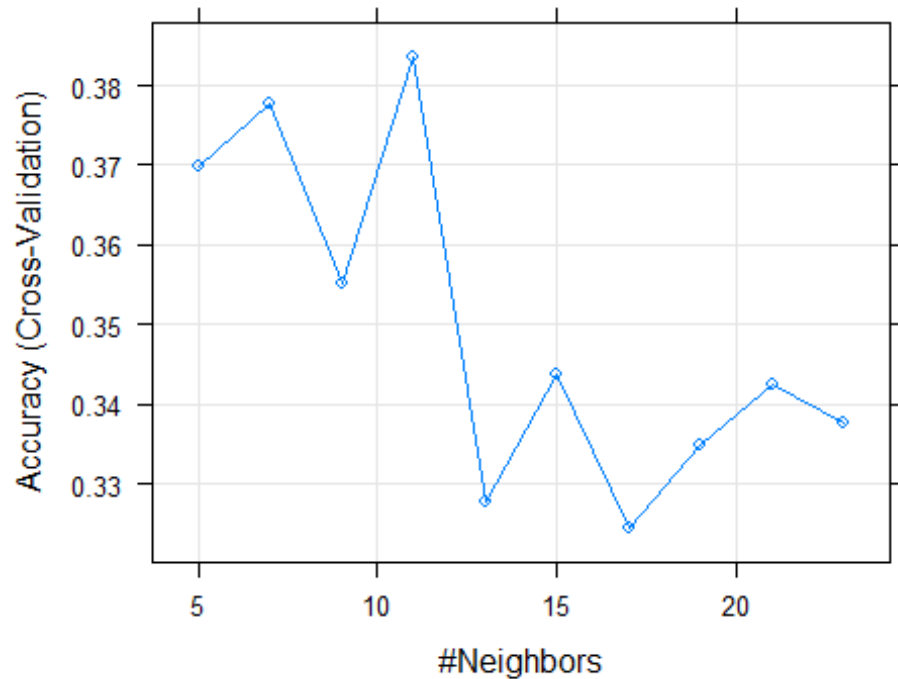
```
IronData_ML <- as.data.frame(t(IronData3))
row.names(IronData_ML) <- NULL
IronData_ML$Class_Type <- ClassType2
IronData_ML <- IronData_ML[,c(74,1:73)]
write.csv(IronData_ML, 'hemochromatosis_ML_ready.csv', row.names=FALSE)
```

The file we want to use ML on is now saved as hemochromatosis_ML_ready.csv from the IronData_ML data table.

```
inTrain <- createDataPartition(y=IronData_ML$Class_Type, p=0.7, list=FALSE)

trainingSet <- IronData_ML[inTrain,]
testingSet <- IronData_ML[-inTrain,]

knnMod <- train(Class_Type ~ .,
                method='knn', preProcess=c('center','scale'),
                tuneLength=10, trControl=trainControl(method='cv'),
                data=trainingSet)
plot(knnMod)
```



```

predKNN <- predict(knnMod, testingSet)
length=length(testingSet$Class_Type)

sumKNN <- sum(predKNN==testingSet$Class_Type)

accuracy_KNN <- sumKNN/length

predDF_3 <- data.frame(predKNN,
                       TYPE=testingSet$Class_Type)
accuracy_KNN

## [1] 0.3947368

predDF3

##               predRF               predlda
## 1      Healthy Control Not Healthy or Treatment Control
## 2 Not Healthy or Treatment Control      Healthy Control
## 3 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 4      Healthy Control Not Healthy or Treatment Control
## 5      Healthy Control Not Healthy or Treatment Control
## 6 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 7 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 8 Not Healthy or Treatment Control Not Healthy or Treatment Control
## 9      Healthy Control      Healthy Control
## 10 Not Healthy or Treatment Control Not Healthy or Treatment Control

```

[illegible]

[illegible]

[illegible]

## 52 Not Healthy or Treatment Control	Healthy Control
## 53 Not Healthy or Treatment Control	Healthy Control

Now use the H2O ML package.

```
h2o.init(nthreads=-1, max_mem_size="2G")

## Connection successful!
##
## R is connected to the H2O cluster:
##   H2O cluster uptime:      23 minutes 6 seconds
##   H2O cluster timezone:    America/Los_Angeles
##   H2O data parsing timezone: UTC
##   H2O cluster version:     3.28.0.2
##   H2O cluster version age:  11 days
##   H2O cluster name:        H2O_started_from_R_m_wkq150
##   H2O cluster total nodes:  1
##   H2O cluster total memory: 2.00 GB
##   H2O cluster total cores:  2
##   H2O cluster allowed cores: 2
##   H2O cluster healthy:     TRUE
##   H2O Connection ip:       localhost
##   H2O Connection port:     54321
##   H2O Connection proxy:    NA
##   H2O Internal Security:   FALSE
##   H2O API Extensions:      Amazon S3, Algos, AutoML, Core V3,
TargetEncoder, Core V4
##   R Version:                R version 3.6.2 (2019-12-12)

h2o.removeAll() ## clean slate - just in case the cluster was already running

D = h2o.importFile(path = normalizePath("hemochromatosis_ML_ready.csv"))

## |
|
|
|=====| 100%

#h2o.summary(D) would print the summary stats of these 251 features

data = h2o.splitFrame(D, ratios=c(.7,.15),
                      destination_frames = c("train", "test", "valid"))
names(data) <- c('Train', 'Test', 'Valid')

multinomial model

m1 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
             x = colnames(data$Train)[2:74],
             y = 'Class_Type',
```

```
family='multinomial',
solver='L_BFGS')
```

```
## |
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```

```
h2o.confusionMatrix(m1, valid=TRUE)
```

```
## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
##
```

	AD Female	AD Healthy Female	AD Healthy Male	AD Male
Male				
## AD Female	1	0	0	
0				
## AD Healthy Female	1	0	0	
0				
## AD Healthy Male	0	0	1	
0				
## AD Male	5	0	0	
0				
## Flu Immunized Only Day 1	0	0	0	
0				

	Flu Immunized Only Day 1	Flu Immunized Only Day 21
## AD Female	0	
0		
## AD Healthy Female	0	
0		
## AD Healthy Male	0	
0		
## AD Male	0	
0		
## Flu Immunized Only Day 1	0	
0		

	Flu Immunized Only Day 3	Flu Immunized Only Day 7
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0

	Flu Immunized Plus Antibiotics Day 1
## AD Female	0
## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0

	Flu Immunized Plus Antibiotics Day 21
## AD Female	0
## AD Healthy Female	0

## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Flu Immunized Plus Antibiotics Day 3	
## AD Female	0
## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Flu Immunized Plus Antibiotics Day 7	
## AD Female	0
## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Flu non immunized healthy Hemo Female	
## AD Female	0 0
## AD Healthy Female	0 0
## AD Healthy Male	0 0
## AD Male	0 0
## Flu Immunized Only Day 1	0 0
## Hemo Healthy Female Hemo Healthy Male Hemo Male	
## AD Female	0 0 0
## AD Healthy Female	0 0 0
## AD Healthy Male	0 0 0
## AD Male	0 0 0
## Flu Immunized Only Day 1	0 0 0
## MI Healthy Males MI Males Overweight Female	
## AD Female	0 0 0
## AD Healthy Female	0 0 0
## AD Healthy Male	0 0 0
## AD Male	0 0 0
## Flu Immunized Only Day 1	0 0 0
## Overweight Female EGCG Treated	
## AD Female	0
## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Overweight Female EGCG+fishOil+VitC Tetanis Immunized	
## AD Female	0
0	
## AD Healthy Female	0
0	
## AD Healthy Male	0
0	
## AD Male	0
0	
## Flu Immunized Only Day 1	0

```

0
##                               Error      Rate
## AD Female                    0.0000 =    0 / 1
## AD Healthy Female            1.0000 =    1 / 1
## AD Healthy Male              0.0000 =    0 / 1
## AD Male                      1.0000 =    5 / 5
## Flu Immunized Only Day 1     NA =    0 / 0
##
## ---
##                               AD Female AD Healthy Female AD Healthy
Male
## MI Males                      0                0
0
## Overweight Female            0                0
0
## Overweight Female EGCG Treated 0                0
0
## Overweight Female EGCG+fishOil+VitC 0                0
0
## Tetanis Immunized           0                0
0
## Totals                       7                0
1
##                               AD Male Flu Immunized Only Day 1
## MI Males                      0                0
## Overweight Female            0                0
## Overweight Female EGCG Treated 0                0
## Overweight Female EGCG+fishOil+VitC 0                0
## Tetanis Immunized           0                0
## Totals                       0                2
##                               Flu Immunized Only Day 21
## MI Males                      0
## Overweight Female            0
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized           0
## Totals                      0
##                               Flu Immunized Only Day 3
## MI Males                      0
## Overweight Female            0
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized           0
## Totals                      0
##                               Flu Immunized Only Day 7
## MI Males                      0
## Overweight Female            0
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized           0

```

## Totals	0		
##	Flu Immunized Plus Antibiotics Day 1		
## MI Males		0	
## Overweight Female		0	
## Overweight Female EGCG Treated		0	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		0	
##	Flu Immunized Plus Antibiotics Day 21		
## MI Males		0	
## Overweight Female		0	
## Overweight Female EGCG Treated		0	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		1	
##	Flu Immunized Plus Antibiotics Day 3		
## MI Males		0	
## Overweight Female		0	
## Overweight Female EGCG Treated		0	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		0	
##	Flu Immunized Plus Antibiotics Day 7		
## MI Males		0	
## Overweight Female		0	
## Overweight Female EGCG Treated		0	
## Overweight Female EGCG+fishOil+VitC		0	
## Tetanis Immunized		0	
## Totals		0	
##	Flu non immunized healthy Hemo Female		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		2	0
##	Hemo Healthy Female Hemo Healthy Male		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		0	1
##	Hemo Male MI Healthy Males MI Males		
## MI Males		0	0
## Overweight Female		0	0
## Overweight Female EGCG Treated		0	0
## Overweight Female EGCG+fishOil+VitC		0	0
## Tetanis Immunized		0	0
## Totals		5	1

```

##                               Overweight Female
## MI Males                               0
## Overweight Female                     0
## Overweight Female EGCG Treated        0
## Overweight Female EGCG+fishOil+VitC   0
## Tetanis Immunized                     0
## Totals                                0
##                               Overweight Female EGCG Treated
## MI Males                               0
## Overweight Female                     0
## Overweight Female EGCG Treated        0
## Overweight Female EGCG+fishOil+VitC   0
## Tetanis Immunized                      1
## Totals                                1
##                               Overweight Female EGCG+fishOil+VitC
## MI Males                               0
## Overweight Female                     2
## Overweight Female EGCG Treated        1
## Overweight Female EGCG+fishOil+VitC   0
## Tetanis Immunized                      0
## Totals                                3
##                               Tetanis Immunized   Error      Rate
## MI Males                               0      NA =    0 / 0
## Overweight Female                     0 1.0000 =    2 / 2
## Overweight Female EGCG Treated        0 1.0000 =    1 / 1
## Overweight Female EGCG+fishOil+VitC   0      NA =    0 / 0
## Tetanis Immunized                      1 0.5000 =    1 / 2
## Totals                                1 0.6800 = 17 / 25

```

This model doesn't use regularization of the default by setting $\lambda=0$, regularization generalizes better between the training set and test and validation set by reducing the over and under fit of model.

```

m2 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
              x = colnames(data$Train)[2:74],
              y = 'Class_Type',
              family='multinomial',
              solver='L_BFGS',
              lambda = 0)

## |
|                                     | 0%
|
|=====| 100%

```

Get confusion matrix in the training data.

```
h2o.confusionMatrix(m2, valid=FALSE)
```

```

## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
##                               AD Female AD Healthy Female AD Healthy Male AD

```

Male			
## AD Female	20	0	0
0			
## AD Healthy Female	0	11	0
0			
## AD Healthy Male	0	0	12
0			
## AD Male	0	0	0
14			
## Flu Immunized Only Day 1	0	0	0
0			
##	Flu Immunized Only Day 1	Flu Immunized Only Day	
21			
## AD Female		0	
0			
## AD Healthy Female		0	
0			
## AD Healthy Male		0	
0			
## AD Male		0	
0			
## Flu Immunized Only Day 1		3	
0			
##	Flu Immunized Only Day 3	Flu Immunized Only Day 7	
## AD Female		0	0
## AD Healthy Female		0	0
## AD Healthy Male		0	0
## AD Male		0	0
## Flu Immunized Only Day 1		0	0
##	Flu Immunized Plus Antibiotics Day 1		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	
##	Flu Immunized Plus Antibiotics Day 21		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	
##	Flu Immunized Plus Antibiotics Day 3		
## AD Female		0	
## AD Healthy Female		0	
## AD Healthy Male		0	
## AD Male		0	
## Flu Immunized Only Day 1		0	
##	Flu Immunized Plus Antibiotics Day 7		
## AD Female		0	
## AD Healthy Female		0	

```

## AD Healthy Male                                0
## AD Male                                         0
## Flu Immunized Only Day 1                       0
##          Flu non immunized healthy Hemo Female
## AD Female                                     0      0
## AD Healthy Female                           0      0
## AD Healthy Male                             0      0
## AD Male                                     0      0
## Flu Immunized Only Day 1                     0      0
##          Hemo Healthy Female Hemo Healthy Male Hemo Male
## AD Female                                   0      0      0
## AD Healthy Female                         0      0      0
## AD Healthy Male                           0      0      0
## AD Male                                   0      0      0
## Flu Immunized Only Day 1                   0      0      0
##          MI Healthy Males MI Males Overweight Female
## AD Female                                 0      0      0
## AD Healthy Female                       0      0      0
## AD Healthy Male                         0      0      0
## AD Male                                 0      0      0
## Flu Immunized Only Day 1                 0      0      0
##          Overweight Female EGCG Treated
## AD Female                               0
## AD Healthy Female                       0
## AD Healthy Male                         0
## AD Male                               0
## Flu Immunized Only Day 1                 0
##          Overweight Female EGCG+fishOil+VitC Tetanis
Immunized
## AD Female                                0
0
## AD Healthy Female                        0
0
## AD Healthy Male                          0
0
## AD Male                                0
0
## Flu Immunized Only Day 1                0
0
##          Error      Rate
## AD Female          0.0000 = 0 / 20
## AD Healthy Female  0.0000 = 0 / 11
## AD Healthy Male    0.0000 = 0 / 12
## AD Male            0.0000 = 0 / 14
## Flu Immunized Only Day 1 0.0000 = 0 / 3
##
## ---
##          AD Female AD Healthy Female AD Healthy
Male
## MI Males                0                0

```

0		
## Overweight Female	0	0
0		
## Overweight Female EGCG Treated	0	0
0		
## Overweight Female EGCG+fishOil+VitC	0	0
0		
## Tetanis Immunized	0	0
0		
## Totals	20	11
12		
##	AD Male Flu Immunized Only Day 1	
## MI Males	0	0
## Overweight Female	0	0
## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	14	3
##	Flu Immunized Only Day 21	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		3
##	Flu Immunized Only Day 3	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		2
##	Flu Immunized Only Day 7	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		2
##	Flu Immunized Plus Antibiotics Day 1	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0
## Overweight Female EGCG+fishOil+VitC		0
## Tetanis Immunized		0
## Totals		2
##	Flu Immunized Plus Antibiotics Day 21	
## MI Males		0
## Overweight Female		0
## Overweight Female EGCG Treated		0

## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	3
## Flu Immunized Plus Antibiotics Day 3	
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	2
## Flu Immunized Plus Antibiotics Day 7	
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	3
## Flu non immunized healthy Hemo Female	
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	5
## Hemo Healthy Female Hemo Healthy Male	
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	1
## Hemo Male MI Healthy Males MI Males	
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	7
## Overweight Female	
## MI Males	0
## Overweight Female	9
## Overweight Female EGCG Treated	0
## Overweight Female EGCG+fishOil+VitC	0
## Tetanis Immunized	0
## Totals	9
## Overweight Female EGCG Treated	
## MI Males	0
## Overweight Female	0
## Overweight Female EGCG Treated	5
## Overweight Female EGCG+fishOil+VitC	0


```
## Tetanis Immunized                                0
## Totals                                           5
##
## Overweight Female EGCG+fishOil+VitC
## MI Males                                         0
## Overweight Female                                0
## Overweight Female EGCG Treated                  0
## Overweight Female EGCG+fishOil+VitC             7
## Tetanis Immunized                                0
## Totals                                           7
##
## Tetanis Immunized   Error      Rate
## MI Males           0 0.0000 = 0 / 5
## Overweight Female   0 0.0000 = 0 / 9
## Overweight Female EGCG Treated   0 0.0000 = 0 / 5
## Overweight Female EGCG+fishOil+VitC 0 0.0000 = 0 / 7
## Tetanis Immunized   4 0.0000 = 0 / 4
## Totals              4 0.0000 = 0 / 131
```

Get confusion matrix in the validation data.

h2o.confusionMatrix(m2, valid=TRUE)

## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class			
##	AD Female	AD Healthy Female	AD Healthy Male
Male			
## AD Female	1	0	0
0			
## AD Healthy Female	1	0	0
0			
## AD Healthy Male	0	1	0
0			
## AD Male	2	0	1
2			
## Flu Immunized Only Day 1	0	0	0
0			
##	Flu Immunized Only Day 1	Flu Immunized Only Day	
21			
## AD Female		0	
0			
## AD Healthy Female		0	
0			
## AD Healthy Male		0	
0			
## AD Male		0	
0			
## Flu Immunized Only Day 1		0	
0			
##	Flu Immunized Only Day 3	Flu Immunized Only Day 7	
## AD Female	0		0
## AD Healthy Female	0		0
## AD Healthy Male	0		0

## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## Flu Immunized Plus Antibiotics Day 1		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu Immunized Plus Antibiotics Day 21		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu Immunized Plus Antibiotics Day 3		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu Immunized Plus Antibiotics Day 7		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	
## Flu non immunized healthy Hemo Female		
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## Hemo Healthy Female Hemo Healthy Male Hemo Male		
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## MI Healthy Males MI Males Overweight Female		
## AD Female	0	0
## AD Healthy Female	0	0
## AD Healthy Male	0	0
## AD Male	0	0
## Flu Immunized Only Day 1	0	0
## Overweight Female EGCG Treated		
## AD Female	0	
## AD Healthy Female	0	
## AD Healthy Male	0	
## AD Male	0	
## Flu Immunized Only Day 1	0	

```

##                                Overweight Female EGCG+fishOil+VitC Tetanis
Immunized
## AD Female                                0
0
## AD Healthy Female                        0
0
## AD Healthy Male                          0
0
## AD Male                                0
0
## Flu Immunized Only Day 1                0
0
##                                Error      Rate
## AD Female                        0.0000 = 0 / 1
## AD Healthy Female                1.0000 = 1 / 1
## AD Healthy Male                  1.0000 = 1 / 1
## AD Male                          0.6000 = 3 / 5
## Flu Immunized Only Day 1         NA = 0 / 0
##
## ---
##                                AD Female AD Healthy Female AD Healthy
Male
## MI Males                            0                0
0
## Overweight Female                    0                0
0
## Overweight Female EGCG Treated        0                0
0
## Overweight Female EGCG+fishOil+VitC  0                0
0
## Tetanis Immunized                    0                0
0
## Totals                              4                1
1
##                                AD Male Flu Immunized Only Day 1
## MI Males                            0                0
## Overweight Female                    0                0
## Overweight Female EGCG Treated        0                0
## Overweight Female EGCG+fishOil+VitC  0                0
## Tetanis Immunized                    0                0
## Totals                              2                2
##                                Flu Immunized Only Day 21
## MI Males                            0
## Overweight Female                    0
## Overweight Female EGCG Treated        0
## Overweight Female EGCG+fishOil+VitC  0
## Tetanis Immunized                    0
## Totals                              0
##                                Flu Immunized Only Day 3
## MI Males                            0

```

## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
##	Flu Immunized Only Day 7	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
##	Flu Immunized Plus Antibiotics Day 1	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	2	
##	Flu Immunized Plus Antibiotics Day 21	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
##	Flu Immunized Plus Antibiotics Day 3	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	0	
##	Flu Immunized Plus Antibiotics Day 7	
## MI Males	0	
## Overweight Female	0	
## Overweight Female EGCG Treated	0	
## Overweight Female EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	
## Totals	1	
##	Flu non immunized healthy Hemo Female	
## MI Males	0	0
## Overweight Female	0	0
## Overweight Female EGCG Treated	0	0
## Overweight Female EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0
## Totals	0	0
##	Hemo Healthy Female	Hemo Healthy Male
## MI Males	0	0
## Overweight Female	0	0

```

## Overweight Female EGCG Treated                0                0
## Overweight Female EGCG+fishOil+VitC            0                0
## Tetanis Immunized                             0                0
## Totals                                         1                1
##
## Hemo Male MI Healthy Males MI Males
## MI Males                                     0                0
## Overweight Female                           0                0
## Overweight Female EGCG Treated               0                0
## Overweight Female EGCG+fishOil+VitC          0                0
## Tetanis Immunized                           0                0
## Totals                                     4                0
##
## Overweight Female
## MI Males                                     0
## Overweight Female                           0
## Overweight Female EGCG Treated               0
## Overweight Female EGCG+fishOil+VitC          0
## Tetanis Immunized                           0
## Totals                                     0
##
## Overweight Female EGCG Treated
## MI Males                                     0
## Overweight Female                           2
## Overweight Female EGCG Treated               1
## Overweight Female EGCG+fishOil+VitC          0
## Tetanis Immunized                           0
## Totals                                     3
##
## Overweight Female EGCG+fishOil+VitC
## MI Males                                     0
## Overweight Female                           0
## Overweight Female EGCG Treated               0
## Overweight Female EGCG+fishOil+VitC          0
## Tetanis Immunized                           0
## Totals                                     0
##
## Tetanis Immunized Error Rate
## MI Males                                     0 NA = 0 / 0
## Overweight Female                           0 1.0000 = 2 / 2
## Overweight Female EGCG Treated               0 0.0000 = 0 / 1
## Overweight Female EGCG+fishOil+VitC          0 NA = 0 / 0
## Tetanis Immunized                           2 0.0000 = 0 / 2
## Totals                                     2 0.4800 = 12 / 25

m3 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
              x = colnames(data$Train)[2:74],
              y = 'Class_Type',
              family='multinomial',
              solver='L_BFGS',
              lambda = 0,
              keep_cross_validation_predictions = TRUE)

## |
| | 0%

```

```
|
|=====| 100%
```

```
h2o.confusionMatrix(m3, valid=TRUE)
```

```
## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
```

```
##           AD Female AD Healthy Female AD Healthy Male AD
```

```
Male
```

```
## AD Female           1           0           0
```

```
0
```

```
## AD Healthy Female   1           0           0
```

```
0
```

```
## AD Healthy Male     0           1           0
```

```
0
```

```
## AD Male             2           0           1
```

```
2
```

```
## Flu Immunized Only Day 1  0           0           0
```

```
0
```

```
##           Flu Immunized Only Day 1 Flu Immunized Only Day
```

```
21
```

```
## AD Female           0
```

```
0
```

```
## AD Healthy Female     0
```

```
0
```

```
## AD Healthy Male       0
```

```
0
```

```
## AD Male               0
```

```
0
```

```
## Flu Immunized Only Day 1  0
```

```
0
```

```
##           Flu Immunized Only Day 3 Flu Immunized Only Day 7
```

```
## AD Female           0           0
```

```
## AD Healthy Female     0           0
```

```
## AD Healthy Male       0           0
```

```
## AD Male               0           0
```

```
## Flu Immunized Only Day 1  0           0
```

```
##
```

```
##           Flu Immunized Plus Antibiotics Day 1
```

```
## AD Female           0
```

```
## AD Healthy Female     0
```

```
## AD Healthy Male       0
```

```
## AD Male               0
```

```
## Flu Immunized Only Day 1  0
```

```
##
```

```
##           Flu Immunized Plus Antibiotics Day 21
```

```
## AD Female           0
```

```
## AD Healthy Female     0
```

```
## AD Healthy Male       0
```

```
## AD Male               0
```

```
## Flu Immunized Only Day 1  0
```

```
##
```

```
##           Flu Immunized Plus Antibiotics Day 3
```

```
## AD Female           0
```

## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Flu Immunized Plus Antibiotics Day 7	
## AD Female	0
## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Flu non immunized healthy Hemo Female	
## AD Female	0 0
## AD Healthy Female	0 0
## AD Healthy Male	0 0
## AD Male	0 0
## Flu Immunized Only Day 1	0 0
## Hemo Healthy Female Hemo Healthy Male Hemo Male	
## AD Female	0 0 0
## AD Healthy Female	0 0 0
## AD Healthy Male	0 0 0
## AD Male	0 0 0
## Flu Immunized Only Day 1	0 0 0
## MI Healthy Males MI Males Overweight Female	
## AD Female	0 0 0
## AD Healthy Female	0 0 0
## AD Healthy Male	0 0 0
## AD Male	0 0 0
## Flu Immunized Only Day 1	0 0 0
## Overweight Female EGCG Treated	
## AD Female	0
## AD Healthy Female	0
## AD Healthy Male	0
## AD Male	0
## Flu Immunized Only Day 1	0
## Overweight Female EGCG+fishOil+VitC Tetanis	
Immunized	
## AD Female	0
0	
## AD Healthy Female	0
0	
## AD Healthy Male	0
0	
## AD Male	0
0	
## Flu Immunized Only Day 1	0
0	
## Error Rate	
## AD Female	0.0000 = 0 / 1
## AD Healthy Female	1.0000 = 1 / 1
## AD Healthy Male	1.0000 = 1 / 1

```

## AD Male          0.6000 = 3 / 5
## Flu Immunized Only Day 1    NA = 0 / 0
##
## ---
##                AD Female AD Healthy Female AD Healthy
Male
## MI Males                0                0
0
## Overweight Female                0                0
0
## Overweight Female EGCG Treated                0                0
0
## Overweight Female EGCG+fishOil+VitC                0                0
0
## Tetanis Immunized                0                0
0
## Totals                4                1
1
##                AD Male Flu Immunized Only Day 1
## MI Males                0                0
## Overweight Female                0                0
## Overweight Female EGCG Treated                0                0
## Overweight Female EGCG+fishOil+VitC                0                0
## Tetanis Immunized                0                0
## Totals                2                2
##                Flu Immunized Only Day 21
## MI Males                0
## Overweight Female                0
## Overweight Female EGCG Treated                0
## Overweight Female EGCG+fishOil+VitC                0
## Tetanis Immunized                0
## Totals                0
##                Flu Immunized Only Day 3
## MI Males                0
## Overweight Female                0
## Overweight Female EGCG Treated                0
## Overweight Female EGCG+fishOil+VitC                0
## Tetanis Immunized                0
## Totals                0
##                Flu Immunized Only Day 7
## MI Males                0
## Overweight Female                0
## Overweight Female EGCG Treated                0
## Overweight Female EGCG+fishOil+VitC                0
## Tetanis Immunized                0
## Totals                0
##                Flu Immunized Plus Antibiotics Day 1
## MI Males                0
## Overweight Female                0
## Overweight Female EGCG Treated                0

```


## Overweight Female	EGCG+fishOil+VitC	0	
## Tetanis Immunized		0	
## Totals		2	
##	Flu Immunized Plus Antibiotics Day 21		
## MI Males		0	
## Overweight Female		0	
## Overweight Female	EGCG Treated	0	
## Overweight Female	EGCG+fishOil+VitC	0	
## Tetanis Immunized		0	
## Totals		0	
##	Flu Immunized Plus Antibiotics Day 3		
## MI Males		0	
## Overweight Female		0	
## Overweight Female	EGCG Treated	0	
## Overweight Female	EGCG+fishOil+VitC	0	
## Tetanis Immunized		0	
## Totals		0	
##	Flu Immunized Plus Antibiotics Day 7		
## MI Males		0	
## Overweight Female		0	
## Overweight Female	EGCG Treated	0	
## Overweight Female	EGCG+fishOil+VitC	0	
## Tetanis Immunized		0	
## Totals		1	
##	Flu non immunized healthy Hemo Female		
## MI Males	0	0	
## Overweight Female	0	0	
## Overweight Female	EGCG Treated	0	
## Overweight Female	EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	0	
## Totals	0	0	
##	Hemo Healthy Female Hemo Healthy Male		
## MI Males	0	0	
## Overweight Female	0	0	
## Overweight Female	EGCG Treated	0	
## Overweight Female	EGCG+fishOil+VitC	0	
## Tetanis Immunized	0	0	
## Totals	1	1	
##	Hemo Male MI Healthy Males MI Males		
## MI Males	0	0	0
## Overweight Female	0	0	0
## Overweight Female	EGCG Treated	0	0
## Overweight Female	EGCG+fishOil+VitC	0	0
## Tetanis Immunized	0	0	0
## Totals	4	0	1
##	Overweight Female		
## MI Males	0		
## Overweight Female	0		
## Overweight Female	EGCG Treated	0	
## Overweight Female	EGCG+fishOil+VitC	0	

```

## Tetanis Immunized          0
## Totals                     0
##                               Overweight Female EGCG Treated
## MI Males                   0
## Overweight Female          2
## Overweight Female EGCG Treated 1
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized          0
## Totals                     3
##                               Overweight Female EGCG+fishOil+VitC
## MI Males                   0
## Overweight Female          0
## Overweight Female EGCG Treated 0
## Overweight Female EGCG+fishOil+VitC 0
## Tetanis Immunized          0
## Totals                     0
##                               Tetanis Immunized Error Rate
## MI Males                   0 NA = 0 / 0
## Overweight Female          0 1.0000 = 2 / 2
## Overweight Female EGCG Treated 0 0.0000 = 0 / 1
## Overweight Female EGCG+fishOil+VitC 0 NA = 0 / 0
## Tetanis Immunized          2 0.0000 = 0 / 2
## Totals                     2 0.4800 = 12 / 25

```

The above H2O commands ran very fast. Even with 23 classes on a selected few features of a smaller subset of genes that were the most or least unique genes in the female and male datasets of fold change in hemochromatosis patients' blood gene expression profiles, the accuracy in prediction is terrible. H2O is an extension of Principal Component Analysis and only keeps the components or features with the most variation in the data. We should shorten this data of 23 classes to something more reasonable. Also, GLM in R can use only binary or 2 features with the settings used. This will be left to determine which classes to fit these 23 current class types into for better accuracy in prediction. The flu samples, combine the mixed gender, make one overweight class, one healthy class, etc.

For now, I am just curious about how immunizations for flu and tetanus react in hemochromatosis people.

```

Flu <- IronData_ML[grep('Flu', IronData_ML$Class_Type),]
Hemo <- IronData_ML[grep('Hemo', IronData_ML$Class_Type),]
tet <- IronData_ML[grep('Tet', IronData_ML$Class_Type),]

FHT <- rbind(Flu, Hemo, tet)
FHT_HemoOnly <- FHT[-grep('Hemo Healthy', FHT$Class_Type),]

#This next line has to be done so the original factors of 23 levels isn't
included in the output ML results
FHT_HemoOnly$Class_Type <- as.factor(as.character(FHT_HemoOnly$Class_Type))
unique(FHT_HemoOnly$Class_Type)

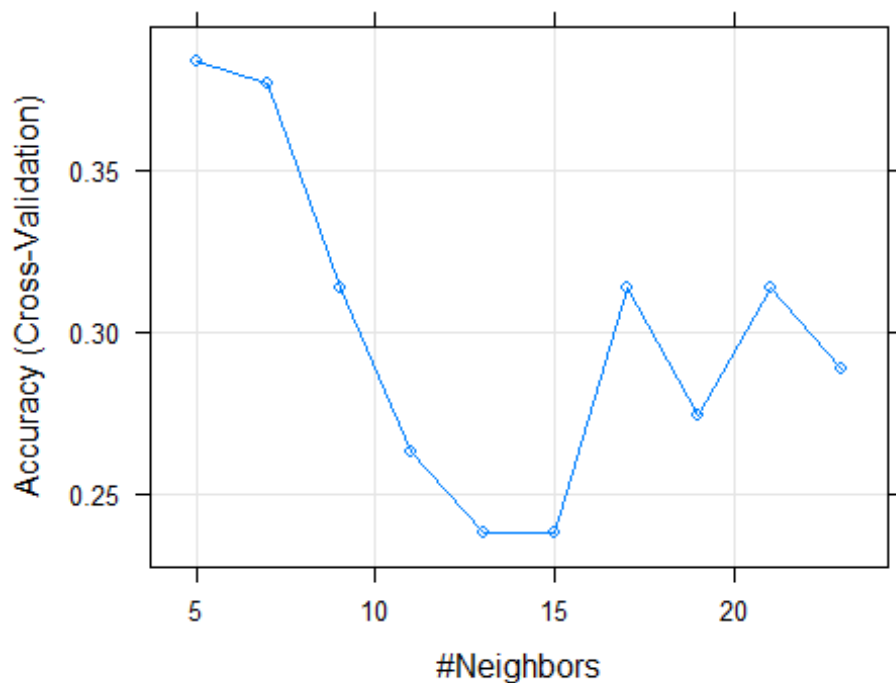
```

```
## [1] Flu non immunized healthy          Flu Immunized Plus Antibiotics
Day 1
## [3] Flu Immunized Plus Antibiotics Day 3  Flu Immunized Plus Antibiotics
Day 7
## [5] Flu Immunized Plus Antibiotics Day 21  Flu Immunized Only Day 1
## [7] Flu Immunized Only Day 3              Flu Immunized Only Day 7
## [9] Flu Immunized Only Day 21             Hemo Male
## [11] Hemo Female                           Tetanis Immunized
## 12 Levels: Flu Immunized Only Day 1 ... Tetanis Immunized
```

```
colnames(FHT_HemoOnly) <- gsub('-', '.', colnames(FHT_HemoOnly))
inTrain <- createDataPartition(y=FHT_HemoOnly$Class_Type, p=0.7, list=FALSE)

trainingSet <- FHT_HemoOnly[inTrain,]
testingSet <- FHT_HemoOnly[-inTrain,]

knnMod <- train(Class_Type ~ .,
                 method='knn', preprocess=c('center', 'scale'),
                 tuneLength=10, trControl=trainControl(method='cv'),
                 data=trainingSet)
plot(knnMod)
```



```
predKNN <- predict(knnMod, testingSet)
length=length(testingSet$Class_Type)
sumKNN <- sum(predKNN==testingSet$Class_Type)
```

```

accuracy_KNN <- sumKNN/length

predDF_3 <- data.frame(predKNN,
                        TYPE=testingSet$Class_Type)
accuracy_KNN
## [1] 0.5

```

Using K-Nearest Neighbor, the prediction accuracy improved from roughly 36% using 23 classes, to 67% using 12 classes, but we can do better by examining those sample IDs again.

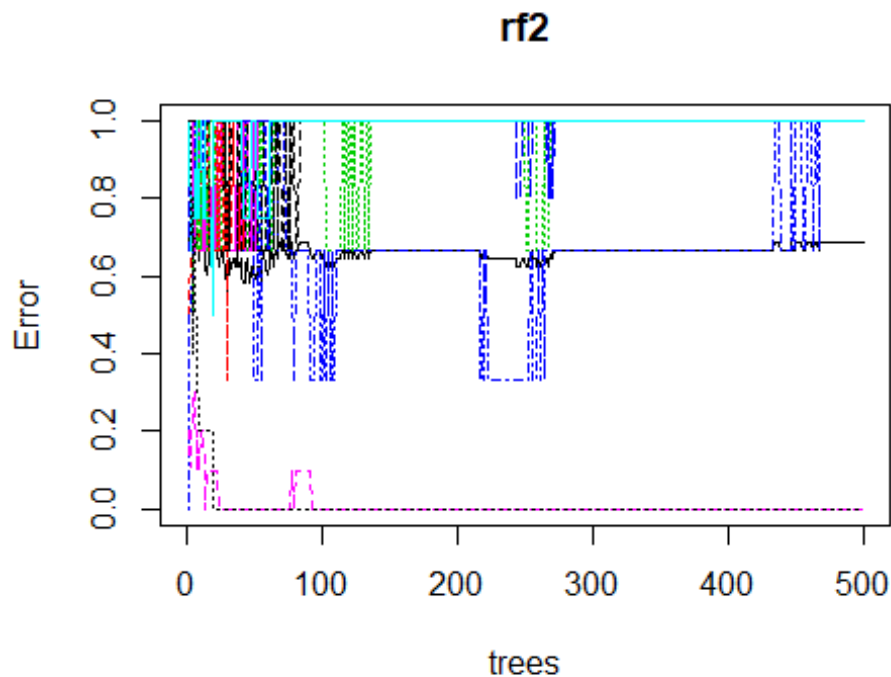
The Random Forest algorithm, with differences by default than the random forest model in the caret package used previously.

```

rf2 <- randomForest(Class_Type~., data=trainingSet)

plot(rf2)

```



```

predRF2 <- predict(rf2, testingSet, type='class')

sum <- sum(predRF2==testingSet$Class_Type)
accuracy_RF2 <- sum/length
accuracy_RF2

```

```
## [1] 0.6666667
```

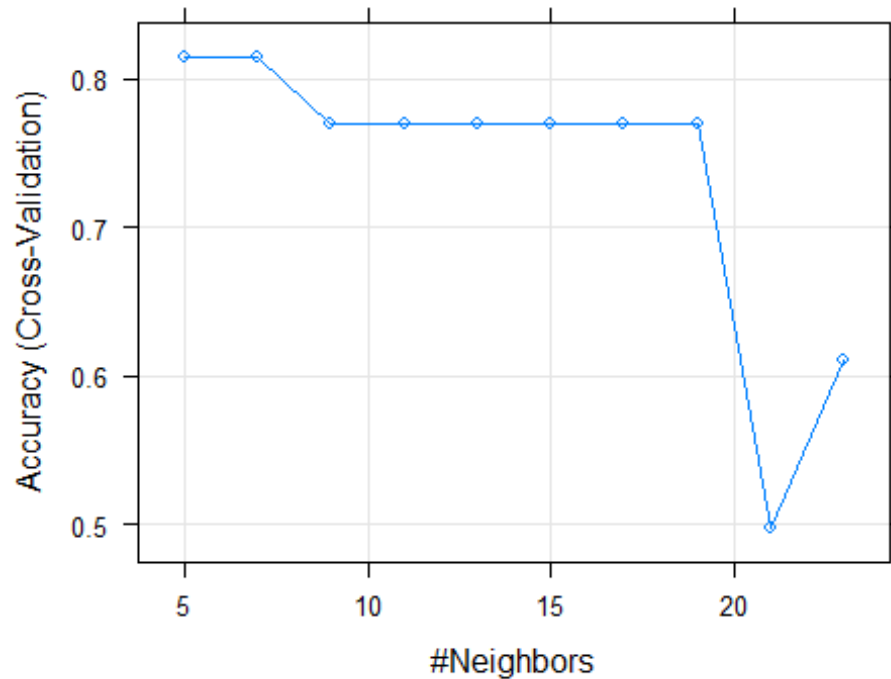
The Random Forest algorithm from the RandomForest R package scored the same as the KNN algorithm with the caret package. And using 12 levels of classes to classify.

Now, let's change the flu non immunized to 'healthy', the flu with antibiotics to its own class, the flu without antibiotics to its own class, combine the Hemo males and females, and keep the tetanus immunized as its own class. Then see how well the prediction accuracy improves.

```
Hemo2 <- FHT_HemoOnly[grep('Hemo', FHT_HemoOnly$Class_Type),]  
Hemo2$Class_Type <- 'Hemochromatosis'  
FluAntb <- FHT_HemoOnly[grep('Flu Immunized Plus', FHT_HemoOnly$Class_Type),]  
FluAntb$Class_Type <- 'Flu Vaccine and Antibiotics'  
FluOnly <- FHT_HemoOnly[grep('Flu Immunized Only', FHT_HemoOnly$Class_Type),]  
FluOnly$Class_Type <- 'Flu vaccinated only'  
healthy <- FHT_HemoOnly[grep('healthy', FHT_HemoOnly$Class_Type),]  
healthy$Class_Type <- 'healthy non-immunized 18-45 year olds'  
tetn <- FHT_HemoOnly[grep('Tetan', FHT_HemoOnly$Class_Type),]  
  
NewDataHemo_ML <- rbind(Hemo2, FluAntb, FluOnly, healthy, tetn)  
unique(NewDataHemo_ML$Class_Type)  
  
## [1] "Hemochromatosis"  
## [2] "Flu Vaccine and Antibiotics"  
## [3] "Flu vaccinated only"  
## [4] "healthy non-immunized 18-45 year olds"  
## [5] "Tetanus Immunized"
```

So now there are five classes to predict if a blood sample was healthy non-vaccinated, flu vaccinated, flu vaccinated with antibiotics, hemochromatosis, or tetanus immunized. Let's see how well KNN and random forest do with fewer classes to predict. The last results were 67% with 12 classes, and 38% with 23 classes for KNN.

```
inTrain <- createDataPartition(y=NewDataHemo_ML$Class_Type, p=0.7,  
list=FALSE)  
  
trainingSet <- NewDataHemo_ML[inTrain,]  
testingSet <- NewDataHemo_ML[-inTrain,]  
  
set.seed(123)  
write.csv(NewDataHemo_ML, 'NewDataHemo_ML.csv', row.names=TRUE)  
  
knnMod <- train(Class_Type ~ .,  
method='knn', preProcess=c('center', 'scale'),  
tuneLength=10, trControl=trainControl(method='cv'),  
data=trainingSet)  
plot(knnMod)
```



```

predKNN <- predict(knnMod, testingSet)
length=length(testingSet$Class_Type)

sumKNN <- sum(predKNN==testingSet$Class_Type)

accuracy_KNN <- sumKNN/length

predDF_3 <- data.frame(predKNN,
                        TYPE=testingSet$Class_Type)
accuracy_KNN
## [1] 0.9230769

```

Using K-Nearest Neighbor, the prediction accuracy improved from roughly 38% using 23 classes, to 67% using 12 classes, and to 92% using 5 classes.

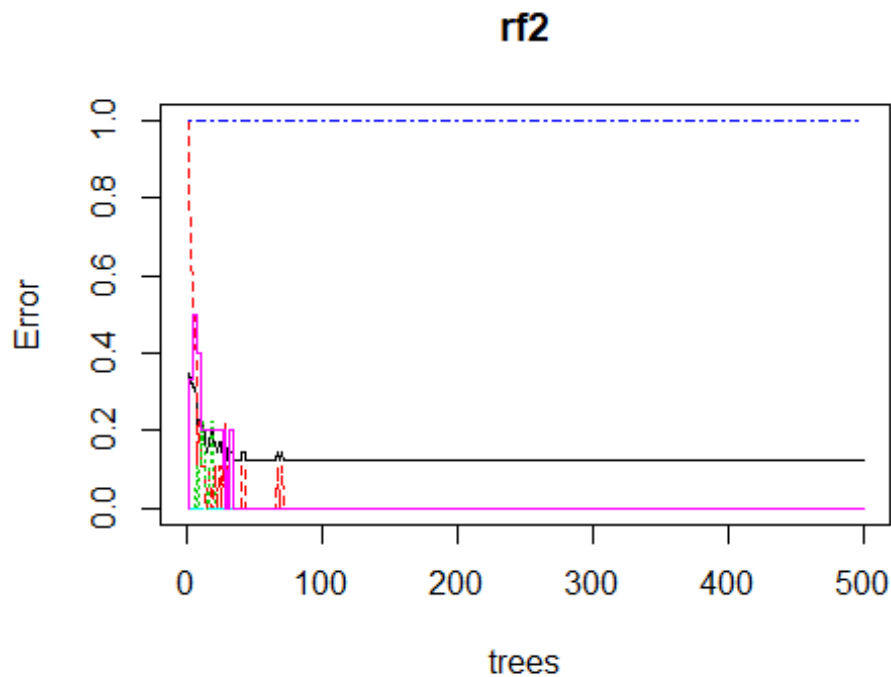
The Random Forest algorithm, with differences by default than the random forest model in the caret package used previously.

```

trainingSet$Class_Type <- as.factor(trainingSet$Class_Type)
testingSet$Class_Type <- as.factor(testingSet$Class_Type)
rf2 <- randomForest(Class_Type~., data=trainingSet)

plot(rf2)

```



```
predRF2 <- predict(rf2, testingSet, type='class')

sum <- sum(predRF2==testingSet$Class_Type)
accuracy_RF2 <- sum/length
accuracy_RF2

## [1] 0.9230769
```

We can see that the models were improved significantly in predicting the five classes from 12 and from 23 classes using the same KNN and random forest R algorithms. The KNN jumped from 67% to 92% and the random forest increased from 67% to 92% as well. The data had 54 observations and 74 features in total, which were the genes found with the least and most expressed using fold change in the males and females with hemochromatosis and filtering for unique genes.

Now use the H2O ML package.

```
library(h2o)
h2o.init(nthreads=-1, max_mem_size="2G")

## Connection successful!
##
## R is connected to the H2O cluster:
```

```

##      H2O cluster uptime:      23 minutes 25 seconds
##      H2O cluster timezone:    America/Los_Angeles
##      H2O data parsing timezone: UTC
##      H2O cluster version:     3.28.0.2
##      H2O cluster version age:  11 days
##      H2O cluster name:        H2O_started_from_R_m_wkq150
##      H2O cluster total nodes:  1
##      H2O cluster total memory: 2.00 GB
##      H2O cluster total cores:  2
##      H2O cluster allowed cores: 2
##      H2O cluster healthy:      TRUE
##      H2O Connection ip:        localhost
##      H2O Connection port:      54321
##      H2O Connection proxy:     NA
##      H2O Internal Security:    FALSE
##      H2O API Extensions:       Amazon S3, Algos, AutoML, Core V3,
TargetEncoder, Core V4
##      R Version:                R version 3.6.2 (2019-12-12)

h2o.removeAll() ## clean slate - just in case the cluster was already running

D = h2o.importFile(path = normalizePath("NewDataHemo_ML.csv"))

##      |
|
|
|=====| 100%

#h2o.summary(D) would print the summary stats of these 251 features

data = h2o.splitFrame(D, ratios=c(.7,.15),
                      destination_frames = c("train", "test", "valid"))
names(data) <- c('Train', 'Test', 'Valid')

multinomial model

m1 = h2o.glm(training_frame = data$Train, validation_frame = data$Valid,
             x = colnames(data$Train)[2:74],
             y = 'Class_Type',
             family='multinomial',
             solver='L_BFGS')

## Warning in .verify_dataxy(training_frame, x, y): removing response
variable from
## the explanatory variables

##      |
|
|
|====| 6%

```


|
|=====| 100%

```
h2o.confusionMatrix(m1, valid=TRUE)
```

```
## Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
##                               Flu Vaccine and Antibiotics
## Flu Vaccine and Antibiotics           2
## Flu vaccinated only                   0
## Hemochromatosis                       0
## Tetanis Immunized                     1
## healthy non-immunized 18-45 year olds  0
## Totals                               3
##                               Flu vaccinated only Hemochromatosis
## Flu Vaccine and Antibiotics           0           0
## Flu vaccinated only                   3           0
## Hemochromatosis                       0           5
## Tetanis Immunized                     0           0
## healthy non-immunized 18-45 year olds  0           0
## Totals                               3           5
##                               Tetanis Immunized
## Flu Vaccine and Antibiotics           0
## Flu vaccinated only                   0
## Hemochromatosis                       0
## Tetanis Immunized                     0
## healthy non-immunized 18-45 year olds  0
## Totals                               0
##                               healthy non-immunized 18-45 year
olds
## Flu Vaccine and Antibiotics
0
## Flu vaccinated only
0
## Hemochromatosis
0
## Tetanis Immunized
0
## healthy non-immunized 18-45 year olds
0
## Totals
0
##                               Error    Rate
## Flu Vaccine and Antibiotics    0.0000 = 0 / 2
## Flu vaccinated only            0.0000 = 0 / 3
## Hemochromatosis                0.0000 = 0 / 5
## Tetanis Immunized              1.0000 = 1 / 1
## healthy non-immunized 18-45 year olds    NA = 0 / 0
## Totals                        0.0909 = 1 / 11
```

Using the H2O GLM algorithm, for error accuracy, the flu and hemochromatosis samples produced 100% accuracy, but the tetanus and healthy non-immunized had error rates of 33% for tetanus immunized in this training and validation set, and 100% error for the healthy non-immunized samples. This GLM model had an error of 2/11. This gave the H2O accuracy in prediction with five classes an 82% accuracy.

2/11

```
## [1] 0.1818182
```

9/11

```
## [1] 0.8181818
```