FINAL PROJECT (MODEL BASED)

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Helper packages

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --

## v tibble  3.1.8     v purrr   0.3.5
## v tidyr   1.2.1     v stringr 1.4.1
## v readr   2.1.3     v forcats 0.5.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x gridExtra::combine() masks dplyr::combine()
## x dplyr::filter()      masks stats::filter()
## x dplyr::lag()         masks stats::lag()
```

```
library(cluster)
library(factoextra)
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
library(readr)
```

loading dataset

```
radiomics <- read_csv("radiomics.csv")
```

```
## Rows: 197 Columns: 431
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr   (1): Institution
## dbl (430): Failure.binary, Failure, Entropy_cooc.W.ADC, GLNU_align.H.PET, Mi...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
str(radiomics)
```

```
## spc_tbl_ [197 x 431] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
##  $ Institution                : chr [1:197] "A" "A" "A" "A" ...
##  $ Failure.binary             : num [1:197] 0 1 0 1 0 1 0 0 1 1 ...
##  $ Failure                    : num [1:197] 49.3 12.6 79.8 17.9 39.6 ...
##  $ Entropy_cooc.W.ADC         : num [1:197] 12.9 12.2 12.8 13.5 12.6 ...
##  $ GLNU_align.H.PET           : num [1:197] 46.3 27.5 90.2 325.6 89.6 ...
##  $ Min_hist.PET               : num [1:197] 6.25 11.01 2.78 6.3 3.58 ...
##  $ Max_hist.PET               : num [1:197] 17.83 26.47 6.88 22.03 7.92 ...
##  $ Mean_hist.PET              : num [1:197] 9.78 15.43 4.3 10.33 4.45 ...
##  $ Variance_hist.PET          : num [1:197] 6.814 12.932 0.923 6.65 0.572 ...
##  $ Standard_Deviation_hist.PET: num [1:197] 2.612 3.598 0.962 2.581 0.757 ...
##  $ Skewness_hist.PET          : num [1:197] 0.689 0.79 0.249 0.832 1.575 ...
##  $ Kurtosis_hist.PET          : num [1:197] -0.34 -0.32 -0.944 0.856 3.25 ...
##  $ Energy_hist.PET            : num [1:197] 0.00509 0.0063 0.00502 0.00329 0.00807 ...
##  $ Entropy_hist.PET           : num [1:197] 9.63 8.07 9.67 10.57 7.62 ...
##  $ AUC_hist.PET               : num [1:197] 0.507 0.508 0.503 0.544 0.544 ...
##  $ H_suv.PET                  : num [1:197] 1.124 1.927 0.411 0.92 0.306 ...
##  $ Volume.PET                 : num [1:197] 13752 9328 26624 51058 29415 ...
##  $ X3D_surface.PET            : num [1:197] 5623 8357 16832 29100 7769 ...
##  $ ratio_3ds_vol.PET          : num [1:197] 3.21 4.85 3.16 2.03 4.82 ...
##  $ ratio_3ds_vol_norm.PET     : num [1:197] 15.9 21.1 19.5 20.1 21 ...
##  $ irregularity.PET           : num [1:197] 2.21 2.35 2.12 1.86 2.22 ...
##  $ tumor_length.PET           : num [1:197] 44 39.4 50.9 76.2 36.9 ...
##  $ Compactness_v1.PET         : num [1:197] 0.00337 0.00308 0.00314 0.00312 0.00308 ...
##  $ Compactness_v2.PET         : num [1:197] 0.00278 0.00264 0.00266 0.00265 0.00264 ...
##  $ Spherical_disproportion.PET: num [1:197] 15.9 21.1 19.5 20.1 21 ...
##  $ Sphericity.PET             : num [1:197] 0.0654 0.0499 0.0538 0.0522 0.0501 ...
```

```
##  $ Asphericity.PET           : num [1:197] 14.9 20.1 18.5 19.1 20 ...
##  $ Center_of_mass.PET        : num [1:197] 0.811 0.588 0.393 0.867 0.526 ...
##  $ Max_3D_diam.PET           : num [1:197] 44 39.4 50.9 76.2 36.9 ...
##  $ Major_axis_length.PET     : num [1:197] 34.6 35.1 48.1 64.1 36 ...
##  $ Minor_axis_length.PET     : num [1:197] 25.9 27.3 30.4 54.5 23.8 ...
##  $ Least_axis_length.PET     : num [1:197] 25 21.2 27.5 51.6 21.4 ...
##  $ Elongation.PET            : num [1:197] 0.751 0.78 0.634 0.852 0.665 ...
##  $ Flatness.PET              : num [1:197] 0.725 0.605 0.574 0.807 0.597 ...
##  $ Max_cooc.L.PET            : num [1:197] 0.00502 0.00819 0.00503 0.00597 0.00755 ...
##  $ Average_cooc.L.PET        : num [1:197] 22.9 21.9 27.3 17.8 15.4 ...
##  $ Variance_cooc.L.PET       : num [1:197] 206 227 209 103 142 ...
##  $ Entropy_cooc.L.PET        : num [1:197] 10.69 10.29 10.88 10.24 9.83 ...
##  $ DAVE_cooc.L.PET           : num [1:197] 11.86 13.99 12.28 7.47 10.24 ...
##  $ DVAR_cooc.L.PET           : num [1:197] 84.2 129.4 85.3 43.9 79.4 ...
##  $ DENT_cooc.L.PET           : num [1:197] 5 5.21 5 4.38 4.8 ...
##  $ SAVE_cooc.L.PET           : num [1:197] 45.8 43.8 54.5 35.6 30.7 ...
##  $ SVAR_cooc.L.PET           : num [1:197] 588 581 600 311 385 ...
##  $ SENT_cooc.L.PET           : num [1:197] 6.53 6.49 6.59 6.11 6.05 ...
##  $ ASM_cooc.L.PET            : num [1:197] 0.0033 0.0036 0.0032 0.00368 0.004 ...
##  $ Contrast_cooc.L.PET       : num [1:197] 234.8 325.1 236.1 99.8 184.2 ...
##  $ Dissimilarity_cooc.L.PET  : num [1:197] 11.86 13.99 12.28 7.47 10.24 ...
##  $ Inv_diff_cooc.L.PET       : num [1:197] 0.166 0.156 0.154 0.229 0.189 ...
##  $ Inv_diff_norm_cooc.L.PET  : num [1:197] 0.859 0.839 0.853 0.905 0.876 ...
##  $ IDM_cooc.L.PET            : num [1:197] 0.0889 0.0854 0.079 0.1416 0.1083 ...
##  $ IDM_norm_cooc.L.PET       : num [1:197] 0.954 0.938 0.953 0.98 0.964 ...
##  $ Inv_var_cooc.L.PET        : num [1:197] 0.0913 0.0875 0.0846 0.1498 0.1144 ...
##  $ Correlation_cooc.L.PET    : num [1:197] 0.432 0.285 0.438 0.517 0.355 ...
##  $ Autocorrelation_cooc.L.PET: num [1:197] 612 544 833 370 286 ...
##  $ Tendency_cooc.L.PET       : num [1:197] 588 581 600 311 385 ...
##  $ Shade_cooc.L.PET          : num [1:197] 6860 4692 403 3806 9785 ...
##  $ Prominence_cooc.L.PET     : num [1:197] 869822 803735 800130 345453 743501 ...
##  $ IC1_.L.PET                : num [1:197] -0.084 -0.0967 -0.0724 -0.0503 -0.0707 ...
##  $ IC2_.L.PET                : num [1:197] 0.79 0.814 0.758 0.655 0.728 ...
##  $ Coarseness_vdif_.L.PET    : num [1:197] 0.01432 0.0142 0.01627 0.00494 0.01724 ...
##  $ Contrast_vdif_.L.PET      : num [1:197] 1.021 1.51 1.014 0.306 0.854 ...
##  $ Busyness_vdif_.L.PET      : num [1:197] 0.0874 0.0802 0.0575 0.3927 0.082 ...
##  $ Complexity_vdif_.L.PET    : num [1:197] 17053 21289 15200 10762 16797 ...
##  $ Strength_vdif_.L.PET      : num [1:197] 27.4 35.76 24.45 5.55 57.04 ...
##  $ SRE_align.L.PET           : num [1:197] 0.987 0.99 0.989 0.973 0.986 ...
##  $ LRE_align.L.PET           : num [1:197] 1.07 1.06 1.06 1.13 1.07 ...
##  $ GLNU_align.L.PET          : num [1:197] 10.16 8.42 9.12 94.57 10.57 ...
##  $ RLNU_align.L.PET          : num [1:197] 384 263 395 2941 262 ...
##  $ RP_align.L.PET            : num [1:197] 0.981 0.985 0.985 0.964 0.981 ...
##  $ LGRE_align.L.PET          : num [1:197] 0.0637 0.0658 0.0392 0.0481 0.0917 ...
##  $ HGRE_align.L.PET          : num [1:197] 590 560 781 387 296 ...
##  $ LGSRE_align.L.PET         : num [1:197] 0.0625 0.0642 0.0388 0.0466 0.0902 ...
##  $ HGSRE_align.L.PET         : num [1:197] 581 555 768 377 292 ...
##  $ LGHRE_align.L.PET         : num [1:197] 0.0687 0.0724 0.041 0.0544 0.0978 ...
##  $ HGLRE_align.L.PET         : num [1:197] 632 584 836 428 309 ...
##  $ GLNU_norm_align.L.PET     : num [1:197] 0.0279 0.0334 0.0248 0.0323 0.0411 ...
##  $ RLNU_norm_align.L.PET     : num [1:197] 0.961 0.97 0.968 0.929 0.96 ...
##  $ GLVAR_align.L.PET         : num [1:197] 202 215 217 108 121 ...
##  $ RLVAR_align.L.PET         : num [1:197] 0.0259 0.0215 0.0208 0.0464 0.0245 ...
##  $ Entropy_align.L.PET       : num [1:197] 5.59 5.39 5.7 5.48 5.05 ...
```

```
##  $ SZSE.L.PET                : num [1:197] 0.927 0.961 0.974 0.906 0.966 ...
##  $ LZSE.L.PET                : num [1:197] 1.38 1.24 1.11 1.62 1.15 ...
##  $ LGLZE.L.PET               : num [1:197] 0.0623 0.0648 0.0405 0.048 0.0933 ...
##  $ HGLZE.L.PET               : num [1:197] 593 567 770 394 301 ...
##  $ SZLGE.L.PET               : num [1:197] 0.0561 0.0606 0.0404 0.0433 0.0911 ...
##  $ SZHGE.L.PET               : num [1:197] 554 546 736 361 296 ...
##  $ LZLGE.L.PET               : num [1:197] 0.09 0.0865 0.0407 0.0768 0.1018 ...
##  $ LZHGE.L.PET               : num [1:197] 832 650 905 591 322 ...
##  $ GLNU_area.L.PET           : num [1:197] 9.17 7.82 8.88 83.35 10.25 ...
##  $ ZSNU.L.PET                : num [1:197] 301 233 372 2206 242 ...
##  $ ZSP.L.PET                 : num [1:197] 0.9 0.941 0.966 0.861 0.956 ...
##  $ GLNU_norm.L.PET           : num [1:197] 0.0275 0.0326 0.0247 0.0319 0.0409 ...
##  $ ZSNU_norm.L.PET           : num [1:197] 0.823 0.9 0.931 0.781 0.91 ...
##  $ GLVAR_area.L.PET          : num [1:197] 202 214 216 110 124 ...
##  $ ZSVAR.L.PET               : num [1:197] 0.142 0.1098 0.0385 0.2592 0.0488 ...
##  $ Entropy_area.L.PET        : num [1:197] 5.89 5.55 5.78 5.9 5.16 ...
##  $ Max_cooc.H.PET            : num [1:197] 0.0312 0.0436 0.1694 0.0402 0.4235 ...
##  $ Average_cooc.H.PET        : num [1:197] 39.9 39.2 44.9 38.2 49.5 ...
##  $ Variance_cooc.H.PET       : num [1:197] 255.3 259.2 226.9 276.5 65.5 ...
##   [list output truncated]
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##   ..   Kurtosis_hist.PET = col_double(),
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##   ..   Least_axis_length.PET = col_double(),
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##   ..   DENT_cooc.L.PET = col_double(),
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##   ..   SZLGE.L.PET = col_double(),
##   ..   SZHGE.L.PET = col_double(),
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##   ..   LZHGE.L.PET = col_double(),
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##   ..   GLVAR_align.H.PET = col_double(),
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##   ..   Inv_var_cooc.W.PET = col_double(),
##   ..   Correlation_cooc.W.PET = col_double(),
##   ..   Autocorrelation_cooc.W.PET = col_double(),
##   ..   Tendency_cooc.W.PET = col_double(),
##   ..   Shade_cooc.W.PET = col_double(),
##   ..   Prominence_cooc.W.PET = col_double(),
##   ..   IC1_d.W.PET = col_double(),
##   ..   IC2_d.W.PET = col_double(),
##   ..   Coarseness_vdif.W.PET = col_double(),
##   ..   Contrast_vdif.W.PET = col_double(),
##   ..   Busyness_vdif.W.PET = col_double(),
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##   ..   SRE_align.W.PET = col_double(),
##   ..   LRE_align.W.PET = col_double(),
##   ..   GLNU_align.W.PET = col_double(),
##   ..   RLNU_align.W.PET = col_double(),
##   ..   RP_align.W.PET = col_double(),
##   ..   LGRE_align.W.PET = col_double(),
##   ..   HGRE_align.W.PET = col_double(),
```

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##   ..   LGHRE_align.W.PET = col_double(),
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##   ..   GLNU_norm_align.W.PET = col_double(),
##   ..   RLNU_norm_align.W.PET = col_double(),
##   ..   GLVAR_align.W.PET = col_double(),
##   ..   RLVAR_align.W.PET = col_double(),
##   ..   Entropy_align.W.PET = col_double(),
##   ..   SZSE.W.PET = col_double(),
##   ..   LZSE.W.PET = col_double(),
##   ..   LGLZE.W.PET = col_double(),
##   ..   HGLZE.W.PET = col_double(),
##   ..   SZLGE.W.PET = col_double(),
##   ..   SZHGE.W.PET = col_double(),
##   ..   LZLGE.W.PET = col_double(),
##   ..   LZHGE.W.PET = col_double(),
##   ..   GLNU_area.W.PET = col_double(),
##   ..   ZSNU.W.PET = col_double(),
##   ..   ZSP.W.PET = col_double(),
##   ..   GLNU_norm.W.PET = col_double(),
##   ..   ZSNU_norm.W.PET = col_double(),
##   ..   GLVAR_area.W.PET = col_double(),
##   ..   ZSVAR.W.PET = col_double(),
##   ..   Entropy_area.W.PET = col_double(),
##   ..   Min_hist.ADC = col_double(),
##   ..   Max_hist.ADC = col_double(),
##   ..   Mean_hist.ADC = col_double(),
##   ..   Variance_hist.ADC = col_double(),
##   ..   Standard_Deviation_hist.ADC = col_double(),
##   ..   Skewness_hist.ADC = col_double(),
##   ..   Kurtosis_hist.ADC = col_double(),
##   ..   Energy_hist.ADC = col_double(),
##   ..   Entropy_hist.ADC = col_double(),
##   ..   AUC_hist.ADC = col_double(),
##   ..   Volume.ADC = col_double(),
##   ..   X3D_surface.ADC = col_double(),
##   ..   ratio_3ds_vol.ADC = col_double(),
##   ..   ratio_3ds_vol_norm.ADC = col_double(),
##   ..   irregularity.ADC = col_double(),
##   ..   Compactness_v1.ADC = col_double(),
##   ..   Compactness_v2.ADC = col_double(),
##   ..   Spherical_disproportion.ADC = col_double(),
##   ..   Sphericity.ADC = col_double(),
##   ..   Asphericity.ADC = col_double(),
##   ..   Center_of_mass.ADC = col_double(),
##   ..   Max_3D_diam.ADC = col_double(),
##   ..   Major_axis_length.ADC = col_double(),
##   ..   Minor_axis_length.ADC = col_double(),
##   ..   Least_axis_length.ADC = col_double(),
##   ..   Elongation.ADC = col_double(),
##   ..   Flatness.ADC = col_double(),
##   ..   Max_cooc.L.ADC = col_double(),
##   ..   Average_cooc.L.ADC = col_double(),
```

```
##   ..   Variance_cooc.L.ADC = col_double(),
##   ..   Entropy_cooc.L.ADC = col_double(),
##   ..   DAVE_cooc.L.ADC = col_double(),
##   ..   DVAR_cooc.L.ADC = col_double(),
##   ..   DENT_cooc.L.ADC = col_double(),
##   ..   SAVE_cooc.L.ADC = col_double(),
##   ..   SVAR_cooc.L.ADC = col_double(),
##   ..   SENT_cooc.L.ADC = col_double(),
##   ..   ASM_cooc.L.ADC = col_double(),
##   ..   Contrast_cooc.L.ADC = col_double(),
##   ..   Dissimilarity_cooc.L.ADC = col_double(),
##   ..   Inv_diff_cooc.L.ADC = col_double(),
##   ..   Inv_diff_norm_cooc.L.ADC = col_double(),
##   ..   IDM_cooc.L.ADC = col_double(),
##   ..   IDM_norm_cooc.L.ADC = col_double(),
##   ..   Inv_var_cooc.L.ADC = col_double(),
##   ..   Correlation_cooc.L.ADC = col_double(),
##   ..   Autocorrelation_.L.ADC = col_double(),
##   ..   Tendency_cooc.L.ADC = col_double(),
##   ..   Shade_.L.ADC = col_double(),
##   ..   Prominence_cooc.L.ADC = col_double(),
##   ..   IC1_.L.ADC = col_double(),
##   ..   IC2_.L.ADC = col_double(),
##   ..   Coarseness_vdif_.L.ADC = col_double(),
##   ..   Contrast_vdif_.L.ADC = col_double(),
##   ..   Busyness_vdif_.L.ADC = col_double(),
##   ..   Complexity_vdif_.L.ADC = col_double(),
##   ..   Strength_vdif_.L.ADC = col_double(),
##   ..   SRE_align.L.ADC = col_double(),
##   ..   LRE_align.L.ADC = col_double(),
##   ..   GLNU_align.L.ADC = col_double(),
##   ..   RLNU_align.L.ADC = col_double(),
##   ..   RP_align.L.ADC = col_double(),
##   ..   LGRE_align.L.ADC = col_double(),
##   ..   HGRE_align.L.ADC = col_double(),
##   ..   LGSRE_align.L.ADC = col_double(),
##   ..   HGSRE_align.L.ADC = col_double(),
##   ..   LGHRE_align.L.ADC = col_double(),
##   ..   HGLRE_align.L.ADC = col_double(),
##   ..   GLNU_norm_align.L.ADC = col_double(),
##   ..   RLNU_norm_align.L.ADC = col_double(),
##   ..   GLVAR_align.L.ADC = col_double(),
##   ..   RLVAR_align.L.ADC = col_double(),
##   ..   Entropy_align.L.ADC = col_double(),
##   ..   SZSE.L.ADC = col_double(),
##   ..   LZSE.L.ADC = col_double(),
##   ..   LGLZE.L.ADC = col_double(),
##   ..   HGLZE.L.ADC = col_double(),
##   ..   SZLGE.L.ADC = col_double(),
##   ..   SZHGE.L.ADC = col_double(),
##   ..   LZLGE.L.ADC = col_double(),
##   ..   LZHGE.L.ADC = col_double(),
##   ..   GLNU_area.L.ADC = col_double(),
##   ..   ZSNU.L.ADC = col_double(),
```

```
##   ..   ZSP.L.ADC = col_double(),
##   ..   GLNU_norm.L.ADC = col_double(),
##   ..   ZSNU_norm.L.ADC = col_double(),
##   ..   GLVAR_area.L.ADC = col_double(),
##   ..   ZSVAR.L.ADC = col_double(),
##   ..   Entropy_area.L.ADC = col_double(),
##   ..   Max_cooc.H.ADC = col_double(),
##   ..   Average_cooc.H.ADC = col_double(),
##   ..   Variance_cooc.H.ADC = col_double(),
##   ..   Entropy_cooc.H.ADC = col_double(),
##   ..   DAVE_cooc.H.ADC = col_double(),
##   ..   DVAR_cooc.H.ADC = col_double(),
##   ..   DENT_cooc.H.ADC = col_double(),
##   ..   SAVE_cooc.H.ADC = col_double(),
##   ..   SVAR_cooc.H.ADC = col_double(),
##   ..   SENT_cooc.H.ADC = col_double(),
##   ..   ASM_cooc.H.ADC = col_double(),
##   ..   Contrast_cooc.H.ADC = col_double(),
##   ..   Dissimilarity_cooc.H.ADC = col_double(),
##   ..   Inv_diff_cooc.H.ADC = col_double(),
##   ..   Inv_diff_norm_cooc.H.ADC = col_double(),
##   ..   IDM_cooc.H.ADC = col_double(),
##   ..   IDM_norm_cooc.H.ADC = col_double(),
##   ..   Inv_var_cooc.H.ADC = col_double(),
##   ..   Correlation_cooc.H.ADC = col_double(),
##   ..   Autocorrelation_cooc.H.ADC = col_double(),
##   ..   Tendency_cooc.H.ADC = col_double(),
##   ..   Shade_cooc.H.ADC = col_double(),
##   ..   Prominence_cooc.H.ADC = col_double(),
##   ..   IC1_d.H.ADC = col_double(),
##   ..   IC2_d.H.ADC = col_double(),
##   ..   Coarseness_vdif.H.ADC = col_double(),
##   ..   Contrast_vdif.H.ADC = col_double(),
##   ..   Busyness_vdif.H.ADC = col_double(),
##   ..   Complexity_vdif.H.ADC = col_double(),
##   ..   Strength_vdif.H.ADC = col_double(),
##   ..   SRE_align.H.ADC = col_double(),
##   ..   LRE_align.H.ADC = col_double(),
##   ..   GLNU_align.H.ADC = col_double(),
##   ..   RLNU_align.H.ADC = col_double(),
##   ..   RP_align.H.ADC = col_double(),
##   ..   LGRE_align.H.ADC = col_double(),
##   ..   HGRE_align.H.ADC = col_double(),
##   ..   LGSRE_align.H.ADC = col_double(),
##   ..   HGSRE_align.H.ADC = col_double(),
##   ..   LGHRE_align.H.ADC = col_double(),
##   ..   HGLRE_align.H.ADC = col_double(),
##   ..   GLNU_norm_align.H.ADC = col_double(),
##   ..   RLNU_norm_align.H.ADC = col_double(),
##   ..   GLVAR_align.H.ADC = col_double(),
##   ..   RLVAR_align.H.ADC = col_double(),
##   ..   Entropy_align.H.ADC = col_double(),
##   ..   SZSE.H.ADC = col_double(),
##   ..   LZSE.H.ADC = col_double(),
```

```
##   ..   LGLZE.H.ADC = col_double(),
##   ..   HGLZE.H.ADC = col_double(),
##   ..   SZLGE.H.ADC = col_double(),
##   ..   SZHGE.H.ADC = col_double(),
##   ..   LZLGE.H.ADC = col_double(),
##   ..   LZHGE.H.ADC = col_double(),
##   ..   GLNU_area.H.ADC = col_double(),
##   ..   ZSNU.H.ADC = col_double(),
##   ..   ZSP.H.ADC = col_double(),
##   ..   GLNU_norm.H.ADC = col_double(),
##   ..   ZSNU_norm.H.ADC = col_double(),
##   ..   GLVAR_area.H.ADC = col_double(),
##   ..   ZSVAR.H.ADC = col_double(),
##   ..   Entropy_area.H.ADC = col_double(),
##   ..   Max_cooc.W.ADC = col_double(),
##   ..   Average_cooc.W.ADC = col_double(),
##   ..   Variance_cooc.W.ADC = col_double(),
##   ..   DAVE_cooc.W.ADC = col_double(),
##   ..   DVAR_cooc.W.ADC = col_double(),
##   ..   DENT_cooc.W.ADC = col_double(),
##   ..   SAVE_cooc.W.ADC = col_double(),
##   ..   SVAR_cooc.W.ADC = col_double(),
##   ..   SENT_cooc.W.ADC = col_double(),
##   ..   ASM_cooc.W.ADC = col_double(),
##   ..   Contrast_cooc.W.ADC = col_double(),
##   ..   Dissimilarity_cooc.W.ADC = col_double(),
##   ..   Inv_diff_cooc.W.ADC = col_double(),
##   ..   Inv_diff_norm_cooc.W.ADC = col_double(),
##   ..   IDM_cooc.W.ADC = col_double(),
##   ..   IDM_norm_cooc.W.ADC = col_double(),
##   ..   Inv_var_cooc.W.ADC = col_double(),
##   ..   Correlation_cooc.W.ADC = col_double(),
##   ..   Autocorrelation_cooc.W.ADC = col_double(),
##   ..   Tendency_cooc.W.ADC = col_double(),
##   ..   Shade_cooc.W.ADC = col_double(),
##   ..   Prominence_cooc.W.ADC = col_double(),
##   ..   IC1_d.W.ADC = col_double(),
##   ..   IC2_d.W.ADC = col_double(),
##   ..   Coarseness_vdif.W.ADC = col_double(),
##   ..   Contrast_vdif.W.ADC = col_double(),
##   ..   Busyness_vdif.W.ADC = col_double(),
##   ..   Complexity_vdif.W.ADC = col_double(),
##   ..   Strength_vdif.W.ADC = col_double(),
##   ..   SRE_align.W.ADC = col_double(),
##   ..   LRE_align.W.ADC = col_double(),
##   ..   GLNU_align.W.ADC = col_double(),
##   ..   RLNU_align.W.ADC = col_double(),
##   ..   RP_align.W.ADC = col_double(),
##   ..   LGRE_align.W.ADC = col_double(),
##   ..   HGRE_align.W.ADC = col_double(),
##   ..   LGSRE_align.W.ADC = col_double(),
##   ..   HGSRE_align.W.ADC = col_double(),
##   ..   LGHRE_align.W.ADC = col_double(),
##   ..   HGLRE_align.W.ADC = col_double(),
```

```
##   ..   GLNU_norm_align.W.ADC = col_double(),
##   ..   RLNU_norm_align.W.ADC = col_double(),
##   ..   GLVAR_align.W.ADC = col_double(),
##   ..   RLVAR_align.W.ADC = col_double(),
##   ..   Entropy_align.W.ADC = col_double(),
##   ..   SZSE.W.ADC = col_double(),
##   ..   LZSE.W.ADC = col_double(),
##   ..   LGLZE.W.ADC = col_double(),
##   ..   HGLZE.W.ADC = col_double(),
##   ..   SZLGE.W.ADC = col_double(),
##   ..   SZHGE.W.ADC = col_double(),
##   ..   LZLGE.W.ADC = col_double(),
##   ..   LZHGE.W.ADC = col_double(),
##   ..   GLNU_area.W.ADC = col_double(),
##   ..   ZSNU.W.ADC = col_double(),
##   ..   ZSP.W.ADC = col_double(),
##   ..   GLNU_norm.W.ADC = col_double(),
##   ..   ZSNU_norm.W.ADC = col_double(),
##   ..   GLVAR_area.W.ADC = col_double(),
##   ..   ZSVAR.W.ADC = col_double(),
##   ..   Entropy_area.W.ADC = col_double()
##   .. )
##  - attr(*, "problems")=<externalptr>
```

```
summary(radiomics)
```

```
##  Institution        Failure.binary      Failure       Entropy_cooc.W.ADC
##  Length:197         Min.   :0.0000   Min.   : 4.767   Min.   : 9.533
##  Class :character   1st Qu.:0.0000   1st Qu.:11.267   1st Qu.:11.559
##  Mode  :character   Median :0.0000   Median :20.500   Median :12.279
##                     Mean   :0.3401   Mean   :26.367   Mean   :12.279
##                     3rd Qu.:1.0000   3rd Qu.:37.900   3rd Qu.:12.977
##                     Max.   :1.0000   Max.   :97.633   Max.   :14.510
##  GLNU_align.H.PET   Min_hist.PET     Max_hist.PET    Mean_hist.PET
##  Min.   :  9.445   Min.   : 1.485   Min.   : 4.164   Min.   : 2.425
##  1st Qu.: 37.518   1st Qu.: 5.152   1st Qu.:13.072   1st Qu.: 7.498
##  Median : 80.035   Median : 7.389   Median :21.014   Median :11.449
##  Mean   : 95.382   Mean   : 8.513   Mean   :24.271   Mean   :13.008
##  3rd Qu.:112.145   3rd Qu.:11.005   3rd Qu.:33.761   3rd Qu.:17.387
##  Max.   :559.352   Max.   :28.404   Max.   :79.986   Max.   :44.043
##  Variance_hist.PET Standard_Deviation_hist.PET Skewness_hist.PET
##  Min.   : 0.1787   Min.   :0.4194              Min.   :-0.001136
##  1st Qu.: 2.2583   1st Qu.:1.6391              1st Qu.: 0.444828
##  Median : 6.4504   Median :2.7341              Median : 0.734796
##  Mean   : 9.2575   Mean   :3.0492              Mean   : 0.911980
##  3rd Qu.:12.6824   3rd Qu.:4.2095              3rd Qu.: 1.199956
##  Max.   :49.0121   Max.   :9.9293              Max.   : 4.901172
##  Kurtosis_hist.PET Energy_hist.PET     Entropy_hist.PET  AUC_hist.PET
##  Min.   :-2.2661   Min.   :-0.063283   Min.   : 5.296   Min.   :0.4403
##  1st Qu.:-0.5259   1st Qu.:-0.012100   1st Qu.: 8.281   1st Qu.:0.5039
##  Median :-0.1672   Median : 0.007731   Median : 9.922   Median :0.5170
##  Mean   : 0.4909   Mean   : 0.003647   Mean   :11.241   Mean   :0.6397
##  3rd Qu.: 0.5017   3rd Qu.: 0.020205   3rd Qu.:12.528   3rd Qu.:0.9764
##  Max.   :33.7421   Max.   : 0.089760   Max.   :25.055   Max.   :1.1242
```

```
##    H_suv.PET        Volume.PET     X3D_surface.PET    ratio_3ds_vol.PET
##  Min.   :0.1557   Min.   :  3584   Min.   :   926.2   Min.   : 0.1171
##  1st Qu.:0.6073   1st Qu.: 16846   1st Qu.:  7680.0   1st Qu.: 2.3726
##  Median :1.0579   Median : 34286   Median : 13705.0   Median : 3.5661
##  Mean   :1.2148   Mean   : 48419   Mean   : 21597.6   Mean   : 3.7876
##  3rd Qu.:1.5739   3rd Qu.: 69138   3rd Qu.: 22901.7   3rd Qu.: 4.9584
##  Max.   :4.1235   Max.   :283502   Max.   :290926.3   Max.   :11.4815
##  ratio_3ds_vol_norm.PET irregularity.PET tumor_length.PET Compactness_v1.PET
##  Min.   : 1.487         Min.   :1.730    Min.   : 13.84   Min.   :-0.061021
##  1st Qu.:14.899         1st Qu.:1.963    1st Qu.: 39.34   1st Qu.: 0.003078
##  Median :18.320         Median :2.123    Median : 51.36   Median : 0.005560
##  Mean   :21.078         Mean   :2.593    Mean   : 62.59   Mean   : 0.005022
##  3rd Qu.:27.985         3rd Qu.:3.553    3rd Qu.: 75.90   3rd Qu.: 0.016708
##  Max.   :75.896         Max.   :5.105    Max.   :306.76   Max.   : 0.040820
##  Compactness_v2.PET  Spherical_disproportion.PET Sphericity.PET
##  Min.   :-0.061536   Min.   : 1.487              Min.   :-0.008712
##  1st Qu.: 0.002703   1st Qu.:14.899              1st Qu.: 0.053418
##  Median : 0.015918   Median :18.320              Median : 0.070447
##  Mean   : 0.038685   Mean   :21.078              Mean   : 0.175106
##  3rd Qu.: 0.032250   3rd Qu.:27.985              3rd Qu.: 0.141500
##  Max.   : 0.509032   Max.   :75.896              Max.   : 1.261968
##  Asphericity.PET   Center_of_mass.PET Max_3D_diam.PET  Major_axis_length.PET
##  Min.   : 0.4868   Min.   :0.02145    Min.   : 13.84   Min.   : 14.11
##  1st Qu.:13.8993   1st Qu.:0.39969    1st Qu.: 41.92   1st Qu.: 37.32
##  Median :17.3200   Median :0.62581    Median : 62.74   Median : 54.19
##  Mean   :19.8243   Mean   :0.83411    Mean   : 79.02   Mean   : 66.81
##  3rd Qu.:26.9567   3rd Qu.:1.04679    3rd Qu.: 98.06   3rd Qu.: 83.98
##  Max.   :73.8960   Max.   :5.95651    Max.   :306.76   Max.   :288.01
##  Minor_axis_length.PET Least_axis_length.PET Elongation.PET    Flatness.PET
##  Min.   : 10.98        Min.   :  6.961       Min.   :0.2847   Min.   :0.2061
##  1st Qu.: 27.29        1st Qu.: 22.247       1st Qu.:0.6649   1st Qu.:0.5117
##  Median : 41.35        Median : 31.747       Median :0.7906   Median :0.6508
##  Mean   : 44.56        Mean   : 36.355       Mean   :0.8943   Mean   :0.7124
##  3rd Qu.: 53.41        3rd Qu.: 42.708       3rd Qu.:0.9866   3rd Qu.:0.7964
##  Max.   :148.69        Max.   :137.273       Max.   :1.9731   Max.   :1.6248
##  Max_cooc.L.PET      Average_cooc.L.PET Variance_cooc.L.PET Entropy_cooc.L.PET
##  Min.   :-0.061012   Min.   : 7.286     Min.   : 24.0       Min.   : 8.077
##  1st Qu.:-0.010176   1st Qu.:20.927     1st Qu.:137.9       1st Qu.:10.376
##  Median : 0.007806   Median :23.525     Median :201.1       Median :10.630
##  Mean   : 0.004478   Mean   :27.099     Mean   :217.0       Mean   :12.948
##  3rd Qu.: 0.020696   3rd Qu.:28.993     3rd Qu.:255.3       3rd Qu.:16.154
##  Max.   : 0.057722   Max.   :64.058     Max.   :575.6       Max.   :22.440
##  DAVE_cooc.L.PET  DVAR_cooc.L.PET  DENT_cooc.L.PET  SAVE_cooc.L.PET
##  Min.   : 4.325   Min.   : 21.97   Min.   : 3.635   Min.   : 14.56
##  1st Qu.: 8.901   1st Qu.: 64.46   1st Qu.: 4.657   1st Qu.: 41.85
##  Median :12.670   Median : 99.01   Median : 5.062   Median : 47.04
##  Mean   :13.886   Mean   :111.59   Mean   : 6.056   Mean   : 54.20
##  3rd Qu.:15.530   3rd Qu.:130.75   3rd Qu.: 7.270   3rd Qu.: 57.95
##  Max.   :38.939   Max.   :395.31   Max.   :10.965   Max.   :128.08
##  SVAR_cooc.L.PET  SENT_cooc.L.PET  ASM_cooc.L.PET       Contrast_cooc.L.PET
##  Min.   :  63.6   Min.   : 4.832   Min.   :-0.0627950   Min.   :  32.37
##  1st Qu.: 399.7   1st Qu.: 6.211   1st Qu.:-0.0121930   1st Qu.: 137.93
##  Median : 558.2   Median : 6.469   Median : 0.0040010   Median : 239.14
##  Mean   : 595.2   Mean   : 7.722   Mean   : 0.0009685   Mean   : 272.95
```

```
##  3rd Qu.: 696.7   3rd Qu.: 9.759   3rd Qu.: 0.0169560   3rd Qu.: 326.69
##  Max.   :1671.9   Max.   :13.423   Max.   : 0.0442660   Max.   :1151.93
##  Dissimilarity_cooc.L.PET Inv_diff_cooc.L.PET Inv_diff_norm_cooc.L.PET
##  Min.   : 4.325           Min.   :0.07774     Min.   :0.7734
##  1st Qu.: 8.901           1st Qu.:0.15401     1st Qu.:0.8409
##  Median :12.670           Median :0.18711     Median :0.8752
##  Mean   :13.886           Mean   :0.22728     Mean   :1.0843
##  3rd Qu.:15.530           3rd Qu.:0.28121     3rd Qu.:1.6137
##  Max.   :38.939           Max.   :0.65958     Max.   :1.9108
##  IDM_cooc.L.PET     IDM_norm_cooc.L.PET Inv_var_cooc.L.PET
##  Min.   :0.006727   Min.   :0.8766      Min.   :0.01145
##  1st Qu.:0.080322   1st Qu.:0.9419      1st Qu.:0.08407
##  Median :0.105318   Median :0.9625      Median :0.10969
##  Mean   :0.129528   Mean   :1.1972      Mean   :0.13310
##  3rd Qu.:0.166520   3rd Qu.:1.8260      3rd Qu.:0.17249
##  Max.   :0.478270   Max.   :2.0165      Max.   :0.47857
##  Correlation_cooc.L.PET Autocorrelation_cooc.L.PET Tendency_cooc.L.PET
##  Min.   :-0.01336       Min.   :  60.68            Min.   :  63.6
##  1st Qu.: 0.34436       1st Qu.: 492.39            1st Qu.: 399.7
##  Median : 0.42414       Median : 614.95            Median : 558.2
##  Mean   : 0.49058       Mean   : 693.99            Mean   : 595.2
##  3rd Qu.: 0.62925       3rd Qu.: 811.25            3rd Qu.: 696.7
##  Max.   : 1.28668       Max.   :2225.86            Max.   :1671.9
##  Shade_cooc.L.PET Prominence_cooc.L.PET   IC1_.L.PET          IC2_.L.PET
##  Min.   :-7233    Min.   :  28425       Min.   :-0.360734   Min.   :0.4430
##  1st Qu.: 2180    1st Qu.: 456518       1st Qu.:-0.126535   1st Qu.:0.6654
##  Median : 4857    Median : 768547       Median :-0.089284   Median :0.7938
##  Mean   : 5987    Mean   : 853930       Mean   :-0.100955   Mean   :0.9102
##  3rd Qu.: 8315    3rd Qu.:1091790       3rd Qu.:-0.056803   3rd Qu.:0.9552
##  Max.   :24034    Max.   :3269996       Max.   :-0.008777   Max.   :1.9104
##  Coarseness_vdif_.L.PET Contrast_vdif_.L.PET Busyness_vdif_.L.PET
##  Min.   :-0.061468      Min.   : 0.1886      Min.   :-0.03228
##  1st Qu.:-0.006006      1st Qu.: 0.5195      1st Qu.: 0.06736
##  Median : 0.017239      Median : 0.9731      Median : 0.15893
##  Mean   : 0.014100      Mean   : 1.4150      Mean   : 0.26365
##  3rd Qu.: 0.033488      3rd Qu.: 1.4553      3rd Qu.: 0.32494
##  Max.   : 0.141802      Max.   :18.6449      Max.   : 2.44794
##  Complexity_vdif_.L.PET Strength_vdif_.L.PET SRE_align.L.PET  LRE_align.L.PET
##  Min.   : 7268          Min.   :  2.002      Min.   :0.8629   Min.   :0.9847
##  1st Qu.:12641          1st Qu.:  8.460      1st Qu.:0.9715   1st Qu.:1.0571
##  Median :17160          Median : 23.324      Median :0.9893   Median :1.0890
##  Mean   :19663          Mean   : 39.906      Mean   :1.2275   Mean   :1.3639
##  3rd Qu.:21957          3rd Qu.: 55.792      3rd Qu.:1.9080   3rd Qu.:2.0723
##  Max.   :69560          Max.   :295.545      Max.   :2.0211   Max.   :2.4167
##  GLNU_align.L.PET  RLNU_align.L.PET   RP_align.L.PET   LGRE_align.L.PET
##  Min.   :  1.647   Min.   :   39.43   Min.   :0.8740   Min.   :-0.03560
##  1st Qu.:  8.230   1st Qu.:  300.12   1st Qu.:0.9627   1st Qu.: 0.03366
##  Median : 21.227   Median :  713.34   Median :0.9843   Median : 0.06100
##  Mean   : 43.923   Mean   : 1406.28   Mean   :1.2196   Mean   : 0.07204
##  3rd Qu.: 62.183   3rd Qu.: 1803.07   3rd Qu.:1.8882   3rd Qu.: 0.10134
##  Max.   :441.820   Max.   :15312.68   Max.   :2.0161   Max.   : 0.36303
##  HGRE_align.L.PET  LGSRE_align.L.PET  HGSRE_align.L.PET LGHRE_align.L.PET
##  Min.   :  67.61   Min.   :-0.03590   Min.   :  65.67   Min.   :-0.03429
##  1st Qu.: 499.26   1st Qu.: 0.03241   1st Qu.: 487.32   1st Qu.: 0.03791
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##  Median : 602.00   Median : 0.06090   Median : 584.44   Median : 0.06539
##  Mean   : 692.34   Mean   : 0.07031   Mean   : 680.33   Mean   : 0.07954
##  3rd Qu.: 820.69   3rd Qu.: 0.10037   3rd Qu.: 801.22   3rd Qu.: 0.11015
##  Max.   :2080.05   Max.   : 0.34822   Max.   :2047.60   Max.   : 0.43073
##  HGLRE_align.L.PET GLNU_norm_align.L.PET RLNU_norm_align.L.PET
##  Min.   :  76.1    Min.   :-0.03837      Min.   :0.8611
##  1st Qu.: 535.8    1st Qu.: 0.02299      1st Qu.:0.9333
##  Median : 665.0    Median : 0.03344      Median :0.9634
##  Mean   : 742.8    Mean   : 0.03685      Mean   :1.1894
##  3rd Qu.: 884.2    3rd Qu.: 0.05188      3rd Qu.:1.7947
##  Max.   :2209.9    Max.   : 0.18495      Max.   :1.9936
##  GLVAR_align.L.PET RLVAR_align.L.PET  Entropy_align.L.PET   SZSE.L.PET
##  Min.   : 25.37    Min.   :-0.04672   Min.   : 4.280      Min.   :0.1768
##  1st Qu.:140.87    1st Qu.: 0.01945   1st Qu.: 5.450      1st Qu.:0.9142
##  Median :196.49    Median : 0.03054   Median : 5.577      Median :0.9499
##  Mean   :211.94    Mean   : 0.03593   Mean   : 6.828      Mean   :1.1618
##  3rd Qu.:248.98    3rd Qu.: 0.05440   3rd Qu.: 8.560      3rd Qu.:1.7686
##  Max.   :542.91    Max.   : 0.16722   Max.   :11.667      Max.   :1.9617
##    LZSE.L.PET     LGLZE.L.PET        HGLZE.L.PET       SZLGE.L.PET
##  Min.   :1.003   Min.   :-0.03560   Min.   :  71.77   Min.   :-0.04675
##  1st Qu.:1.248   1st Qu.: 0.03474   1st Qu.: 502.88   1st Qu.: 0.03069
##  Median :1.354   Median : 0.06054   Median : 603.02   Median : 0.05654
##  Mean   :1.758   Mean   : 0.07159   Mean   : 695.76   Mean   : 0.06579
##  3rd Qu.:2.358   3rd Qu.: 0.10166   3rd Qu.: 819.19   3rd Qu.: 0.09873
##  Max.   :5.785   Max.   : 0.35820   Max.   :1988.06   Max.   : 0.30999
##   SZHGE.L.PET       LZLGE.L.PET        LZHGE.L.PET     GLNU_area.L.PET
##  Min.   :  65.32   Min.   :-0.02915   Min.   : 115.8   Min.   :  1.551
##  1st Qu.: 467.58   1st Qu.: 0.04621   1st Qu.: 623.2   1st Qu.:  7.695
##  Median : 561.06   Median : 0.08144   Median : 783.7   Median : 19.019
##  Mean   : 652.04   Mean   : 0.10463   Mean   : 926.5   Mean   : 39.542
##  3rd Qu.: 772.90   3rd Qu.: 0.13560   3rd Qu.:1075.6   3rd Qu.: 57.064
##  Max.   :1911.50   Max.   : 0.71824   Max.   :3030.5   Max.   :408.095
##    ZSNU.L.PET         ZSP.L.PET      GLNU_norm.L.PET    ZSNU_norm.L.PET
##  Min.   :   35.19   Min.   :0.3864   Min.   :-0.03836   Min.   :0.7155
##  1st Qu.:  254.69   1st Qu.:0.8886   1st Qu.: 0.02259   1st Qu.:0.8153
##  Median :  594.33   Median :0.9286   Median : 0.03365   Median :0.8713
##  Mean   : 1125.99   Mean   :1.1336   Mean   : 0.03628   Mean   :1.0601
##  3rd Qu.: 1322.79   3rd Qu.:1.6321   3rd Qu.: 0.05133   3rd Qu.:1.4555
##  Max.   :12249.90   Max.   :1.9410   Max.   : 0.18003   Max.   :1.8450
##  GLVAR_area.L.PET  ZSVAR.L.PET      Entropy_area.L.PET Max_cooc.H.PET
##  Min.   : 27.01   Min.   :0.00253   Min.   : 4.512     Min.   :-0.04902
##  1st Qu.:144.01   1st Qu.:0.08041   1st Qu.: 5.689     1st Qu.: 0.02770
##  Median :196.99   Median :0.12536   Median : 5.858     Median : 0.06533
##  Mean   :213.84   Mean   :0.17957   Mean   : 7.134     Mean   : 0.10212
##  3rd Qu.:250.79   3rd Qu.:0.20093   3rd Qu.: 9.648     3rd Qu.: 0.14406
##  Max.   :534.49   Max.   :1.05837   Max.   :12.150     Max.   : 0.81117
##  Average_cooc.H.PET Variance_cooc.H.PET Entropy_cooc.H.PET DAVE_cooc.H.PET
##  Min.   :36.47      Min.   :  1.866     Min.   : 2.473     Min.   : 0.6999
##  1st Qu.:38.49      1st Qu.:226.943     1st Qu.: 5.687     1st Qu.:11.9980
##  Median :42.01      Median :276.466     Median : 7.103     Median :14.1391
##  Mean   :51.10      Mean   :305.171     Mean   : 7.840     Mean   :16.3158
##  3rd Qu.:72.93      3rd Qu.:297.145     3rd Qu.: 7.871     3rd Qu.:18.1939
##  Max.   :93.09      Max.   :611.179     Max.   :16.101     Max.   :36.3879
##  DVAR_cooc.H.PET   DENT_cooc.H.PET   SAVE_cooc.H.PET  SVAR_cooc.H.PET
```

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##  Min.   :  2.353   Min.   : 0.8283   Min.   : 72.92   Min.   :   4.611
##  1st Qu.:121.528   1st Qu.: 3.0993   1st Qu.: 76.41   1st Qu.: 656.858
##  Median :151.762   Median : 4.1300   Median : 79.88   Median : 753.357
##  Mean   :169.383   Mean   : 4.3811   Mean   : 99.66   Mean   : 840.679
##  3rd Qu.:191.314   3rd Qu.: 4.9869   3rd Qu.:145.84   3rd Qu.: 886.786
##  Max.   :394.861   Max.   :10.0676   Max.   :186.16   Max.   :1776.231
##  SENT_cooc.H.PET  ASM_cooc.H.PET     Contrast_cooc.H.PET
##  Min.   : 0.302   Min.   :-0.05834   Min.   :   2.821
##  1st Qu.: 2.981   1st Qu.: 0.01188   1st Qu.: 266.667
##  Median : 4.955   Median : 0.03473   Median : 349.442
##  Mean   : 5.092   Mean   : 0.05256   Mean   : 389.651
##  3rd Qu.: 5.976   3rd Qu.: 0.07810   3rd Qu.: 457.092
##  Max.   :12.565   Max.   : 0.65981   Max.   :1055.743
##  Dissimilarity_cooc.H.PET Inv_diff_cooc.H.PET Inv_diff_norm_cooc.H.PET
##  Min.   : 0.6999          Min.   :0.1124      Min.   :0.7478
##  1st Qu.:11.9980          1st Qu.:0.2252      1st Qu.:0.8304
##  Median :14.1391          Median :0.3182      Median :0.8601
##  Mean   :16.3158          Mean   :0.3705      Mean   :1.0644
##  3rd Qu.:18.1939          3rd Qu.:0.4680      3rd Qu.:1.5894
##  Max.   :36.3879          Max.   :1.2243      Max.   :1.8274
##  IDM_cooc.H.PET    IDM_norm_cooc.H.PET Inv_var_cooc_.H.PET
##  Min.   :0.05396   Min.   :0.8484      Min.   :-0.055882
##  1st Qu.:0.16043   1st Qu.:0.9278      1st Qu.: 0.009132
##  Median :0.25827   Median :0.9475      Median : 0.027178
##  Mean   :0.30526   Mean   :1.1756      Mean   : 0.026354
##  3rd Qu.:0.38620   3rd Qu.:1.7906      3rd Qu.: 0.044357
##  Max.   :1.17324   Max.   :1.9649      Max.   : 0.123834
##  Correlation_cooc.H.PET Autocorrelation_cooc.H.PET Tendency_cooc.H.PET
##  Min.   :-0.000138      Min.   :1474               Min.   :   4.611
##  1st Qu.: 0.315680      1st Qu.:1599               1st Qu.: 629.846
##  Median : 0.392730      Median :1849               Median : 753.311
##  Mean   : 0.450630      Mean   :2206               Mean   : 831.034
##  3rd Qu.: 0.558411      3rd Qu.:2950               3rd Qu.: 888.115
##  Max.   : 1.225154      Max.   :4427               Max.   :1776.231
##  Shade_cooc.H.PET Prominence_cooc.H.PET  IC1_d.H.PET        IC2_d.H.PET
##  Min.   :-15874   Min.   :    134       Min.   :-0.26739   Min.   :0.2221
##  1st Qu.: -5732   1st Qu.: 729696       1st Qu.:-0.09830   1st Qu.:0.4330
##  Median : -3931   Median :1173937       Median :-0.05559   Median :0.5250
##  Mean   : -4088   Mean   :1214525       Mean   :-0.06806   Mean   :0.6034
##  3rd Qu.: -2025   3rd Qu.:1469772       3rd Qu.:-0.03012   3rd Qu.:0.7239
##  Max.   :  3449   Max.   :3219875       Max.   : 0.01637   Max.   :1.4532
##  Coarseness_vdif.H.PET Contrast_vdif.H.PET Busyness_vdif.H.PET
##  Min.   :-0.063165     Min.   :   0.2156   Min.   :-0.02149
##  1st Qu.:-0.012344     1st Qu.:  38.2720   1st Qu.: 0.12606
##  Median : 0.005432     Median :  62.4850   Median : 0.31395
##  Mean   : 0.001635     Mean   : 112.8780   Mean   : 2.29160
##  3rd Qu.: 0.018121     3rd Qu.: 134.1018   3rd Qu.: 0.83327
##  Max.   : 0.052168     Max.   :1099.8953   Max.   :40.35804
##  Complexity_vdif.H.PET Strength_vdif.H.PET SRE_align.H.PET  LRE_align.H.PET
##  Min.   : 1806         Min.   :   0.2884   Min.   :0.4984   Min.   :1.163
##  1st Qu.:17897         1st Qu.:   4.5072   1st Qu.:0.8453   1st Qu.:1.393
##  Median :25517         Median :  13.9361   Median :0.9161   Median :1.828
##  Mean   :27323         Mean   :  39.8013   Mean   :1.0944   Mean   :2.249
##  3rd Qu.:33113         3rd Qu.:  39.7754   3rd Qu.:1.4601   3rd Qu.:2.706
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##  Max.   :77554         Max.   :2126.3694   Max.   :1.9425   Max.   :6.679
##  RLNU_align.H.PET   RP_align.H.PET   LGRE_align.H.PET    HGRE_align.H.PET
##  Min.   :   29.06   Min.   :0.4429   Min.   :-0.061932   Min.   :1443
##  1st Qu.:  166.08   1st Qu.:0.8112   1st Qu.:-0.010726   1st Qu.:1551
##  Median :  493.35   Median :0.8881   Median : 0.005428   Median :1765
##  Mean   : 1003.64   Mean   :1.0512   Mean   : 0.002599   Mean   :2118
##  3rd Qu.: 1232.19   3rd Qu.:1.3806   3rd Qu.: 0.018529   3rd Qu.:2920
##  Max.   :12515.43   Max.   :1.9135   Max.   : 0.058436   Max.   :4928
##  LGSRE_align.H.PET   HGSRE_align.H.PET LGHRE_align.H.PET   HGLRE_align.H.PET
##  Min.   :-0.062119   Min.   :1105      Min.   :-0.060688   Min.   : 1739
##  1st Qu.:-0.010919   1st Qu.:1389      1st Qu.:-0.009758   1st Qu.: 2166
##  Median : 0.005302   Median :1475      Median : 0.006693   Median : 3318
##  Mean   : 0.002353   Mean   :1826      Mean   : 0.004084   Mean   : 3978
##  3rd Qu.: 0.018418   3rd Qu.:2615      3rd Qu.: 0.020079   3rd Qu.: 4836
##  Max.   : 0.057712   Max.   :3746      Max.   : 0.061592   Max.   :15092
##  GLNU_norm_align.H.PET RLNU_norm_align.H.PET GLVAR_align.H.PET
##  Min.   :0.000795      Min.   :0.2702        Min.   :  1.666
##  1st Qu.:0.107847      1st Qu.:0.6952        1st Qu.:232.056
##  Median :0.174514      Median :0.8057        Median :295.015
##  Mean   :0.222793      Mean   :0.9222        Mean   :324.108
##  3rd Qu.:0.295122      3rd Qu.:1.0280        3rd Qu.:329.111
##  Max.   :0.883282      Max.   :1.8171        Max.   :695.249
##  RLVAR_align.H.PET Entropy_align.H.PET   SZSE.H.PET       LZSE.H.PET
##  Min.   :0.02306   Min.   :2.128       Min.   :0.1136   Min.   :   1.946
##  1st Qu.:0.13992   1st Qu.:3.381       1st Qu.:0.6298   1st Qu.:   3.659
##  Median :0.25736   Median :3.839       Median :0.7709   Median :   7.177
##  Mean   :0.37168   Mean   :4.472       Mean   :0.8590   Mean   :  78.744
##  3rd Qu.:0.49132   3rd Qu.:4.953       3rd Qu.:0.8672   3rd Qu.:  21.995
##  Max.   :2.02894   Max.   :9.332       Max.   :1.7258   Max.   :3263.559
##   LGLZE.H.PET         HGLZE.H.PET    SZLGE.H.PET         SZHGE.H.PET
##  Min.   :-0.062002   Min.   :1213   Min.   :-0.062397   Min.   : 244.1
##  1st Qu.:-0.010533   1st Qu.:1534   1st Qu.:-0.011847   1st Qu.:1084.3
##  Median : 0.005468   Median :1870   Median : 0.005118   Median :1212.6
##  Mean   : 0.002728   Mean   :2183   Mean   : 0.002011   Mean   :1427.6
##  3rd Qu.: 0.018478   3rd Qu.:2748   3rd Qu.: 0.017706   3rd Qu.:1618.4
##  Max.   : 0.063216   Max.   :4732   Max.   : 0.062112   Max.   :3237.0
##   LZLGE.H.PET         LZHGE.H.PET      GLNU_area.H.PET     ZSNU.H.PET
##  Min.   :-0.054985   Min.   :   2645   Min.   :  3.737   Min.   :   2.096
##  1st Qu.: 0.008822   1st Qu.:   5590   1st Qu.: 23.451   1st Qu.:  52.451
##  Median : 0.027093   Median :  15647   Median : 51.916   Median : 174.378
##  Mean   : 0.075976   Mean   : 161924   Mean   : 94.734   Mean   : 458.281
##  3rd Qu.: 0.064368   3rd Qu.:  44703   3rd Qu.:132.613   3rd Qu.: 511.028
##  Max.   : 2.074899   Max.   :5859252   Max.   :872.124   Max.   :6851.599
##    ZSP.H.PET       GLNU_norm.H.PET    ZSNU_norm.H.PET  GLVAR_area.H.PET
##  Min.   :0.00288   Min.   :0.000309   Min.   :0.1394   Min.   :  4.462
##  1st Qu.:0.40544   1st Qu.:0.106671   1st Qu.:0.3770   1st Qu.:229.704
##  Median :0.62856   Median :0.172544   Median :0.5521   Median :297.243
##  Mean   :0.64546   Mean   :0.215413   Mean   :0.5858   Mean   :324.218
##  3rd Qu.:0.76959   3rd Qu.:0.287310   3rd Qu.:0.6712   3rd Qu.:340.901
##  Max.   :1.59616   Max.   :0.855168   Max.   :1.3792   Max.   :719.046
##   ZSVAR_H.PET        Entropy_area.H.PET Max_cooc.W.PET      Average_cooc.W.PET
##  Min.   :   0.3741   Min.   : 2.980     Min.   :-0.059812   Min.   : 1.598
##  1st Qu.:   1.3509   1st Qu.: 4.319     1st Qu.: 0.006934   1st Qu.: 5.456
##  Median :   5.0446   Median : 4.662     Median : 0.025257   Median : 9.169
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##  Mean   :  71.8617   Mean   : 5.548     Mean   : 0.033306   Mean   :10.771
##  3rd Qu.:  16.7681   3rd Qu.: 6.824     3rd Qu.: 0.051286   3rd Qu.:14.611
##  Max.   :2860.0216   Max.   :10.652     Max.   : 0.449036   Max.   :36.018
##  Variance_cooc.W.PET Entropy_cooc.W.PET DAVE_cooc.W.PET   DVAR_cooc.W.PET
##  Min.   :  0.8107    Min.   : 2.897     Min.   : 0.6561   Min.   : 0.5749
##  1st Qu.:  9.3123    1st Qu.: 6.861     1st Qu.: 2.6785   1st Qu.: 4.7001
##  Median : 27.0179    Median : 8.627     Median : 4.6500   Median :12.8543
##  Mean   : 37.3629    Mean   : 9.635     Mean   : 5.1596   Mean   :18.6218
##  3rd Qu.: 53.1635    3rd Qu.:10.508     3rd Qu.: 7.0237   3rd Qu.:28.4017
##  Max.   :201.4968    Max.   :20.210     Max.   :15.3052   Max.   :86.3098
##  DENT_cooc.W.PET SAVE_cooc.W.PET  SVAR_cooc.W.PET   SENT_cooc.W.PET
##  Min.   :1.532   Min.   : 3.179   Min.   :  2.122   Min.   : 2.149
##  1st Qu.:2.966   1st Qu.:10.896   1st Qu.: 25.538   1st Qu.: 4.207
##  Median :3.812   Median :18.391   Median : 72.682   Median : 5.079
##  Mean   :4.220   Mean   :21.542   Mean   :104.483   Mean   : 5.817
##  3rd Qu.:4.501   3rd Qu.:29.255   3rd Qu.:139.053   3rd Qu.: 6.449
##  Max.   :8.815   Max.   :72.004   Max.   :665.393   Max.   :12.170
##  ASM_cooc.W.PET      Contrast_cooc.W.PET Dissimilarity_cooc.W.PET
##  Min.   :-0.062353   Min.   :  1.089     Min.   : 0.6561
##  1st Qu.:-0.004474   1st Qu.: 11.192     1st Qu.: 2.6785
##  Median : 0.016520   Median : 30.108     Median : 4.6500
##  Mean   : 0.014274   Mean   : 44.970     Mean   : 5.1596
##  3rd Qu.: 0.034118   3rd Qu.: 73.855     3rd Qu.: 7.0237
##  Max.   : 0.253551   Max.   :202.948     Max.   :15.3052
##  Inv_diff_cooc.W.PET Inv_diff_norm_cooc.W.PET IDM_cooc.W.PET
##  Min.   :0.1633      Min.   :0.7791           Min.   :0.07432
##  1st Qu.:0.2752      1st Qu.:0.8451           1st Qu.:0.18502
##  Median :0.3964      Median :0.8758           Median :0.30145
##  Mean   :0.4418      Mean   :1.0870           Mean   :0.33895
##  3rd Qu.:0.5466      3rd Qu.:1.6416           3rd Qu.:0.43576
##  Max.   :1.2799      Max.   :1.9114           Max.   :1.21935
##  IDM_norm_cooc.W.PET Inv_var_cooc.W.PET Correlation_cooc.W.PET
##  Min.   :0.8769      Min.   :0.07723    Min.   :-0.0277
##  1st Qu.:0.9430      1st Qu.:0.19117    1st Qu.: 0.3427
##  Median :0.9636      Median :0.28977    Median : 0.4127
##  Mean   :1.1979      Mean   :0.32696    Mean   : 0.4866
##  3rd Qu.:1.8477      3rd Qu.:0.41129    3rd Qu.: 0.6186
##  Max.   :2.0164      Max.   :1.04619    Max.   : 1.2818
##  Autocorrelation_cooc.W.PET Tendency_cooc.W.PET Shade_cooc.W.PET
##  Min.   :  2.776            Min.   :  2.122     Min.   : -472.31
##  1st Qu.: 32.984            1st Qu.: 25.538     1st Qu.:   24.62
##  Median : 86.175            Median : 72.682     Median :  218.44
##  Mean   :130.362            Mean   :104.483     Mean   :  692.68
##  3rd Qu.:178.427            3rd Qu.:139.053     3rd Qu.:  707.21
##  Max.   :749.138            Max.   :665.393     Max.   :16137.66
##  Prominence_cooc.W.PET  IC1_d.W.PET        IC2_d.W.PET
##  Min.   :     21.1     Min.   :-0.21907   Min.   :0.3013
##  1st Qu.:   1874.4     1st Qu.:-0.08709   1st Qu.:0.4948
##  Median :  13676.0     Median :-0.05299   Median :0.5904
##  Mean   :  55611.2     Mean   :-0.06354   Mean   :0.6821
##  3rd Qu.:  45767.4     3rd Qu.:-0.03315   3rd Qu.:0.8056
##  Max.   :1509311.3     Max.   : 0.00861   Max.   :1.5168
##  Coarseness_vdif.W.PET Contrast_vdif.W.PET Busyness_vdif.W.PET
##  Min.   :-0.06146      Min.   :0.000965    Min.   : 0.03516
```

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##  1st Qu.:-0.00453      1st Qu.:0.150611    1st Qu.: 0.56267
##  Median : 0.01781      Median :0.280164    Median : 1.43660
##  Mean   : 0.01721      Mean   :0.342734    Mean   : 2.16432
##  3rd Qu.: 0.03610      3rd Qu.:0.452249    3rd Qu.: 3.15534
##  Max.   : 0.20872      Max.   :1.444736    Max.   :11.12206
##  Complexity_vdif.W.PET Strength_vdif.W.PET SRE_align.W.PET  LRE_align.W.PET
##  Min.   :    5.614     Min.   : 0.1781     Min.   :0.7395   Min.   :1.046
##  1st Qu.:  194.871     1st Qu.: 1.1065     1st Qu.:0.9134   1st Qu.:1.170
##  Median :  984.268     Median : 2.2893     Median :0.9574   Median :1.370
##  Mean   : 2062.542     Mean   : 5.0491     Mean   :1.1734   Mean   :1.662
##  3rd Qu.: 2569.228     3rd Qu.: 5.8991     3rd Qu.:1.7269   3rd Qu.:2.255
##  Max.   :20059.404     Max.   :61.7200     Max.   :1.9861   Max.   :3.585
##  GLNU_align.W.PET  RLNU_align.W.PET   RP_align.W.PET   LGRE_align.W.PET
##  Min.   :  5.344   Min.   :   34.44   Min.   :0.6657   Min.   :-0.01941
##  1st Qu.: 27.625   1st Qu.:  243.12   1st Qu.:0.8961   1st Qu.: 0.09795
##  Median : 60.907   Median :  588.96   Median :0.9437   Median : 0.17543
##  Mean   : 93.014   Mean   : 1247.59   Mean   :1.1491   Mean   : 0.21609
##  3rd Qu.:112.549   3rd Qu.: 1477.14   3rd Qu.:1.6687   3rd Qu.: 0.28936
##  Max.   :585.246   Max.   :14756.99   Max.   :1.9718   Max.   : 0.80922
##  HGRE_align.W.PET LGSRE_align.W.PET  HGSRE_align.W.PET LGHRE_align.W.PET
##  Min.   :  2.83   Min.   :-0.02025   Min.   :  2.439   Min.   :-0.01581
##  1st Qu.: 31.63   1st Qu.: 0.09226   1st Qu.: 29.165   1st Qu.: 0.11778
##  Median : 85.35   Median : 0.15830   Median : 82.365   Median : 0.22250
##  Mean   :130.67   Mean   : 0.19832   Mean   :125.584   Mean   : 0.31693
##  3rd Qu.:181.54   3rd Qu.: 0.27032   3rd Qu.:176.987   3rd Qu.: 0.43051
##  Max.   :749.93   Max.   : 0.70224   Max.   :721.820   Max.   : 2.01331
##  HGLRE_align.W.PET GLNU_norm_align.W.PET RLNU_norm_align.W.PET
##  Min.   :  5.043   Min.   :-0.03140      Min.   :0.5313
##  1st Qu.: 41.894   1st Qu.: 0.05388      1st Qu.:0.8197
##  Median :102.892   Median : 0.09042      Median :0.8985
##  Mean   :153.740   Mean   : 0.11510      Mean   :1.0688
##  3rd Qu.:207.370   3rd Qu.: 0.15921      3rd Qu.:1.3888
##  Max.   :872.887   Max.   : 0.53440      Max.   :1.9165
##  GLVAR_align.W.PET  RLVAR_align.W.PET  Entropy_align.W.PET   SZSE.W.PET
##  Min.   :  0.6799   Min.   :-0.02491   Min.   : 2.364      Min.   :0.1446
##  1st Qu.:  8.9257   1st Qu.: 0.05873   1st Qu.: 3.940      1st Qu.:0.7905
##  Median : 26.1549   Median : 0.11017   Median : 4.641      Median :0.8713
##  Mean   : 37.3810   Mean   : 0.14379   Mean   : 5.332      Mean   :1.0228
##  3rd Qu.: 51.2124   3rd Qu.: 0.19111   3rd Qu.: 5.889      3rd Qu.:1.2783
##  Max.   :197.9114   Max.   : 0.74587   Max.   :10.991      Max.   :1.8620
##    LZSE.W.PET      LGLZE.W.PET        HGLZE.W.PET       SZLGE.W.PET
##  Min.   : 1.319   Min.   :-0.01897   Min.   :  4.719   Min.   :-0.02662
##  1st Qu.: 1.828   1st Qu.: 0.09971   1st Qu.: 32.919   1st Qu.: 0.08003
##  Median : 3.062   Median : 0.16869   Median : 88.919   Median : 0.13095
##  Mean   : 5.582   Mean   : 0.20838   Mean   :132.558   Mean   : 0.15976
##  3rd Qu.: 5.821   3rd Qu.: 0.29480   3rd Qu.:187.907   3rd Qu.: 0.22850
##  Max.   :52.606   Max.   : 0.74683   Max.   :739.930   Max.   : 0.59463
##   SZHGE.W.PET       LZLGE.W.PET        LZHGE.W.PET      GLNU_area.W.PET
##  Min.   :  3.586   Min.   :-0.00334   Min.   :  29.12   Min.   :  3.955
##  1st Qu.: 24.620   1st Qu.: 0.17882   1st Qu.: 117.24   1st Qu.: 19.251
##  Median : 77.473   Median : 0.39627   Median : 219.86   Median : 43.031
##  Mean   :116.907   Mean   : 1.68893   Mean   : 279.58   Mean   : 70.400
##  3rd Qu.:164.783   3rd Qu.: 1.22155   3rd Qu.: 390.53   3rd Qu.: 80.177
##  Max.   :648.206   Max.   :38.43046   Max.   :1468.92   Max.   :523.768
```

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##    ZSNU.W.PET         ZSP.W.PET      GLNU_norm.W.PET    ZSNU_norm.W.PET
##  Min.   :   13.29   Min.   :0.2638   Min.   :-0.03171   Min.   :0.3028
##  1st Qu.:  126.68   1st Qu.:0.6851   1st Qu.: 0.05384   1st Qu.:0.5907
##  Median :  369.19   Median :0.8149   Median : 0.08874   Median :0.7271
##  Mean   :  807.76   Mean   :0.9093   Mean   : 0.11167   Mean   :0.8091
##  3rd Qu.:  976.44   3rd Qu.:0.9165   3rd Qu.: 0.15491   3rd Qu.:0.8512
##  Max.   :10982.07   Max.   :1.8140   Max.   : 0.53949   Max.   :1.6323
##  GLVAR_area.W.PET   ZSVAR.W.PET       Entropy_area.W.PET  Min_hist.ADC
##  Min.   :  1.139   Min.   : 0.08773   Min.   : 3.231     Min.   :  -0.0629
##  1st Qu.:  9.309   1st Qu.: 0.31288   1st Qu.: 4.692     1st Qu.:   0.0159
##  Median : 26.776   Median : 0.82646   Median : 5.089     Median : 202.0159
##  Mean   : 38.267   Mean   : 2.67281   Mean   : 6.053     Mean   : 372.1823
##  3rd Qu.: 52.241   3rd Qu.: 2.10797   3rd Qu.: 6.989     3rd Qu.: 657.0025
##  Max.   :205.064   Max.   :42.32352   Max.   :11.929     Max.   :1834.0386
##   Max_hist.ADC  Mean_hist.ADC    Variance_hist.ADC Standard_Deviation_hist.ADC
##  Min.   :1584   Min.   : 770.5   Min.   : 24185    Min.   :155.5
##  1st Qu.:2157   1st Qu.:1105.7   1st Qu.: 54876    1st Qu.:237.2
##  Median :2491   Median :1246.8   Median : 97348    Median :324.6
##  Mean   :2881   Mean   :1471.6   Mean   :110699    Mean   :358.0
##  3rd Qu.:3206   3rd Qu.:1698.2   3rd Qu.:128881    3rd Qu.:420.9
##  Max.   :6566   Max.   :3979.1   Max.   :433425    Max.   :931.1
##  Skewness_hist.ADC  Kurtosis_hist.ADC  Energy_hist.ADC     Entropy_hist.ADC
##  Min.   :-2.86142   Min.   :-1.03080   Min.   :-0.061697   Min.   : 6.367
##  1st Qu.: 0.08714   1st Qu.: 0.07697   1st Qu.:-0.010850   1st Qu.: 8.912
##  Median : 0.47482   Median : 0.56705   Median : 0.005925   Median : 9.427
##  Mean   : 0.48975   Mean   : 0.91228   Mean   : 0.002762   Mean   :11.377
##  3rd Qu.: 0.86498   3rd Qu.: 1.22031   3rd Qu.: 0.018290   3rd Qu.:12.734
##  Max.   : 2.90688   Max.   : 7.95446   Max.   : 0.056900   Max.   :21.409
##   AUC_hist.ADC      Volume.ADC     X3D_surface.ADC   ratio_3ds_vol.ADC
##  Min.   :0.4209   Min.   :  3309   Min.   :  836.3   Min.   :0.06764
##  1st Qu.:0.5013   1st Qu.: 17331   1st Qu.: 4274.9   1st Qu.:0.19507
##  Median :0.5321   Median : 34939   Median : 7760.7   Median :0.26240
##  Mean   :0.6578   Mean   : 49327   Mean   :11891.5   Mean   :0.31648
##  3rd Qu.:0.8417   3rd Qu.: 69781   3rd Qu.:15321.4   3rd Qu.:0.35928
##  Max.   :1.2567   Max.   :283036   Max.   :60866.2   Max.   :1.12860
##  ratio_3ds_vol_norm.ADC irregularity.ADC Compactness_v1.ADC Compactness_v2.ADC
##  Min.   :1.152          Min.   :1.420    Min.   :-0.04630   Min.   :0.03537
##  1st Qu.:1.419          1st Qu.:1.660    1st Qu.: 0.01935   1st Qu.:0.27212
##  Median :1.530          Median :1.775    Median : 0.03492   Median :0.34432
##  Mean   :1.892          Mean   :2.192    Mean   : 0.03625   Mean   :0.39037
##  3rd Qu.:2.633          3rd Qu.:2.840    3rd Qu.: 0.04998   3rd Qu.:0.45219
##  Max.   :4.304          Max.   :4.526    Max.   : 0.10334   Max.   :0.94104
##  Spherical_disproportion.ADC Sphericity.ADC   Asphericity.ADC
##  Min.   :1.152               Min.   :0.3986   Min.   :0.1525
##  1st Qu.:1.419               1st Qu.:0.6457   1st Qu.:0.4186
##  Median :1.530               Median :0.7019   Median :0.5299
##  Mean   :1.892               Mean   :0.8408   Mean   :0.6381
##  3rd Qu.:2.633               3rd Qu.:0.8910   3rd Qu.:0.7901
##  Max.   :4.304               Max.   :1.5696   Max.   :2.3040
##  Center_of_mass.ADC Max_3D_diam.ADC  Major_axis_length.ADC
##  Min.   :0.03906    Min.   : 19.46   Min.   : 18.66
##  1st Qu.:0.44876    1st Qu.: 59.94   1st Qu.: 44.70
##  Median :0.74819    Median : 84.20   Median : 58.07
##  Mean   :1.14812    Mean   :101.26   Mean   : 67.84
```

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##  3rd Qu.:1.44506    3rd Qu.:124.32   3rd Qu.: 80.89
##  Max.   :6.61714    Max.   :319.24   Max.   :205.34
##  Minor_axis_length.ADC Least_axis_length.ADC Elongation.ADC    Flatness.ADC
##  Min.   : 11.84        Min.   :  9.012       Min.   :0.3876   Min.   :0.2899
##  1st Qu.: 29.77        1st Qu.: 21.457       1st Qu.:0.6664   1st Qu.:0.4574
##  Median : 43.04        Median : 31.121       Median :0.8188   Median :0.5959
##  Mean   : 49.96        Mean   : 36.797       Mean   :0.9163   Mean   :0.6695
##  3rd Qu.: 60.53        3rd Qu.: 45.643       3rd Qu.:0.9657   3rd Qu.:0.7832
##  Max.   :146.27        Max.   :126.071       Max.   :1.9194   Max.   :1.6007
##  Max_cooc.L.ADC      Average_cooc.L.ADC Variance_cooc.L.ADC Entropy_cooc.L.ADC
##  Min.   :-0.060698   Min.   :11.94      Min.   : 26.79      Min.   : 7.953
##  1st Qu.:-0.005478   1st Qu.:24.84      1st Qu.: 57.78      1st Qu.: 9.459
##  Median : 0.009990   Median :29.80      Median : 91.69      Median : 9.990
##  Mean   : 0.008675   Mean   :34.80      Mean   :102.87      Mean   :12.091
##  3rd Qu.: 0.024420   3rd Qu.:41.31      3rd Qu.:125.60      3rd Qu.:16.775
##  Max.   : 0.070194   Max.   :87.69      Max.   :364.52      Max.   :21.438
##  DAVE_cooc.L.ADC  DVAR_cooc.L.ADC  DENT_cooc.L.ADC  SAVE_cooc.L.ADC
##  Min.   : 3.797   Min.   : 15.20   Min.   : 3.477   Min.   : 23.88
##  1st Qu.: 6.137   1st Qu.: 31.59   1st Qu.: 4.117   1st Qu.: 49.69
##  Median : 7.790   Median : 45.96   Median : 4.445   Median : 59.59
##  Mean   : 8.909   Mean   : 52.47   Mean   : 5.329   Mean   : 69.60
##  3rd Qu.: 9.895   3rd Qu.: 63.89   3rd Qu.: 7.051   3rd Qu.: 82.59
##  Max.   :24.018   Max.   :192.64   Max.   :10.000   Max.   :175.38
##  SVAR_cooc.L.ADC  SENT_cooc.L.ADC   ASM_cooc.L.ADC     Contrast_cooc.L.ADC
##  Min.   : 76.88   Min.   : 0.4244   Min.   :-0.06258   Min.   : 30.25
##  1st Qu.:168.78   1st Qu.: 3.5924   1st Qu.:-0.01124   1st Qu.: 68.18
##  Median :238.12   Median : 4.6982   Median : 0.00535   Median :101.13
##  Mean   :290.97   Mean   : 4.9922   Mean   : 0.00231   Mean   :120.50
##  3rd Qu.:361.56   3rd Qu.: 5.2351   3rd Qu.: 0.01817   3rd Qu.:146.32
##  Max.   :977.73   Max.   :10.7853   Max.   : 0.04834   Max.   :480.30
##  Dissimilarity_cooc.L.ADC Inv_diff_cooc.L.ADC Inv_diff_norm_cooc.L.ADC
##  Min.   : 3.797           Min.   :0.1211      Min.   :0.8159
##  1st Qu.: 6.137           1st Qu.:0.2120      1st Qu.:0.8884
##  Median : 7.790           Median :0.2541      Median :0.9164
##  Mean   : 8.909           Mean   :0.3072      Mean   :1.1370
##  3rd Qu.: 9.895           3rd Qu.:0.3664      3rd Qu.:1.7296
##  Max.   :24.018           Max.   :0.7329      Max.   :1.9233
##  IDM_cooc.L.ADC    IDM_norm_cooc.L.ADC Inv_var_cooc.L.ADC
##  Min.   :0.03829   Min.   :0.9046      Min.   :0.04011
##  1st Qu.:0.12604   1st Qu.:0.9695      1st Qu.:0.13166
##  Median :0.16496   Median :0.9873      Median :0.17144
##  Mean   :0.19917   Mean   :1.2268      Mean   :0.20488
##  3rd Qu.:0.24259   3rd Qu.:1.9071      3rd Qu.:0.24624
##  Max.   :0.56514   Max.   :2.0233      Max.   :0.57456
##  Correlation_cooc.L.ADC Autocorrelation_.L.ADC Tendency_cooc.L.ADC
##  Min.   :0.1004         Min.   : 159.6         Min.   : 76.88
##  1st Qu.:0.3627         1st Qu.: 660.4         1st Qu.:168.78
##  Median :0.4566         Median : 901.9         Median :238.12
##  Mean   :0.5177         Mean   :1049.5         Mean   :290.97
##  3rd Qu.:0.5883         3rd Qu.:1255.8         3rd Qu.:361.56
##  Max.   :1.3433         Max.   :3868.3         Max.   :977.73
##   Shade_.L.ADC     Prominence_cooc.L.ADC   IC1_.L.ADC          IC2_.L.ADC
##  Min.   :-9355.5   Min.   :  31891       Min.   :-0.355780   Min.   :0.3575
##  1st Qu.:  339.3   1st Qu.: 104430       1st Qu.:-0.105700   1st Qu.:0.6076
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##  Median : 1241.6   Median : 193879       Median :-0.069750   Median :0.6945
##  Mean   : 1925.1   Mean   : 271202       Mean   :-0.082097   Mean   :0.8307
##  3rd Qu.: 2696.2   3rd Qu.: 358073       3rd Qu.:-0.049570   3rd Qu.:0.9135
##  Max.   :17923.8   Max.   :1477801       Max.   :-0.000042   Max.   :1.8831
##  Coarseness_vdif_.L.ADC Contrast_vdif_.L.ADC Busyness_vdif_.L.ADC
##  Min.   :-0.061827      Min.   :0.03438      Min.   :-0.00377
##  1st Qu.:-0.006482      1st Qu.:0.18037      1st Qu.: 0.07402
##  Median : 0.011012      Median :0.30336      Median : 0.15940
##  Mean   : 0.010556      Mean   :0.43449      Mean   : 0.28774
##  3rd Qu.: 0.024980      3rd Qu.:0.50912      3rd Qu.: 0.38552
##  Max.   : 0.159060      Max.   :2.88890      Max.   : 2.83448
##  Complexity_vdif_.L.ADC Strength_vdif_.L.ADC SRE_align.L.ADC  LRE_align.L.ADC
##  Min.   : 3160          Min.   :  0.6215     Min.   :0.8781   Min.   :1.013
##  1st Qu.: 5699          1st Qu.:  3.5323     1st Qu.:0.9595   1st Qu.:1.099
##  Median : 7329          Median :  6.7704     Median :0.9763   Median :1.158
##  Mean   : 7989          Mean   : 11.7712     Mean   :1.2112   Mean   :1.444
##  3rd Qu.: 8949          3rd Qu.: 10.9074     3rd Qu.:1.8500   3rd Qu.:2.124
##  Max.   :19146          Max.   :124.5108     Max.   :2.0115   Max.   :2.695
##  GLNU_align.L.ADC   RLNU_align.L.ADC   RP_align.L.ADC   LGRE_align.L.ADC
##  Min.   :   2.928   Min.   :   83.32   Min.   :0.8566   Min.   :-0.060495
##  1st Qu.:  23.171   1st Qu.:  735.51   1st Qu.:0.9450   1st Qu.:-0.009555
##  Median :  58.656   Median : 1490.24   Median :0.9671   Median : 0.011670
##  Mean   : 139.308   Mean   : 3196.96   Mean   :1.1970   Mean   : 0.007212
##  3rd Qu.: 184.212   3rd Qu.: 3845.10   3rd Qu.:1.8070   3rd Qu.: 0.023320
##  Max.   :1551.693   Max.   :32004.16   Max.   :2.0027   Max.   : 0.104120
##  HGRE_align.L.ADC LGSRE_align.L.ADC   HGSRE_align.L.ADC LGHRE_align.L.ADC
##  Min.   : 222.5   Min.   :-0.060661   Min.   : 213.9    Min.   :-0.060251
##  1st Qu.: 760.1   1st Qu.:-0.009606   1st Qu.: 730.4    1st Qu.:-0.009340
##  Median : 990.4   Median : 0.011614   Median : 953.5    Median : 0.012690
##  Mean   :1151.2   Mean   : 0.006945   Mean   :1118.1    Mean   : 0.008564
##  3rd Qu.:1363.1   3rd Qu.: 0.022950   3rd Qu.:1335.9    3rd Qu.: 0.024449
##  Max.   :3836.6   Max.   : 0.099580   Max.   :3606.7    Max.   : 0.129340
##  HGLRE_align.L.ADC GLNU_norm_align.L.ADC RLNU_norm_align.L.ADC
##  Min.   : 263.5    Min.   :-0.03396      Min.   :0.7932
##  1st Qu.: 811.0    1st Qu.: 0.02674      1st Qu.:0.9002
##  Median :1161.0    Median : 0.04254      Median :0.9359
##  Mean   :1299.7    Mean   : 0.04488      Mean   :1.1483
##  3rd Qu.:1507.8    3rd Qu.: 0.05889      3rd Qu.:1.6802
##  Max.   :4967.3    Max.   : 0.15004      Max.   :1.9751
##  GLVAR_align.L.ADC RLVAR_align.L.ADC  Entropy_align.L.ADC   SZSE.L.ADC
##  Min.   : 34.75    Min.   :-0.03777   Min.   : 4.855      Min.   :0.7951
##  1st Qu.: 66.38    1st Qu.: 0.03397   1st Qu.: 5.201      1st Qu.:0.8893
##  Median : 99.51    Median : 0.05501   Median : 5.413      Median :0.9265
##  Mean   :113.33    Mean   : 0.06600   Mean   : 6.663      Mean   :1.1414
##  3rd Qu.:137.79    3rd Qu.: 0.09048   3rd Qu.: 9.883      3rd Qu.:1.6840
##  Max.   :414.54    Max.   : 0.27810   Max.   :11.550      Max.   :1.9782
##    LZSE.L.ADC     LGLZE.L.ADC         HGLZE.L.ADC      SZLGE.L.ADC
##  Min.   :1.095   Min.   :-0.060558   Min.   : 247.2   Min.   :-0.060905
##  1st Qu.:1.378   1st Qu.:-0.009506   1st Qu.: 765.0   1st Qu.:-0.009813
##  Median :1.602   Median : 0.011602   Median :1004.7   Median : 0.009820
##  Mean   :2.053   Mean   : 0.007065   Mean   :1162.8   Mean   : 0.006419
##  3rd Qu.:2.632   3rd Qu.: 0.023204   3rd Qu.:1385.0   3rd Qu.: 0.022040
##  Max.   :5.694   Max.   : 0.094520   Max.   :3778.6   Max.   : 0.083520
##   SZHGE.L.ADC      LZLGE.L.ADC        LZHGE.L.ADC     GLNU_area.L.ADC
```

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##  Min.   : 221.9   Min.   :-0.05978   Min.   : 572.3   Min.   :   2.825
##  1st Qu.: 716.6   1st Qu.:-0.00818   1st Qu.:1056.8   1st Qu.:  21.085
##  Median : 924.7   Median : 0.01568   Median :1444.9   Median :  51.834
##  Mean   :1070.6   Mean   : 0.01295   Mean   :1770.0   Mean   : 117.810
##  3rd Qu.:1273.6   3rd Qu.: 0.02897   3rd Qu.:2113.7   3rd Qu.: 141.882
##  Max.   :3188.0   Max.   : 0.19624   Max.   :8508.1   Max.   :1158.523
##    ZSNU.L.ADC         ZSP.L.ADC      GLNU_norm.L.ADC    ZSNU_norm.L.ADC
##  Min.   :   78.23   Min.   :0.7039   Min.   :-0.03427   Min.   :0.6298
##  1st Qu.:  593.23   1st Qu.:0.8479   1st Qu.: 0.02621   1st Qu.:0.7773
##  Median : 1285.11   Median :0.8961   Median : 0.04183   Median :0.8263
##  Mean   : 2429.57   Mean   :1.0881   Mean   : 0.04322   Mean   :0.9974
##  3rd Qu.: 2959.09   3rd Qu.:1.5089   3rd Qu.: 0.05692   3rd Qu.:1.3535
##  Max.   :25131.32   Max.   :1.9628   Max.   : 0.13852   Max.   :1.8940
##  GLVAR_area.L.ADC  ZSVAR.L.ADC      Entropy_area.L.ADC Max_cooc.H.ADC
##  Min.   : 37.86   Min.   :0.03177   Min.   : 5.194     Min.   :-0.061367
##  1st Qu.: 68.97   1st Qu.:0.14187   1st Qu.: 5.561     1st Qu.:-0.011254
##  Median :101.65   Median :0.21926   Median : 5.754     Median : 0.005600
##  Mean   :116.09   Mean   :0.36882   Mean   : 7.090     Mean   : 0.002366
##  3rd Qu.:139.58   3rd Qu.:0.42200   3rd Qu.:10.476     3rd Qu.: 0.018330
##  Max.   :425.25   Max.   :2.14718   Max.   :12.226     Max.   : 0.049158
##  Average_cooc.H.ADC Variance_cooc.H.ADC Entropy_cooc.H.ADC DAVE_cooc.H.ADC
##  Min.   :28.16      Min.   :297.5       Min.   : 9.89      Min.   :10.34
##  1st Qu.:30.69      1st Qu.:314.3       1st Qu.:11.38      1st Qu.:13.82
##  Median :31.71      Median :321.4       Median :11.58      Median :15.39
##  Mean   :39.11      Mean   :397.5       Mean   :14.26      Mean   :18.54
##  3rd Qu.:56.32      3rd Qu.:601.2       3rd Qu.:19.78      3rd Qu.:20.68
##  Max.   :68.81      Max.   :663.0       Max.   :23.56      Max.   :37.03
##  DVAR_cooc.H.ADC  DENT_cooc.H.ADC  SAVE_cooc.H.ADC  SVAR_cooc.H.ADC
##  Min.   : 97.48   Min.   : 4.857   Min.   : 56.32   Min.   : 724.4
##  1st Qu.:139.62   1st Qu.: 5.226   1st Qu.: 61.38   1st Qu.: 857.9
##  Median :160.65   Median : 5.370   Median : 63.42   Median : 955.4
##  Mean   :189.30   Mean   : 6.636   Mean   : 78.21   Mean   :1121.2
##  3rd Qu.:197.36   3rd Qu.: 9.714   3rd Qu.:112.64   3rd Qu.:1448.9
##  Max.   :400.90   Max.   :11.187   Max.   :137.58   Max.   :2106.8
##  SENT_cooc.H.ADC ASM_cooc.H.ADC       Contrast_cooc.H.ADC
##  Min.   :3.088   Min.   :-6.334e-02   Min.   : 210.8
##  1st Qu.:3.594   1st Qu.:-1.234e-02   1st Qu.: 338.6
##  Median :3.768   Median : 3.080e-03   Median : 402.3
##  Mean   :4.602   Mean   : 6.846e-05   Mean   : 468.8
##  3rd Qu.:6.240   3rd Qu.: 1.633e-02   3rd Qu.: 518.7
##  Max.   :8.211   Max.   : 3.973e-02   Max.   :1062.3
##  Dissimilarity_cooc.H.ADC Inv_diff_cooc.H.ADC Inv_diff_norm_cooc.H.ADC
##  Min.   :10.34            Min.   :0.06013     Min.   :0.7359
##  1st Qu.:13.82            1st Qu.:0.13807     1st Qu.:0.8182
##  Median :15.39            Median :0.16200     Median :0.8424
##  Mean   :18.54            Mean   :0.18794     Mean   :1.0408
##  3rd Qu.:20.68            3rd Qu.:0.21904     3rd Qu.:1.5697
##  Max.   :37.03            Max.   :0.43808     Max.   :1.7813
##  IDM_cooc.H.ADC     IDM_norm_cooc.H.ADC Inv_var_cooc.H.ADC
##  Min.   :-0.00194   Min.   :0.8397      Min.   :-0.000839
##  1st Qu.: 0.07046   1st Qu.:0.9197      1st Qu.: 0.076110
##  Median : 0.09089   Median :0.9388      Median : 0.094310
##  Mean   : 0.10088   Mean   :1.1632      Mean   : 0.104632
##  3rd Qu.: 0.13118   3rd Qu.:1.7772      3rd Qu.: 0.128963
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##  Max.   : 0.28066   Max.   :1.9478      Max.   : 0.284360
##  Correlation_cooc.H.ADC Autocorrelation_cooc.H.ADC Tendency_cooc.H.ADC
##  Min.   :0.1050         Min.   : 876.6             Min.   : 724.4
##  1st Qu.:0.3585         1st Qu.:1080.2             1st Qu.: 857.9
##  Median :0.4504         Median :1116.9             Median : 955.4
##  Mean   :0.5131         Mean   :1385.0             Mean   :1121.2
##  3rd Qu.:0.5837         3rd Qu.:1753.3             3rd Qu.:1448.9
##  Max.   :1.3649         Max.   :2505.6             Max.   :2106.8
##  Shade_cooc.H.ADC  Prominence_cooc.H.ADC  IC1_d.H.ADC         IC2_d.H.ADC
##  Min.   :-8499.7   Min.   :1213171       Min.   :-0.570580   Min.   :0.4320
##  1st Qu.:  748.5   1st Qu.:1618184       1st Qu.:-0.112350   1st Qu.:0.6404
##  Median : 3042.8   Median :1824374       Median :-0.068910   Median :0.7285
##  Mean   : 2950.7   Mean   :2126432       Mean   :-0.090971   Mean   :0.8845
##  3rd Qu.: 5104.4   3rd Qu.:2426342       3rd Qu.:-0.044849   3rd Qu.:1.0007
##  Max.   :18630.6   Max.   :4294925       Max.   :-0.003503   Max.   :2.0014
##  Coarseness_vdif.H.ADC Contrast_vdif.H.ADC Busyness_vdif.H.ADC
##  Min.   :-0.061933     Min.   :1.145       Min.   :0.01268
##  1st Qu.:-0.007910     1st Qu.:1.612       1st Qu.:0.09566
##  Median : 0.009940     Median :1.840       Median :0.22381
##  Mean   : 0.009101     Mean   :2.202       Mean   :0.43392
##  3rd Qu.: 0.024210     3rd Qu.:2.314       3rd Qu.:0.50409
##  Max.   : 0.153460     Max.   :4.627       Max.   :4.36709
##  Complexity_vdif.H.ADC Strength_vdif.H.ADC SRE_align.H.ADC  LRE_align.H.ADC
##  Min.   : 9957         Min.   :  0.4551    Min.   :0.9156   Min.   :0.9794
##  1st Qu.:14427         1st Qu.:  2.6916    1st Qu.:0.9784   1st Qu.:1.0466
##  Median :16384         Median :  6.1903    Median :0.9908   Median :1.0801
##  Mean   :19867         Mean   : 13.4790    Mean   :1.2334   Mean   :1.3406
##  3rd Qu.:21148         3rd Qu.: 10.5148    3rd Qu.:1.9250   3rd Qu.:2.0588
##  Max.   :42297         Max.   :181.9847    Max.   :2.0252   Max.   :2.3153
##  GLNU_align.H.ADC  RLNU_align.H.ADC   RP_align.H.ADC   LGRE_align.H.ADC
##  Min.   :  1.584   Min.   :   85.87   Min.   :0.9078   Min.   :-0.03979
##  1st Qu.: 12.706   1st Qu.:  764.05   1st Qu.:0.9724   1st Qu.: 0.01467
##  Median : 25.814   Median : 1550.12   Median :0.9859   Median : 0.02747
##  Mean   : 58.815   Mean   : 3496.20   Mean   :1.2264   Mean   : 0.02925
##  3rd Qu.: 70.386   3rd Qu.: 4241.95   3rd Qu.:1.9094   3rd Qu.: 0.04298
##  Max.   :588.394   Max.   :34324.60   Max.   :2.0230   Max.   : 0.09034
##  HGRE_align.H.ADC LGSRE_align.H.ADC  HGSRE_align.H.ADC LGHRE_align.H.ADC
##  Min.   :1339     Min.   :-0.04251   Min.   :1291      Min.   :-0.03747
##  1st Qu.:1357     1st Qu.: 0.01308   1st Qu.:1332      1st Qu.: 0.02119
##  Median :1361     Median : 0.02689   Median :1343      Median : 0.03304
##  Mean   :1704     Mean   : 0.02799   Mean   :1677      Mean   : 0.03599
##  3rd Qu.:2678     3rd Qu.: 0.04101   3rd Qu.:2582      3rd Qu.: 0.04858
##  Max.   :2770     Max.   : 0.09016   Max.   :2766      Max.   : 0.11562
##  HGLRE_align.H.ADC GLNU_norm_align.H.ADC RLNU_norm_align.H.ADC
##  Min.   :1393      Min.   :-0.047696     Min.   :0.8817
##  1st Qu.:1440      1st Qu.: 0.003221     1st Qu.:0.9506
##  Median :1472      Median : 0.018760     Median :0.9658
##  Mean   :1826      Mean   : 0.019683     Mean   :1.2020
##  3rd Qu.:2787      3rd Qu.: 0.035140     3rd Qu.:1.8572
##  Max.   :3188      Max.   : 0.071516     Max.   :2.0141
##  GLVAR_align.H.ADC RLVAR_align.H.ADC  Entropy_align.H.ADC   SZSE.H.ADC
##  Min.   :322.1     Min.   :-0.04738   Min.   : 5.897      Min.   :0.8714
##  1st Qu.:327.3     1st Qu.: 0.01435   1st Qu.: 6.059      1st Qu.:0.9437
##  Median :329.0     Median : 0.03147   Median : 6.110      Median :0.9633
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##  Mean   :411.1     Mean   : 0.03018   Mean   : 7.628      Mean   :1.1969
##  3rd Qu.:644.2     3rd Qu.: 0.04710   3rd Qu.:11.797      3rd Qu.:1.8366
##  Max.   :666.8     Max.   : 0.14354   Max.   :12.434      Max.   :2.0318
##    LZSE.H.ADC     LGLZE.H.ADC        HGLZE.H.ADC    SZLGE.H.ADC
##  Min.   :1.002   Min.   :-0.04387   Min.   :1294   Min.   :-0.04717
##  1st Qu.:1.170   1st Qu.: 0.01170   1st Qu.:1345   1st Qu.: 0.01008
##  Median :1.273   Median : 0.02622   Median :1358   Median : 0.02373
##  Mean   :1.565   Mean   : 0.02660   Mean   :1693   Mean   : 0.02353
##  3rd Qu.:2.032   3rd Qu.: 0.04063   3rd Qu.:2602   3rd Qu.: 0.03775
##  Max.   :3.168   Max.   : 0.09077   Max.   :2782   Max.   : 0.09001
##   SZHGE.H.ADC    LZLGE.H.ADC        LZHGE.H.ADC   GLNU_area.H.ADC
##  Min.   :1194   Min.   :-0.03357   Min.   :1380   Min.   :  1.591
##  1st Qu.:1276   1st Qu.: 0.03276   1st Qu.:1637   1st Qu.: 12.263
##  Median :1297   Median : 0.04771   Median :1730   Median : 24.973
##  Mean   :1610   Mean   : 0.05474   Mean   :2186   Mean   : 55.897
##  3rd Qu.:2389   3rd Qu.: 0.07758   3rd Qu.:2821   3rd Qu.: 67.941
##  Max.   :2771   Max.   : 0.25488   Max.   :5458   Max.   :558.830
##    ZSNU.H.ADC         ZSP.H.ADC      GLNU_norm.H.ADC     ZSNU_norm.H.ADC
##  Min.   :   87.02   Min.   :0.8333   Min.   :-0.047639   Min.   :0.7801
##  1st Qu.:  678.59   1st Qu.:0.9189   1st Qu.: 0.003343   1st Qu.:0.8701
##  Median : 1396.50   Median :0.9466   Median : 0.018810   Median :0.8990
##  Mean   : 3030.35   Mean   :1.1728   Mean   : 0.019767   Mean   :1.1151
##  3rd Qu.: 3667.15   3rd Qu.:1.7747   3rd Qu.: 0.035190   3rd Qu.:1.6280
##  Max.   :29629.65   Max.   :2.0318   Max.   : 0.071972   Max.   :2.0318
##  GLVAR_area.H.ADC  ZSVAR.H.ADC       Entropy_area.H.ADC Max_cooc.W.ADC
##  Min.   :304.7    Min.   :-0.02688   Min.   : 5.896     Min.   :-0.062539
##  1st Qu.:319.8    1st Qu.: 0.05756   1st Qu.: 6.205     1st Qu.:-0.011760
##  Median :324.5    Median : 0.10225   Median : 6.310     Median : 0.005340
##  Mean   :403.0    Mean   : 0.12984   Mean   : 7.838     Mean   : 0.001454
##  3rd Qu.:612.4    3rd Qu.: 0.16953   3rd Qu.:11.797     3rd Qu.: 0.017830
##  Max.   :667.6    Max.   : 0.67137   Max.   :13.040     Max.   : 0.044078
##  Average_cooc.W.ADC Variance_cooc.W.ADC DAVE_cooc.W.ADC DVAR_cooc.W.ADC
##  Min.   : 29.56     Min.   : 202.5      Min.   :11.03   Min.   : 111.7
##  1st Qu.: 76.40     1st Qu.: 515.9      1st Qu.:19.68   1st Qu.: 270.4
##  Median :101.18     Median : 875.9      Median :23.47   Median : 406.2
##  Mean   :112.13     Mean   :1021.3      Mean   :26.92   Mean   : 500.7
##  3rd Qu.:127.59     3rd Qu.:1215.9      3rd Qu.:31.46   3rd Qu.: 632.5
##  Max.   :287.27     Max.   :4153.9      Max.   :67.92   Max.   :1928.6
##  DENT_cooc.W.ADC  SAVE_cooc.W.ADC SVAR_cooc.W.ADC   SENT_cooc.W.ADC
##  Min.   : 4.951   Min.   : 59.1   Min.   :  576.1   Min.   : 0.4612
##  1st Qu.: 5.724   1st Qu.:152.8   1st Qu.: 1358.0   1st Qu.: 4.4419
##  Median : 6.029   Median :201.6   Median : 2445.7   Median : 5.6292
##  Mean   : 7.295   Mean   :222.1   Mean   : 2969.2   Mean   : 6.2348
##  3rd Qu.: 9.905   3rd Qu.:258.6   3rd Qu.: 3452.3   3rd Qu.: 6.9115
##  Max.   :13.086   Max.   :574.5   Max.   :13038.4   Max.   :14.5664
##  ASM_cooc.W.ADC       Contrast_cooc.W.ADC Dissimilarity_cooc.W.ADC
##  Min.   :-0.0633940   Min.   : 234.1      Min.   :11.03
##  1st Qu.:-0.0125000   1st Qu.: 658.3      1st Qu.:19.68
##  Median : 0.0031100   Median : 912.7      Median :23.47
##  Mean   :-0.0000207   Mean   :1116.0      Mean   :26.92
##  3rd Qu.: 0.0161900   3rd Qu.:1396.9      3rd Qu.:31.46
##  Max.   : 0.0400080   Max.   :4232.8      Max.   :67.92
##  Inv_diff_cooc.W.ADC Inv_diff_norm_cooc.W.ADC IDM_cooc.W.ADC
##  Min.   :-0.05393    Min.   :0.8150           Min.   :-0.02253
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##  1st Qu.: 0.09815    1st Qu.:0.8872           1st Qu.: 0.04441
##  Median : 0.11970    Median :0.9153           Median : 0.06268
##  Mean   : 0.14050    Mean   :1.1357           Mean   : 0.07154
##  3rd Qu.: 0.17216    3rd Qu.:1.7277           3rd Qu.: 0.09256
##  Max.   : 0.40997    Max.   :1.9223           Max.   : 0.25187
##  IDM_norm_cooc.W.ADC Inv_var_cooc.W.ADC Correlation_cooc.W.ADC
##  Min.   :0.9041      Min.   :-0.02408   Min.   :0.1014
##  1st Qu.:0.9687      1st Qu.: 0.04662   1st Qu.:0.3624
##  Median :0.9868      Median : 0.06495   Median :0.4571
##  Mean   :1.2262      Mean   : 0.07465   Mean   :0.5182
##  3rd Qu.:1.9060      3rd Qu.: 0.09746   3rd Qu.:0.5887
##  Max.   :2.0230      Max.   : 0.26587   Max.   :1.3440
##  Autocorrelation_cooc.W.ADC Tendency_cooc.W.ADC Shade_cooc.W.ADC
##  Min.   :  928.8            Min.   :  576.1     Min.   :-231517
##  1st Qu.: 5977.2            1st Qu.: 1358.0     1st Qu.:   7524
##  Median : 9096.7            Median : 2445.7     Median :  31458
##  Mean   :11144.9            Mean   : 2969.2     Mean   :  58766
##  3rd Qu.:14469.5            3rd Qu.: 3452.3     3rd Qu.:  85528
##  Max.   :43202.8            Max.   :13038.4     Max.   : 755230
##  Prominence_cooc.W.ADC  IC1_d.W.ADC        IC2_d.W.ADC
##  Min.   :  1433500     Min.   :-0.50566   Min.   :0.5665
##  1st Qu.:  5716560     1st Qu.:-0.16643   1st Qu.:0.7903
##  Median : 19224987     Median :-0.11797   Median :0.8772
##  Mean   : 33910637     Mean   :-0.13225   Mean   :1.0345
##  3rd Qu.: 34839926     3rd Qu.:-0.07287   3rd Qu.:1.2267
##  Max.   :307755358     Max.   :-0.02415   Max.   :1.9966
##  Coarseness_vdif.W.ADC Contrast_vdif.W.ADC Busyness_vdif.W.ADC
##  Min.   :-0.061838     Min.   : 0.2571     Min.   :-0.05337
##  1st Qu.:-0.006689     1st Qu.: 0.8881     1st Qu.: 0.01175
##  Median : 0.010730     Median : 1.2594     Median : 0.02935
##  Mean   : 0.009025     Mean   : 1.7176     Mean   : 0.03315
##  3rd Qu.: 0.024410     3rd Qu.: 1.8783     3rd Qu.: 0.05108
##  Max.   : 0.136240     Max.   :11.8652     Max.   : 0.20823
##  Complexity_vdif.W.ADC Strength_vdif.W.ADC SRE_align.W.ADC  LRE_align.W.ADC
##  Min.   :  13124       Min.   :  5.875     Min.   :0.9168   Min.   :0.971
##  1st Qu.:  80886       1st Qu.: 26.207     1st Qu.:0.9827   1st Qu.:1.033
##  Median : 171030       Median : 39.950     Median :0.9948   Median :1.050
##  Mean   : 230384       Mean   : 55.180     Mean   :1.2398   Mean   :1.309
##  3rd Qu.: 319660       3rd Qu.: 69.655     3rd Qu.:1.9273   3rd Qu.:2.036
##  Max.   :1592687       Max.   :275.938     Max.   :2.0293   Max.   :2.231
##  GLNU_align.W.ADC  RLNU_align.W.ADC   RP_align.W.ADC   LGRE_align.W.ADC
##  Min.   :  2.009   Min.   :   84.52   Min.   :0.9094   Min.   :-0.062656
##  1st Qu.:  9.596   1st Qu.:  782.23   1st Qu.:0.9791   1st Qu.:-0.011249
##  Median : 21.609   Median : 1579.33   Median :0.9919   Median : 0.006620
##  Mean   : 41.983   Mean   : 3616.56   Mean   :1.2353   Mean   : 0.003831
##  3rd Qu.: 49.552   3rd Qu.: 4373.92   3rd Qu.:1.9126   3rd Qu.: 0.019870
##  Max.   :399.403   Max.   :37073.37   Max.   :2.0264   Max.   : 0.083100
##  HGRE_align.W.ADC LGSRE_align.W.ADC   HGSRE_align.W.ADC LGHRE_align.W.ADC
##  Min.   : 1203    Min.   :-0.062658   Min.   : 1197     Min.   :-0.062644
##  1st Qu.: 6277    1st Qu.:-0.011255   1st Qu.: 6229     1st Qu.:-0.011226
##  Median :10535    Median : 0.006610   Median :10430     Median : 0.006850
##  Mean   :11874    Mean   : 0.003696   Mean   :11767     Mean   : 0.004544
##  3rd Qu.:15160    3rd Qu.: 0.019860   3rd Qu.:15039     3rd Qu.: 0.020246
##  Max.   :44980    Max.   : 0.079860   Max.   :44616     Max.   : 0.100080
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##  HGLRE_align.W.ADC GLNU_norm_align.W.ADC RLNU_norm_align.W.ADC
##  Min.   : 1228     Min.   :-0.054220     Min.   :0.8830
##  1st Qu.: 6510     1st Qu.: 0.001565     1st Qu.:0.9630
##  Median :10971     Median : 0.016165     Median :0.9811
##  Mean   :12314     Mean   : 0.015675     Mean   :1.2181
##  3rd Qu.:15680     3rd Qu.: 0.032238     3rd Qu.:1.8599
##  Max.   :46468     Max.   : 0.087040     Max.   :2.0143
##  GLVAR_align.W.ADC RLVAR_align.W.ADC   Entropy_align.W.ADC   SZSE.W.ADC
##  Min.   : 245.7    Min.   :-0.051522   Min.   : 5.391      Min.   :0.8776
##  1st Qu.: 552.4    1st Qu.: 0.004423   1st Qu.: 6.386      1st Qu.:0.9617
##  Median : 976.3    Median : 0.019194   Median : 6.872      Median :0.9785
##  Mean   :1109.8    Mean   : 0.018487   Mean   : 8.232      Mean   :1.2124
##  3rd Qu.:1292.1    3rd Qu.: 0.033640   3rd Qu.:10.782      3rd Qu.:1.8489
##  Max.   :4324.2    Max.   : 0.104882   Max.   :15.143      Max.   :1.9947
##    LZSE.W.ADC     LGLZE.W.ADC         HGLZE.W.ADC     SZLGE.W.ADC
##  Min.   :1.029   Min.   :-0.062651   Min.   : 1226   Min.   :-0.062658
##  1st Qu.:1.103   1st Qu.:-0.011240   1st Qu.: 6306   1st Qu.:-0.011250
##  Median :1.144   Median : 0.006480   Median :10639   Median : 0.006184
##  Mean   :1.433   Mean   : 0.003563   Mean   :11908   Mean   : 0.003268
##  3rd Qu.:2.069   3rd Qu.: 0.019763   3rd Qu.:15245   3rd Qu.: 0.019752
##  Max.   :2.761   Max.   : 0.073640   Max.   :45137   Max.   : 0.065320
##   SZHGE.W.ADC     LZLGE.W.ADC         LZHGE.W.ADC    GLNU_area.W.ADC
##  Min.   : 1191   Min.   :-0.062616   Min.   : 1369   Min.   :  2.016
##  1st Qu.: 6169   1st Qu.:-0.011160   1st Qu.: 6882   1st Qu.:  9.340
##  Median :10324   Median : 0.009070   Median :11686   Median : 20.363
##  Mean   :11600   Mean   : 0.006405   Mean   :13334   Mean   : 40.154
##  3rd Qu.:14845   3rd Qu.: 0.021579   3rd Qu.:17173   3rd Qu.: 48.480
##  Max.   :44249   Max.   : 0.136980   Max.   :51885   Max.   :387.349
##    ZSNU.W.ADC         ZSP.W.ADC      GLNU_norm.W.ADC     ZSNU_norm.W.ADC
##  Min.   :   84.04   Min.   :0.8518   Min.   :-0.054262   Min.   :0.7920
##  1st Qu.:  741.28   1st Qu.:0.9458   1st Qu.: 0.001476   1st Qu.:0.9085
##  Median : 1479.04   Median :0.9661   Median : 0.018532   Median :0.9380
##  Mean   : 3334.08   Mean   :1.1938   Mean   : 0.016572   Mean   :1.1576
##  3rd Qu.: 3976.61   3rd Qu.:1.7974   3rd Qu.: 0.033476   3rd Qu.:1.6779
##  Max.   :35037.70   Max.   :1.9805   Max.   : 0.086040   Max.   :2.0071
##  GLVAR_area.W.ADC  ZSVAR.W.ADC       Entropy_area.W.ADC
##  Min.   : 253.6   Min.   :-0.02982   Min.   : 5.585
##  1st Qu.: 564.9   1st Qu.: 0.03180   1st Qu.: 6.626
##  Median : 983.1   Median : 0.05597   Median : 7.026
##  Mean   :1114.7   Mean   : 0.06550   Mean   : 8.507
##  3rd Qu.:1295.2   3rd Qu.: 0.09194   3rd Qu.:11.170
##  Max.   :4306.8   Max.   : 0.31875   Max.   :15.381
```

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View(radiomics)
```

Scaling radiomics and excluding the institution and failure binary.

```
df <- scale(radiomics[c(3:431)])
sum(is.na(df))
```

```
## [1] 0
```

Modeling packages

```
library(mclust)   # for fitting clustering algorithms
```

```
## Package 'mclust' version 6.0.0
## Type 'citation("mclust")' for citing this R package in publications.

##
## Attaching package: 'mclust'

## The following object is masked from 'package:purrr':
##
##     map
```

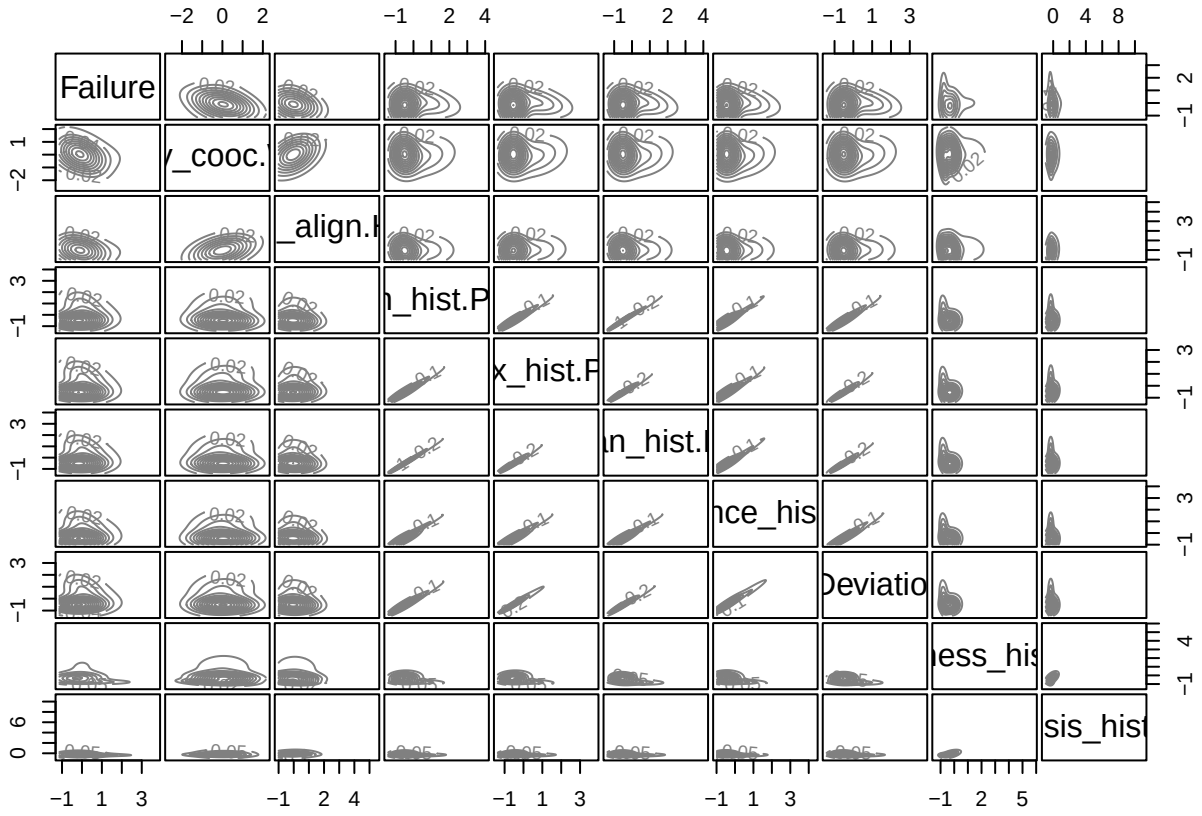
Apply GMM model with 3 components awith a scale of 1:10 to fit the figure in the canvast.

```
rad_mc <- Mclust(df[,1:10], G=3)
summary(rad_mc)
```

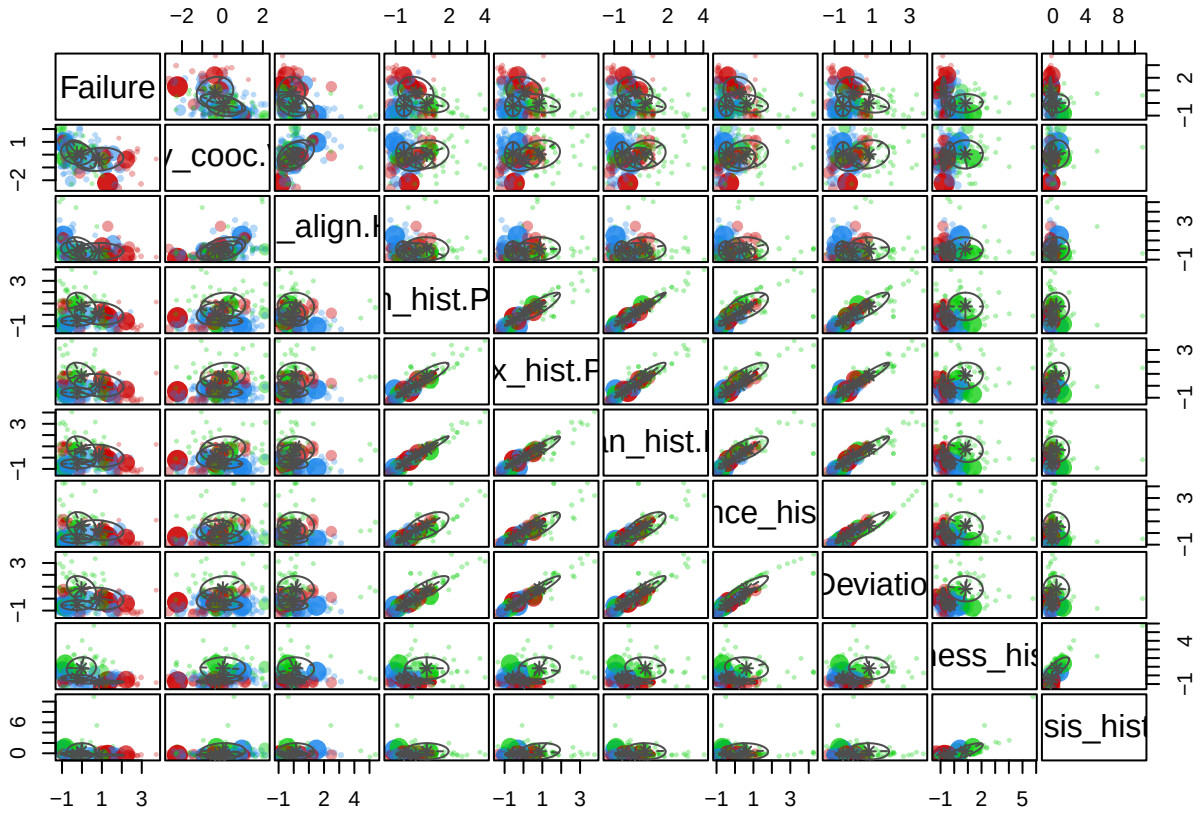
```
## ----------------------------------------------------
## Gaussian finite mixture model fitted by EM algorithm
## ----------------------------------------------------
##
## Mclust VVE (ellipsoidal, equal orientation) model with 3 components:
##
##  log-likelihood   n  df       BIC       ICL
##        -938.143 197 107 -2441.589 -2453.073
##
## Clustering table:
##   1   2   3
## 100  32  65
```

Plot results

```
plot(rad_mc, what = "density")
```




```
plot(rad_mc, what = "uncertainty")
```



Observations with high uncertainty

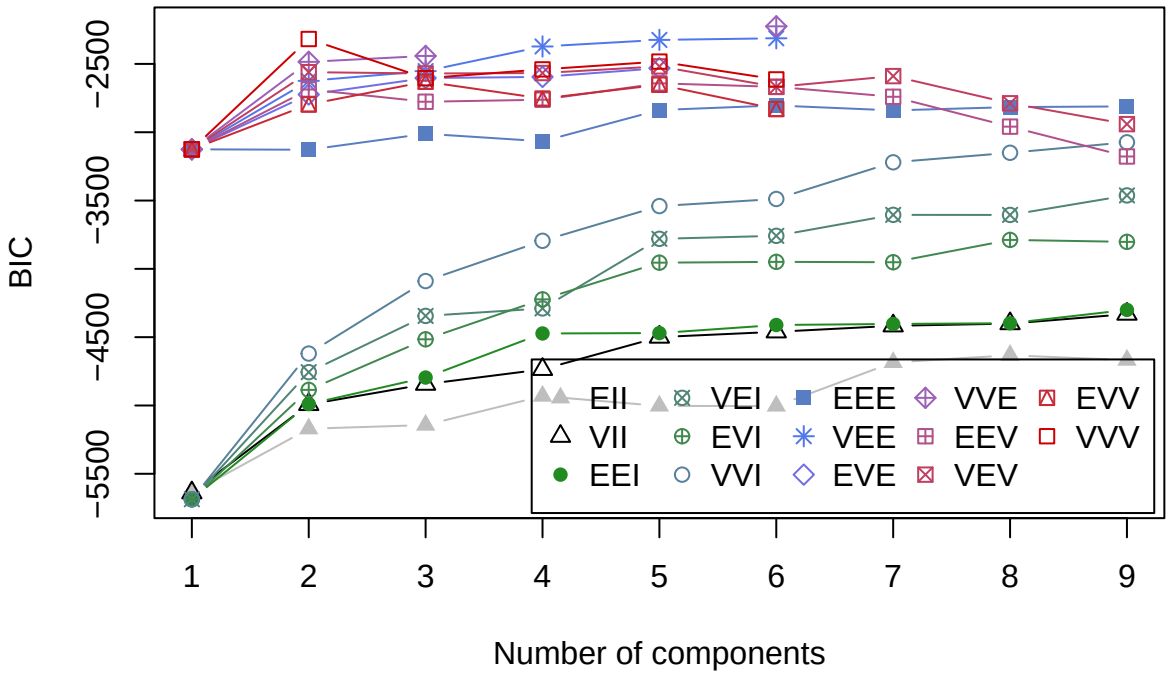
```
sort(rad_mc$uncertainty, decreasing = TRUE) %>% head()
```

```
## [1] 0.4726531 0.4289286 0.3576204 0.3410472 0.3211691 0.3066230
```

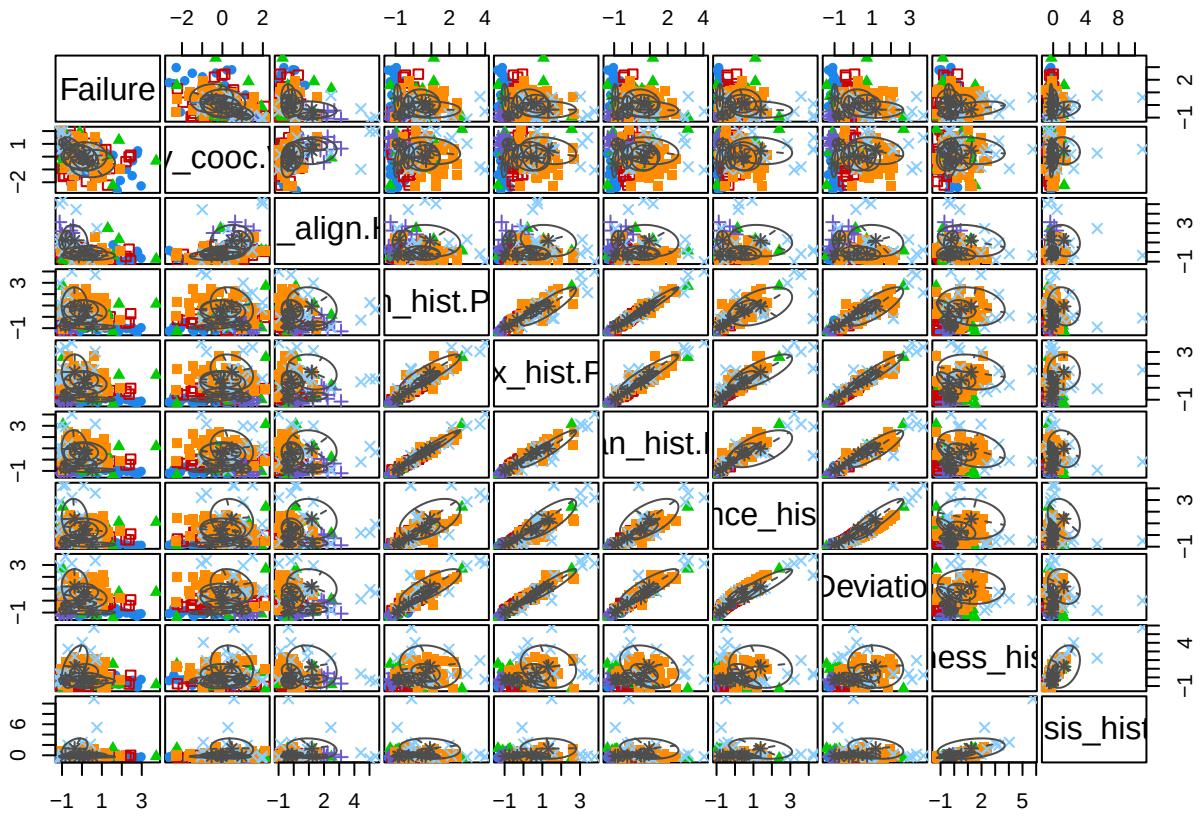
```
rad_optimal_mc <- Mclust(df[,1:10])
summary(rad_optimal_mc)
```

```
## ----------------------------------------------------
## Gaussian finite mixture model fitted by EM algorithm
## ----------------------------------------------------
##
## Mclust VVE (ellipsoidal, equal orientation) model with 6 components:
##
##  log-likelihood   n  df       BIC       ICL
##       -663.4418 197 170 -2225.028 -2234.092
##
## Clustering table:
##  1  2  3  4  5  6
## 37 52 24 18 48 18
```

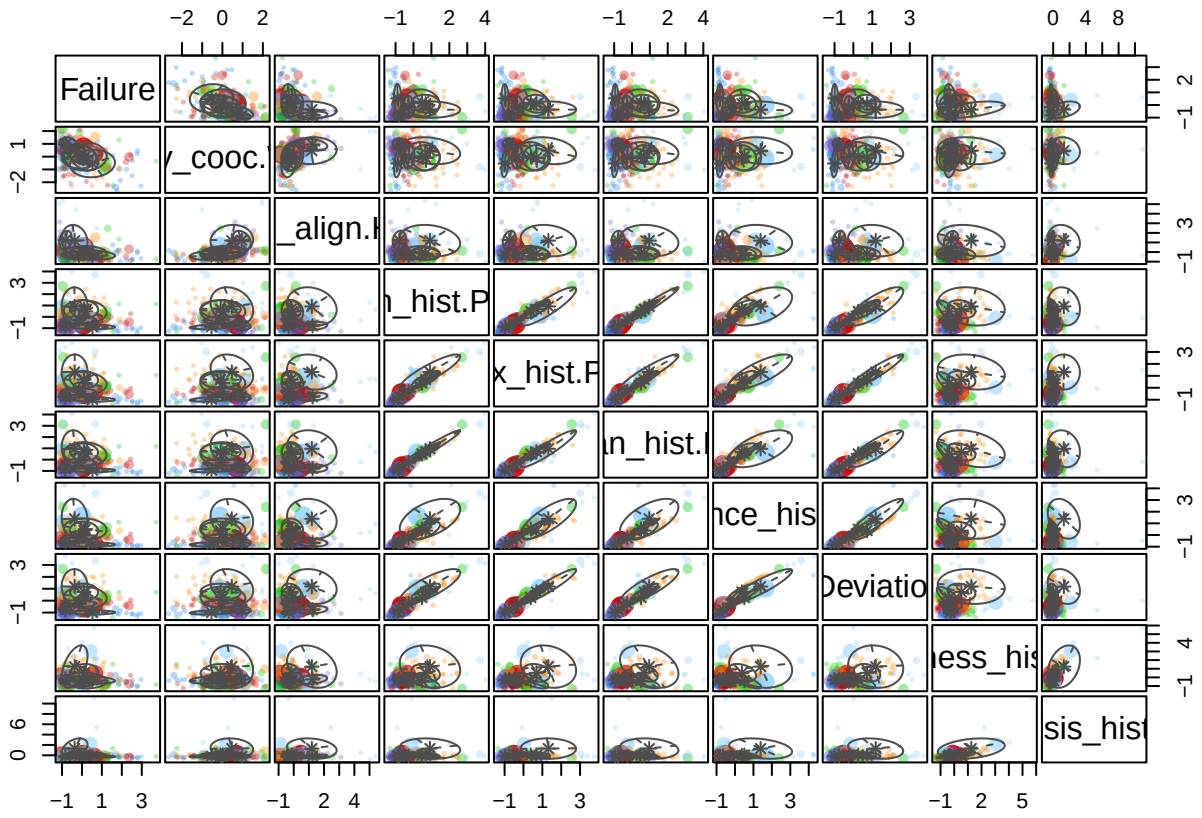
```
legend_args <- list(x = "bottomright", ncol = 5)
plot(rad_optimal_mc, what = 'BIC',
     legendArgs = list(x = "bottomright", ncol = 5))
```




```
plot(rad_optimal_mc, what = 'classification')
```




```
plot(rad_optimal_mc, what = 'uncertainty')
```



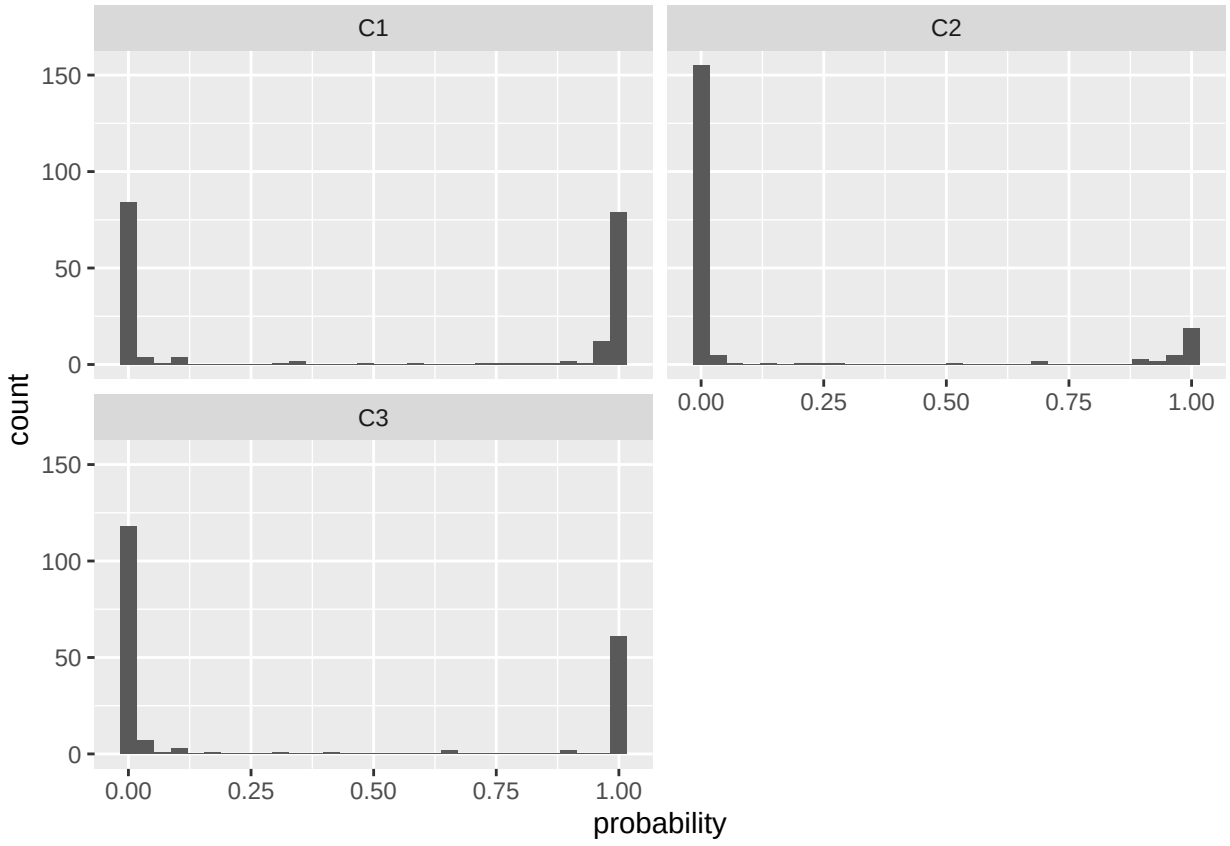

```
library(stringr)  # provides consistent wrappers and simplifies the manipulation of character strings.
```

```
probabilities <- rad_mc$z
colnames(probabilities) <- paste0('C', 1:3)
```

```
probabilities <- probabilities %>%
  as.data.frame() %>%
  mutate(id = row_number()) %>%
  tidyr::gather(cluster, probability, -id)
```

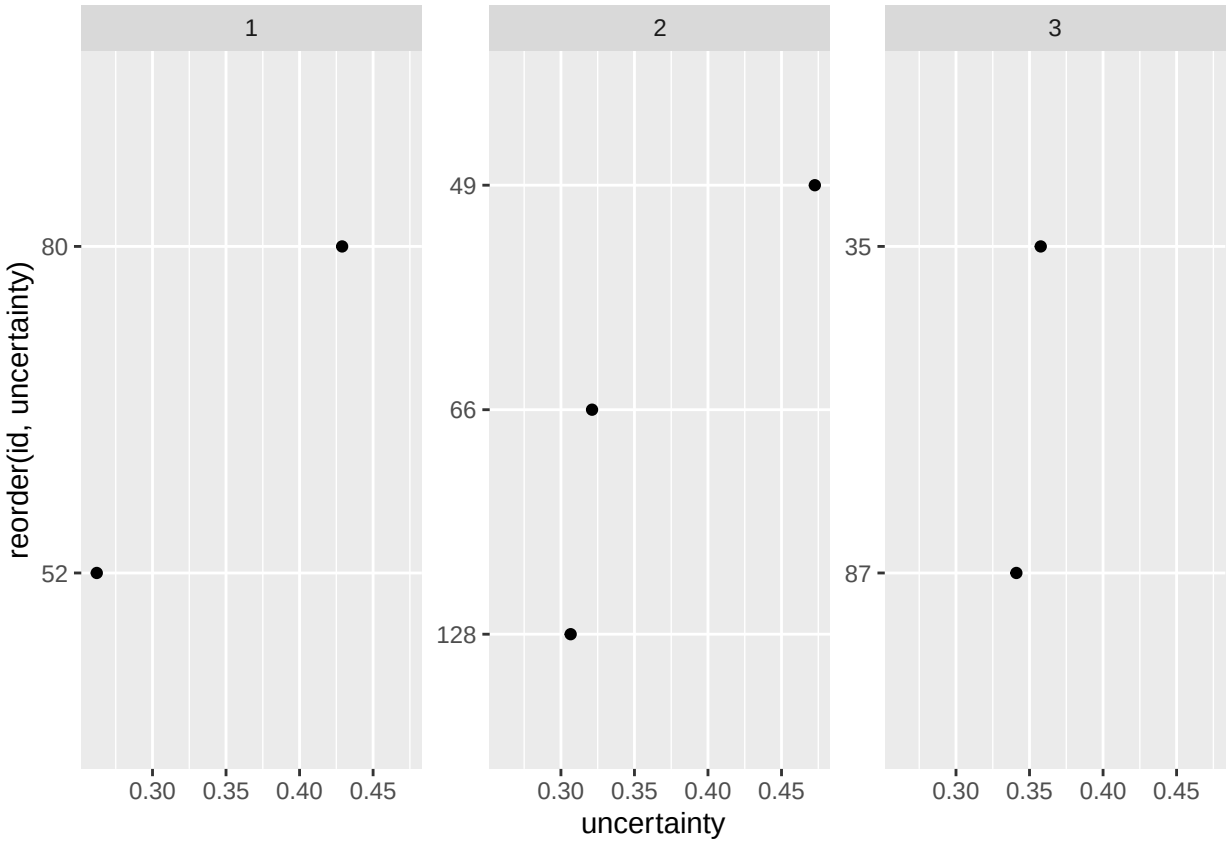
```
ggplot(probabilities, aes(probability)) +
  geom_histogram() +
  facet_wrap(~ cluster, nrow = 2)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



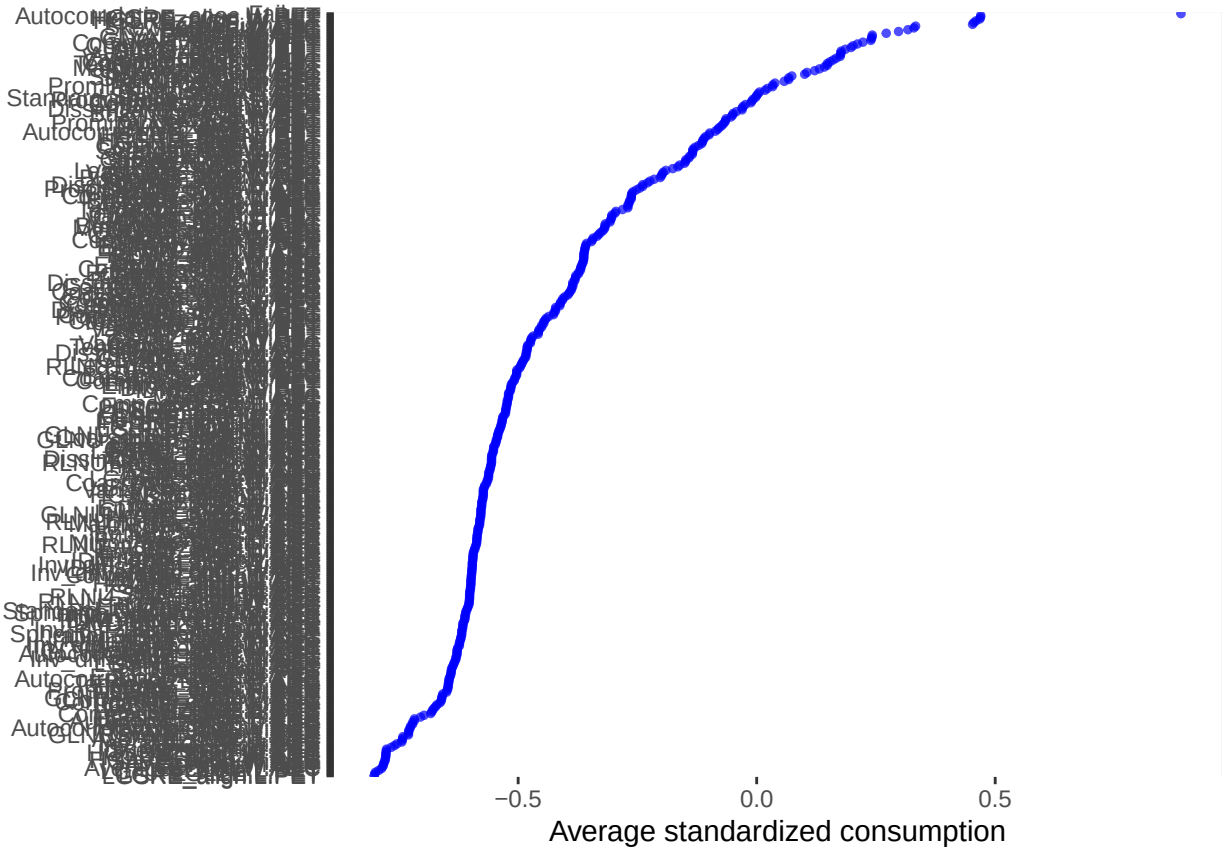

```
uncertainty <- data.frame(
  id = 1:nrow(radiomics),
  cluster = rad_mc$classification,
  uncertainty = rad_mc$uncertainty
)
```

```
uncertainty %>%
  group_by(cluster) %>%
  filter(uncertainty > 0.25) %>%
  ggplot(aes(uncertainty, reorder(id, uncertainty))) +
  geom_point() +
  facet_wrap(~ cluster, scales = 'free_y', nrow = 1)
```




```
cluster2 <- df %>%
  scale() %>%
  as.data.frame() %>%
  mutate(cluster = rad_mc$classification) %>%
  filter(cluster == 2) %>%
  select(-cluster)
```

```
cluster2 %>%
  tidyr::gather(product, std_count) %>%
  group_by(product) %>%
  summarize(avg = mean(std_count)) %>%
  ggplot(aes(avg, reorder(product, avg))) +
  geom_point(color = "blue", alpha = .7, size = 1) +
  labs(x = "Average standardized consumption", y = NULL)
```


−0.5
0.0
0.5
Average standardized consumption