INFS 692 Final Project M2

2022-12-16

Data entry

```
library(readr)
df = read.csv("radiomics_completedata.csv")
```

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(keras)
library(caret)
```

```
## Loading required package: ggplot2

## Loading required package: lattice
```

```
library(rsample)
library(recipes)
```

```
##
## Attaching package: 'recipes'

## The following object is masked from 'package:stats':
##
##     step
```

```
library(tfruns)
```

Data prepreation

```
summary(df)
```

```
##  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
##  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
##  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
```

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##  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
##  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
```

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##  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
##  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
```

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##  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
##  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
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##  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
##    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
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##  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
##  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
##  Median : 1241.6   Median : 193878       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.   :1477800       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
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##  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
##  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
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##  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
##  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
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##  1st Qu.:-0.007910     1st Qu.:1.612       1st Qu.:0.09567
##  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
##  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
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##    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
##  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
##  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
```

```
df <- na.omit(df)
```

split data (70% and 30%)

```
index<-createDataPartition(df$Failure.binary,p=0.7,list=F)

X <- data.matrix(df[index,-2])
Y <- df[index,2]
test_X <- data.matrix(df[-index,-2])
test_Y <- df[-index,2]
```

binary conversion

```
as.matrix(apply(X, 2, function(x) (x-min(x))/(max(x) - min(x)))) ->
  X

as.matrix(apply(test_X, 2, function(x) (x-min(x))/(max(x) - min(x)))) ->
  test_X

to_categorical(Y, num_classes = 2) -> Y
```

```
## Loaded Tensorflow version 2.10.0
```

```
to_categorical(test_Y, num_classes = 2) -> test_Y
```

Create five hidden layers with 256, 128, 128, 64 and 64 neurons, respectively with activation functions of Sigmoid. Create an output layer with two neurons respectively with activation functions of Softmax. Every layer is followed by a dropout to avoid overfitting.

```
model <- keras_model_sequential() %>%
  layer_dense(units = 256, activation = "sigmoid", input_shape=ncol(X))%>%
  layer_dropout(rate = 0.2) %>%
  layer_dense(units = 128, activation = "sigmoid") %>%
  layer_dropout(rate = 0.2) %>%
  layer_dense(units = 128, activation = "sigmoid") %>%
  layer_dropout(rate = 0.2) %>%
  layer_dense(units = 64, activation = "sigmoid") %>%
  layer_dropout(rate = 0.2) %>%
  layer_dense(units = 64, activation = "sigmoid") %>%
  layer_dropout(rate = 0.2) %>%
  layer_dense(units = 2, activation = "sigmoid")
```

Backpropagation

```
model %>% compile(
    loss = "categorical_crossentropy",
    optimizer = optimizer_rmsprop(),
    metrics = c("accuracy")
  )
```

Compiler approach

```
model %>% compile(
  loss = "categorical_crossentropy",
  optimizer = optimizer_adam(),
  metrics = c("accuracy")
)
```

Train the model with epoch = 10, batch size = 128 and validation split = 0.15

```
history <- model %>%
  fit(X, Y, epochs = 10, batch_size = 128, validation_split = 0.15)
```

Model evaluation

```
model %>%
  evaluate(test_X, test_Y)
```

```
##      loss  accuracy
## 0.7129784 0.5423729
```

Model prediction

```
model %>%
  predict(test_X)
```

```
##            [,1]      [,2]
##  [1,] 0.4698074 0.3243001
##  [2,] 0.4696147 0.3244551
##  [3,] 0.4698167 0.3243344
##  [4,] 0.4697458 0.3243830
##  [5,] 0.4694597 0.3246007
##  [6,] 0.4699126 0.3242027
##  [7,] 0.4694518 0.3245486
##  [8,] 0.4695139 0.3245243
##  [9,] 0.4695762 0.3244777
## [10,] 0.4701330 0.3240569
## [11,] 0.4698735 0.3242435
## [12,] 0.4700211 0.3241931
## [13,] 0.4697992 0.3243539
## [14,] 0.4697675 0.3243532
## [15,] 0.4699444 0.3242369
## [16,] 0.4693668 0.3246267
## [17,] 0.4699391 0.3241310
## [18,] 0.4700198 0.3241336
## [19,] 0.4700218 0.3241491
## [20,] 0.4696687 0.3244081
## [21,] 0.4696196 0.3243927
## [22,] 0.4697078 0.3243408
## [23,] 0.4695638 0.3245145
## [24,] 0.4697049 0.3243306
## [25,] 0.4698599 0.3242084
## [26,] 0.4692355 0.3246979
## [27,] 0.4699242 0.3241314
## [28,] 0.4698199 0.3242700
## [29,] 0.4694557 0.3245160
## [30,] 0.4694781 0.3245158
## [31,] 0.4695267 0.3245277
## [32,] 0.4695452 0.3246062
## [33,] 0.4696083 0.3244746
## [34,] 0.4694126 0.3246331
## [35,] 0.4696992 0.3243249
## [36,] 0.4696337 0.3243618
## [37,] 0.4696940 0.3242533
## [38,] 0.4698134 0.3243516
```

```
## [39,] 0.4695239 0.3246853
## [40,] 0.4694180 0.3246826
## [41,] 0.4695694 0.3245603
## [42,] 0.4694530 0.3248183
## [43,] 0.4695472 0.3245191
## [44,] 0.4695590 0.3246789
## [45,] 0.4696535 0.3246341
## [46,] 0.4691903 0.3244716
## [47,] 0.4690206 0.3244705
## [48,] 0.4687246 0.3247531
## [49,] 0.4689852 0.3244819
## [50,] 0.4693359 0.3242297
## [51,] 0.4696499 0.3241161
## [52,] 0.4696336 0.3240324
## [53,] 0.4692596 0.3242627
## [54,] 0.4692057 0.3243583
## [55,] 0.4696338 0.3240307
## [56,] 0.4693976 0.3242553
## [57,] 0.4694827 0.3242147
## [58,] 0.4692234 0.3243311
## [59,] 0.4690595 0.3247002
```