main

September 13, 2021

1 Examine tissue specific genes for correlation with gene expression or cell type proportion

[1]:
```
library(dplyr)
```

```
Attaching package: ‘dplyr’


The following objects are masked from ‘package:stats’:

    filter, lag


The following objects are masked from ‘package:base’:

    intersect, setdiff, setequal, union
```

1.1 Functions

[2]:
```
get_tpm <- function(){
    cc_file = paste0("/ceph/projects/v4_phase3_paper/inputs/counts/",
                     "text_files_counts/tpm/_m/caudate/gene/log2tpm.csv")
    dd_file = paste0("/ceph/projects/v4_phase3_paper/inputs/counts/",
                     "text_files_counts/tpm/_m/dlpfc/gene/log2tpm.csv")
    hh_file = paste0("/ceph/projects/v4_phase3_paper/inputs/counts/",
                     "text_files_counts/tpm/_m/hippocampus/gene/log2tpm.csv")
    cc = data.table::fread(cc_file) %>% tibble::column_to_rownames("names") %>%
        t %>% as.data.frame %>% tibble::rownames_to_column("RNum")
    dd = data.table::fread(dd_file) %>% tibble::column_to_rownames("names") %>%
        t %>% as.data.frame %>% tibble::rownames_to_column("RNum")
    hh = data.table::fread(hh_file) %>% tibble::column_to_rownames("names") %>%
        t %>% as.data.frame %>% tibble::rownames_to_column("RNum")
    return(bind_rows(cc, hh, dd))
}
memTPM <- memoise::memoise(get_tpm)
```

```
get_pheno <- function(){
    filename = "/ceph/projects/v4_phase3_paper/inputs/phenotypes/_m/
 ↪merged_phenotypes.csv"
    df = data.table::fread(filename) %>%
        filter(Age > 13, Race %in% c("AA", "EA"), Dx %in% c("CTL", "SZ"))
    return(df)
}
memPHENO <- memoise::memoise(get_pheno)
```

2 Extract tissue specific eGenes

[3]:
```
eFeature = data.table::fread("../../_m/genes/significant_geneSNP_pairs_3tissues.
 ↪tsv") %>%
    filter(N_Regions_Shared == 1) %>% select(-N_Regions_Shared)
eFeature %>% head(2)
```

A data.table: 2 × 5

gene_id <chr>	variant_id <chr>	Caudate <int>	DLPFC <int>	Hippocampus <int>
ENSG00000008018.8	chr6:170116315:G:A	1	0	0
ENSG00000027697.13	chr6:137196751:G:T	1	0	0

2.1 Prepare data

[4]:
```
df = memPHENO() %>% inner_join(memTPM(), by="RNum")
df %>% dim
```

1. 1173 2. 49603

2.2 Linear model for expression and brain region

[5]:
```
pvals = c(); genes = c()
for(gene_id in eFeature$gene_id){
    model = paste(paste0(gene_id, "~ Region*Sex"), "Dx + Age + mitoRate +␣
 ↪rRNA_rate",
                  "overallMapRate + RIN + ERCCsumLogErr + totalAssignedGene +␣
 ↪snpPC1",
                  "snpPC2 + snpPC3", sep=" + ")
    fitted = anova(lm(model, data=df))
    #fit_lm = aov(lm(model, data=df))
    pvals = c(pvals, fitted["Region", "Pr(>F)"])
    genes = c(genes, gene_id)
}
pval_df = data.frame("gene_id"=genes, "p_values"=pvals)
print(sum(pvals > 0.05))
pval_df %>% head(2)
```

```
[1] 0
```

A data.frame: 2 × 2

	gene_id <chr>	p_values <dbl>
1	ENSG00000008018.8	0
2	ENSG00000027697.13	0

2.3 Comparison of expression

[6]:
```
dt = df %>% select(Region, all_of(eFeature$gene_id)) %>%
    aggregate(. ~ Region, ., mean) %>%
    mutate(Region = gsub("HIPPO", "Hippocampus", Region)) %>%
    tibble::column_to_rownames("Region") %>%
    t %>% as.data.frame %>% tibble::rownames_to_column("gene_id") %>%
    inner_join(eFeature, by="gene_id", suffix=c("_Expression", "_eQTL")) %>%
    select(-c("variant_id")) %>% inner_join(pval_df, by="gene_id")
tt = dt %>% select(ends_with("Expression"))
dt = dt %>% mutate("Max Expression"=gsub("_Expression", "",␣
 ↪colnames(tt)[apply(tt, 1, which.max)]),
                   "Min Expression"=gsub("_Expression", "",␣
 ↪colnames(tt)[apply(tt, 1, which.min)]),
                   "Mean Expresion"=rowMeans(tt),
                   "Ratio (DLPFC / Caudate)" = DLPFC_Expression/
 ↪Caudate_Expression,
                   "Ratio (Hippocampus / Caudate)" = Hippocampus_Expression/
 ↪Caudate_Expression,
                   "Ratio (Hippocampus / DLPFC)" = Hippocampus_Expression/
 ↪DLPFC_Expression)
dt %>% data.table::fwrite("eQTL_regionSpecific_summary.tsv", sep='\t')
dt %>% head(2)
```

A data.frame: 2 × 14

	gene_id <chr>	Caudate_Expression <dbl>	DLPFC_Expression <dbl>	Hippocampus_E <dbl>
1	ENSG00000008018.8	7.083493	5.471561	4.543546
2	ENSG00000027697.13	6.204708	4.622967	4.164173

[7]:
```
sum(dt$`Ratio (DLPFC / Caudate)` > 0.9)
```

3

[8]:
```
sum(dt$`Ratio (Hippocampus / Caudate)` > 0.9)
```

0

[9]:
```
nochange = sum(dt$`Ratio (DLPFC / Caudate)` > 0.9) + sum(dt$`Ratio (Hippocampus␣
 ↪/ Caudate)` > 0.9)
print(nochange)
nochange / dim(eFeature)[1]
```

```
[1] 3
```

0.0348837209302326

[10]:
```
sum(dt$`Ratio (Hippocampus / DLPFC)` > 0.9)
```

19

[11]:
```
## Low expression genes
sum(dt$`Mean Expresion` < 1)
sum(dt$`Mean Expresion` < 1) / dim(eFeature)[1]
```

1

0.0116279069767442

[12]:
```
sum(dt$Caudate_eQTL == 1 & dt$`Max Expression` == "Caudate")
sum(dt$Caudate_eQTL == 1 & dt$`Max Expression` == "Caudate" &
    (dt$`Ratio (DLPFC / Caudate)` < 0.9 | dt$`Ratio (Hippocampus / Caudate)` <␣
 ↪0.9))
sum(dt$Caudate_eQTL == 1 & dt$`Max Expression` == "Caudate" &
    (dt$`Ratio (DLPFC / Caudate)` < 0.9 | dt$`Ratio (Hippocampus / Caudate)` <␣
 ↪0.9)) / dim(eFeature)[1]
```

86

86

1

[13]:
```
sum(dt$DLPFC_eQTL == 1 & dt$`Max Expression` == "DLPFC")
sum(dt$Hippocampus_eQTL == 1 & dt$`Max Expression` == "Hippocampus")
```

0

0

[14]:
```
sum(dt$Caudate_eQTL == 1 & dt$`Min Expression` == "Caudate")
sum(dt$DLPFC_eQTL == 1 & dt$`Min Expression` == "DLPFC")
sum(dt$Hippocampus_eQTL == 1 & dt$`Min Expression` == "Hippocampus")
```

0

0

0

[15]:
```
sum(eFeature$Caudate == 1)
sum(eFeature$DLPFC == 1)
sum(eFeature$Hippocampus == 1)
```

86

0

0

2.3.1 Summary

- All specific genes are caudate, and caudate has the highest expression!

2.4 Reproducibility information

[16]:
```
Sys.time()
proc.time()
options(width=120)
sessioninfo::session_info()
```

```
[1] "2021-09-13 13:57:48 EDT"
```

```
   user  system elapsed
 46.467   9.882  57.497
```

```
 Session info
setting  value
version  R version 4.0.3 (2020-10-10)
os       Arch Linux
system   x86_64, linux-gnu
ui       X11
language (EN)
collate  en_US.UTF-8
ctype    en_US.UTF-8
tz       America/New_York
date     2021-09-13

 Packages
package     * version date       lib source
assertthat    0.2.1   2019-03-21 [1] CRAN (R 4.0.2)
base64enc     0.1-3   2015-07-28 [1] CRAN (R 4.0.2)
cachem        1.0.6   2021-08-19 [1] CRAN (R 4.0.3)
cli           3.0.1   2021-07-17 [1] CRAN (R 4.0.3)
crayon        1.4.1   2021-02-08 [1] CRAN (R 4.0.3)
data.table    1.14.0  2021-02-21 [1] CRAN (R 4.0.3)
DBI           1.1.1   2021-01-15 [1] CRAN (R 4.0.2)
digest        0.6.27  2020-10-24 [1] CRAN (R 4.0.2)
dplyr       * 1.0.7   2021-06-18 [1] CRAN (R 4.0.3)
ellipsis      0.3.2   2021-04-29 [1] CRAN (R 4.0.3)
evaluate      0.14    2019-05-28 [1] CRAN (R 4.0.2)
fansi         0.5.0   2021-05-25 [1] CRAN (R 4.0.3)
fastmap       1.1.0   2021-01-25 [1] CRAN (R 4.0.2)
generics      0.1.0   2020-10-31 [1] CRAN (R 4.0.2)
glue          1.4.2   2020-08-27 [1] CRAN (R 4.0.2)
htmltools     0.5.2   2021-08-25 [1] CRAN (R 4.0.3)
IRdisplay     1.0     2021-01-20 [1] CRAN (R 4.0.2)
```

```
 IRkernel      1.2     2021-05-11 [1] CRAN (R 4.0.3)
 jsonlite      1.7.2   2020-12-09 [1] CRAN (R 4.0.2)
 lifecycle     1.0.0   2021-02-15 [1] CRAN (R 4.0.3)
 magrittr      2.0.1   2020-11-17 [1] CRAN (R 4.0.2)
 memoise       2.0.0   2021-01-26 [1] CRAN (R 4.0.2)
 pbdZMQ        0.3-5   2021-02-10 [1] CRAN (R 4.0.3)
 pillar        1.6.2   2021-07-29 [1] CRAN (R 4.0.3)
 pkgconfig     2.0.3   2019-09-22 [1] CRAN (R 4.0.2)
 purrr         0.3.4   2020-04-17 [1] CRAN (R 4.0.2)
 R6            2.5.1   2021-08-19 [1] CRAN (R 4.0.3)
 repr          1.1.3   2021-01-21 [1] CRAN (R 4.0.2)
 rlang         0.4.11  2021-04-30 [1] CRAN (R 4.0.3)
 sessioninfo   1.1.1   2018-11-05 [1] CRAN (R 4.0.2)
 tibble        3.1.4   2021-08-25 [1] CRAN (R 4.0.3)
 tidyselect    1.1.1   2021-04-30 [1] CRAN (R 4.0.3)
 utf8          1.2.2   2021-07-24 [1] CRAN (R 4.0.3)
 uuid          0.1-4   2020-02-26 [1] CRAN (R 4.0.2)
 vctrs         0.3.8   2021-04-29 [1] CRAN (R 4.0.3)
 withr         2.4.2   2021-04-18 [1] CRAN (R 4.0.3)

[1] /home/jbenja13/R/x86_64-pc-linux-gnu-library/4.0
[2] /usr/lib/R/library
```