

# SWATH2stats example script

Example R code showing the usage of the SWATH2stats package. The data processed is the publicly available dataset of *S.pyogenes* (Röst et al. 2014) (<http://www.peptideatlas.org/PASS/PASS00289>). The results file 'rawOpenSwathResults\_1pcnt\_only.tsv' can be found on PeptideAtlas (<ftp://PASS00289@ftp.peptideatlas.org/./Spyogenes/results/>). This is a R Markdown file, showing the result of processing this data. The lines shaded in grey represent the R code executed during this analysis.

The SWATH2stats package can be directly installed from Bioconductor using the commands below (<http://bioconductor.org/packages/devel/bioc/html/SWATH2stats.html>).

```
if (!require("BiocManager"))
  install.packages("BiocManager")
BiocManager::install("SWATH2stats")
```

## Part 1: Loading and annotation

Load the SWATH-MS example data from the package, this is a reduced file in order to limit the file size of the package.

```
library(SWATH2stats)
library(data.table)
data('Spyogenes', package = 'SWATH2stats')
```

Alternatively the original file downloaded from the Peptide Atlas can be loaded from the working directory.

```
data <- data.frame(fread('rawOpenSwathResults_1pcnt_only.tsv', sep='\t', header=TRUE))
```

Extract the study design information from the file names. Alternatively, the study design table can be provided as an external table.

```
Study_design <- data.frame(FileName = unique(data$align_origfilename))
Study_design$FileName <- gsub(".*strep_align/(.*)_all_peakgroups.*", "\\1",
  Study_design$FileName)
Study_design$Condition <- gsub("(Strep.*)_Repl.*", "\\1", Study_design$FileName)
Study_design$BioReplicate <- gsub(".*Repl([[:digit:]]).*", "\\1", Study_design$FileName)
Study_design$Run <- seq(1:nrow(Study_design))
head(Study_design)
```

##		Filename	Condition	BioReplicate	Run
## 1	Strep0_Repl1_R02/split_hroest_K120808	Strep0	1	1	
## 2	Strep0_Repl2_R02/split_hroest_K120808	Strep0	2	2	
## 3	Strep10_Repl1_R02/split_hroest_K120808	Strep10	1	3	
## 4	Strep10_Repl2_R02/split_hroest_K120808	Strep10	2	4	

The SWATH-MS data is annotated using the study design table.

```
data.annotated <- sample_annotation(data, Study_design, column.file = "align_origfilename")
```

Remove the decoy peptides for a subsequent inspection of the data.

```
data.annotated.nodecoy <- subset(data.annotated, decoy==FALSE)
```

## Part 2: Analyze correlation, variation and signal

Count the different analytes for the different injections.

```
count_analytes(data.annotated.nodcocy)
```

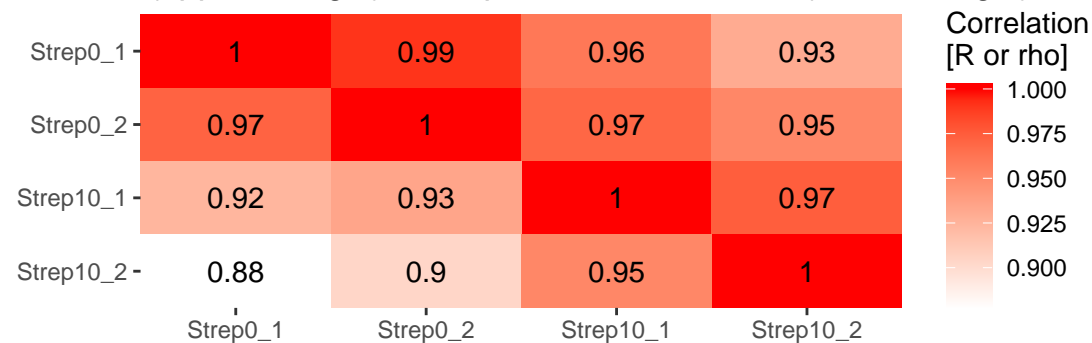
```
##      run_id transition_group_id FullPeptideName ProteinName
## 1 Strep0_1_1           10229           8377      1031
## 2 Strep0_2_2           9716           7970      1003
## 3 Strep10_1_3          8692           7138       943
## 4 Strep10_2_4          8424           6941       910
```

Plot the correlation of the signal intensity.

```
correlation <- plot_correlation_between_samples(data.annotated.nodcocy, column.values = 'Intensity')
```

```
## Warning: Ignoring unknown aesthetics: fill
```

Intensity correlation between samples:  
Pearson (upper triangle) and Spearman correlation (lower triangle)



Plot the correlation of the delta\_rt, which is the deviation of the retention time from the expected retention time.

```
correlation <- plot_correlation_between_samples(data.annotated.nodcocy, column.values = 'delta_rt')
```

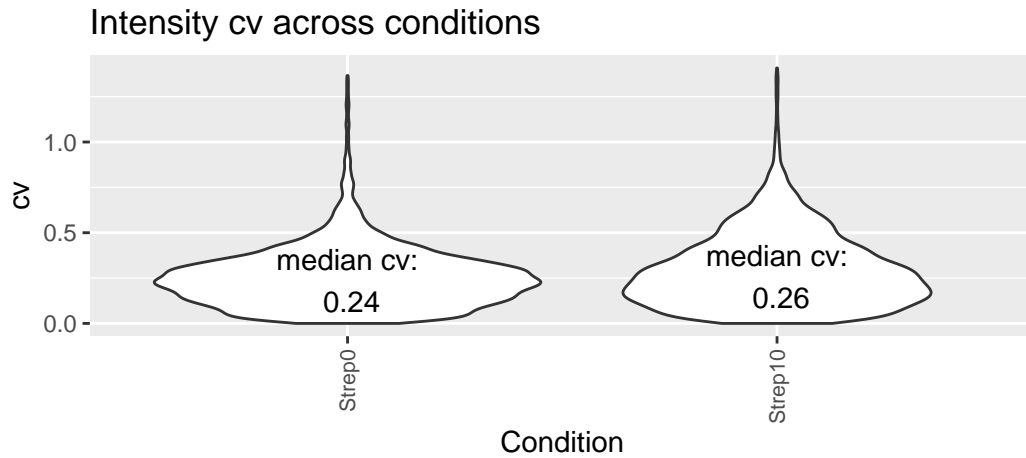
```
## Warning: Ignoring unknown aesthetics: fill
```

delta\_rt correlation between samples:  
Pearson (upper triangle) and Spearman correlation (lower triangle)



Plot the variation of the signal across replicates.

```
variation <- plot_variation(data.annotated.nodecoy)
```

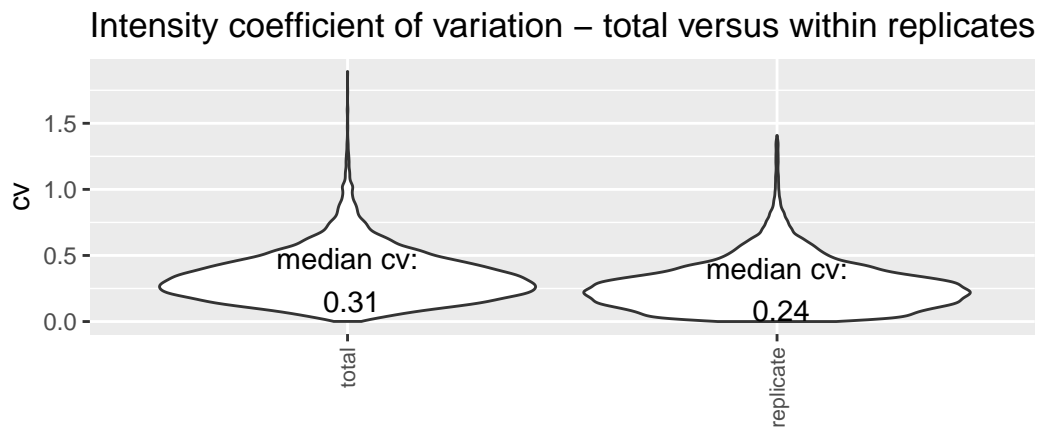


```
variation[[2]]
```

```
## Condition mode_cv mean_cv median_cv
## 1 Strep0 0.2280372 0.2545450 0.2351859
## 2 Strep10 0.1706934 0.2947144 0.2592725
```

Plot the total variation versus variation within replicates.

```
variation_total <- plot_variation_vs_total(data.annotated.nodecoy)
```



```
variation_total[[2]]
```

```
## scope mode_cv mean_cv median_cv
## 1 replicate 0.2209867 0.2728681 0.2438041
## 2 total 0.2655678 0.3439050 0.3139993
```

Calculate the summed signal per peptide and protein across samples.

```
peptide_signal <- write_matrix_peptides(data.annotated.nodecoy)
protein_signal <- write_matrix_proteins(data.annotated.nodecoy)
head(protein_signal)
```

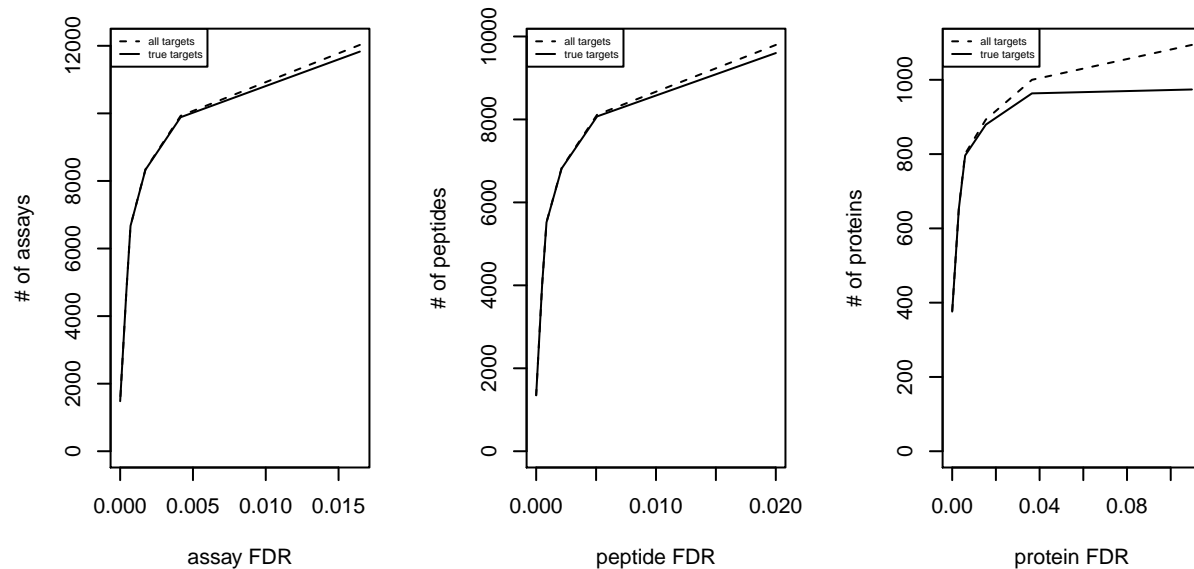
```
## ProteinName Strep0_1_1 Strep0_2_2 Strep10_1_3
## 1 Spyo_Exp3652_DDB_SeqID_1571119 265206 163326 51831
## 2 Spyo_Exp3652_DDB_SeqID_1579753 185725 150672 21483
```

## 3	Spyo_Exp3652_DDB_SeqID_1631459	176686	132415	42165
## 4	Spyo_Exp3652_DDB_SeqID_1640263	3310	6617	98550
## 5	Spyo_Exp3652_DDB_SeqID_1709452	852502	747772	503581
## 6	Spyo_Exp3652_DDB_SeqID_17244480	17506	29578	7607
##	Strep10_2_4			
## 1	45021			
## 2	144314			
## 3	32735			
## 4	45169			
## 5	504761			
## 6	2482			

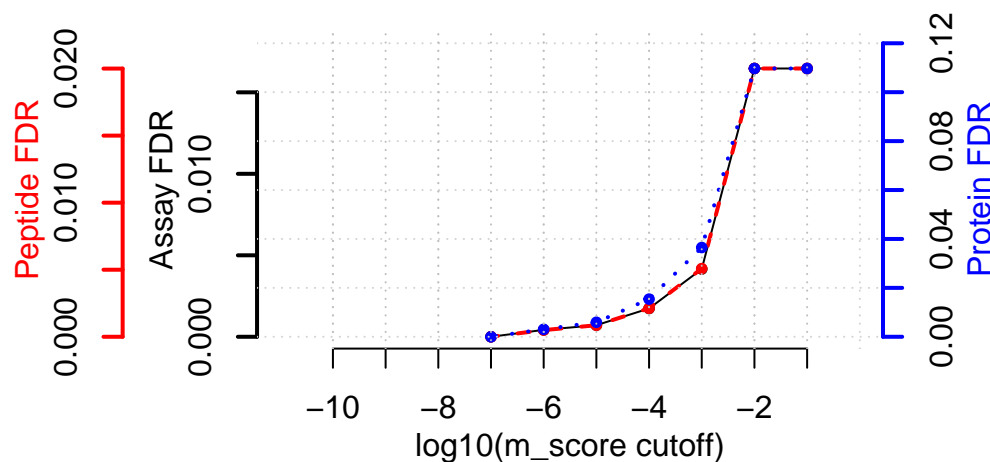
## Part 3: FDR estimation

Estimate the overall FDR across runs using a target decoy strategy.

```
par(mfrow = c(1, 3))
fdr_target_decoy <- assess_fdr_overall(data.annotated, n.range = 10, FFT = 0.25, output = 'Rconsole')
```



### Global m-score cutoff connectivity to FDR quality



According to this FDR estimation one would need to filter the data with a lower mscore threshold to reach an overall protein FDR of 5%.

```
mscore4protfdr(data, FFT = 0.25, fdr_target = 0.05)
```

```
## Target protein FDR:0.05
## Required overall m-score cutoff:0.0017783
## achieving protein FDR =0.0488
## [1] 0.001778279
```

## Part 4: Filtering

Filter data for values that pass the 0.001 mscore criteria in at least two replicates of one condition.

```
data.filtered <- filter_mscore_condition(data.annotated, 0.001, n.replica = 2)
```

```
## Fraction of peptides selected: 0.67
```

```
## Dimension difference: 7226, 0
```

Select only the 10 peptides showing strongest signal per protein.

```
data.filtered2 <- filter_on_max_peptides(data.filtered, n_peptides = 10)
```

```
## Before filtering:
```

```
##   Number of proteins: 884
```

```
##   Number of peptides: 6594
```

```
##
```

```
## Percentage of peptides removed: 29.6%
```

```
##
```

```
## After filtering:
```

```
##   Number of proteins: 884
```

```
##   Number of peptides: 4642
```

Filter for proteins that are supported by at least two peptides.

```
data.filtered3 <- filter_on_min_peptides(data.filtered2, n_peptides = 2)
```

```
## Before filtering:
##   Number of proteins: 884
##   Number of peptides: 4642
##
## Percentage of peptides removed: 3.6%
##
## After filtering:
##   Number of proteins: 717
##   Number of peptides: 4475
```

## Part 5: Conversion

Convert the data into a transition-level format (one row per transition measured).

```
data.transition <- disaggregate(data.filtered3)
```

```
## The library contains 6 transitions per precursor.
##
## The data table was transformed into a table containing one row per transition.
```

Convert the data into the format required by MSstats.

```
MSstats.input <- convert4MSstats(data.transition)
```

```
## One or several columns required by MSstats were not in the data. The columns were created and filled
## Missing columns: ProductCharge, IsotopeLabelType
## IsotopeLabelType was filled with light.
## Warning in convert4MSstats(data.transition): Intensity values that were 0,
## were replaced by NA
```

```
head(MSstats.input)
```

```
##           ProteinName      PeptideSequence PrecursorCharge
## 1 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR      3
## 2 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR      3
## 3 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR      3
## 4 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR      3
## 5 Spyo_Exp3652_DDB_SeqID_1571119      AHIAYLPSDGR      2
## 6 Spyo_Exp3652_DDB_SeqID_1571119      AHIAYLPSDGR      2
##           FragmentIon ProductCharge IsotopeLabelType Intensity
## 1 105801_AEAAIYQFLEAIGENPNR/3_y6      NA      light      4752
## 2 105801_AEAAIYQFLEAIGENPNR/3_y6      NA      light      6144
## 3 105801_AEAAIYQFLEAIGENPNR/3_y6      NA      light      3722
## 4 105801_AEAAIYQFLEAIGENPNR/3_y6      NA      light      6624
## 5      118149_AHIAYLPSDGR/2_y8      NA      light      4036
## 6      118149_AHIAYLPSDGR/2_y8      NA      light      1642
## BioReplicate Condition Run
## 1           2      Strep0      2
## 2           1      Strep10     3
## 3           2      Strep10     4
## 4           1      Strep0      1
```

```
## 5          1      Strep0      1
## 6          1      Strep10     3
```

Convert the data into the format required by mapDIA.

```
mapDIA.input <- convert4mapDIA(data.transition)
head(mapDIA.input)
```

```
##              ProteinName      PeptideSequence
## 1 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR
## 2 Spyo_Exp3652_DDB_SeqID_1571119 AHIAYLPSDGR
## 3 Spyo_Exp3652_DDB_SeqID_1571119 EEFTAVFK
## 4 Spyo_Exp3652_DDB_SeqID_1571119 EKAEAAIYQFLEAIGENPNR
## 5 Spyo_Exp3652_DDB_SeqID_1571119 EQHEDVVIVK
## 6 Spyo_Exp3652_DDB_SeqID_1571119 LTSQIADALVEALNPK
##              FragmentIon Strep0_1 Strep0_2 Strep10_1 Strep10_2
## 1 105801_AEAAIYQFLEAIGENPNR/3_y6 6624 4752 6144 3722
## 2 118149_AHIAYLPSDGR/2_y8 4036 2405 1642 720
## 3 35179_EEFTAVFK/2_y5 2307 1541 1561 NaN
## 4 28903_EKAEAAIYQFLEAIGENPNR/3_y6 3410 2185 NaN 1984
## 5 73581_EQHEDVVIVK/2_b6 2423 1343 NaN NaN
## 6 115497_LTSQIADALVEALNPK/2_y11 6553 6349 NaN NaN
```

Convert the data into the format required by aLFQ.

```
aLFQ.input <- convert4aLFQ(data.transition)
head(aLFQ.input)
```

```
##      run_id      protein_id      peptide_id
## 1 Strep0_2_2 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR
## 2 Strep10_1_3 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR
## 3 Strep10_2_4 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR
## 4 Strep0_1_1 Spyo_Exp3652_DDB_SeqID_1571119 AEAAIYQFLEAIGENPNR
## 5 Strep0_1_1 Spyo_Exp3652_DDB_SeqID_1571119 AHIAYLPSDGR
## 6 Strep10_1_3 Spyo_Exp3652_DDB_SeqID_1571119 AHIAYLPSDGR
##              transition_id      peptide_sequence
## 1 AEAAIYQFLEAIGENPNR 105801_AEAAIYQFLEAIGENPNR/3_y6 AEAAIYQFLEAIGENPNR
## 2 AEAAIYQFLEAIGENPNR 105801_AEAAIYQFLEAIGENPNR/3_y6 AEAAIYQFLEAIGENPNR
## 3 AEAAIYQFLEAIGENPNR 105801_AEAAIYQFLEAIGENPNR/3_y6 AEAAIYQFLEAIGENPNR
## 4 AEAAIYQFLEAIGENPNR 105801_AEAAIYQFLEAIGENPNR/3_y6 AEAAIYQFLEAIGENPNR
## 5 AHIAYLPSDGR 118149_AHIAYLPSDGR/2_y8 AHIAYLPSDGR
## 6 AHIAYLPSDGR 118149_AHIAYLPSDGR/2_y8 AHIAYLPSDGR
## precursor_charge transition_intensity concentration
## 1          3          4752          ?
## 2          3          6144          ?
## 3          3          3722          ?
## 4          3          6624          ?
## 5          2          4036          ?
## 6          2          1642          ?
```

Session info on the R version and packages used.

```
sessionInfo()
```

```
## R version 3.5.1 Patched (2018-07-12 r74967)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: OS X El Capitan 10.11.6
##
```



```

## Matrix products: default
## BLAS: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRlapack.dylib
##
## locale:
## [1] C/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## other attached packages:
## [1] data.table_1.11.8  SWATH2stats_1.12.1
##
## loaded via a namespace (and not attached):
## [1] progress_1.2.0      tidyselect_0.2.5    purrr_0.2.5
## [4] reshape2_1.4.3      colorspace_1.3-2    htmltools_0.3.6
## [7] stats4_3.5.1        yaml_2.2.0          blob_1.1.1
## [10] XML_3.98-1.16       rlang_0.3.0.1       pillar_1.3.0
## [13] glue_1.3.0          DBI_1.0.0           BiocGenerics_0.28.0
## [16] bit64_0.9-7         bindrcpp_0.2.2      bindr_0.1.1
## [19] plyr_1.8.4          stringr_1.3.1       munsell_0.5.0
## [22] gtable_0.2.0        evaluate_0.12       memoise_1.1.0
## [25] labeling_0.3        Biobase_2.42.0      knitr_1.20
## [28] IRanges_2.16.0      biomaRt_2.38.0      parallel_3.5.1
## [31] AnnotationDbi_1.44.0 Rcpp_1.0.0          scales_1.0.0
## [34] backports_1.1.2     formatR_1.5         S4Vectors_0.20.1
## [37] bit_1.1-14          ggplot2_3.1.0       hms_0.4.2
## [40] digest_0.6.18       stringi_1.2.4       dplyr_0.7.8
## [43] grid_3.5.1          rprojroot_1.3-2     tools_3.5.1
## [46] bitops_1.0-6        magrittr_1.5        lazyeval_0.2.1
## [49] RCurl_1.95-4.11     tibble_1.4.2        RSQLite_2.1.1
## [52] crayon_1.3.4        pkgconfig_2.0.2     prettyunits_1.0.2
## [55] assertthat_0.2.0    rmarkdown_1.10      httr_1.3.1
## [58] R6_2.3.0            compiler_3.5.1

```