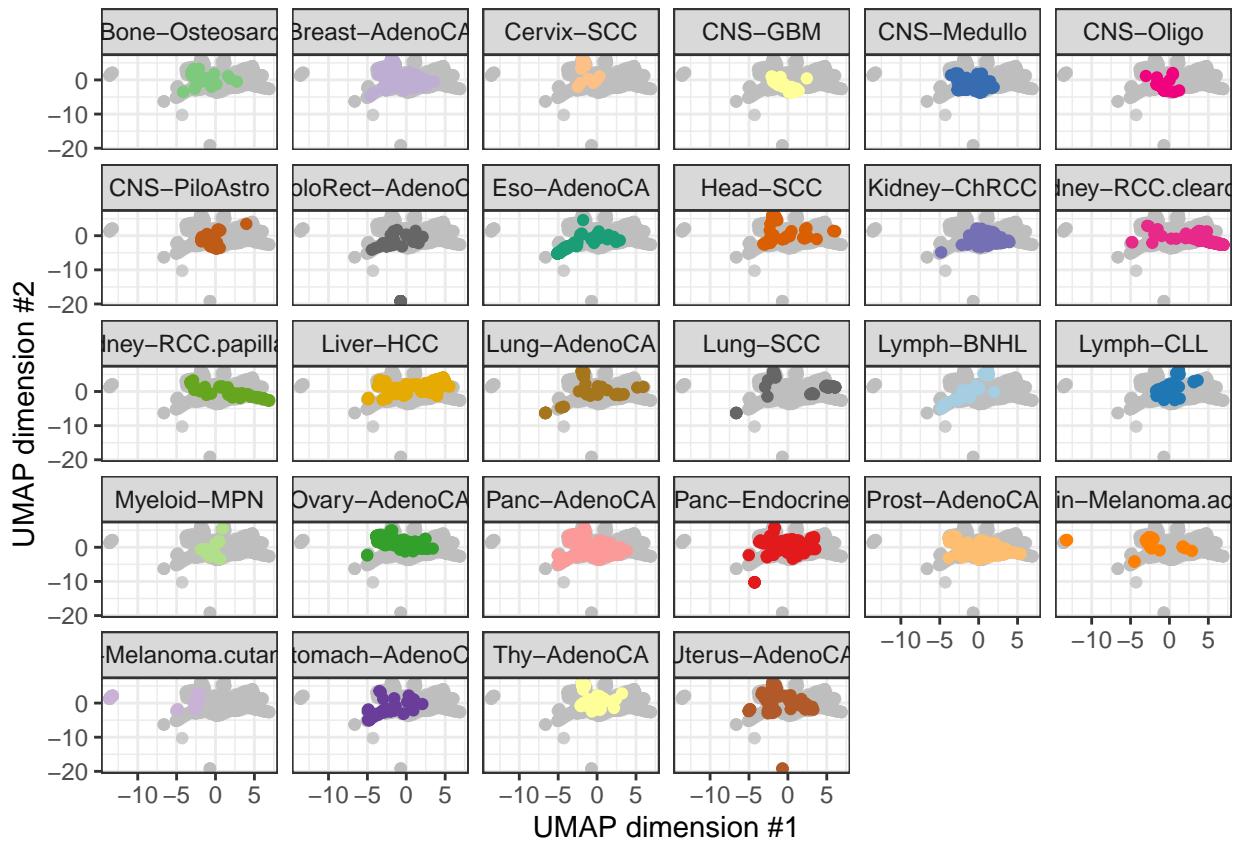


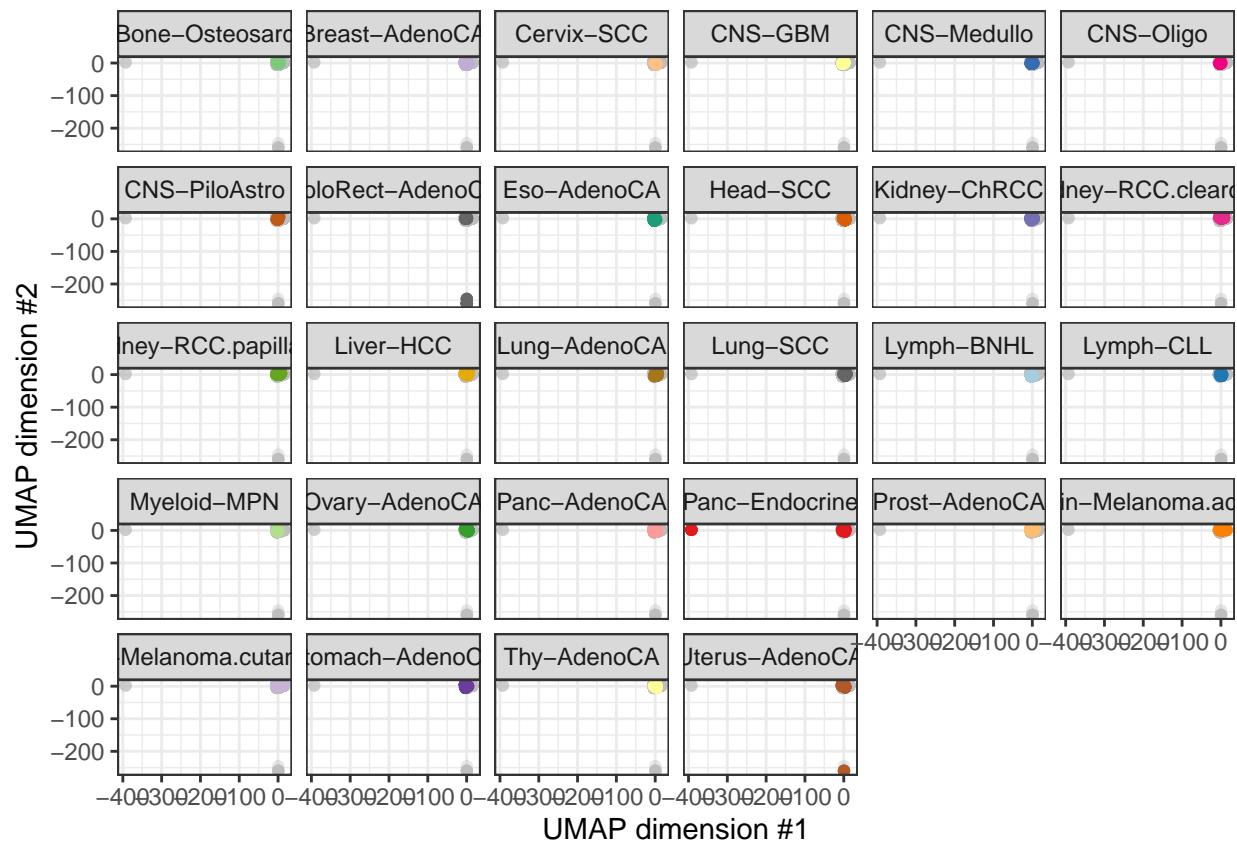
# Summary of TMB runs

Lena Morrill

24/05/2021

```
## Loading required package: viridisLite
## Loading required package: coda
## Loading required package: MASS
## Warning in .recacheSubclasses(def@class, def, env): undefined subclass
## "numericVector" of class "Mnumeric"; definition not updated
## ##
## ## Markov Chain Monte Carlo Package (MCMCpack)
## ## Copyright (C) 2003-2021 Andrew D. Martin, Kevin M. Quinn, and Jong Hee Park
## ##
## ## Support provided by the U.S. National Science Foundation
## ## (Grants SES-0350646 and SES-0350613)
## ##
## Error in slot(i, "count_matrices_all") :
##   cannot get a slot ("count_matrices_all") from an object of type "logical"
## Error in slot(i, "count_matrices_all") :
##   cannot get a slot ("count_matrices_all") from an object of type "logical"
```





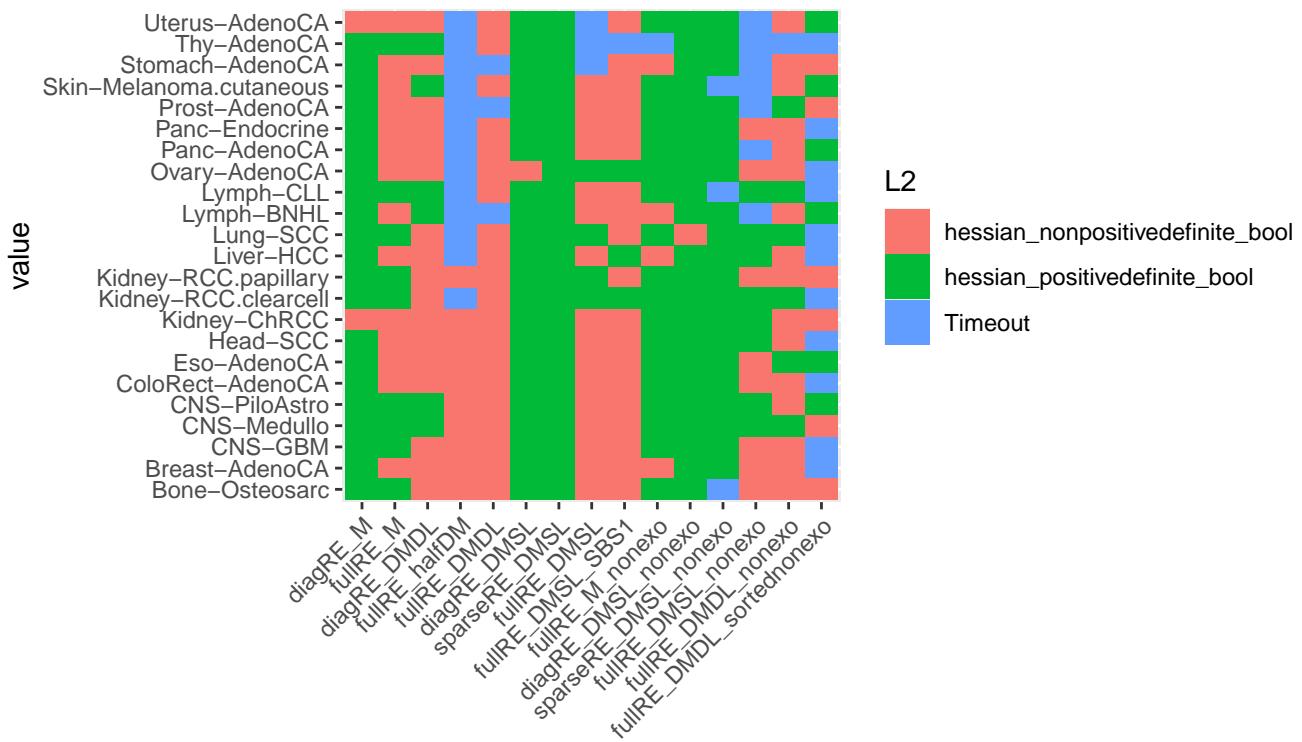
## Information about models

### Default order of categories for each model

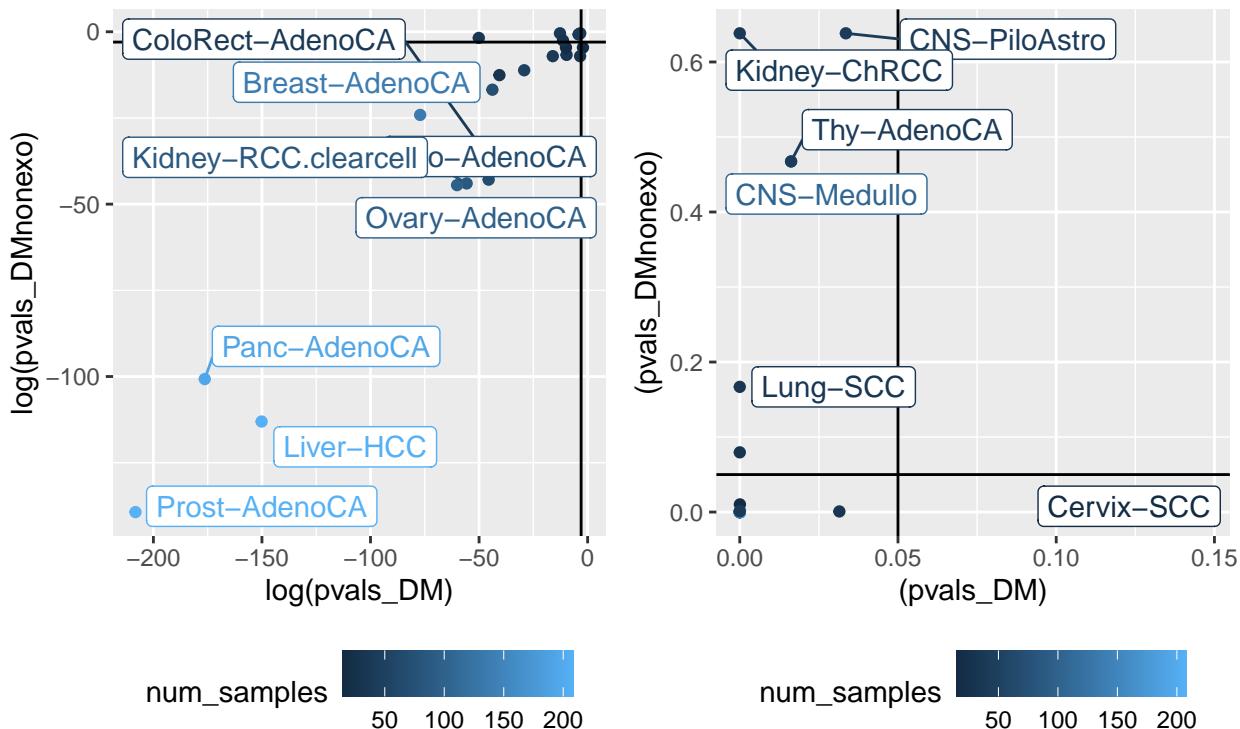
| Name model                  | Extension                                | Sorted  | File in which th |
|-----------------------------|--|---|------------------|
| fullREDMsinglelambda        | fullRE_DMSL_                             | Not sorted                                    | run_TMB_PCAWG    |
| fullREDMsinglelambda2       | fullRE_DMSL2_                            | Sorted  | run_TMB_PCAWG    |
| diagREDMsinglelambda        | diagRE_DMSL_                             | Unknown                                       | run_TMB_PCAWG    |
| fullRE_M                    | fullRE_M_                                | Sorted in previous version of wrapper_run_TMB | run_TMB_PCAWG    |
| diagRE_DM                   | diagRE_DM_                               | Sorted in previous version of wrapper_run_TMB | run_TMB_PCAWG    |
| fullRE_DM                   | fullRE_DM_                               | Sorted in previous version of wrapper_run_TMB | run_TMB_PCAWG    |
| sparseRE_DMSL2              | sparseRE_nonexo_DMSL_                    | Sorted  | find_subset_s    |
| fullREDMsinglelambda        | fullRE_nonexo_DMSL_                      | Not sorted                                    | find_subset_s    |
| fullRE_M                    | fullRE_nonexo_M_                         | Not sorted                                    | find_subset_s    |
| diagREDMsinglelambda        | diagRE_nonexo_DMSL_                      | Not sorted                                    | find_subset_s    |
| fullRE_DM                   | fullRE_nonexo_DM_                        | Not sorted                                    | find_subset_s    |
| diagREDMsinglelambda        | diagRE_DMSL_                             | Not sorted                                    | find_subset_s    |
| fullREDMsinglelambda for SP | fullREDMsinglelambda_..._signaturesPCAWG | Not sorted (it was commented out)             | run_TMB_PCAWG    |
| fullREM for SP              | fullREM_..._signaturesPCAWG              | Not sorted (it was commented out)             | run_TMB_PCAWG    |

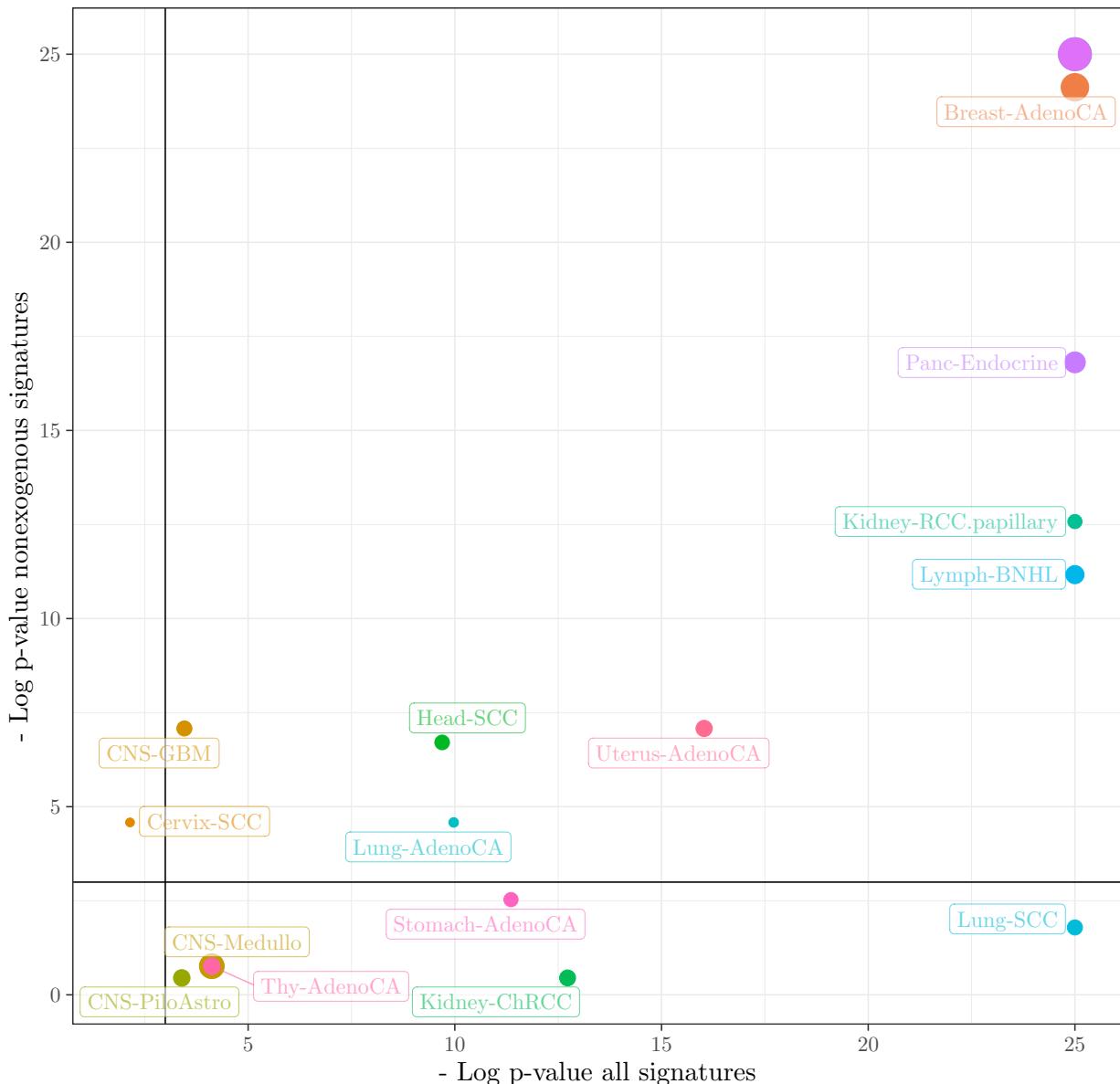
### General results of all models

Check the results of all of the models



P-values for all cancer types





|    |                |                      |               |                         |
|----|----------------|----------------------|---------------|-------------------------|
| ct | Bone-Osteosarc | ColoRect-AdenoCA     | Lung-AdenoCA  | Panc-Endocrine          |
|    | Breast-AdenoCA | Eso-AdenoCA          | Lung-SCC      | Prost-AdenoCA           |
|    | Cervix-SCC     | Head-SCC             | Lymph-BNHL    | Skin-Melanoma.acral     |
|    | CNS-GBM        | Kidney-ChRCC         | Lymph-CLL     | Skin-Melanoma.cutaneous |
|    | CNS-Medullo    | Kidney-RCC.clearcell | Myeloid-MPN   | Stomach-AdenoCA         |
|    | CNS-Oligo      | Kidney-RCC.papillary | Ovary-AdenoCA | Thy-AdenoCA             |
|    | CNS-PiloAstro  | Liver-HCC            | Panc-AdenoCA  | Uterus-AdenoCA          |

### All betas with SBS1 as baseline

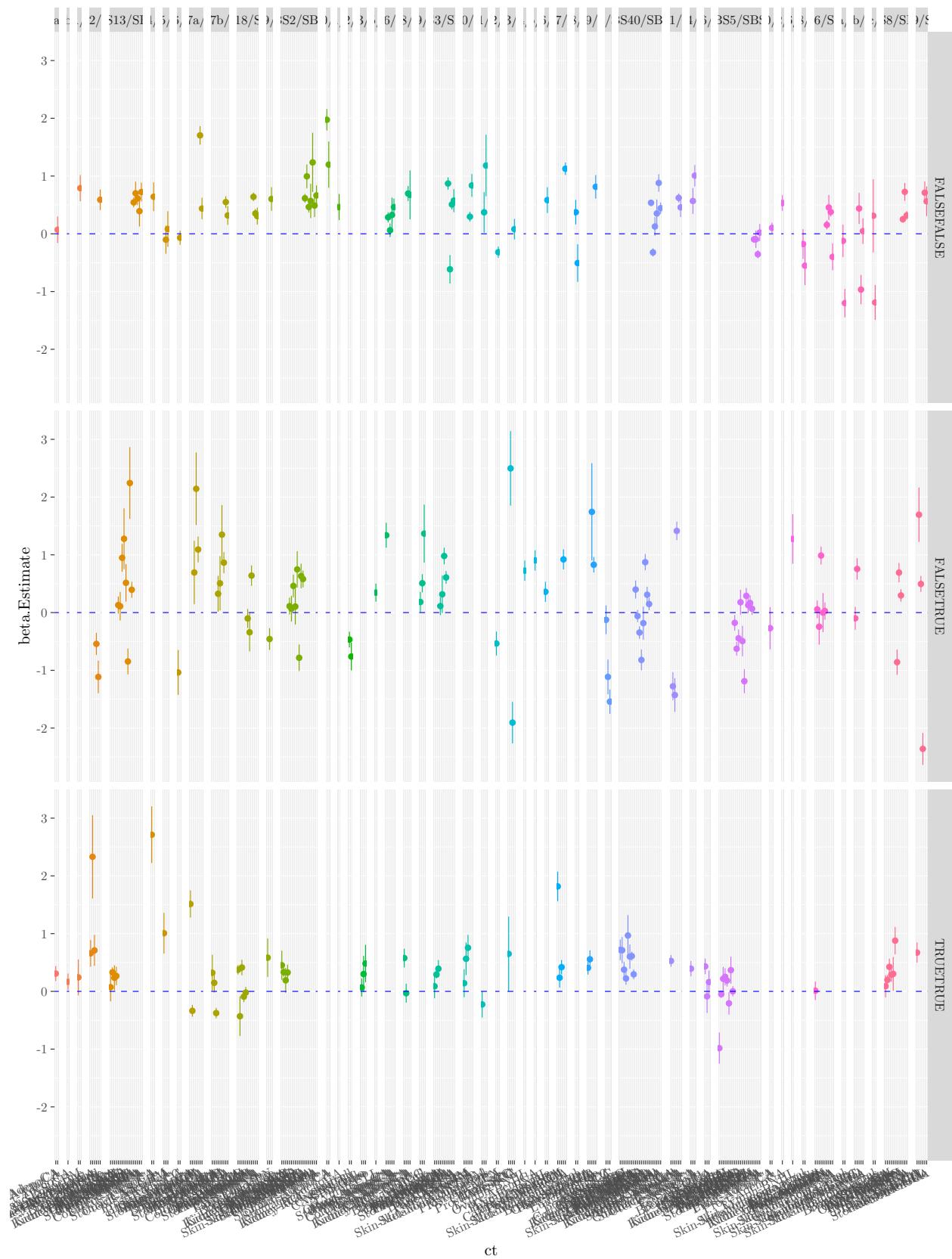
```
##  
## FALSEFALSE FALSETRUE TRUETRUE
```

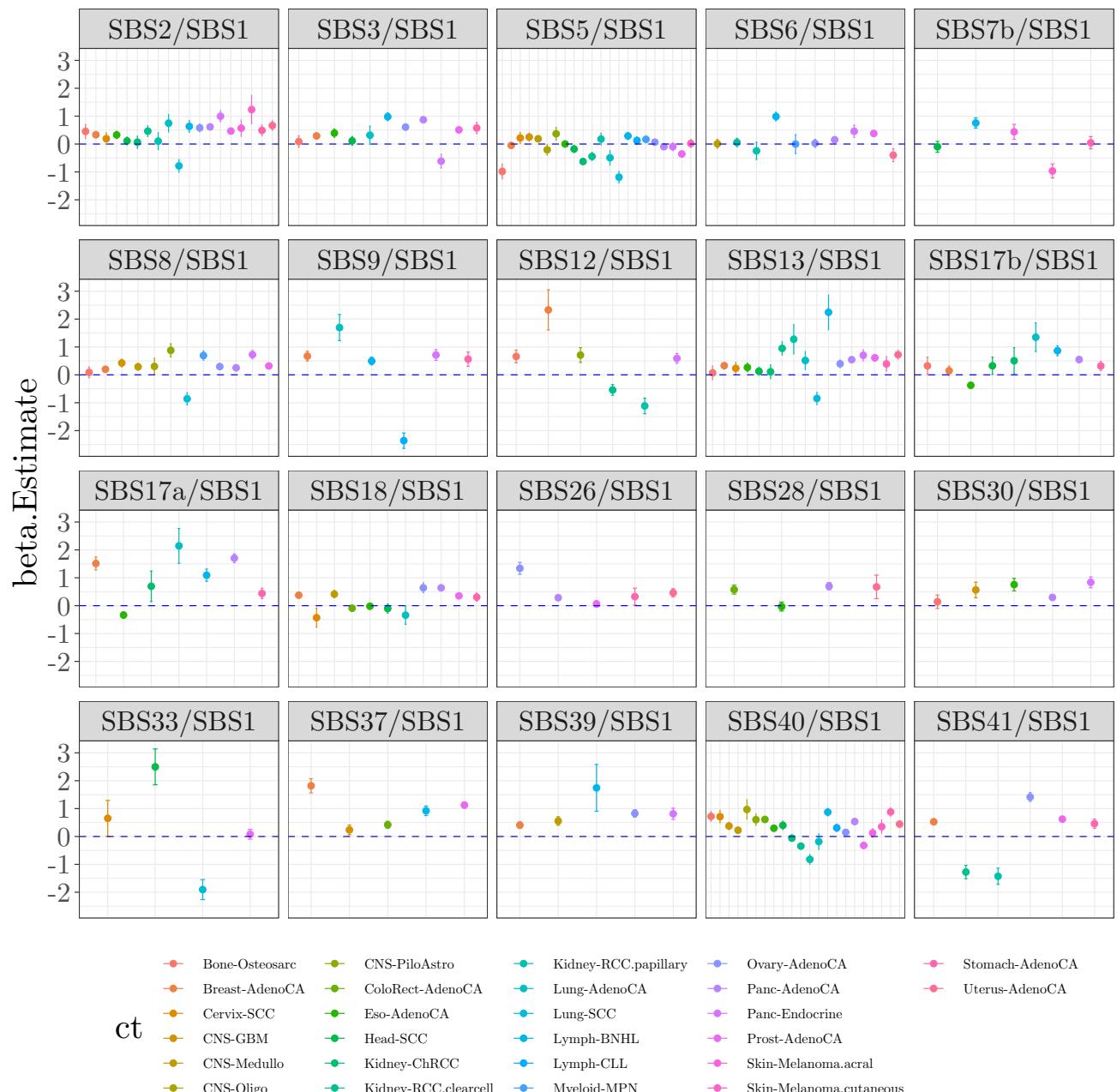
##

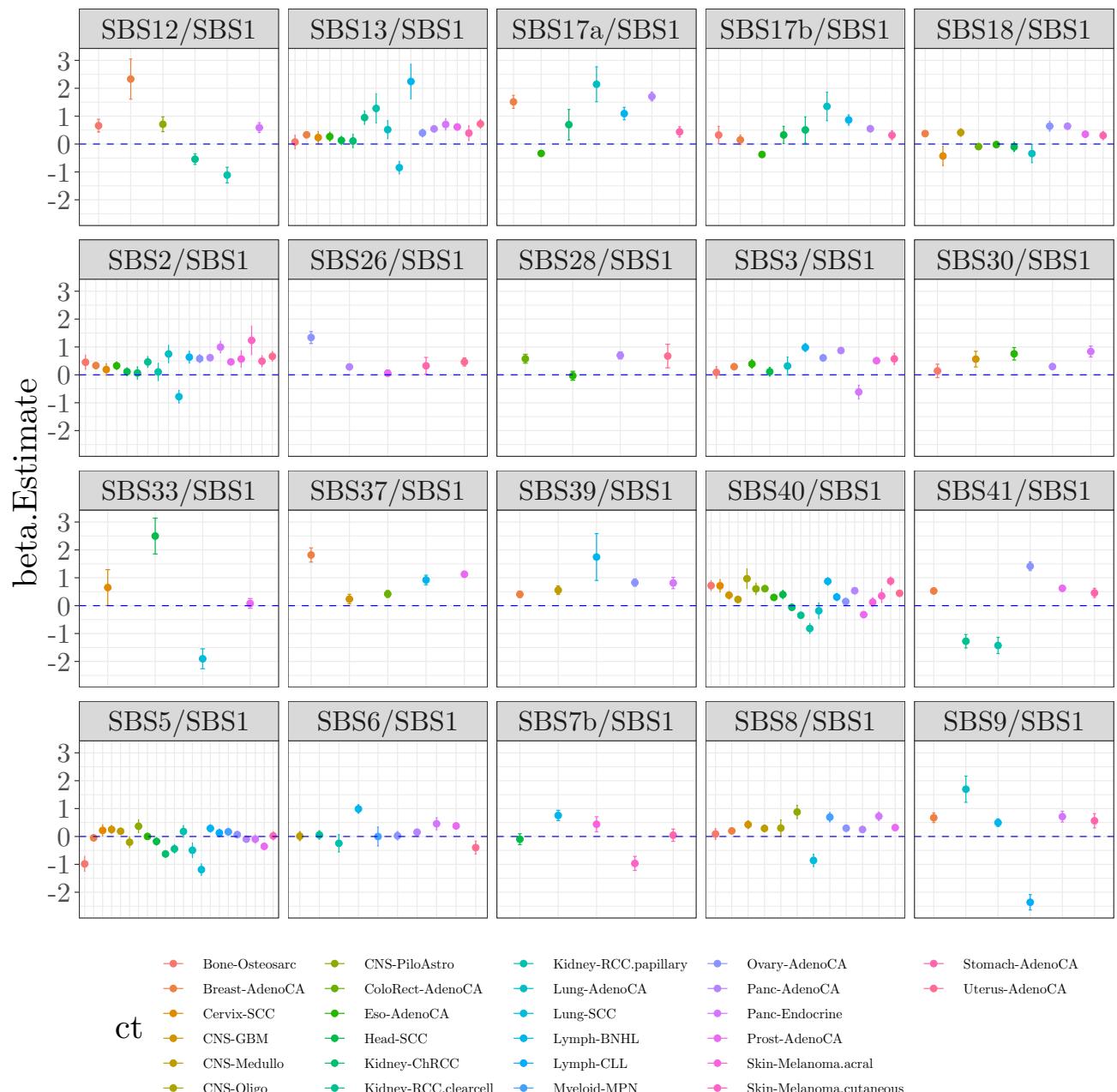
85

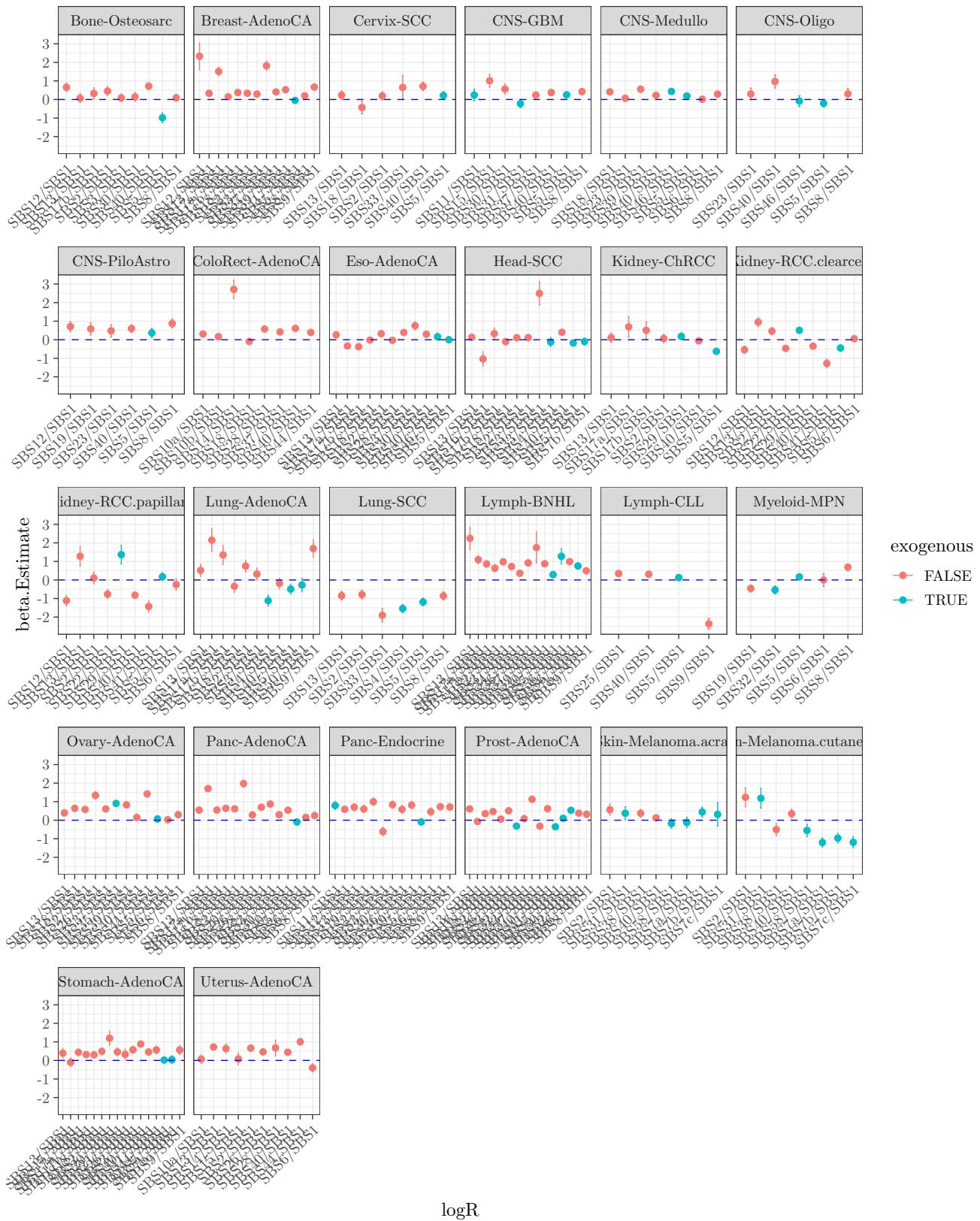
89

74





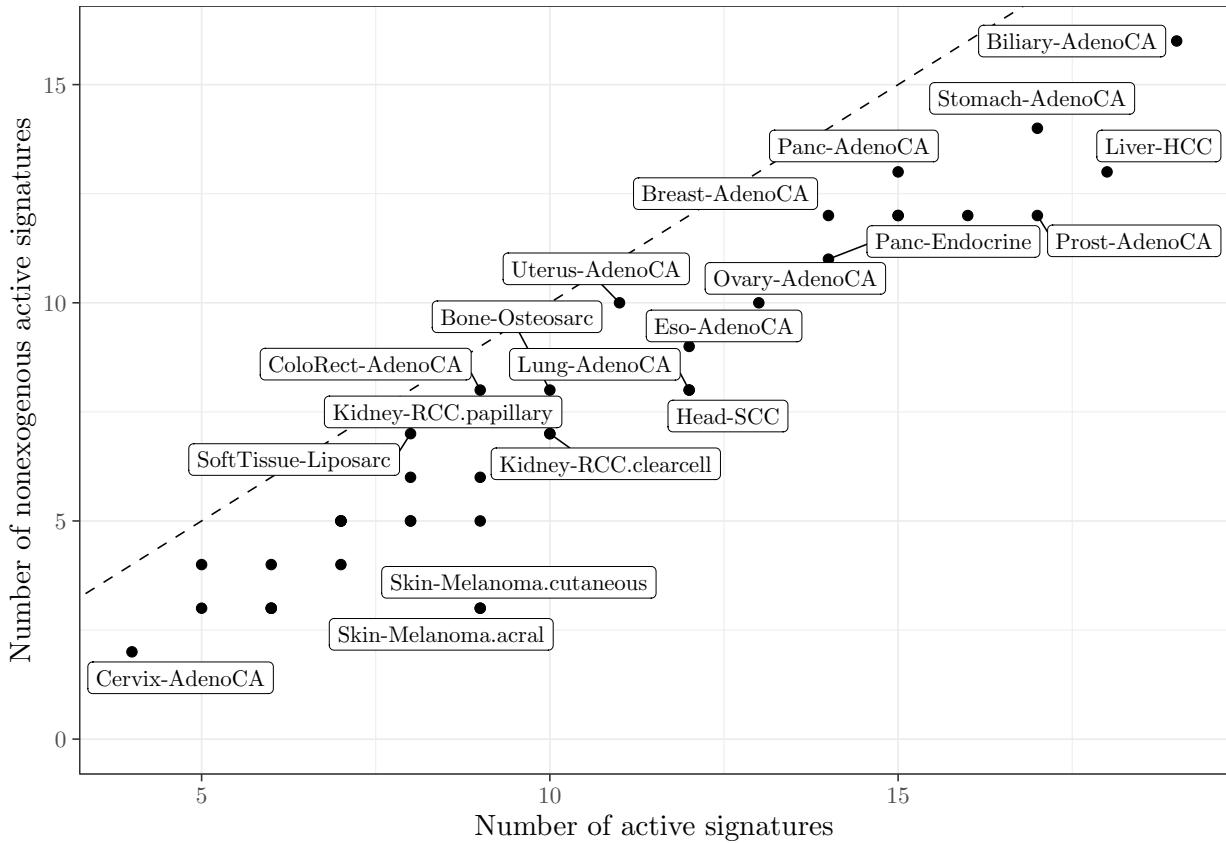




logR

How many signatures so we have in total and how many nonexogenous ones?

```
## Error in slot(i, "count_matrices_active") :
##   cannot get a slot ("count_matrices_active") from an object of type "logical"
## Error in signature_roo_active[[j]][[1]][, !(colnames(signature_roo_active[[j]][[1]])) %in% :
##   incorrect number of dimensions
## Error in signature_roo_active[[j]][[1]][, !(colnames(signature_roo_active[[j]][[1]])) %in% :
##   incorrect number of dimensions
```

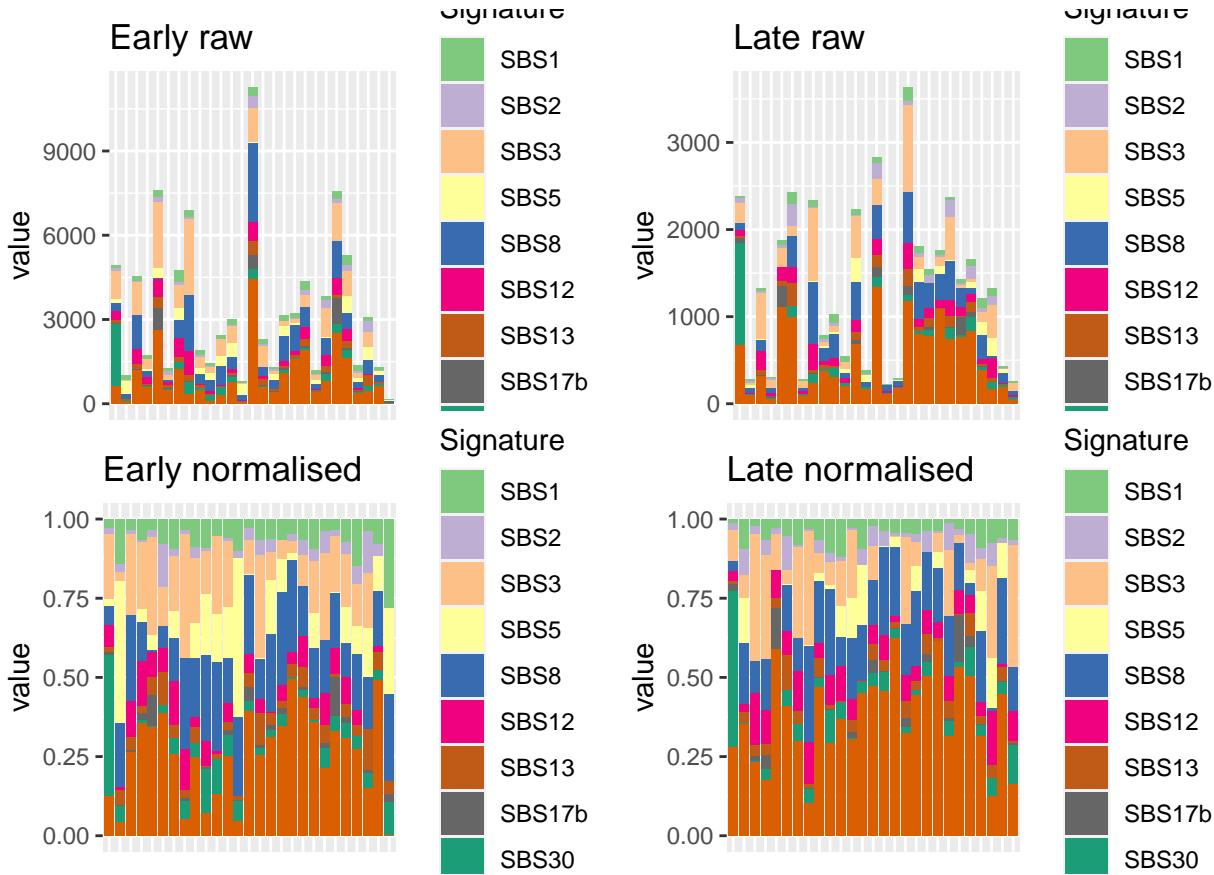


## Analysis per cancer type

### Bone osteosarcoma

#### Barplot and general statistics

```
## [1] 27
```



The number of samples and signatures is:

```
## [1] 54 10
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS3"   "SBS5"   "SBS8"   "SBS12"  "SBS13"  "SBS17b"
## [9] "SBS30"  "SBS40"
```

### Convergence table

We only have converged results for the multinomial with full RE, and the DM with a single lambda (diag and full RE). It is the same for nonexogenous signatures.

|                      | value                            | L2 | L1                 |
|----------------------|----------------------------------|----|--------------------|
| ## 1 Bone-Osteosarc  | hessian_positivedefinite_bool    |    | diagRE_M           |
| ## 2 Bone-Osteosarc  | hessian_positivedefinite_bool    |    | fullRE_M           |
| ## 3 Bone-Osteosarc  | hessian_nonpositivedefinite_bool |    | diagRE_DMDL        |
| ## 4 Bone-Osteosarc  | hessian_nonpositivedefinite_bool |    | fullRE_halfDM      |
| ## 5 Bone-Osteosarc  | hessian_nonpositivedefinite_bool |    | fullRE_DMDL        |
| ## 6 Bone-Osteosarc  | hessian_positivedefinite_bool    |    | diagRE_DMSL        |
| ## 7 Bone-Osteosarc  | hessian_positivedefinite_bool    |    | sparseRE_DMSL      |
| ## 8 Bone-Osteosarc  | hessian_nonpositivedefinite_bool |    | fullRE_DMSL        |
| ## 9 Bone-Osteosarc  | hessian_nonpositivedefinite_bool |    | fullRE_DMSL_SBS1   |
| ## 10 Bone-Osteosarc | hessian_positivedefinite_bool    |    | fullRE_M_nonexo    |
| ## 11 Bone-Osteosarc | hessian_positivedefinite_bool    |    | diagRE_DMSL_nonexo |

```

## 12 Bone-Osteosarc           Timeout      sparseRE_DMSL_nonexo
## 13 Bone-Osteosarc hessian_nonpositivedefinite_bool    fullRE_DMSL_nonexo
## 14 Bone-Osteosarc hessian_nonpositivedefinite_bool    fullRE_DMDL_nonexo
## 15 Bone-Osteosarc hessian_nonpositivedefinite_bool fullRE_DMDL_sortednonexo

```

### Re-running of fitting

```
# Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

If we use the values of the fullRE M as initial values for the fullRE DM, we also don't get convergence:

```
## [1] FALSE
```

### Potentially problematic signatures

We notice that we have several signatures with low exposures, and many zero exposures

```
colSums(obj_Bone_Osteosarc$Y == 0)/nrow(obj_Bone_Osteosarc$Y)
```

```

##      SBS1      SBS2      SBS3      SBS5      SBS8      SBS12     SBS13
## 0.00000000 0.03703704 0.14814815 0.37037037 0.01851852 0.09259259 0.00000000
##      SBS17b     SBS30     SBS40
## 0.37037037 0.12962963 0.01851852

```

```
colSums(obj_Bone_Osteosarc$Y)/sum(obj_Bone_Osteosarc$Y)
```

```

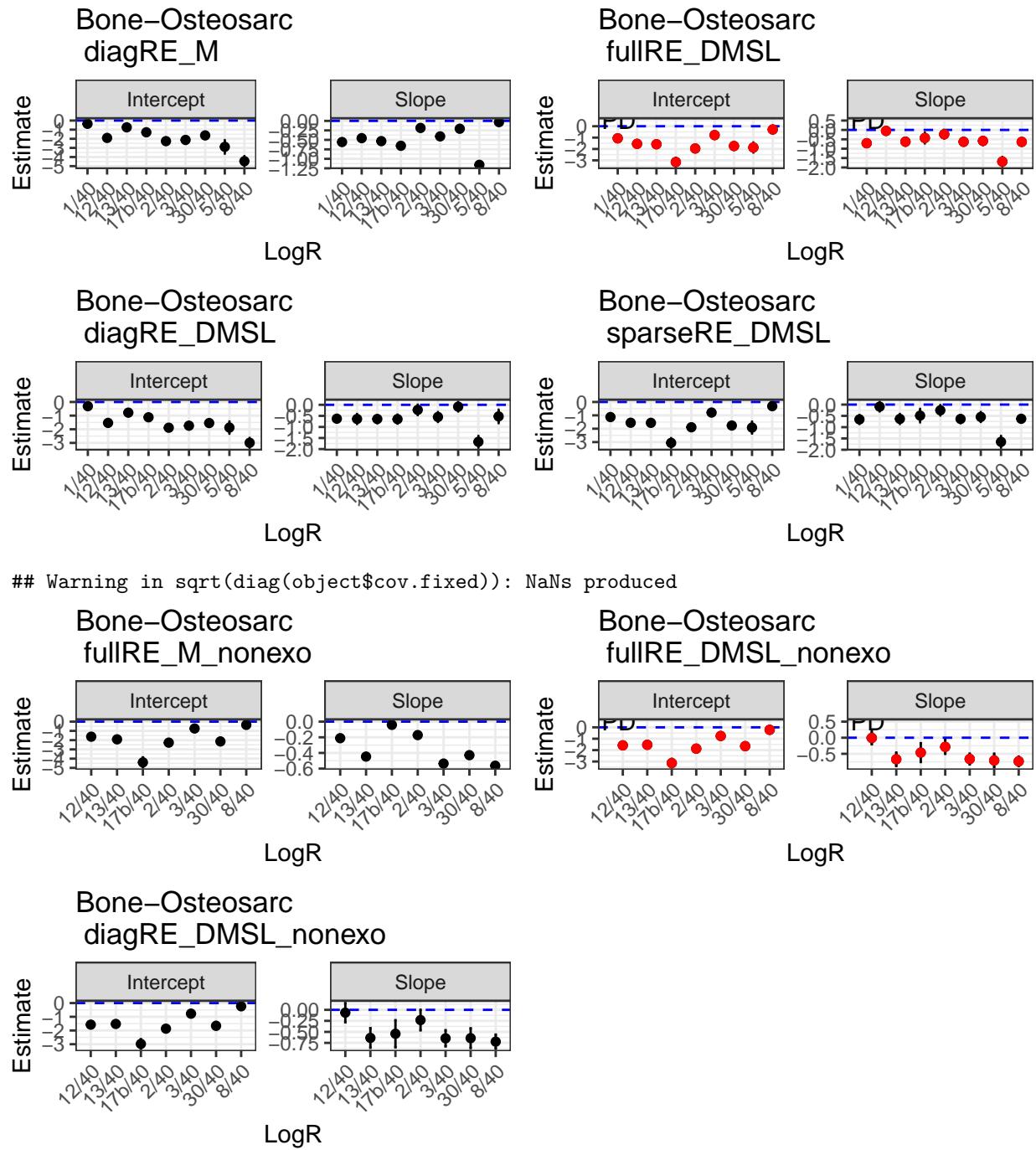
##      SBS1      SBS2      SBS3      SBS5      SBS8      SBS12     SBS13
## 0.05099661 0.03376971 0.17876022 0.05053018 0.17164713 0.07538325 0.04159022
##      SBS17b     SBS30     SBS40
## 0.02866227 0.06128922 0.30737119

```

E.g.

- SBS17b is 0 in 37% of cases and has an overall exposure of 2.9%
- SBS30 is 0 in 13% of cases and overall has an exposure of only 6.1%
- SBS5 is 0 in 37% of cases and has an overall exposure of 5.1%

## Betas



We use the results from the diagonal single lambda DM to test for differential abundance, giving a p-value of  $3.8923434 \times 10^{-5}$ .

## Covariance matrices

Note that sortedDM did not converge.

Nevertheless, both versions of fullRE M – both of which converged and use the same baseline – give very different covariances matrices.

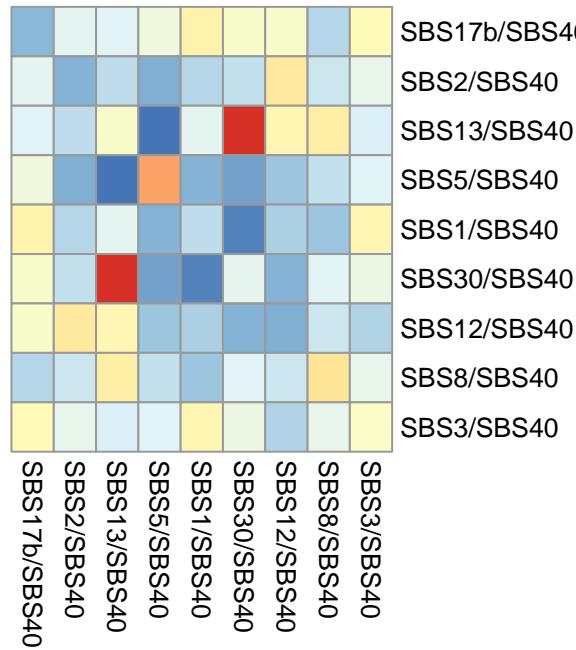
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

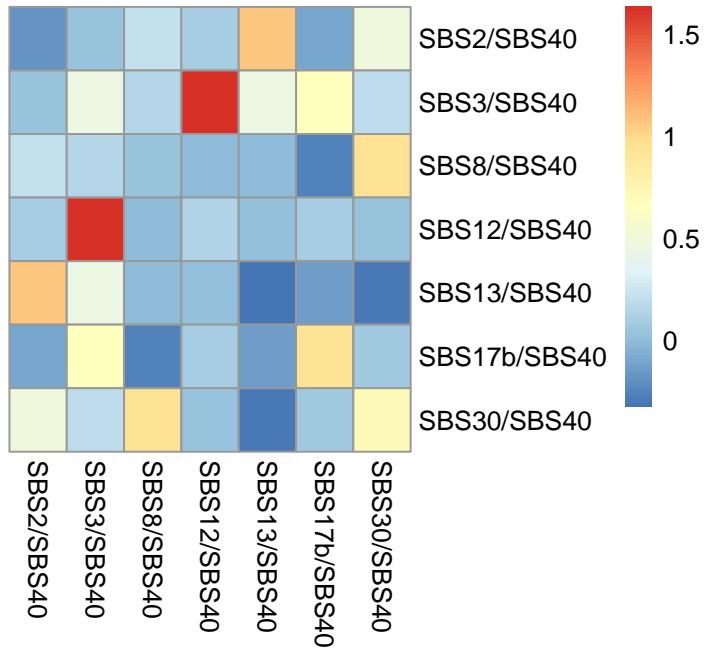
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

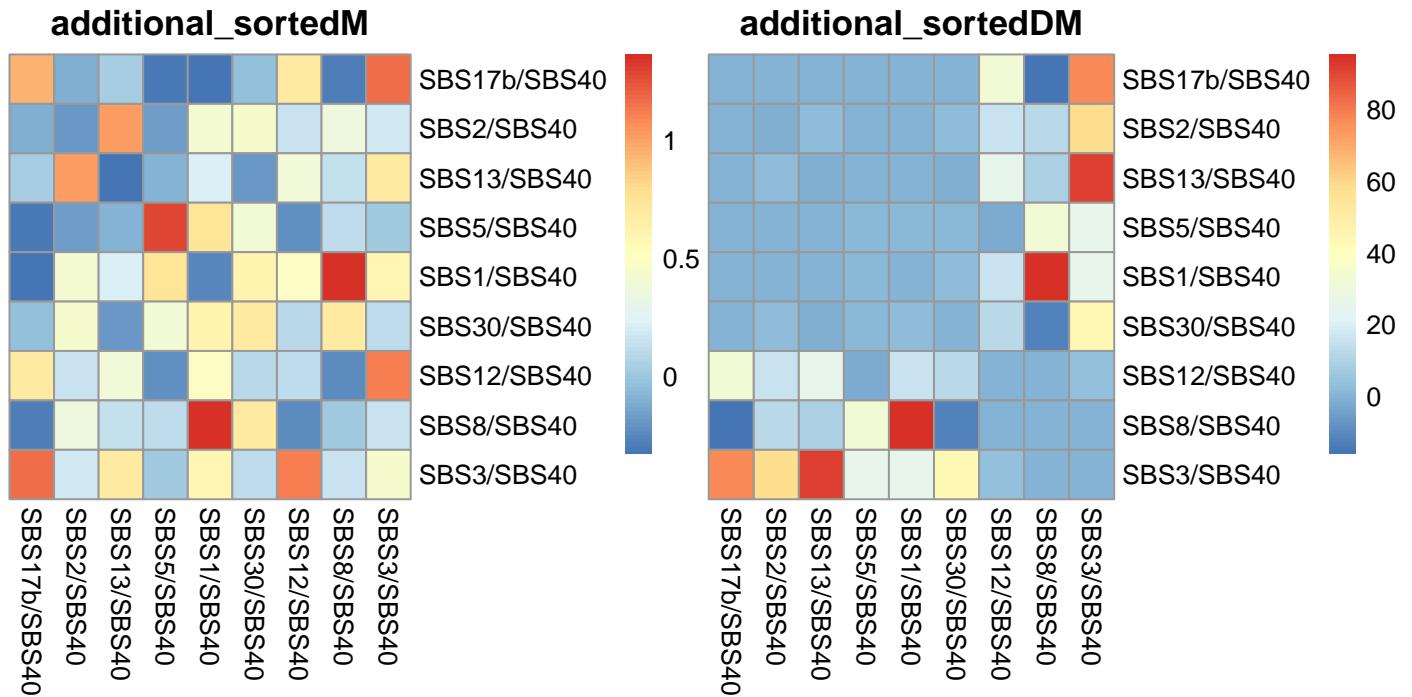
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

**fullRE\_M**



**fullRE\_M\_nonexo**



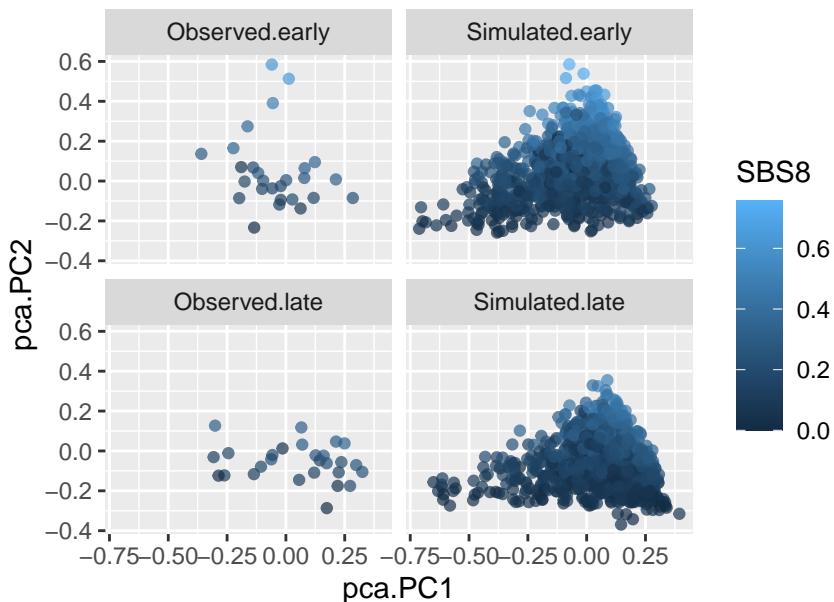


### Simulation under inferred data

Simulating with diagRE DMSL nonexo.

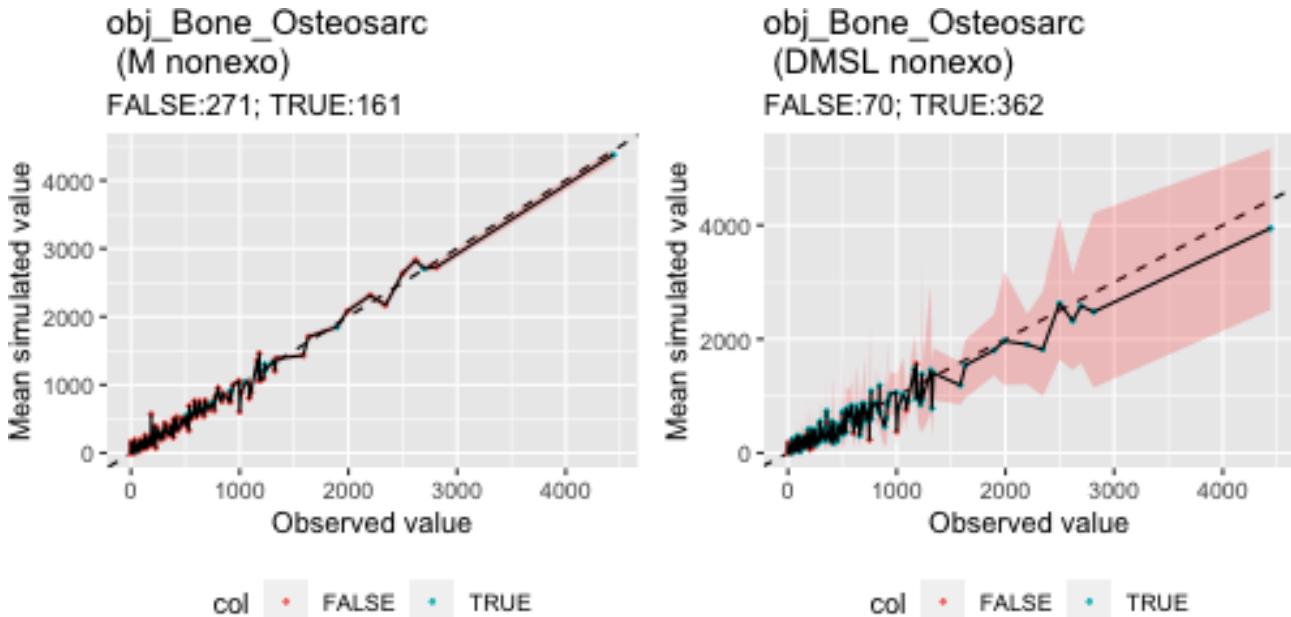
```
## [1] 27
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

## Simulation of Bone osteosarcoma samples



### Ranked plot for coverage

Note that fullRE DMSL nonexo has not converged!



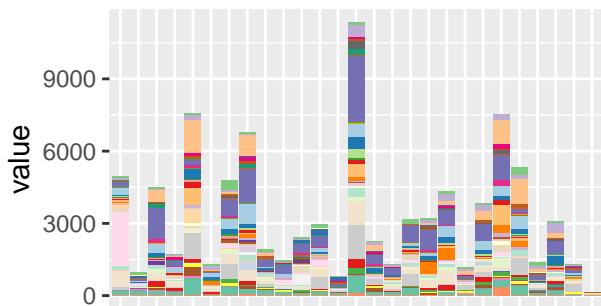
73/359=20% of values are not included in the confidence interval of the DMSL.

### Signatures from mutSigExtractor

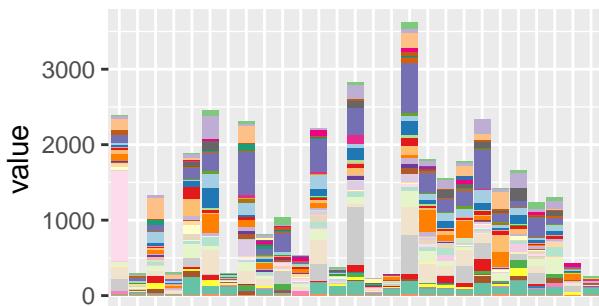
The signatures from mutSigExtractor are a bit more chaotic:

```
## [1] 27
```

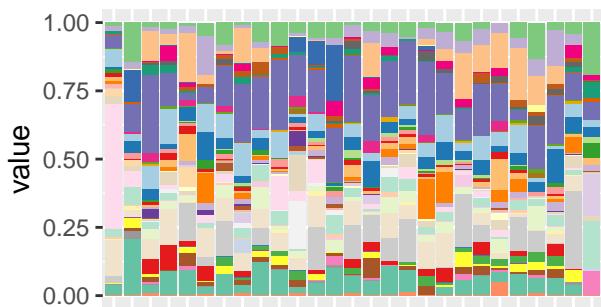
Early raw



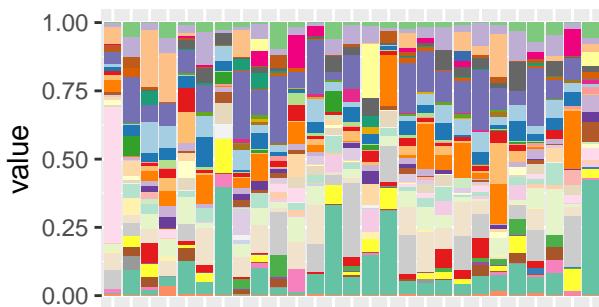
Late raw



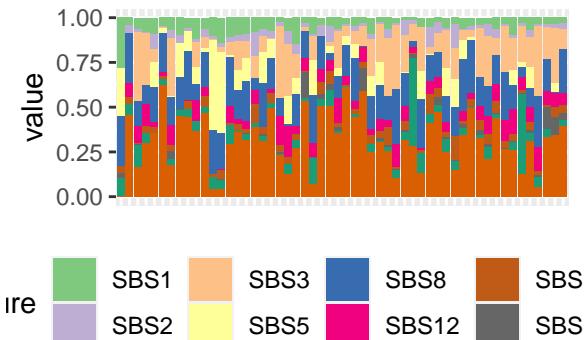
Early normalised



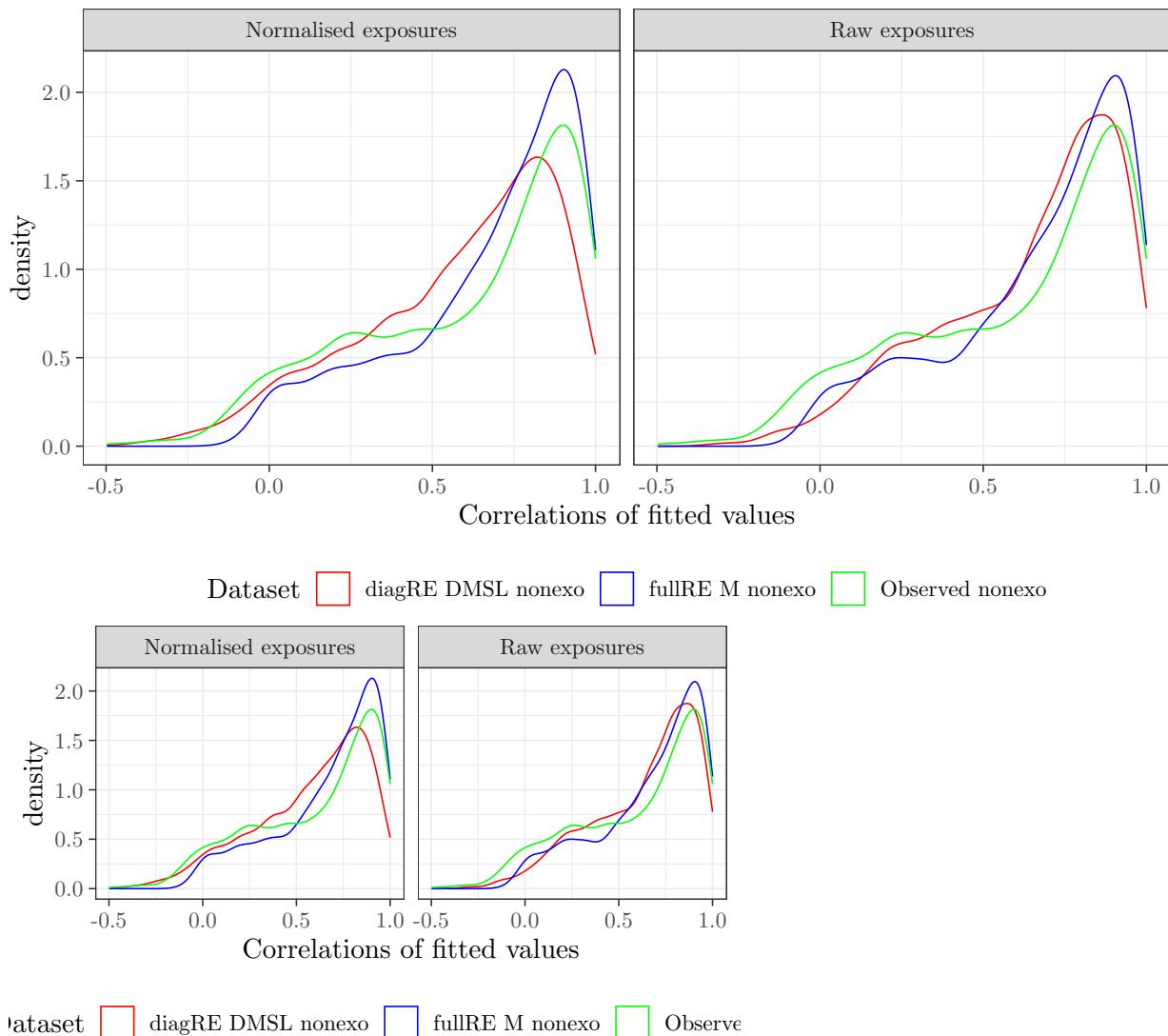
Late normalised



Exposures sorted by increasing number of mutations: there is no trend



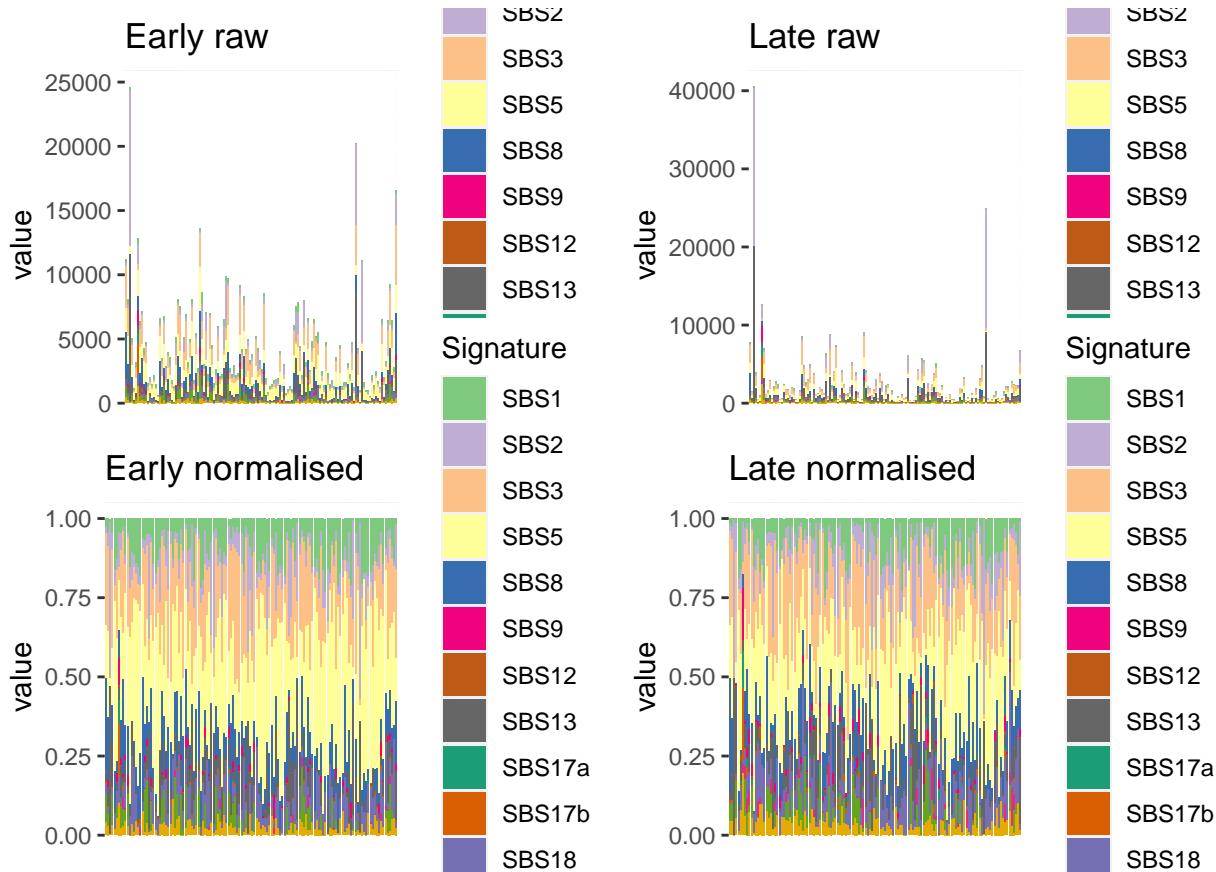
## Correlations of signatures



## Breast-AdenoCA

### Barplot and general statistics

```
## [1] 136
```



There are many signatures, and also many samples.

The number of samples and signatures is:

```
## [1] 272 14
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS3"   "SBS5"   "SBS8"   "SBS9"   "SBS12"  "SBS13"
## [9] "SBS17a" "SBS17b" "SBS18"  "SBS37"  "SBS39"  "SBS41"
```

### Convergence table

We only have converged results for the diagRE\_DMSL, with diagonal or sparse covariance structure, and diagonal M. This is probably due to the very high number of signatures, which make it impossible to infer the whole covariance structure.

|      | value          | L2                               | L1            |
|------|----------------|----------------------------------|---------------|
| ## 1 | Breast-AdenoCA | hessian_positivedefinite_bool    | diagRE_M      |
| ## 2 | Breast-AdenoCA | hessian_nonpositivedefinite_bool | fullRE_M      |
| ## 3 | Breast-AdenoCA | hessian_nonpositivedefinite_bool | diagRE_DMDL   |
| ## 4 | Breast-AdenoCA | hessian_nonpositivedefinite_bool | fullRE_halfDM |

```

## 5 Breast-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL
## 6 Breast-AdenoCA hessian_positivedefinite_bool diagRE_DMSL
## 7 Breast-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL
## 8 Breast-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL
## 9 Breast-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL_SBS1
## 10 Breast-AdenoCA hessian_nonpositivedefinite_bool fullRE_M_nonexo
## 11 Breast-AdenoCA hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Breast-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Breast-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL_nonexo
## 14 Breast-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 Breast-AdenoCA Timeout fullRE_DMDL_sortednonexo

```

### Re-running of fitting

If we use the values of the diagRE M as initial values for the diagRE DM, we see that it has converged. This is probably due to a combination of things: we are using the optimiser nlminb (better in general than the alternative, optim) and we are starting with these - better - values, and we are sorting the columns so that the category with highest total value is the baseline.

```
# [1] TRUE
```

### Potentially problematic signatures

We notice that we have several signatures with low exposures, and many zero exposures

```
colSums(obj_Breast_AdenoCA$Y == 0)/nrow(obj_Breast_AdenoCA$Y)
```

```

##      SBS1      SBS2      SBS3      SBS5      SBS8      SBS9
## 0.000000000 0.000000000 0.025735294 0.007352941 0.088235294 0.562500000
##      SBS12     SBS13     SBS17a     SBS17b     SBS18     SBS37
## 0.955882353 0.073529412 0.709558824 0.500000000 0.036764706 0.772058824
##      SBS39     SBS41
## 0.599264706 0.084558824

```

```
colSums(obj_Breast_AdenoCA$Y)/sum(obj_Breast_AdenoCA$Y)
```

```

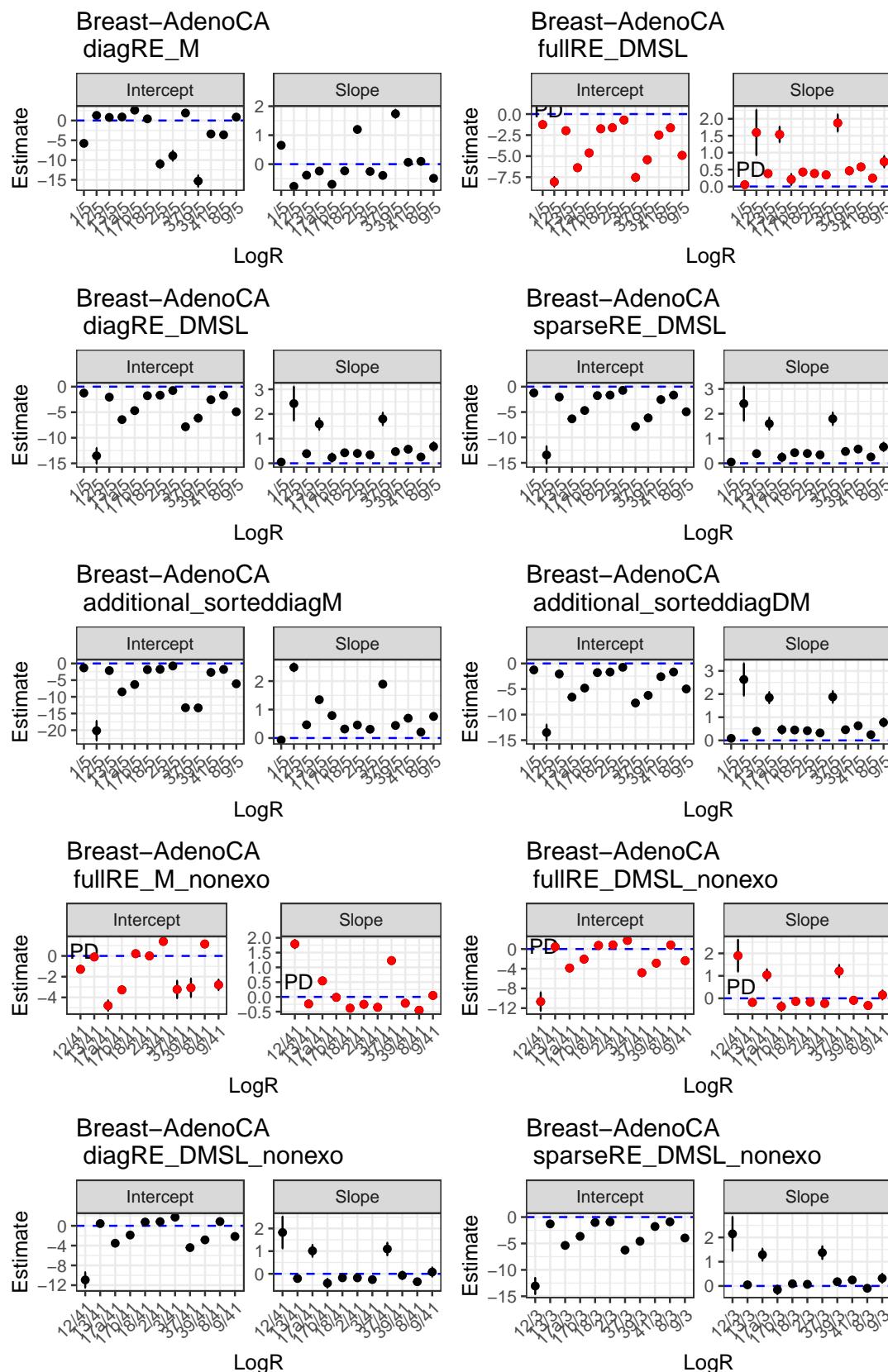
##      SBS1      SBS2      SBS3      SBS5      SBS8      SBS9
## 0.0553410311 0.1376261991 0.1993274971 0.2185906789 0.0969490005 0.0132833987
##      SBS12     SBS13     SBS17a     SBS17b     SBS18     SBS37
## 0.0003532317 0.1360853961 0.0036266519 0.0081714966 0.0531199688 0.0057240307
##      SBS39     SBS41
## 0.0402034279 0.0315979909

```

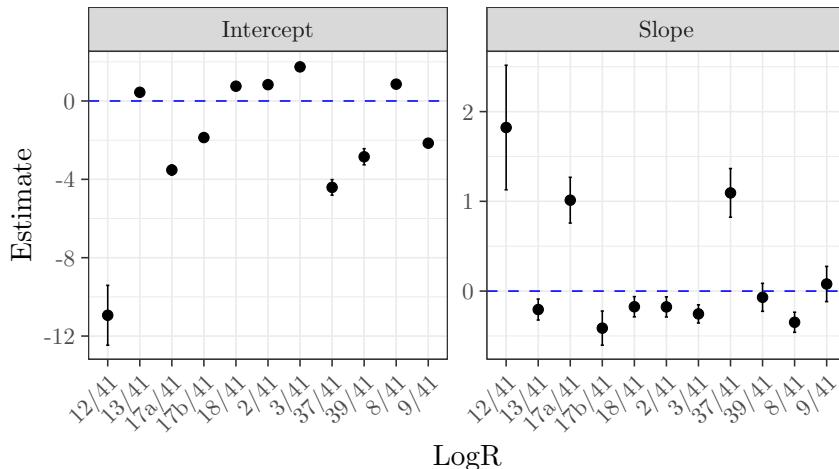
E.g.

- SBS9 is 0 in 56.2% of cases and has an overall exposure of 1.3%
- SBS12 is 0 in 95.6% of cases and has an overall exposure of 0%
- SBS17a is 0 in 71% of cases and has an overall exposure of 0.4%
- SBS17b is 0 in 50% of cases and has an overall exposure of 0.8%
- SBS37 is 0 in 77.2% of cases and has an overall exposure of 0.6%
- SBS39 is 0 in 59.9% of cases and has an overall exposure of 4%

## Betas



Breast-AdenoCA  
Breast adenocarcinoma  
diagRE DMSL non-exogenous

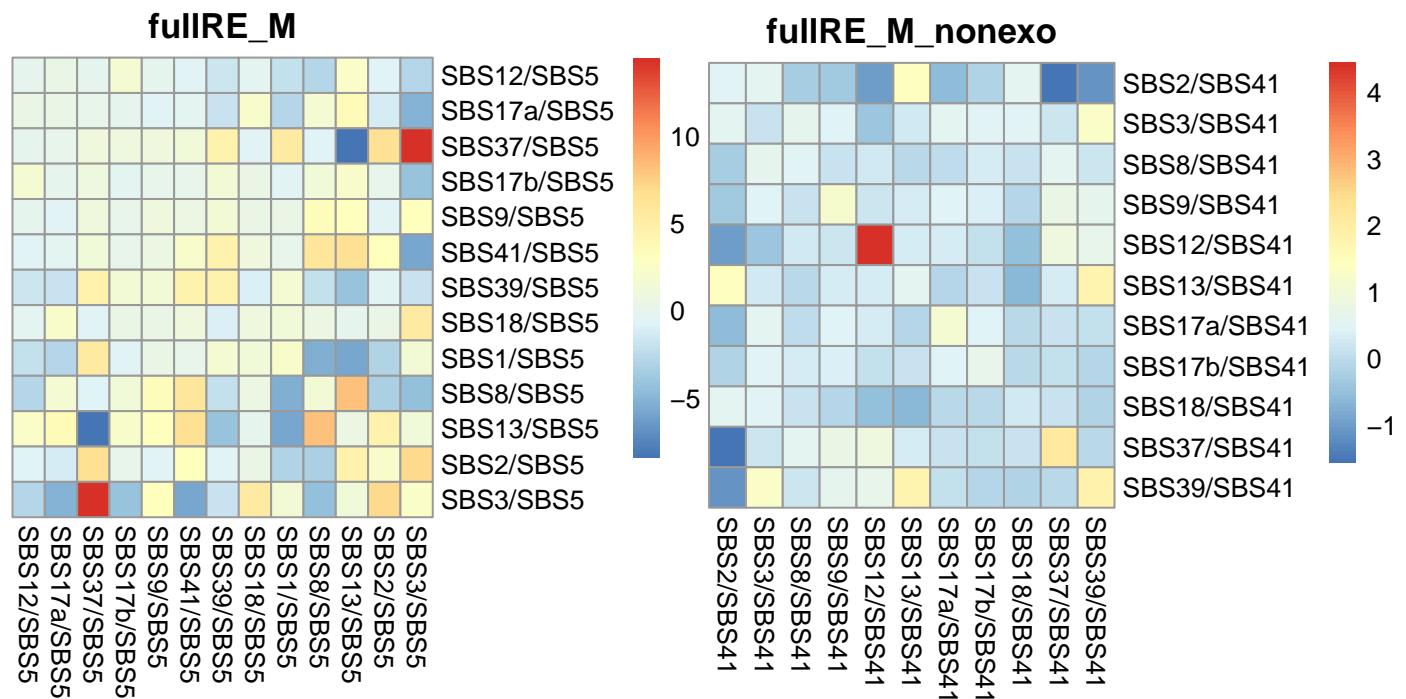


We use the results from the diagonal single lambda DM to test for differential abundance, giving a p-value of  $7.748574 \times 10^{-12}$ .

#### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]])$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]])$par.fixed, : This function had been incorrect until now (30 july 2021)
```

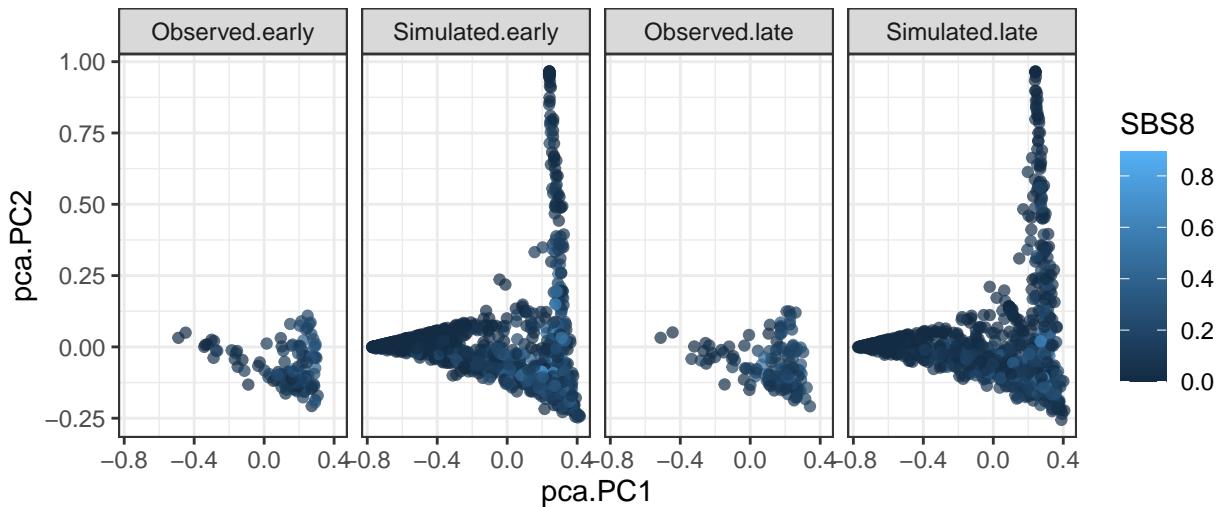


### Simulation under inferred data

Sorting the object as we are using sparseRE\_DM.

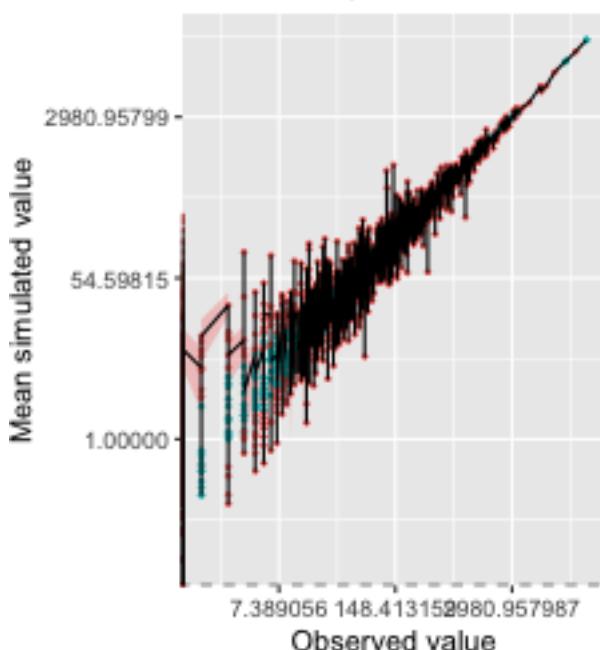
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :  
## This function had been incorrect until now (30 july 2021)  
  
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :  
## This function had been incorrect until now (30 july 2021)  
  
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):  
## sigma is numerically not positive semidefinite
```

### Simulation of Breast Adenocarcinoma samples

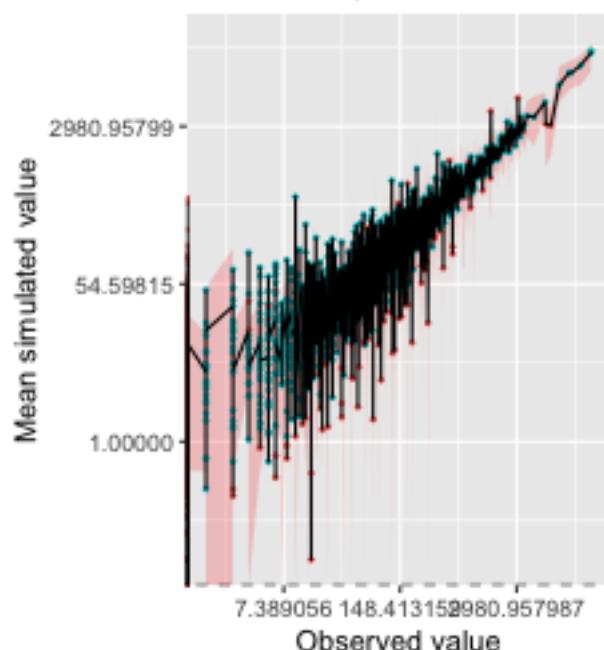


Ranked plot for coverage

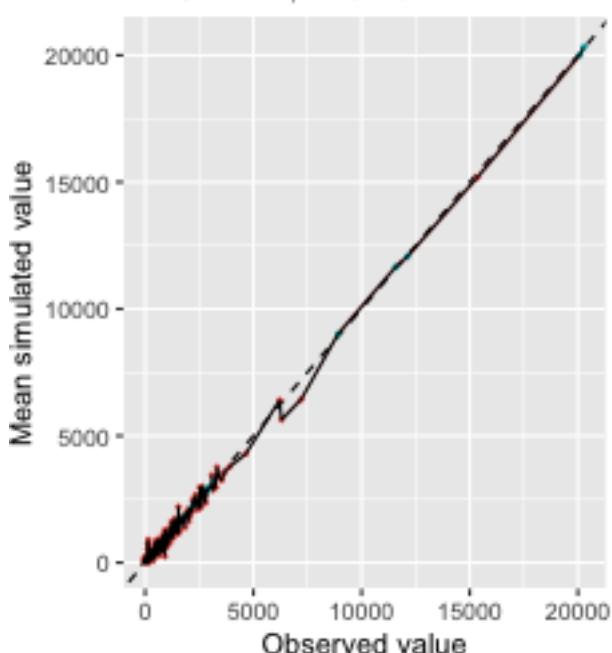
Breast\_AdenoCA\_nonexo (I)  
FALSE:2396; TRUE:868



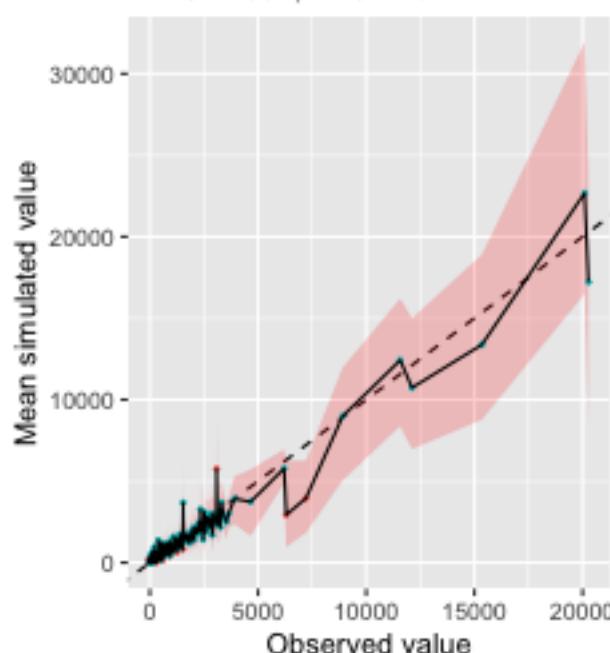
Breast\_AdenoCA\_nonexo (L)  
FALSE:1347; TRUE:1917



col ● FALSE ● TRUE  
Breast\_AdenoCA\_nonexo (M)  
FALSE:2417; TRUE:847



col ● FALSE ● TRUE  
Breast\_AdenoCA\_nonexo (DMS)  
FALSE:1337; TRUE:1927



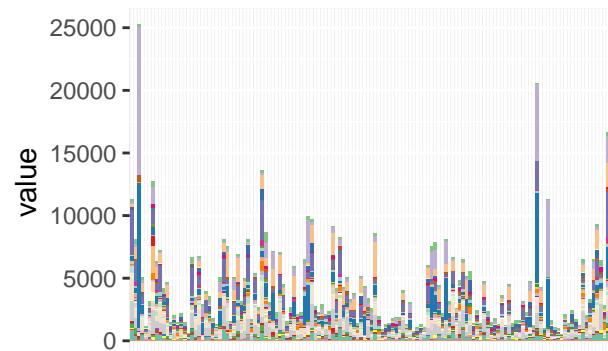
col ● FALSE ● TRUE

col ● FALSE ● TRUE

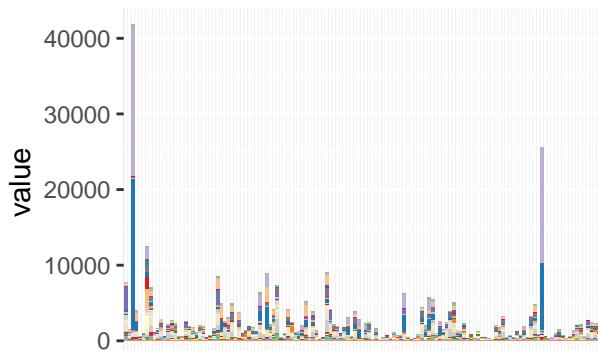
Signatures from mutSigExtractor

## [1] 136

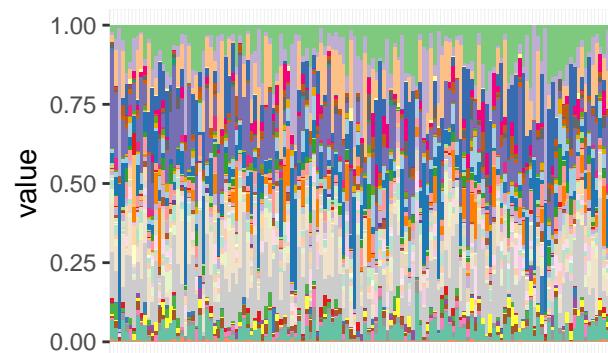
Early raw



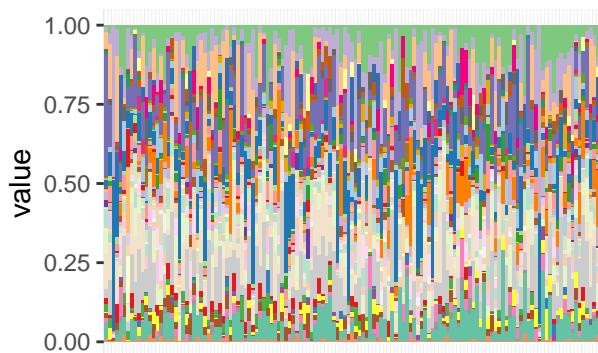
Late raw



Early normalised



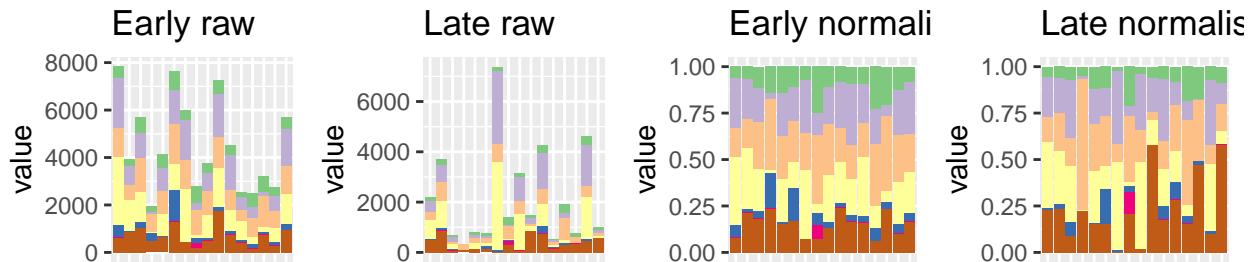
Late normalised



## Cervix-SCC

### Barplot and general statistics

```
## [1] 16
```



The number of samples and signatures is:

```
## [1] 32 7
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS5"  "SBS13" "SBS18" "SBS33" "SBS40"
```

### Convergence table

```
## [1] value L2     L1  
## <0 rows> (or 0-length row.names)
```

### Potentially problematic signatures

SBS33 is a potentially problematic signature, being 0 in 81.2% of cases and with an overall exposure of 0.4%.

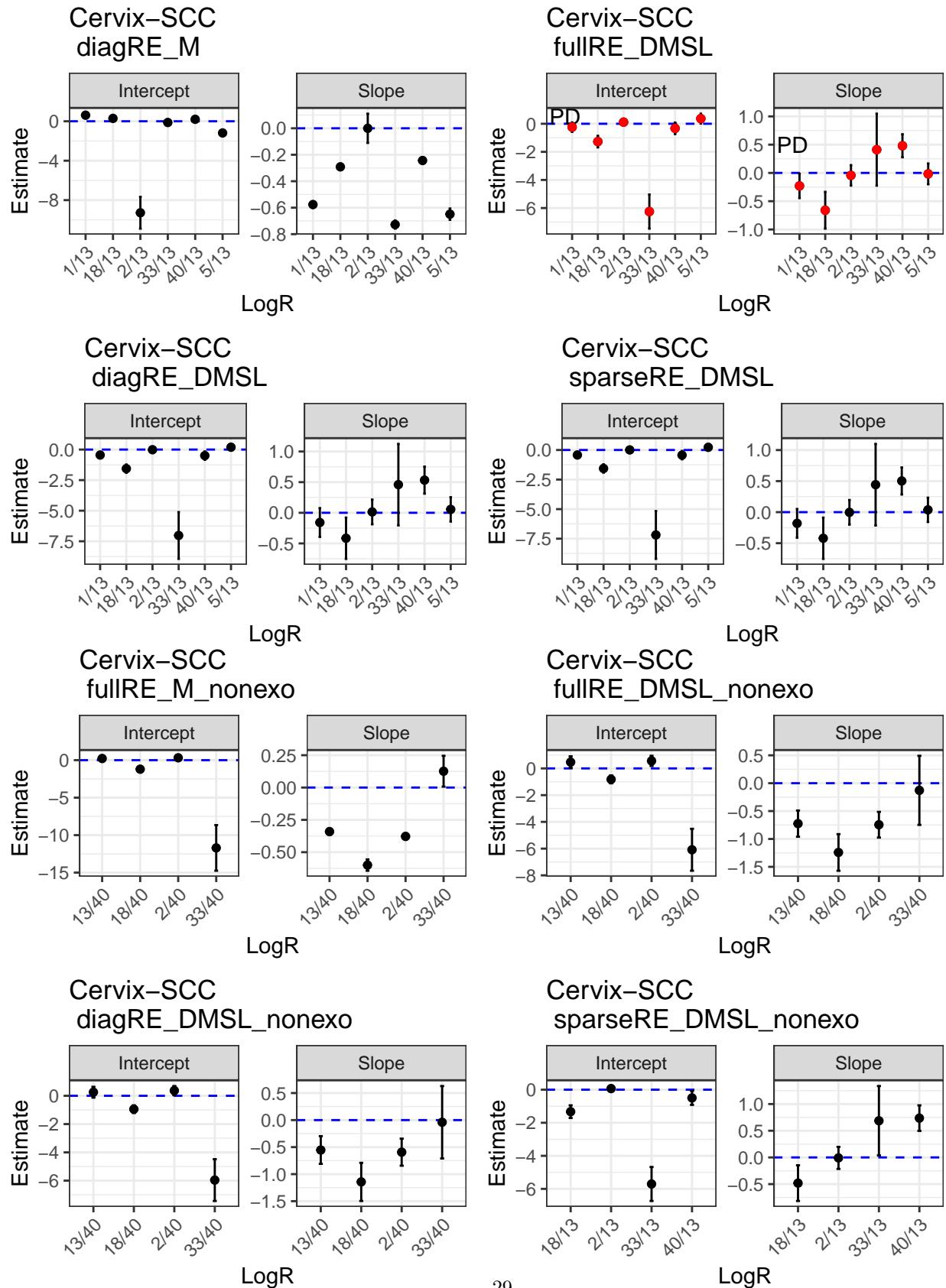
```
colSums(obj_Cervix_SCC$Y == 0)/nrow(obj_Cervix_SCC$Y)
```

```
##      SBS1      SBS2      SBS5      SBS13      SBS18      SBS33      SBS40  
## 0.00000 0.00000 0.00000 0.03125 0.15625 0.81250 0.03125  
colSums(obj_Cervix_SCC$Y)/sum(obj_Cervix_SCC$Y)
```

```
##          SBS1          SBS2          SBS5          SBS13          SBS18          SBS33  
## 0.099164517 0.235000561 0.211562185 0.250439236 0.046577698 0.003560615  
##          SBS40  
## 0.153695189
```

## Betas



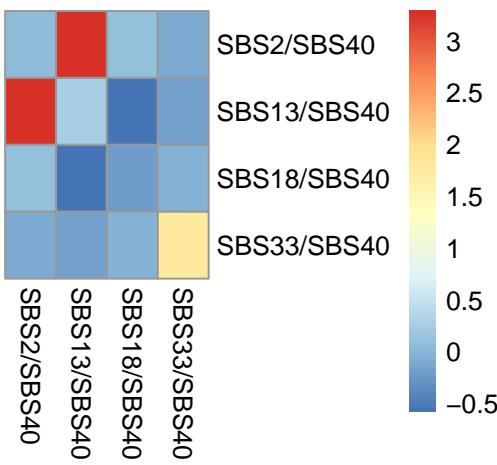
We use the results from the fullRE single lambda DM to test for differential abundance, giving a p-value of  $3.8923434 \times 10^{-5}$ .

### Covariance matrices

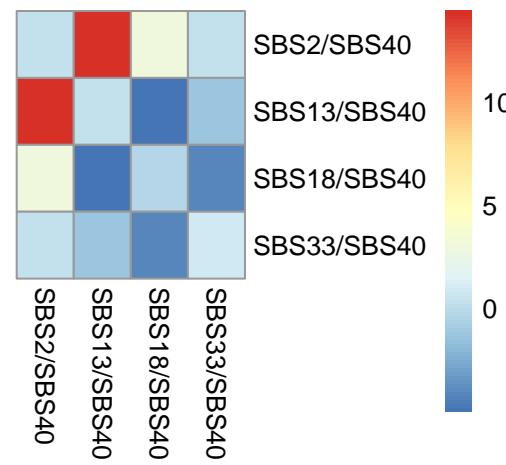
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

**IIRE\_M\_nonexo**



**RE\_DMSL\_nonexo**



### Simulation under inferred data

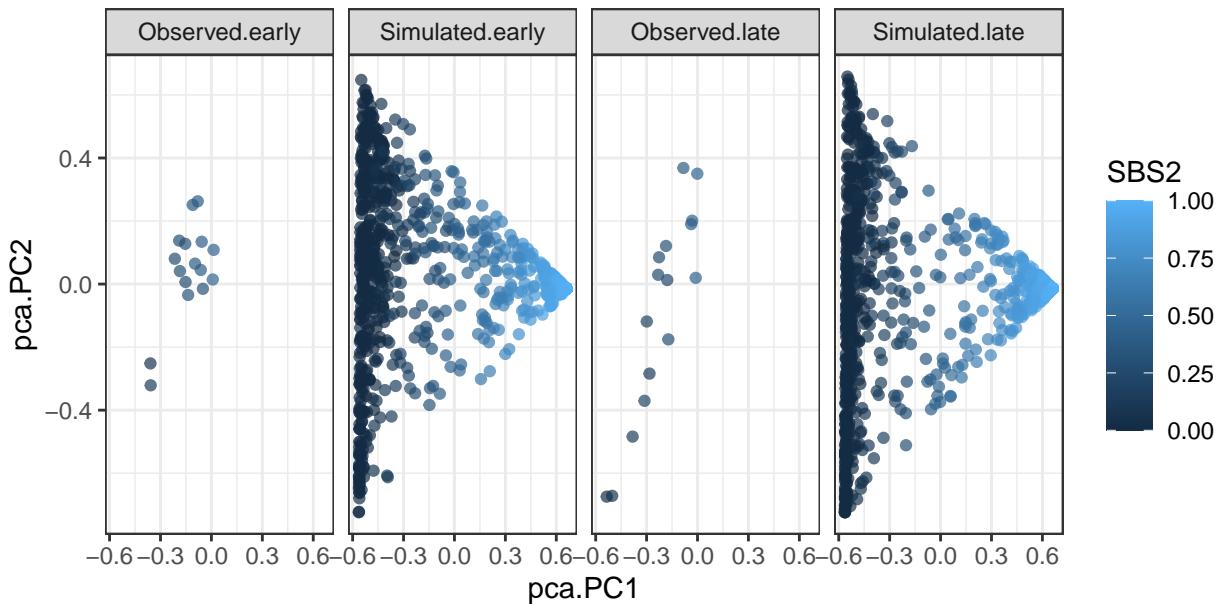
We are using the sorted version of the exposures, as we are using sparseRE DMSL.

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of Cervix SCC samples



Comparison of the estimated covariance matrix and the closest positive semidefinite matrix.

```
ct <- "Cervix-SCC"

dmin1_Cervix_SCC_cov_mat_sparse <- length(python_like_select_name(sparseRE_DMSL_nonexo[[ct]]$par.fixed, "dmin1"))
cov_vec_Cervix_SCC_cov_mat_sparse = rep(0, (dmin1_Cervix_SCC_cov_mat_sparse*2-dmin1_Cervix_SCC_cov_mat_sparse))
cov_vec_Cervix_SCC_cov_mat_sparse[as.numeric(strsplit(subset_sigs_sparse_cov_idx_nonexo[subset_sigs_sparse], ",")[[1]])] = 1

cov_mat_Cervix_SCC <- fill_covariance_matrix(arg_d = dmin1_Cervix_SCC_cov_mat_sparse,
                                                arg_entries_var = exp(python_like_select_name(sparseRE_DMSL_nonexo[[ct]]$var, "var")),
                                                arg_entries_cov = cov_vec_Cervix_SCC_cov_mat_sparse)

cov_mat_Cervix_SCC

##          [,1]      [,2]      [,3]      [,4]
## [1,] 2.690655  1.554016  1.337713  0.0000000
## [2,] 1.554016  1.246623 103.048586  0.0000000
## [3,] 1.337713 103.048586   1.490150  0.0000000
## [4,] 0.000000  0.000000   0.000000  0.2029568

Matrix:::nearPD(cov_mat_Cervix_SCC)

## $mat
## 4 x 4 Matrix of class "dpoMatrix"
##          [,1]      [,2]      [,3]      [,4]
## [1,] 2.690877  1.447736  1.443865  0.0000000
## [2,] 1.447736 52.148325 52.208484  0.0000000
## [3,] 1.443865 52.208484 52.268725  0.0000000
## [4,] 0.000000  0.000000   0.000000  0.2029568
##
## $eigenvalues
```

```

## [1] 1.044581e+02 2.649802e+00 2.029568e-01 1.044581e-06
##
## $corr
## [1] FALSE
##
## $normF
## [1] 101.6805
##
## $iterations
## [1] 2
##
## $rel.tol
## [1] 0
##
## $converged
## [1] TRUE
##
## attr(,"class")
## [1] "nearPD"

```

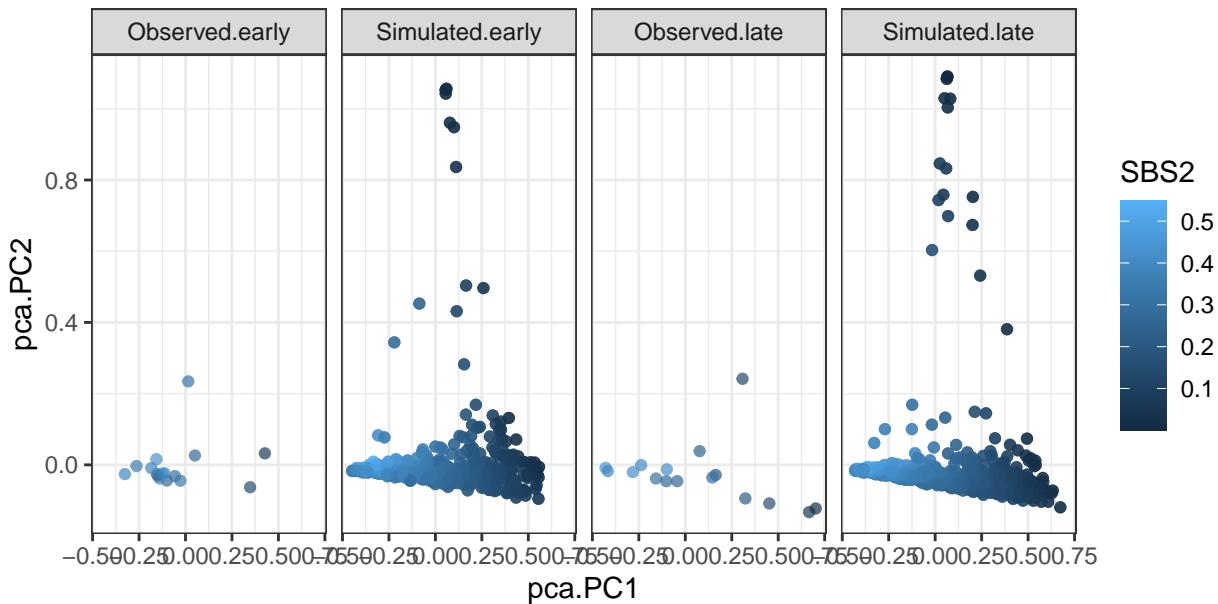
Now with fullRE M:

```

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
## Warning in mvtnorm:::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite

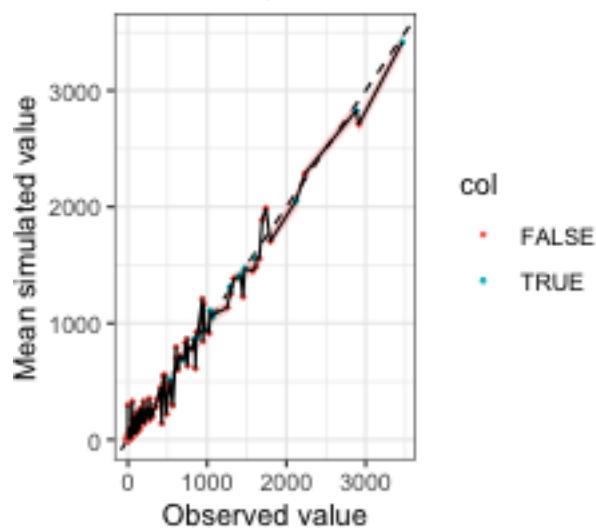
```

### Simulation of Cervix SCC samples

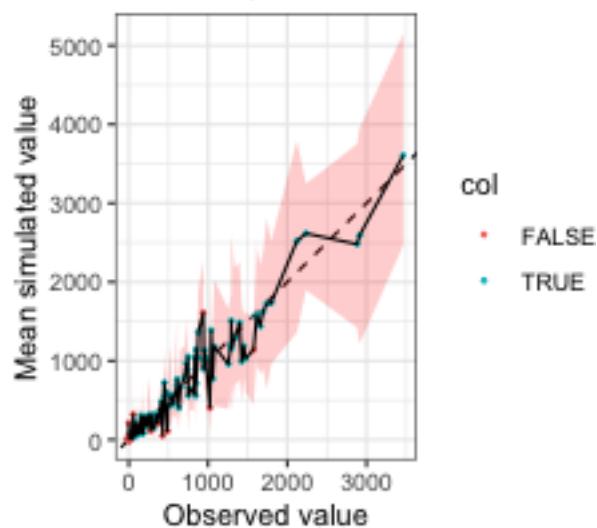


Ranked plot for coverage

obj\_Cervix\_SCC\_nonexo  
(fullRE M)  
FALSE:122; TRUE:38

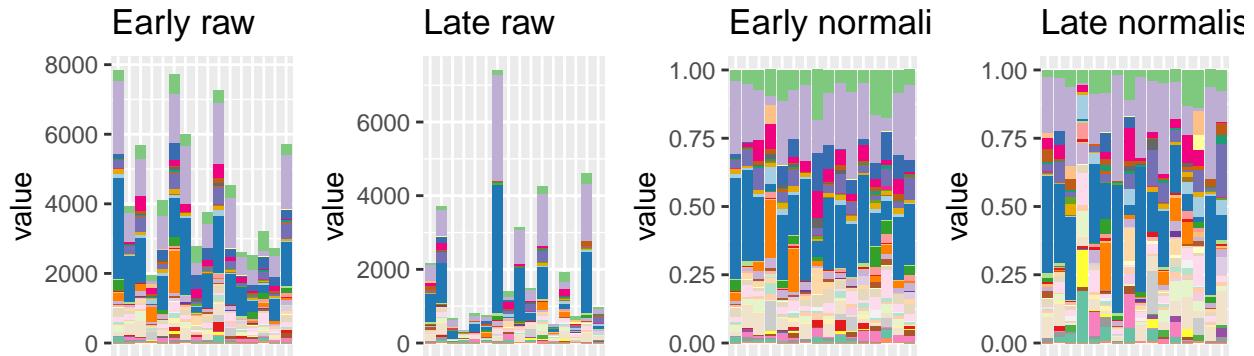


obj\_Cervix\_SCC\_nonexo  
(fullRE DMSL)  
FALSE:44; TRUE:116



## Signatures from mutSigExtractor

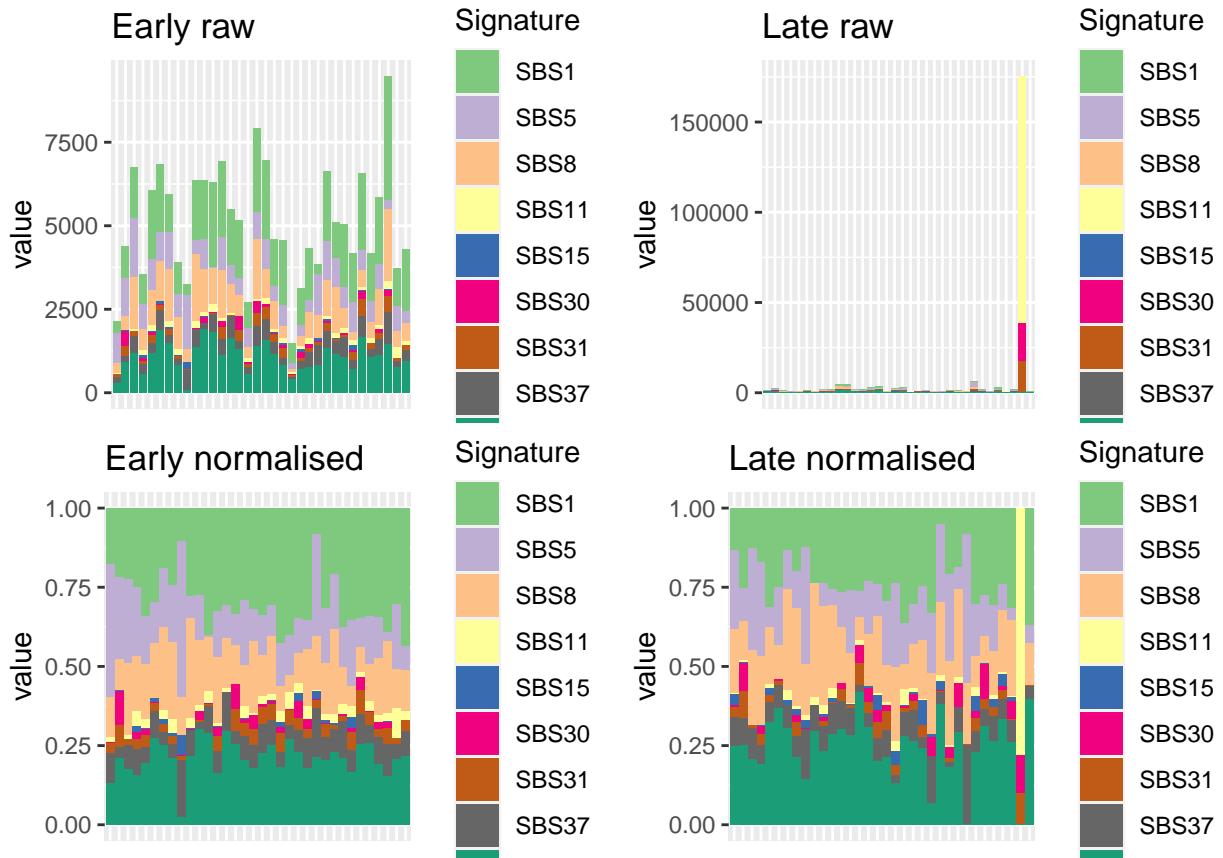
```
## [1] 16
```



## CNS-GBM

### Barplot and general statistics

```
## [1] 34
```



The number of samples and signatures is:

```
## [1] 68 9
```

The signatures are:

```
## [1] "SBS1"  "SBS5"  "SBS8"  "SBS11" "SBS15" "SBS30" "SBS31" "SBS37" "SBS40"
```

### Convergence table

We only have converged results for the multinomial with full RE, and the DM with a single lambda (diag and sparse RE). It is the same for nonexogenous signatures.

|               | L2                               | L1                       |
|---------------|----------------------------------|--------------------------|
| ## 1 CNS-GBM  | hessian_positivedefinite_bool    | diagRE_M                 |
| ## 2 CNS-GBM  | hessian_positivedefinite_bool    | fullRE_M                 |
| ## 3 CNS-GBM  | hessian_nonpositivedefinite_bool | diagRE_DMDL              |
| ## 4 CNS-GBM  | hessian_nonpositivedefinite_bool | fullRE_halfDM            |
| ## 5 CNS-GBM  | hessian_nonpositivedefinite_bool | fullRE_DMDL              |
| ## 6 CNS-GBM  | hessian_positivedefinite_bool    | diagRE_DMSL              |
| ## 7 CNS-GBM  | hessian_positivedefinite_bool    | sparseRE_DMSL            |
| ## 8 CNS-GBM  | hessian_nonpositivedefinite_bool | fullRE_DMSL              |
| ## 9 CNS-GBM  | hessian_nonpositivedefinite_bool | fullRE_DMSL_SBS1         |
| ## 10 CNS-GBM | hessian_positivedefinite_bool    | fullRE_M_nonexo          |
| ## 11 CNS-GBM | hessian_positivedefinite_bool    | diagRE_DMSL_nonexo       |
| ## 12 CNS-GBM | hessian_positivedefinite_bool    | sparseRE_DMSL_nonexo     |
| ## 13 CNS-GBM | hessian_nonpositivedefinite_bool | fullRE_DMSL_nonexo       |
| ## 14 CNS-GBM | hessian_nonpositivedefinite_bool | fullRE_DMDL_nonexo       |
| ## 15 CNS-GBM | Timeout                          | fullRE_DMDL_sortednonexo |

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo do converge:

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

### Potentially problematic signatures

We notice that there are no truly problematic signatures (SBS15 has the most zeros; 50%).

```
colSums(obj_CNS_GBM$Y == 0)/nrow(obj_CNS_GBM$Y)
```

```
##      SBS1     SBS5     SBS8     SBS11    SBS15     SBS30     SBS31
## 0.01470588 0.02941176 0.01470588 0.20588235 0.50000000 0.33823529 0.13235294
##      SBS37     SBS40
## 0.01470588 0.02941176
```

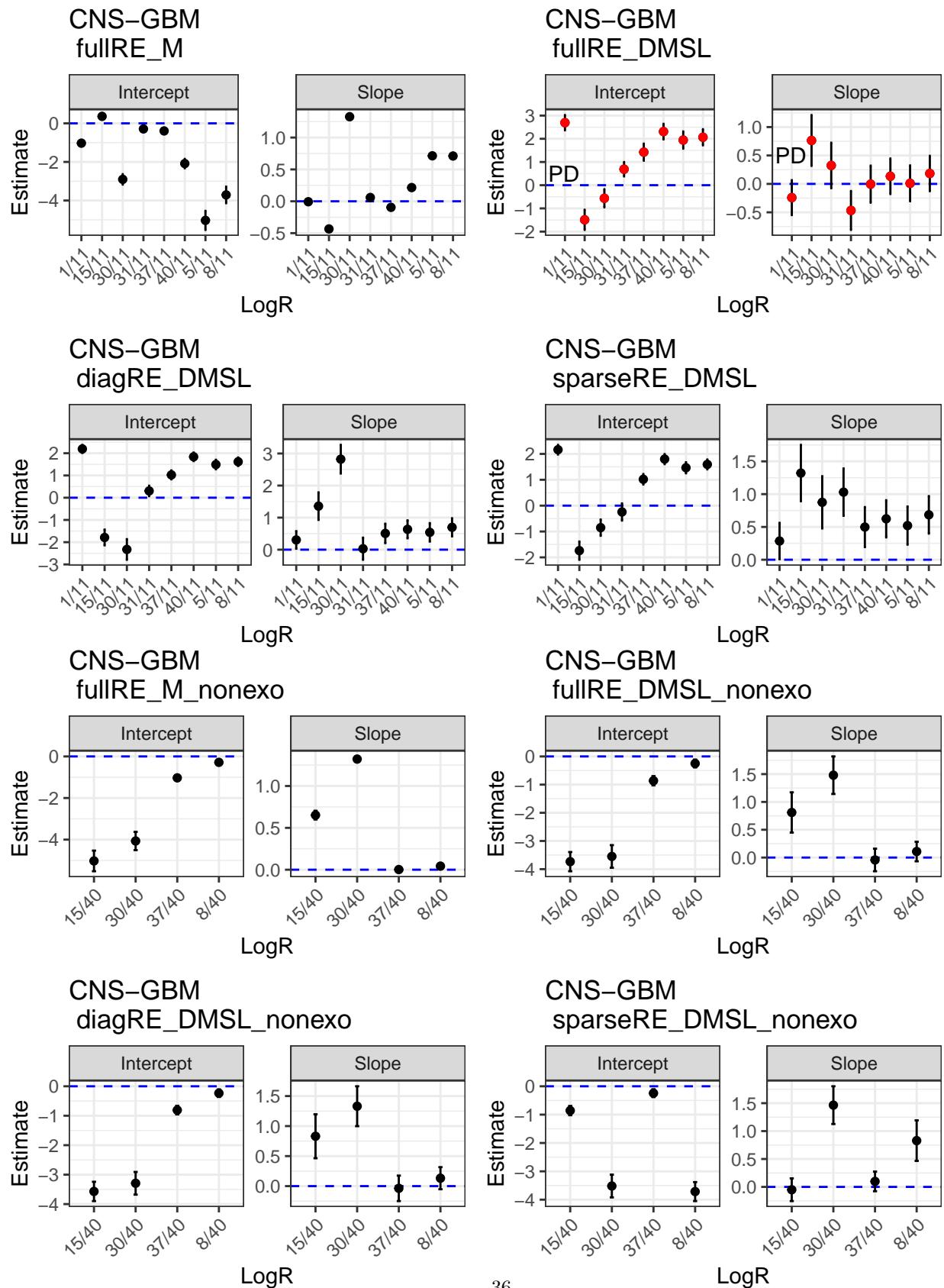
```
colSums(obj_CNS_GBM$Y)/sum(obj_CNS_GBM$Y)
```

```
##      SBS1     SBS5     SBS8     SBS11    SBS15     SBS30
## 0.164856854 0.087757118 0.103223676 0.345294365 0.004258098 0.060917020
##      SBS31     SBS37     SBS40
## 0.060793210 0.046931329 0.125968329
```

```
additional_sortedMnonexo <- list()
additional_sortedDMSLnonexo <- list()
```

```
additional_sortedMnonexo[["CNS-GBM"]] <- sortedM_CNSGBM
additional_sortedDMSLnonexo[["CNS-GBM"]] <- sortedDM_CNSGBM
```

## Betas



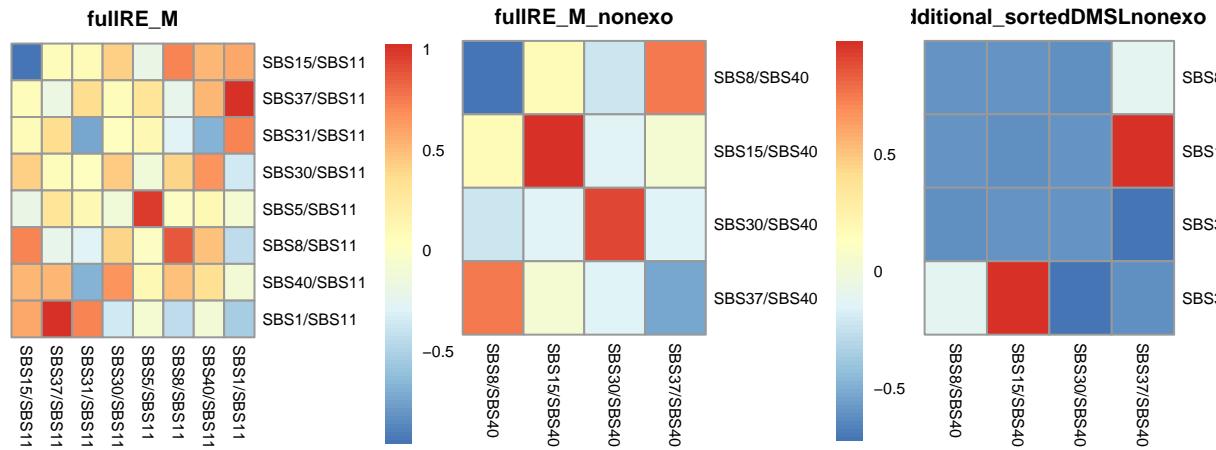
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $6.6827492 \times 10^{-5}$ .

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



### Simulation under inferred data

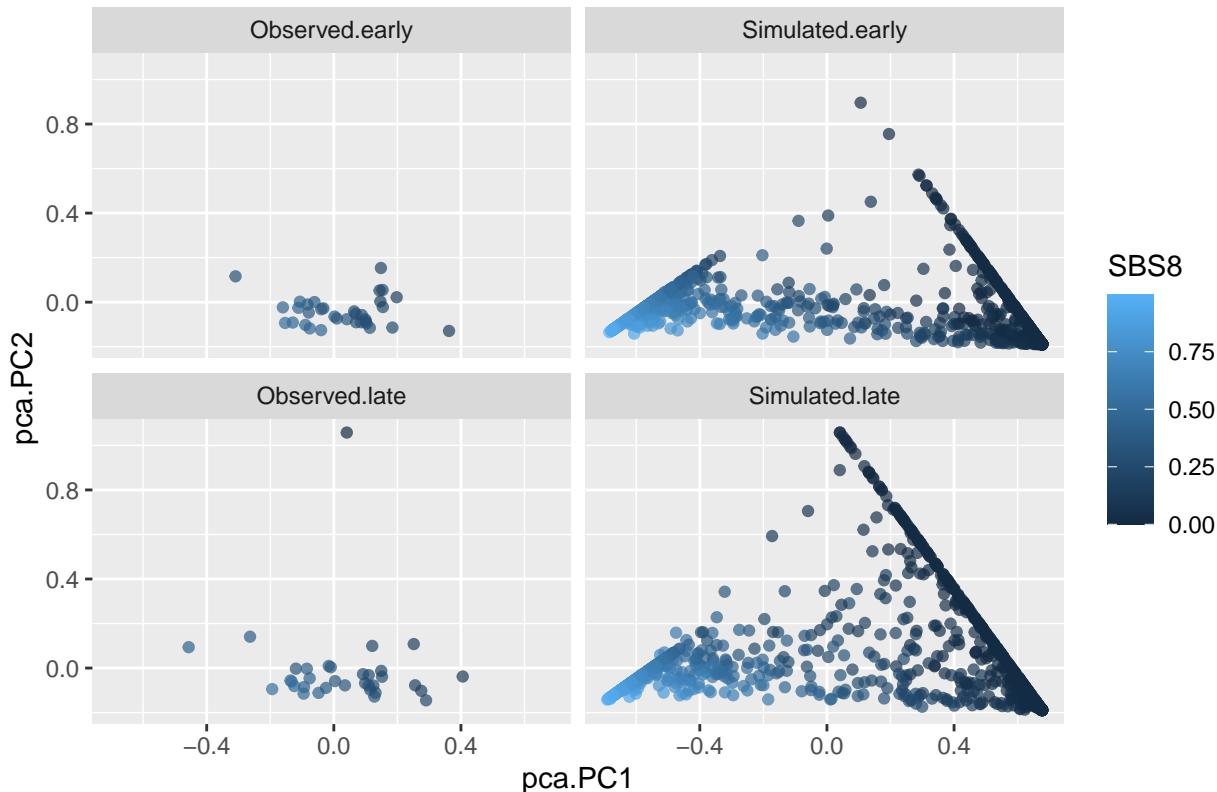
With fullRE DMSL:

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of CNS–GBM samples



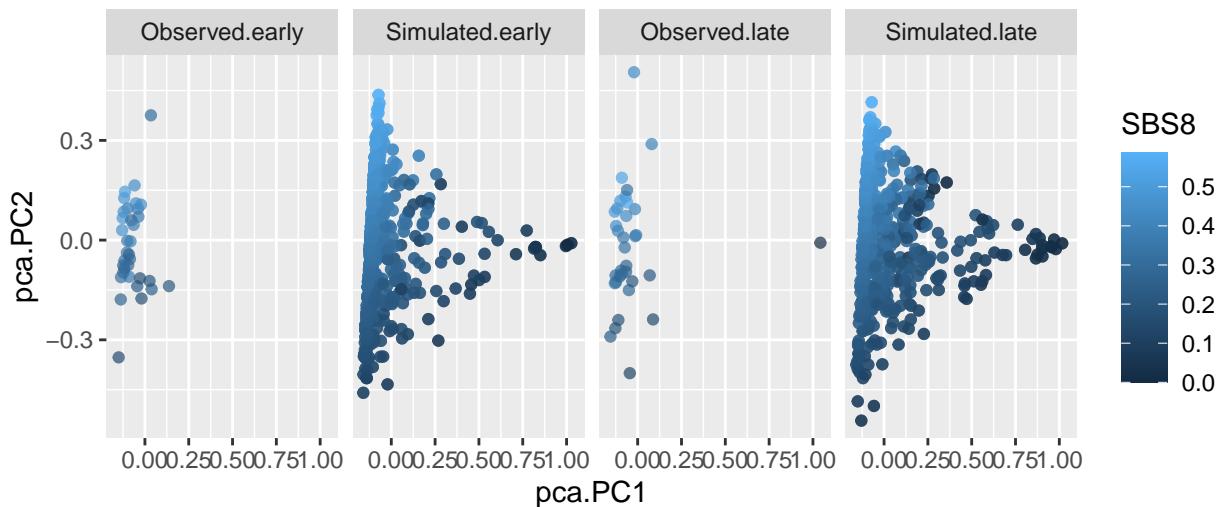
With fullRE M, this time the covariance matrix is positive semi-definite:

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

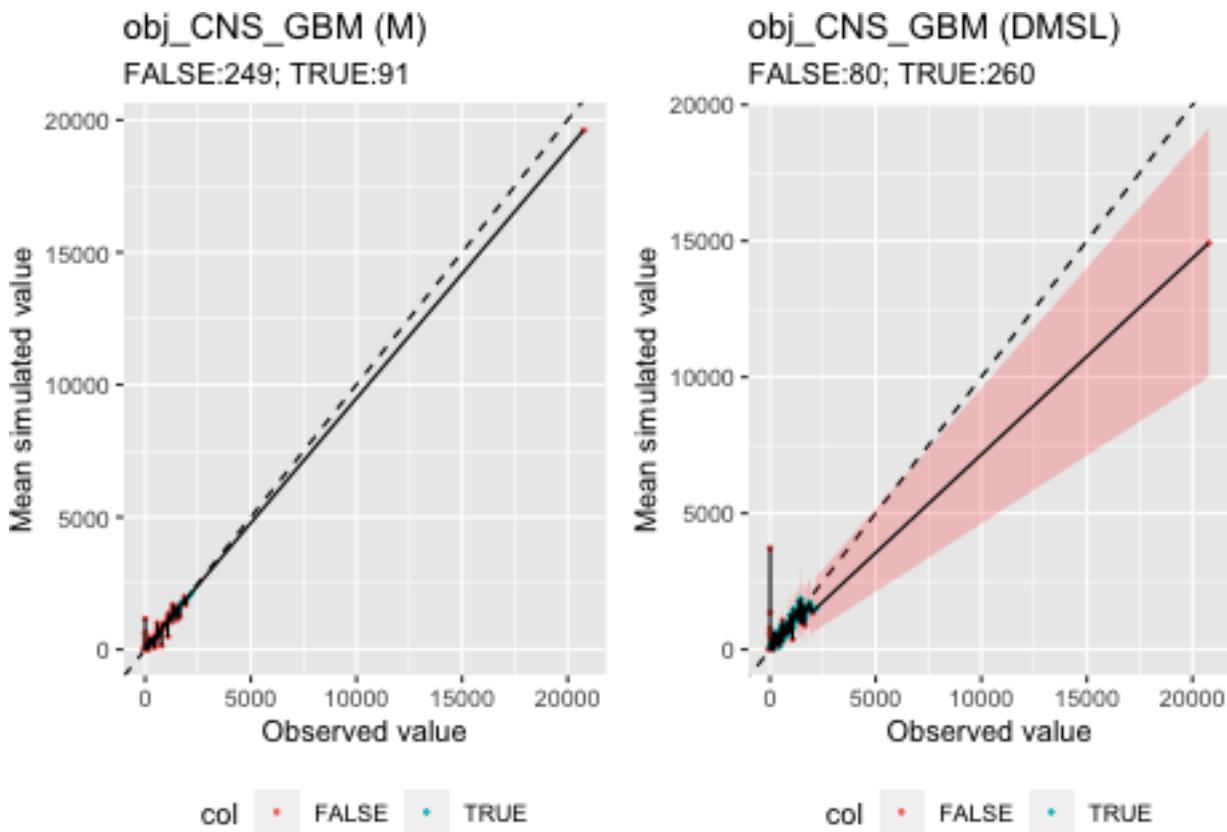
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of CNS–GBM samples (M)



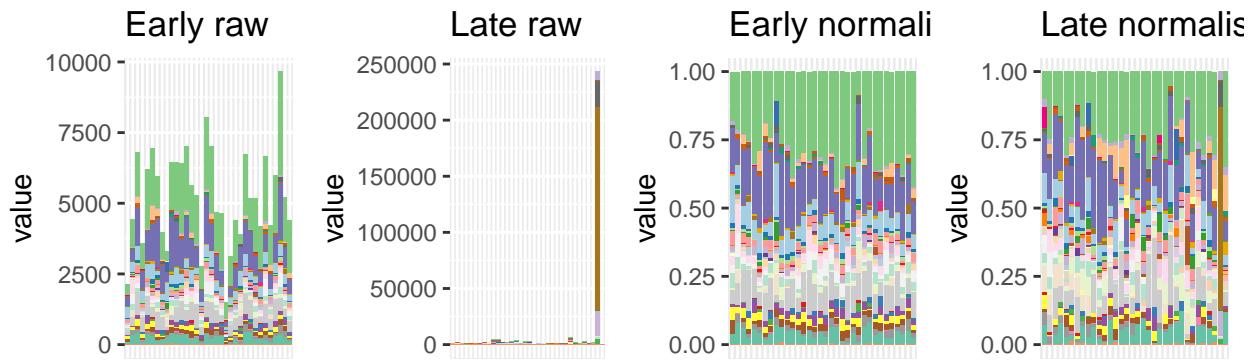
Ranked plot for coverage



## Signatures from mutSigExtractor

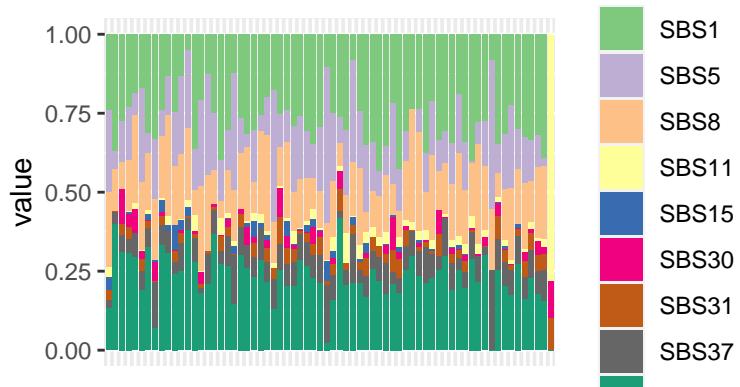
The signatures from mutSigExtractor are a bit more chaotic:

```
## [1] 34
```



Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.

```
## Creating plot... it might take some time if the data are large. Number of samples: 68
```

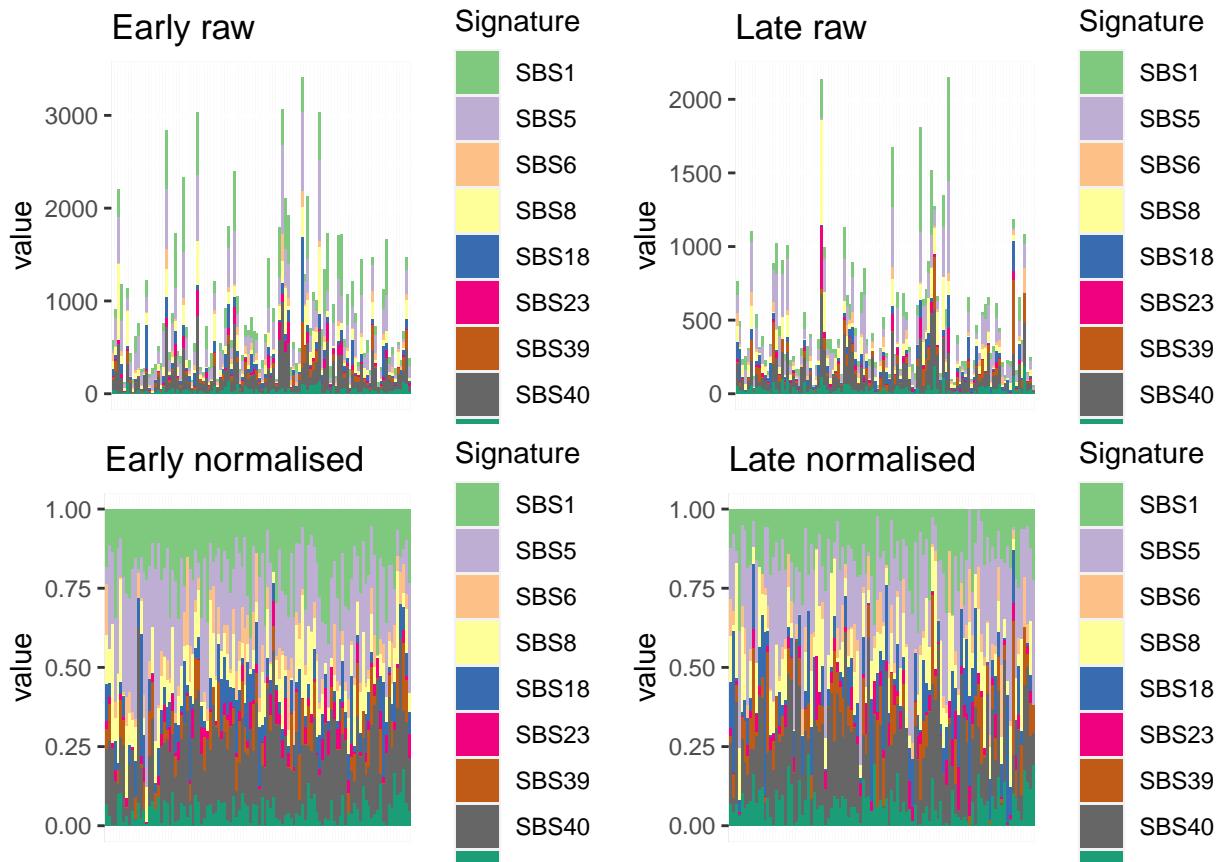


## CNS-Medullo

### Barplot and general statistics

```
## [1] 106
```

```
## Creating plot... it might take some time if the data are large. Number of samples: 106
## Creating plot... it might take some time if the data are large. Number of samples: 106
## Creating plot... it might take some time if the data are large. Number of samples: 106
## Creating plot... it might take some time if the data are large. Number of samples: 106
```



The number of samples and signatures is:

```
## [1] 212 9
```

The signatures are:

```
## [1] "SBS1" "SBS5" "SBS6" "SBS8" "SBS18" "SBS23" "SBS39" "SBS40" "SBS46"
```

### Convergence table

Pretty much everything has converged in this case

|                   | L2                               | L1                   |
|-------------------|----------------------------------|----------------------|
| ## 1 CNS-Medullo  | hessian_positivedefinite_bool    | diagRE_M             |
| ## 2 CNS-Medullo  | hessian_positivedefinite_bool    | fullRE_M             |
| ## 3 CNS-Medullo  | hessian_positivedefinite_bool    | diagRE_DMDL          |
| ## 4 CNS-Medullo  | hessian_nonpositivedefinite_bool | fullRE_halfDM        |
| ## 5 CNS-Medullo  | hessian_nonpositivedefinite_bool | fullRE_DMDL          |
| ## 6 CNS-Medullo  | hessian_positivedefinite_bool    | diagRE_DMSL          |
| ## 7 CNS-Medullo  | hessian_positivedefinite_bool    | sparseRE_DMSL        |
| ## 8 CNS-Medullo  | hessian_nonpositivedefinite_bool | fullRE_DMSL          |
| ## 9 CNS-Medullo  | hessian_nonpositivedefinite_bool | fullRE_DMSL_SBS1     |
| ## 10 CNS-Medullo | hessian_positivedefinite_bool    | fullRE_M_nonexo      |
| ## 11 CNS-Medullo | hessian_positivedefinite_bool    | diagRE_DMSL_nonexo   |
| ## 12 CNS-Medullo | hessian_positivedefinite_bool    | sparseRE_DMSL_nonexo |
| ## 13 CNS-Medullo | hessian_positivedefinite_bool    | fullRE_DMSL_nonexo   |

```

## 14 CNS-Medullo hessian_positivedefinite_bool fullRE_DMDL_nonexo
## 15 CNS-Medullo hessian_nonpositivedefinite_bool fullRE_DMDL_sortednonexo

```

As nonexo DMSL has already converged, we don't re-run anything.

### Potentially problematic signatures

We notice that there are no truly problematic signatures

```
colSums(obj_CNS_Medullo$Y == 0)/nrow(obj_CNS_Medullo$Y)
```

```

##      SBS1      SBS5      SBS6      SBS8      SBS18     SBS23
## 0.004716981 0.056603774 0.264150943 0.089622642 0.155660377 0.235849057
##      SBS39     SBS40     SBS46
## 0.353773585 0.066037736 0.099056604

```

```
colSums(obj_CNS_Medullo$Y)/sum(obj_CNS_Medullo$Y)
```

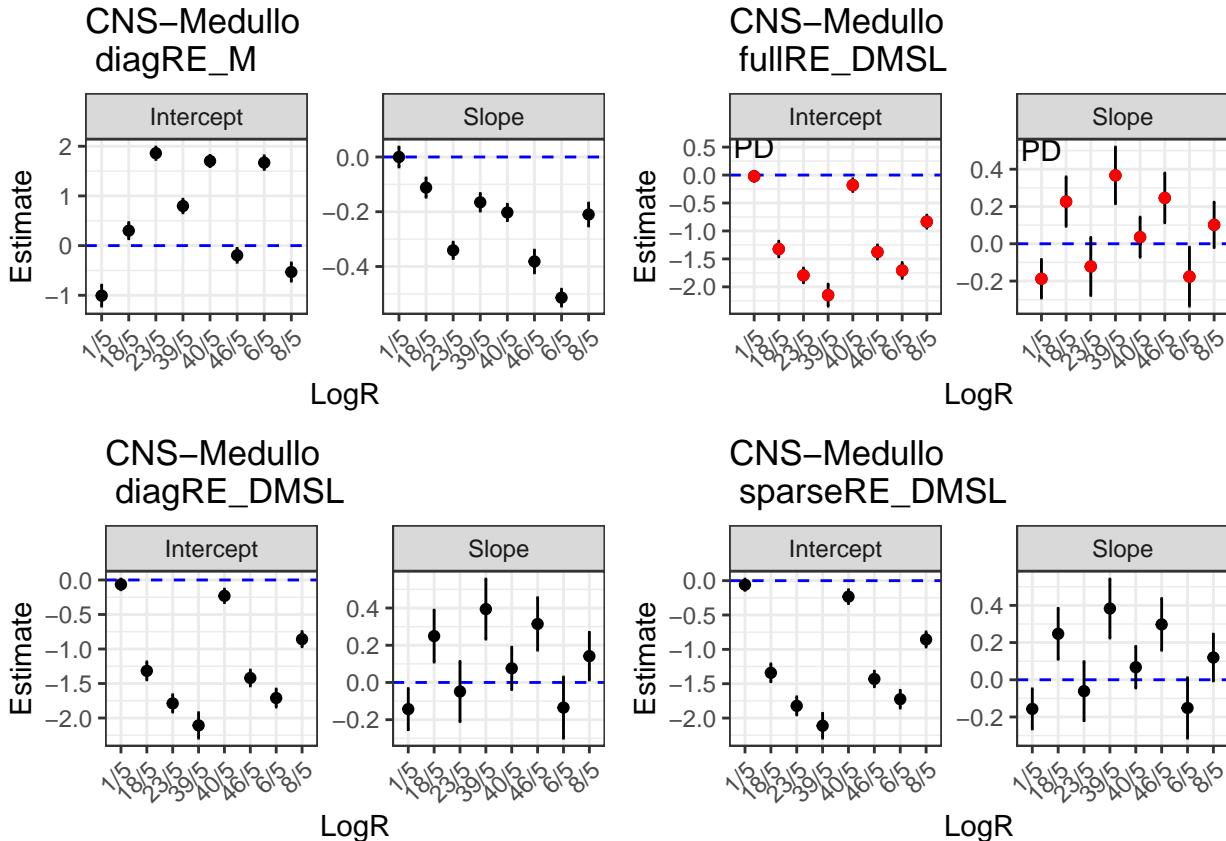
```

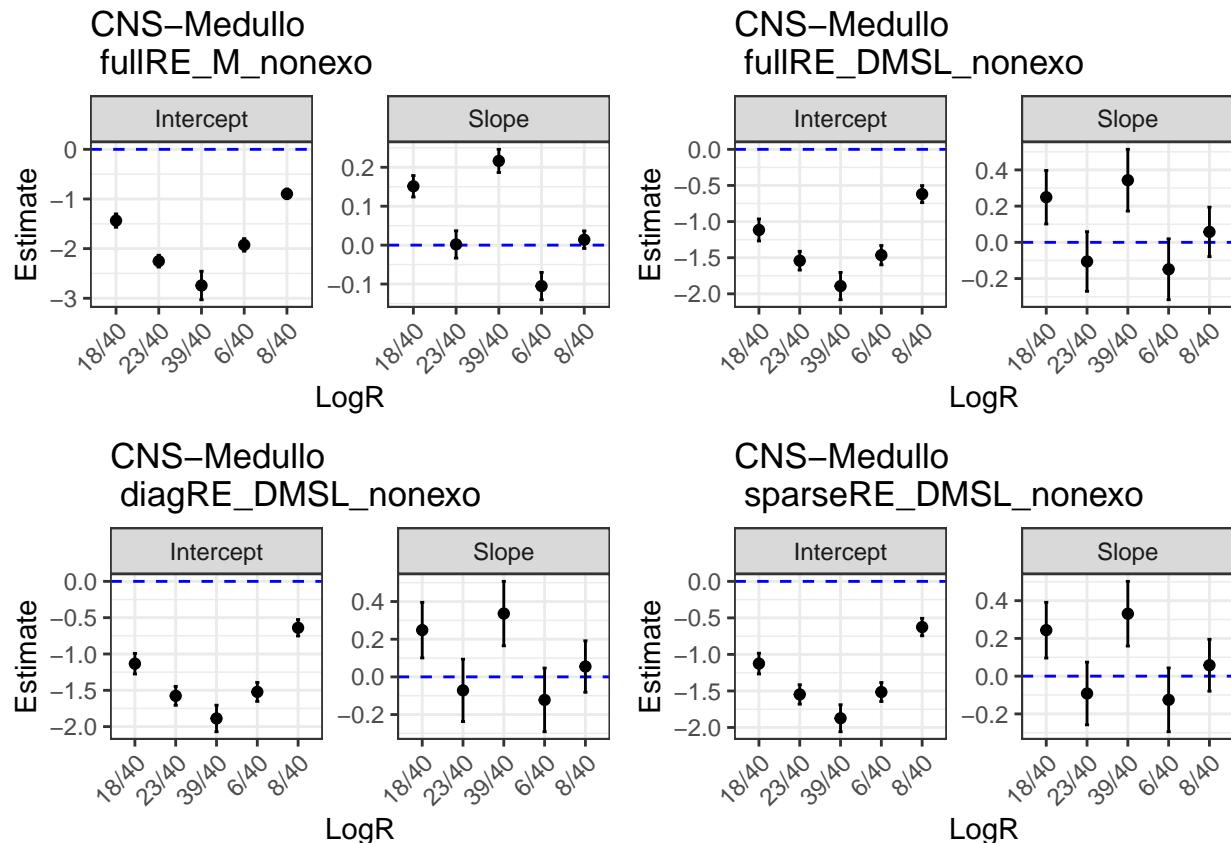
##      SBS1      SBS5      SBS6      SBS8      SBS18     SBS23     SBS39
## 0.19177483 0.22946904 0.03737123 0.11614418 0.07466844 0.03836035 0.05498025
##      SBS40     SBS46
## 0.21065558 0.04657610

```

### Betas

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```





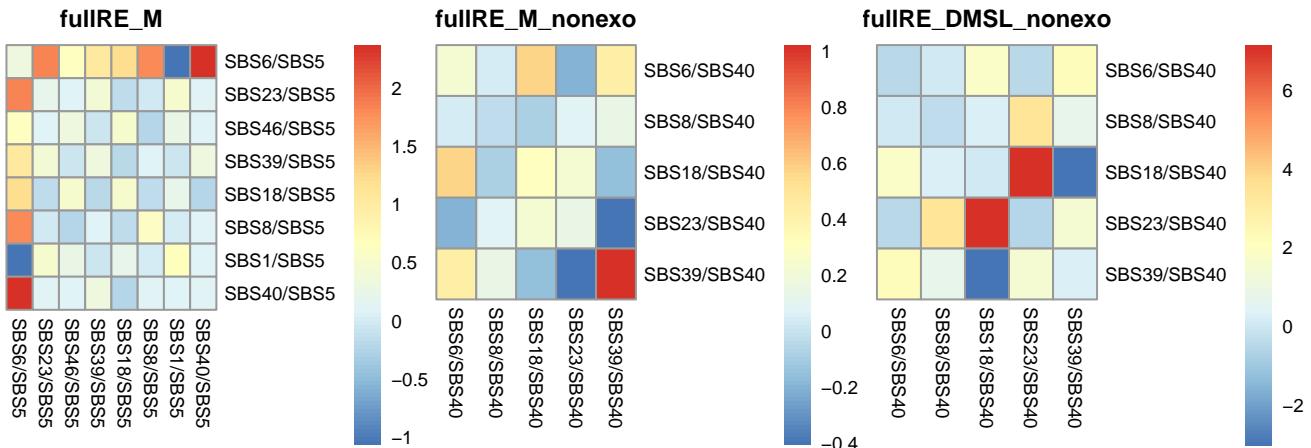
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of 0.0677062.

#### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



### Simulation under inferred data

```

obj_CNS_Medullo_nonexo <- give_subset_sigs_TMBobj(obj_CNS_Medullo, nonexogenous$V1)

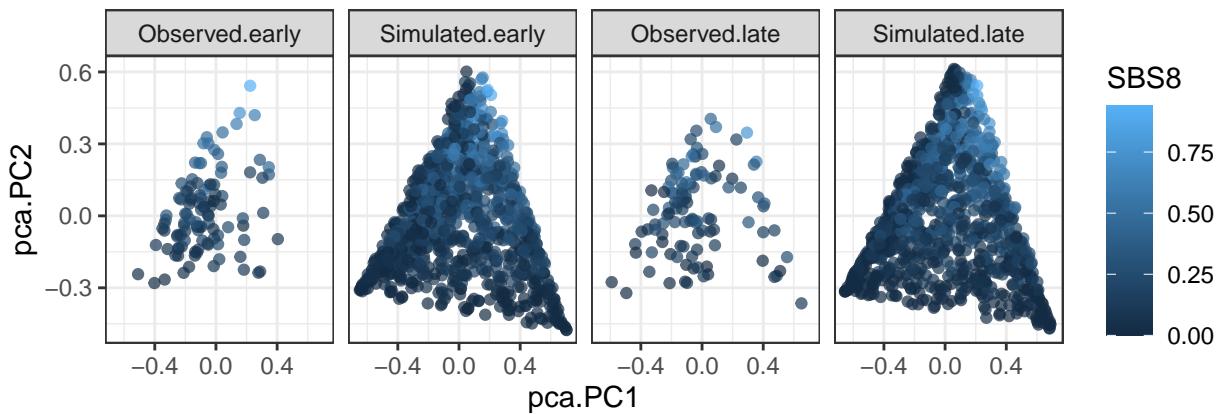
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

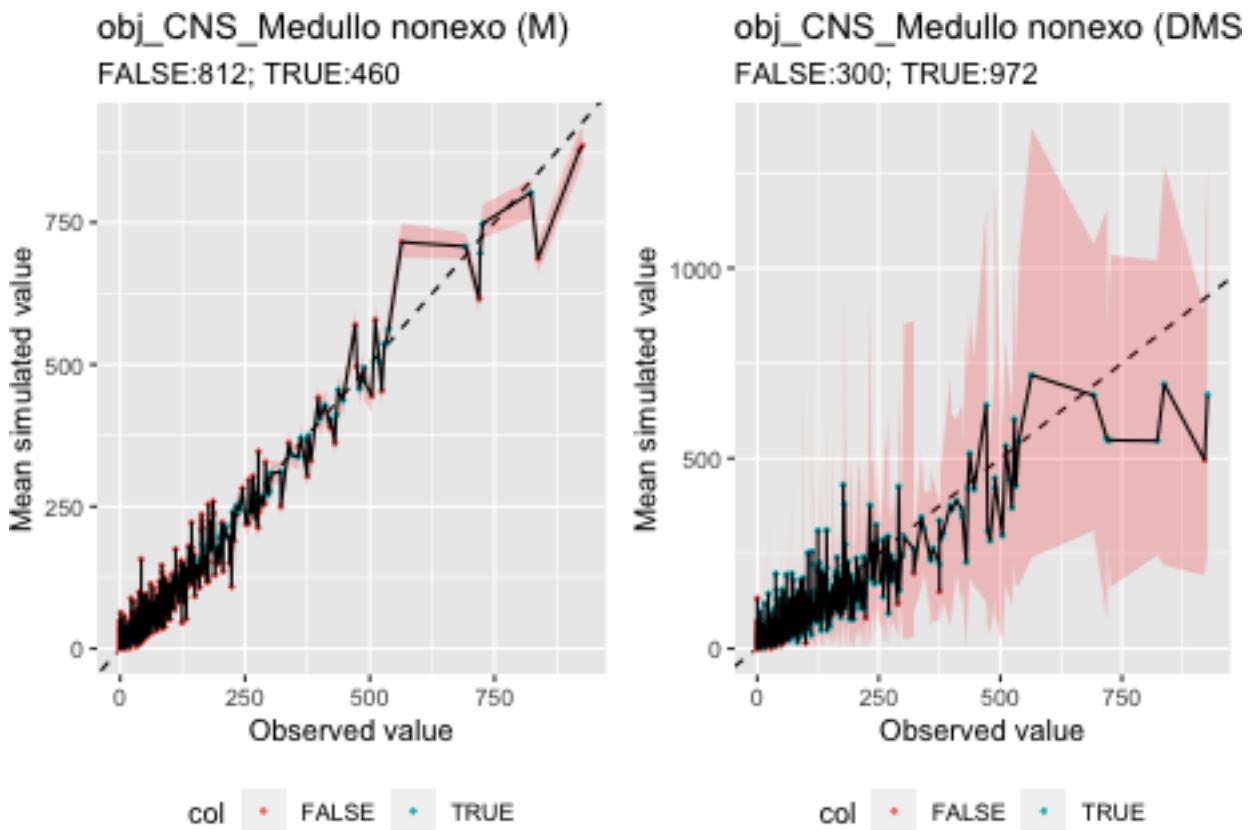
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite

```

### Simulation of CNS-Medullo samples



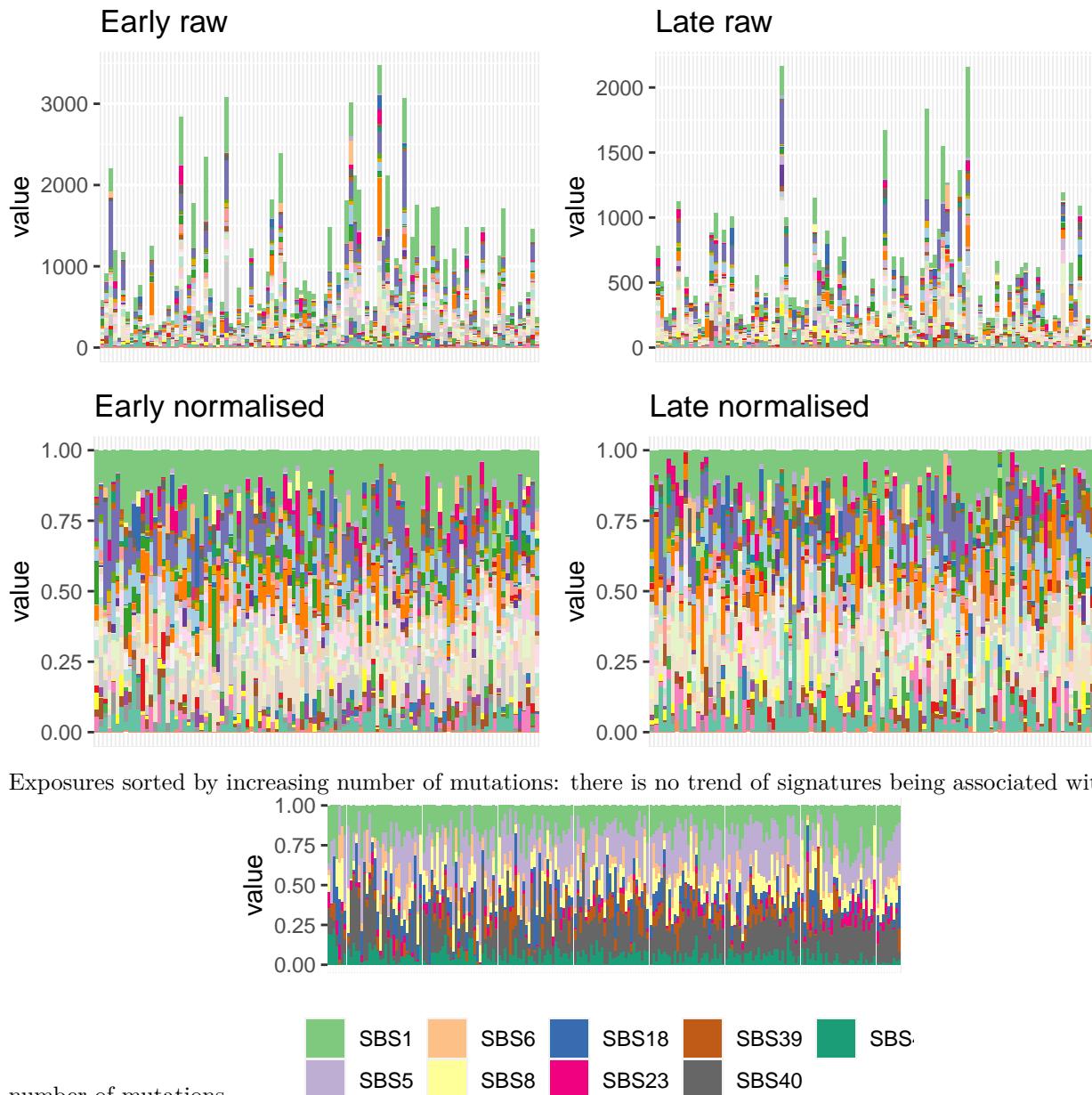
### Ranked plot for coverage



### Signatures from mutSigExtractor

The signatures from mutSigExtractor are a bit more chaotic:

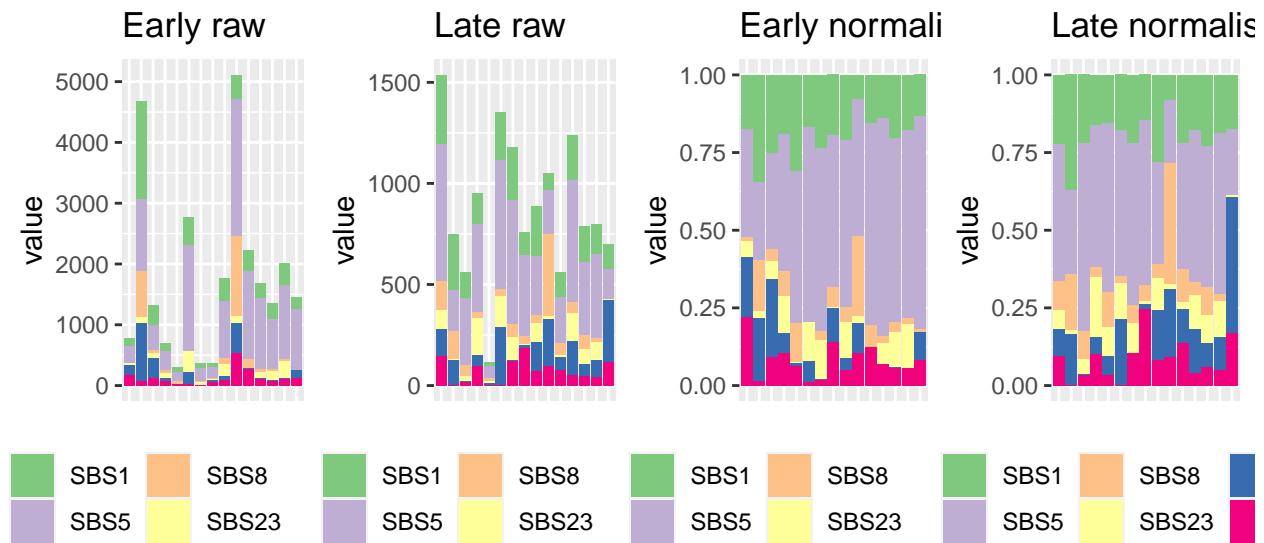
```
## [1] 106
```



## CNS-Oligo

### Barplot and general statistics

```
## [1] 15
```



The number of samples and signatures is:

```
## [1] 30 6
```

The signatures are:

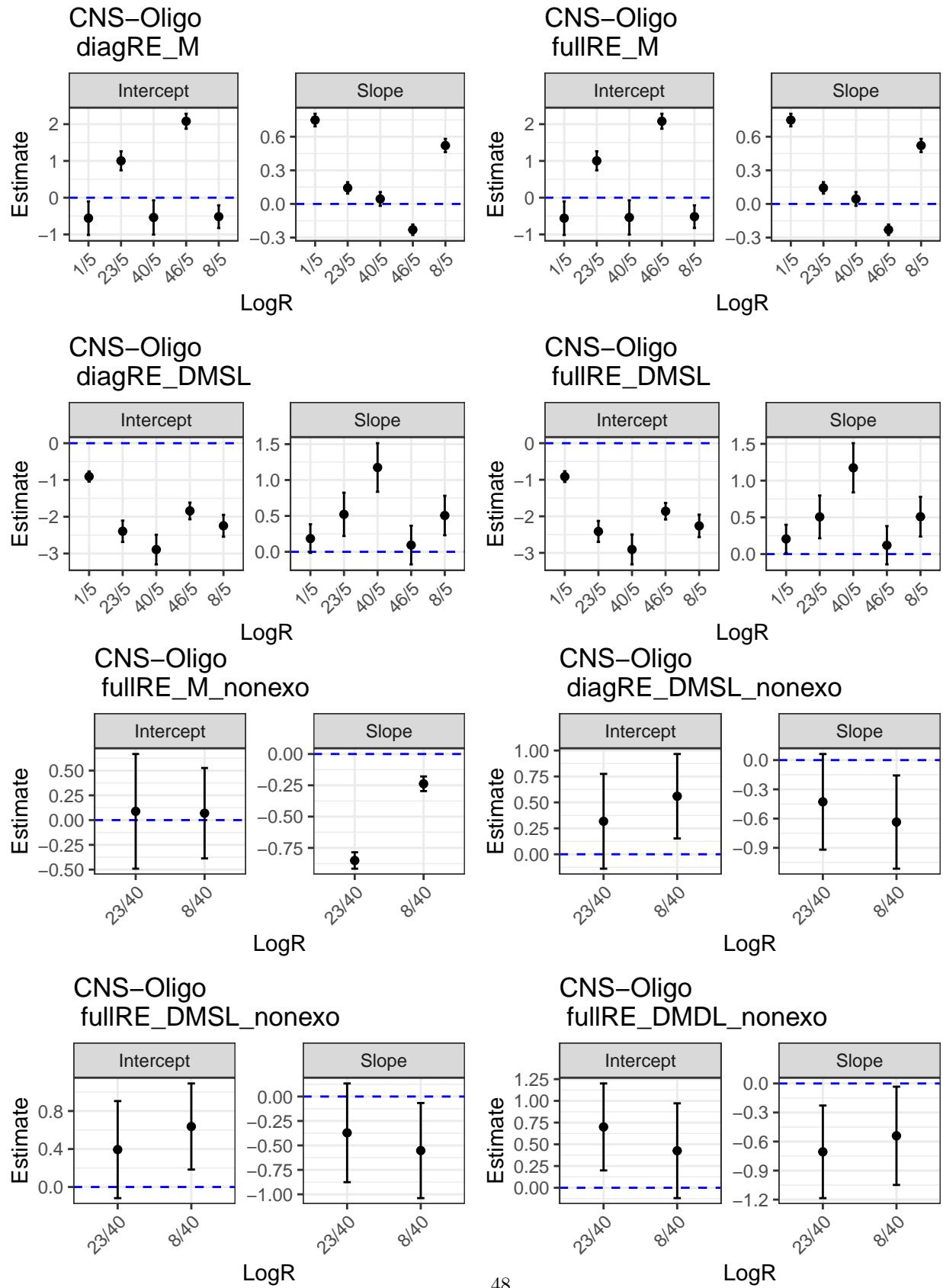
```
## [1] "SBS1"  "SBS5"  "SBS8"  "SBS23" "SBS40" "SBS46"
```

### Convergence table

Pretty much everything has converged

```
## [1] value L2      L1  
## <0 rows> (or 0-length row.names)
```

### Betas



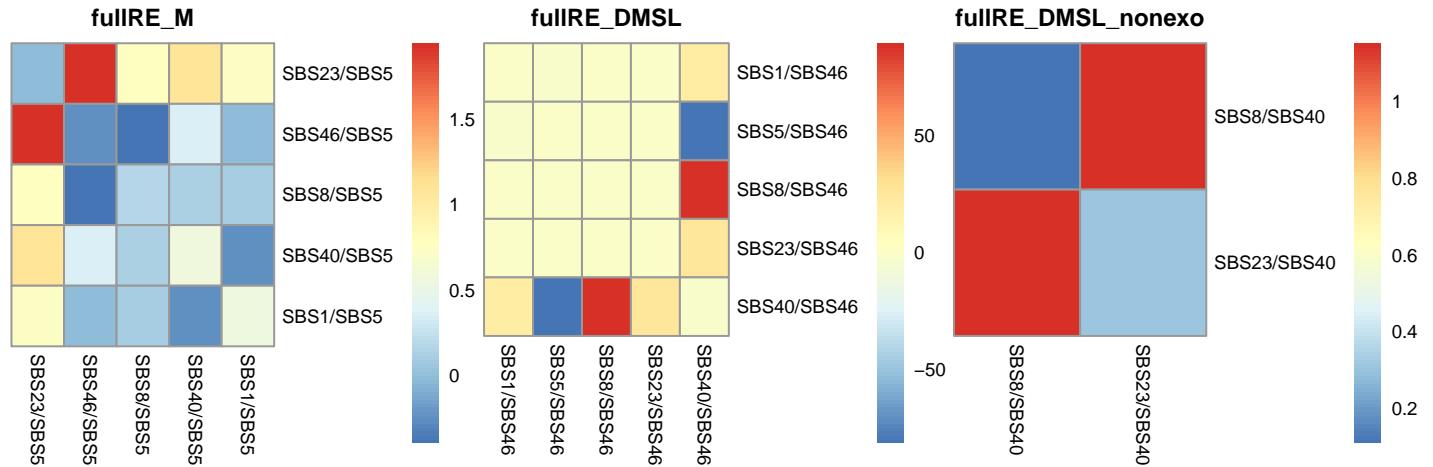
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of 0.5220955.

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

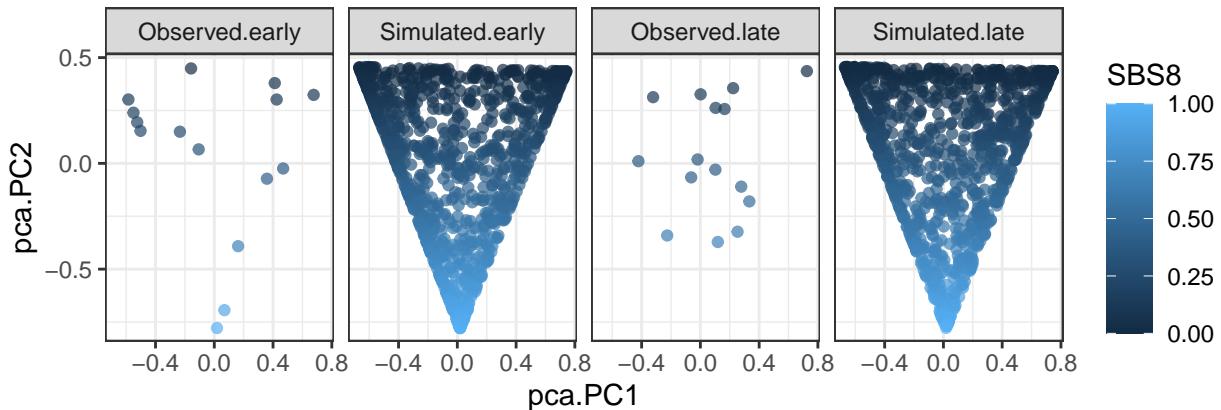


### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

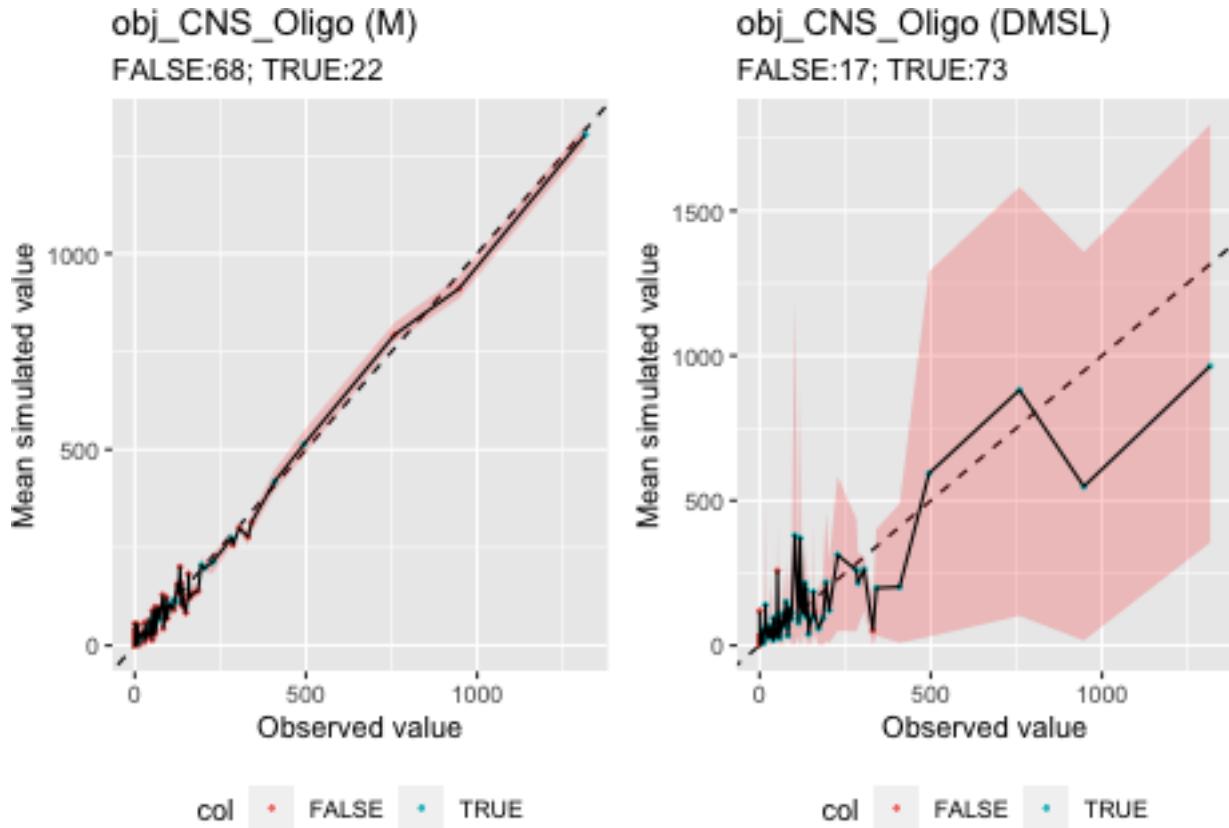
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

### Simulation of CNS-Oligo samples



### Ranked plot for coverage

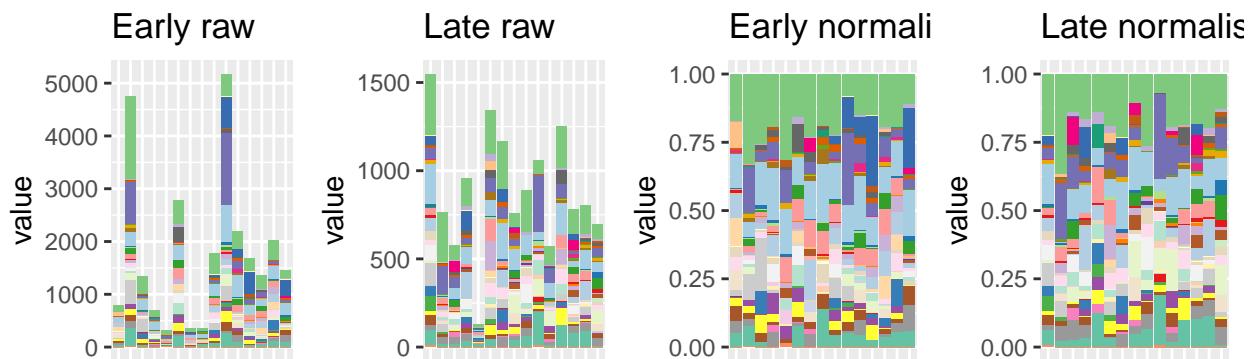
The values for DMSL nonexo look considerably better than for M nonexo.



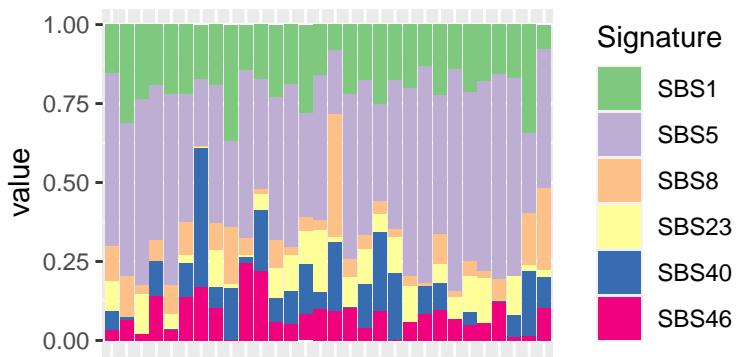
### Signatures from mutSigExtractor

These are the signatures from mutSigExtractor:

```
## [1] 15
```



Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.

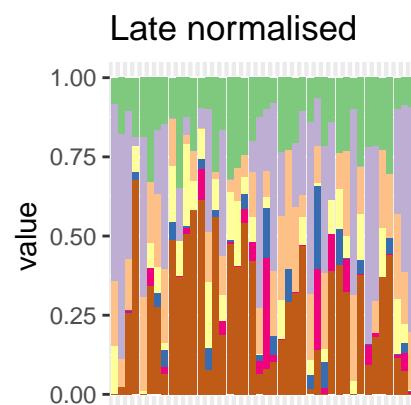
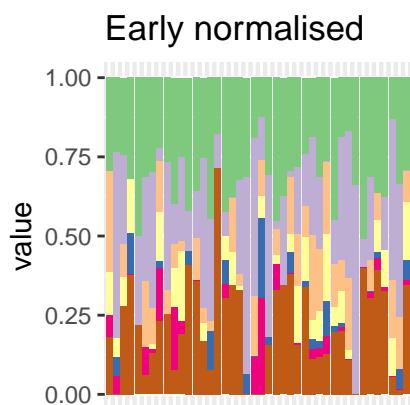
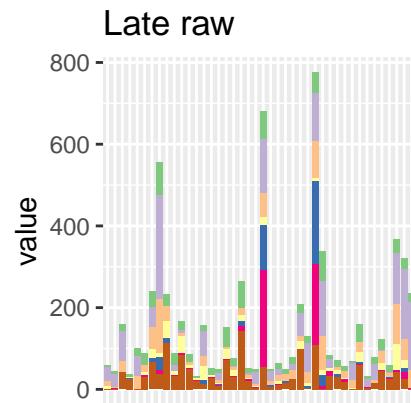
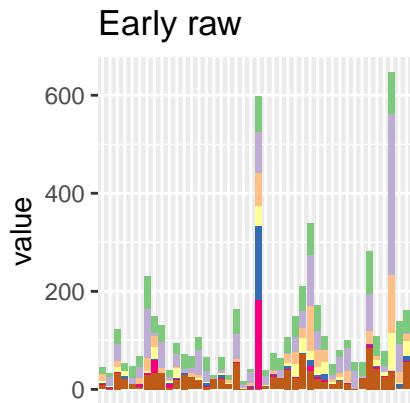


CNS-PiloAstro

CNS-PiloAstro

Barplot and general statistics

```
## [1] 42
```



The number of samples and signatures is:

```
## [1] 84 7
```

The signatures are:

```
## [1] "SBS1"  "SBS5"  "SBS8"  "SBS12" "SBS19" "SBS23" "SBS40"
```

## Convergence table

We have converged results for everything except for full RE DM, in the case of all signatures (with only nonexo everything has).

```
##           value          L2          L1
## 1 CNS-PiloAstro hessian_positivedefinite_bool diagRE_M
## 2 CNS-PiloAstro hessian_positivedefinite_bool fullRE_M
## 3 CNS-PiloAstro hessian_positivedefinite_bool diagRE_DMDL
## 4 CNS-PiloAstro hessian_nonpositivedefinite_bool fullRE_halfDM
## 5 CNS-PiloAstro hessian_nonpositivedefinite_bool fullRE_DMDL
## 6 CNS-PiloAstro hessian_positivedefinite_bool diagRE_DMSL
## 7 CNS-PiloAstro hessian_positivedefinite_bool sparseRE_DMSL
## 8 CNS-PiloAstro hessian_nonpositivedefinite_bool fullRE_DMSL
## 9 CNS-PiloAstro hessian_nonpositivedefinite_bool fullRE_DMSL_SBS1
## 10 CNS-PiloAstro hessian_positivedefinite_bool fullRE_M_nonexo
## 11 CNS-PiloAstro hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 CNS-PiloAstro hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 CNS-PiloAstro hessian_positivedefinite_bool fullRE_DMSL_nonexo
## 14 CNS-PiloAstro hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 CNS-PiloAstro hessian_positivedefinite_bool fullRE_DMDL_sortednonexo
```

## Re-running of fitting

Using fullRE\_M to fit fullRE\_DMSL (all sigs, as the one with nonexo has already converged)

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

If we use the values of the fullRE M as initial values for the fullRE DMSL still do not converge:

```
## [1] FALSE
```

## Potentially problematic signatures

We notice that there are no truly problematic signatures (SBS15 has the most zeros; 50%).

```
colSums(obj_CNS_PiloAstro$Y == 0)/nrow(obj_CNS_PiloAstro$Y)
```

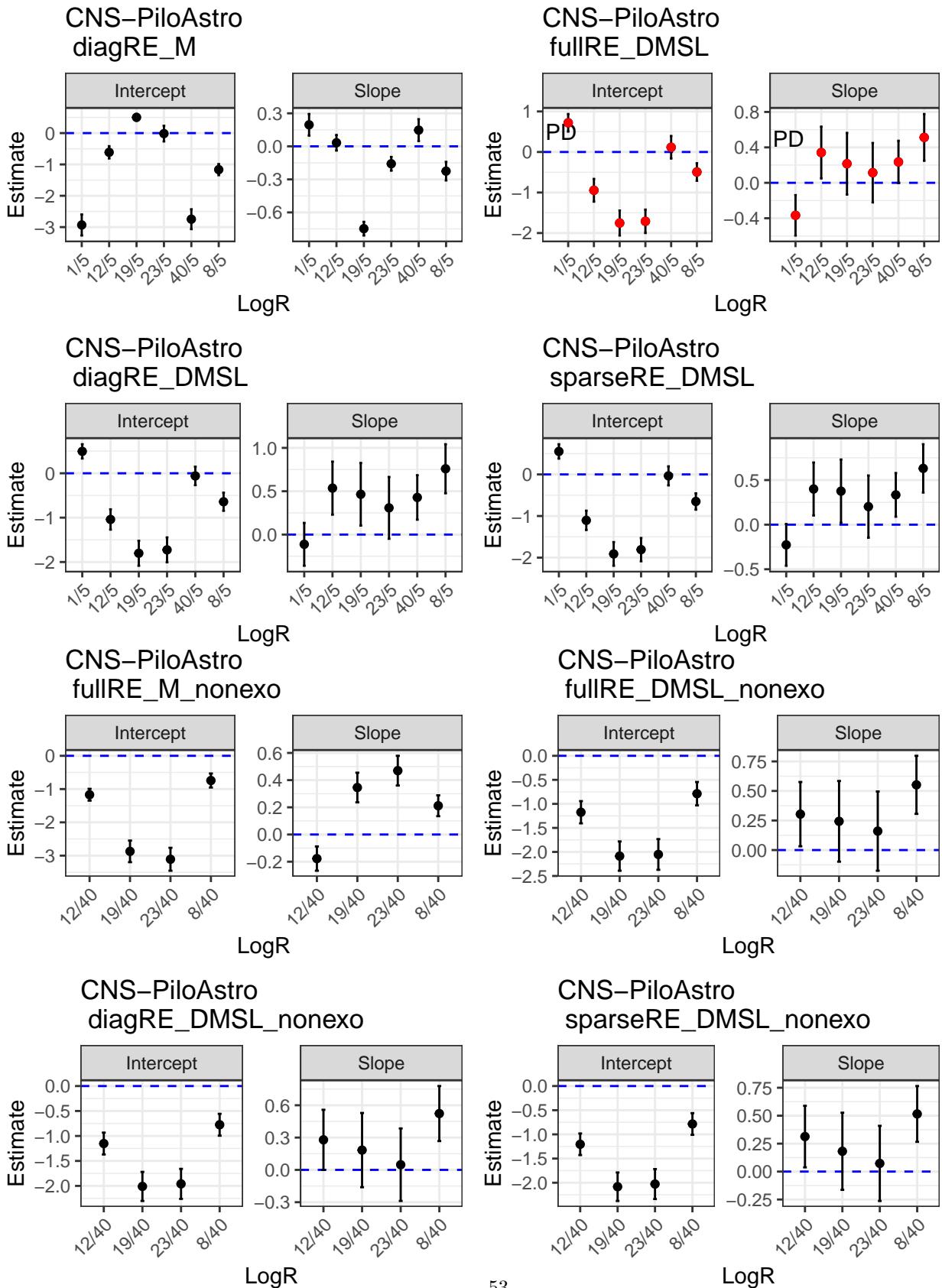
```
##      SBS1      SBS5      SBS8      SBS12      SBS19      SBS23      SBS40
## 0.0000000 0.2261905 0.2023810 0.2857143 0.5119048 0.5000000 0.1190476
```

```
colSums(obj_CNS_PiloAstro$Y)/sum(obj_CNS_PiloAstro$Y)
```

```
##      SBS1      SBS5      SBS8      SBS12      SBS19      SBS23      SBS40
## 0.19840611 0.26357297 0.14212187 0.07313631 0.05894073 0.06749128 0.19633073
```

SBS19 and SBS23 are quite sparse.

Betas



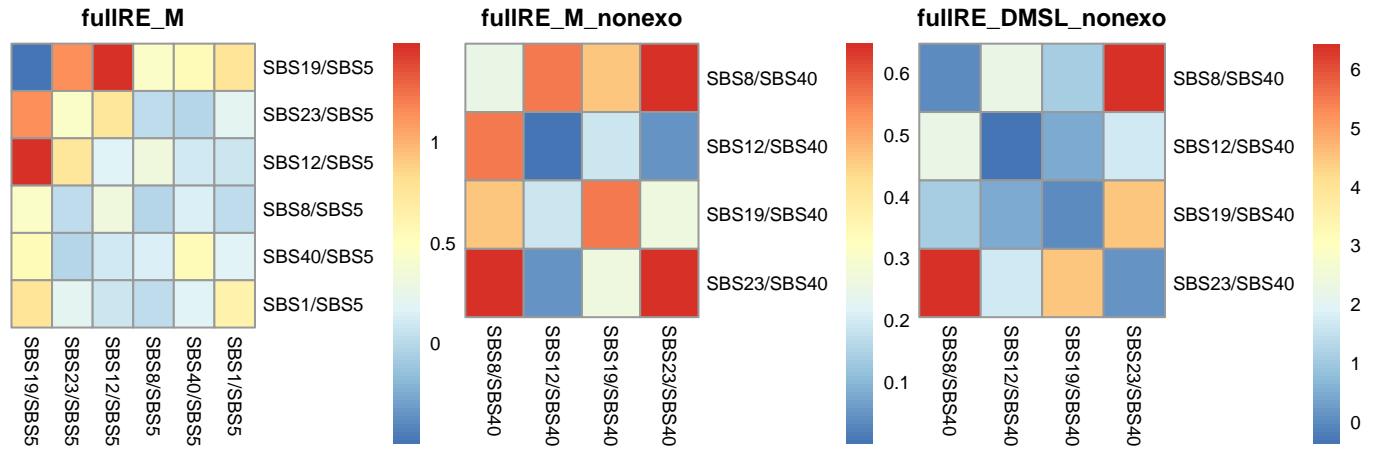
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of 0.2632004.

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



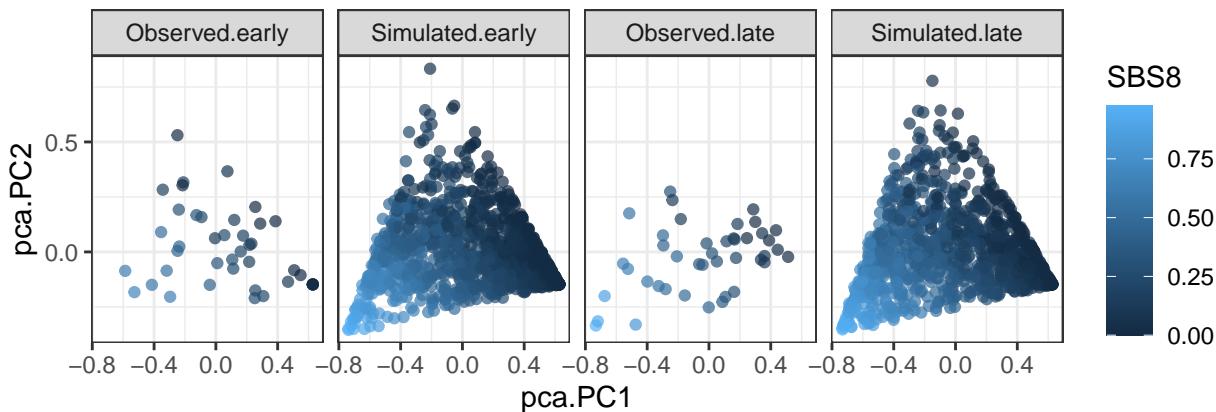
### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

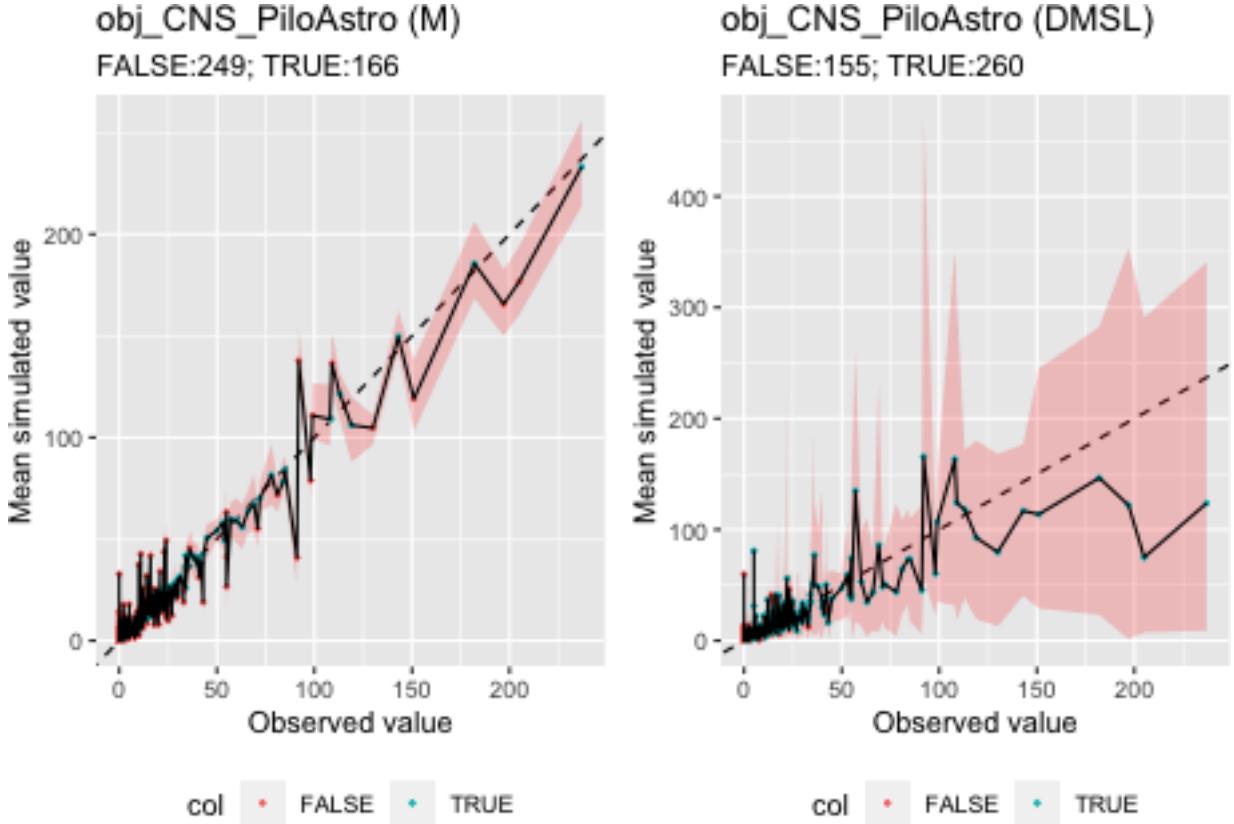
```
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

### Simulation of CNS–PiloAstro samples



### Ranked plot for coverage

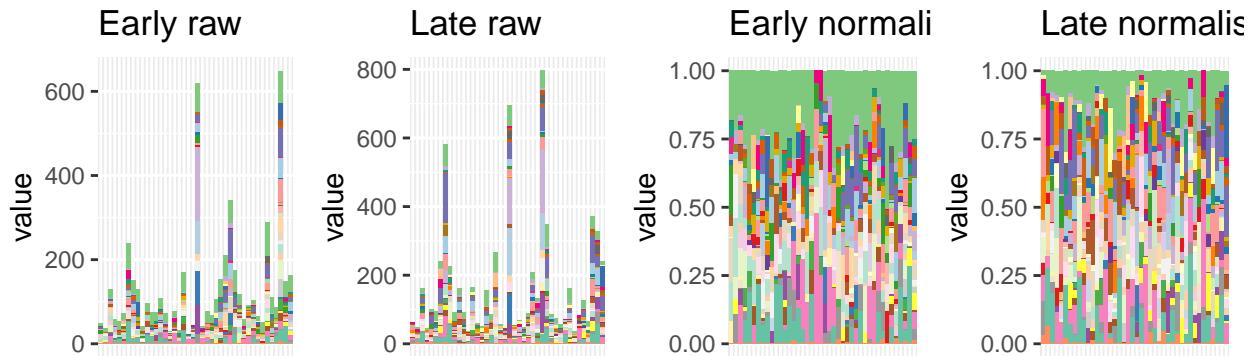
The strange pattern in DMSL is worth pointing out. The beta coefficients are too very different between M and DMSL for nonexo.



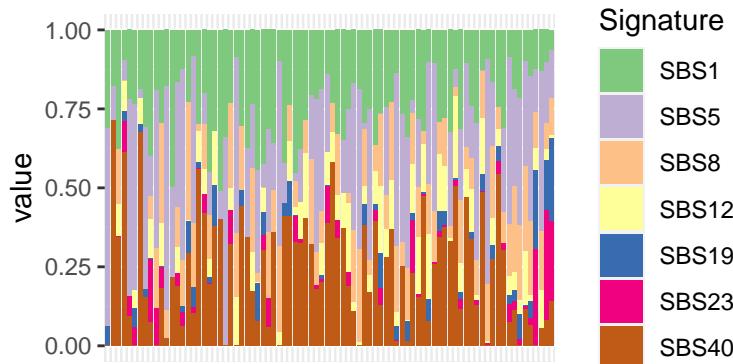
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are a bit more chaotic:

```
## [1] 42
```



Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations, with perhaps SBS9 being slightly found in the rightmost side preferentially.

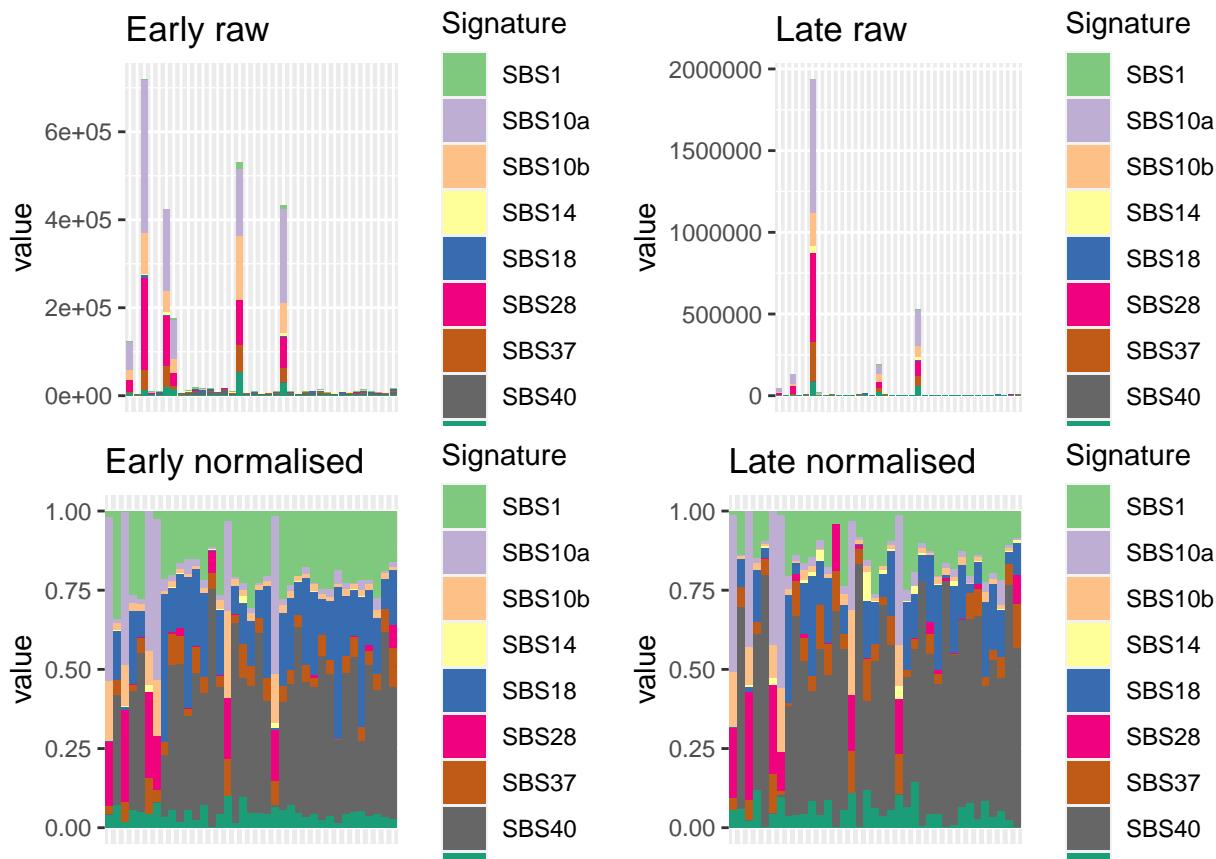


## ColoRect-AdenoCA

### ColoRect-AdenoCA

#### Barplot and general statistics

```
## [1] 37
```



The number of samples and signatures is:

```
## [1] 74 9
```

The signatures are:

```
## [1] "SBS1"   "SBS10a" "SBS10b" "SBS14"  "SBS18"  "SBS28"  "SBS37"  "SBS40"
## [9] "SBS44"
```

### Convergence table

We only have converged results for the multinomial with diag RE, when including all mutations. For exogenous mutations, full DMSL is has not converged.

|                        | L2                               | L1                       |
|------------------------|----------------------------------|--------------------------|
| ## 1 ColoRect-AdenoCA  | hessian_positivedefinite_bool    | diagRE_M                 |
| ## 2 ColoRect-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_M                 |
| ## 3 ColoRect-AdenoCA  | hessian_nonpositivedefinite_bool | diagRE_DMDL              |
| ## 4 ColoRect-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_halfDM            |
| ## 5 ColoRect-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_DMDL              |
| ## 6 ColoRect-AdenoCA  | hessian_positivedefinite_bool    | diagRE_DMSL              |
| ## 7 ColoRect-AdenoCA  | hessian_positivedefinite_bool    | sparseRE_DMSL            |
| ## 8 ColoRect-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_DMSL              |
| ## 9 ColoRect-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_DMSL_SBS1         |
| ## 10 ColoRect-AdenoCA | hessian_positivedefinite_bool    | fullRE_M_nonexo          |
| ## 11 ColoRect-AdenoCA | hessian_positivedefinite_bool    | diagRE_DMSL_nonexo       |
| ## 12 ColoRect-AdenoCA | hessian_positivedefinite_bool    | sparseRE_DMSL_nonexo     |
| ## 13 ColoRect-AdenoCA | hessian_nonpositivedefinite_bool | fullRE_DMSL_nonexo       |
| ## 14 ColoRect-AdenoCA | hessian_nonpositivedefinite_bool | fullRE_DMDL_nonexo       |
| ## 15 ColoRect-AdenoCA | Timeout                          | fullRE_DMDL_sortednonexo |

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

Now the fullM doesn't converge (even though the original fullRE M nonexo did converge?), so I cannot use all the parameters to find the starting parameters of the DM, as some are NA. I can however use some, such as beta.

What parameters are NA? Betas, logsd and covariances are not NA. Therefore, we use these values as starting values, and give an empty random effects matrix.

I get the error “gradient function must rerurn a number vector of length 43” for some reason I don't understand - it's as though the initial values I am giving are not correct.

### Potentially problematic signatures

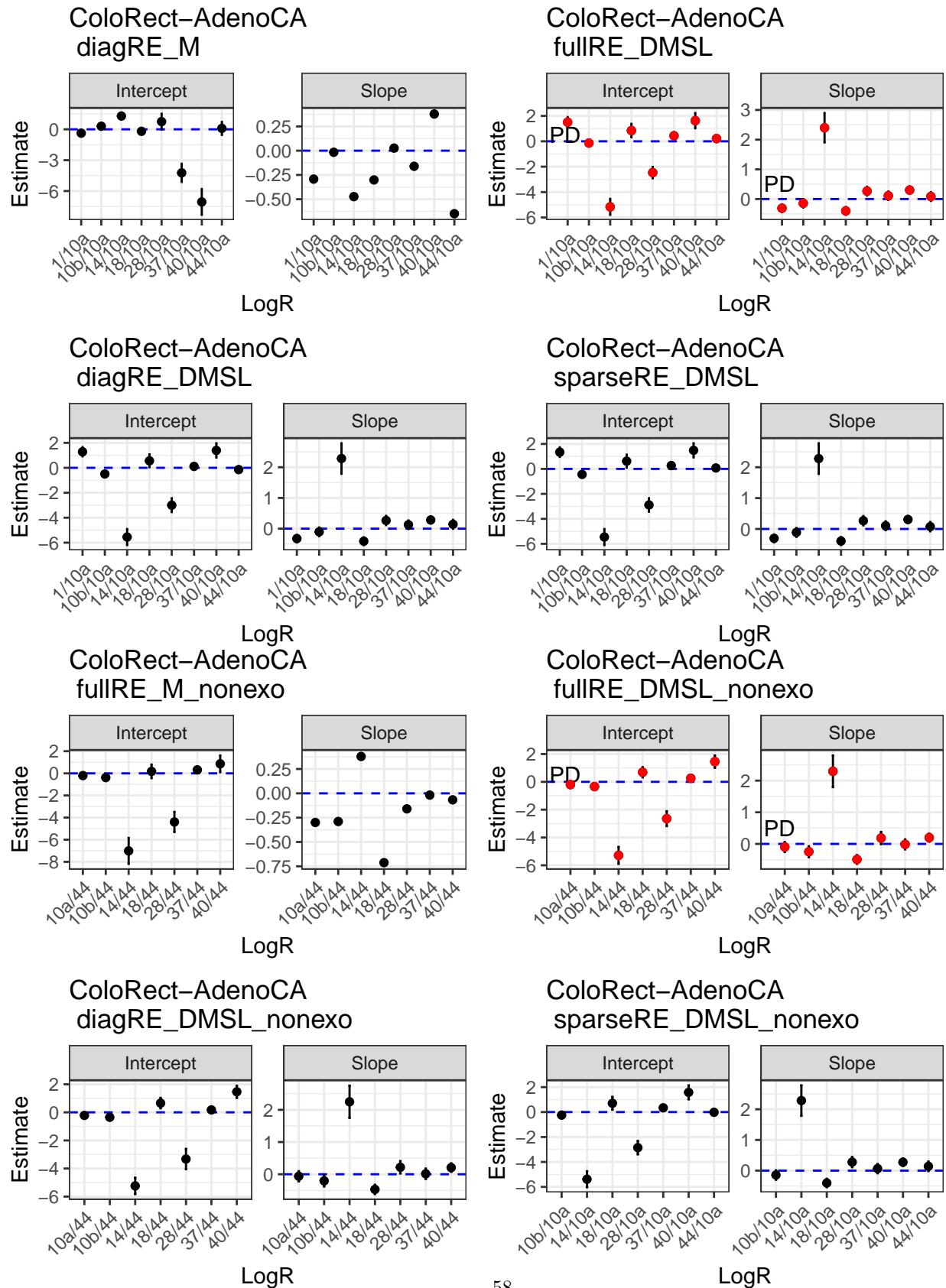
```
colSums(obj_ColoRect_AdenoCA$Y == 0) / nrow(obj_ColoRect_AdenoCA$Y)

##      SBS1     SBS10a    SBS10b     SBS14     SBS18     SBS28     SBS37
## 0.02702703 0.04054054 0.02702703 0.68918919 0.13513514 0.52702703 0.04054054
##      SBS40     SBS44
## 0.09459459 0.05405405

colSums(obj_ColoRect_AdenoCA$Y) / sum(obj_ColoRect_AdenoCA$Y)

##      SBS1     SBS10a    SBS10b     SBS14     SBS18     SBS28     SBS37
## 0.02342633 0.39302667 0.13415977 0.01502674 0.01674129 0.22524153 0.09998130
##      SBS40     SBS44
## 0.03731777 0.05507859
```

## Betas



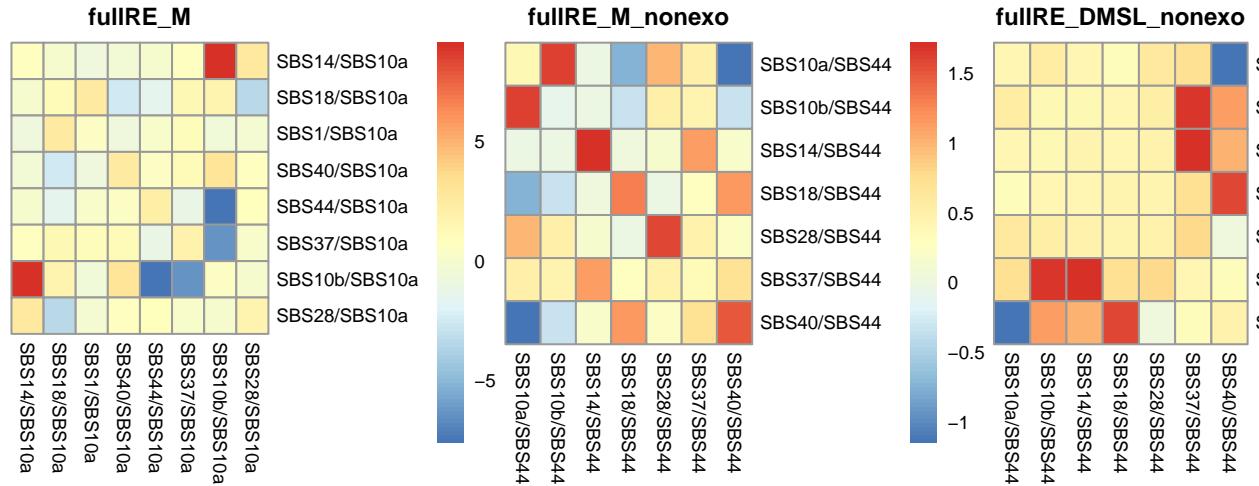
We use the results from the diagonal RE single lambda DM nonexo to test for differential abundance, giving a p-value of  $8.8714208 \times 10^{-16}$ .

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



### Simulation under inferred data

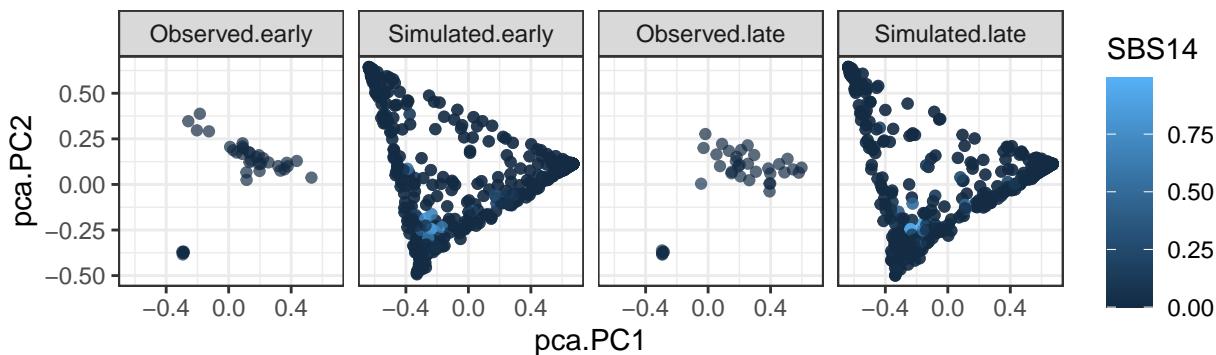
I am simulating using the full effects multinomial, because the function needs to be adapted to diagDMSL.

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

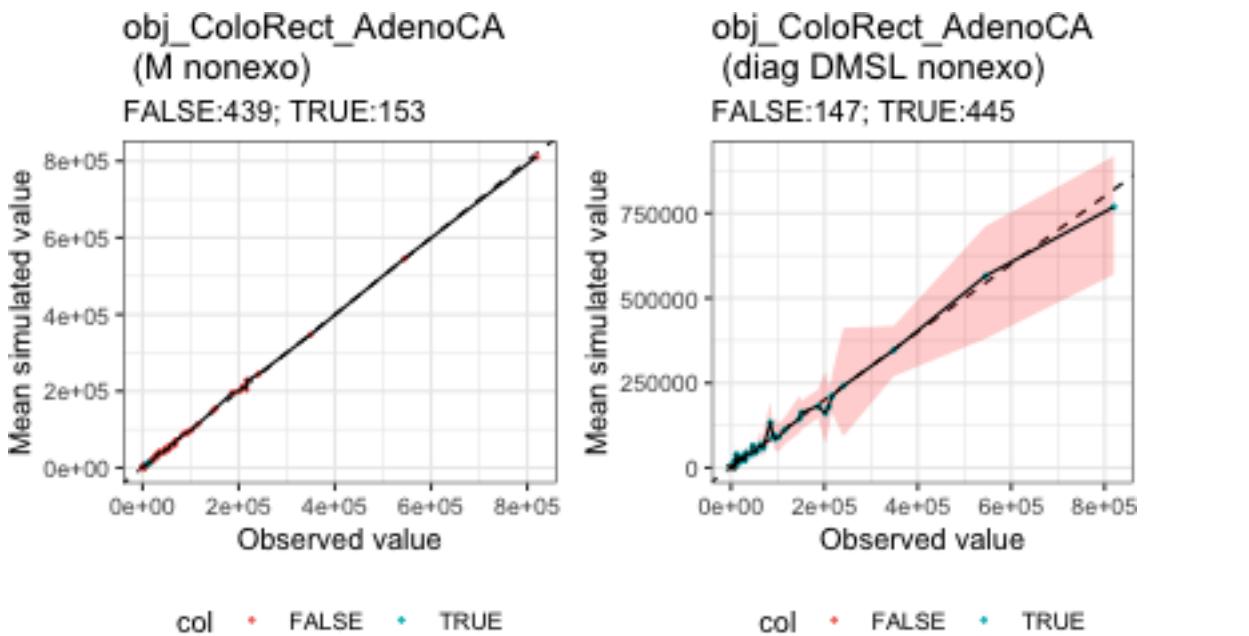
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of ColoRect–AdenoCA samples

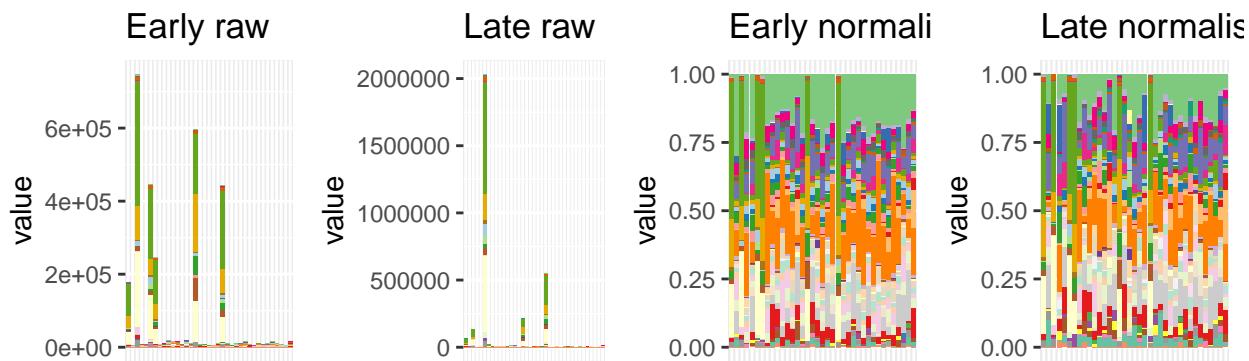


Ranked plot for coverage



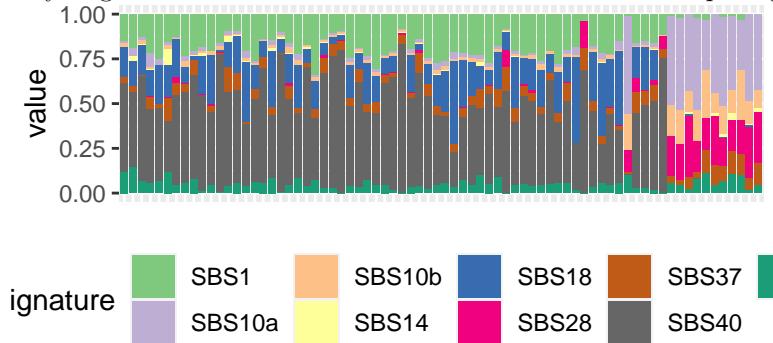
Signatures from mutSigExtractor

```
## [1] 37
```



very clearly there are a few samples with

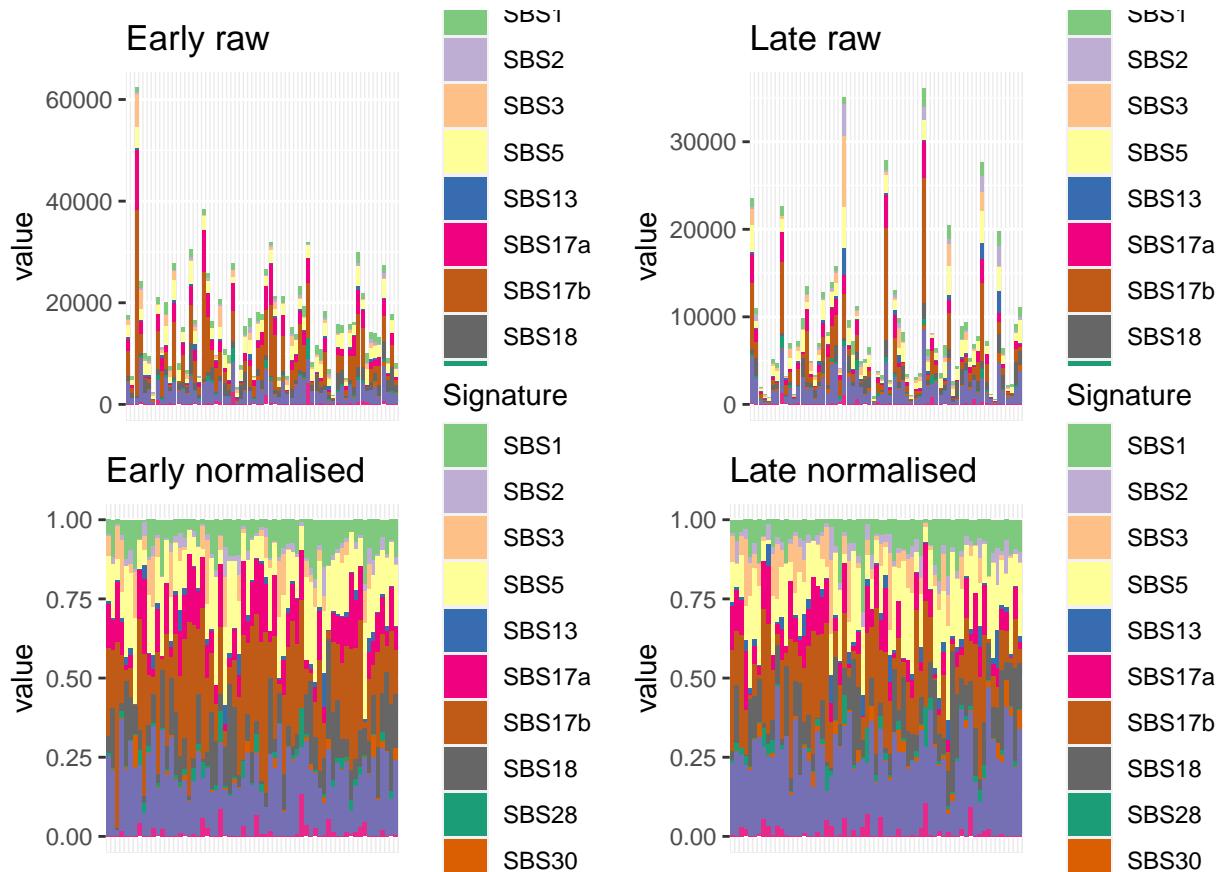
very high number of mutations that also have a completely different mutational signature exposure.



## Eso-AdenoCA

### Barplot and general statistics

```
## [1] 65
```



The number of samples and signatures is:

```
## [1] 130 12
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS3"   "SBS5"   "SBS13"  "SBS17a" "SBS17b" "SBS18"
```

```
## [9] "SBS28"  "SBS30"  "SBS40"  "SBS46"
```

### Convergence table

None of the fullRE have converged when including all signatures. When including nonexo, all but fullRE\_DMSL\_nonexo (using either the highest absolute signature or SBS1) have converged.

| ##    | value  | L2                       | L1                   |
|-------|--|--------------------------|----------------------|
| ## 1  | Eso-AdenoCA hessian_positivedefinite_bool    |                          | diagRE_M             |
| ## 2  | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | fullRE_M             |
| ## 3  | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | diagRE_DMDL          |
| ## 4  | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | fullRE_halfDM        |
| ## 5  | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | fullRE_DMDL          |
| ## 6  | Eso-AdenoCA hessian_positivedefinite_bool    |                          | diagRE_DMSL          |
| ## 7  | Eso-AdenoCA hessian_positivedefinite_bool    |                          | sparseRE_DMSL        |
| ## 8  | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | fullRE_DMSL          |
| ## 9  | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | fullRE_DMSL_SBS1     |
| ## 10 | Eso-AdenoCA hessian_positivedefinite_bool    |                          | fullRE_M_nonexo      |
| ## 11 | Eso-AdenoCA hessian_positivedefinite_bool    |                          | diagRE_DMSL_nonexo   |
| ## 12 | Eso-AdenoCA hessian_positivedefinite_bool    |                          | sparseRE_DMSL_nonexo |
| ## 13 | Eso-AdenoCA hessian_nonpositivedefinite_bool |                          | fullRE_DMSL_nonexo   |
| ## 14 | Eso-AdenoCA hessian_positivedefinite_bool    |                          | fullRE_DMDL_nonexo   |
| ## 15 | Eso-AdenoCA hessian_positivedefinite_bool    | fullRE_DMDL_sortednonexo |                      |

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo

which has a positive-semidefinite covariance matrix, i.e. has converged

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

The fullRE DMSL hasn't, though:

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

```
## [1] FALSE
```

Running fullRE DMSL, this time without sorting, doesn't converge either:

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

Bafflingly, using two lambdas does:

### Potentially problematic signatures

We notice that there are no truly problematic signatures (SBS30 has the most zeros; 54.6%).

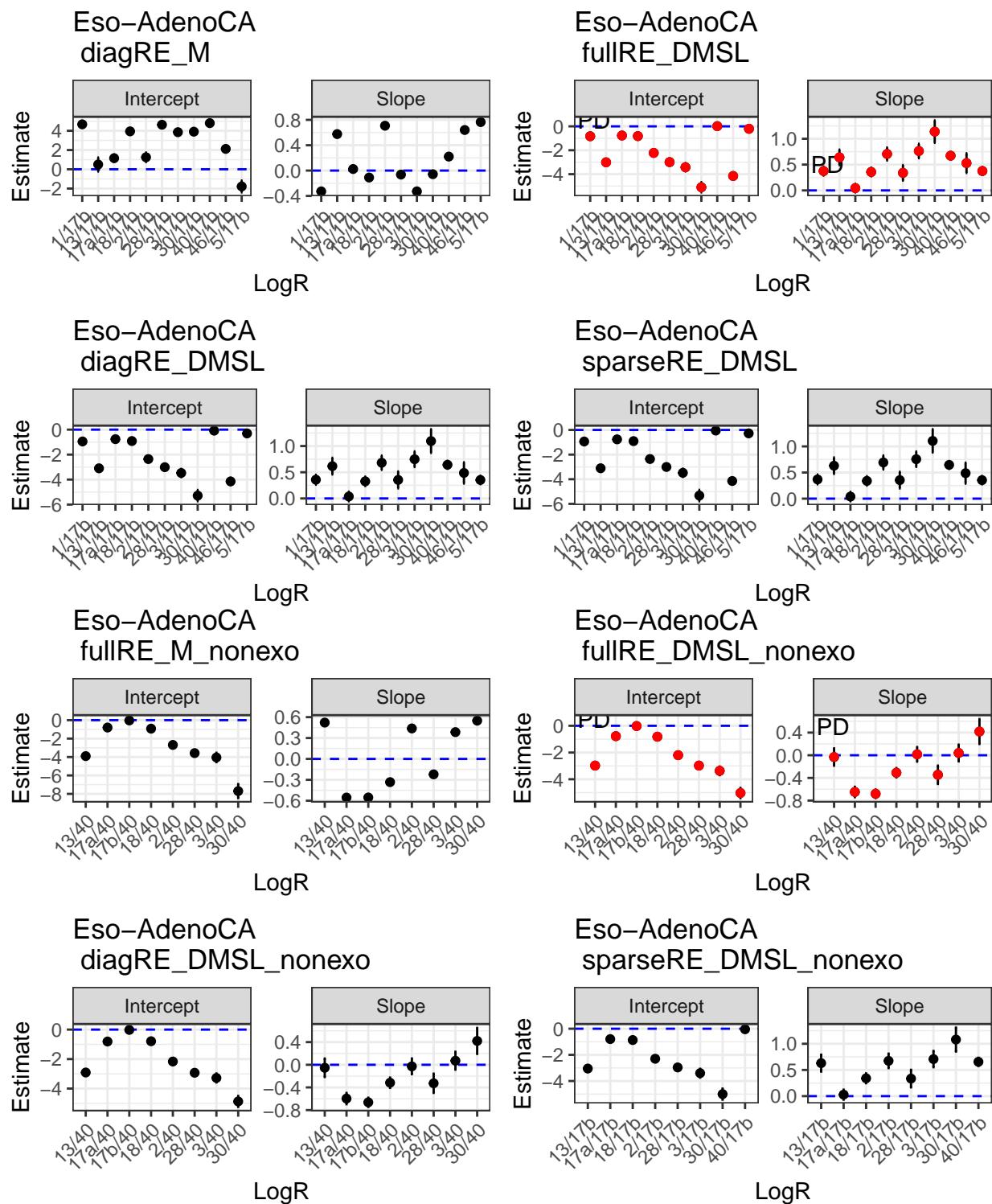
```
colSums(obj_Eso_AdenoCA$Y == 0)/nrow(obj_Eso_AdenoCA$Y)
```

```
##      SBS1      SBS2      SBS3      SBS5      SBS13     SBS17a
## 0.000000000 0.023076923 0.392307692 0.000000000 0.215384615 0.038461538
##      SBS17b     SBS18     SBS28     SBS30     SBS40     SBS46
## 0.007692308 0.038461538 0.238461538 0.546153846 0.000000000 0.476923077
```

```
colSums(obj_Eso_AdenoCA$Y)/sum(obj_Eso_AdenoCA$Y)
```

```
##      SBS1      SBS2      SBS3      SBS5      SBS13     SBS17a
## 0.069743929 0.022981455 0.042124010 0.135767687 0.017294837 0.118553858
##      SBS17b     SBS18     SBS28     SBS30     SBS40     SBS46
## 0.265599550 0.088385597 0.020133817 0.006873288 0.198223396 0.014318577
```

## Betas

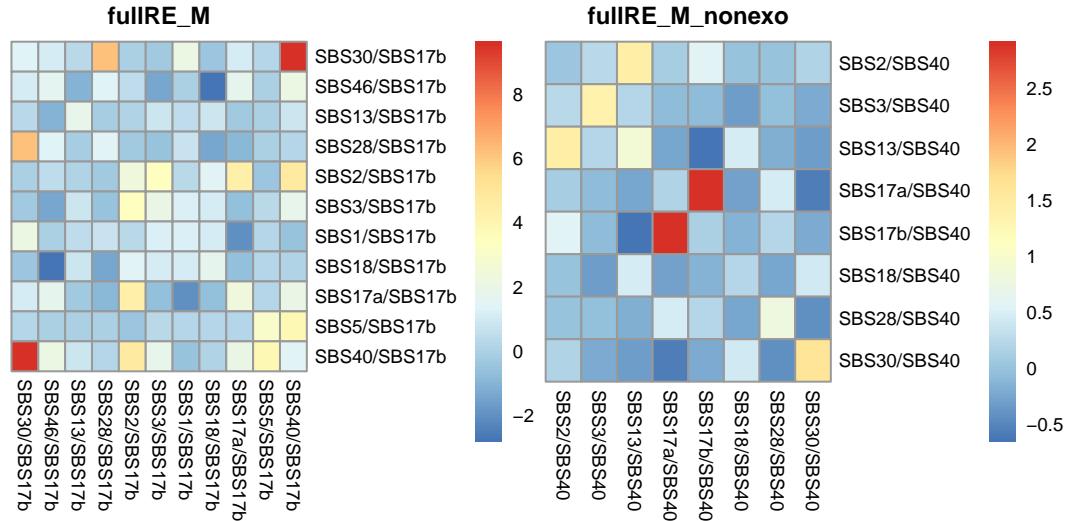


We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of  $2.4465743 \times 10^{-18}$ .

## Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

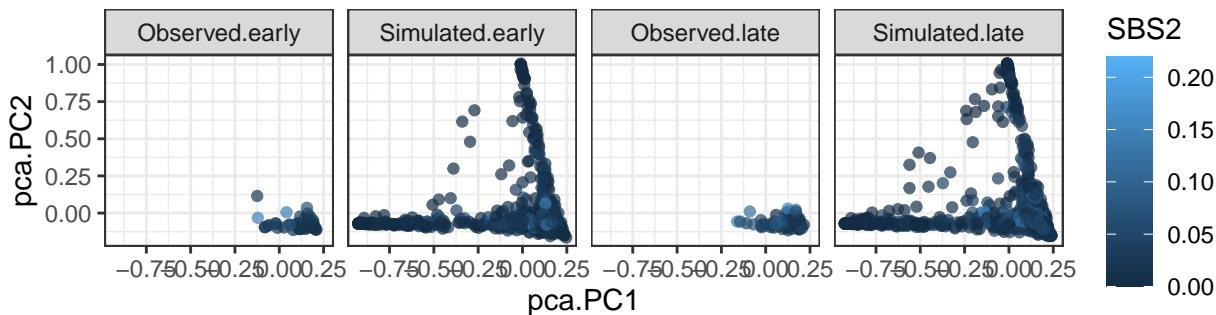


## Simulation under inferred data

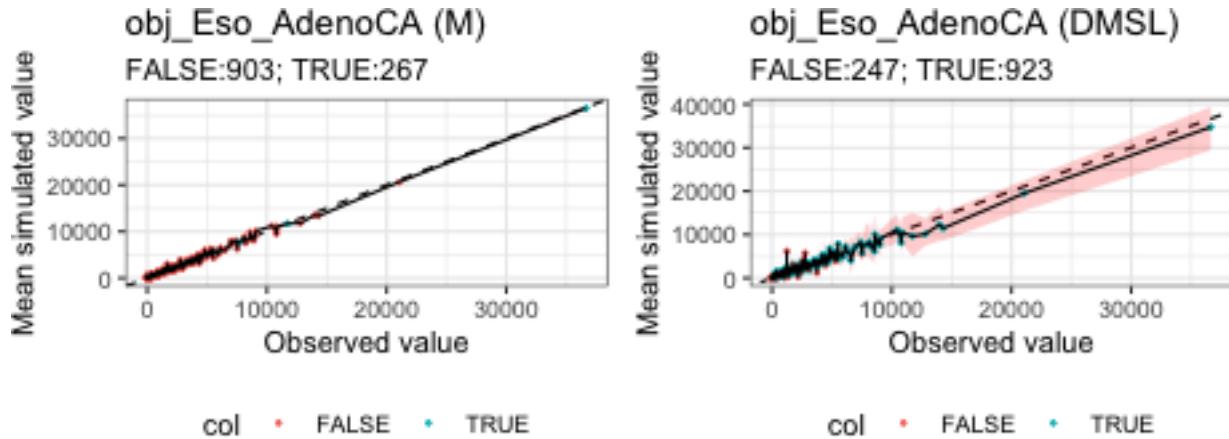
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

### Simulation of Eso-AdenoCA samples



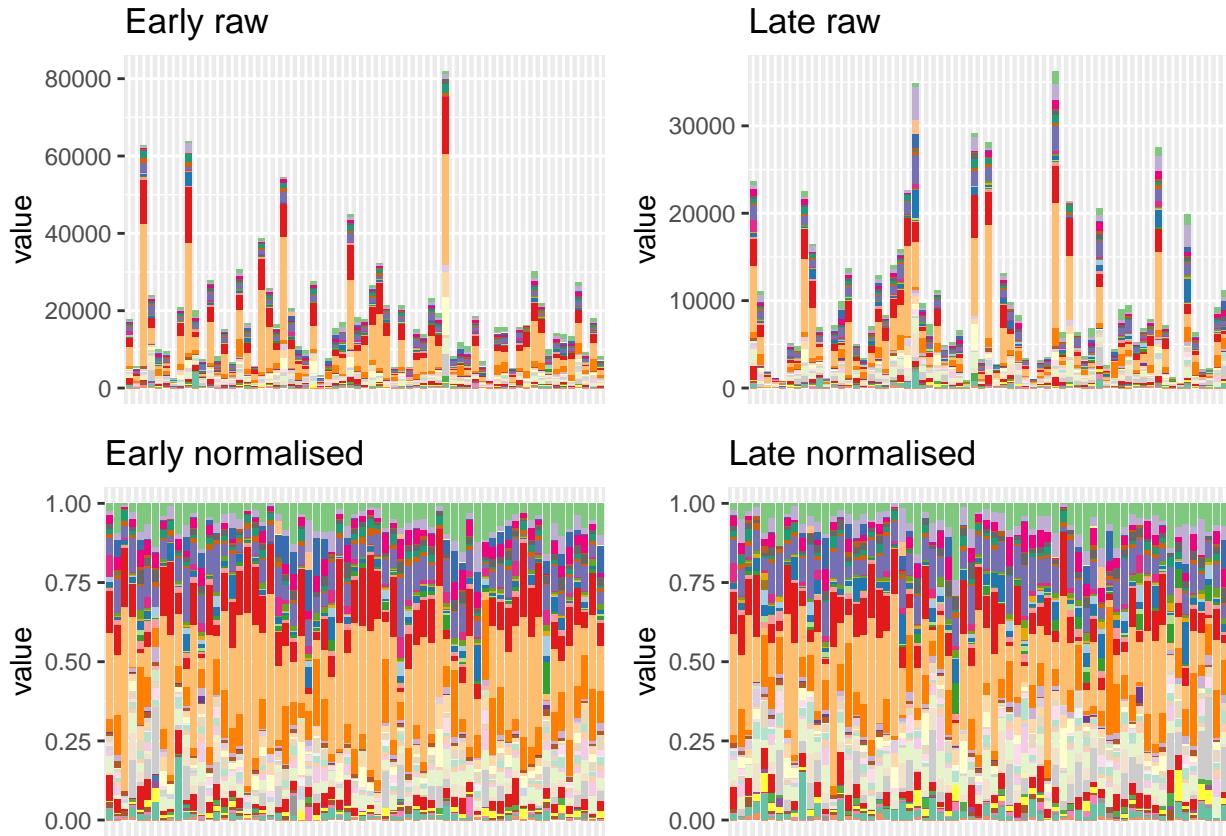
### Ranked plot for coverage



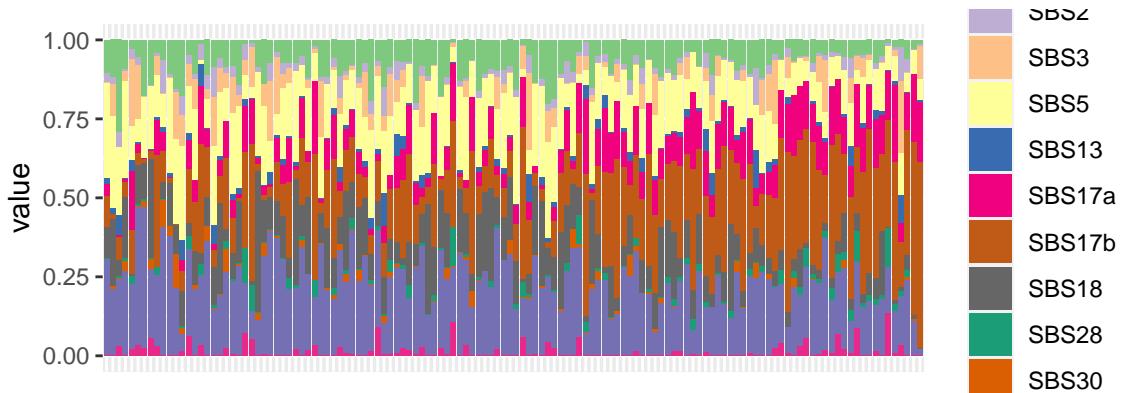
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 65
```



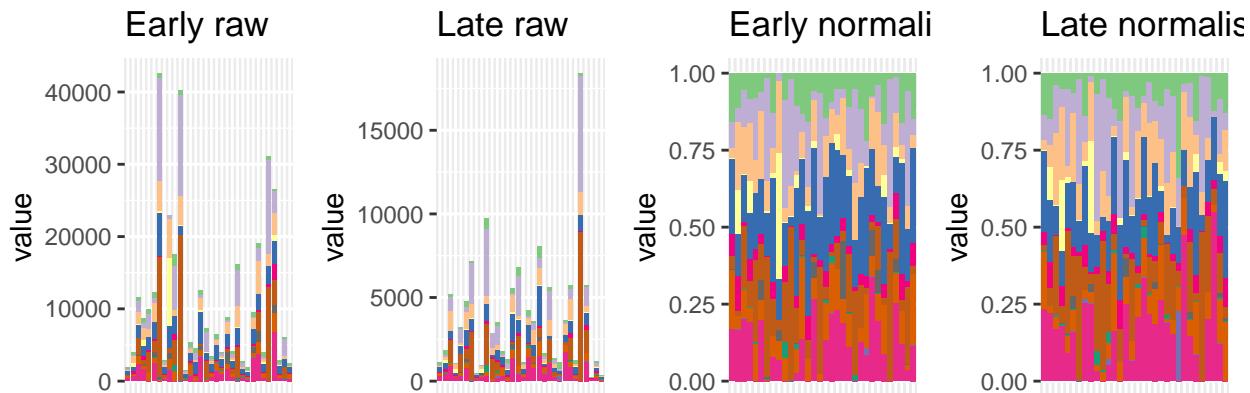
Exposures sorted by increasing number of mutations: there is a trend of samples with more mutations having more SBS17b and less SBS5, relatively.



## Head-SCC

### Barplot and general statistics

```
## [1] 32
```



The number of samples and signatures is:

```
## [1] 64 12
```

The signatures are:

```
## [1] "SBS1"    "SBS2"    "SBS3"    "SBS4"    "SBS5"    "SBS7b"   "SBS13"   "SBS16"
## [9] "SBS17b"  "SBS18"   "SBS33"   "SBS40"
```

### Convergence table

We don't have converged results for the multinomial with full RE, but for nonexogenous signatures everything has.

|  | L2 | L1            |
|--|----|---------------|
| ## 1 Head-SCC hessian_positivedefinite_bool    |    | diagRE_M      |
| ## 2 Head-SCC hessian_nonpositivedefinite_bool |    | fullRE_M      |
| ## 3 Head-SCC hessian_nonpositivedefinite_bool |    | diagRE_DMDL   |
| ## 4 Head-SCC hessian_nonpositivedefinite_bool |    | fullRE_halfDM |
| ## 5 Head-SCC hessian_nonpositivedefinite_bool |    | fullRE_DMDL   |
| ## 6 Head-SCC hessian_positivedefinite_bool    |    | diagRE_DMSL   |
| ## 7 Head-SCC hessian_positivedefinite_bool    |    | sparseRE_DMSL |
| ## 8 Head-SCC hessian_nonpositivedefinite_bool |    | fullRE_DMSL   |

```

## 9 Head-SCC hessian_nonpositivedefinite_bool      fullRE_DMSL_SBS1
## 10 Head-SCC    hessian_positivedefinite_bool     fullRE_M_nonexo
## 11 Head-SCC    hessian_positivedefinite_bool     diagRE_DMSL_nonexo
## 12 Head-SCC    hessian_positivedefinite_bool     sparseRE_DMSL_nonexo
## 13 Head-SCC    hessian_positivedefinite_bool     fullRE_DMSL_nonexo
## 14 Head-SCC hessian_nonpositivedefinite_bool     fullRE_DMDL_nonexo
## 15 Head-SCC                           Timeout fullRE_DMDL_sortednonexo

```

### Re-running of fitting

We don't need refitting, as the results have already converged.

### Potentially problematic signatures

SBS33 is likely to be problematic.

```

colSums(obj_Head(SCC$Y == 0)/nrow(obj_Head(SCC$Y)

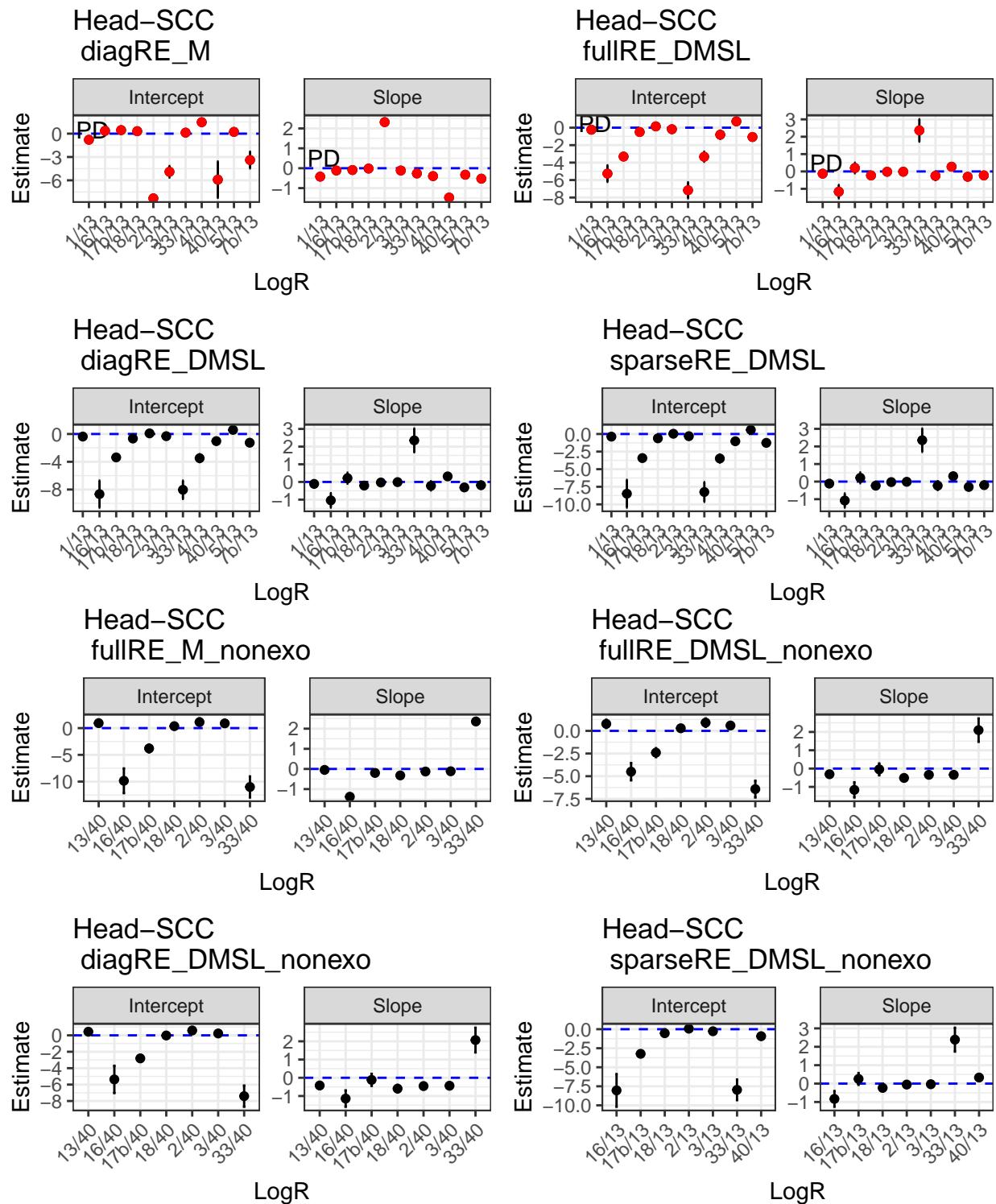
##      SBS1      SBS2      SBS3      SBS4      SBS5      SBS7b      SBS13      SBS16      SBS17b      SBS18
## 0.00000 0.00000 0.06250 0.50000 0.00000 0.06250 0.00000 0.75000 0.40625 0.09375
##      SBS33      SBS40
## 0.81250 0.21875

colSums(obj_Head(SCC$Y)/sum(obj_Head(SCC$Y)

##          SBS1          SBS2          SBS3          SBS4          SBS5          SBS7b
## 0.052157398 0.209133263 0.121874082 0.030243442 0.152377754 0.025011542
##          SBS13          SBS16          SBS17b          SBS18          SBS33          SBS40
## 0.225057712 0.017861490 0.005867786 0.056873033 0.001013641 0.102528856

```

## Betas



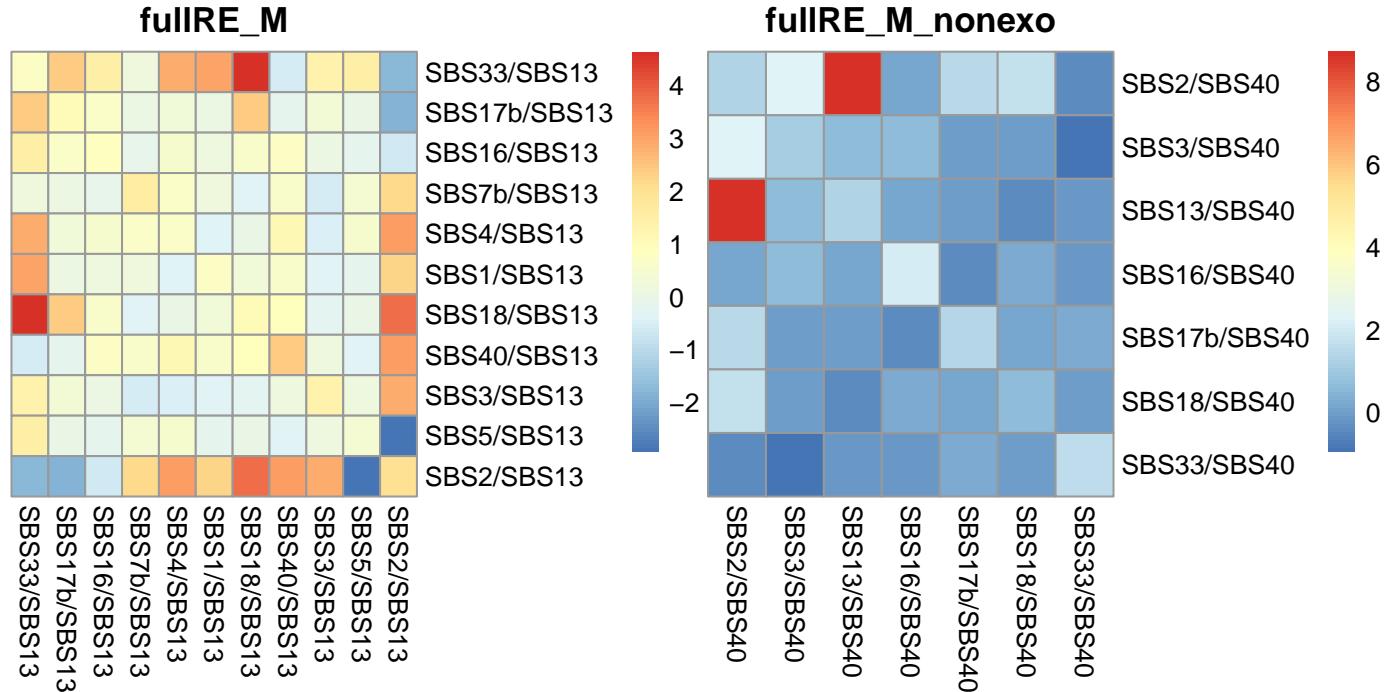
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $8.4420109 \times 10^{-5}$ .

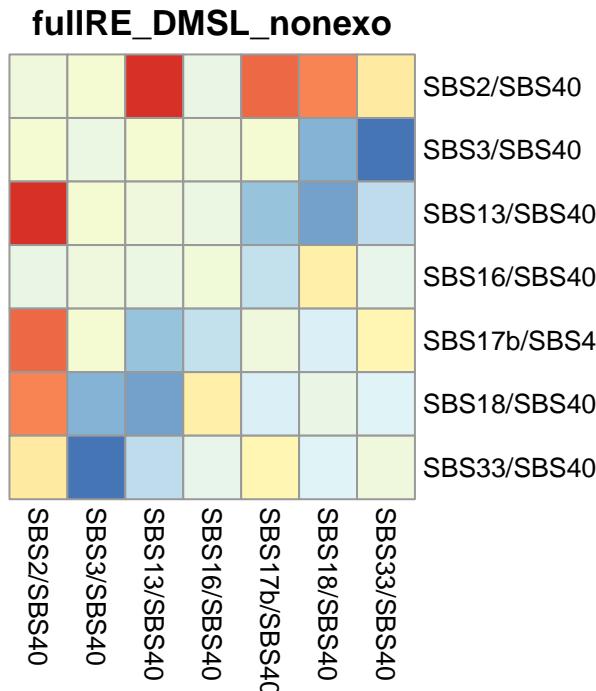
## Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```





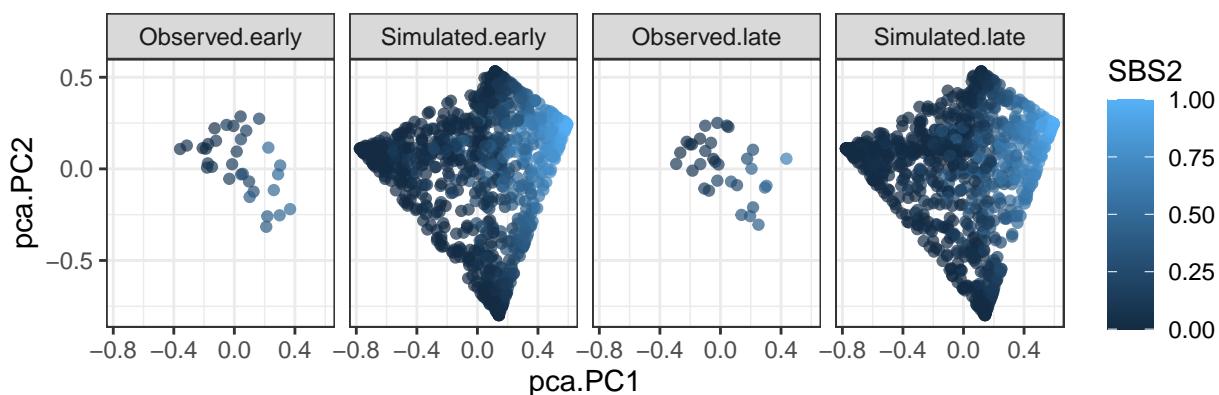
#### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

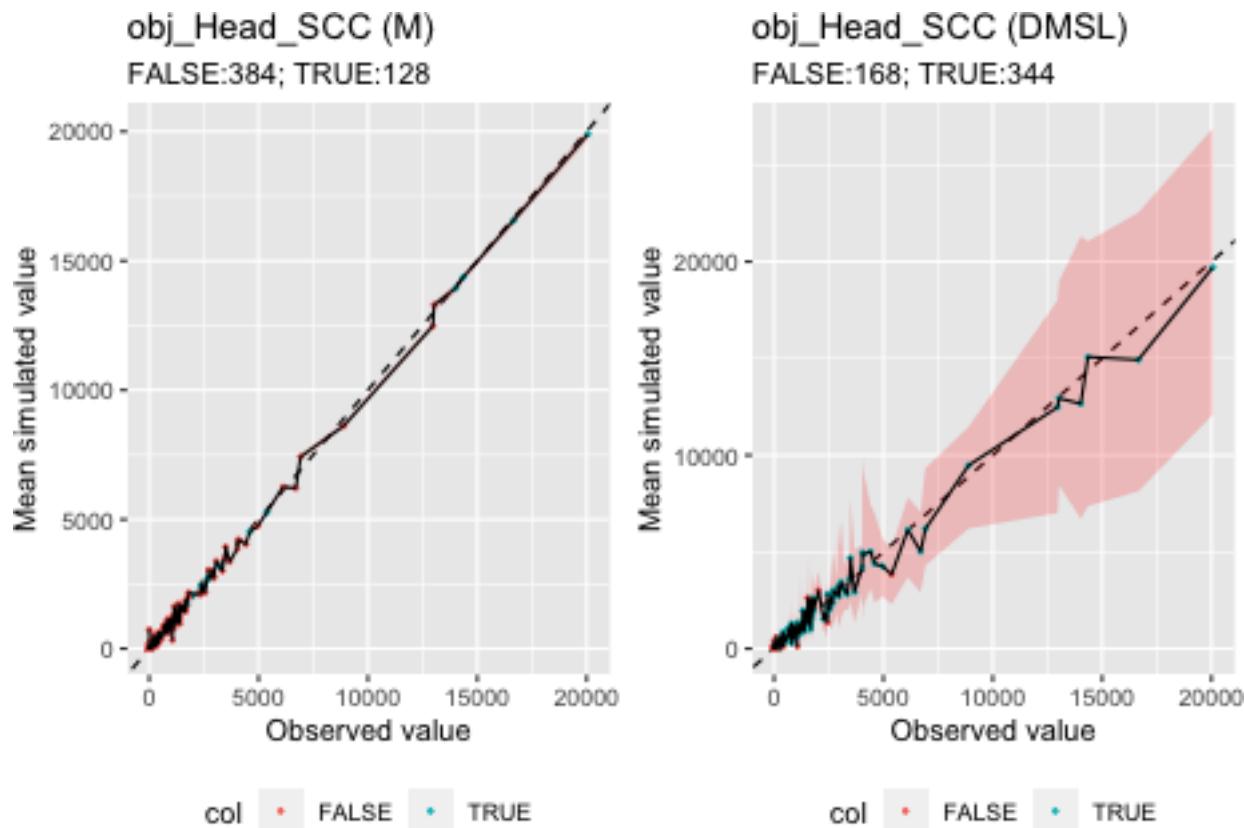
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

#### Simulation of Head-SCC samples



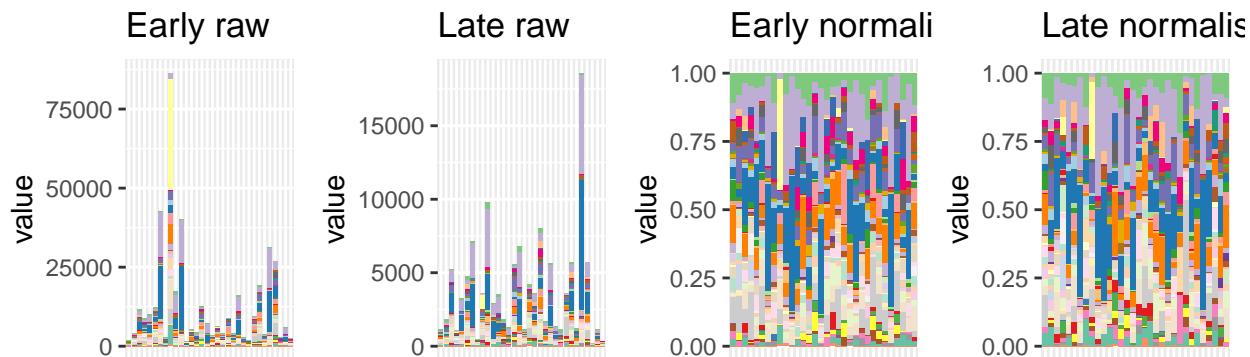
### Ranked plot for coverage



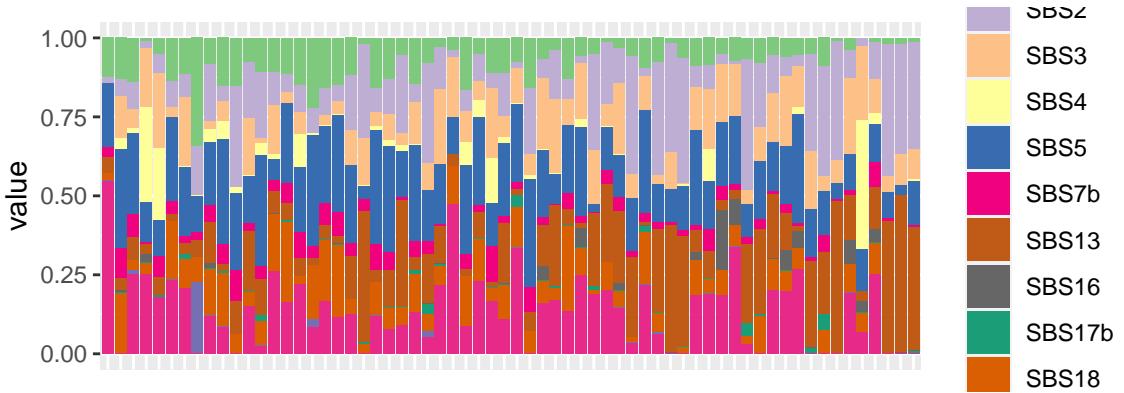
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 32
```



Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the num-

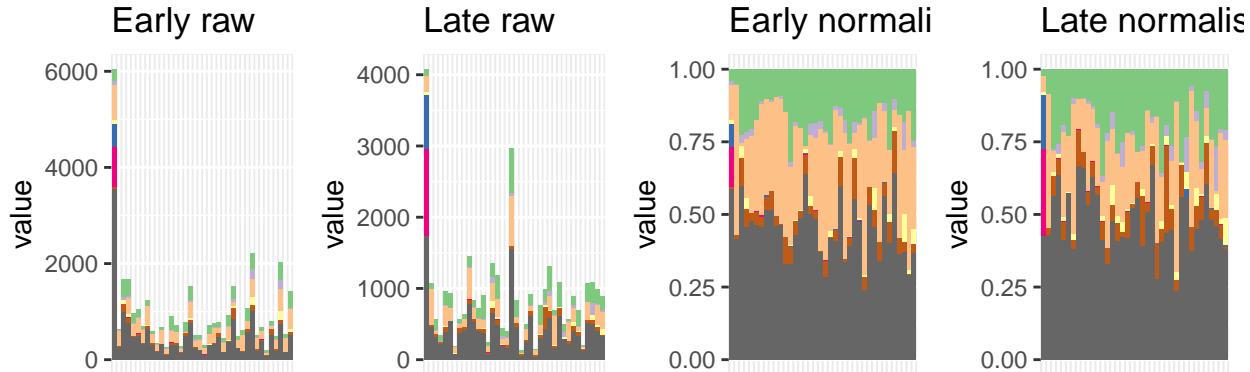


ber of mutations.

## Kidney-ChRCC

### Barplot and general statistics

```
## [1] 38
```



The number of samples and signatures is:

```
## [1] 76 8
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS5"   "SBS13"  "SBS17a" "SBS17b" "SBS29"  "SBS40"
```

### Convergence table

For all signatures, no fullRE model has converged. For nonexogenous ones, all have.

|                    | value                            | L2 | L1                 |
|--------------------|----------------------------------|----|--------------------|
| ## 1 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | diagRE_M           |
| ## 2 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | fullRE_M           |
| ## 3 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | diagRE_DMDL        |
| ## 4 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | fullRE_halfDM      |
| ## 5 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | fullRE_DMDL        |
| ## 6 Kidney-ChRCC  | hessian_positivedefinite_bool    |    | diagRE_DMSL        |
| ## 7 Kidney-ChRCC  | hessian_positivedefinite_bool    |    | sparseRE_DMSL      |
| ## 8 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | fullRE_DMSL        |
| ## 9 Kidney-ChRCC  | hessian_nonpositivedefinite_bool |    | fullRE_DMSL_SBS1   |
| ## 10 Kidney-ChRCC | hessian_positivedefinite_bool    |    | fullRE_M_nonexo    |
| ## 11 Kidney-ChRCC | hessian_positivedefinite_bool    |    | diagRE_DMSL_nonexo |

```

## 12 Kidney-ChRCC    hessian_positivedefinite_bool    sparseRE_DMSL_nonexo
## 13 Kidney-ChRCC    hessian_positivedefinite_bool    fullRE_DMSL_nonexo
## 14 Kidney-ChRCC    hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 Kidney-ChRCC    hessian_nonpositivedefinite_bool fullRE_DMDL_sortednonexo

```

### Re-running of fitting

We do not need to re-run any model fitting.

### Potentially problematic signatures

We notice that SBS17a and SBS17b are perhaps problematic.

```
colSums(obj_Kidney_ChRCC$Y == 0) / nrow(obj_Kidney_ChRCC$Y)
```

```

##      SBS1      SBS2      SBS5      SBS13      SBS17a      SBS17b      SBS29
## 0.00000000 0.23684211 0.05263158 0.35526316 0.89473684 0.89473684 0.09210526
##      SBS40
## 0.00000000

```

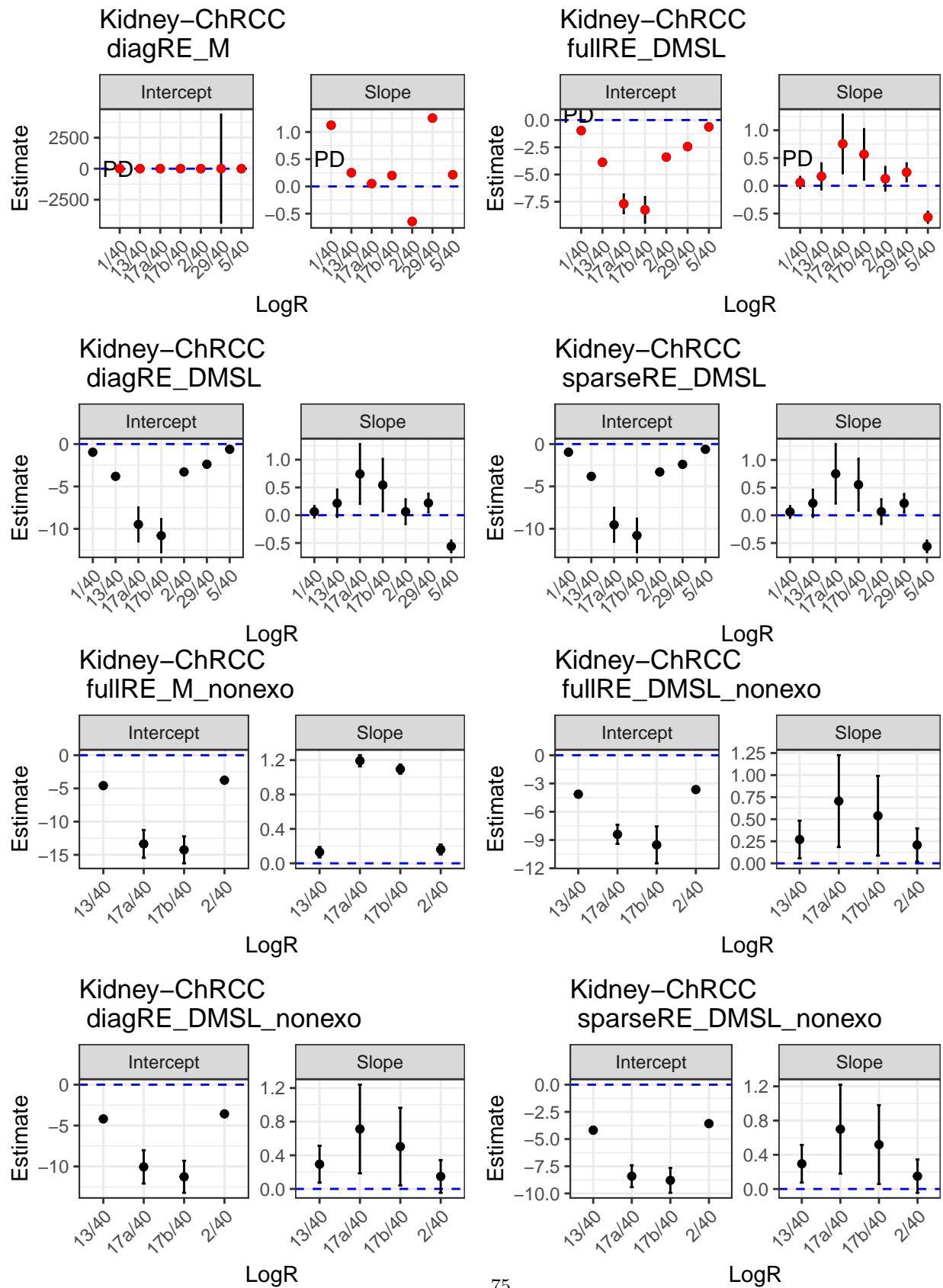
```
colSums(obj_Kidney_ChRCC$Y) / sum(obj_Kidney_ChRCC$Y)
```

```

##      SBS1      SBS2      SBS5      SBS13      SBS17a      SBS17b      SBS29
## 0.17183661 0.02350905 0.21046460 0.02066116 0.01747822 0.02920482 0.04789759
##      SBS40
## 0.47894796

```

## Betas



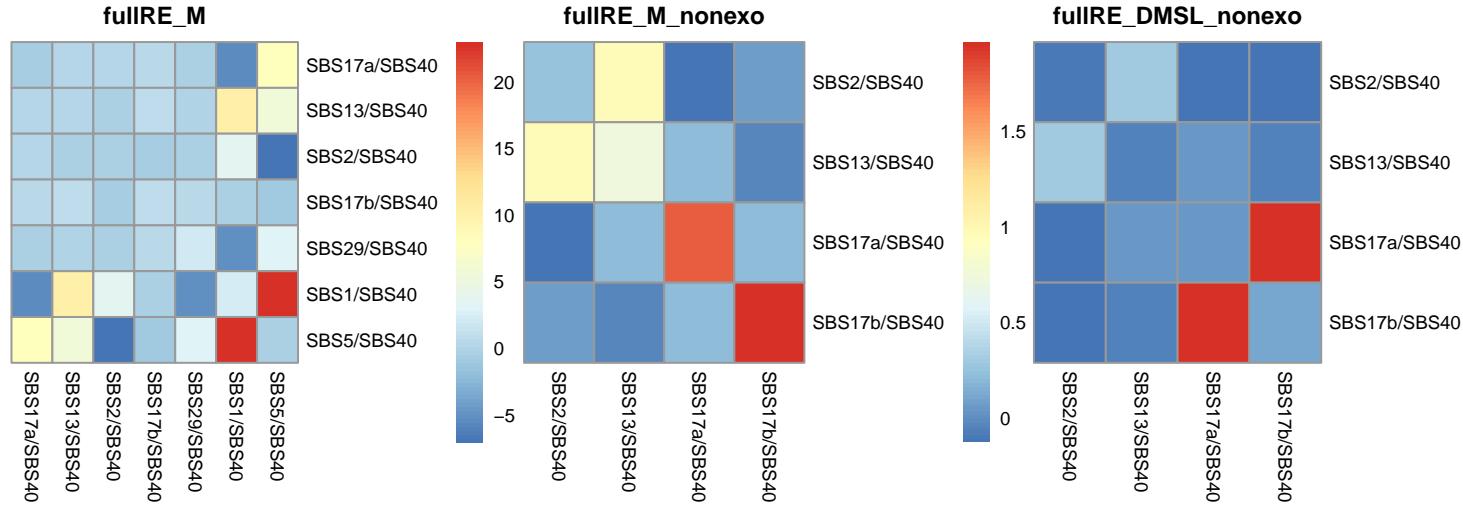
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of 0.2664763.

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



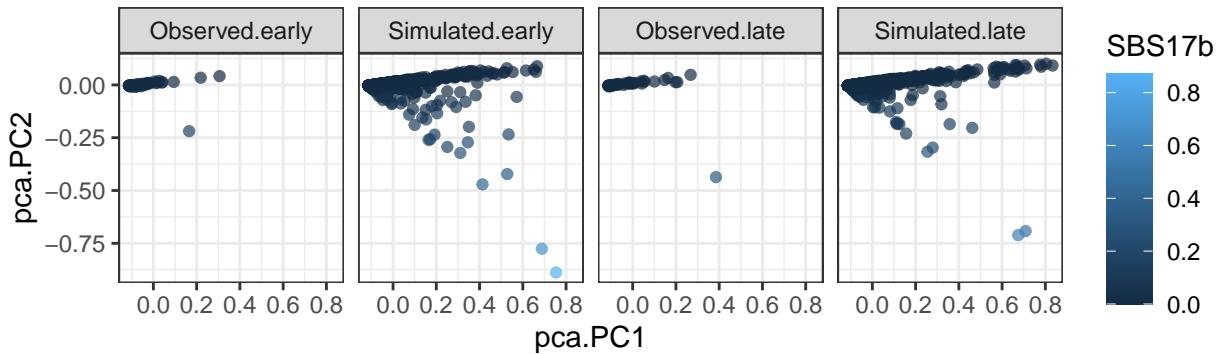
### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

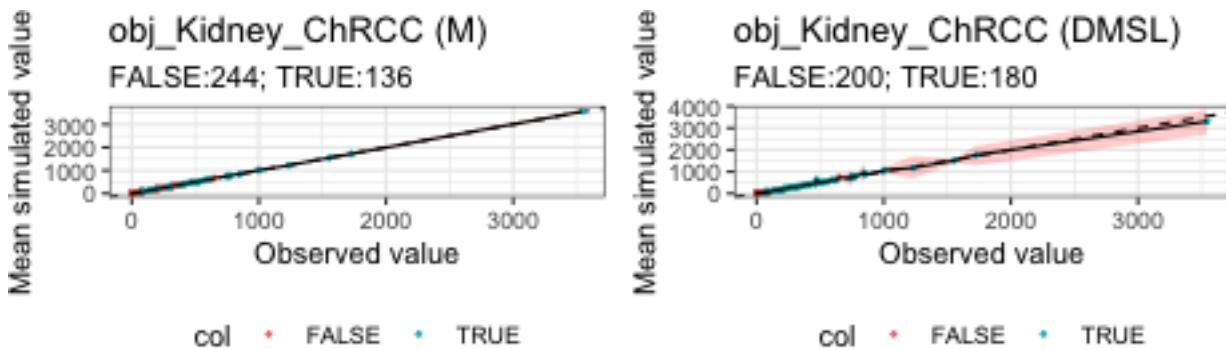
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in mvtnorm:::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

### Simulation of Kidney–ChRCC samples



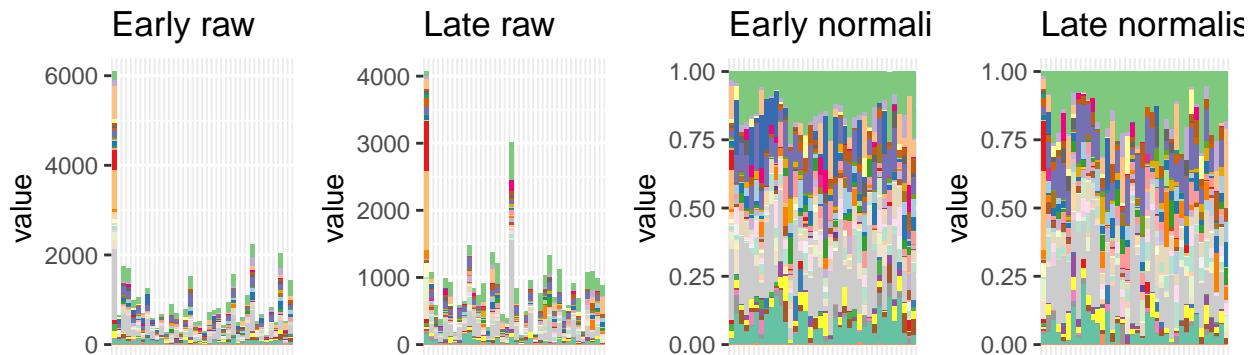
### Ranked plot for coverage



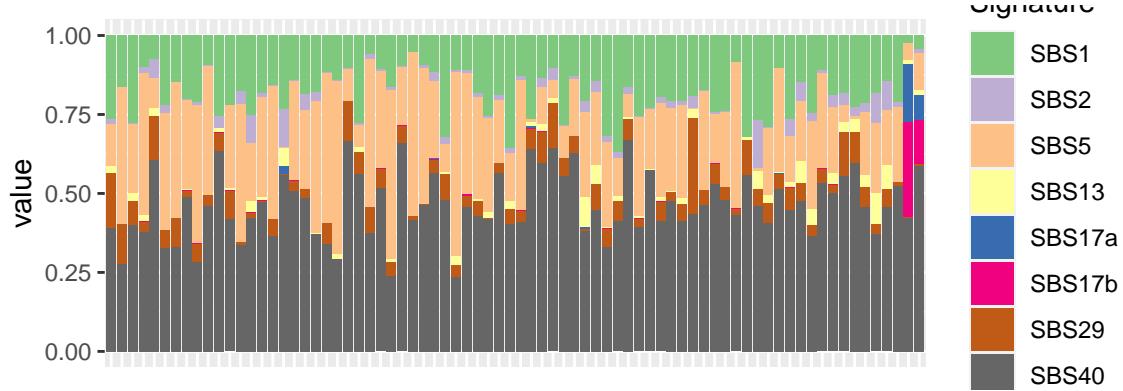
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 38
```



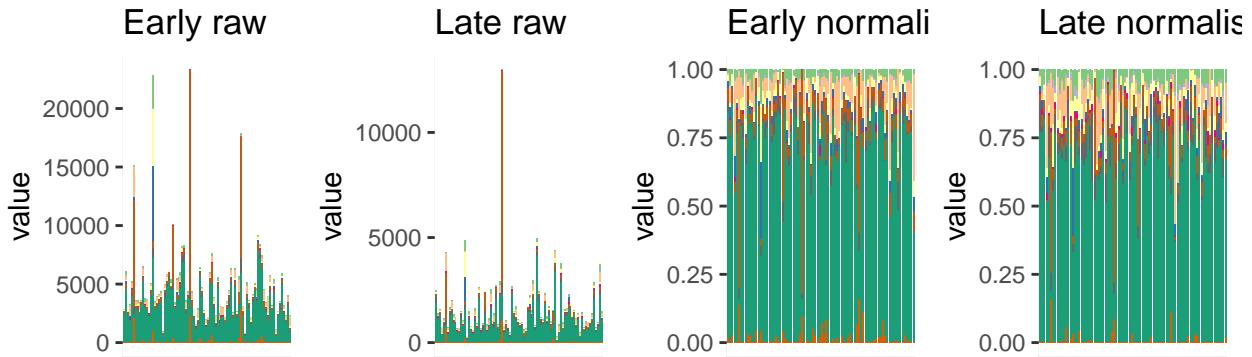
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



### Kidney-RCC.clearcell

#### Barplot and general statistics

```
## [1] 86
```



The number of samples and signatures is:

```
## [1] 172 10
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS5"  "SBS6"  "SBS12" "SBS13" "SBS22" "SBS29" "SBS40"
## [10] "SBS41"
```

### Convergence table

Essentially, everything has converged.

```
##               value          L2
## 1 Kidney-RCC.clearcell  hessian_positivedefinite_bool
## 2 Kidney-RCC.clearcell  hessian_positivedefinite_bool
## 3 Kidney-RCC.clearcell hessian_nonpositivedefinite_bool
## 4 Kidney-RCC.clearcell                         Timeout
## 5 Kidney-RCC.clearcell hessian_nonpositivedefinite_bool
## 6 Kidney-RCC.clearcell  hessian_positivedefinite_bool
## 7 Kidney-RCC.clearcell  hessian_positivedefinite_bool
## 8 Kidney-RCC.clearcell  hessian_positivedefinite_bool
## 9 Kidney-RCC.clearcell  hessian_positivedefinite_bool
## 10 Kidney-RCC.clearcell hessian_positivedefinite_bool
## 11 Kidney-RCC.clearcell hessian_positivedefinite_bool
## 12 Kidney-RCC.clearcell hessian_positivedefinite_bool
## 13 Kidney-RCC.clearcell hessian_positivedefinite_bool
## 14 Kidney-RCC.clearcell hessian_positivedefinite_bool
## 15 Kidney-RCC.clearcell                         Timeout
##
##               value          L1
## 1           diagRE_M
## 2           fullRE_M
## 3      diagRE_DMDL
## 4      fullRE_halfDM
## 5      fullRE_DMDL
## 6      diagRE_DMSL
## 7 sparseRE_DMSL
## 8      fullRE_DMSL
## 9 fullRE_DMSL_SBS1
## 10      fullRE_M_nonexo
## 11      diagRE_DMSL_nonexo
## 12 sparseRE_DMSL_nonexo
```

```
## 13      fullRE_DMSL_nonexo
## 14      fullRE_DMDL_nonexo
## 15 fullRE_DMDL_sortednonexo
```

### Potentially problematic signatures

There are no problematic signatures.

```
colSums(obj_Kidney_RCCclearcell$Y == 0)/nrow(obj_Kidney_RCCclearcell$Y)

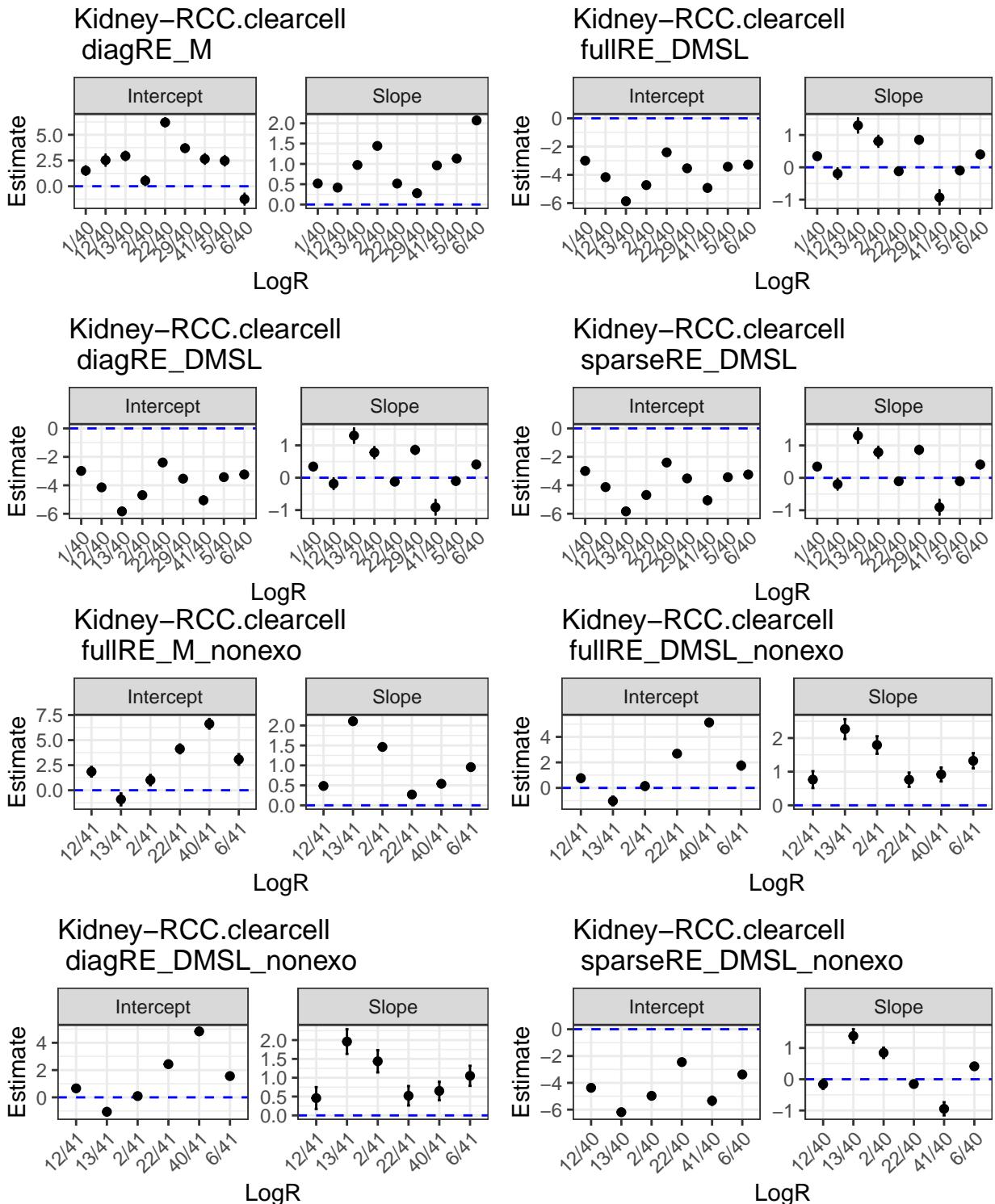
##      SBS1      SBS2      SBS5      SBS6      SBS12      SBS13      SBS22
## 0.02906977 0.26744186 0.33139535 0.11627907 0.35465116 0.52325581 0.00000000
##      SBS29      SBS40      SBS41
## 0.13372093 0.00000000 0.58720930

colSums(obj_Kidney_RCCclearcell$Y)/sum(obj_Kidney_RCCclearcell$Y)

##      SBS1      SBS2      SBS5      SBS6      SBS12      SBS13
## 0.033881764 0.005632854 0.060208144 0.036168761 0.026758216 0.003701688
##      SBS22      SBS29      SBS40      SBS41
## 0.140375696 0.036802695 0.629055577 0.027414605
```

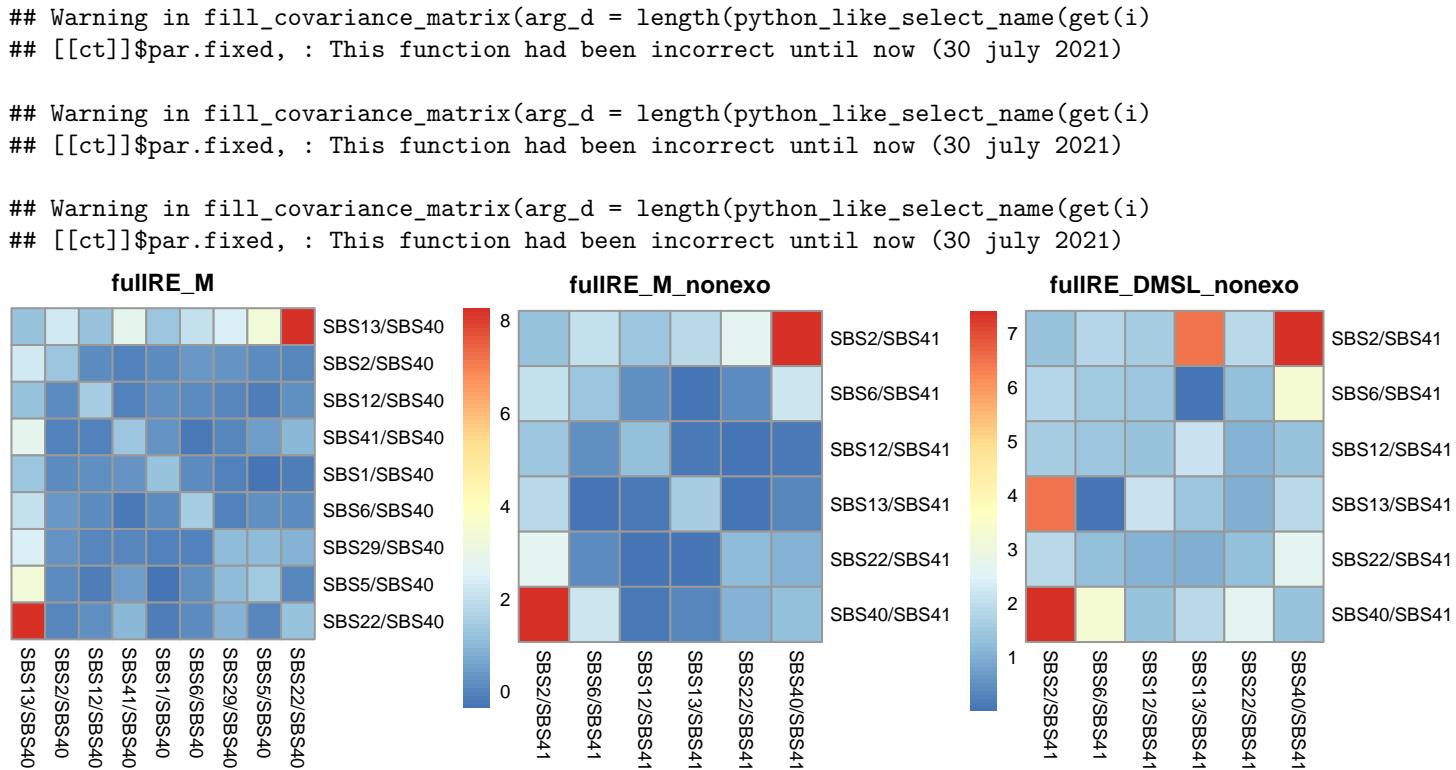
We would need to run `fullRE_DMSL`, because it timed out.

## Betas



We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $3.2572102 \times 10^{-21}$ .

## Covariance matrices



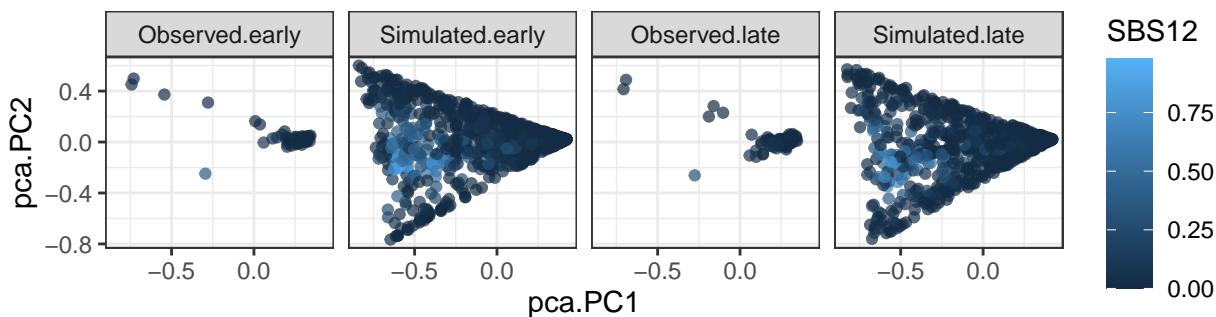
## Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

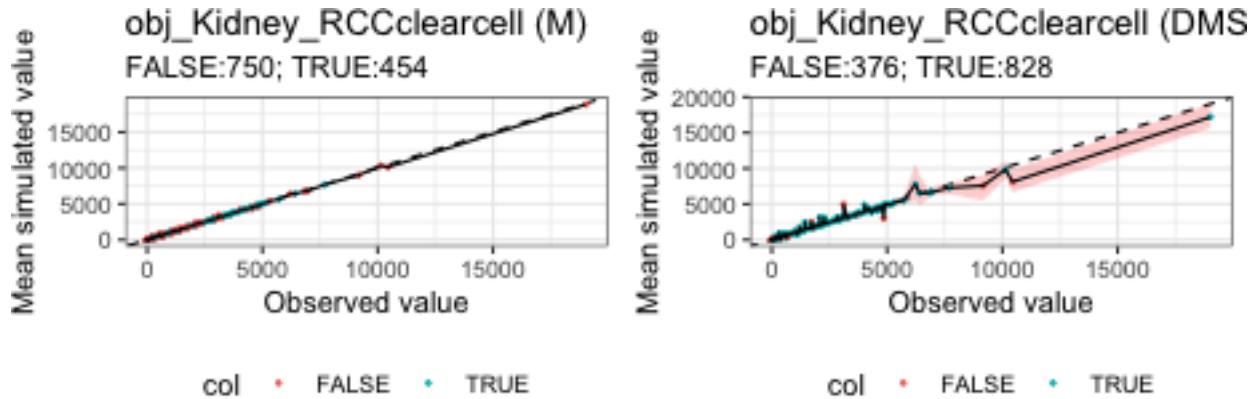
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of Kidney–RCC.clearcell samples



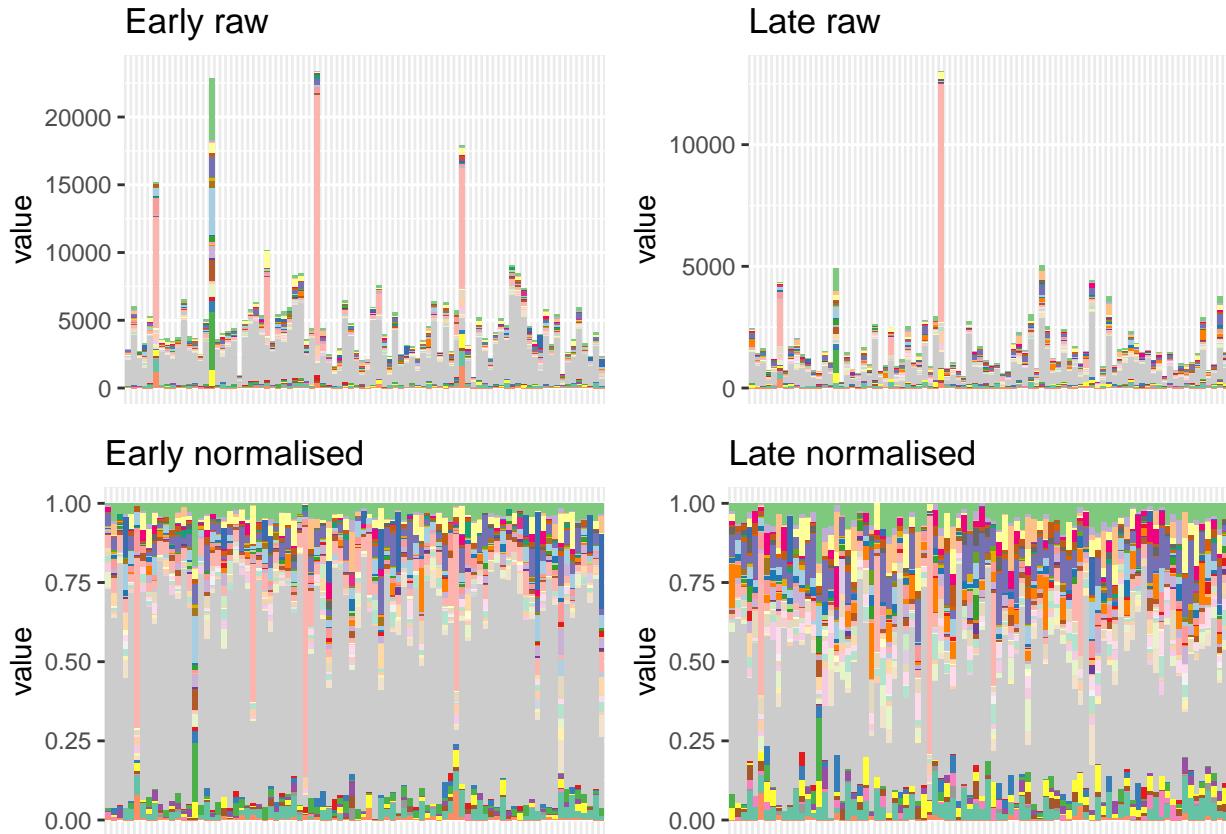
### Ranked plot for coverage



### Signatures from mutSigExtractor

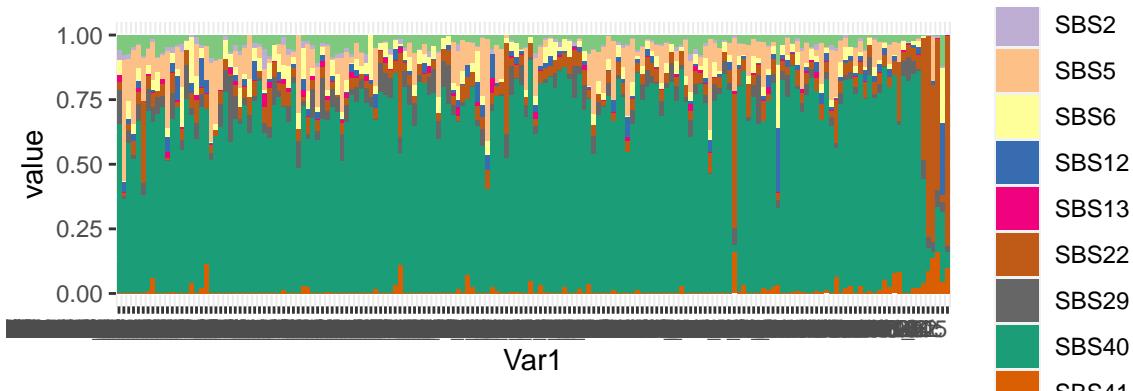
The signatures from mutSigExtractor are as follows:

```
## [1] 86
```



I should check if this grey exposure corresponds to SBS40.

Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations except for perhaps the very few with highest exposure.

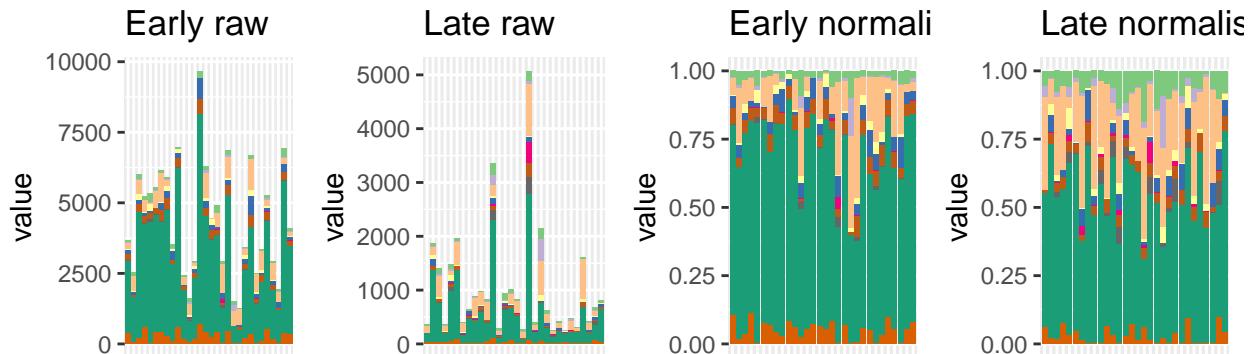


## Kidney-RCC.papillary

It looks very similar to clear cell, looking generally at the signatures.

### Barplot and general statistics

```
## [1] 30
```



The number of samples and signatures is:

```
## [1] 60 10
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS5"  "SBS6"  "SBS12" "SBS13" "SBS22" "SBS29" "SBS40"
## [10] "SBS41"
```

### Convergence table

Although fulLRE DMSL has in one case converged, it hasn't when using SBS1 as baseline. The nonexogenous version has not converged, but M has.

```
##               value          L2
## 1 Kidney-RCC.papillary hessian_positivedefinite_bool
## 2 Kidney-RCC.papillary hessian_positivedefinite_bool
## 3 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
## 4 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
## 5 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
## 6 Kidney-RCC.papillary hessian_positivedefinite_bool
## 7 Kidney-RCC.papillary hessian_positivedefinite_bool
```

```

## 8 Kidney-RCC.papillary    hessian_positivedefinite_bool
## 9 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
## 10 Kidney-RCC.papillary    hessian_positivedefinite_bool
## 11 Kidney-RCC.papillary    hessian_positivedefinite_bool
## 12 Kidney-RCC.papillary    hessian_positivedefinite_bool
## 13 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
## 14 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
## 15 Kidney-RCC.papillary hessian_nonpositivedefinite_bool
##
## L1
## 1          diagRE_M
## 2          fullRE_M
## 3          diagRE_DMDL
## 4          fullRE_halfDM
## 5          fullRE_DMDL
## 6          diagRE_DMSL
## 7          sparseRE_DMSL
## 8          fullRE_DMSL
## 9          fullRE_DMSL_SBS1
## 10         fullRE_M_nonexo
## 11         diagRE_DMSL_nonexo
## 12         sparseRE_DMSL_nonexo
## 13         fullRE_DMSL_nonexo
## 14         fullRE_DMDL_nonexo
## 15 fullRE_DMDL_sortednonexo

```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo. We first re-run M.

The we use it to re-run DM.

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo do converge:

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

### Potentially problematic signatures

We explore whether there are problematic signatures:

```
colSums(obj_Kidney_RCCpapillary$Y == 0) / nrow(obj_Kidney_RCCpapillary$Y)
```

```

##      SBS1      SBS2      SBS5      SBS6      SBS12     SBS13      SBS22     SBS29
## 0.0000000 0.2333333 0.1000000 0.2666667 0.1833333 0.6500000 0.0000000 0.6333333
##      SBS40      SBS41
## 0.0000000 0.2166667

```

```
colSums(obj_Kidney_RCCpapillary$Y) / sum(obj_Kidney_RCCpapillary$Y)
```

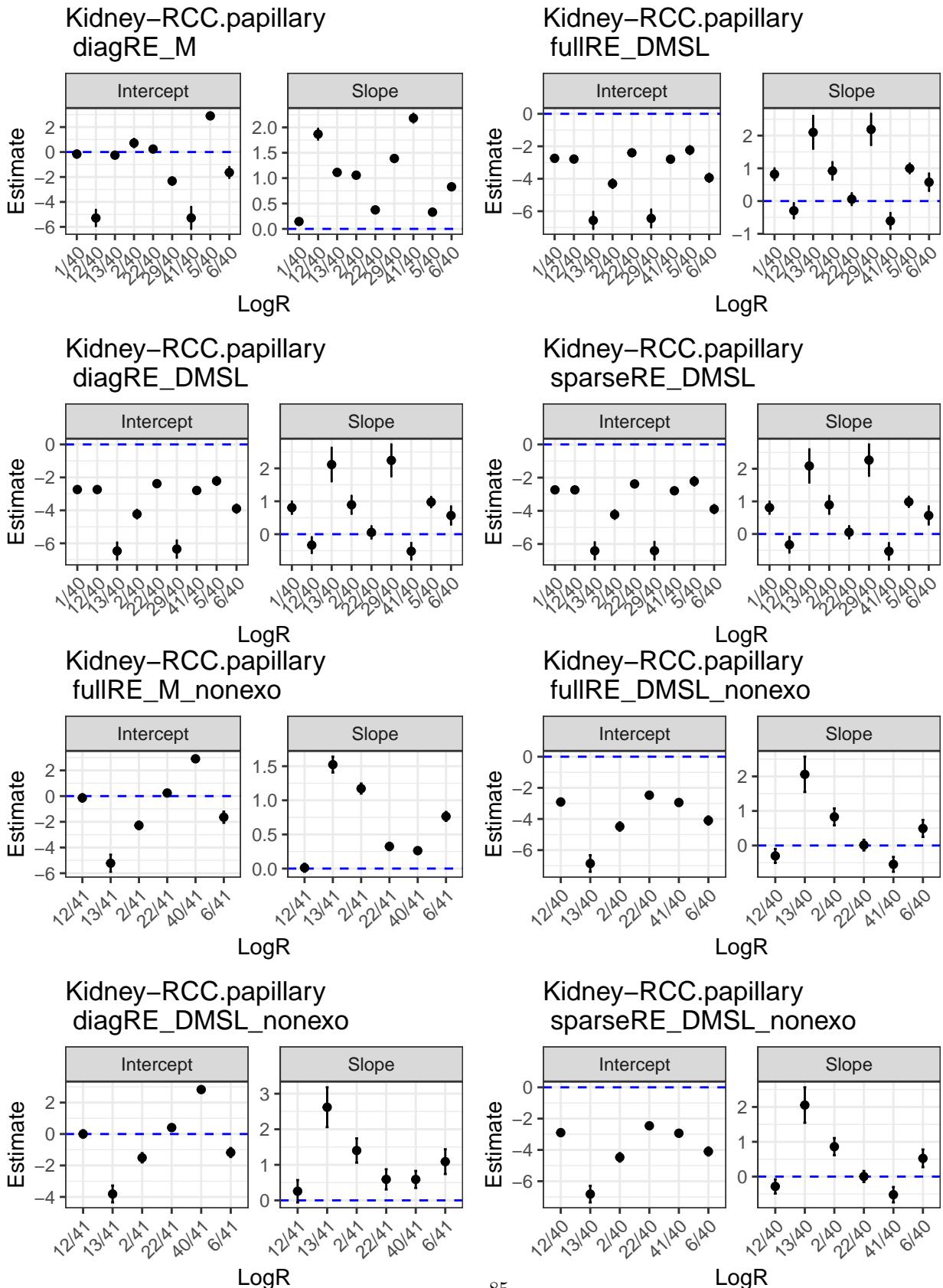
```

##      SBS1      SBS2      SBS5      SBS6      SBS12     SBS13
## 0.035736437 0.010720323 0.116403371 0.016521337 0.039719314 0.004438931
##      SBS22      SBS29      SBS40      SBS41
## 0.049284298 0.007187420 0.669488124 0.050500444

```

SBS29 is found in relatively small quantities.

### Betas



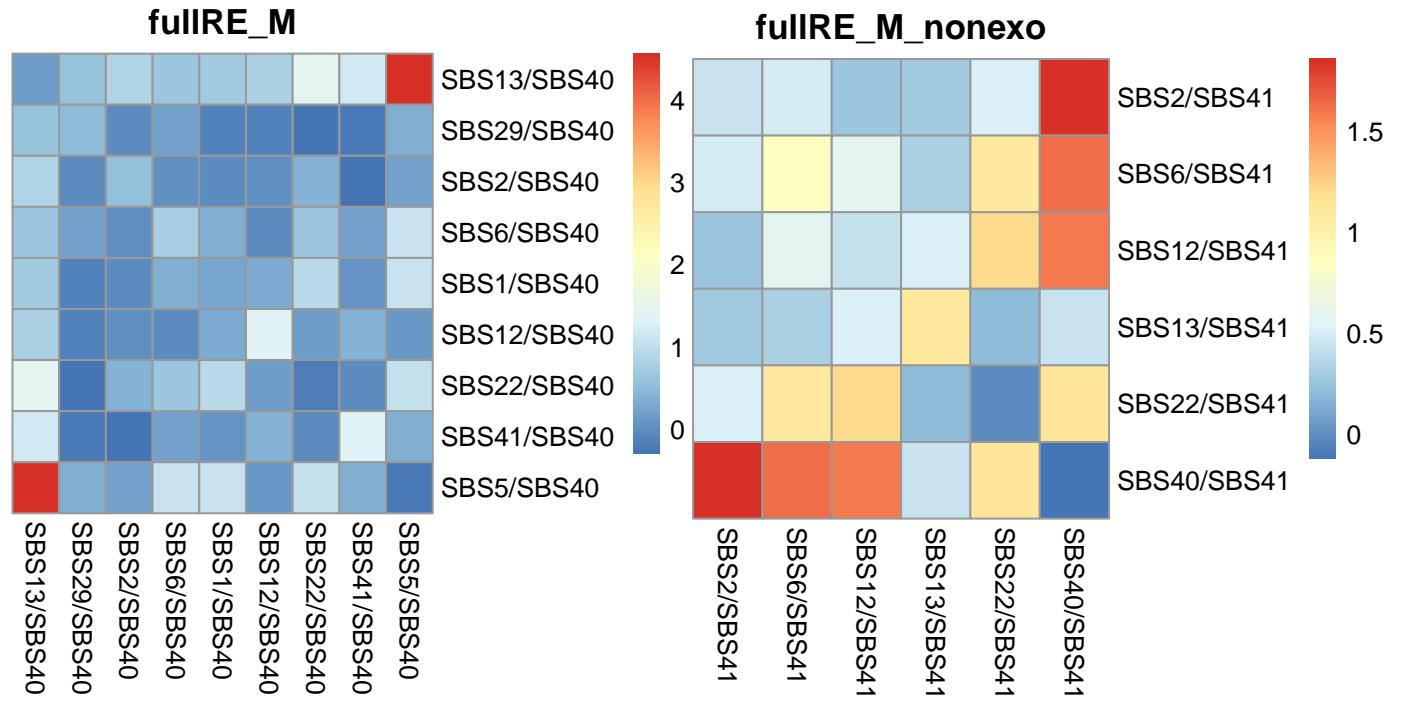
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $2.591235 \times 10^{-7}$ .

### Covariance matrices

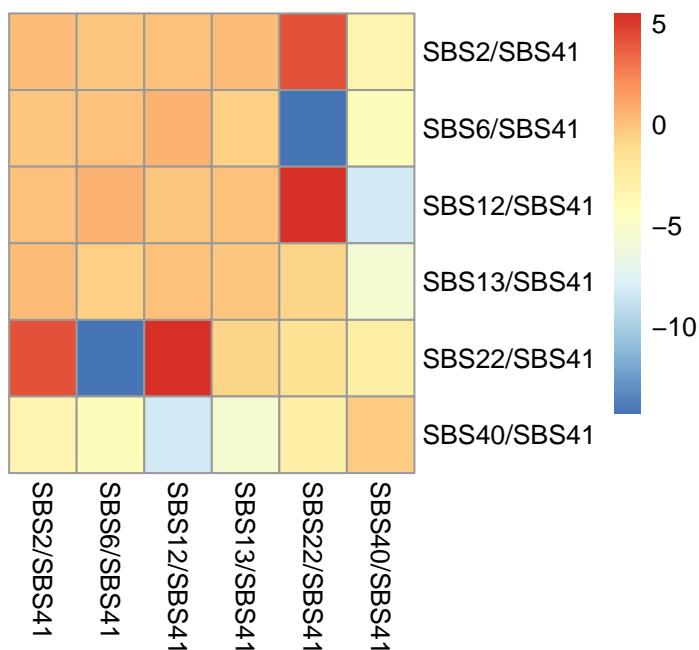
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



## ditional\_sortedDMSLnonexo



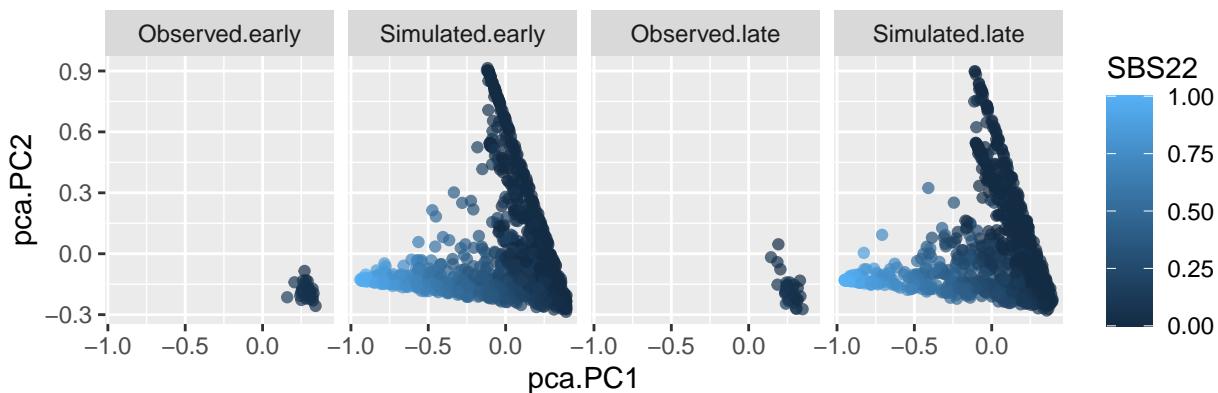
## Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

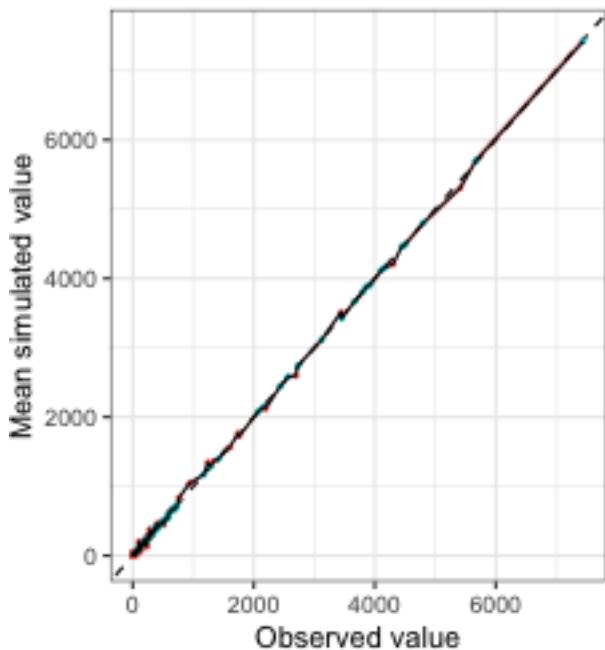
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of Kidney–RCC.papillary samples

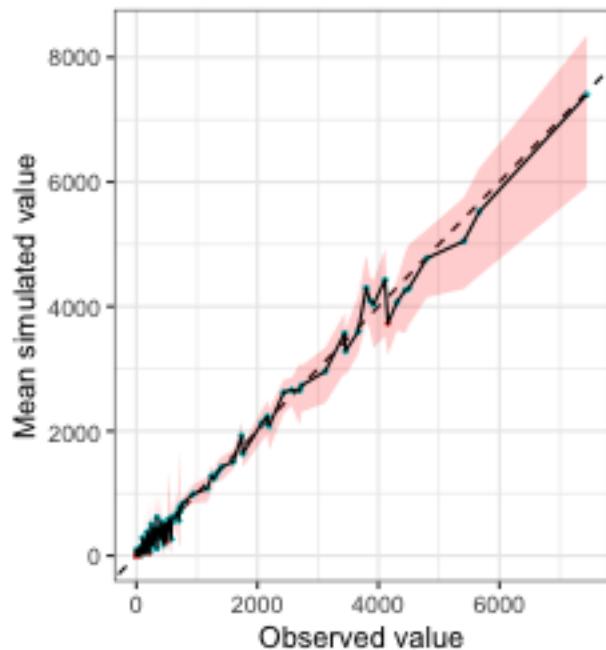


### Ranked plot for coverage

obj\_Kidney\_RCCpapillary (M)  
FALSE:224; TRUE:196



obj\_Kidney\_RCCpapillary (DMSI)  
FALSE:114; TRUE:306



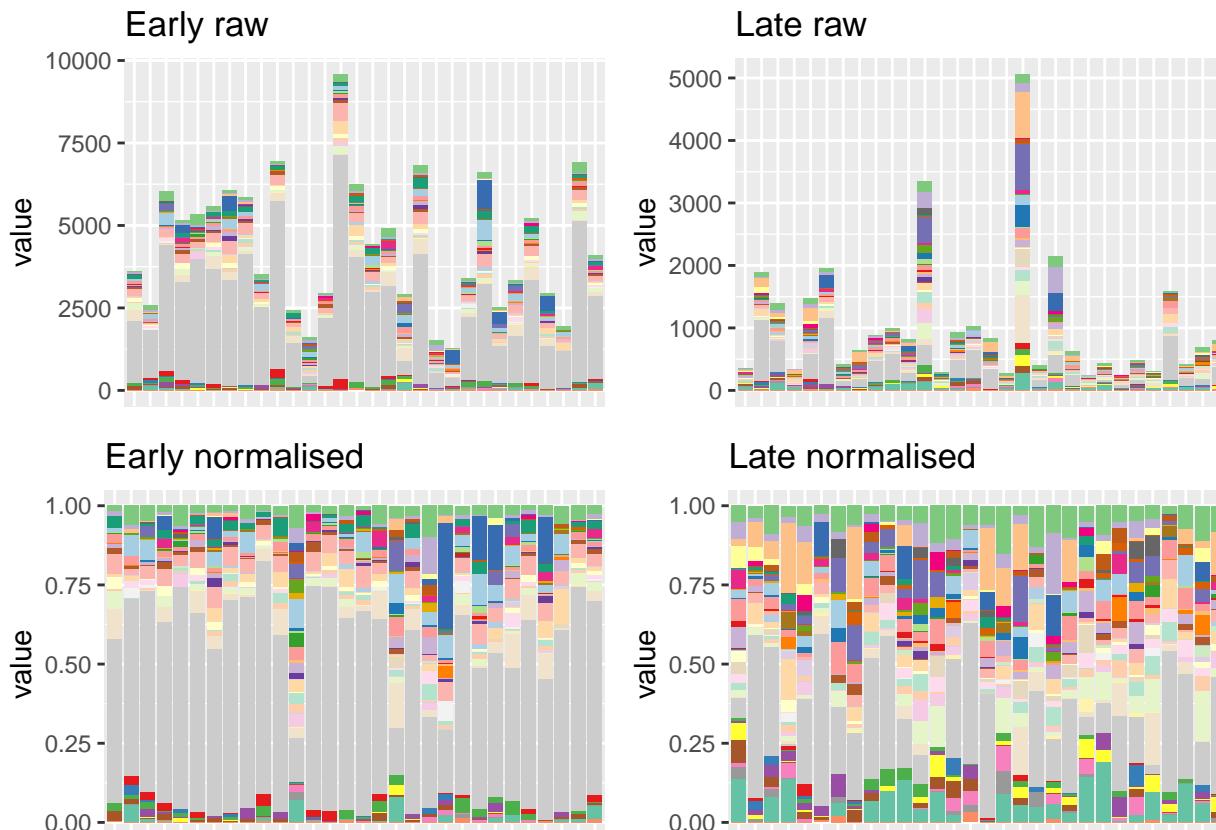
col    + FALSE    \* TRUE

col    + FALSE    \* TRUE

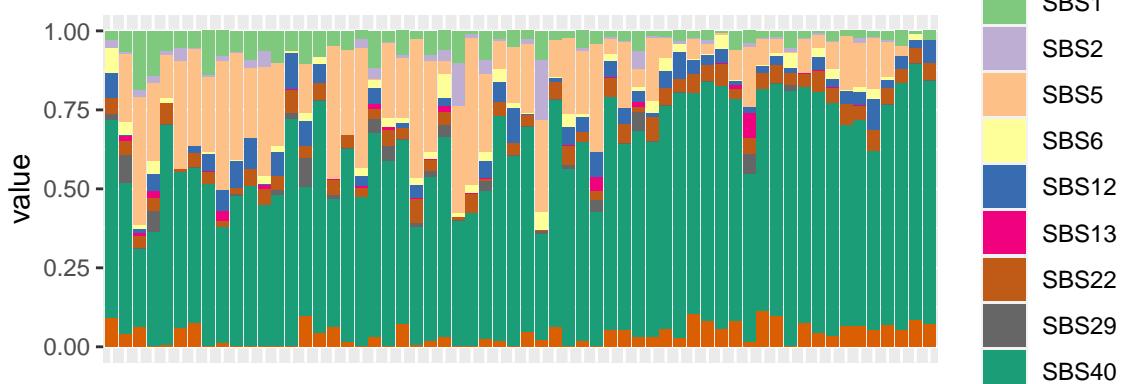
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 30
```



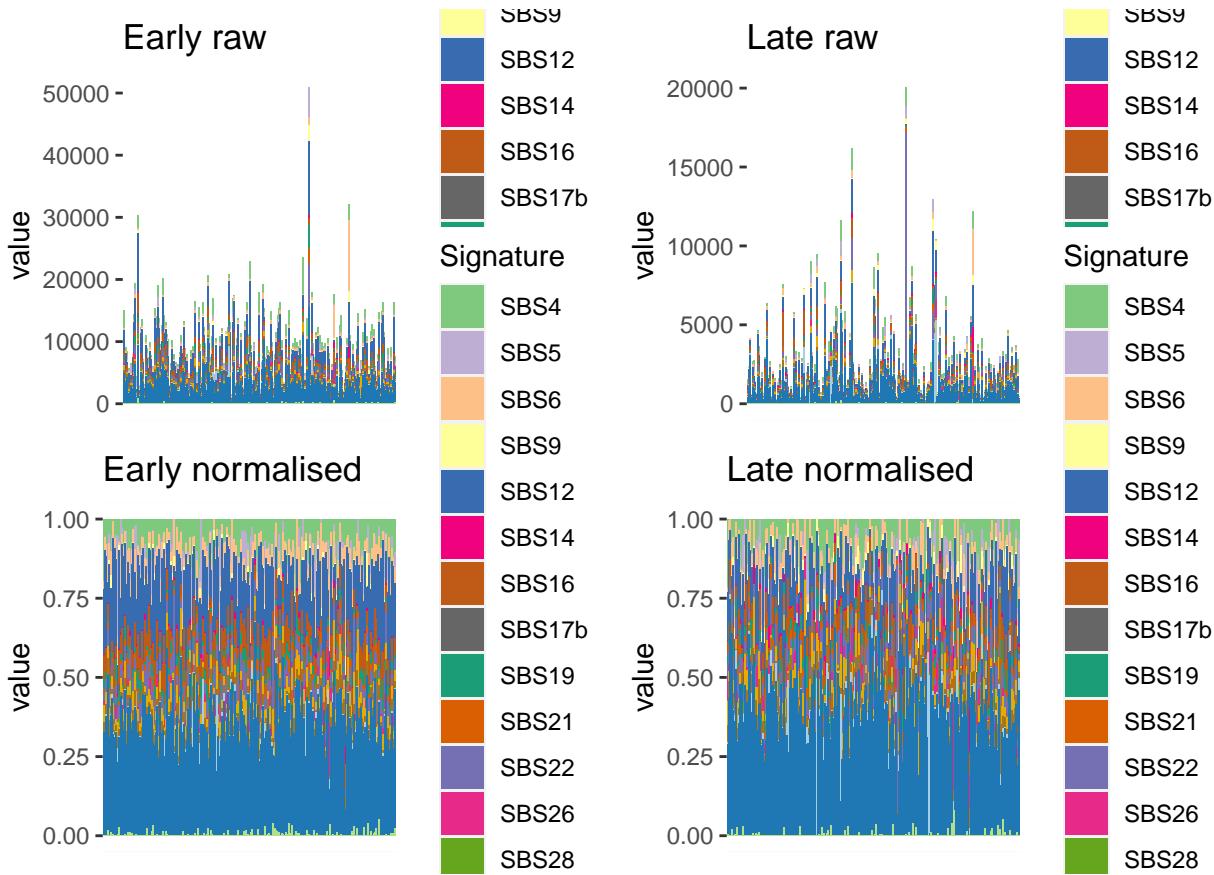
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



Liver-HCC

Barplot and general statistics

```
## [1] 207
```



The number of samples and signatures is:

```
## [1] 414 18
```

The signatures are:

```
## [1] "SBS4"   "SBS5"   "SBS6"   "SBS9"   "SBS12"  "SBS14"  "SBS16"  "SBS17b"
## [9] "SBS19"  "SBS21"  "SBS22"  "SBS26"  "SBS28"  "SBS29"  "SBS30"  "SBS35"
## [17] "SBS40"  "SBS54"
```

### Convergence table

The fullRE versions with all signatures have not converged. Neither has fullRE\_M\_nonexo, but fullRE\_DMSL\_nonexo has.

```
##      value          L2          L1
## 1 Liver-HCC hessian_positivedefinite_bool diagRE_M
## 2 Liver-HCC hessian_nonpositivedefinite_bool fullRE_M
## 3 Liver-HCC hessian_nonpositivedefinite_bool diagRE_DMDL
## 4 Liver-HCC                                     Timeout fullRE_halfDM
## 5 Liver-HCC hessian_nonpositivedefinite_bool fullRE_DMDL
## 6 Liver-HCC hessian_positivedefinite_bool    diagRE_DMSL
## 7 Liver-HCC hessian_positivedefinite_bool sparseRE_DMSL
## 8 Liver-HCC hessian_nonpositivedefinite_bool fullRE_DMSL
## 9 Liver-HCC hessian_positivedefinite_bool fullRE_DMSL_SBS1
## 10 Liver-HCC hessian_nonpositivedefinite_bool fullRE_M_nonexo
```

```

## 11 Liver-HCC    hessian_positivedefinite_bool      diagRE_DMSL_nonexo
## 12 Liver-HCC    hessian_positivedefinite_bool      sparseRE_DMSL_nonexo
## 13 Liver-HCC    hessian_positivedefinite_bool      fullRE_DMSL_nonexo
## 14 Liver-HCC    hessian_nonpositivedefinite_bool   fullRE_DMDL_nonexo
## 15 Liver-HCC                    Timeout fullRE_DMDL_sortednonexo

```

### Potentially problematic signatures

We explore whether there are problematic signatures:

```
colSums(obj_Liver_HCC$Y == 0) / nrow(obj_Liver_HCC$Y)
```

```

##      SBS4      SBS5      SBS6      SBS9      SBS12     SBS14
## 0.084541063 0.548309179 0.007246377 0.642512077 0.026570048 0.434782609
##      SBS16     SBS17b     SBS19     SBS21     SBS22     SBS26
## 0.048309179 0.649758454 0.120772947 0.176328502 0.012077295 0.613526570
##      SBS28     SBS29     SBS30     SBS35     SBS40     SBS54
## 0.934782609 0.096618357 0.113526570 0.628019324 0.007246377 0.649758454

```

```
colSums(obj_Liver_HCC$Y) / sum(obj_Liver_HCC$Y)
```

```

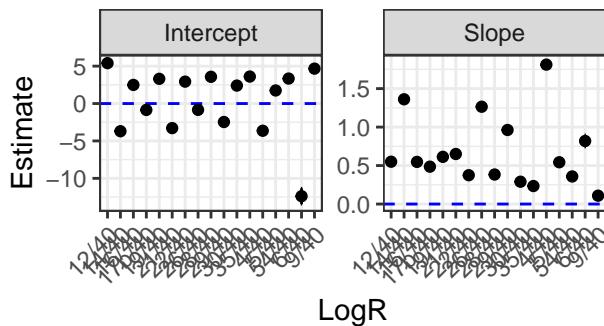
##      SBS4      SBS5      SBS6      SBS9      SBS12     SBS14
## 0.081740962 0.026465897 0.047036092 0.007670584 0.206143096 0.005884273
##      SBS16     SBS17b     SBS19     SBS21     SBS22     SBS26
## 0.068804779 0.001835835 0.028215636 0.016888238 0.058186725 0.011387208
##      SBS28     SBS29     SBS30     SBS35     SBS40     SBS54
## 0.000603818 0.036248511 0.025723410 0.015247453 0.357387133 0.004530350

```

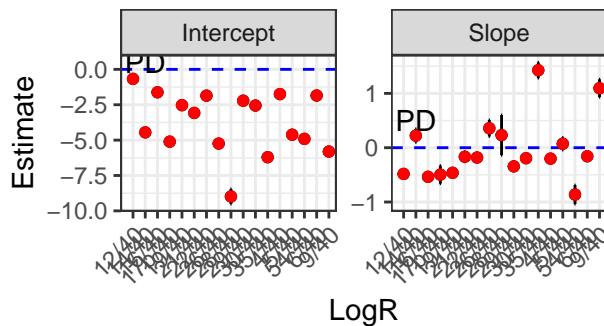
SBS28 is only present in 7% of samples and has extremely low exposure - we could consider removing it.

## Betas

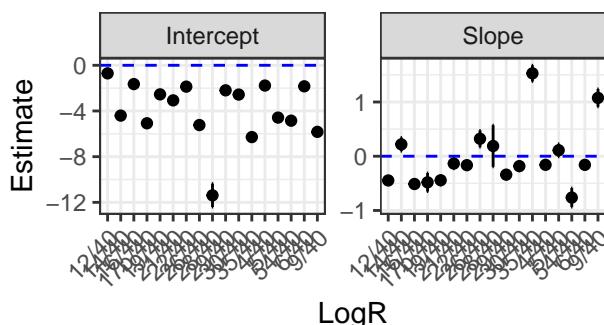
Liver-HCC  
diagRE\_M



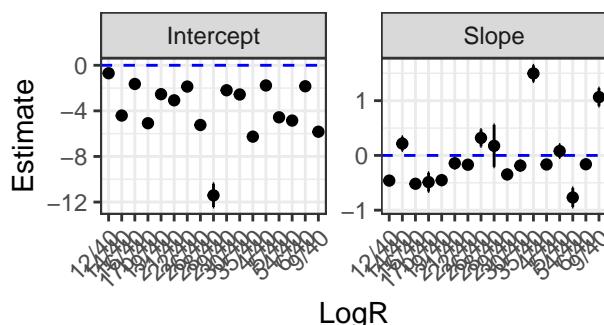
Liver-HCC  
fullRE\_DMSL



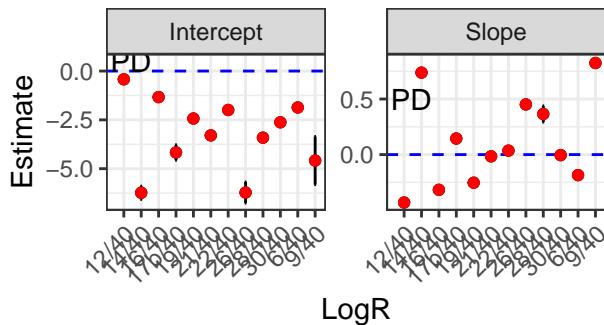
Liver-HCC  
diagRE\_DMSL



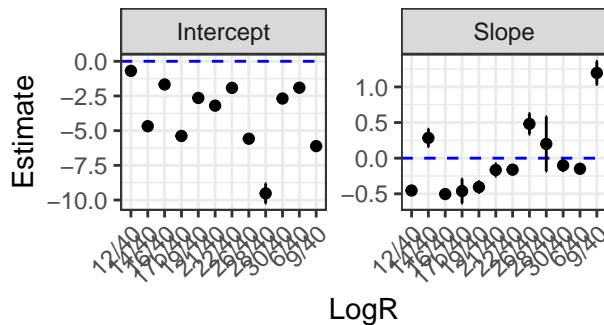
Liver-HCC  
sparseRE\_DMSL



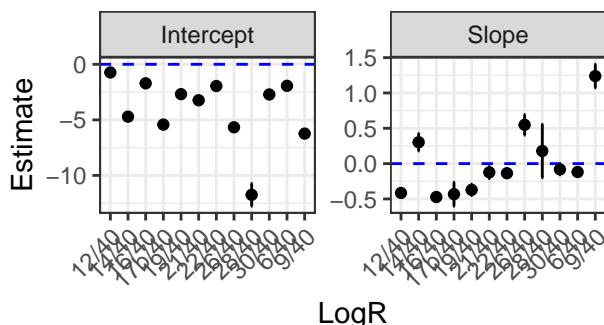
Liver-HCC  
fullRE\_M\_nonexo



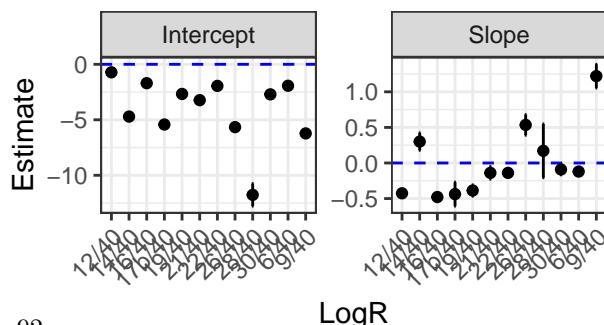
Liver-HCC  
fullRE\_DMSL\_nonexo



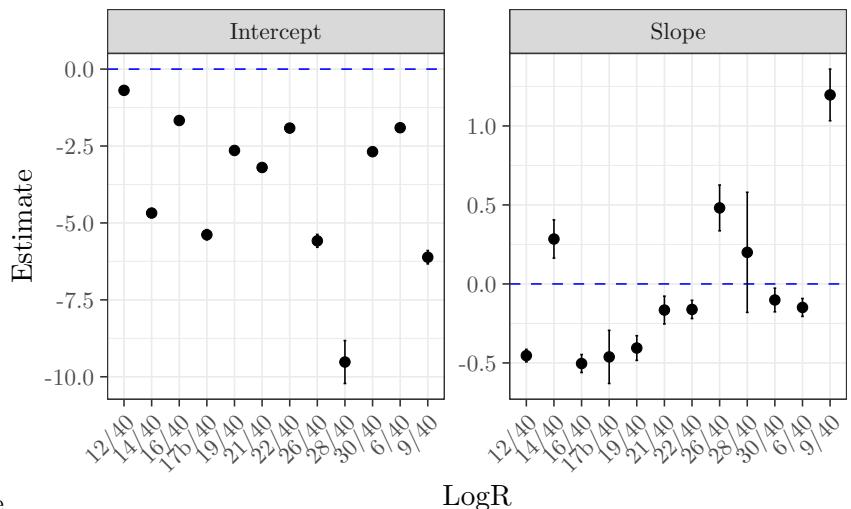
Liver-HCC  
diagRE\_DMSL\_nonexo



Liver-HCC  
sparseRE\_DMSL\_nonexo



## Liver-HCCfullRE DMSL non-exogenous



Difficult to see the labels, so I replot it here

We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $1.0407591 \times 10^{-55}$ .

### Covariance matrices

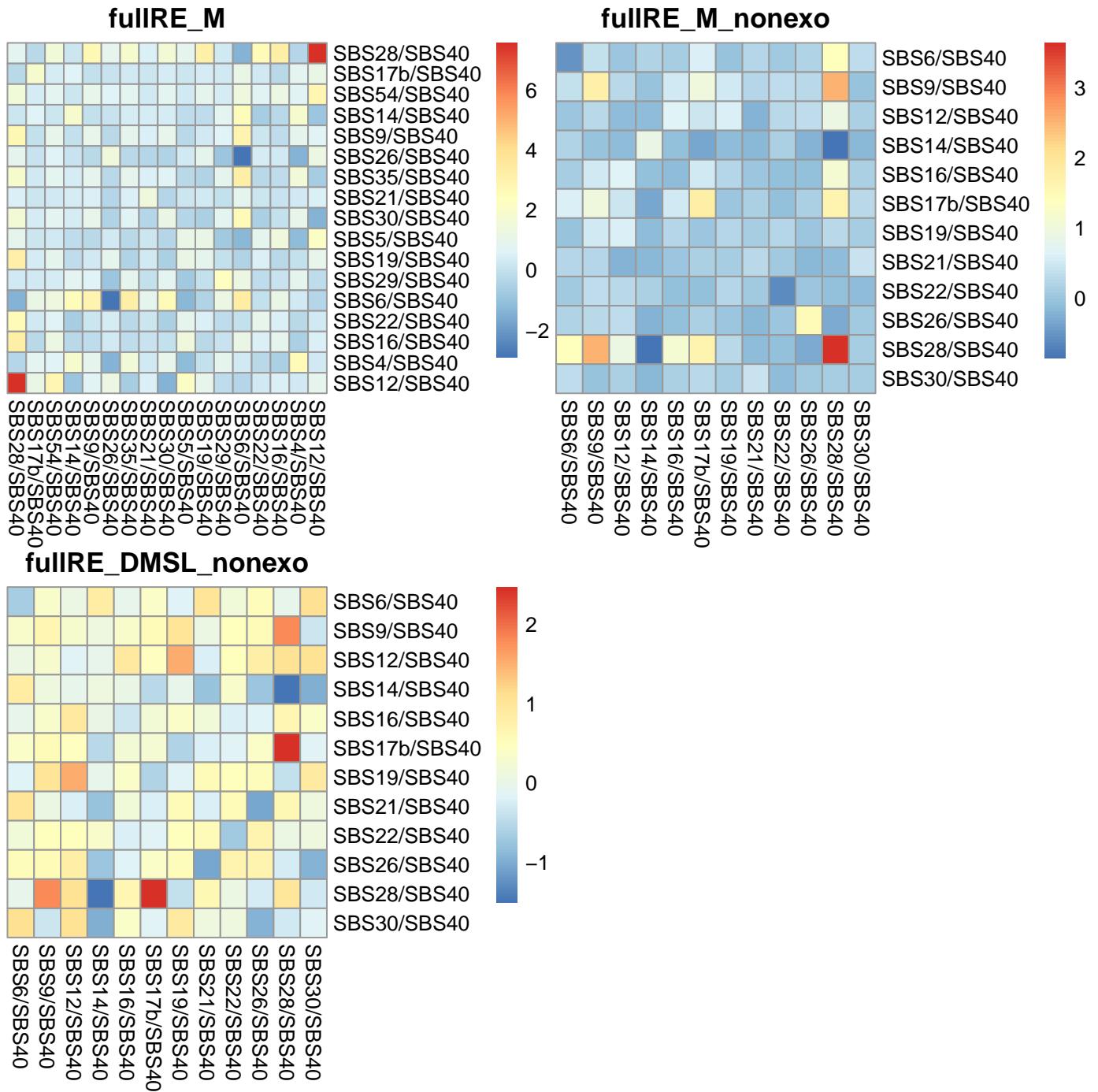
```

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

```



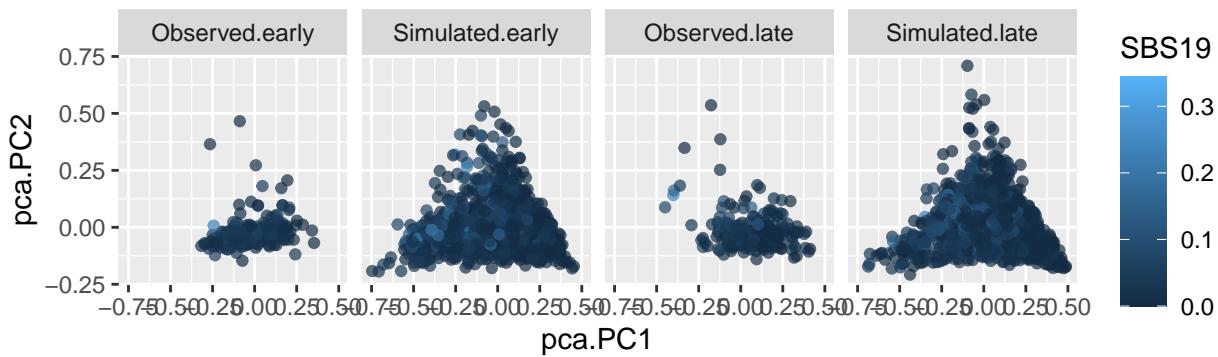
#### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

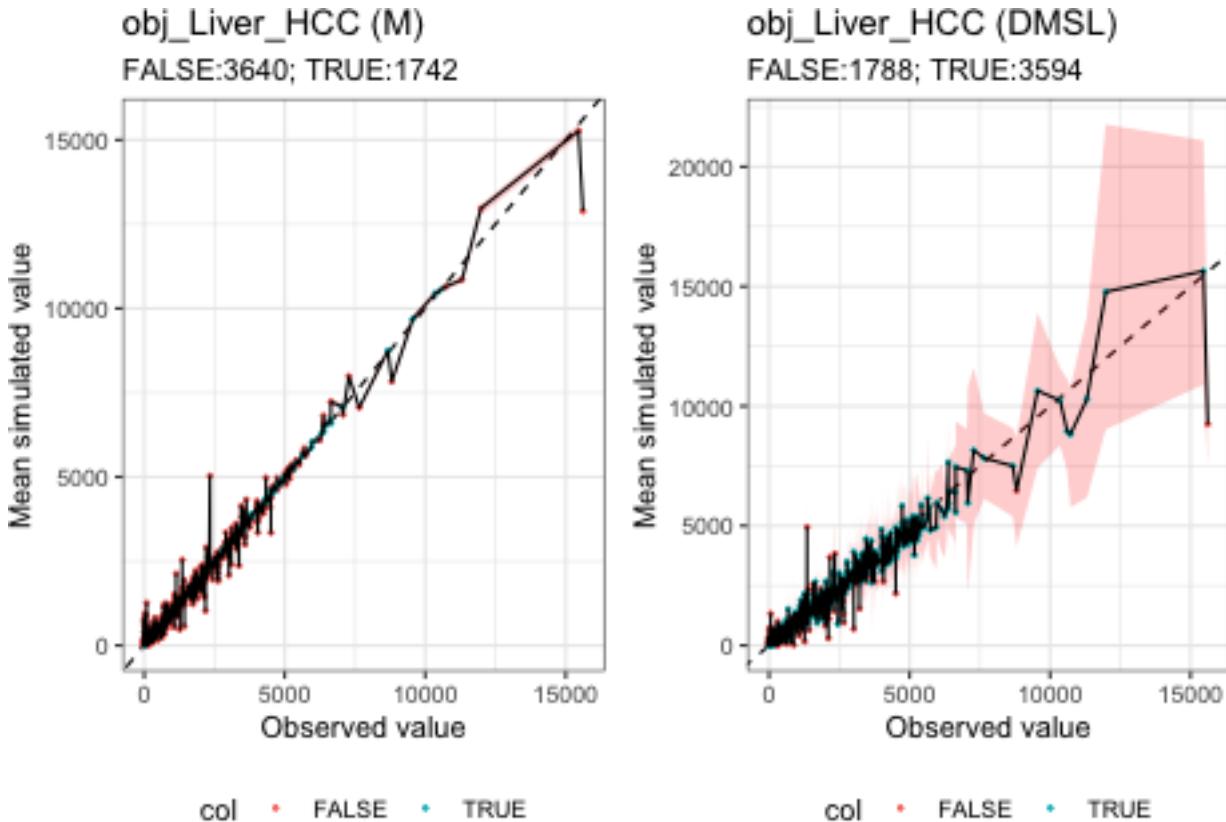
```
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

### Simulation of Liver–HCC samples



### Ranked plot for coverage

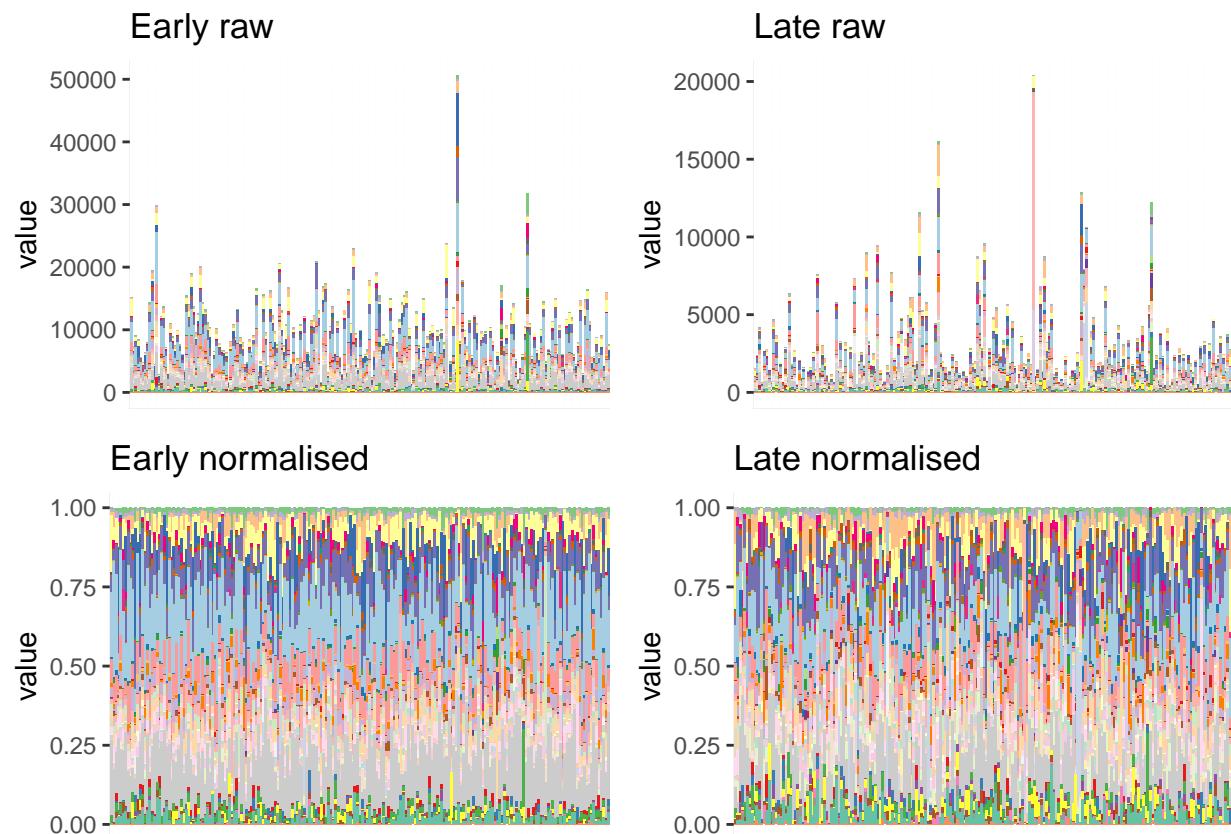
Remember that fullRE M has not converged, and it should be re-run:



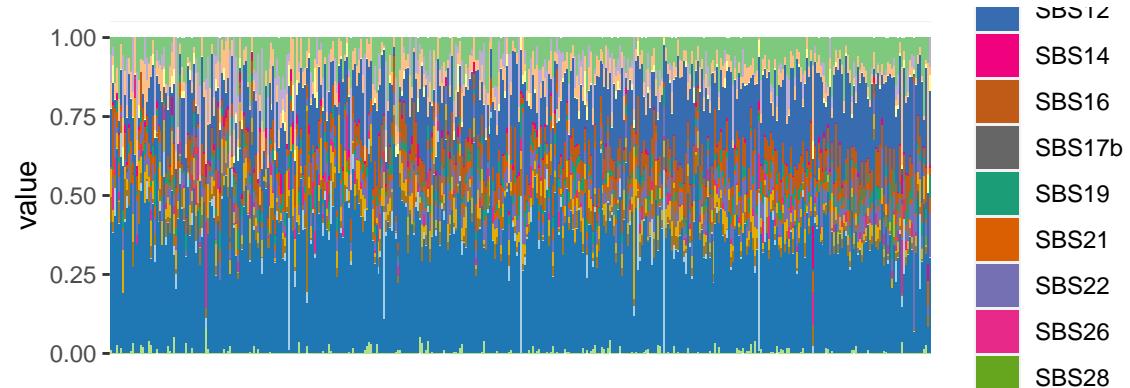
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 207
```



Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.

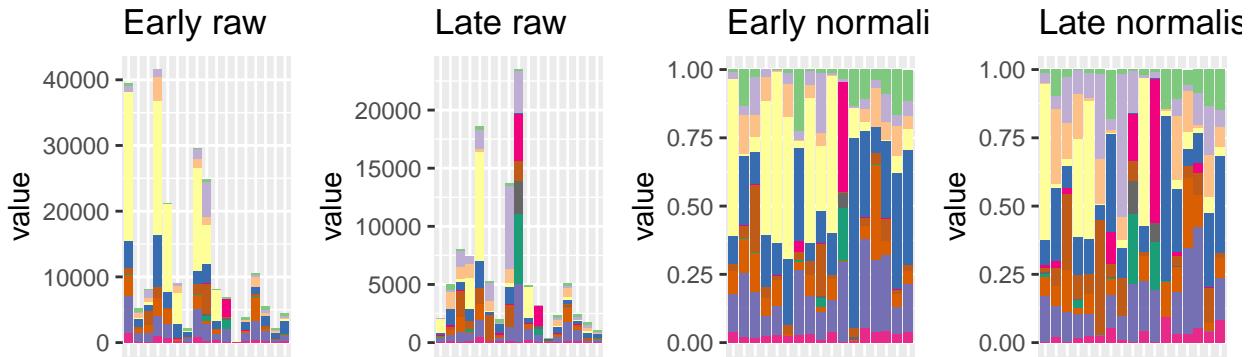


## Lung-AdenoCA

How can we have such few samples?

### Barplot and general statistics

```
## [1] 17
```



The number of samples and signatures is:

```
## [1] 34 12
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS3"   "SBS4"   "SBS5"   "SBS9"   "SBS13"  "SBS17a"
## [9] "SBS17b" "SBS18"  "SBS40"  "SBS50"
```

### Convergence table

No fullRE DMSL have converged.

```
## [1] value L2     L1
## <0 rows> (or 0-length row.names)
```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo. We re-run fullRE\_M\_nonexo and it has converged:

But fullRE DMSL hasn't:

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo does not converge:

```
## [1] FALSE
```

### Potentially problematic signatures

We explore whether there are problematic signatures:

```
colSums(obj_Lung_AdenoCA$Y == 0) / nrow(obj_Lung_AdenoCA$Y)
```

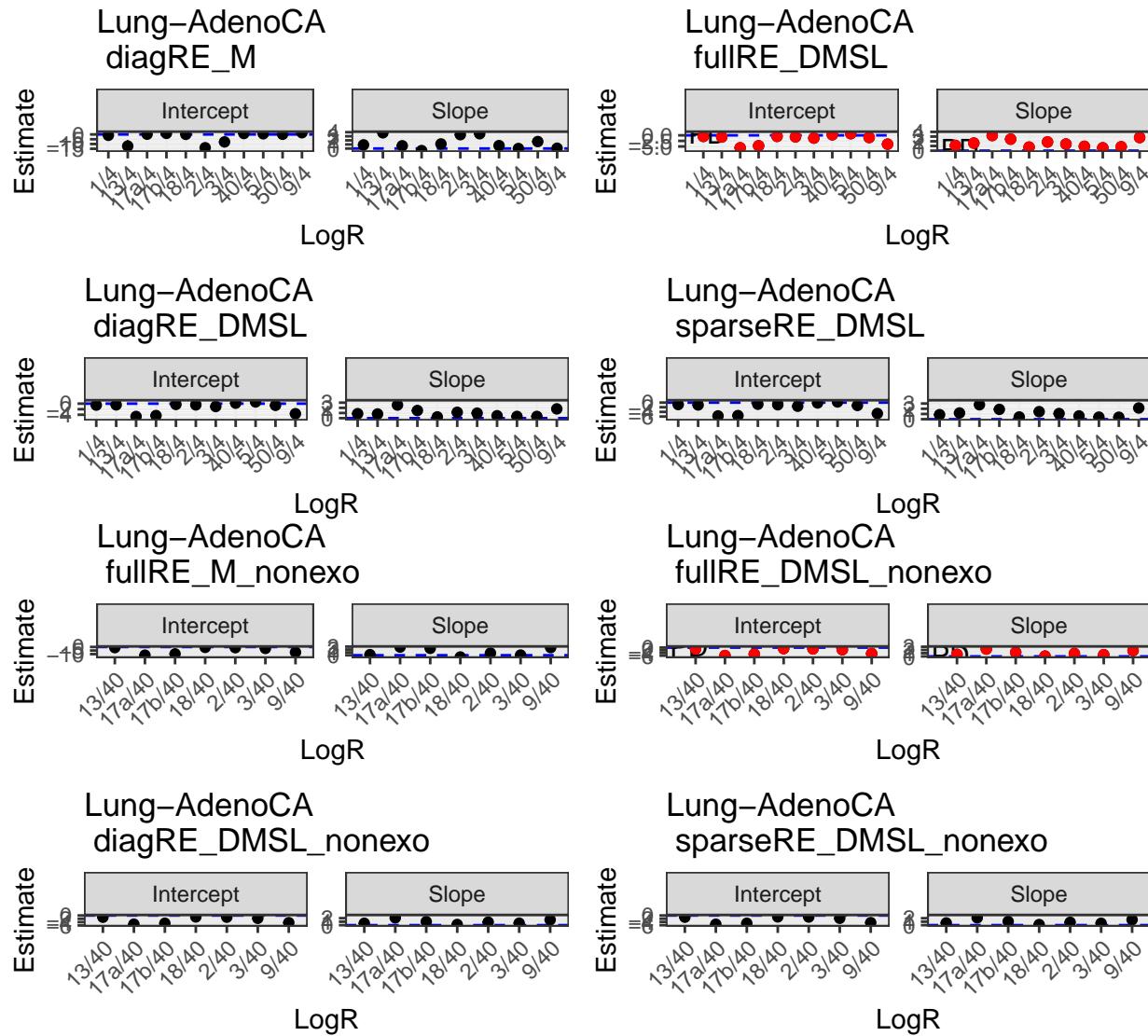
```
##      SBS1      SBS2      SBS3      SBS4      SBS5      SBS9      SBS13
## 0.02941176 0.02941176 0.26470588 0.17647059 0.08823529 0.58823529 0.08823529
##      SBS17a     SBS17b     SBS18     SBS40     SBS50
## 0.64705882 0.64705882 0.14705882 0.14705882 0.11764706
```

```
colSums(obj_Lung_AdenoCA$Y) / sum(obj_Lung_AdenoCA$Y)
```

```
##      SBS1      SBS2      SBS3      SBS4      SBS5      SBS9      SBS13
## 0.02550030 0.09137609 0.05699124 0.32022800 0.13218445 0.02860308 0.07430021
##      SBS17a     SBS17b     SBS18     SBS40     SBS50
## 0.01139098 0.02722878 0.07136089 0.13654347 0.02429249
```

None seem to be problematic.

## Betas

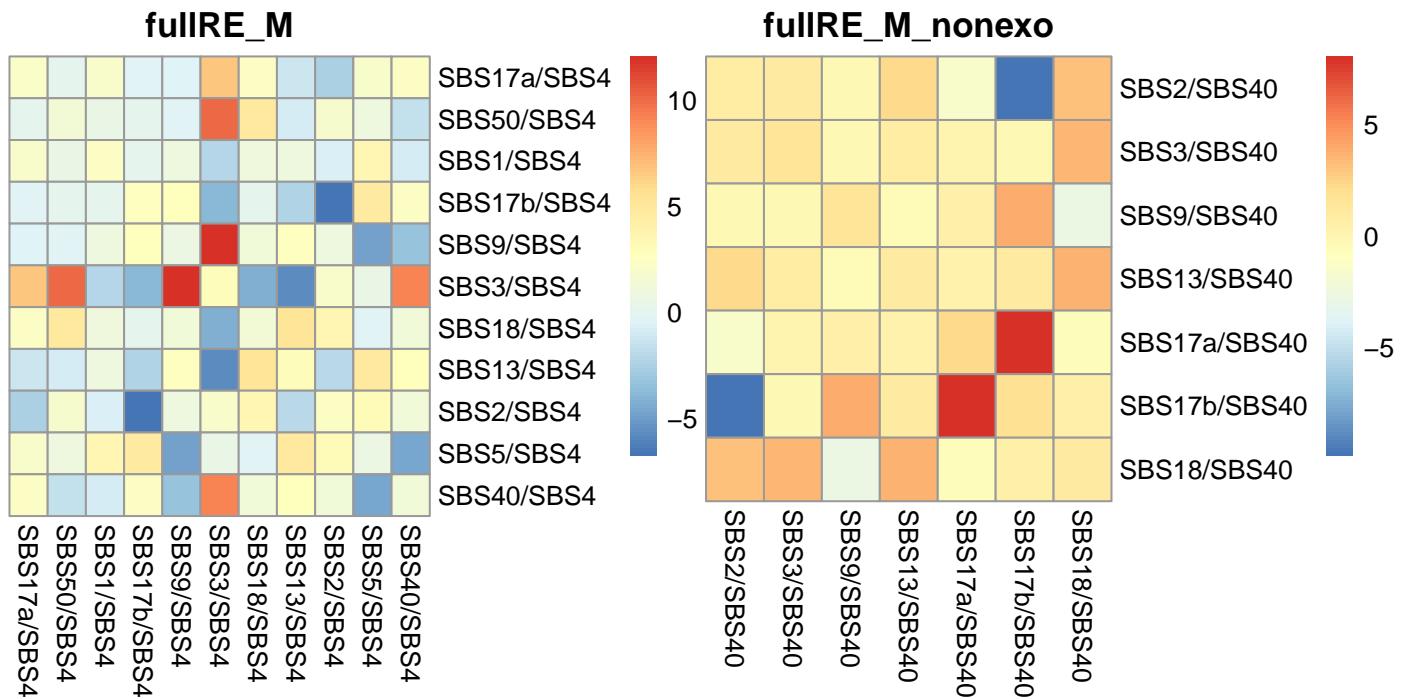


We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of 0.0034356.

## Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

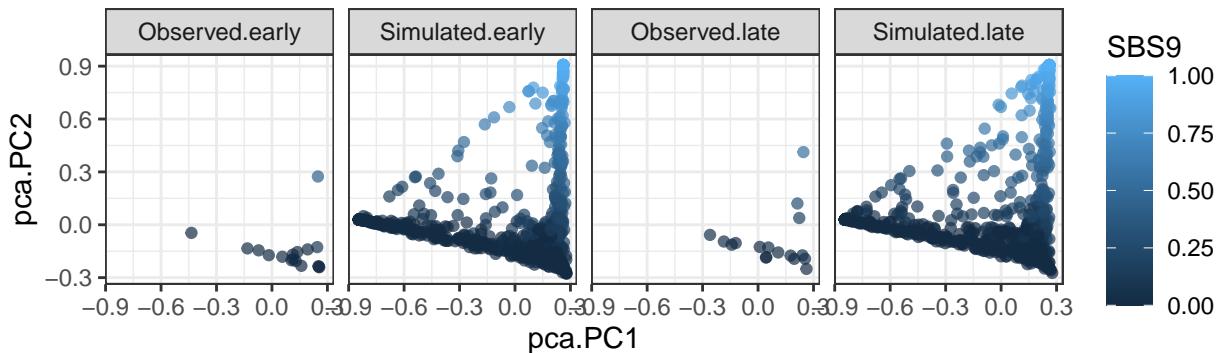
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



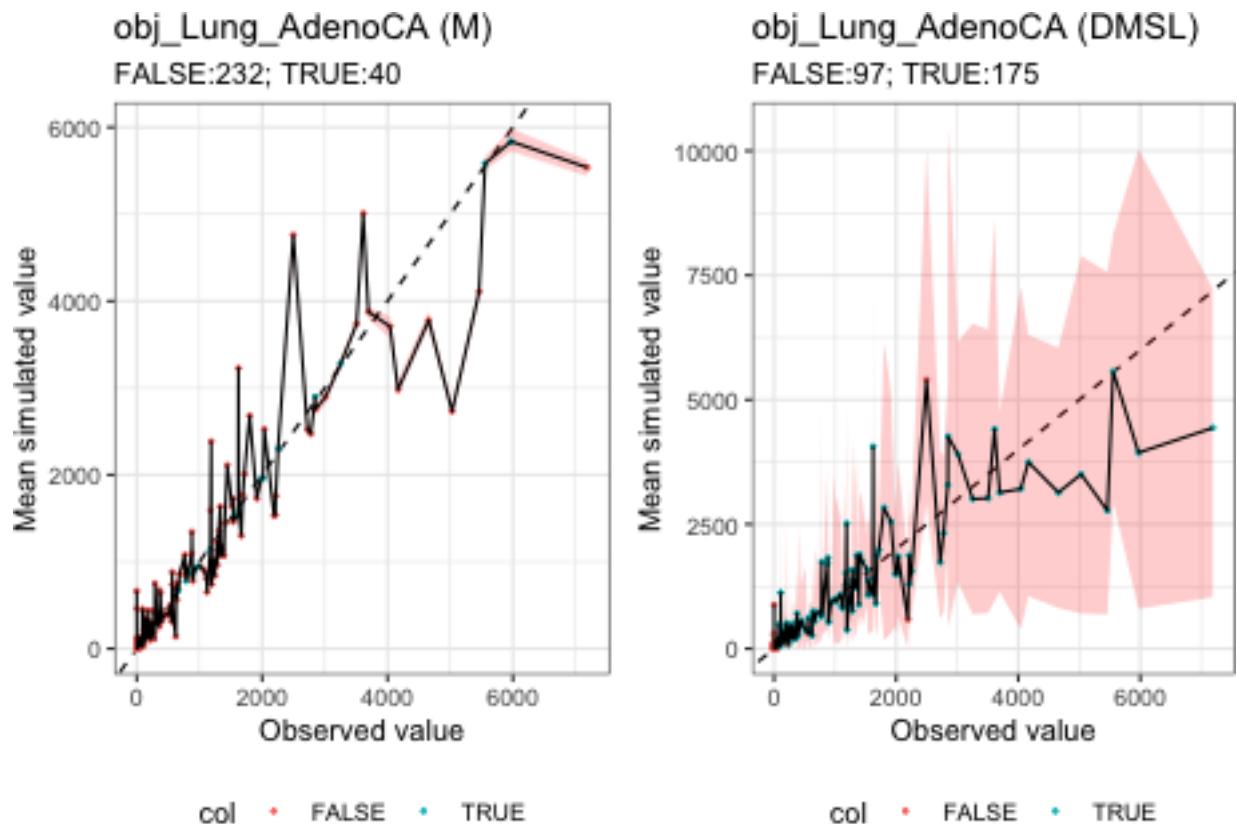
#### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

#### Simulation of Lung–AdenoCA samples



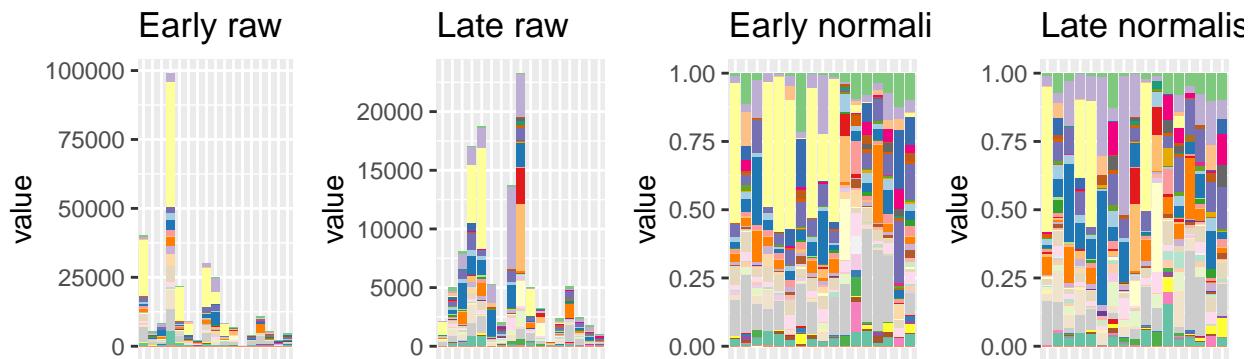
### Ranked plot for coverage



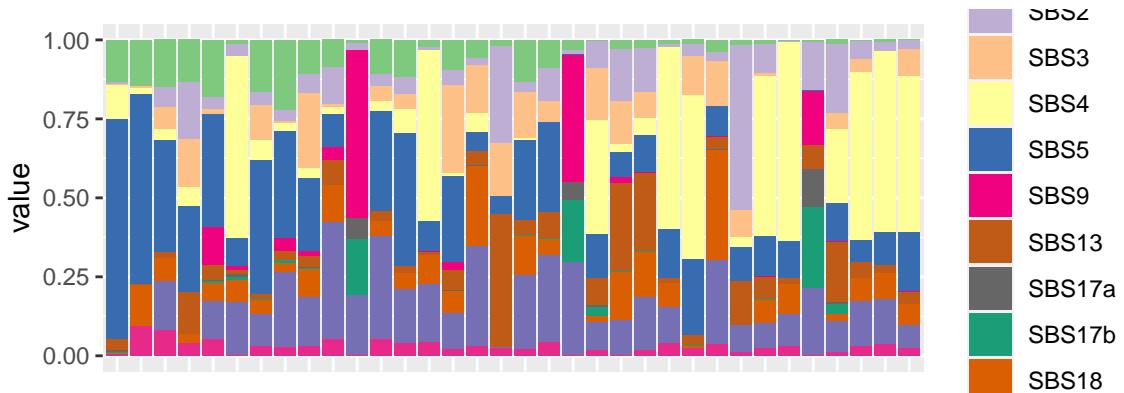
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 17
```



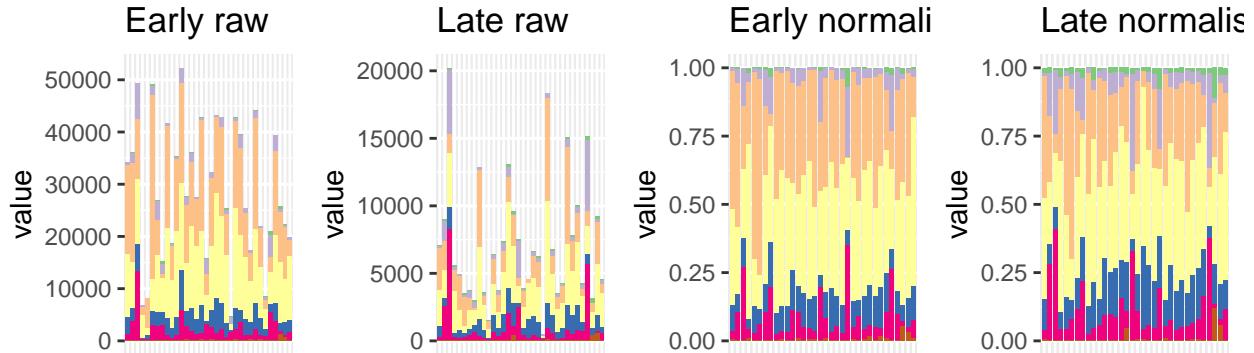
Exposures sorted by increasing number of mutations: there is a trend in which SBS5 decreases and SBS4 increases with the number of mutations.



## Lung-SCC

### Barplot and general statistics

```
## [1] 34
```



The number of samples and signatures is:

```
## [1] 68 7
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS4"  "SBS5"  "SBS8"  "SBS13" "SBS33"
```

### Convergence table

We have converged results in most cases, and all in nonexo.

|                | value                            | L2                 | L1 |
|----------------|----------------------------------|--------------------|----|
| ## 1 Lung-SCC  | hessian_positivedefinite_bool    | diagRE_M           |    |
| ## 2 Lung-SCC  | hessian_positivedefinite_bool    | fullRE_M           |    |
| ## 3 Lung-SCC  | hessian_nonpositivedefinite_bool | diagRE_DMDL        |    |
| ## 4 Lung-SCC  | Timeout                          | fullRE_halfDM      |    |
| ## 5 Lung-SCC  | hessian_nonpositivedefinite_bool | fullRE_DMDL        |    |
| ## 6 Lung-SCC  | hessian_positivedefinite_bool    | diagRE_DMSL        |    |
| ## 7 Lung-SCC  | hessian_positivedefinite_bool    | sparseRE_DMSL      |    |
| ## 8 Lung-SCC  | hessian_positivedefinite_bool    | fullRE_DMSL        |    |
| ## 9 Lung-SCC  | hessian_nonpositivedefinite_bool | fullRE_DMSL_SBS1   |    |
| ## 10 Lung-SCC | hessian_positivedefinite_bool    | fullRE_M_nonexo    |    |
| ## 11 Lung-SCC | hessian_nonpositivedefinite_bool | diagRE_DMSL_nonexo |    |

```

## 12 Lung-SCC    hessian_positivedefinite_bool    sparseRE_DMSL_nonexo
## 13 Lung-SCC    hessian_positivedefinite_bool    fullRE_DMSL_nonexo
## 14 Lung-SCC    hessian_positivedefinite_bool    fullRE_DMDL_nonexo
## 15 Lung-SCC          Timeout fullRE_DMDL_sortednonexo

```

### Potentially problematic signatures

We explore whether there are problematic signatures; none are.

```
colSums(obj_Lung_SCC$Y == 0)/nrow(obj_Lung_SCC$Y)
```

```

##      SBS1      SBS2      SBS4      SBS5      SBS8      SBS13     SBS33
## 0.11764706 0.01470588 0.01470588 0.00000000 0.00000000 0.00000000 0.35294118

```

```
colSums(obj_Lung_SCC$Y)/sum(obj_Lung_SCC$Y)
```

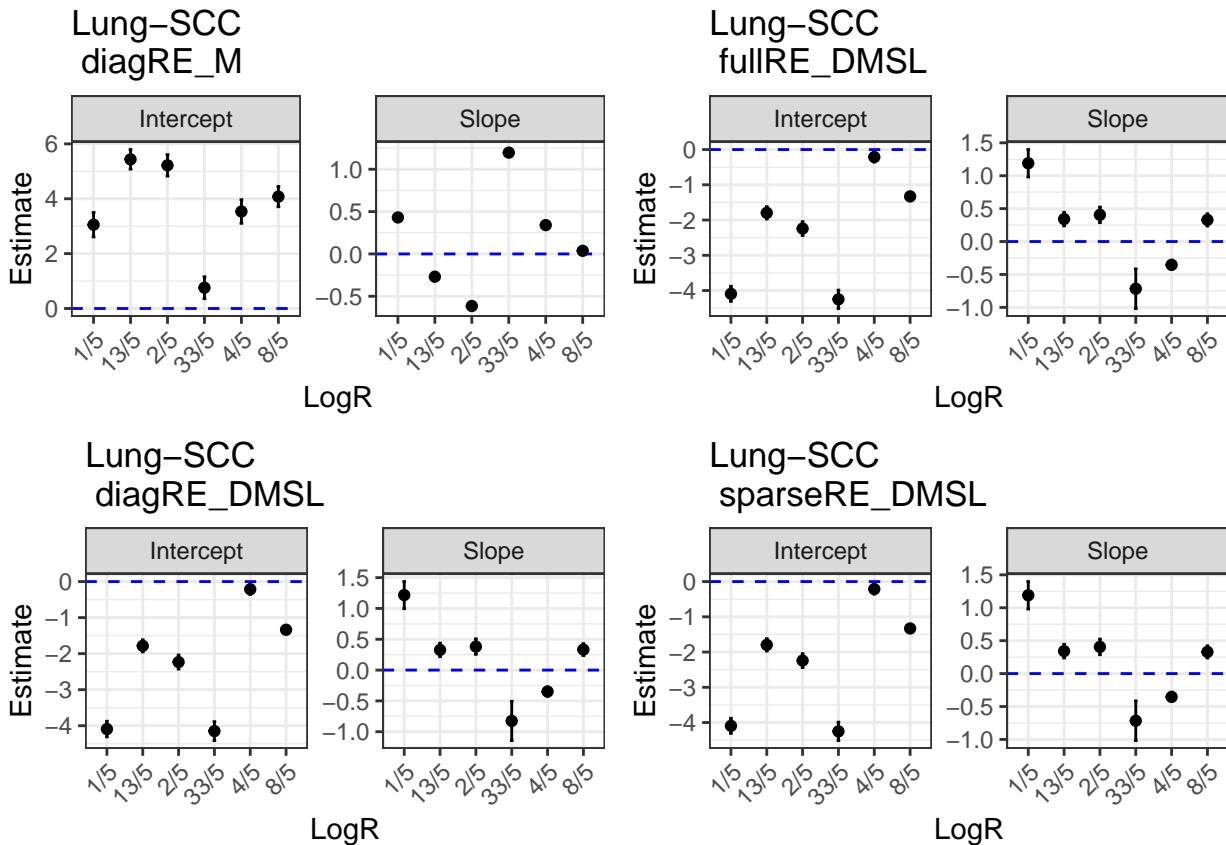
```

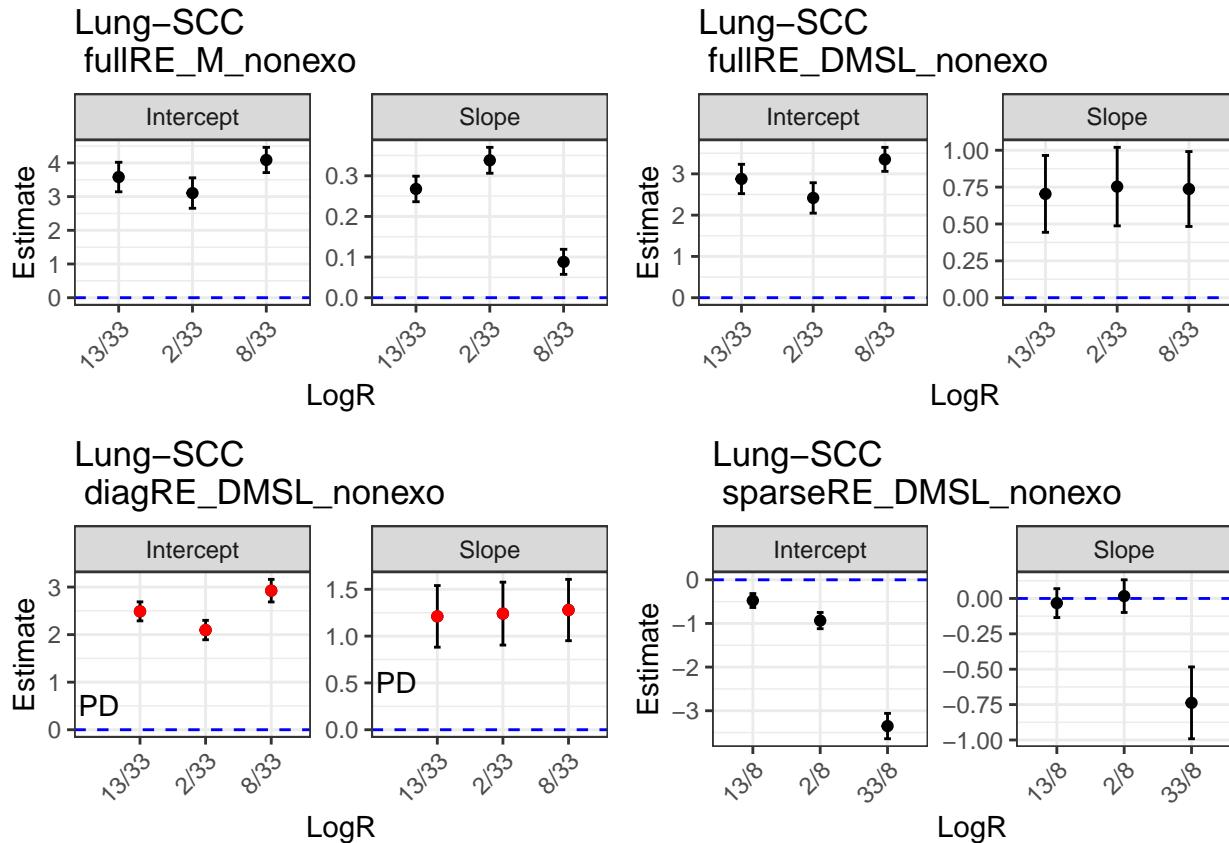
##      SBS1      SBS2      SBS4      SBS5      SBS8      SBS13
## 0.007157222 0.057307486 0.361344268 0.373780803 0.107939657 0.086773493
##      SBS33
## 0.005697071

```

### Betas

Very clear example of only one signature changing:





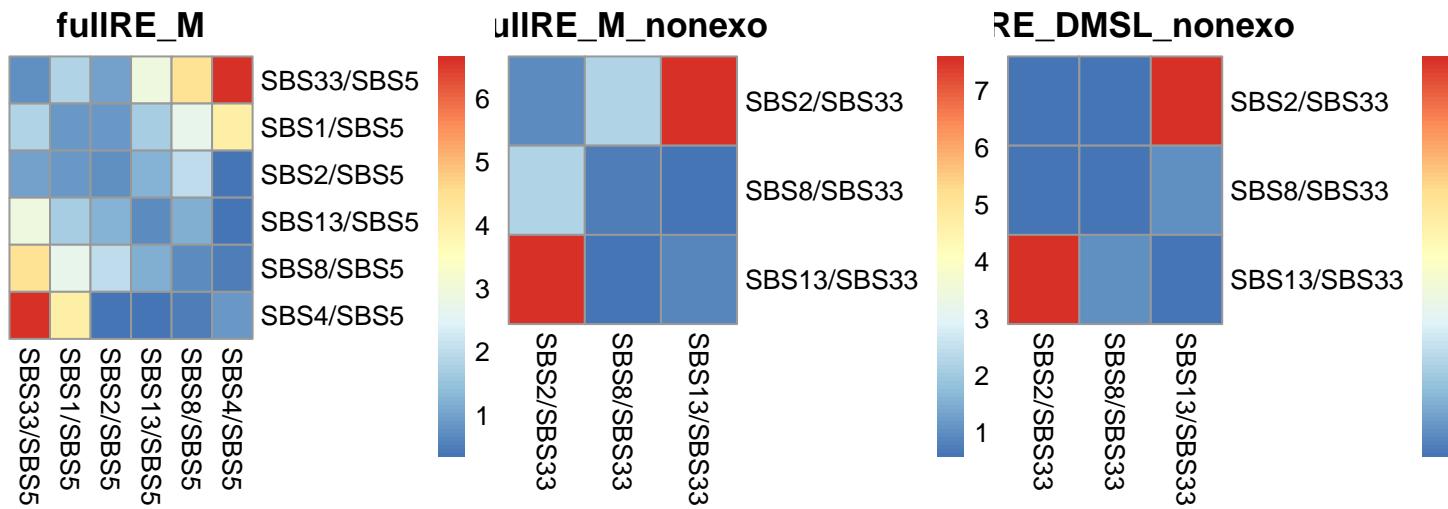
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of 0.0338506.

#### Covariance matrices

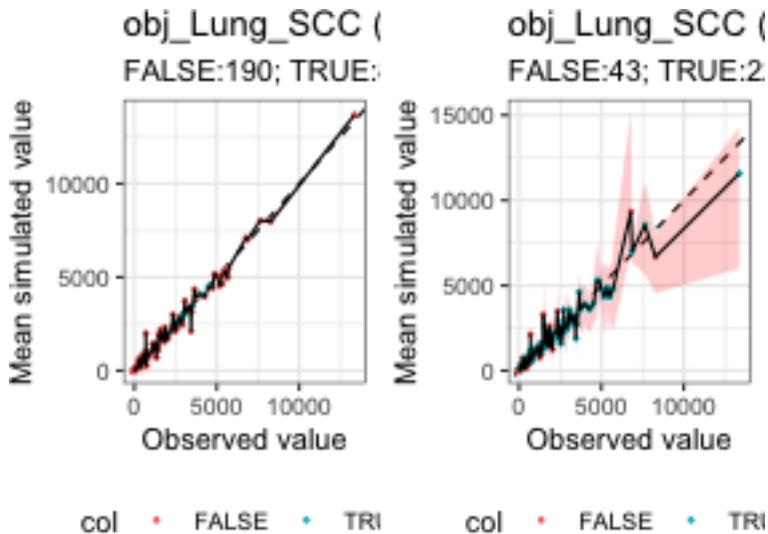
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



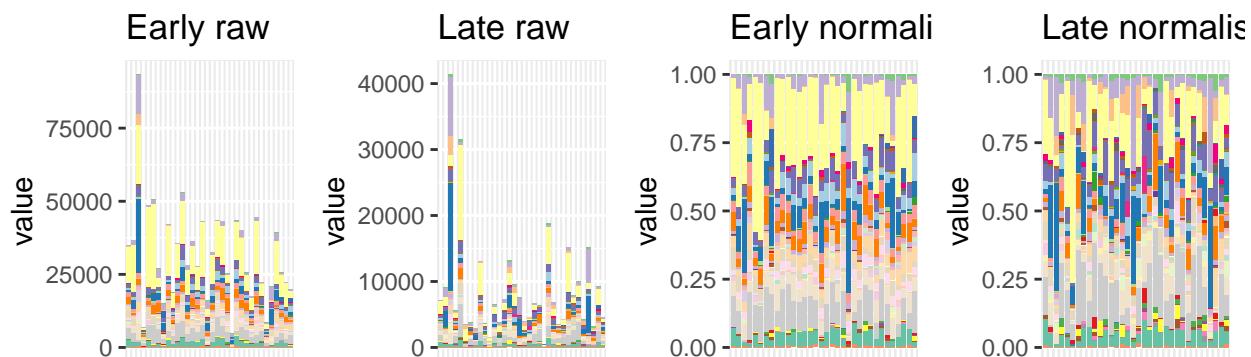
Ranked plot for coverage



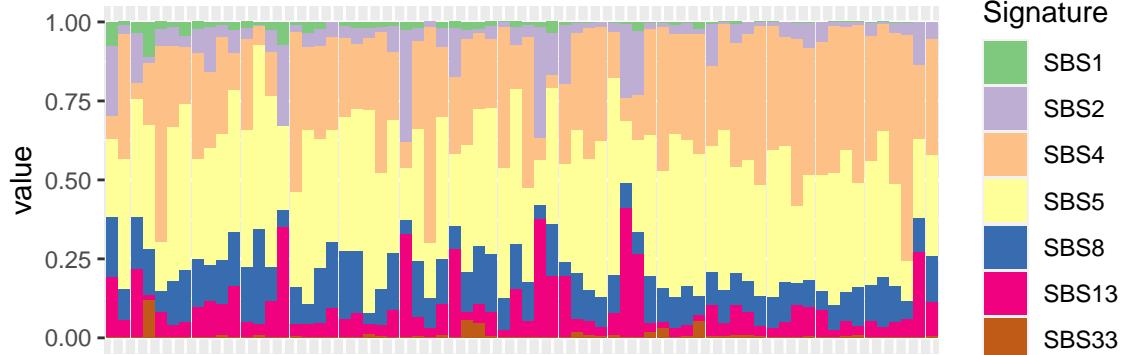
#### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 34
```



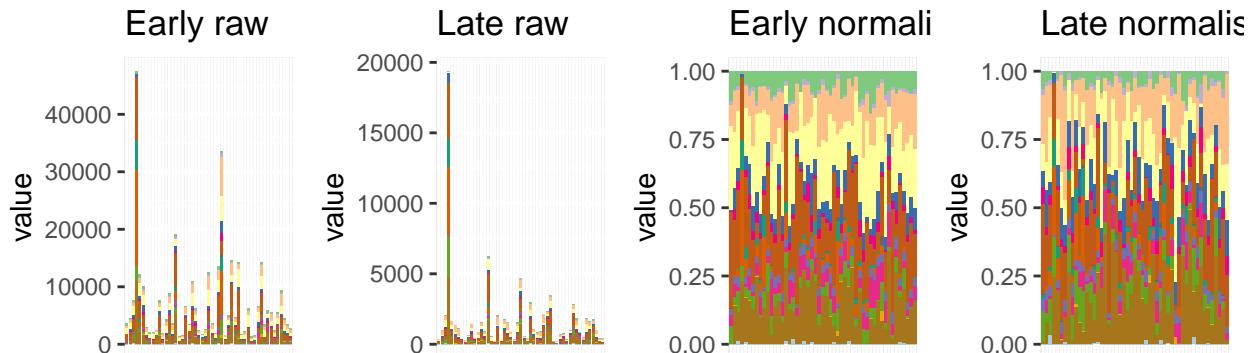
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



## Lymph-BNHL

### Barplot and general statistics

```
## [1] 51
```



The number of samples and signatures is:

```
## [1] 102 16
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS3"   "SBS5"   "SBS6"   "SBS7b"  "SBS9"   "SBS13"
## [9] "SBS17a" "SBS17b" "SBS34"  "SBS36"  "SBS37"  "SBS39"  "SBS40"  "SBS56"
```

### Convergence table

fullRE\_DMSL\_nonexo had not run, and fullRE\_M\_nonexo didn't converge.

|      | value      | L2                               | L1            |
|------|------------|----------------------------------|---------------|
| ## 1 | Lymph-BNHL | hessian_positivedefinite_bool    | diagRE_M      |
| ## 2 | Lymph-BNHL | hessian_nonpositivedefinite_bool | fullRE_M      |
| ## 3 | Lymph-BNHL | hessian_positivedefinite_bool    | diagRE_DMDL   |
| ## 4 | Lymph-BNHL |                                  | fullRE_halfDM |
| ## 5 | Lymph-BNHL |                                  | fullRE_DMDL   |
| ## 6 | Lymph-BNHL | hessian_positivedefinite_bool    | diagRE_DMSL   |
| ## 7 | Lymph-BNHL | hessian_positivedefinite_bool    | sparseRE_DMSL |
| ## 8 | Lymph-BNHL | hessian_nonpositivedefinite_bool | fullRE_DMSL   |

```

## 9 Lymph-BNHL hessian_nonpositivedefinite_bool fullRE_DMSL_SBS1
## 10 Lymph-BNHL hessian_nonpositivedefinite_bool fullRE_M_nonexo
## 11 Lymph-BNHL hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Lymph-BNHL hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Lymph-BNHL Timeout fullRE_DMSL_nonexo
## 14 Lymph-BNHL hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 Lymph-BNHL hessian_positivedefinite_bool fullRE_DMDL_sortednonexo

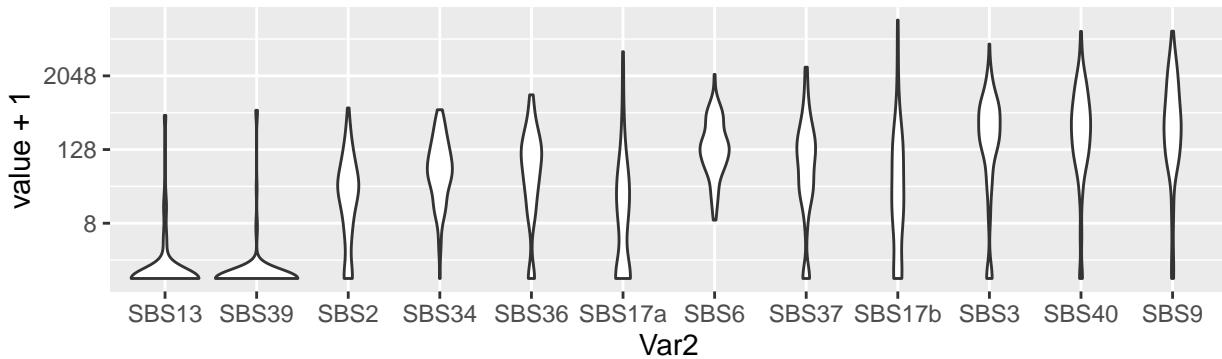
```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo. Very clearly there are too many signatures.

```
#> ## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

Which signatures should be omitted from the analysis?



SBS13 and SBS39 should definitely be removed.

Has fullRE M now converged? converge:

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

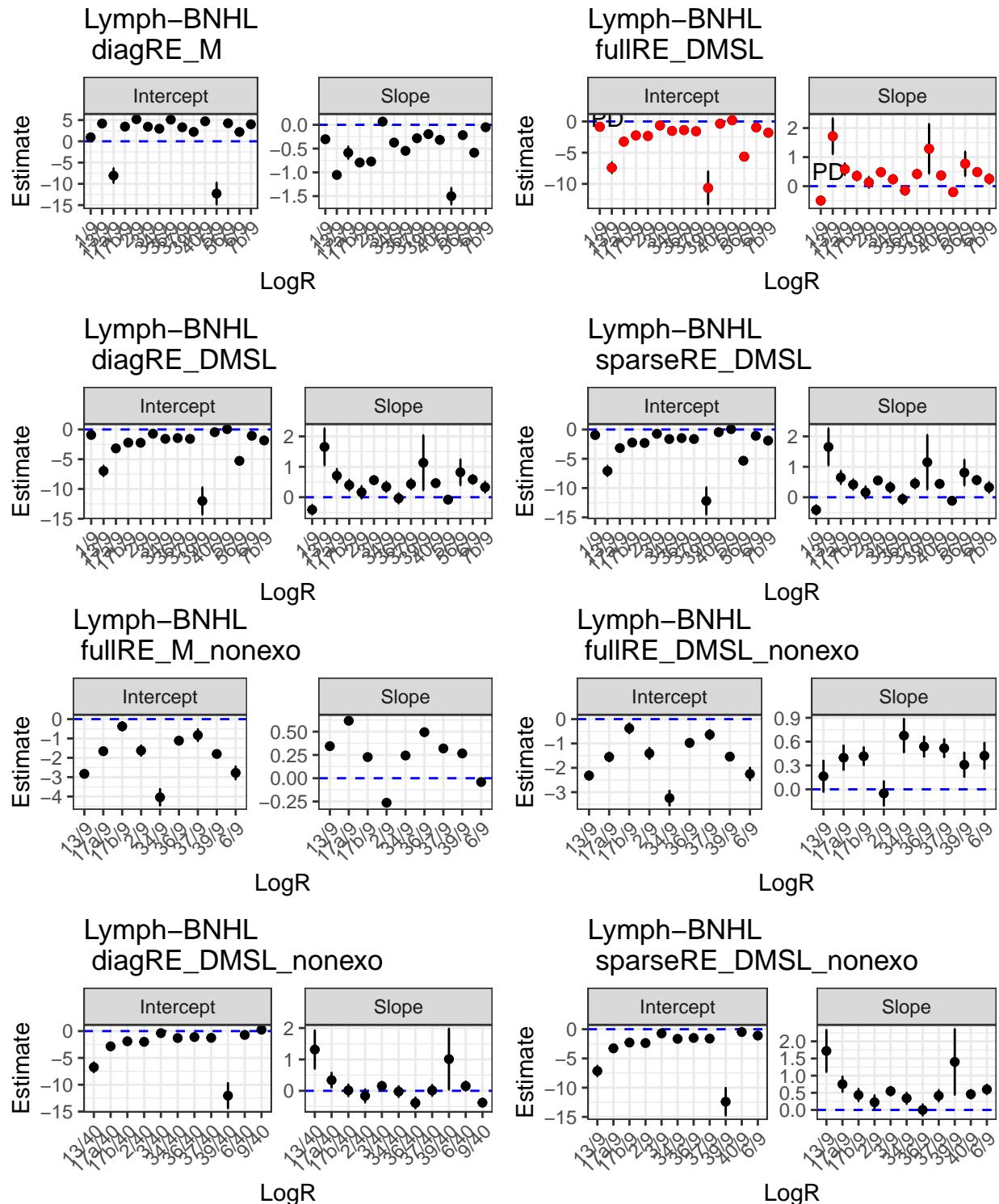
it has. I now run DM with this subset

Its convergence is as follows:

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

it has also converged

## Betas



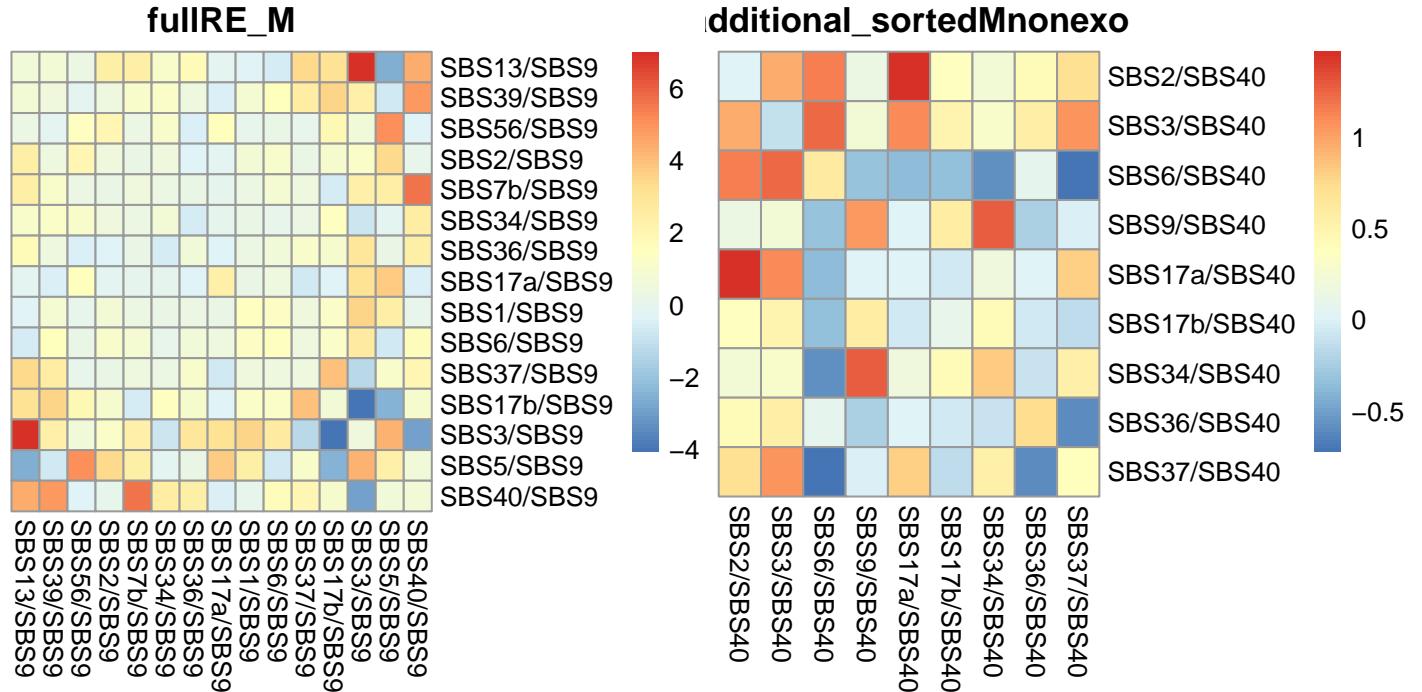
We use the results from the full RE single lambda DM with the subset of signatures (removing the two problematic ones) to test for differential abundance, giving a p-value of  $9.5835037 \times 10^{-7}$ .

## Covariance matrices

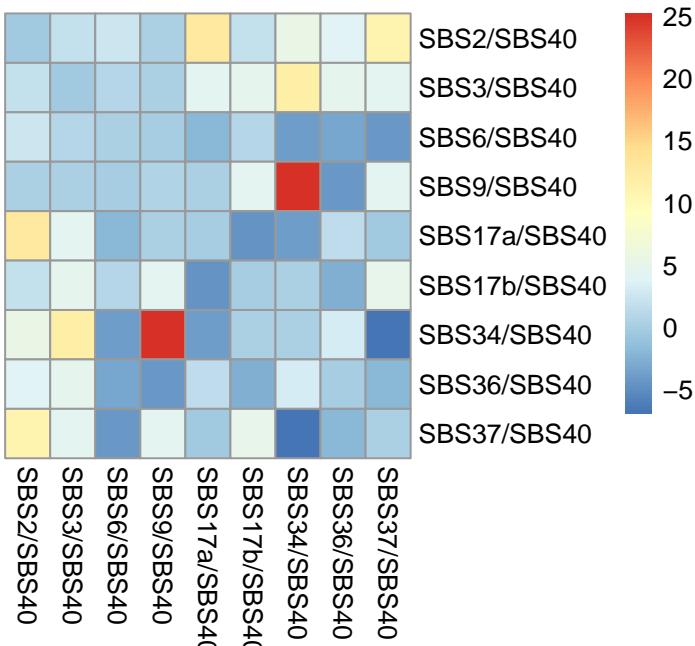
```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



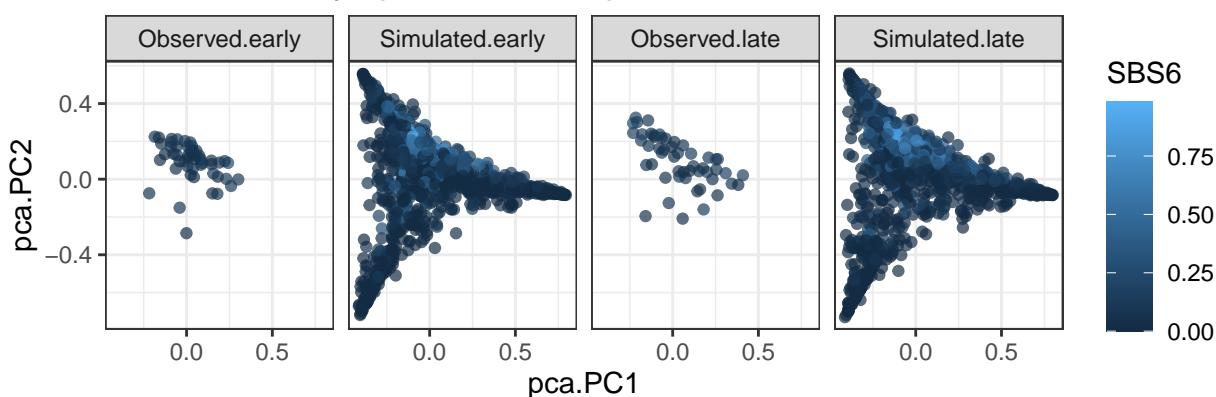
## ditional\_sortedDMSLnonexo



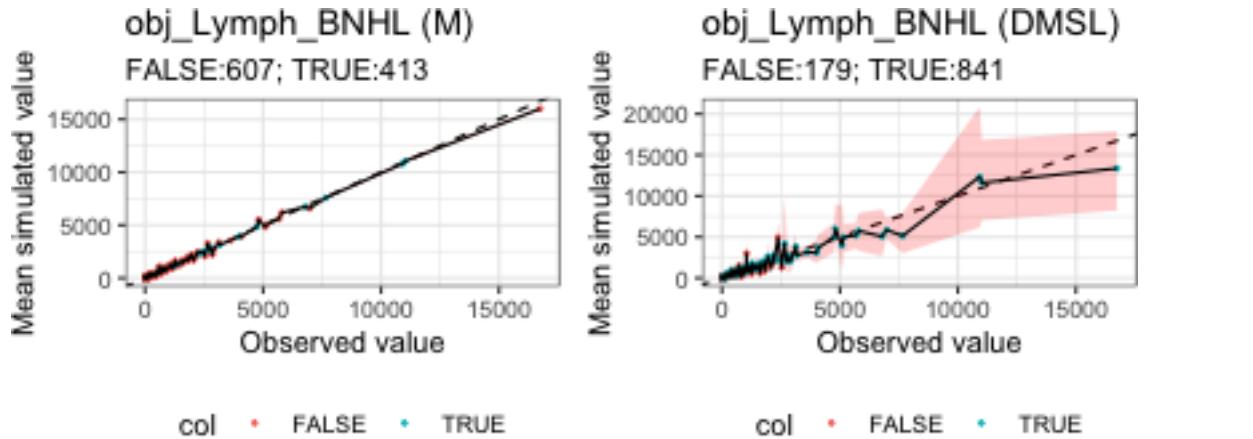
## Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

## Simulation of Lymph-BNHL samples



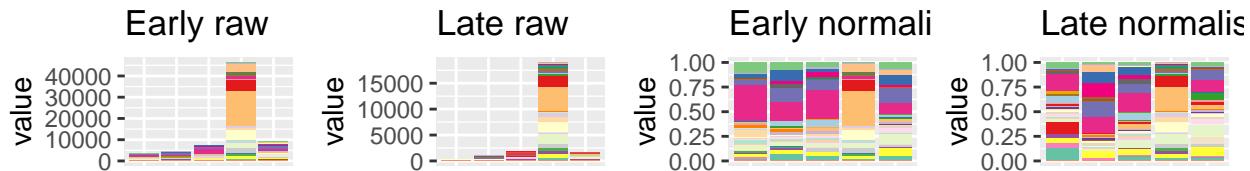
### Ranked plot for coverage



### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 5
```

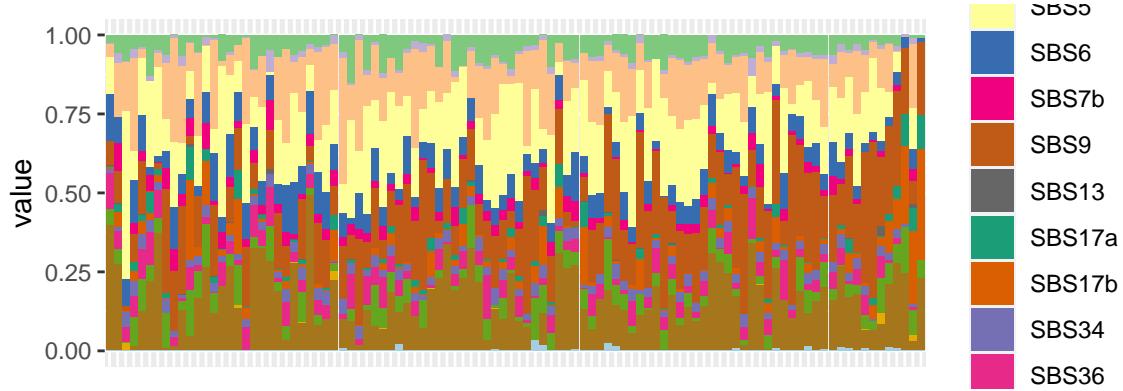


something must have gone wrong here. Dims of Y for mutsigextractor and normal signatures:

```
## [1] 10 53
```

```
## [1] 102 16
```

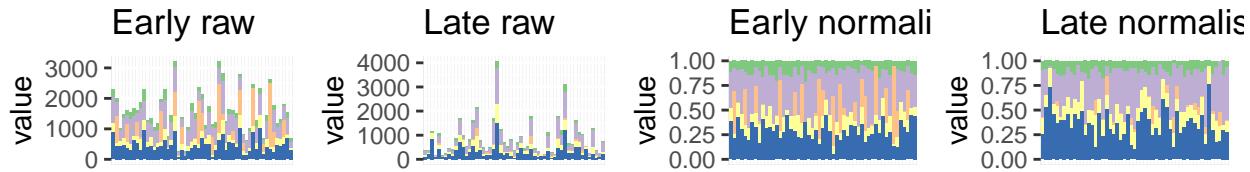
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



### Lymph-CLL

#### Barplot and general statistics

```
## [1] 53
```



The number of samples and signatures is:

```
## [1] 106 5
```

The signatures are:

```
## [1] "SBS1" "SBS5" "SBS9" "SBS25" "SBS40"
```

### Convergence table

We have converged results in most cases

|                 | L2                               | L1                       |
|-----------------|----------------------------------|--------------------------|
| ## 1 Lymph-CLL  | hessian_positivedefinite_bool    | diagRE_M                 |
| ## 2 Lymph-CLL  | hessian_positivedefinite_bool    | fullRE_M                 |
| ## 3 Lymph-CLL  | hessian_positivedefinite_bool    | diagRE_DMDL              |
| ## 4 Lymph-CLL  | Timeout                          | fullRE_halfDM            |
| ## 5 Lymph-CLL  | hessian_nonpositivedefinite_bool | fullRE_DMDL              |
| ## 6 Lymph-CLL  | hessian_positivedefinite_bool    | diagRE_DMSL              |
| ## 7 Lymph-CLL  | hessian_positivedefinite_bool    | sparseRE_DMSL            |
| ## 8 Lymph-CLL  | hessian_nonpositivedefinite_bool | fullRE_DMSL              |
| ## 9 Lymph-CLL  | hessian_nonpositivedefinite_bool | fullRE_DMSL_SBS1         |
| ## 10 Lymph-CLL | hessian_positivedefinite_bool    | fullRE_M_nonexo          |
| ## 11 Lymph-CLL | hessian_positivedefinite_bool    | diagRE_DMSL_nonexo       |
| ## 12 Lymph-CLL | Timeout                          | sparseRE_DMSL_nonexo     |
| ## 13 Lymph-CLL | hessian_positivedefinite_bool    | fullRE_DMSL_nonexo       |
| ## 14 Lymph-CLL | hessian_positivedefinite_bool    | fullRE_DMDL_nonexo       |
| ## 15 Lymph-CLL | Timeout                          | fullRE_DMDL_sortednonexo |

### Potentially problematic signatures

SBS9 has quite a lot of zeros.

```
colSums(obj_Lymph_CLL$Y == 0) / nrow(obj_Lymph_CLL$Y)

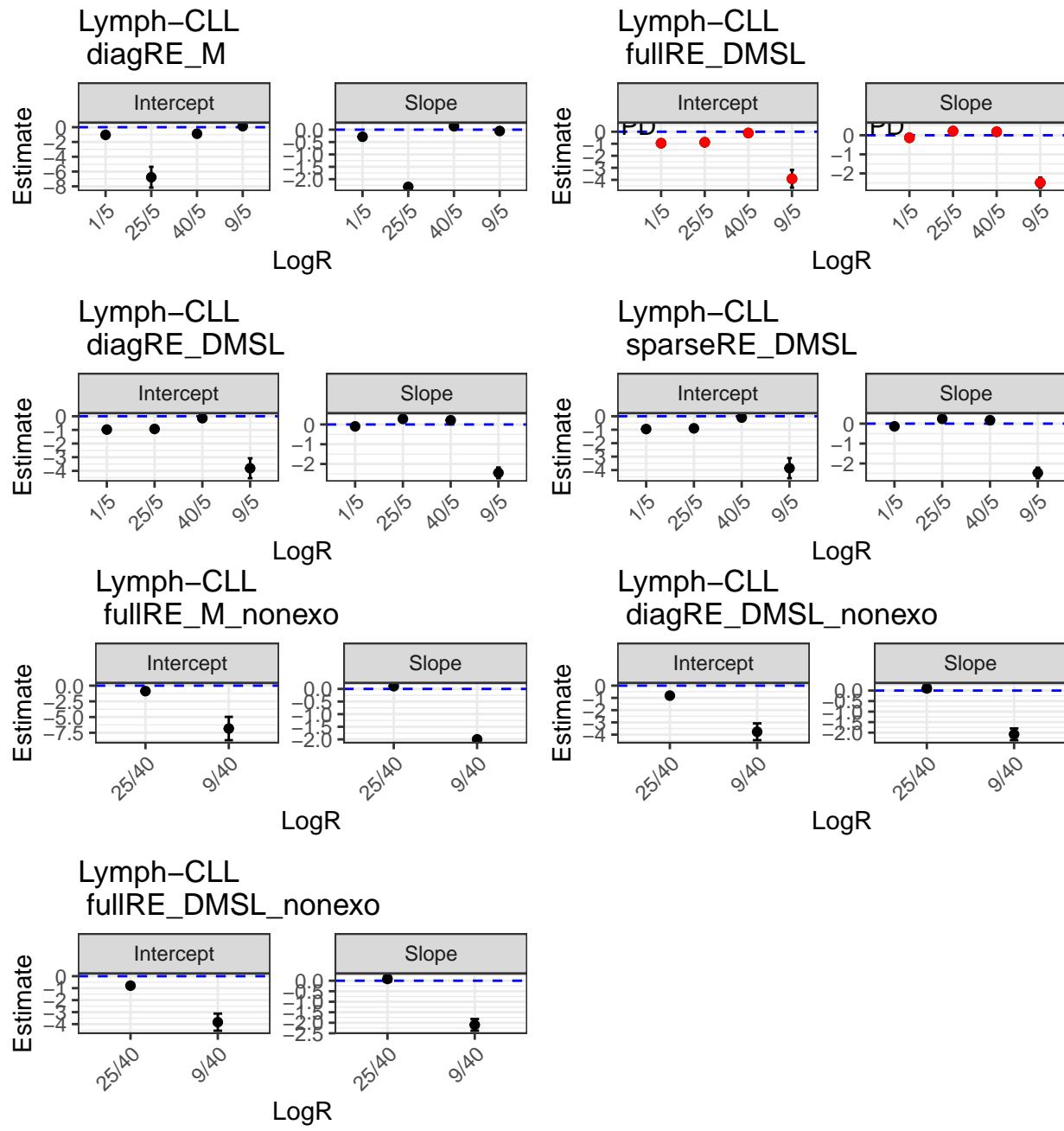
##          SBS1         SBS5         SBS9         SBS25        SBS40
## 0.0000000000 0.028301887 0.613207547 0.009433962 0.0000000000

colSums(obj_Lymph_CLL$Y) / sum(obj_Lymph_CLL$Y)

##          SBS1         SBS5         SBS9         SBS25        SBS40
## 0.09712712 0.33726681 0.12275176 0.13805198 0.30480234
```

### Betas

It's interesting the very high correlation between intercept and slope betas.



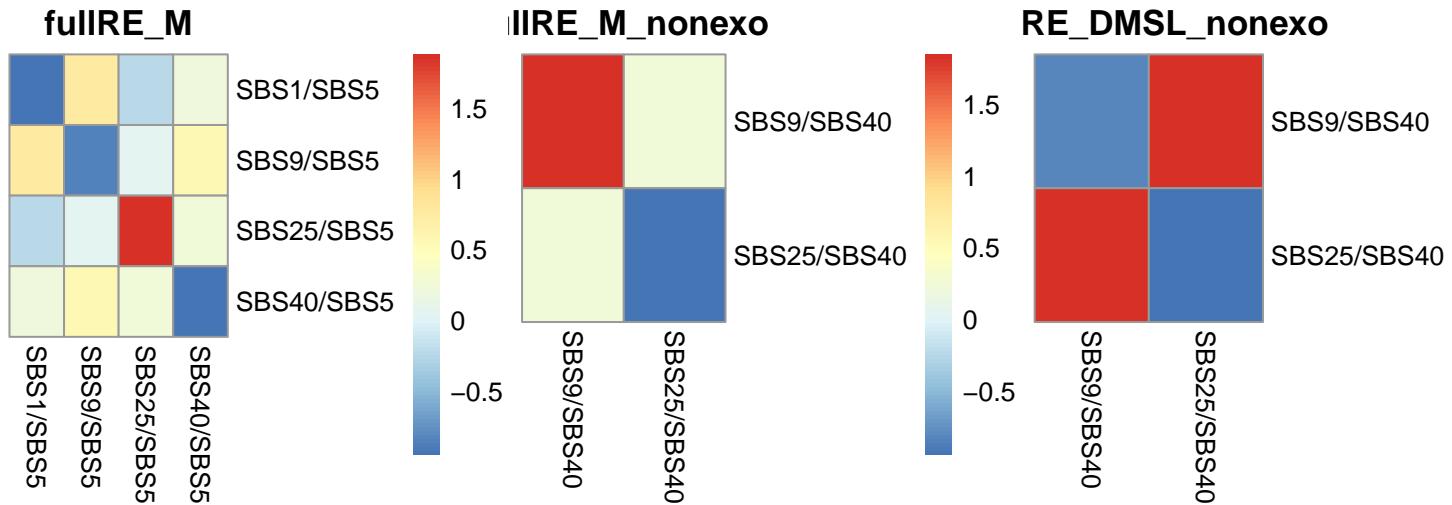
We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $6.1779312 \times 10^{-14}$ .

#### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]])$par.fixed, : This function had been incorrect until now (30 july 2021)
```



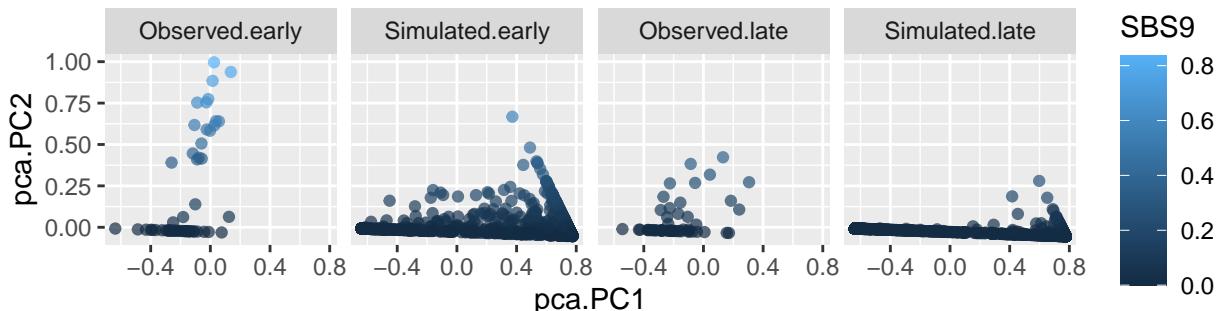
#### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

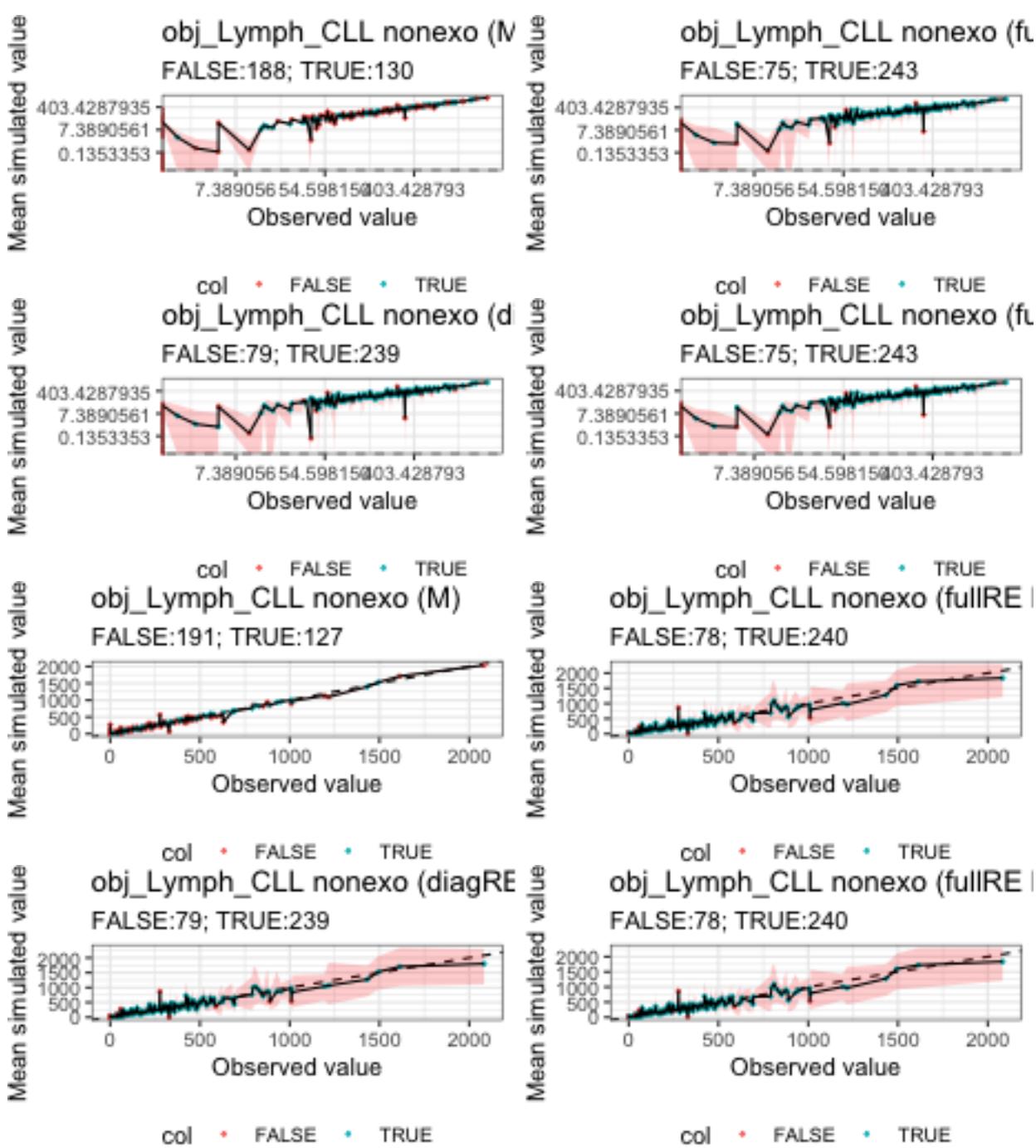
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

## Warning in mvtnorm:::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

#### Simulation of Lymph–CLL samples



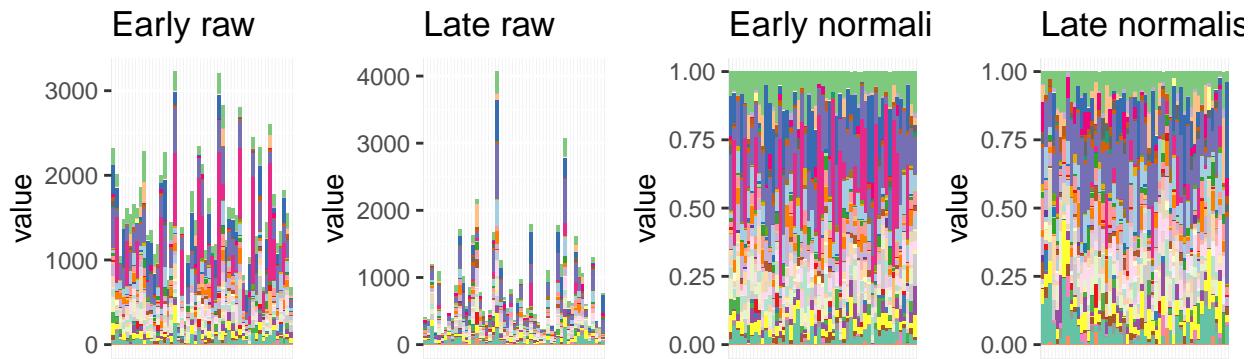
### Ranked plot for coverage



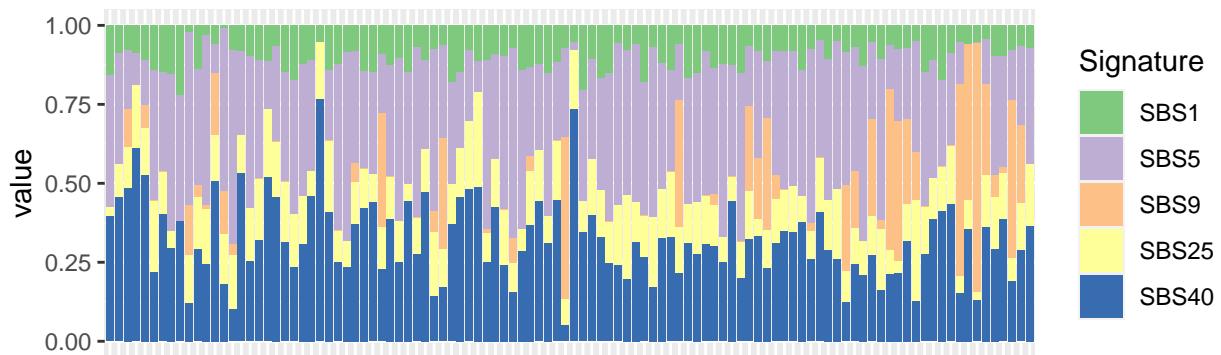
### Signatures from mutSigExtractor

These are the signatures from mutSigExtractor:

```
## [1] 53
```



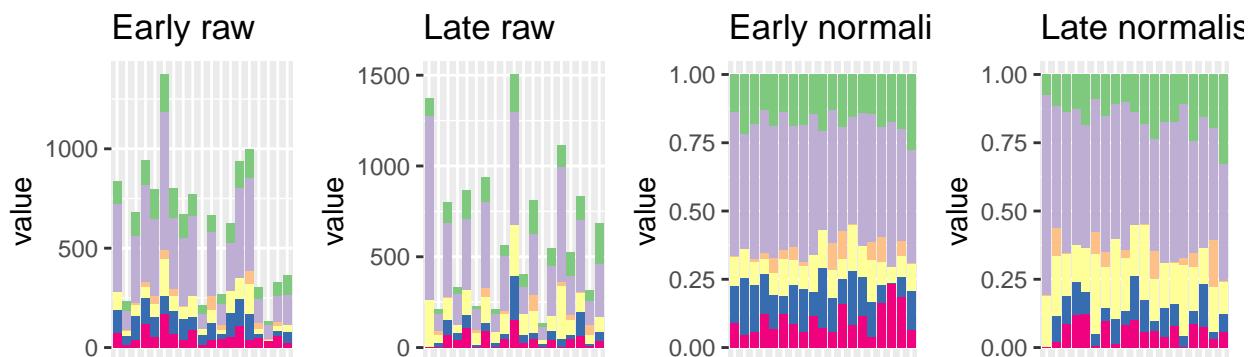
Exposures sorted by increasing number of mutations: SBS9 and SBS25 seem to be somewhat associated with samples with a high number of mutations.



## Myeloid-MPN

### Barplot and general statistics

```
## [1] 19
```



The number of samples and signatures is:

```
## [1] 38 6
```

The signatures are:

```
## [1] "SBS1"  "SBS5"  "SBS6"  "SBS8"  "SBS19" "SBS32"
```

### Convergence table

These are the results for the convergence of models fits. The fullRE DMSL have not converged, or have not run.

```
## [1] value L2      L1  
## <0 rows> (or 0-length row.names)
```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo do converge:

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

### Potentially problematic signatures

We explore whether there are problematic signatures. There are none.

```
colSums(obj_Myeloid_MPN$Y == 0) / nrow(obj_Myeloid_MPN$Y)
```

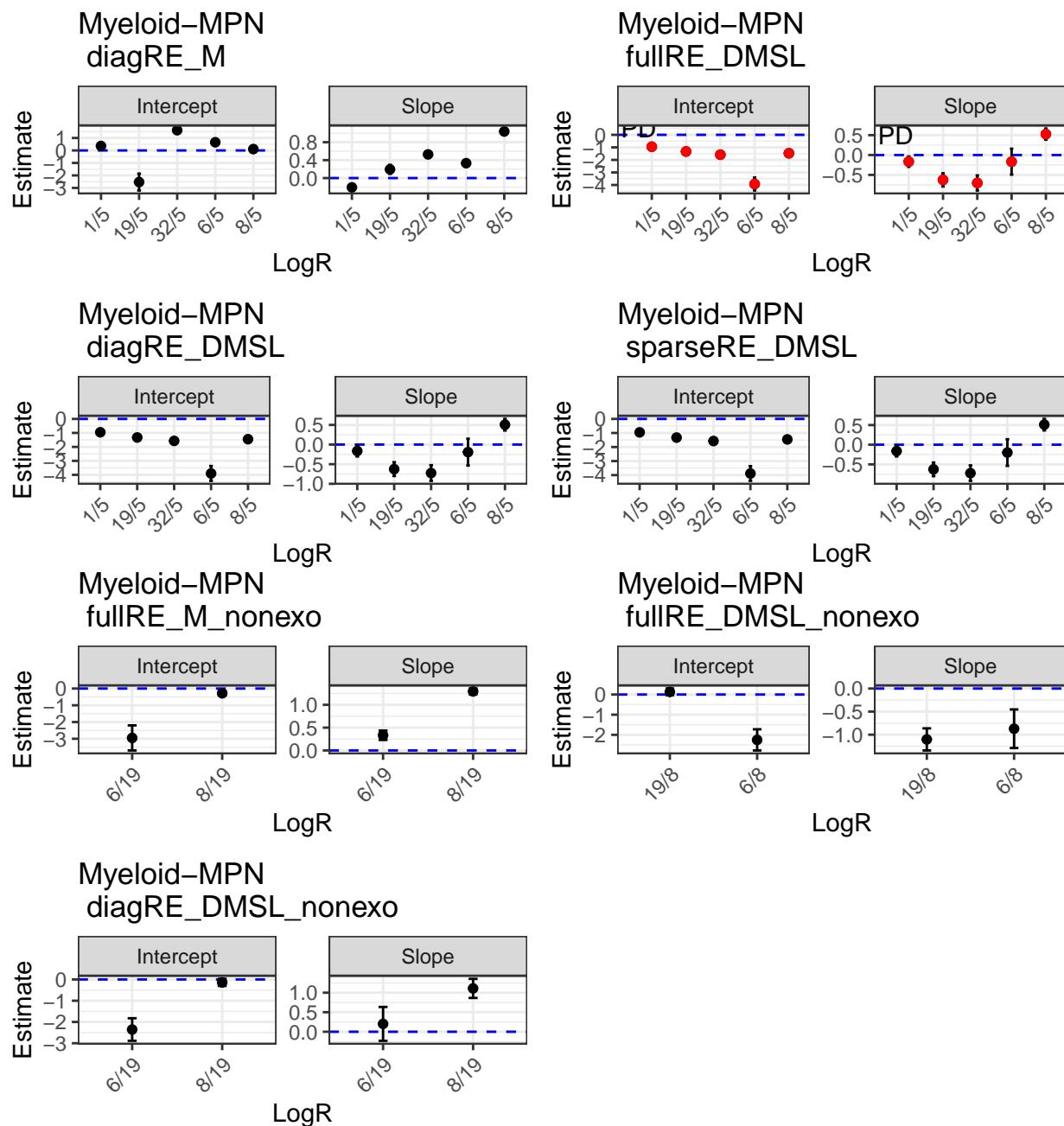
```
##      SBS1      SBS5      SBS6      SBS8      SBS19      SBS32  
## 0.00000000 0.00000000 0.50000000 0.00000000 0.05263158 0.05263158
```

```
colSums(obj_Myeloid_MPN$Y) / sum(obj_Myeloid_MPN$Y)
```

```
##      SBS1      SBS5      SBS6      SBS8      SBS19      SBS32  
## 0.16009042 0.48849157 0.02737361 0.14488286 0.10098644 0.07817509
```

We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of  $1.367896 \times 10^{-5}$ .

## Betas



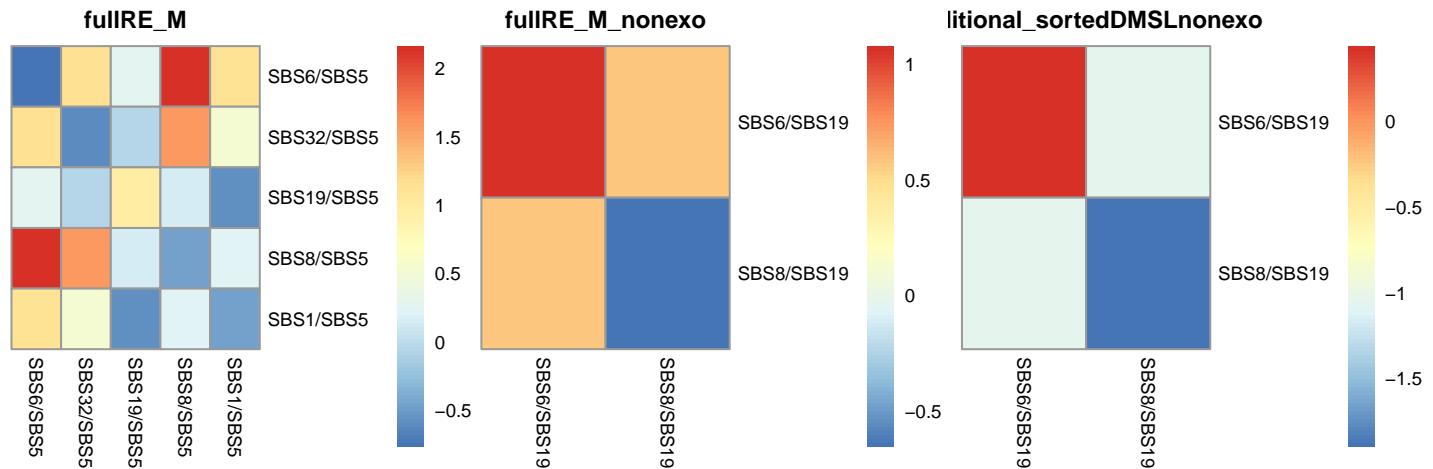
## Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
```

```
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



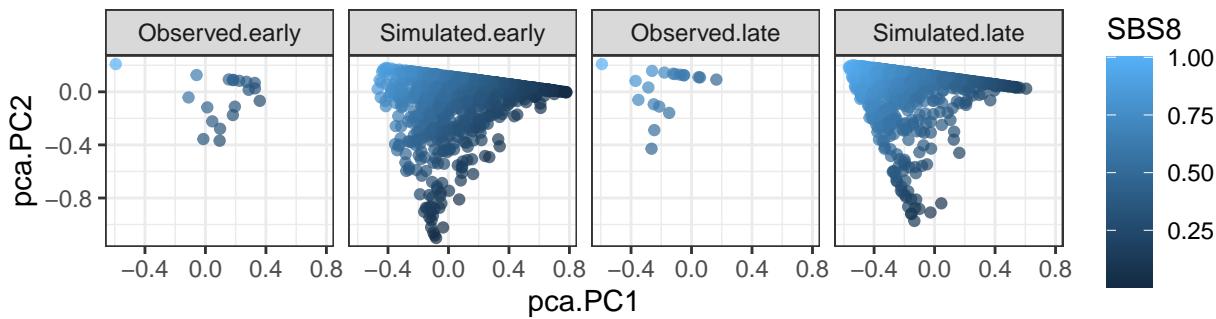
### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

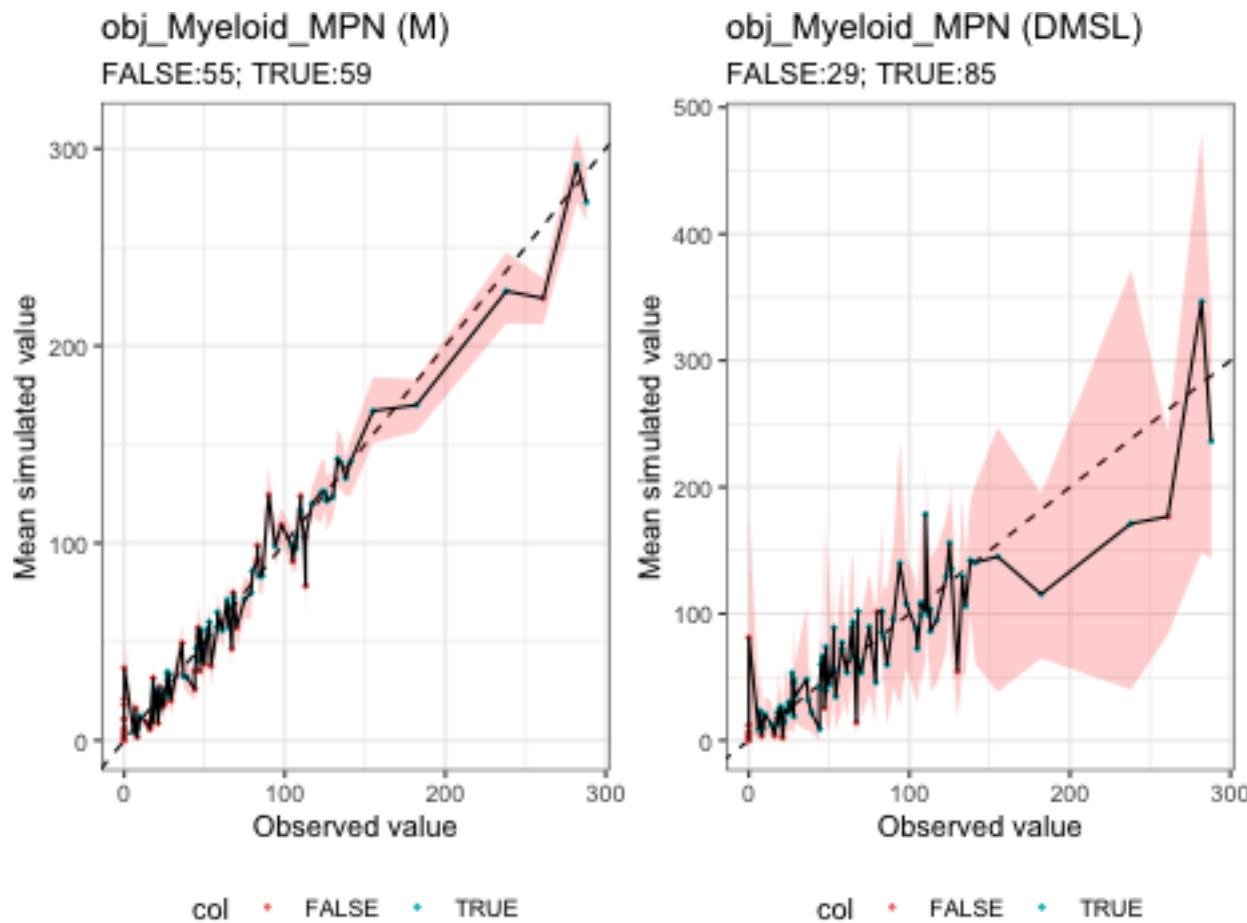
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in mvtnorm::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite
```

### Simulation of Myeloid–MPN samples



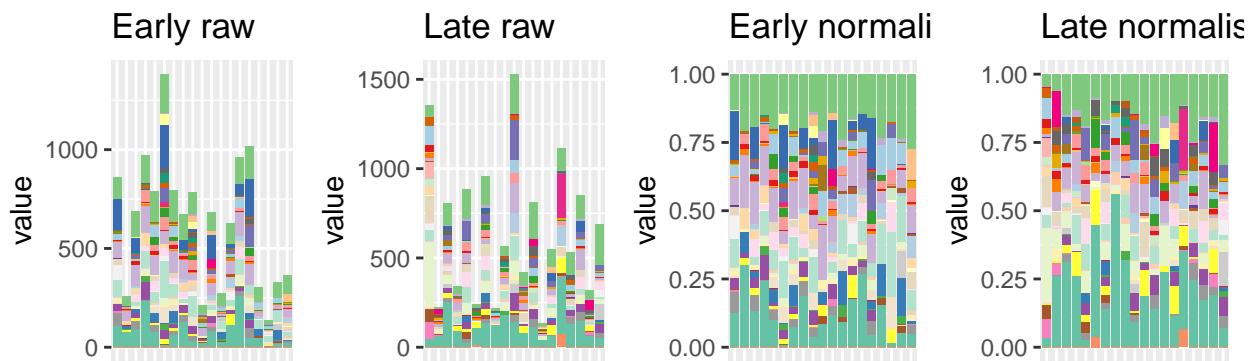
### Ranked plot for coverage



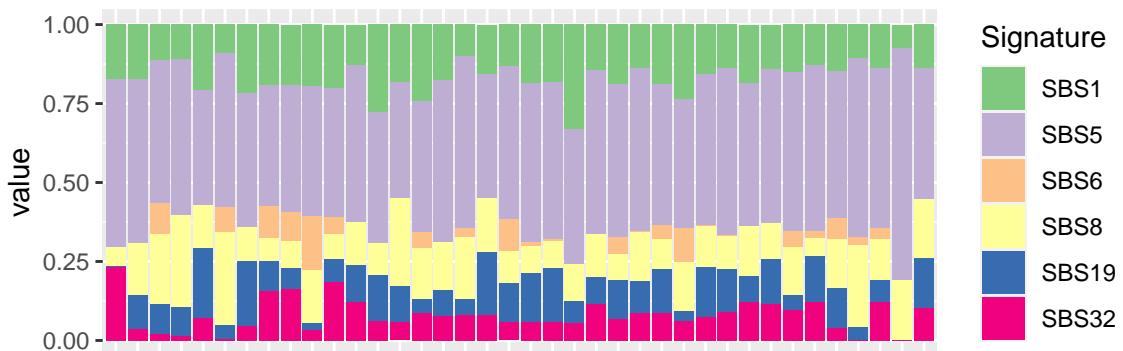
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 19
```



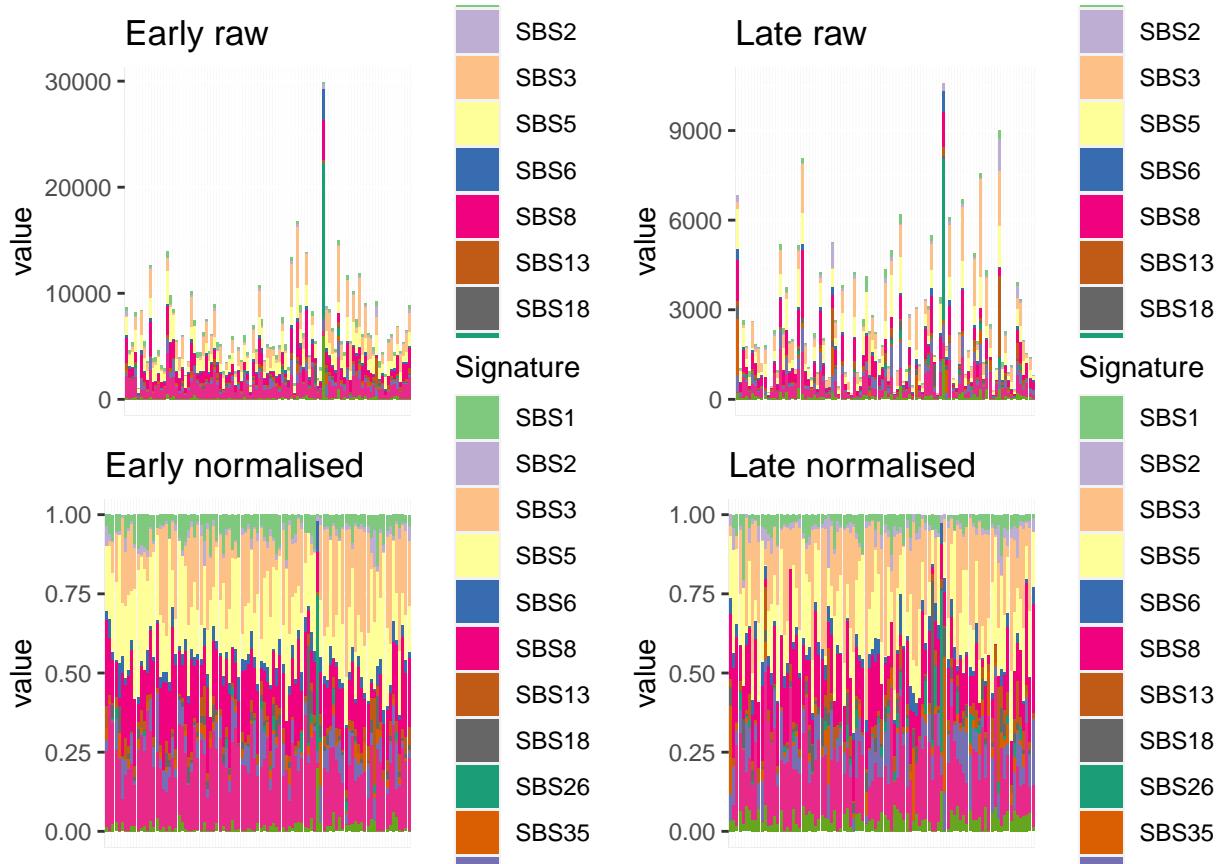
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



## Ovary-AdenoCA

### Barplot and general statistics

```
## [1] 97
```



The number of samples and signatures is:

```
## [1] 194 13
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS3"  "SBS5"  "SBS6"  "SBS8"  "SBS13" "SBS18" "SBS26"
## [10] "SBS35" "SBS39" "SBS40" "SBS41"
```

## Convergence table

These are the results for the convergence of models fits. None of the all-signatures models converged (we do have many signatures!) but nonexo generally have, except fullRE\_DMSL\_nonexo.

```
##           value          L2          L1
## 1 Ovary-AdenoCA hessian_positivedefinite_bool diagRE_M
## 2 Ovary-AdenoCA hessian_nonpositivedefinite_bool fullRE_M
## 3 Ovary-AdenoCA hessian_nonpositivedefinite_bool diagRE_DMDL
## 4 Ovary-AdenoCA                                     Timeout fullRE_halfDM
## 5 Ovary-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL
## 6 Ovary-AdenoCA hessian_nonpositivedefinite_bool diagRE_DMSL
## 7 Ovary-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL
## 8 Ovary-AdenoCA hessian_positivedefinite_bool fullRE_DMSL
## 9 Ovary-AdenoCA hessian_positivedefinite_bool fullRE_DMSL_SBS1
## 10 Ovary-AdenoCA hessian_positivedefinite_bool fullRE_M_nonexo
## 11 Ovary-AdenoCA hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Ovary-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Ovary-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL_nonexo
## 14 Ovary-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 Ovary-AdenoCA                                     Timeout fullRE_DMDL_sortednonexo
```

## Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo do not yet converge:

```
## [1] FALSE
```

## Potentially problematic signatures

We explore whether there are problematic signatures. There doesn't seem to be.

```
colSums(obj_Ovary_AdenoCA$Y == 0) / nrow(obj_Ovary_AdenoCA$Y)

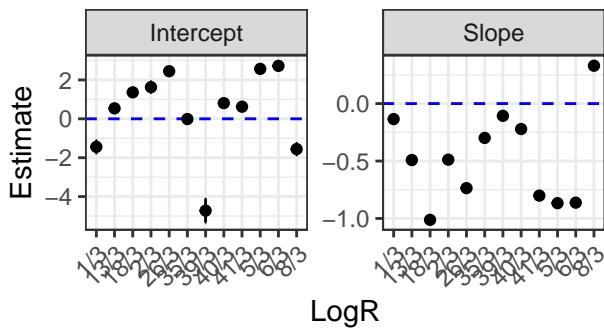
##      SBS1      SBS2      SBS3      SBS5      SBS6      SBS8      SBS13
## 0.02061856 0.04639175 0.15463918 0.04639175 0.11855670 0.01546392 0.04123711
##      SBS18     SBS26     SBS35     SBS39     SBS40     SBS41
## 0.36597938 0.64432990 0.35567010 0.16494845 0.07216495 0.19587629

colSums(obj_Ovary_AdenoCA$Y) / sum(obj_Ovary_AdenoCA$Y)

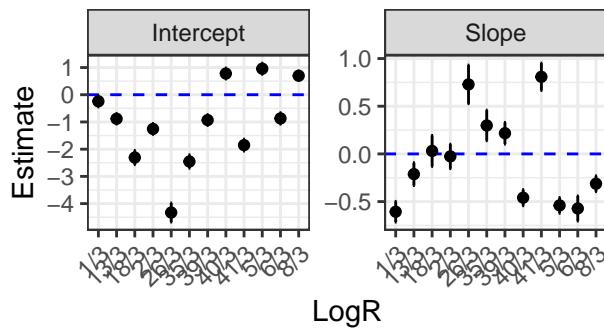
##      SBS1      SBS2      SBS3      SBS5      SBS6      SBS8      SBS13
## 0.04443406 0.01997521 0.18513114 0.18242339 0.02948011 0.16654912 0.03420887
##      SBS18     SBS26     SBS35     SBS39     SBS40     SBS41
## 0.01553666 0.03041662 0.01913467 0.06447749 0.17833631 0.02989634
```

Betas

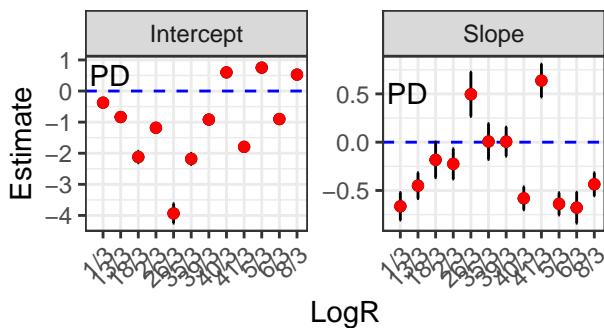
Ovary–AdenoCA  
diagRE\_M



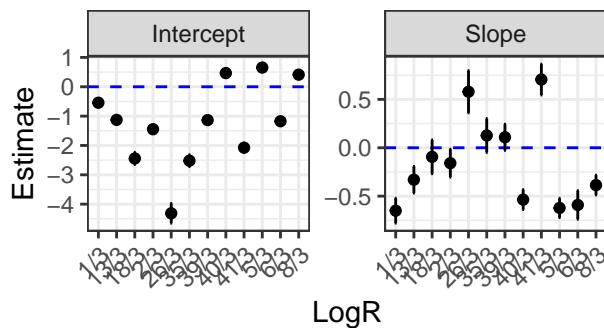
Ovary–AdenoCA  
fullRE\_DMSL



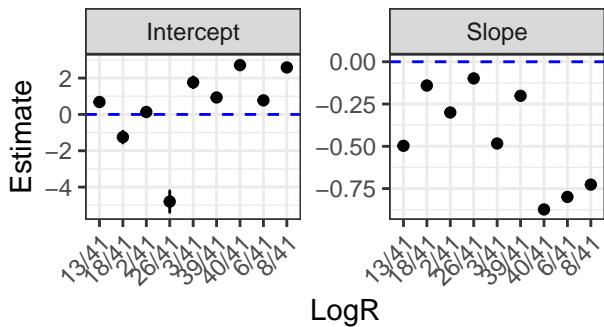
Ovary–AdenoCA  
diagRE\_DMSL



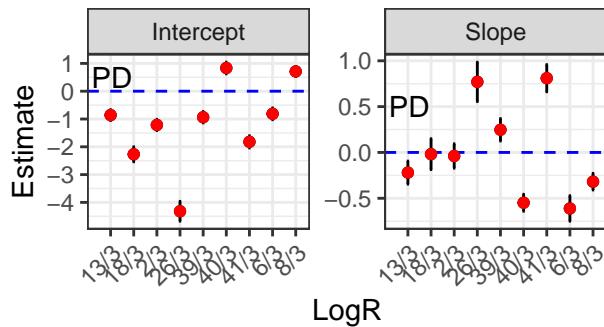
Ovary–AdenoCA  
sparseRE\_DMSL



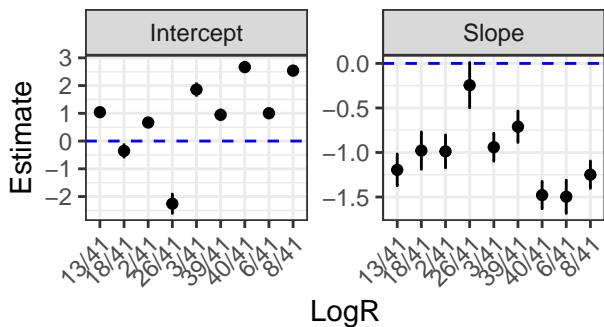
Ovary–AdenoCA  
fullRE\_M\_nonexo



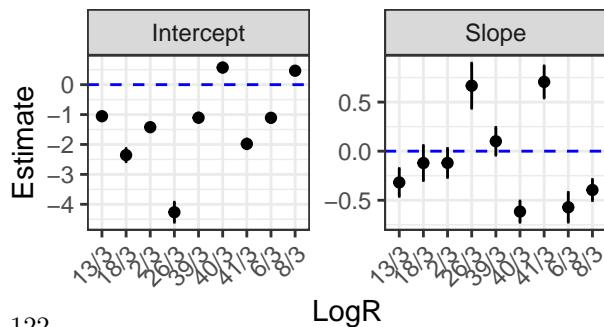
Ovary–AdenoCA  
fullRE\_DMSL\_nonexo



Ovary–AdenoCA  
diagRE\_DMSL\_nonexo



Ovary–AdenoCA  
sparseRE\_DMSL\_nonexo

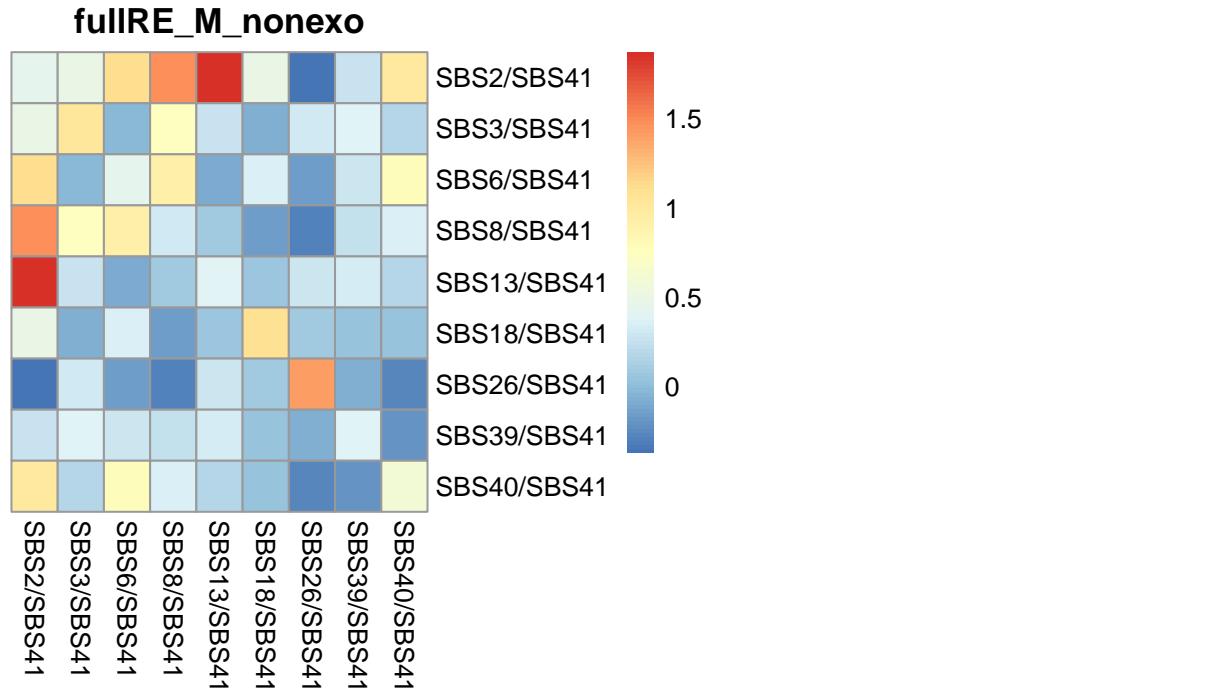


We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of  $2.6852565 \times 10^{-28}$ .

### Covariance matrices

Keep in mind that fullRE DMSL nonexo has not converged.

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```



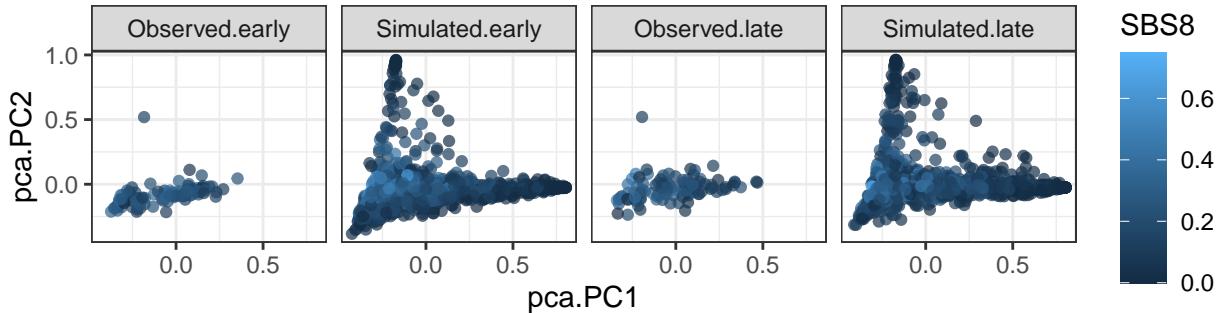
### Simulation under inferred data

Using diagRE DMSL nonexo.

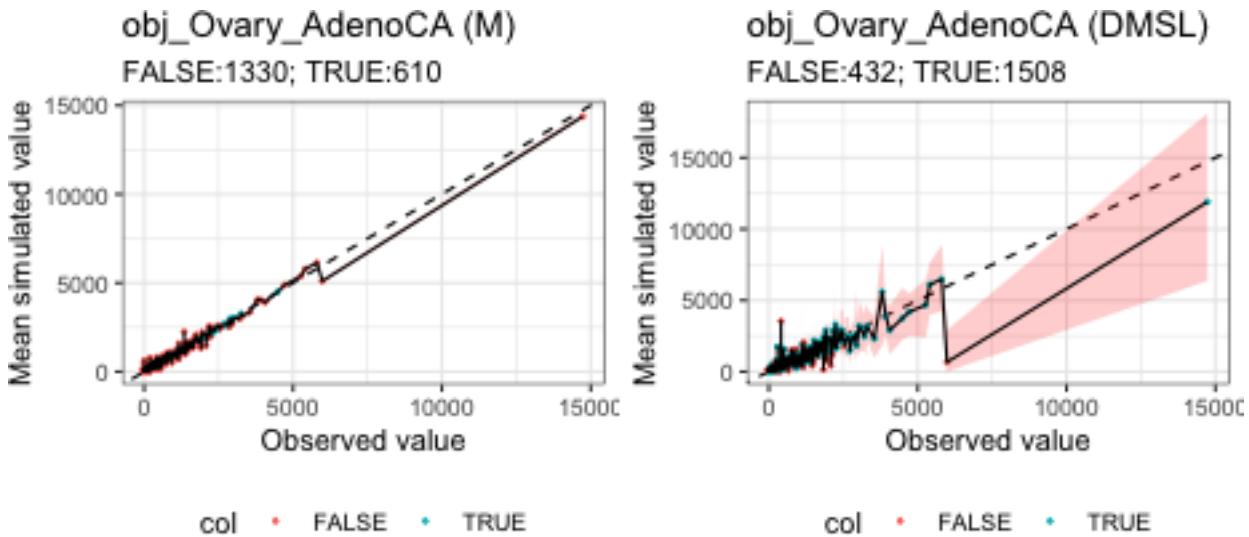
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

### Simulation of Ovary–AdenoCA samples



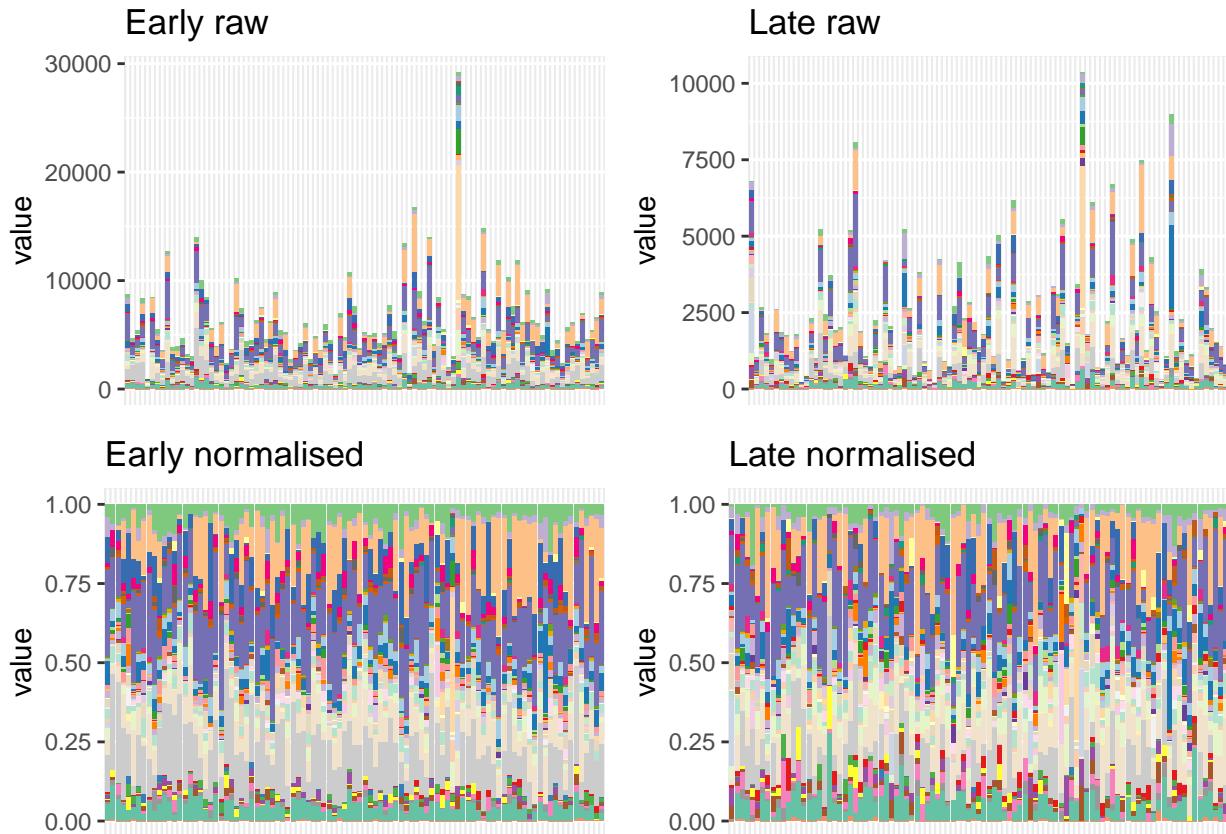
### Ranked plot for coverage



### Signatures from mutSigExtractor

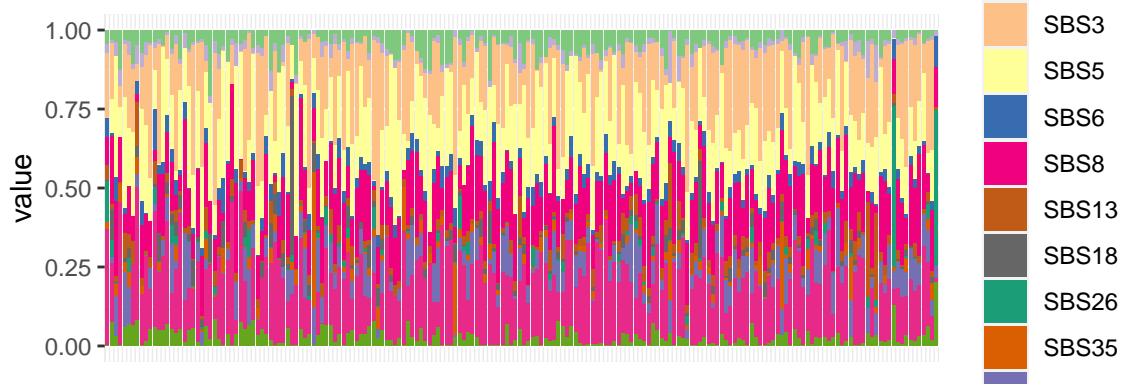
The signatures from mutSigExtractor are as follows:

```
## [1] 97
```



Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the

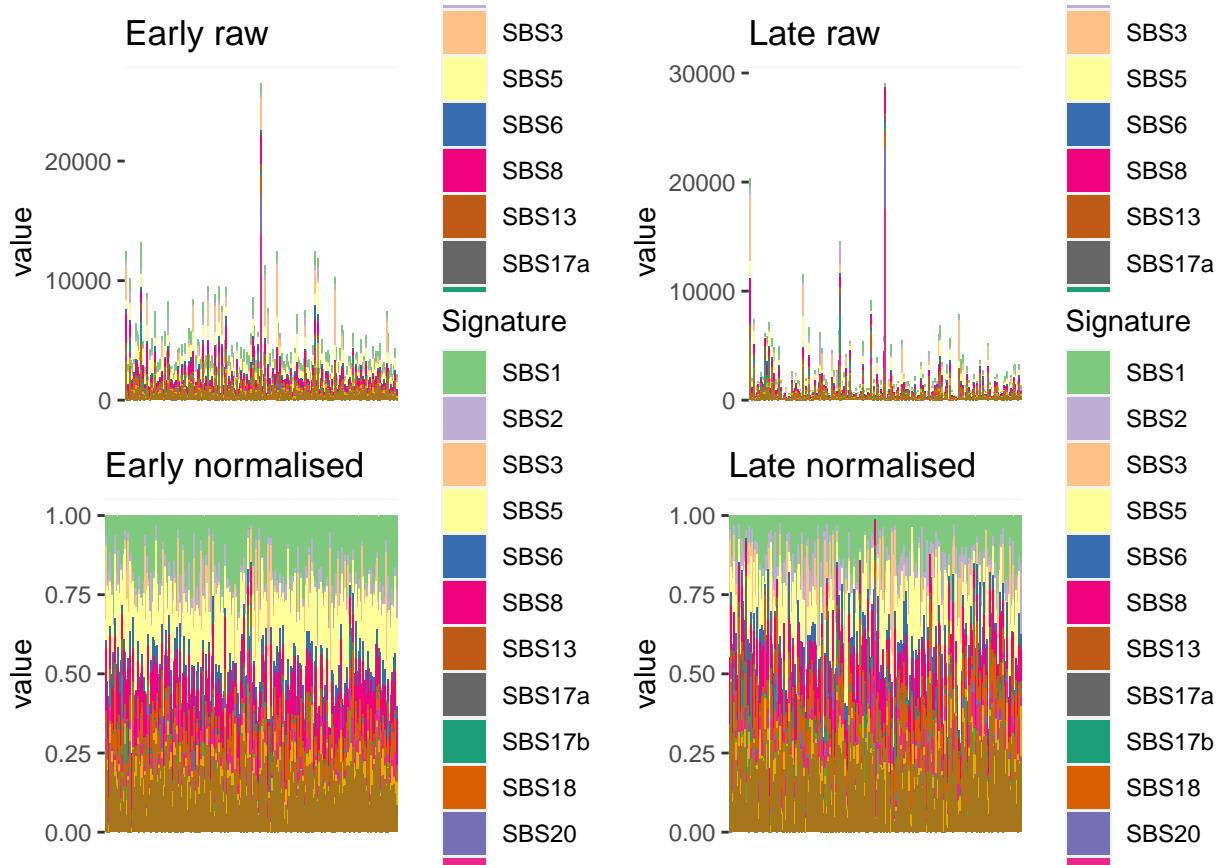
number of mutations.



## Panc-AdenoCA

### Barplot and general statistics

```
## [1] 193
```



The number of samples and signatures is:

```
## [1] 386 15
```

The signatures are:

```

## [1] "SBS1"   "SBS2"   "SBS3"   "SBS5"   "SBS6"   "SBS8"   "SBS13"  "SBS17a"
## [9] "SBS17b" "SBS18"  "SBS20"  "SBS26"  "SBS28"  "SBS30"  "SBS40"

```

### Convergence table

These are the results for the convergence of models fits. Most runs have converged. fullRE\_DMSL\_nonexo hadn't run.

|                    | L2                               | L1                       |
|--------------------|----------------------------------|--------------------------|
| ## 1 Panc-AdenoCA  | hessian_positivedefinite_bool    | diagRE_M                 |
| ## 2 Panc-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_M                 |
| ## 3 Panc-AdenoCA  | hessian_nonpositivedefinite_bool | diagRE_DMDL              |
| ## 4 Panc-AdenoCA  | Timeout                          | fullRE_halfDM            |
| ## 5 Panc-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_DMDL              |
| ## 6 Panc-AdenoCA  | hessian_positivedefinite_bool    | diagRE_DMSL              |
| ## 7 Panc-AdenoCA  | hessian_positivedefinite_bool    | sparseRE_DMSL            |
| ## 8 Panc-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_DMSL              |
| ## 9 Panc-AdenoCA  | hessian_nonpositivedefinite_bool | fullRE_DMSL_SBS1         |
| ## 10 Panc-AdenoCA | hessian_positivedefinite_bool    | fullRE_M_nonexo          |
| ## 11 Panc-AdenoCA | hessian_positivedefinite_bool    | diagRE_DMSL_nonexo       |
| ## 12 Panc-AdenoCA | hessian_positivedefinite_bool    | sparseRE_DMSL_nonexo     |
| ## 13 Panc-AdenoCA | Timeout                          | fullRE_DMSL_nonexo       |
| ## 14 Panc-AdenoCA | hessian_nonpositivedefinite_bool | fullRE_DMDL_nonexo       |
| ## 15 Panc-AdenoCA | hessian_positivedefinite_bool    | fullRE_DMDL_sortednonexo |

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo. M hasn't converged.

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

### Potentially problematic signatures

We explore whether there are problematic signatures. SBS17a is potentially problematic.

```
colSums(obj_Panc_AdenoCA$Y == 0) / nrow(obj_Panc_AdenoCA$Y)
```

```

##      SBS1     SBS2     SBS3     SBS5     SBS6     SBS8
## 0.000000000 0.012953368 0.634715026 0.051813472 0.069948187 0.005181347
##      SBS13    SBS17a    SBS17b    SBS18    SBS20    SBS26
## 0.036269430 0.575129534 0.183937824 0.093264249 0.647668394 0.134715026
##      SBS28    SBS30    SBS40
## 0.409326425 0.124352332 0.023316062

```

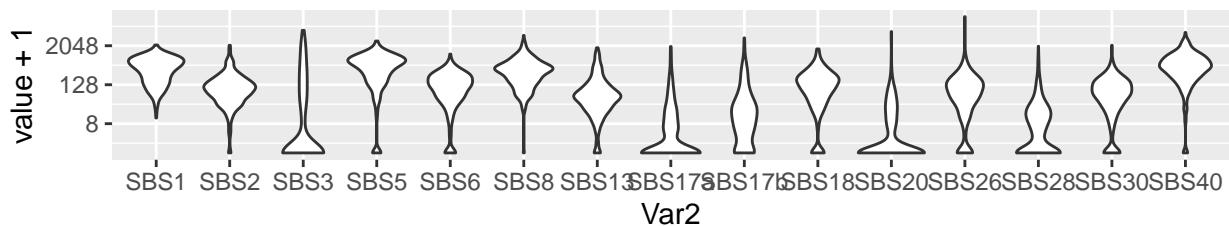
```
colSums(obj_Panc_AdenoCA$Y) / sum(obj_Panc_AdenoCA$Y)
```

```

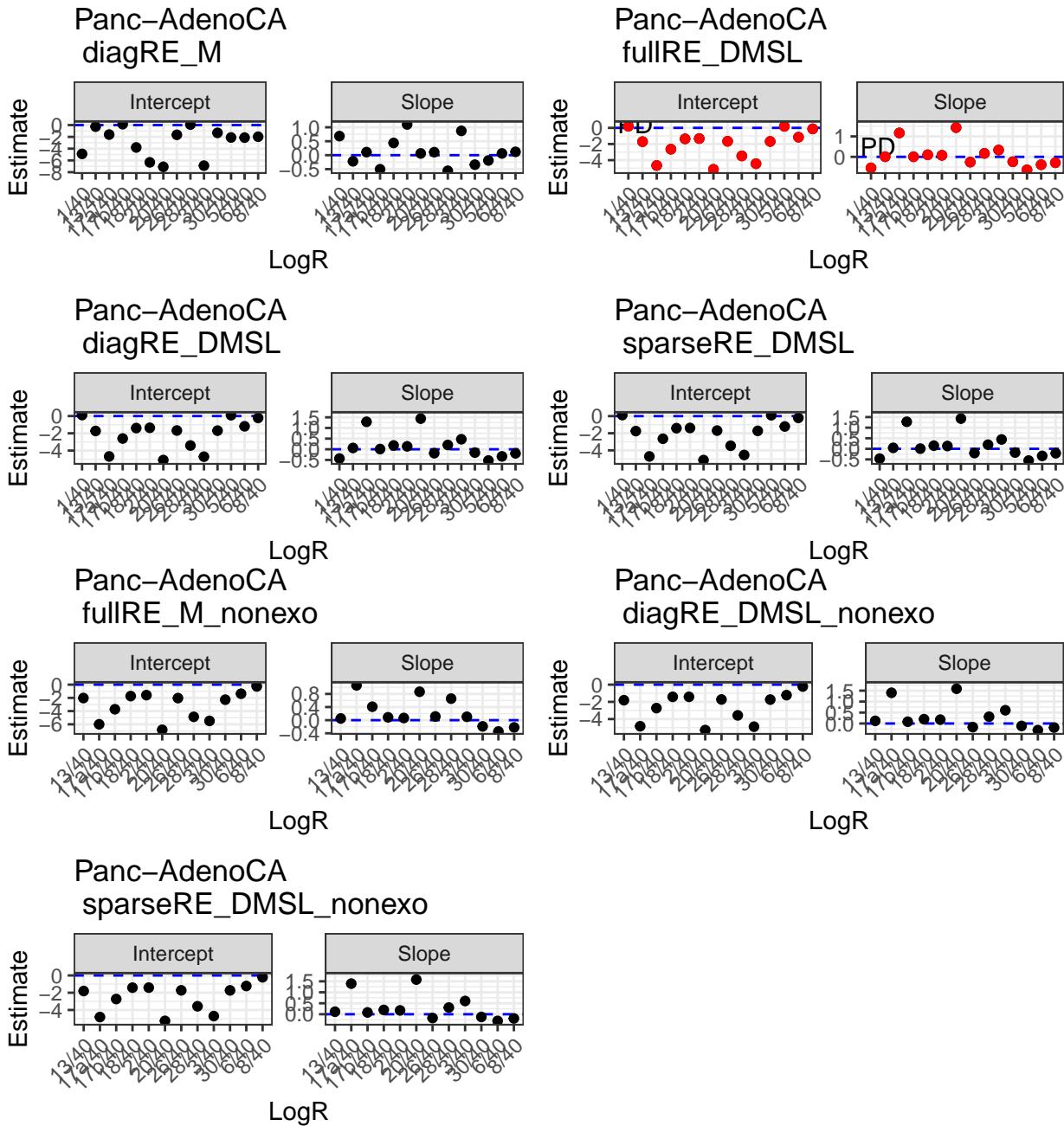
##      SBS1     SBS2     SBS3     SBS5     SBS6     SBS8
## 0.146510755 0.044043854 0.068370611 0.164694624 0.043276473 0.126954041
##      SBS13    SBS17a    SBS17b    SBS18    SBS20    SBS26
## 0.035397768 0.009365890 0.021818955 0.052439007 0.011446261 0.054377412
##      SBS28    SBS30    SBS40
## 0.008232467 0.029313201 0.183758680

```

From the violin plot, none seem too problematic.



### Betas



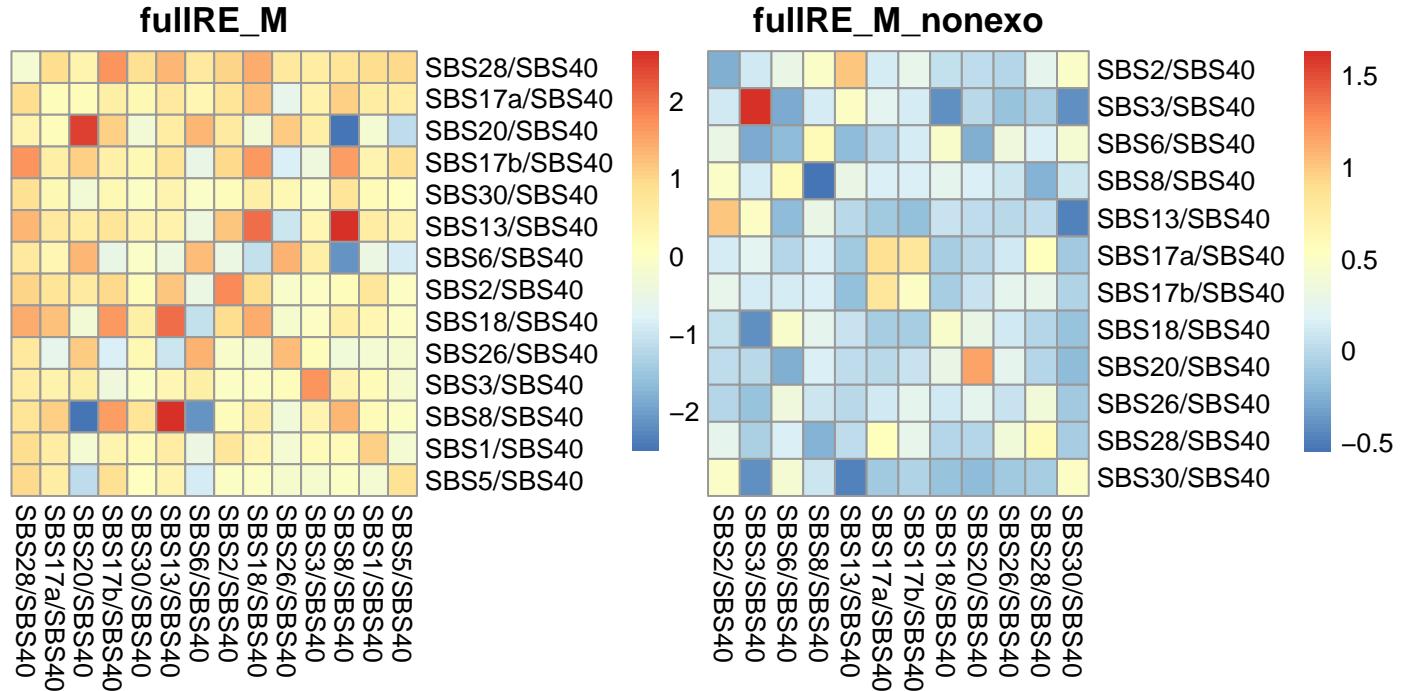
We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of

$6.8710408 \times 10^{-46}$ .

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

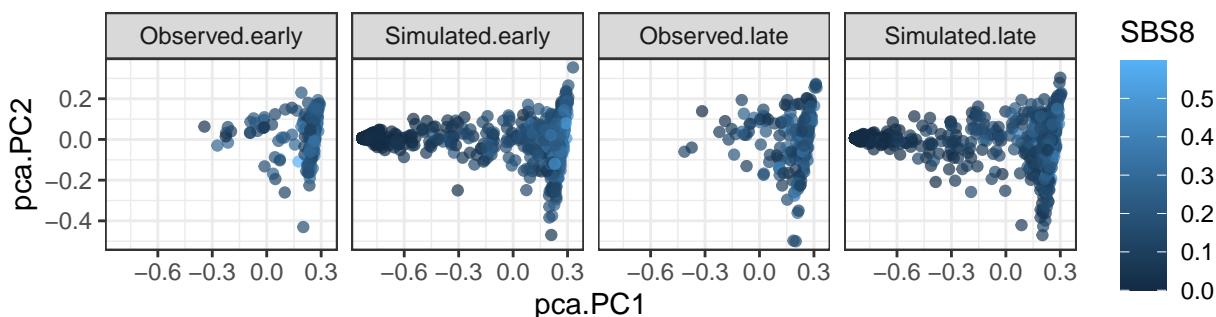


### Simulation under inferred data

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

### Simulation of Panc–AdenoCA samples



Multinomial:

```

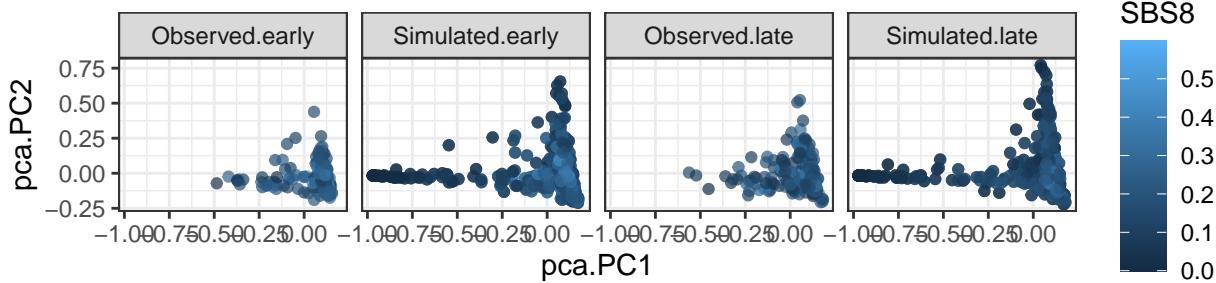
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)

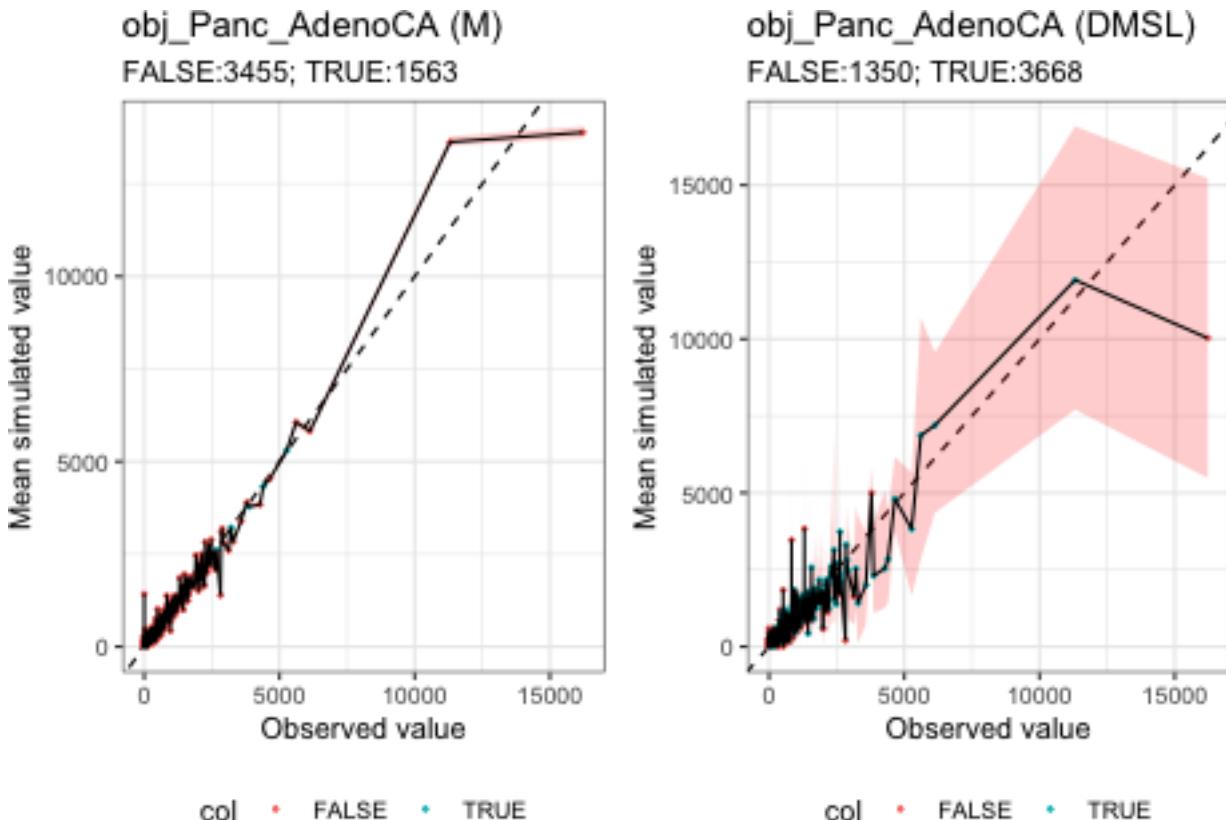
## Warning in mvtnorm:::rmvnorm(n = n_sim, mean = rep(0, dmin1), sigma = cov_mat):
## sigma is numerically not positive semidefinite

```

### Simulation of Panc–AdenoCA samples Using multinomial



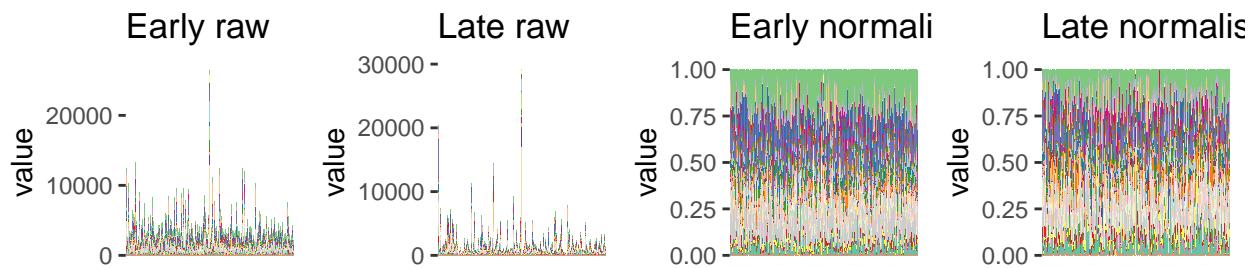
### Ranked plot for coverage



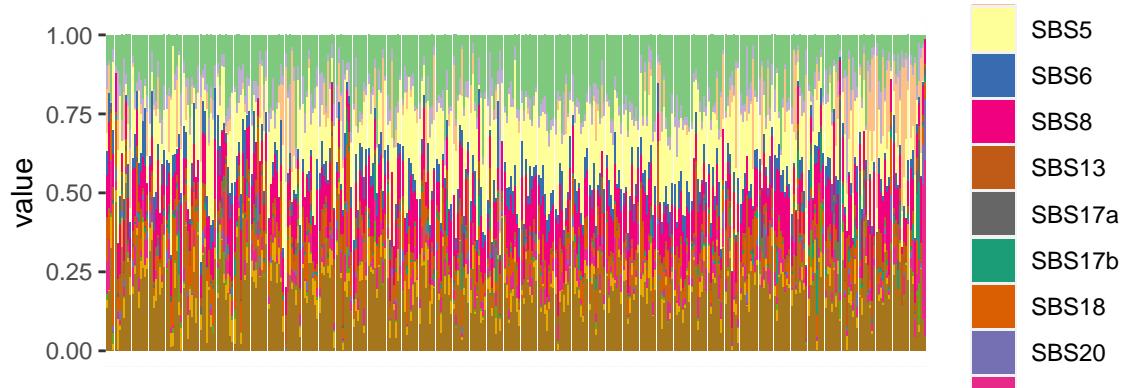
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 193
```



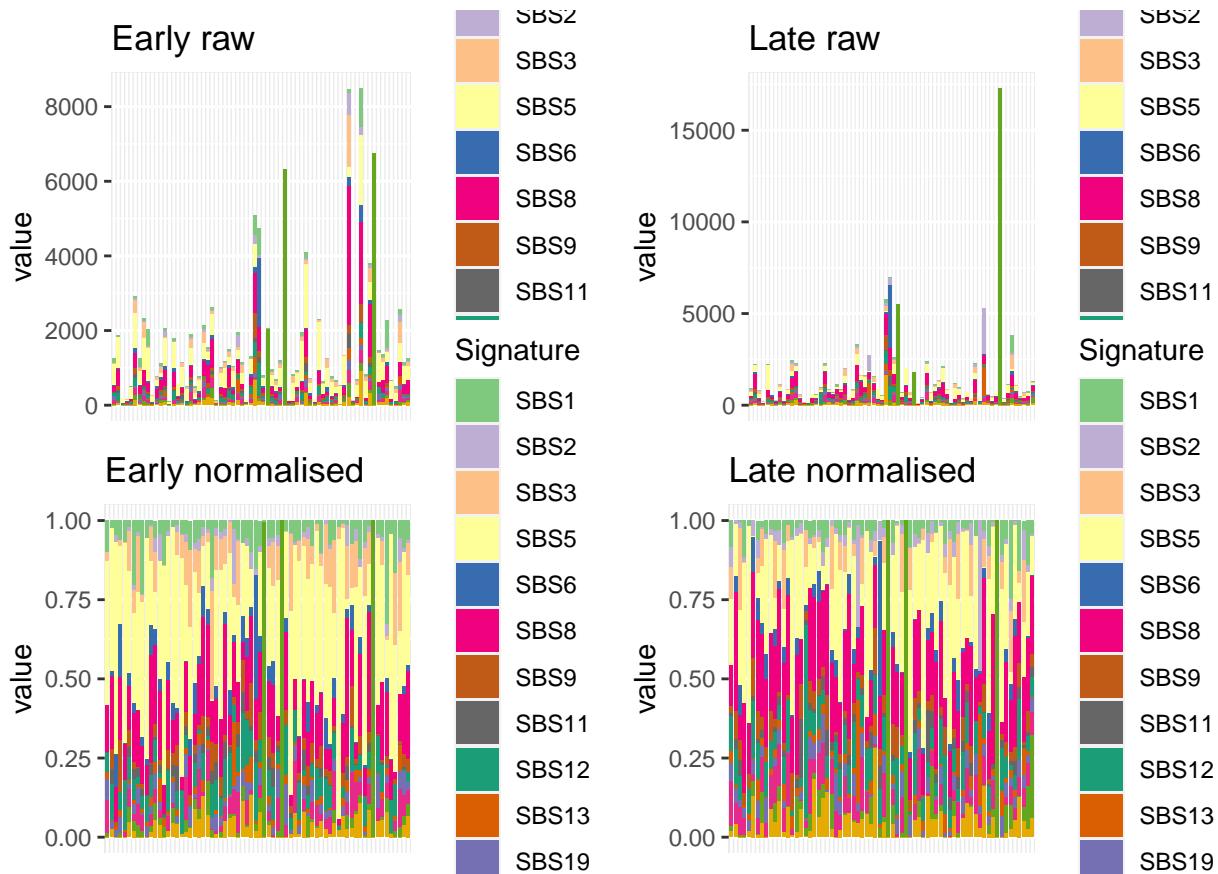
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



## Panc-Endocrine

### Barplot and general statistics

```
## [1] 70
```



The number of samples and signatures is:

```
## [1] 140 14
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS3"  "SBS5"  "SBS6"  "SBS8"  "SBS9"  "SBS11" "SBS12"
## [10] "SBS13" "SBS19" "SBS30" "SBS36" "SBS39"
```

### Convergence table

These are the results for the convergence of models fits. fullRE\_DMSL and fullRE\_DMSL\_nonexo haven't.

|      |   | L2 | L1            |
|------|---|----|---------------|
| ## 1 | Panc-Endocrine hessian_positivedefinite_bool    |    | diagRE_M      |
| ## 2 | Panc-Endocrine hessian_nonpositivedefinite_bool |    | fullRE_M      |
| ## 3 | Panc-Endocrine hessian_nonpositivedefinite_bool |    | diagRE_DMDL   |
| ## 4 | Panc-Endocrine Timeout                          |    | fullRE_halfDM |
| ## 5 | Panc-Endocrine hessian_nonpositivedefinite_bool |    | fullRE_DMDL   |
| ## 6 | Panc-Endocrine hessian_positivedefinite_bool    |    | diagRE_DMSL   |
| ## 7 | Panc-Endocrine hessian_positivedefinite_bool    |    | sparseRE_DMSL |

```

## 8 Panc-Endocrine hessian_nonpositivedefinite_bool fullRE_DMSL
## 9 Panc-Endocrine hessian_nonpositivedefinite_bool fullRE_DMSL_SBS1
## 10 Panc-Endocrine hessian_positivedefinite_bool fullRE_M_nonexo
## 11 Panc-Endocrine hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Panc-Endocrine hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Panc-Endocrine hessian_nonpositivedefinite_bool fullRE_DMSL_nonexo
## 14 Panc-Endocrine hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 Panc-Endocrine Timeout fullRE_DMDL_sortednonexo

```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

```
#> ## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo doesn't converge:

```
#> ## [1] FALSE
```

### Potentially problematic signatures

We explore whether there are problematic signatures:

```
colSums(obj_Panc_Endocrine$Y == 0)/nrow(obj_Panc_Endocrine$Y)
```

```

##      SBS1      SBS2      SBS3      SBS5      SBS6      SBS8      SBS9
## 0.08571429 0.20714286 0.43571429 0.09285714 0.35714286 0.05000000 0.14285714
##      SBS11     SBS12     SBS13     SBS19     SBS30     SBS36     SBS39
## 0.32142857 0.12142857 0.13571429 0.18571429 0.25000000 0.35000000 0.26428571

```

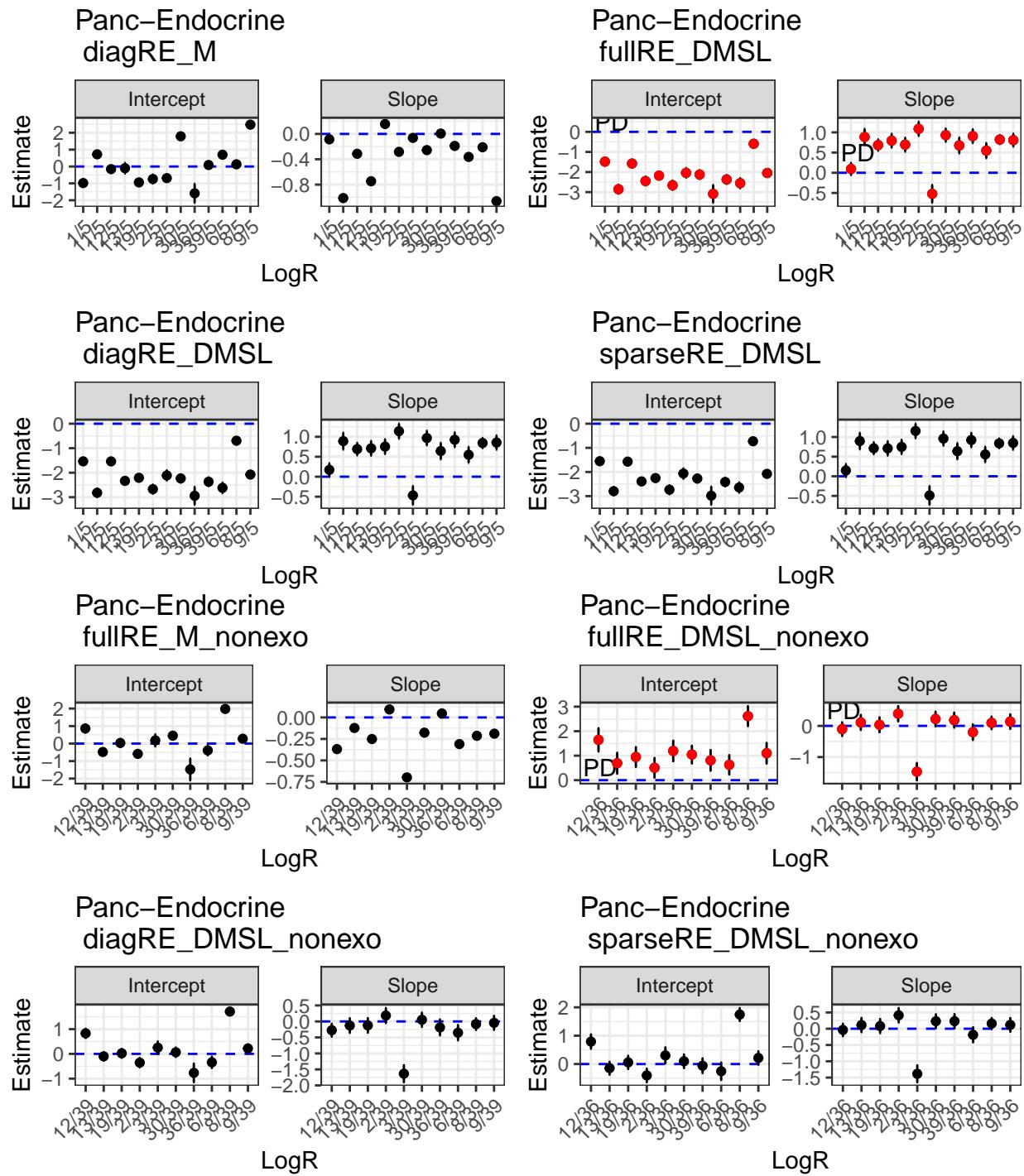
```
colSums(obj_Panc_Endocrine$Y)/sum(obj_Panc_Endocrine$Y)
```

```

##      SBS1      SBS2      SBS3      SBS5      SBS6      SBS8      SBS9
## 0.04497473 0.03735807 0.05104230 0.19581878 0.04501764 0.17414887 0.03565881
##      SBS11     SBS12     SBS13     SBS19     SBS30     SBS36     SBS39
## 0.01924975 0.05892071 0.03124330 0.02551471 0.04475588 0.19146763 0.04482883

```

## Betas

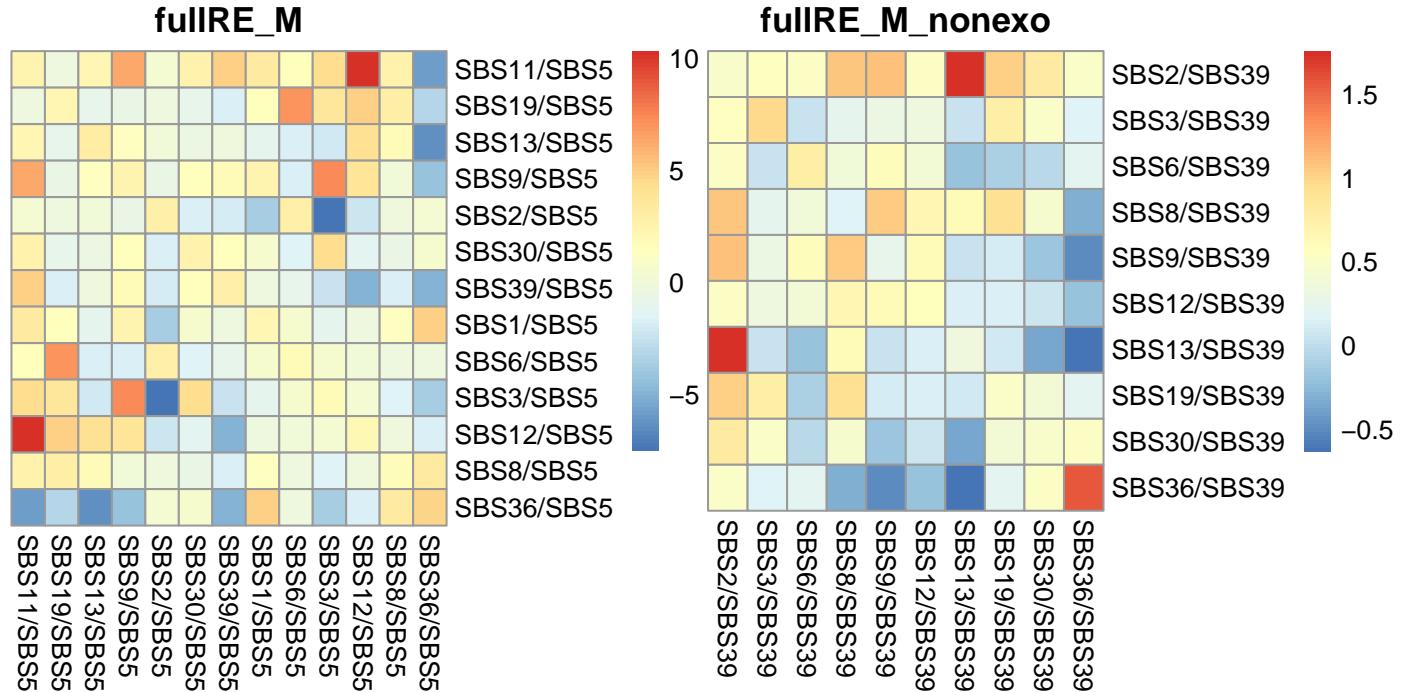


We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of  $1.9645842 \times 10^{-9}$ .

## Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

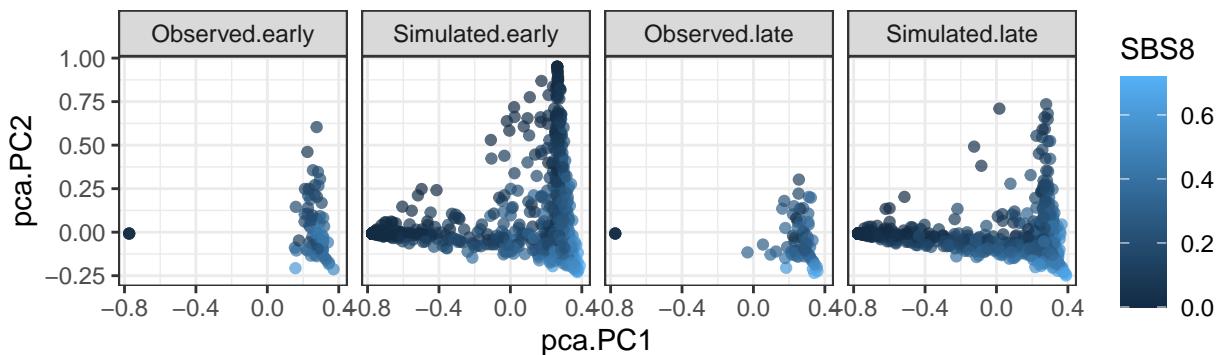


## Simulation under inferred data

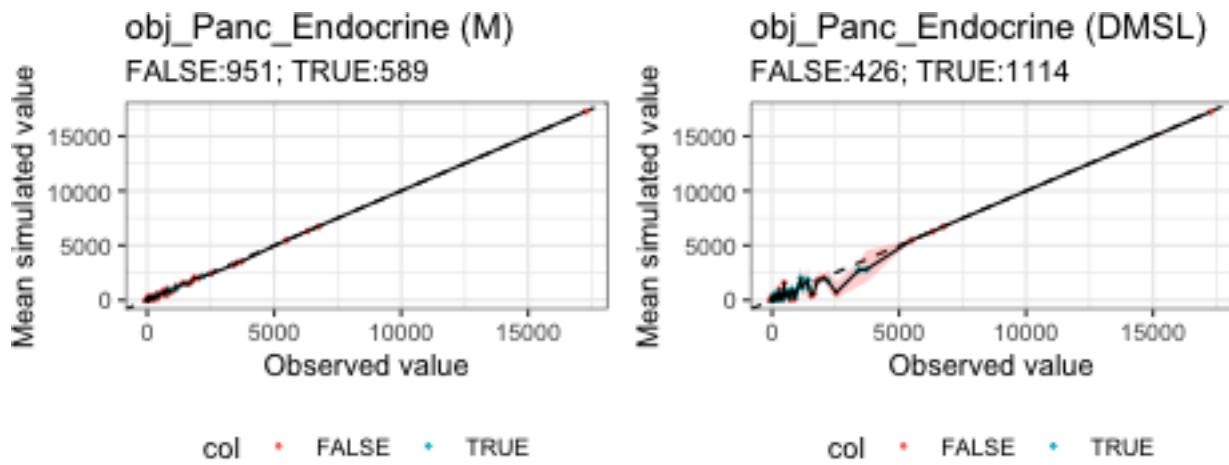
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

## Simulation of Panc–Endocrine samples



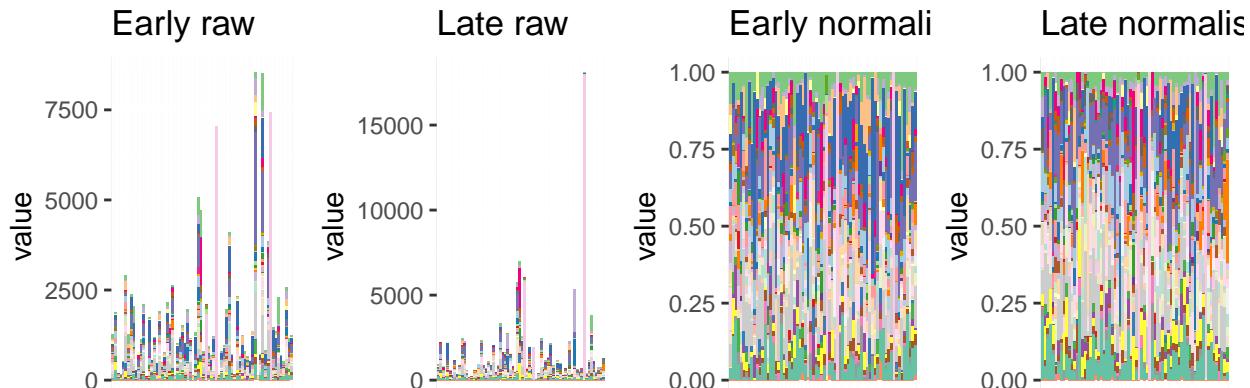
### Ranked plot for coverage



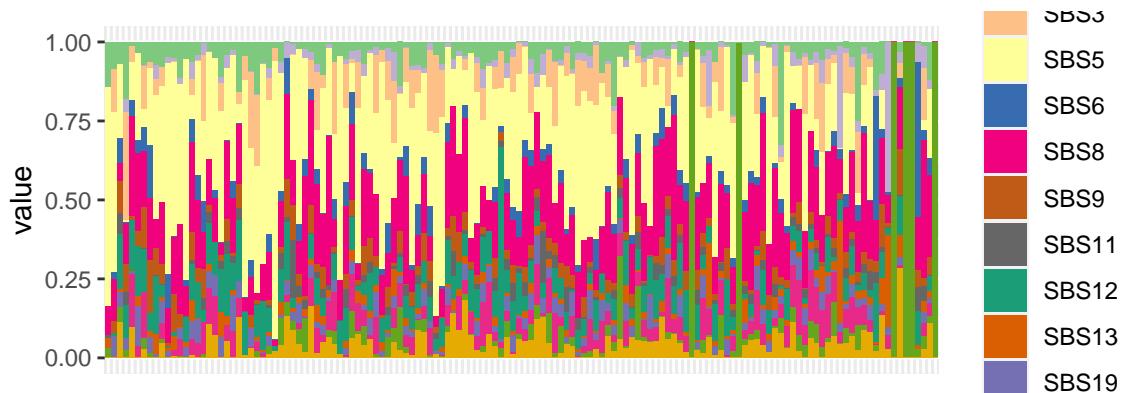
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 70
```



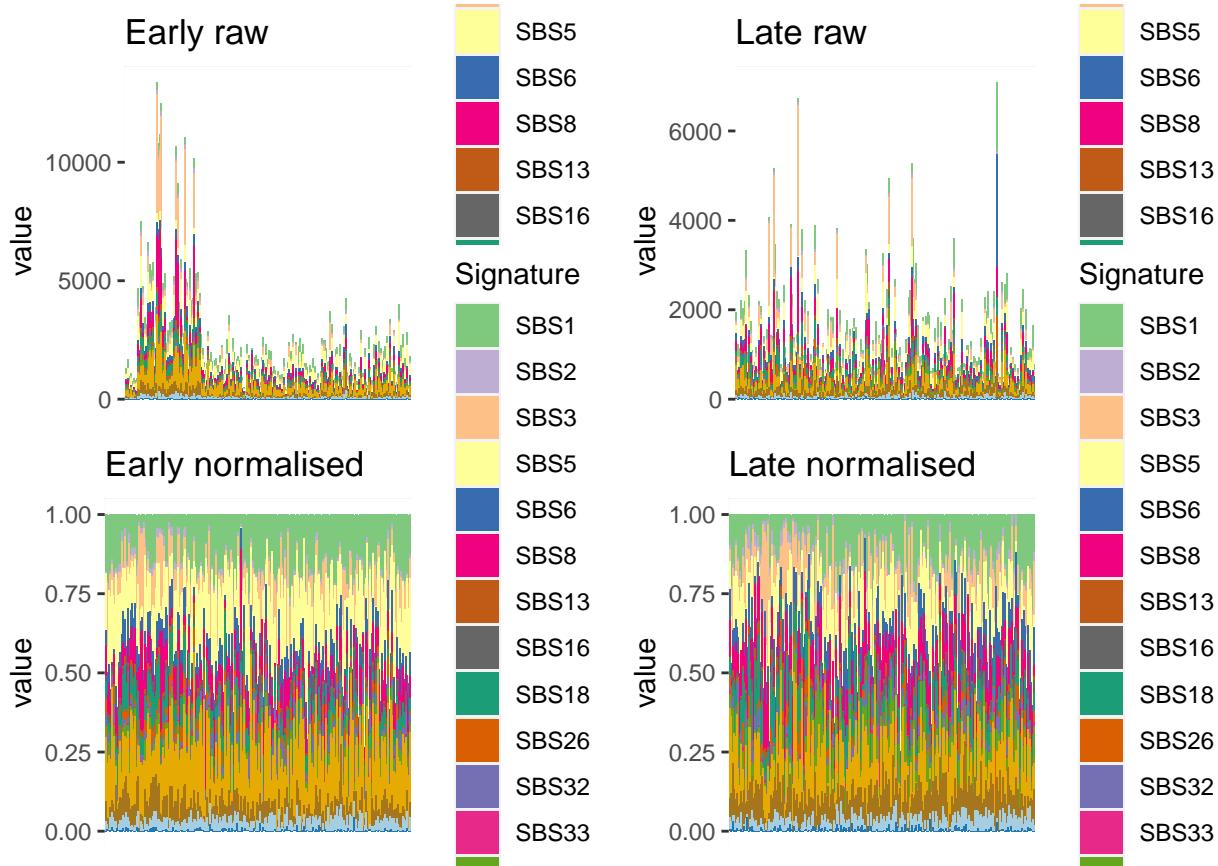
Exposures sorted by increasing number of mutations: there is a trend with one signature only being present, and in very large amounts, in hypermutated samples.



## Prost-AdenoCA

### Barplot and general statistics

```
## [1] 208
```



The number of samples and signatures is:

```
## [1] 416 17
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS3"  "SBS5"  "SBS6"  "SBS8"  "SBS13" "SBS16" "SBS18"
## [10] "SBS26" "SBS32" "SBS33" "SBS37" "SBS40" "SBS41" "SBS50" "SBS52"
```

### Convergence table

These are the results for the convergence of models fits. Most have converged. fullRE\_DMSL\_nonexo hasn't run and needs to be re-run.

|                    | value                            | L2      | L1            |
|--------------------|----------------------------------|---------|---------------|
| ## 1 Prost-AdenoCA | hessian_positivedefinite_bool    | Timeout | diagRE_M      |
| ## 2 Prost-AdenoCA | hessian_nonpositivedefinite_bool | Timeout | fullRE_M      |
| ## 3 Prost-AdenoCA | hessian_nonpositivedefinite_bool | Timeout | diagRE_DMDL   |
| ## 4 Prost-AdenoCA |                                  | Timeout | fullRE_halfDM |
| ## 5 Prost-AdenoCA |                                  | Timeout | fullRE_DMDL   |
| ## 6 Prost-AdenoCA | hessian_positivedefinite_bool    |         | diagRE_DMSL   |

```

## 7 Prost-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL
## 8 Prost-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL
## 9 Prost-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL_SBS1
## 10 Prost-AdenoCA hessian_positivedefinite_bool fullRE_M_nonexo
## 11 Prost-AdenoCA hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Prost-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Prost-AdenoCA Timeout fullRE_DMSL_nonexo
## 14 Prost-AdenoCA hessian_positivedefinite_bool fullRE_DMDL_nonexo
## 15 Prost-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL_sortednonexo

```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

But DMSL hasn't:

```

## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
## [1] FALSE

```

### Potentially problematic signatures

We explore whether there are problematic signatures. None seem to be, although SBS33 is absent in 60% of samples.

```

colSums(obj_Prost_AdenoCA$Y == 0) / nrow(obj_Prost_AdenoCA$Y)

##      SBS1      SBS2      SBS3      SBS5      SBS6      SBS8
## 0.007211538 0.040865385 0.225961538 0.108173077 0.033653846 0.052884615
##      SBS13     SBS16     SBS18     SBS26     SBS32     SBS33
## 0.259615385 0.331730769 0.043269231 0.317307692 0.100961538 0.665865385
##      SBS37     SBS40     SBS41     SBS50     SBS52
## 0.257211538 0.086538462 0.026442308 0.057692308 0.427884615

```

```

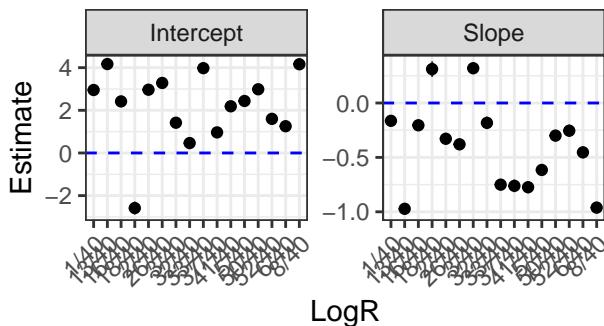
colSums(obj_Prost_AdenoCA$Y) / sum(obj_Prost_AdenoCA$Y)

##      SBS1      SBS2      SBS3      SBS5      SBS6      SBS8
## 0.123798623 0.018138349 0.101489206 0.145492714 0.063352195 0.110930563
##      SBS13     SBS16     SBS18     SBS26     SBS32     SBS33
## 0.011721046 0.011380527 0.071927318 0.022167235 0.022482663 0.003387275
##      SBS37     SBS40     SBS41     SBS50     SBS52
## 0.028615602 0.166680208 0.065069131 0.029925110 0.003442236

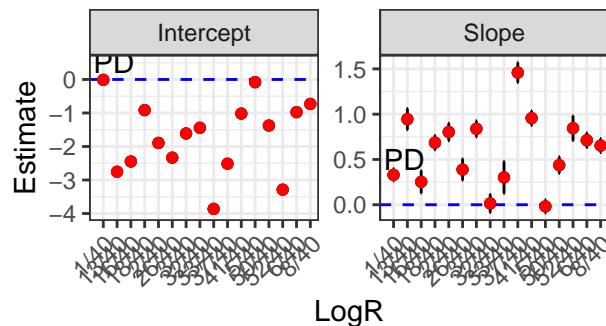
```

Betas

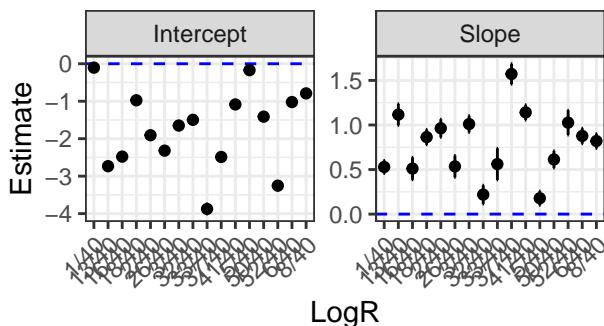
Prost-AdenoCA  
diagRE\_M



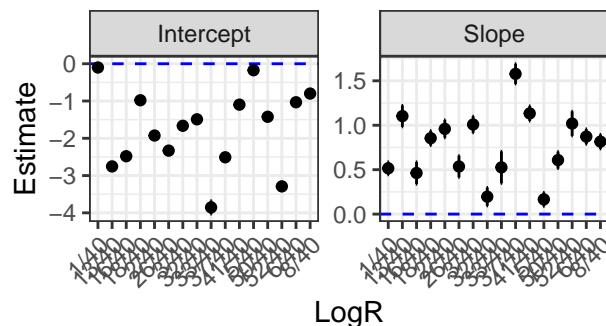
Prost-AdenoCA  
fullRE\_DMSL



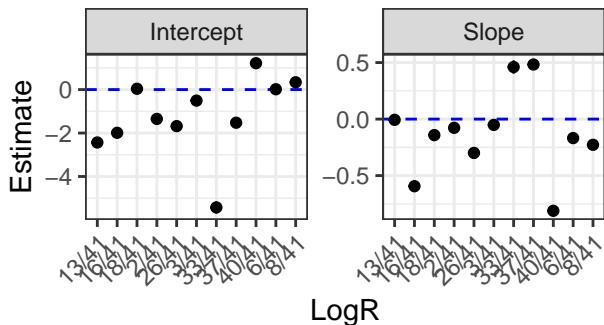
Prost-AdenoCA  
diagRE\_DMSL



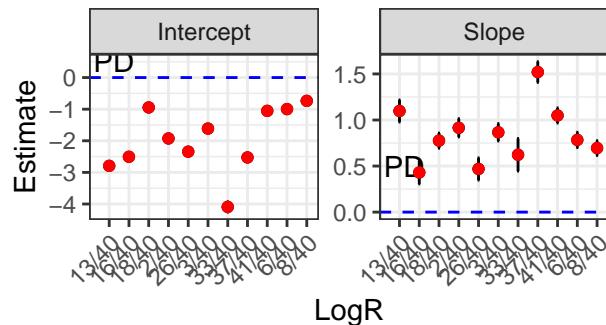
Prost-AdenoCA  
sparseRE\_DMSL



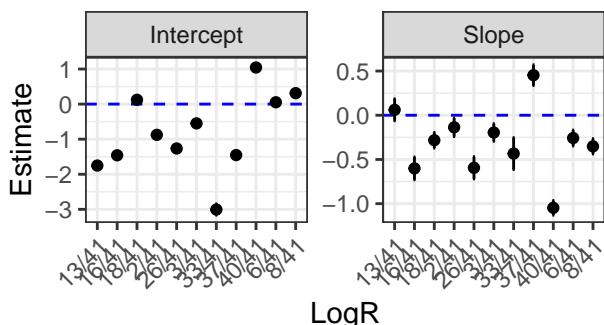
Prost-AdenoCA  
fullRE\_M\_nonexo



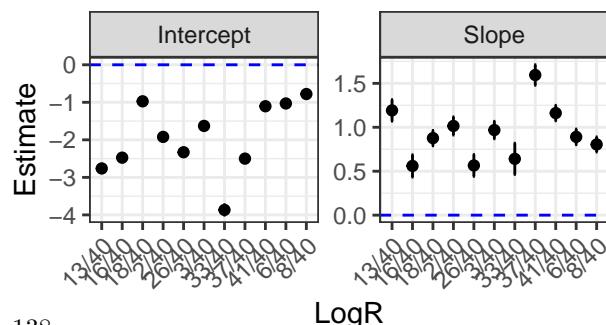
Prost-AdenoCA  
fullRE\_DMSL\_nonexo



Prost-AdenoCA  
diagRE\_DMSL\_nonexo



Prost-AdenoCA  
sparseRE\_DMSL\_nonexo

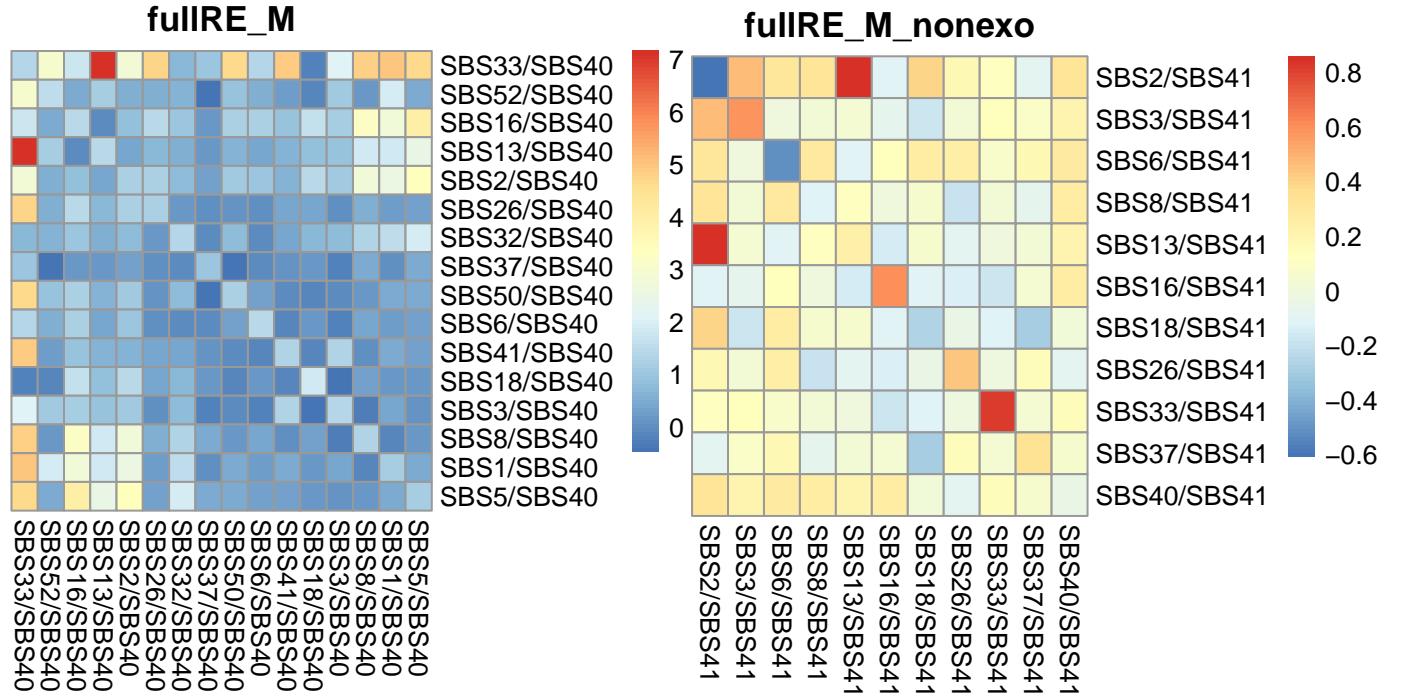


We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of  $5.142907 \times 10^{-58}$ .

### Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

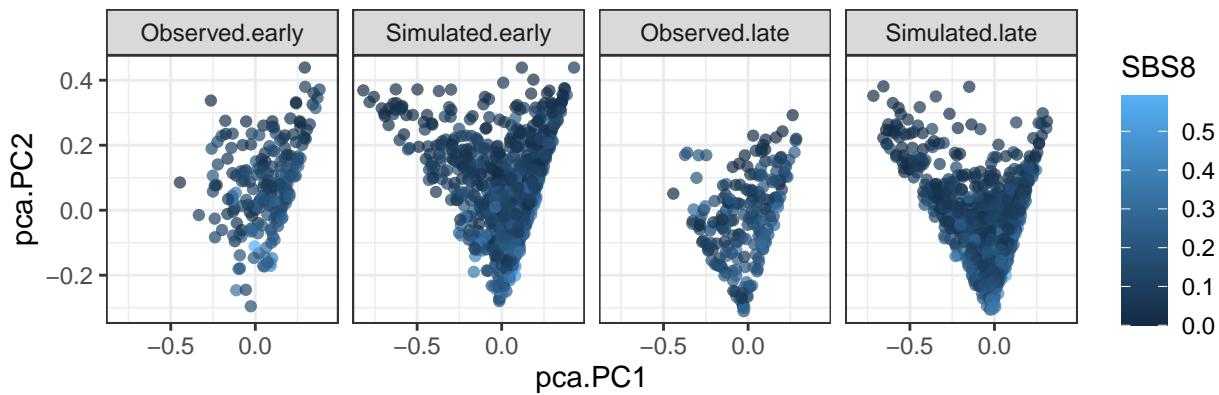


### Simulation under inferred data

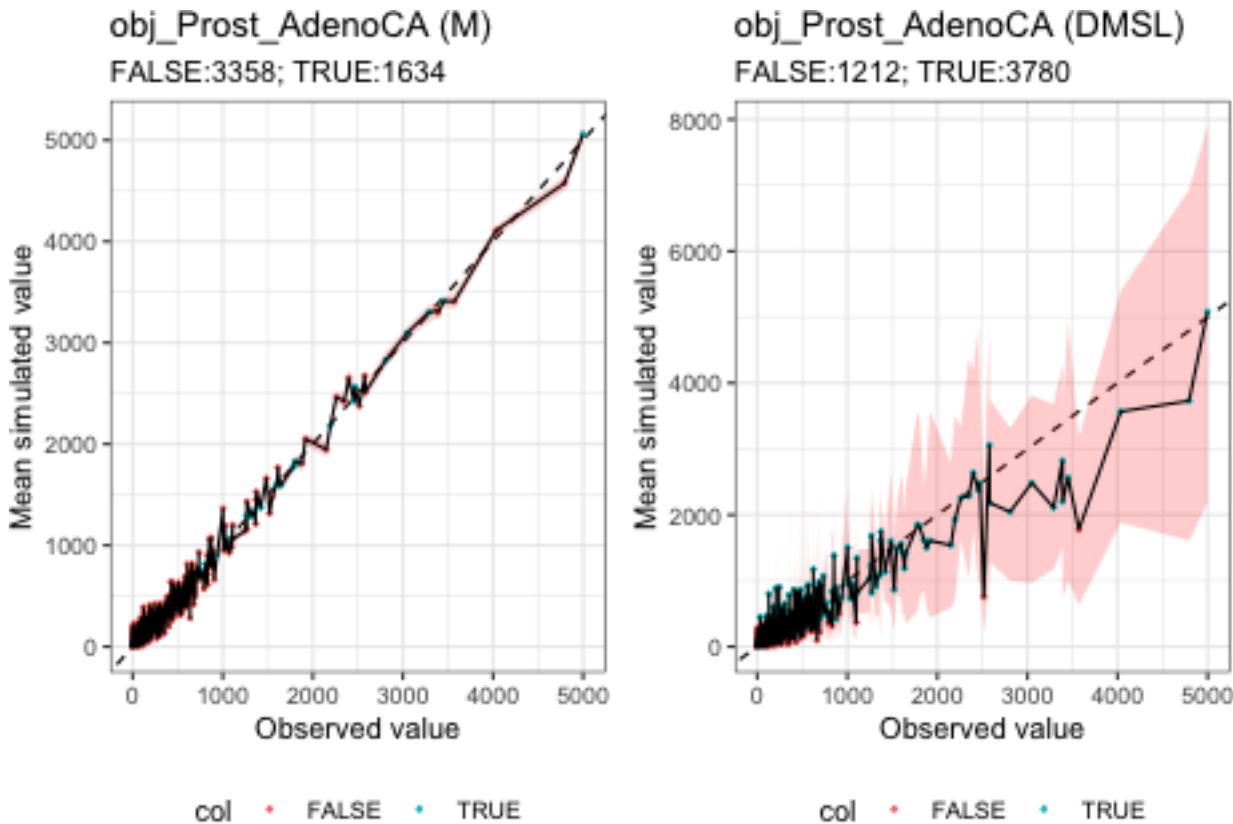
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

## Simulation of Prost–AdenoCA samples



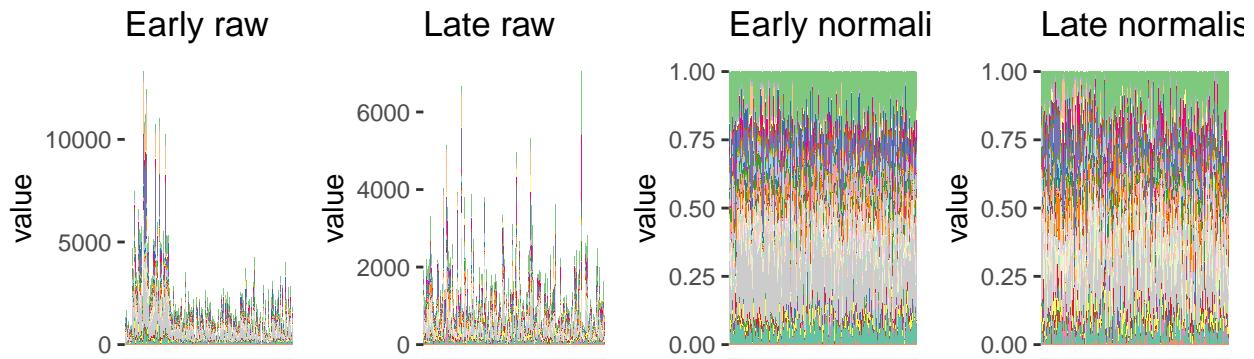
## Ranked plot for coverage



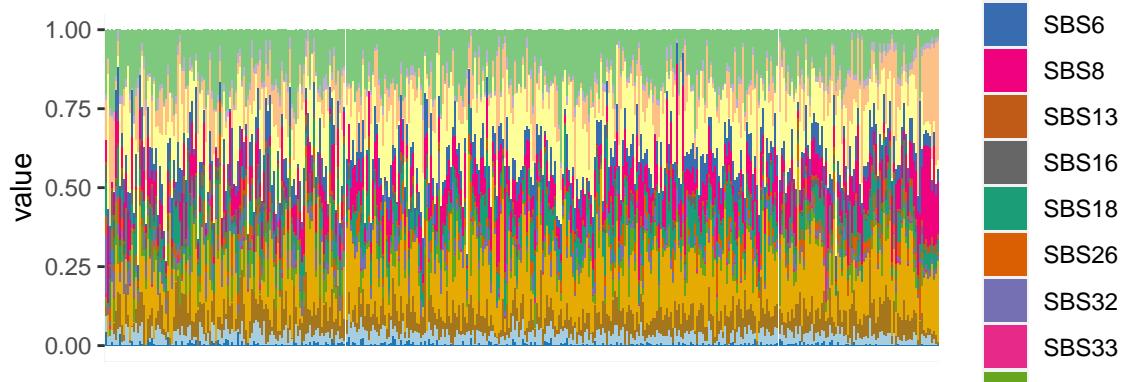
## Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 208
```



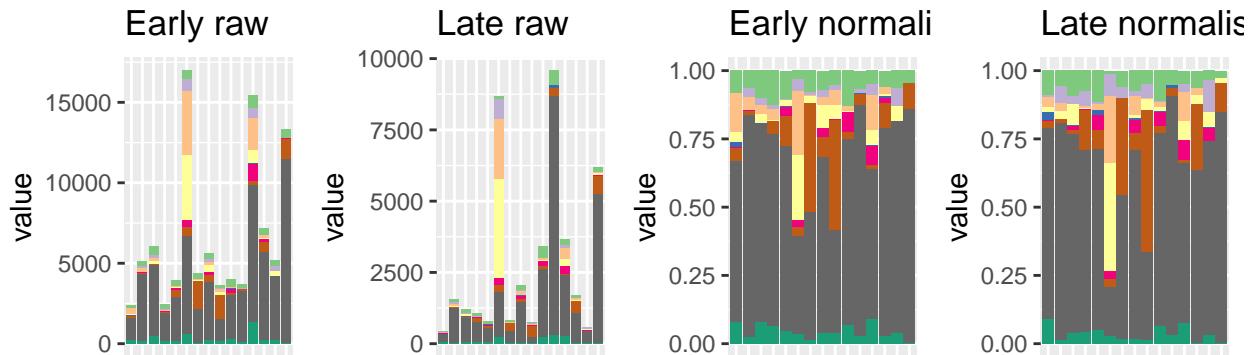
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations, except perhaps SBS3 in the hypermutated ones.



### Skin-Melanoma.acral

#### Barplot and general statistics

```
## [1] 15
```



The number of samples and signatures is:

```
## [1] 30 9
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS7a" "SBS7b" "SBS7c" "SBS31" "SBS38" "SBS40" "SBS58"
```

## Convergence table

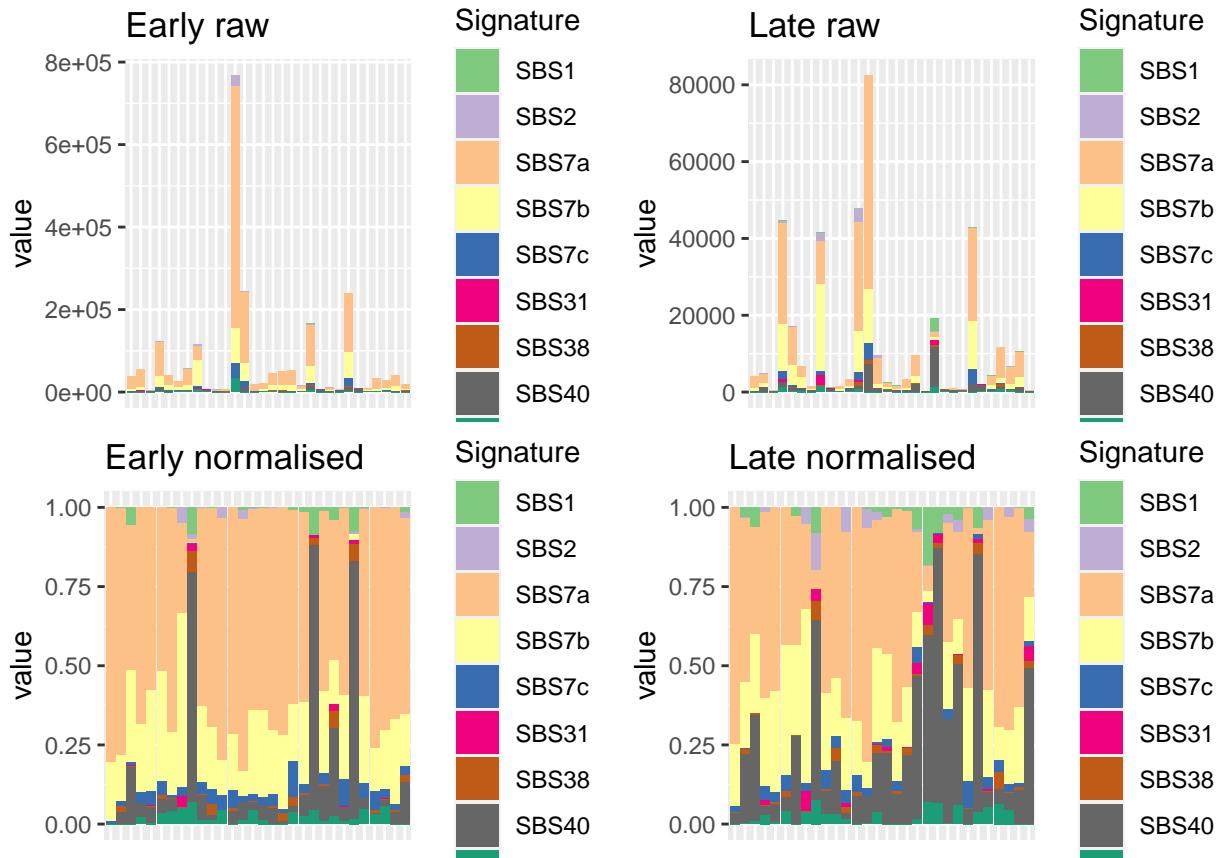
These are the results for the convergence of models fits. They have converged even though very clearly we have very few observations and too many parameters. I thought I would have excluded this cancer type? In CT\_sufficient\_samples.txt it does appear but shouldn't - I don't continue the analyses for this cancer type.

```
## [1] value L2     L1
## <0 rows> (or 0-length row.names)
```

## Skin-Melanoma.cutaneous

### Barplot and general statistics

```
## [1] 30
```



The number of samples and signatures is:

```
## [1] 60  9
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS7a" "SBS7b" "SBS7c" "SBS31" "SBS38" "SBS40" "SBS58"
```

## Convergence table

These are the results for the convergence of models fits. fullRE\_DMSL have not converged.

| ## | value | L2 |
|----|-------|----|
|----|-------|----|

```

## 1 Skin-Melanoma.cutaneous    hessian_positivedefinite_bool
## 2 Skin-Melanoma.cutaneous hessian_nonpositivedefinite_bool
## 3 Skin-Melanoma.cutaneous    hessian_positivedefinite_bool
## 4 Skin-Melanoma.cutaneous                                Timeout
## 5 Skin-Melanoma.cutaneous hessian_nonpositivedefinite_bool
## 6 Skin-Melanoma.cutaneous    hessian_positivedefinite_bool
## 7 Skin-Melanoma.cutaneous    hessian_positivedefinite_bool
## 8 Skin-Melanoma.cutaneous hessian_nonpositivedefinite_bool
## 9 Skin-Melanoma.cutaneous hessian_nonpositivedefinite_bool
## 10 Skin-Melanoma.cutaneous   hessian_positivedefinite_bool
## 11 Skin-Melanoma.cutaneous   hessian_positivedefinite_bool
## 12 Skin-Melanoma.cutaneous                                Timeout
## 13 Skin-Melanoma.cutaneous                                Timeout
## 14 Skin-Melanoma.cutaneous hessian_nonpositivedefinite_bool
## 15 Skin-Melanoma.cutaneous   hessian_positivedefinite_bool
##
## L1
## 1          diagRE_M
## 2          fullRE_M
## 3          diagRE_DMDL
## 4          fullRE_halfDM
## 5          fullRE_DMDL
## 6          diagRE_DMSL
## 7          sparseRE_DMSL
## 8          fullRE_DMSL
## 9          fullRE_DMSL_SBS1
## 10         fullRE_M_nonexo
## 11         diagRE_DMSL_nonexo
## 12         sparseRE_DMSL_nonexo
## 13         fullRE_DMSL_nonexo
## 14         fullRE_DMDL_nonexo
## 15 fullRE_DMDL_sortednonexo

```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo do converge:

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

It has converged.

### Potentially problematic signatures

We explore whether there are problematic signatures; there are none.

```
colSums(obj_Skin_Melanomacutaneous$Y == 0)/nrow(obj_Skin_Melanomacutaneous$Y)
```

```

##      SBS1      SBS2      SBS7a      SBS7b      SBS7c      SBS31      SBS38
## 0.31666667 0.68333333 0.03333333 0.06666667 0.13333333 0.71666667 0.11666667
##      SBS40      SBS58
## 0.05000000 0.25000000

```

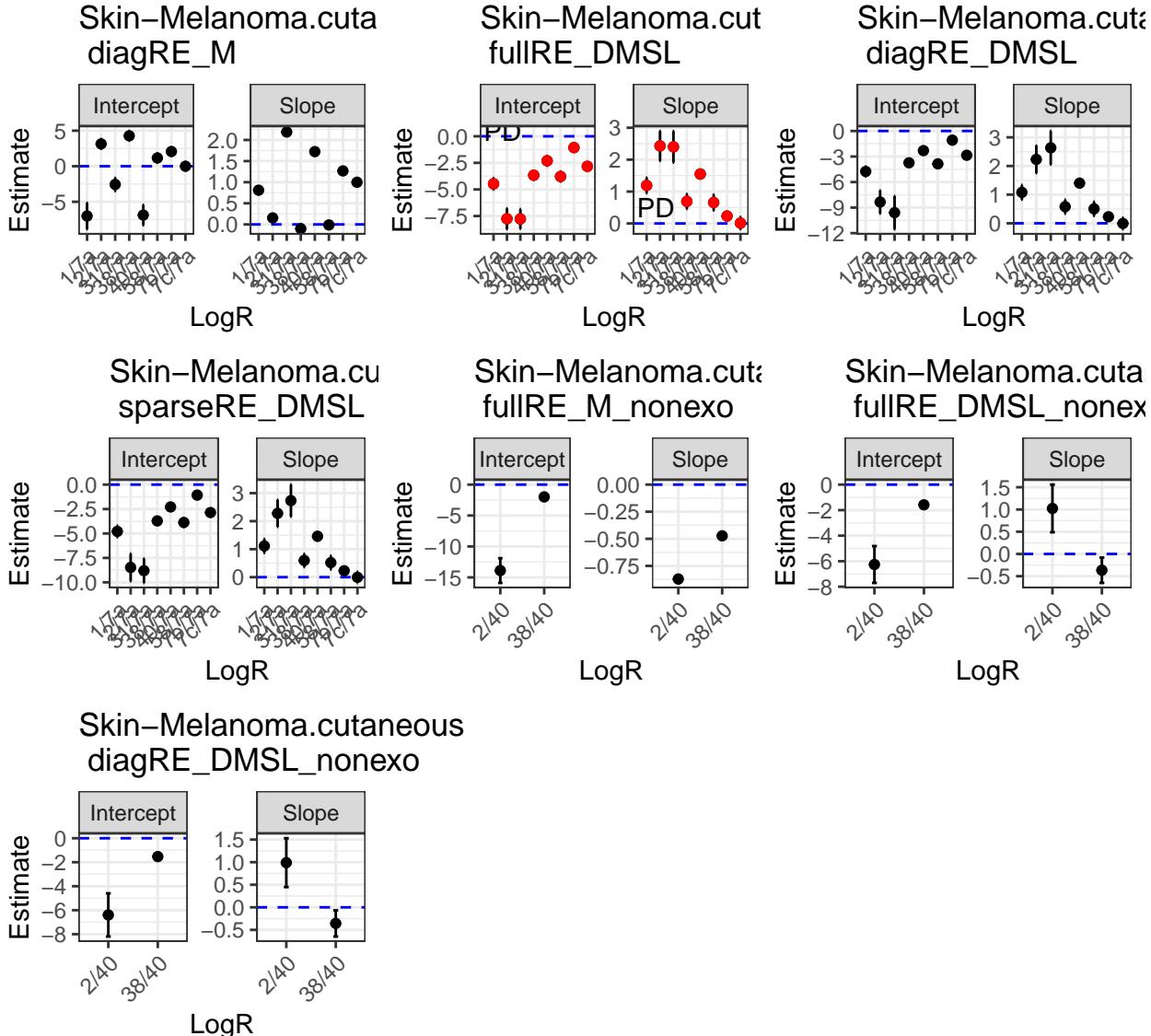
```
colSums(obj_Skin_Melanomacutaneous$Y)/sum(obj_Skin_Melanomacutaneous$Y)
```

```

##      SBS1      SBS2      SBS7a      SBS7b      SBS7c      SBS31
## 0.004433478 0.015369819 0.652197003 0.207691993 0.044244244 0.003864520
##      SBS38      SBS40      SBS58
## 0.005701701 0.042679042 0.023818200

```

### Betas



We use the results from the full RE single lambda DM to test for differential abundance, giving a p-value of 0.0628799.

### Covariance matrices

```

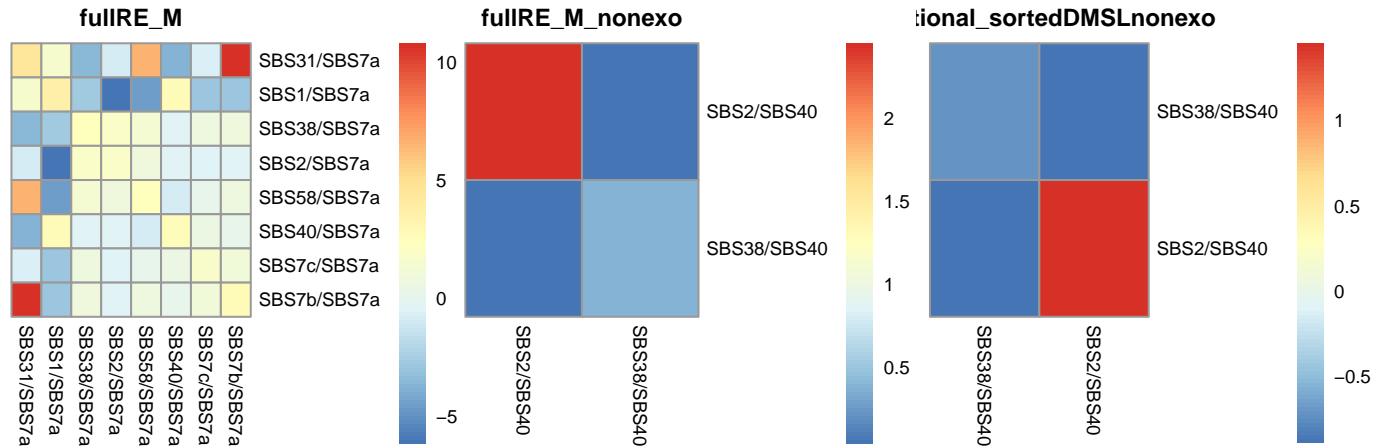
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))

```

```
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))  
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

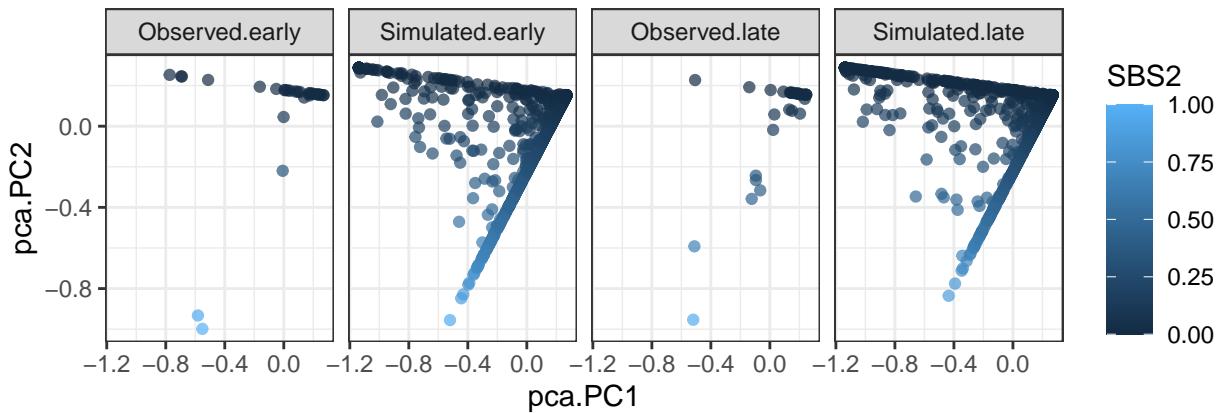


### Simulation under inferred data

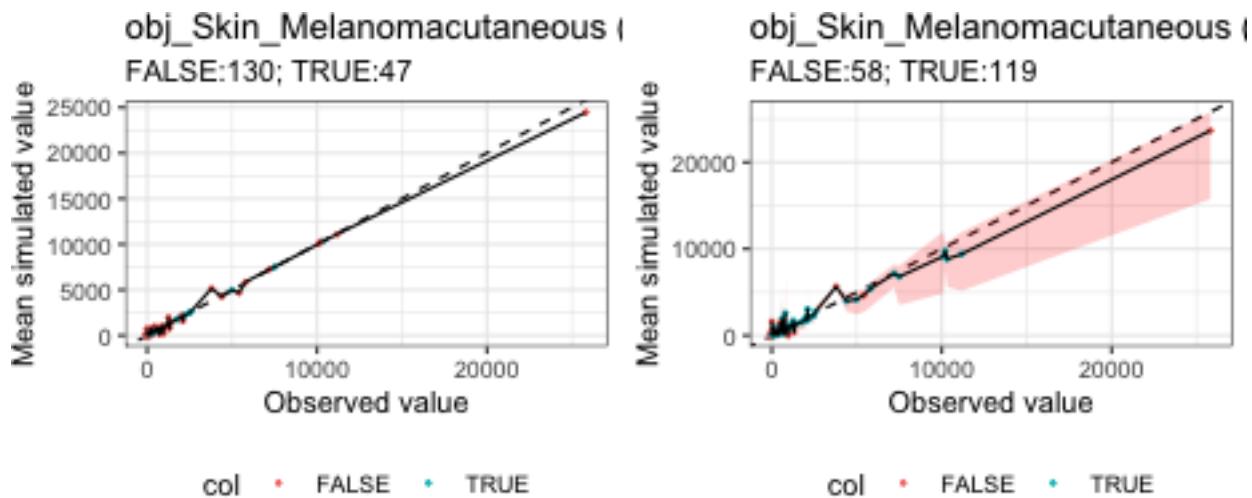
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :  
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :  
## This function had been incorrect until now (30 july 2021)
```

### Simulation of Skin–Melanoma.cutaneous samples



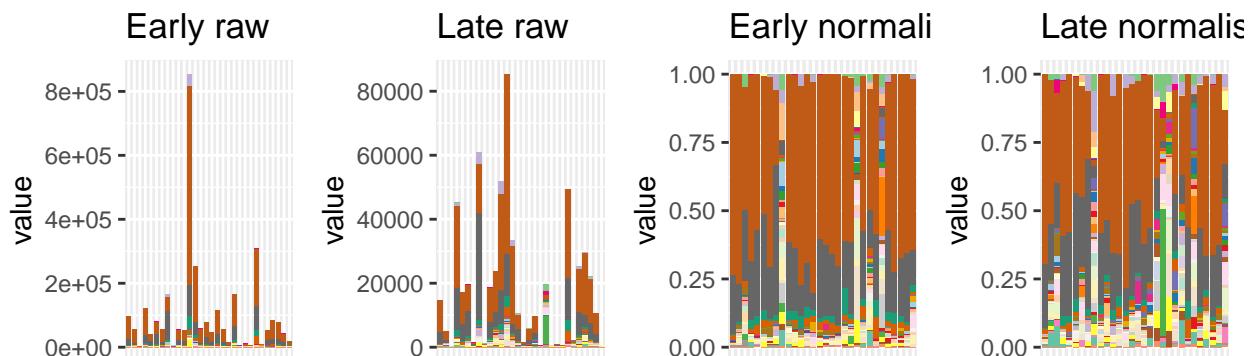
### Ranked plot for coverage



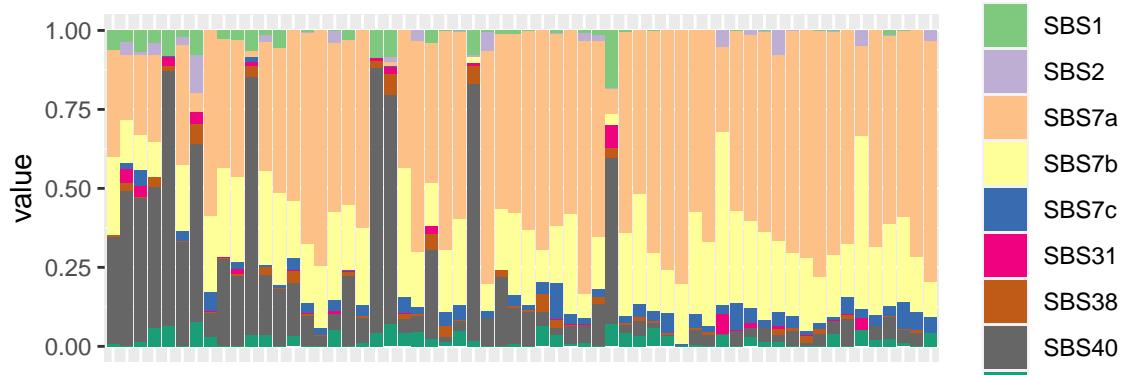
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 30
```



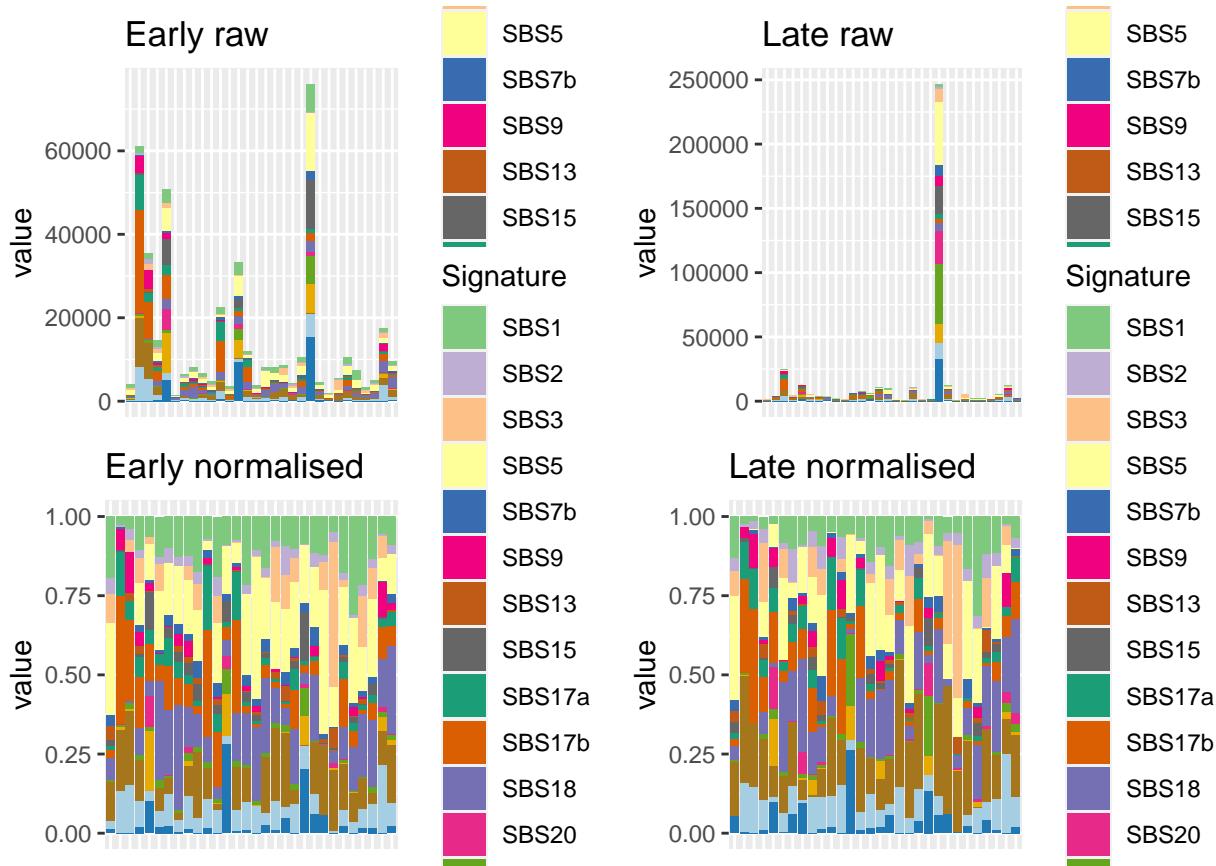
Exposures sorted by increasing number of mutations: SBS40 is clearly prevalent in samples with few mutations.



## Stomach-AdenoCA

### Barplot and general statistics

```
## [1] 30
```



The number of samples and signatures is:

```
## [1] 60 17
```

The signatures are:

```
## [1] "SBS1"   "SBS2"   "SBS3"   "SBS5"   "SBS7b"  "SBS9"   "SBS13"  "SBS15"
## [9] "SBS17a" "SBS17b" "SBS18"  "SBS20"  "SBS21"  "SBS26"  "SBS40"  "SBS41"
## [17] "SBS44"
```

### Convergence table

These are the results for the convergence of models fits. Besides fullRE\_DMSL\_nonexo, we have convergence with almost everything.

|                      | value                            | L2      | L1            |
|----------------------|----------------------------------|---------|---------------|
| ## 1 Stomach-AdenoCA | hessian_positivedefinite_bool    |         | diagRE_M      |
| ## 2 Stomach-AdenoCA | hessian_nonpositivedefinite_bool |         | fullRE_M      |
| ## 3 Stomach-AdenoCA | hessian_nonpositivedefinite_bool |         | diagRE_DMDL   |
| ## 4 Stomach-AdenoCA |                                  | Timeout | fullRE_halfDM |
| ## 5 Stomach-AdenoCA |                                  | Timeout | fullRE_DMDL   |

```

## 6 Stomach-AdenoCA hessian_positivedefinite_bool diagRE_DMSL
## 7 Stomach-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL
## 8 Stomach-AdenoCA Timeout fullRE_DMSL
## 9 Stomach-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMSL_SBS1
## 10 Stomach-AdenoCA hessian_nonpositivedefinite_bool fullRE_M_nonexo
## 11 Stomach-AdenoCA hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Stomach-AdenoCA hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Stomach-AdenoCA Timeout fullRE_DMSL_nonexo
## 14 Stomach-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL_nonexo
## 15 Stomach-AdenoCA hessian_nonpositivedefinite_bool fullRE_DMDL_sortednonexo

```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo, but M hasn't converged. We should include fewer signatures.

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

### Potentially problematic signatures

We explore whether there are problematic signatures:

```
colSums(obj_Stomach_AdenoCA$Y == 0) / nrow(obj_Stomach_AdenoCA$Y)
```

```

##      SBS1      SBS2      SBS3      SBS5      SBS7b      SBS9      SBS13
## 0.00000000 0.05000000 0.45000000 0.13333333 0.08333333 0.41666667 0.30000000
##      SBS15     SBS17a     SBS17b     SBS18     SBS20     SBS21     SBS26
## 0.21666667 0.05000000 0.06666667 0.06666667 0.70000000 0.06666667 0.68333333
##      SBS40     SBS41     SBS44
## 0.11666667 0.05000000 0.26666667

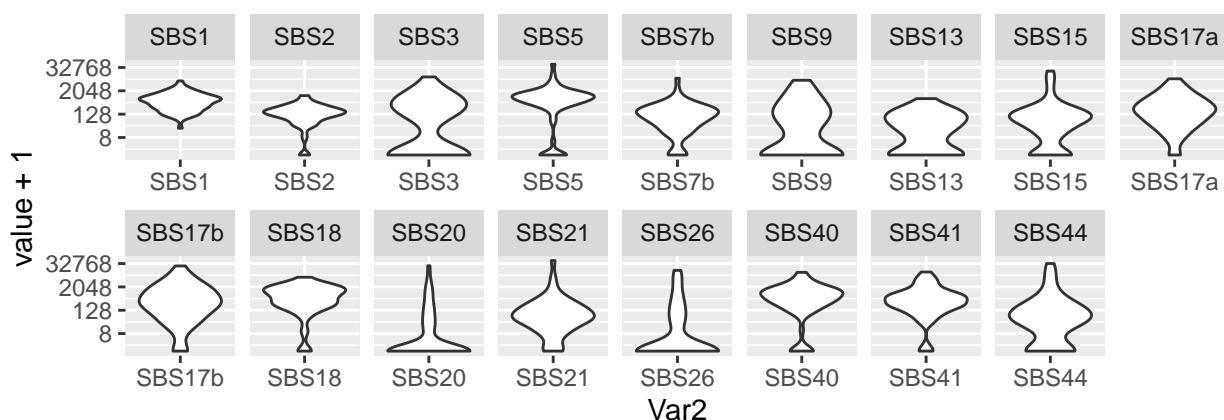
```

```
colSums(obj_Stomach_AdenoCA$Y) / sum(obj_Stomach_AdenoCA$Y)
```

```

##      SBS1      SBS2      SBS3      SBS5      SBS7b      SBS9
## 0.060565293 0.014095732 0.036577106 0.141513807 0.023236523 0.033484479
##      SBS13     SBS15     SBS17a     SBS17b     SBS18     SBS20
## 0.005394089 0.054607746 0.047754477 0.106132160 0.070925941 0.041749297
##      SBS21     SBS26     SBS40     SBS41     SBS44
## 0.074860849 0.047217740 0.084139891 0.076236383 0.081508486

```

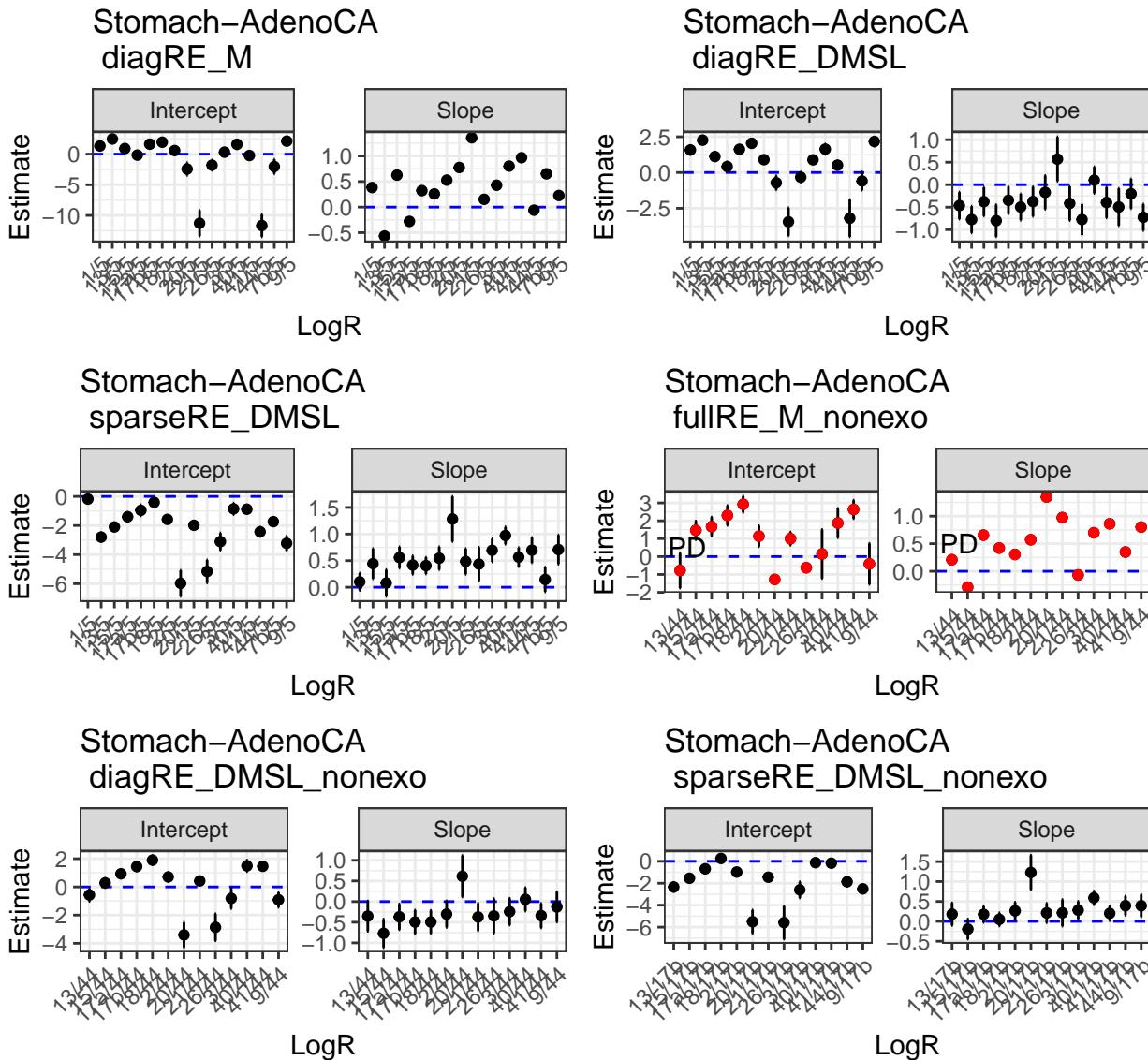


- Removing SBS20, SBS26, fullM still hasn't converged

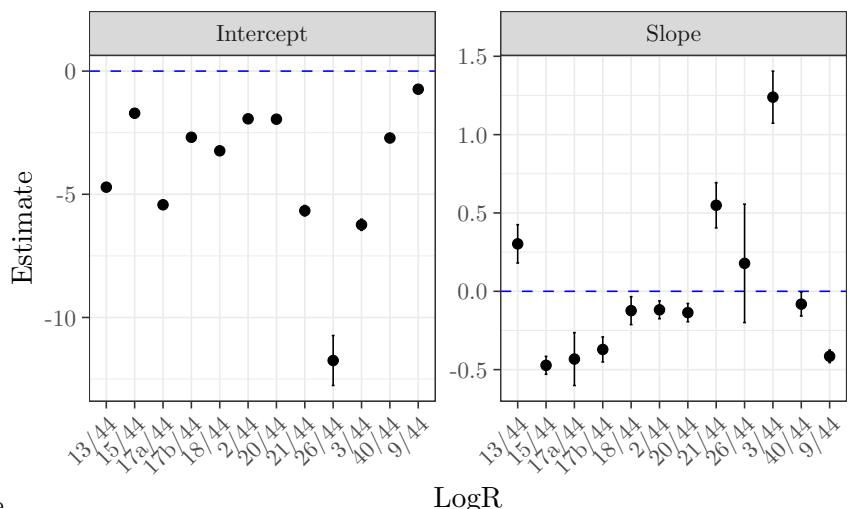
- Removing SBS20, SBS26, SBS9 fullM still hasn't converged
- Removing SBS20, SBS26, SBS9, SBS13 fullM still hasn't converged
- Removing SBS20, SBS26, SBS9, SBS13, SBS44 fullM still hasn't converged

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced
```

### Betas



## Stomach-AdenoCA diagRE DMSL non-exogenous



Difficult to see the labels, so I replot it here

We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of 0.047603.

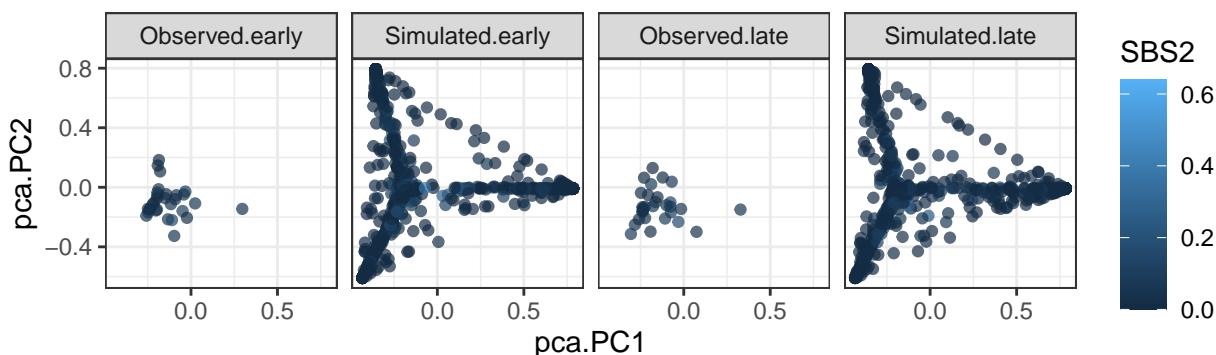
### Covariance matrices

I do not include this section as I have had to use only diagonal matrices.

### Simulation under inferred data

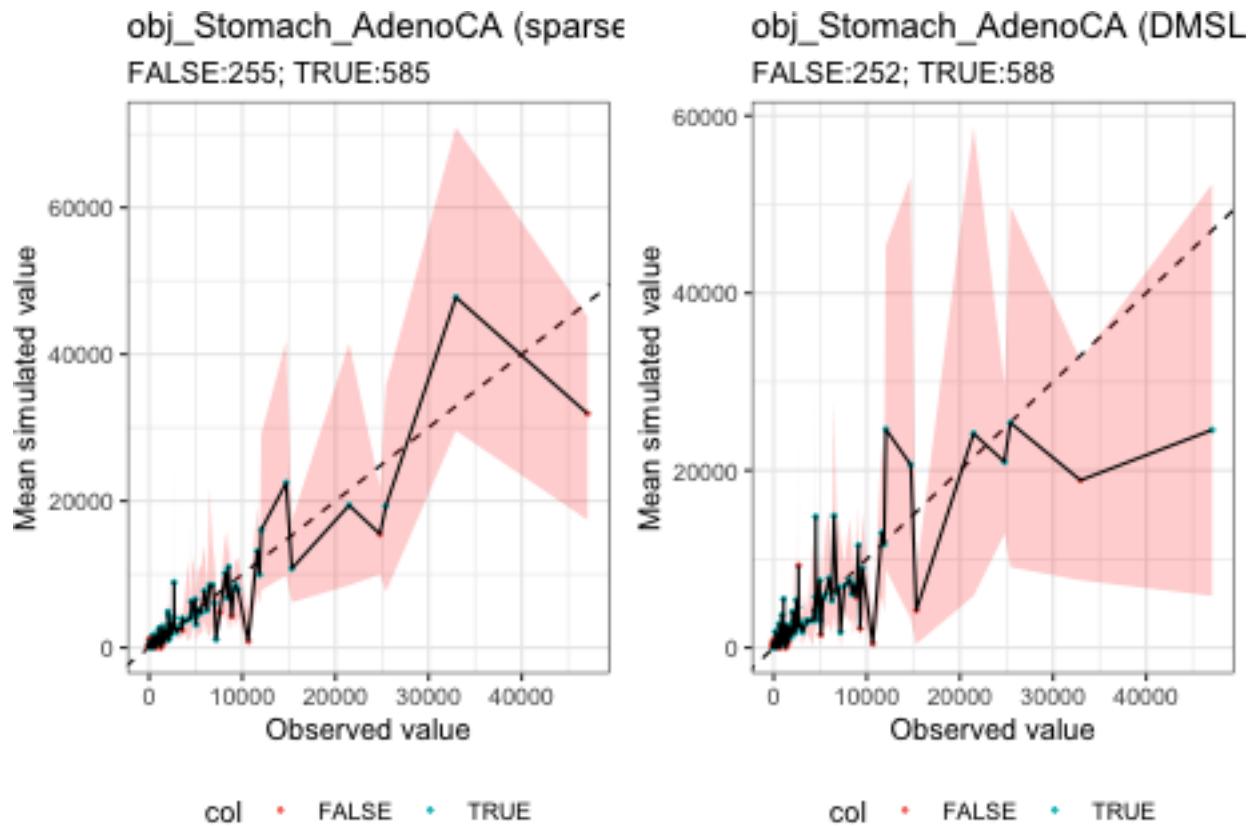
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

### Simulation of Stomach–AdenoCA samples



### Ranked plot for coverage

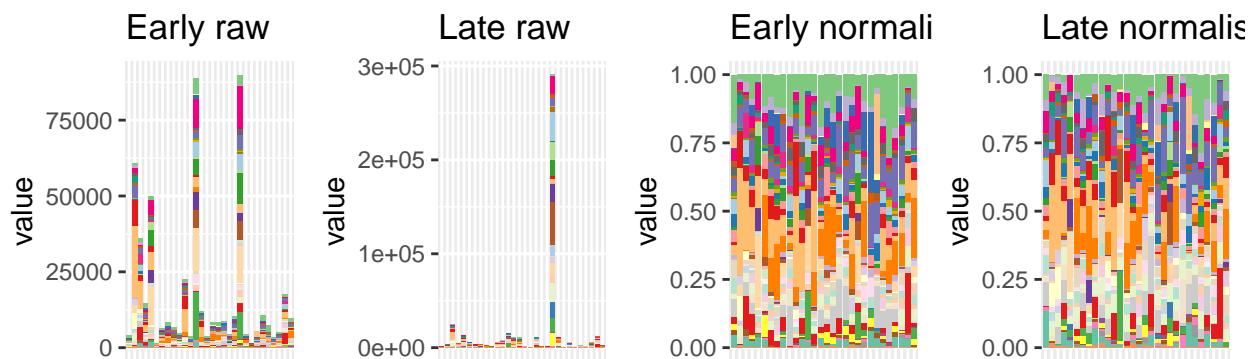
Comparing for now only diagRE\_DMSL\_nonexo and sparse for nonexo. The blue/red dots seem to behave incorrectly.



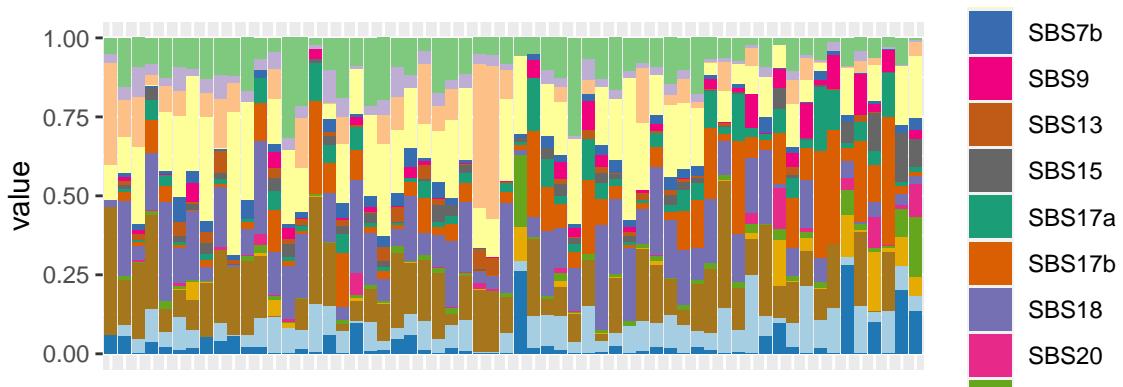
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 30
```



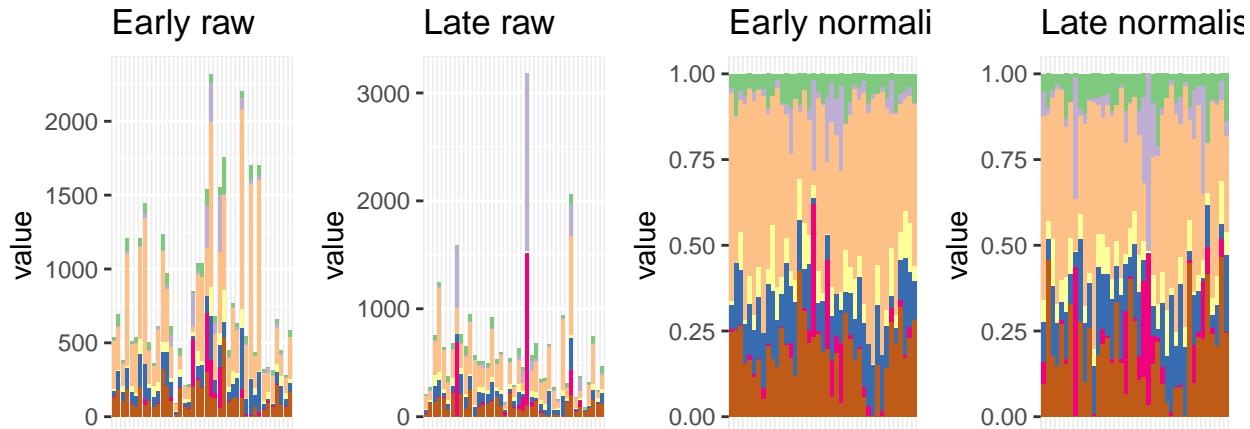
Exposures sorted by increasing number of mutations: there is no clear trend of signatures being associated with the number of mutations.



## Thy-AdenoCA

### Barplot and general statistics

```
## [1] 41
```



The number of samples and signatures is:

```
## [1] 82 7
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS5"  "SBS6"  "SBS8"  "SBS13" "SBS40"
```

### Convergence table

These are the results for the convergence of models fits. Practically everything timed-out.

|      |             |                                  | L2      | L1               |
|------|-------------|----------------------------------|---------|------------------|
| ## 1 | Thy-AdenoCA | hessian_positivedefinite_bool    |         | diagRE_M         |
| ## 2 | Thy-AdenoCA | hessian_positivedefinite_bool    |         | fullRE_M         |
| ## 3 | Thy-AdenoCA | hessian_positivedefinite_bool    |         | diagRE_DMDL      |
| ## 4 | Thy-AdenoCA |                                  | Timeout | fullRE_halfDM    |
| ## 5 | Thy-AdenoCA | hessian_nonpositivedefinite_bool |         | fullRE_DMDL      |
| ## 6 | Thy-AdenoCA | hessian_positivedefinite_bool    |         | diagRE_DMSL      |
| ## 7 | Thy-AdenoCA | hessian_positivedefinite_bool    |         | sparseRE_DMSL    |
| ## 8 | Thy-AdenoCA |                                  | Timeout | fullRE_DMSL      |
| ## 9 | Thy-AdenoCA |                                  | Timeout | fullRE_DMSL_SBS1 |

```

## 10 Thy-AdenoCA           Timeout           fullRE_M_nonexo
## 11 Thy-AdenoCA   hessian_positivedefinite_bool diagRE_DMSL_nonexo
## 12 Thy-AdenoCA   hessian_positivedefinite_bool sparseRE_DMSL_nonexo
## 13 Thy-AdenoCA           Timeout           fullRE_DMSL_nonexo
## 14 Thy-AdenoCA           Timeout           fullRE_DMDL_nonexo
## 15 Thy-AdenoCA           Timeout fullRE_DMDL_sortednonexo

```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo do not converge, even though there aren't many signatures:

```
## [1] FALSE
```

### Potentially problematic signatures

We explore whether there are problematic signatures:

```
colSums(obj_Thy_AdenoCA$Y == 0) / nrow(obj_Thy_AdenoCA$Y)
```

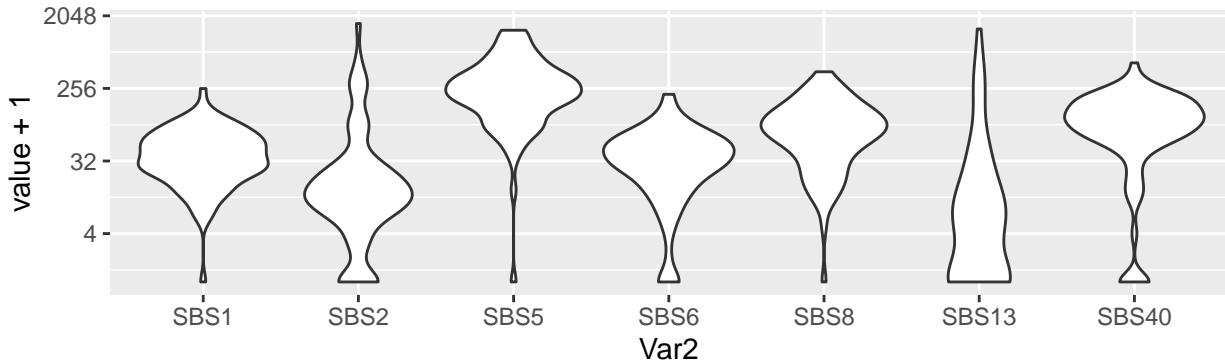
```
##      SBS1      SBS2      SBS5      SBS6      SBS8      SBS13     SBS40
```

```
## 0.01219512 0.12195122 0.01219512 0.06097561 0.01219512 0.35365854 0.07317073
```

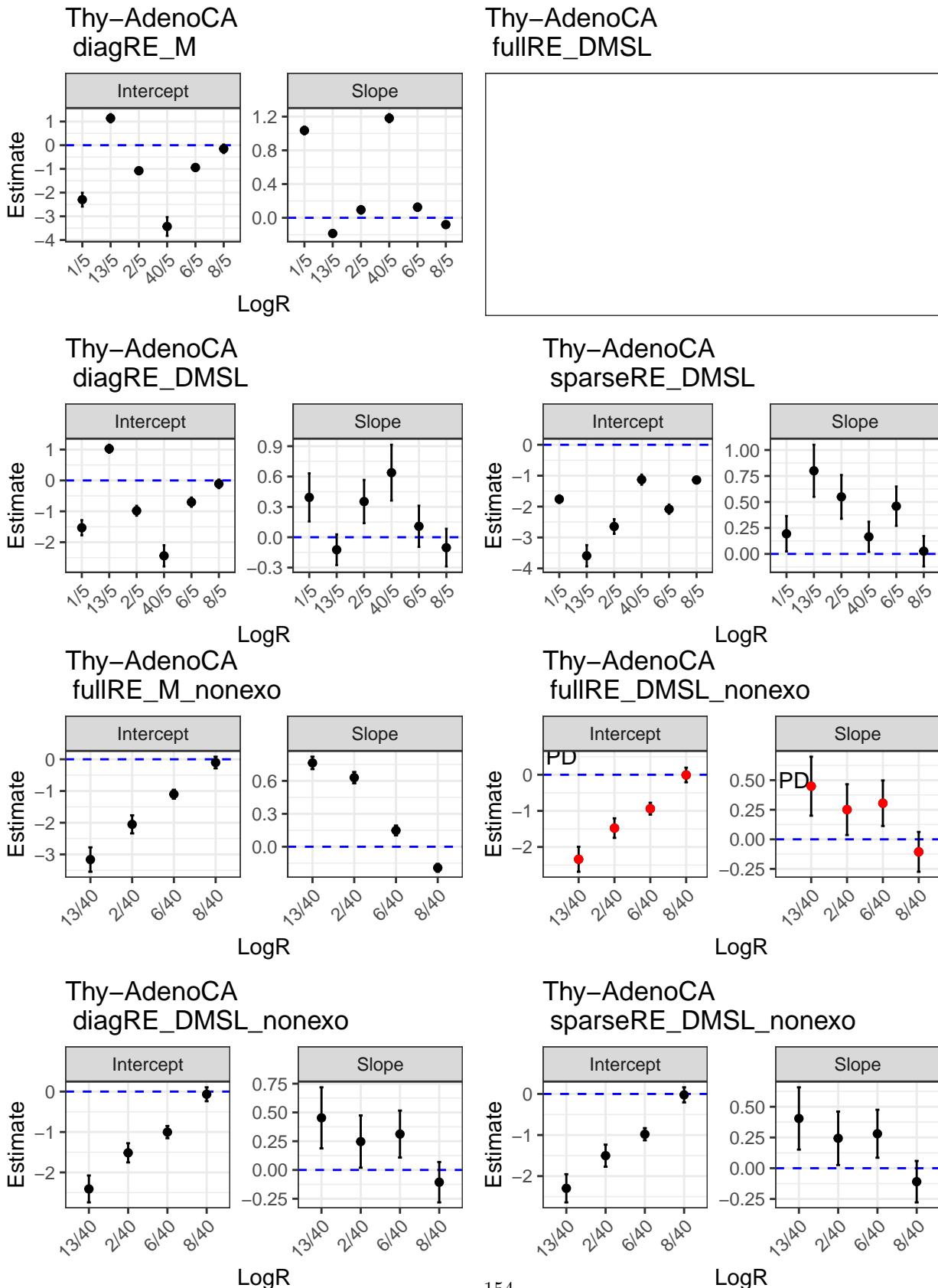
```
colSums(obj_Thy_AdenoCA$Y) / sum(obj_Thy_AdenoCA$Y)
```

```
##      SBS1      SBS2      SBS5      SBS6      SBS8      SBS13     SBS40
```

```
## 0.06120959 0.08303459 0.44489809 0.05581557 0.12930691 0.07239594 0.15333931
```



## Betas



We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of 0.1064332.

### Covariance matrices

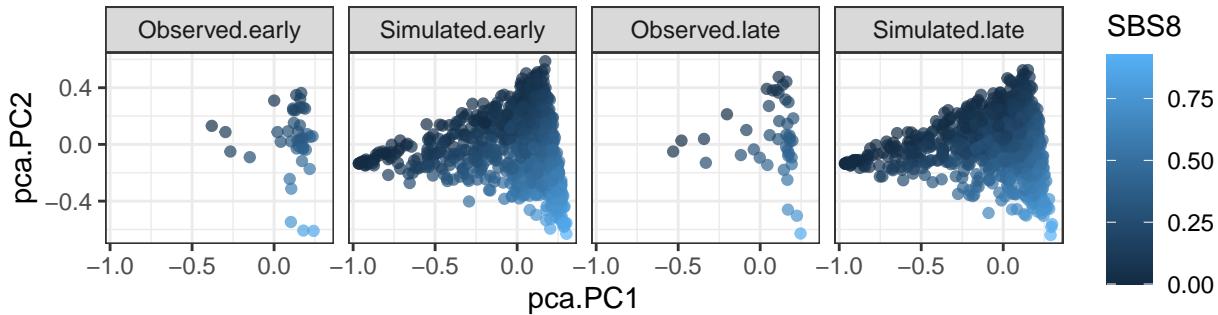
I do not include those.

### Simulation under inferred data

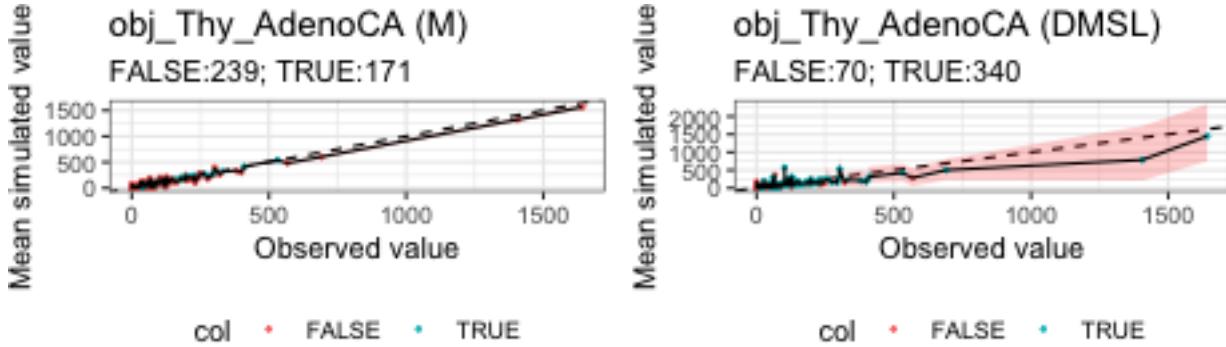
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

### Simulation of Thy–AdenoCA samples



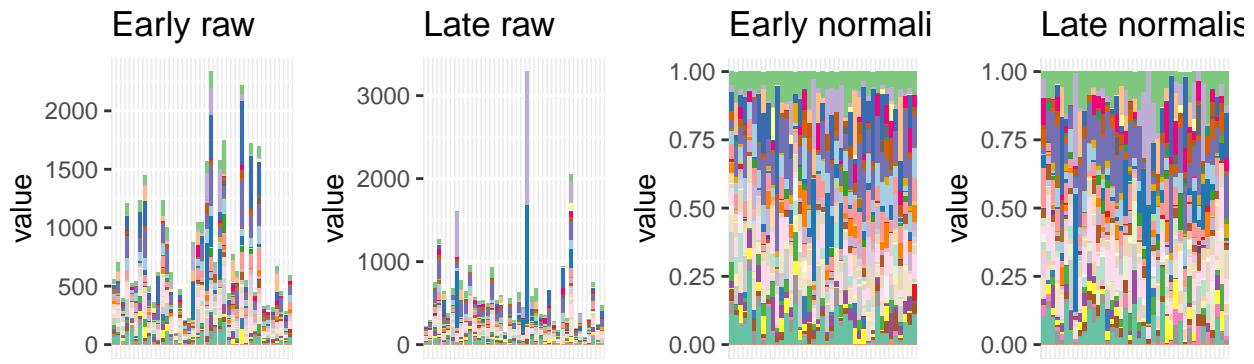
### Ranked plot for coverage



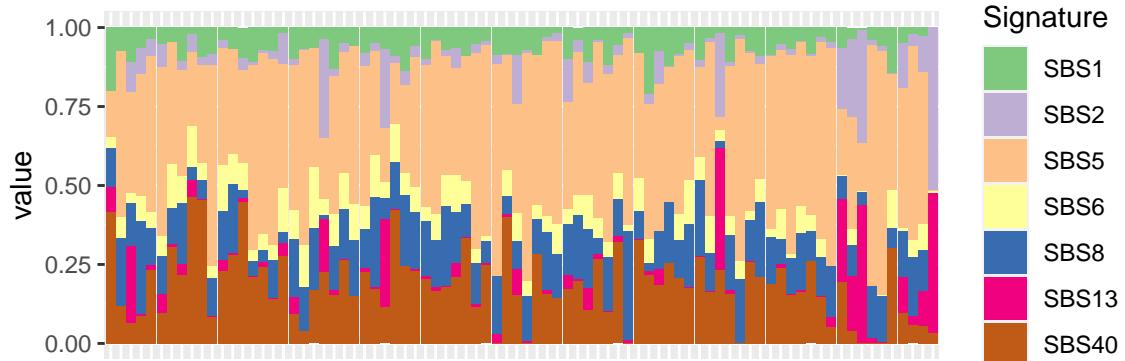
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 41
```



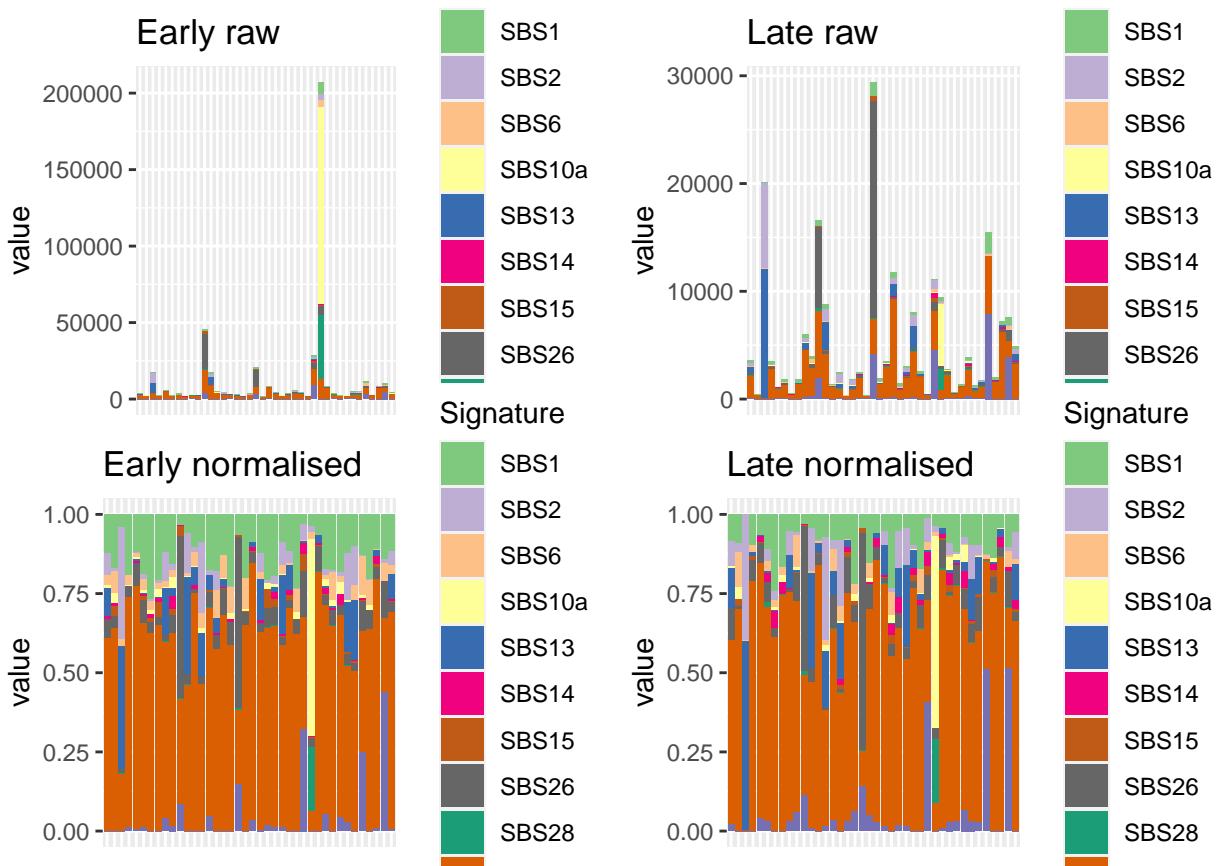
Exposures sorted by increasing number of mutations: there is no trend of signatures being associated with the number of mutations.



## Uterus-AdenoCA

### Barplot and general statistics

```
## [1] 40
```



The number of samples and signatures is:

```
## [1] 82 7
```

The signatures are:

```
## [1] "SBS1"  "SBS2"  "SBS5"  "SBS6"  "SBS8"  "SBS13" "SBS40"
```

### Convergence table

These are the results for the convergence of models fits. Almost everything has converged.

| ##    | value   | L2      | L1                   |
|-------|---|---------|----------------------|
| ## 1  | Uterus-AdenoCA hessian_nonpositivedefinite_bool |         | diagRE_M             |
| ## 2  | Uterus-AdenoCA hessian_nonpositivedefinite_bool |         | fullRE_M             |
| ## 3  | Uterus-AdenoCA hessian_nonpositivedefinite_bool |         | diagRE_DMDL          |
| ## 4  | Uterus-AdenoCA                                  | Timeout | fullRE_halfDM        |
| ## 5  | Uterus-AdenoCA hessian_nonpositivedefinite_bool |         | fullRE_DMDL          |
| ## 6  | Uterus-AdenoCA hessian_positivedefinite_bool    |         | diagRE_DMSL          |
| ## 7  | Uterus-AdenoCA hessian_positivedefinite_bool    |         | sparseRE_DMSL        |
| ## 8  | Uterus-AdenoCA                                  | Timeout | fullRE_DMSL          |
| ## 9  | Uterus-AdenoCA hessian_nonpositivedefinite_bool |         | fullRE_DMSL_SBS1     |
| ## 10 | Uterus-AdenoCA hessian_positivedefinite_bool    |         | fullRE_M_nonexo      |
| ## 11 | Uterus-AdenoCA hessian_positivedefinite_bool    |         | diagRE_DMSL_nonexo   |
| ## 12 | Uterus-AdenoCA hessian_positivedefinite_bool    |         | sparseRE_DMSL_nonexo |
| ## 13 | Uterus-AdenoCA                                  | Timeout | fullRE_DMSL_nonexo   |

```
## 14 Uterus-AdenoCA hessian_nonpositivedefinite_bool      fullRE_DMDL_nonexo
## 15 Uterus-AdenoCA    hessian_positivedefinite_bool fullRE_DMDL_sortednonexo
```

### Re-running of fitting

Using fullRE\_M\_nonexo to fit fullRE\_DMSL\_nonexo.

If we use the values of the fullRE M exo as initial values for the fullRE DMSL exo doesn't converge:

```
## [1] FALSE
```

### Potentially problematic signatures

We explore whether there are problematic signatures:

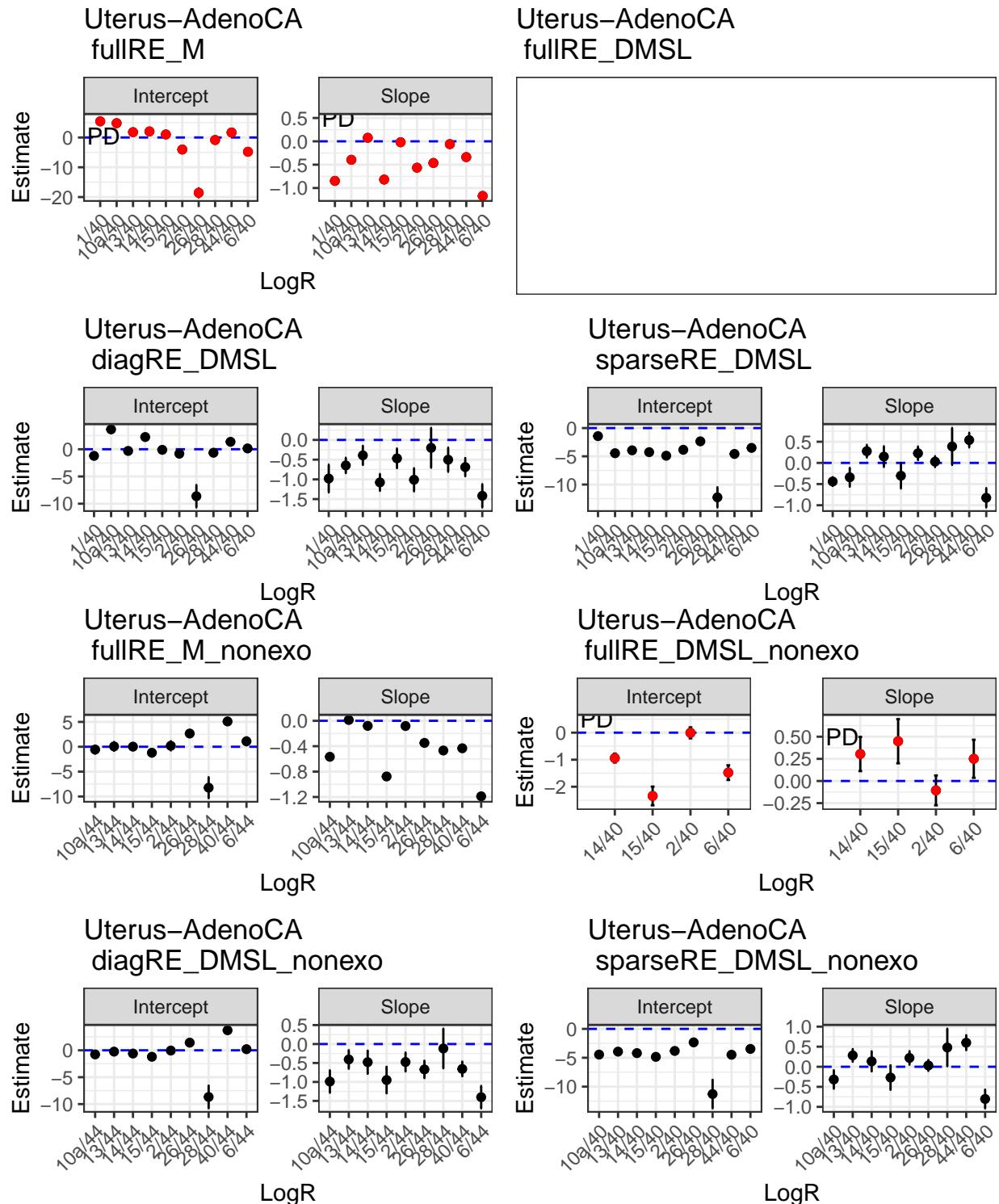
```
colSums(obj_Uterus_AdenoCA$Y == 0)/nrow(obj_Uterus_AdenoCA$Y)
```

```
##      SBS1      SBS2      SBS5      SBS6      SBS8      SBS13     SBS40
## 0.01219512 0.12195122 0.01219512 0.06097561 0.01219512 0.35365854 0.07317073
```

```
colSums(obj_Uterus_AdenoCA$Y)/sum(obj_Uterus_AdenoCA$Y)
```

```
##      SBS1      SBS2      SBS5      SBS6      SBS8      SBS13     SBS40
## 0.06120959 0.08303459 0.44489809 0.05581557 0.12930691 0.07239594 0.15333931
```

## Betas

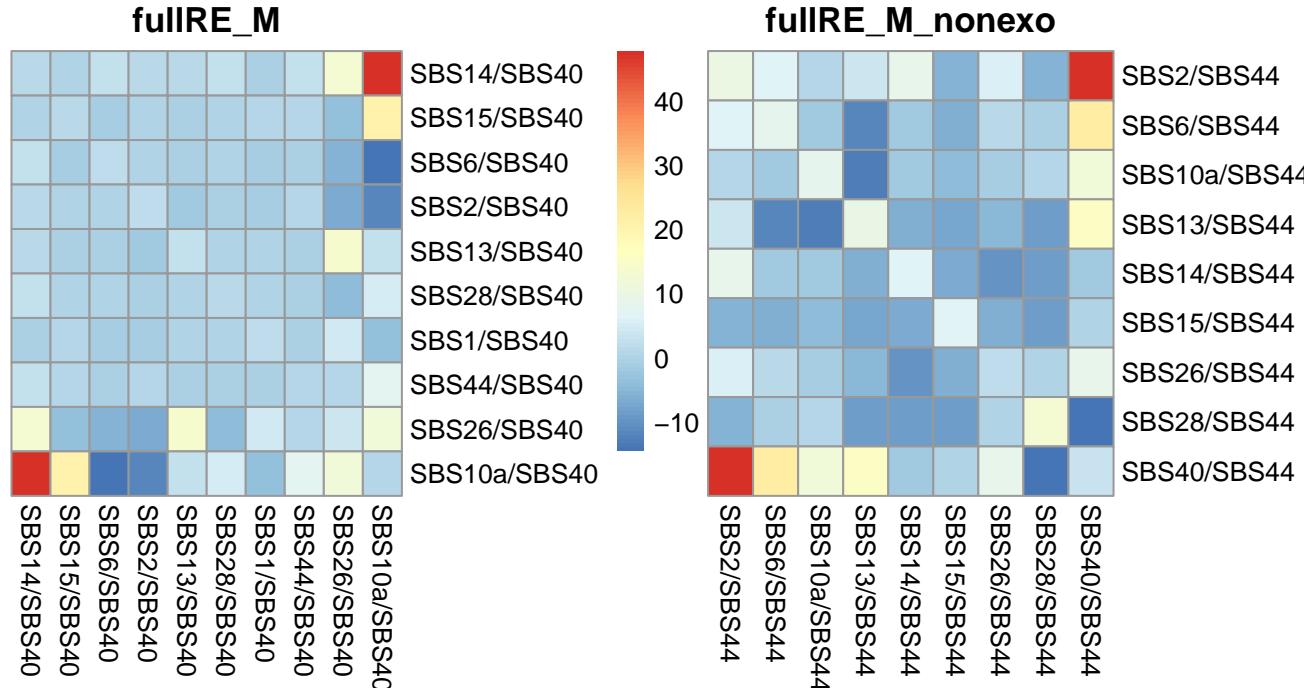


We use the results from the diag RE single lambda DM to test for differential abundance, giving a p-value of  $1.4837739 \times 10^{-4}$ .

## Covariance matrices

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

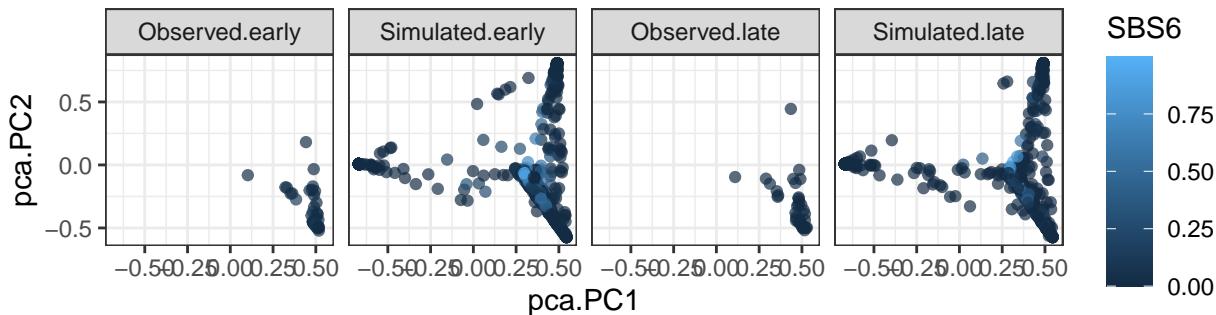


## Simulation under inferred data

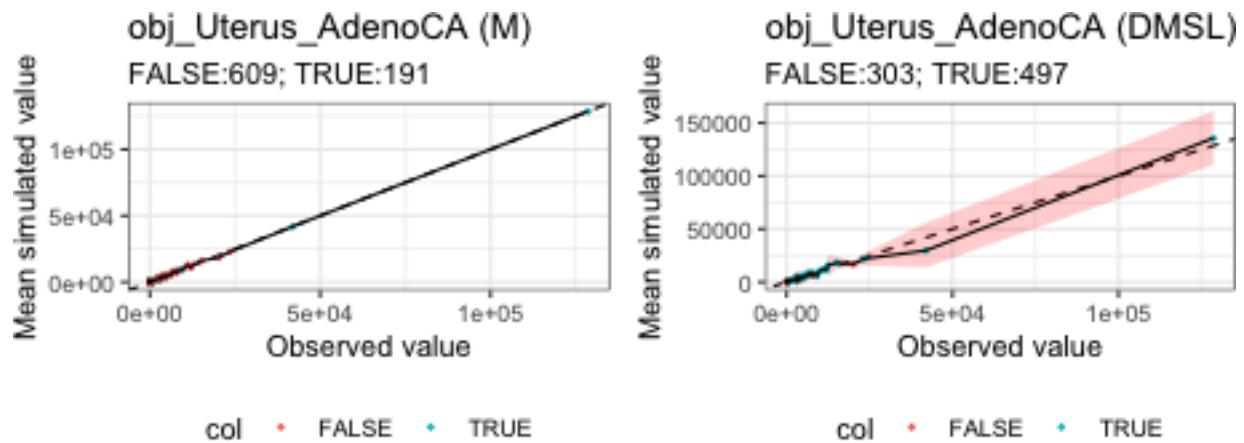
```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec, :
## This function had been incorrect until now (30 july 2021)
```

```
## Warning in fill_covariance_matrix(arg_d = dmin1, arg_entries_var = var_vec_v2, :
## This function had been incorrect until now (30 july 2021)
```

## Simulation of Uterus–AdenoCA samples



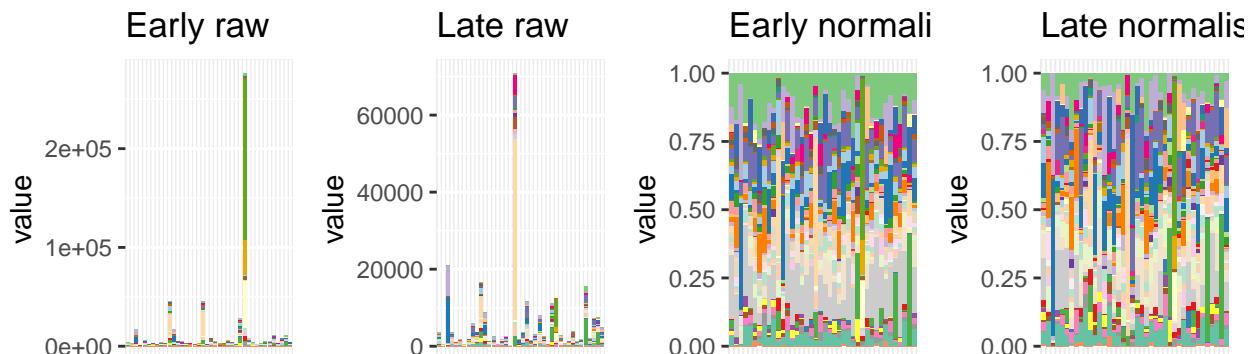
### Ranked plot for coverage



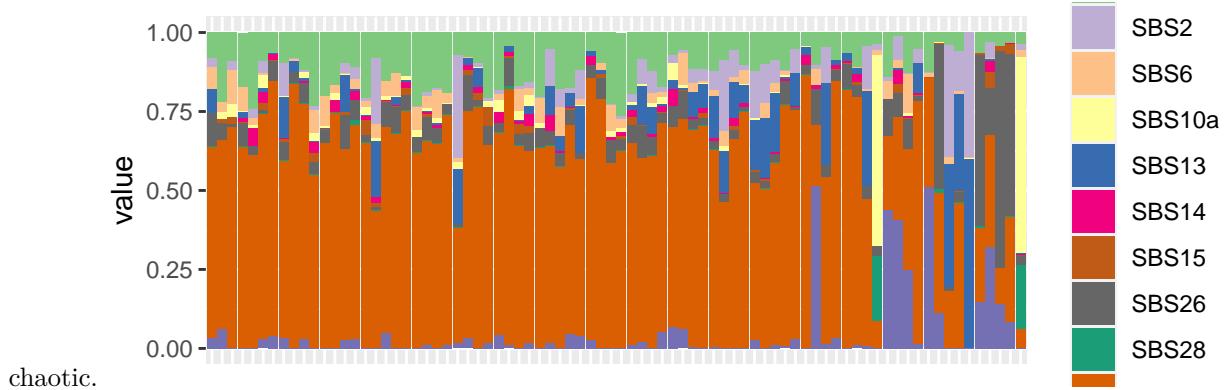
### Signatures from mutSigExtractor

The signatures from mutSigExtractor are as follows:

```
## [1] 40
```



Exposures sorted by increasing number of mutations: there is a trend of hypermutated samples being very



## All p-values for non-exogenous signatures

% latex table generated in R 4.0.3 by xtable 1.8-4 package % Thu Jul 15 14:31:19 2021

| ct |                         | pvalue | model              |
|----|-------------------------|--------|--------------------|
| 1  | Bone-Osteosarc          | 0.00   | diagRE_DMSL_nonexo |
| 2  | Breast-AdenoCA          | 0.00   | diagRE_DMSL_nonexo |
| 3  | Cervix-SCC              | 0.00   | fullRE_DMSL_nonexo |
| 4  | CNS-GBM                 | 0.00   | fullRE_DMSL_nonexo |
| 5  | CNS-Medullo             | 0.07   | fullRE_DMSL_nonexo |
| 6  | CNS-Oligo               | 0.52   | fullRE_DMSL_nonexo |
| 7  | CNS-PiloAstro           | 0.26   | fullRE_DMSL_nonexo |
| 8  | ColoRect-AdenoCA        | 0.00   | diagRE_DMSL_nonexo |
| 9  | Eso-AdenoCA             | 0.00   | diagRE_DMSL_nonexo |
| 10 | Head-SCC                | 0.00   | fullRE_DMSL_nonexo |
| 11 | Kidney-ChRCC            | 0.27   | fullRE_DMSL_nonexo |
| 12 | Kidney-RCC.clearcell    | 0.00   | fullRE_DMSL_nonexo |
| 13 | Kidney-RCC.papillary    | 0.00   | fullRE_DMSL_nonexo |
| 14 | Liver-HCC               | 0.00   | fullRE_DMSL_nonexo |
| 15 | Lung-AdenoCA            | 0.00   | diagRE_DMSL_nonexo |
| 16 | Lung-SCC                | 0.03   | diagRE_DMSL_nonexo |
| 17 | Lymph-BNHL              | 0.00   | fullRE_DMSL_nonexo |
| 18 | Lymph-CLL               | 0.00   | fullRE_DMSL_nonexo |
| 19 | Myeloid-MPN             | 0.00   | fullRE_DMSL_nonexo |
| 20 | Ovary-AdenoCA           | 0.00   | diagRE_DMSL_nonexo |
| 21 | Panc-AdenoCA            | 0.00   | diagRE_DMSL_nonexo |
| 22 | Panc-Endocrine          | 0.00   | diagRE_DMSL_nonexo |
| 23 | Prost-AdenoCA           | 0.00   | diagRE_DMSL_nonexo |
| 24 | Skin-Melanoma.acral     |        |                    |
| 25 | Skin-Melanoma.cutaneous | 0.06   | fullRE_DMSL_nonexo |
| 26 | Stomach-AdenoCA         | 0.05   | diagRE_DMSL_nonexo |
| 27 | Thy-AdenoCA             | 0.11   | diagRE_DMSL_nonexo |
| 28 | Uterus-AdenoCA          | 0.00   | diagRE_DMSL_nonexo |

## All p-values

% latex table generated in R 4.0.3 by xtable 1.8-4 package % Thu Jul 15 14:13:08 2021

## Correlation between p-values and number of samples

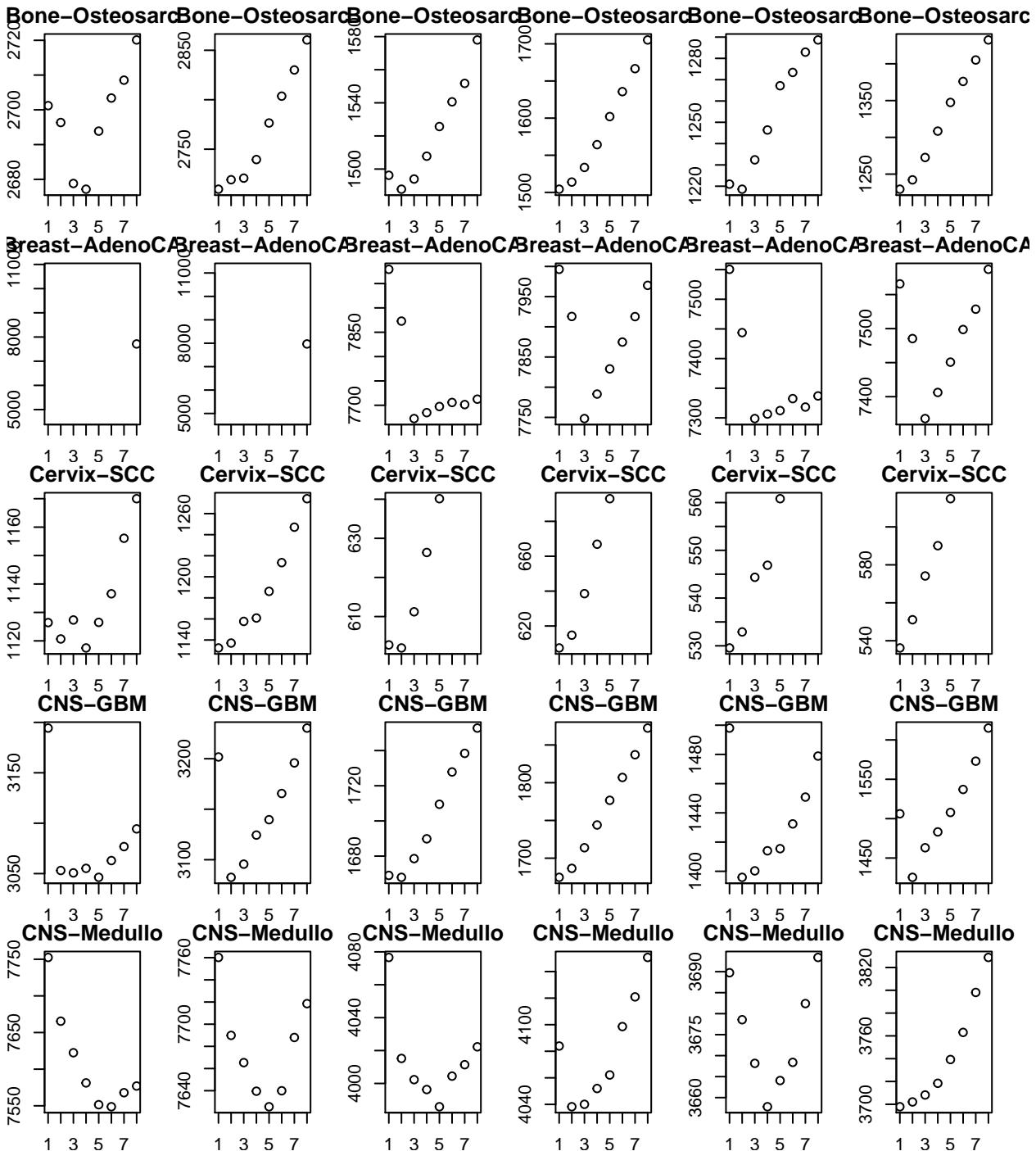
|                         | pvals_fullRE_M | pvals_diagRE_DM | pvals_DM | pvals_DMnonexo |
|-------------------------|----------------|-----------------|----------|----------------|
| Bone-Osteosarc          | 0.00           | 0.00            | 0.00     |                |
| Breast-AdenoCA          | 0.00           | 0.00            | 0.00     | 0.00           |
| Cervix-SCC              | 0.00           | 0.11            | 0.12     | 0.01           |
| CNS-GBM                 | 0.00           | 0.00            | 0.03     | 0.00           |
| CNS-Medullo             | 0.00           | 0.02            | 0.02     | 0.47           |
| CNS-Oligo               | 0.00           | 0.03            | 0.03     |                |
| CNS-PiloAstro           | 0.00           | 0.03            | 0.03     | 0.64           |
| ColoRect-AdenoCA        | 0.00           | 0.00            | 0.00     | 0.00           |
| Eso-AdenoCA             | 0.00           | 0.00            | 0.00     | 0.00           |
| Head-SCC                | 0.00           | 0.00            | 0.00     | 0.00           |
| Kidney-ChRCC            | 0.00           | 0.00            | 0.00     | 0.64           |
| Kidney-RCC.clearcell    | 0.00           | 0.00            | 0.00     | 0.00           |
| Kidney-RCC.papillary    | 0.00           | 0.00            | 0.00     | 0.00           |
| Liver-HCC               | 0.00           | 0.00            | 0.00     | 0.00           |
| Lung-AdenoCA            | 0.00           | 0.01            | 0.00     | 0.01           |
| Lung-SCC                | 0.00           | 0.00            | 0.00     | 0.17           |
| Lymph-BNHL              | 0.00           | 0.00            | 0.00     | 0.00           |
| Lymph-CLL               | 0.00           | 0.00            | 0.00     |                |
| Myeloid-MPN             | 0.00           | 0.00            | 0.00     |                |
| Ovary-AdenoCA           | 0.00           | 0.00            | 0.00     | 0.00           |
| Panc-AdenoCA            | 0.00           | 0.00            | 0.00     | 0.00           |
| Panc-Endocrine          | 0.00           | 0.00            | 0.00     | 0.00           |
| Prost-AdenoCA           | 0.00           | 0.00            | 0.00     | 0.00           |
| Skin-Melanoma.acral     | 0.00           | 0.18            | 0.15     |                |
| Skin-Melanoma.cutaneous | 0.00           | 0.00            | 0.00     |                |
| Stomach-AdenoCA         | 0.00           | 0.00            | 0.00     | 0.08           |
| Thy-AdenoCA             | 0.00           | 0.03            | 0.02     | 0.47           |
| Uterus-AdenoCA          | 0.00           | 0.00            | 0.00     | 0.00           |

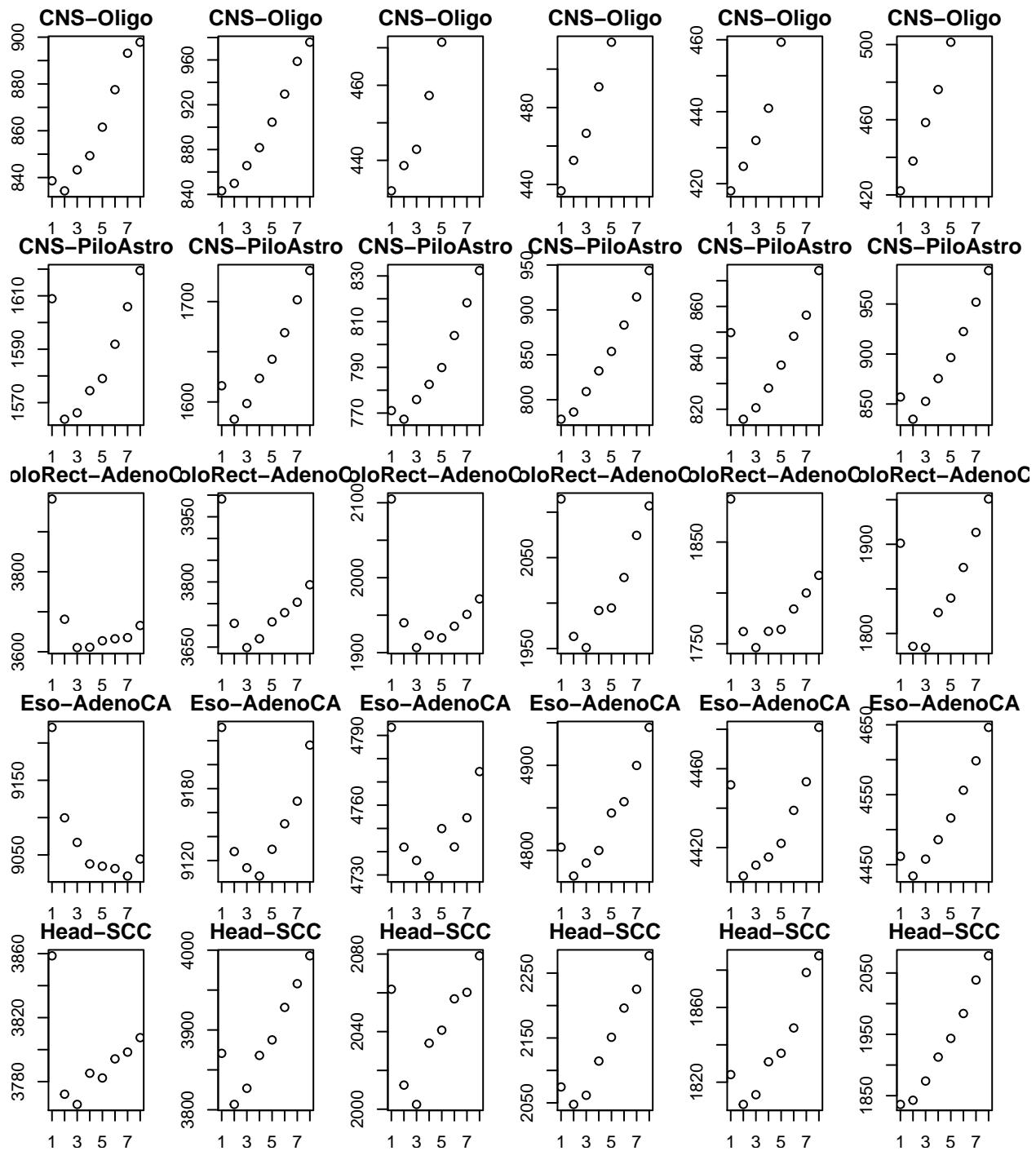
## Dirichlet-Multinomial Mixtures

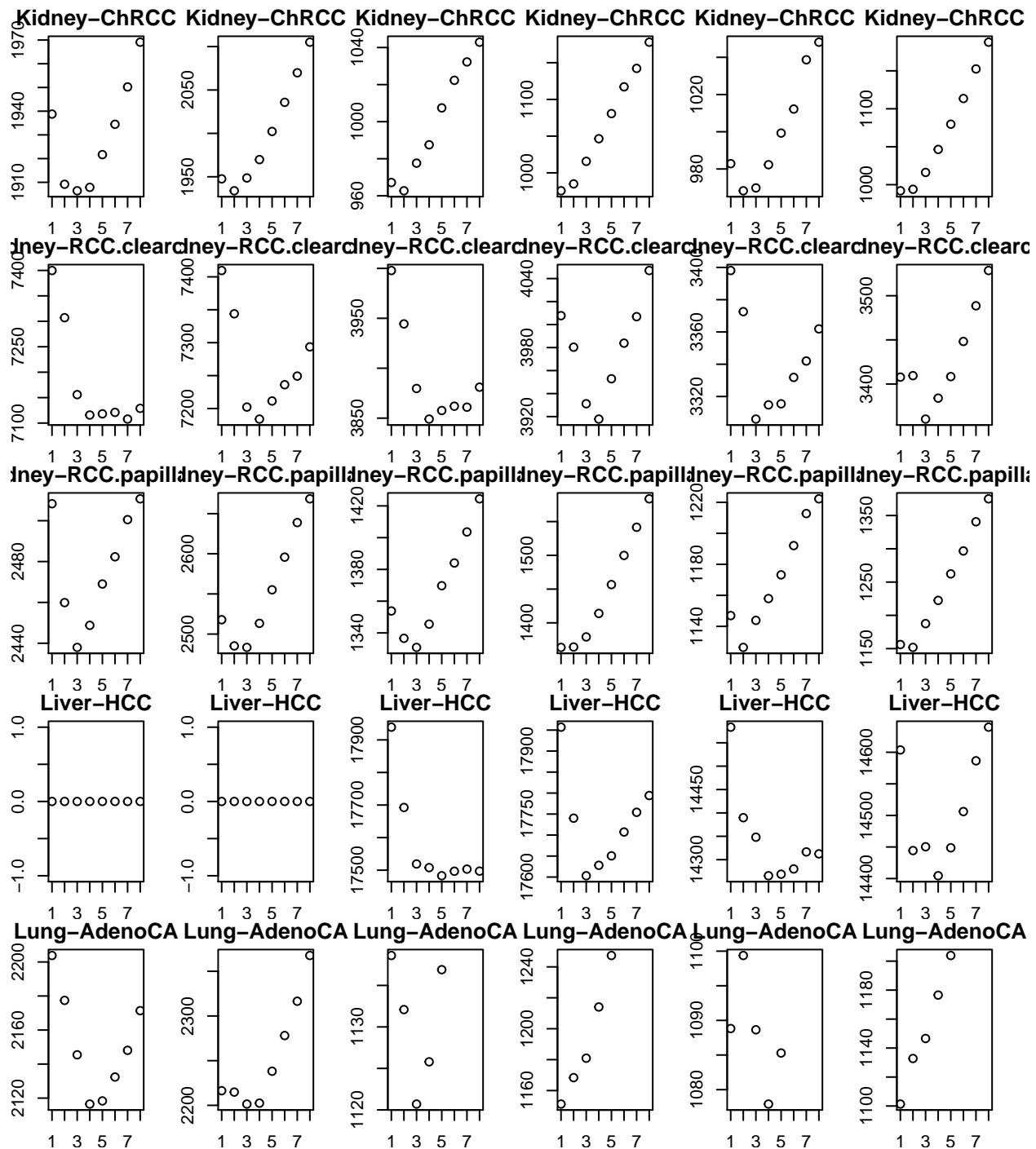
We run the software MicrobeDMMv1.0 to determine whether we are facing DMM mixtures or not.

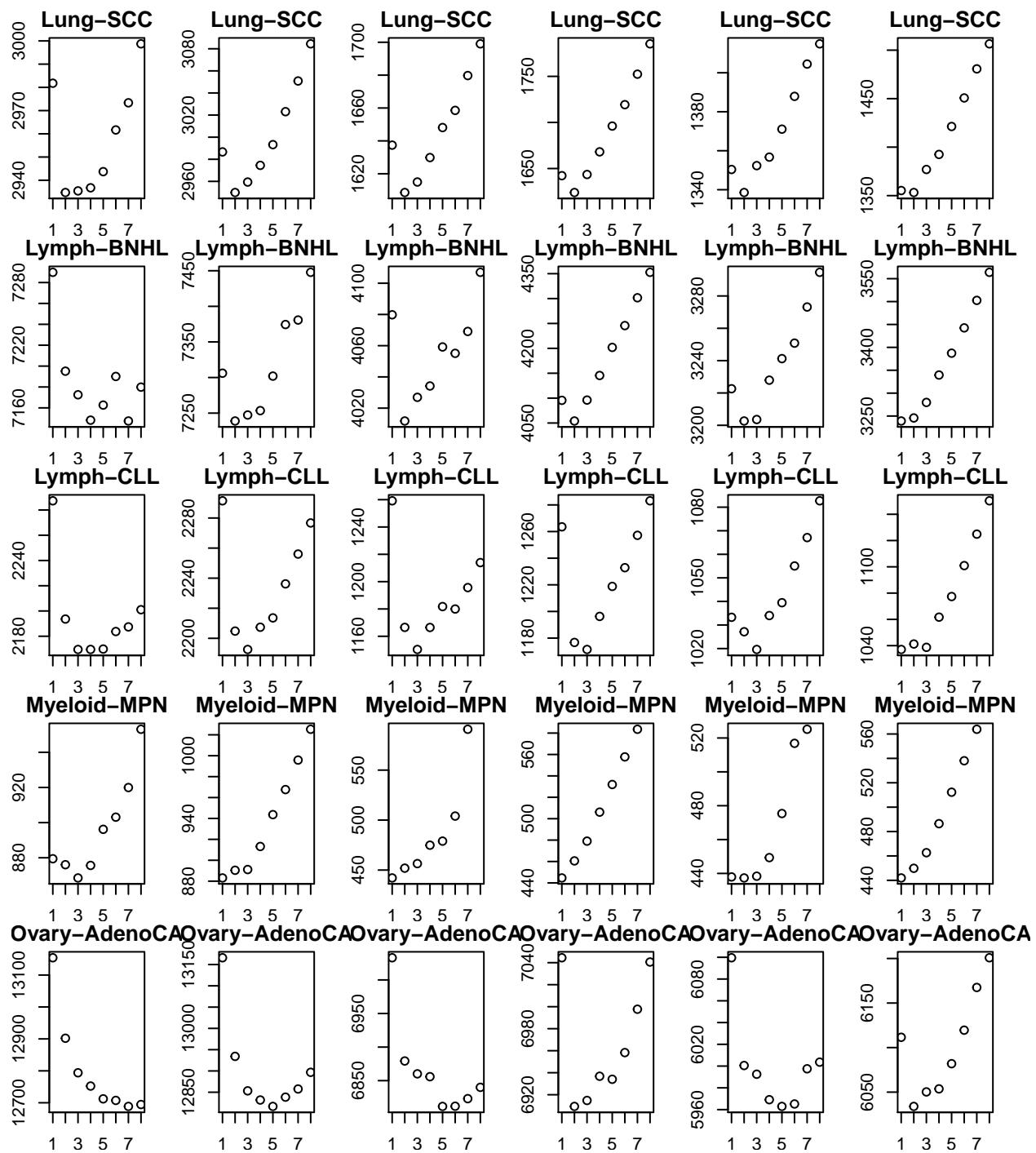
We save the files in two ways: all of the samples - early or not - together, and separately.

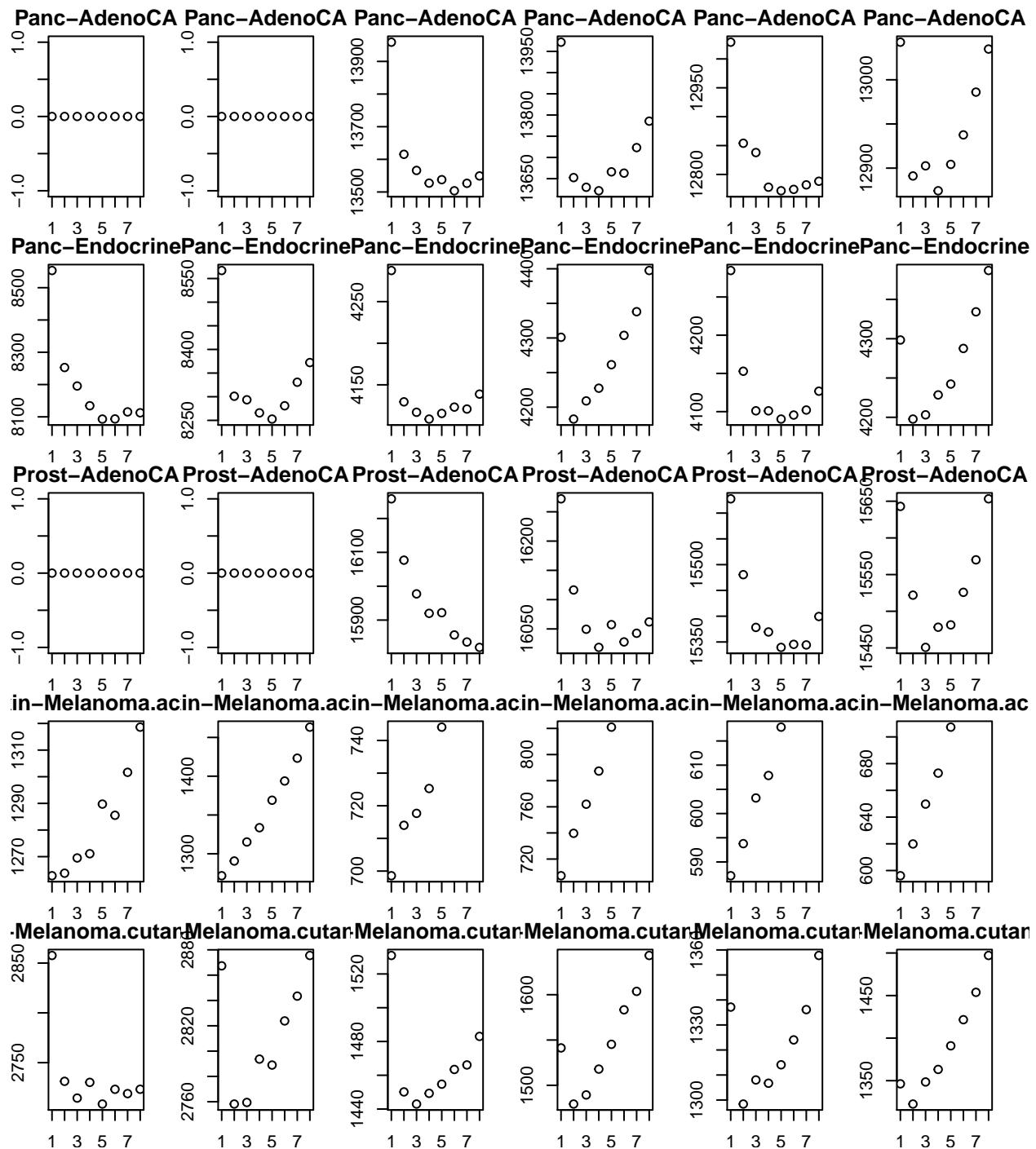
In some cases DMM says that there is an error with the input file - in this case the AIC or BIC is not plotted. If all of them are missing, all BIC and AIC are set to zero.

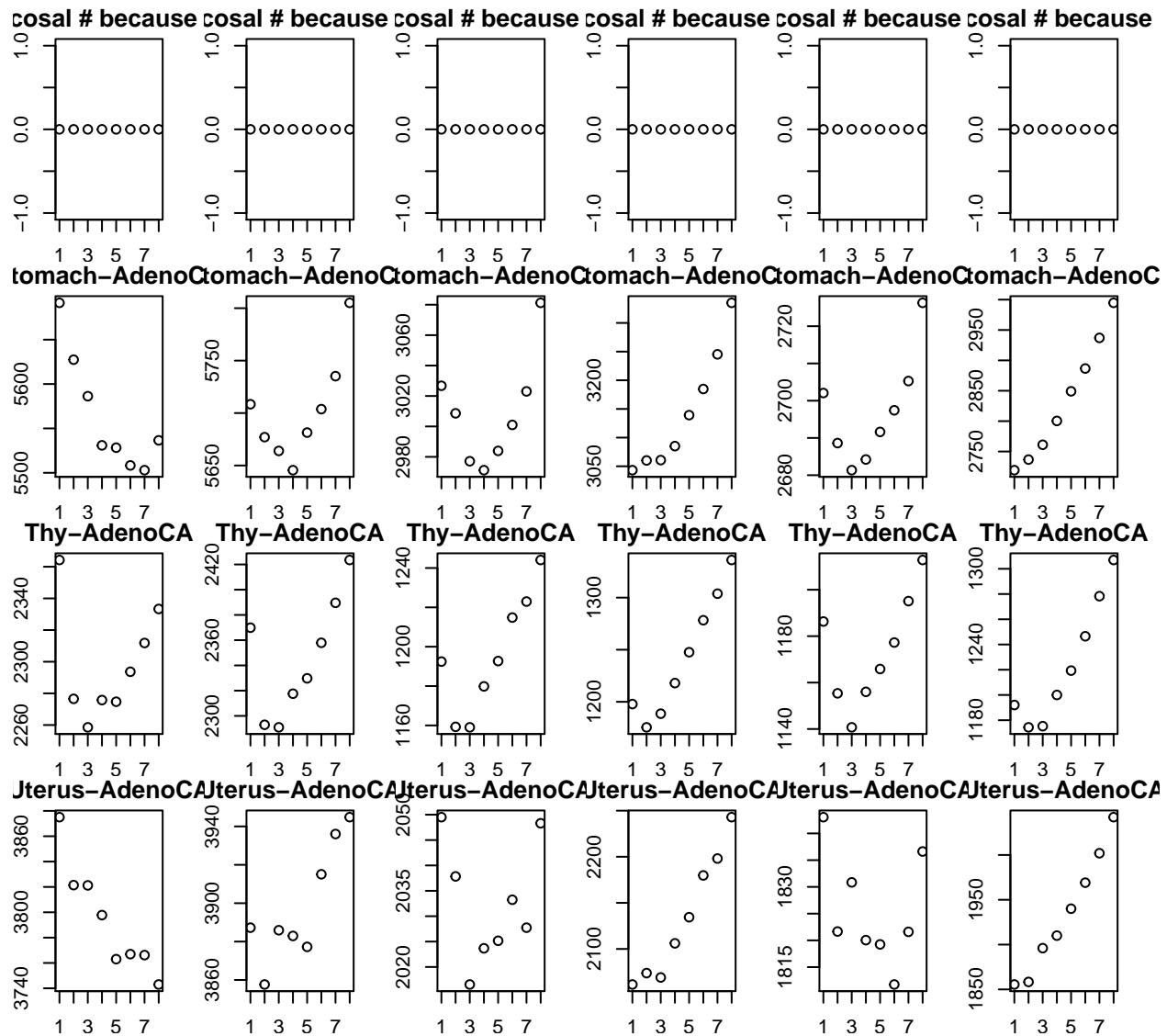




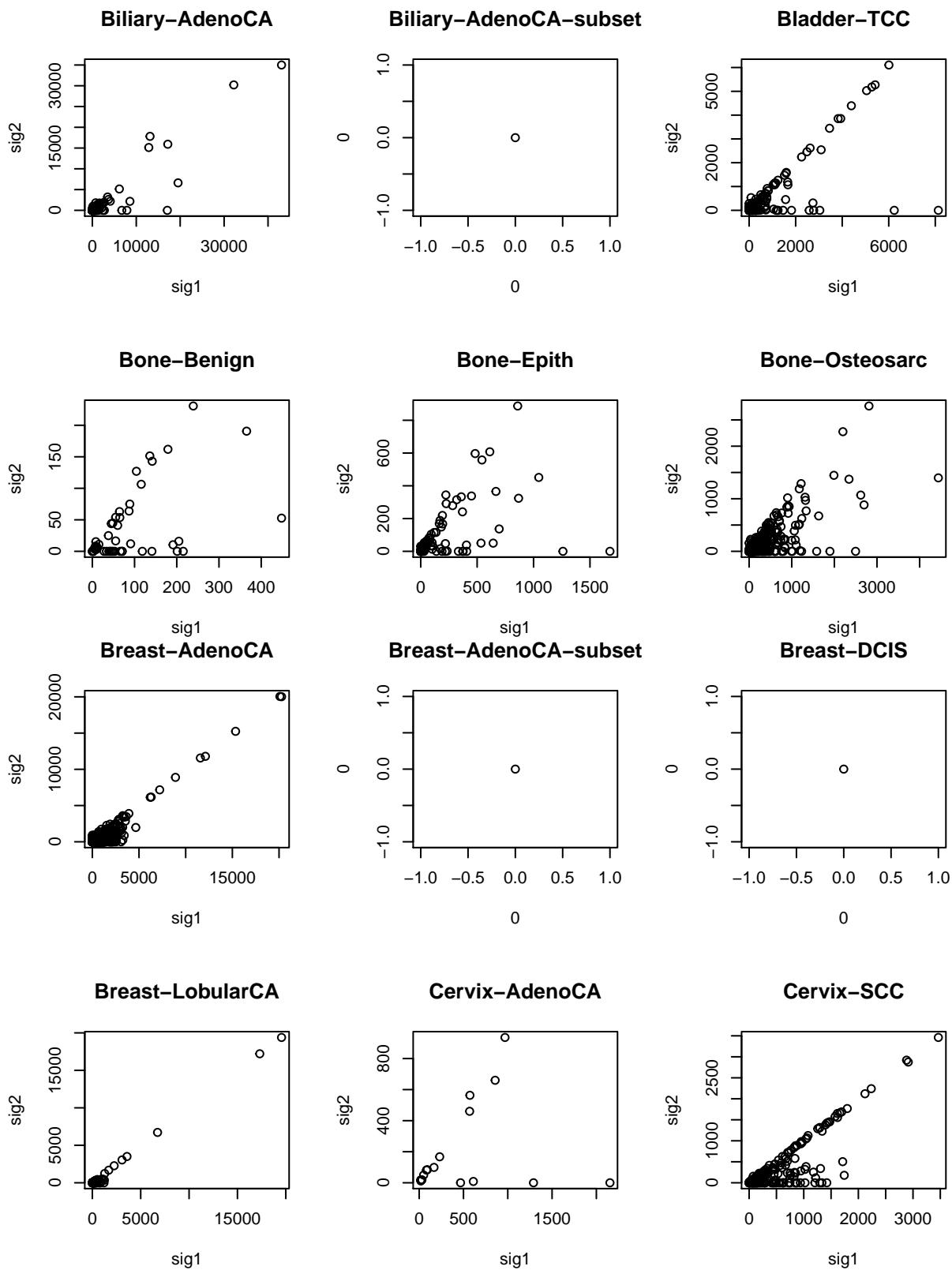


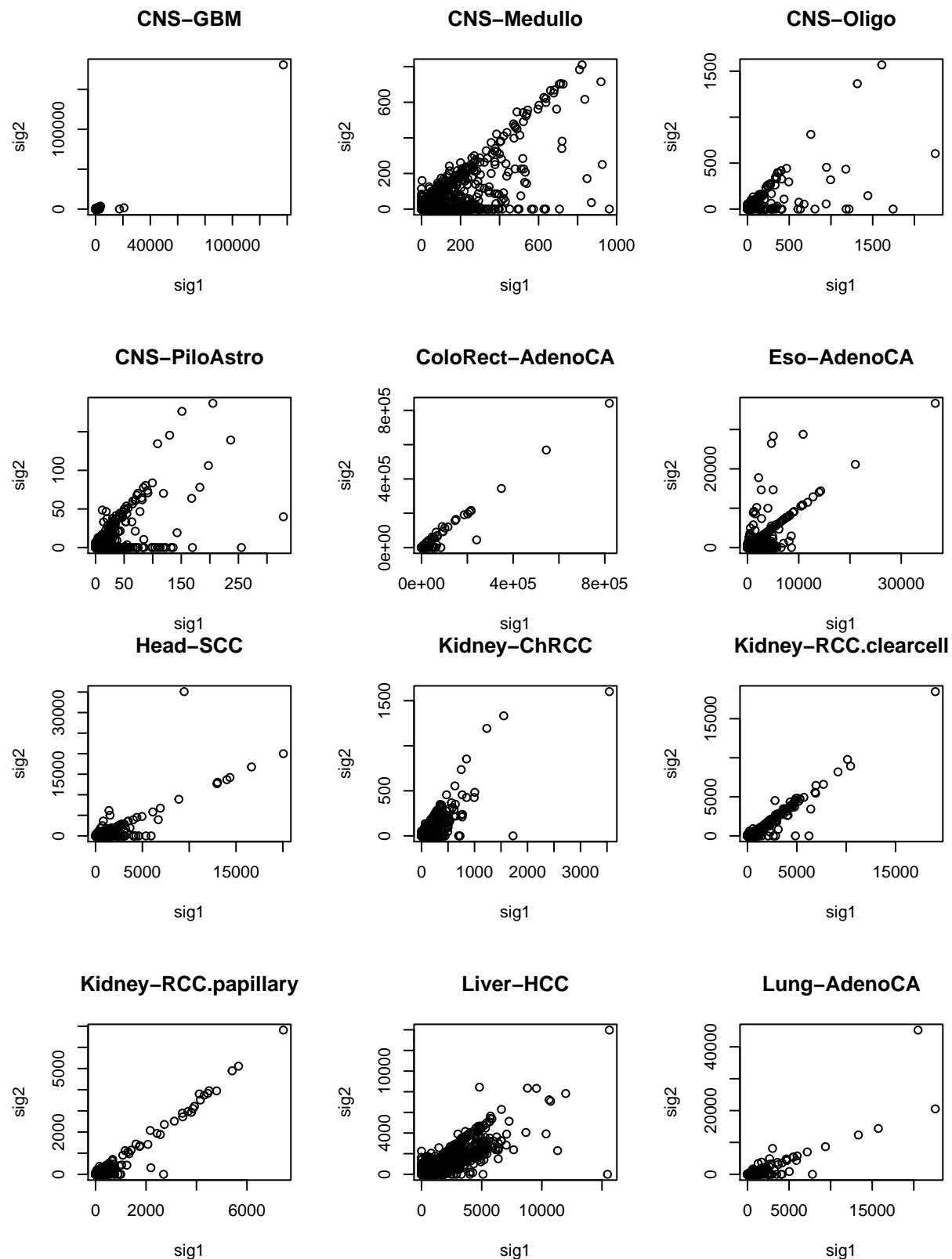


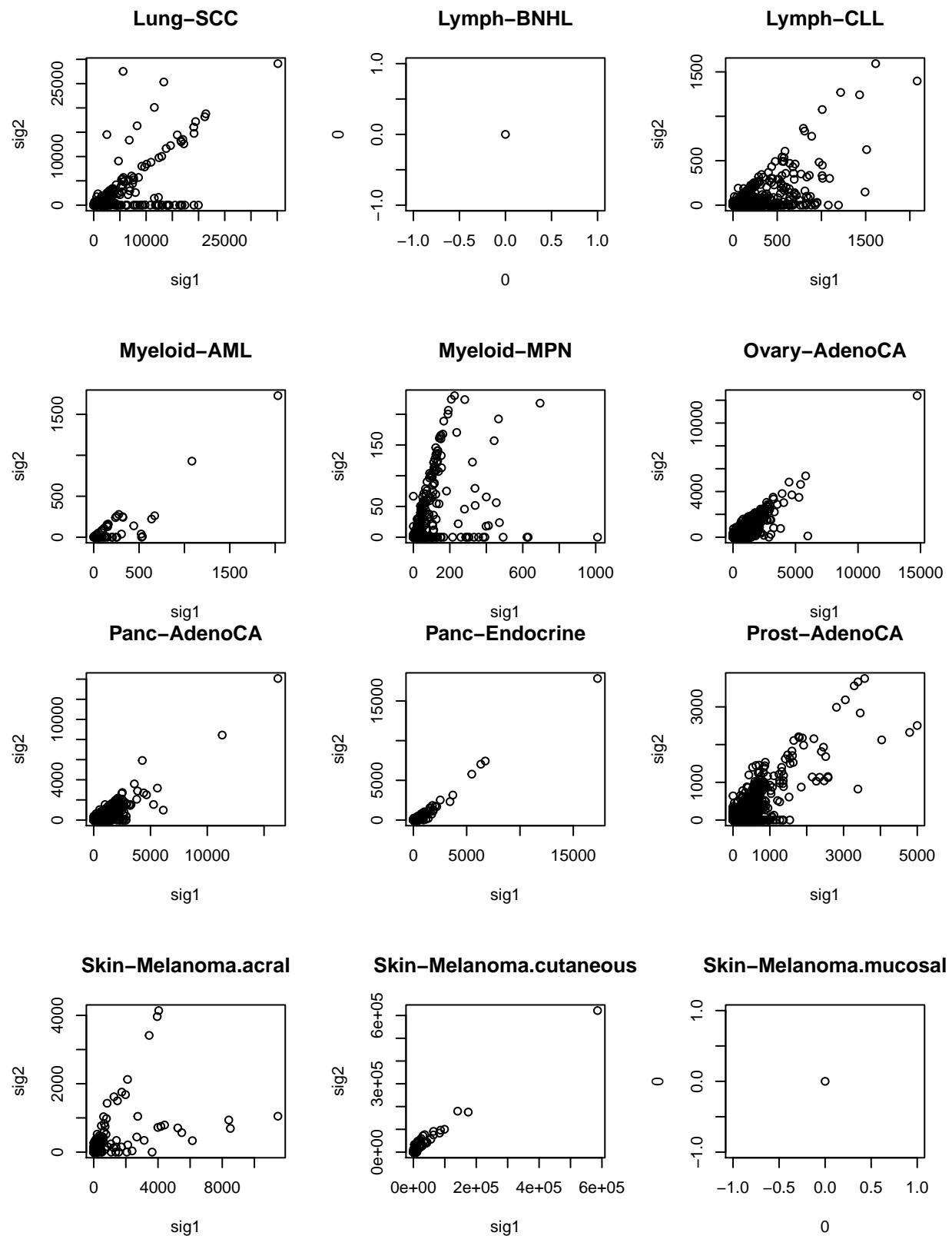


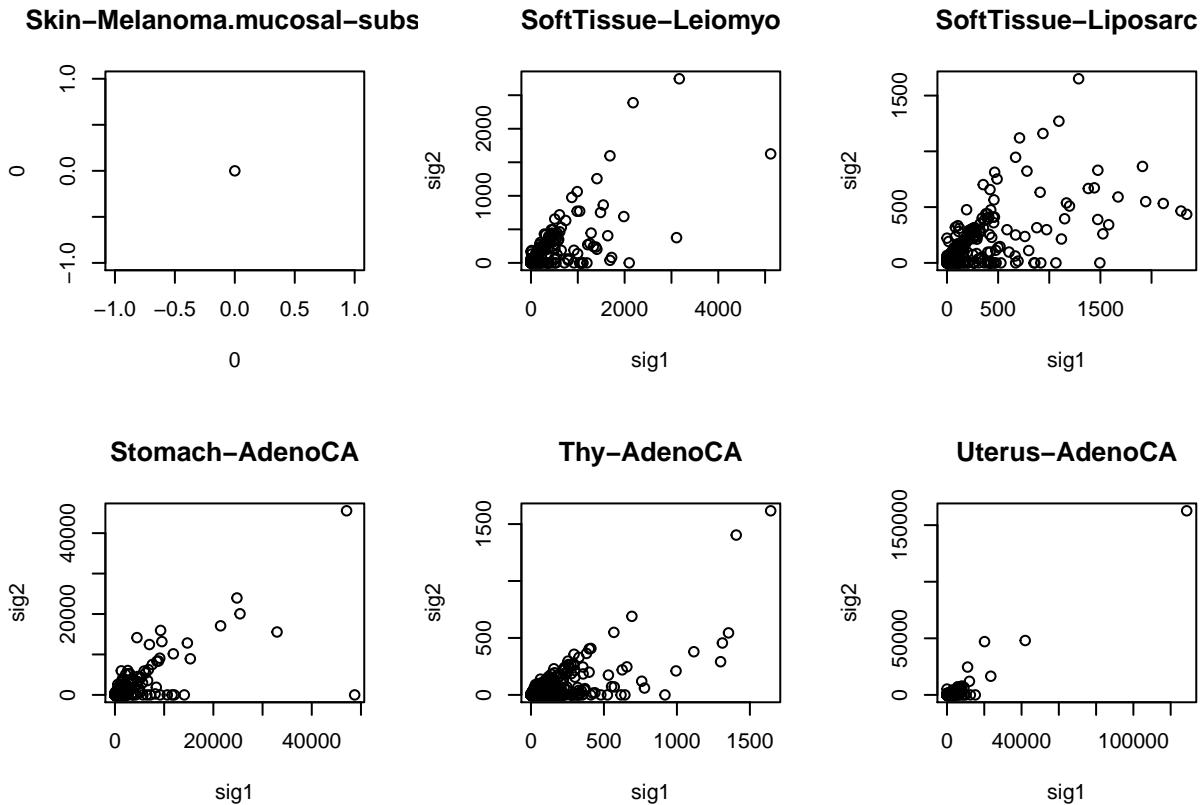


## Comparison of signature exposures with QP and mutsigextractor









## Correlation of p-values and number of samples

```

pcawg_palette <- pcawg.colour.palette(gsub("\\\\..*", "", all_pvals$ct),
                                         scheme = "tumour_subtype")

names(pcawg_palette) <- all_pvals$ct

ggplot(data.frame(num_samples=num_samples[match(all_pvals$ct, names(num_samples))]),
       pvalue=all_pvals$pvalue,
       ct=all_pvals$ct), aes(x=num_samples, y=pvalue, label=ct, col=ct, group=1)+
  geom_point() + scale_y_continuous(trans = "log2") +
  geom_smooth(method = lm) + theme_bw() +
  geom_label_repel() + geom_hline(yintercept = log2(0.05), lty='dashed') +
  labs(x='Number of samples', y = 'p-value (log2)') +
  scale_color_manual(values = pcawg_palette) +
  guides(col=FALSE)

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

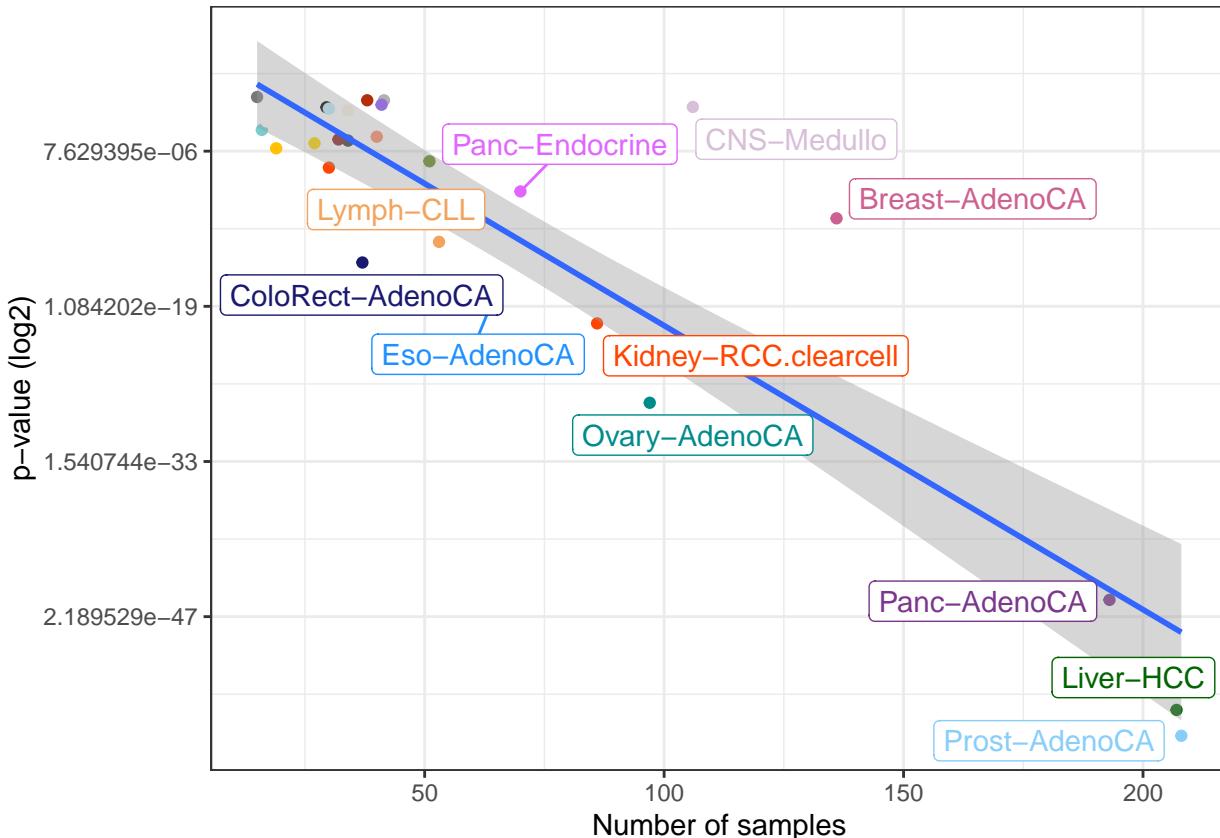
## Warning in log(x, base): NaNs produced
## Warning: Transformation introduced infinite values in continuous y-axis
## `geom_smooth()` using formula 'y ~ x'
## Warning: Removed 1 rows containing non-finite values (stat_smooth).

```

```

## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_label_repel).
## Warning: Removed 1 rows containing missing values (geom_hline).
## Warning: ggrepel: 16 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

```



## Effect size

We are dealing with multivariate data, and it is not clear how we could come up with a metric to show the change between two sets of paired mutational signatures.

- From the Aitchison school, the ‘perturbation’ is what is used, and is a  $d - 1$ -dimensional vector. We must turn this value into a single value.

$$e_1 = \frac{\sum_{i=1}^n (\bar{W}_i^l - \bar{W}_i^e)^2}{n}$$

```

## [1] 27 8
## [1] 27 8
## [1] 136 12
## [1] 136 12
## [1] 34 5
## [1] 34 5

```

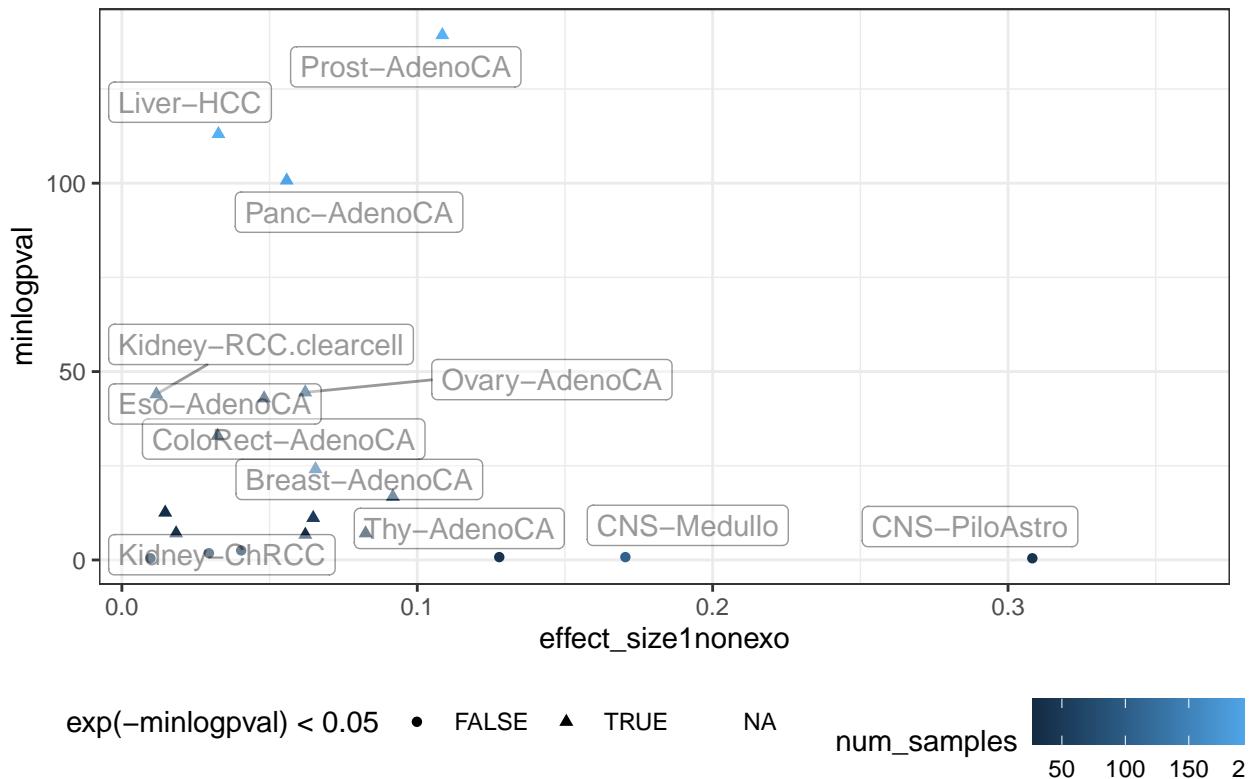
```

## [1] 106   6
## [1] 106   6
## [1] 41   5
## [1] 41   5
## [1] 37   8
## [1] 37   8
## [1] 65   9
## [1] 65   9
## [1] 32   8
## [1] 32   8
## [1] 38   5
## [1] 38   5
## [1] 86   7
## [1] 86   7
## [1] 30   7
## [1] 30   7
## [1] 207  13
## [1] 207  13
## [1] 34   4
## [1] 34   4
## [1] 51  12
## [1] 51  12
## [1] 53   3
## [1] 53   3
## [1] 97  10
## [1] 97  10
## [1] 193  13
## [1] 193  13
## [1] 70  11
## [1] 70  11
## [1] 208  12
## [1] 208  12
## [1] 29   3
## [1] 29   3
## [1] 30  14
## [1] 30  14
## [1] 41   5
## [1] 41   5
## [1] 40  10
## [1] 40  10

## Warning: Removed 3 rows containing missing values (geom_point).
## Warning: Removed 3 rows containing missing values (geom_label_repel).
## Warning: ggrepel: 8 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

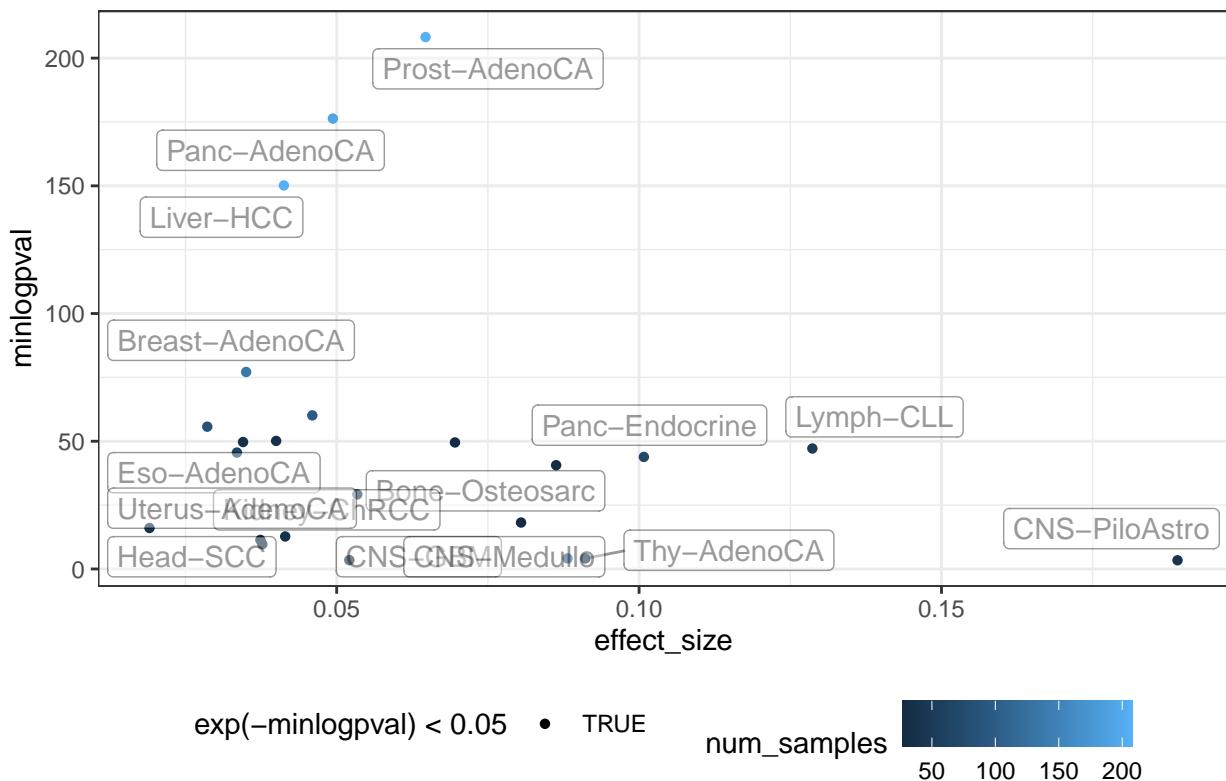
```

### Effect size #1, nonexo



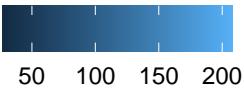
```
## Warning: ggrepel: 8 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```

## Effect size #1, all sigs



$\exp(-\text{minlogpval}) < 0.05$  • TRUE

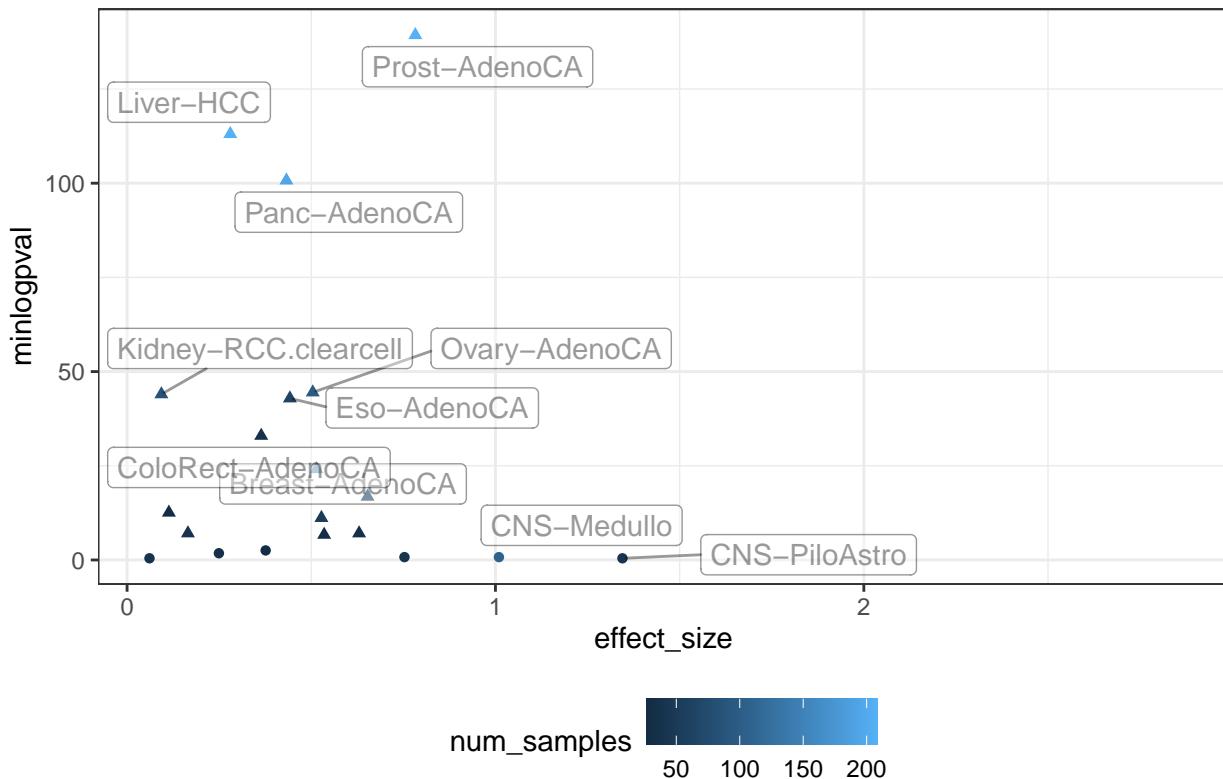
num\_samples



$$e_2 = \frac{\sum_{i=1}^n (\bar{W}_i^l - \bar{W}_i^e)^2}{n} \cdot \log \left( \frac{\sum_{i=1}^n \sum_{j=1}^k W_{ij}}{n} \right)$$

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
## Warning: Removed 3 rows containing missing values (geom_point).
## Warning: Removed 3 rows containing missing values (geom_label_repel).
## Warning: ggrepel: 10 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```

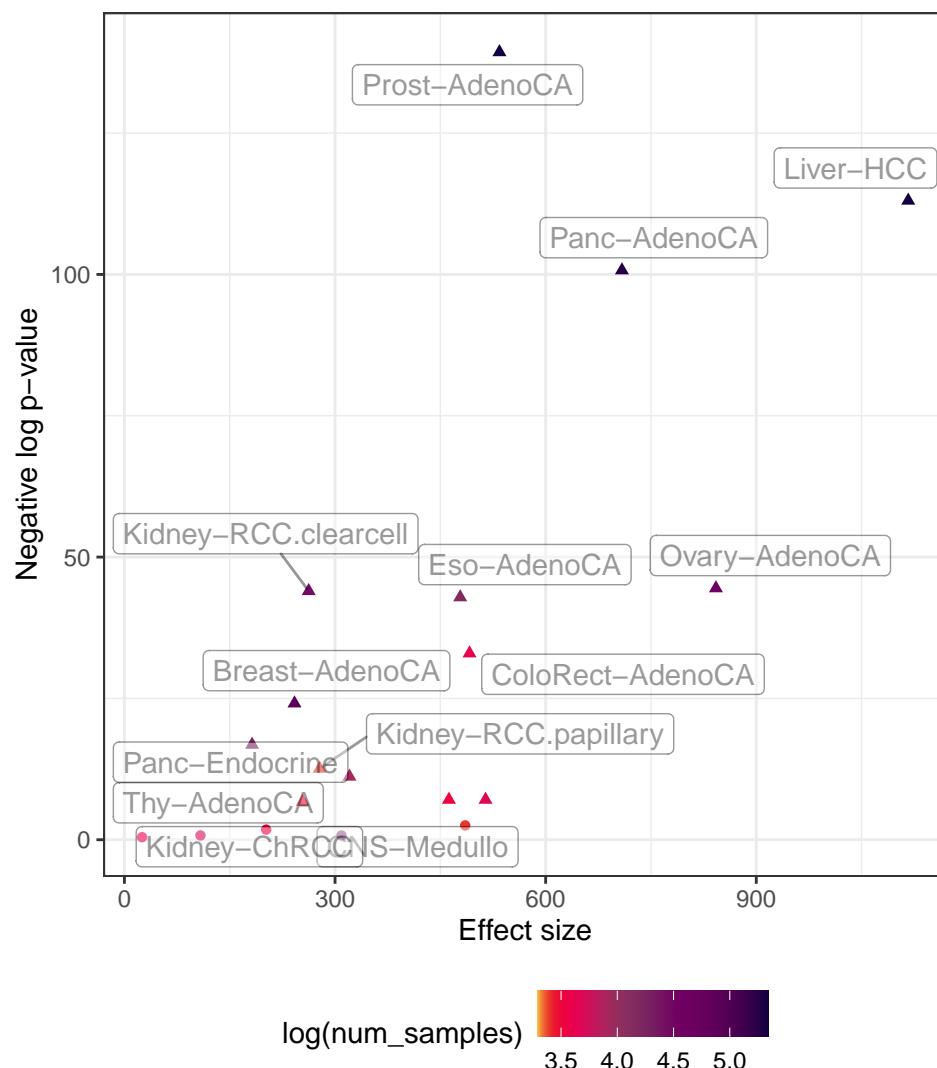
## Effect size #2, nonexo



Signature-averaged perturbation

```
## Error in apply(pert, 1, function(i) sqrt(sum((i - 1/(ncol(exposures_cancertype_obj$Y)))^2))) :
##   dim(X) must have a positive length
## Error in apply(pert, 1, function(i) sqrt(sum((i - 1/(ncol(exposures_cancertype_obj$Y)))^2))) :
##   dim(X) must have a positive length
## Warning: NAs introduced by coercion
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
## Warning: Removed 4 rows containing missing values (geom_point).
## Warning: Removed 4 rows containing missing values (geom_label_repel).
## Warning: ggrepel: 6 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```

## Total perturbation, non-exogenous signatures

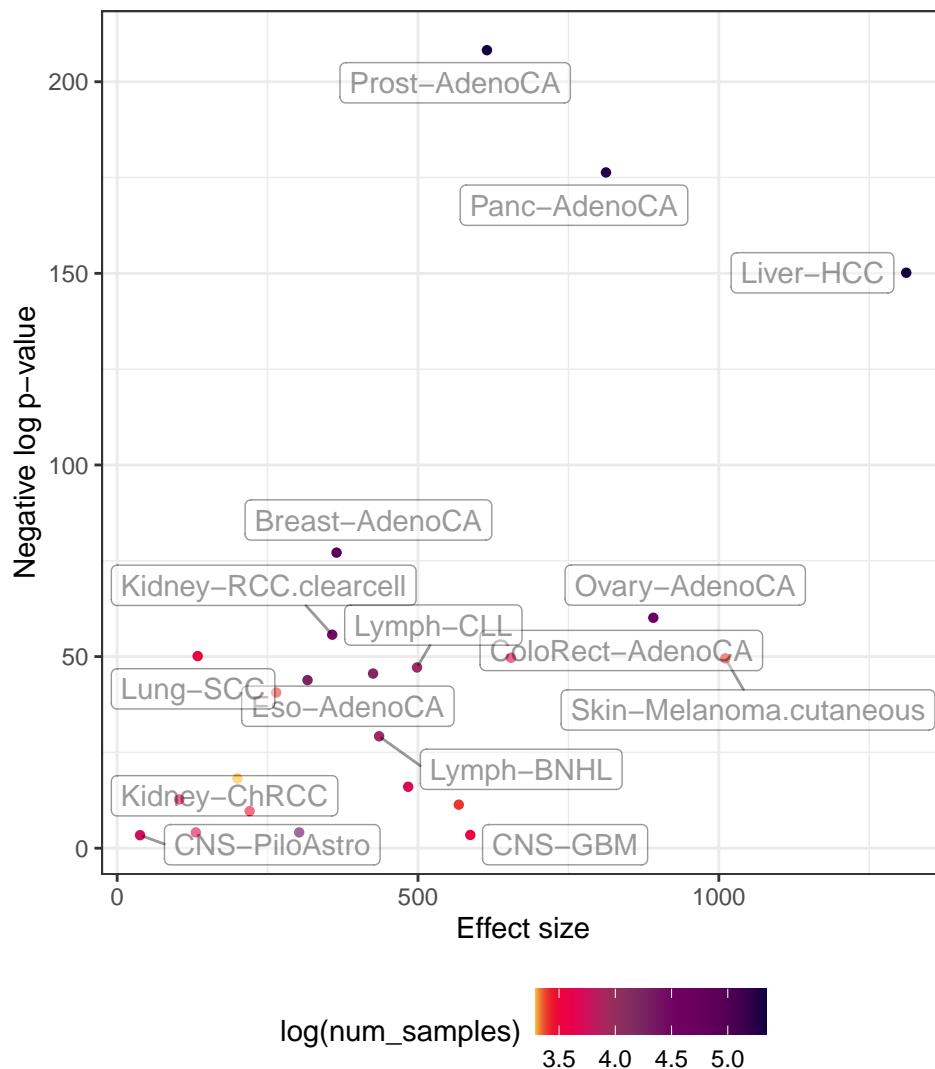


Signature-averaged perturbation (all sigs)

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: ggrepel: 8 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```

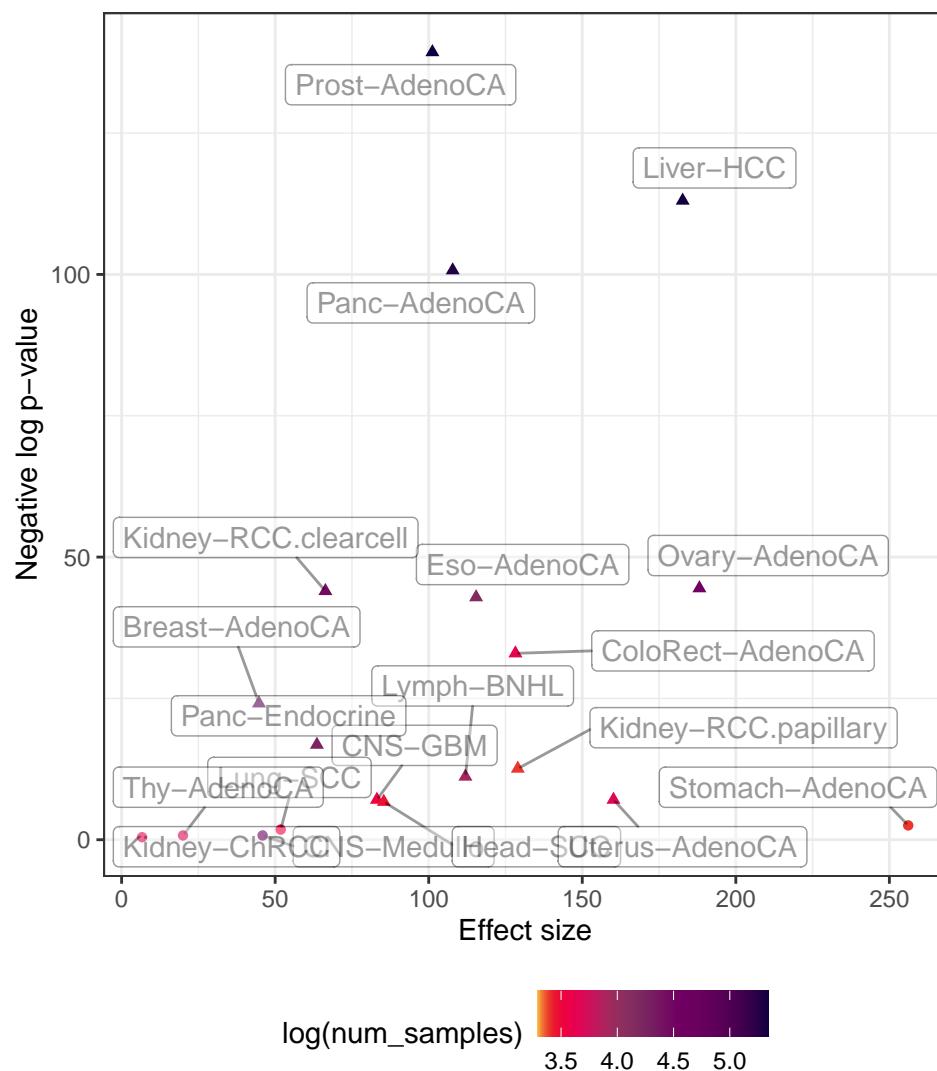
## Total perturbation, all signatures



Total perturbation (sample-averaged)

```
## Error in apply(pert, 2, function(i) sqrt(sum((i - 1/(ncol(exposures_cancertype_obj$Y)))^2))) :
##   dim(X) must have a positive length
## Error in apply(pert, 2, function(i) sqrt(sum((i - 1/(ncol(exposures_cancertype_obj$Y)))^2))) :
##   dim(X) must have a positive length
## Warning: NAs introduced by coercion
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
## Warning: Removed 4 rows containing missing values (geom_point).
## Warning: Removed 4 rows containing missing values (geom_label_repel).
```

## Total perturbation, non-exogenous signatures

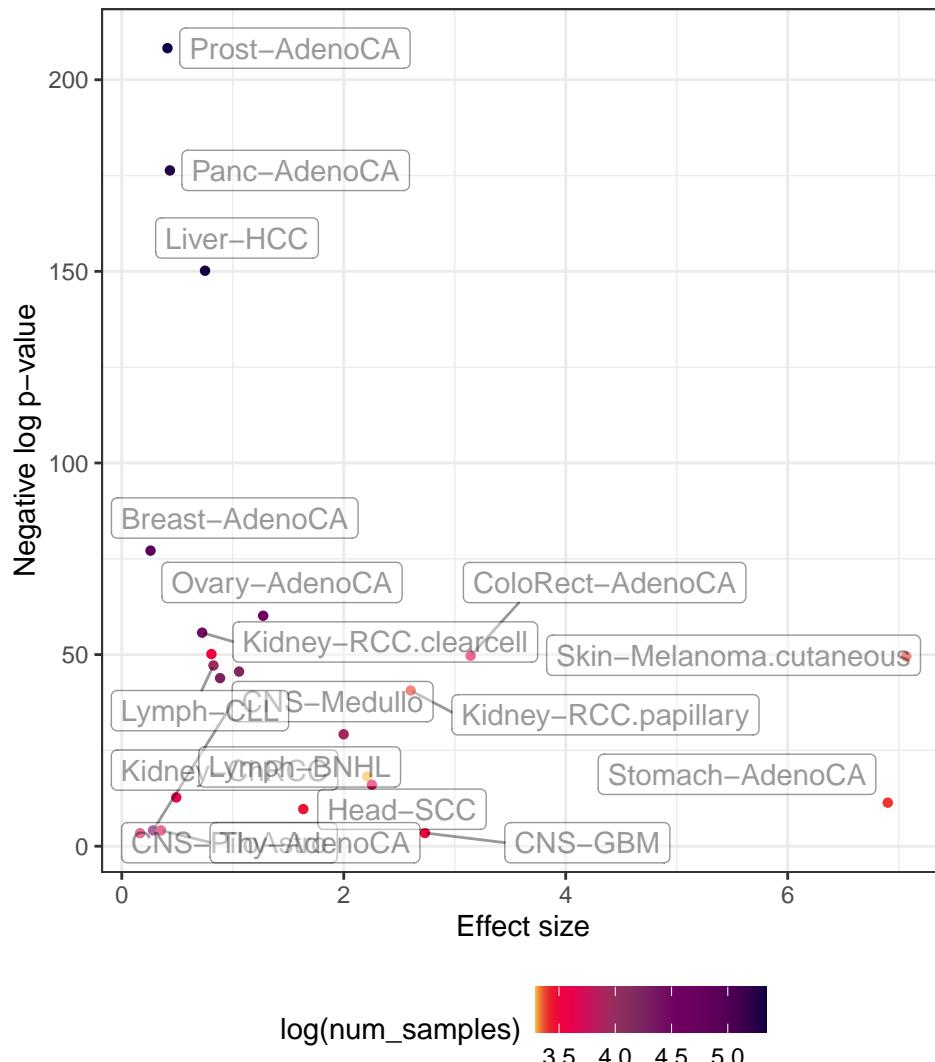


Weighted total perturbation

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: ggrepel: 5 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```

## Weighted total perturbation, all signatures



## Which inferred covariance matrices are not positive semi-definite?

```
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)))
```

```
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i))
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)
```

```

## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :

```

```

## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
## replacement has length zero

```

```

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

```

```

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors

```

```

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

```

```

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

```

```

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero
## Error : $ operator is invalid for atomic vectors

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

```

```
## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

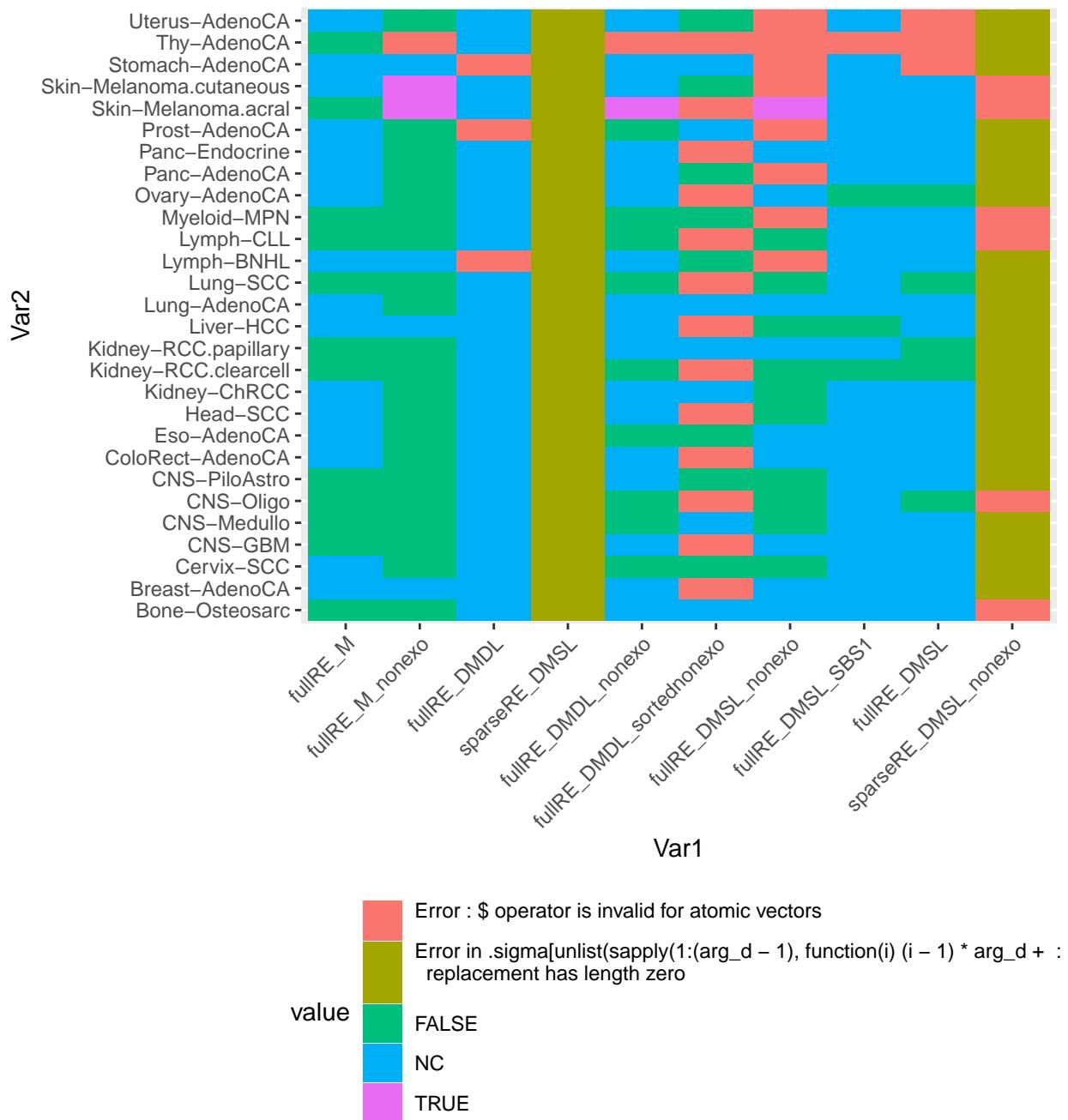
## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

## Warning in fill_covariance_matrix(arg_d = length(python_like_select_name(get(i)
## [[ct]]$par.fixed, : This function had been incorrect until now (30 july 2021)

## Error in m[unlist(sapply(2:nrow(m), function(rw) seq(from = rw, length.out = (rw - :
##   replacement has length zero

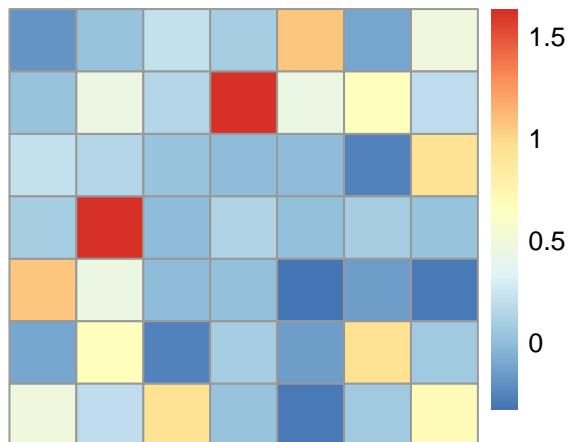
## [1] 11 28
## [1] 308   3
## [1] "Var1"  "Var2"  "value"
```



## Comparison of the inferred covariance matrices and the matrices from the fitted intercepts

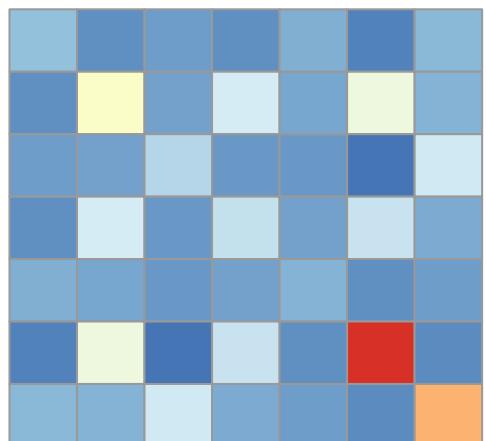
```
## [1] "Bone-Osteosarc"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Bone–Osteosarc**  
**inferred**

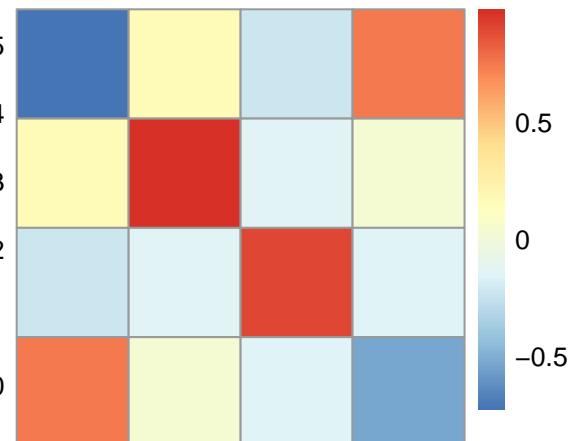


```
## [1] "CNS-GBM"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

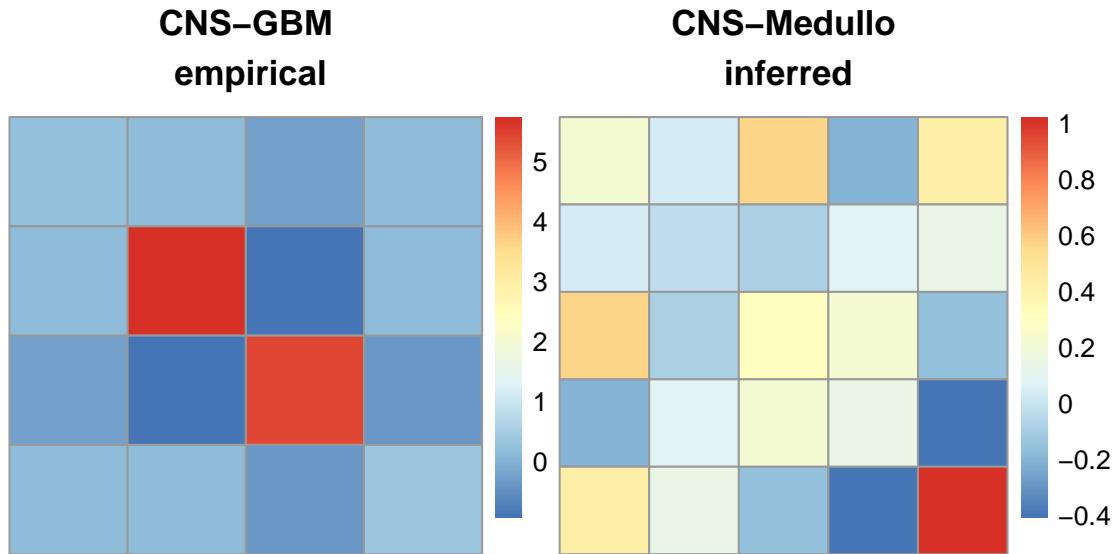
**Bone–Osteosarc**  
**empirical**



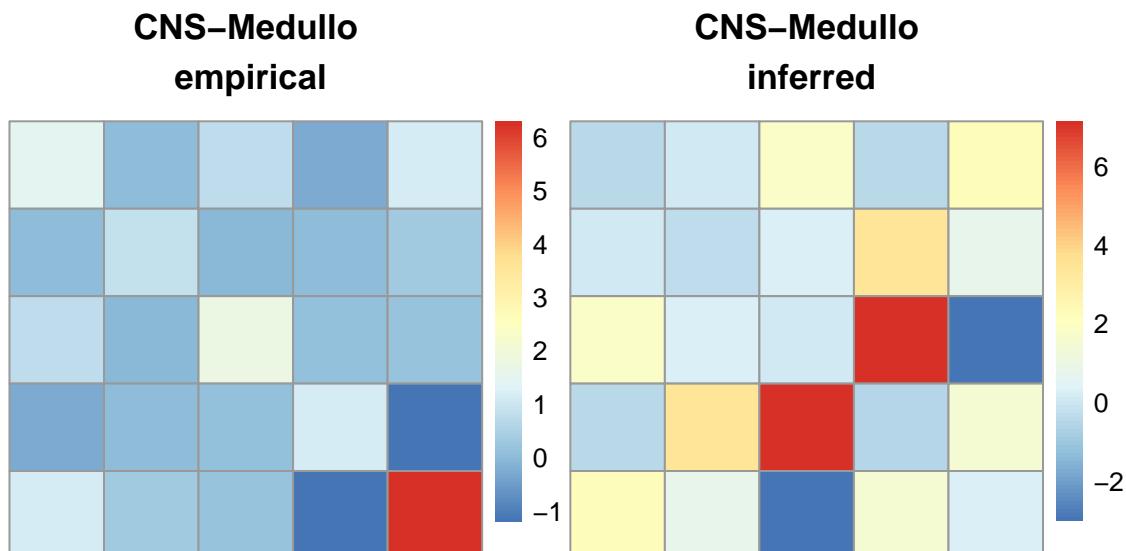
**CNS–GBM**  
**inferred**



```
## [1] "CNS-Medullo"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

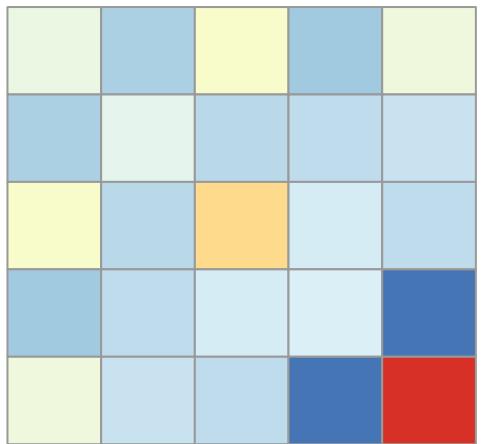


```
## [1] "CNS-Medullo"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

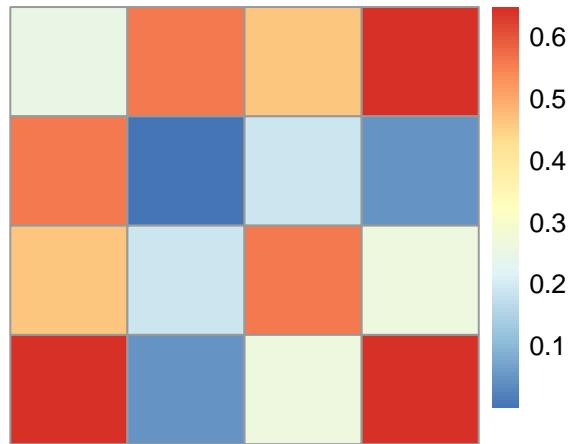


```
## [1] "CNS-PiloAstro"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**CNS-Medullo**  
**empirical**

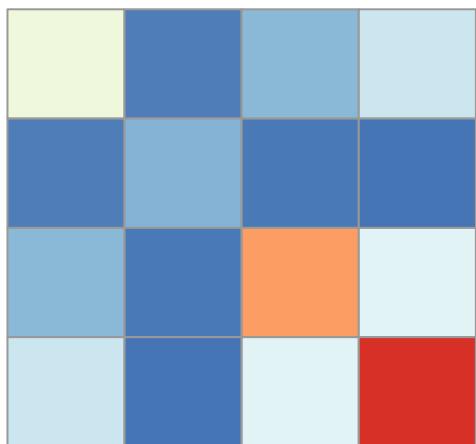


**CNS-PiloAstro**  
**inferred**

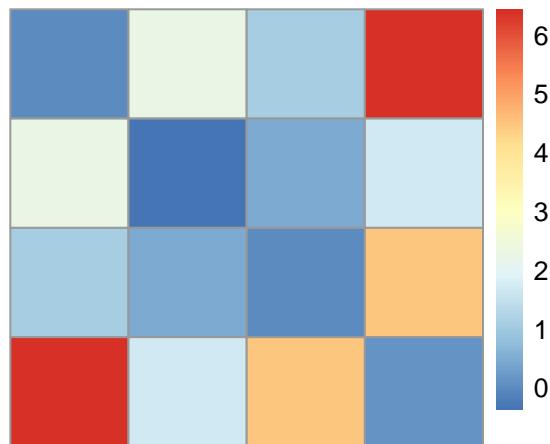


```
## [1] "CNS-PiloAstro"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

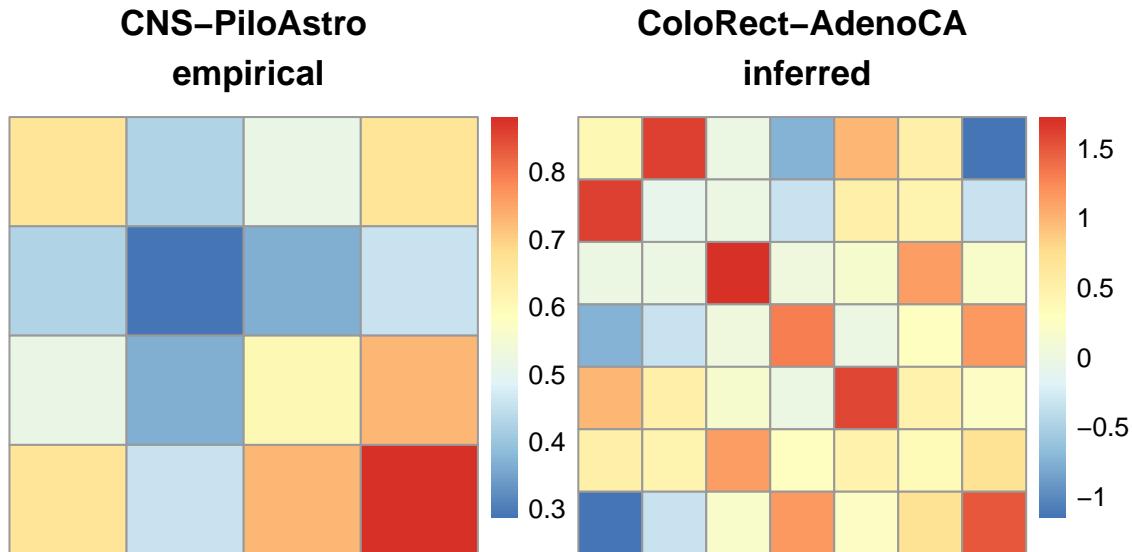
**CNS-PiloAstro**  
**empirical**



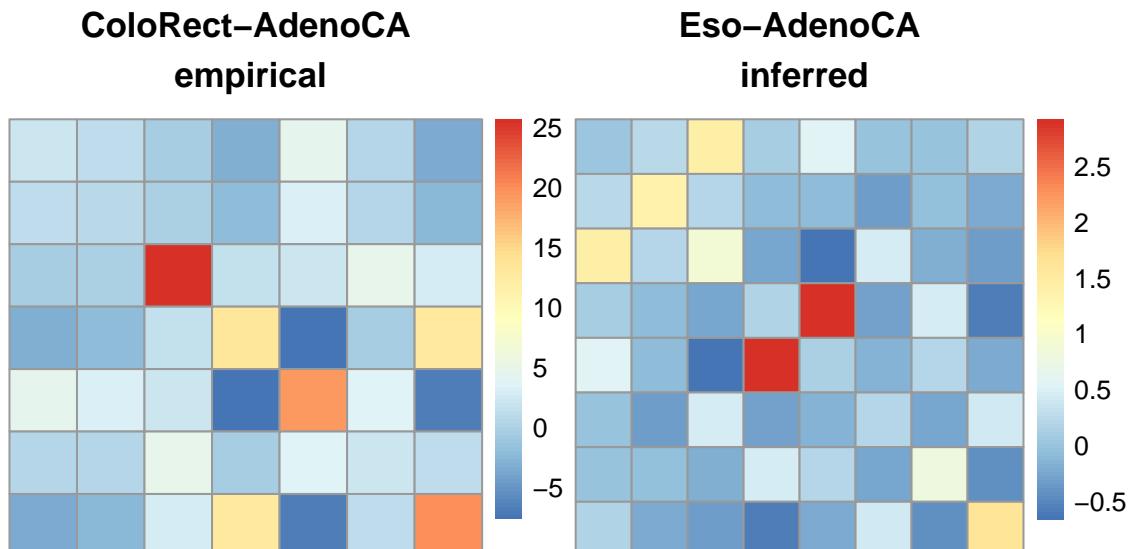
**CNS-PiloAstro**  
**inferred**



```
## [1] "ColoRect-AdenoCA"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

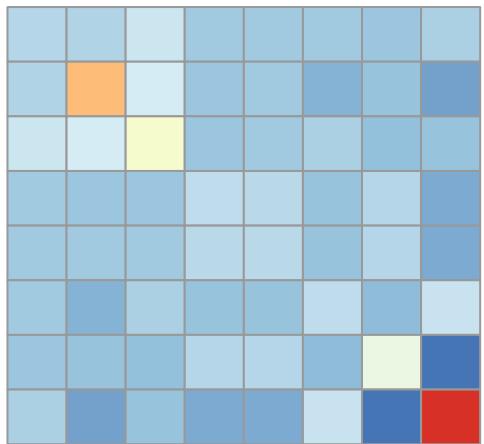


```
## [1] "Eso-AdenoCA"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

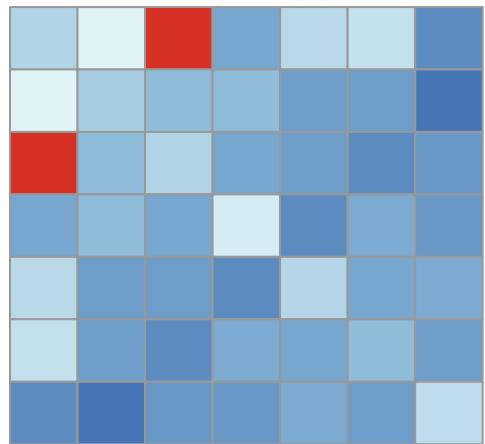


```
## [1] "Head-SCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Eso-AdenoCA**  
**empirical**

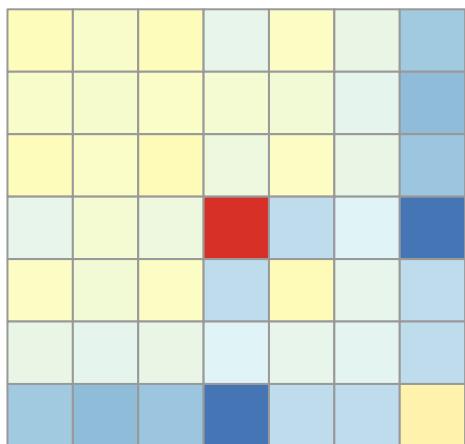


**Head-SCC**  
**inferred**

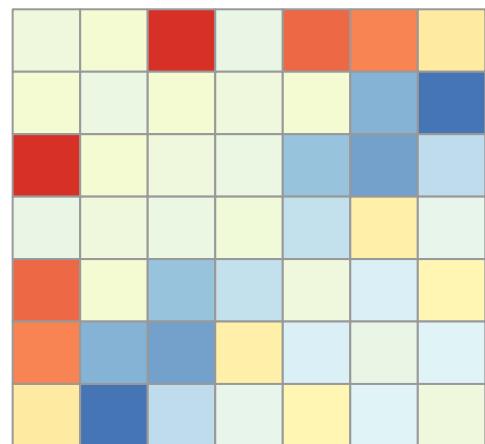


```
## [1] "Head-SCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

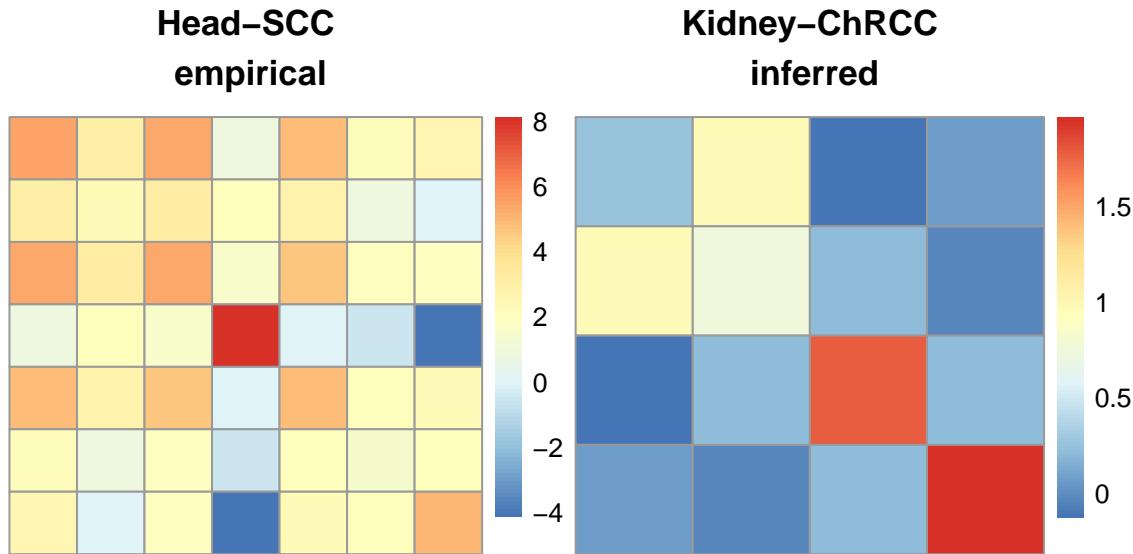
**Head-SCC**  
**empirical**



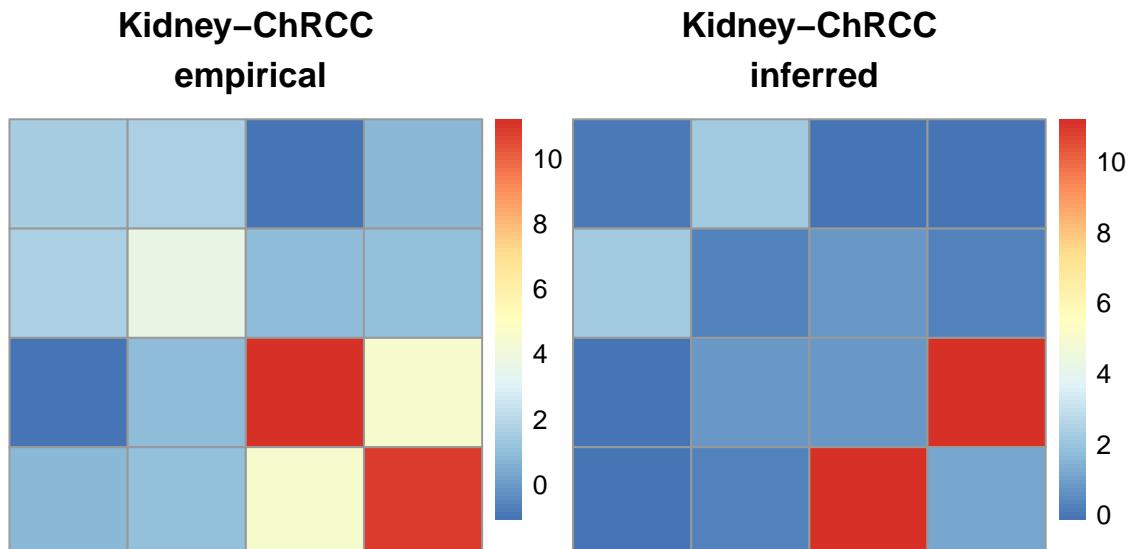
**Head-SCC**  
**inferred**



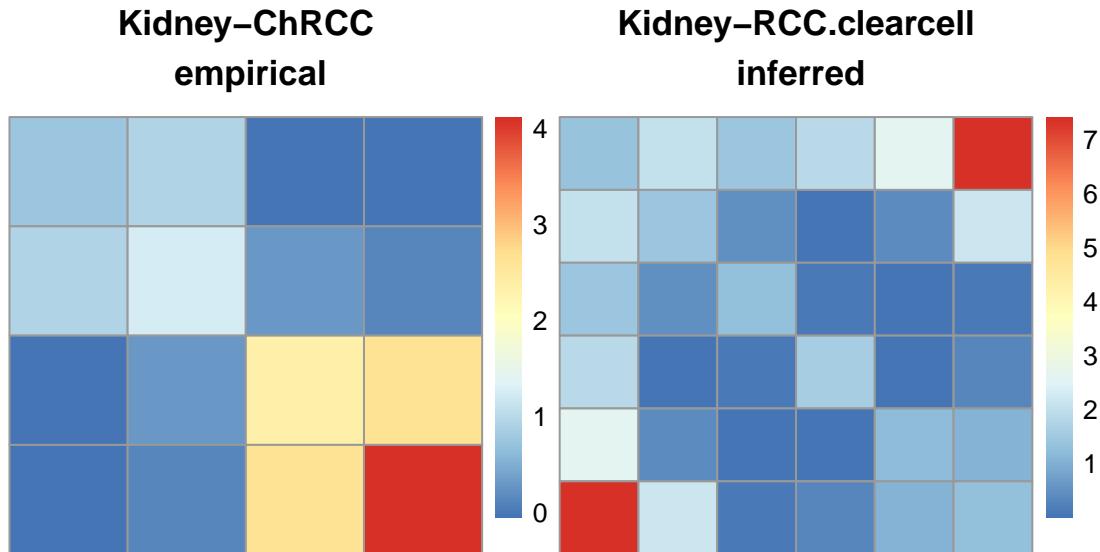
```
## [1] "Kidney-ChRCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```



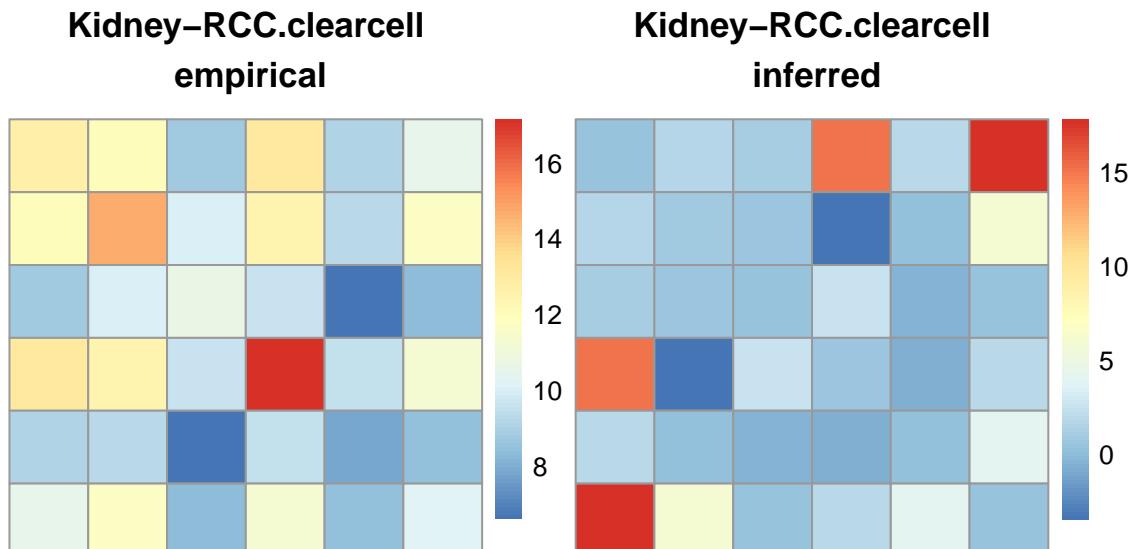
```
## [1] "Kidney-ChRCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```



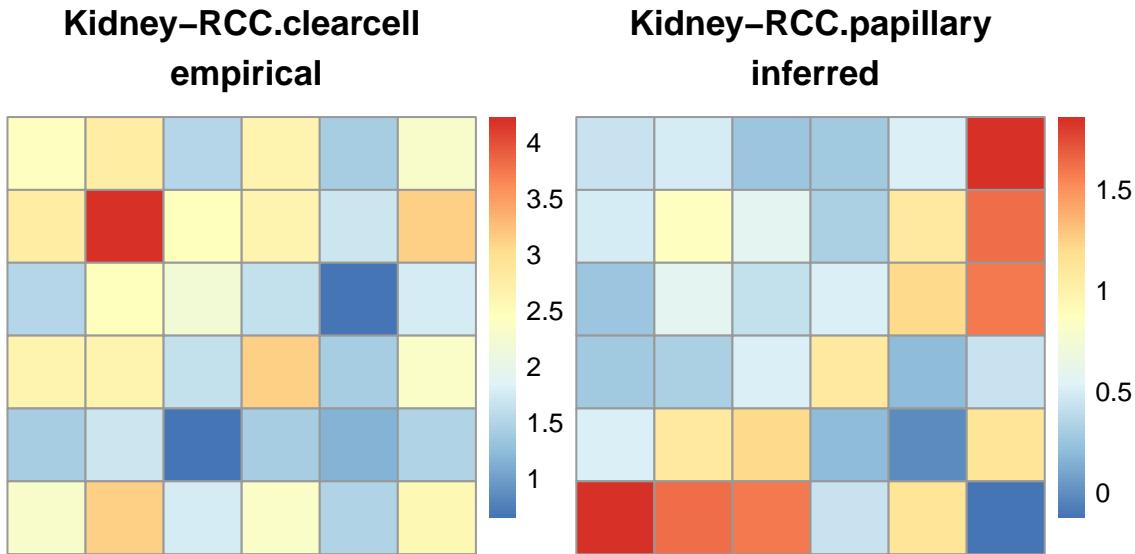
```
## [1] "Kidney-RCC.clearcell"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```



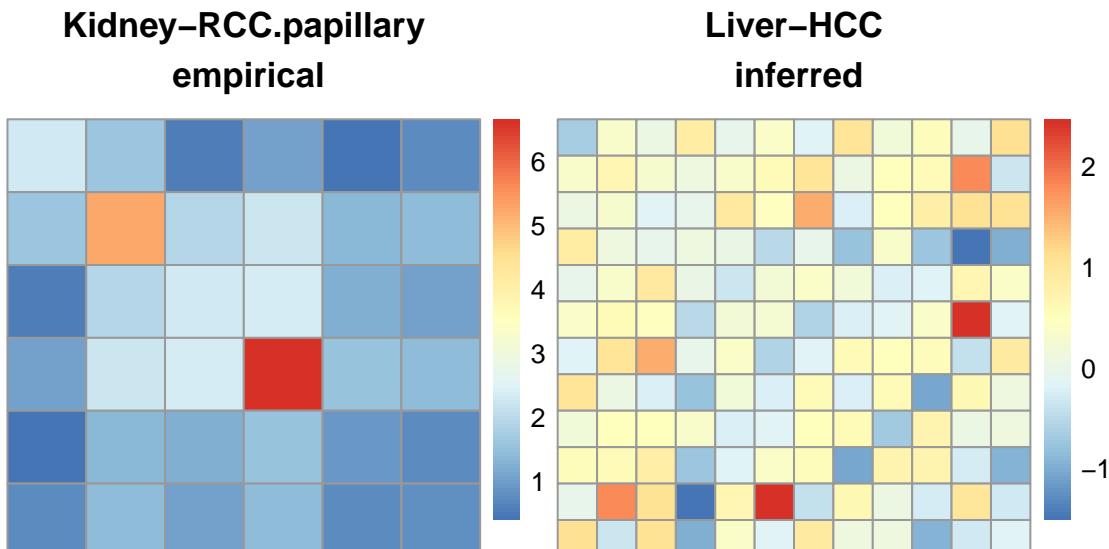
```
## [1] "Kidney-RCC.clearcell"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```



```
## [1] "Kidney-RCC.papillary"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

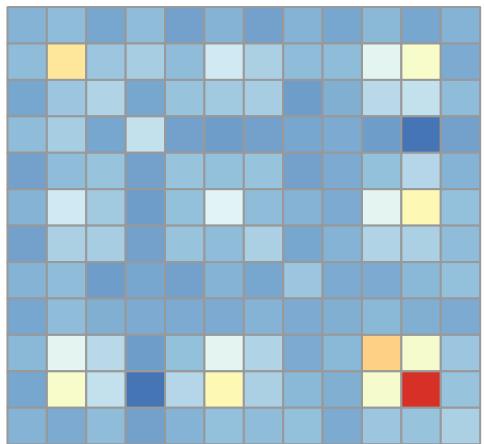


```
## [1] "Liver-HCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

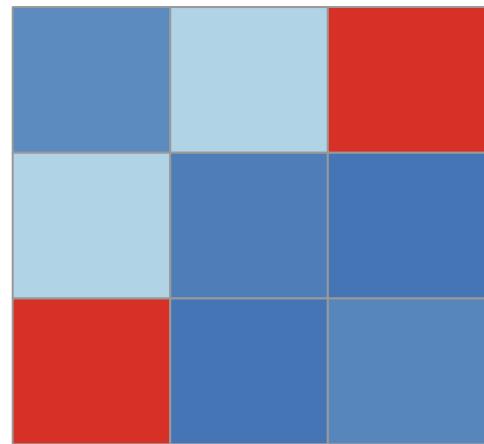


```
## [1] "Lung-SCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Liver-HCC**  
**empirical**

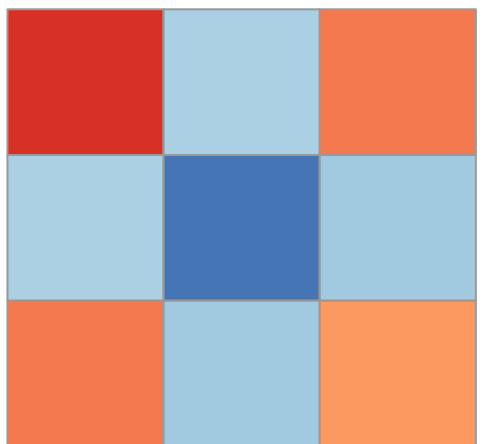


**Lung-SCC**  
**inferred**

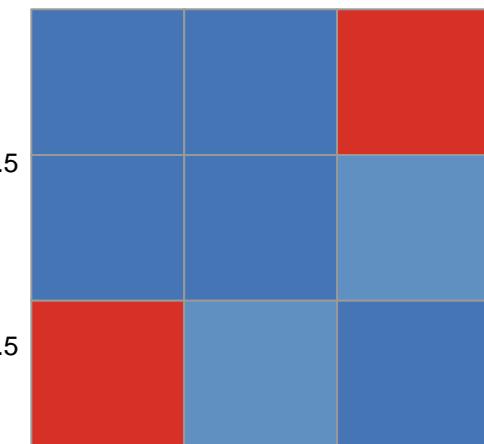


```
## [1] "Lung-SCC"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Lung-SCC**  
**empirical**

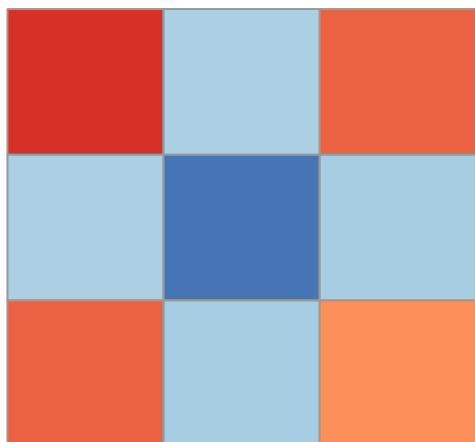


**Lung-SCC**  
**inferred**

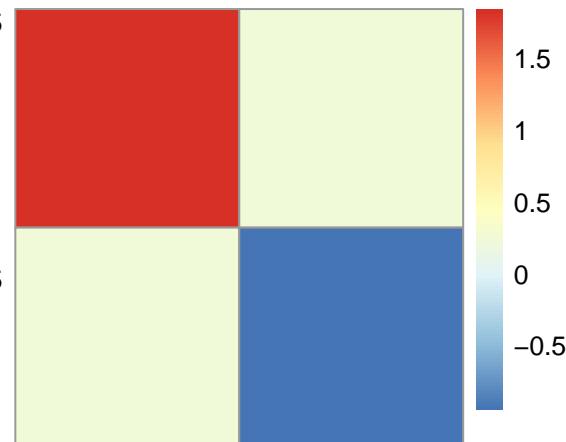


```
## Error : $ operator is invalid for atomic vectors
## [1] "Lymph-CLL"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Lung-SCC  
empirical**

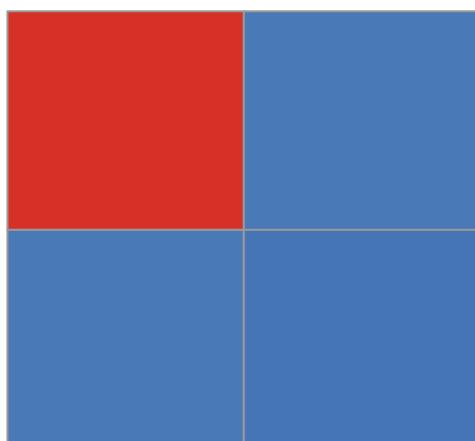


**Lymph-CLL  
inferred**

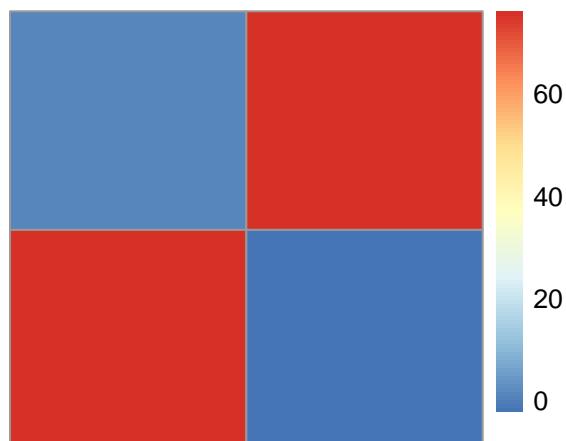


```
## [1] "Lymph-CLL"  
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =  
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been  
## incorrect until now (30 july 2021)
```

**Lymph-CLL  
empirical**

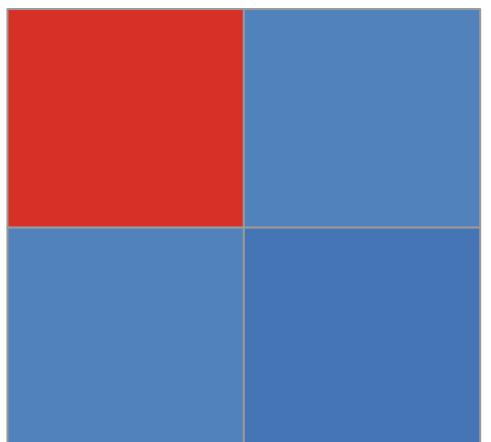


**Lymph-CLL  
inferred**

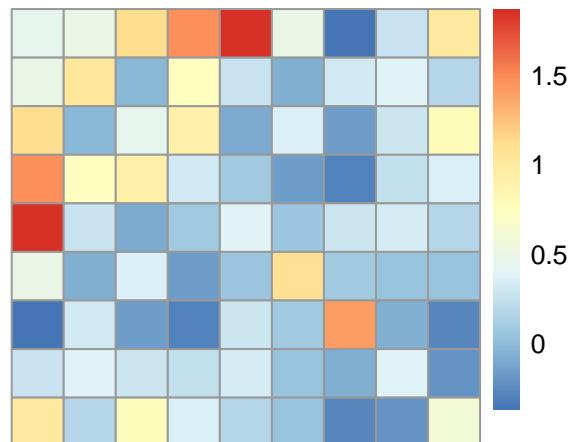


```
## [1] "Ovary-AdenoCA"  
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =  
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been  
## incorrect until now (30 july 2021)
```

**Lymph–CLL**  
**empirical**

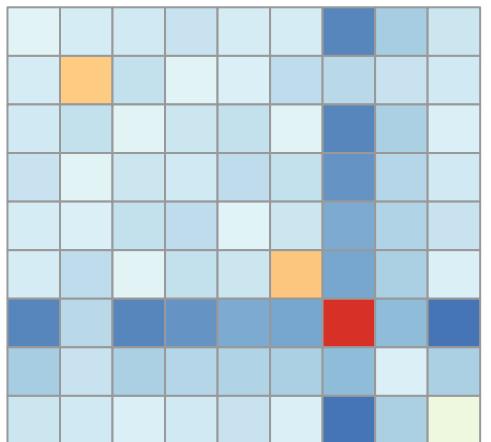


**Ovary–AdenoCA**  
**inferred**

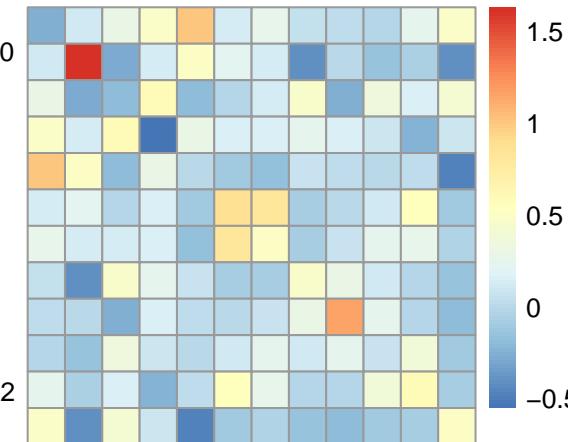


```
## [1] "Panc-AdenoCA"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Ovary–AdenoCA**  
**empirical**

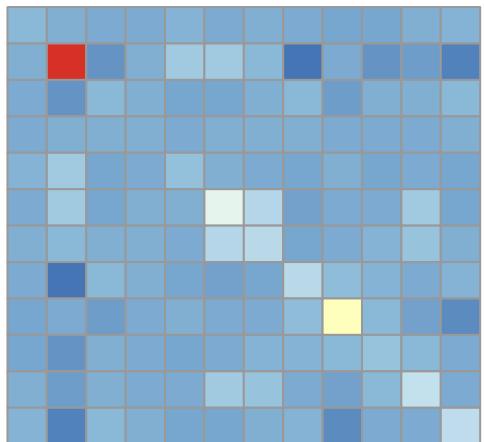


**Panc–AdenoCA**  
**inferred**

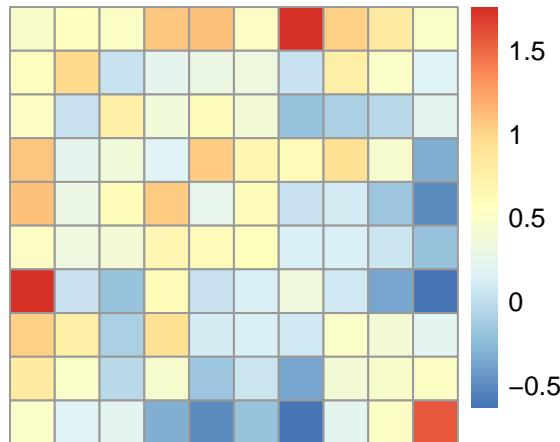


```
## Error : $ operator is invalid for atomic vectors
## [1] "Panc-Endocrine"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Panc–AdenoCA**  
empirical

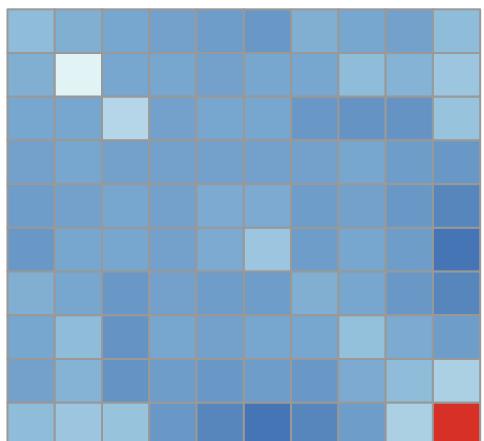


**Panc–Endocrine**  
inferred

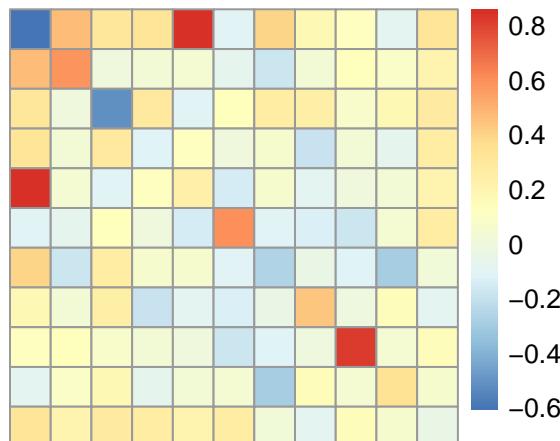


```
## [1] "Prost–AdenoCA"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Panc–Endocrine**  
empirical

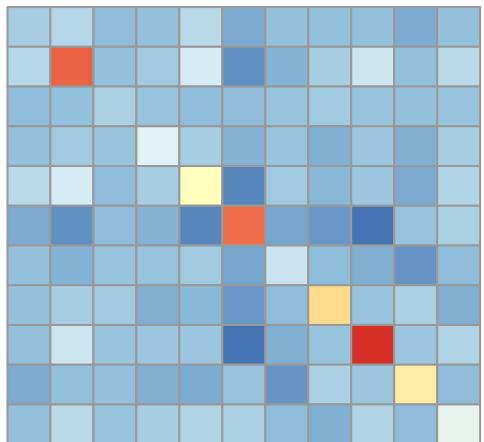


**Prost–AdenoCA**  
inferred

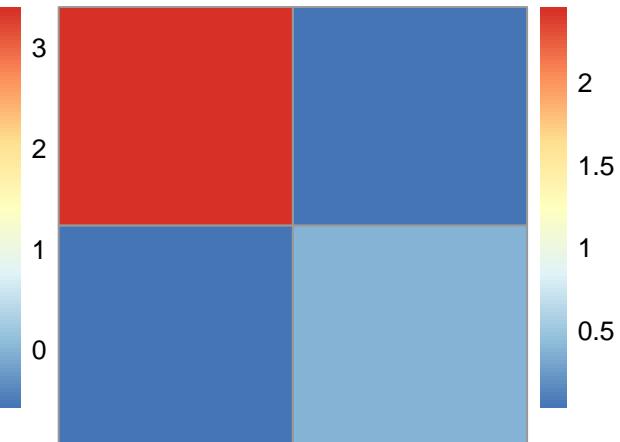


```
## Error : $ operator is invalid for atomic vectors
## [1] "Skin–Melanoma.cutaneous"
## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Prost–AdenoCA**  
empirical



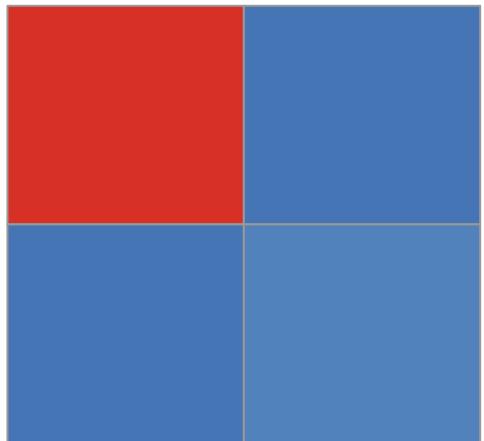
**Skin–Melanoma.cutaneous**  
inferred



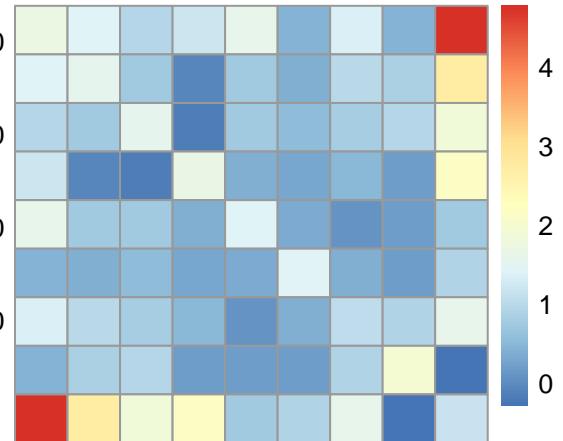
```
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## [1] "Uterus–AdenoCA"

## Warning in fill_covariance_matrix(arg_d = .d_logR, arg_entries_var =
## python_like_select_name(get(i)[[ct]]$par.fixed, : This function had been
## incorrect until now (30 july 2021)
```

**Skin–Melanoma.cutaneous**  
empirical



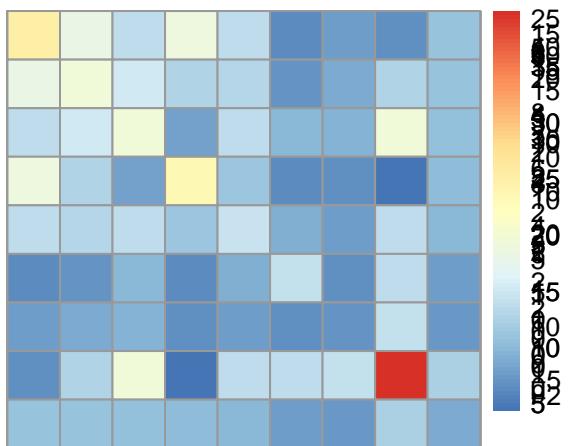
**Uterus–AdenoCA**  
inferred



```
## Error : $ operator is invalid for atomic vectors
```

## Skirtomyiasus

### empirical



```
## $`Bone-Osteosarc`  
## $`Bone-Osteosarc`$fullRE_M_nonexo  
##  
## $`Bone-Osteosarc`$fullRE_DMSL_nonexo  
## [1] "No convergence"  
##  
##  
## $`Breast-AdenoCA`  
##     fullRE_M_nonexo fullRE_DMSL_nonexo  
##     "No convergence"    "No convergence"  
##  
## $`CNS-GBM`  
## $`CNS-GBM`$fullRE_M_nonexo  
##  
## $`CNS-GBM`$fullRE_DMSL_nonexo  
## [1] "No convergence"  
##  
##  
## $`CNS-Medullo`  
##     fullRE_M_nonexo fullRE_DMSL_nonexo  
## tree_row NA             NA  
## tree_col NA             NA  
## kmeans   NA             NA  
## gtable   List,12        List,12  
##  
## $`CNS-PiloAstro`  
##     fullRE_M_nonexo fullRE_DMSL_nonexo  
## tree_row NA             NA  
## tree_col NA             NA  
## kmeans   NA             NA  
## gtable   List,12        List,12  
##  
## $`ColoRect-AdenoCA`  
## $`ColoRect-AdenoCA`$fullRE_M_nonexo
```

```

## 
## $`ColoRect-AdenoCA`$fullRE_DMSL_nonexo
## [1] "No convergence"
##
## 
## $`Eso-AdenoCA`
## $`Eso-AdenoCA`$fullRE_M_nonexo
##
## $`Eso-AdenoCA`$fullRE_DMSL_nonexo
## [1] "No convergence"
##
## 
## $`Head-SCC`
##           fullRE_M_nonexo fullRE_DMSL_nonexo
## tree_row NA             NA
## tree_col NA             NA
## kmeans   NA             NA
## gtable   List,12        List,12
##
## $`Kidney-ChRCC`
##           fullRE_M_nonexo fullRE_DMSL_nonexo
## tree_row NA             NA
## tree_col NA             NA
## kmeans   NA             NA
## gtable   List,12        List,12
##
## $`Kidney-RCC.clearcell`
##           fullRE_M_nonexo fullRE_DMSL_nonexo
## tree_row NA             NA
## tree_col NA             NA
## kmeans   NA             NA
## gtable   List,12        List,12
##
## $`Kidney-RCC.papillary`
## $`Kidney-RCC.papillary`$fullRE_M_nonexo
##
## $`Kidney-RCC.papillary`$fullRE_DMSL_nonexo
## [1] "No convergence"
##
## 
## $`Liver-HCC`
## $`Liver-HCC`$fullRE_M_nonexo
## [1] "No convergence"
##
## $`Liver-HCC`$fullRE_DMSL_nonexo
##
## 
## $`Lung-SCC`
##           fullRE_M_nonexo fullRE_DMSL_nonexo
## tree_row NA             NA
## tree_col NA             NA

```

```

## kmeans NA NA
## gtable List,12 List,12
##
## $`Lymph-BNHL`
## fullRE_M_nonexo
## "No convergence"
## fullRE_DMSL_nonexo
## "Error : $ operator is invalid for atomic vectors\n"
##
## $`Lymph-CLL`
## fullRE_M_nonexo fullRE_DMSL_nonexo
## tree_row NA NA
## tree_col NA NA
## kmeans NA NA
## gtable List,12 List,12
##
## $`Ovary-AdenoCA`
## $`Ovary-AdenoCA`$fullRE_M_nonexo
##
## $`Ovary-AdenoCA`$fullRE_DMSL_nonexo
## [1] "No convergence"
##
##
## $`Panc-AdenoCA`
## $`Panc-AdenoCA`$fullRE_M_nonexo
##
## $`Panc-AdenoCA`$fullRE_DMSL_nonexo
## [1] "Error : $ operator is invalid for atomic vectors\n"
## attr(,"class")
## [1] "try-error"
## attr(,"condition")
## <simpleError: $ operator is invalid for atomic vectors>
##
##
## $`Panc-Endocrine`
## $`Panc-Endocrine`$fullRE_M_nonexo
##
## $`Panc-Endocrine`$fullRE_DMSL_nonexo
## [1] "No convergence"
##
##
## $`Prost-AdenoCA`
## $`Prost-AdenoCA`$fullRE_M_nonexo
##
## $`Prost-AdenoCA`$fullRE_DMSL_nonexo
## [1] "Error : $ operator is invalid for atomic vectors\n"
## attr(,"class")
## [1] "try-error"
## attr(,"condition")
## <simpleError: $ operator is invalid for atomic vectors>
##

```

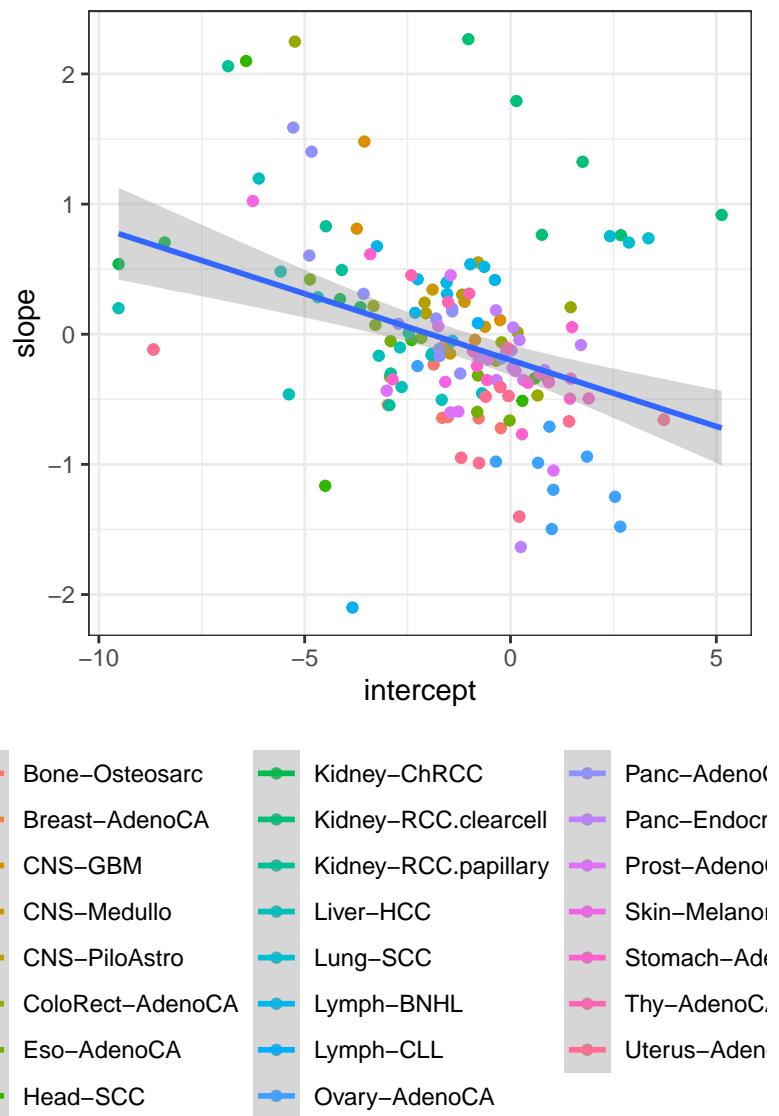
```

## 
## $`Skin-Melanoma.cutaneous`$fullRE_M_nonexo
## 
## $`Skin-Melanoma.cutaneous`$fullRE_DMSL_nonexo
## [1] "Error : $ operator is invalid for atomic vectors\n"
## attr(,"class")
## [1] "try-error"
## attr(,"condition")
## <simpleError: $ operator is invalid for atomic vectors>
## 
## 
## $`Stomach-AdenoCA`$fullRE_M_nonexo
##                               "No convergence"
## $`Stomach-AdenoCA`$fullRE_DMSL_nonexo
## "Error : $ operator is invalid for atomic vectors\n"
## 
## $`Thy-AdenoCA`$fullRE_M_nonexo
##                               "No convergence"
## $`Thy-AdenoCA`$fullRE_DMSL_nonexo
## "Error : $ operator is invalid for atomic vectors\n"
## 
## $`Uterus-AdenoCA`$fullRE_M_nonexo
## $`Uterus-AdenoCA`$fullRE_DMSL_nonexo
## [1] "Error : $ operator is invalid for atomic vectors\n"
## attr(,"class")
## [1] "try-error"
## attr(,"condition")
## <simpleError: $ operator is invalid for atomic vectors>

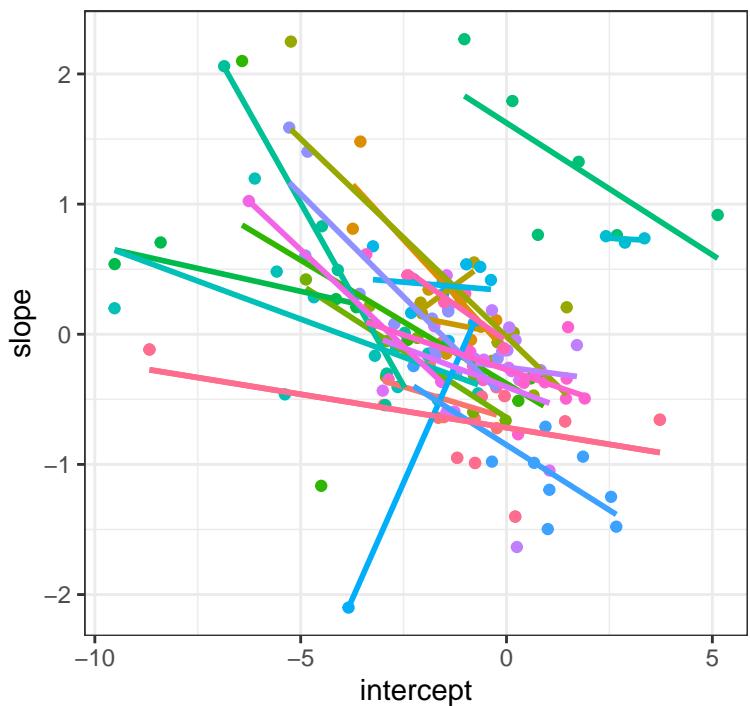
```

## Correlation of intercept and slope values

```
## `geom_smooth()` using formula 'y ~ x'
```

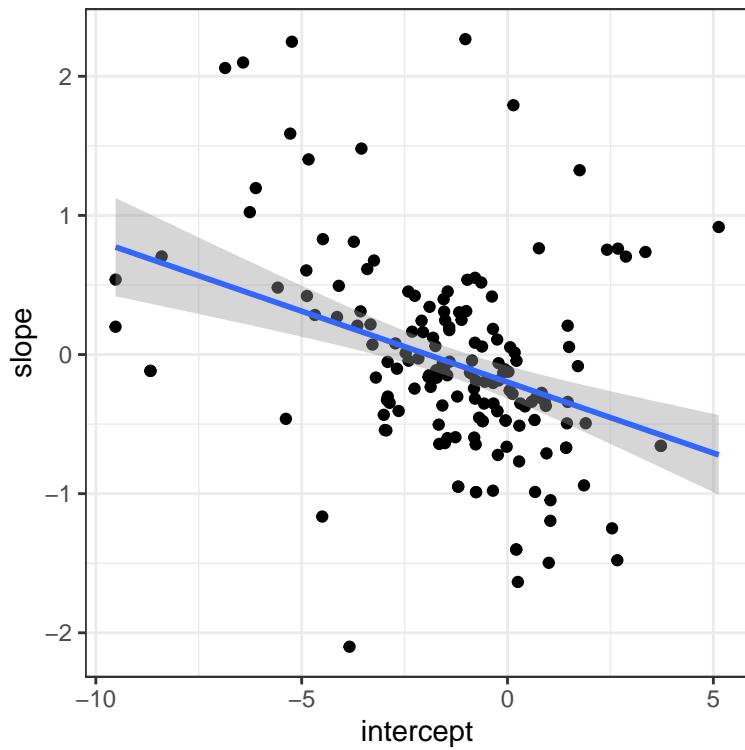


```
## `geom_smooth()` using formula 'y ~ x'
```

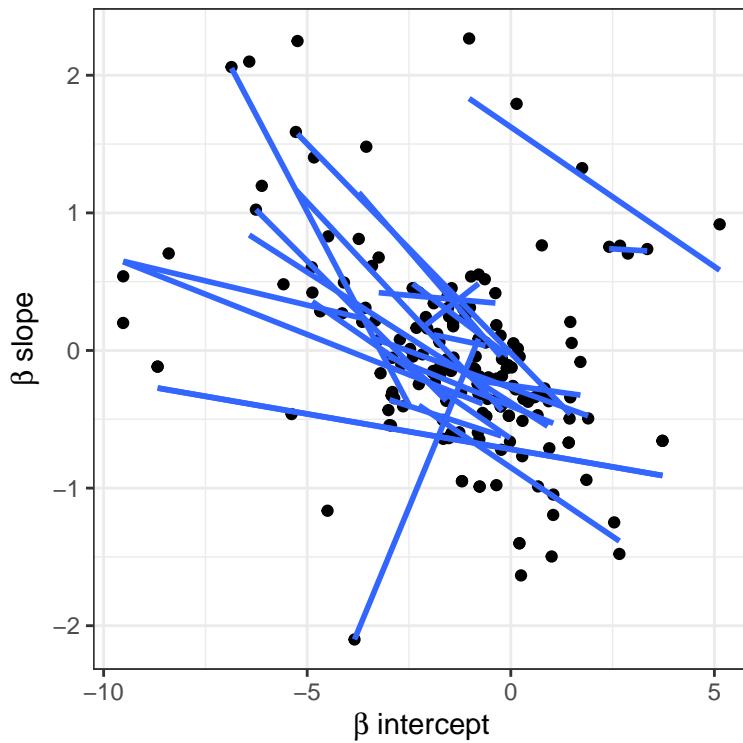


- Bone–Osteosarc      ▲ Kidney–ChRCC      ○ Panc–AdenoC
- Breast–AdenoCA      ▲ Kidney–RCC.clearcell      △ Panc–Endocr
- CNS–GBM      ▲ Kidney–RCC.papillary      △ Prost–AdenoC
- CNS–Medullo      ▲ Liver–HCC      △ Skin–MelanoC
- CNS–PiloAstro      ▲ Lung–SCC      △ Stomach–AdenoC
- ColoRect–AdenoCA      ▲ Lymph–BNHL      △ Thy–AdenoC.
- Eso–AdenoCA      ▲ Lymph–CLL      △ Uterus–Aden
- Head–SCC      ▲ Ovary–AdenoCA

```
## `geom_smooth()` using formula 'y ~ x'
```

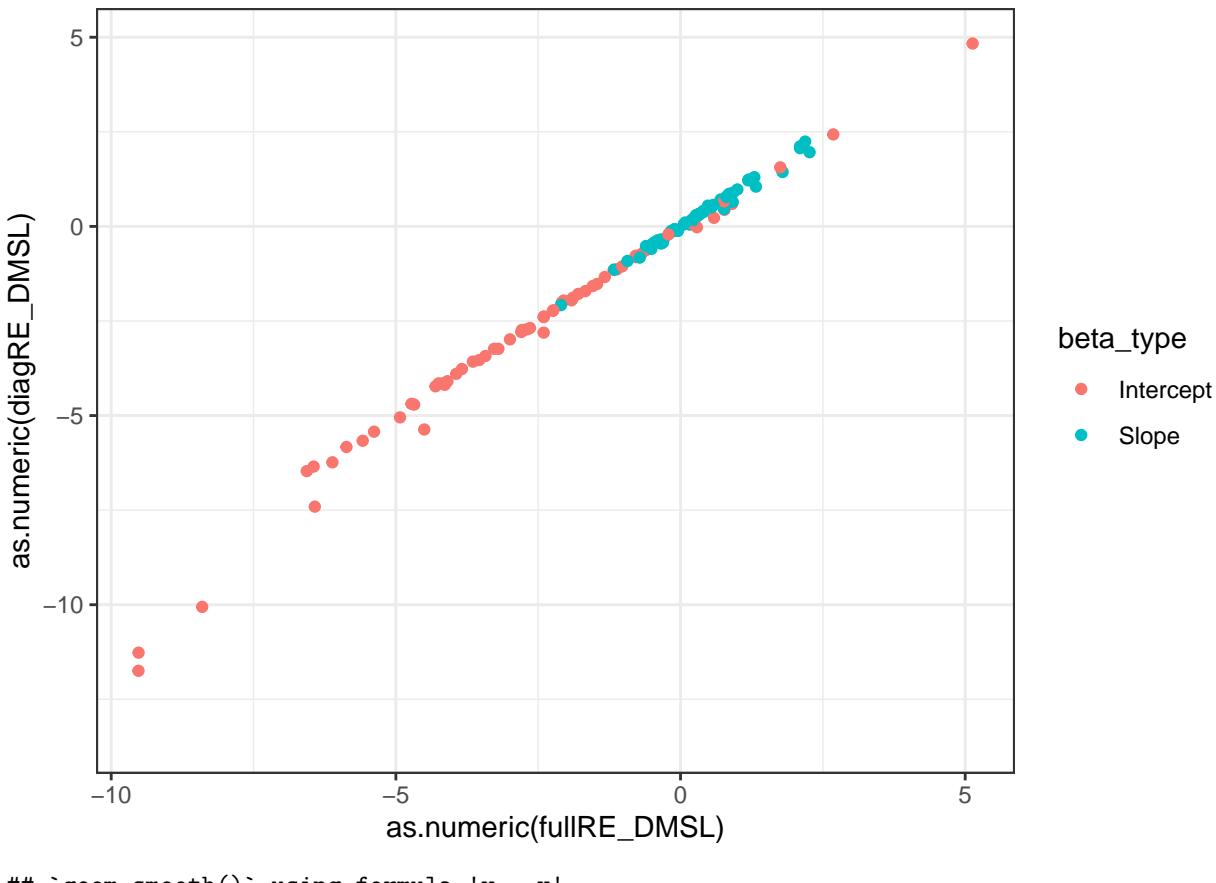


```
## `geom_smooth()` using formula 'y ~ x'
```

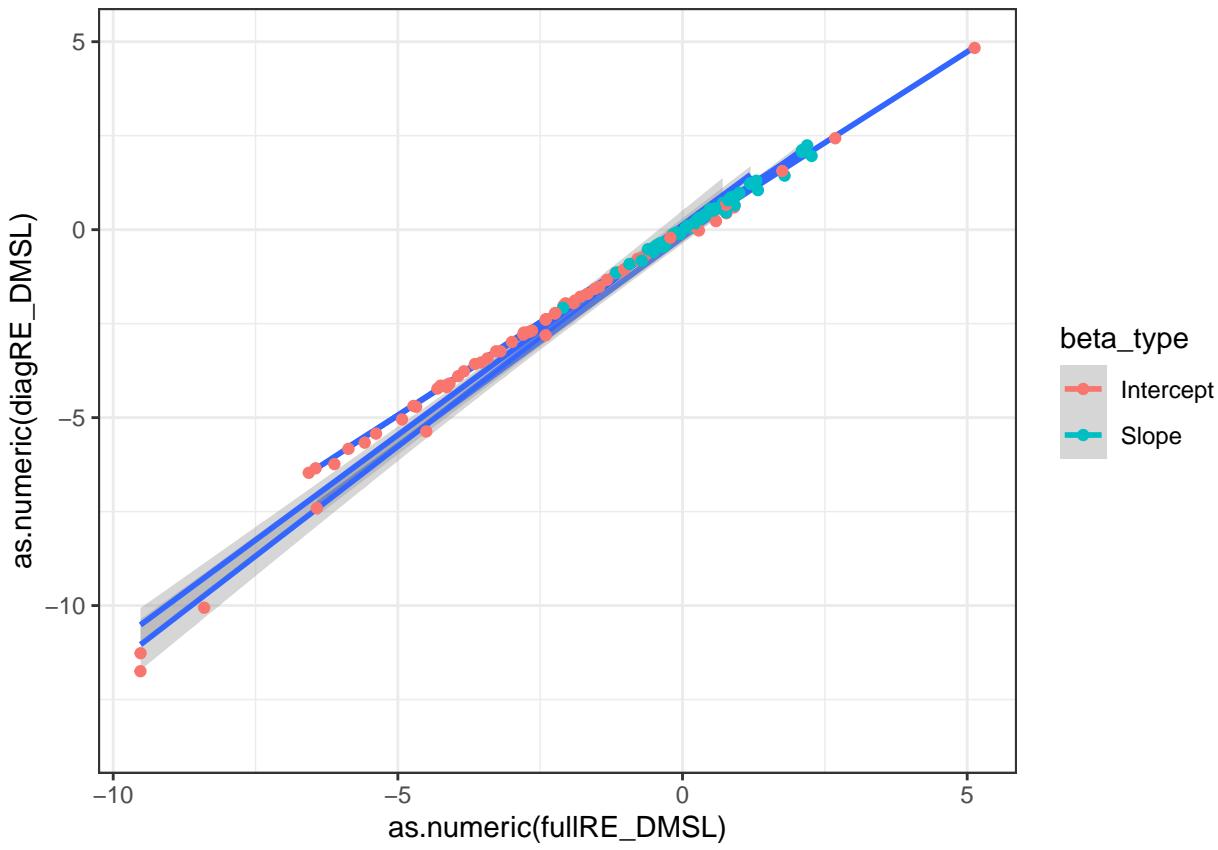


For the cancer types for which we have both fullRE and diagRE, see how the beta coefficients change in these two models, in a scatterplot where we show beta intercepts and slopes.

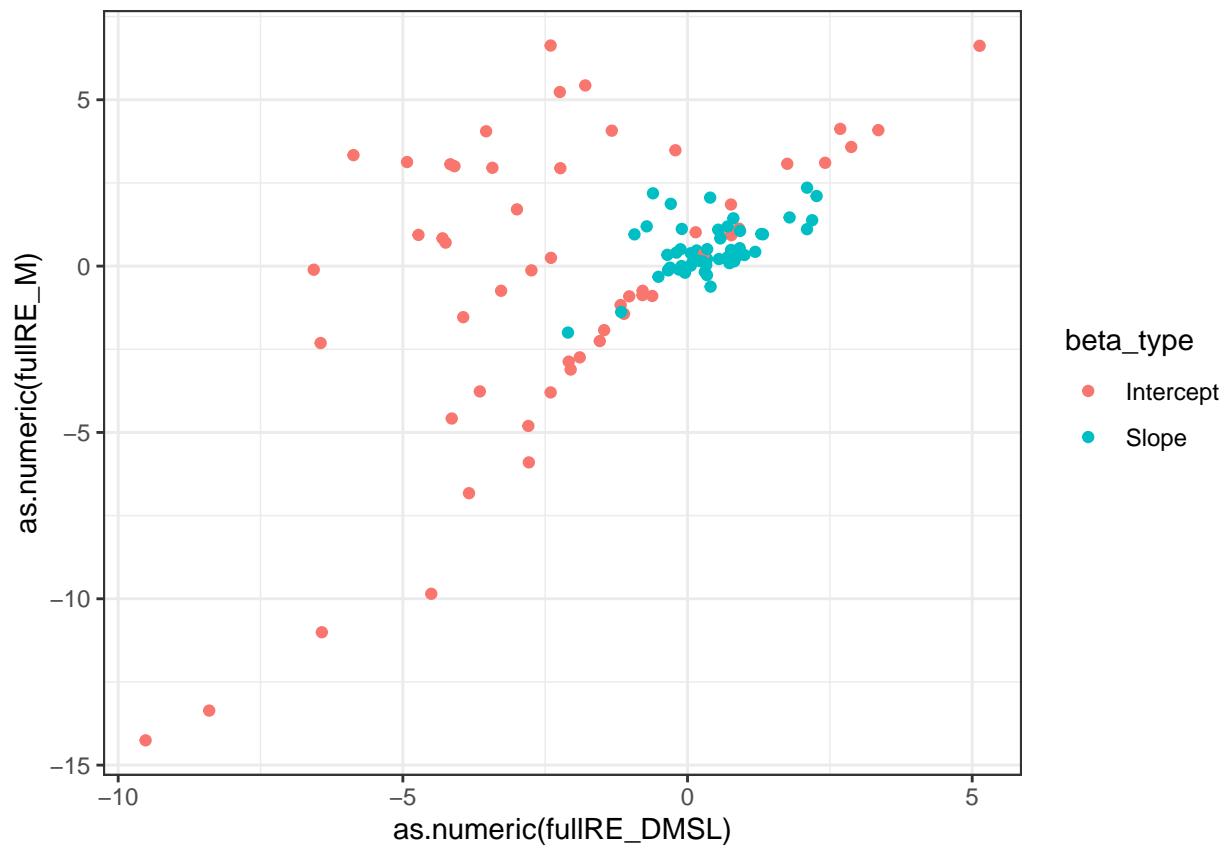
Note that not all fullRE M or diagM have converged - I have removed those which haven't. In some cases I ran DMSL with a subset of signatures, so that diagRE DMSL (with more signatures) cannot be compared to fullRE DMSL.



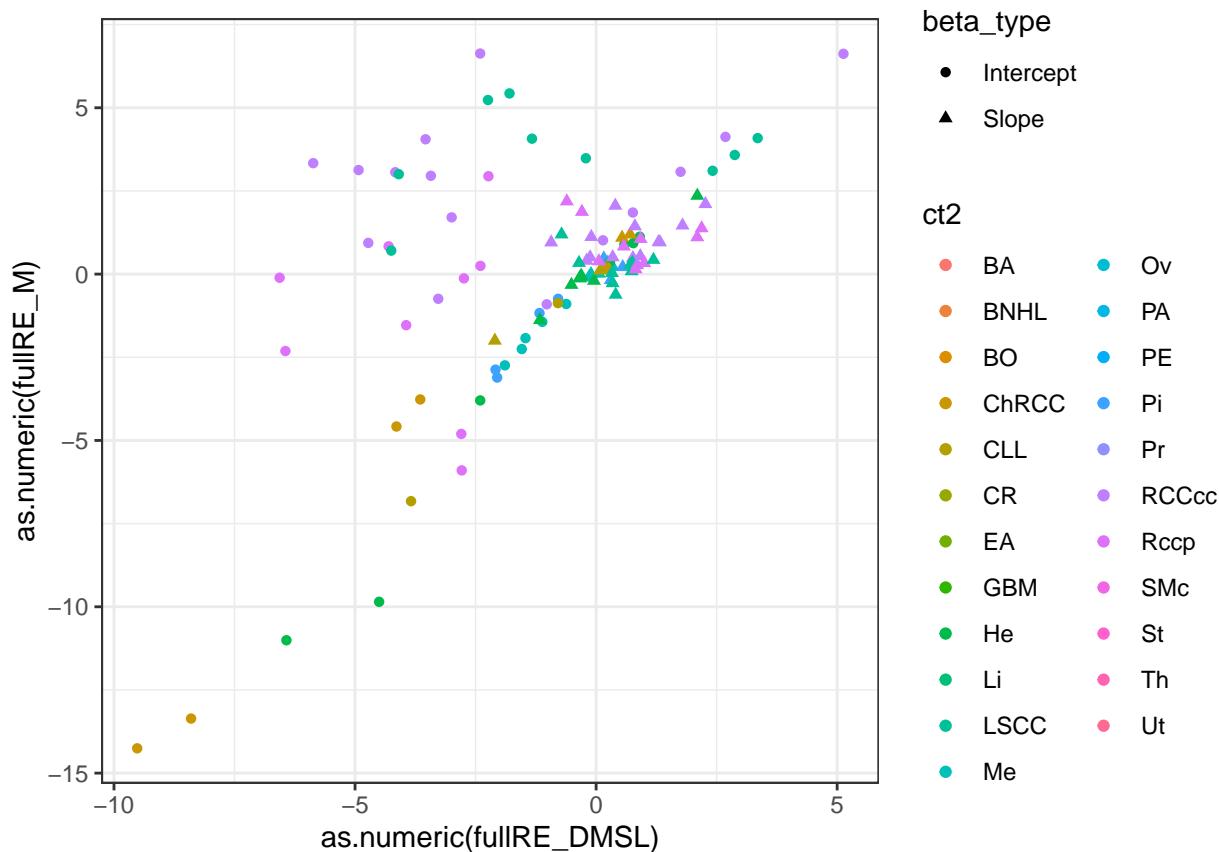
```
## `geom_smooth()` using formula 'y ~ x'  
## Warning: Removed 678 rows containing non-finite values (stat_smooth).  
## Warning: Removed 678 rows containing missing values (geom_point).
```



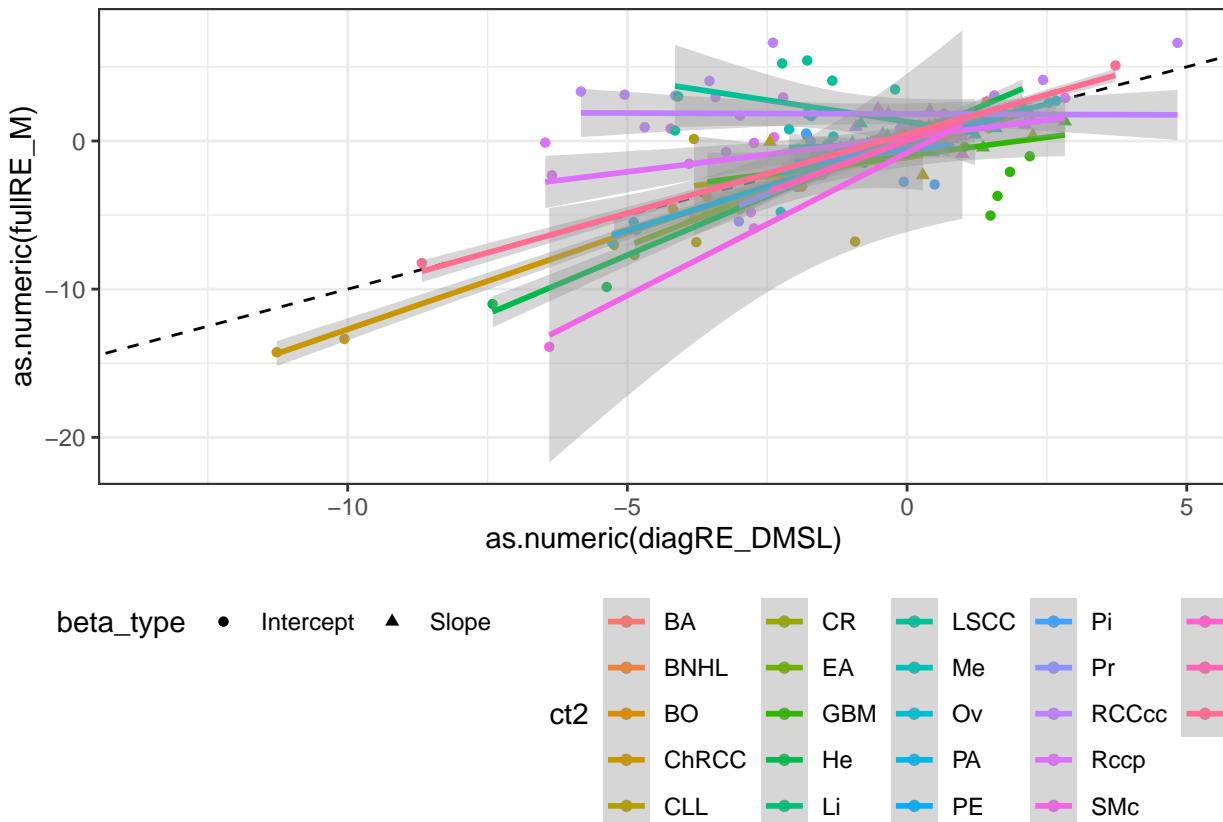
```
## Warning: Removed 696 rows containing missing values (geom_point).
```



```
## Warning: Removed 696 rows containing missing values (geom_point).
```



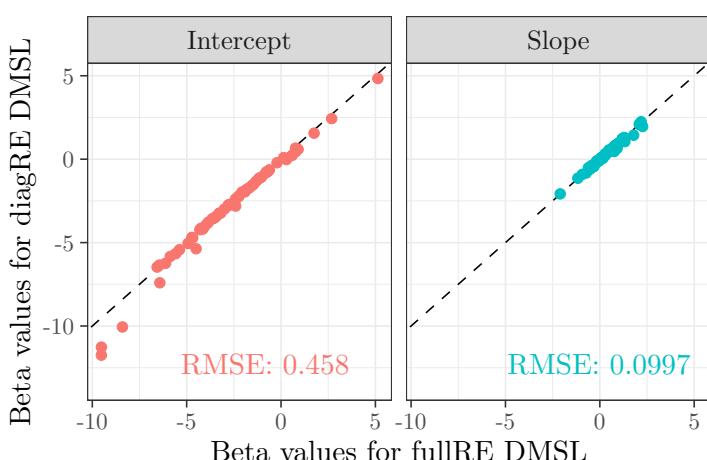
```
## `geom_smooth()` using formula 'y ~ x'
## Warning: Removed 450 rows containing non-finite values (stat_smooth).
## Warning: Removed 450 rows containing missing values (geom_point).
```



```
##   rmse_diag_full_DMSL rmse_fullDMSL_fullM beta_type
## 1          0.09972866          0.7838289     Slope
## 2          0.45761210          4.1215070 Intercept

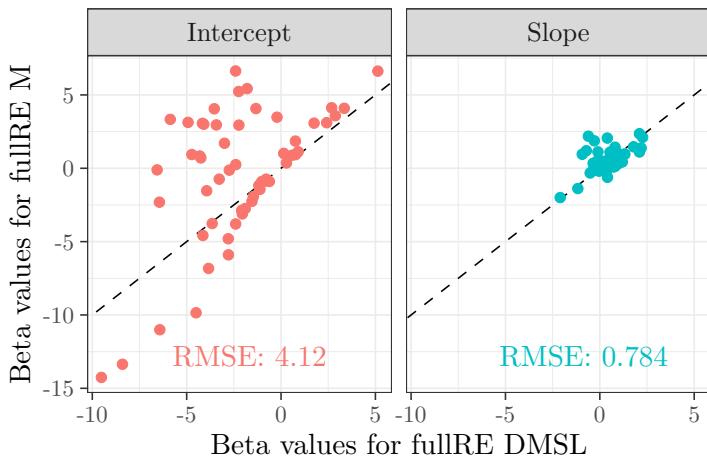
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: Removed 678 rows containing missing values (geom_point).
```



```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

```
## Warning: Removed 696 rows containing missing values (geom_point).
```



```
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
## Error in lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...):
##   0 (non-NA) cases
```

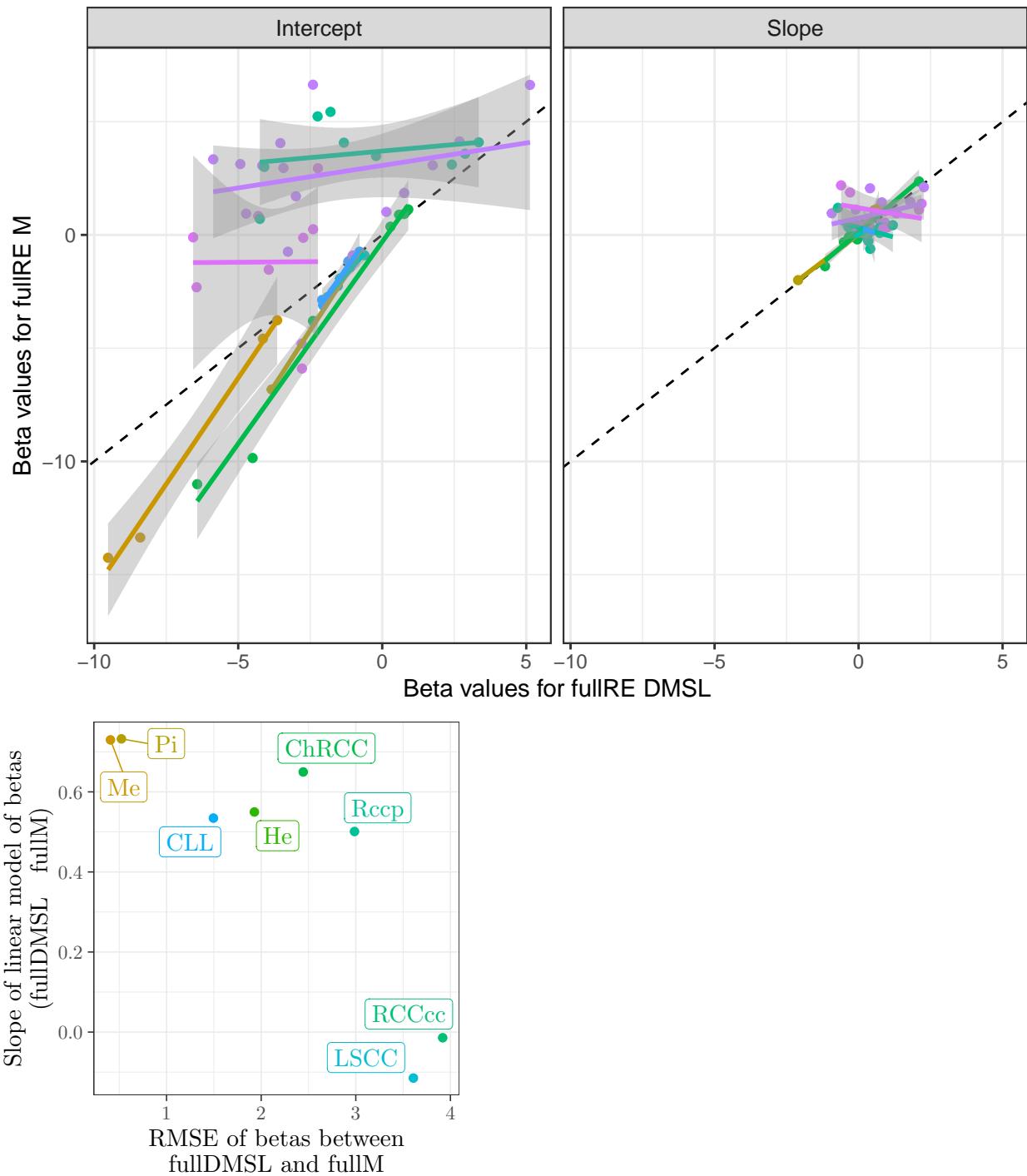


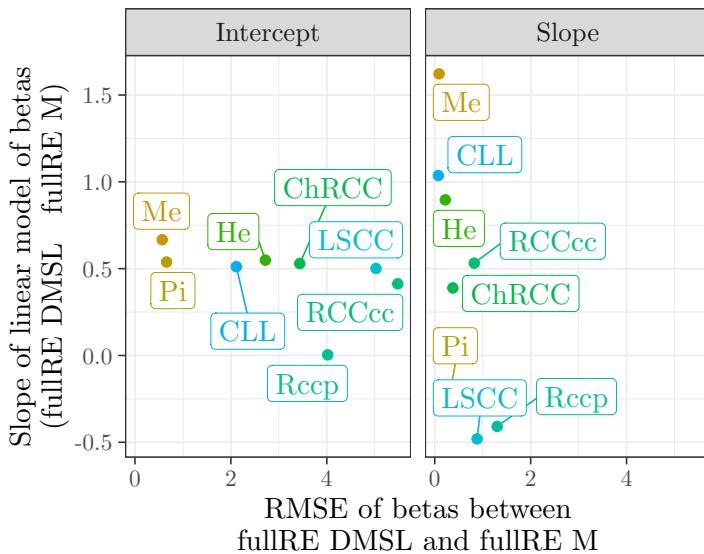




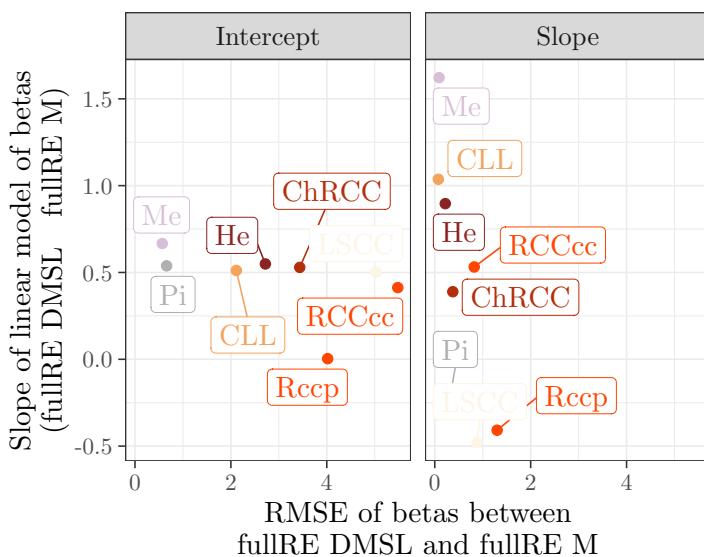
|       |  |              |       |           |
|-------|--|--------------|-------|-----------|
| ## 14 | Lymph-BNHL   | NaN          |       | NA        |
| ## 15 | Lymph-CLL  | 0.01890391   |       | 0.9998600 |
| ## 16 | Ovary-AdenoCA                                      | NaN          |       | NA        |
| ## 17 | Panc-AdenoCA                                       | NaN          |       | NA        |
| ## 18 | Panc-Endocrine                                     | NaN          |       | NA        |
| ## 19 | Prost-AdenoCA                                      | NaN          |       | NA        |
| ## 20 | Skin-Melanoma.cutaneous                            | NaN          |       | NA        |
| ## 21 | Stomach-AdenoCA                                    | NaN          |       | NA        |
| ## 22 | Thy-AdenoCA  | NaN          |       | NA        |
| ## 23 | Uterus-AdenoCA                                     | NaN          |       | NA        |
| ## 24 | Bone-Osteosarc                                     | NaN          |       | NA        |
| ## 25 | Breast-AdenoCA                                     | NaN          |       | NA        |
| ## 26 | CNS-GBM  | NaN          |       | NA        |
| ## 27 | CNS-Medullo  | 0.03219255   |       | 1.0027564 |
| ## 28 | CNS-PiloAstro                                      | 0.06126289   |       | 1.0620811 |
| ## 29 | ColoRect-AdenoCA                                   | NaN          |       | NA        |
| ## 30 | Eso-AdenoCA  | NaN          |       | NA        |
| ## 31 | Head-SCC   | 0.57577998   |       | 0.9145442 |
| ## 32 | Kidney-ChRCC                                       | 1.20493056   |       | 0.7500070 |
| ## 33 | Kidney-RCC.clearcell                               | 0.12124177   |       | 1.0300353 |
| ## 34 | Kidney-RCC.papillary                               | 0.05713314   |       | 1.0202147 |
| ## 35 | Liver-HCC  | 0.64474403   |       | 0.8268624 |
| ## 36 | Lung-SCC   | 0.04132926   |       | 1.0154875 |
| ## 37 | Lymph-BNHL   | NaN          |       | NA        |
| ## 38 | Lymph-CLL  | 0.05207686   |       | 1.0313870 |
| ## 39 | Ovary-AdenoCA                                      | NaN          |       | NA        |
| ## 40 | Panc-AdenoCA                                       | NaN          |       | NA        |
| ## 41 | Panc-Endocrine                                     | NaN          |       | NA        |
| ## 42 | Prost-AdenoCA                                      | NaN          |       | NA        |
| ## 43 | Skin-Melanoma.cutaneous                            | NaN          |       | NA        |
| ## 44 | Stomach-AdenoCA                                    | NaN          |       | NA        |
| ## 45 | Thy-AdenoCA  | NaN          |       | NA        |
| ## 46 | Uterus-AdenoCA                                     | NaN          |       | NA        |
| ##    | rmse_fullDMSL_fullM slope_fullDMSL_fullM beta_type | ct2          |       |           |
| ## 1  | NaN  | NA           | Slope | BO        |
| ## 2  | NaN  | NA           | Slope | BA        |
| ## 3  | NaN  | NA           | Slope | GBM       |
| ## 4  | 0.09059152   | 1.621940968  | Slope | Me        |
| ## 5  | 0.33664739   | -0.191799809 | Slope | Pi        |
| ## 6  | NaN  | NA           | Slope | CR        |
| ## 7  | NaN  | NA           | Slope | EA        |
| ## 8  | 0.21918157   | 0.896372091  | Slope | He        |
| ## 9  | 0.37670836   | 0.389119063  | Slope | ChRCC     |
| ## 10 | 0.82278832   | 0.531725788  | Slope | RCCcc     |
| ## 11 | 1.30070772   | -0.408535086 | Slope | Rccp      |
| ## 12 | NaN  | NA           | Slope | Li        |
| ## 13 | 0.88196759   | -0.480178978 | Slope | LSCC      |
| ## 14 | NaN  | NA           | Slope | BNHL      |
| ## 15 | 0.07406513   | 1.036692829  | Slope | CLL       |
| ## 16 | NaN  | NA           | Slope | Ov        |
| ## 17 | NaN  | NA           | Slope | PA        |

|       |            |              |           |       |
|-------|------------|--------------|-----------|-------|
| ## 18 | NaN        | NA           | Slope     | PE    |
| ## 19 | NaN        | NA           | Slope     | Pr    |
| ## 20 | NaN        | NA           | Slope     | SMc   |
| ## 21 | NaN        | NA           | Slope     | St    |
| ## 22 | NaN        | NA           | Slope     | Th    |
| ## 23 | NaN        | NA           | Slope     | Ut    |
| ## 24 | NaN        | NA Intercept | BO        |       |
| ## 25 | NaN        | NA Intercept | BA        |       |
| ## 26 | NaN        | NA Intercept | GBM       |       |
| ## 27 | 0.56916461 | 0.666803710  | Intercept | Me    |
| ## 28 | 0.65905520 | 0.538204984  | Intercept | Pi    |
| ## 29 | NaN        | NA Intercept | CR        |       |
| ## 30 | NaN        | NA Intercept | EA        |       |
| ## 31 | 2.71848733 | 0.549152181  | Intercept | He    |
| ## 32 | 3.43614717 | 0.529239927  | Intercept | ChRCC |
| ## 33 | 5.47957627 | 0.412829456  | Intercept | RCCcc |
| ## 34 | 4.01789367 | 0.003543566  | Intercept | Rccp  |
| ## 35 | NaN        | NA Intercept | Li        |       |
| ## 36 | 5.02604140 | 0.501340467  | Intercept | LSCC  |
| ## 37 | NaN        | NA Intercept | BNHL      |       |
| ## 38 | 2.11315976 | 0.511657714  | Intercept | CLL   |
| ## 39 | NaN        | NA Intercept | Ov        |       |
| ## 40 | NaN        | NA Intercept | PA        |       |
| ## 41 | NaN        | NA Intercept | PE        |       |
| ## 42 | NaN        | NA Intercept | Pr        |       |
| ## 43 | NaN        | NA Intercept | SMc       |       |
| ## 44 | NaN        | NA Intercept | St        |       |
| ## 45 | NaN        | NA Intercept | Th        |       |
| ## 46 | NaN        | NA Intercept | Ut        |       |





```
##          ct rmse_diag_full_DMSL slope_diag_full_DMSL rmse_fullDMSL_fullM
## 1  Bone-Osteosarc           NaN           NA           NaN
## 2  Breast-AdenoCA          NaN           NA           NaN
## 3    CNS-GBM                 NaN           NA           NaN
## 4  CNS-Medullo            0.01960951      1.081707   0.09059152
## 5  CNS-PiloAstro           0.06634326      0.834093   0.33664739
## 6 ColoRect-AdenoCA         NaN           NA           NaN
##   slope_fullDMSL_fullM beta_type ct2
## 1                   NA     Slope  BO
## 2                   NA     Slope  BA
## 3                   NA     Slope GBM
## 4      1.6219410     Slope  Me
## 5     -0.1917998     Slope  Pi
## 6                   NA     Slope CR
```



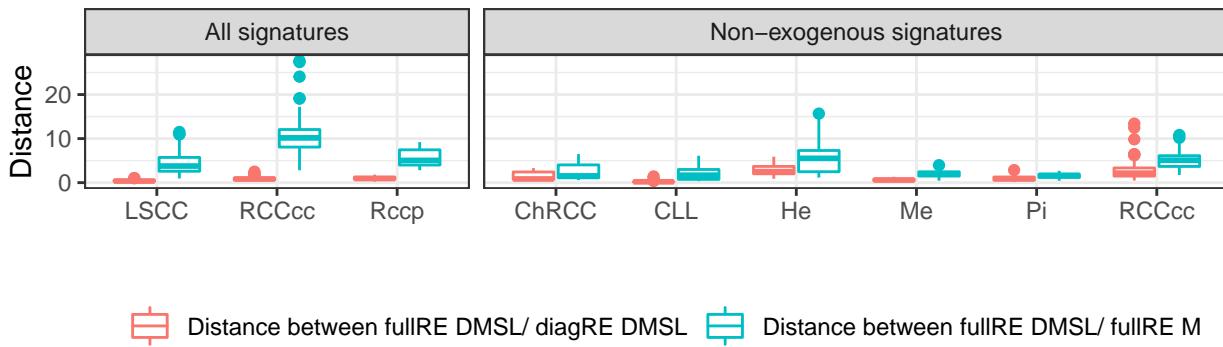
Compare the random effects intercepts. We cannot compare across cancer types because the number of observation

is different. For each cancer type, compare the intercept fullRE DMSL of each patient to the intercept of fullRE M and diagRE DMSL. I.e. for each cancer type we have a boxplot.

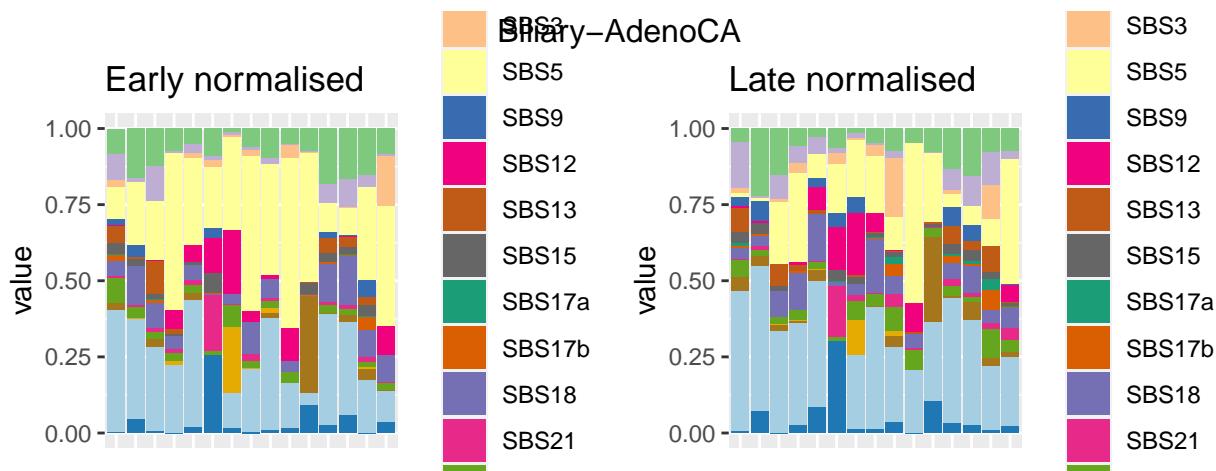
```
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
## Warning in FUN(X[[i]], ...): NAs introduced by coercion
## Error : $ operator is invalid for atomic vectors
## Error : $ operator is invalid for atomic vectors
```

Would like to have the picture below in computer modern, but I cannot make boxplot work with tikz

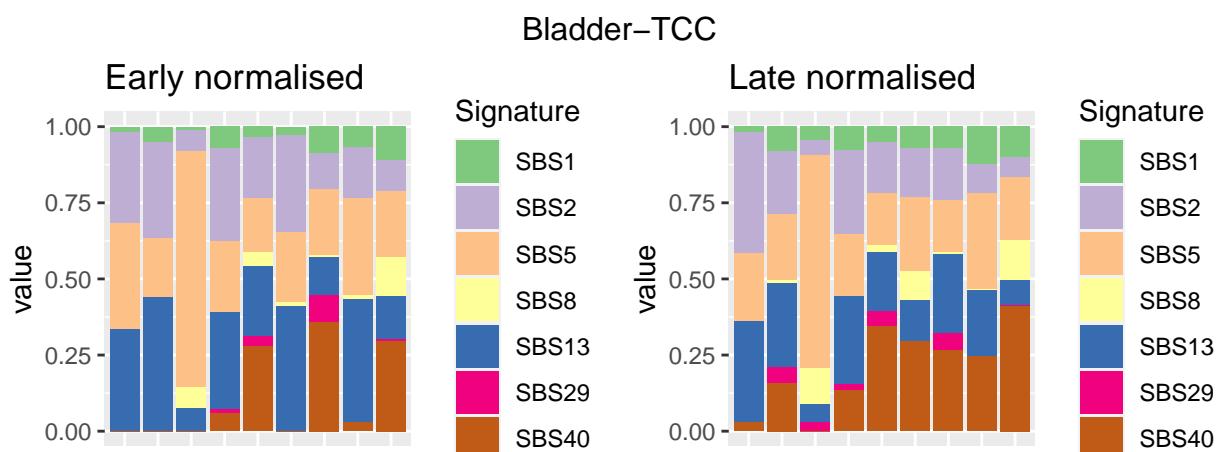
```
## `summarise()` has grouped output by 'ct'. You can override using the `.groups` argument.
## `summarise()` has grouped output by 'ct'. You can override using the `.groups` argument.
```



## Using subset of active signatures from the PCAWG paper



```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.328]
```



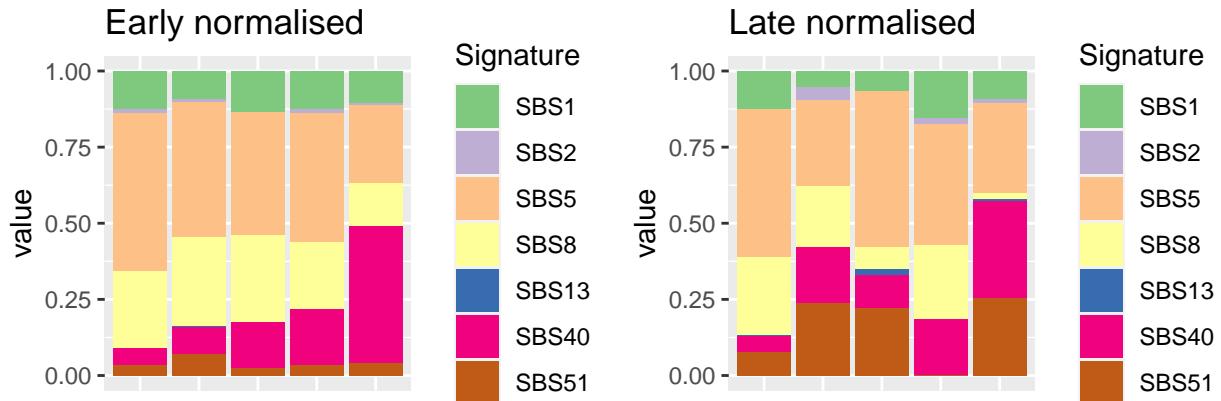
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
```

```

## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.503]

```

### Bone-Benign

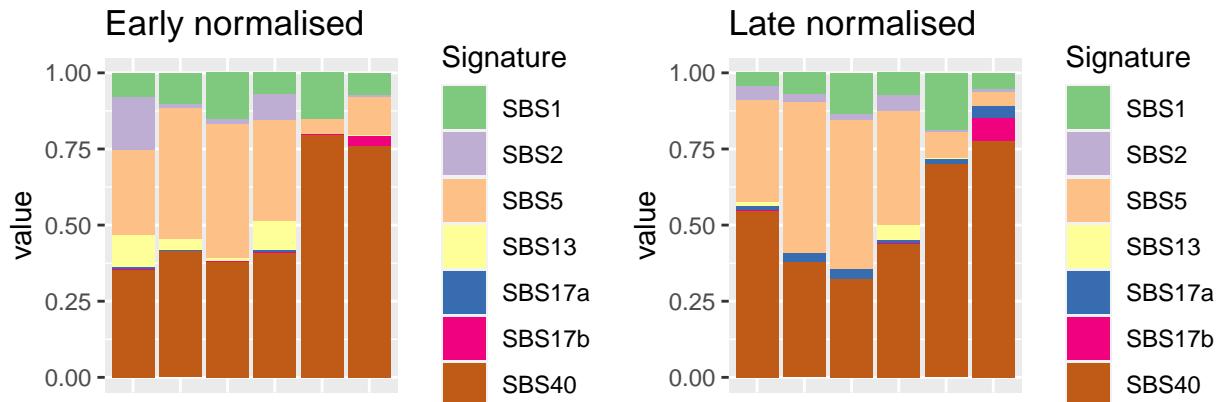


```

## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.678]

```

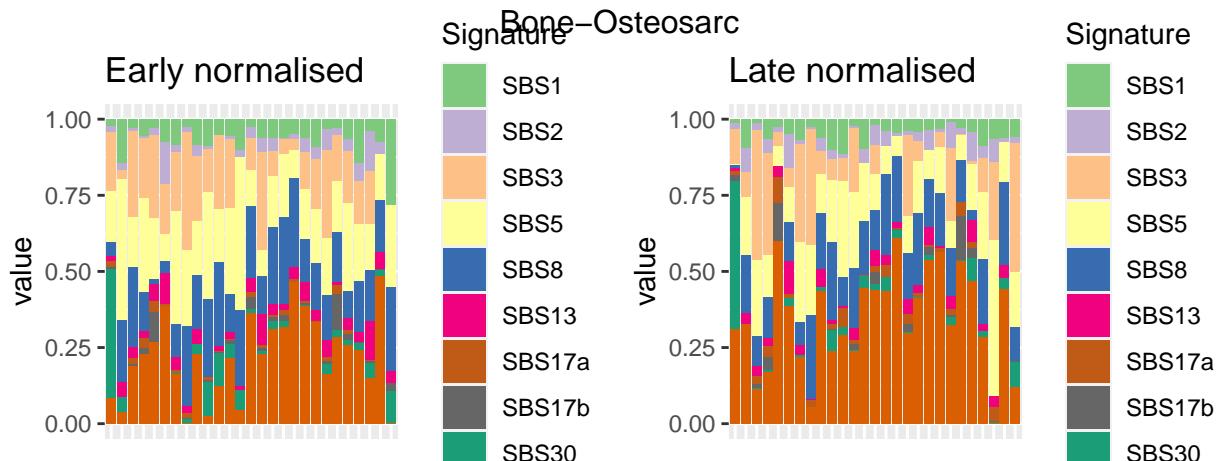
### Bone-Epith



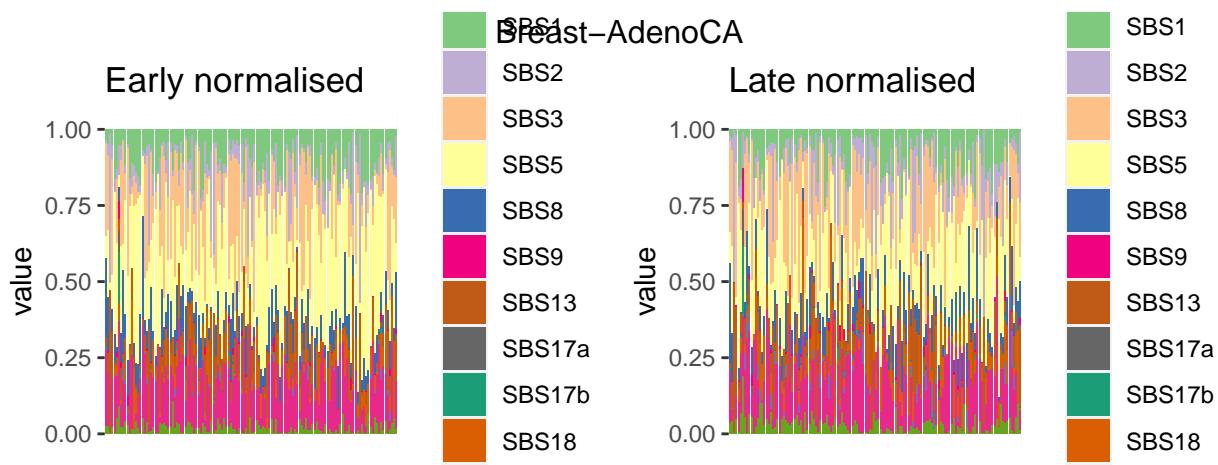
```

## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.853]

```

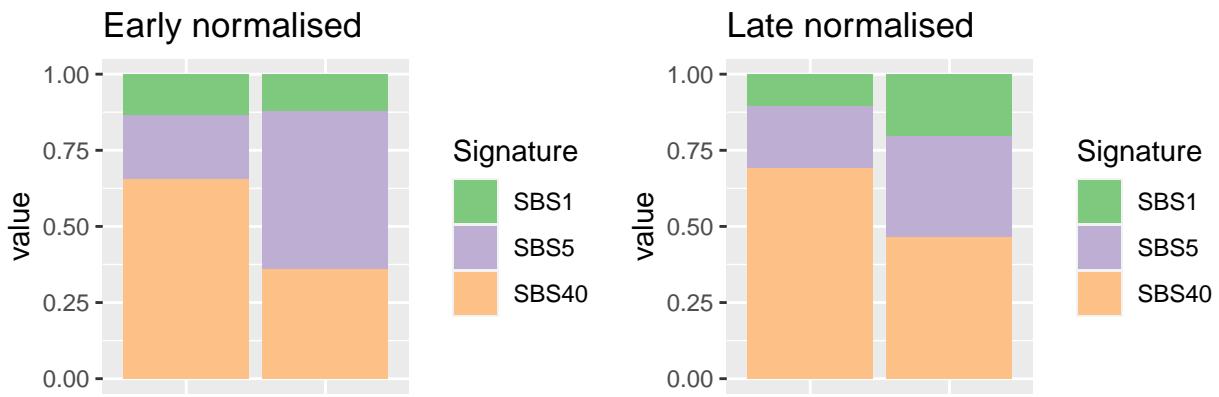


```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1070]
```



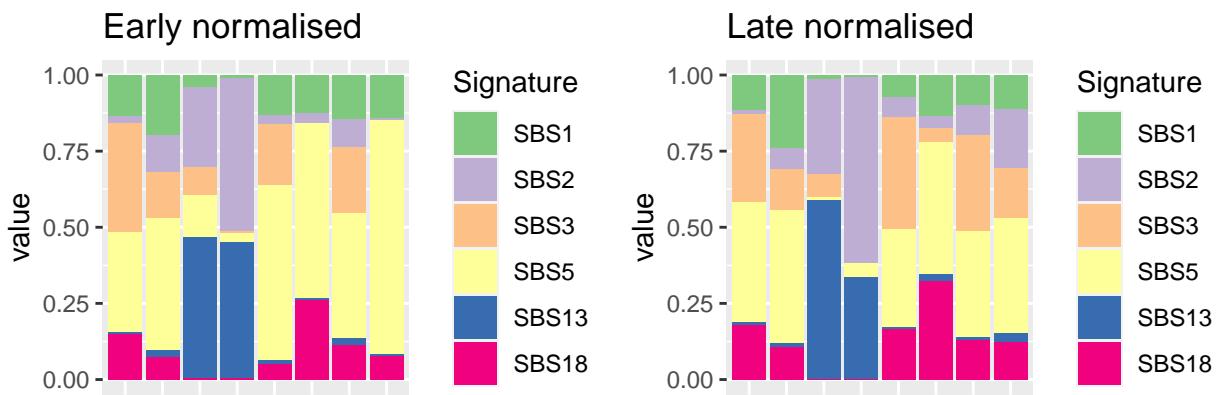
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1329]
```

### Breast-DCIS



```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1448]
```

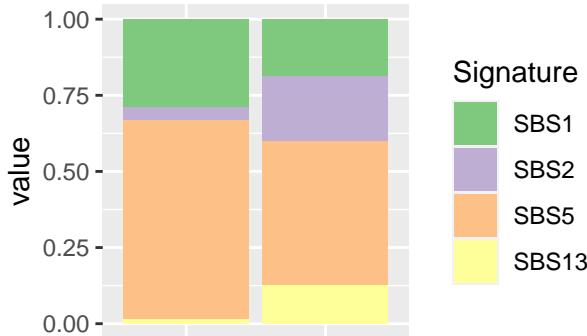
### Breast-LobularCA



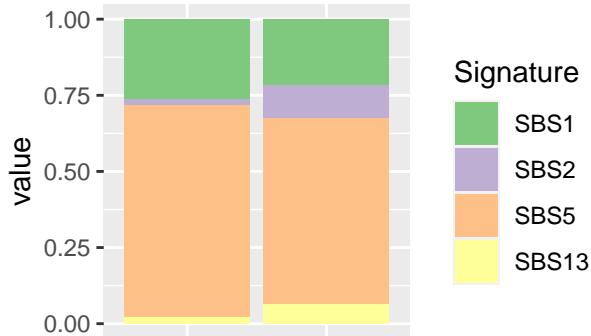
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1609]
```

### Cervix–AdenoCA

Early normalised



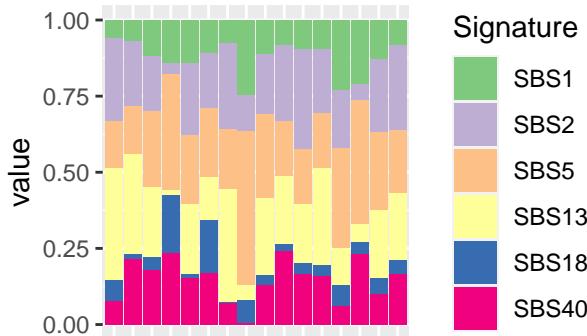
Late normalised



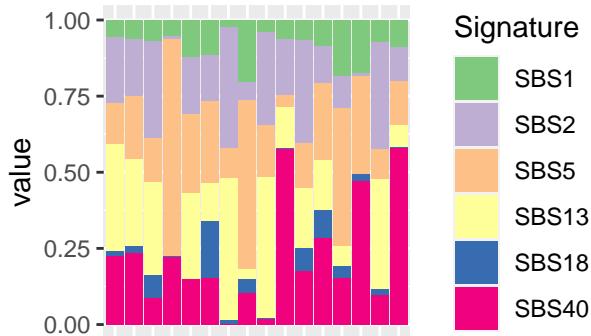
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1742]
```

### Cervix–SCC

Early normalised

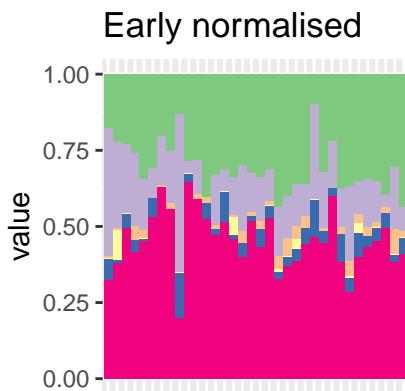


Late normalised

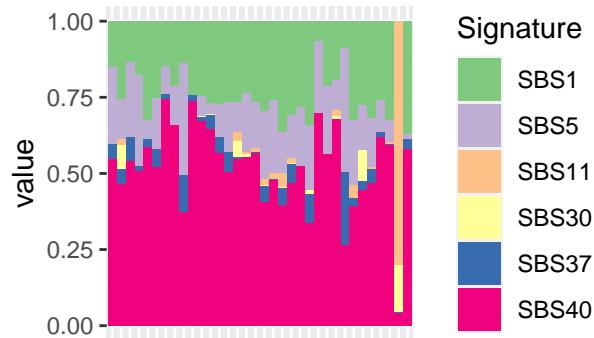


```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1903]
```

### CNS–GBM

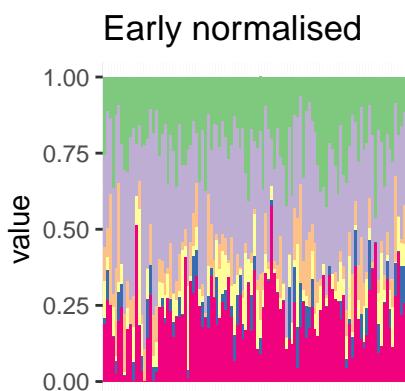


**Late normalised**

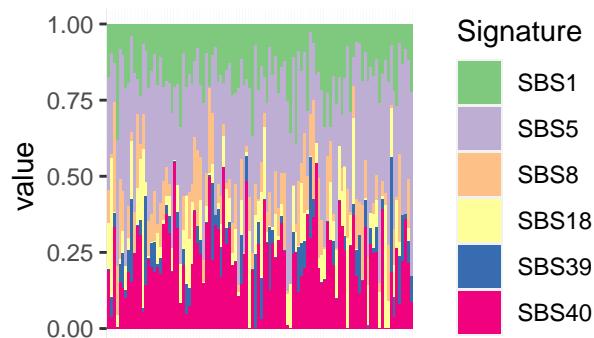


```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2064]
```

### CNS–Medullo



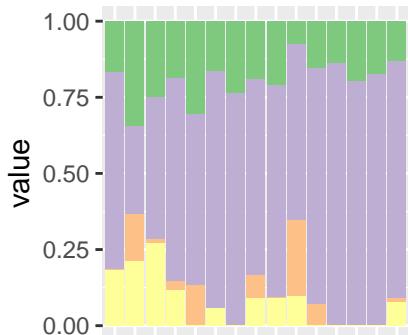
**Late normalised**



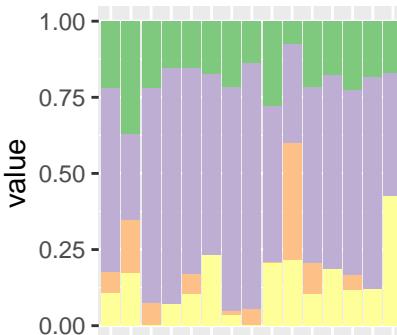
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2225]
```

### CNS–Oligo

Early normalised



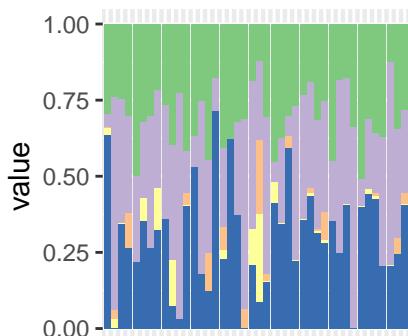
Late normalised



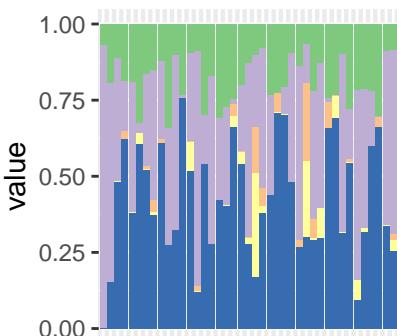
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2358]
```

### CNS–PiloAstro

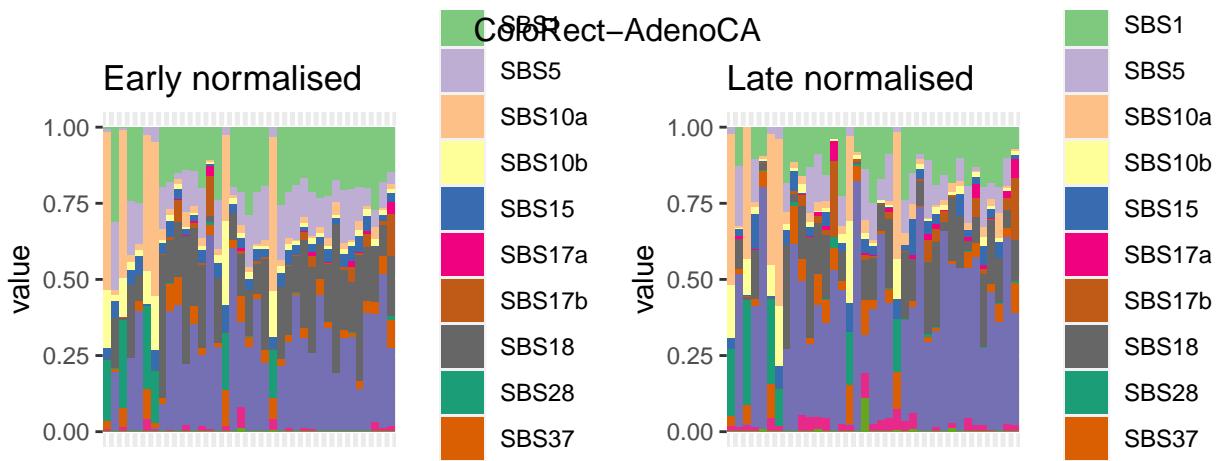
Early normalised



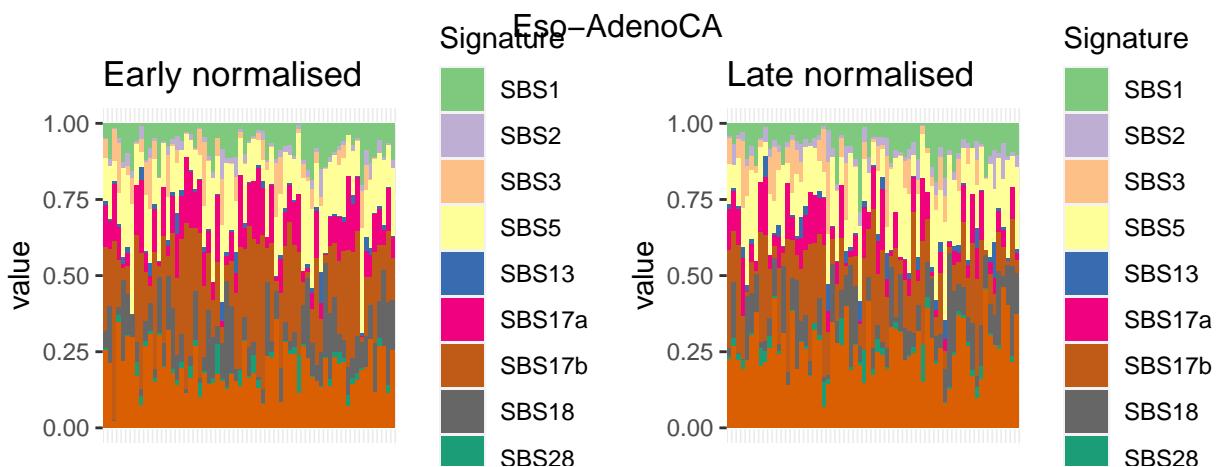
Late normalised



```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2505]
```

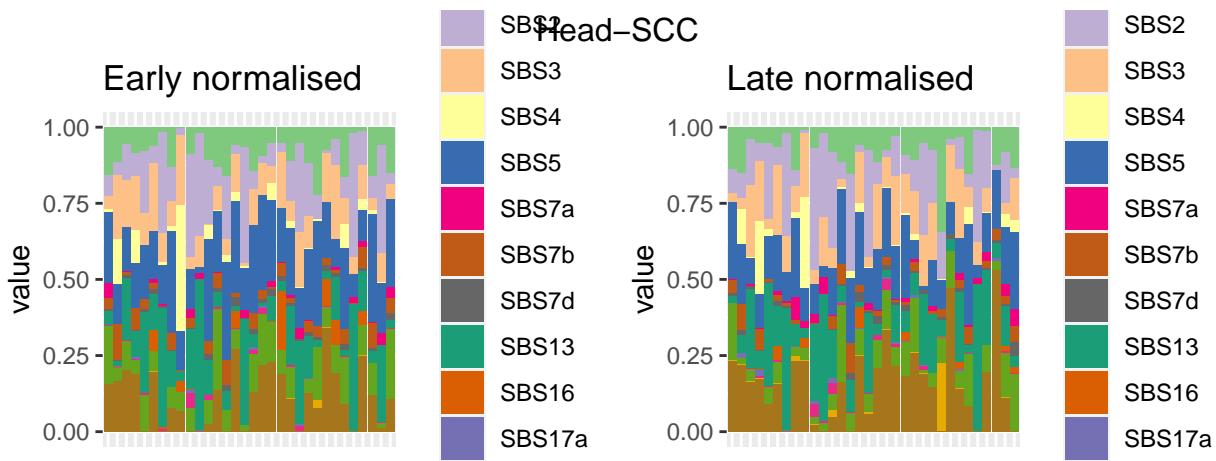


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2764]
```

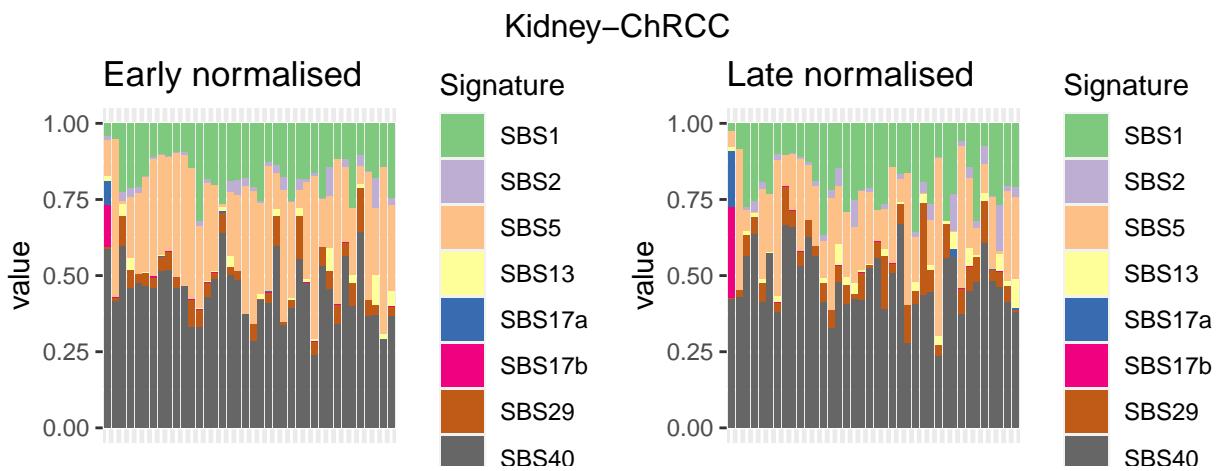


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2981]
```



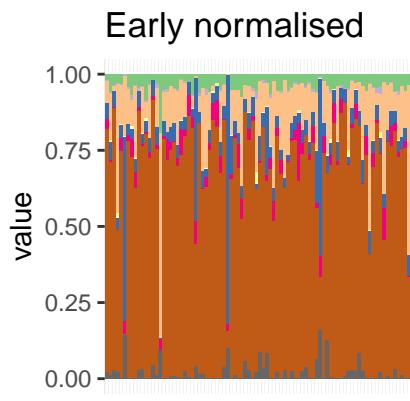


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3268]
```



```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3457]
```

### Kidney–RCC.clearcell



Signature

- SBS1
- SBS2
- SBS5
- SBS13
- SBS22
- SBS29
- SBS40
- SBS41

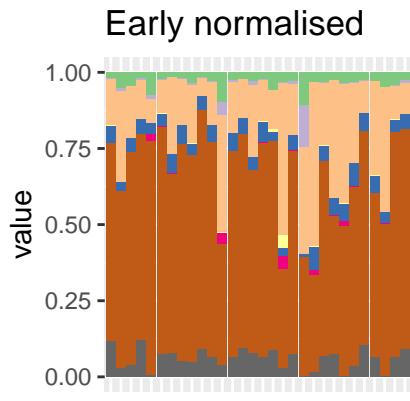


Signature

- SBS1
- SBS2
- SBS5
- SBS13
- SBS22
- SBS29
- SBS40
- SBS41

```
## TableGrob (2 x 2) "arrange": 3 grobs
## z cells name grob
## 1 1 (2-2,1-1) arrange gtable[layout]
## 2 2 (2-2,2-2) arrange gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3646]
```

### Kidney–RCC.papillary



Signature

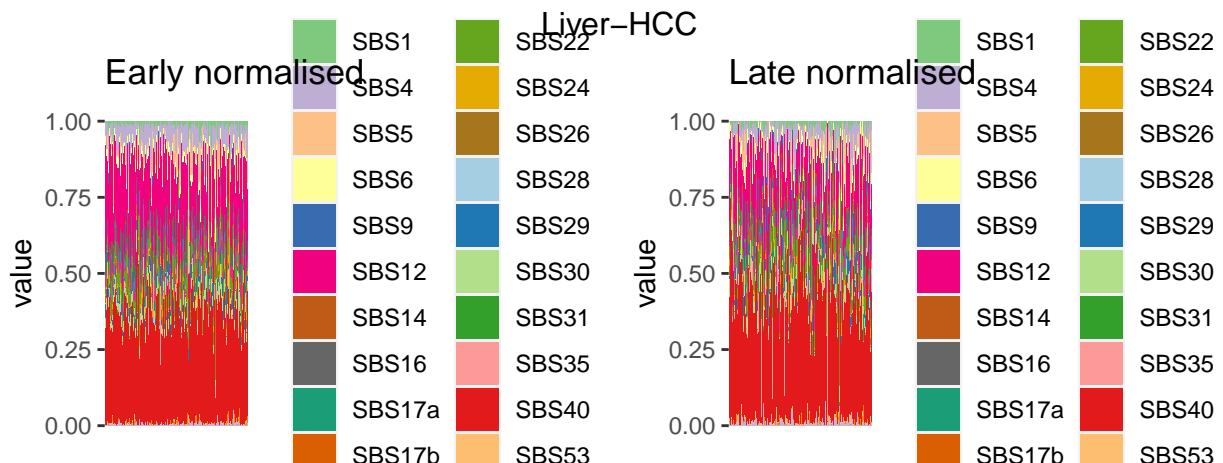
- SBS1
- SBS2
- SBS5
- SBS13
- SBS22
- SBS29
- SBS40
- SBS41



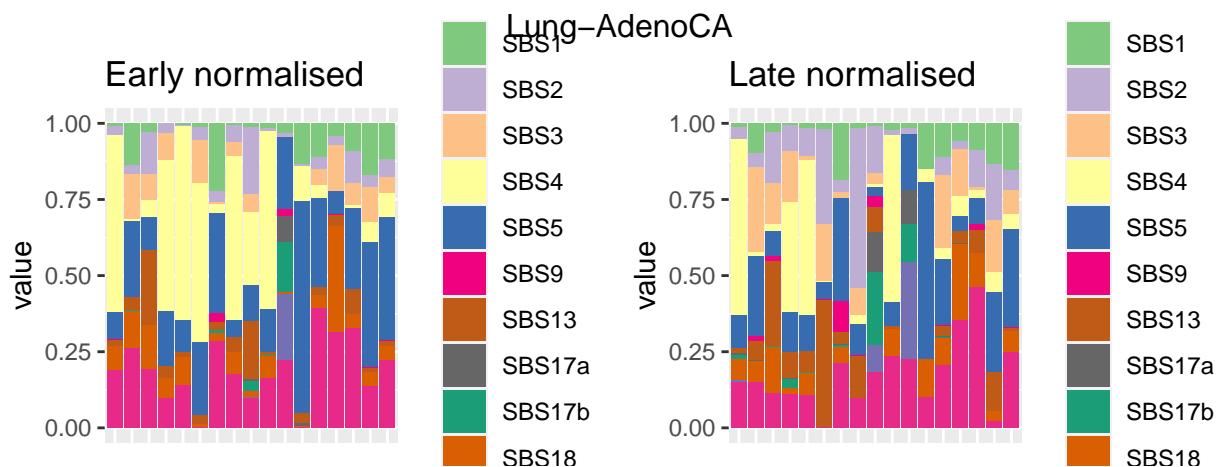
Signature

- SBS1
- SBS2
- SBS5
- SBS13
- SBS22
- SBS29
- SBS40
- SBS41

```
## TableGrob (2 x 2) "arrange": 3 grobs
## z cells name grob
## 1 1 (2-2,1-1) arrange gtable[layout]
## 2 2 (2-2,2-2) arrange gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3835]
```



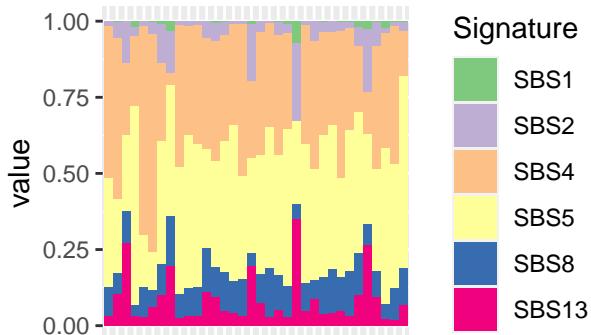
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4248]
```



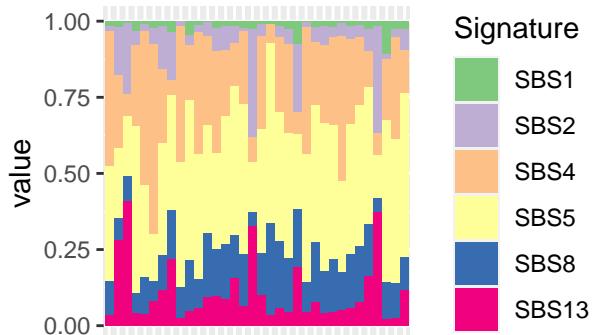
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4493]
```

### Lung-SCC

Early normalised

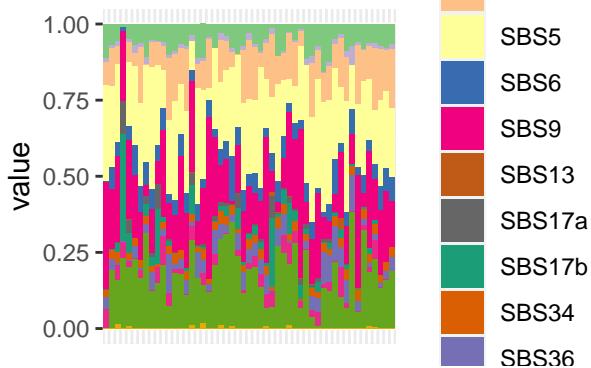


Late normalised

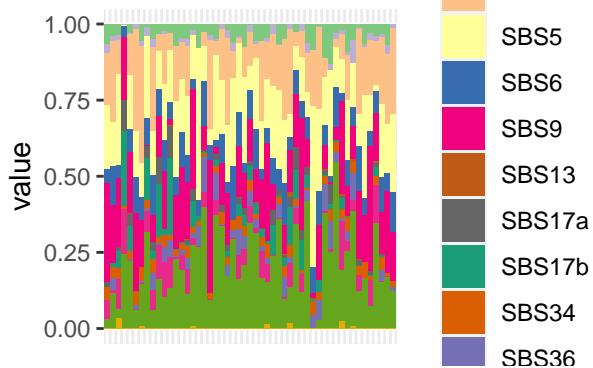


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4654]
```

Early normalised

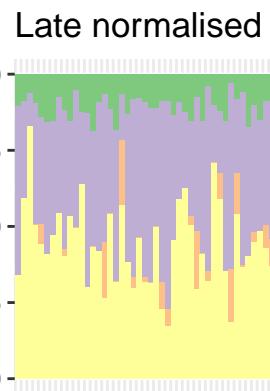
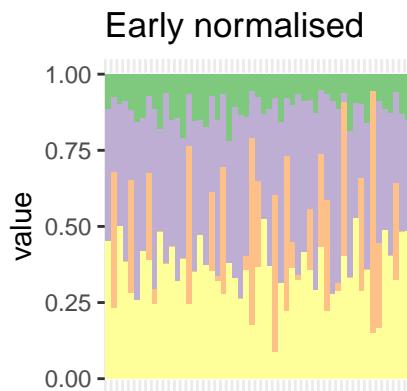


Late normalised



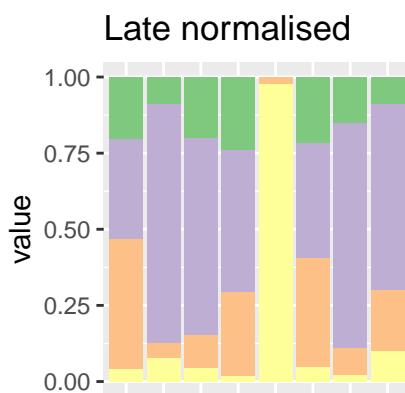
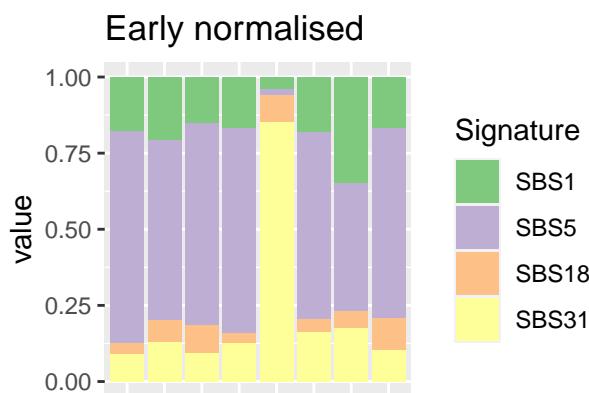
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4927]
```

### Lymph-CLL



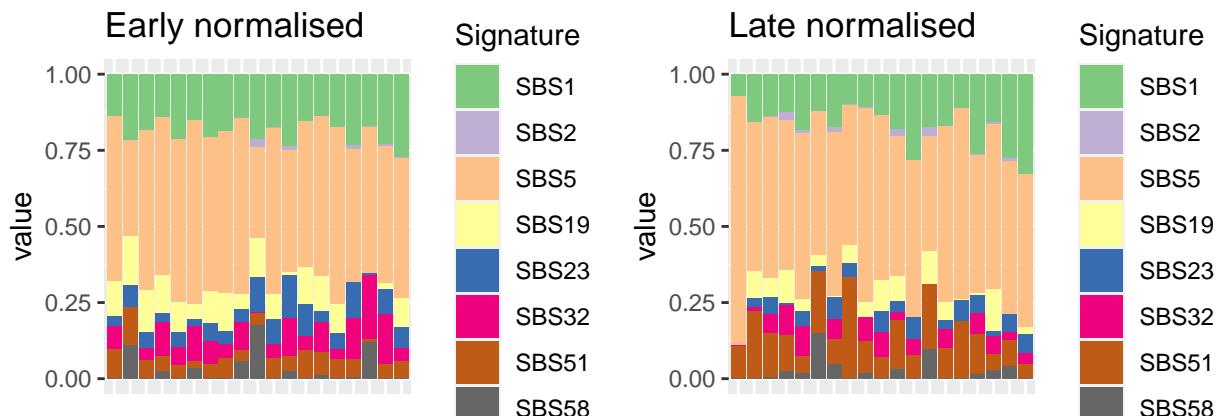
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5060]
```

### Myeloid-AML

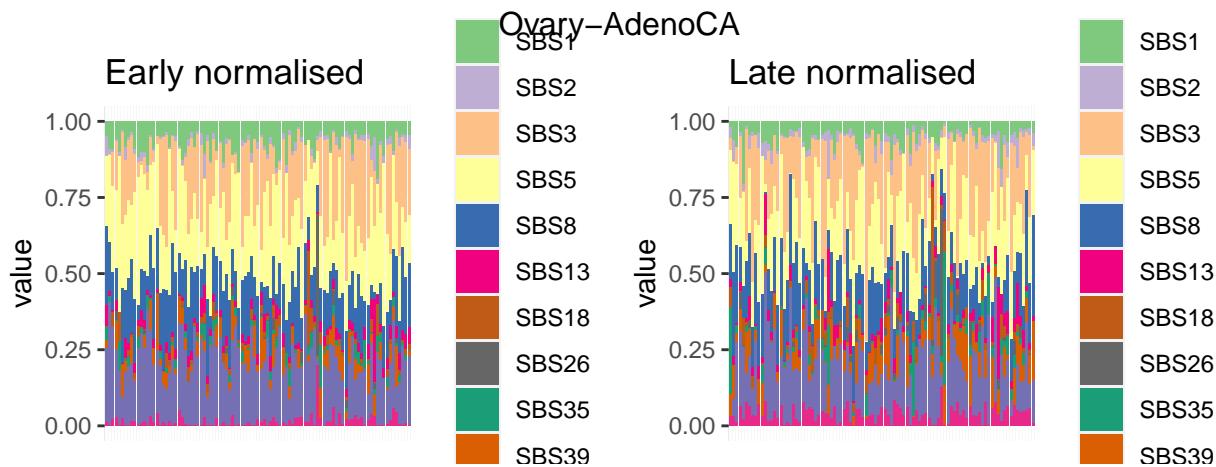


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name      grob
## 1 1 (2-2,1-1) arrange    gtable[layout]
## 2 2 (2-2,2-2) arrange    gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5193]
```

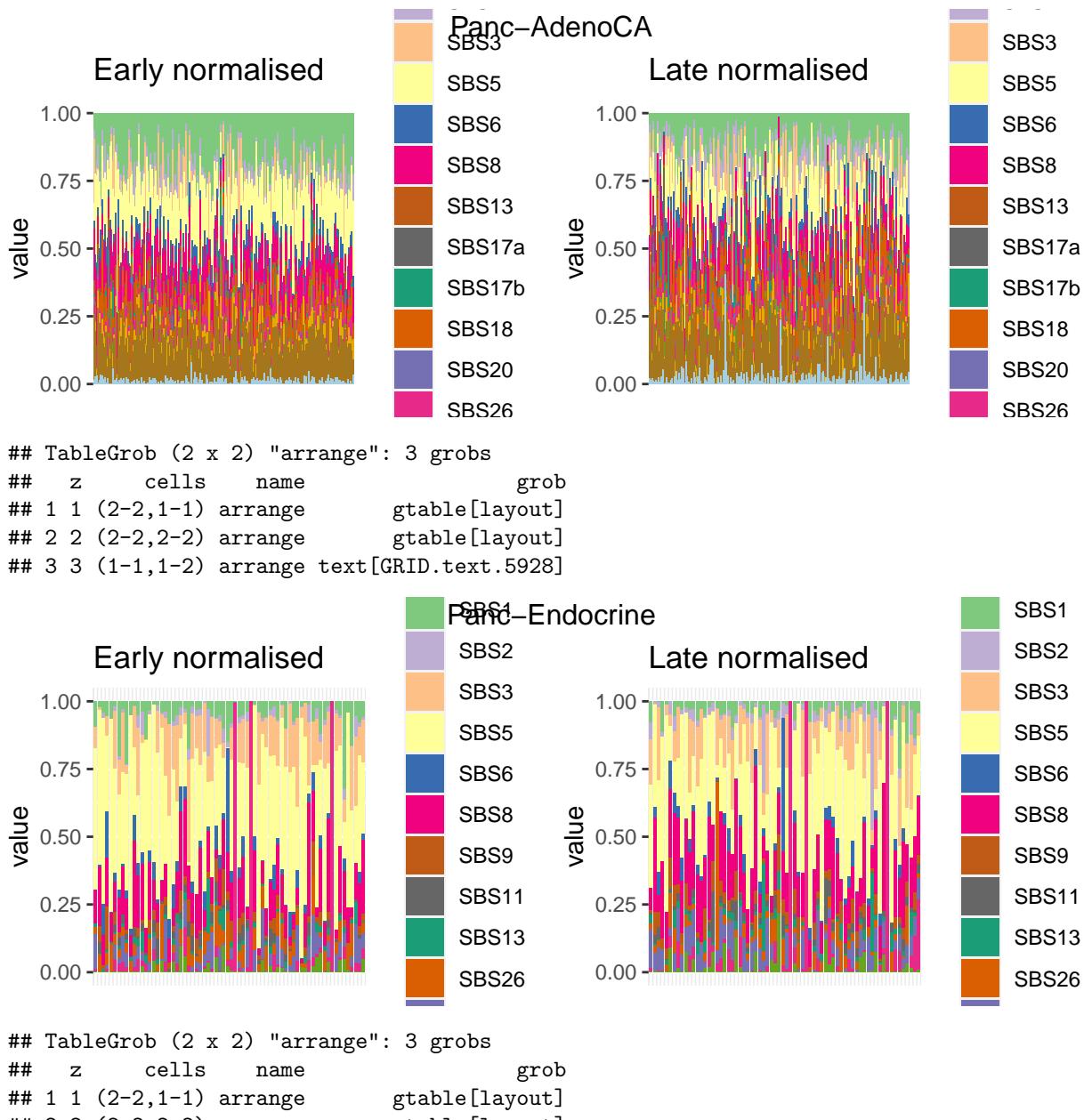
### Myeloid–MPN

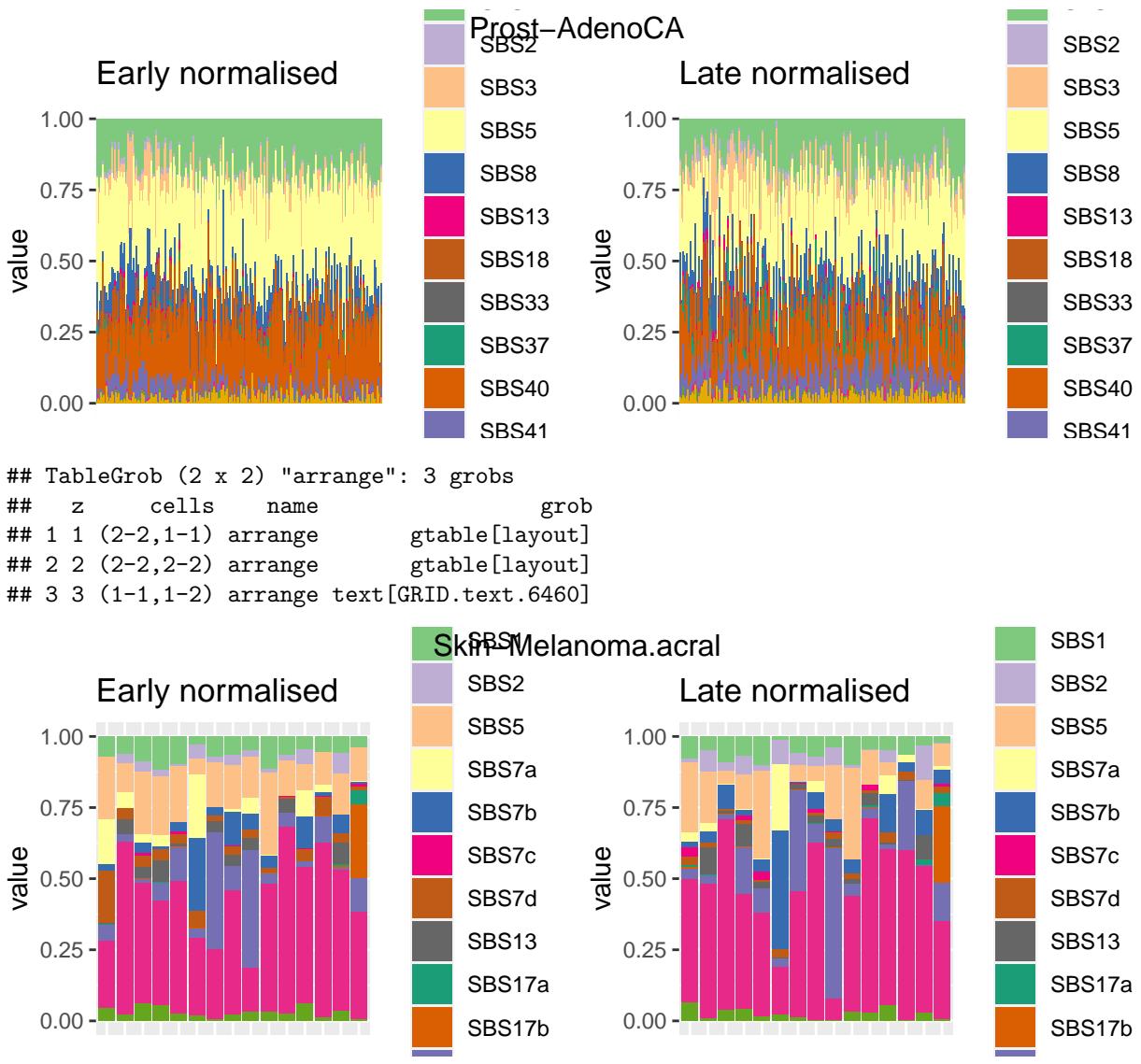


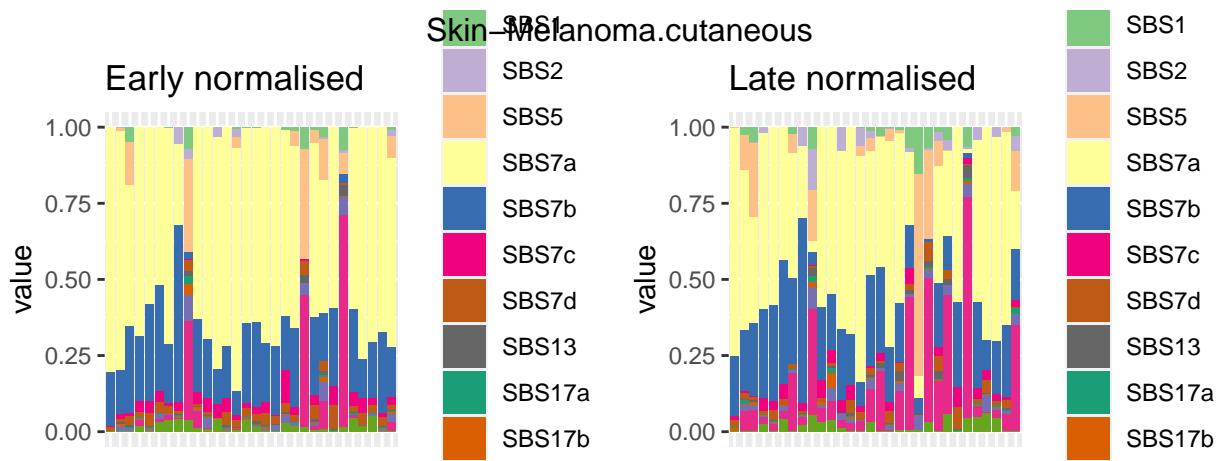
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5382]
```



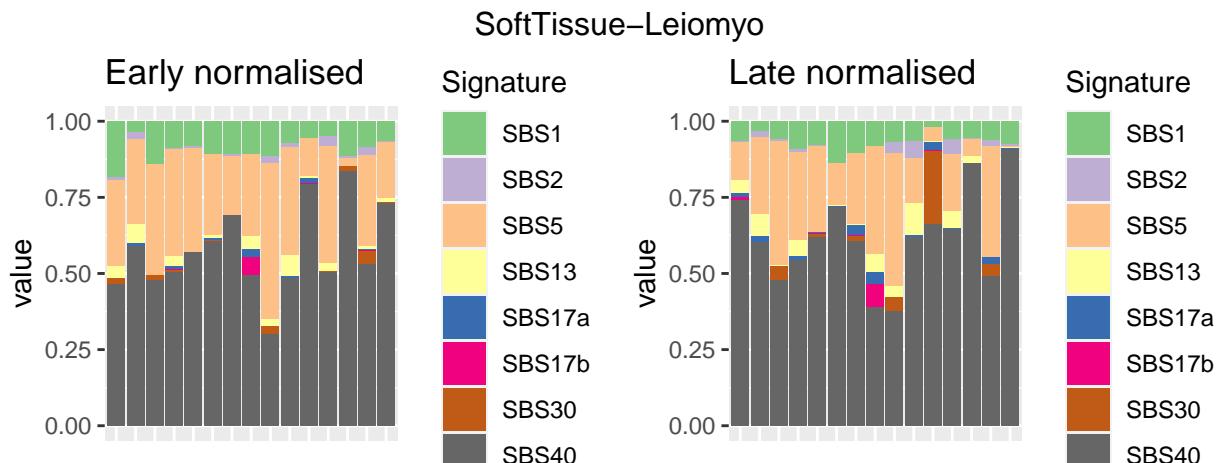
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells  name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5627]
```





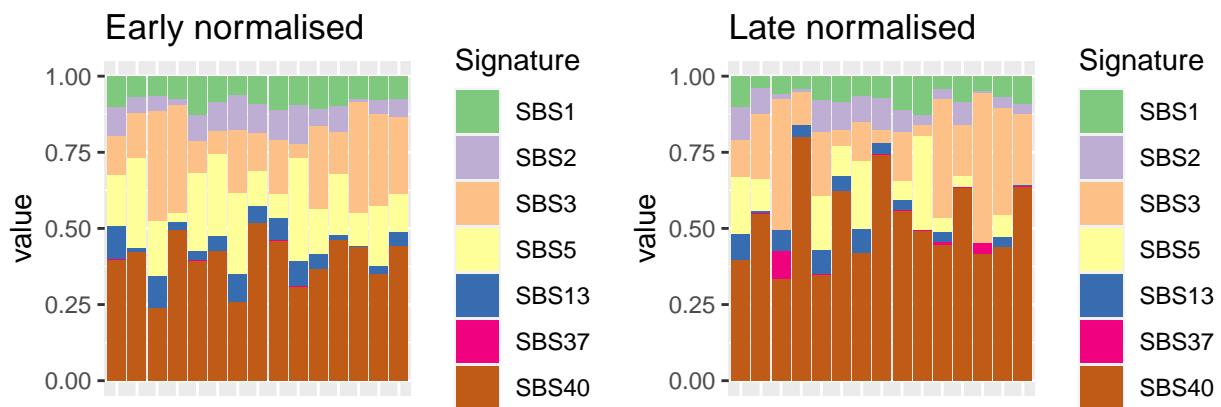


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.6978]
## Error : $ operator is invalid for atomic vectors
```

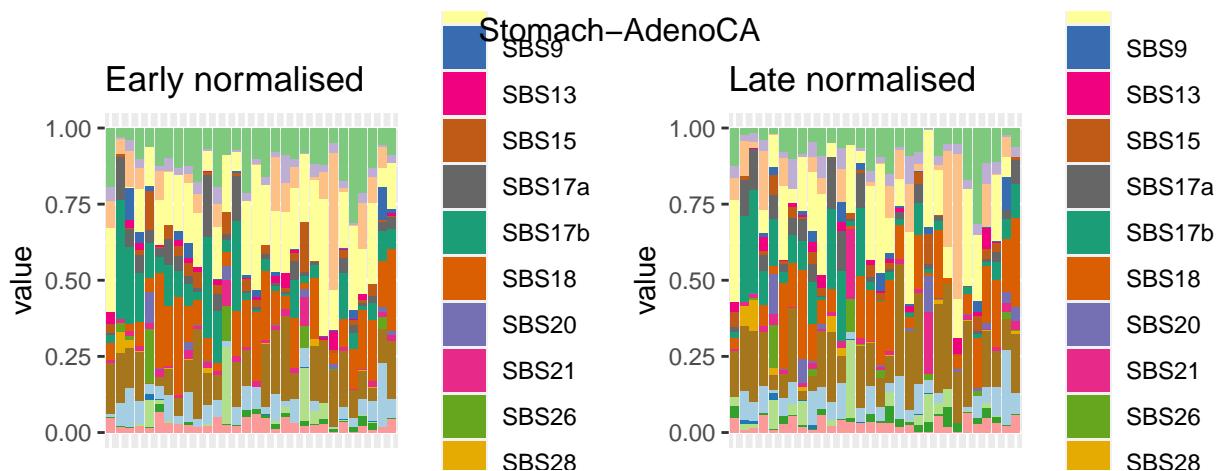


```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7167]
```

### SoftTissue–Liposarc



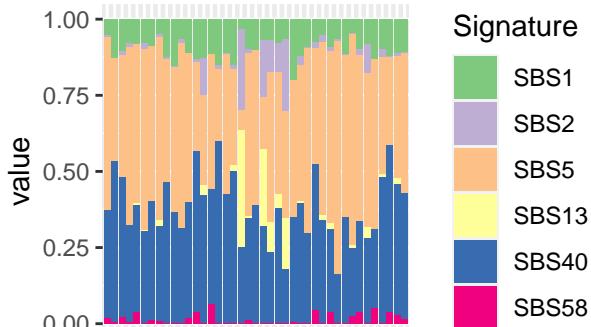
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7342]
```



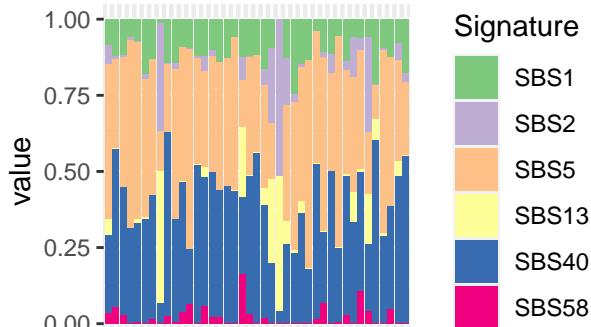
```
## TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7699]
```

### Thy–AdenoCA

**Early normalised**



**Late normalised**



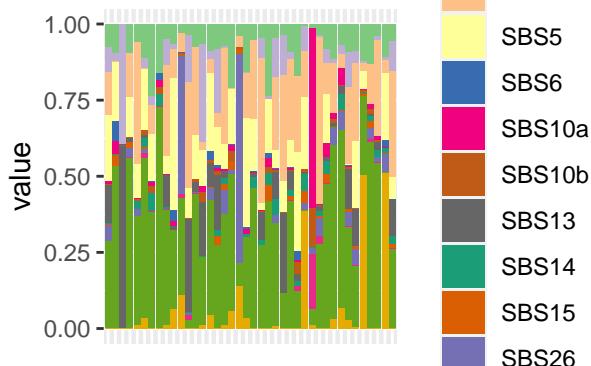
```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7860]
```

**Early normalised**

**Uterus–AdenoCA**

- SBS2
- SBS3
- SBS5
- SBS6
- SBS10a
- SBS10b
- SBS13
- SBS14
- SBS15
- SBS26

**Late normalised**



```
## # TableGrob (2 x 2) "arrange": 3 grobs
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.8133]
```

```
## $`Biliary-AdenoCA`
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.328]
##
## $`Bladder-TCC`
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.503]
```

```

## 
## $`Bone-Benign` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.678]
##
## $`Bone-Epith` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.853]
##
## $`Bone-Osteosarc` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1070]
##
## $`Breast-AdenoCA` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1329]
##
## $`Breast-DCIS` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1448]
##
## $`Breast-LobularCA` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1609]
##
## $`Cervix-AdenoCA` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1742]
##
## $`Cervix-SCC` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.1903]
##
## $`CNS-GBM` 
##   z   cells   name           grob

```

```

## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2064]
##
## $`CNS-Medullo`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2225]
##
## $`CNS-Oligo`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2358]
##
## $`CNS-PiloAstro`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2505]
##
## $`ColoRect-AdenoCA`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2764]
##
## $`Eso-AdenoCA`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.2981]
##
## $`Head-SCC`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3268]
##
## $`Kidney-ChRCC`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3457]
##
## $`Kidney-RCC.clearcell`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3646]

```

```

## 
## $`Kidney-RCC.papillary` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.3835]
##
## $`Liver-HCC` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4248]
##
## $`Lung-AdenoCA` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4493]
##
## $`Lung-SCC` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4654]
##
## $`Lymph-BNHL` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.4927]
##
## $`Lymph-CLL` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5060]
##
## $`Myeloid-AML` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5193]
##
## $`Myeloid-MPN` 
##   z   cells   name           grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5382]
##
## $`Ovary-AdenoCA` 
##   z   cells   name           grob

```

```

## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5627]
##
## $`Panc-AdenoCA`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.5928]
##
## $`Panc-Endocrine`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.6187]
##
## $`Prost-AdenoCA`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.6460]
##
## $`Skin-Melanoma.acral`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.6719]
##
## $`Skin-Melanoma.cutaneous`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.6978]
##
## $`Skin-Melanoma.mucosal`
## [1] "Error : $ operator is invalid for atomic vectors\n"
## attr(,"class")
## [1] "try-error"
## attr(,"condition")
## <simpleError: $ operator is invalid for atomic vectors>
##
## $`SoftTissue-Leiomyo`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7167]
##
## $`SoftTissue-Liposarc`
##   z   cells   name          grob
## 1 1 (2-2,1-1) arrange      gtable[layout]
## 2 2 (2-2,2-2) arrange      gtable[layout]

```

```

## 3 3 (1-1,1-2) arrange text[GRID.text.7342]
##
## $`Stomach-AdenoCA`
## z cells name grob
## 1 1 (2-2,1-1) arrange gtable[layout]
## 2 2 (2-2,2-2) arrange gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7699]
##
## $`Thy-AdenoCA`
## z cells name grob
## 1 1 (2-2,1-1) arrange gtable[layout]
## 2 2 (2-2,2-2) arrange gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.7860]
##
## $`Uterus-AdenoCA`
## z cells name grob
## 1 1 (2-2,1-1) arrange gtable[layout]
## 2 2 (2-2,2-2) arrange gtable[layout]
## 3 3 (1-1,1-2) arrange text[GRID.text.8133]

pvals_diagRE_DMDL_SP <- sapply(diagRE_DMDL_SP, function(i) try(wald_TMB_wrapper(i)))
pvals_diagRE_DMDL_nonexo_SP <- sapply(diagRE_DMDL_nonexo_SP, function(i) try(wald_TMB_wrapper(i)))

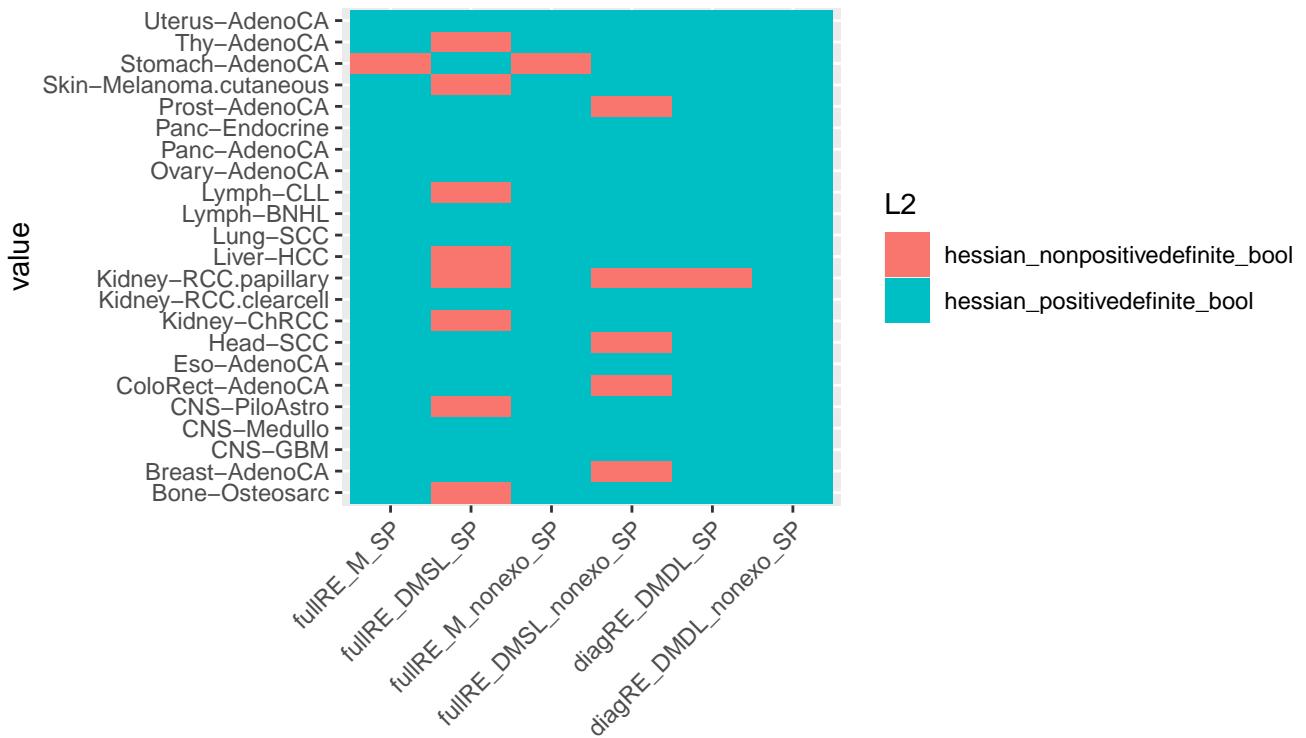
## Check data - slope appears to be of length one (binomial)
pvals_fullRE_M_nonexo_SP <- sapply(fullRE_M_nonexo_SP, function(i) try(wald_TMB_wrapper(i)))

## Check data - slope appears to be of length one (binomial)
pvals_fullRE_DMSL_nonexo_SP <- sapply(fullRE_DMSL_nonexo_SP, function(i) try(wald_TMB_wrapper(i)))

## Check data - slope appears to be of length one (binomial)
names(pvals_diagRE_DMDL_SP) <- names(pvals_diagRE_DMDL_nonexo_SP) <- names(pvals_fullRE_M_nonexo_SP) <-
  names(pvals_fullRE_DMSL_nonexo_SP) <- enough_samples

pvals_diagRE_DMDL_SP
```

|    | Bone-Osteosarc       | Breast-AdenoCA          | CNS-GBM          |
|----|----------------------|-------------------------|------------------|
| ## | 1.080828e-04         | 2.239756e-28            | 3.390137e-03     |
| ## | CNS-Medullo          | CNS-PiloAstro           | ColoRect-AdenoCA |
| ## | 8.431463e-03         | 5.615238e-04            | 6.356131e-26     |
| ## | Eso-AdenoCA          | Head-SCC                | Kidney-ChRCC     |
| ## | 5.329093e-21         | 4.975610e-05            | 1.562125e-09     |
| ## | Kidney-RCC.clearcell | Kidney-RCC.papillary    | Liver-HCC        |
| ## | 4.027485e-18         | NA                      | 4.747822e-107    |
| ## | Lung-SCC             | Lympsh-BNHL             | Lympsh-CLL       |
| ## | 7.747310e-22         | 3.908637e-19            | 6.611927e-20     |
| ## | Ovary-AdenoCA        | Panc-AdenoCA            | Panc-Endocrine   |
| ## | 8.965185e-38         | 4.096402e-119           | 3.987099e-10     |
| ## | Prost-AdenoCA        | Skin-Melanoma.cutaneous | Stomach-AdenoCA  |
| ## | 6.474116e-99         | 9.272113e-25            | 1.715150e-06     |
| ## | Thy-AdenoCA          | Uterus-AdenoCA          |                  |
| ## | 8.821583e-06         | 4.819867e-10            |                  |



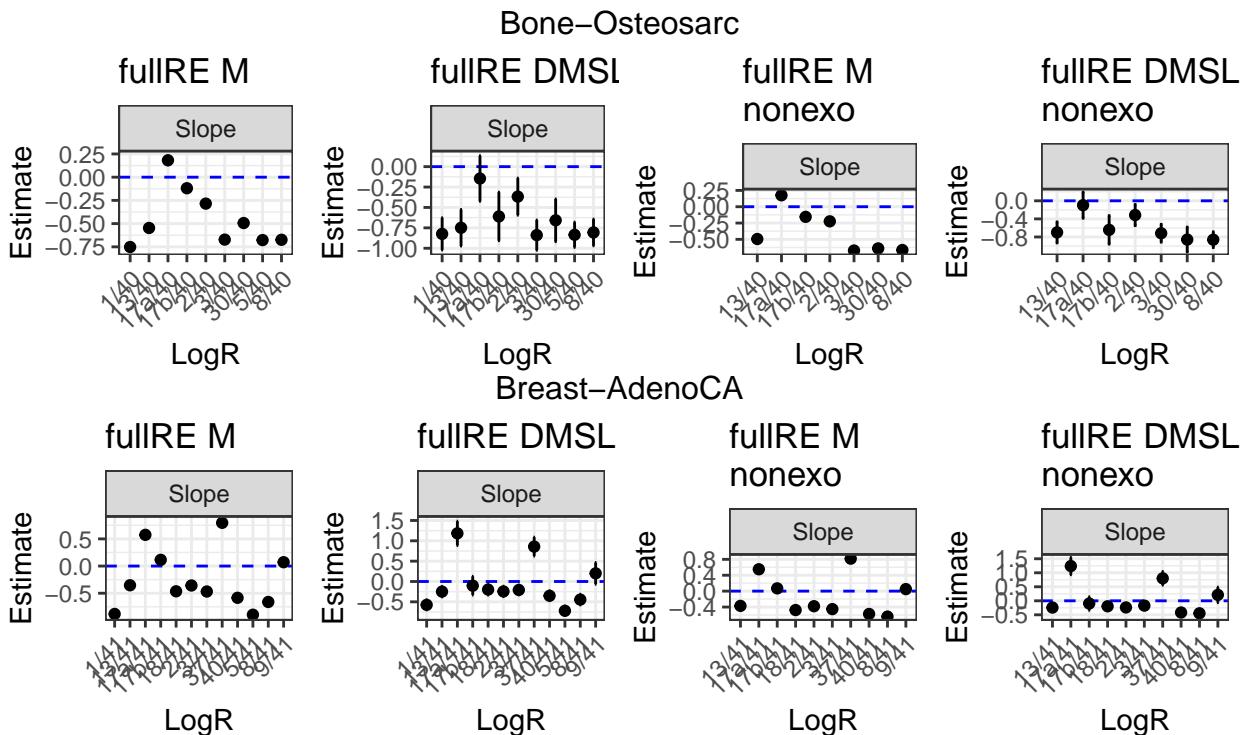
differences between signatures from sigprofiler from the paper, and the ones I get

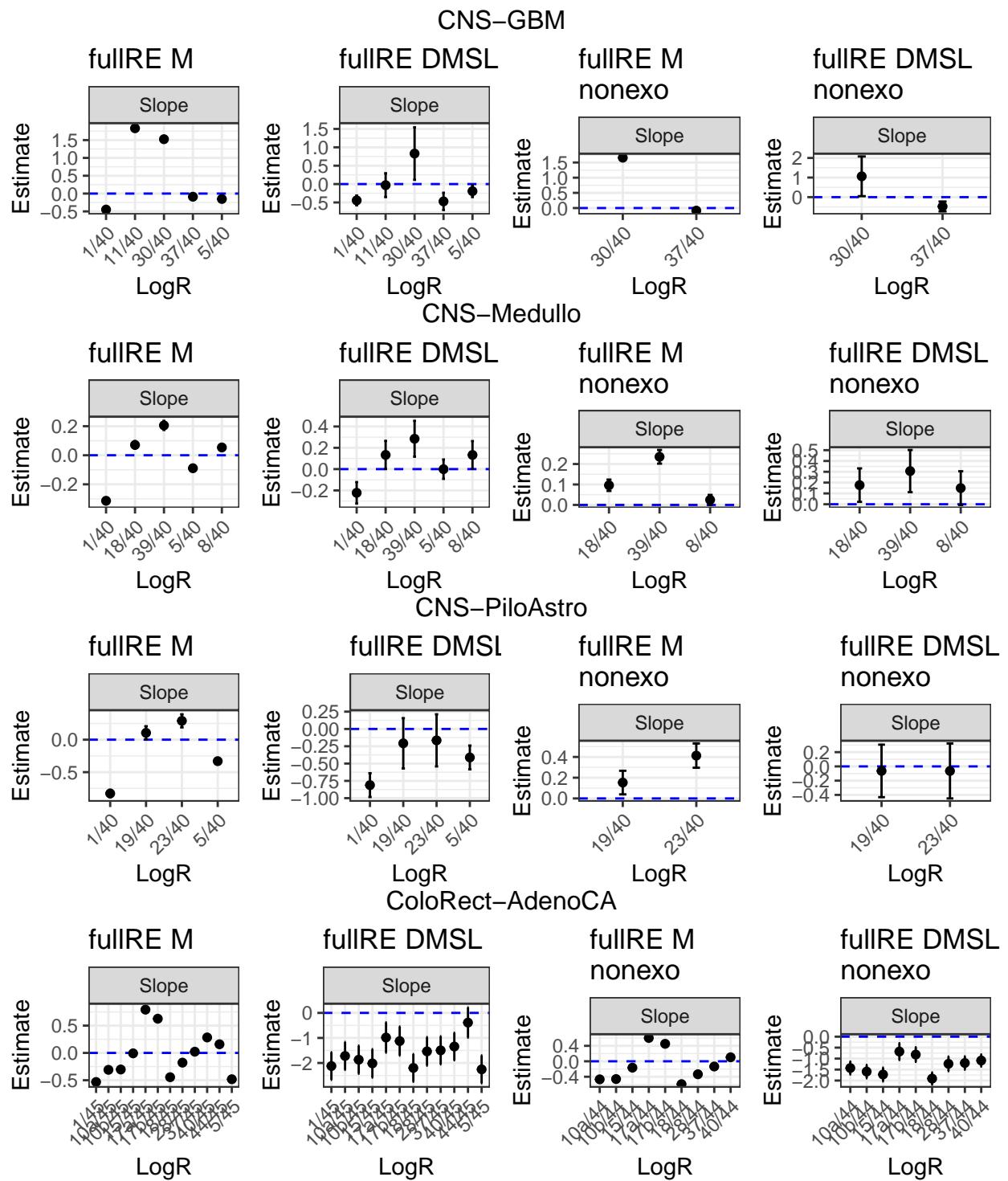
- biliary adenoca similar, though not exact
- bladder tcc: very similar
- bone benign: similar
- bone epith: extremely similar
- bone osteosarc: I have a lot of SBS8, which they don't. Other than that, similar
- breast adenocaL I have a lot of SBS9, which they don't. Other than that, similar
- breast DCIS: I have more SBS40 than they do
- breast lobularca: very similar
- cervix adenoca: very similar
- cervix SCC: very similar, although I have more SBS40
- CNS GBM: very similar, mine seem to be more homogeneous
- CNS medullo: very similar, mine seem to be more homogeneous
- CNS oligo: very similar, mine seem to be more homogeneous
- CNS piloastro: very similar, mine seem to be more homogeneous
- Colorect adenoca: quite similar
- eso adenoca: very similar
- head scc: very similar, mine seem to be more homogeneous
- kidney chrcc: very similar
- kidney rcc.clearcell: very similar, although I have more SBS29
- kidney papillary: only I have it
- liver hcc: different. I have a lot of SBS40 and SBS12, they have mostly SBS5 \*\*\*
- lung adenoca: very similar
- lung SCC: very similar, though I have more SBS8
- lymph BNHL: very similar
- Lymph CLL: very similar, althpugh theirs are much more sparse
- myeloid AML: very similar, although I don't have any SBS60 and they seem to have

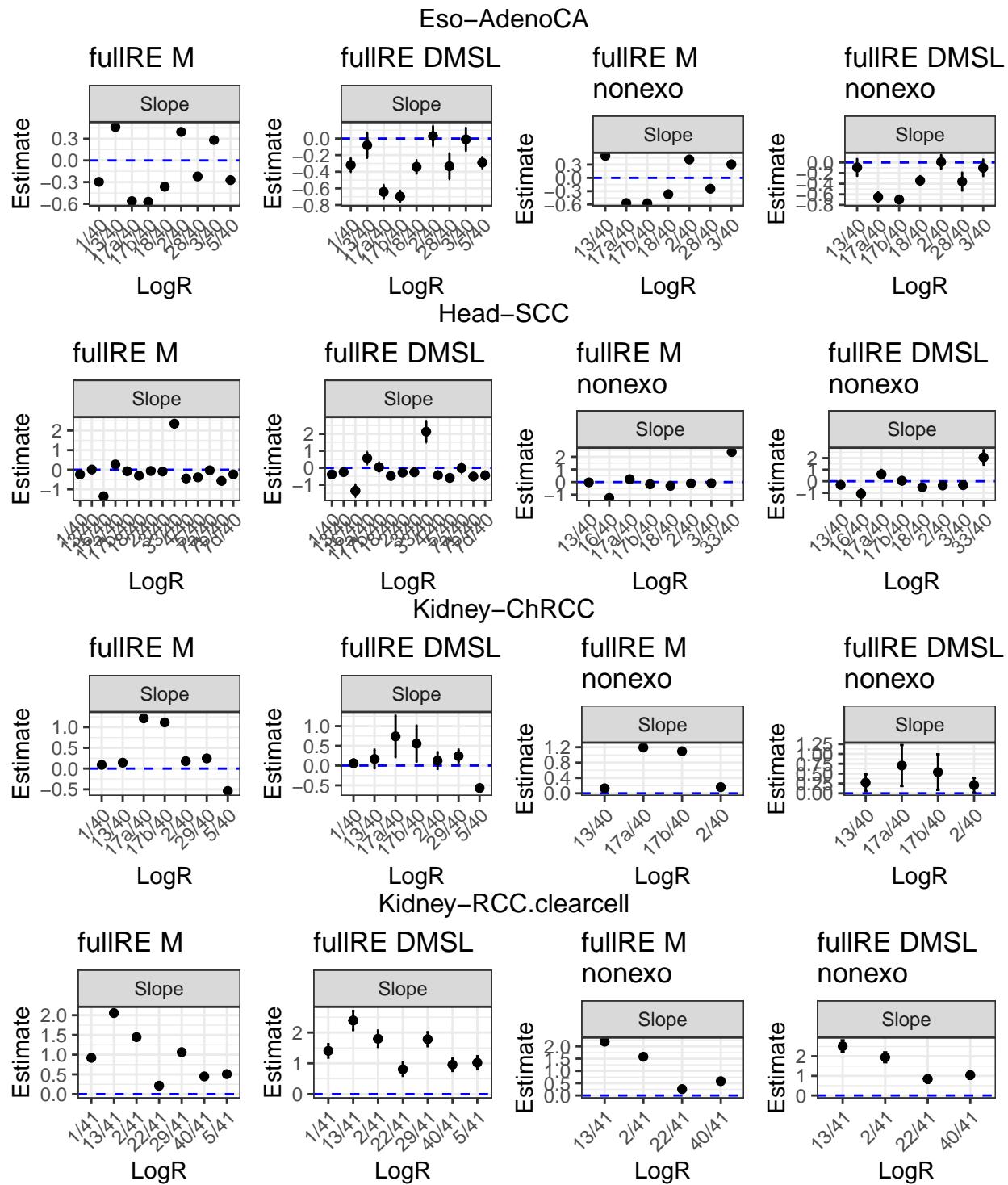
- myeloid MDS: I don't have it
- myeloid MPN: similar, although mine is much more sparse
- ovary adenoca: different. I have a lot of SBS40, which in their case is rare, and they have much more of SBS3 than I do \*\*\*
- panc-adenoca: different. I have a lot of SBS8 that they don't have. \*\*\*
- panc-endocrine: sort of similar. I have more SBS8 than they and they have more SBS5
- Prost-adenoca: sort of similar, I have more SBS8
- skin-melanoma.acral: they don't have this category. They have "skin-melanoma", which might be both together? (!!!) Similar exposures...
- softtissue-leiomyo: very similar exposures
- softtissue-liposarc: very similar exposures
- stomach adenoca: very similar, mine seem to be more homogeneous
- thy-adenoca: very similar
- uterus-adenoca: very similar

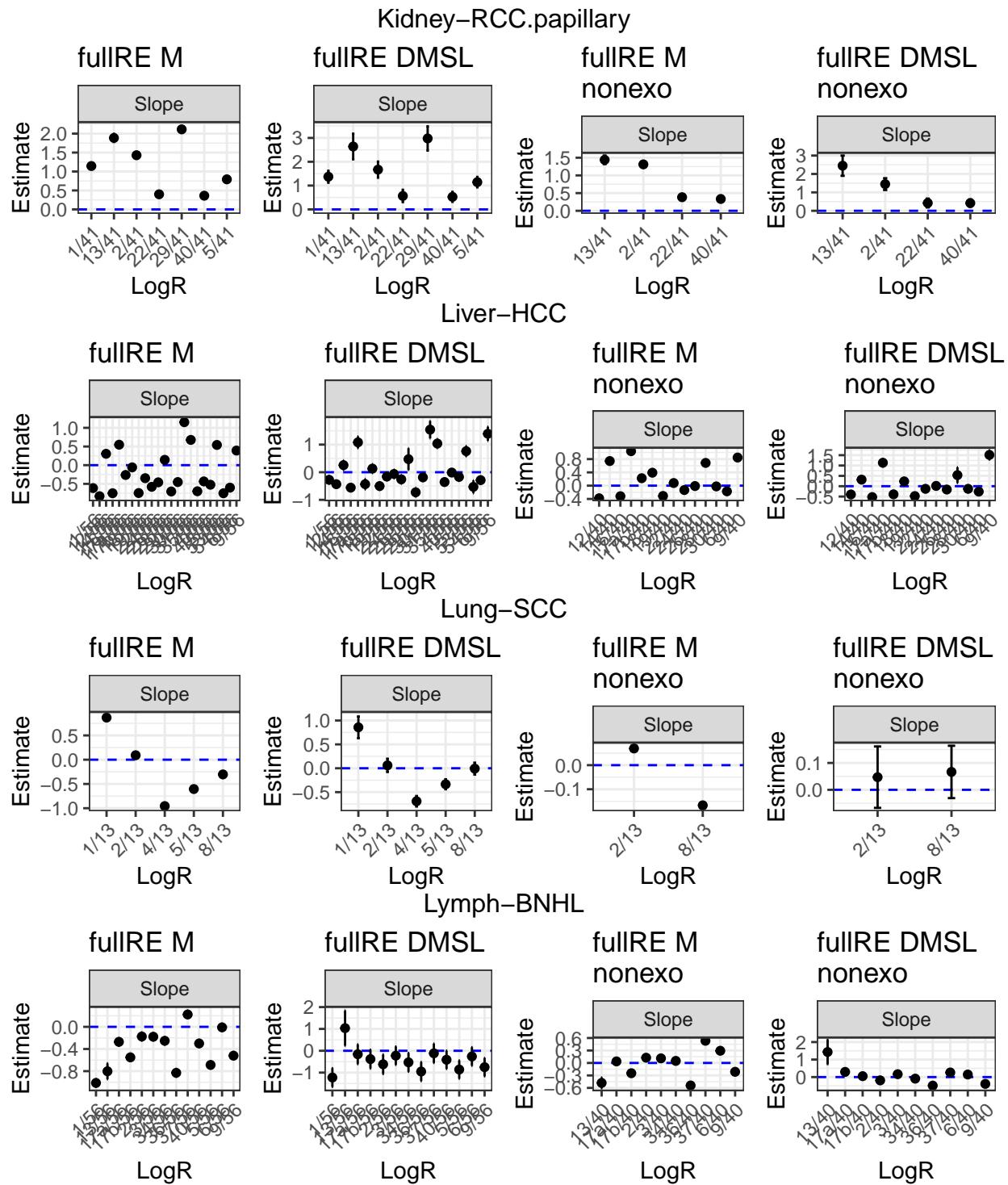
## Betas from PCAWG subset of signatures

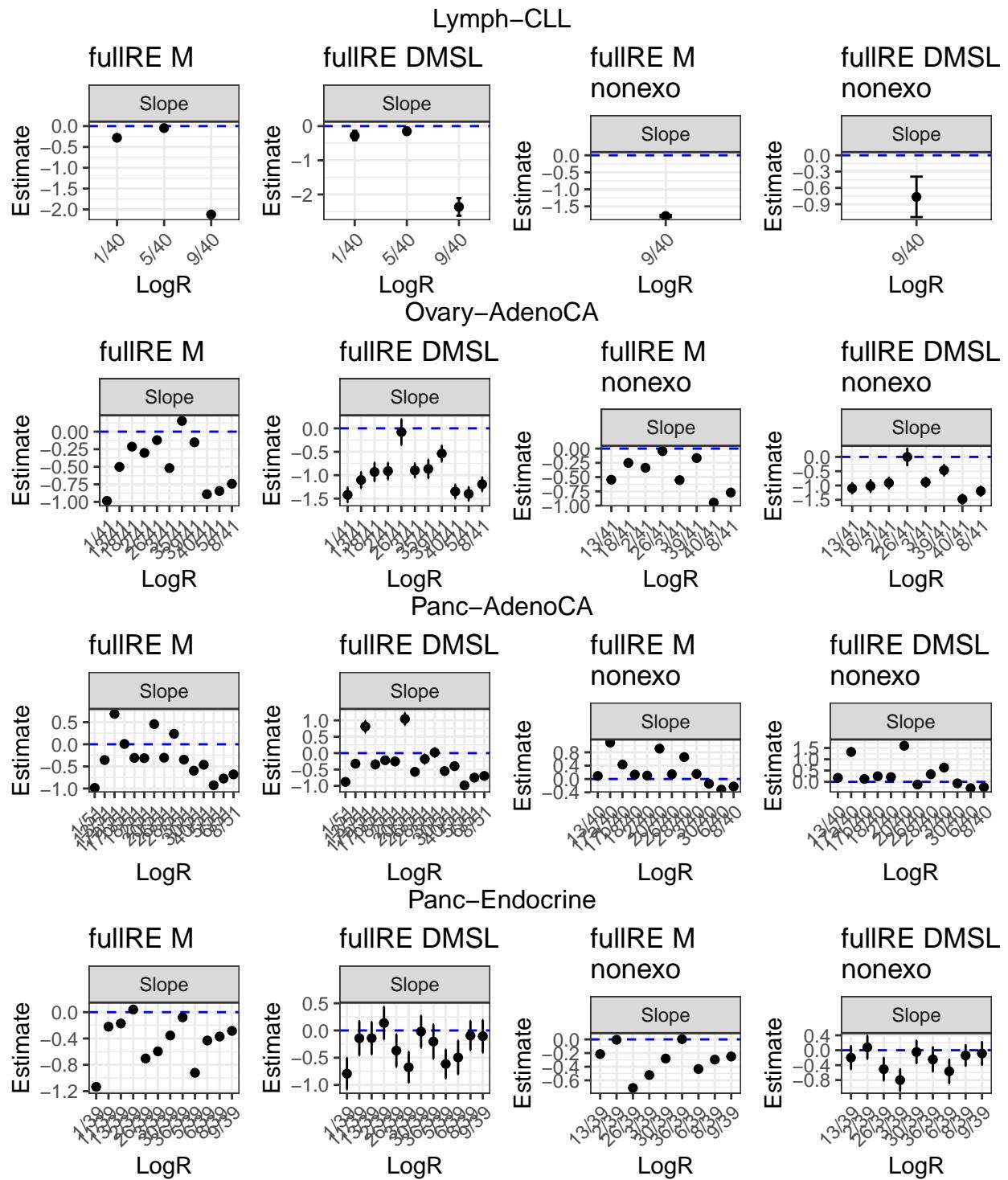
Reminder that the clonesig signatures were a subset of WES data.



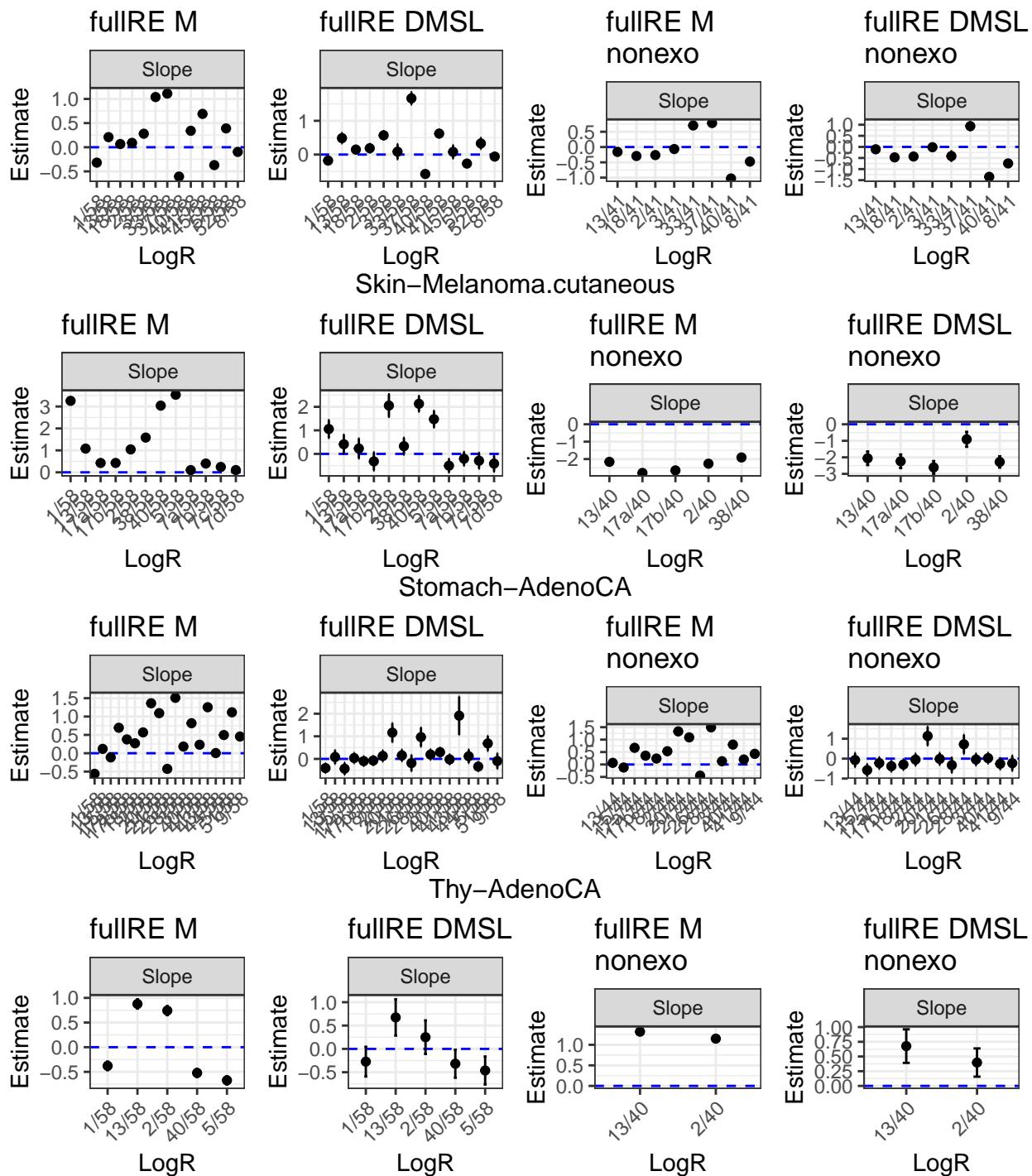


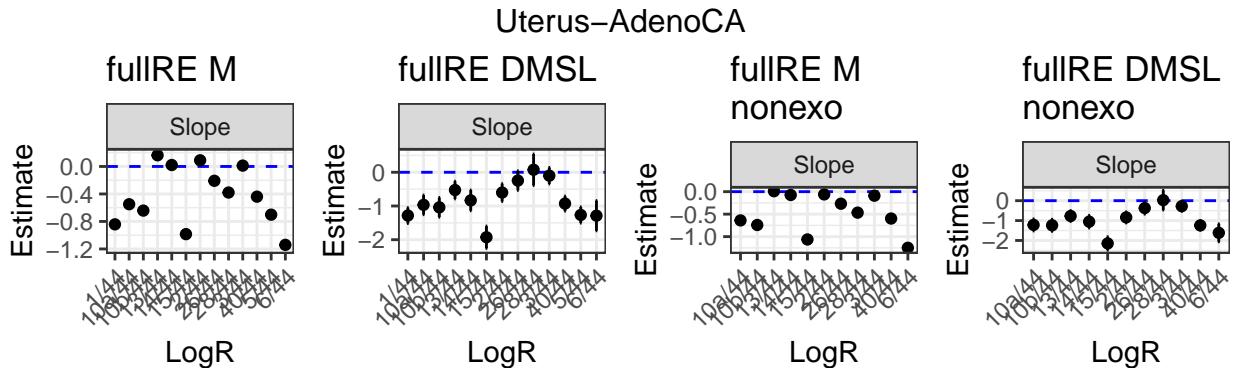






### Prost–AdenoCA





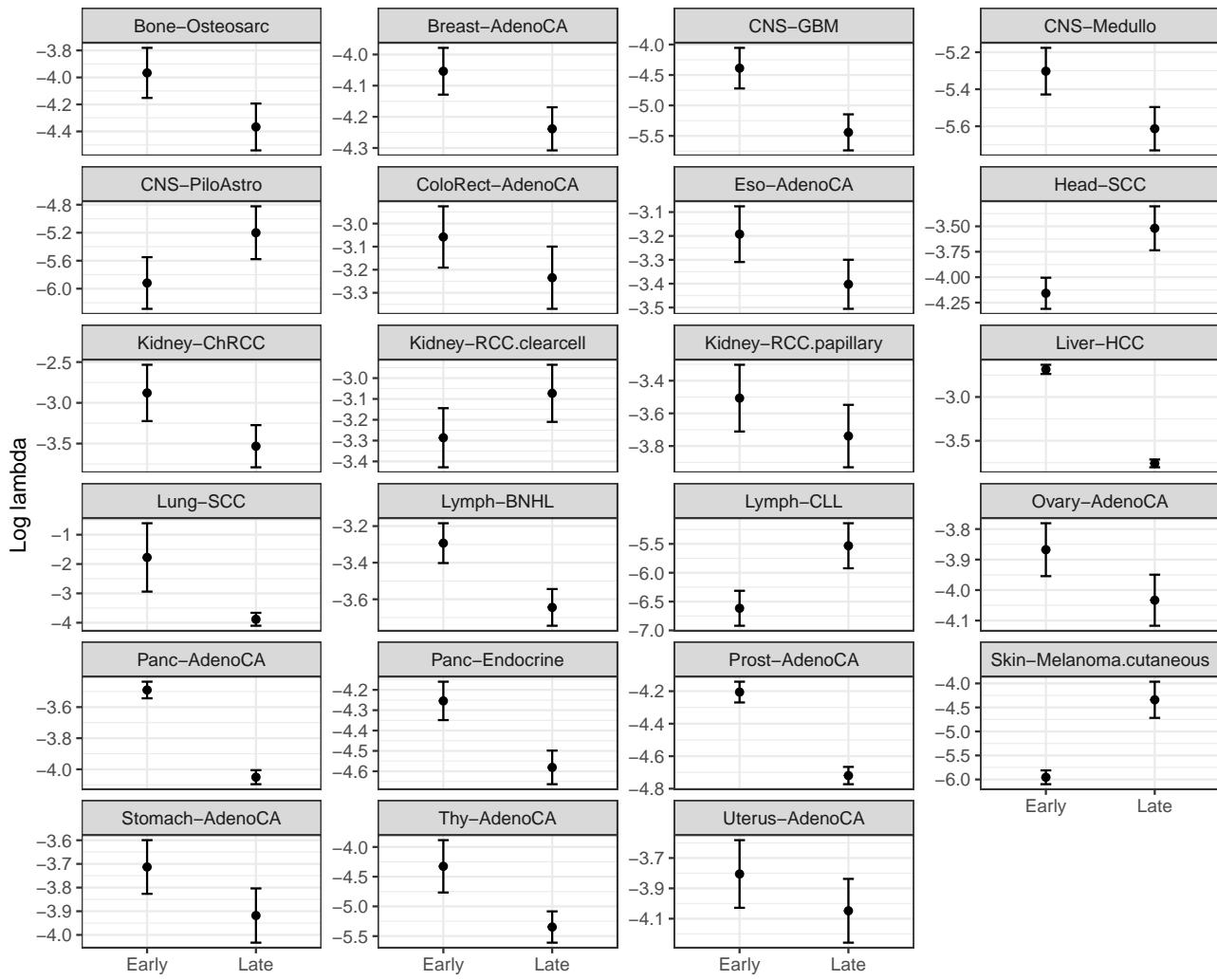
## Overdispersion parameters in double-lambda DM

```

ovrdisp <- do.call('rbind.data.frame', lapply(1:length(diagRE_DMDL_nonexo_SP), try(function(idx){
  if(diagRE_DMDL_nonexo_SP[[idx]]$pdHess){
    cbind.data.frame( plot_lambdas(diagRE_DMDL_nonexo_SP[[idx]], return_df=T, plot=F), ct=names(diagRE_DMDL_nonexo_SP[[idx]]))
  } else{
    c(NA, NA)
  }
})))
ovrdisp[ovrdisp$name == 'Lambda 1', 'name'] = 'Early'
ovrdisp[ovrdisp$name == 'Lambda 2', 'name'] = 'Late'

ggplot(ovrdisp, aes(x=name, y='Estimate'))+
  geom_point()+
  geom_errorbar(aes(ymin='Estimate'-`Std..Error`, ymax='Estimate'+`Std..Error`), width=.1)+
  theme_bw()+
  facet_wrap(~ct, scales = "free_y", nrow=6)+
  labs(x='', y='Log lambda')

```



Test for differential precision (1/overdispersion) parameter

```
differential_precision <- p.adjust(sapply(diagRE_DMDL_nonexo_SP, wald_TMB_wrapper_overdisp), method = 'fdr')
names(differential_precision) <- names(diagRE_DMDL_nonexo_SP)
sort(differential_precision)
```

|    |                 |                |                         |
|----|-----------------|----------------|-------------------------|
| ## | Liver-HCC       | Panc-AdenoCA   | Skin-Melanoma.cutaneous |
| ## | 5.160159e-58    | 7.096293e-18   | 9.923539e-09            |
| ## | Prost-AdenoCA   | Lung-SCC       | Head-SCC                |
| ## | 1.219769e-07    | 1.139987e-05   | 8.968677e-02            |
| ## | Panc-Endocrine  | CNS-GBM        | Lymph-CLL               |
| ## | 8.968677e-02    | 1.094428e-01   | 1.257732e-01            |
| ## | Thy-AdenoCA     | Lymph-BNHL     | CNS-Medullo             |
| ## | 1.332616e-01    | 1.707526e-01   | 2.670091e-01            |
| ## | Breast-AdenoCA  | Kidney-ChRCC   | CNS-PiloAstro           |
| ## | 3.645074e-01    | 3.883654e-01   | 4.524310e-01            |
| ## | Stomach-AdenoCA | Uterus-AdenoCA | Bone-Osteosarc          |
| ## | 4.524310e-01    | 4.524310e-01   | 4.745719e-01            |
| ## | Eso-AdenoCA     | Ovary-AdenoCA  | Kidney-RCC.clearcell    |
| ## | 4.815932e-01    | 4.979627e-01   | 5.431631e-01            |

```

##          ColoRect-AdenoCA      Kidney-RCC.papillary
##          6.589716e-01      6.806308e-01


|    | Liver-HCC     | Lung-SCC                | Panc-AdenoCA |
|----|---------------|-------------------------|--------------|
| ## | 5.160159e-58  | 1.139987e-05            | 7.096293e-18 |
| ## | Prost-AdenoCA | Skin-Melanoma.cutaneous |              |
| ## | 1.219769e-07  | 9.923539e-09            |              |



```

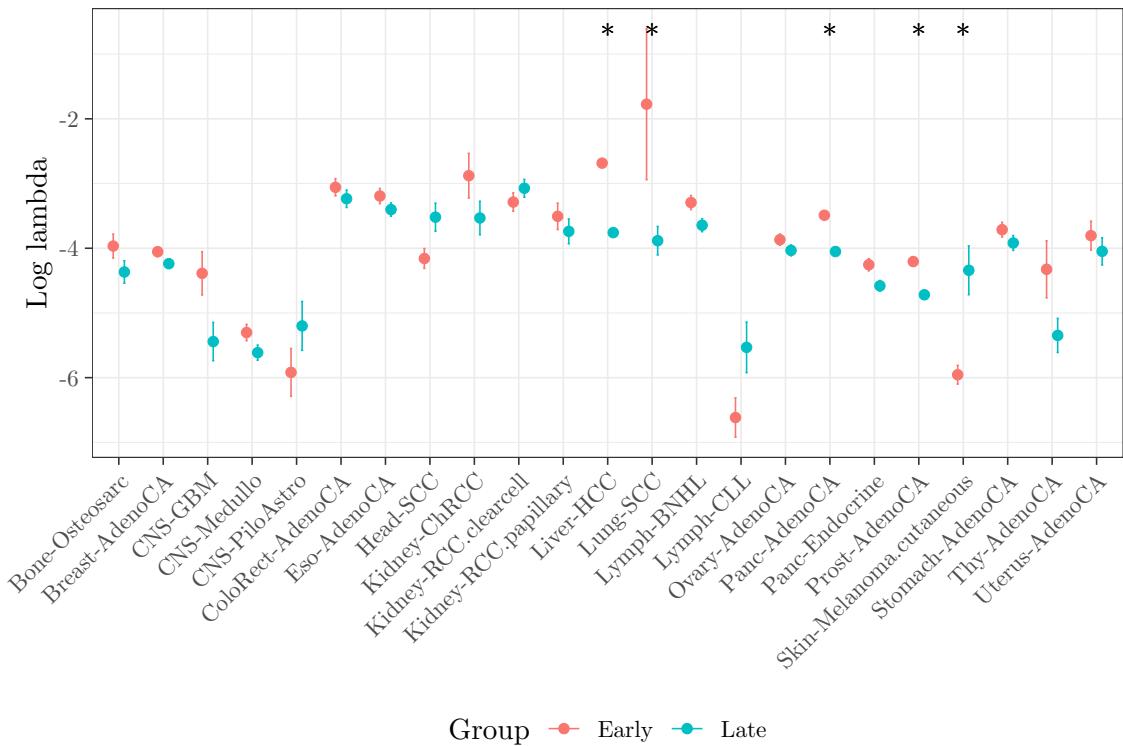
ovrdisp$differentially_abundant = ifelse(ovrdisp$ct %in% names(differential_precision[(differential_precision <= 0.05)]), differential_precision[(differential_precision <= 0.05)], 0)
ovrdisp$differentially_abundant
```



```

## [1] ""
## [20] "*"
## [39] "*"
ggplot(ovrdisp, aes(x=ct, y=Estimate, group=name, col=name))+
  geom_point(position=position_dodge(width=0.5))+
  geom_errorbar(aes(ymin=Estimate-Std..Error,
                     ymax=Estimate+Std..Error), width=.1, position=position_dodge(width=0.5))+
  theme_bw()+
  geom_text(aes(y=Inf, label=differentially_abundant, vjust=1.8), col='black')+
  theme(axis.text.x=element_text(angle = 45, hjust = 1, vjust=1))+
  labs(x='', y='Log lambda', col='Group')+theme(legend.position = "bottom")+
  theme(
    legend.margin=margin(0,0,0,0),
    legend.box.margin=margin(-10,-10,-10,-10),
    plot.margin = unit(c(1,1,1,1), "cm"))
```


```



Group —●— Early —●— Late

Test for differential precision (1/overdispersion) parameter

```
differential_precision_2 <- p.adjust(sapply(diagRE_DMDL_nonexo_SP, ttest_TMB_wrapper_overdisp), method = names(differential_precision_2) <- names(diagRE_DMDL_nonexo_SP)
sort(differential_precision_2)
```

|    |                         |                      |                  |
|----|-------------------------|----------------------|------------------|
| ## | Liver-HCC               | Panc-AdenoCA         | Prost-AdenoCA    |
| ## | 8.145123e-24            | 2.860615e-07         | 1.126237e-04     |
| ## | Skin-Melanoma.cutaneous | CNS-GBM              | Head-SCC         |
| ## | 1.723631e-02            | 2.834265e-01         | 2.834265e-01     |
| ## | Lymph-BNHL              | Panc-Endocrine       | Lung-SCC         |
| ## | 2.834265e-01            | 2.834265e-01         | 3.053481e-01     |
| ## | Lymph-CLL               | Thy-AdenoCA          | Breast-AdenoCA   |
| ## | 3.053481e-01            | 3.147768e-01         | 3.578140e-01     |
| ## | CNS-Medullo             | Bone-Osteosarc       | Kidney-ChRCC     |
| ## | 3.578140e-01            | 4.331744e-01         | 4.331744e-01     |
| ## | CNS-PiloAstro           | Eso-AdenoCA          | Ovary-AdenoCA    |
| ## | 4.352908e-01            | 4.352908e-01         | 4.352908e-01     |
| ## | Stomach-AdenoCA         | Kidney-RCC.clearcell | ColoRect-AdenoCA |
| ## | 4.502790e-01            | 5.128995e-01         | 5.601231e-01     |
| ## | Kidney-RCC.papillary    | Uterus-AdenoCA       |                  |
| ## | 5.770837e-01            | 5.770837e-01         |                  |

```
table(differential_precision_2 <= 0.05)
```

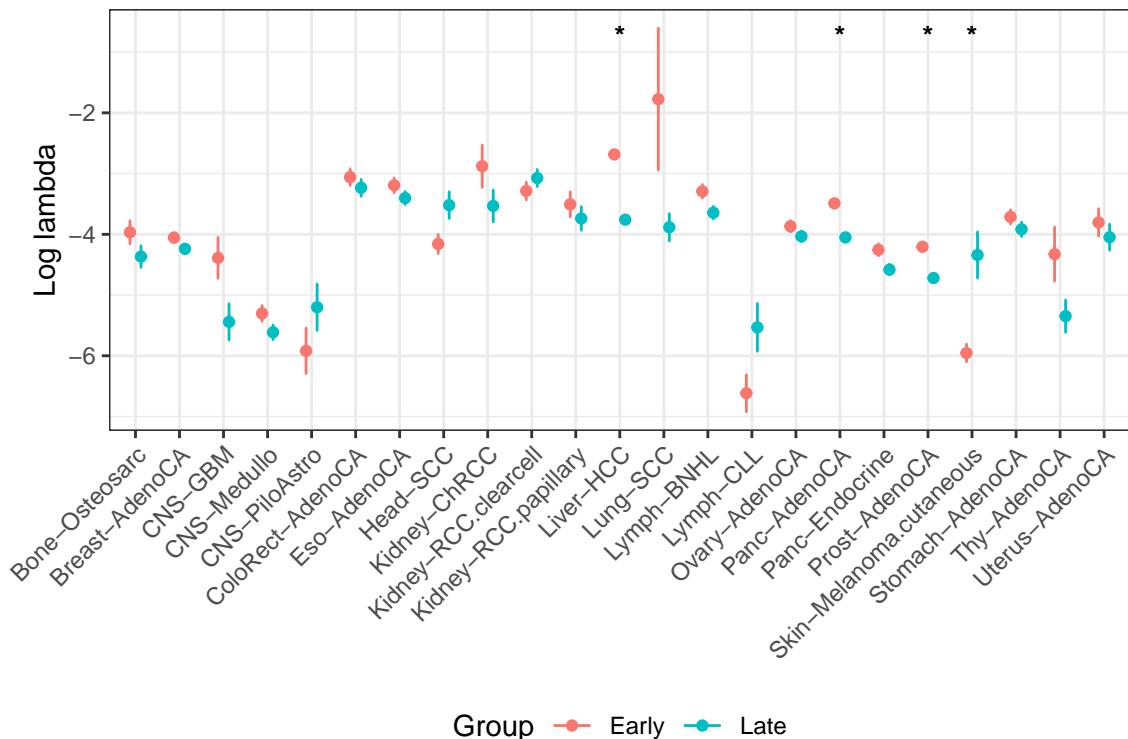
```
##
## FALSE TRUE
## 19 4
```

```
differential_precision_2[(differential_precision_2 <= 0.05)]
```

```
##          Liver-HCC      Panc-AdenoCA      Prost-AdenoCA
## 8.145123e-24 2.860615e-07 1.126237e-04
## Skin-Melanoma.cutaneous
## 1.723631e-02

ovrdisp$differential_precision_2 = ifelse(ovrdisp$ct %in% names(differential_precision_2)[(differential_precision_2 <= 0.05)], differential_precision_2, 0)

ggplot(ovrdisp, aes(x=ct, y=Estimate, group=name, col=name))+
  geom_point(position=position_dodge(width=0.5))+
  geom_errorbar(aes(ymin=Estimate-Std..Error,
                     ymax=Estimate+Std..Error), width=.1, position=position_dodge(width=0.5))+
  theme_bw()+
  geom_text(aes(y=Inf, label=differential_precision_2, vjust=1.8), col='black')+
  theme(axis.text.x=element_text(angle = 45, hjust = 1, vjust=1))+
  labs(x='', y='Log lambda', col='Group')+theme(legend.position = "bottom")+
  theme(
    legend.margin=margin(0,0,0,0),
    legend.box.margin=margin(-10,-10,-10,-10),
    plot.margin = unit(c(1,1,1,1), "cm"))
```



## Minimal perturbation

Note: this is using the original, non SP, signatures (hence not the best version).

```
minimalpert_L2 <- function(i){
  sum(i)/sum(i^2)
}
```

```

betas_breast <- data.frame(plot_betas(diagRE_DMSL_nonexo[["Breast-AdenoCA"]], names_cats= logR_nonexo_notsorted,
                                         return_df=T, plot=F))

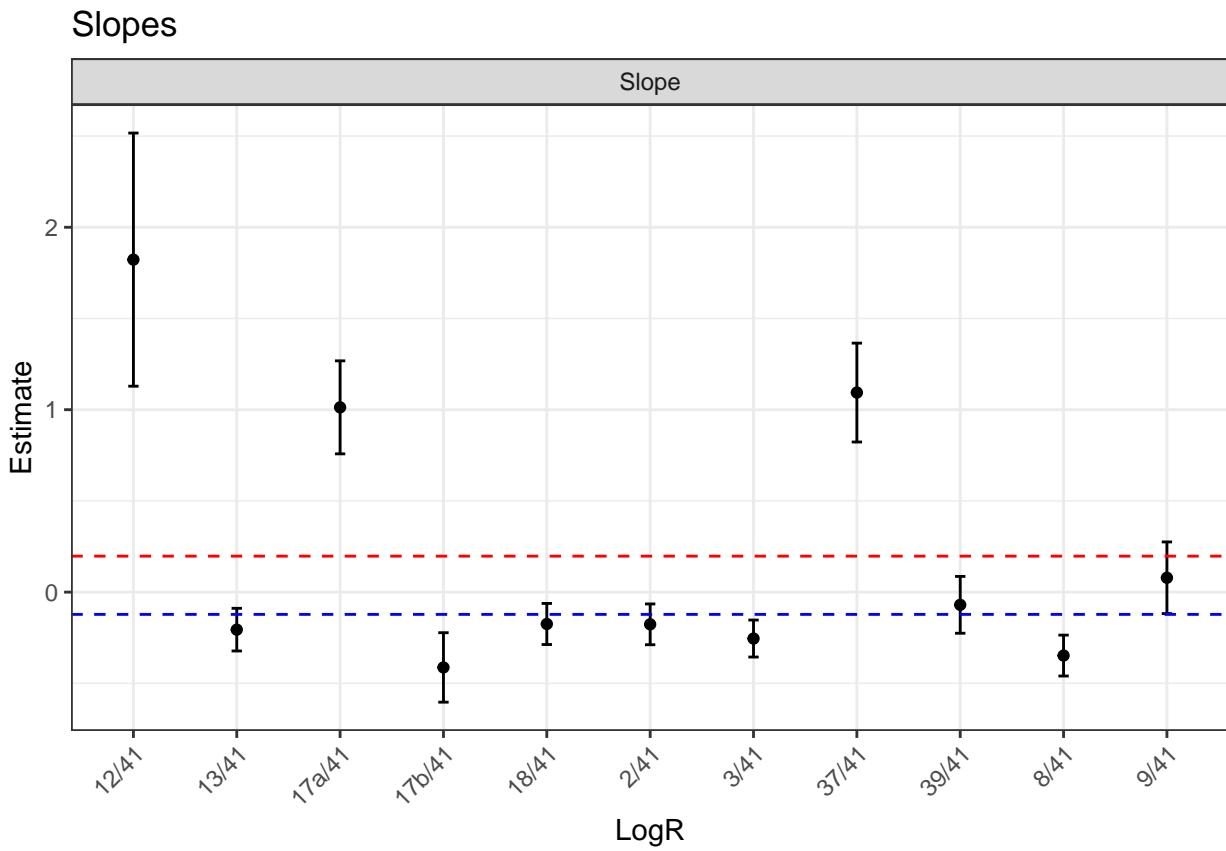
.slopes_minpert <- betas_breast %>% dplyr::filter(type_beta == "Slope") %>% dplyr::select(Estimate) %>% unlist()

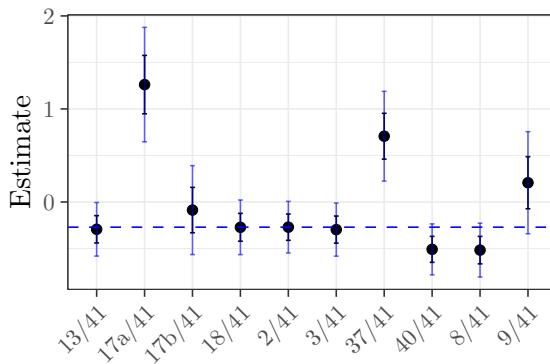
# minimalpert_L2(softmax(c(.slopes_minpert, 0)))
median(c(.slopes_minpert, 0))

## [1] -0.1222111

aa <- plot_betas(diagRE_DMSL_nonexo[["Breast-AdenoCA"]], names_cats= logR_nonexo_notsorted[["Breast-AdenoCA"]],
                   return_df=F, plot=F, only_slope = T, line_zero=F)
# aa <- geom_hline(yintercept = 0)+geom_vline(xintercept = 1)+geom_hline(yintercept = median(c(.slopes_minpert, 0)))
aa + geom_hline(yintercept = median(c(.slopes_minpert, 0)), lty='dashed', col='blue')+
  geom_hline(yintercept = mean(c(.slopes_minpert, 0)), lty='dashed', col='red')

```





For the thesis:

Log ratio of signatures

```

pdf("../results/results_TMB/pcawg/minimalperturbation_SP_all.pdf", width = 4, height = 3)
for(ct in names(diagRE_DMDL_nonexo_SP)){
  .betas_ct_it <- data.frame(plot_betas(TMB_obj = diagRE_DMDL_nonexo_SP[[ct]],
                                         names_cats= logR_nonexo_notsorted_SP[[ct]],
                                         return_df=T, plot=F))
  .slopes_minpert <- .betas_ct_it %>% dplyr::filter(type_beta == "Slope") %>% dplyr::select(Estimate) %>%
    print(aaa <- plot_betas(TMB_obj = diagRE_DMDL_nonexo_SP[[ct]], names_cats= logR_nonexo_notsorted_SP[[ct]],
                             return_df=F, plot=F, only_slope = T, line_zero=F, add_confint = T) +
      geom_hline(yintercept = median(c(.slopes_minpert, 0)), lty='dashed', col='blue') + ggtitle(ct))
}
dev.off()

## pdf
## 2

\subsection{Minimal perturbation in diagRE_DMDL_nonexo_S}

perturbed_betas_diagRE_DMDL_nonexo_SP <- lapply(names(diagRE_DMDL_nonexo_SP), try(function(idx_sp){
  .betas_SP <- data.frame(plot_betas(diagRE_DMDL_nonexo_SP[[idx_sp]], names_cats= logR_nonexo_notsorted_SP[[idx_sp]],
                                       return_df=T, plot=F))

  .slopes_minpert_SP <- .betas_SP %>% dplyr::filter(type_beta == "Slope") %>% dplyr::select(Estimate) %>%
    # print(.slopes_minpert_SP)
    ## check if the CI of the betas touches this median value
    .summary_betas_slope_SP <- python_like_select_rownames(summary(diagRE_DMDL_nonexo_SP[[idx_sp]]), 'beta')
    nrow(.summary_betas_slope_SP)

  minimal_change_baseline <- median(c(.slopes_minpert_SP, 0))
  # print(.summary_betas_slope_SP)
  # print(logR_nonexo_notsorted_SP[[idx_sp]])
  # print(dim(.summary_betas_slope_SP))
  if(!is.null(dim(.summary_betas_slope_SP))){
    .params_in_ci <- give_params_in_CI(vec_est=.summary_betas_slope_SP[,1],
                                         vec_stderr=.summary_betas_slope_SP[,2],
                                         vec_true=rep(minimal_change_baseline, nrow(.summary_betas_slope_SP)))
  }else{
    .params_in_ci <- give_params_in_CI(vec_est=.summary_betas_slope_SP[1],
                                         vec_stderr=.summary_betas_slope_SP[2],
                                         vec_true=minimal_change_baseline)
  }
})

```

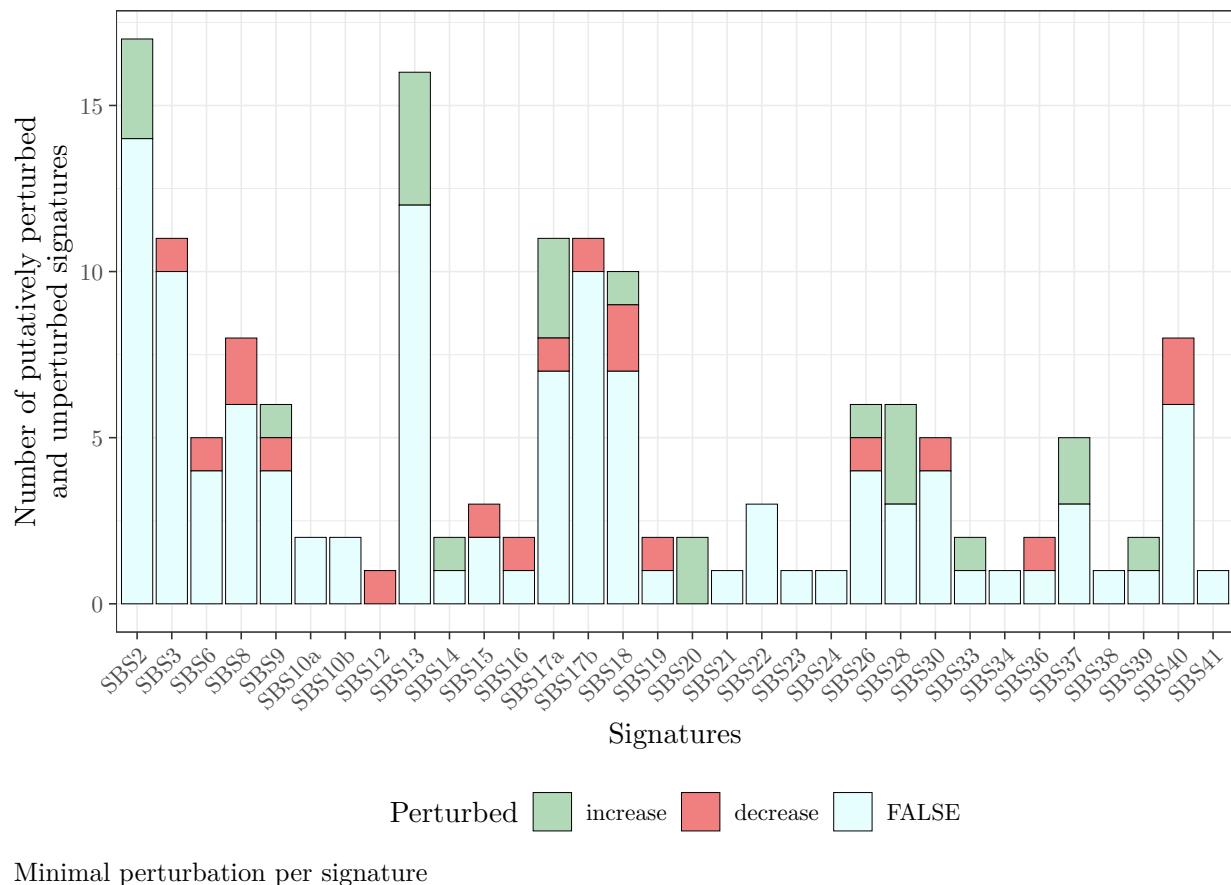
```

.params_in_ci <- sapply(1:length(.params_in_ci), function(i){
  ## for the ones in which there is a change, say whether it's up- or down-regulated
  if(!.params_in_ci[i]){
    ## if there is a change: not in confidence interval
    if(is.null(dim(.summary_betas_slope_SP))){ 
      ## one-dim
      if(.summary_betas_slope_SP[1] > minimal_change_baseline){
        'increase'
      }else{
        'decrease'
      }
    }else{
      ## multi-dim
      if(.summary_betas_slope_SP[i,1] > minimal_change_baseline){
        'increase'
      }else{
        'decrease'
      }
    }
  }else{
    'FALSE'
  }
})
names(.params_in_ci) <- sapply(logR_nonexo_notsorted_SP[[idx_sp]], function(i) strsplit(i, '/')[[1]][1])
.baseline <- strsplit(logR_nonexo_notsorted_SP[[idx_sp]][[1]], '/')[[1]][2]
return(list(betas_perturbed=.params_in_ci, baseline=.baseline))
}))
```

perturbed\_betas\_diagRE\_DMDL\_nonexo\_SP\_vec <- do.call('c', sapply(perturbed\_betas\_diagRE\_DMDL\_nonexo\_SP, f

```

perturbed_betas_diagRE_DMDL_nonexo_SP_df <- cbind.data.frame(sig=gsub("betas_perturbed.", "", names(perturbed_betas_diagRE_DMDL_r
ggplot(perturbed_betas_diagRE_DMDL_nonexo_SP_df, aes(x=factor(sig, levels=gtools::mixedsort(unique(sig))), fill=factor(perturbed, levels=c('increase', 'decreas
geom_bar(col='black', size=0.001)+theme_bw()+
scale_fill_manual(values=c( '#b1d8b7', '#f08080', '#e7feff'))+
theme(axis.text.x=element_text(angle = 45, hjust = 1, vjust=1), legend.position = "bottom")+
labs(x='Signatures', y='Number of putatively perturbed\n and unperturbed signatures', fill='Perturbed')
```



Minimal perturbation per signature

```

names(perturbed_betas_diagRE_DMDL_nonexo_SP) <- names(diagRE_DMDL_nonexo_SP)
ggplot(reshape2::melt(lapply(perturbed_betas_diagRE_DMDL_nonexo_SP, `[, 'betas_perturbed')),
  aes(x=L1, fill=factor(value, levels=c('increase', 'decrease', 'FALSE')))+geom_bar(col='black', si
    scale_fill_manual(values=c('#b1d8b7', '#f08080', '#e7feff'))+theme(legend.position = "bottom")+
  theme(axis.text.x=element_text(angle = 45, hjust = 1, vjust=1))+labs(x='Cancer type',
  y='Number of putatively perturbed and unperturbed signatures')
  
```

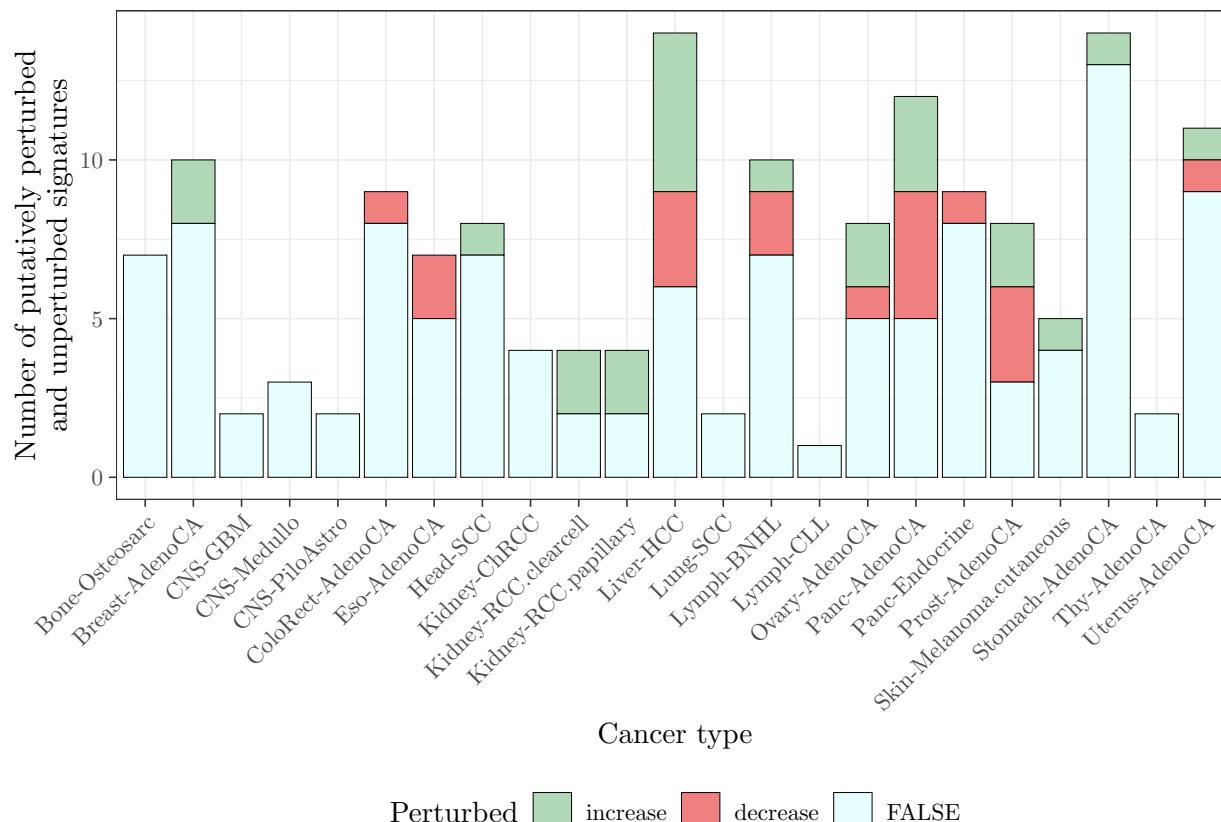


Table of perturbed signatures

```

relevel_perturbation <- cbind(c('increase', 'decrease'), c('+', '-'))

write("", ".../results/results_TMB/pcawg/minimal_perturbation_sigs.txt", append = F)
# for(i in names(perturbed_betas_diagRE_DMDL_nonexo_SP)){
#   write(paste0(i, '&', paste0(names(perturbed_betas_diagRE_DMDL_nonexo_SP[[i]]$betas_perturbed)[perturbed_betas_diagRE_DMDL_nonexo_SP[[i]]$betas_perturbed], collapse = ", ")), file = ".../results/results_TMB/pcawg/minimal_perturbation_sigs.txt")
# }
for(i in names(perturbed_betas_diagRE_DMDL_nonexo_SP)){
  # write(x = paste0(i, '&', paste0(sapply(which(perturbed_betas_diagRE_DMDL_nonexo_SP[[i]]$betas_perturbed), '+', relevel_perturbation), collapse = ', ', sep = '')), file = ".../results/results_TMB/pcawg/minimal_perturbation_sigs.txt")
  # write(x = paste0(paste0(i, '&', paste0(sapply(which(perturbed_betas_diagRE_DMDL_nonexo_SP[[i]]$betas_perturbed), '+', relevel_perturbation), collapse = ', ', sep = ''))), file = ".../results/results_TMB/pcawg/minimal_perturbation_sigs.txt")
  write(x = paste0(paste0(i, '&', paste0(sapply(which(perturbed_betas_diagRE_DMDL_nonexo_SP[[i]]$betas_perturbed), '+', relevel_perturbation), collapse = ', ', sep = ''))), file = ".../results/results_TMB/pcawg/minimal_perturbation_sigs.txt")
}
## [1] 27 8
## [1] 27 8
## [1] 136 11
## [1] 136 11
## [1] 34 3
## [1] 34 3
## [1] 106 4
## [1] 106 4
## [1] 41 3

```

```

## [1] 41  3
## [1] 37 10
## [1] 37 10
## [1] 65  8
## [1] 65  8
## [1] 32  9
## [1] 32  9
## [1] 38  5
## [1] 38  5
## [1] 86  5
## [1] 86  5
## [1] 30  5
## [1] 30  5
## [1] 207 15
## [1] 207 15
## [1] 34  3
## [1] 34  3
## [1] 51 11
## [1] 51 11
## [1] 53  2
## [1] 53  2
## [1] 97  9
## [1] 97  9
## [1] 193 13
## [1] 193 13
## [1] 70 10
## [1] 70 10
## [1] 208  9
## [1] 208  9
## [1] 29  6
## [1] 29  6
## [1] 30 15
## [1] 30 15
## [1] 41  3
## [1] 41  3
## [1] 40 12
## [1] 40 12

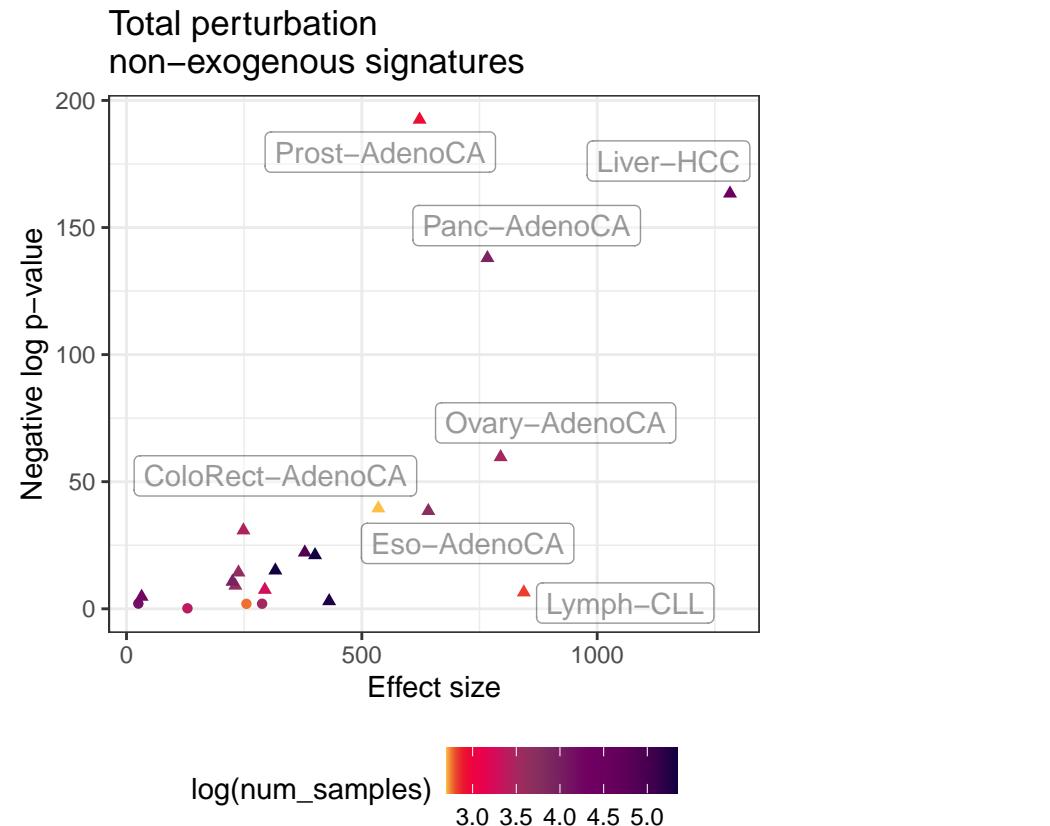
##          Bone-Osteosarc      Breast-AdenoCA      CNS-GBM
##                      8                  11                  3
##          CNS-Medullo      CNS-PiloAstro      ColoRect-AdenoCA
##                      4                  3                  10
##          Eso-AdenoCA       Head-SCC        Kidney-ChRCC
##                      8                  9                  5
##          Kidney-RCC.clearcell Kidney-RCC.papillary Liver-HCC
##                      5                  5                  15
##          Lung-SCC           Lymph-BNHL       Lymph-CLL
##                      3                  11                  2
##          Ovary-AdenoCA      Panc-AdenoCA      Panc-Endocrine
##                      9                  13                  10
##          Prost-AdenoCA     Skin-Melanoma.cutaneous Stomach-AdenoCA
##                      9                  6                  15

```

```

##          Thy-AdenoCA           Uterus-AdenoCA
##                3                  12
## Error in apply(pert, 1, function(i) sqrt(sum((i - 1/(ncol(exposures_cancertype_obj$Y)))^2))) :
##   dim(X) must have a positive length
## Error in apply(pert, 1, function(i) sqrt(sum((i - 1/(ncol(exposures_cancertype_obj$Y)))^2))) :
##   dim(X) must have a positive length
## Warning: NAs introduced by coercion
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
## Warning: Removed 2 rows containing missing values (geom_point).
## Warning: Removed 2 rows containing missing values (geom_label_repel).
## Warning: ggrepel: 14 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

```



```

##          Bone-Osteosarc      Breast-AdenoCA      CNS-GBM
##            320.02704        469.29125        524.08517
##          CNS-Medullo       CNS-PiloAstro      ColoRect-AdenoCA
##            217.31161        27.02067        1031.46320
##          Eso-AdenoCA        Head-SCC          Kidney-ChRCC
##            522.66804        221.26052        103.16727
##          Kidney-RCC.clearcell  Kidney-RCC.papillary  Liver-HCC
##            247.53963        156.30958        1332.22216
##          Lung-SCC             Lymp-BNHL          Lymp-CLL

```

```

##          86.07143      345.88535      442.78303
## Ovary-AdenoCA      Panc-AdenoCA      Panc-Endocrine
##          755.21919      829.19711      220.55650
## Prost-AdenoCA Skin-Melanoma.cutaneous      Stomach-AdenoCA
##          459.55271      1017.96421      540.50633
## Thy-AdenoCA       Uterus-AdenoCA
##          82.57481      458.24059

## Bone-Osteosarc      Breast-AdenoCA      CNS-GBM
##          1.080828e-04      2.239756e-28      3.390137e-03
## CNS-Medullo      CNS-PiloAstro      ColoRect-AdenoCA
##          8.431463e-03      5.615238e-04      6.356131e-26
## Eso-AdenoCA       Head-SCC      Kidney-ChRCC
##          5.329093e-21      4.975610e-05      1.562125e-09
## Kidney-RCC.clearcell      Kidney-RCC.papillary      Liver-HCC
##          4.027485e-18      NA      4.747822e-107
## Lung-SCC      Lymph-BNHL      Lymph-CLL
##          7.747310e-22      3.908637e-19      6.611927e-20
## Ovary-AdenoCA      Panc-AdenoCA      Panc-Endocrine
##          8.965185e-38      4.096402e-119      3.987099e-10
## Prost-AdenoCA Skin-Melanoma.cutaneous      Stomach-AdenoCA
##          6.474116e-99      9.272113e-25      1.715150e-06
## Thy-AdenoCA       Uterus-AdenoCA
##          8.821583e-06      4.819867e-10

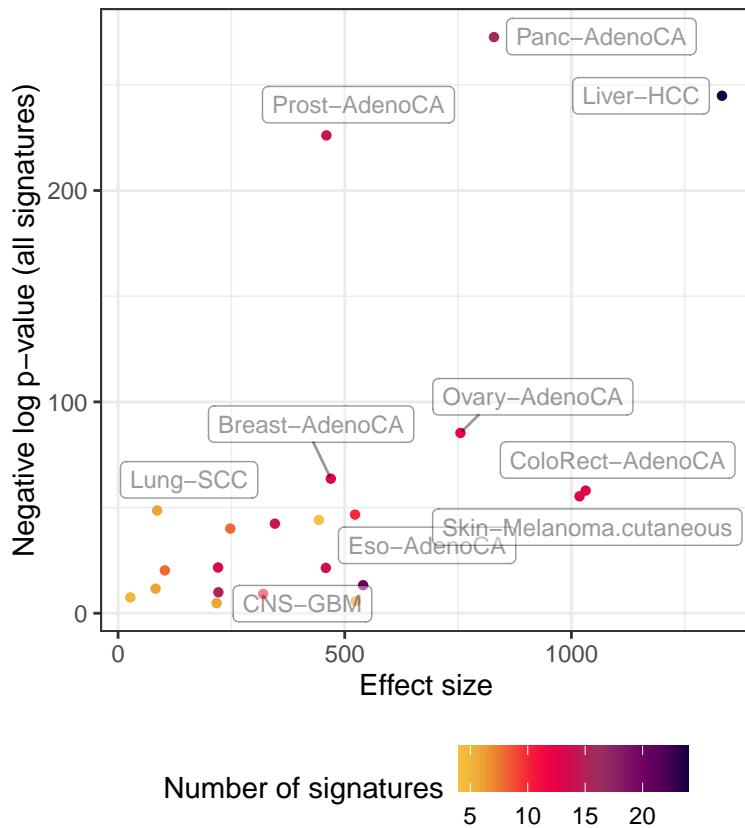
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_label_repel).

## Warning: ggrepel: 12 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

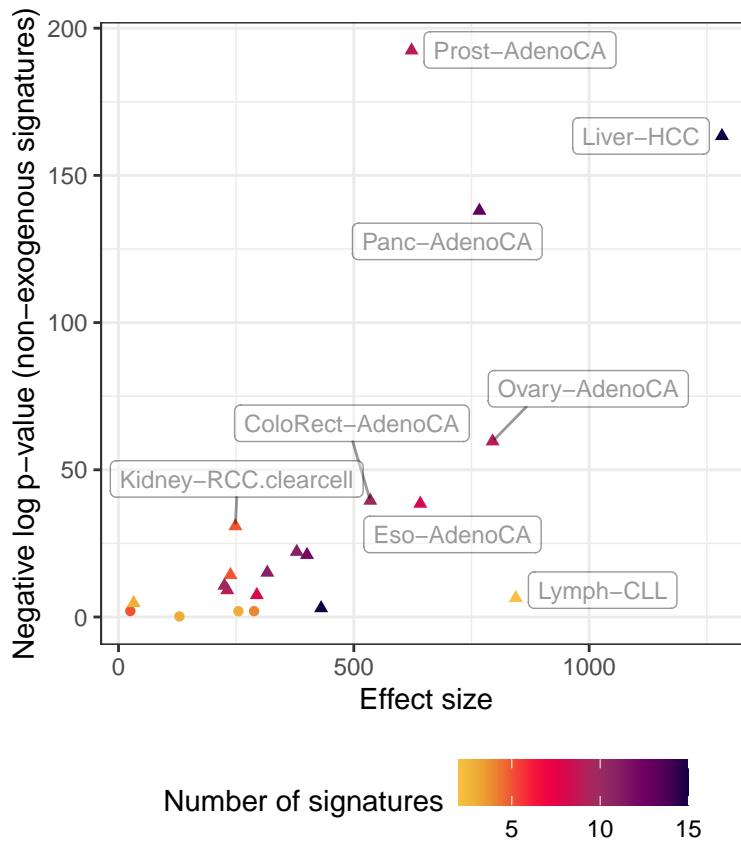
```



```

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
## Warning: Removed 2 rows containing missing values (geom_point).
## Warning: Removed 2 rows containing missing values (geom_label_repel).
## Warning: ggrepel: 13 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

```



## HMP

Simple HMP tests to see what is differentially abundant

```

## [1] "Bone-Osteosarc.p value"           "Breast-AdenoCA.p value"
## [3] "Cervix-SCC.p value"             "CNS-GBM.p value"
## [5] "CNS-Medullo.p value"            "CNS-Oligo.p value"
## [7] "CNS-PiloAstro.p value"          "ColoRect-AdenoCA.p value"
## [9] "Eso-AdenoCA.p value"            "Head-SCC.p value"
## [11] "Kidney-ChRCC.p value"           "Kidney-RCC.clearcell.p value"
## [13] "Kidney-RCC.papillary.p value"   "Liver-HCC.p value"
## [15] "Lung-AdenoCA.p value"           "Lung-SCC.p value"
## [17] "Lymph-BNHL.p value"              "Lymph-CLL.p value"
## [19] "Myeloid-MPN.p value"             "Ovary-AdenoCA.p value"
## [21] "Panc-AdenoCA.p value"            "Panc-Endocrine.p value"
## [23] "Prost-AdenoCA.p value"           "Skin-Melanoma.acral.p value"
## [25] "Skin-Melanoma.cutaneous.p value" "Stomach-AdenoCA.p value"
## [27] "Thy-AdenoCA.p value"             "Uterus-AdenoCA.p value"

## [1] "Bone-Osteosarc"                 "Breast-AdenoCA"
## [3] "CNS-GBM"                        "CNS-Medullo"
## [5] "CNS-PiloAstro"                  "ColoRect-AdenoCA"
## [7] "Eso-AdenoCA"                    "Head-SCC"
## [9] "Kidney-ChRCC"                   "Kidney-RCC.clearcell"
## [11] "Kidney-RCC.papillary"           "Liver-HCC"

```

```

## [13] "Lung-SCC"          "Lymph-BNHL"
## [15] "Lymph-CLL"          "Ovary-AdenoCA"
## [17] "Panc-AdenoCA"       "Panc-Endocrine"
## [19] "Prost-AdenoCA"      "Skin-Melanoma.cutaneous"
## [21] "Stomach-AdenoCA"    "Thy-AdenoCA"
## [23] "Uterus-AdenoCA"

##           Bone-Osteosarc.p value      Breast-AdenoCA.p value
##                               1                      1
##           CNS-GBM.p value        CNS-Medullo.p value
##                               1                      1
##           CNS-PiloAstro.p value   ColoRect-AdenoCA.p value
##                               1                      1
##           Eso-AdenoCA.p value    Head-SCC.p value
##                               1                      1
##           Kidney-ChRCC.p value   Kidney-RCC.clearcell.p value
##                               1                      1
##           Kidney-RCC.papillary.p value Liver-HCC.p value
##                               1                      1
##           Lung-SCC.p value       Lymph-BNHL.p value
##                               0                      1
##           Lymph-CLL.p value      Ovary-AdenoCA.p value
##                               1                      1
##           Panc-AdenoCA.p value   Panc-Endocrine.p value
##                               1                      1
##           Prost-AdenoCA.p value  Skin-Melanoma.cutaneous.p value
##                               1                      1
##           Stomach-AdenoCA.p value Thy-AdenoCA.p value
##                               1                      1
##           Uterus-AdenoCA.p value
##                               0

pvals_diagRE_DMDL_SP_adj <- p.adjust(pvals_diagRE_DMDL_SP, 'fdr')
pvals_diagRE_DMDL_nonexo_SP_adj <- p.adjust(pvals_diagRE_DMDL_nonexo_SP, 'fdr')
pvals_fullRE_M_nonexo_SP_adj <- p.adjust(pvals_fullRE_M_nonexo_SP, 'fdr')
pvals_fullRE_DMSL_nonexo_SP_adj <- p.adjust(pvals_fullRE_DMSL_nonexo_SP, 'fdr')
names(pvals_diagRE_DMDL_SP_adj) <- names(pvals_diagRE_DMDL_nonexo_SP_adj) <- names(pvals_fullRE_M_nonexo_SP)

table(diagRE_DMDL_DA=pvals_diagRE_DMDL_nonexo_SP_adj <= 0.05,
      fullRE_DMSL_DA=pvals_fullRE_DMSL_nonexo_SP_adj <= 0.05)

##           fullRE_DMSL_DA
## diagRE_DMDL_DA FALSE TRUE
##           FALSE      5     1
##           TRUE       1    11

names(pvals_diagRE_DMDL_nonexo_SP_adj)[which((pvals_diagRE_DMDL_nonexo_SP_adj <= 0.05) & (fullRE_DMSL_DA <= 0.05))

## [1] "Lymph-CLL"
names(pvals_diagRE_DMDL_nonexo_SP_adj)[which((pvals_diagRE_DMDL_nonexo_SP_adj > 0.05) & (fullRE_DMSL_DA > 0.05))

## [1] "Stomach-AdenoCA"

```

```



```

```

##          1.170750e-02          1.568961e-09

pcawg_palette <- pcawg.colour.palette(gsub("\\\\..*", "", enough_samples), scheme = "tumour.subtype")
names(pcawg_palette) <- enough_samples

df_pvals_DMDL_SP <- cbind.data.frame(pvals_DM=pvals_diagRE_DMDL_SP_adj,
                                         pvals_DMnonexo=pvals_diagRE_DMDL_nonexo_SP_adj,
                                         num_samples=as.numeric(num_samples_all_SP),
                                         num_sigs_nonexo=as.numeric(num_sigs_nonexo_SP),
                                         ct=enough_samples,
                                         pvals_DM_censored=sapply(-log(pvals_diagRE_DMDL_SP_adj),
                                                       function(i) min(i, 25)),
                                         pvals_DMnonexo_censored=sapply(-log(pvals_diagRE_DMDL_nonexo_SP_adj),
                                                       function(i) min(i, 25)),
                                         bool_censored=(( -log(pvals_diagRE_DMDL_nonexo_SP_adj) > 25 ) | ( -log(pvals_diagRE_
```

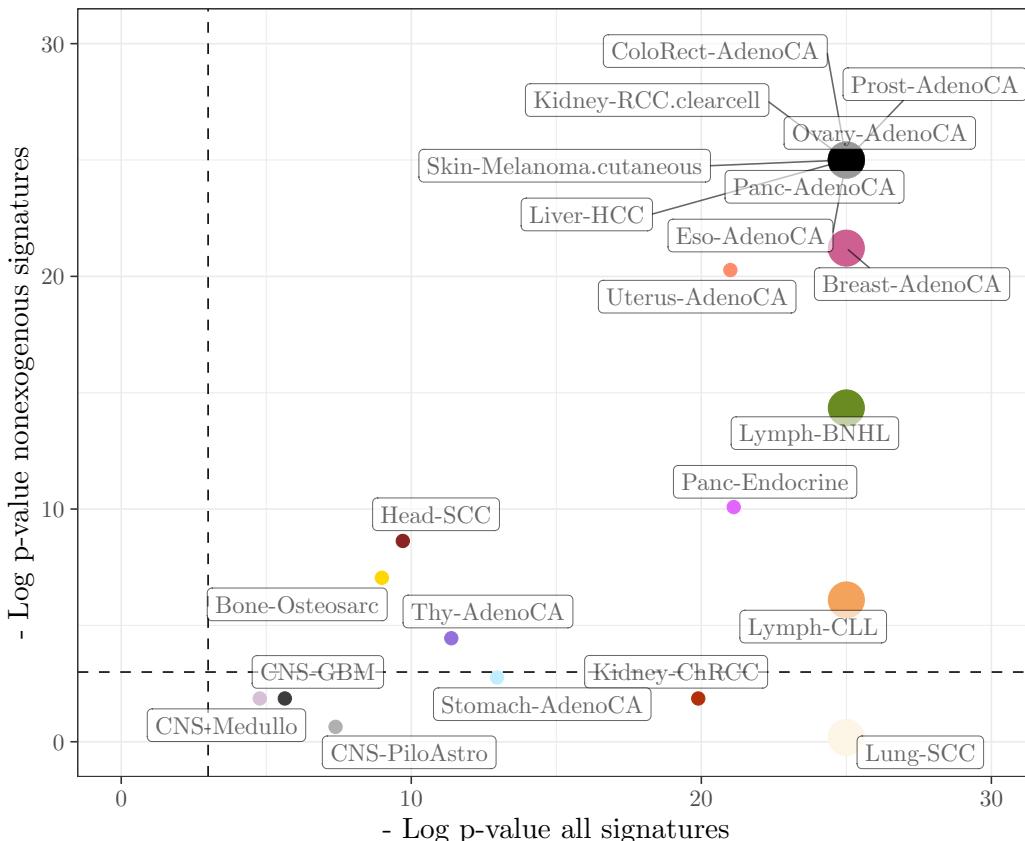
`ggplot(df_pvals_DMDL_SP,`
 `aes(x=pvals_DM_censored, y=pvals_DMnonexo_censored,`
 `# size=num_samples,`
 `label=ct, size=bool_censored))+geom_point(aes (col=ct))+`
 `geom_hline(yintercept = -log(0.05), lty='dashed')+geom_vline(xintercept = -log(0.05), lty='dashed')+`
 `geom_label_repel(size=3.2, alpha=0.6, max.overlaps = 30)+ theme_bw()+`
 `theme(legend.position = "bottom", legend.text=element_text(size=8))+`
 `labs(x='- Log p-value all signatures', y='- Log p-value nonexogenous signatures')+`
 `guides(size=FALSE, col=FALSE)+ #, col=guide_legend(ncol=4),`
 `scale_color_manual(values = pcawg_palette)+theme(legend.position = "bottom")+`
 `lims(x=c(0, 30), y=c(0,30))`

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> = "none")` instead.

## Warning: Using size for a discrete variable is not advised.

## Warning: Removed 1 rows containing missing values (geom\_point).

## Warning: Removed 1 rows containing missing values (geom\_label\_repel).



```
t.test(df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo <= 0.05, 'num_samples'],
       df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo > 0.05, 'num_samples'])
```

```
##
## Welch Two Sample t-test
##
## data: df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo <= 0.05, "num_samples"] and df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo > 0.05, "num_samples"]
## t = 1.8016, df = 19.213, p-value = 0.08733
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -5.663104 76.055261
## sample estimates:
## mean of x mean of y
## 82.52941 47.33333

t.test(df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo <= 0.05, 'num_sigs_nonexo'],
       df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo > 0.05, 'num_sigs_nonexo'])

##
## Welch Two Sample t-test
##
## data: df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo <= 0.05, "num_sigs_nonexo"] and df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo > 0.05, "num_sigs_nonexo"]
## t = 1.466, df = 7.0453, p-value = 0.1858
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -1.886557 8.063027
```

```

## sample estimates:
## mean of x mean of y
## 8.588235 5.500000
mean(df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo <= 0.05, 'num_sigs_nonexo'])

## [1] 8.588235
mean(df_pvals_DMDL_SP[df_pvals_DMDL_SP$pvals_DMnonexo > 0.05, 'num_sigs_nonexo'])

## [1] 5.5

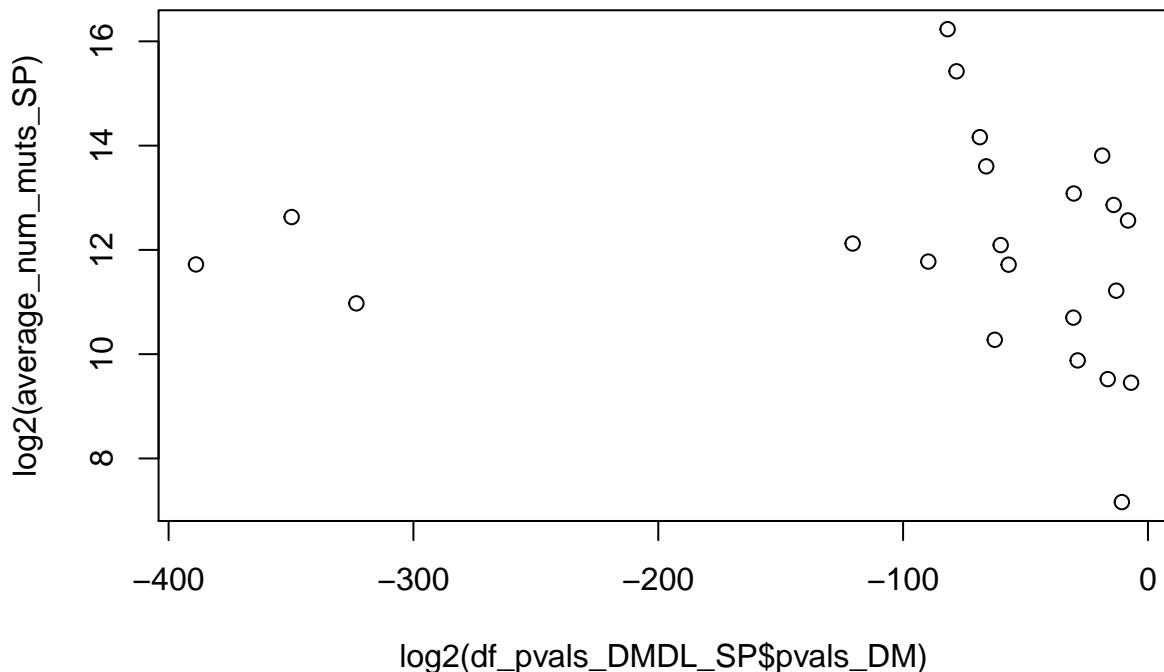
Does DA or not scale with the average number of mutations in the observed exposures (i.e. per patient and group) of the relevant ct?

average_num_muts_SP <- sapply(enough_samples, function(ct){
  .xx <- all_objects_SP[[ct]]
  try(mean(rowSums(.xx$Y)))
})

average_num_muts_SP

##          Bone-Osteosarc      Breast-AdenoCA      CNS-GBM
##                2382.1852        3507.5588       6057.6618
##          CNS-Medullo      CNS-PiloAstro  ColoRect-AdenoCA
##                  700.8915        143.3452       77035.7838
##          Eso-AdenoCA      Head-SCC           Kidney-ChRCC
##                 12439.3692       7445.4219       942.5263
## Kidney-RCC.clearcell Kidney-RCC.papillary      Liver-HCC
##                   3365.9477        2740.9833       6340.5121
##          Lung-SCC          Lymph-BNHL      Lymph-CLL
##                   18340.1471        4367.0392      1239.9057
##          Ovary-AdenoCA      Panc-AdenoCA      Panc-Endocrine
##                   4458.4691        3376.0415       1664.5857
## Prost-AdenoCA Skin-Melanoma.cutaneous      Stomach-AdenoCA
##                  2011.8966        43998.4833      14345.9667
##          Thy-AdenoCA      Uterus-AdenoCA
##                   734.8902        8670.1125
plot(log2(df_pvals_DMDL_SP$pvals_DM), log2(average_num_muts_SP))

```



$\log_2(\text{average\_num\_muts\_SP})$

```
t.test(log2(average_num_muts_SP)[df_pvals_DMDL_SP$pvals_DMnonexo <= 0.05],
       log2(average_num_muts_SP)[df_pvals_DMDL_SP$pvals_DMnonexo > 0.05])
```

##

## Welch Two Sample t-test

##

## data:  $\log_2(\text{average\_num\_muts\_SP})$  [df\_pvals\_DMDL\_SP\$pvals\_DMnonexo  $\leq 0.05$ ] and  $\log_2(\text{average\_num\_muts\_SP})$  [df\_pvals\_DMDL\_SP\$pvals\_DMnonexo  $> 0.05$ ]

##  $t = 0.85052$ ,  $df = 6.3966$ , p-value = 0.4257

## alternative hypothesis: true difference in means is not equal to 0

## 95 percent confidence interval:

## -1.88287 3.93586

## sample estimates:

## mean of x mean of y

## 12.19856 11.17207

See script PCAWG\_HMP\_and\_alternative\_methods.R for the analyses of PCAWG data using alternative models.

## Tracksig

```
tracksig = read.csv("../data/restricted/tracksig/changepoints_stats_tracksig.csv", stringsAsFactors =
tracksig = tracksig %>% group_by(type) %>%
  dplyr::summarize(count = n(), bool_changepoints=sum(n_changepoints > 0)) %>%
  mutate(tracksig_frac= bool_changepoints/count)
tracksig = cbind.data.frame(pvals_diagRE_DMDL_SP_adj,
                           tracksig[match(names(pvals_diagRE_DMDL_SP_adj), tracksig$type),],
                           effect_size3_SP=effect_size3_SP[match(names(pvals_diagRE_DMDL_SP_adj), names(effect_size3_SP))])
tracksig$ct = rownames(tracksig)
tracksig$minpvals = -log2(tracksig$pvals_diagRE_DM)

ggplot(tracksig, aes(x=-log2(pvals_diagRE_DMDL_SP_adj), y=tracksig_frac, label=ct, size=count))+geom_point()
```

```

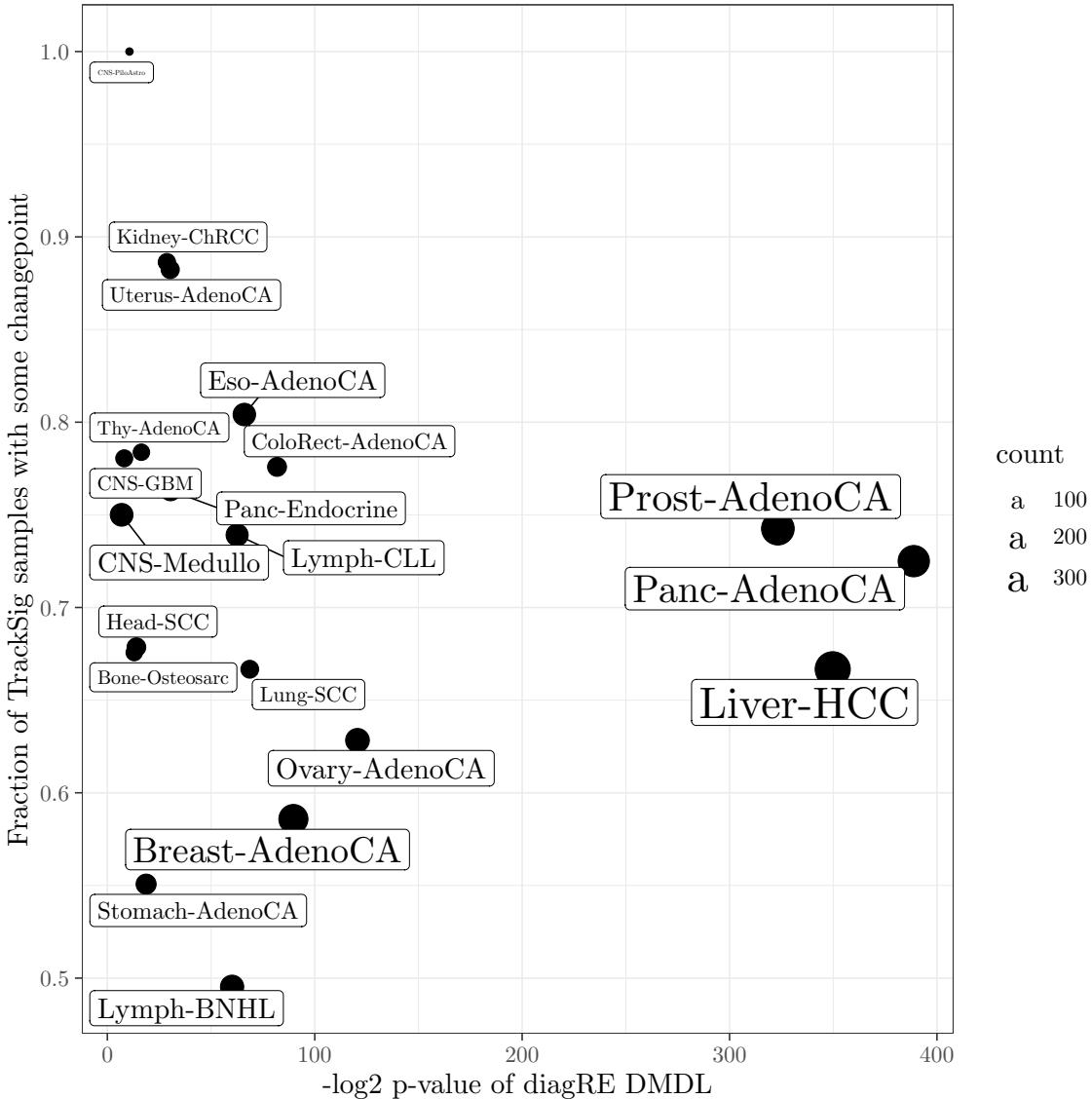
  labs(x = '-log2 p-value of diagRE DMDL', y = 'Fraction of TrackSig samples with some changepoint')+
  # scale_x_continuous(trans = "log2")+
  theme_bw()

```

```

## Warning: Removed 3 rows containing missing values (geom_point).
## Warning: Removed 3 rows containing missing values (geom_label_repel).

```



```

pcawg_palette <- pcawg.colour.palette(gsub("\\..*", "", tracksig$ct), scheme = "tumour.subtype")
names(pcawg_palette) <- tracksig$ct

```

```

ggplot(tracksig, aes(x=effect_size3_SP, y=tracksig_frac, label=ct, col=ct))+
  geom_point(aes(size=minpvals))+geom_label_repel(max.overlaps = 5)+  

  labs(x='Effect size', y='Fraction of TrackSig samples with some changepoint', col="")  

  +theme_bw()+
  scale_color_manual(values = pcawg_palette)+theme(legend.position = "bottom")+

```

```

guides(col=guide_legend(ncol=4), size=FALSE)

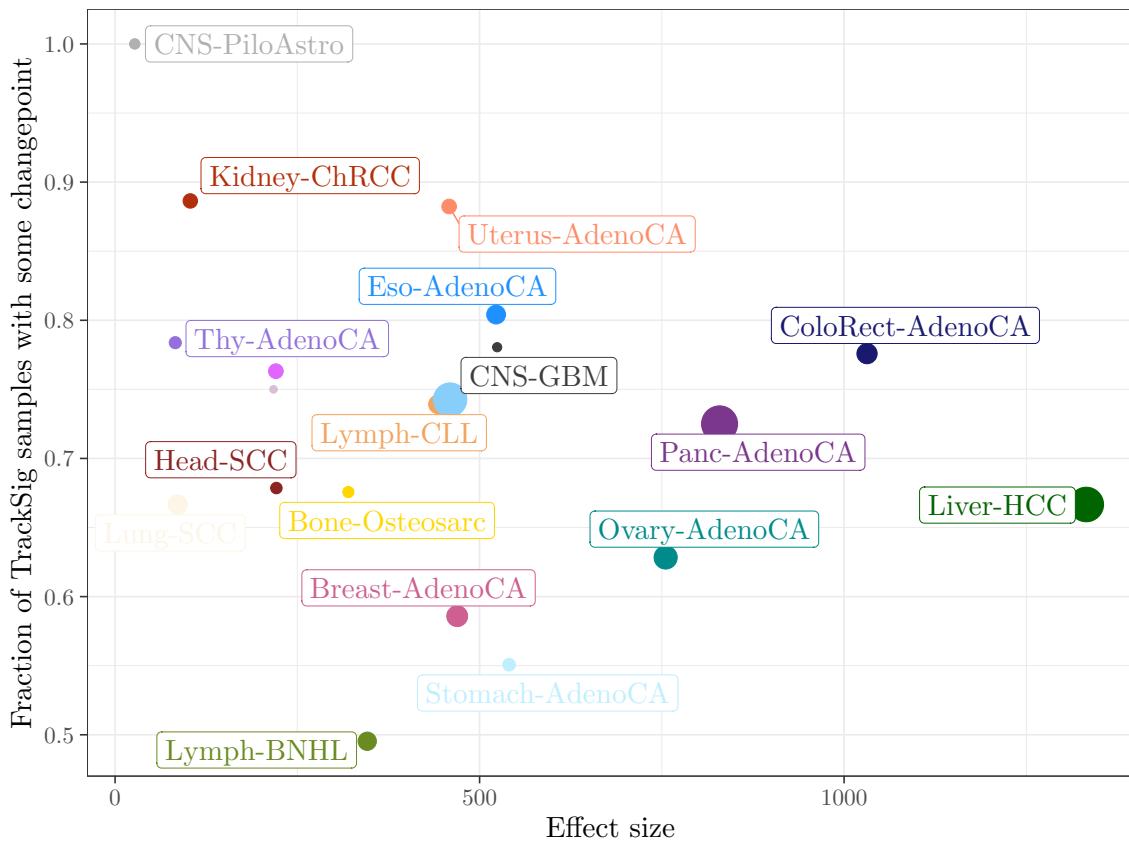
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: Removed 3 rows containing missing values (geom_point).

## Warning: Removed 3 rows containing missing values (geom_label_repel).

## Warning: ggrepel: 3 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

```



|   |                  |   |                      |   |                |   |                      |
|---|------------------|---|----------------------|---|----------------|---|----------------------|
| a | Bone-Osteosarc   | a | Eso-AdenoCA          | a | Lung-SCC       | a | Prost-AdenoCA        |
| a | Breast-AdenoCA   | a | Head-SCC             | a | Lymph-BNHL     | a | Skin-Melanoma.cutane |
| a | CNS-GBM          | a | Kidney-ChRCC         | a | Lymph-CLL      | a | Stomach-AdenoCA      |
| a | CNS-Medullo      | a | Kidney-RCC.clearcell | a | Ovary-AdenoCA  | a | Thy-AdenoCA          |
| a | CNS-PiloAstro    | a | Kidney-RCC.papillary | a | Panc-AdenoCA   | a | Uterus-AdenoCA       |
| a | ColoRect-AdenoCA | a | Liver-HCC            | a | Panc-Endocrine |   |                      |

Barplots of cancer types with and without differential abundance

```

give_barplot_from_obj(obj = signatures_PCAWG[['CNS-Medullo']], legend_on = F,
                      nrow=1, verbose=F,
                      only_normalised=T)

```

```

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =

```

```

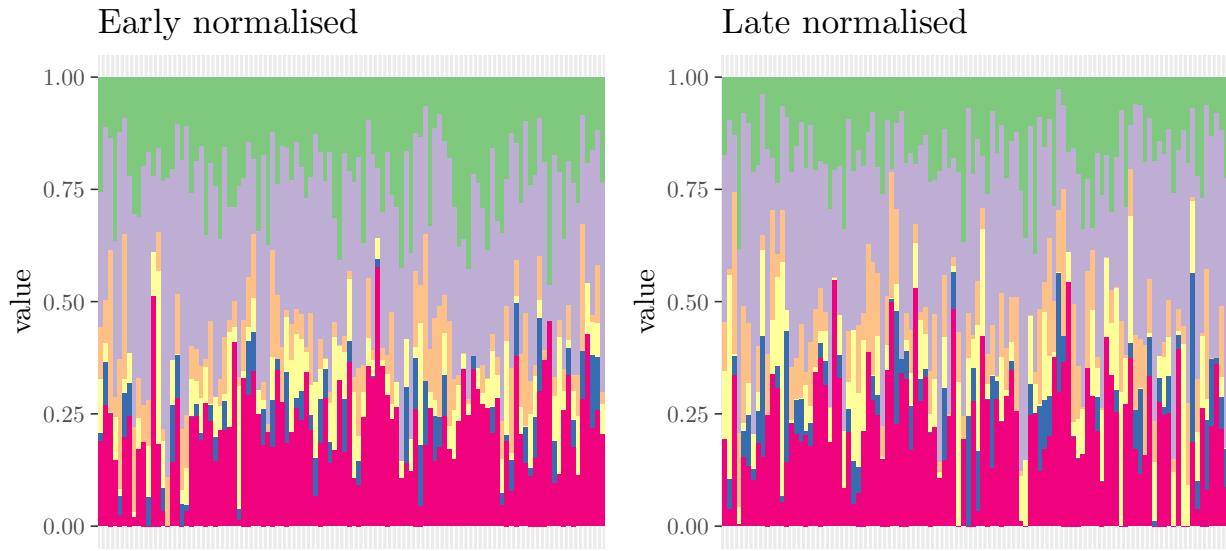
## "none")` instead.

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

```



```

give_barplot_from_obj(obj = signatures_PCAWG[['Uterus-AdenoCA']], legend_on = F,
                      nrow=1, verbose=F,
                      only_normalised=T)

```

```

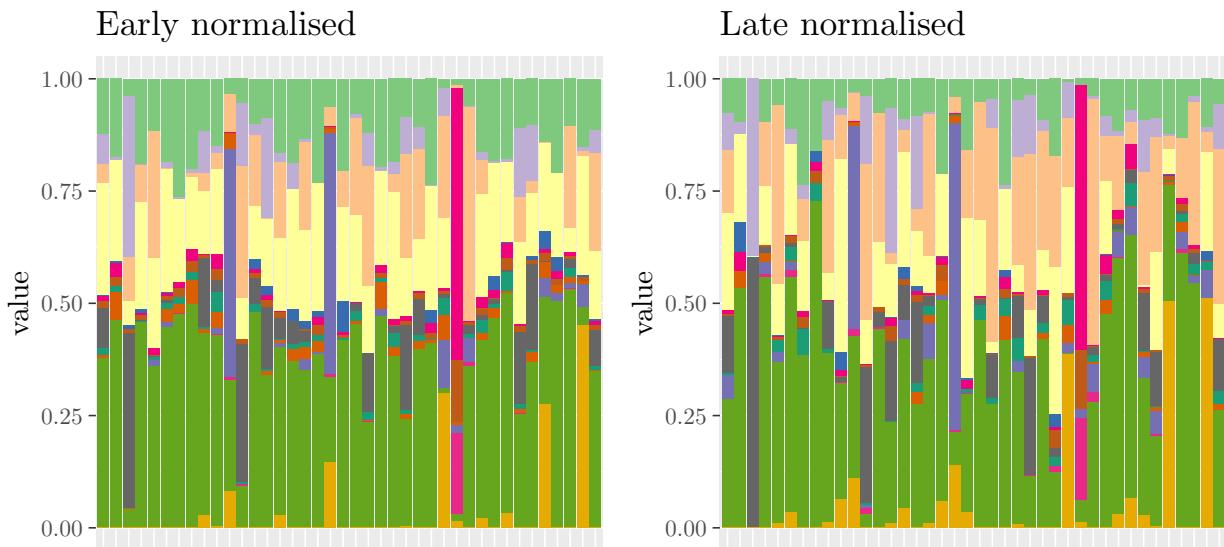
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

```



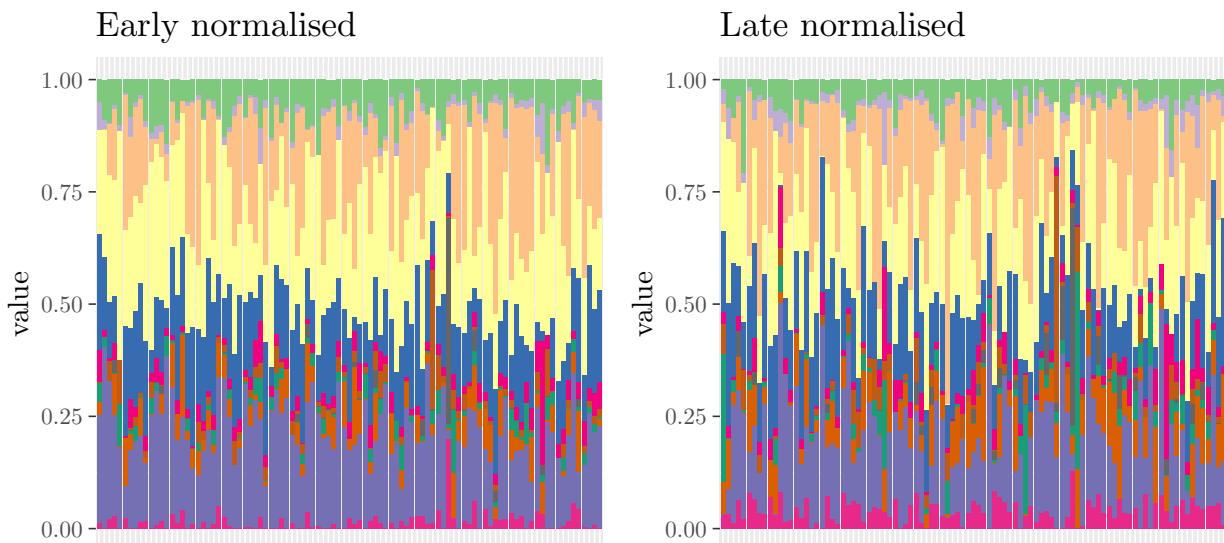
```
give_barplot_from_obj(obj = signatures_PCAWG[['Ovary-AdenoCA']], legend_on = F,
                      nrow=1, verbose=F,
                      only_normalised=T)
```

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

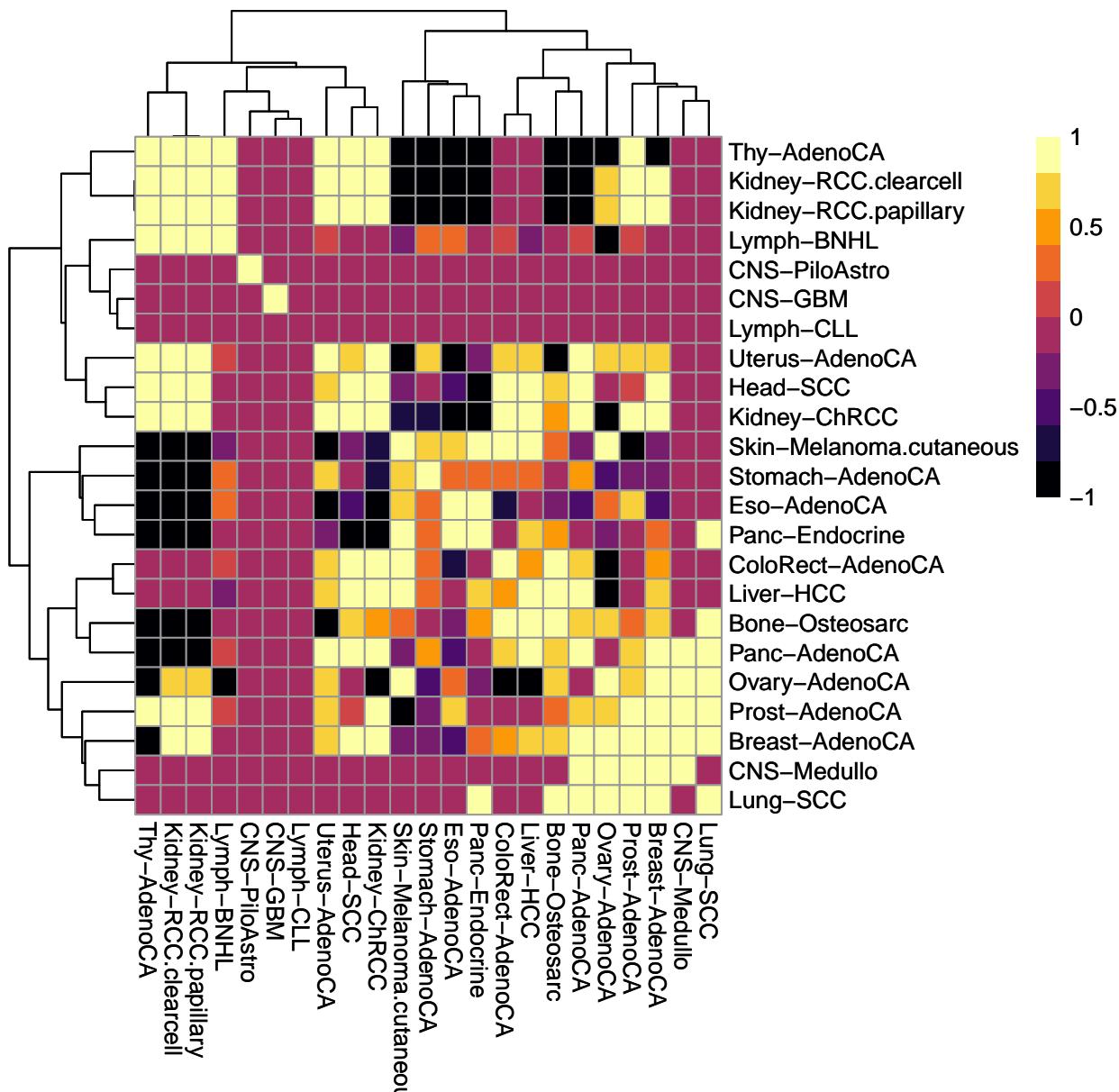
```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

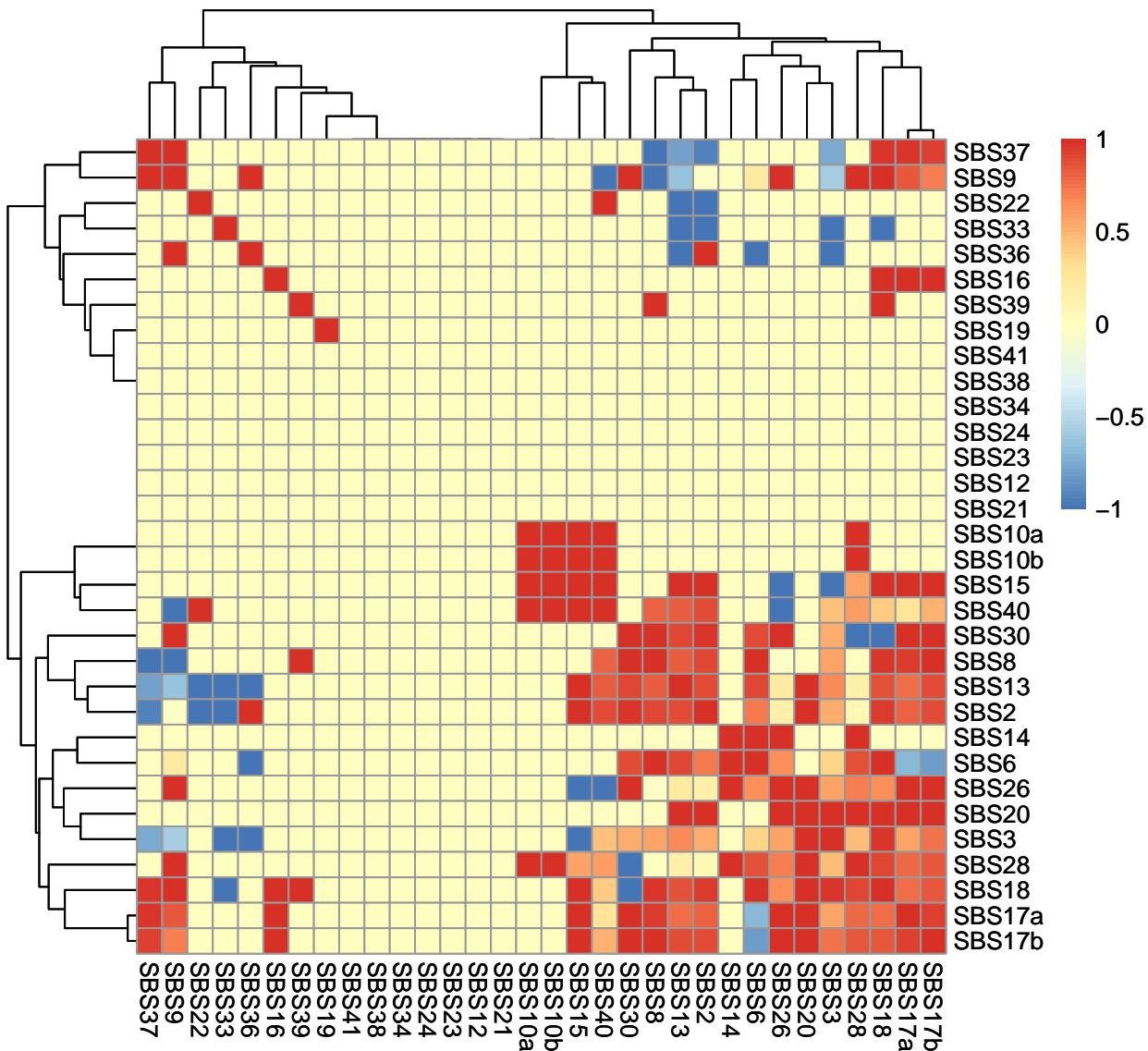
```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```



## Correlations of cancer types and of signatures based on betas



```
## null device
##      1
## null device
##      1
```



```
## null device  
## 1  
## null device  
## 1
```