

Lab 5

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Objective

To provide students with hands-on experience in genomics data analysis techniques, including data preprocessing, Principal Component Analysis (PCA), clustering, and association analysis with phenotypes (including population substructure) using linear and logistic regression. The tasks are to be done in R and PLINK software.

Quality Control and PCA

Filter data

```
plink --bfile your_data \
  --maf 0.08 \
  --geno 0.001 \
  --hwe 0.01 \
  --make-bed \
  --out cleaned_data
```

```
omar-alldawy@omar-alldawy-ASUS-TUF-Dash-F15-FX516PM-FX516PM:/University/Third year/second semester/Bio-Informatics/Labs/Bio-Informatics-Labs/Lab 5/Data$ plink --bfile Qatar156_filtered \
--maf 0.08 \
--geno 0.001 \
--hwe 0.01 \
--make-bed \
--out cleaned_data
PLINK v1.9.0.b.7.7 64-bit (22 Oct 2024)          cog-genomics.org/plink/1.9/
(C) 2005-2024 Shaun Purcell, Christopher Chang   GNU General Public License v3
Logging to cleaned_data.log.
Options in effect:
--bfile Qatar156_filtered_pruned
--geno 0.001
--hwe 0.01
--maf 0.08
--make-bed
--out cleaned_data
15685 MB RAM detected; reserving 7842 MB for main workspace.
67735 variants loaded from .bim file.
156 people (49 males, 107 females) loaded from .fam.
Using 1 thread (no multithreaded calculations invoked).
Before main variant filters, 156 founders and 0 nonfounders present.
Calculating allele frequencies... done.
Warning: 1388 het. haploid genotypes present (see cleaned_data.hh ); many
commands treat these as missing.
Total genotyping rate is 0.999816.
12509 variants removed due to missing genotype data (--geno).
Warning: --hwe observation counts vary by more than 10%, due to the X
chromosome. You may want to use a more stringent (i.e., less extreme) --hwe
p-value threshold for X chromosome variants: male samples are ignored there, so
the same degree of HWE violation corresponds to a less-extreme p-value than it
does elsewhere in the genome.
--hwe: 1076 variants removed due to Hardy-Weinberg exact test.
8678 variants removed due to minor allele threshold(s)
(--maf/--max-maf/--mac/--max-mac).
45472 variants and 156 people pass filters and QC.
Note: No phenotypes present.
--make-bed to cleaned_data.bed + cleaned_data.bim + cleaned_data.fam ... done.
```

Figure 1: filter data

Create ped and map files from cleaned data

```
plink --bfile cleaned_data --recode --out cleaned_data
```

```
omar-alldawy@omar-alldawy-ASUS-TUF-Dash-F15-FX516PM-FX516PM:~/University/Third year/second semester/Bio-Informatics/Labs/Bio-Informatics-Labs/Lab 5/Data$ plink --bfile cleaned_data --recode --out cleaned_data
PLINK v1.9.0-b.7.7 64-bit (22 Oct 2024)      cog-genomics.org/plink/1.9/
(C) 2005-2024 Shaun Purcell, Christopher Chang   GNU General Public License v3
Logging to cleaned_data.log.
Options in effect:
  --bfile cleaned_data
  --out cleaned_data
  --recode
15685 MB RAM detected; reserving 7842 MB for main workspace.
45472 variants loaded from .bim file.
156 people (49 males, 107 females) loaded from .fam.
Using 1 thread (no multithreaded calculations invoked).
Before main variant filters, 156 founders and 0 nonfounders present.
Calculating allele frequencies... done.
Warning: 1047 het. haploid genotypes present (see cleaned_data.hh ); many
commands treat these as missing.
Total genotyping rate is exactly 1.
45472 variants and 156 people pass filters and QC.
Note: No phenotypes present.
```

Figure 2: map and ped

Calculate PCA (Eigen vectors and Eigen values)

```
plink --bfile cleaned_data \
  --pca \
  --out cleaned_data_pca
```

```
omar-alldawy@omar-alldawy-ASUS-TUF-Dash-F15-FX516PM-FX516PM:~/University/Third year/second semester/Bio-Informatics/Labs/Bio-Informatics-Labs/Lab 5/Data$ plink --bfile cleaned_data \
  --pca \
  --out cleaned_data_pca
PLINK v1.9.0-b.7.7 64-bit (22 Oct 2024)      cog-genomics.org/plink/1.9/
(C) 2005-2024 Shaun Purcell, Christopher Chang   GNU General Public License v3
Logging to cleaned_data_pca.log.
Options in effect:
  --bfile cleaned_data
  --out cleaned_data_pca
  --pca
15685 MB RAM detected; reserving 7842 MB for main workspace.
45472 variants loaded from .bim file.
156 people (49 males, 107 females) loaded from .fam.
Using up to 8 threads (change this with --threads).
Before main variant filters, 156 founders and 0 nonfounders present.
Calculating allele frequencies... done.
Warning: 1047 het. haploid genotypes present (see cleaned_data_pca.hh ); many
commands treat these as missing.
Total genotyping rate is exactly 1.
45472 variants and 156 people pass filters and QC.
Note: No phenotypes present.
Excluding 1143 variants on non-autosomes from relationship matrix calc.
Relationship matrix calculation complete.
--pca: Results saved to cleaned_data_pca.eigenval and cleaned_data_pca.eigenvec
```

Figure 3: PCA

Part 1: Identify SNPs associated with Population Structure

Task 1.1: Identify SNPs associated with genomic PCs using Linear Regression Analysis

Encode SNPs using additive approach

```
plink --bfile cleaned_data --recode A --out recoded_data
```

Load required libraries

```
install_and_load <- function(pkg) {
  if (!requireNamespace(pkg, quietly = TRUE)) {
    install.packages(pkg)}
```

```

omar-alldawy@omar-alldawy-ASUS-TUF-Dash-F15-FX516PM-FX516PM:~/University/Third year/second semester/Bio-Informatics/Labs/Bio-Informatics-Labs/Lab 5/Data$ plink --bfile cleaned_data --rec
ode A --out recoded_data
PLINK v1.9.0-b.7.7 64-bit (22 Oct 2024)      cog-genomics.org/plink/1.9/
(C) 2005-2024 Shaun Purcell, Christopher Chang   GNU General Public License v3
Logging to recoded_data.log.
Options in effect:
  --bfile cleaned_data
  --out recoded_data
  --recode A
15685 MB RAM detected; reserving 7842 MB for main workspace.
45472 variants loaded from .bim file.
156 people (49 males, 107 females) loaded from .fam.
Using 1 thread (no multithreaded calculations invoked).
Before main variant filters, 156 founders and 0 nonfounders present.
Calculating allele frequencies... done.
Warning: 1047 het. haploid genotypes present (see recoded_data.hh); many
commands treat these as missing.
Total genotyping rate is exactly 1.
45472 variants and 156 people pass filters and QC.
Note: No phenotypes present.
--recode A to recoded_data.raw ... done.

```

Figure 4: Additive Encoding

```

}
library(pkg, character.only = TRUE)
}

install_and_load("tidyverse")
install_and_load("scatterplot3d")
install_and_load("caret")
install_and_load("qqman")

```

Read raw file and select the SNPs' columns

```

# Read the .raw file
geno <- read.table("Data/recoded_data.raw", header = TRUE, sep = "")

# Isolate only the SNP columns (after the first 6 columns)
snp_data <- geno %>% select(-(1:6))

```

Read PCA components and select the top 3 components

```

# Read the eigenvectors (PCs)
pcs <- read.table("Data/cleaned_data_pca.eigenvec", header = FALSE, sep = "")

# Assign column names
colnames(pcs) <- c("FID", "IID", paste0("PC", 1:20)) # If PLINK gives 20 PCs

# Join PCs with SNP data using individual IDs
merged_data <- cbind(pcs[, 3:5], snp_data) # PC1, PC2, PC3 + SNPs

```

Run 3 linear regression sets, each set is composed of one PC as a dependent variable against all SNPs while correcting the model for the other two PCs.

```

results_pc1_stats <- lapply(snp_data, function(snp) {
  tryCatch({
    coefs <- summary(lm(PC1 ~ snp + PC2 + PC3, data = pcs[, 3:5]))$coefficients
    c(Beta = coefs[2, "Estimate"],
      SE = coefs[2, "Std. Error"],
      P_Value = coefs[2, "Pr(>|t|)"])
  }, error = function(e) c(Beta = NA, SE = NA, P_Value = NA))

```

```

})

# Convert list to data frame
results_pc1_df <- as.data.frame(do.call(rbind, results_pc1_stats))
results_pc1_df$SNP <- names(results_pc1_stats)

# Reorder columns
results_pc1_df <- results_pc1_df[, c("SNP", "Beta", "SE", "P_Value")]

results_pc2_stats <- lapply(snp_data, function(snp) {
  tryCatch({
    coefs <- summary(lm(PC2 ~ snp + PC1 + PC3, data = pcs[, 3:5]))$coefficients
    c(Beta = coefs[2, "Estimate"],
      SE = coefs[2, "Std. Error"],
      P_Value = coefs[2, "Pr(>|t|)"])
  }, error = function(e) c(Beta = NA, SE = NA, P_Value = NA))
})

results_pc2_df <- as.data.frame(do.call(rbind, results_pc2_stats))
results_pc2_df$SNP <- names(results_pc2_stats)
results_pc2_df <- results_pc2_df[, c("SNP", "Beta", "SE", "P_Value")]

results_pc3_stats <- lapply(snp_data, function(snp) {
  tryCatch({
    coefs <- summary(lm(PC3 ~ snp + PC1 + PC2, data = pcs[, 3:5]))$coefficients
    c(Beta = coefs[2, "Estimate"],
      SE = coefs[2, "Std. Error"],
      P_Value = coefs[2, "Pr(>|t|)"])
  }, error = function(e) c(Beta = NA, SE = NA, P_Value = NA))
})

results_pc3_df <- as.data.frame(do.call(rbind, results_pc3_stats))
results_pc3_df$SNP <- names(results_pc3_stats)
results_pc3_df <- results_pc3_df[, c("SNP", "Beta", "SE", "P_Value")]

```

Calculate Bonferroni-threshold and determine the significant SNPs

```

bonf_threshold <- 0.05 / ncol(snp_data)

# Significant SNPs
sig_snps_pc1 <- results_pc1_df %>% filter(P_Value < bonf_threshold)
sig_snps_pc2 <- results_pc2_df %>% filter(P_Value < bonf_threshold)
sig_snps_pc3 <- results_pc3_df %>% filter(P_Value < bonf_threshold)

cat("Bonferroni threshold =", bonf_threshold, "\n")

## Bonferroni threshold = 1.099578e-06
print(sig_snps_pc1)

##          SNP      Beta        SE   P_Value
## rs2840528_G  rs2840528_G  0.04994067 0.008196754 8.725736e-09
## rs4292923_C  rs4292923_C  0.10635554 0.013883082 2.015266e-12
## rs11260666_A rs11260666_A  0.11453846 0.013908285 7.631473e-14
## rs6577427_C  rs6577427_C  0.09317253 0.012245854 2.702390e-12

```

```

## rs10495758_C rs10495758_C 0.07642655 0.010203836 5.237015e-12
## rs1341306_A rs1341306_A 0.10216991 0.011009502 1.620866e-16
## rs4912105_C rs4912105_C 0.09410705 0.013489052 8.721246e-11
## rs213037_A rs213037_A 0.09490631 0.010291362 2.296592e-16
## rs2473317_G rs2473317_G 0.05521725 0.010581417 5.830156e-07
## rs4514282_C rs4514282_C 0.10922881 0.011393975 2.567321e-17
## rs4659378_G rs4659378_G 0.05448211 0.008429088 1.314465e-09
## rs578800_A rs578800_A 0.07684477 0.013708845 9.519002e-08
## rs12033154_A rs12033154_A 0.06922845 0.011419395 1.016144e-08
## rs10493049_G rs10493049_G 0.06870228 0.011603553 2.054604e-08
## rs4970614_T rs4970614_T 0.06027787 0.011664598 7.348388e-07
## rs2492791_G rs2492791_G 0.08919452 0.016269314 1.708555e-07
## rs320050_C rs320050_C 0.07499209 0.010751426 8.790445e-11
## rs2494884_T rs2494884_T 0.05996237 0.010098462 1.889209e-08
## rs884586_C rs884586_C 0.08946004 0.014426933 5.055560e-09
## rs6676020_C rs6676020_C 0.05854612 0.010088884 3.663747e-08
## rs834347_T rs834347_T 0.06828249 0.009258033 9.881933e-12
## rs305580_G rs305580_G 0.05910513 0.010280162 4.756329e-08
## rs635154_T rs635154_T 0.05402099 0.008295005 1.019636e-09
## rs10889553_A rs10889553_A 0.09570667 0.013413412 3.694024e-11
## rs1158573_A rs1158573_A 0.05733075 0.008899084 1.467529e-09
## rs1358041_C rs1358041_C -0.04753138 0.008456552 8.852239e-08
## rs10449706_G rs10449706_G 0.08820171 0.015327900 4.644715e-08
## rs9324189_G rs9324189_G 0.04633934 0.008669873 3.252855e-07
## rs315542_A rs315542_A 0.06025040 0.011523171 5.561370e-07
## rs3003703_C rs3003703_C 0.12109438 0.011685144 2.275372e-19
## rs17130950_T rs17130950_T 0.07822025 0.013919457 8.901884e-08
## rs12134748_A rs12134748_A -0.04915393 0.008145925 1.169926e-08
## rs10157512_G rs10157512_G 0.05817704 0.010332371 8.441835e-08
## rs514341_T rs514341_T 0.07848954 0.010837966 2.059399e-11
## rs2820095_T rs2820095_T 0.06418260 0.010844818 2.080384e-08
## rs6692745_G rs6692745_G 0.04992639 0.008923879 1.002302e-07
## rs6665259_A rs6665259_A 0.07998644 0.012899412 5.058726e-09
## rs10801944_G rs10801944_G 0.05190252 0.009608278 2.494107e-07
## rs6674970_G rs6674970_G 0.05489098 0.008871843 5.421869e-09
## rs12723898_G rs12723898_G 0.04937066 0.009061687 2.006162e-07
## rs7517189_G rs7517189_G 0.07220312 0.008877581 1.374179e-13
## rs1212352_A rs1212352_A 0.04635809 0.007860893 2.307122e-08
## rs2485668_C rs2485668_C 0.06672825 0.012795423 5.919219e-07
## rs12136856_C rs12136856_C 0.05443402 0.009655319 8.156638e-08
## rs1408554_C rs1408554_C 0.04767602 0.007728088 5.936291e-09
## rs16861569_A rs16861569_A 0.10590531 0.014163734 5.622384e-12
## rs4233412_G rs4233412_G 0.04818831 0.009276296 6.492343e-07
## rs1407956_C rs1407956_C 0.07741563 0.011372677 2.160674e-10
## rs11806870_C rs11806870_C 0.09246167 0.013975721 5.939104e-10
## rs12079554_G rs12079554_G 0.06568532 0.012434423 4.340721e-07
## rs6425457_G rs6425457_G 0.04404427 0.008464740 6.245706e-07
## rs16852381_A rs16852381_A 0.05764551 0.010458414 1.486162e-07
## rs10159067_C rs10159067_C 0.04808814 0.008850963 2.154516e-07
## rs881964_C rs881964_C 0.05828823 0.010930216 3.440955e-07
## rs10911419_A rs10911419_A 0.07593714 0.012913235 2.505361e-08
## rs800819_A rs800819_A 0.06258555 0.011461350 1.893476e-07
## rs16827680_G rs16827680_G 0.08946711 0.013418364 4.526941e-10
## rs10921075_C rs10921075_C 0.05562107 0.009087237 7.577954e-09

```

```

## rs10754182_C rs10754182_C -0.04795310 0.008705143 1.509453e-07
## rs12758297_T rs12758297_T 0.07183001 0.012332060 3.296260e-08
## rs10800620_T rs10800620_T 0.07488623 0.011072001 2.724057e-10
## rs6671391_T rs6671391_T 0.07235014 0.010554948 1.677547e-10
## rs6427974_A rs6427974_A 0.04250367 0.008215668 7.153821e-07
## rs291092_G rs291092_G 0.10697611 0.014121380 3.250930e-12
## rs4844477_T rs4844477_T 0.06939761 0.012536927 1.328993e-07
## rs7554295_C rs7554295_C 0.06561627 0.011014777 1.716641e-08
## rs2813704_C rs2813704_C 0.04707315 0.008664227 2.155027e-07
## rs1073461_C rs1073461_C 0.09227227 0.014179527 1.046751e-09
## rs2889945_C rs2889945_C 0.04961226 0.008119378 7.986542e-09
## rs9783086_C rs9783086_C 0.05975964 0.011353959 4.742295e-07
## rs2639703_C rs2639703_C 0.05134233 0.009585163 3.082545e-07
## rs4653526_A rs4653526_A 0.05479086 0.009479228 4.097357e-08
## rs7529252_A rs7529252_A 0.05866447 0.009408987 4.253162e-09
## rs1294324_G rs1294324_G 0.08135271 0.013780876 2.239885e-08
## rs6658741_A rs6658741_A 0.07390099 0.011676626 2.631417e-09
## rs12038267_G rs12038267_G 0.09799549 0.013135736 6.179302e-12
## rs6428989_A rs6428989_A 0.07165602 0.013830910 6.917681e-07
## rs1912230_A rs1912230_A 0.08149068 0.015663841 6.268337e-07
## rs4525028_C rs4525028_C 0.05970636 0.010118651 2.269677e-08
## rs10802777_G rs10802777_G 0.07693358 0.010576893 1.731059e-11
## rs7525142_T rs7525142_T 0.05446508 0.008690588 3.609987e-09
## rs4339853_A rs4339853_A 0.09458159 0.011186824 2.136135e-14
## rs10489351_T rs10489351_T 0.07230066 0.011655169 4.994201e-09
## rs12057937_T rs12057937_T 0.04206866 0.008055920 5.730738e-07
## rs4634945_C rs4634945_C 0.05473418 0.010173922 2.764050e-07
## rs6728339_C rs6728339_C 0.06892822 0.010567802 9.678883e-10
## rs9678657_A rs9678657_A 0.07535216 0.014021222 2.838500e-07
## rs12618771_C rs12618771_C 0.10952170 0.012866623 1.528691e-14
## rs1358135_A rs1358135_A 0.04524253 0.007806619 3.802686e-08
## rs2712038_A rs2712038_A 0.09268415 0.011543649 2.497760e-13
## rs2172114_C rs2172114_C 0.04768860 0.008173753 3.143367e-08
## rs10206339_A rs10206339_A 0.04939470 0.007951972 4.787903e-09
## rs41395753_C rs41395753_C 0.07350810 0.010304063 3.719312e-11
## rs40996_G rs40996_G 0.05529139 0.007933879 9.082055e-11
## rs3102945_C rs3102945_C 0.06084385 0.009338843 1.005582e-09
## rs12624227_C rs12624227_C 0.04865262 0.009048882 2.805694e-07
## rs1878847_T rs1878847_T 0.08044212 0.011257817 3.492521e-11
## rs7607460_T rs7607460_T 0.05481650 0.008505796 1.450272e-09
## rs7563129_G rs7563129_G 0.05489429 0.008975562 7.763941e-09
## rs4666321_G rs4666321_G 0.06895303 0.013281734 6.588171e-07
## rs11692176_T rs11692176_T 0.08516430 0.012231702 9.402251e-11
## rs12613530_T rs12613530_T 0.11991260 0.012084308 3.341921e-18
## rs10193016_C rs10193016_C 0.07717758 0.012990555 1.858779e-08
## rs4670713_C rs4670713_C 0.06623952 0.008961170 9.027578e-12
## rs10175061_A rs10175061_A 0.05704666 0.011163075 9.526710e-07
## rs698781_T rs698781_T 0.08844234 0.016428504 2.717782e-07
## rs731399_A rs731399_A 0.06898865 0.011414506 1.114185e-08
## rs7575099_C rs7575099_C 0.10351774 0.012374129 3.586472e-14
## rs6745913_A rs6745913_A 0.04428129 0.007989466 1.285520e-07
## rs13423962_C rs13423962_C 0.09001867 0.013852490 1.097229e-09
## rs12328060_A rs12328060_A 0.08994970 0.013987160 1.557031e-09
## rs11125373_A rs11125373_A 0.06285630 0.008836622 4.163488e-11

```

```

## rs6713490_A    rs6713490_A    0.06259505 0.009475622 6.258116e-10
## rs11692361_C  rs11692361_C  0.07634282 0.011106502 1.514827e-10
## rs3771808_A   rs3771808_A   0.05894879 0.010677811 1.425470e-07
## rs7604227_A   rs7604227_A   0.07687328 0.011833020 1.107946e-09
## rs11675369_T  rs11675369_T  0.06681537 0.012854212 6.399494e-07
## rs17014459_T  rs17014459_T  0.10972908 0.014434077 2.801166e-12
## rs6745816_T   rs6745816_T   0.08004027 0.015666590 9.583738e-07
## rs1979515_T   rs1979515_T   0.09101740 0.013607477 4.046738e-10
## rs6721311_T   rs6721311_T   0.07833397 0.014751415 3.818867e-07
## rs7572313_A   rs7572313_A   0.07432508 0.014482083 8.628189e-07
## rs17023791_A  rs17023791_A  0.06244330 0.011730414 3.596973e-07
## rs11695568_C  rs11695568_C  0.07952042 0.014111851 8.263563e-08
## rs11123880_A  rs11123880_A  0.06627152 0.011938365 1.233568e-07
## rs4384813_T   rs4384813_T   0.06890399 0.012404820 1.213346e-07
## rs11677201_C  rs11677201_C  0.05071586 0.009342827 2.203343e-07
## rs11123676_A  rs11123676_A  0.09179624 0.016041240 5.419611e-08
## rs260699_G    rs260699_G    0.05728670 0.008928457 1.679785e-09
## rs7557870_T   rs7557870_T   0.06370584 0.010241962 4.586767e-09
## rs11122849_A  rs11122849_A  0.08627259 0.010830404 3.584789e-13
## rs12616209_T  rs12616209_T  0.09509116 0.012862677 8.979794e-12
## rs12470817_G  rs12470817_G  0.04793619 0.007899277 9.857162e-09
## rs4954117_A   rs4954117_A   0.08061598 0.014681557 1.640631e-07
## rs7561482_T   rs7561482_T   0.05813124 0.010778825 2.598325e-07
## rs1899375_T   rs1899375_T   0.07482929 0.014185032 4.489485e-07
## rs16843897_T  rs16843897_T  0.10593774 0.014302925 8.313855e-12
## rs11894353_C  rs11894353_C  0.07482459 0.013317987 8.952315e-08
## rs1567538_C   rs1567538_C   0.06911985 0.011289274 7.508725e-09
## rs11884875_G  rs11884875_G  0.07308823 0.011189022 9.203515e-10
## rs4667458_G   rs4667458_G   0.05918899 0.009141816 1.241886e-09
## rs1869369_C   rs1869369_C   0.08535570 0.013925717 7.257953e-09
## rs7578592_T   rs7578592_T   0.06260936 0.009500760 6.804501e-10
## rs7566253_T   rs7566253_T   0.07923764 0.013316997 1.777234e-08
## rs1554406_C   rs1554406_C   0.07402708 0.014456004 9.083082e-07
## rs10930976_C  rs10930976_C  0.08639734 0.012760275 2.621389e-10
## rs10177433_G  rs10177433_G  0.08093741 0.014152322 5.512128e-08
## rs897200_T    rs897200_T    0.04445145 0.008563085 6.603596e-07
## rs6737056_G   rs6737056_G   0.08192012 0.013704256 1.549820e-08
## rs12693898_G  rs12693898_G  0.07041017 0.010578982 4.818368e-10
## rs12466870_C  rs12466870_C  0.05259615 0.010237916 8.428141e-07
## rs849565_G    rs849565_G    0.05290782 0.009748492 2.214099e-07
## rs16775_G     rs16775_G     0.07908544 0.014332802 1.445106e-07
## rs7583970_G   rs7583970_G   0.08223018 0.013124523 3.642349e-09
## rs10804262_G  rs10804262_G  0.07111980 0.012859134 1.359439e-07
## rs750132_A    rs750132_A    0.05352481 0.009895987 2.415052e-07
## rs10207037_A  rs10207037_A  0.07734615 0.013055072 2.016306e-08
## rs4380225_T   rs4380225_T   0.05732579 0.011279282 1.080351e-06
## rs282249_A    rs282249_A    0.05509342 0.008450892 9.843154e-10
## rs13395556_G  rs13395556_G  0.05859966 0.010212010 5.020269e-08
## rs31276_C     rs31276_C     0.06554693 0.010076609 1.060836e-09
## rs4246633_A   rs4246633_A   0.07298443 0.011304128 1.364042e-09
## rs10490186_C  rs10490186_C  0.04150050 0.008161799 1.069098e-06
## rs6756438_C   rs6756438_C   0.05127897 0.010030685 9.444881e-07
## rs9678598_G   rs9678598_G   0.08163943 0.014663960 1.141958e-07
## rs3106304_G   rs3106304_G   0.04747500 0.009058426 5.255277e-07

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## rs6723979_C    rs6723979_C    0.07492329 0.013606267 1.524280e-07
## rs4663652_G    rs4663652_G    0.08961421 0.013463400 4.806482e-10
## rs934397_A     rs934397_A     0.05036998 0.009340547 2.604158e-07
## rs13023077_A   rs13023077_A   0.05751113 0.009578279 1.357678e-08
## rs6720803_T    rs6720803_T    0.06942796 0.012118254 5.246812e-08
## rs1672735_T    rs1672735_T    0.05937947 0.010124676 2.706961e-08
## rs812750_G     rs812750_G    0.06033557 0.010302647 2.822472e-08
## rs2306877_C    rs2306877_C    0.05966525 0.010761559 1.274363e-07
## rs458381_T     rs458381_T    0.05584411 0.010699341 5.801554e-07
## rs17042874_A   rs17042874_A   0.07227339 0.010405796 1.030785e-10
## rs2730303_C    rs2730303_C    0.07676982 0.014885114 7.693616e-07
## rs7636104_C    rs7636104_C    0.12816906 0.013657827 8.678636e-17
## rs9841674_T    rs9841674_T    0.05655448 0.010999300 8.267181e-07
## rs17037876_G   rs17037876_G   0.09081057 0.015061821 1.199408e-08
## rs9811516_A    rs9811516_A    0.05614746 0.010058791 1.065296e-07
## rs10510483_C   rs10510483_C   0.09181333 0.013544211 2.512576e-10
## rs6802448_G    rs6802448_G    0.04387636 0.008556948 8.811265e-07
## rs6549876_C    rs6549876_C    0.04532207 0.008195787 1.364352e-07
## rs981829_C     rs981829_C    -0.04209975 0.008206864 8.721970e-07
## rs6768053_T    rs6768053_T    0.09316021 0.012010068 1.173410e-12
## rs9854271_A    rs9854271_A    0.08339514 0.013392075 4.423828e-09
## rs9878447_C    rs9878447_C    0.06886456 0.011454803 1.307743e-08
## rs6806766_A    rs6806766_A    0.04928357 0.008496296 3.707625e-08
## rs6550181_G    rs6550181_G    0.07759622 0.009184186 2.210044e-14
## rs9845173_G    rs9845173_G    0.05149314 0.009621154 3.145729e-07
## rs9845811_A    rs9845811_A    0.06342325 0.009085939 8.543402e-11
## rs9842768_C    rs9842768_C    0.08631697 0.012606632 1.747679e-10
## rs704962_C     rs704962_C    0.06155796 0.008703710 5.188918e-11
## rs4676558_T    rs4676558_T    0.07792759 0.014582716 3.268571e-07
## rs676098_T     rs676098_T    0.07031226 0.013407498 5.176938e-07
## rs267240_G     rs267240_G    0.06658805 0.012682592 5.033918e-07
## rs6766988_A    rs6766988_A    0.06763931 0.009616842 6.415767e-11
## rs3923436_G    rs3923436_G    0.11037764 0.014821969 6.653874e-12
## rs1495371_T    rs1495371_T    0.08154819 0.011669139 8.183233e-11
## rs17361780_G   rs17361780_G   0.07596540 0.013383720 6.786636e-08
## rs2252742_C    rs2252742_C    0.06471267 0.012721100 1.058037e-06
## rs1447926_C    rs1447926_C    0.04964585 0.008912006 1.124045e-07
## rs11130791_A   rs11130791_A   0.04612715 0.008156124 7.488130e-08
## rs9311796_C    rs9311796_C    0.08383672 0.014782177 6.934803e-08
## rs9883112_C    rs9883112_C    0.06416100 0.011962614 2.983447e-07
## rs6808984_A    rs6808984_A    -0.04850574 0.008680149 1.034263e-07
## rs7642335_C    rs7642335_C    0.06524627 0.009469831 1.388992e-10
## rs2634743_T    rs2634743_T    0.05504314 0.009954809 1.368380e-07
## rs6782870_C    rs6782870_C    0.07069694 0.013649211 6.958721e-07
## rs1125008_G    rs1125008_G    0.06720026 0.012852822 5.566116e-07
## rs4677530_C    rs4677530_C    0.10850454 0.012986245 3.807819e-14
## rs6766242_T    rs6766242_T    0.05349771 0.008032531 4.706402e-10
## rs9864349_C    rs9864349_C    0.06184271 0.009714744 2.177265e-09
## rs7640661_A    rs7640661_A    0.07495415 0.009606668 9.075155e-13
## rs4521284_C    rs4521284_C    0.08652225 0.012231828 5.163033e-11
## rs2317212_T    rs2317212_T    0.06071782 0.011280977 2.732400e-07
## rs1851065_C    rs1851065_C    0.06636408 0.012108981 1.723214e-07
## rs3856765_G    rs3856765_G    0.04386263 0.008392145 5.612597e-07
## rs11927186_A   rs11927186_A   0.05545431 0.010845733 9.410968e-07

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## rs6437659_G    rs6437659_G    0.08020879 0.013094260 7.400649e-09
## rs4894849_T    rs4894849_T    0.06946366 0.012948225 2.965933e-07
## rs6787278_A    rs6787278_A    0.07562321 0.010867089 9.589675e-11
## rs2942062_A    rs2942062_A    0.08781020 0.015560416 7.945805e-08
## rs7625411_G    rs7625411_G    0.06568646 0.012612732 6.113418e-07
## rs9289034_A    rs9289034_A    0.04515524 0.008356339 2.472537e-07
## rs12496088_C   rs12496088_C   0.04447404 0.008697077 9.382519e-07
## rs820335_T     rs820335_T     0.05207577 0.008995159 3.917441e-08
## rs4234280_T    rs4234280_T    0.06638850 0.010679194 4.668083e-09
## rs2062129_C    rs2062129_C    0.06805007 0.013352927 1.014937e-06
## rs1381083_C    rs1381083_C    0.12862421 0.014068983 3.693552e-16
## rs663729_A     rs663729_A     0.08139785 0.014624884 1.150929e-07
## rs349543_G     rs349543_G     0.09455909 0.013297234 4.208424e-11
## rs6776299_T    rs6776299_T    0.08590711 0.012133415 4.979440e-11
## rs6781362_A    rs6781362_A    0.05562548 0.009462195 2.528391e-08
## rs1828560_A    rs1828560_A    0.05315849 0.010457811 1.076762e-06
## rs1354197_T    rs1354197_T    0.07693769 0.014254299 2.545307e-07
## rs10513443_C   rs10513443_C   0.07921174 0.014630116 2.353065e-07
## rs16827657_T   rs16827657_T   0.07859087 0.011782135 4.459954e-10
## rs13325182_C   rs13325182_C   0.07471314 0.011612755 1.534351e-09
## rs9809961_C    rs9809961_C    0.08132807 0.011999682 2.529575e-10
## rs471474_G     rs471474_G     0.04487616 0.007837735 5.337850e-08
## rs475170_A     rs475170_A     0.04657393 0.008741054 3.514798e-07
## rs7355960_T    rs7355960_T    0.13388731 0.010212914 9.510475e-27
## rs6809817_G    rs6809817_G    0.09171483 0.014934793 6.843660e-09
## rs6806162_T    rs6806162_T    0.09280558 0.014550603 2.044100e-09
## rs2590442_C    rs2590442_C    0.06008505 0.010642871 7.855116e-08
## rs6793337_T    rs6793337_T    0.05519973 0.010548354 5.450645e-07
## rs16865318_A   rs16865318_A   0.08094618 0.013755447 2.455353e-08
## rs7651888_T    rs7651888_T    0.05880195 0.009763664 1.239938e-08
## rs9817203_T    rs9817203_T    0.10508951 0.015288281 1.513570e-10
## rs293844_T     rs293844_T     -0.04745652 0.008755788 2.290812e-07
## rs17132406_G   rs17132406_G   0.08649110 0.013478629 1.673607e-09
## rs2285789_C    rs2285789_C    0.05101169 0.007960064 1.748273e-09
## rs6838127_T    rs6838127_T    0.06486927 0.011608722 1.034985e-07
## rs11737688_C   rs11737688_C   -0.04833193 0.008619371 9.434061e-08
## rs6448953_T    rs6448953_T    0.05940960 0.010900796 1.989839e-07
## rs7655357_A    rs7655357_A    0.05223124 0.009160968 5.999610e-08
## rs9994673_C    rs9994673_C    0.07605641 0.014044690 2.341842e-07
## rs759100_C     rs759100_C     0.08909217 0.010780604 6.459656e-14
## rs11931817_C   rs11931817_C   0.08059015 0.014432308 1.054771e-07
## rs7683823_A    rs7683823_A    0.08327615 0.008916527 1.135446e-16
## rs3105209_G    rs3105209_G    0.06060528 0.011279020 2.850101e-07
## rs4861175_A    rs4861175_A    0.08968006 0.012434167 2.423194e-11
## rs16857127_C   rs16857127_C   0.10026646 0.014392028 9.191204e-11
## rs9291279_G    rs9291279_G    0.07685288 0.014026567 1.735227e-07
## rs11733050_A   rs11733050_A   0.06094010 0.011066560 1.523123e-07
## rs1507968_G    rs1507968_G    0.08394459 0.014096346 1.734194e-08
## rs1860625_A    rs1860625_A    0.04649663 0.008881639 5.397869e-07
## rs2318805_T    rs2318805_T    0.07916318 0.014130409 9.664002e-08
## rs980363_G     rs980363_G     0.04128827 0.008049086 8.732312e-07
## rs3775530_G    rs3775530_G    0.07187308 0.011810690 9.051878e-09
## rs2868185_G    rs2868185_G    0.07855881 0.011233585 7.972152e-11
## rs2868215_A    rs2868215_A    0.06248460 0.011459640 1.966062e-07

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## rs3182340_T    rs3182340_T    0.11372707 0.013416392 1.879044e-14
## rs2178603_G    rs2178603_G    0.05030536 0.008158324 6.028444e-09
## rs3114015_C    rs3114015_C    0.07088113 0.012136709 3.054267e-08
## rs7693338_C    rs7693338_C    0.05376821 0.008459695 2.292739e-09
## rs10003330_G    rs10003330_G    0.08353618 0.015046474 1.229244e-07
## rs3806801_T    rs3806801_T    0.10349768 0.013319890 1.088395e-12
## rs4352481_G    rs4352481_G    0.04627252 0.008597252 2.733336e-07
## rs1508468_T    rs1508468_T    0.09131943 0.014300717 1.966370e-09
## rs6850796_C    rs6850796_C    0.08852570 0.011551792 1.986358e-12
## rs2544398_C    rs2544398_C    0.05134921 0.008310735 5.658519e-09
## rs1492469_C    rs1492469_C    0.08508580 0.014764262 4.453856e-08
## rs10033893_A    rs10033893_A    0.06922636 0.011348081 8.401765e-09
## rs12503758_A    rs12503758_A    0.05418415 0.008221393 6.779699e-10
## rs7700052_A    rs7700052_A    0.05278529 0.009480004 1.138082e-07
## rs7673947_G    rs7673947_G    0.05871275 0.010425636 8.400868e-08
## rs6845502_G    rs6845502_G    0.08535025 0.013871063 6.438403e-09
## rs17009345_G    rs17009345_G    0.10262112 0.010912796 7.721481e-17
## rs9884193_G    rs9884193_G    0.07080540 0.009933826 3.846714e-11
## rs13123010_C    rs13123010_C    0.04435679 0.008287820 3.146174e-07
## rs12510249_T    rs12510249_T    0.07553034 0.014511738 6.202703e-07
## rs12508383_A    rs12508383_A    0.04840935 0.008805312 1.588938e-07
## rs1517944_T    rs1517944_T    0.06477042 0.010654344 9.336696e-09
## rs2166596_G    rs2166596_G    0.06129124 0.011612541 4.432078e-07
## rs336330_T    rs336330_T    0.10702882 0.012722820 2.734030e-14
## rs12501107_T    rs12501107_T    -0.04264479 0.007893140 2.483490e-07
## rs17028828_G    rs17028828_G    0.06870771 0.013201566 6.210160e-07
## rs2090381_T    rs2090381_T    0.08682287 0.015959318 2.083250e-07
## rs11931144_G    rs11931144_G    0.09038955 0.014170170 2.036378e-09
## rs3864176_T    rs3864176_T    0.04283463 0.008362766 9.033469e-07
## rs1876031_G    rs1876031_G    0.06973646 0.011219658 4.693303e-09
## rs7668488_T    rs7668488_T    -0.04347147 0.008368476 6.495605e-07
## rs4691400_T    rs4691400_T    0.09433650 0.012638252 6.038721e-12
## rs182016_C    rs182016_C    0.08426192 0.011306508 6.449470e-12
## rs17046863_A    rs17046863_A    0.10364718 0.014031365 9.281626e-12
## rs35646569_G    rs35646569_G    0.07443592 0.010962689 2.368070e-10
## rs6850861_C    rs6850861_C    0.07078687 0.012691296 1.087565e-07
## rs7678945_G    rs7678945_G    0.07861028 0.015005099 5.305483e-07
## rs325032_G    rs325032_G    0.08114593 0.009762443 4.894536e-14
## rs4862774_C    rs4862774_C    0.05830770 0.008468453 1.423823e-10
## rs12649171_C    rs12649171_C    0.04715346 0.008726301 2.473792e-07
## rs6815218_C    rs6815218_C    0.07519793 0.013375094 8.785573e-08
## rs6555267_G    rs6555267_G    0.09772597 0.014174647 1.355831e-10
## rs6555282_C    rs6555282_C    0.08423734 0.013152344 1.782092e-09
## rs153264_C    rs153264_C    0.05268497 0.009553690 1.466995e-07
## rs9313195_G    rs9313195_G    -0.04308220 0.007945760 2.269239e-07
## rs1805971_T    rs1805971_T    0.07848245 0.010865009 2.281306e-11
## rs4429819_T    rs4429819_T    0.07286546 0.014223402 8.998299e-07
## rs2921159_C    rs2921159_C    0.06361152 0.011449983 1.207673e-07
## rs10491237_C    rs10491237_C    0.05855339 0.010921312 3.012359e-07
## rs258841_C    rs258841_C    0.09104510 0.014578974 4.041785e-09
## rs7704706_A    rs7704706_A    0.07030755 0.009685509 1.876515e-11
## rs6887662_T    rs6887662_T    0.05934123 0.010748675 1.424701e-07
## rs2455458_A    rs2455458_A    -0.04625708 0.008528504 2.250323e-07
## rs16868050_C    rs16868050_C    0.07294105 0.012029606 1.010541e-08

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## rs10213765_T rs10213765_T 0.05245844 0.008287423 2.619061e-09
## rs4242074_A rs4242074_A 0.08923715 0.013648002 8.904218e-10
## rs6880596_T rs6880596_T 0.07097966 0.011645589 8.627901e-09
## rs12516484_C rs12516484_C 0.04892426 0.008170696 1.474263e-08
## rs11744487_C rs11744487_C 0.04678760 0.008265448 7.306620e-08
## rs10035816_G rs10035816_G 0.04688918 0.009034171 6.629303e-07
## rs1966590_A rs1966590_A 0.06566929 0.009088621 2.256113e-11
## rs2036010_A rs2036010_A 0.10412580 0.014016473 7.355773e-12
## rs2962792_T rs2962792_T 0.06963450 0.013681911 1.046212e-06
## rs6450874_G rs6450874_G 0.05588705 0.008742487 1.897420e-09
## rs256295_A rs256295_A 0.06098285 0.011764062 6.824866e-07
## rs954286_C rs954286_C 0.05934811 0.010510475 7.817491e-08
## rs1908369_A rs1908369_A 0.05973664 0.011557863 7.318577e-07
## rs2434622_G rs2434622_G 0.09714148 0.015288764 2.316740e-09
## rs1345483_A rs1345483_A 0.10102705 0.014327175 5.820073e-11
## rs352363_C rs352363_C 0.06112653 0.009180592 4.753655e-10
## rs2968223_T rs2968223_T 0.07245808 0.012404913 3.041525e-08
## rs7722743_G rs7722743_G 0.08106501 0.011880882 1.984286e-10
## rs7716441_G rs7716441_G 0.08953803 0.014459619 5.281419e-09
## rs1651023_A rs1651023_A 0.05702342 0.010081734 7.466933e-08
## rs10053051_C rs10053051_C 0.05821433 0.010670781 1.939340e-07
## rs11741285_C rs11741285_C 0.05756049 0.011206065 8.460311e-07
## rs1382880_G rs1382880_G 0.04582986 0.008743214 5.236330e-07
## rs12054837_C rs12054837_C 0.07321321 0.013464325 2.109747e-07
## rs6880680_G rs6880680_G 0.06911155 0.009825738 6.405218e-11
## rs7702166_G rs7702166_G 0.07848590 0.011364177 1.271304e-10
## rs1056503_G rs1056503_G 0.05222379 0.010159015 8.305036e-07
## rs6865544_C rs6865544_C 0.07282738 0.013942840 5.699297e-07
## rs6452955_T rs6452955_T 0.06872184 0.011652804 2.305472e-08
## rs6876638_T rs6876638_T 0.08268766 0.013254359 4.176291e-09
## rs9918149_T rs9918149_T 0.08548924 0.014561849 2.629060e-08
## rs2964663_T rs2964663_T 0.09549724 0.013904651 1.561704e-10
## rs6893943_A rs6893943_A 0.08033440 0.012446953 1.380386e-09
## rs4275005_T rs4275005_T 0.09027818 0.013579559 5.014254e-10
## rs17144660_C rs17144660_C 0.08981935 0.014167463 2.488773e-09
## rs10900751_T rs10900751_T 0.06511571 0.009544701 1.994498e-10
## rs2112258_A rs2112258_A 0.08535801 0.015013979 6.489662e-08
## rs2029549_A rs2029549_A 0.05432449 0.010574720 8.435199e-07
## rs1469044_C rs1469044_C 0.05762253 0.009794575 2.474247e-08
## rs10035591_G rs10035591_G 0.09926089 0.013489984 1.087692e-11
## rs1181981_G rs1181981_G 0.06328037 0.011737020 2.617531e-07
## rs7716389_A rs7716389_A 0.06573113 0.012477117 4.638600e-07
## rs767186_T rs767186_T 0.09833901 0.013519648 1.730639e-11
## rs6876869_C rs6876869_C 0.09679395 0.014202004 2.066661e-10
## rs11960108_G rs11960108_G 0.08032121 0.012742090 2.996288e-09
## rs525208_C rs525208_C 0.08196089 0.014865872 1.475780e-07
## rs778825_T rs778825_T 0.04716578 0.007882765 1.506611e-08
## rs10072468_C rs10072468_C 0.07756849 0.012114462 1.798482e-09
## rs13154599_T rs13154599_T 0.04500734 0.007983971 8.176657e-08
## rs4349736_A rs4349736_A 0.07889756 0.009572114 7.321925e-14
## rs4495201_A rs4495201_A 0.06141131 0.010974141 9.960682e-08
## rs10516085_C rs10516085_C 0.05058122 0.008910261 6.761092e-08
## rs7736784_A rs7736784_A 0.07922106 0.013901412 6.078979e-08
## rs7727502_C rs7727502_C 0.09024358 0.014592411 5.499800e-09

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## rs359428_A      rs359428_A  0.09055811 0.012132414 6.046037e-12
## rs884823_C      rs884823_C  0.05295308 0.009566792 1.331288e-07
## rs7444766_G      rs7444766_G  0.05417456 0.008724121 4.833910e-09
## rs6870937_A      rs6870937_A  0.11655557 0.010765138 1.313383e-20
## rs262048_A      rs262048_A  0.04625246 0.008648709 3.207320e-07
## rs10479576_A      rs10479576_A  0.06631807 0.009081910 1.480214e-11
## rs2666970_T      rs2666970_T  0.05581426 0.010770502 6.877458e-07
## rs4959880_G      rs4959880_G  0.06202036 0.010873160 5.927893e-08
## rs2493013_A      rs2493013_A  0.05409155 0.008480827 2.044396e-09
## rs742520_G      rs742520_G  0.05376057 0.010056036 3.234330e-07
## rs2569885_T      rs2569885_T  0.11123969 0.012554078 1.967544e-15
## rs6910043_C      rs6910043_C  0.05284729 0.010337624 9.448266e-07
## rs9405212_C      rs9405212_C  0.04631811 0.008719929 3.792722e-07
## rs9328222_G      rs9328222_G  0.07875615 0.013341398 2.241698e-08
## rs11963854_A      rs11963854_A  0.08656236 0.013078558 5.853420e-10
## rs17142407_T      rs17142407_T  0.05058835 0.009099245 1.184783e-07
## rs1322239_T      rs1322239_T  0.07973841 0.013628393 2.898468e-08
## rs6920770_A      rs6920770_A  0.07866595 0.014783410 3.629866e-07
## rs10478723_A      rs10478723_A  0.07851474 0.015170597 7.090094e-07
## rs2560768_T      rs2560768_T  0.11335845 0.012936025 3.506015e-15
## rs7752108_C      rs7752108_C  0.07663484 0.011085909 1.228517e-10
## rs3819403_T      rs3819403_T  0.08123541 0.015175643 3.132049e-07
## rs2282831_G      rs2282831_G  0.04636845 0.008048239 4.489516e-08
## rs2743571_G      rs2743571_G  0.07795884 0.013422985 3.578345e-08
## rs10806983_G      rs10806983_G  0.06373345 0.011962783 3.523582e-07
## rs3095345_C      rs3095345_C  0.08563014 0.016618271 7.860244e-07
## rs7766930_T      rs7766930_T  0.06429209 0.011962255 2.832834e-07
## rs2938602_C      rs2938602_C  0.07972571 0.012331112 1.302064e-09
## rs6938342_A      rs6938342_A  0.08165659 0.014437644 7.477762e-08
## rs4711658_C      rs4711658_C  0.04174158 0.008129933 8.546570e-07
## rs9369325_T      rs9369325_T  0.05253683 0.007709750 2.079659e-10
## rs704497_G      rs704497_G  0.07091209 0.012350570 4.940615e-08
## rs2789604_T      rs2789604_T  0.08402013 0.014823801 7.054460e-08
## rs11966724_T      rs11966724_T  0.05034210 0.009491921 3.937040e-07
## rs4495246_T      rs4495246_T  0.07207871 0.013471963 3.172170e-07
## rs6454267_G      rs6454267_G  0.08032811 0.014670128 1.763862e-07
## rs220428_A      rs220428_A  0.06570254 0.010083912 1.003268e-09
## rs4299797_G      rs4299797_G  0.07073212 0.012136767 3.244000e-08
## rs6903926_T      rs6903926_T  0.08341647 0.014087082 2.047615e-08
## rs17766774_G      rs17766774_G -0.05474522 0.010006611 1.803540e-07
## rs9386290_T      rs9386290_T  0.07015387 0.011923919 2.469974e-08
## rs4598119_G      rs4598119_G  0.04628934 0.008086975 5.382404e-08
## rs4072698_T      rs4072698_T  0.08851441 0.015419809 4.971865e-08
## rs2353589_C      rs2353589_C  0.05692494 0.009655569 2.327113e-08
## rs9486459_T      rs9486459_T  0.08025243 0.013142582 8.151328e-09
## rs9486729_G      rs9486729_G  0.07391667 0.012044680 6.988191e-09
## rs2503770_T      rs2503770_T  0.04417194 0.008169407 2.434841e-07
## rs2503765_C      rs2503765_C  0.07269548 0.011239934 1.287321e-09
## rs4897531_T      rs4897531_T  0.04921337 0.008892210 1.335441e-07
## rs235679_C      rs235679_C  0.08845734 0.012373811 3.430104e-11
## rs1494137_G      rs1494137_G  0.08057363 0.012764353 2.864618e-09
## rs1012049_A      rs1012049_A  0.05131897 0.007844412 8.737247e-10
## rs4569989_A      rs4569989_A  0.05364578 0.010081486 3.630112e-07
## rs7775514_A      rs7775514_A  0.04678441 0.008415999 1.188373e-07

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## rs4896151_T    rs4896151_T    0.08023343 0.014005964 5.264272e-08
## rs9321616_C    rs9321616_C    0.11109389 0.011870611 1.011833e-16
## rs6570193_G    rs6570193_G    0.04384826 0.008327126 4.690573e-07
## rs9321819_G    rs9321819_G    0.06261269 0.011091101 7.864894e-08
## rs1414747_G    rs1414747_G    0.04825861 0.007837454 6.299501e-09
## rs6912373_G    rs6912373_G    0.05487673 0.010014736 1.731109e-07
## rs4242283_C    rs4242283_C    0.05507572 0.009836915 9.824516e-08
## rs9480548_C    rs9480548_C    0.09297494 0.013679952 2.287542e-10
## rs1771798_T    rs1771798_T    0.10969169 0.013652633 2.420999e-13
## rs41462348_C    rs41462348_C    0.10934260 0.013770487 4.143837e-13
## rs6916438_A    rs6916438_A    0.08170022 0.013534945 1.157897e-08
## rs162999_T    rs162999_T    0.05145960 0.009962322 7.421210e-07
## rs12530271_T    rs12530271_T    -0.04786895 0.008524408 9.072974e-08
## rs6905220_C    rs6905220_C    0.04626062 0.008705034 3.749362e-07
## rs7764847_A    rs7764847_A    0.06344365 0.010990018 4.244700e-08
## rs3817643_C    rs3817643_C    0.07144874 0.010440196 1.779010e-10
## rs6940854_C    rs6940854_C    0.05013605 0.009367845 3.147855e-07
## rs7769343_T    rs7769343_T    0.05939768 0.010526612 7.967124e-08
## rs12662190_A    rs12662190_A    0.07983259 0.014395794 1.266783e-07
## rs11514810_T    rs11514810_T    0.07038518 0.012075240 3.228744e-08
## rs11976431_G    rs11976431_G    0.05196878 0.007973383 9.918279e-10
## rs3816852_G    rs3816852_G    0.04772635 0.008679391 1.580928e-07
## rs852499_C    rs852499_C    0.04834355 0.008761785 1.446810e-07
## rs2714410_G    rs2714410_G    0.04642881 0.008789212 4.341951e-07
## rs6967342_G    rs6967342_G    0.08206515 0.011766653 8.823630e-11
## rs17166188_C    rs17166188_C    0.06670693 0.012305915 2.283269e-07
## rs991088_C    rs991088_C    0.06511970 0.012571073 6.940985e-07
## rs9986893_A    rs9986893_A    0.05611613 0.011045579 1.090030e-06
## rs2190324_T    rs2190324_T    0.04894465 0.009348858 5.392398e-07
## rs6461071_C    rs6461071_C    0.05768578 0.008179665 5.791399e-11
## rs10245285_T    rs10245285_T    0.04123994 0.008012264 8.065071e-07
## rs10258077_G    rs10258077_G    0.06800148 0.010497249 1.219560e-09
## rs2191994_C    rs2191994_C    0.05903885 0.011617667 1.083177e-06
## rs12333630_T    rs12333630_T    0.04910591 0.009514880 7.573256e-07
## rs6461171_G    rs6461171_G    0.05007853 0.009826244 1.014297e-06
## rs6959663_G    rs6959663_G    0.06735145 0.008663179 1.062335e-12
## rs1178111_C    rs1178111_C    0.04928573 0.009208604 3.144801e-07
## rs116_T    rs116_T    -0.04200798 0.008171353 8.295678e-07
## rs757803_G    rs757803_G    0.07072102 0.011999303 2.347783e-08
## rs6968494_G    rs6968494_G    0.04991551 0.009211193 2.301692e-07
## rs4476905_T    rs4476905_T    0.08138180 0.015443318 4.605073e-07
## rs7811855_T    rs7811855_T    0.09724139 0.014753317 6.761062e-10
## rs2701003_C    rs2701003_C    -0.04460030 0.007977482 1.021253e-07
## rs17171805_C    rs17171805_C    0.08051967 0.013934194 4.128030e-08
## rs6965961_T    rs6965961_T    0.08959785 0.013289067 3.050508e-10
## rs2270628_T    rs2270628_T    0.07367950 0.011760859 3.653107e-09
## rs12533855_C    rs12533855_C    0.04514406 0.008178258 1.430014e-07
## rs6955132_G    rs6955132_G    0.05866472 0.010934519 2.960828e-07
## rs9649706_C    rs9649706_C    0.06058798 0.011457405 4.230649e-07
## rs7800722_A    rs7800722_A    0.05675150 0.008689824 9.267952e-10
## rs12719015_T    rs12719015_T    0.07804628 0.014166011 1.503675e-07
## rs6976662_A    rs6976662_A    0.11028313 0.012910099 1.280503e-14
## rs6460356_C    rs6460356_C    0.05254840 0.010335617 1.071597e-06
## rs3113304_G    rs3113304_G    0.04335210 0.008228344 4.628042e-07

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## rs10950240_A rs10950240_A 0.04611775 0.008613309 3.114185e-07
## rs10272163_G rs10272163_G 0.07585192 0.008112967 1.069714e-16
## rs7796112_A rs7796112_A 0.06060517 0.010030844 1.125737e-08
## rs10479665_A rs10479665_A 0.07712507 0.014320684 2.691236e-07
## rs398608_A rs398608_A 0.04812460 0.009150467 4.832139e-07
## rs6961988_T rs6961988_T 0.04219884 0.008028574 4.903067e-07
## rs17155665_T rs17155665_T 0.07324262 0.013566071 2.528130e-07
## rs2371874_A rs2371874_A 0.06107907 0.011271245 2.301574e-07
## rs12155512_G rs12155512_G 0.05359341 0.008193251 8.780210e-10
## rs6964209_T rs6964209_T 0.08403432 0.014738935 5.998999e-08
## rs6945984_C rs6945984_C 0.06463951 0.008517361 3.011520e-12
## rs4727586_C rs4727586_C 0.07621562 0.011175802 2.021070e-10
## rs10253341_C rs10253341_C 0.06389328 0.012213217 5.489060e-07
## rs6977560_A rs6977560_A 0.05913107 0.008774468 3.103156e-10
## rs6974742_C rs6974742_C 0.07319768 0.013294918 1.530347e-07
## rs719917_T rs719917_T 0.05826228 0.011270938 7.293175e-07
## rs2257043_T rs2257043_T 0.06720883 0.009849789 1.981852e-10
## rs10953704_C rs10953704_C 0.04647544 0.008678261 3.097670e-07
## rs2029623_C rs2029623_C 0.09629337 0.011599463 5.201909e-14
## rs6970371_C rs6970371_C 0.05141693 0.009402676 1.825570e-07
## rs350655_A rs350655_A 0.06563845 0.009923682 5.987739e-10
## rs3800665_T rs3800665_T 0.08077849 0.013934335 3.771709e-08
## rs2373177_C rs2373177_C 0.06545911 0.009453754 1.156082e-10
## rs11974602_C rs11974602_C 0.07237555 0.012096894 1.509751e-08
## rs520556_C rs520556_C 0.05073066 0.008486169 1.547308e-08
## rs2622248_C rs2622248_C 0.07077097 0.011727336 1.166847e-08
## rs4960568_T rs4960568_T 0.06135049 0.010659728 4.621573e-08
## rs7805719_T rs7805719_T 0.08243182 0.012735653 1.254899e-09
## rs749539_C rs749539_C 0.06748448 0.012977271 6.333516e-07
## rs12698138_G rs12698138_G 0.09114524 0.012059315 3.582777e-12
## rs12670758_G rs12670758_G 0.06808122 0.012036333 7.459867e-08
## rs6997614_G rs6997614_G 0.10021072 0.010452973 2.563063e-17
## rs330010_T rs330010_T 0.07472919 0.012121226 6.058632e-09
## rs430949_T rs430949_T 0.07023322 0.013552503 6.872295e-07
## rs13269822_T rs13269822_T 0.05423792 0.010101416 2.902870e-07
## rs11990555_C rs11990555_C 0.08083099 0.012268242 6.850814e-10
## rs12543900_G rs12543900_G 0.07483958 0.011744430 2.105820e-09
## rs1368538_G rs1368538_G 0.06403789 0.012225533 5.326453e-07
## rs10102876_G rs10102876_G 0.07905203 0.015158144 5.915342e-07
## rs10503671_G rs10503671_G 0.06343324 0.008199481 1.317987e-12
## rs9785089_G rs9785089_G 0.06853847 0.011177960 7.177399e-09
## rs7845953_T rs7845953_T 0.07521522 0.010126821 7.416709e-12
## rs10108438_G rs10108438_G 0.04523918 0.008305082 2.016726e-07
## rs6557989_A rs6557989_A 0.07607455 0.013003151 2.904635e-08
## rs939709_A rs939709_A 0.08279013 0.013153723 3.146541e-09
## rs7006959_T rs7006959_T 0.05619442 0.008775221 1.791113e-09
## rs4346962_G rs4346962_G 0.07211536 0.011773362 7.407846e-09
## rs7829371_T rs7829371_T 0.09792071 0.015843652 5.607861e-09
## rs10504109_A rs10504109_A 0.06279981 0.012210540 8.213444e-07
## rs9643470_C rs9643470_C 0.05906571 0.011515993 8.753837e-07
## rs7388668_T rs7388668_T 0.05730946 0.009985307 4.994243e-08
## rs2120558_T rs2120558_T 0.04879114 0.008530723 5.500360e-08
## rs6997050_T rs6997050_T 0.08255213 0.013559447 8.928384e-09
## rs16919928_A rs16919928_A 0.07259807 0.014148215 8.665639e-07

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## rs13439780_T rs13439780_T 0.06605736 0.010272031 1.557661e-09
## rs2622580_C rs2622580_C 0.05757523 0.010192306 7.730697e-08
## rs6471623_T rs6471623_T 0.06205194 0.010187709 8.808220e-09
## rs11998573_A rs11998573_A 0.06671686 0.011732230 6.446143e-08
## rs7845684_C rs7845684_C 0.08624181 0.016034460 2.781136e-07
## rs4147445_C rs4147445_C 0.04758623 0.008251761 4.371435e-08
## rs1482133_C rs1482133_C -0.04365112 0.008574395 1.039924e-06
## rs11996713_A rs11996713_A 0.08461875 0.014721289 4.788368e-08
## rs272592_T rs272592_T 0.05264237 0.008793450 1.483291e-08
## rs6983881_C rs6983881_C 0.08474358 0.015040111 8.283603e-08
## rs17686978_C rs17686978_C 0.04484952 0.007829046 5.262049e-08
## rs4734607_G rs4734607_G 0.06154778 0.012020734 9.112636e-07
## rs16869925_G rs16869925_G 0.06818283 0.010677225 1.964700e-09
## rs6999963_A rs6999963_A 0.05701436 0.010400131 1.710952e-07
## rs6982827_A rs6982827_A 0.07917846 0.012120718 9.186666e-10
## rs218021_T rs218021_T 0.05659885 0.008093561 7.978066e-11
## rs6997001_C rs6997001_C 0.04249798 0.008085874 4.908739e-07
## rs13273011_C rs13273011_C 0.06364055 0.011860287 2.950390e-07
## rs4870855_A rs4870855_A 0.09349475 0.012891690 1.946984e-11
## rs2385516_G rs2385516_G 0.07141661 0.012612819 7.250582e-08
## rs4620270_T rs4620270_T 0.05660330 0.008418912 3.371066e-10
## rs6470376_A rs6470376_A 0.08153420 0.014404387 7.315446e-08
## rs7840975_T rs7840975_T 0.06742465 0.010984650 6.945850e-09
## rs6470600_A rs6470600_A 0.07995239 0.012760746 3.640301e-09
## rs885085_A rs885085_A 0.07830669 0.013709203 5.703133e-08
## rs16903682_G rs16903682_G 0.05913975 0.010989760 2.744778e-07
## rs16904967_C rs16904967_C 0.05411504 0.010079035 2.906508e-07
## rs11784191_C rs11784191_C 0.05016622 0.007667581 8.712928e-10
## rs10107255_A rs10107255_A 0.08095213 0.013528014 1.501890e-08
## rs6578167_C rs6578167_C 0.05901234 0.010066695 2.742977e-08
## rs10125065_G rs10125065_G 0.06038089 0.011330310 3.499113e-07
## rs10976135_T rs10976135_T 0.07358609 0.013242969 1.201847e-07
## rs7026937_A rs7026937_A 0.08080609 0.015557030 6.509998e-07
## rs16924694_C rs16924694_C 0.04378275 0.008296474 4.447418e-07
## rs10816082_C rs10816082_C 0.05426199 0.010301388 4.653345e-07
## rs2498599_C rs2498599_C 0.06681818 0.011857383 8.257859e-08
## rs10810128_C rs10810128_C 0.05202943 0.010103157 7.966243e-07
## rs10961684_T rs10961684_T 0.06026130 0.009799834 6.566379e-09
## rs7028604_C rs7028604_C 0.05589782 0.009373301 1.662994e-08
## rs1889050_C rs1889050_C -0.05321038 0.009233846 4.462941e-08
## rs10961780_G rs10961780_G 0.08156101 0.014390802 7.066078e-08
## rs7037559_G rs7037559_G 0.09803567 0.013227685 8.101045e-12
## rs16932980_T rs16932980_T 0.08242173 0.013213873 4.197822e-09
## rs1927636_C rs1927636_C 0.05075173 0.007957766 2.049273e-09
## rs7037443_T rs7037443_T 0.08493908 0.014976138 6.929638e-08
## rs10738555_A rs10738555_A 0.06875426 0.0106555480 1.392328e-09
## rs16931315_T rs16931315_T 0.07859118 0.014894292 4.461271e-07
## rs3731213_T rs3731213_T 0.08068074 0.015146921 3.541597e-07
## rs16910463_A rs16910463_A 0.06617964 0.013002030 1.044251e-06
## rs7031019_C rs7031019_C 0.07839488 0.013124713 1.585950e-08
## rs6476155_A rs6476155_A 0.08493730 0.011901056 3.657835e-11
## rs10732353_T rs10732353_T 0.07909807 0.011973849 6.258205e-10
## rs4271053_A rs4271053_A 0.07660785 0.013878600 1.431068e-07
## rs6420267_A rs6420267_A 0.08842332 0.013282658 4.783388e-10

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## rs10217478_A rs10217478_A 0.04495480 0.008501465 4.234917e-07
## rs2997685_T rs2997685_T 0.07899697 0.013928073 6.924553e-08
## rs10114124_C rs10114124_C 0.07609139 0.010894724 8.367116e-11
## rs7024831_A rs7024831_A 0.04891486 0.008815565 1.248003e-07
## rs1930383_A rs1930383_A 0.05721352 0.010674947 3.037433e-07
## rs12352526_T rs12352526_T 0.07897679 0.014948521 4.326484e-07
## rs7865343_A rs7865343_A 0.08267160 0.011505775 2.811156e-11
## rs10868691_C rs10868691_C 0.05695302 0.008638629 6.701946e-10
## rs337558_G rs337558_G 0.05574303 0.010853479 8.482891e-07
## rs1413299_T rs1413299_T 0.06321987 0.008462713 5.839441e-12
## rs10991456_G rs10991456_G 0.07442507 0.013812189 2.656412e-07
## rs13295440_T rs13295440_T 0.06747556 0.013159942 8.820274e-07
## rs1417603_C rs1417603_C 0.04344720 0.008495304 9.357792e-07
## rs7037742_C rs7037742_C 0.05974700 0.009346932 1.901635e-09
## rs12004156_T rs12004156_T 0.07247517 0.013420772 2.513193e-07
## rs10981230_T rs10981230_T 0.05490948 0.009259177 1.960566e-08
## rs7037658_G rs7037658_G 0.04719933 0.008753968 2.614543e-07
## rs3181360_T rs3181360_T 0.09340379 0.012577875 7.469872e-12
## rs230103_A rs230103_A 0.08355584 0.014794892 7.778266e-08
## rs7859203_A rs7859203_A 0.09333931 0.013920592 3.712089e-10
## rs7870398_C rs7870398_C 0.10747634 0.013779502 9.208536e-13
## rs10819601_T rs10819601_T 0.07586569 0.013415740 7.507833e-08
## rs541216_T rs541216_T 0.05214788 0.009888484 4.523354e-07
## rs1024277_T rs1024277_T 0.09564263 0.011212905 1.379192e-14
## rs7864448_C rs7864448_C 0.05086804 0.008772896 3.749044e-08
## rs7921993_A rs7921993_A 0.06244872 0.011448094 1.944311e-07
## rs7915861_T rs7915861_T 0.07136410 0.010301820 1.136453e-10
## rs7910212_C rs7910212_C 0.07088612 0.011606150 8.096449e-09
## rs2483932_A rs2483932_A 0.05481880 0.010758283 1.018462e-06
## rs10906050_C rs10906050_C -0.04617459 0.008420461 1.698581e-07
## rs11258009_C rs11258009_C 0.05128848 0.009203054 1.111719e-07
## rs7079806_T rs7079806_T 0.05786704 0.009166939 2.861883e-09
## rs11259333_C rs11259333_C 0.06739038 0.011121966 1.032256e-08
## rs11254031_G rs11254031_G 0.07586983 0.014567158 6.104187e-07
## rs10795411_C rs10795411_C -0.05338017 0.008622498 5.321198e-09
## rs2688787_G rs2688787_G -0.05026513 0.009773726 8.220849e-07
## rs11818989_G rs11818989_G 0.07034088 0.013718868 8.821698e-07
## rs16922768_G rs16922768_G 0.07771579 0.014777785 4.838584e-07
## rs16924036_C rs16924036_C 0.07401211 0.014197851 5.976333e-07
## rs12267286_C rs12267286_C 0.11906794 0.013401741 1.710390e-15
## rs7358151_G rs7358151_G 0.09921422 0.014413459 1.437919e-10
## rs709616_A rs709616_A 0.06260688 0.010505706 1.697948e-08
## rs7914253_C rs7914253_C 0.05264018 0.009573210 1.581797e-07
## rs3810947_A rs3810947_A 0.07106153 0.012597434 8.031163e-08
## rs1373003_G rs1373003_G 0.06233545 0.011762276 4.011825e-07
## rs10822088_C rs10822088_C 0.07371740 0.013591580 2.251028e-07
## rs16920386_G rs16920386_G 0.09348667 0.015127794 5.626124e-09
## rs7078234_C rs7078234_C 0.05649565 0.008898746 2.377763e-09
## rs10762276_C rs10762276_C 0.09300325 0.012203608 2.520054e-12
## rs1417207_G rs1417207_G 0.05307394 0.008425510 3.064762e-09
## rs16933980_G rs16933980_G 0.08634994 0.012819799 3.158235e-10
## rs7100515_C rs7100515_C 0.09947041 0.011453708 5.563751e-15
## rs10882097_G rs10882097_G 0.05109636 0.008207230 4.456013e-09
## rs2207782_A rs2207782_A 0.06155218 0.007868205 8.076320e-13

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## rs7897939_T    rs7897939_T    0.11900668 0.013641995 4.423269e-15
## rs2078061_A    rs2078061_A    0.08357663 0.014282967 2.890146e-08
## rs3829142_T    rs3829142_T    0.08971421 0.013408499 4.002810e-10
## rs10509523_T   rs10509523_T   0.08299857 0.014762648 8.787051e-08
## rs7894606_A    rs7894606_A    0.06954669 0.012867323 2.458741e-07
## rs701878_G     rs701878_G     0.06550146 0.012217015 3.010862e-07
## rs7084684_G    rs7084684_G    0.07647485 0.010700459 3.465405e-11
## rs2242052_G    rs2242052_G    0.06225371 0.011600140 2.939671e-07
## rs10786792_A   rs10786792_A   0.06359468 0.011526914 1.450138e-07
## rs1269918_C    rs1269918_C    0.04332602 0.008477556 9.510693e-07
## rs1889959_A    rs1889959_A    0.04470185 0.008252260 2.324272e-07
## rs10509838_A   rs10509838_A   0.06782209 0.012157383 1.081961e-07
## rs41384349_C   rs41384349_C   0.06669630 0.012000696 1.195646e-07
## rs929493_C     rs929493_C     0.05556520 0.009757668 6.205395e-08
## rs10510046_C   rs10510046_C   0.06580206 0.010957991 1.353556e-08
## rs10788067_G   rs10788067_G   0.04746615 0.008715013 2.023257e-07
## rs10788091_T   rs10788091_T   0.11894352 0.012738631 1.151215e-16
## rs2766049_C    rs2766049_C    0.04107685 0.007845799 5.388439e-07
## rs7950446_A    rs7950446_A    0.08611525 0.012679207 2.344068e-10
## rs956453_C     rs956453_C     0.06220676 0.008788280 5.029168e-11
## rs1346833_G    rs1346833_G    0.06882378 0.013365301 7.980055e-07
## rs16915415_A   rs16915415_A   0.06979917 0.011093757 3.183629e-09
## rs7478946_C    rs7478946_C    0.05267260 0.009515011 1.327216e-07
## rs10500787_T   rs10500787_T   0.06010012 0.010278789 2.954445e-08
## rs11024739_C   rs11024739_C   0.04959136 0.008765358 7.411785e-08
## rs11024787_A   rs11024787_A   0.08533139 0.013114761 1.051742e-09
## rs12365265_T   rs12365265_T   0.07220986 0.011104188 1.071493e-09
## rs1125498_G    rs1125498_G    0.07212972 0.013641490 4.242017e-07
## rs4418809_C    rs4418809_C    0.07587622 0.014571393 6.134257e-07
## rs1386253_A    rs1386253_A    0.04436286 0.008265442 2.930984e-07
## rs1018022_T    rs1018022_T    0.07756465 0.012205725 2.304944e-09
## rs6484552_C    rs6484552_C    0.05096594 0.009583333 3.681458e-07
## rs2024967_C    rs2024967_C    0.07327609 0.013796119 3.799711e-07
## rs4356198_C    rs4356198_C    0.05389067 0.010548153 9.582142e-07
## rs7941147_C    rs7941147_C    0.07377869 0.012861927 5.071658e-08
## rs11032877_T   rs11032877_T   0.04607293 0.008259857 1.085794e-07
## rs6484807_G    rs6484807_G    0.07468924 0.010351399 2.383916e-11
## rs1376486_T    rs1376486_T    0.07733371 0.012973523 1.684815e-08
## rs3016165_T    rs3016165_T    0.07816132 0.011446131 1.927193e-10
## rs3862736_G    rs3862736_G    0.07838246 0.012932779 1.024305e-08
## rs11228612_C   rs11228612_C   0.05571817 0.010290526 2.350672e-07
## rs11263451_C   rs11263451_C   0.09731371 0.011484715 1.916697e-14
## rs10897789_C   rs10897789_C   0.04559669 0.008783290 6.596235e-07
## rs12416804_G   rs12416804_G   0.07273067 0.013085708 1.193825e-07
## rs17133841_G   rs17133841_G   0.07537614 0.014027236 2.846375e-07
## rs10501481_G   rs10501481_G   0.07233901 0.014179033 9.897938e-07
## rs6591943_T    rs6591943_T    0.06704404 0.012954451 7.092925e-07
## rs1943711_C    rs1943711_C    0.06728553 0.012505830 2.757834e-07
## rs7107455_G    rs7107455_G    0.06106816 0.011558567 4.324168e-07
## rs2433416_T    rs2433416_T    0.05644821 0.009486257 1.773610e-08
## rs1939168_A    rs1939168_A    0.05350117 0.010088519 3.946254e-07
## rs7125378_A    rs7125378_A    0.08469785 0.011983314 5.320804e-11
## rs1815907_G    rs1815907_G    0.07638524 0.011635324 7.754922e-10
## rs676587_T     rs676587_T     0.06838731 0.010536148 1.141692e-09

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## rs1371352_G    rs1371352_G    0.07738980 0.014853871 6.054240e-07
## rs1347913_C    rs1347913_C    0.06319291 0.008969769 6.022942e-11
## rs1894209_G    rs1894209_G    0.05025082 0.009074932 1.317269e-07
## rs661329_G     rs661329_G     0.04460063 0.008236967 2.348686e-07
## rs1648142_G    rs1648142_G    -0.04488874 0.008247225 2.057686e-07
## rs4938639_G    rs4938639_G    0.06673699 0.008505785 7.082334e-13
## rs10891352_C   rs10891352_C   0.07614575 0.011870763 1.693986e-09
## rs10891623_T   rs10891623_T   0.05093449 0.008129171 3.637530e-09
## rs1632799_C    rs1632799_C    0.08464059 0.012655917 4.067098e-10
## rs7949670_A    rs7949670_A    0.07449927 0.013529523 1.525043e-07
## rs9633948_T    rs9633948_T    0.08478973 0.014372858 2.284610e-08
## rs1941410_A    rs1941410_A    0.05890432 0.009705182 9.810841e-09
## rs17311303_A   rs17311303_A   -0.04663521 0.008097351 4.533368e-08
## rs7928560_A    rs7928560_A    0.05040077 0.008776056 4.907578e-08
## rs1944605_A    rs1944605_A    0.10735050 0.014055592 2.296043e-12
## rs7115792_A    rs7115792_A    0.07445245 0.010229951 1.692056e-11
## rs4936823_G    rs4936823_G    0.04684041 0.008567501 1.835143e-07
## rs10466604_C   rs10466604_C   0.10545991 0.007847282 1.241129e-27
## rs10893331_G   rs10893331_G   0.04433842 0.008121550 1.904384e-07
## rs12289208_T   rs12289208_T   0.07581277 0.014107239 2.840059e-07
## rs7117643_A    rs7117643_A    0.06036136 0.009881920 8.070930e-09
## rs580481_T     rs580481_T    0.05193458 0.010223003 1.091235e-06
## rs7950184_C    rs7950184_C    0.07537395 0.012416295 9.752078e-09
## rs12098973_G   rs12098973_G   0.05057429 0.009812325 7.810843e-07
## rs1940147_C    rs1940147_C    0.07909485 0.013543895 3.059318e-08
## rs11223262_G   rs11223262_G   0.07813211 0.013404721 3.231651e-08
## rs4391826_T    rs4391826_T    0.06825359 0.012278068 1.188377e-07
## rs11223511_G   rs11223511_G   0.04714207 0.008732619 2.534849e-07
## rs10894900_G   rs10894900_G   0.04893218 0.009490442 7.747820e-07
## rs7132285_T    rs7132285_T    0.07727618 0.015108668 9.339617e-07
## rs767870_G     rs767870_G     0.05459435 0.010183987 3.020564e-07
## rs10848596_A   rs10848596_A   0.04415982 0.008255386 3.187862e-07
## rs7957163_A    rs7957163_A    0.08133142 0.011511716 5.404604e-11
## rs7316728_C    rs7316728_C    0.08405338 0.012342137 2.125100e-10
## rs10849033_G   rs10849033_G   0.09206517 0.011888311 1.260367e-12
## rs4149623_G    rs4149623_G    0.09819904 0.013684558 2.958017e-11
## rs11054692_G   rs11054692_G   -0.04693516 0.008515262 1.486107e-07
## rs7972255_C    rs7972255_C    0.09040139 0.011331688 3.348039e-13
## rs7314880_T    rs7314880_T    0.07690049 0.014709286 5.576860e-07
## rs2058798_A    rs2058798_A    0.08481834 0.014135406 1.384370e-08
## rs1991587_A    rs1991587_A    0.10458339 0.011659171 1.030128e-15
## rs10770503_T   rs10770503_T   0.04964298 0.009765859 1.075881e-06
## rs11051944_T   rs11051944_T   0.08574936 0.013480203 2.230851e-09
## rs12315721_G   rs12315721_G   0.09520939 0.013746818 1.145074e-10
## rs7971936_T    rs7971936_T    0.08344027 0.013119963 2.246250e-09
## rs3911501_G    rs3911501_G    0.08801721 0.013476149 9.242223e-10
## rs2643626_G    rs2643626_G    0.10173069 0.014027372 1.947284e-11
## rs11174878_A   rs11174878_A   0.07535402 0.013393070 8.614271e-08
## rs2062861_G    rs2062861_G    0.05334980 0.010455909 9.874321e-07
## rs2620752_C    rs2620752_C    0.06871926 0.011439040 1.336849e-08
## rs725446_A     rs725446_A     0.07117298 0.013688933 6.359528e-07
## rs1836060_G    rs1836060_G    0.04510318 0.008086331 1.086969e-07
## rs6539905_A    rs6539905_A    0.08272241 0.011248233 1.111118e-11
## rs11609178_T   rs11609178_T   0.08093333 0.013943889 3.642648e-08

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## rs2058343_A    rs2058343_A    0.11178853 0.013772660 1.510856e-13
## rs10160926_C  rs10160926_C  0.10256722 0.013165908 9.709303e-13
## rs1718377_A   rs1718377_A   0.08101338 0.015118501 3.052283e-07
## rs10850376_G  rs10850376_G  0.07368736 0.014060529 5.261369e-07
## rs6489982_G   rs6489982_G   0.05566483 0.009968295 1.053877e-07
## rs11067687_T  rs11067687_T  0.04533846 0.008295500 1.850688e-07
## rs9300329_G   rs9300329_G   0.06124124 0.011476771 3.387987e-07
## rs2730448_T   rs2730448_T   0.04713234 0.009004999 5.425681e-07
## rs345645_T    rs345645_T    0.05772192 0.010251096 8.431972e-08
## rs1214212_A   rs1214212_A   0.08610741 0.014693484 2.768568e-08
## rs10734948_C  rs10734948_C  0.05308079 0.010393949 9.674356e-07
## rs7953756_C   rs7953756_C   0.05187785 0.009512992 1.958787e-07
## rs7975245_C   rs7975245_C   0.06384476 0.010756106 1.908911e-08
## rs1567760_C   rs1567760_C   0.07941021 0.013053219 9.136435e-09
## rs12303986_T  rs12303986_T  0.10254964 0.012482600 8.558602e-14
## rs4769389_T   rs4769389_T   0.07866464 0.010959054 2.923519e-11
## rs7987204_C   rs7987204_C   0.05994827 0.009940681 1.190992e-08
## rs9509982_A   rs9509982_A   0.05075797 0.008659779 2.753633e-08
## rs9317020_G   rs9317020_G   0.05955829 0.010554086 7.946881e-08
## rs2114222_C   rs2114222_C   0.07243251 0.013106157 1.386016e-07
## rs9552824_A   rs9552824_A   0.09583790 0.015138818 2.609394e-09
## rs1028696_G   rs1028696_G   0.06279696 0.011543003 2.083246e-07
## rs874150_T    rs874150_T    0.07584070 0.014449847 5.075782e-07
## rs4402410_C   rs4402410_C   0.09594101 0.015231978 3.073217e-09
## rs2027576_T   rs2027576_T   0.04369364 0.008229088 3.829680e-07
## rs7981680_G   rs7981680_G   0.09506350 0.012972811 1.284962e-11
## rs7318474_G   rs7318474_G   0.05562449 0.009408183 2.142099e-08
## rs2388084_A   rs2388084_A   0.06715414 0.011962160 9.144275e-08
## rs7336382_T   rs7336382_T   0.04526872 0.008483539 3.388592e-07
## rs17080180_G  rs17080180_G  0.06410078 0.011560597 1.271521e-07
## rs2122208_A   rs2122208_A   0.05905568 0.009168145 1.474542e-09
## rs2151236_T   rs2151236_T   0.05510053 0.008140333 2.649024e-10
## rs9316153_G   rs9316153_G   0.05774791 0.010442625 1.363734e-07
## rs1417985_G   rs1417985_G   0.08593626 0.016076075 3.241847e-07
## rs7998115_C   rs7998115_C   0.05228647 0.009682202 2.512693e-07
## rs10220140_C  rs10220140_C  0.07344661 0.008645828 1.688649e-14
## rs667131_A    rs667131_A    0.04253289 0.008151405 5.842528e-07
## rs1631696_A   rs1631696_A   0.07838848 0.013344343 2.583987e-08
## rs6562034_T   rs6562034_T   0.06528554 0.012263484 3.590722e-07
## rs9598458_G   rs9598458_G   0.07686679 0.013973562 1.565609e-07
## rs2482565_C   rs2482565_C   0.07947662 0.014299789 1.194595e-07
## rs11840536_A  rs11840536_A  0.07066484 0.010805150 8.837388e-10
## rs11148886_C  rs11148886_C  0.08428415 0.007970686 6.227159e-20
## rs9564847_A   rs9564847_A   0.07154499 0.011750572 8.907104e-09
## rs7317250_G   rs7317250_G   0.06795625 0.013322427 9.939921e-07
## rs9318525_C   rs9318525_C   0.07391241 0.012413336 1.740962e-08
## rs1316834_T   rs1316834_T   0.07007627 0.013281126 4.465728e-07
## rs7994255_T   rs7994255_T   0.04432565 0.008518148 6.234052e-07
## rs9601485_T   rs9601485_T   0.05755291 0.010498777 1.712664e-07
## rs9531827_C   rs9531827_C   0.05150416 0.008980974 5.106200e-08
## rs6492403_T   rs6492403_T   0.06464394 0.012491128 7.098705e-07
## rs9522498_C   rs9522498_C   0.08183680 0.014641638 1.028369e-07
## rs6650322_G   rs6650322_G   0.07473504 0.011963888 4.005753e-09
## rs7326592_A   rs7326592_A   0.06807019 0.010069143 2.772046e-10

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## rs1333758_A    rs1333758_A    0.08623038 0.011490165 4.824755e-12
## rs12020174_G  rs12020174_G  0.07206602 0.012903383 1.049556e-07
## rs16962932_G  rs16962932_G  0.08495674 0.014366631 2.130241e-08
## rs3916940_C   rs3916940_C   0.05574597 0.010095266 1.416643e-07
## rs9300927_A   rs9300927_A   0.07027469 0.011203227 3.508615e-09
## rs1253837_G   rs1253837_G   0.08198050 0.013884705 2.228099e-08
## rs7990201_A   rs7990201_A   0.06396363 0.010537403 9.772420e-09
## rs9519862_C   rs9519862_C   0.04980799 0.008986211 1.283971e-07
## rs11843523_G  rs11843523_G  0.09406466 0.013437360 7.675705e-11
## rs4771572_G   rs4771572_G   0.05251951 0.009496008 1.359372e-07
## rs1408016_G   rs1408016_G   0.05562260 0.009627913 4.155134e-08
## rs494558_C    rs494558_C   0.06863600 0.012918204 3.768764e-07
## rs9555714_G   rs9555714_G   0.04780782 0.009194051 6.343377e-07
## rs7339401_T   rs7339401_T   0.08255699 0.012669728 1.000649e-09
## rs7994315_A   rs7994315_A   0.07332603 0.014332202 9.277287e-07
## rs11850259_T  rs11850259_T  0.04301982 0.007912506 2.116000e-07
## rs938892_A    rs938892_A   0.06355531 0.009509675 4.167028e-10
## rs10137743_G  rs10137743_G  0.07713572 0.014026878 1.578517e-07
## rs222670_C    rs222670_C   0.06693390 0.012194925 1.658558e-07
## rs1474966_G   rs1474966_G   0.05205796 0.009768377 3.497709e-07
## rs4981166_A   rs4981166_A   0.08185433 0.011574354 5.204940e-11
## rs1012023_A   rs1012023_A   0.08793406 0.010815084 1.394158e-13
## rs1998852_G   rs1998852_G   0.05471362 0.010390228 4.687129e-07
## rs12890607_G  rs12890607_G  0.04845011 0.007753493 3.963293e-09
## rs41356944_T  rs41356944_T  0.08265331 0.015827384 5.728355e-07
## rs10132964_T  rs10132964_T  0.08241608 0.014156348 3.341892e-08
## rs6572795_G   rs6572795_G   0.08062517 0.014016859 4.697136e-08
## rs4901174_T   rs4901174_T   0.05624998 0.008523631 6.478663e-10
## rs17127765_G  rs17127765_G  0.08605521 0.015652706 1.588636e-07
## rs6573073_T   rs6573073_T   0.07425742 0.013497542 1.560595e-07
## rs862153_T    rs862153_T   0.05602489 0.008687933 1.420681e-09
## rs7144649_G   rs7144649_G   0.05021222 0.008007088 3.540019e-09
## rs1152522_T   rs1152522_T   0.04766067 0.009062184 4.831206e-07
## rs217632_G    rs217632_G   0.09955144 0.013452490 8.618220e-12
## rs1255741_A   rs1255741_A   0.05238043 0.008191034 1.875360e-09
## rs7148755_C   rs7148755_C   0.10910405 0.011420546 3.137386e-17
## rs7147935_G   rs7147935_G   0.08188256 0.012825952 1.981856e-09
## rs2526941_C   rs2526941_C   0.06259752 0.011275407 1.230361e-07
## rs205817_T    rs205817_T   0.08311734 0.013041838 2.097343e-09
## rs31420_G     rs31420_G    0.05308341 0.009476843 9.707787e-08
## rs7158064_G   rs7158064_G   0.04333243 0.008266940 5.238991e-07
## rs1152360_A   rs1152360_A   0.07633001 0.013245735 4.461363e-08
## rs12435434_C  rs12435434_C  0.06856308 0.011966671 5.239227e-08
## rs10132942_T  rs10132942_T  0.04751605 0.009057066 5.128511e-07
## rs10467867_G  rs10467867_G  0.05668414 0.009557246 1.953457e-08
## rs1211448_G   rs1211448_G   0.09789356 0.013509405 2.012126e-11
## rs12889368_T  rs12889368_T  0.06240632 0.010602779 2.441112e-08
## rs1462266_G   rs1462266_G  -0.05441006 0.008814012 5.819030e-09
## rs4905865_T   rs4905865_T   0.09457765 0.010865962 4.961849e-15
## rs7146460_T   rs7146460_T   0.05443681 0.009475158 4.854823e-08
## rs2763550_G   rs2763550_G   0.07515364 0.010243065 1.221935e-11
## rs8020729_T   rs8020729_T   0.05267543 0.009892502 3.570608e-07
## rs7174716_A   rs7174716_A   0.05248159 0.009476846 1.313819e-07
## rs7173713_T   rs7173713_T   0.07150204 0.013090379 1.879199e-07

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## rs2346050_C    rs2346050_C    0.04617085 0.008822365 5.441462e-07
## rs1258735_G    rs1258735_G    0.08280683 0.014278131 3.726445e-08
## rs16960230_G    rs16960230_G    0.09079827 0.015067425 1.217856e-08
## rs619196_T      rs619196_T      0.07114677 0.013709342 6.645878e-07
## rs8029071_A      rs8029071_A      0.07453321 0.010368089 2.758125e-11
## rs7177212_A      rs7177212_A      0.08617540 0.014463269 1.707205e-08
## rs16962582_T    rs16962582_T    0.08181722 0.013647535 1.422074e-08
## rs2204212_T      rs2204212_T      0.05240023 0.009749470 2.831570e-07
## rs12898413_C    rs12898413_C    0.06035700 0.009682458 4.281273e-09
## rs381732_A      rs381732_A      0.05683707 0.009343545 9.161343e-09
## rs626744_G      rs626744_G      0.08368287 0.013416163 4.198848e-09
## rs6493397_T      rs6493397_T      0.05659566 0.009863939 5.036724e-08
## rs8031463_C      rs8031463_C      0.06033867 0.010508078 4.928222e-08
## rs9920517_T      rs9920517_T      0.08011603 0.013546934 2.125158e-08
## rs2163194_A      rs2163194_A      0.07884638 0.013596458 3.735894e-08
## rs2553215_G      rs2553215_G      0.09791658 0.013687202 3.335630e-11
## rs728244_A      rs728244_A      0.07741564 0.007970992 1.201171e-17
## rs4774825_G      rs4774825_G      0.07356089 0.014443170 1.029400e-06
## rs7183768_C      rs7183768_C      0.08282216 0.012203465 2.408176e-10
## rs8035628_A      rs8035628_A      0.05631781 0.010866195 6.855409e-07
## rs1234805_T      rs1234805_T      0.06599910 0.009212518 3.155349e-11
## rs7175117_T      rs7175117_T      0.06418816 0.011203559 5.245257e-08
## rs12442231_A      rs12442231_A      0.06126858 0.011832010 7.001853e-07
## rs898593_C      rs898593_C      -0.04285278 0.007746050 1.349622e-07
## rs1838541_A      rs1838541_A      0.07940052 0.013414657 2.073565e-08
## rs11072034_A      rs11072034_A      0.05211299 0.009165414 6.471055e-08
## rs11636972_G      rs11636972_G      0.05592209 0.009953697 8.956103e-08
## rs7183919_T      rs7183919_T      0.07663798 0.012918851 1.941432e-08
## rs9630453_G      rs9630453_G      0.05048422 0.009578448 4.586125e-07
## rs293365_T      rs293365_T      0.04441951 0.008328676 3.432018e-07
## rs8036168_C      rs8036168_C      0.06595433 0.011439360 4.397790e-08
## rs47777911_A      rs47777911_A      0.07665028 0.013964209 1.655554e-07
## rs12442336_A      rs12442336_A      0.09371085 0.012742986 1.113222e-11
## rs1424741_A      rs1424741_A      0.04198261 0.008013329 5.300797e-07
## rs6496141_A      rs6496141_A      0.09305554 0.013927934 4.211455e-10
## rs4350538_C      rs4350538_C      0.05495892 0.010453247 4.869101e-07
## rs4965117_C      rs4965117_C      0.04593582 0.008537953 2.759655e-07
## rs11854132_A      rs11854132_A      0.05899503 0.010446451 7.787225e-08
## rs907801_C      rs907801_C      0.05585736 0.010972173 1.040152e-06
## rs4483828_T      rs4483828_T      0.04684062 0.008217811 6.046410e-08
## rs4965810_C      rs4965810_C      0.05444001 0.010267144 3.961263e-07
## rs4566169_A      rs4566169_A      0.05944053 0.011129152 3.312231e-07
## rs2660228_G      rs2660228_G      0.07472313 0.010185325 1.226486e-11
## rs7185578_G      rs7185578_G      0.05921817 0.008779566 3.005935e-10
## rs9931378_C      rs9931378_C      0.04551592 0.008439941 2.600470e-07
## rs11641750_G      rs11641750_G      0.04237363 0.008169783 6.738227e-07
## rs4786910_C      rs4786910_C      0.04394495 0.008404493 5.558434e-07
## rs7188849_T      rs7188849_T      0.05450636 0.007599013 3.008179e-11
## rs1395585_G      rs1395585_G      0.05062610 0.009551635 3.999855e-07
## rs1034978_T      rs1034978_T      0.06897852 0.012401205 1.170085e-07
## rs9922204_T      rs9922204_T      0.07554885 0.014054338 2.820923e-07
## rs1451595_T      rs1451595_T      0.05408608 0.009494682 6.147409e-08
## rs8053877_T      rs8053877_T      0.06246118 0.008350009 5.524584e-12
## rs9925652_C      rs9925652_C      0.06108465 0.009615895 2.332454e-09

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## rs13335336_G rs13335336_G 0.08844420 0.015052382 2.565305e-08
## rs12595990_A rs12595990_A 0.04502762 0.008800776 9.270986e-07
## rs7193298_G rs7193298_G 0.08842419 0.010432359 1.887533e-14
## rs2113334_T rs2113334_T 0.05673057 0.009732479 3.227002e-08
## rs836279_T rs836279_T 0.05958940 0.010727129 1.211014e-07
## rs4782026_A rs4782026_A 0.04734170 0.008565067 1.381425e-07
## rs8045281_T rs8045281_T 0.11611947 0.012396763 9.633167e-17
## rs1989807_T rs1989807_T 0.07647352 0.014760848 6.918495e-07
## rs980125_A rs980125_A 0.04679701 0.009033115 6.925713e-07
## rs237150_T rs237150_T -0.04540023 0.008438068 2.756902e-07
## rs4479245_C rs4479245_C 0.05059134 0.009143403 1.343956e-07
## rs9931454_C rs9931454_C 0.04738696 0.009323184 1.078877e-06
## rs11076556_C rs11076556_C 0.07165658 0.009696325 9.115976e-12
## rs936873_C rs936873_C 0.08222041 0.013701253 1.380770e-08
## rs4784054_A rs4784054_A 0.08893914 0.013691437 1.111041e-09
## rs1506826_T rs1506826_T 0.04821243 0.009183353 5.042435e-07
## rs3865181_A rs3865181_A 0.06061964 0.009418550 1.514776e-09
## rs11648843_A rs11648843_A 0.04913898 0.009049165 2.183774e-07
## rs9928306_A rs9928306_A 0.08947694 0.012600547 4.447048e-11
## rs4843485_T rs4843485_T 0.09771733 0.012957200 3.929159e-12
## rs7186136_C rs7186136_C 0.12037338 0.012015210 1.869684e-18
## rs154659_C rs154659_C 0.08214000 0.010943822 4.800845e-12
## rs12925933_A rs12925933_A 0.06000018 0.008269319 1.910666e-11
## rs12950579_A rs12950579_A 0.07977008 0.014911854 3.184498e-07
## rs2269459_A rs2269459_A 0.04987334 0.009785307 1.012692e-06
## rs3935951_T rs3935951_T 0.11553386 0.013620499 1.818378e-14
## rs7212298_C rs7212298_C 0.06263506 0.009817239 2.023339e-09
## rs1513747_A rs1513747_A 0.05339075 0.008504873 3.421122e-09
## rs9904592_A rs9904592_A 0.07364079 0.011679977 2.977011e-09
## rs7212279_G rs7212279_G 0.08133195 0.015395268 4.333132e-07
## rs8082001_G rs8082001_G 0.07305333 0.013489197 2.337713e-07
## rs8068853_C rs8068853_C 0.04303704 0.008280866 6.421987e-07
## rs3093704_T rs3093704_T 0.07107932 0.013970050 1.053549e-06
## rs317403_T rs317403_T 0.05966897 0.009766366 8.015254e-09
## rs1860278_T rs1860278_T 0.07099643 0.012331815 4.580791e-08
## rs3815053_C rs3815053_C -0.04592094 0.008553850 2.914873e-07
## rs1009204_T rs1009204_T 0.05619362 0.009219436 8.621708e-09
## rs1473626_A rs1473626_A 0.05036153 0.009432710 3.342264e-07
## rs9912445_T rs9912445_T 0.06238627 0.011860940 4.819751e-07
## rs242939_C rs242939_C 0.07021376 0.013706337 9.006663e-07
## rs6504256_G rs6504256_G 0.04486505 0.008171152 1.642997e-07
## rs11079830_G rs11079830_G 0.04428639 0.008341757 3.841338e-07
## rs12453270_A rs12453270_A -0.04596009 0.008683999 4.145665e-07
## rs17817950_A rs17817950_A 0.08516018 0.011791873 2.299807e-11
## rs7214685_A rs7214685_A 0.06668601 0.011345458 2.540063e-08
## rs17821126_A rs17821126_A -0.04389859 0.008597188 9.706562e-07
## rs9904395_G rs9904395_G 0.11427182 0.011535211 3.698028e-18
## rs2465429_A rs2465429_A 0.07831883 0.015396673 1.059452e-06
## rs2706669_C rs2706669_C 0.07626743 0.013996380 1.998666e-07
## rs3888200_T rs3888200_T 0.08230609 0.010158697 1.643633e-13
## rs473923_T rs473923_T 0.07458093 0.013763652 2.305128e-07
## rs1826508_C rs1826508_C 0.07089406 0.010379500 1.911059e-10
## rs3850801_G rs3850801_G 0.04707703 0.007985377 2.328841e-08
## rs9963999_G rs9963999_G 0.07016507 0.012014985 3.060707e-08

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## rs4798212_T    rs4798212_T    0.09927984 0.012479039 3.796254e-13
## rs1595361_C    rs1595361_C    0.05473601 0.008745451 3.766709e-09
## rs7240175_T    rs7240175_T    0.06746361 0.012184228 1.319525e-07
## rs9955524_G    rs9955524_G    0.08498215 0.011276718 4.051068e-12
## rs4629068_C    rs4629068_C    0.09391535 0.013795790 2.156338e-10
## rs10853328_C   rs10853328_C   0.08435984 0.013630195 5.364845e-09
## rs7235436_C   rs7235436_C   0.08007028 0.014830267 2.526288e-07
## rs10502360_C   rs10502360_C   0.09839805 0.013957567 5.871648e-11
## rs11662690_G   rs11662690_G   -0.04936191 0.008470482 3.250377e-08
## rs535823_A     rs535823_A     0.04306915 0.008459664 1.038759e-06
## rs6505813_T    rs6505813_T    0.06499742 0.011582189 9.233942e-08
## rs507579_C     rs507579_C     0.06021743 0.011096348 2.219337e-07
## rs13313624_T   rs13313624_T   0.05744601 0.007864737 1.463730e-11
## rs1379641_C    rs1379641_C    0.07148722 0.012420816 4.619678e-08
## rs1241078_T    rs1241078_T    0.10864894 0.014321482 3.057644e-12
## rs11873862_T   rs11873862_T   0.08368898 0.014750771 6.866336e-08
## rs7236694_T    rs7236694_T    0.09147752 0.014465439 2.701116e-09
## rs9967367_T    rs9967367_T    0.05853605 0.008040435 1.670616e-11
## rs7234298_T    rs7234298_T    0.08143475 0.013850647 2.518664e-08
## rs12456701_A   rs12456701_A   0.04600855 0.008402077 1.761953e-07
## rs1304551_T    rs1304551_T    0.12246555 0.011670046 1.019484e-19
## rs221878_G     rs221878_G     0.05141846 0.009649044 3.503674e-07
## rs1495807_T    rs1495807_T    0.05504252 0.009563400 4.617380e-08
## rs7242701_G    rs7242701_G    0.05542424 0.008372090 5.808353e-10
## rs1592717_A    rs1592717_A    0.09245669 0.012801150 2.292366e-11
## rs9964268_A    rs9964268_A    0.09384128 0.014425502 1.058770e-09
## rs1432074_G    rs1432074_G    0.05677973 0.009858935 4.535616e-08
## rs1380711_G    rs1380711_G    0.04407635 0.008494358 6.668906e-07
## rs10514193_G   rs10514193_G   0.07778871 0.013640468 5.962290e-08
## rs2082463_C    rs2082463_C    0.06446694 0.012632892 9.841277e-07
## rs17271883_T   rs17271883_T   0.05053226 0.009094896 1.204727e-07
## rs7253024_T    rs7253024_T    0.06610872 0.008730599 3.313310e-12
## rs460698_G     rs460698_G     0.05692194 0.009574809 1.823092e-08
## rs10416140_C   rs10416140_C   0.06980476 0.010912966 1.859495e-09
## rs318720_G     rs318720_G     0.06953388 0.012564793 1.338048e-07
## rs1593000_T    rs1593000_T    0.05783937 0.010796828 3.073496e-07
## rs10416717_G   rs10416717_G   0.06233502 0.009289833 3.617173e-10
## rs10422148_A   rs10422148_A   0.05567020 0.010514070 4.101376e-07
## rs1120559_T    rs1120559_T    0.06066474 0.010244849 2.047617e-08
## rs8111801_C    rs8111801_C    0.05037236 0.009197814 1.756112e-07
## rs3212752_C    rs3212752_C    0.08890179 0.012705097 7.796789e-11
## rs2435044_C    rs2435044_C    0.07420157 0.014014315 4.103855e-07
## rs2866971_A    rs2866971_A    0.07773830 0.011032236 5.978509e-11
## rs7258461_T    rs7258461_T    0.05459818 0.010514865 6.560954e-07
## rs6510328_C    rs6510328_C    0.04352426 0.008318301 5.467369e-07
## rs494387_C     rs494387_C     0.05863235 0.010386875 7.882280e-08
## rs12461618_A   rs12461618_A   0.04690890 0.007913967 1.989089e-08
## rs10405150_C   rs10405150_C   0.04979674 0.009379727 3.841783e-07
## rs11665965_A   rs11665965_A   0.04643443 0.008487718 1.804610e-07
## rs2965157_C    rs2965157_C    0.11134190 0.012792548 4.972847e-15
## rs11879934_G   rs11879934_G   0.06355401 0.012429332 9.401556e-07
## rs8104498_C    rs8104498_C    0.06171124 0.011682694 4.345945e-07
## rs892166_C     rs892166_C     0.06905298 0.012830950 2.739652e-07
## rs260445_T     rs260445_T     0.09435780 0.013656198 1.250406e-10

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## rs6084644_G    rs6084644_G    0.05563227 0.010434179 3.457378e-07
## rs6054431_G    rs6054431_G    0.06059883 0.008702681 9.369461e-11
## rs1017165_T    rs1017165_T    0.06944813 0.013298936 5.730700e-07
## rs10485593_G   rs10485593_G   0.05076787 0.007943485 1.911634e-09
## rs4815221_C    rs4815221_C    0.04387751 0.008404617 5.768538e-07
## rs6100096_C    rs6100096_C    0.09169617 0.013891044 6.417740e-10
## rs1883784_A    rs1883784_A    0.05980510 0.010054113 1.793073e-08
## rs6102159_A    rs6102159_A    0.05604333 0.010456442 3.036209e-07
## rs6072202_A    rs6072202_A    0.04401242 0.008230745 3.216052e-07
## rs6124623_G    rs6124623_G    0.05989518 0.010242000 2.940103e-08
## rs228219_C     rs228219_C     0.08947249 0.013007275 1.475276e-10
## rs6095097_T    rs6095097_T    0.07435324 0.010085982 1.007750e-11
## rs7268640_C    rs7268640_C    0.09888042 0.012241104 1.889503e-13
## rs1555140_G    rs1555140_G    -0.04532773 0.008894588 1.015691e-06
## rs11905489_G   rs11905489_G   0.06402682 0.011416046 9.383128e-08
## rs6095624_A    rs6095624_A    0.05738256 0.010173866 8.060558e-08
## rs16995010_G   rs16995010_G   0.05602477 0.009193417 8.670173e-09
## rs6091084_C    rs6091084_C    0.08160363 0.014868051 1.659705e-07
## rs6091253_G    rs6091253_G    0.05895588 0.010540662 1.009558e-07
## rs7263115_T    rs7263115_T    0.08940414 0.014892983 1.365971e-08
## rs6097296_A    rs6097296_A    0.05453107 0.008131197 3.687139e-10
## rs3787397_A    rs3787397_A    0.06754673 0.008926933 3.415761e-12
## rs4810001_G    rs4810001_G    0.05823258 0.009142348 2.136417e-09
## rs6025100_C    rs6025100_C    0.04750365 0.008840520 2.848450e-07
## rs1276430_G    rs1276430_G    0.08340370 0.015079723 1.358358e-07
## rs1556176_C    rs1556176_C    0.07334035 0.009939596 9.713012e-12
## rs4812108_G    rs4812108_G    -0.05022782 0.009361288 2.955489e-07
## rs16983054_T   rs16983054_T   0.09568519 0.013451720 4.161856e-11
## rs168982_G     rs168982_G     0.07061659 0.011614994 9.311999e-09
## rs2427043_A    rs2427043_A    0.05734925 0.010494183 1.855643e-07
## rs6061663_C    rs6061663_C    0.07263345 0.013163548 1.445258e-07
## rs6061279_T    rs6061279_T    0.04774899 0.009011686 4.031230e-07
## rs9680065_G    rs9680065_G    0.04457125 0.008675194 8.413137e-07
## rs10485825_G   rs10485825_G   0.05856641 0.011054362 4.041066e-07
## rs2847443_A    rs2847443_A    0.11607662 0.012475454 1.401705e-16
## rs2823376_G    rs2823376_G    0.04782526 0.009346022 9.235276e-07
## rs1022457_A    rs1022457_A    0.08366252 0.013741073 8.913321e-09
## rs2824011_C    rs2824011_C    0.10905111 0.012025888 5.753657e-16
## rs2825252_G    rs2825252_G    0.07011948 0.013763918 1.023315e-06
## rs216772_T     rs216772_T     0.07497968 0.012327931 9.204295e-09
## rs2830201_C    rs2830201_C    0.06099669 0.010417763 2.839860e-08
## rs2836181_T    rs2836181_T    0.08661965 0.012006889 2.399804e-11
## rs2837968_T    rs2837968_T    0.07634449 0.013072952 3.059432e-08
## rs2837974_G    rs2837974_G    0.07433949 0.012144823 7.566694e-09
## rs7280100_C    rs7280100_C    0.09239452 0.014013499 6.687199e-10
## rs9982929_G    rs9982929_G    0.06069627 0.010342844 2.659431e-08
## rs2838578_C    rs2838578_C    0.08841363 0.012768838 1.155883e-10
## rs1858758_G    rs1858758_G    0.04715021 0.007996015 2.313856e-08
## rs4395341_C    rs4395341_C    0.07822501 0.013513558 3.930438e-08
## rs2227235_C    rs2227235_C    0.07108460 0.013366069 3.679701e-07
## rs136503_G     rs136503_G     0.07186517 0.013112067 1.720980e-07
## rs542981_A     rs542981_A     0.06482680 0.012262770 4.262675e-07
## rs1005887_C    rs1005887_C    0.04634724 0.008478140 1.839854e-07
## rs7511209_A    rs7511209_A    0.07211070 0.013490516 3.246542e-07

```

```

## rs2213533_A    rs2213533_A    0.05309252 0.009105005 3.193366e-08
## rs9680635_C    rs9680635_C    0.07915078 0.012075927 8.192996e-10
## rs6518834_C    rs6518834_C    0.04864583 0.008428142 4.265597e-08
## rs5999086_G    rs5999086_G    0.05899156 0.011058272 3.411569e-07
## rs12168968_C   rs12168968_C   0.08407503 0.013900279 1.089418e-08
## rs762919_A     rs762919_A     0.05324488 0.009940535 3.083971e-07
## rs16997569_T   rs16997569_T   0.07814854 0.013115790 1.706099e-08
## rs6006470_G    rs6006470_G    -0.05137953 0.009142200 8.878472e-08
## rs5767536_A    rs5767536_A    0.04982508 0.008766100 6.533608e-08
## rs133582_C     rs133582_C    0.06333872 0.009029630 7.105033e-11
## rs5769644_C    rs5769644_C    0.05457934 0.010567529 7.441706e-07
## rs4824056_G    rs4824056_G    0.04533303 0.008568505 4.181139e-07
## rs5988643_T    rs5988643_T    0.06168344 0.011071066 1.119131e-07
## rs311121_T     rs311121_T    0.08755467 0.010751325 1.294259e-13
## rs4465107_T    rs4465107_T    0.05874525 0.009289248 2.699210e-09
## rs5978528_A    rs5978528_A    0.07929599 0.012071196 7.591230e-10
## rs5978532_G    rs5978532_G    0.05191768 0.009958368 5.960962e-07
## rs239757_C     rs239757_C    0.04606666 0.008428514 1.849421e-07
## rs4129871_A    rs4129871_A    0.05728862 0.008613964 4.946769e-10
## rs4281248_G    rs4281248_G    0.04693760 0.007978424 2.474734e-08
## rs5943477_T    rs5943477_T    0.09881831 0.010268264 2.051664e-17
## rs6527130_A    rs6527130_A    0.05430061 0.008888356 8.033567e-09
## rs401285_A     rs401285_A    0.06820301 0.010221865 4.414935e-10
## rs2209585_A    rs2209585_A    0.07216494 0.012305590 2.712594e-08
## rs5980804_T    rs5980804_T    -0.04364679 0.007559234 4.221455e-08
## rs7053611_G    rs7053611_G    0.06958333 0.013490152 7.672886e-07
## rs6524598_G    rs6524598_G    0.07222777 0.012285080 2.520928e-08
## rs10442389_C   rs10442389_C   0.05335837 0.008829653 1.118965e-08
## rs4827980_A    rs4827980_A    0.04812159 0.007319663 7.385034e-10
## rs5952167_T    rs5952167_T    0.05293903 0.009207270 4.750261e-08
## rs5956063_T    rs5956063_T    0.05952948 0.008473427 6.699037e-11
## rs1989818_G    rs1989818_G    0.03923920 0.007679868 9.567319e-07
## rs4345730_T    rs4345730_T    0.05555499 0.010714046 6.780776e-07
## rs5930769_A    rs5930769_A    0.05962345 0.010448849 5.864176e-08
## rs6528444_A    rs6528444_A    0.04588745 0.008802028 5.966154e-07
## rs5974804_C    rs5974804_C    0.04015014 0.007368371 1.999580e-07
## rs5909010_T    rs5909010_T    0.09644518 0.010669428 6.822567e-16
## rs5954038_C    rs5954038_C    0.05820387 0.007677074 3.142860e-12
## rs5954072_T    rs5954072_T    0.08670222 0.013678416 2.504364e-09
## rs6636441_C    rs6636441_C    0.04380581 0.007186619 8.606873e-09
## rs971662_A     rs971662_A    0.04149235 0.007539240 1.546134e-07
## rs5954844_A    rs5954844_A    0.07761133 0.010573776 1.202177e-11
## rs5908525_A    rs5908525_A    0.07000119 0.011560746 1.053863e-08
## rs5945492_C    rs5945492_C    0.04208736 0.007728145 2.027975e-07
## rs5920606_A    rs5920606_A    -0.03905591 0.007412709 4.624884e-07
## rs1740317_G    rs1740317_G    0.06439695 0.010175096 2.632606e-09
## rs5920320_T    rs5920320_T    0.06187367 0.008512177 1.778265e-11
## rs5969969_C    rs5969969_C    0.04789097 0.008350828 5.104509e-08
## rs6526129_A    rs6526129_A    0.05174069 0.009421896 1.636237e-07

print(sig_snps_pc2)

##                               SNP          Beta         SE      P_Value
## rs7530095_T   rs7530095_T   -0.04718314 0.008914476 4.138699e-07
## rs4656856_T   rs4656856_T   0.05059284 0.009515057 3.699414e-07

```

```

## rs4655445_G    rs4655445_G    0.04632018 0.008776380 4.436141e-07
## rs3101468_A    rs3101468_A    0.07059358 0.012296911 4.960976e-08
## rs9326164_G    rs9326164_G    0.07864562 0.015391217 9.549412e-07
## rs4337447_C    rs4337447_C    -0.06972337 0.013706980 1.059605e-06
## rs4954599_A    rs4954599_A    0.04551038 0.008093808 8.759183e-08
## rs867005_T     rs867005_T     0.04638286 0.008693618 3.401024e-07
## rs6749365_A    rs6749365_A    -0.04537326 0.008812440 8.004105e-07
## rs2922309_G    rs2922309_G    0.06841554 0.012586667 2.129792e-07
## rs4854102_T    rs4854102_T    0.03983115 0.007748418 8.308146e-07
## rs4894705_T    rs4894705_T    0.04910319 0.008516508 4.395937e-08
## rs28711160_G   rs28711160_G   0.04954780 0.008278973 1.496379e-08
## rs7355960_T    rs7355960_T    -0.10160636 0.017983554 7.691093e-08
## rs2111278_C    rs2111278_C    0.06451385 0.012151277 3.837368e-07
## rs2711158_G    rs2711158_G    -0.05899593 0.010263347 4.784602e-08
## rs2642849_G    rs2642849_G    0.04986479 0.009631653 7.034651e-07
## rs17754933_G   rs17754933_G   0.07933893 0.014037293 7.615658e-08
## rs2880416_G    rs2880416_G    0.07421542 0.012296584 1.162493e-08
## rs749169_C     rs749169_C     -0.08549943 0.013944859 7.189041e-09
## rs2445074_A    rs2445074_A    0.04884724 0.009497185 8.203884e-07
## rs9350410_G    rs9350410_G    -0.04196033 0.008194167 9.087111e-07
## rs259396_C     rs259396_C     0.05300145 0.010337043 8.820775e-07
## rs10499504_G   rs10499504_G   0.07753682 0.014826619 5.537518e-07
## rs2241056_T    rs2241056_T    0.08149100 0.014079356 3.942995e-08
## rs10261664_G   rs10261664_G   0.06408976 0.011622792 1.470297e-07
## rs6965479_A    rs6965479_A    0.05739015 0.010991627 5.752271e-07
## rs7835212_C    rs7835212_C    0.05089596 0.008602693 2.100940e-08
## rs2410516_T    rs2410516_T    -0.04485630 0.008818629 1.060399e-06
## rs7821631_T    rs7821631_T    0.07801595 0.015031128 6.626610e-07
## rs2599675_T    rs2599675_T    -0.04414393 0.008173891 2.508765e-07
## rs10122575_C   rs10122575_C   0.04519746 0.008437219 3.075721e-07
## rs340900_C     rs340900_C     0.04367409 0.008493300 8.247023e-07
## rs9299046_G    rs9299046_G    0.06130128 0.011297227 2.225120e-07
## rs10960942_G   rs10960942_G   0.04867157 0.009456574 8.074278e-07
## rs10961166_C   rs10961166_C   -0.04844963 0.008921905 2.181821e-07
## rs10905087_A   rs10905087_A   -0.05275299 0.010105193 5.775397e-07
## rs3895938_A    rs3895938_A    0.05510645 0.009645422 5.668916e-08
## rs1326644_A    rs1326644_A    -0.04846500 0.008069194 1.345240e-08
## rs4918589_C    rs4918589_C    0.05086792 0.009661864 4.710026e-07
## rs1442728_G    rs1442728_G    0.04307106 0.008474696 1.080758e-06
## rs286911_T     rs286911_T     -0.05132201 0.008794360 3.121427e-08
## rs11033844_G   rs11033844_G   -0.06217947 0.011179943 1.173122e-07
## rs1451316_T    rs1451316_T    0.07701238 0.014973547 8.207953e-07
## rs7117793_T    rs7117793_T    -0.06229555 0.011741414 3.901761e-07
## rs11051410_G   rs11051410_G   0.07250277 0.013495020 2.859656e-07
## rs10783486_A   rs10783486_A   -0.04789938 0.009314940 8.245956e-07
## rs7308149_G    rs7308149_G    0.06209653 0.010133670 7.317216e-09
## rs12582634_T   rs12582634_T   0.06896892 0.013429976 8.502625e-07
## rs4964576_A    rs4964576_A    0.08270845 0.015286023 2.392718e-07
## rs2072136_A    rs2072136_A    0.06099533 0.010678113 5.697550e-08
## rs222670_C     rs222670_C     -0.07058127 0.011844917 1.702499e-08
## rs4779532_G    rs4779532_G    0.06928231 0.013614215 1.048864e-06
## rs1025199_A    rs1025199_A    0.04556112 0.008919729 9.630315e-07
## rs1021746_A    rs1021746_A    -0.04849346 0.009161930 4.137500e-07
## rs4438253_A    rs4438253_A    0.05510617 0.010243587 2.767567e-07

```

```

## rs4360905_C    rs4360905_C    0.04858955 0.008516350 5.886277e-08
## rs7165633_T    rs7165633_T    0.06500299 0.011550368 8.554940e-08
## rs909921_C     rs909921_C     0.04968314 0.009700885 9.056350e-07
## rs1543940_T    rs1543940_T    0.05333302 0.009671247 1.467167e-07
## rs11074528_G   rs11074528_G   -0.04633167 0.008623372 2.856401e-07
## rs3853178_A    rs3853178_A    0.07005159 0.012958188 2.446536e-07
## rs936873_C     rs936873_C     -0.08187000 0.013737301 1.694880e-08
## rs8051764_C    rs8051764_C    -0.04659682 0.008568682 2.105120e-07
## rs9894837_G    rs9894837_G    -0.05155044 0.009916456 6.383795e-07
## rs2447095_A    rs2447095_A    -0.05421104 0.008898767 8.759342e-09
## rs6502937_T    rs6502937_T    0.04539183 0.008027855 7.532626e-08
## rs7501602_T    rs7501602_T    -0.05670980 0.009621571 2.344699e-08
## rs933577_T     rs933577_T     0.06990778 0.012919484 2.389238e-07
## rs2526354_C    rs2526354_C    0.06471686 0.011932048 2.250715e-07
## rs9895541_A    rs9895541_A    -0.08704013 0.015312614 6.521814e-08
## rs4911540_T    rs4911540_T    0.06466941 0.012126381 3.437899e-07
## rs6073285_C    rs6073285_C    0.07618534 0.014418026 4.310896e-07
## rs2281202_T    rs2281202_T    0.07737222 0.015058355 8.398758e-07
## rs6024378_T    rs6024378_T    0.05515709 0.010368071 3.652339e-07
## rs5998067_G    rs5998067_G    0.06950017 0.012641097 1.587369e-07
## rs727048_T     rs727048_T     0.05413148 0.010627086 1.026617e-06
## rs5770498_T    rs5770498_T    -0.04376663 0.007920554 1.391933e-07
## rs6588874_G    rs6588874_G    0.06861568 0.012857675 3.380911e-07

print(sig_snps_pc3)

```

```

##              SNP        Beta        SE      P_Value
## rs12078697_C rs12078697_C -0.04657890 0.008446644 1.467925e-07
## rs6679275_A   rs6679275_A -0.04691387 0.009063685 7.071678e-07
## rs4684859_A   rs4684859_A  0.05284539 0.008509981 4.832211e-09
## rs17609498_T  rs17609498_T  0.06919924 0.013605526 1.062434e-06
## rs2204732_C   rs2204732_C  -0.04799006 0.008195540 2.831991e-08
## rs7793347_T   rs7793347_T  0.06437681 0.011445520 8.685355e-08
## rs11820583_C  rs11820583_C  0.05588871 0.009271381 1.206009e-08
## rs7104248_G   rs7104248_G  -0.04367106 0.008196759 3.520309e-07
## rs11050714_A  rs11050714_A  0.04741429 0.008908471 3.610561e-07
## rs10850824_G  rs10850824_G  0.05709974 0.008021524 4.048356e-11
## rs17661962_C  rs17661962_C  0.05121937 0.009876104 6.751672e-07
## rs16963743_A  rs16963743_A  0.09453990 0.014670443 1.452997e-09

```

Task 2.2: Identify SNPs that associate with the population subgroups (clusters) using logistic regression

Run the k-means clustering algorithm using the first 3 PCs and plot the 3D scatterplot.

```

# Set seed and cluster
set.seed(42)

kmeans_res <- kmeans(merged_data[, c("PC1", "PC2", "PC3")],
                      centers = 3,
                      nstart = 25,
                      iter.max = 1000)

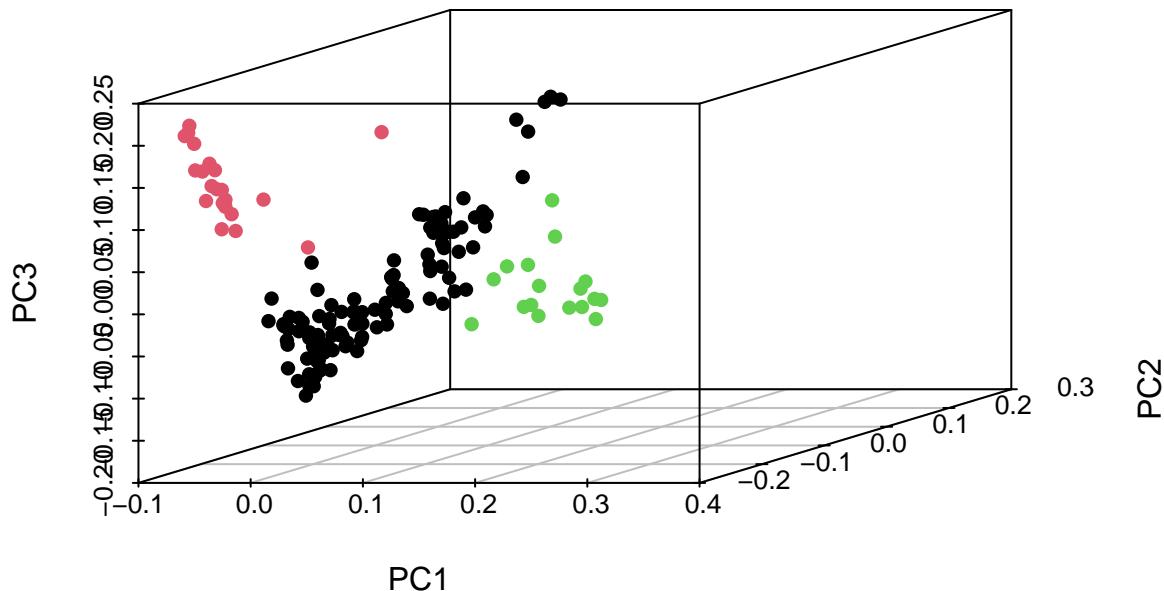
# 3D plot
scatterplot3d(merged_data$PC1,
               merged_data$PC2,

```

```

merged_data$PC3,
color = kmeans_res$cluster,
xlab = "PC1",
ylab = "PC2",
zlab = "PC3",
pch = 16)

```



Perform one-hot encoding for the cluster labels obtained from the k means.

```

# One-hot encode cluster labels
merged_data$cluster <- as.factor(kmeans_res$cluster)
dummies <- dummyVars(~ cluster, data = merged_data)
cluster_encoded <- predict(dummies, newdata = merged_data)
merged_cluster <- cbind(merged_data, cluster_encoded)

```

Perform logistic regression as each set is composed of cluster encoding against all SNPs.

```

# Logistic regression for cluster 1 (cluster.1 encoded as dependent variable)
results_cluster1_stats <- lapply(snp_data, function(snp) {
  tryCatch({
    coefs <- summary(glm(cluster_encoded[, 1] ~ snp, family = binomial))$coefficients
    c(Beta = coefs[2, "Estimate"],
      SE = coefs[2, "Std. Error"],
      P_Value = coefs[2, "Pr(>|z|)"])
  }, error = function(e) c(Beta = NA, SE = NA, P_Value = NA))
}

```

```

})

results_cluster1_df <- as.data.frame(do.call(rbind, results_cluster1_stats))
results_cluster1_df$SNP <- names(results_cluster1_stats)
results_cluster1_df <- results_cluster1_df[, c("SNP", "Beta", "SE", "P_Value")]

# Logistic regression for cluster 2 (cluster.2 encoded as dependent variable)
results_cluster2_stats <- lapply(snp_data, function(snp) {
  tryCatch({
    coefs <- summary(glm(cluster_encoded[, 2] ~ snp, family = binomial))$coefficients
    c(Beta = coefs[2, "Estimate"],
      SE = coefs[2, "Std. Error"],
      P_Value = coefs[2, "Pr(>|z|)"])
  }, error = function(e) c(Beta = NA, SE = NA, P_Value = NA))
})

results_cluster2_df <- as.data.frame(do.call(rbind, results_cluster2_stats))
results_cluster2_df$SNP <- names(results_cluster2_stats)
results_cluster2_df <- results_cluster2_df[, c("SNP", "Beta", "SE", "P_Value")]

# Logistic regression for cluster 3 (cluster.3 encoded as dependent variable)
results_cluster3_stats <- lapply(snp_data, function(snp) {
  tryCatch({
    coefs <- summary(glm(cluster_encoded[, 3] ~ snp, family = binomial))$coefficients
    c(Beta = coefs[2, "Estimate"],
      SE = coefs[2, "Std. Error"],
      P_Value = coefs[2, "Pr(>|z|)"])
  }, error = function(e) c(Beta = NA, SE = NA, P_Value = NA))
})

results_cluster3_df <- as.data.frame(do.call(rbind, results_cluster3_stats))
results_cluster3_df$SNP <- names(results_cluster3_stats)
results_cluster3_df <- results_cluster3_df[, c("SNP", "Beta", "SE", "P_Value")]

```

Identify significant SNPs that are associated with each of the 3 clusters using a Bonferroni threshold

```

sig_snps_cluster1 <- results_cluster1_df %>% filter(P_Value < bonf_threshold)
sig_snps_cluster2 <- results_cluster2_df %>% filter(P_Value < bonf_threshold)
sig_snps_cluster3 <- results_cluster3_df %>% filter(P_Value < bonf_threshold)

print(sig_snps_cluster1)

##                      SNP      Beta       SE   P_Value
## rs4337447_C rs4337447_C -2.230629 0.4203683 1.118315e-07
## rs9784244_C rs9784244_C -2.052706 0.4208190 1.072301e-06
## rs6597149_T rs6597149_T -1.682329 0.3305979 3.604412e-07
## rs1561081_A rs1561081_A -1.825045 0.3706886 8.505663e-07
## rs286911_T  rs286911_T -1.598594 0.3277967 1.078281e-06
## rs6562034_T rs6562034_T -1.942455 0.3899805 6.328769e-07
## rs222670_C  rs222670_C -2.284550 0.4115623 2.841681e-08
## rs936873_C  rs936873_C -2.160374 0.4147789 1.903781e-07
## rs9895541_A rs9895541_A -2.671420 0.5252317 3.653592e-07
## rs9956302_C rs9956302_C -1.890742 0.3860664 9.708730e-07

```

```

## rs455052_T    rs455052_T -2.106841 0.4244375 6.911217e-07
print(sig_snps_cluster2)

##                               SNP      Beta       SE   P_Value
## rs12126278_T rs12126278_T 2.224858 0.4358491 3.314027e-07
## rs10000959_C rs10000959_C 2.394240 0.4895808 1.006376e-06
## rs17197376_A rs17197376_A 2.674764 0.5271533 3.895837e-07
## rs10850824_G rs10850824_G 2.567891 0.5038685 3.462628e-07
## rs2447095_A   rs2447095_A  2.320307 0.4756415 1.070212e-06
## rs16963743_A rs16963743_A 2.507515 0.5101845 8.881912e-07

print(sig_snps_cluster3)

##                               SNP      Beta       SE   P_Value
## rs4292923_C  rs4292923_C 2.935397 0.5929865 7.413990e-07
## rs1341306_A  rs1341306_A  3.268261 0.6624549 8.074430e-07
## rs4514282_C  rs4514282_C 3.084115 0.6107341 4.421591e-07
## rs884586_C   rs884586_C  3.101498 0.6228209 6.366351e-07
## rs3003703_C  rs3003703_C 4.089437 0.8020323 3.417357e-07
## rs12618771_C rs12618771_C 2.885550 0.5857220 8.372267e-07
## rs12613530_T rs12613530_T 3.934509 0.7941867 7.265262e-07
## rs7636104_C  rs7636104_C  3.087201 0.6032723 3.097341e-07
## rs6766988_A  rs6766988_A  2.205972 0.4504623 9.724674e-07
## rs1381083_C  rs1381083_C  3.811778 0.6997202 5.106143e-08
## rs4349736_A  rs4349736_A  2.615866 0.5334929 9.424926e-07
## rs2569885_T  rs2569885_T  2.784532 0.5694726 1.010059e-06
## rs2560768_T  rs2560768_T  2.863927 0.5793256 7.671129e-07
## rs9321616_C  rs9321616_C  3.412036 0.6796083 5.151240e-07
## rs10272163_G rs10272163_G 2.386399 0.4824218 7.547954e-07
## rs6945984_C  rs6945984_C  2.633734 0.5261651 5.570934e-07
## rs6997614_G  rs6997614_G  2.895950 0.5838477 7.045254e-07
## rs12267286_C rs12267286_C 3.109034 0.6050063 2.764313e-07
## rs7100515_C  rs7100515_C  2.940312 0.5889476 5.960733e-07
## rs10788091_T rs10788091_T 3.130277 0.6075738 2.575958e-07
## rs4938639_G  rs4938639_G  2.483142 0.4908060 4.207641e-07
## rs1944605_A  rs1944605_A  3.008691 0.5978435 4.839398e-07
## rs2643626_G  rs2643626_G  3.101498 0.6228209 6.366351e-07
## rs11148886_C rs11148886_C 3.194738 0.6476954 8.119593e-07
## rs7148755_C  rs7148755_C  2.855381 0.5730049 6.255085e-07
## rs728244_A   rs728244_A  3.376367 0.6801137 6.890836e-07
## rs8053877_T  rs8053877_T 2.515737 0.5085196 7.529712e-07
## rs8045281_T  rs8045281_T 3.150979 0.6110833 2.517677e-07
## rs7186136_C  rs7186136_C 3.254143 0.6307302 2.478400e-07
## rs9904395_G  rs9904395_G  3.285991 0.6326800 2.060833e-07
## rs4798212_T  rs4798212_T 3.424385 0.6783819 4.467582e-07
## rs9967367_T  rs9967367_T 2.462477 0.5014668 9.082251e-07
## rs1304551_T  rs1304551_T 3.556072 0.6636572 8.401059e-08
## rs2965157_C  rs2965157_C  2.784532 0.5694726 1.010059e-06
## rs6095097_T  rs6095097_T 2.384336 0.4863886 9.480720e-07
## rs2847443_A  rs2847443_A  3.183546 0.6255380 3.594002e-07
## rs2824011_C  rs2824011_C  2.839101 0.5766307 8.496496e-07
## rs5943477_T  rs5943477_T 2.211207 0.4455963 6.964339e-07
## rs5909010_T  rs5909010_T 2.538619 0.4914584 2.398204e-07

```

Task 2: Manhattan, Annotation, and Discussion

Load map file of the cleaned data to use it for the plot

```
map_data <- read.table("Data/cleaned_data.map", header = FALSE)
colnames(map_data) <- c("CHR", "SNP", "GD", "BP")
```

Use the values we got before from the analysis

```
results_linear_pc1_df <- data.frame(SNP = rownames(results_pc1_df),
                                      P = results_pc1_df[, "P_Value"])

results_linear_pc2_df <- data.frame(SNP = rownames(results_pc2_df),
                                      P = results_pc2_df[, "P_Value"])

results_linear_pc3_df <- data.frame(SNP = rownames(results_pc3_df),
                                      P = results_pc3_df[, "P_Value"])

results_logistic_cluster1_df <- data.frame(SNP = rownames(results_cluster1_df),
                                             P = results_cluster1_df[, "P_Value"])

results_logistic_cluster2_df <- data.frame(SNP = rownames(results_cluster2_df),
                                             P = results_cluster2_df[, "P_Value"])

results_logistic_cluster3_df <- data.frame(SNP = rownames(results_cluster3_df),
                                             P = results_cluster3_df[, "P_Value"])
```

Editing SNPs column as we need it to merge with the table from map file

```
results_linear_pc1_df$SNP <- substr(results_linear_pc1_df$SNP, 1,
                                       nchar(results_linear_pc1_df$SNP) - 2)

results_linear_pc2_df$SNP <- substr(results_linear_pc2_df$SNP, 1,
                                       nchar(results_linear_pc2_df$SNP) - 2)

results_linear_pc3_df$SNP <- substr(results_linear_pc3_df$SNP, 1,
                                       nchar(results_linear_pc3_df$SNP) - 2)

results_logistic_cluster1_df$SNP <- substr(results_logistic_cluster1_df$SNP, 1,
                                              nchar(results_logistic_cluster1_df$SNP) - 2)

results_logistic_cluster2_df$SNP <- substr(results_logistic_cluster2_df$SNP, 1,
                                              nchar(results_logistic_cluster2_df$SNP) - 2)

results_logistic_cluster3_df$SNP <- substr(results_logistic_cluster3_df$SNP, 1,
                                              nchar(results_logistic_cluster3_df$SNP) - 2)
```

Merging the two tables to make the data ready for plotting

```
manhattan_data_pc1 <- merge(map_data, results_linear_pc1_df, by = "SNP")
manhattan_data_pc2 <- merge(map_data, results_linear_pc2_df, by = "SNP")
```

```

manhattan_data_pc3 <- merge(map_data, results_linear_pc3_df, by = "SNP")

manhattan_data_cluster1 <- merge(map_data, results_logistic_cluster1_df, by = "SNP")
manhattan_data_cluster2 <- merge(map_data, results_logistic_cluster2_df, by = "SNP")
manhattan_data_cluster3 <- merge(map_data, results_logistic_cluster3_df, by = "SNP")

```

Function to plot Manhattan-Plot

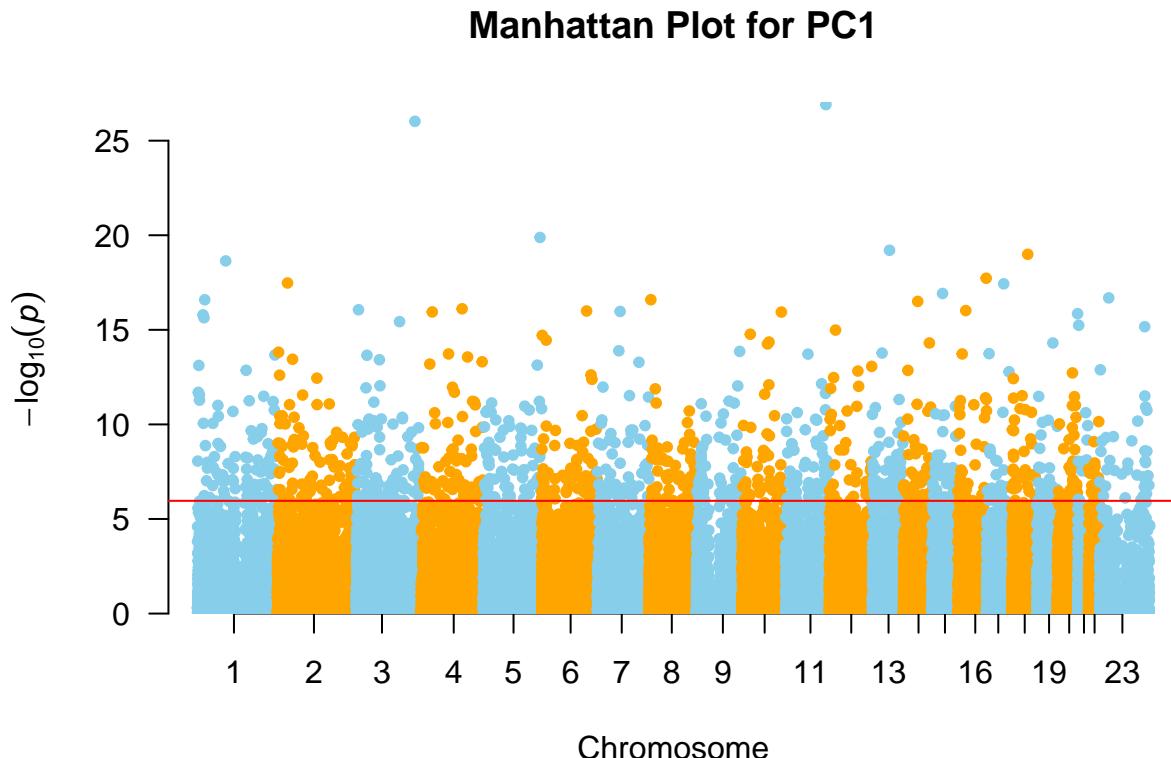
```

draw_manhattan_plot <- function(data, title) {
  #data <- data %>% filter(CHR < 23)
  manhattan(data,
            main = title,
            col = c("skyblue", "orange"),
            suggestiveline = FALSE,
            genomewideline = -log10(bonf_threshold))
}

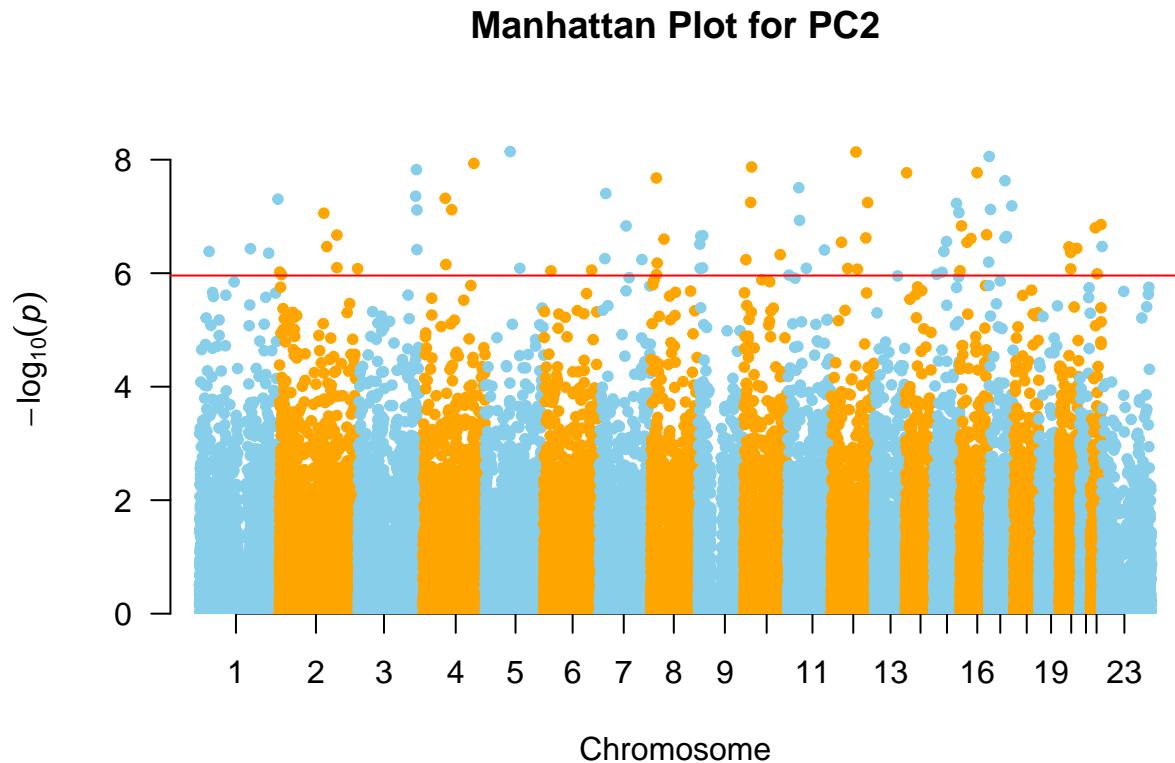
```

Drawing Manhattan-Plots for the p-values we got from each analysis we had made

```
draw_manhattan_plot(manhattan_data_pc1, "Manhattan Plot for PC1")
```

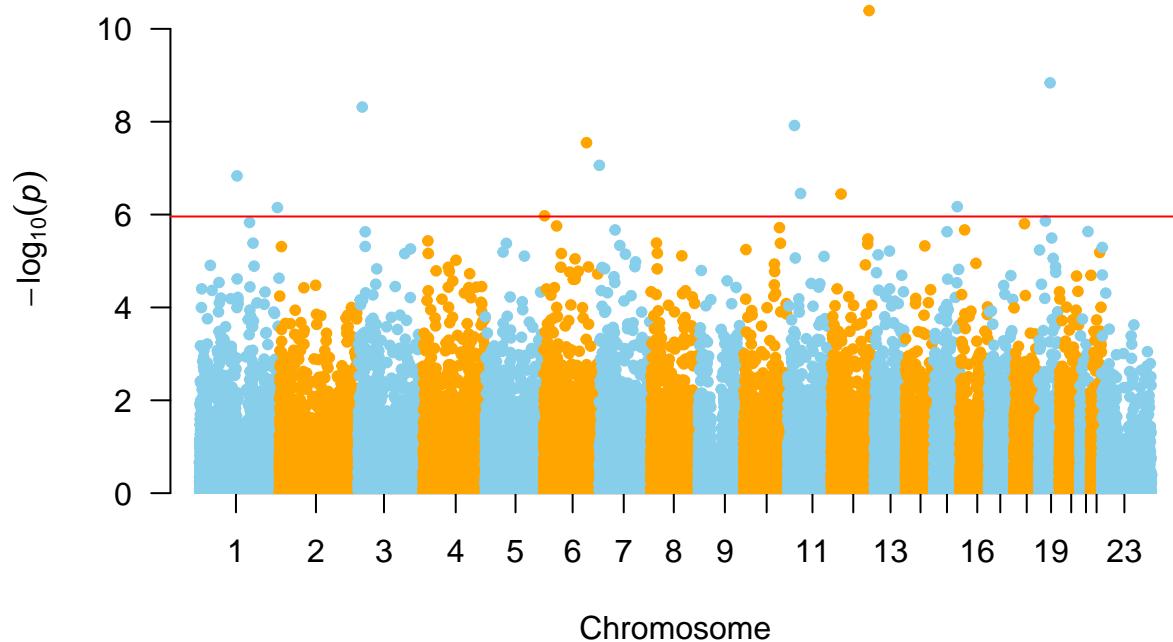


```
draw_manhattan_plot(manhattan_data_pc2, "Manhattan Plot for PC2")
```



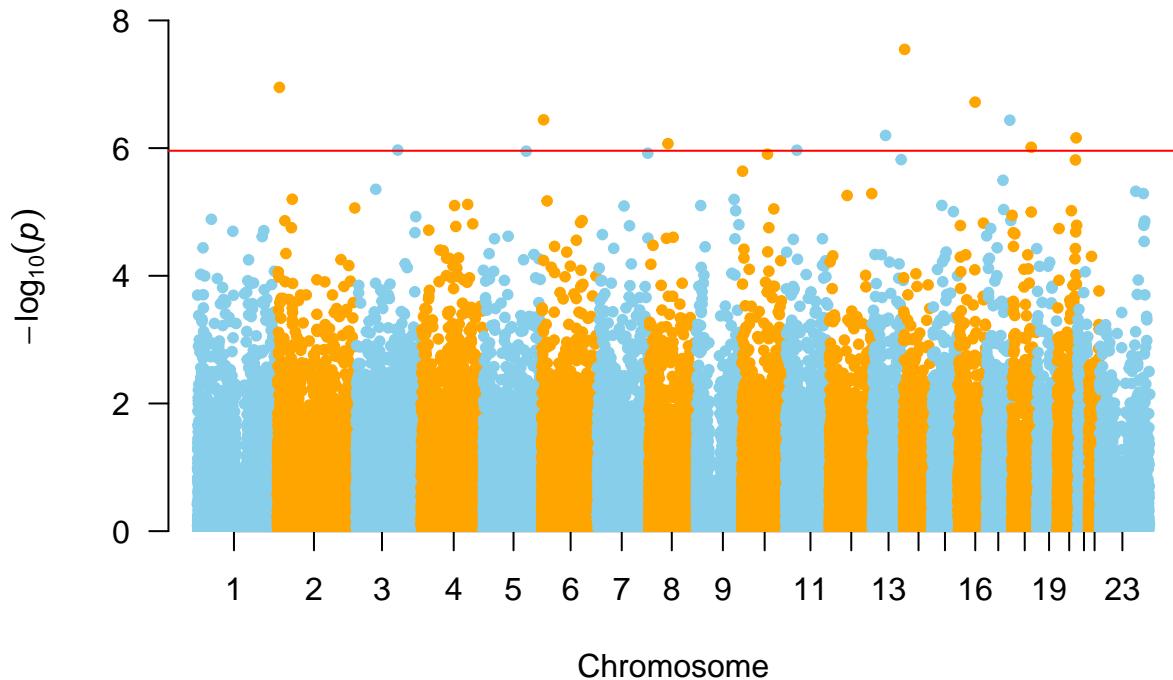
```
draw_manhattan_plot(manhattan_data_pc3, "Manhattan Plot for PC3")
```

Manhattan Plot for PC3



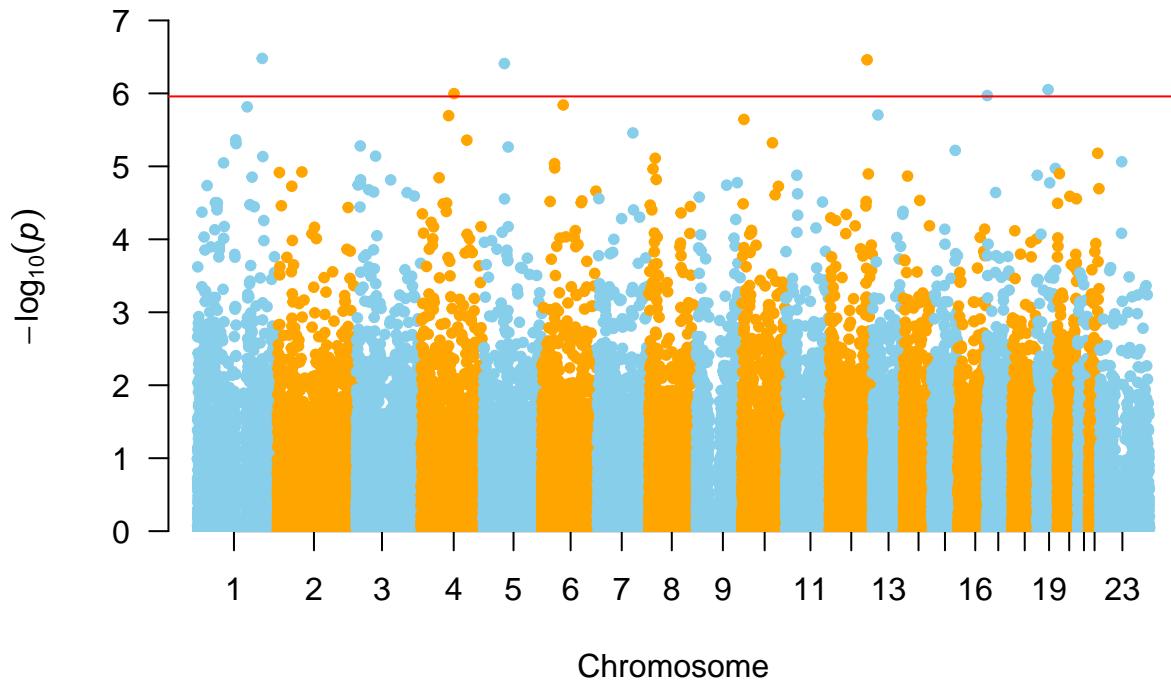
```
draw_manhattan_plot(manhattan_data_cluster1, "Manhattan Plot for Cluster 1")
```

Manhattan Plot for Cluster 1



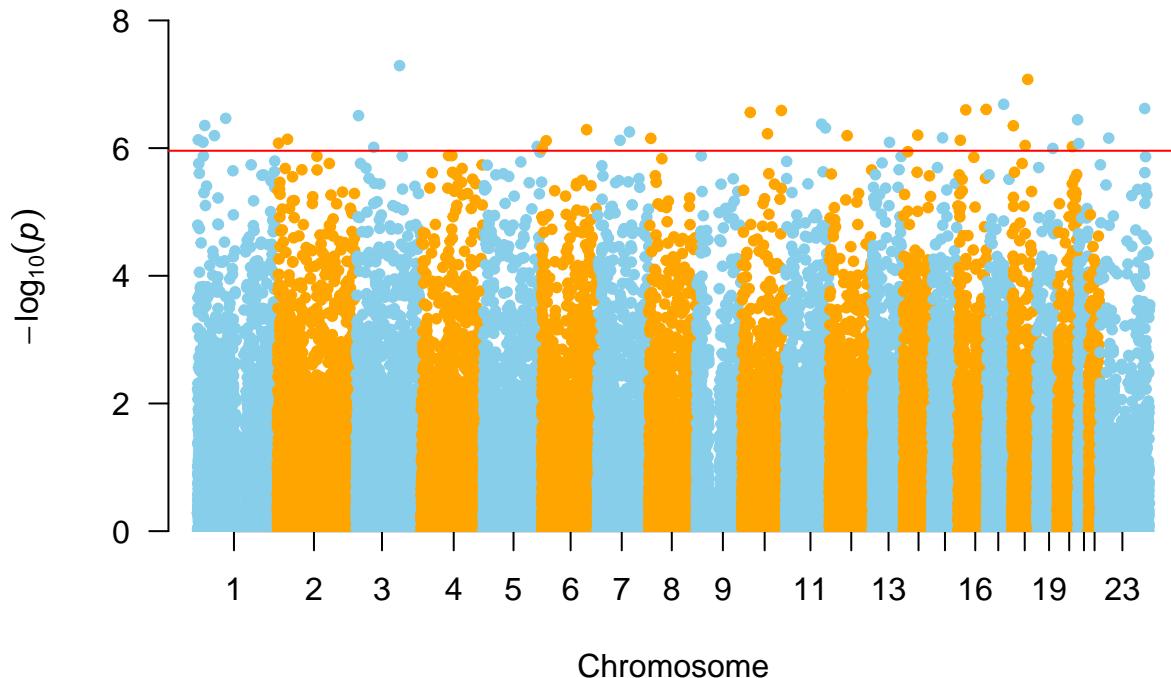
```
draw_manhattan_plot(manhattan_data_cluster2, "Manhattan Plot for Cluster 2")
```

Manhattan Plot for Cluster 2



```
draw_manhattan_plot(manhattan_data_cluster3, "Manhattan Plot for Cluster 3")
```

Manhattan Plot for Cluster 3



Get the top 10 significant SNPs

```
top10 <- results_pc1_df[order(results_pc1_df[, "P_Value"]), ][1:10, ]
top10 <- data.frame(top10)
top10$SNP <- substr(top10$SNP, 1, nchar(top10$SNP) - 2)
# Merge the positional information
annotated_top10 <- merge(top10, map_data, by.x = "SNP", by.y = "SNP")
annotated_top10 <- annotated_top10[order(annotated_top10$P_Value), ]
```

Use dbSNP from NCBI website to check the information on the 10 most significant SNPs from the linear regression and PC1

```
gene_names <- c("MSANTD2", "MFN1", "Introne", "DACH1", "DCC", "Introne",
                 "Introne", "CAPN14", "MSI2", "LOC124903496")
freq <- c(
  "C=0.255752/4958 (ALFA)",
  "C=0.171667/103 (NorthernSweden)",
  "C=0.175926/38 (Qatari)",
  "C=0.200401/200 (GoNL)",
  "C=0.200647/744 (TWINSUK)",
  "C=0.201349/776 (ALSPAC)",
  "C=0.202009/905 (Estonian)",
  "C=0.202812/163393 (GnomAD_exomes)",
  "C=0.208333/45 (Vietnamese)",
  "C=0.275/11 (GENOME_DK)")
```

```
C=0.277317/2005 (Korea4K)
C=0.282253/827 (KOREAN)
C=0.290393/532 (Korea1K)
C=0.327309/48731 (GnomAD_genomes)
C=0.334913/25935 (TOMMO)
C=0.345248/1729 (1000Genomes)
C=0.345313/91401 (TOPMED)
C=0.352124/2255 (1000Genomes_30X)
G=0.355856/79 (SGDP_PRJ)
C=0.40625/767 (HapMap)
G=0.416667/5 (Siberian)",

"T=0.019987/5600 (ALFA)
T=0.001563/7 (Estonian)
T=0.002004/2 (GoNL)
T=0.002967/11 (TWINSUK)
T=0.003633/14 (ALSPAC)
T=0.017572/11 (Chileans)
T=0.115741/25 (Qatari)
T=0.128333/19125 (GnomAD_genomes)
T=0.142469/37710 (TOPMED)
T=0.14976/750 (1000Genomes)
T=0.156777/1004 (1000Genomes_30X)
T=0.206066/16217 (PAGE_STUDY)
C=0.28125/18 (SGDP_PRJ)
T=0.317708/366 (HapMap)",

"A=0.066912/3077 (ALFA)
A=0./0 (PRJEB36033)
A=0.000446/2 (Estonian)
A=0.001002/1 (GoNL)
A=0.00204/158 (TOMMO)
A=0.002427/9 (TWINSUK)
A=0.003114/12 (ALSPAC)
A=0.004147/30 (Korea4K)
A=0.005818/17 (KOREAN)
A=0.00655/12 (Korea1K)
A=0.023962/15 (Chileans)
A=0.115741/25 (Qatari)
A=0.132941/19830 (GnomAD_genomes)
A=0.149361/748 (1000Genomes)
A=0.150652/39876 (TOPMED)
A=0.158807/1017 (1000Genomes_30X)
A=0.247235/447 (HapMap)
G=0.297297/22 (SGDP_PRJ)",

"C=0.156855/2963 (ALFA)
C=0.024107/108 (Estonian)
C=0.028333/17 (NorthernSweden)
C=0.039105/145 (TWINSUK)
C=0.03944/152 (ALSPAC)
C=0.194444/42 (Qatari)
C=0.25609/38120 (GnomAD_genomes)
```

```

C=0.258646/20013 (TOMMO)
C=0.262637/769 (KOREAN)
C=0.265833/1914 (Korea4K)
C=0.273585/58 (Vietnamese)
C=0.286868/75931 (TOPMED)
C=0.322684/1616 (1000Genomes)
C=0.335728/2150 (1000Genomes_30X)
G=0.347368/66 (SGDP_PRJ)
C=0.411111/777 (HapMap)
G=0.5/9 (Siberian)",

"T=0.061196/1156 (ALFA)
T=0./0 (GENOME_DK)
C=0./0 (KOREAN)
T=0./0 (Korea1K)
T=0./0 (Korea4K)
T=0./0 (NorthernSweden)
T=0./0 (Siberian)
T=0./0 (Vietnamese)
T=0.000039/3 (TOMMO)
T=0.000778/3 (ALSPAC)
T=0.001002/1 (GoNL)
T=0.001618/6 (TWINSUK)
T=0.027778/15 (SGDP_PRJ)
A=0.046816/25 (MGP)
T=0.097222/21 (Qatari)
T=0.10416/15525 (GnomAD_genomes)
T=0.110423/553 (1000Genomes)
T=0.112586/721 (1000Genomes_30X)
T=0.118187/31283 (TOPMED)
T=0.272727/348 (HapMap)",

"C=0.091795/1734 (ALFA)
C=0.008091/30 (TWINSUK)
C=0.010638/41 (ALSPAC)
C=0.011079/858 (TOMMO)
C=0.011667/7 (NorthernSweden)
C=0.014028/14 (GoNL)
C=0.015402/69 (Estonian)
C=0.017454/51 (KOREAN)
C=0.019635/142 (Korea4K)
C=0.019651/36 (Korea1K)
C=0.117925/25 (Vietnamese)
C=0.134259/29 (Qatari)
C=0.153379/22855 (GnomAD_genomes)
C=0.166674/44117 (TOPMED)
C=0.167732/840 (1000Genomes)
C=0.173641/1112 (1000Genomes_30X)
C=0.207632/370 (HapMap)
G=0.358696/33 (SGDP_PRJ)
G=0.5/1 (Siberian)",

"C=0.158421/33521 (ALFA)

```

```
C=0.000684/2 (KOREAN)
C=0.106481/23 (Qatari)
C=0.108696/10 (PRJEB36033)
C=0.112764/235 (HGDP_Stanford)
C=0.135783/85 (Chileans)
C=0.156473/701 (Estonian)
C=0.160093/617 (ALSPAC)
C=0.161003/597 (TWINSUK)
C=0.16893/846 (1000Genomes)
C=0.173333/104 (NorthernSweden)
C=0.175/7 (GENOME_DK)
C=0.175828/1126 (1000Genomes_30X)
C=0.178357/178 (GoNL)
C=0.203465/30355 (GnomAD_genomes)
C=0.212369/56212 (TOPMED)
C=0.212963/368 (HapMap)
T=0.433962/46 (SGDP_PRJ)
T=0.5/5 (Siberian)",

"T=0.058562/1846 (ALFA)
T=0.010491/47 (Estonian)
T=0.014028/14 (GoNL)
T=0.01453/56 (ALSPAC)
T=0.015642/58 (TWINSUK)
T=0.025/1 (GENOME_DK)
T=0.031667/19 (NorthernSweden)
T=0.036741/23 (Chileans)
T=0.119623/17820 (GnomAD_genomes)
T=0.125/27 (Qatari)
T=0.131641/34844 (TOPMED)
T=0.180911/906 (1000Genomes)
T=0.2004/15515 (TOMMO)
T=0.203042/15979 (PAGE_STUDY)
T=0.203057/372 (Korea1K)
T=0.206167/1491 (Korea4K)
T=0.219113/642 (KOREAN)
T=0.222222/48 (Vietnamese)
T=0.2463/466 (HapMap)
C=0.333333/2 (Siberian)
C=0.353448/41 (SGDP_PRJ)",

"G=0.060874/9517 (ALFA)
G=0.014927/1156 (TOMMO)
G=0.020534/60 (KOREAN)
G=0.025/1 (GENOME_DK)
G=0.026201/48 (Korea1K)
G=0.029721/215 (Korea4K)
G=0.03125/2 (PRJEB36033)
G=0.031667/19 (NorthernSweden)
G=0.037074/37 (GoNL)
G=0.039914/148 (TWINSUK)
G=0.040477/156 (ALSPAC)
G=0.047923/30 (Chileans)
```

```

G=0.070089/314 (Estonian)
G=0.087963/19 (Qatari)
G=0.098369/205 (HGDP_Stanford)
G=0.146694/21834 (GnomAD_genomes)
G=0.153754/770 (1000Genomes)
G=0.157402/1008 (1000Genomes_30X)
G=0.15896/42075 (TOPMED)
G=0.222516/421 (HapMap)
A=0.319149/30 (SGDP_PRJ)
A=0.5/5 (Siberian)",

"A=0.273214/9704 (ALFA)
A=0.120982/542 (Estonian)
A=0.125/5 (GENOME_DK)
A=0.129393/81 (Chileans)
A=0.147295/147 (GoNL)
A=0.151012/582 (ALSPAC)
A=0.152373/565 (TWINSUK)
A=0.196667/118 (NorthernSweden)
A=0.242043/1749 (Korea4K)
A=0.244541/448 (Korea1K)
A=0.248802/727 (KOREAN)
A=0.277778/60 (Qatari)
A=0.278136/21540 (TOMMO)
A=0.296296/64 (Vietnamese)
G=0.302419/75 (SGDP_PRJ)
A=0.338911/50497 (GnomAD_genomes)
A=0.354978/93959 (TOPMED)
A=0.404553/2026 (1000Genomes)
A=0.410369/2628 (1000Genomes_30X)
G=0.444444/8 (Siberian)
A=0.457266/35985 (PAGE_STUDY)
A=0.487831/922 (HapMap)")

max_freq <- c(0.416667, 0.317708, 0.297297, 0.5, 0.272727, 0.5, 0.5,
            0.353448, 0.5, 0.120982)
min_freq <- c(0.171667, 0.001563, 0., 0.024107, 0., 0.008091, 0.000684,
            0.010491, 0.014927, 0.487831)

```

Finally our final table

```

annotated_top10$Genes <- gene_names
annotated_top10$Freq <- freq
annotated_top10$Max_Freq <- max_freq
annotated_top10$Min_Freq <- min_freq

print(annotated_top10)

##           SNP       Beta        SE     P_Value  CHR      GD        BP
## 1  rs10466604 0.10545991 0.007847282 1.241129e-27  11 124.15914 124159136
## 9  rs7355960 0.13388731 0.010212914 9.510475e-27    3 180.56674 180566740
## 6  rs6870937 0.11655557 0.010765138 1.313383e-20    5 175.09091 175090907
## 2  rs11148886 0.08428415 0.007970686 6.227159e-20   13  71.17852  71178521

```

```

## 4   rs1304551 0.12246555 0.011670046 1.019484e-19  18  48.56647  48566472
## 5   rs3003703 0.12109438 0.011685144 2.275372e-19   1  88.14932  88149315
## 7   rs7186136 0.12037338 0.012015210 1.869684e-18  16  87.65024  87650240
## 3   rs12613530 0.11991260 0.012084308 3.341921e-18   2  31.30746  31307461
## 10  rs9904395 0.11427182 0.011535211 3.698028e-18  17  52.79027  52790274
## 8    rs728244 0.07741564 0.007970992 1.201171e-17  15  53.60428  53604277
##
##          Genes
## 1       MSANTD2
## 9        MFN1
## 6       Introne
## 2        DACH1
## 4        DCC
## 5       Introne
## 7       Introne
## 3       CAPN14
## 10      MSI2
## 8 LOC124903496
##
## 1           C=0.255752/4958 (ALFA)\nC=0.171667/103 (NorthernSweden)\nC=0.175926/38 (Qat)
## 9
## 6
## 2
## 4
## 5
## 7           C=0.158421/
## 3           T=0.058562/1846 (ALFA)\nT=0.010491/47 (Estonian)
## 10      G=0.060874/9517 (ALFA)\nG=0.014927/1156 (TOMMO)\nG=0.020534/60 (KOREAN)\nG=0.025/1
## 8 A=0.273214/9704 (ALFA)\nA=0.120982/542 (Estonian)\nA=0.125/5 (GENOME_DK)\nA=0.129393/81 (Chileans)
##
##  Max_Freq Min_Freq
## 1  0.416667 0.171667
## 9  0.317708 0.001563
## 6  0.297297 0.000000
## 2  0.500000 0.024107
## 4  0.272727 0.000000
## 5  0.500000 0.008091
## 7  0.500000 0.000684
## 3  0.353448 0.010491
## 10 0.500000 0.014927
## 8  0.120982 0.487831

```