R Boot Camp Problem Set

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Establishing reliable biomarkers for assessing and validating clinical diagnosis at early stages of Parkinson's disease is crucial for developing therapies to slow or halt disease progression. This data set uses whole blood gene expression profiling from over 500 individuals where we will attempt to find a gene signature. This repository contains the gene expression profiles collected in the GENEPARK consortium. The main study sought a classifier for IPD. These data contain 233 healthy controls, 205 IPD patients, and 48 patients with other neurodegenerative diseases (NDD). Other samples are available in the data and can be used for additional analyses. The largest class of these additional samples are 22 samples from genetic unaffected controls and 41 genetic PD patients.

Note: the original study which uploaded this data to NIH Geo is not yet published.

Data Wrangling

Let's start by loading in our data sets. Download these from the canvas site, and make a new folder for R bootcamp. We'll switch to this directory here.

The tinyTex package will allow you to actually knit .pdf documentats from RMarkdown:

Note that we have both a phenotype file, as well as a file which includes the normalized and log transformed expression values. We can use the read.csv function to load in these files.

```
pheno <- read.csv("/Users/kevinrouse78/Desktop/QBS 103/Final Project/parkPheno.csv")
expr <- read.csv("/Users/kevinrouse78/Desktop/QBS 103/Final Project/simulatedData.csv")
```

We should start by summarizing both these files. Try the following functions: head(), and View(). Note that while the dimensions on our phenotype file are reasonable, we have 552 columns in our expression file. Just summarize the first 10 columns of this file.

```
head(pheno)
```

```
##   geo_accession submission_date last_update_date type      tissue     organism
## 1    GSM2631171     May 17 2017      May 20 2017  RNA Whole blood Homo sapiens
## 2    GSM2631309     May 17 2017      May 20 2017  RNA Whole blood Homo sapiens
## 3    GSM2631219     May 17 2017      May 20 2017  RNA Whole blood Homo sapiens
## 4    GSM2630775     May 17 2017      May 20 2017  RNA Whole blood Homo sapiens
## 5    GSM2631147     May 17 2017      May 20 2017  RNA Whole blood Homo sapiens
## 6    GSM2630853     May 17 2017      May 20 2017  RNA Whole blood Homo sapiens
##   subject_id disease_label     sex mutated_pd_genes age_at_exam age_at_symptoms
## 1      L2899   ATYPICAL_PD    Male             NONE          NA              53
## 2      L2872   ATYPICAL_PD    Male             NONE          NA              64
```

```
## 3      L2131   ATYPICAL_PD    Male             NONE          NA              NA
## 4      L2573           CBD  Female             NONE          NA              60
## 5      L2697           CBD  Female             NONE          NA              66
## 6      L3031       CONTROL    Male             NONE          NA              41
##   updrs updrs_ii updrs_iii_score_on updrs_iii_score_off updrs_iv hoehn_yahr_on
## 1     1        4                 19                    0        0             2
## 2     0        0                  0                    0        0             9
## 3     0        0                  0                    0        0             0
## 4     0        0                  0                    0        0             9
## 5     0        0                 30                    0        0             9
## 6     0        0                  1                    0        0             8
##   hoehn_yahr_off moca_score
## 1              0         21
## 2              0          0
## 3              0          0
## 4              0          0
## 5              0          0
## 6              0         30
```

```
head(expr,10)
```

```
##     X GeneName GSM2631171  GSM2631309 GSM2631219  GSM2630775 GSM2631147
## 1   1     A1BG -1.0366136 -0.27662929 -2.6292442  1.52266682  0.3358301
## 2   2 A1BG-AS1 -0.8753413  0.54284119 -1.4575540  0.69927167  2.4918360
## 3   3     A1CF  1.2650380  0.07009968  0.7666068  0.02032404  2.5133798
## 4   4      A2M -1.1735898 -1.61353987  0.3632498 -1.22731028  0.3997275
## 5   5  A2M-AS1  1.2247663 -0.93452615  0.4948203  0.75509020  1.7236542
## 6   6    A2ML1 -0.4382954  0.51954673  0.2610932 -1.54324974  1.4411747
## 7   7    A2MP1  3.2851995 -1.44529094  1.9451148 -1.37177595  0.7558682
## 8   8   A4GALT  1.2079401  2.67892104  1.3698828  0.85893047  0.5298866
## 9   9    A4GNT -1.1412399 -1.40679284 -0.7431315 -0.58716951  1.2491990
## 10 10     AA06  0.3092303 -1.91521093 -1.4380664  0.77570705  1.4594648
##     GSM2630853 GSM2630769  GSM2631196 GSM2631194 GSM2631197 GSM2631195
## 1   0.97332552  3.4533159  1.81379834 -1.9211147  0.7257764  0.6575387
## 2  -1.30756851  1.5772826  4.00922478  0.4967702 -0.3360566 -1.5340809
## 3   1.82584774  1.4629778  1.01145195  0.4692595 -0.3195250  1.2800251
## 4   0.86599329  0.2364756 -0.87955380  0.4852329 -1.8378022  1.2444026
## 5  -0.22818120 -2.0413473  0.59855387  1.1834725  1.5956586 -1.8124371
## 6   0.01398596 -0.7479307 -0.07684364 -0.4987176 -0.1837047 -1.9271727
## 7  -2.81229684 -3.9922871  1.29577092  0.8054886  2.3211813 -1.6478297
## 8   1.69213388 -1.4793768 -1.25656494 -1.2463617  0.4741902  2.6318294
## 9   0.48280355  2.2612409 -0.75372407 -2.2630838 -0.6081893 -0.2258280
## 10  0.01830108  1.9274289  4.19638881 -0.6106920  0.8404534 -0.1942755
##     GSM2631198  GSM2631306  GSM2631162  GSM2631172 GSM2631241 GSM2631252
## 1  -0.91583986 -0.84655288  1.17912789 -3.91968778  0.4744313 -2.0468679
## 2   1.05406203  1.26922525  1.49600825 -0.16006865 -0.5493613 -0.6329077
## 3   0.05179562 -0.61375284 -0.67896078 -0.67247680  1.0463665 -1.9405701
## 4   0.99429936  0.03649272 -0.90764109  1.02033109 -0.7038708 -0.5943931
## 5  -1.54911402  0.24188310 -0.95716132  0.74200518 -1.2601389  0.7727551
## 6   0.87524246 -0.43301581  1.92972953 -0.78853340  0.6856696 -1.6556987
## 7   4.08440846  0.86973096 -0.55601841  1.47711423  0.8603296  0.3056335
## 8   0.73131494  2.09845398 -1.17563821  0.06547123  1.4450885 -0.5249494
## 9   1.18739538  0.73640241 -0.03527526 -0.61277611  0.3313171 -0.5779571
## 10  0.12662467 -1.29816844 -0.94008978  0.31746815  1.9397035 -0.9109047
```

```
##     GSM2630927  GSM2630928  GSM2631227 GSM2631231  GSM2631235 GSM2631236
## 1   1.64638684  2.34946214 -1.28747722 -0.1375166 -2.64930848 -0.5211835
## 2   0.76567160  0.89185792  2.20784667  0.2789515 -0.15288028 -1.0366904
## 3   0.97085682 -0.71857321  0.02302333 -2.0125364 -1.64575408  0.8203788
## 4  -0.01985207  2.39436972 -0.27391520  3.0961026 -0.37190510 -0.5522156
## 5  -1.60393326 -1.07721967 -0.61419330 -1.1996913  2.39657548 -1.6125899
## 6  -0.21708071  1.22369389  2.52062795  0.7489049 -0.06606603 -2.3478171
## 7  -0.81852495  3.08002603  1.34742749  0.7256872 -1.27856983 -2.8642013
## 8   1.44543304  1.50670650  1.27316300  2.2294115 -1.05738533 -1.2177038
## 9   0.12978455 -1.23517114  2.56253631 -1.2093752  0.14377861  1.1856652
## 10  0.38520770  0.06296449 -1.42370880  0.5056275 -1.80439327 -2.8436696
##    GSM2631238  GSM2631239 GSM2631243 GSM2630771 GSM2630783 GSM2630830
## 1   2.3866101  1.49160533 -0.1782536 -1.6599626 -0.7384035  0.9146473
## 2  -0.4633186  0.66658410  0.5192995 -1.2771405  0.4070137 -1.4913926
## 3   2.4663765 -2.32907178  0.8769891  0.2966910  0.3015948  0.3285657
## 4   0.9172300  0.04663840 -1.4333307  1.1220820 -1.4973222 -1.1639669
## 5   0.1666942  0.14941678 -1.6651591 -1.2227057 -1.7475125 -1.2604841
## 6  -0.6764611 -1.41871630 -0.1474803  1.1937860  2.7291049 -0.8678376
## 7   0.4019931 -1.32667977 -1.1203738 -0.2780517  1.5720485 -1.9512447
## 8   0.4030763  1.72279983 -0.7655453  2.0447482  1.4964231 -0.4541787
## 9  -0.3209111  0.04684471  1.2333573 -0.7467021 -0.9521281 -0.4756290
## 10  0.3325739  1.25516934 -1.8362962  1.3691804  0.8458574 -0.5712672
##     GSM2630857    GSM2630868 GSM2630818 GSM2630907  GSM2630909 GSM2630916
## 1   1.38723172  2.0282589115  0.2867639 0.87655032  2.08729263  1.3751344
## 2   0.31651129 -0.1954580107  2.6901454 0.18532550 -1.37467254 -1.5710871
## 3  -0.32255513 -2.2136408014  0.2940256 1.90856767 -2.50835849  0.7822219
## 4   0.31919656 -1.5002781106 -0.2019019 1.32127645 -1.74592908  0.0169678
## 5  -1.59258362  1.3021516710 -3.1433825 0.33617513 -0.85923943 -1.2375982
## 6  -0.07839134 -0.0004901291  0.2447780 0.58874523 -0.03101765  0.3052142
## 7   0.08202354  0.5220514189 -1.2991054 0.09878648 -1.44379240 -0.5852495
## 8  -0.18557021  0.5967570668 -1.0899284 2.48200881  0.08384573 -1.8994663
## 9   1.47899573 -1.7354873790 -1.7860583 0.49028132  0.21137466 -2.4235473
## 10  0.47406287 -1.8248224870 -2.3850390 1.29625718 -0.27335754 -1.5452844
##    GSM2630923  GSM2630925  GSM2630929  GSM2630930    GSM2630932   GSM2631221
## 1  -1.0568484 -0.29582834 -2.10300595 -0.04158138  1.2354445734  0.945052270
## 2  -2.8557396  1.34695235 -1.82135528 -0.38894496  0.0071051808 -1.090033105
## 3  -2.2953350 -3.84220523  0.73112033  2.15930231  2.1235227231 -1.135663786
## 4  -2.5227859  0.91959789 -0.33096684  0.62955475  1.2427952651  0.004803398
## 5   0.1887502  1.29959067 -0.01940292  0.73045524 -1.4692743866 -1.795355641
## 6  -0.6726640  1.16711101  0.48598974  2.22099957  0.0002136866 -1.077369034
## 7  -0.1525330  1.62933660 -0.44100072 -0.91776530 -0.7187750676 -1.833579596
## 8  -1.0558191  2.60989403  0.36004520 -0.12061674 -0.4145453435 -3.009054088
## 9   2.3298560 -0.04110741 -1.35026254  1.64007362  0.5347242581  1.476901568
## 10 -1.8694250  1.34488387 -2.25899044  0.64651595 -0.1763053048 -1.577698207
##    GSM2631230 GSM2631232  GSM2631234  GSM2631237 GSM2631240 GSM2631242
## 1  -1.9297252  0.1310315  0.30293246  0.93292405  0.2450774 -2.2010466
## 2   0.4064769 -0.6413753 -1.88399454  0.97608066  0.4029095 -2.0829699
## 3  -0.2278403  1.0109173  0.17615901 -0.09362843 -0.2220153  0.6564502
## 4  -0.4513778 -0.2036200 -1.44646132 -2.10500710  1.4502341  0.9879688
## 5   1.0710448  0.1302830 -2.64104271 -0.15299668  0.0286268 -0.6600126
## 6   0.1596775 -1.0913582  1.09658718  0.01632357 -1.4416563  2.6812462
## 7   1.1044553 -1.1366979 -0.61789096 -1.79828837 -1.5621787  0.8563066
## 8   1.3353919  0.3183621  1.76631135 -0.69669024  2.8873655 -0.8489388
## 9   2.2298172  0.9669922 -0.01212299 -0.52462694 -0.5538449  1.5206822
```

```
## 10 -0.3036707  2.1875913 -1.45301289 -1.52038292  0.3140559 -2.9503693
##      GSM2631248 GSM2630899 GSM2630905  GSM2630906  GSM2630917 GSM2630922
## 1   0.078728181 -0.5619655  0.8303993 -0.24152334 -0.04881529  2.4694273
## 2  -1.474817321 -0.9276068  1.3494852 -0.52145494  0.65227447  2.6459861
## 3   0.582238081  1.1728327  1.4226776 -1.05983269  0.52152354  2.5326991
## 4  -0.056217463  1.0841522  1.2791545  0.09251289  0.35721429 -0.6689961
## 5   1.156994408 -1.0304385  0.1649847  2.18569789 -0.52206253 -4.1137056
## 6  -1.043205457 -0.5379009  0.4572370  1.08616722 -0.92926893 -0.9148150
## 7   0.009098796  1.2708930 -0.4847301 -1.73746881 -0.73737002 -0.9313105
## 8   0.325589754  0.7174057 -0.1181506  0.62777540  1.89001828 -0.9713107
## 9   1.698378536  1.9172282 -0.9831040 -3.34364680 -0.59978554 -1.3167763
## 10  0.940491689  1.9949470  0.2082255 -0.29146136 -1.42994551  1.2642086
##    GSM2630924 GSM2631298 GSM2631300 GSM2631301 GSM2631304 GSM2631305 GSM2631310
## 1  -0.2634438 -2.4041004  0.4142408  2.3051650  1.2032466  0.3102905  1.7362371
## 2   0.5821107  1.2034354  0.6377265  1.4346190  2.6897943 -0.1815019  0.6370929
## 3  -0.2391859  0.1616847  0.9017189  2.4009772 -2.0181330  1.0952450  1.6810226
## 4  -0.5378807 -0.6081584 -2.3985431 -0.1928422  2.1144050  0.4915416 -2.0634988
## 5  -1.2505132  0.9835483  1.4162336 -3.5037736  1.2611128 -0.7937164 -0.7809311
## 6   1.5600256  1.2264029  0.7266947  3.9301177  0.5370959  1.5592591  1.1318930
## 7   1.5653279 -1.4195627  1.1392734  1.5733792  0.4867787  2.2221329  1.7429192
## 8  -2.0606453 -0.5257079 -0.8981559  1.0471418  1.0250869  1.8531091  1.2828056
## 9   0.9225962 -1.4628347  1.4093250  1.9753967 -2.5402363 -0.6037134  0.8816555
## 10 -1.6130990 -0.9582852 -2.1752551  0.2078266  2.3850840  0.2101043  0.2405369
##    GSM2631312  GSM2631152  GSM2631153 GSM2631158 GSM2631159  GSM2631161
## 1  -1.4367006 -0.72592990  1.66561611 -1.2741775  0.5933994  2.69854110
## 2  -0.4128298 -2.29867241 -1.27274431  0.3678687 -1.2929641  1.80110090
## 3   1.5093923  2.07877411 -1.08143804 -0.7687855 -0.1583923 -0.21089494
## 4   1.1022631  0.47757174  0.97263681  1.4798518  1.8658899 -2.30680656
## 5   2.0441711  2.39637960  1.05361092  1.4657355 -1.0820489 -0.07070203
## 6  -1.4997471 -0.09733715  0.40415672  1.0818082  0.7551520 -0.35814807
## 7   0.6436074  0.85282350  0.28387687  1.9634189  2.6470102  1.17479864
## 8   0.8786408 -1.10402346  1.37539655 -0.1164292  0.3022390  1.25040011
## 9  -1.3700181 -3.09456313 -0.35773722  1.6968603  1.1530476  1.84719207
## 10  1.1201369 -1.36447577 -0.05028964 -0.8940912  0.3756658  1.90240431
##     GSM2631163 GSM2631165 GSM2631167 GSM2631175  GSM2631176 GSM2631177
## 1  -1.25297257 -0.1222497 -1.0789216  1.5665290  0.99871115  0.1889327
## 2  -0.78758624 -0.5373867  0.3892825 -2.0829855 -2.16717950 -1.2980895
## 3   4.05260964 -1.1355584 -0.9998817  1.0559839  0.86282082  0.6923748
## 4  -1.66847828  0.3718242 -2.7818915  2.2347142  1.01160928 -0.4044052
## 5  -1.01998782  0.2939756  0.5576378  0.8806920  0.68944848 -1.7259526
## 6  -1.05835117 -0.3863178 -1.5446292 -0.7098110  2.03769336 -1.5553287
## 7   0.58344448  1.1699378  0.8620785  0.7947427  0.34383573 -2.5299089
## 8  -0.30032373  0.3206783 -2.1270845  1.0918564 -2.38048315 -0.4323905
## 9  -3.05081459  0.6631333  1.3448637 -0.1860938  0.46395106  0.9307407
## 10  0.09935478  0.4706144 -3.3768615 -0.8162749 -0.01087197  0.3769182
##     GSM2630777 GSM2630788  GSM2631173  GSM2630908  GSM2630787 GSM2630790
## 1  -2.57214026  2.3263281  1.14330877  0.33480168  1.88952065  1.3762785
## 2  -1.20746737  1.8176666 -1.00868577 -2.13654681 -0.35119117 -0.4478314
## 3   0.05547596  1.9799421 -1.42092396  2.58002782 -2.18349455 -2.3061270
## 4  -0.25345266  0.1262320  0.46002738  1.13479164 -0.97404785  0.4491862
## 5  -1.51679548 -0.8335691  0.36480581 -0.07249906 -0.21075807  0.2913374
## 6   0.80176416  2.2422168 -1.37545874 -1.66898638  3.25938011  1.1504076
## 7  -0.08802850 -1.6714207 -0.97578852 -0.55600780 -0.58925431  1.3703793
## 8  -0.03232778 -0.3007416  0.02083894  2.33113428 -0.08180881  1.5291663
```

```
## 9   1.71637918  0.2502072 -0.48660291 -2.77942232  1.83968617  2.0325688
## 10  3.26291950  1.8341935 -4.39346323 -0.46485721  0.86827931 -0.4689690
##     GSM2630810 GSM2631138  GSM2631028  GSM2631287 GSM2631100   GSM2631056
## 1  -0.74705084  2.5770894  0.52698585 -0.40755485  2.3157312  0.008797516
## 2  -1.29001456 -1.7157469  2.20410107 -0.50654069 -2.3643848  1.637490214
## 3  -0.30136830 -0.8003415  0.78370739  0.65126507 -1.4705216 -0.107786530
## 4   0.09954752 -1.4483073  0.01856317  0.89494062  1.8185474 -0.857038646
## 5  -1.03057215  1.9680884 -0.62248236 -0.88625227  1.4138548  0.712979748
## 6  -1.75377378  1.5024215  1.47218901  1.91371396  1.5735769  1.899656047
## 7  -0.63341981  2.1511312 -1.24216440  1.53970848 -0.1551754  0.678167999
## 8   0.97693052 -0.3275231  1.13390226 -0.48187085  0.5963074  1.024593943
## 9  -1.51045508  1.8576715 -0.06613709 -0.05907669  0.2133768  2.482909479
## 10  0.37887217  0.2892563  0.98807436  2.71079821  2.9231436  2.283939436
##    GSM2631118  GSM2631025  GSM2631281 GSM2631039 GSM2631057 GSM2631110
## 1   0.9740736 -0.14549094 -1.73513049  0.3808066 -1.5458882 -3.0564501
## 2  -1.3569627  0.84664460  0.59478051  1.2028405 -0.6623765  1.5138483
## 3  -0.8652369  0.01782888 -2.53239110 -0.4115594  0.4554766 -0.5420236
## 4   1.0411629  0.23380696 -1.81550500  0.1217753  1.3740148 -0.1332096
## 5  -0.5784515  0.79508014 -1.70031549  0.6344448  0.9252425 -1.0453155
## 6   0.3787707 -1.34104537  1.75121499  0.8523116 -0.1901621 -0.1564972
## 7   0.7906738 -1.93768751  0.07981374 -0.5999431 -1.5786920 -0.9019048
## 8  -2.1681699 -1.92581546 -0.28639995  1.2359267  0.5753791  0.6531896
## 9  -1.5075211 -2.27042828 -0.60123440  1.0769852 -1.8465069 -2.0754546
## 10 -0.3245963 -0.53422881 -2.79047310  3.3624974  1.0183714  0.3255244
##    GSM2631010  GSM2631102 GSM2631103  GSM2631017 GSM2631143 GSM2631024
## 1   0.6290531 -0.59629003 -0.5823345 -0.87853228 -1.7813371 -1.9767790
## 2   3.3469296 -0.65688493 -0.5830482  0.07439874 -0.4595939 -0.4162442
## 3   1.8493693 -1.18571877  1.6540798 -0.48347565  1.2879970  0.3310463
## 4  -0.1180980 -0.02744244  1.2625902 -2.33379235 -0.1357224  0.3258514
## 5   3.8906284 -2.30940390 -0.1582876  0.28988425 -1.0916108 -0.8019365
## 6   0.5843132  0.76503528  0.7188814  0.80314671 -1.4096304  1.8122266
## 7   0.8517269 -0.18139756 -0.1416783 -2.11421382 -0.7747713 -0.3159705
## 8  -0.6224056  2.67327892 -0.8483592  0.08229721 -0.2724185  1.7560624
## 9  -1.2566085 -0.93901927 -0.5817937  2.38222285 -0.3923834  1.7407895
## 10 -0.3981583  0.28013147  1.7988176 -1.99426160  0.4107726  0.3262523
##    GSM2631091 GSM2631275  GSM2631061  GSM2631273 GSM2631027  GSM2631101
## 1  -1.4422440  2.5379420  0.07145703  1.62539002 -0.5252060  0.38358051
## 2   0.3061578  2.0518596 -1.06527536  1.07325558 -0.3886405  0.01148672
## 3   0.2365571 -0.1488802  1.13474823  0.97976986 -2.5120573  0.76669521
## 4   1.2145831 -2.3105343 -1.51628874 -1.19772226 -0.6401546 -1.09335145
## 5  -1.2614718 -0.7845362 -0.68313960  1.26814376  0.4962858  1.62720997
## 6   1.1655381 -0.2559388 -0.34840860 -0.54398113 -1.1232809  0.24317858
## 7   1.4878699 -1.2978887 -0.92145825  0.36469594  0.4577257  0.07210199
## 8  -0.5404244 -1.3573007  0.14610873  0.03835789 -0.3219301 -2.94267538
## 9  -1.5459271  0.7791115  2.64537115 -0.19823856  0.4672313 -2.30410567
## 10  0.4035588  1.0087100 -0.14364960 -0.63547564  0.1233820 -1.24138226
##    GSM2631043  GSM2631125 GSM2630980 GSM2631031  GSM2631130  GSM2631065
## 1  -1.7799365 -1.72614200  0.7246159  0.6261896 -0.29874524 -0.70032978
## 2  -1.1526044 -0.82240507 -2.9806320  0.5489321  1.21215898  1.01536201
## 3  -1.4211508 -0.31830012  1.3330879 -2.1587893  3.82549650  0.28188325
## 4   0.3594610  1.37195629 -1.7138857 -1.6569751  0.91585804  2.83442160
## 5   1.0765254 -1.02319485  0.5132847 -0.3278649  0.45318630  0.72421295
## 6  -1.5155467  0.72473120 -0.5224958  1.3821682 -0.07073392 -0.34801746
## 7   0.5858839 -0.33940346 -0.8228332 -0.8126910  2.21707654  2.15422882
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## 8  -2.0041797  0.40797175 -2.6350327 -1.8834525  0.57552220  1.15800139
## 9  -1.0274757  1.78975600 -0.8887713 -0.4166241  1.57810920 -1.18454273
## 10 -0.2561347  0.04310359 -3.4823253 -0.5898263  2.17338316  0.07613158
##    GSM2631105  GSM2631032   GSM2631082  GSM2631029   GSM2631109 GSM2631005
## 1  -0.0130223 -2.01464502 -0.005375429 -0.00657707 -0.176132999 -1.2703050
## 2  -0.1671471  0.01481410  0.617685172  0.59296794 -0.488867920  1.7564457
## 3   2.8488830  1.40958337  0.876435907  0.62688123 -0.008372826  0.1633467
## 4   1.8624700  0.25772950  2.735238068  1.11879834 -0.487787580  1.3388416
## 5  -1.9804688  1.80949369  0.733913196  0.78404326 -0.335284994  2.5598942
## 6  -0.4300965  0.76926397  2.007983514 -0.71612239 -1.017798100 -0.1120748
## 7  -0.6140522 -0.85008441  1.624562766  1.87094815  0.349361659  0.3725715
## 8   2.2604858  1.88381554  0.098909757  0.47197966  2.657189522 -0.4856543
## 9   2.1441381  0.34570554 -0.120242867  2.02640887  0.015369337 -0.6819524
## 10 -0.1885102 -0.06276323  1.456184231  0.69555731  2.111167727 -0.1488553
##    GSM2630961 GSM2631280  GSM2631289  GSM2631131   GSM2630990 GSM2631126
## 1  -1.7383726  0.6542143 -0.45374436  1.95975513 -0.006288985 -0.1486120
## 2  -1.0078234 -1.1817298 -0.34548552 -0.81112795 -0.812004639 -0.6701084
## 3  -1.5899370 -2.2073443  0.42800943 -2.29692034  0.287382440  0.2404943
## 4   0.3850796 -2.3433585 -1.14954643  0.41457100  1.604406773 -0.9202510
## 5  -1.7941523  0.4791979 -2.24682356  0.71339273 -0.320995441 -0.2702325
## 6  -0.1882884  0.6157505 -0.84010644 -1.79972614  0.478528813 -0.6732020
## 7  -1.3240018 -0.3051590  2.85894632 -1.55247718  0.845555382 -0.5820609
## 8   3.3118656  2.3025934 -0.06992666  0.06022229  0.500620013 -1.3224205
## 9   0.6864900 -1.5878588 -0.23142205  0.48408790 -0.322301662  0.3749663
## 10  3.0058866 -0.6965040  1.37268607 -1.89509398  0.878122145 -1.6003043
##    GSM2631047   GSM2631180 GSM2631049  GSM2631276  GSM2631038  GSM2631041
## 1  -1.6657266  0.574442802 -0.0414362  2.68494702  0.52380115  1.42444199
## 2   1.3709726 -2.667689592  1.2857053  0.67557808 -0.39117463 -0.31383525
## 3   0.4195041  0.818617982  1.8774089 -1.24893863  1.49877145 -0.50102608
## 4  -0.7035831 -1.162276958 -1.4313841 -1.69070048  0.90094781 -0.31815564
## 5  -1.1184597  2.210427062  1.6951576 -1.64423825 -2.59056113  0.34238483
## 6  -0.6898093  0.635448373  2.2645528 -0.82261257 -0.82367714 -0.09696512
## 7  -1.3125161 -2.096276488  1.8593372  0.88763894 -0.08574386  0.60723760
## 8  -2.2584028 -0.370194543 -1.0286846  0.39475944  0.40111600  0.30153683
## 9  -0.8265418  0.009757406  1.0000548  0.35465720  1.24379762 -1.49609209
## 10  3.4655929 -1.822858472 -0.5853424 -0.02013729 -0.68931268  0.01410851
##       GSM2631111 GSM2631059  GSM2631079 GSM2631012 GSM2631085  GSM2631077
## 1  -0.5133414771  0.6018857 -0.59678180 -1.3119656  0.1445498 -0.77824323
## 2   1.4802044962  1.2191924  1.10767081  0.7133019  0.9195574 -2.85381327
## 3   1.0171982274  3.2773973  0.80947622  1.2298903  0.0142644  0.82026203
## 4  -0.2945238057 -2.4237729  0.03434935 -0.5911419  0.5817370 -1.27141339
## 5  -0.7013252059  1.8971469  0.52884767 -1.6105446 -2.7723251  1.55938334
## 6   0.2438322824  2.1391033  0.77902942  0.9199876 -0.5829344  0.84125651
## 7   0.0006324812  1.3189535  1.38941458 -1.1601440  0.6380692  0.31245096
## 8   0.4333823916 -0.1532859  1.81616018  2.7718804  1.9014562 -0.14391817
## 9   0.0454249508 -2.9012124  0.18140417 -0.7125056 -0.9056830 -0.11995710
## 10  0.6672621432 -2.7274183  1.02279378  1.8336832 -0.4514591  0.01230845
##    GSM2630761 GSM2631022  GSM2631011 GSM2631136 GSM2630971  GSM2631279
## 1  -0.6621799 -1.4397310 -0.01079765 -1.3580874  0.6767844  0.24822362
## 2   2.4034807 -0.2855208 -1.01541055 -0.5620236 -0.2247734  2.13204451
## 3   2.9316805 -0.9566524  2.79936551  1.0335741 -0.3574654  0.18512102
## 4   1.4517983  0.2734970  0.63779439  0.8226159 -0.3449582 -0.07084703
## 5  -0.7030889  1.4760425 -0.69784088 -0.1664608  1.8601628 -3.15956761
## 6  -0.8365451 -0.4202488 -0.60715530  1.8582394 -0.9929007 -1.88047059
```

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## 7   0.9343358 -1.1624848  0.48464565 -0.7458869 -1.9927320 -1.48176575
## 8   0.6233383 -1.0850678 -1.63421866  0.7073238 -0.2936773  0.93167114
## 9   0.7792611  0.7912574  0.13006080  0.7856011 -1.5821283  0.94697336
## 10  0.3973076  1.2875803 -0.31347477 -0.4115412  1.4438693  1.51180594
##    GSM2631137  GSM2631185  GSM2631277   GSM2631072  GSM2631075 GSM2631026
## 1   0.5958569  1.97475013 -1.39450183  1.211791840 -1.85793278 -0.8569993
## 2   1.1550869 -0.85835870  0.40010379  1.647163140  0.40005541 -2.6325459
## 3   0.1622205  1.95118647 -1.62684370  0.379795128  0.03401872 -1.9535139
## 4   2.0315725  0.80873250 -0.57449777 -0.004533444  0.23779417  1.8222826
## 5   1.4847417 -1.46853176  1.15532100 -1.472630009 -1.46899056 -2.6350817
## 6   1.2446217  0.58253928 -0.70474519  0.128044702 -0.12248576  1.6260681
## 7   2.0410585  1.47520661  0.16745976  1.139635491 -0.98479349  1.6026886
## 8   0.6919425 -0.32458115 -0.59396127 -0.277477168 -1.75322100 -1.9533734
## 9  -0.8007770  0.60937949  0.07832227  0.571433001  2.02430831  3.1451479
## 10 -0.7608092  0.06739756 -1.69383171  0.176780291 -2.85174207  0.2222824
##    GSM2631064  GSM2631191 GSM2631084 GSM2631284 GSM2631042  GSM2631274
## 1   1.6575005 -3.69837788 -1.4998651 -1.7335238 -0.2508002 -0.19297860
## 2   0.9753336 -2.06325543  0.2677603  0.8322555 -0.1837639 -0.09181115
## 3   1.7832400 -2.52525359 -2.1364791  1.7778852 -0.1212560  0.11774514
## 4   2.5258067 -0.05292615 -2.7553230  1.0006457 -0.8630717 -2.30145875
## 5  -2.1917706  3.27001876 -1.3372618  1.9882784  1.6348581 -0.22869657
## 6  -1.0279670 -0.55488699 -0.1030791  0.7962318  1.0903450 -1.23370193
## 7   2.9896711 -0.95162192 -0.1692367  1.2709972 -0.3212874  1.00890325
## 8   3.3649050  0.59555649  0.2227083 -0.2257859 -4.7009674  1.50678920
## 9   0.2322138  0.70587870 -2.2229592  1.0543904 -1.8974638 -0.42802511
## 10 -0.1421977 -1.55920741  0.8043606  0.9099455 -1.5320475 -2.38182277
##     GSM2630774 GSM2630888  GSM2630910 GSM2631001  GSM2631015 GSM2630993
## 1  -2.04216993 -1.4737406 -0.49455264  0.4744007 -1.08237658  0.5954746
## 2  -0.05562984 -1.0135349 -0.61010286 -0.8384263 -0.01633685  0.2859204
## 3   0.95298645  0.1331115 -0.08088916 -0.8476263 -2.05198372  0.5947390
## 4  -1.35434587  1.2115518  0.61438292  1.3005096 -1.26011808 -0.8725275
## 5   0.08293144 -1.3751410  1.16766042 -1.3055796 -1.95834331  1.4441232
## 6  -1.56724976  1.3902641 -0.60315833  1.8454994 -1.37849863  2.1599959
## 7  -2.03733457  2.4908279 -0.11652767  0.1358659  1.24447512  1.7070684
## 8   0.14165176  2.4940270 -0.35273741 -0.6095593  1.03397635 -1.4068449
## 9  -0.70045193 -1.9096972  2.44928821 -4.4136219  1.77675673 -0.3689620
## 10 -0.37796826  2.1900528 -0.65674382 -0.7529053 -0.62117280 -0.8789689
##     GSM2631046 GSM2631112 GSM2631142 GSM2630984  GSM2631020  GSM2631033
## 1  -0.28099952 -0.5750774  0.8847492  0.8753416 -2.48354148  2.15835028
## 2  -0.10741767  0.3376264  1.0563840 -1.3219969 -0.50137259 -0.03706037
## 3  -2.12113865 -0.4001051 -1.4520147  0.5813996  0.17452569 -2.02068438
## 4   1.51273106  1.8170247  0.6928014  0.3711322  0.34691250  1.05804235
## 5   0.30092252  1.8997046 -3.2638935 -0.9294172  1.94922601 -0.41902617
## 6  -0.58155943 -0.9829718 -3.7769798 -1.6175987 -1.32154002 -2.53014029
## 7   2.34170787  0.1491123 -2.3050104 -1.4761437  0.04115781 -0.63444517
## 8   0.49745795 -0.6769792  1.0971346 -2.7813988 -1.56312718  0.49131923
## 9  -0.07225541  1.8571064 -2.6938808  0.4560372  1.37560111  2.43738524
## 10  2.01009915  0.1983636 -2.1260370 -2.2020505 -0.52915882 -1.02162961
##    GSM2631083 GSM2631076  GSM2631068 GSM2631037 GSM2631272  GSM2631278
## 1   0.8132632 -0.1665356 -0.45336088  0.7764306  0.2887474 -0.89689621
## 2  -1.5583816 -1.3671551 -0.11831075 -0.9382491  2.8599579 -1.74929736
## 3  -2.8634790  0.5530108  0.34090698 -2.0879133 -0.1957375 -0.45104950
## 4  -2.0311809 -1.6229216 -0.63544560 -1.7475981 -0.9689664  3.01481099
## 5   1.0803221  1.1208230 -1.46053974  0.2795217 -1.1435162  0.29201773
```

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## 6  -0.9779857  1.8359800 -1.47526325 -0.9769487 -0.5094334 -0.43775785
## 7  -3.7079980 -1.1697545  0.04264998 -0.7262174  1.2585200 -0.07583135
## 8  -1.9165946 -1.7321609 -1.84884742 -0.6527780 -2.8138253 -0.47814653
## 9   0.5381769 -2.0340148 -1.77200076 -1.6980759 -0.2938130  0.69143998
## 10 -0.9486619 -2.0895774 -3.85409342 -2.2091994 -0.7162288  1.81639048
##    GSM2631123  GSM2631073 GSM2631135  GSM2630855  GSM2630758  GSM2630800
## 1   1.6098799  2.30457342 -0.5139108  0.28827377  0.12803488 -2.78279194
## 2   2.8032541 -0.03736602  0.5825417 -1.88382470  1.27382314 -2.15053713
## 3  -0.5826275  1.30731740 -0.4037840  0.50733515  0.68600903 -0.07151086
## 4  -0.7770252 -0.49201201 -1.4054259 -0.29451766 -0.13684929 -3.41616641
## 5  -0.9885841  0.05869560 -1.4606700 -0.78832726  0.07768596  2.81996646
## 6   1.0975914 -0.40957281 -1.9623860 -1.10349865 -0.46828826 -1.44753150
## 7   1.2799809 -0.04850639 -1.3143614  0.50386697  1.43005294  0.48519647
## 8   1.0819725  1.09247053 -0.2425036 -0.07931383  0.78612116 -0.80763008
## 9   0.3372886  0.96063561  1.1992091 -0.99405281  0.70247235 -0.98294091
## 10  1.9388404 -0.08568530  0.1881208  1.41159224  0.88022668 -0.13346739
##    GSM2630864  GSM2630863   GSM2630865 GSM2630866  GSM2630897 GSM2630869
## 1  -0.9955399  3.57605310  1.060177243  0.9551789 -1.62706826  0.4851587
## 2  -2.2294953 -1.31525382 -1.246625089 -2.0880019 -0.09900947  0.8682380
## 3  -1.1448278 -1.64598292 -0.700052242 -2.0084536  0.22750715  0.8281284
## 4   1.2438209 -1.19050468  0.004009321  1.0525064 -0.76345712 -1.4298399
## 5  -1.6889511  0.19828946  1.226606156 -0.6484885  0.23352453 -1.8446979
## 6   1.1372986 -0.03249254 -0.420138931 -0.9206416  1.00934982  1.4644204
## 7  -2.4301533 -1.03475502 -0.079236969 -1.5012085 -1.39576908  1.1474731
## 8  -0.9073315 -1.46463513 -0.166624589  0.9060086 -1.29045556 -1.4199168
## 9  -0.8264274 -1.79957869 -2.259147337  1.7742464 -1.81886770  3.8553332
## 10 -0.6068808 -0.95296011 -1.397684255 -0.4573416 -1.37146019 -1.9310842
##     GSM2630789 GSM2630872 GSM2630877 GSM2630880  GSM2630840 GSM2630799
## 1   2.16309157 -0.3540056 -1.0366153  0.2655742  0.52625706  0.5313232
## 2   0.11426792  0.7582431  0.8604537  2.6260678  0.11438487 -1.4539887
## 3  -0.58142086  0.8365683  2.3922543 -0.7327170  1.35788396  0.7477949
## 4   1.59320219  0.3687222  2.3048555  2.4958387  0.31364276 -0.9460197
## 5  -1.33834448 -0.2289534  0.4649464  0.1510526  0.04284032  0.8720284
## 6  -1.67218528  1.2489190  0.7312674 -2.2775310  0.82643768  1.9918721
## 7  -1.33105901 -0.3217162  0.4880092 -1.3896538  2.67370077  0.9172920
## 8  -0.07068685  0.7930039  0.3192135  2.5369879  1.33196514  0.7255057
## 9  -1.32550095 -0.6425355  0.5731713  0.5656838 -2.09953586 -0.8590474
## 10 -1.95319965  3.0668654  5.0037481  1.6761292 -0.34446046 -0.8140956
##      GSM2630778  GSM2630878   GSM2630876 GSM2630965  GSM2630958  GSM2631054
## 1  -0.405133105  2.03204432  0.638313375 -0.3234034  0.82414669  1.68996869
## 2   1.807236561  1.63519659 -0.034728166 -0.1337309  2.15125991  0.07565683
## 3  -0.296241812  0.10067382 -2.445855742 -2.1784096 -2.58381415  1.47548783
## 4  -0.008897561 -0.29126214 -1.094225358  1.8463706  0.97944577  1.53688690
## 5  -4.312471140 -1.31739544  1.161795772  1.0485654 -2.07571383  1.21866061
## 6   1.058603217  2.86550053  0.084603137 -3.1627962  1.38256925 -0.71070139
## 7  -2.504743563 -0.07366442  0.003853824 -0.6014314  0.08522171  0.93936165
## 8  -0.744189964  0.72870970 -1.155030915  2.0356305  1.08349766 -0.62718278
## 9  -1.360042354  0.91611457  0.495901644 -2.2046719  1.91596751  0.28732690
## 10  0.353275302  1.72985435 -0.492986287 -0.1232462 -3.93588512  0.94765060
##    GSM2631121   GSM2631044  GSM2631074 GSM2631080 GSM2631179 GSM2631181
## 1  -0.2450795 -0.451056152 -1.30504998  0.5574428  0.7280974 -0.4422642
## 2   1.1627951  2.018871597 -0.55401732 -2.1754949 -0.9168467  0.6970140
## 3  -1.0686879 -0.006553977 -0.07509473 -0.3930274  1.0986744  1.3671002
## 4   1.2470483  0.536701739 -0.04266681  0.9711842  0.4399270 -0.2012428
```

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## 5   0.8438397 -1.623538792  0.39021641 -1.9522432  2.1377246  1.6730906
## 6   1.3018340  0.588906510 -0.62497032 -2.4683918 -0.8707716  0.1429637
## 7  -0.5387092 -0.575021542 -1.51174841  0.1726670  0.6081632 -2.7013958
## 8   0.6665737  1.108784651  0.05560154 -0.8211944 -1.4814825 -0.4587062
## 9   0.4090930  0.310913876 -0.04070002 -0.4508593  1.4964731  0.5833070
## 10  2.7216267 -0.636302435 -0.92795584 -0.7598263  0.4187254  1.0696413
##    GSM2631132 GSM2631122 GSM2631295  GSM2631040  GSM2631116  GSM2631283
## 1  -0.1472550  2.2862897 -0.2695502  0.08859814  1.10043081  4.47381607
## 2   1.5271219  0.1417431 -0.1646073  2.32379637 -0.97727546  0.06003625
## 3   1.2633472 -1.2295959 -0.5327321  0.35948290  2.60152528  0.55695504
## 4   2.9859738  3.0566889  0.5495787 -0.06080490  0.51162259 -0.13864699
## 5   0.3253378 -0.5408809  2.0199070 -0.35020465 -0.34348443  0.01797183
## 6   0.6042389 -2.3906790 -2.2778674  0.40121134  0.94742811 -0.77325586
## 7   0.1791420  0.2347103 -0.1260126 -0.02769235 -0.04069715 -0.30330521
## 8   1.5909425  1.1781675 -3.4878182  0.07193456  2.61811398  0.10489977
## 9  -2.5627049  2.3061951  2.3059457  0.63665299 -0.33457645 -0.95444043
## 10  1.4792764  1.6224561 -1.4221965  0.08975407  1.38092486 -0.55658679
##    GSM2630999 GSM2631023  GSM2631058  GSM2631081 GSM2631140  GSM2631045
## 1   2.0070914 -1.3544320  0.86961956 -0.09816091  2.1263195  0.98299969
## 2   0.8989509 -2.1147392 -0.14016759  0.43607676  1.7540595  0.48506653
## 3   0.7020283  0.1890884  0.77956697  1.97126660 -0.8039588  0.73441052
## 4  -0.8161250  1.9350101  0.48642147  1.23995016 -0.9083851 -0.08056894
## 5   0.8990312  0.8669565  1.41491102 -1.01651194 -0.3111239  3.77600749
## 6   0.2240085 -1.6033564 -0.34020917  0.20084008 -0.9980821  1.04015824
## 7   0.9123321  0.9353593 -0.29671714  0.03023450  0.5630131  0.61598355
## 8   3.8777857  0.6751919 -2.73989152  1.27975211 -2.6099409  1.70759369
## 9  -1.5794568  1.9548958  0.02108593 -0.02052472  0.4914530 -0.76226390
## 10  1.0812103  0.4580034 -1.15683131 -0.17507461 -0.9843906 -2.76342762
##    GSM2631016  GSM2631070  GSM2631133  GSM2631055 GSM2630974  GSM2630812
## 1   1.8729932 -0.08199385 -0.39596988 -0.01781219   1.726817 -0.11137486
## 2  -0.2512882 -0.07732189 -0.97029490  1.18010654   2.182153  1.86080779
## 3  -2.0449685 -1.05673436  0.68220562  0.45094070   1.361244 -2.85605601
## 4   0.1355115 -0.75907847  0.59820036  1.76425529   2.015668 -2.97167360
## 5   0.6820395  1.18643542 -0.40062343  0.53460195  -1.606576  3.74625512
## 6  -0.5283904 -1.44993459 -1.60088073 -0.54258838   0.849591 -2.90971148
## 7  -2.0877113 -0.15084152 -1.08549801  0.91764089   1.033923 -0.08435711
## 8   0.3244470 -0.25484459 -1.25879333  1.17370504   2.776353 -0.11602535
## 9   1.3569267  0.79524123 -0.14241643  1.55859365   0.343392  1.39726165
## 10 -1.4511897 -0.87221471  0.01499846 -1.45143166   1.390345 -0.37662524
##     GSM2630780  GSM2630816 GSM2630871 GSM2630873  GSM2630874 GSM2630881
## 1   1.81127698  0.71098552  1.6521639  1.3091015  0.41227596  0.8336254
## 2   4.17293934  1.16817749 -3.4048560  2.2369101 -0.54536453 -1.4738963
## 3   1.10902799  0.81561138 -1.3480853  2.9911421  2.62973302  1.5677235
## 4  -0.35828302 -1.34676226 -0.3457633  0.7505215  3.06156655  0.6154556
## 5  -0.05346301  1.60992368 -1.0069409  0.2929605  1.72520938  0.6434004
## 6   1.02921213 -0.09619389 -1.4236535  0.3429904  0.14825181 -1.9566537
## 7   1.71696405 -0.14220904 -1.6026871 -0.1385784  0.76571177 -1.0591078
## 8   1.90750795 -1.35663272 -0.4425920  0.3396931  0.49780432  0.7880551
## 9  -1.17481957 -2.35261877 -1.3940357 -0.7277343  3.32105338 -3.2242082
## 10 -0.04641412  0.90087813 -2.3705056  2.5321026 -0.01224282 -1.1418317
##     GSM2630896  GSM2630913 GSM2630784  GSM2630843  GSM2630884 GSM2631149
## 1  -0.21484673  0.08060693  0.1808670 -2.26753707 -0.34923227 -0.4374839
## 2  -0.07202177  0.94214563 -1.2920595 -1.15741320 -0.95510201 -2.3555882
## 3  -0.81658164  0.78668032 -1.9000184  0.79750461  2.04656810 -0.8976752
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## 4   2.16652548  0.79246096 -1.4589184  0.34546316  0.02100691 -0.3113275
## 5   1.35576818  0.94357695 -4.2031847  0.06455922 -0.27422236  0.8035920
## 6   1.73713650  0.84446387  0.7571270 -1.96283598  1.38895346  0.5050591
## 7   0.12859100 -1.08486426  0.8346810 -1.10770257 -0.22817085  1.0651795
## 8  -0.15181102  0.11299508  0.8967256  0.04278297  0.06959549 -0.8643807
## 9   0.80902242  1.12141603  0.9511811  0.84849719  0.11081437 -1.7874870
## 10 -1.99712612 -0.15796425  1.4101971  0.76154891  1.21305365 -1.0164235
##    GSM2630882  GSM2630883  GSM2630885  GSM2630912  GSM2630861 GSM2630879
## 1  -0.4566960 -0.07651831 -2.16523424  2.40364339  1.84535703  0.9829156
## 2   1.3368513 -0.16429595 -0.83796031  1.52153746 -1.52210906 -1.6454411
## 3  -0.0147355 -1.90264602 -2.55634953 -1.26478312 -0.38762210  0.5339187
## 4  -0.5359418 -1.10750709  0.20689659 -2.94130874 -1.22145252  0.3450632
## 5   2.9860535 -0.14927114  0.98533852  0.43186458  0.49306118 -0.8671823
## 6   2.3269982  0.41396481 -0.96868038 -1.66071339  1.45336818  0.2952022
## 7  -2.2395247  0.37047400 -0.02994131  0.01583505 -3.18391083  1.2189226
## 8   1.3879044  1.07160335 -0.88747677 -0.64162797  0.17339438  2.3110495
## 9  -1.5215983  0.10308598 -0.54781534  1.29007238 -3.27257579 -1.4920017
## 10 -2.6475824 -3.80041791 -0.91572076 -2.32401459 -0.07685851 -1.6305144
##    GSM2630785 GSM2630803 GSM2630779 GSM2630772 GSM2630875 GSM2630767
## 1   0.6972424  0.7615698  1.5594929  2.4013352 -2.5514166 -0.8397405
## 2   0.8961529  0.2047758  0.1312732 -1.8095569 -0.4964831 -1.2996112
## 3   1.0152980 -0.5032352  0.6654876 -0.7076195 -1.8275705  0.5020707
## 4   1.0765632  1.0693646  0.1203579  3.9675519 -1.4765361 -0.8154002
## 5  -1.5619163 -1.5424990  0.1164749 -0.8403366  2.9739504  1.3214948
## 6  -1.3979587 -1.9343446  0.7127972 -1.0539378  0.8064198  1.1658008
## 7   1.1786742  0.9255790 -1.1654144 -0.6570614 -0.6011207  0.5086473
## 8   0.9151281  0.3671463  0.2755972  0.2769915  0.7142432  0.5769864
## 9  -0.8443238 -1.2743521 -0.1643252  0.9304151  0.9378934 -0.1271638
## 10  2.6833657 -0.5139966 -0.5307196  1.7744165 -1.5139621 -5.1766842
##     GSM2631145 GSM2631303   GSM2631308 GSM2631311  GSM2630832 GSM2631302
## 1  -1.49990442  1.2407076  0.182449839  1.0414307  0.40214818  3.6658353
## 2   0.79665186  2.4733899  3.169432312  1.4829696  1.02828090 -1.8275640
## 3  -0.14092144 -0.6263343 -0.243826717  1.6152926  2.14601498 -1.2782202
## 4   1.10521974  0.3367187 -2.842095353  3.2142075 -1.34488765 -0.6029543
## 5  -0.07615102  1.6347751 -0.239801472 -0.7246055  0.04782523 -0.9618192
## 6  -0.55747072 -0.1625275  1.803330183 -1.1839583  1.06881224  0.2667522
## 7  -1.62405736 -2.1779687 -0.009448867 -1.4716695 -0.96830009  0.6579969
## 8   3.09806109 -0.8408828 -0.117456444  1.8085096  1.20588703 -1.2743057
## 9  -1.29313686 -0.3266422  0.773769186 -0.1555128  2.23506561 -2.1098439
## 10  0.42863269  2.2363438  0.837059147  1.9949236 -0.71767326 -0.9541272
##      GSM2631307 GSM2630919 GSM2631222 GSM2630933   GSM2630934 GSM2630935
## 1  -0.180210587  1.3483058  0.2852920 -0.7267964 -3.544427913  0.7237088
## 2  -4.019929161 -1.1262076  0.8343550 -0.9410521 -1.642997531  1.4570222
## 3  -0.127100716  1.2577649 -1.0899355 -1.0008434 -1.089282187 -0.6486775
## 4   2.444104233 -0.1307031  1.2334014 -0.4741005 -1.318389922  1.0976942
## 5   1.502021833  0.6545610  0.8891888 -0.5590053  0.887493343 -2.7470495
## 6  -2.305017216  2.8131676 -0.3885623 -0.6485836 -1.653489622  0.2976375
## 7   0.272319120 -2.2359074 -0.4148108 -1.5540065 -1.786251977  0.3102223
## 8  -0.004081412  0.9636126 -1.4793171  0.9498587  0.003672115  0.1406652
## 9  -2.493641559  0.6032706  1.0475709  1.1352481  0.216010586  0.2427715
## 10 -0.677256257 -0.5772583 -1.7622655  1.1312421 -2.563285627 -1.3410902
##    GSM2631250  GSM2630936 GSM2630937 GSM2630926  GSM2630833  GSM2630920
## 1  -0.8615052 -1.67618729 -2.5704700 -0.9075943 -0.92213376 -0.41709417
## 2   1.0222164  1.17271894 -0.6766507 -2.1637730 -1.95378993  1.77239602
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## 3   0.7668590 -0.82879079  1.1143742 -2.3096814  0.05453025  0.03080373
## 4   1.9611691  0.15315115 -0.6401510  0.4041687  1.30107069 -0.73035170
## 5   0.4819399 -0.05950031 -1.1835529  0.1875655  3.48231285 -0.58962376
## 6   1.9675371 -0.31441317  1.2102524 -1.1843326  1.13091121  0.91935818
## 7  -2.5705197 -1.41155319  0.7291878  1.7306666 -0.27034632 -0.73620814
## 8   0.6725650 -1.11246220 -1.1449900  0.4372879 -1.24758585  1.61655376
## 9   0.2266526 -1.26338365  0.1708547 -0.3390002  0.38371408  1.93380858
## 10  0.5003161  2.92252842  1.8514202  0.3213204 -2.35058212  1.04289206
##     GSM2630844 GSM2630834 GSM2630847 GSM2631217 GSM2630848 GSM2630798
## 1  -2.01974778 -1.1497743  0.3593286  3.4303709 -0.6377118  1.7676495
## 2  -0.05392453 -1.3315041  3.7884726  0.8790657  0.2527629 -2.2220643
## 3  -0.88912580 -0.7683926  0.4330502  1.3050043  0.8412057 -2.3800666
## 4   1.44103776 -0.9487000  1.2092206  0.7558618  1.3117698  0.9058562
## 5   1.07427237  2.0443349 -0.6571164  0.9862983  0.2385470  0.1314863
## 6  -3.38999739 -1.1597187  2.2140089 -0.6259500  0.6816004 -0.7288785
## 7  -2.05682541 -0.6637575  3.5612755  0.2651120  0.3851457 -1.6484474
## 8   0.97076600  1.2591102  1.0953775  1.9073172 -0.2742774 -1.9229855
## 9   0.38550838 -1.6533589  0.7363931  0.1916312 -0.7866652  1.0773762
## 10  0.16626686  1.5005697  3.6409280  1.3498556  1.5152919  0.5872689
##    GSM2630849 GSM2631229  GSM2631226 GSM2631202  GSM2631062 GSM2631206
## 1  -0.5015730 -1.1914224 -0.76236318 -1.2111075 -1.14809531 -1.1957774
## 2  -1.0391876 -1.2302900  0.10256914  0.9219089  1.32693118 -2.5780624
## 3  -0.6557411 -3.1237347 -0.48895418 -1.0816982 -0.95526157 -0.3753229
## 4  -1.5988363  0.8113810 -0.53590471  1.2965380  2.26735137  0.8976925
## 5  -0.7849668  1.6054008  0.55243817 -0.5087077 -0.05123880 -1.6226672
## 6   1.0454908 -2.1424980 -0.03667886 -0.7448849  0.28895214  1.0211205
## 7   1.5955382 -3.0304266 -0.96002153 -0.8336500  2.38595046 -0.5779744
## 8   1.2221435  0.8873731 -2.74023457  1.5376144  0.07038372  0.9744621
## 9   0.4332427 -0.5296232 -1.85200909 -0.1492064  0.58384999  1.9402426
## 10 -1.7441792  0.6379608  0.80894095 -1.2636592  1.45636147  1.5110514
##     GSM2631205   GSM2631201 GSM2631207 GSM2631193 GSM2630955  GSM2631203
## 1   0.74167888 -1.360234194 -1.2033843 -1.1591597 -1.6338993 -1.29006324
## 2   1.60532245  0.477794834  0.1404821 -3.2700809 -0.6436568 -1.37783819
## 3  -0.36748929  0.460667366 -0.3981390 -0.4572879 -0.3462053 -0.51000977
## 4  -0.66796135 -2.115593348  1.7919720  0.3948714 -1.2635245 -2.73588491
## 5   2.20607989 -1.964118890 -0.7453575 -0.3718707 -0.8374466 -0.42286056
## 6  -2.02893895  0.409788144  2.2560777 -3.4880238  1.8811388  1.46055951
## 7  -0.03677116  0.339536304 -1.8100458 -0.3064116 -0.1675126 -2.04257597
## 8  -1.22024538  0.575652634 -1.3541539  2.2065046 -0.6156231  1.86094535
## 9  -3.70871444  1.362398062  2.6562530 -0.5149697 -0.1475798 -0.08609174
## 10 -0.55665714 -0.008809495  0.6985660  0.5448363  1.6098117 -0.52152960
##    GSM2630811   GSM2631282  GSM2631063 GSM2631141 GSM2630946 GSM2631294
## 1  -0.8571240 -1.232013640 -0.60494483 -0.3876590 -0.4828608  0.3324155
## 2   2.2085579  0.725556529  0.17976684  0.5050713 -0.5459387 -0.5667721
## 3  -0.1226983  0.316187786 -1.26291830 -0.8387031 -3.2483731 -1.0092337
## 4   3.7153521 -0.170180663 -1.38813624 -2.3104037  0.5271802  0.1267025
## 5  -0.6905953  0.005194436  0.87705687  1.8385740 -0.9385243 -3.1400500
## 6   0.9187864  0.514823762  0.61714832 -0.3351933 -2.6466666  0.6153448
## 7   0.9757077 -0.897398559  2.86893365 -0.8445684  2.4472097  0.2615665
## 8   1.2198270 -1.307284068  0.07962502 -3.2506512  2.5623312 -0.2773303
## 9  -1.0557479 -0.230017259  1.59006346 -1.1969703  2.1422675 -0.8812641
## 10  1.3715411 -2.804160683  0.57551295 -1.0173521 -0.5446089 -1.1969917
##    GSM2630845 GSM2631255 GSM2630809 GSM2631018 GSM2630987  GSM2630851
## 1  -0.4391544 -1.0106745 -1.1083826 -2.6875508 -0.9173226 -0.76764428
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## 2  -3.0193836 -1.6861420  0.7802439 -4.4755934  0.9281720  0.31830953
## 3   0.5970295 -0.7813371  3.0992954 -0.9053522 -0.8739992 -0.90370136
## 4  -0.4870853 -1.3489689 -3.7320674  1.9349311 -1.2551727 -0.25057233
## 5  -2.2835696 -0.2769043  0.8979115 -1.9681822  1.7660997  1.49878465
## 6   1.5374995  1.0581987  0.4574137  0.9486238 -0.3122088  0.06904076
## 7   0.7754624  0.9336568  0.4139013  0.4152410 -0.2598305 -2.01293006
## 8  -0.3259067 -0.1342223 -0.5129482  1.1297195  1.4543049 -0.38857147
## 9   1.4742385 -3.9721447 -0.5937188  0.9535894  1.1536984 -2.32140159
## 10  1.5714478 -0.6809389  0.3203621 -1.0560677  1.0733334  0.55933853
##    GSM2630996 GSM2630796  GSM2631292 GSM2630887  GSM2630819  GSM2630850
## 1  -0.8589442 -0.4700442 -2.52265188 -1.8783165  0.93646900 -1.32825436
## 2   2.4942995  1.1152344  0.02320227 -1.6913829 -0.06709222 -0.23105871
## 3   1.8898746 -1.2218764 -0.93966881 -1.6289648 -0.78351058  0.03551342
## 4  -0.8521667  0.7468373 -1.30931469 -0.2513103  0.40717358 -1.55006601
## 5  -3.2712217 -0.7110857  0.16428379  0.6202517  3.25109367 -0.26906879
## 6  -0.3422267  0.6492021  0.03724693  0.5131735 -1.31520492 -0.33255513
## 7   0.1246341 -1.6458987 -1.04373008  1.1699897  0.65310281 -0.18157444
## 8   1.8110893 -1.1149621 -0.26863828 -0.8183964 -1.35882447 -0.88560670
## 9   0.2278106 -0.9739079 -1.14824186 -0.3448536  0.82544832  3.01106418
## 10  1.6492575 -0.4770355 -0.10219978  0.4019415  0.30773300  0.53597402
##    GSM2631069 GSM2630820 GSM2631251 GSM2630782 GSM2630858 GSM2630786 GSM2630846
## 1  -0.9589495 -1.8959157  0.2539446 -1.7701014 -1.4818171 -1.0376929 -2.5619360
## 2  -0.4504241  1.7066288 -0.4483734  1.9770960  0.6629819 -0.3294843 -0.1178808
## 3  -1.2130022 -0.4437509 -0.9278382  0.3664970 -2.4278685  0.6942003 -0.4026135
## 4   0.6484371  0.9282020 -1.3645759 -0.2582078 -0.6430071  0.2017015  1.7539388
## 5   0.9651497 -1.1668979  1.2727199  1.8558053 -1.2931958  0.5405148  1.0531320
## 6  -2.0283444 -0.9555321 -0.1518477 -0.4512699 -1.9903513 -0.7549119  1.5572617
## 7   0.1135072  1.5436364  0.3349463 -1.2853356 -0.9683103 -0.8409862  0.9595845
## 8  -0.2287039 -0.5355483  0.3249259 -2.2048946 -0.9222489 -1.7364632 -0.8805002
## 9  -1.7761156  2.9711586 -1.2745057 -0.3128864 -0.7902313 -0.2540656  0.3808112
## 10 -0.3177667  1.2781285 -0.8886495 -0.7392365 -1.2721035  0.9996561 -2.1037491
##     GSM2631218 GSM2630797 GSM2631228  GSM2630860 GSM2630859   GSM2630852
## 1   0.08055711 -1.2181568 -1.2855767  0.92995150 -1.2365196 -0.972200993
## 2  -1.09146696 -0.7596254 -0.9498746  0.01636692  1.9682346 -0.596191590
## 3  -0.16974664  1.5056399 -0.8748691  2.66524010  0.9106952 -0.968626394
## 4   0.73544571 -0.2335612  0.5153979 -0.50887611  2.6749423  0.741711713
## 5   1.06966646 -2.5806811  1.7096362  0.19639006 -1.7216788 -2.870057914
## 6   2.67699011  0.9556707 -0.2197358  0.75427414  2.0605258 -1.029398942
## 7   3.03185140 -1.7993828 -0.6868850  1.29558112  1.5869430  0.798529479
## 8  -1.28424803  0.1248215 -2.2069569 -0.72552445  1.6057110  0.006563419
## 9   2.58849174  0.8161880  0.4531040 -0.24075665  2.3423801 -2.431369409
## 10  2.02662758 -0.2331890 -1.8421500 -0.13149490 -1.4552503  0.257284277
##     GSM2631088 GSM2631087 GSM2631139 GSM2630952 GSM2631285 GSM2630953
## 1  -2.02560171 -1.0897619  2.9288311 -0.7742563  1.2388876 -1.2170413
## 2  -1.01133551 -1.8086644  0.9589744  2.2363733 -2.3101121  1.5750327
## 3   0.87003832  1.5396297 -0.2020964 -0.8730254  0.2259918  1.7408934
## 4  -1.35539264  1.5669716 -1.1731534  0.5171663 -1.9527740 -0.5002877
## 5  -0.31263598  0.2430791  0.4166722  1.0571114  0.2207533  2.6860543
## 6   1.26673906  1.4940747 -0.7964007  0.2629671 -1.1877441  0.5021782
## 7  -2.69264495  1.9167164 -0.2937388 -0.7431772  0.2532032 -0.3951948
## 8  -1.54444643  2.5766764  0.2137613  2.1876145 -0.1524751 -2.5234691
## 9   1.07249309  1.2100080 -0.4224791 -0.8419735 -2.1681365  1.0480137
## 10 -0.08245161 -0.3092493  0.3764724 -0.1049188 -1.7522087 -0.9038468
##      GSM2631086 GSM2631270 GSM2630962 GSM2630963 GSM2630954 GSM2631000
```

```
## 1   1.338519362  0.6549759  1.0767303  0.9866417 -1.5649693  0.7974478
## 2  -0.470711001 -0.6389563  1.8540541 -0.2372467  0.4551308 -2.4641422
## 3  -2.084651929  1.5631676 -0.1804550  0.2700906 -0.9205626 -2.1934623
## 4  -1.082792651  0.1556494  1.3622466  0.6638912 -1.0448715 -2.0489023
## 5   3.017944515 -0.8344649  0.3120049  0.8982164  2.8042585  2.0540807
## 6   0.632477526  1.5852673  0.7140946 -1.0398024 -1.4181667  0.5853475
## 7   0.004607277  1.2328293 -1.1091244  2.4976349  0.1502793  1.7605927
## 8   0.613892485 -0.2901202 -2.3813062  2.0304900 -1.3079623  0.5121668
## 9  -1.402851478  0.1451606  2.2203235 -2.0405254  0.6496036 -1.8810321
## 10 -1.558111336 -1.0557139 -0.8425393 -1.7252379  0.7819514 -1.2877259
##     GSM2631034 GSM2631288 GSM2631092  GSM2631286 GSM2631113 GSM2631098
## 1   2.02374607 -0.1909183 -0.7562428 -1.08568312  0.2724468  3.7114051
## 2  -0.50471745  0.4733015 -0.1420464 -0.02988436  1.5154031 -1.3837900
## 3   0.08449291 -1.1618634 -0.6817765  0.12082333 -1.6965196  4.0709246
## 4  -1.34335866 -0.2717609 -2.0272399  0.58136244 -1.7869708  1.7508827
## 5  -4.11715053  0.6947429 -0.4162787 -1.69977363  4.2856709  1.6404151
## 6  -0.25083227 -3.2123897 -2.3554965  1.02770076  1.7117783  0.6760802
## 7  -0.64615628  1.3054328  0.4834999 -2.04312280  1.9263559 -0.5843291
## 8  -1.78801481 -2.6956661 -1.3974528  2.10243223  0.8932016 -1.0199984
## 9   0.51485464 -1.1796443  1.9880179  1.04691312  1.6764365  0.3029508
## 10  1.66009359  0.3531367 -0.9692620 -0.96922569  0.1118892  0.4374479
##    GSM2631093  GSM2630768  GSM2630989 GSM2631127 GSM2631258  GSM2630802
## 1   0.4984759 -0.83860568 -0.74064328 -1.5495944 -1.6929337 -2.84909581
## 2   0.7246344  1.03252101 -0.07185176 -0.3880660  0.8166720  0.03749752
## 3   1.2591368 -2.25171699  0.83825625  0.7654619 -0.5302560  2.63938842
## 4  -1.7100305  1.30806449  0.74248755 -1.7384800 -1.4135656 -0.42840880
## 5  -5.1151786 -0.19307891 -1.18802939  3.1044464 -1.3324648 -0.19948102
## 6  -1.6974102  2.32107655 -0.39852916 -0.4084369 -1.1639908 -0.50482302
## 7  -1.3886136  0.54881140  1.21491425  2.8130457 -0.9170300 -0.82886494
## 8   0.2528913 -0.07335528  3.24538004 -0.3737106  0.6223625 -0.85449054
## 9  -0.5678794  0.67525086  3.21177739 -1.6447766  0.6506149  0.47232271
## 10  1.3809679 -0.30798491  2.73384985 -3.3996645 -2.5069737 -0.13144875
##    GSM2630770 GSM2630854 GSM2630801 GSM2630983  GSM2630914 GSM2630997
## 1  -2.3715391  0.3339154 -0.7573349 -1.4593277  0.25660485  0.9952940
## 2  -1.5025354 -1.0418032 -0.6470000  1.9304994  1.58544511  0.5375188
## 3  -0.7979930  1.1283544 -1.3002454  1.8970389 -0.81259552 -0.5304101
## 4  -2.0496676  2.3717067 -1.2088167 -0.8437321  1.21889363  0.6393521
## 5   0.2150763  0.3693599  0.4762589 -2.7803432  1.42478006 -0.2924676
## 6   0.1794318 -0.8588559 -0.8153944 -0.1315860 -0.07425011  0.4636789
## 7  -0.7093600  1.6815299 -1.2243794 -0.4759551  0.76707919 -0.8775098
## 8  -0.9872548 -1.0931381  2.1476529 -0.3862914 -1.07445454  0.2811306
## 9   1.1104862  0.3214447  1.1606428 -0.9295425  0.19988226  0.9883144
## 10 -1.9514472  1.0016257 -1.0740134 -1.5569128  2.65089338 -0.8809126
##    GSM2631188 GSM2630964 GSM2630945 GSM2631119 GSM2631124 GSM2630806 GSM2630921
## 1  -1.3469058 -2.6288359 -0.6004389 -3.6448690  0.4604806 -1.7610496 -1.9920017
## 2   0.4849139  0.1851821 -0.8126650  1.5784185 -0.4324193  1.3646026 -1.0992078
## 3   1.4112754 -2.7503869  0.2768437 -0.3669341 -0.7770545 -1.8486124 -3.5285698
## 4   0.5247390 -1.0666782  0.4229489  1.6791770 -1.9217731  0.1547986 -1.3762800
## 5  -0.0393988  0.1494384  0.7503645 -1.2916385 -2.6804973  0.2857544  2.5316725
## 6  -1.3464223 -2.3465660 -0.4503549  1.6227011  0.6490980 -2.1824287 -1.3092043
## 7  -2.3848373 -0.4976022  0.2349163 -0.3129543  1.7471054 -0.1538989  0.9418136
## 8  -1.6376142 -1.0600058  0.8885599 -1.1984707  2.1026528 -1.2425385 -0.3844166
## 9   0.6351000  1.7711132 -1.8216303  1.4444593 -0.4191006 -0.1487206  1.0206032
## 10 -1.3309519  0.2759774  0.4822584  0.7062990  0.9908913 -0.8619160  0.2785667
```

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##    GSM2630972 GSM2630807  GSM2631108 GSM2630988 GSM2630992 GSM2631263
## 1  -1.5775681 -0.2813225 -2.03602760 -1.2907785 -0.4253443 -0.5103930
## 2  -1.0487502 -0.3115299 -2.32265723  2.6255155 -0.3318395 -2.0855719
## 3   2.1013188  1.3446661  0.03279319 -0.2083101 -0.1840665 -1.4644222
## 4  -0.3023897  2.5924390  0.44802348 -1.4146712 -0.1612782  2.1680091
## 5   0.3394547 -0.3960770 -1.85661345 -1.1728334 -0.7997469 -0.4912030
## 6  -0.8410377  1.0544945 -0.20773138  0.2764553 -2.3564241  2.0748019
## 7  -0.1954656 -0.5142107  1.15703258 -0.5153331  0.6901087  0.4331724
## 8   1.0763874  0.2417785 -1.02371118 -1.6056569  0.2340040  1.8494039
## 9   1.4303907 -1.0739010 -0.50242427  0.7975025  0.1029088  0.3564932
## 10  0.3076906  3.1199839  1.32599777  0.1919314  2.3086759  2.7319450
##    GSM2630823  GSM2631002  GSM2630949  GSM2631254  GSM2631050  GSM2631052
## 1  -1.2246214 -1.40324525 -2.41584963 -2.22350140 -0.76460953 -2.36853221
## 2   1.6518916  0.08143373  0.84549361  0.36128372  2.36792865  3.00240179
## 3   0.6981699 -2.73991585 -0.71959463 -0.86067669  1.59327432  1.18558979
## 4  -0.7452748 -1.07063151 -1.47301565 -1.24518327 -1.95005075  0.54370750
## 5  -1.0116534  1.56540344  0.38794244 -0.61310166  0.09477680 -0.31103721
## 6   2.1189323  0.80792017  0.10680897  0.84286114  0.09846694  0.87612226
## 7   2.1757719  0.37755419  2.03230623  0.10963275 -1.33038592 -0.05599217
## 8   2.5929809  1.31285929 -0.30704551  0.38463857  0.18914667  2.22033805
## 9  -0.8872399 -1.34055147 -0.65649019  1.49970971 -0.05604034  0.19286395
## 10  0.6347932 -0.23757743 -0.04418725  0.04402516 -0.78217374  0.04849714
##    GSM2630835 GSM2631290 GSM2630994  GSM2630975 GSM2631021  GSM2630825
## 1  -0.8036398  0.1382104 -1.0755093 -1.15882104 -0.7863459 -4.25614871
## 2   0.6702478 -1.7558121 -1.2562552  1.52141854  1.0846899  1.93215473
## 3   0.2164077 -1.9180887 -1.2159128 -0.69377644  1.6081912 -2.70581790
## 4  -1.3103535 -3.1066575 -0.8986997  0.01229438 -0.2684751 -2.20433841
## 5   1.2135375  0.9965829 -1.5967986  1.97630073  1.8143218 -0.85571934
## 6  -1.9657801 -1.8767866 -0.8367942  0.45847003  0.8578002 -0.15226986
## 7   0.8024077 -0.7398994 -0.6282576  0.05807180 -1.1179832 -0.36737764
## 8   0.0390351 -0.5055679  0.2995440  0.09072447  3.7057578 -0.08253432
## 9  -2.9966143 -2.6694154 -0.5324730  1.60740511 -1.7703927  0.28755151
## 10 -0.9041829  1.4712742 -2.4886455  3.67951416 -0.1507041  0.04321400
##     GSM2630821 GSM2631297 GSM2630978 GSM2631114  GSM2631117 GSM2631260
## 1  -0.16222739 -1.1443590 -0.7532958 -1.5370875  1.82655665  0.7218192
## 2  -0.77471354 -0.1513008  0.7612781 -0.3381853  0.42434275  0.2783784
## 3   3.57730993 -0.8792346 -3.5246298  0.5523385  2.10679075  0.4791960
## 4   0.87596244  0.1899872  0.6405843  1.4726698  0.68538181  0.2121191
## 5  -0.24869162  1.8689987  0.4489273 -4.0054246  0.01183867  0.5595167
## 6   2.03107902 -0.2015794 -0.8389120  1.3811014 -1.51268614 -0.1939641
## 7  -0.75741238 -0.4459944  0.2727155 -1.0759591  1.56428836  0.3662841
## 8   0.86482462 -0.3698005  2.1901199  0.9537428  0.79759847  0.9344887
## 9   2.95310824  0.2225693 -0.7868689 -0.2372672  0.53338846 -1.5184970
## 10  0.02578534  1.6026782  1.0304011  1.1398301 -0.52875689 -1.0759974
##    GSM2631200 GSM2631096  GSM2631257 GSM2631003 GSM2631190 GSM2630985
## 1  -0.6612711 -2.4212539 -1.06302197 -1.2130250 -0.4617777 -1.0117914
## 2  -0.1561070  1.5147531 -0.33091720  0.3136001  0.7050810  0.1423768
## 3   1.1697372  1.9645479  1.29755515 -1.6743548 -0.5661822  0.4317530
## 4   1.2254250  0.3114422  2.19449918 -0.8528134  0.3399771 -0.4818381
## 5   0.8606279  0.4907612 -1.27699379  1.7048295 -0.3928432  0.8290455
## 6  -0.2580617  1.5377082 -0.06833721  1.8263866  2.3763421 -4.4379861
## 7   0.4989733  1.5107086 -0.31017417  0.2805058 -1.6163793 -0.8103918
## 8   1.3478797  0.5099060 -0.61057140 -0.6540694  1.8807310  0.2057198
## 9  -1.0348557 -1.6245546 -0.67203958 -2.5417267  1.6545851 -1.0885524
```

```
## 10  2.0004663  0.3496364  0.94111773 -1.7143435  0.8241818  0.9342494
##      GSM2631120 GSM2631030  GSM2631095 GSM2631256  GSM2630837 GSM2630940
## 1   0.007785086 -1.5352028 -2.17955881 -0.6929879 -3.21701314 -1.8192779
## 2   2.376800984 -2.3326461  1.32363883 -0.4937494  0.68376772  0.9010151
## 3   2.010469875  1.6185871 -0.89231743  1.5692905 -0.65985416 -2.3261075
## 4   0.014261062 -1.5010816  1.01863192 -1.1515244  0.35782589 -2.2142404
## 5  -2.269813753 -0.6337451 -0.99520994  2.0115955 -0.03992841  1.6019707
## 6  -0.096749201  0.2654832  1.40052729 -2.3159228 -1.57183188 -1.5297614
## 7   0.609358635  1.1748773 -1.10958974 -0.7950461  1.58357265 -1.7660239
## 8  -0.120661096 -0.1237464 -1.19374620 -2.1780691  1.07466654 -1.3151991
## 9   0.645285928 -1.5158929  0.06622446  0.5455262  1.77385056  0.2798673
## 10 -0.091981357 -1.6599341  1.73368100 -1.5256258  0.04602504 -0.8245934
##     GSM2630805  GSM2631253  GSM2630986 GSM2631009   GSM2630944 GSM2631225
## 1  -1.30369789 -0.28906205 -0.19193068 -1.2311383 -2.392966844 -1.7681824
## 2   2.20391920 -0.40139853  0.76874921  0.7224752 -2.235159857 -1.6916056
## 3   0.06090074  3.11376005  0.03180602 -0.3864629  1.480966563 -1.0865089
## 4  -1.21951463  1.27434204  1.17901815 -0.2717955 -1.087226088 -3.4248327
## 5  -1.82031947 -1.87092959 -1.11761266 -0.7103786  2.908685358  1.1190407
## 6   0.99725330  2.41458716 -0.33861885  1.9648486 -2.138952641 -1.6290558
## 7  -0.57508434 -0.29763997  0.82928602 -1.5981886 -2.626843236 -1.6963506
## 8  -1.22956751  1.14030786 -0.59487039 -0.6011964 -2.031981582 -0.1279708
## 9   0.84096495  1.56560547  0.57511493 -1.3467974  0.390532147 -0.1049285
## 10 -1.04292046 -0.07155816 -2.83394588 -1.5324994 -0.002099063 -1.1903959
##    GSM2631014 GSM2631071  GSM2630842  GSM2630795 GSM2630773  GSM2630759
## 1  -0.4820649 -1.3289695  0.13087469 -1.55208032 -1.3866572 -0.06445793
## 2  -1.3247027  1.9265923 -1.12711868  1.85461976 -1.4207905  1.71342996
## 3  -0.2184726  0.5128313  0.41133369  3.29001382  0.3106350 -1.64283867
## 4  -1.9517511 -1.5062462 -1.84953383 -0.37479862  2.6810301  1.10387333
## 5   3.6344712 -0.1916060  0.15977479 -2.96527158 -1.4968257  1.39734056
## 6  -1.9914970 -1.7496990  0.27317737  1.08859193  0.2276535  0.84098376
## 7  -2.4499761  0.2958142 -1.11492614  0.06078748  0.4734267  3.39435002
## 8  -1.8235173  2.4630610 -1.92339428 -0.52267833  0.9938389  1.58775026
## 9  -1.1030648 -2.8183342 -0.07968013  1.97225656 -0.4492327  1.45145096
## 10 -1.6700722  0.2619909  0.11394986 -0.15863080  3.3451671  1.44656867
##    GSM2630947 GSM2630892  GSM2630973  GSM2630828  GSM2631192 GSM2631144
## 1  -0.8860218 -0.5668457 -2.45748013  0.25504585 -1.79292786  0.1347951
## 2  -0.8398652 -0.3581936 -0.06077072 -1.17027433  0.38685741 -0.2615195
## 3   0.3420142 -0.5601045 -1.59082985  0.77384758  0.29467956  1.6032987
## 4  -0.3624510  0.4016261 -1.34028180 -1.20942232  1.25008118 -3.3455574
## 5   2.3799516 -1.2756506  3.65585758  0.60288047 -1.03937148  0.2622450
## 6  -1.5762497  0.7889591  1.30910763  0.72241496  1.56733397  1.0004102
## 7   1.6914051 -0.4721114 -2.43617463 -0.09772172 -0.98059470 -0.8343428
## 8   1.2479492 -1.2582161 -1.01813107 -0.41620749 -0.09365077 -1.6062564
## 9   1.2700967  1.6786380  0.12040908 -2.01737918 -0.74225356  3.8650838
## 10 -1.2789306  1.0156074 -2.03594987 -0.42030535  1.60880178  2.3782909
##     GSM2630822  GSM2630998 GSM2631134 GSM2631183 GSM2630969 GSM2631296
## 1  -1.72714698 -0.49682473 -0.3068574 -1.6197081 -1.8650792 -0.8094853
## 2  -1.12221062  0.40732227  1.3451030 -2.2579868  0.7256644  1.3620749
## 3   0.47635309  1.71392242  0.7512489  0.9713404  0.1347048  1.6651827
## 4   0.05965252  0.98900018  0.5787729  0.5735459 -0.5158575 -0.7671034
## 5   0.24821305 -1.70792923  0.5394397  2.8804621  0.2687693  1.8066045
## 6   0.07108647  0.12231789 -0.3179972  0.3105416  1.3394577  1.5870281
## 7   1.92613236  1.47670519 -1.2682504  0.4514711 -1.4806020  2.0011996
## 8  -0.84953284  2.19508121  2.2011479 -3.5702947 -0.1174555  2.1331480
```

```
## 9  -0.67529216 -1.17862750  1.3062641  1.1369325 -2.2929598  2.0372098
## 10 -2.83352093 -0.09987652  1.0821959  1.2883742 -0.9465870  2.0313466
##    GSM2631053  GSM2630941  GSM2630982  GSM2631271  GSM2630956  GSM2631008
## 1  -0.2752381 -0.49323778 -1.31670144 -1.76084037 -0.69439097 -0.78097025
## 2  -3.2233097 -0.11067295  0.92723336 -0.94077657 -1.48994087 -0.74647250
## 3  -0.0859006 -0.62758220 -0.04111648 -0.28826751 -0.11495293 -1.11901992
## 4   2.5859527 -1.80014649 -0.92814344 -1.33804070  0.02946498 -0.37508794
## 5   2.4093135  1.60353814  1.68328145  0.09384828 -0.26772644 -0.56783778
## 6   1.9586991 -0.52952105 -1.14438473 -1.01532791 -0.21394266  0.61738994
## 7   1.2440765 -0.09425205 -2.51662337  0.05938415  2.74252319 -0.05938828
## 8  -1.4239663 -0.15906651  1.36935612 -2.53621399  1.42106099 -0.17612733
## 9  -0.9697318 -1.79171653  1.58281375 -0.42125078  1.10409167  0.57058115
## 10 -1.4949207 -0.55548455  1.58889452 -0.62537382 -0.29339812 -1.67520915
##    GSM2630951  GSM2630957 GSM2631006 GSM2630959 GSM2630948 GSM2631148
## 1  -1.5660034 -0.81369088 -1.3471725 -1.5177243  0.2052843 -1.4534225
## 2   0.5604905  0.68453813 -1.1838408  1.4696764  0.6488713  1.5320964
## 3   1.8939693 -1.10751962 -0.3041053 -2.5127760  0.7456361 -0.1806734
## 4   2.3603219 -0.82759098 -0.1254125 -1.1569297 -2.5560028 -1.2356528
## 5   1.5751923  1.09895717  0.2713802 -1.4449753  0.2492546  0.3432307
## 6   1.8608349  0.20659823  0.6213892 -0.8437152  0.6846856 -0.9624983
## 7   0.7342375  0.06166324  0.5176663 -1.7128169  0.7469110 -0.4947513
## 8   0.7006280 -0.19593645 -0.1164326  1.3352723 -0.8656933 -0.2127028
## 9   0.8398266  0.34254264  0.2967302  0.2434428  1.4291729 -0.7395921
## 10  0.5753377 -1.82072385 -1.6049137 -0.8454206 -2.6101826  1.5779923
##    GSM2631007   GSM2630939 GSM2630970 GSM2631066  GSM2630967  GSM2631291
## 1  -0.2114351 -2.065763436 -1.8510976 -1.2968154  0.22153774 -1.73808057
## 2  -2.0374561 -0.022157147  0.9694143  1.0604712  0.31653120 -0.32387918
## 3   0.8862420 -1.265041451 -2.0604068  0.9954290 -0.44931668  0.82059334
## 4   1.9492697 -0.003278473  1.0086813  0.5340759 -0.08455345  2.42485164
## 5  -0.5286115 -1.035860784 -0.5988114  0.9956399  0.72605717  1.00061174
## 6   1.5528926  0.872332576 -1.3708169 -1.6604372  0.08442453 -0.21110118
## 7   4.2530999 -1.367433970 -0.8233221  1.0983828 -0.35167906  1.58043224
## 8   1.3598746  0.314799406  1.0325990  0.9804854 -0.35339099  0.26866463
## 9  -0.3963341  0.684446898  0.4345207 -0.3229165 -1.09008455  0.01309642
## 10  0.3286979 -1.179357302 -1.7782264  2.0130898 -2.83425353  1.93476171
##    GSM2630981 GSM2631115 GSM2630824 GSM2631067 GSM2631107 GSM2631097
## 1  -0.5934177 -0.9629834 -0.1138853 -1.5898242 -0.9739718 -0.7179147
## 2  -0.2477040  0.4033683 -2.1581080  0.0717733 -0.7224086 -3.0883940
## 3   0.3421513 -0.8268833  1.1674422 -1.3245795 -1.6356987 -1.5128747
## 4  -1.3343908 -0.4308926 -1.9239171  1.5104257 -0.1552184  0.8863757
## 5  -2.7020389  0.4208248  1.6265413 -1.2216904  1.7156022 -0.2537189
## 6   0.1744080 -2.1694413 -1.5639067  1.6116437 -0.6954149  1.8186869
## 7   1.4865804  0.6017518 -1.0388379  0.1871933  1.1182553  0.6368734
## 8   1.4387360  0.6427661  0.5393204  1.6324077 -1.2538834 -2.2112509
## 9   2.3522817 -1.9100571 -1.5031526  0.8026206  0.5126049  0.7902524
## 10  0.1256070  0.8441282 -2.2636868 -0.5723138 -2.2610250 -0.9411513
##      GSM2631036 GSM2631186 GSM2630979   GSM2631262 GSM2630960 GSM2630942
## 1  -0.925369635 -0.9818926 -1.7458252 -0.694421315 -1.0501747 -2.5952102
## 2  -2.106625909 -1.4326404 -3.0848940 -0.258485044 -0.2877108 -0.1810444
## 3  -0.692826832  0.9829072 -2.0333059  0.088730561  2.8949967  3.1345713
## 4   0.005652508 -0.2714030  1.7357947  0.986114790  0.1336727 -0.2269786
## 5  -0.385480363 -0.6298005 -2.0480845 -1.157041375 -4.3992315 -0.6628863
## 6  -0.960849676 -0.5225415 -1.5198351  0.556621023  2.1828713  0.4955701
## 7   0.945615597 -2.4929571  0.2926909 -0.009864444 -1.4850765  1.0364623
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## 8   2.371948158 -0.9141599  0.1022683 -1.787592884  1.0655321  0.4979795
## 9  -0.248433856 -0.6064766 -1.1005213  0.050910404  0.4840054  0.4566891
## 10 -1.891505633 -0.9656623 -0.5181381  0.774156552  1.7987290  1.1536886
##     GSM2630867  GSM2631094 GSM2631266  GSM2631293 GSM2631089 GSM2631184
## 1  -0.05407524 -1.51197572 -0.8711843 -0.85913069 -1.1469050 -2.1068226
## 2   0.34667709  0.06280491 -1.7319095 -1.16275784  2.0404509  1.4341754
## 3   1.19697026  1.80316659  0.2212331 -0.43816973  0.9519919  1.9416845
## 4   0.68194648 -0.16581476  0.3591209  1.21461188 -1.9585188  0.1666770
## 5   0.73238797 -1.42973513 -0.4548546 -1.79277656  1.0614899 -0.3866254
## 6   0.97260758  2.37936592  1.5323763 -0.27147164 -0.3290498  1.0939036
## 7   0.31460097  2.02402591 -0.2174077  2.12584935 -0.1911610  1.3762836
## 8   0.90948952 -1.57166042 -2.2855422 -0.02605607  1.9408017 -2.5172707
## 9   0.34085517  1.30014787 -0.6884856  1.04509034 -0.9287406  2.6589037
## 10  1.44417344  1.12574380 -0.5598169  0.06024316 -2.1123798  2.2749331
##      GSM2630815   GSM2630763 GSM2631220 GSM2631265 GSM2631267  GSM2631268
## 1  -1.094622476 -1.210545605 -1.3327316  0.4511375 -1.3910108 -0.51684365
## 2  -0.792890069  0.826584733 -2.3320596 -1.9727023 -1.8576513 -1.28001515
## 3  -0.008425992 -0.108839723 -2.0135913  1.1194101 -1.6007191  2.39137770
## 4  -0.442004812 -0.520986506 -2.5347666  0.2784159 -1.9591825 -0.31676634
## 5   0.395022879 -1.593034895  0.8535663 -1.3680189  0.3552181  0.45836683
## 6   0.099346939 -0.691478946 -1.1954855  4.4215435  1.3691075 -0.05379665
## 7  -0.990716728  1.146822327 -1.2557481 -1.5845199 -0.2140629  4.64319858
## 8  -0.696475725  0.009670066 -3.5785456  0.6736680  0.7258374 -0.79819645
## 9   1.628184220  0.186095311 -2.6732107  0.8502700  2.4254963  1.78282331
## 10 -2.327406479  2.201269156 -2.3931290  1.2145590  1.6432758  1.75651118
##    GSM2630793 GSM2630766  GSM2630839 GSM2631004 GSM2630991  GSM2631048
## 1  -1.0915782 -0.5271289 -1.85737643 -0.5077607 -1.1200137 -0.15374120
## 2  -1.0291323  2.2450508  1.20759048  0.1086124 -0.2740660  0.31820532
## 3   0.2842064 -0.9194415  0.40088796  0.1044426 -0.1889586 -0.11367331
## 4   1.3168862 -1.1104305  0.70578663  0.1745603 -0.6192581  1.67550368
## 5  -0.7534361  0.2013076 -0.08190932 -0.1203836 -0.1510299  0.01744889
## 6   1.9647524  0.1428687  1.06916993 -0.8284710 -2.0476375 -0.86173055
## 7   1.8259462 -2.1071972  1.44206500  1.0099398 -0.7860837  0.21540083
## 8   0.6866605 -1.3250397 -0.63782743  0.7493388 -1.9690810 -0.50097221
## 9  -0.8028064 -2.0439104  0.47319519  0.2898149 -0.4189007  0.85863278
## 10  1.3628170  1.4079992  2.51798940 -0.7801648 -0.3282751  0.56352801
##    GSM2631090  GSM2631104  GSM2631259 GSM2630760 GSM2631051 GSM2630977
## 1  -1.7485344  0.83951225 -0.15204624 -2.2786491 -0.5666831 -1.4585332
## 2  -1.2277700  0.62982078 -2.26425188 -1.9303279 -0.9595825  0.9747705
## 3   0.1941571  2.46967092 -0.06262525  3.3288026 -0.9975200  1.0420441
## 4   1.6309044  0.07444913  1.23983880  1.5346696 -1.5579128  0.5954689
## 5  -0.9272385 -3.19901355 -1.32234578 -1.8390993  0.1818649  1.0241005
## 6   1.2566474  1.90342347  0.28276929  1.6659341 -4.0821619  1.9401031
## 7  -0.7433492  1.77047876  0.34964104  1.5572564 -0.8063033 -1.0807355
## 8   0.8277760 -0.11274247  1.86054871  1.9824615  0.1878316  1.1044720
## 9   0.7315305 -0.61994661 -0.37728193 -1.3135161 -1.6990479 -0.5307943
## 10  0.4131055  1.82538376 -0.74661496  0.9167061  0.3574324  1.0133322
##    GSM2630829 GSM2631264  GSM2630938  GSM2630966 GSM2631269 GSM2631129
## 1  -0.7953674 -0.5058689 -1.34167262 -0.66248760 -1.4377106 -0.1690443
## 2   0.5077913 -0.4134887 -1.49280621 -0.22238330 -0.7957836 -1.6075090
## 3  -1.1815935  0.8847078  0.78873469  1.02312460  1.2394915  0.6369946
## 4  -1.5211193  1.1682399 -3.25535716  0.09272712  0.3978321 -0.6032546
## 5  -1.4561993 -3.1967779  0.03454615 -0.39298937 -1.4730465 -1.4724794
## 6   0.1563138 -1.0634005 -0.30759402  0.81010773  0.4062617 -0.1880743
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## 7  -0.9927001  1.5850815  0.17410361  0.80098282  1.9974941 -1.6862375
## 8  -2.3792193  1.7664738  0.28101790  0.56078423  2.4283620  0.8600664
## 9  -1.9124928 -1.0221695  0.48461771  1.14294206  1.7033134 -1.2962880
## 10 -0.6623185  0.8976598 -1.66260500  0.55408225  2.1135216 -0.4405015
##    GSM2631013  GSM2630968   GSM2630893  GSM2630804 GSM2630995   GSM2631099
## 1  -2.0468439  0.50804723 -1.551709319 -2.08479077 -1.2917122 -0.011241915
## 2  -0.7125311 -0.48607670 -0.105184265 -0.51182039 -2.2323878  0.002007725
## 3   0.2236099  1.88914131 -2.273596535 -1.63140248 -0.7385566 -0.816077852
## 4  -1.0590484  3.84117725  0.005706778 -1.75083457  1.5285242 -0.450266476
## 5  -1.9039240 -1.10862022 -0.838587812 -1.50864580  0.3996913  0.550356134
## 6  -0.5164401  1.29260719 -2.325125187  1.93261075 -0.1289923 -1.867645759
## 7  -1.5837931 -0.11961766 -1.394965101 -0.09868586 -0.6602200 -0.339192988
## 8  -0.2325537 -0.07253499  1.421845159  0.22509685  0.8169918  1.048320318
## 9  -0.5016221  0.92579282 -0.486673888 -0.30044630 -2.1434852 -0.313192180
## 10 -2.3063737  3.57492852 -1.270863847  0.20097174 -1.9164608 -1.906003187
##     GSM2631106 GSM2631146 GSM2631187  GSM2631261 GSM2630950 GSM2631128
## 1  -1.64402182  0.1035240 -0.9993951 -2.31663432  0.8778112  0.4071387
## 2   1.36286256 -0.6213251  1.8612672 -0.22948078  0.9873322  0.3170618
## 3  -0.16806877  0.2415535 -0.1269104 -0.16228491  0.5140307  1.1473247
## 4   1.56790108  1.5169937 -0.8112110  2.62693296  1.4708719  3.4444170
## 5   1.07999023 -1.0975514  2.1821346  0.48537858  1.0298641  1.0138297
## 6  -0.42959784  1.6945018  0.2530582 -2.74955083 -0.3260145  0.0531847
## 7   0.69349361  1.3347449  1.5603115  0.82225741 -0.7741482  3.6458769
## 8   0.07496142  0.4293394  0.5111996 -1.12774840  1.9865123  0.1342736
## 9  -1.91651330  1.3186369 -0.4870701 -1.03937367 -1.9635046  0.5377316
## 10  1.52956415  0.6724051  0.6633348  0.04473353  1.5992759 -0.2684696
##     GSM2631182 GSM2631078 GSM2631060 GSM2631189 GSM2630891 GSM2630976
## 1  -2.54725410 -0.8806653  0.2554293 -0.9725052 -0.2296447 -0.9915351
## 2   0.62508879  0.9246205  3.9100273  0.1962435 -1.3776335 -0.1011587
## 3   0.93441834 -2.3892165  1.1715350  1.1034283 -2.3470833  2.0353925
## 4  -0.84113034  2.4462454 -1.2068418  0.8252213 -0.5154171  2.4922071
## 5  -0.92261955 -0.7691148 -2.5888016  0.9691800 -0.8953786  2.7523347
## 6   0.24963068 -0.9531151 -0.9048991 -2.0074446 -2.7725265  2.1888079
## 7  -2.50688505  0.0797960  2.6522436 -0.8136174 -0.1621829  1.4992613
## 8  -0.61854936  2.4560557  0.6025882 -2.2834011 -2.8289674 -0.7340555
## 9   3.70667335 -0.5317402  1.6214033 -1.7945917  0.2055135 -0.4312602
## 10  0.04825742 -1.5472011 -2.2002501 -0.9580298  2.7992269 -2.7372248
##    GSM2630911 GSM2630856 GSM2630813 GSM2630827 GSM2631035 GSM2630841 GSM2630918
## 1  -1.8750664 -0.4646803 -2.5757948  0.5438591 -1.5434953 -1.3155691 -1.2986092
## 2   2.7102561  1.2333097 -0.8929845  1.8778427 -0.4226869 -1.7352509  0.3465669
## 3  -0.8087983  3.1124356  0.5526647 -1.2078296 -0.8029114 -2.5366676  0.8493634
## 4  -0.5692714 -1.0639654  1.2902401  0.9006928 -1.7780069 -0.7949673 -1.5202480
## 5   1.0825978 -0.6203469 -0.3998847 -0.3467247 -0.3430218  3.5007693 -1.7931431
## 6  -0.7576955  1.5597356  0.7027909 -2.1996613  0.3258566  0.1920471 -1.2726958
## 7   2.1573461 -0.1251887 -0.1687934  1.5277798 -1.4908209  1.2552762  1.7909471
## 8   2.0063535 -3.3676822  2.0206729  1.6065428 -0.5025149  1.0729340  2.1536156
## 9  -0.5565975  0.7657907  0.2365012  1.1854512  3.3867273 -1.0154906  2.5287212
## 10 -1.1140513 -0.3789588  0.3738767  3.0056741  0.5371335 -1.1383199 -0.3227132
##     GSM2631249 GSM2630762  GSM2630817  GSM2630826  GSM2630895 GSM2630915
## 1  -2.42941895 -0.9350261 -0.37996662 -0.45840356 -0.69238779 -2.1617964
## 2   0.05149691  1.1108494  0.26030700 -2.25059160  0.89422510 -1.1630619
## 3  -0.94044765 -1.2715152  0.81079661  0.15349125 -0.02163383 -0.1535229
## 4  -0.75500556 -0.7416564  0.05808131 -2.05976072  0.66738612  1.7257607
## 5  -0.81336074  3.4432288 -0.36783057 -0.57202718 -2.78615588  0.5151349
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## 6   1.31302528 -1.0914065  0.06458691  2.01657367  0.41071473  0.3990196
## 7  -0.93543432  0.6324947  0.95980055  0.04959247 -0.93961383  0.4035298
## 8  -1.89828767 -2.2337538  1.07026090 -0.36329370  2.82004564  1.4254794
## 9   0.49173237 -3.4991086  2.31626133  1.63130214  1.38823051  0.4350431
## 10 -3.68554087 -1.2562572 -1.54619311  0.87132387  0.92924233  0.8908939
##    GSM2630838 GSM2630900 GSM2631224  GSM2631244 GSM2631245  GSM2631246
## 1  -2.9460590 -3.2483643 -1.0006847 -1.63095660 -2.0338106 -1.39393569
## 2  -0.4383554  1.4244318 -2.1456871 -0.78385860  0.5408137  0.07039058
## 3  -0.6301082 -2.8449701 -1.8251298 -0.80077557  0.2636484 -0.69858486
## 4   0.4795585  0.3067929 -3.1554234  0.32948632 -1.4724555 -0.10892016
## 5  -0.5017270  0.7477007 -0.8315515  1.10381996  0.1027122  2.11318780
## 6  -0.1669634  2.2484424  0.7162219 -0.22581102  0.8898958  0.25544186
## 7  -1.5625500  1.6100570 -1.2572139 -0.58157787 -0.5542990  0.69182758
## 8   0.1890425 -0.7115431  0.9461930  1.86861940 -0.1560656 -1.28901282
## 9  -0.1551468 -0.6937471 -0.3515473  0.08164747  1.6299457 -0.02994431
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##    GSM2631247 GSM2630794  GSM2630870  GSM2630890  GSM2630901 GSM2630902
## 1  -2.4753535  0.7991488 -1.40960390 -0.63370802 -1.50662866 -1.8395544
## 2   0.9822148 -0.2551122  0.83835754 -2.31659375  0.25015145  0.2488519
## 3  -1.4221877  0.6031899 -0.09603965  0.89034944 -1.04196712  1.4884015
## 4  -0.8548419  1.3079159  0.12845980 -1.62294589 -0.39361727 -0.9591289
## 5   1.5416138  3.3182213  1.06532594 -1.43724099 -0.08971241  0.3287321
## 6   1.9241219  0.5483882  1.98021674  1.51864655 -2.50160101 -0.1706318
## 7  -2.7699040  1.1214066  0.27108272  0.01828891 -1.62785187  1.7430582
## 8   0.6866335  1.5181807  0.97570929 -0.33575887 -1.01791464 -0.2237671
## 9  -0.8343387 -1.9160077 -0.17851676 -0.05226723 -0.21088925 -1.3633682
## 10  1.0880665  0.8787579  0.21255801  0.09024712 -0.90043786 -1.9537052
##     GSM2630904 GSM2630764  GSM2630781 GSM2630791 GSM2630862  GSM2630898
## 1   0.12536363  0.6046803 -1.95391688 -0.6687297 -0.4248194 -0.08884345
## 2   0.29457297 -1.2632990 -2.16164638  1.0633079 -1.4184357  2.10651825
## 3   1.11147168 -0.9397692  0.94325478 -1.2234248  0.2227079 -0.06559287
## 4   0.07180930 -2.0337492 -0.86594119 -0.8073664 -0.5313776 -0.10746751
## 5  -1.94451658 -0.3978018  0.07081287 -0.3135973  0.3379879 -1.43685363
## 6  -2.88551370  0.6338114 -0.34048153  0.8991488 -2.3761936 -0.41727529
## 7  -1.30701908  2.1580630  1.03952666 -1.4065394 -0.1045208  0.47375406
## 8   1.46783249  0.0223418  0.96340348 -2.0498609 -1.8508805  0.70902245
## 9  -0.34507418 -1.7045234 -0.52245480 -0.9418938  0.8346672 -2.09628338
## 10  0.02410954 -2.4602402 -0.74192577 -0.6282734  0.2111409  1.20688160
##    GSM2630903 GSM2630931 GSM2631150 GSM2631151  GSM2631155 GSM2631156
## 1  -0.9729093 -0.7205041 -1.8279255 -1.6272927 -1.02188472 -0.3030778
## 2   2.1354871  3.2053897  0.3156530  0.9477126 -2.23292421 -0.2826414
## 3   1.1211419  0.8662322 -1.7624382  1.1713244  0.09656530 -1.9224780
## 4   2.1393422  1.3141604 -0.8578469 -1.7569774  1.25159885  1.3405230
## 5  -0.9372988 -0.4733000 -0.5279991  0.4059818 -0.34102972  3.3732013
## 6  -0.2351801  0.8366783 -1.1768148 -2.0200991 -0.02430283 -1.1990947
## 7  -1.5792052  0.8482678 -1.0322766 -0.6570083  0.05410995  0.3604821
## 8   1.8128098 -1.0439315  0.9080910  0.1128380  1.05059746 -3.1002515
## 9   1.3662097 -0.3567194  0.0894138  0.2032917  0.19691407  1.0281952
## 10  2.4889906 -1.0066173 -0.2925723 -1.0468232  0.82362416 -0.1752416
##    GSM2631157  GSM2631160 GSM2631169 GSM2631154 GSM2631164 GSM2631166
## 1  -0.5422523  0.04725979 -1.1099001 -1.0273597 -1.4456580 -1.7858547
## 2  -2.4505954 -2.05168976  0.5904935 -0.5084441  1.4034084  0.1951422
## 3  -0.1501010 -0.33821937  0.1357660 -2.8707103  0.4180560 -1.2119563
## 4  -0.1525208  1.96718555  1.3873547 -2.6130987 -0.6005612  0.2702867
```

```
## 5   2.2906663  0.81164647  0.5248717  1.6765126  0.6401359 -0.8962291
## 6  -0.2696430 -1.22897043 -0.7205411 -0.4615426  2.5951893  1.2824862
## 7  -1.6128104  2.04499759 -0.3768312  0.5306320 -0.1184724 -0.6026118
## 8   1.3997785  0.66635495 -1.4931160 -0.9246077 -0.6656506  0.5028838
## 9   0.3101733 -0.93913306 -1.3872434 -0.2902066  2.2131411  0.2952501
## 10  2.2203366 -1.43104270  0.2113026 -1.3995883  2.7186935 -0.7377302
##     GSM2631168  GSM2631170    GSM2631178 GSM2631019 GSM2630886 GSM2630765
## 1  -1.86787636 -1.74967542 -1.1327505734 -3.0081613 -0.9991245 -0.4969681
## 2   0.24927716 -0.82887470 -0.6814695654 -1.6452205  1.8169026  2.3886774
## 3  -1.44836641 -0.18454581 -1.4938808451  1.6590180 -1.6057020  2.3485171
## 4  -1.14206299 -0.04992567 -1.4915257484 -3.5315773  1.2048392 -0.9250487
## 5   2.23808444  0.15756681  0.9589022805 -1.1915869 -1.1013387 -1.5079540
## 6  -0.06497648  2.41532699  0.0004061308  3.0659404 -3.4045271  1.8612625
## 7  -1.56926183  0.72315652  0.7314615614  0.9128251  0.5535988 -0.4061381
## 8  -0.09029771  0.22893834 -2.5320296222 -0.9717200  2.6180561  0.9194321
## 9   3.65635400  0.49243598 -0.6768714109 -1.2264771  1.6094476  0.7537491
## 10 -0.06314897 -0.12692465  1.6081203878 -0.3395239  0.1892462 -0.3077332
##    GSM2630831  GSM2631315 GSM2630814 GSM2630776  GSM2631204 GSM2630943
## 1   2.2484317  2.20927469  0.6651546  2.2135823  1.76544755  1.0995474
## 2   1.4722638 -1.47914201 -1.3190896 -0.5982497 -0.03760468  0.4629934
## 3  -0.9689060 -1.11353700 -0.6498948  1.9491410 -2.13039273  0.8892568
## 4   1.3091459 -0.37045225 -1.1137832 -1.6589510 -1.33587653 -0.7164474
## 5  -0.8022214 -0.09040963  1.6516621  0.6565135  1.89144254 -0.9794713
## 6  -1.5007237 -0.19918438  0.9448221  1.3535971  1.49580444 -0.6143860
## 7   0.1460574 -2.10623948  0.6765536  0.2086783  0.24512638 -1.2107923
## 8   1.2575029  0.17172954 -1.2010559  3.3831993 -1.29178934 -1.9515247
## 9   1.7183706 -0.03909474  1.9571365 -1.2479452  0.07314566 -2.0510919
## 10  1.4787214 -1.16834342  0.4100977 -0.9973168  1.66578525 -1.0569464
##    GSM2631199 GSM2631299 GSM2631223  GSM2631233 GSM2631313 GSM2630808
## 1   0.7946736  2.3605210 -2.2012231 -0.02146046 -0.6326650  2.5049257
## 2   0.6515067 -1.7673217 -1.7258935 -0.25278472 -1.6125410 -2.3967102
## 3  -1.0151381  0.8265741 -1.5204924 -0.51980557 -2.2917605  1.0289422
## 4   0.8255911 -0.8028693 -0.5615761 -2.08426765  0.3029939 -0.3865245
## 5  -0.6025549  0.5505165  0.3204596  2.41206947 -0.7231661 -0.1578205
## 6   2.1925398  0.3544965 -0.9325789 -1.15736210 -1.7341359  3.7518119
## 7   2.1413013 -1.8929682  1.6810657  0.54987747 -0.1155210  0.8848613
## 8   1.1612778 -0.1448406  1.2979649 -2.56063017 -1.3570210 -1.3183369
## 9  -1.9425897  0.7907592 -1.7583940  0.75345376  1.2161013  1.1386033
## 10  1.4628875  0.5943801 -1.7320431 -1.74374670  0.5929599  1.0831788
##    GSM2631314 GSM2630836  GSM2631216 GSM2630889 GSM2631174 GSM2630894
## 1  -2.3359606 -0.1942268  2.53162113 -1.1165815  1.4991129  0.8804499
## 2   0.5067168  0.2582003 -0.08970246  0.9657226 -1.2643005  0.1925006
## 3  -0.4145393 -0.0167197  1.75623085  0.3486122  0.2483123  0.3231254
## 4  -1.3629297 -1.0357384 -0.73100763 -1.2232381  1.0063012  0.2391760
## 5   1.6636426 -1.0738555  0.42965378 -1.0862381  0.3670247  0.5919914
## 6  -2.1687875 -0.2819072 -0.72533283 -0.2918044 -0.4020399 -0.2462007
## 7  -0.6230213 -0.2012687  1.24536529  0.9611260  0.6367888  1.2611701
## 8   1.8379224  0.7857344  3.78509997 -0.2806835  2.1922381 -0.8982817
## 9  -3.3068858  0.4368821 -2.91517174  0.4485293 -0.2987615 -1.1046762
## 10 -0.2546930 -2.4237833 -0.25257856  0.5368397  2.7537925  0.3442400
##    GSM2630792
## 1   1.5075483
## 2  -0.8114261
## 3   1.1785312
```

```
## 4   1.8140335
## 5  -0.2519061
## 6  -0.4054978
## 7   1.9115156
## 8   0.7921362
## 9  -0.9894306
## 10 -1.4503751
```

Try summarizing the phenotype data:

```
summary(pheno)
```

```
##  geo_accession      submission_date    last_update_date       type
##  Length:550         Length:550         Length:550         Length:550
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##     tissue            organism          subject_id        disease_label
##  Length:550         Length:550         Length:550         Length:550
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##      sex            mutated_pd_genes    age_at_exam    age_at_symptoms
##  Length:550         Length:550         Min.   :30.00   Min.   :10.00
##  Class :character   Class :character   1st Qu.:54.75   1st Qu.:45.00
##  Mode  :character   Mode  :character   Median :61.00   Median :55.00
##                                        Mean   :60.56   Mean   :53.61
##                                        3rd Qu.:68.25   3rd Qu.:64.00
##                                        Max.   :82.00   Max.   :78.00
##                                        NA's   :266     NA's   :325
##      updrs           updrs_ii      updrs_iii_score_on updrs_iii_score_off
##  Min.   : 0.000   Min.   : 0.000   Length:550         Length:550
##  1st Qu.: 0.000   1st Qu.: 0.000   Class :character   Class :character
##  Median : 0.000   Median : 0.000   Mode  :character   Mode  :character
##  Mean   : 1.171   Mean   : 4.593
##  3rd Qu.: 2.000   3rd Qu.: 7.000
##  Max.   :36.000   Max.   :35.000
##  NA's   :122      NA's   :123
##     updrs_iv      hoehn_yahr_on      hoehn_yahr_off      moca_score
##  Min.   : 0.000   Length:550         Length:550         Length:550
##  1st Qu.: 0.000   Class :character   Class :character   Class :character
##  Median : 0.000   Mode  :character   Mode  :character   Mode  :character
##  Mean   : 1.236
##  3rd Qu.: 1.000
##  Max.   :14.000
##  NA's   :118
```

We make the following observations.

1. We have some unnecessary data in this file. We aren't interested in the submission and last update date. We can reduce the dimensions of this file so it handles nicer from now on.
2. We have a LOT of missing data. You'll learn how to handle this in some of your biostats classes! For now, we'll run what analyses we can given the data we have.
3. Some of our scores have been read in as character values (and they should be numbers). If you investigate this further, you'll find that some values have been recorded as "ND", which we'll assume means "no data". We will need to record these as NA values in R.

Our next step is to address item one. We will reduce the dimensions of our pheno data frame to include only that information that we're interested in modelling. We can exclude the dates, type (as it's all RNA), tissue (all whole blood), organism (all homo sapiens), and subject ID (we will be using geo_accession as our unique indicator). As well, we will exclude mutated_pd_genes, as we indend to define our own gene signature later this week.

Subset your pheno data frame to include columns 1,8,9,11:20.

```
pheno <- pheno[,c(1,8,9,11:20)]
```

Next we need to correct the columns which contain "ND". You can use the "which" function to find the index of of the matrices which are "ND", and then set these to NA. Set columns 8,9,11,12,13 to numeric values using the "as.numeric" function inside a "sapply" loop. Run a summary of the data frame again.

```
index <- which(pheno == " ND", arr.ind=T)
pheno[index] <- NA

j <- c(8,9,11,12,13)
pheno[,j] <- sapply(unlist(pheno[,j]),as.numeric)

summary(pheno)
```

```
##  geo_accession      disease_label          sex             age_at_exam
##  Length:550         Length:550         Length:550         Min.   :30.00
##  Class :character   Class :character   Class :character   1st Qu.:54.75
##  Mode  :character   Mode  :character   Mode  :character   Median :61.00
##                                                           Mean   :60.56
##                                                           3rd Qu.:68.25
##                                                           Max.   :82.00
##                                                           NA's   :266
##  age_at_symptoms     updrs           updrs_ii      updrs_iii_score_on
##  Min.   :10.00   Min.   : 0.000   Min.   : 0.000   Min.   : 0.0
##  1st Qu.:45.00   1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 0.0
##  Median :55.00   Median : 0.000   Median : 0.000   Median : 0.5
##  Mean   :53.61   Mean   : 1.171   Mean   : 4.593   Mean   : 9.0
##  3rd Qu.:64.00   3rd Qu.: 2.000   3rd Qu.: 7.000   3rd Qu.:16.0
##  Max.   :78.00   Max.   :36.000   Max.   :35.000   Max.   :75.0
##  NA's   :325     NA's   :122      NA's   :123      NA's   :154
##  updrs_iii_score_off    updrs_iv      hoehn_yahr_on   hoehn_yahr_off
##  Min.   : 0.000      Min.   : 0.000   Min.   :0.000   Min.   :0.0000
##  1st Qu.: 0.000      1st Qu.: 0.000   1st Qu.:0.000   1st Qu.:0.0000
##  Median : 0.000      Median : 0.000   Median :1.000   Median :0.0000
##  Mean   : 2.523      Mean   : 1.236   Mean   :2.487   Mean   :0.1961
##  3rd Qu.: 0.000      3rd Qu.: 1.000   3rd Qu.:3.000   3rd Qu.:0.0000
```

```
##  Max.   :64.000      Max.   :14.000   Max.   :9.000   Max.   :5.0000
##  NA's   :110         NA's   :118      NA's   :158     NA's   :109
##    moca_score
##  Min.   : 0.00
##  1st Qu.: 0.00
##  Median :26.00
##  Mean   :17.62
##  3rd Qu.:29.00
##  Max.   :30.00
##  NA's   :16
```

We have a LOT of missing values present in the data! As mentioned before, imputation of missing values is an entire field unto itself. While we won't be imputing data today, we are going to wrangle the above data to attempt to ameliorate some of these missing values.

To do this we will:

1. Combine our Age variables to be age_at_exam where known, but age_at_symptoms where that is observed without age at exam
2. Combine our updrs scores to be the average updrs
3. Combine our hoehn scores to be the average hoehn
4. Keep our moca score as is
5. Remove the old variables from our pheno dataset.

```
#1
for (i in 1:nrow(pheno)){
  if(is.na(pheno$age_at_exam[i])==FALSE){
    pheno$AgeMaster[i] <- pheno$age_at_exam[i]
  } else if(is.na(pheno$age_at_symptoms[i])==FALSE){
    pheno$AgeMaster[i] <- pheno$age_at_symptoms[i]
  } else
    pheno$AgeMaster[i] <- NA
}

#2
for (i in 1:nrow(pheno)){
  pheno$AvgUpdrs[i] <- mean(c(pheno$updrs[i],
                              pheno$updrs_ii[i], pheno$updrs_iii_score_on[i],
                              pheno$updrs_iii_score_off[i], pheno$updrs_iv[i]
                              ),na.rm=T)
}
#3
for (i in 1:nrow(pheno)){
  pheno$AvgHoehn[i] <- mean(c(pheno$hoehn_yahr_off[i], pheno$hoehn_yahr_on[i]
                              ),na.rm=T)
}
#4 Keep moca score
#5
pheno$age_at_exam <- NULL
pheno$age_at_symptoms <- NULL
pheno$hoehn_yahr_off <- NULL
pheno$hoehn_yahr_on <- NULL
pheno$updrs <- NULL
pheno$updrs_ii <- NULL
```

```
pheno$updrs_iii_score_off <- NULL
pheno$updrs_iii_score_on <- NULL
pheno$updrs_iv <- NULL
```

As you can see, we have far fewer missing values to contend with!

Let's look at a summary of the first 10 columns of expression data set.

```
summary(expr[,1:10])
```

```
##        X           GeneName           GSM2631171          GSM2631309
##  Min.   :    1   Length:20668       Min.   :-5.223788   Min.   :-6.09018
##  1st Qu.: 5168   Class :character   1st Qu.:-0.960423   1st Qu.:-0.92906
##  Median :10334   Mode  :character   Median :-0.004842   Median : 0.01385
##  Mean   :10334                      Mean   :-0.009648   Mean   : 0.01249
##  3rd Qu.:15501                      3rd Qu.: 0.953228   3rd Qu.: 0.95912
##  Max.   :20668                      Max.   : 5.766301   Max.   : 5.66627
##    GSM2631219         GSM2630775          GSM2631147         GSM2630853
##  Min.   :-6.39097   Min.   :-5.206869   Min.   :-5.27578   Min.   :-6.115736
##  1st Qu.:-0.97337   1st Qu.:-0.981831   1st Qu.:-0.96379   1st Qu.:-0.944666
##  Median :-0.01097   Median : 0.001772   Median : 0.01906   Median :-0.007942
##  Mean   :-0.00354   Mean   :-0.000010   Mean   : 0.00298   Mean   :-0.009892
##  3rd Qu.: 0.95324   3rd Qu.: 0.971013   3rd Qu.: 0.98545   3rd Qu.: 0.945826
##  Max.   : 6.56118   Max.   : 5.275719   Max.   : 5.18612   Max.   : 5.570111
##    GSM2630769          GSM2631196
##  Min.   :-5.608142   Min.   :-6.303044
##  1st Qu.:-0.968002   1st Qu.:-0.970730
##  Median :-0.001583   Median :-0.004689
##  Mean   : 0.014813   Mean   :-0.006484
##  3rd Qu.: 0.987677   3rd Qu.: 0.977216
##  Max.   : 5.591597   Max.   : 5.434250
```

We don't need the X1 variable - this is just remaining row labels in the csv file. Let's remove this variable.

```
expr$X <-NULL
```

We don't see any evidence of missing values in our summary, but we should check all of the columns (excluding the GeneName). You can check this with the "anyNA"" function.

```
anyNA(expr)
```

```
## [1] TRUE
```

Let's identify how big this problem is, and where it occurs.

```
which(is.na(expr),arr.ind=T)
```

```
##        row col
## [1,] 20668   1
```

So one of our gene names is NA! This isn't useful, so let's remove this row.

```
expr <- expr[-nrow(expr),]
```

We should see if the unique identifiers in our two data sets match. Check for a perfect match using the "identical" function.

```
identical(colnames(expr[,-1]),as.character(pheno[,1]))
```

```
## [1] TRUE
```

So that we don't lose any work, let's clean up our workspace to include only our cleaned expression and pheno data sets, which we can reload later.

Exploratory Data Analysis

In this section we are going to explore some of the data we have, and maybe develop a diagnostic signature for Parkinson's disease.

First, load in your data from yesterday.

Let's re-examine our pheno data set with the summary function again.

```
summary(pheno)
```

```
##  geo_accession      disease_label          sex              moca_score
##  Length:550         Length:550         Length:550         Min.   : 0.00
##  Class :character   Class :character   Class :character   1st Qu.: 0.00
##  Mode  :character   Mode  :character   Mode  :character   Median :26.00
##                                                           Mean   :17.62
##                                                           3rd Qu.:29.00
##                                                           Max.   :30.00
##                                                           NA's   :16
##    AgeMaster        AvgUpdrs         AvgHoehn
##  Min.   :10.00   Min.   : 0.000   Min.   :0.000
##  1st Qu.:53.00   1st Qu.: 0.000   1st Qu.:0.000
##  Median :60.00   Median : 0.000   Median :0.000
##  Mean   :59.37   Mean   : 3.422   Mean   :1.226
##  3rd Qu.:67.00   3rd Qu.: 5.950   3rd Qu.:2.000
##  Max.   :82.00   Max.   :37.000   Max.   :5.000
##  NA's   :199                      NA's   :9
```

We need to further delve into our disease label in order to simplify some of this analysis. Attach your pheno data frame using the attach function, and then summarize the disease label vector.

```
attach(pheno)
#can just refer to column names now
summary(disease_label)
```

```
##    Length     Class      Mode
##       550 character character
```

```
summary(as.factor(disease_label))
```

```
##         ATYPICAL_PD                 CBD             CONTROL                 DRD
##                   3                   2                 233                   3
##            DRD-DYT5 GENETIC_UNAFFECTED                 GPD                  HD
##                   3                  22                  41                  19
##                 IPD                 MSA        PD_DEMENTIA                 PSP
##                 205                   8                   2                   8
##   Vascular dementia
##                   1
```

Here we have the counts of all the diseases in our data set. If you look at the actual excel file (not the csv), I've put in a dictionary for these acronyms if you're curious. Here, our controls and our genetic unaffected are both considered to be healthy controls. Any label which contains PD is some subset of Parkison's Disease, and the other labels represent other neurological disorders. We need to make a variable which records a 1 for our cases, and a 0 for our controls. Here, since we are interested in a signature that distinguishes PD from our other disease, the other diseases are technically part of the control set.

Try to set your case control vector using the grep function to find the indicies which contain "PD". At the end, sum your case vector to check that it worked. Make another variable of the words "case" and "control"

```
pdI <- grep("PD",disease_label, value =F)
case <- rep(0, length(disease_label))
case[pdI] <-1
sum(case)
```

```
## [1] 251
```

```
#alternative
case <- grepl("PD", disease_label)*1
sum(case)
```

```
## [1] 251
```

```
caseName <- ifelse(case==1,"case","control")
```

We need to find differentially expressed genes. You'll learn more about this later. For now, feel free to use some of my code. Start by downloading the limma package

```
## If using Windows, first go to https://cran.rstudio.com/bin/windows/Rtools/ and install the appropria
if (!requireNamespace("BiocManager", quietly = TRUE))
    install.packages("BiocManager")
BiocManager::install("limma")
library(limma)
```

We will use the following code. **Comment this code with your thoughts below.**

```
#subset our data for a training and test set
#Makes data reproducible by setting the seed
set.seed(2)
#creates random values for the length of expr -2 between 0 and 1
```

```
prob<-runif(ncol(expr)-1)
#k is the indexes where prob is greater than 0.333
k<-which(prob>=0.3333333)
#creates eset which is expr but without the first column
eset<-expr[,2:ncol(expr)]
#picks columns where prob >= 0.333333
eset<-eset[,k]
#Makes the rownames of eset the first row of expr
rownames(eset)<-expr[,1]
#creates two contrast columns that show columns where case is 0 and 1
design <- model.matrix(~0+as.factor(case[k]))
#Runs statistical model
fit <- eBayes(lmFit(eset,design))
#prints some results to console
topTable(fit, coef=2)
```

```
##                logFC   AveExpr         t       P.Value     adj.P.Val        B
## EXOC3L4     3.142306  1.470262  29.52147 4.614334e-149 4.880349e-145 329.7149
## FAM132A    -3.159535 -1.457137 -29.52019 4.722843e-149 4.880349e-145 329.6918
## CCR3       -3.145072 -1.544135 -29.42457 2.678696e-148 1.795730e-144 327.9645
## MDM2        3.127701  1.413201  29.41022 3.475550e-148 1.795730e-144 327.7053
## MYO9A      -3.172079 -1.564695 -29.28365 3.449096e-147 1.425650e-143 325.4211
## GADD45GIP1 -3.086818 -1.391535 -29.09557 1.039632e-145 3.581013e-142 322.0313
## ANXA2      -3.106348 -1.512452 -29.05756 2.067587e-145 6.104404e-142 321.3470
## CCNJ       -3.123721 -1.443575 -28.98244 8.044362e-145 1.873309e-141 319.9948
## EMC6        3.070413  1.582692  28.98166 8.157829e-145 1.873309e-141 319.9809
## GEMIN4      3.100428  1.425635  28.89971 3.587630e-144 7.414556e-141 318.5067
```

```
#save all results to the table
results<-topTable(fit, coef=2, number=Inf)
```

Here, we have our gene names, our log fold change for expression, average expression, t statistic, pvalue, adjusted pvalue (for multiple testing!!), and the log odds of differential expression.

Next, we select those genes that have adjusted p-values below 0.001. **Comment the code with your thoughts about what its doing below.**

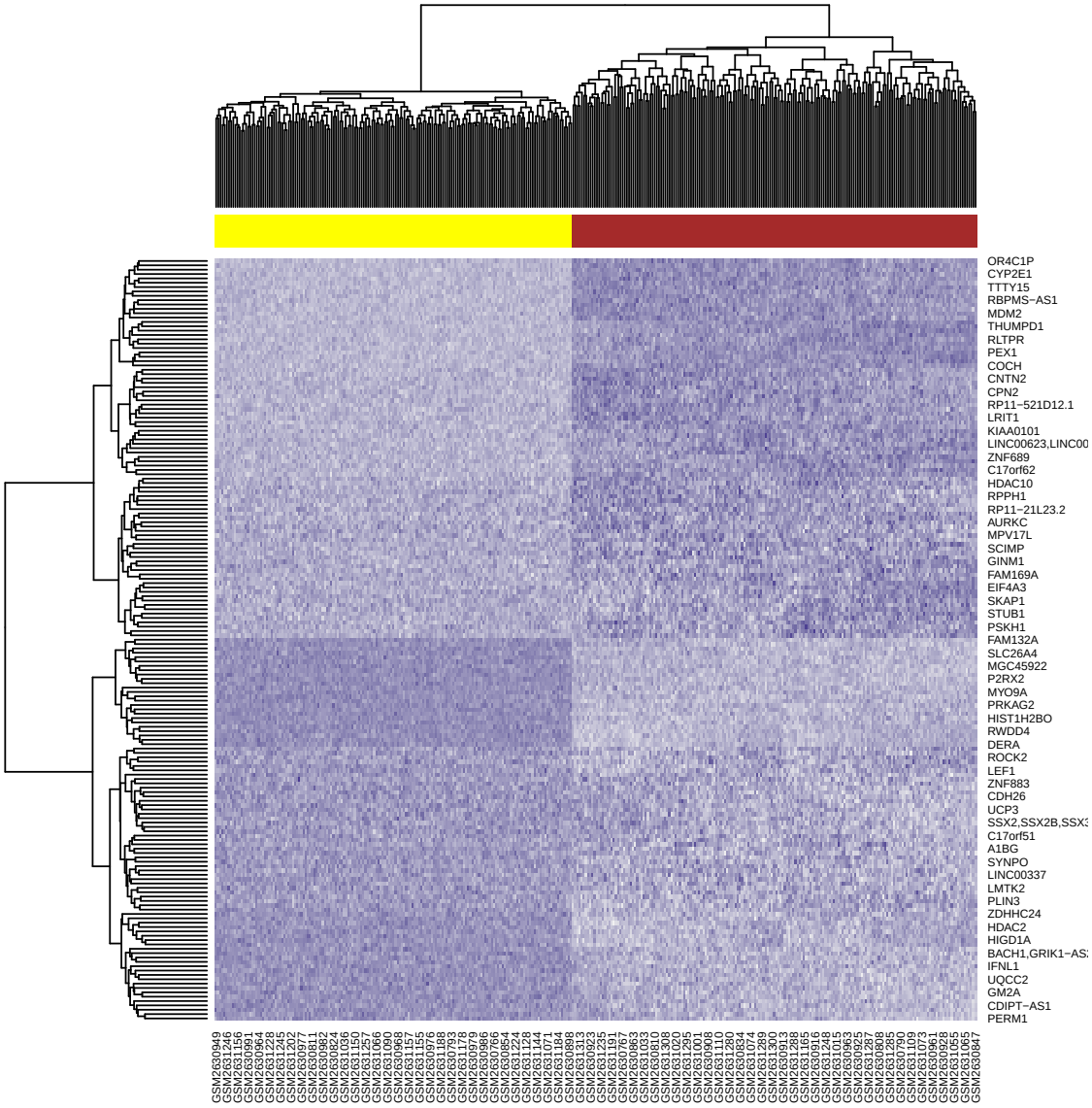
```
# selects rows where the p value is below 0.001
selected  <- row.names(results)[p.adjust(results$P.Value, method="fdr")<0.001]
#checks if the log column is positive or negative
direction <- sign(results$logFC)
#selects rows where p value is < 0.001
esetSel <- eset[selected, ]
#call number of rows of esetsel
nrow(esetSel)
```

```
## [1] 175
```

Okay! So we're now looking at just 175 genes!

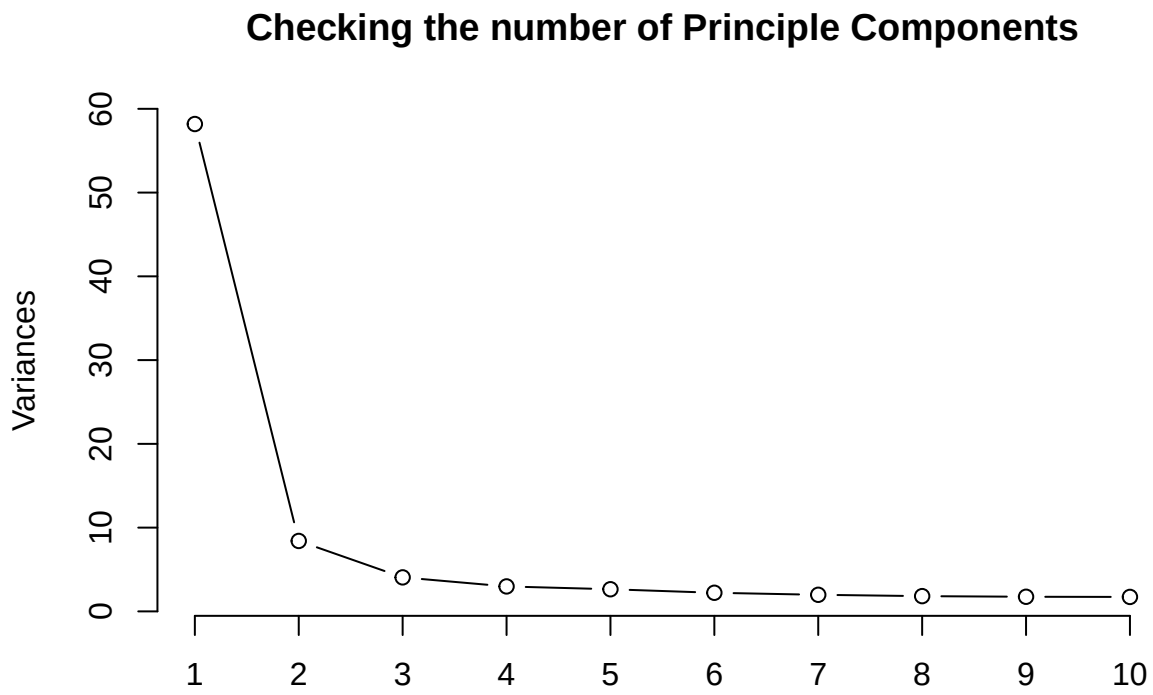
We are going to make a heat map here. I've provided the code, but **try changing colours, labels, etc. to make it your own.**

```
patientcolors <-ifelse(case[k]==1,"yellow","brown")
heatmap(as.matrix(esetSel), col=hcl.colors(100,palette="Purples 2"), ColSideColors=patientcolors, distfu
```


OR4C1P
CYP2E1
TTTY15
RBPMS−AS1
MDM2
THUMPD1
RLTPR
PEX1
COCH
CNTN2
CPN2
RP11−521D12.1
LRIT1
KIAA0101
LINC00623,LINC00
ZNF689
C17orf62
HDAC10
RPPH1
RP11−21L23.2
AURKC
MPV17L
SCIMP
GINM1
FAM169A
EIF4A3
SKAP1
STUB1
PSKH1
FAM132A
SLC26A4
MGC45922
P2RX2
MYO9A
PRKAG2
HIST1H2BO
RWDD4
DERA
ROCK2
LEF1
ZNF883
CDH26
UCP3
SSX2,SSX2B,SSX
C17orf51
A1BG
SYNPO
LINC00337
LMTK2
PLIN3
ZDHHC24
HDAC2
HIGD1A
BACH1,GRIK1−AS
IFNL1
UQCC2
GM2A
CDIPT−AS1
PERM1

Notice the annotation bar along the top. This indicates PD vs not PD samples. This heat map is an example of a 'non-supervised method' - where we didn't feed the labelled data to the algorithm. Instead, it is just clustering similar samples together. Because all of our PD samples cluster away from the non-PD samples, we are relatively certian we've picked good biomarkers! We should also check a PCA plot.

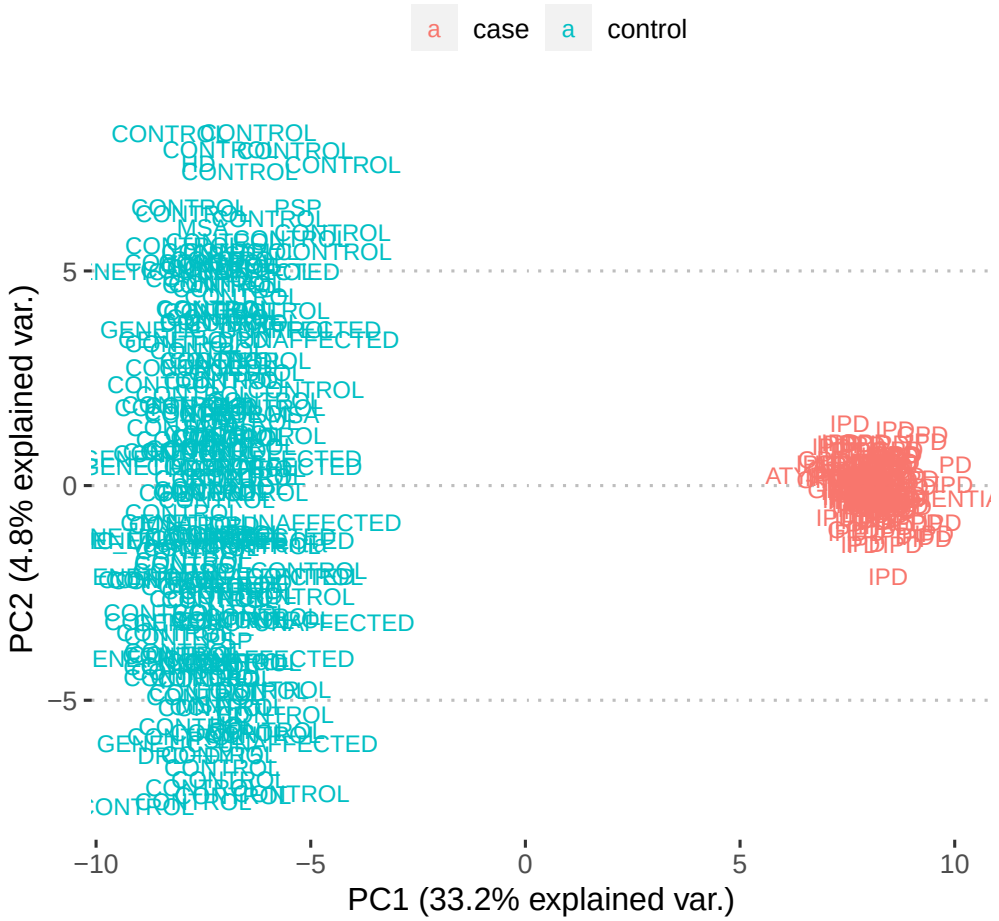
```
pc<-prcomp(t(esetSel),center=T,scale=T)
plot(pc,type="l",main="Checking the number of Principle Components")
```




```
#mainly shows 2 principle components
```

Again, I've provided code for you here. **Change it to something you like better!**

```
#install.packages("devtools")
library(devtools)
library(ggpubr)
#install_github("vqv/ggbiplot")

library(ggbiplot)
g <- ggbiplot(pc, obs.scale = 1, var.scale = 1,
              groups = as.factor(caseName[k]), ellipse = F,
              circle = F, labels=disease_label[k],var.axes = F)
g <- g + scale_color_discrete(name="")
g <- g + theme(legend.direction = 'horizontal',
               legend.position = 'top', axis.title.y =element_text(size=100))
g <- g + theme_pubclean()
print(g)
```



We have separation! Notice the obvious differences between cases and controls.

Make a variable which only contains the differential gene names and call it diffGenes AND print out all of these gene names using one line of code.

```
diffGenes <- selected
```

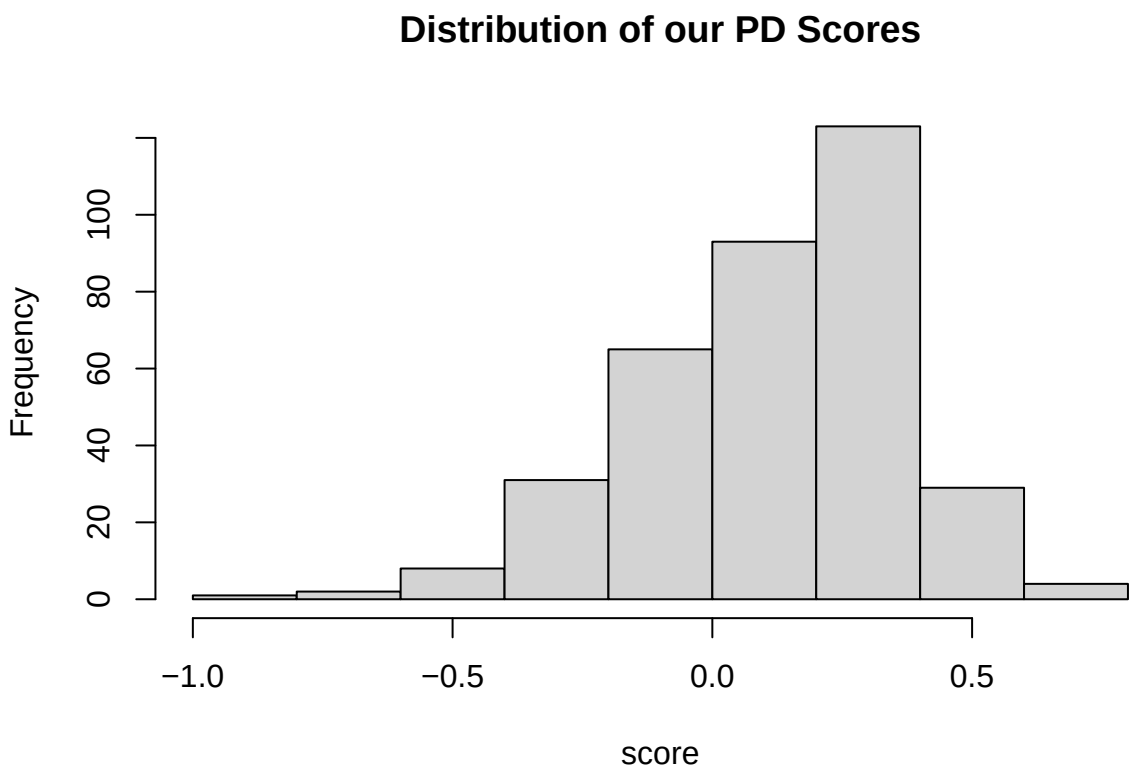
To use these genes as a classifier, we will need to define a score function. Our score will be the sum of the average expression for the upregulated (positive) genes and the average for the down regulated (negative) genes. Here, I've written you a function which will do this. Please enter it and **make comments to show you understand what its doing.**

```
PDscore<-function(x,g,v,s){
  #x expression values for a sample
  #g all the genes
  #v the diffGenes
  #s is the sign of the logFC

  #sets i equal to indeces where all genes (g) are in v
  i<-which(g%in%v)
  #changes x to where g is in v
  x<-x[i]
  #changes s to where g is in v
  s<-s[i]
```

```
  #sets up empty vector p
  p<-c()
  #sets up empty vector n
  n<-c()
  #goes through length of x and if s[i]>0, that value is added to p
  #if s[i] is less than 0, that value is added to n
  for(i in 1:length(x)){
    if(s[i]>0){
      p<-append(p,(x[i]))
    }
    else if(s[i]<0){
      n<-append(n,(x[i]))
    }
  }
  #replaces NA values of p and with zeros
  if(is.null(p)){p[1]=0}
  if(is.null(n)){n[1]=0}
  #sets score equal to difference of the average of p and n
  score<-mean(p)-mean(n)
  return(score)
}
```

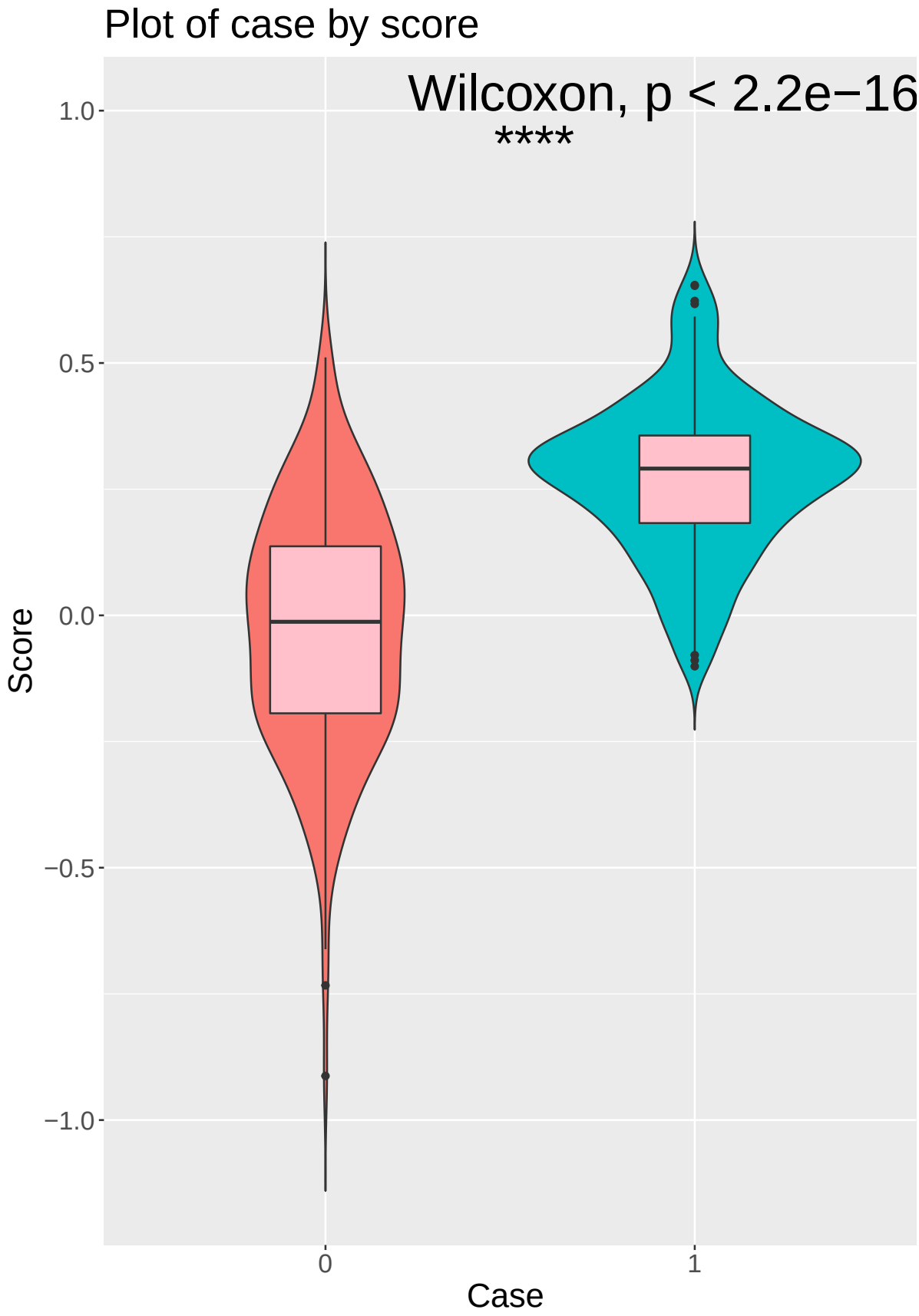
Now we can apply our function to our expression set to define a score for each patient. **Comment what this is doing and why each step is necessary!**

```
#sets score equal to an empty vector
score<-c()
#gets list of all genes that are also in results table
allGenes<-as.character(expr[as.character(expr$GeneName)%in%rownames(results),1])
#go through each column in eset and assign PD score
for(i in 1:ncol(eset)){
  score[i]<-PDscore(eset[,i],allGenes,diffGenes,direction)
}

hist(score,main="Distribution of our PD Scores")
```



Now we'll use ggplot to make and interpret a violin plot of our score. I've provided some code to do this, but **try to change labels, colours, etc. to make it your own.**

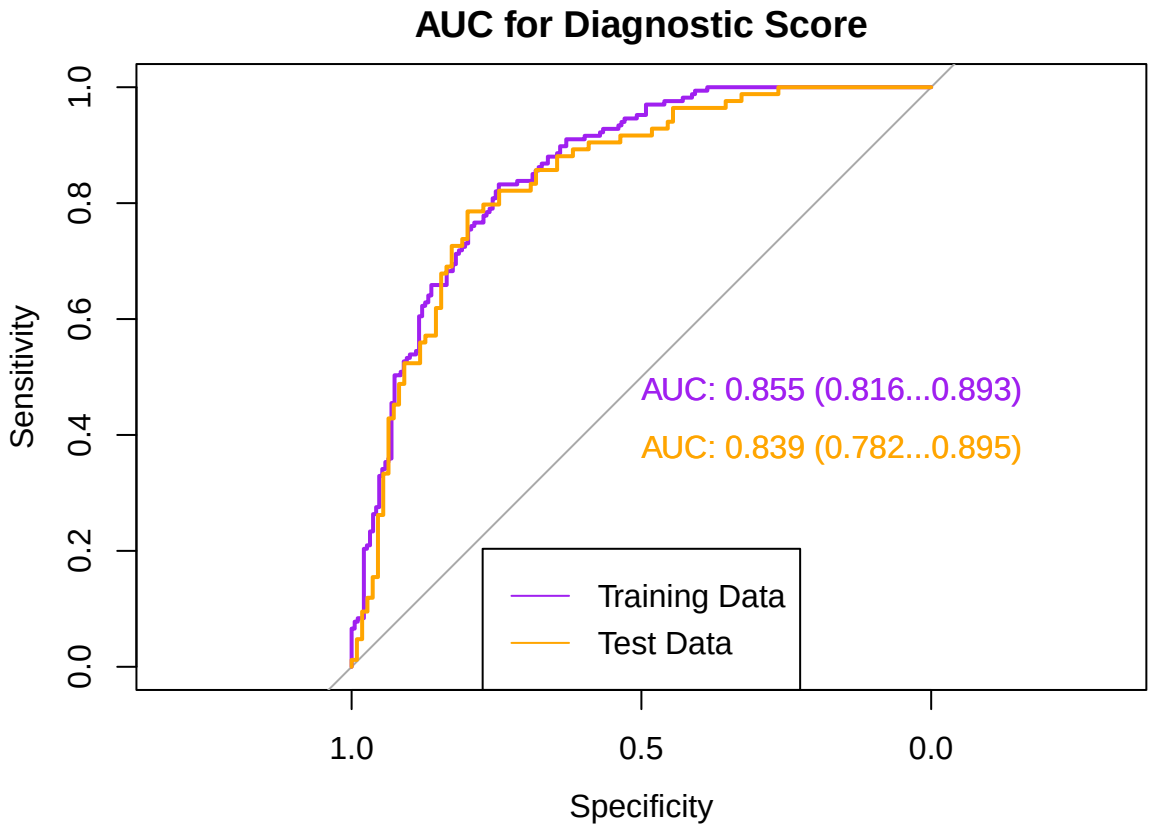
```
#install.packages("ggpubr")
library(ggpubr)

df<-data.frame(cbind(case[k],score))

dp <- ggplot(df, aes(x=as.factor(case[k]), y=score, fill=as.factor(case[k]))) +
  geom_violin(trim=FALSE)+
  geom_boxplot(width=0.3, fill="pink")+
  labs(title="Plot of case by score",x="Case ", y = "Score")+
  stat_compare_means(label.x = 1.5, label.y = 1, size=10)+
  stat_compare_means(aes(label = ..p.signif..),
                     label.x = 1.5, label.y = 0.9, size =10)
dp + theme(text = element_text(size = 18),legend.position="none")
```


Plot of case by score
Wilcoxon, p < 2.2e−16
****
1.0
0.5
0.0
−0.5
−1.0
Score
0
1
Case

This shows not only the boxplot of our data, but also the distribution of our data points around the boxplot! As before, we can see that we DO have significant separation for our score, and we can see that the cases are trending to have a higher score. With more time and data cleaning we may be able to find something here!

Let's make a roc plot, first with our training data, and then with our test data. As before, **play with the plot options to make something you like!**

```
#install.packages("verification")
#install.packages("pROC")
library("pROC")
testEset<-expr[,2:ncol(expr)]
testEset<-testEset[,-k]
newScore<-apply(testEset,2,FUN=PDscore,allGenes,diffGenes,direction)
plot.roc(case[k]~score, data=df,legacy.axes=F,print.auc=T, ci=T, main="AUC for Diagnostic Score",col="pu
plot.roc(case[-k]~newScore,data=data.frame(cbind(case[-k],newScore)),add=T,print.auc=T, ci=T, col="orang
legend("bottom",c("Training Data","Test Data"),lty=c(1,1),col=c("purple","orange"))
```



Notice that our score does better with our training data - this is expected! This is why we need to split our data, to avoid problems with over-fitting. These scores are better than random (the grey line), but we'd like to see an AUC as close to 1 as possible. Let's see if we can do better!

Statistics!

We can run a t-test to see if our score is significantly different between cases and controls. Try using the t.test function in R.

```
allScore <- c(score,newScore)
mergeCase <- c(case[k],case[-k])
t.test(allScore[mergeCase==0],allScore[mergeCase==1])
```

```
##
##  Welch Two Sample t-test
##
## data:  allScore[mergeCase == 0] and allScore[mergeCase == 1]
## t = -17.199, df = 523.03, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.3243096 -0.2578180
## sample estimates:
##   mean of x   mean of y
## -0.01804049  0.27302333
```

The mean scores for our cases and controls are close, but they are significantly different with an extremely small p-value of 2.787e-13. This highlights a classical statistical fallacy - while small p-values are great, they are often meaningless without a large enough effect size. Here, we have achieved significance due to the large sample size of our study, hence our study is adequately powered.

We could also run a simple regression to examine the impact of the score on the log odds of being a case.

```
smallModel <- glm(case[k]~score,family=binomial)
summary(smallModel)
```

```
##
## Call:
## glm(formula = case[k] ~ score, family = binomial)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.3813  -0.7217  -0.1572   0.7629   2.0754
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.2378     0.1949  -6.351 2.14e-10 ***
## score         7.8498     0.8500   9.235  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 492.16  on 355  degrees of freedom
## Residual deviance: 332.07  on 354  degrees of freedom
## AIC: 336.07
##
## Number of Fisher Scoring iterations: 5
```

Summarize this output!

Again, we conclude that the score is a statistically significant indicator of the odds of having PD. Let's build a larger model which examines other phenotype variables.

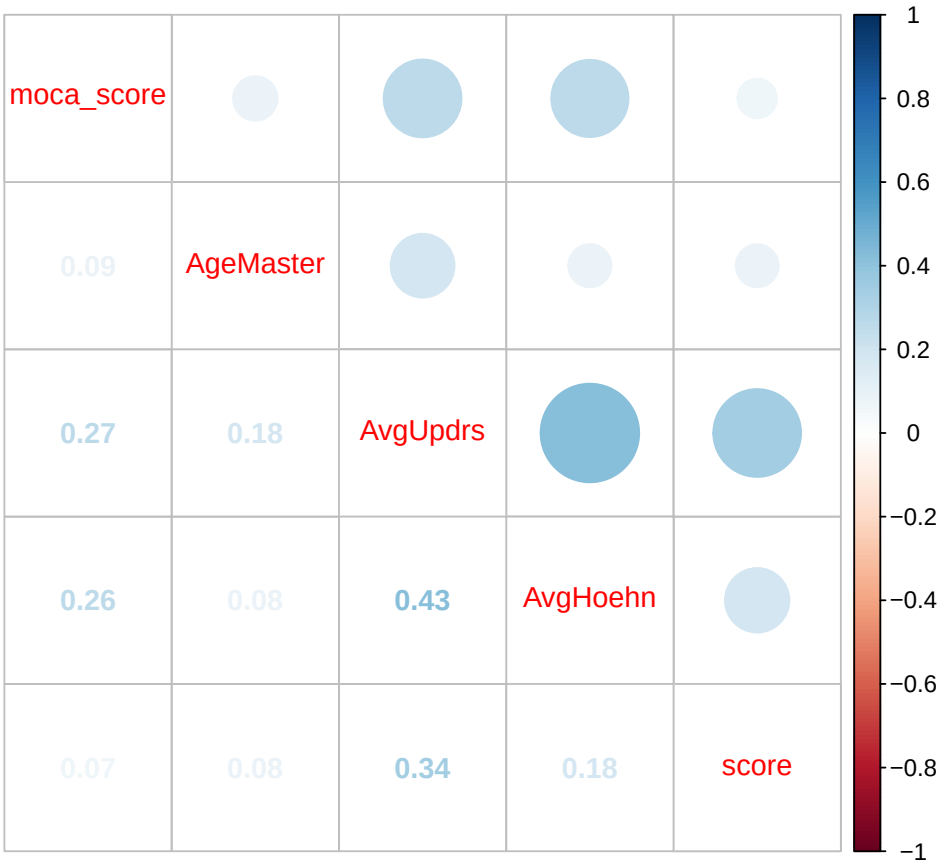
First, build a data frame which includes all the model data we're interested in. Start with the age variables in your pheno set, and then use the cbind() function to add on our scores and the binary case vector. Print a summary of the model data.

```
modelData <- cbind(pheno[k,3:7],score)
summary(modelData)
```

```
##      sex                moca_score      AgeMaster        AvgUpdrs
##  Length:356         Min.   : 0.00   Min.   :26.00   Min.   : 0.000
##  Class :character   1st Qu.: 0.00   1st Qu.:53.50   1st Qu.: 0.000
##  Mode  :character   Median :25.00   Median :62.00   Median : 0.200
##                     Mean   :16.96   Mean   :60.15   Mean   : 3.587
##                     3rd Qu.:29.00   3rd Qu.:67.00   3rd Qu.: 6.062
##                     Max.   :30.00   Max.   :82.00   Max.   :37.000
##                     NA's   :12      NA's   :133
##     AvgHoehn          score
##  Min.   :0.000   Min.   :-0.91260
##  1st Qu.:0.000   1st Qu.:-0.05396
##  Median :0.000   Median : 0.15105
##  Mean   :1.286   Mean   : 0.11374
##  3rd Qu.:2.000   3rd Qu.: 0.30042
##  Max.   :5.000   Max.   : 0.65451
##  NA's   :5
```

We should examine the correlations in our data set. You can do this quickly by building a correlation plot matrix.

```
#install.packages("corrplot")
library(corrplot)
M<-cor(modelData[-1],use="pairwise.complete.obs") #for  missing data
corrplot.mixed(M)
```


moca_score
0.09
AgeMaster
0.27
0.18
AvgUpdrs
0.26
0.08
0.43
AvgHoehn
0.07
0.08
0.34
0.18
score
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

How would you interpret this output? **Answer below!**

```
#Bigger and darker circles correspond to stronger correlation. AvgUpdrs and AvgHoehn are
#strongly correlated. Score and moca score are the least correlate
```

Let's build our first model. Here, we consider the case as our dependent variable, and the others as our explanatory variables.

```
model1<-glm(case[k]~.,family=binomial,data=modelData)
summary(model1)
```

```
##
## Call:
## glm(formula = case[k] ~ ., family = binomial, data = modelData)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.7127  -0.1688   0.0099   0.2470   2.4863
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.86239    1.88994  -0.985    0.324
## sex Male     0.50904    0.61786   0.824    0.410
## moca_score   0.01906    0.02764   0.690    0.490
## AgeMaster   -0.03901    0.02796  -1.395    0.163
## AvgUpdrs     0.58811    0.11753   5.004 5.61e-07 ***
## AvgHoehn     0.36901    0.24141   1.529    0.126
## score        8.94945    1.92380   4.652 3.29e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 284.402  on 206  degrees of freedom
## Residual deviance:  79.922  on 200  degrees of freedom
##   (149 observations deleted due to missingness)
## AIC: 93.922
##
## Number of Fisher Scoring iterations: 7
```

We will iteratively remove variables with the highest p-values, and then rerun the model until we have our optimal fit!.

Try this on your own first.

```
model1<-glm(case[k]~.,family=binomial,data=modelData)
summary(model1)
```

```
##
## Call:
## glm(formula = case[k] ~ ., family = binomial, data = modelData)
##
## Deviance Residuals:
```

```
##     Min       1Q   Median       3Q      Max
## -3.7127  -0.1688   0.0099   0.2470   2.4863
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.86239    1.88994  -0.985    0.324
## sex Male     0.50904    0.61786   0.824    0.410
## moca_score   0.01906    0.02764   0.690    0.490
## AgeMaster   -0.03901    0.02796  -1.395    0.163
## AvgUpdrs     0.58811    0.11753   5.004 5.61e-07 ***
## AvgHoehn     0.36901    0.24141   1.529    0.126
## score        8.94945    1.92380   4.652 3.29e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 284.402  on 206  degrees of freedom
## Residual deviance:  79.922  on 200  degrees of freedom
##   (149 observations deleted due to missingness)
## AIC: 93.922
##
## Number of Fisher Scoring iterations: 7
```

```
model2 <- glm(case[k]~.,family=binomial,data=modelData[,-2])
summary(model2)
```

```
##
## Call:
## glm(formula = case[k] ~ ., family = binomial, data = modelData[,
##     -2])
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.1500  -0.3342   0.1669   0.5369   1.9720
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.46455    1.19128  -0.390   0.6966
## sex Male     0.40194    0.46349   0.867   0.3858
## AgeMaster   -0.03010    0.01947  -1.546   0.1222
## AvgUpdrs     0.13143    0.05681   2.313   0.0207 *
## AvgHoehn     0.39109    0.20739   1.886   0.0593 .
## score        8.59236    1.42448   6.032 1.62e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 299.10  on 217  degrees of freedom
## Residual deviance: 140.81  on 212  degrees of freedom
##   (138 observations deleted due to missingness)
## AIC: 152.81
##
```

```
## Number of Fisher Scoring iterations: 6
```

```
model3 <- glm(case[k]~.,family=binomial,data=modelData[,c(-2,-1)])
summary(model3)
```

```
##
## Call:
## glm(formula = case[k] ~ ., family = binomial, data = modelData[,
##     c(-2, -1)])
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.1611  -0.3210   0.1736   0.5036   1.8925
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.33513    1.19332  -0.281   0.7788
## AgeMaster   -0.03073    0.01961  -1.567   0.1171
## AvgUpdrs     0.13621    0.05667   2.403   0.0162 *
## AvgHoehn     0.42711    0.20392   2.095   0.0362 *
## score        8.57169    1.40872   6.085 1.17e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 299.10  on 217  degrees of freedom
## Residual deviance: 141.57  on 213  degrees of freedom
##   (138 observations deleted due to missingness)
## AIC: 151.57
##
## Number of Fisher Scoring iterations: 6
```

```
model4 <- glm(case[k]~.,family=binomial,data=modelData[,c(-1,-2,-3)])
summary(model4)
```

```
##
## Call:
## glm(formula = case[k] ~ ., family = binomial, data = modelData[,
##     c(-1, -2, -3)])
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.6006  -0.5882  -0.1514   0.6241   2.1715
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.62315    0.23902  -6.791 1.11e-11 ***
## AvgUpdrs     0.23651    0.04184   5.653 1.57e-08 ***
## AvgHoehn    -0.21008    0.10440  -2.012   0.0442 *
## score        7.12752    0.91193   7.816 5.46e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 484.51  on 350  degrees of freedom
## Residual deviance: 281.24  on 347  degrees of freedom
##   (5 observations deleted due to missingness)
## AIC: 289.24
##
## Number of Fisher Scoring iterations: 5
```

This is our final model! Notice that our largest effect size is controlled by our genetic score. At a first glance, we might assume this means that the score has the largest effect on the model. However, if we recall how to interpret our coefficients, the estimated effect size is the change in log odds of being a case for a 1 unit increase in our score. Think about the score distribution: the range of our scores is fairly small. In contrast, the range of the updrs scores varies from 0 to 36. Keep in mind the scale of our data when interpreting these models!

Compare this to your outcome if you use a step function to reduce the model:

```
modelData$case <- case[k]
modelData2 <- na.omit(modelData)
model1 <-glm(case~sex+AgeMaster+moca_score+AvgUpdrs+AvgHoehn+score,family=binomial,data=modelData2)
summary(model1)
```

```
##
## Call:
## glm(formula = case ~ sex + AgeMaster + moca_score + AvgUpdrs +
##     AvgHoehn + score, family = binomial, data = modelData2)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.7127  -0.1688   0.0099   0.2470   2.4863
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.86239    1.88994  -0.985    0.324
## sex Male     0.50904    0.61786   0.824    0.410
## AgeMaster   -0.03901    0.02796  -1.395    0.163
## moca_score   0.01906    0.02764   0.690    0.490
## AvgUpdrs     0.58811    0.11753   5.004 5.61e-07 ***
## AvgHoehn     0.36901    0.24141   1.529    0.126
## score        8.94945    1.92380   4.652 3.29e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 284.402  on 206  degrees of freedom
## Residual deviance:  79.922  on 200  degrees of freedom
## AIC: 93.922
##
## Number of Fisher Scoring iterations: 7
```

```
stepModel <-step(model1)
```

```
## Start:  AIC=93.92
## case ~ sex + AgeMaster + moca_score + AvgUpdrs + AvgHoehn + score
##
##              Df Deviance     AIC
## - moca_score  1   80.403  92.403
## - sex         1   80.601  92.601
## <none>            79.922  93.922
## - AgeMaster   1   81.973  93.973
## - AvgHoehn    1   82.360  94.360
## - score       1  117.509 129.509
## - AvgUpdrs    1  121.168 133.168
##
## Step:  AIC=92.4
## case ~ sex + AgeMaster + AvgUpdrs + AvgHoehn + score
##
##             Df Deviance     AIC
## - sex        1   81.104  91.104
## - AvgHoehn   1   82.379  92.379
## <none>           80.403  92.403
## - AgeMaster  1   82.654  92.654
## - score      1  120.197 130.197
## - AvgUpdrs   1  124.437 134.437
##
## Step:  AIC=91.1
## case ~ AgeMaster + AvgUpdrs + AvgHoehn + score
##
##             Df Deviance     AIC
## <none>           81.104  91.104
## - AgeMaster  1   83.388  91.388
## - AvgHoehn   1   83.631  91.631
## - score      1  121.513 129.513
## - AvgUpdrs   1  125.743 133.743
```

```
summary(stepModel)
```

```
##
## Call:
## glm(formula = case ~ AgeMaster + AvgUpdrs + AvgHoehn + score,
##     family = binomial, data = modelData2)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.5523  -0.1721   0.0093   0.2368   2.2761
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.16285    1.71278  -0.679    0.497
## AgeMaster   -0.04137    0.02819  -1.468    0.142
## AvgUpdrs     0.59429    0.11651   5.101 3.38e-07 ***
## AvgHoehn     0.31938    0.20821   1.534    0.125
```

```
## score        9.24574    1.90762   4.847 1.26e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 284.402  on 206  degrees of freedom
## Residual deviance:  81.104  on 202  degrees of freedom
## AIC: 91.104
##
## Number of Fisher Scoring iterations: 7
```

Notice that our step-wise reduced model chose to keep both age and overallHoehn despite the insignificant p-value. Why? Answer below!

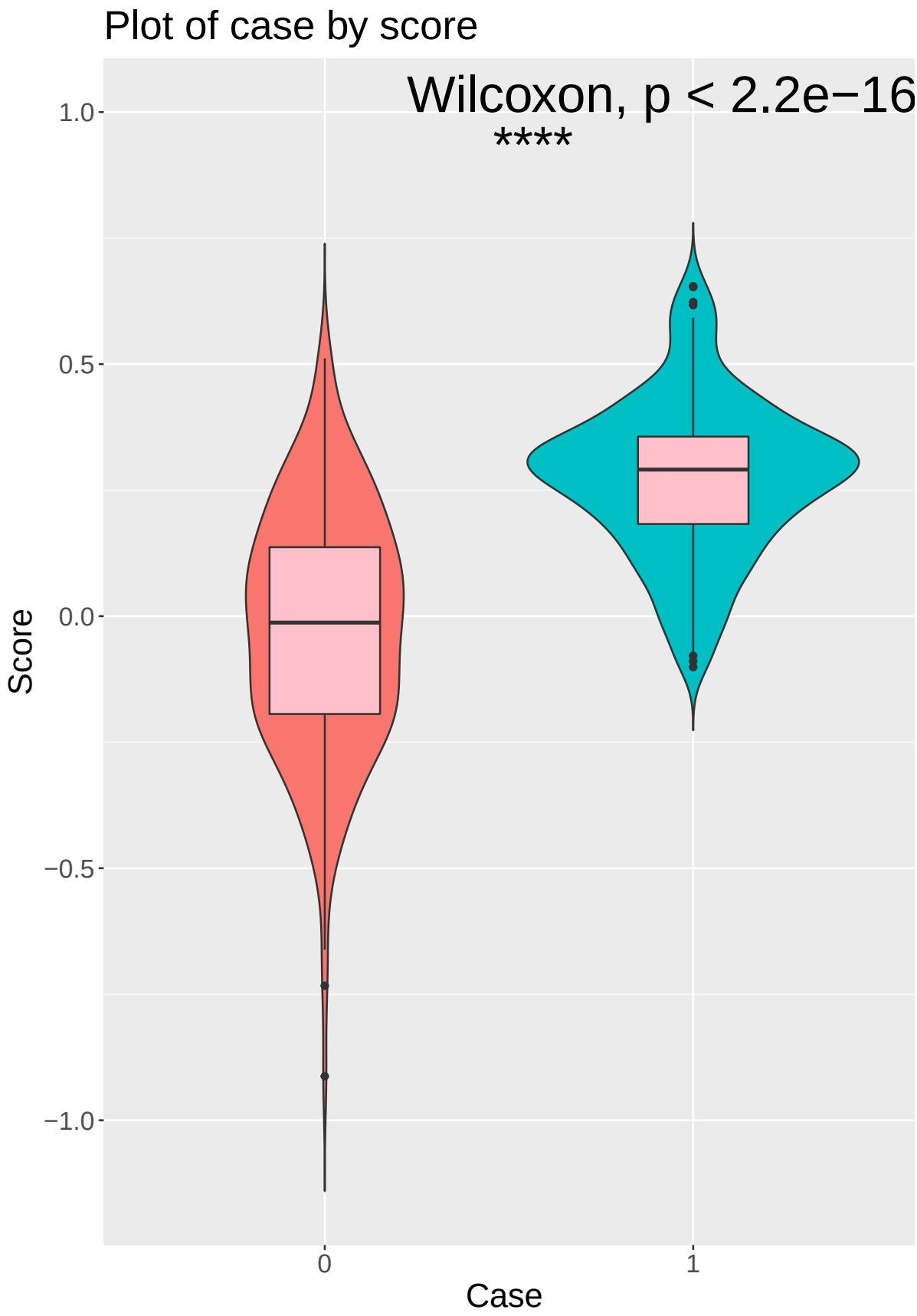
Let's predict the probability of having a case given our manually reduced model. Make a histogram of the score from this model.

```
modelScore <- predict(model4,newdata=modelData)
hist(modelScore,main="Histogram of Logistic Regrssion Model")
```

Like before, we'll build a violin plot to compare the output of our regression model. See if you can adapt the violin plot code from before to do this now.

```
library(ggpubr)
```

```
df<-data.frame(cbind(case[k],modelScore))

dp <- ggplot(df, aes(x=as.factor(case[k]), y=score, fill=as.factor(case[k]))) +
  geom_violin(trim=FALSE)+
  geom_boxplot(width=0.3, fill="pink")+
  labs(title="Plot of case by score",x="Case ", y = "Score")+
  stat_compare_means(label.x = 1.5, label.y = 1, size=10)+
  stat_compare_means(aes(label = ..p.signif..),
                       label.x = 1.5, label.y = 0.9, size =10)
dp + theme(text = element_text(size = 18),legend.position="none")
```


Plot of case by score
Wilcoxon, p < 2.2e−16
****
1.0
0.5
0.0
−0.5
−1.0
Score
0
1
Case

Now we're starting to see a clearer separation of scores! It's clear that by including the established tests to pre-screen patients for PD and other neurological diseases we have improved overall performance. While this may be an obvious conclusion, it is worth noting that the context with which our diagnostic signature would be used would be on patients already exhibiting potential PD symptoms. Clearly this needs a little more work, but for a first pass at assessing raw data, it's not bad!

Again, we can examine ROC curves. I've done some of the set up to get the data in the right format. Use the ROC code above to then build your own plot!

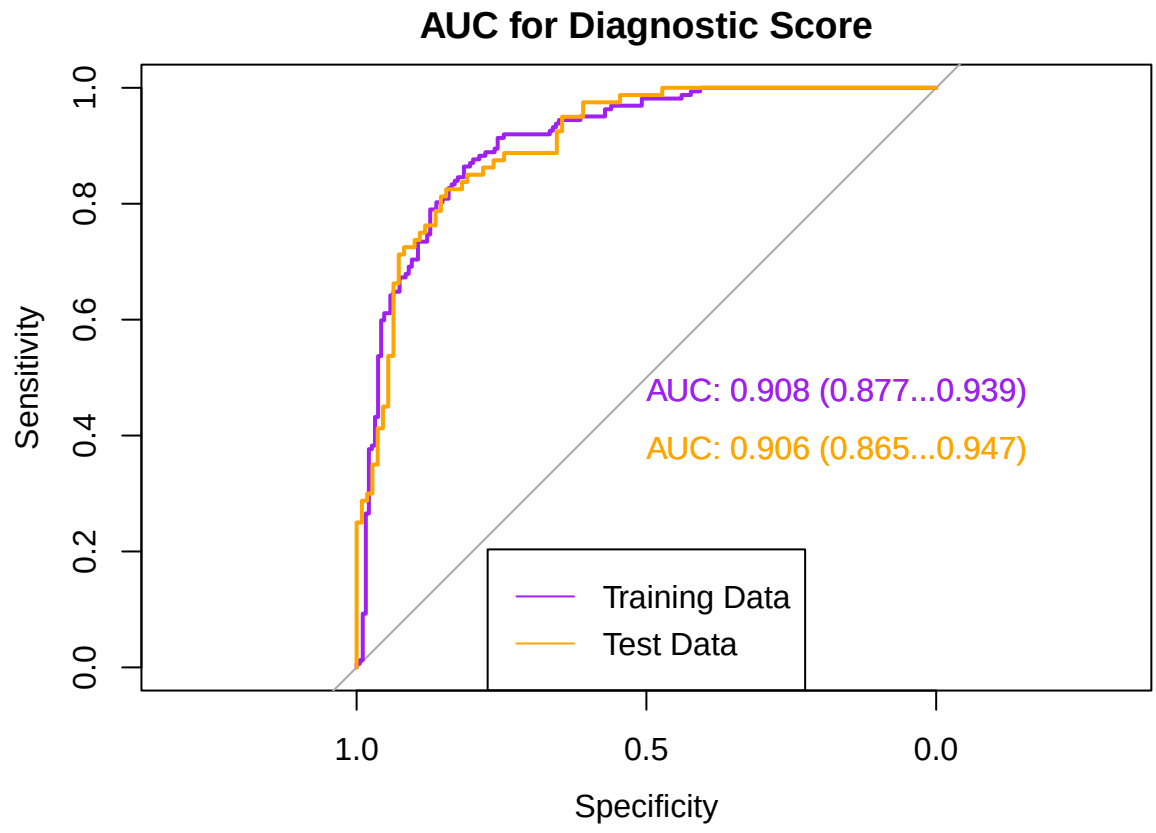
```
library("pROC")
nd<-cbind(pheno[-k,],newScore)
colnames(nd)<-c(colnames(nd[1:ncol(nd)-1]),"score")
newMScore<-predict(model4,newdata=nd)

plot.roc(case[k]~modelScore, data=nd,legacy.axes=F,print.auc=T, ci=T, main="AUC for Diagnostic Score",c
```

```
## Setting levels: control = 0, case = 1

## Setting direction: controls < cases
```

```
plot.roc(case[-k]~newMScore,data=data.frame(cbind(case[-k],newMScore)),add=T,print.auc=T, ci=T, col="ora
```

```
## Setting levels: control = 0, case = 1
## Setting direction: controls < cases
```

```
legend("bottom",c("Training Data","Test Data"),lty=c(1,1),col=c("purple","orange"))
```



```
#your code for ROC plots here
```

Here, we have a notable increase in AUC, particularly for our training data. Our test data shows an overal improvement as well, although with a large confidence interval. There are clearly some data points in here which are abnormal - and perhaps worth investigating.

##Congratulations, you have finished the R Bootcamp Assignment!