mrr_project_bio

2025-11-10

Classification of Cancer outcome using Genetic and Clinical data

Introduction

This project investigates the effect of genetic and clinical variables on the survival outcome of breast cancer patients. The data contains records of more than 1000 breast cancer patients from several research institutions. Clinical data contains patient-related and tumor-related information. Additionally mRNA gene expression data is available for each patient. The gene expression data has been processed to include only the top 5000 most variable genes on the transformed scale (log2(counts + 1)).

We consider that the main outcome variable of interest is **vital_status**, which is defined in clinical data.

Load data

```
load("mrr_bio.Rdata")
```

Genes data

```
dim(GeneX)
```

```
## [1] 1231 5000
```

```
str(GeneX)
```

```
##  num [1:1231, 1:5000] 0 0 10.92 3.17 5 ...
##  - attr(*, "dimnames")=List of 2
##   ..$ : chr [1:1231] "EW-A2FS-01A-11R-A17B" "OL-A6VR-01A-32R-A33J" "E9-A226-01A-21R-A157" "A8-A08H-0:
##   ..$ : chr [1:5000] "CLEC3A" "SCGB2A2" "CPB1" "GSTM1" ...
```

```
colnames(GeneX)[1:10]
```

```
##  [1] "CLEC3A"    "SCGB2A2"   "CPB1"      "GSTM1"     "TFF1"      "SCGB1D2"
##  [7] "KCNJ3"     "MUCL1"     "LINC00993" "ANKRD30A"
```

```
rownames(GeneX)[1:10]
```

```
##  [1] "EW-A2FS-01A-11R-A17B" "OL-A6VR-01A-32R-A33J" "E9-A226-01A-21R-A157"
##  [4] "A8-A08H-01A-21R-A00Z" "D8-A27H-01A-11R-A16F" "D8-A3Z6-01A-11R-A239"
##  [7] "B6-A1KN-01A-11R-A13Q" "BH-A0DL-01A-11R-A115" "A8-A09X-01A-11R-A00Z"
## [10] "BH-A2L8-01A-11R-A18M"
```

`GeneX` est un tableau de 1231 lignes par 5000 colonnes :

- Les lignes correspondent aux patients avec le nom de chaque ligne l'identifiant du patient comme `EW-A2FS-01A-11R-A17B`.
- Les colonnes correspondent aux gènes avec chaque nom de colonne un gène comme `CLEC3A`, qui sont les 5000 gènes les plus variables d'une personne à l'autre.
- Chaque case correspond à la valeur d'expression (un flottant) d'un certain gène (colonne) pour un certain patient (ligne) -> variables continues

Clinical data

```
load("mrr_bio.Rdata")
dim(clinical_data)
```

```
## Loading required namespace: S4Vectors
```

```
## NULL
```

```
head(clinical_data[, 1:5])
```

```
## DataFrame with 6 rows and 5 columns
##                     initial_weight tissue_type  laterality
##                          <numeric> <character> <character>
## EW-A2FS-01A-11R-A17B            110       Tumor        Left
## OL-A6VR-01A-32R-A33J            380       Tumor       Right
## E9-A226-01A-21R-A157            510       Tumor        Left
## A8-A08H-01A-21R-A00Z            250       Tumor        Left
## D8-A27H-01A-11R-A16F            170       Tumor       Right
## D8-A3Z6-01A-11R-A239             60       Tumor        Left
##                     tissue_or_organ_of_origin age_at_diagnosis
##                                   <character>        <integer>
## EW-A2FS-01A-11R-A17B               Breast, NOS            15302
## OL-A6VR-01A-32R-A33J               Breast, NOS            17702
## E9-A226-01A-21R-A157               Breast, NOS            16511
## A8-A08H-01A-21R-A00Z               Breast, NOS            24137
## D8-A27H-01A-11R-A16F               Breast, NOS            26588
## D8-A3Z6-01A-11R-A239               Breast, NOS            20629
```

```
colnames(clinical_data)
```

```
##  [1] "initial_weight"            "tissue_type"
##  [3] "laterality"                "tissue_or_organ_of_origin"
##  [5] "age_at_diagnosis"          "primary_diagnosis"
##  [7] "prior_treatment"           "diagnosis_is_primary_disease"
##  [9] "ajcc_pathologic_t"         "morphology"
## [11] "classification_of_tumor"   "sites_of_involvement"
## [13] "days_to_last_follow_up"    "follow_ups_disease_response"
## [15] "race"                      "gender"
## [17] "ethnicity"                 "vital_status"
## [19] "age_at_index"              "days_to_birth"
## [21] "age_is_obfuscated"         "bcr_patient_barcode"
## [23] "primary_site"              "disease_type"
```

clinical_data est un tableau de 1231 lignes par 24 colonnes :

- Les lignes correspondent aux noms des patients comme pour GeneX.
- Les colonnes sont les noms des données cliniques, comme initial_weight, sites_of_involvement et vital_status.
- Chaque case correspond à la valeur de la donnée clinique pour chaque patient, donc ce peut être un entier ou une chaîne de caractères.

Outcome variable

The outcome variable is the vital status of the patient (dead or alive) :

```
y <- clinical_data$vital_status
table(y)
```
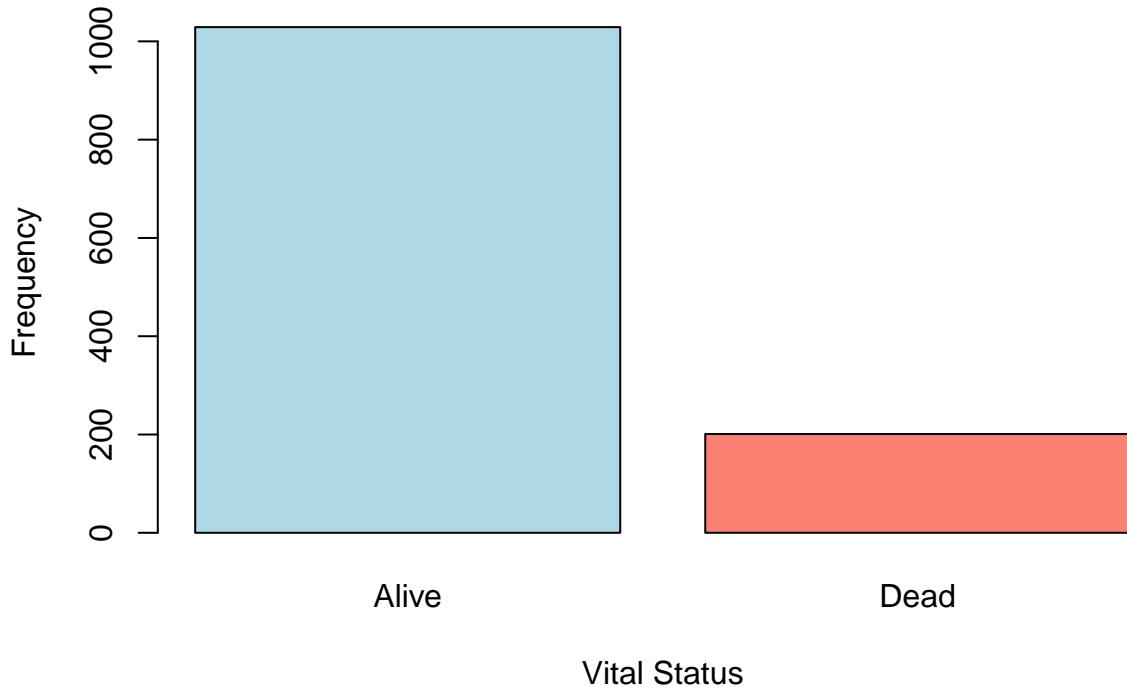
```
## y
## Alive  Dead
##  1029   201
```

```r
barplot(table(y),
        main = "Distribution of Vital Status",
        xlab = "Vital Status",
        ylab = "Frequency",
        col = c("lightblue", "salmon"))
```

Distribution of Vital Status

Exploratory data analysis

Genes

Clinical Data

Voici chaque type correspondant à chaque donnée ainsi que les fréquences de chaque occurrence :

```r
for (col in colnames(clinical_data)) {
  cat("\n=== ", col, " ===\n", sep = "")
  current_col <- clinical_data[[col]]
  print(unique(current_col))

  if (is.atomic(current_col) || is.factor(current_col)) {
    print(table(as.vector(current_col), useNA = "ifany"))
  } else {
    cat("table() skipped: column is", class(current_col), "\n")
  }
}
```

```
##
## === initial_weight ===
```

```
##    [1]  110  380  510  250  170   60   80  350  150  210  120  900  320  200   70
##   [16]   90   NA  100 1740  240  360  140   50  740 1050  430  370  460  130  420
##   [31] 1070  290 1020  440  160  600  780  410  190  540  220  490  400  180   40
##   [46]  980  620  640  450  680  330  270  730  230  280  260   20  650  310  570
##   [61]  580   30  920  750  710  470  560  390  590 1500  520 1650  700  800  340
##   [76]  950  960 1250 1710 1530  550  890  300  930  630  610  530 1830  940  480
##   [91]  500  840 1300 1360   10 1180 1270 1190  670  770 1040  830    5  970 1350
##  [106]  720  990 1550  760 1100  690 1520 1390 1080  158 1170 2190 1760  910  850
##  [121] 1210 1460  810 1030  880
##
##     5   10   20   30   40   50   60   70   80   90  100  110  120  130  140  150
##     1    2   10    5   11   16   17   25   35   16   43   42   42   40   38   31
##   158  160  170  180  190  200  210  220  230  240  250  260  270  280  290  300
##     1   33   36   27   37   44   36   23   32   25   22   27   14   25   19   22
##   310  320  330  340  350  360  370  380  390  400  410  420  430  440  450  460
##    17   12   12   13   14   17   12   12    6   17   11   13   10    7    7    6
##   470  480  490  500  510  520  530  540  550  560  570  580  590  600  610  620
##     8    6   12    5    8    7    5    7    7    3    2    7    8    8    3    8
##   630  640  650  670  680  690  700  710  720  730  740  750  760  770  780  800
##     5    4    6    3    4    2    3    2    2    8    5    4    3    4    2    4
##   810  830  840  850  880  890  900  910  920  930  940  950  960  970  980  990
##     1    3    2    1    1    3    3    1    2    1    1    2    3    2    3    4
##  1020 1030 1040 1050 1070 1080 1100 1170 1180 1190 1210 1250 1270 1300 1350 1360
##     1    1    1    2    2    1    3    1    2    1    1    1    1    1    1    1
##  1390 1460 1500 1520 1530 1550 1650 1710 1740 1760 1830 2190 <NA>
##     2    1    2    1    1    1    1    1    1    1    1    1   15
##
## === tissue_type ===
## [1] "Tumor"  "Normal"
##
## Normal  Tumor
##    113   1118
##
## === laterality ===
## [1] "Left"  "Right" NA
##
##  Left Right  <NA>
##   581   556    94
##
## === tissue_or_organ_of_origin ===
##  [1] "Breast, NOS"                    "Kidney, NOS"
##  [3] "Liver"                          "Colon, NOS"
##  [5] "Cervix uteri"                   "Bone, NOS"
##  [7] "Lung, NOS"                      "Not Reported"
##  [9] "Overlapping lesion of breast"   "Lower limb, NOS"
## [11] "Brain, NOS"                     "Thorax, NOS"
## [13] "Lower-inner quadrant of breast" "Upper-outer quadrant of breast"
## [15] "Upper-inner quadrant of breast" "Skin of scalp and neck"
## [17] "Intrathoracic lymph nodes"      "Bladder, NOS"
## [19] "Lymph nodes of head, face and neck" "Specified parts of peritoneum"
## [21] "Rectum, NOS"                    "Ovary"
## [23] NA                               "Bone marrow"
## [25] "Skin of lower limb and hip"     "Lower-outer quadrant of breast"
##
```

```
##                      Bladder, NOS                              Bone marrow
##                                1                                        1
##                        Bone, NOS                               Brain, NOS
##                               22                                        2
##                      Breast, NOS                              Cervix uteri
##                             1127                                        2
##                       Colon, NOS                 Intrathoracic lymph nodes
##                                5                                        1
##                      Kidney, NOS                                    Liver
##                                4                                        7
##                  Lower limb, NOS          Lower-inner quadrant of breast
##                                2                                        6
##   Lower-outer quadrant of breast                                Lung, NOS
##                                1                                       13
## Lymph nodes of head, face and neck                            Not Reported
##                                1                                       13
##                            Ovary          Overlapping lesion of breast
##                                1                                        3
##                      Rectum, NOS               Skin of lower limb and hip
##                                1                                        3
##              Skin of scalp and neck      Specified parts of peritoneum
##                                1                                        1
##                      Thorax, NOS          Upper-inner quadrant of breast
##                                5                                        2
##     Upper-outer quadrant of breast                                     <NA>
##                                5                                        1
##
## === age_at_diagnosis ===
##     [1] 15302 17702 16511 24137 26588 20629 21183 23628 22858 16658 15369    NA
##    [13] 24017 19846 19781 29345 21002 32208 19723 17440 23358 18433 14503 29474
##    [25] 13458 17807 15837 25345 15780 28981 14122 17332 30742 24788 19298 17689
##    [37] 21294 17817 23108 17539 31351 29529 19160 15533 19629 28940 16911 18584
##    [49] 25089 18334 22449 16458 14894 16109 28331 19570 23021 26693 15625 16363
##    [61] 20401 17637 18014 20347 27389 24075 14383 22686 18684 16824 20625 27106
##    [73] 18520 17465 17529 15166 17172 21898 28233 19028 21230 26141 16971 19731
##    [85] 21837 17474 15602 20471 16719 26883 20678 14264 24439 17523 15432 23065
##    [97] 23423 21857 21428 13445 19027 22751 21910 17652 24779 30125 18733 14883
##   [109] 23686 22958 32842 31805 23318 24891 25475 28495 20820 19031 19478 23150
##   [121] 17699 15812 21623 23928 29444 23008 10832 25259 32478 21926 25350 24104
##   [133] 25186 29146 23500 20152 12142 25966 21197 23653 24877 26052 22629 24219
##   [145] 10898 19152 17640 17033 24319 17224 20425 23404 15216 18152 22411 18628
##   [157] 25830 22788 22995 17070 29751 24999 16377 28923 19805 19900 22849 16955
##   [169] 30407 22344 17080 20719 23230 17468 27163 18507 30196 26121 13307 22052
##   [181] 32872 22900 21369 25142 10564 17779 20332 26535 24660 28855 26186 20764
##   [193] 21628 22199 28609 24923 20930 25770 20694 21479 14316 15052 18524 18151
##   [205] 22976 15122 17300 20585 25110 13671 18401 21397 24813 23031 22833 19131
##   [217] 25714 29335 31748 11120 14175 30489 27392 14906 14272 19309 23851 20227
##   [229] 17624 19479 21640 24155 17026 20900 18038 23855 22448 18282 20574 18296
##   [241] 19340 21014 15027 32295 21386 22672 17490 27160 16022 15989 14669 25558
##   [253] 21514 22896 20766 13243 23266 25867 27241 26931 17580 15774 19989 15969
##   [265] 26723 21613 26484 26845 25937 19607 24262 23000 28664 30958 24232 20497
##   [277] 22942 28715 12528 23058 25477 16174 19706 20717 16817 21793 20924 18985
##   [289] 23576 23753 19123 23507 21608 28063 23660 16884 18482 18492 20065 23521
##   [301] 22422 18237 14532 20570 27400 27917 20705 27934 22536 18475 25029 21646
```

```
## [313] 27964 25643 27865 24850 23485 17763 30783 21394 22462 24647 25190 14969
## [325] 29734 24053 25119 20468 25010 20713 15593 21343 26363 23395 22997 22922
## [337] 24442 19802 27143 28660 18117 26988 21534 13004 18721 12729 18771 19814
## [349] 23972 26426 30984 19778 22515 24230 30912 15820 21750 19250 19679 13836
## [361] 22520 17806 20077 28178 11204 19627 22332 21160 22962 27627 23041 19822
## [373] 17715 31223 22238 22222 15540 20675 19767 22966 23229 12525 19169 22524
## [385] 21309 26248 14250 28177 21895 19464 23870 30339 17879 18621 28003 15996
## [397] 22583 26221 27063 22707 13483 32462 27121 20381 15705 21465 25242 23225
## [409] 23103 17815 19746 14854 25747 23006 23926 26550 18084 18936 12006 24831
## [421] 26239 19216 24803 27977 26998 16757 23570 21047 24380 20080 18538 23380
## [433] 17921 19117 23397 23300 14853 18830 29331 28416 19314 28974 16289 19895
## [445] 22656 18942 22325 29113 23347 25282 19030 13340 17456 27287 13409 21555
## [457] 18870 19237 22625 17871 16887 25825 26281 17588 29131 27191 14564 29006
## [469] 25959 16688 24719 24519 18025 27455 21622 23922 16504 26278 24279 21865
## [481] 28706 30085 16508 22905 21228 25097 30590 18900 27489 16689 16736 25957
## [493] 18852 22179 18594 17238 22710 22539 24353 21426 23675 23560 18839 23741
## [505] 24875 21122 23684 20380 16642 29199 18806 20127 18514 19596 19591 15590
## [517] 20072 26734 15085 19415 15284 28198 18508 24139 14626 22798 25136 14653
## [529] 29728 27705 24266 21344 15158 23827 16310 21338 20795 25771 28022 23246
## [541] 17438 27605 23366 25659 22341 25693 15980 20774 15507 14858 14115 13039
## [553] 16370 20664 10869 24692 19563 22544 28375 14755 22703 14134 20504 18434
## [565] 29406 26823 22096 21918 20092 16101 23927 32750 21201 27837 17022 25944
## [577] 23650 21731 29014 12840 23883 29144 19758 18659 17363 26684 18384 18177
## [589] 17727 26466 18506 29330 22115 21949 10812 16702 24541 15524 21488 18501
## [601] 20715 21348 18060 20374 23011 16882 17135 18611 25666 25833 20075 15744
## [613] 19002 26299 22340 16533 22842 18695 17981 29858 15670 20210 26021 27521
## [625] 18002 22071 23072 13510 32871 26999 22810 23530 25598 22397 23543 25811
## [637] 18500 22779 25223 24731 25674 20691 28403 14494 15942 20048 16195 29555
## [649] 17372 22587 22928 25567 28699 16750 18346 17969 17420 19533 16623 18345
## [661] 20483 22797 20861 23639 21562 17275 27047 18741 27557 29211 14119 25362
## [673] 22848 23284 14174 20776 21831 22878 14595 20482 21856 16742 11650 28724
## [685] 23742 26224 11929 16649 21464 19880 20053 21933 23371 20346 22317 20712
## [697] 20804 19389 19266 14374 21501 25515 16627 18850 21198 12841 22714 17521
## [709] 24288 12755 19985 29256 24046 25158 15050 29251 23057 15283 17660 21922
## [721] 12671 26269 13138 22889 15469 23387 14976 29285 29370 20102 21463 18851
## [733] 20863 22936 32404 22772 19701 17996 18140 17930 29463 20352 15324 13985
## [745] 29115 20448 28013 26642 17729 18875 17759 30025 25658 27280 24493 15007
## [757] 16974 21038 24544 18756 23278 24710 18021 21288 19975 17157 22094  9873
## [769] 14868 31932 17443 16787 24929 27313 29280 21773 27967 25677 13817 26817
## [781] 24083 28644 23314 16213 17352 17257 30950 21056 21575 23667 24417 19516
## [793] 20722 28247 18270 19192 20105 28444 23224 21762 17045 27729 18354 16615
## [805] 18109 20940 23055 24577 18046 26896 27421 28411 16978 22133 21391 17710
## [817] 27811 25294 22643 18927 13642 31173 19794 20118 21602 15286 18561 31657
## [829] 22883 22441 24322 20052 13680 14638 28876 12968 28084 18161 30528 20479
## [841] 30101 15977 29916 22077 22510 16983 16634 15504 17774 21024 14731 26724
## [853] 23294 21641 26993 13805 13208 21389 30859 24315 18519 19966 22380 19010
## [865] 17141 26399 23327 26862 20049 19614 25355 27288 23845 18748 25974 22805
## [877] 19643 24054 24434 14784 16603 18558 22809 13556 15212 16829 22284 20173
## [889] 24327 16961 14816 17426 29907 24125 20956 14723 23708 14920 24746 10616
## [901] 15289 18691 16403 22844 16163 23116 24411 28625 12965 27341 24735 17039
## [913] 13743 12642 15078 19849  9840 14090 11199 16858 25370 19489 18535 18371
## [925] 24826 28596 20123 26042 15055 17682 22683 18788 27942 24242 24791 19085
## [937] 25263 12715 23337 22708 24181 20539 18984 30830 23164 21064 20488 23461
## [949] 22019 23126 24940 18053 11379 25499 31404 26514 12668 28304 20239 26007
```

```
##  [961] 19114 16697 22598 21755 23215 32061 25066 20028 19073 23992 26869 25289
##  [973] 18999 23878 25230 18362 21520 26627 29966 23980 19074 14778 22023 22872
##  [985] 24235 25305 21327 22355 25000 17597 22416 29820 16948 19729 28338 29358
##  [997] 22961 22780 29104 22157 20606 19432 27731 25408 26026 17152 18041 27684
## [1009] 18171 12443 22279 17708
##
##  9840  9873 10564 10616 10812 10832 10869 10898 11120 11199 11204 11379 11650
##     1     1     1     1     1     1     1     1     1     1     2     2     3
## 11929 12006 12142 12443 12525 12528 12642 12668 12671 12715 12729 12755 12840
##     1     1     1     1     2     1     1     1     1     1     1     1     1
## 12841 12965 12968 13004 13039 13138 13208 13243 13307 13340 13409 13445 13458
##     1     1     1     1     1     2     1     1     1     1     1     1     1
## 13483 13510 13556 13642 13671 13680 13743 13805 13817 13836 13985 14090 14115
##     1     1     1     1     1     1     1     1     1     2     1     2     1
## 14119 14122 14134 14174 14175 14250 14264 14272 14316 14374 14383 14494 14503
##     1     2     1     1     2     1     1     1     1     1     1     2     1
## 14532 14564 14595 14626 14638 14653 14669 14723 14731 14755 14778 14784 14816
##     2     1     1     1     1     1     1     1     1     2     1     1     1
## 14853 14854 14858 14868 14883 14894 14906 14920 14969 14976 15007 15027 15050
##     1     2     1     1     1     2     1     2     1     1     1     2     1
## 15052 15055 15078 15085 15122 15158 15166 15212 15216 15283 15284 15286 15289
##     1     2     2     1     1     1     1     1     1     2     1     1     1
## 15302 15324 15369 15432 15469 15504 15507 15524 15533 15540 15590 15593 15602
##     1     1     1     1     1     1     1     1     2     1     1     2     1
## 15625 15670 15705 15744 15774 15780 15812 15820 15837 15942 15969 15977 15980
##     1     1     1     1     1     1     1     1     1     2     1     1     2
## 15989 15996 16022 16101 16109 16163 16174 16195 16213 16289 16310 16363 16370
##     1     1     1     1     1     2     2     1     1     2     1     2     1
## 16377 16403 16458 16504 16508 16511 16533 16603 16615 16623 16627 16634 16642
##     1     1     1     2     1     1     1     1     1     1     1     1     1
## 16649 16658 16688 16689 16697 16702 16719 16736 16742 16750 16757 16787 16817
##     1     1     2     1     1     1     2     3     1     2     2     1     1
## 16824 16829 16858 16882 16884 16887 16911 16948 16955 16961 16971 16974 16978
##     2     1     1     1     1     2     1     1     1     1     1     1     1
## 16983 17022 17026 17033 17039 17045 17070 17080 17135 17141 17152 17157 17172
##     1     1     1     1     1     1     3     1     1     1     1     1     2
## 17224 17238 17257 17275 17300 17332 17352 17363 17372 17420 17426 17438 17440
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 17443 17456 17465 17468 17474 17490 17521 17523 17529 17539 17580 17588 17597
##     1     1     2     1     1     1     1     1     1     1     1     1     1
## 17624 17637 17640 17652 17660 17682 17689 17699 17702 17708 17710 17715 17727
##     1     1     1     1     1     3     1     1     2     1     1     2     1
## 17729 17759 17763 17774 17779 17806 17807 17815 17817 17871 17879 17921 17930
##     1     1     1     1     1     1     1     1     1     1     1     1     3
## 17969 17981 17996 18002 18014 18021 18025 18038 18041 18046 18053 18060 18084
##     2     1     2     1     1     1     1     1     1     1     1     1     1
## 18109 18117 18140 18151 18152 18161 18171 18177 18237 18270 18282 18296 18334
##     1     1     1     1     1     1     1     1     2     1     1     1     1
## 18345 18346 18354 18362 18371 18384 18401 18433 18434 18475 18482 18492 18500
##     2     1     1     1     1     1     1     1     1     1     1     1     1
## 18501 18506 18507 18508 18514 18519 18520 18524 18535 18538 18558 18561 18584
##     1     1     1     1     1     2     1     2     1     1     1     1     1
## 18594 18611 18621 18628 18659 18684 18691 18695 18721 18733 18741 18748 18756
##     1     1     1     1     1     1     2     1     1     1     1     1     1
```

```
## 18771 18788 18806 18830 18839 18850 18851 18852 18870 18875 18900 18927 18936
##     2     1     1     1     2     1     1     1     1     2     1     1     1
## 18942 18984 18985 18999 19002 19010 19027 19028 19030 19031 19073 19074 19085
##     2     1     1     1     1     1     1     1     2     1     1     1     1
## 19114 19117 19123 19131 19152 19160 19169 19192 19216 19237 19250 19266 19298
##     1     1     1     2     1     1     1     2     2     1     1     1     1
## 19309 19314 19340 19389 19415 19432 19464 19478 19479 19489 19516 19533 19563
##     1     1     1     1     1     1     1     1     2     1     1     1     1
## 19570 19591 19596 19607 19614 19627 19629 19643 19679 19701 19706 19723 19729
##     1     1     1     1     1     1     1     1     1     2     1     1     1
## 19731 19746 19758 19767 19778 19781 19794 19802 19805 19814 19822 19846 19849
##     1     1     1     1     1     2     1     1     1     1     1     1     1
## 19880 19895 19900 19966 19975 19985 19989 20028 20048 20049 20052 20053 20065
##     1     2     1     1     3     1     1     1     1     2     1     1     1
## 20072 20075 20077 20080 20092 20102 20105 20118 20123 20127 20152 20173 20210
##     1     1     1     1     1     1     1     1     1     1     1     1     2
## 20227 20239 20332 20346 20347 20352 20374 20380 20381 20401 20425 20448 20468
##     1     1     1     1     1     1     2     1     1     1     2     1     1
## 20471 20479 20482 20483 20488 20497 20504 20539 20570 20574 20585 20606 20625
##     1     1     1     1     1     1     1     1     4     1     1     1     2
## 20629 20664 20675 20678 20691 20694 20705 20712 20713 20715 20717 20719 20722
##     1     1     2     2     1     2     1     1     1     1     1     1     1
## 20764 20766 20774 20776 20795 20804 20820 20861 20863 20900 20924 20930 20940
##     1     1     1     1     2     1     1     1     2     1     1     1     1
## 20956 21002 21014 21024 21038 21047 21056 21064 21122 21160 21183 21197 21198
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 21201 21228 21230 21288 21294 21309 21327 21338 21343 21344 21348 21369 21386
##     1     2     1     1     1     1     1     1     1     1     1     1     2
## 21389 21391 21394 21397 21426 21428 21463 21464 21465 21479 21488 21501 21514
##     1     1     1     2     1     2     1     1     1     1     2     1     3
## 21520 21534 21555 21562 21575 21602 21608 21613 21622 21623 21628 21640 21641
##     1     2     1     1     1     1     1     1     1     1     3     1     1
## 21646 21731 21750 21755 21762 21773 21793 21831 21837 21856 21857 21865 21895
##     1     1     1     1     1     1     1     1     1     2     1     1     1
## 21898 21910 21918 21922 21926 21933 21949 22019 22023 22052 22071 22077 22094
##     1     2     2     1     1     2     2     1     1     1     2     1     1
## 22096 22115 22133 22157 22179 22199 22222 22238 22279 22284 22317 22325 22332
##     1     1     1     1     1     4     2     1     1     1     1     1     1
## 22340 22341 22344 22355 22380 22397 22411 22416 22422 22441 22448 22449 22462
##     1     1     1     1     2     1     1     1     1     1     1     1     1
## 22510 22515 22520 22524 22536 22539 22544 22583 22587 22598 22625 22629 22643
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 22656 22672 22683 22686 22703 22707 22708 22710 22714 22751 22772 22779 22780
##     1     1     1     1     2     1     1     1     1     1     1     1     1
## 22788 22797 22798 22805 22809 22810 22833 22842 22844 22848 22849 22858 22872
##     1     1     2     1     1     1     1     1     1     1     1     1     1
## 22878 22883 22889 22896 22900 22905 22922 22928 22936 22942 22958 22961 22962
##     1     1     1     2     1     1     1     1     1     1     1     1     1
## 22966 22976 22995 22997 23000 23006 23008 23011 23021 23031 23041 23055 23057
##     1     1     1     1     1     2     1     1     2     1     1     1     1
## 23058 23065 23072 23103 23108 23116 23126 23150 23164 23215 23224 23225 23229
##     1     1     1     2     1     1     1     1     1     1     2     1     1
## 23230 23246 23266 23278 23284 23294 23300 23314 23318 23327 23337 23347 23358
##     1     4     1     1     1     3     1     1     1     1     1     1     1
```

```
## 23366 23371 23380 23387 23395 23397 23404 23423 23461 23485 23500 23507 23521
##     2     1     2     1     1     2     3     1     1     1     1     1     1
## 23530 23543 23560 23570 23576 23628 23639 23650 23653 23660 23667 23675 23684
##     1     1     1     1     1     2     1     1     1     1     1     1     1
## 23686 23708 23741 23742 23753 23827 23845 23851 23855 23870 23878 23883 23922
##     1     1     1     1     1     1     1     2     1     1     1     1     1
## 23926 23927 23928 23972 23980 23992 24017 24046 24053 24054 24075 24083 24104
##     1     1     1     2     1     1     1     1     1     1     1     1     1
## 24125 24137 24139 24155 24181 24219 24230 24232 24235 24242 24262 24266 24279
##     1     1     1     1     1     1     1     1     1     1     2     2     1
## 24288 24315 24319 24322 24327 24353 24380 24411 24417 24434 24439 24442 24493
##     1     2     1     1     1     1     1     1     1     1     1     1     1
## 24519 24541 24544 24577 24647 24660 24692 24710 24719 24731 24735 24746 24779
##     1     1     1     1     1     1     1     1     2     1     1     1     2
## 24788 24791 24803 24813 24826 24831 24850 24875 24877 24891 24923 24929 24940
##     1     1     1     1     1     1     1     1     1     1     1     1     2
## 24999 25000 25010 25029 25066 25089 25097 25110 25119 25136 25142 25158 25186
##     1     1     1     1     1     1     1     1     2     2     1     1     2
## 25190 25223 25230 25242 25259 25263 25282 25289 25294 25305 25345 25350 25355
##     1     1     1     1     1     1     1     2     1     1     1     1     1
## 25362 25370 25408 25475 25477 25499 25515 25558 25567 25598 25643 25658 25659
##     1     1     1     1     2     1     1     1     1     1     1     1     1
## 25666 25674 25677 25693 25714 25747 25770 25771 25811 25825 25830 25833 25867
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 25937 25944 25957 25959 25966 25974 26007 26021 26026 26042 26052 26121 26141
##     1     1     1     1     1     2     1     1     1     1     2     1     1
## 26186 26221 26224 26239 26248 26269 26278 26281 26299 26363 26399 26426 26466
##     1     1     1     1     1     1     1     1     1     1     1     2     1
## 26484 26514 26535 26550 26588 26627 26642 26684 26693 26723 26724 26734 26817
##     1     1     1     1     1     1     1     2     1     1     1     1     1
## 26823 26845 26862 26869 26883 26896 26931 26988 26993 26998 26999 27047 27063
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 27106 27121 27143 27160 27163 27191 27241 27280 27287 27288 27313 27341 27389
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 27392 27400 27421 27455 27489 27521 27557 27605 27627 27684 27705 27729 27731
##     1     2     1     1     1     1     1     1     1     1     1     1     1
## 27811 27837 27865 27917 27934 27942 27964 27967 27977 28003 28013 28022 28063
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 28084 28177 28178 28198 28233 28247 28304 28331 28338 28375 28403 28411 28416
##     1     1     1     1     1     1     1     1     1     1     2     1     1
## 28444 28495 28596 28609 28625 28644 28660 28664 28699 28706 28715 28724 28855
##     1     1     1     2     1     1     1     1     2     2     1     2     1
## 28876 28923 28940 28974 28981 29006 29014 29104 29113 29115 29131 29144 29146
##     1     1     1     2     1     1     1     2     1     1     1     1     1
## 29199 29211 29251 29256 29280 29285 29330 29331 29335 29345 29358 29370 29406
##     1     1     1     1     1     1     1     1     2     1     1     1     1
## 29444 29463 29474 29529 29555 29728 29734 29751 29820 29858 29907 29916 29966
##     1     1     1     3     4     1     1     2     1     1     1     1     1
## 30025 30085 30101 30125 30196 30339 30407 30489 30528 30590 30742 30783 30830
##     1     1     1     1     1     2     1     1     1     1     1     1     1
## 30859 30912 30950 30958 30984 31173 31223 31351 31404 31657 31748 31805 31932
##     1     1     1     1     1     1     1     1     1     1     1     2     1
## 32061 32208 32295 32404 32462 32478 32750 32842 32871 32872  <NA>
##     1     1     2     2     1     1     1     1     2     9    55
```

9

```
## 
## === primary_diagnosis ===
##  [1] "Infiltrating duct carcinoma, NOS"
##  [2] "Lobular carcinoma, NOS"
##  [3] "Metaplastic carcinoma, NOS"
##  [4] "Clear cell carcinoma"
##  [5] "Infiltrating duct mixed with other types of carcinoma"
##  [6] "Infiltrating lobular mixed with other types of carcinoma"
##  [7] "Not Reported"
##  [8] "Papillary carcinoma, NOS"
##  [9] "Adenocarcinoma, NOS"
## [10] "Paget disease and infiltrating duct carcinoma of breast"
## [11] "Intraductal carcinoma, noninfiltrating, NOS"
## [12] "Mucinous adenocarcinoma"
## [13] "Medullary carcinoma, NOS"
## [14] "Pleomorphic carcinoma"
## [15] "Infiltrating duct and lobular carcinoma"
## [16] "Basal cell carcinoma, NOS"
## [17] "Lobular carcinoma in situ, NOS"
## [18] "Invasive micropapillary carcinoma"
## [19] "Tubular adenocarcinoma"
## [20] "Cribriform carcinoma, NOS"
## [21] "Intraductal papillary adenocarcinoma with invasion"
## [22] "Carcinoma, NOS"
## [23] "Adenoid cystic carcinoma"
## [24] "Large cell neuroendocrine carcinoma"
## [25] "Apocrine adenocarcinoma"
## [26] NA
## [27] "Myelodysplastic syndrome, NOS"
## [28] "Phyllodes tumor, malignant"
## 
##                                           Adenocarcinoma, NOS
##                                                             2
##                                      Adenoid cystic carcinoma
##                                                             1
##                                       Apocrine adenocarcinoma
##                                                             1
##                                      Basal cell carcinoma, NOS
##                                                             3
##                                                Carcinoma, NOS
##                                                             1
##                                          Clear cell carcinoma
##                                                             2
##                                      Cribriform carcinoma, NOS
##                                                             1
##                       Infiltrating duct and lobular carcinoma
##                                                            37
##                              Infiltrating duct carcinoma, NOS
##                                                           857
##         Infiltrating duct mixed with other types of carcinoma
##                                                            20
## Infiltrating lobular mixed with other types of carcinoma
##                                                             5
##                  Intraductal carcinoma, noninfiltrating, NOS
```

```
##                                                       4
##      Intraductal papillary adenocarcinoma with invasion
##                                                       6
##                     Invasive micropapillary carcinoma
##                                                       4
##                  Large cell neuroendocrine carcinoma
##                                                       1
##                        Lobular carcinoma in situ, NOS
##                                                       3
##                               Lobular carcinoma, NOS
##                                                     195
##                             Medullary carcinoma, NOS
##                                                       7
##                           Metaplastic carcinoma, NOS
##                                                      16
##                             Mucinous adenocarcinoma
##                                                      15
##                        Myelodysplastic syndrome, NOS
##                                                       1
##                                         Not Reported
##                                                      37
##  Paget disease and infiltrating duct carcinoma of breast
##                                                       4
##                             Papillary carcinoma, NOS
##                                                       2
##                            Phyllodes tumor, malignant
##                                                       1
##                               Pleomorphic carcinoma
##                                                       3
##                               Tubular adenocarcinoma
##                                                       1
##                                                    <NA>
##                                                       1
##
## === prior_treatment ===
## [1] "No"          NA            "Yes"          "Not Reported"
##
##            No Not Reported         Yes          <NA>
##          1100            1          85            45
##
## === diagnosis_is_primary_disease ===
## [1]   TRUE FALSE     NA
##
## FALSE   TRUE  <NA>
##   119   1108     4
##
## === ajcc_pathologic_t ===
##  [1] "T2"         "T1b"        "T3"         "T4b"        "T1c"
##  [6] NA           "T1"         "TX"         "T1a"        "Tis (LCIS)"
## [11] "T2b"        "Tis (DCIS)" "T4"         "T4d"        "Tis"
## [16] "T3a"        "T2a"
##
##          T1          T1a          T1b          T1c           T2          T2a          T2b
##          43            6           17          227          655            1            2
```

11

```
##            T3          T3a          T4          T4b          T4d         Tis Tis (DCIS)
##           131            1           8           29            4           2           1
## Tis (LCIS)           TX         <NA>
##            2            2          100
##
## === morphology ===
##  [1] "8500/3"      "8520/3"      "8575/3"      "8310/3"      "8523/3"
##  [6] "8524/3"      "Not Reported" "8050/3"     "8140/3"      "8541/3"
## [11] "8500/2"      "8480/3"      "8510/3"      "8022/3"      "8522/3"
## [16] "8090/3"      "8520/2"      "8507/3"      "8211/3"      "8201/3"
## [21] "8503/3"      "8010/3"      "8200/3"      "8013/3"      "8401/3"
## [26] NA            "9989/3"      "9020/3"
##
##        8010/3       8013/3       8022/3       8050/3       8090/3       8140/3
##             1            1            3            2            3            2
##        8200/3       8201/3       8211/3       8310/3       8401/3       8480/3
##             1            1            1            2            1           15
##        8500/2       8500/3       8503/3       8507/3       8510/3       8520/2
##             4          857            6            4            7            3
##        8520/3       8522/3       8523/3       8524/3       8541/3       8575/3
##           195           37           20            5            4           16
##        9020/3       9989/3 Not Reported         <NA>
##             1            1           37            1
##
## === classification_of_tumor ===
## [1] "primary"              "Prior primary"       "Subsequent Primary"
## [4] "metastasis"           "Synchronous primary" "not reported"
## [7] "recurrence"           NA
##
##        metastasis         not reported              primary       Prior primary
##                44                   13                 1108                  21
##        recurrence  Subsequent Primary Synchronous primary                <NA>
##                11                   10                   23                   1
##
## === sites_of_involvement ===
## [[1]]
## [1] "Breast, Left Upper Outer"
##
## [[2]]
## [1] "Breast, NOS"
##
## [[3]]
## [1] "Breast, Left Lower Inner"
##
## [[4]]
## [1] "Breast, Left Upper Inner"
##
## [[5]]
## [1] "Breast, Right Upper Outer"
##
## [[6]]
## [1] "Breast, Right Upper Inner"
##
## [[7]]
```

```
## [1] "Breast, Left Upper Inner" "Breast, Left Lower Inner"
## [3] "Breast, Left Lower Outer" "Breast, NOS"
##
## [[8]]
## [1] "Breast, Right Lower Outer"
##
## [[9]]
## [1] "Breast, Left Upper Inner" "Breast, Left Upper Outer"
##
## [[10]]
## NULL
##
## [[11]]
## [1] "Breast, NOS"              "Breast, Right Lower Outer"
##
## [[12]]
## [1] "Breast, NOS"              "Breast, Left Upper Inner"
## [3] "Breast, Left Upper Outer" "Breast, Left Lower Inner"
## [5] "Breast, Left Lower Outer"
##
## [[13]]
## [1] "Breast, Right Lower Inner"
##
## [[14]]
## [1] "Breast, Right Upper Inner" "Breast, NOS"
##
## [[15]]
## [1] "Breast, Right Upper Outer" "Breast, NOS"
##
## [[16]]
## [1] "Breast, NOS"              "Breast, Left Upper Outer"
##
## [[17]]
## [1] "Breast, Left Upper Outer" "Breast, NOS"
##
## [[18]]
## [1] "Breast, NOS"               "Breast, Right Upper Outer"
##
## [[19]]
## [1] "Breast, NOS"               "Breast, Right Lower Inner"
##
## [[20]]
## [1] "Bone, NOS"                "Breast, Left Upper Outer"
##
## [[21]]
## [1] "Bone, NOS"    "Breast, NOS"
##
## [[22]]
## [1] "Breast, Left Upper Outer" "Breast, Left Lower Outer"
##
## [[23]]
## [1] "Breast, Left Lower Inner" "Breast, Left Lower Outer"
##
## [[24]]
```

```
## [1] "Breast, Right Upper Inner" "Breast, Right Upper Outer"
## [3] "Breast, NOS"
##
## [[25]]
## [1] "Breast, Left Upper Inner" "Breast, Left Upper Outer"
## [3] "Breast, Left Lower Inner" "Breast, Left Lower Outer"
##
## [[26]]
## [1] "Breast, Right Upper Outer" "Breast, Right Lower Outer"
##
## [[27]]
## [1] "Breast, Left Lower Outer"
##
## [[28]]
## [1] "Breast, Right Upper Inner" "Breast, Right Lower Inner"
## [3] "Breast, NOS"
##
## [[29]]
## [1] "Breast, NOS"              "Breast, Left Lower Inner"
##
## [[30]]
## [1] "Breast, Right Lower Inner" "Breast, NOS"
##
## [[31]]
## [1] "Breast, NOS"              "Breast, Left Upper Inner"
##
## [[32]]
## [1] "Breast, Left Lower Outer" "Breast, NOS"
##
## [[33]]
## [1] "Breast, Left Upper Inner" "Breast, Left Upper Outer"
## [3] "Breast, Left Lower Inner" "Breast, Left Lower Outer"
## [5] "Breast, NOS"
##
## [[34]]
## [1] "Breast, Left Upper Inner" "Breast, Left Upper Outer"
## [3] "Breast, NOS"
##
## [[35]]
## [1] "Breast, Left Upper Outer" "Breast, Left Lower Outer"
## [3] "Breast, NOS"
##
## [[36]]
## [1] "Breast, NOS"              "Breast, Right Upper Inner"
##
## [[37]]
## [1] "Breast, Right Upper Outer" "Breast, Right Lower Inner"
## [3] "Breast, Right Lower Outer"
##
## [[38]]
## [1] "Breast, Right Lower Inner" "Breast, Right Lower Outer"
## [3] "Breast, NOS"
##
## [[39]]
```

```
## [1] "Breast, Right Upper Outer" "Breast, Right Lower Outer"
## [3] "Breast, NOS"
##
## [[40]]
## [1] "Breast, Right Upper Inner" "Breast, Right Upper Outer"
## [3] "Breast, Right Lower Inner" "Breast, Right Lower Outer"
## [5] "Breast, NOS"
##
## [[41]]
## [1] "Breast, Left Lower Inner" "Breast, Left Lower Outer"
## [3] "Breast, NOS"
##
## [[42]]
## [1] "Breast, Right Lower Outer" "Breast, NOS"
##
## [[43]]
## [1] "Lung, NOS"                 "Bone, NOS"
## [3] "Liver"                     "Breast, Right Upper Inner"
## [5] "Breast, Right Upper Outer" "Breast, Right Lower Inner"
## [7] "Breast, Right Lower Outer" "Breast, NOS"
##
## [[44]]
## [1] "Breast, Right Upper Inner" "Breast, Right Lower Inner"
##
## [[45]]
## [1] "Breast, Left Upper Inner" "Breast, Left Lower Inner"
## [3] "Breast, NOS"
##
## [[46]]
## [1] "Breast, Right Upper Inner" "Breast, Right Upper Outer"
##
## [[47]]
## [1] "Liver"        "Breast, NOS"
##
## [[48]]
## [1] "Breast, Left Upper Inner" "Breast, NOS"
##
## [[49]]
## [1] "Bone, NOS"                "Breast, Left Lower Outer"
## [3] "Breast, NOS"
##
## [[50]]
## [1] "Breast, Right Lower Inner" "Breast, Right Lower Outer"
##
## [[51]]
## [1] "Breast, Left Lower Inner" "Breast, NOS"
##
## [[52]]
## [1] "Bone, NOS"                "Breast, Left Upper Inner"
##
## [[53]]
## [1] "Bone, NOS"                "Liver"
## [3] "Breast, NOS"              "Breast, Left Upper Outer"
##
```

```
## [[54]]
## [1] "Breast, Left Upper Inner" "Breast, Left Lower Inner"
##
## [[55]]
## [1] "Lung, NOS"                "Bone, NOS"
## [3] "Liver"                    "Skin"
## [5] "Breast, Left Upper Outer"
##
## [[56]]
## [1] "Bone, NOS"                "Liver"
## [3] "Breast, NOS"              "Breast, Right Upper Inner"
## [5] "Breast, Right Upper Outer" "Breast, Right Lower Inner"
## [7] "Breast, Right Lower Outer"
##
## [[57]]
## [1] "Breast, NOS"              "Breast, Left Upper Outer"
## [3] "Breast, Left Lower Outer"
##
## [[58]]
## [1] "Ovary, NOS"  "Breast, NOS"
##
## [[59]]
## [1] "Skin"                     "Breast, NOS"
## [3] "Breast, Left Lower Inner"
##
## [[60]]
## [1] "Breast, Left Upper Inner" "Breast, Left Upper Outer"
## [3] "Breast, Left Lower Outer" "Breast, NOS"
##
## [[61]]
## [1] "Lung, NOS"                "Adrenal gland, NOS"
## [3] "Breast, NOS"              "Breast, Left Upper Inner"
## [5] "Breast, Left Lower Inner"
##
## [[62]]
## [1] "Bone, NOS"                "Breast, Right Lower Outer"
##
## [[63]]
## [1] "Breast, Left Upper Inner" "Breast, Left Upper Outer"
## [3] "Breast, Left Lower Inner" "Breast, NOS"
##
## [[64]]
## [1] "Lymph node, NOS" "Breast, NOS"
##
## [[65]]
## [1] "Liver"       "Abdomen"      "Breast, NOS"
##
## table() skipped: column is list
##
## === days_to_last_follow_up ===
##   [1] 1604 1220 1048    0  397  563 4233 2381  426  612  518  352  881 1015 2064
##  [16] 1996   31  492  734 1522   10 4456  531  302  714  942 1001  911  499  858
##  [31]  402  258 2618  365 2191   30 1062 1285 3296 1219  285  332 1371 2534 2190
##  [46]   98    5  538  759 6292 1013  575 7777  554  630 2019 1309  287  769  396
```

```
##  [61] 7106  765 1102 1611  991 1318  586  416 1174   59 2763 2365  503  489 1919
##  [76]  326  552 1034  480  727 1728 2965  562  996 1463  504 2654  975  383 1620
##  [91]  849 3307  754 3128 1477  652  856  170   90 3203  585  410 1039  162  747
## [106]  447  304 1953 1474  381  375 2282  792  288 3088 1308  118  303 2989 1369
## [121] 4275  510 2255 1026  446  641  745  394 2240  558 1043  821 1649  451  385
## [136] 1411  742  918  595 6593 1972 1104  218 1662 3286  266 3262  322  526 2520
## [151]  860 2645  435 1783  457  875  647  783  965  178  591 1124 1246 1185  829
## [166]  624 3256 1157 1847 1198  661 1121 2329  616  640 3276 1163  273  655  795
## [181]  403  728 1088  358   34 1535 1301  789 1673  812 1980 2091  608  320  788
## [196] 1587 1142  600  889  307 1239 3603  579 1855 1196 1112  421 2236 2156 1093
## [211] 1059  785  448 2866  134 2383 1419  454  528 1234  521 7455 1203 4354 1616
## [226] 3001 8556 2632  506 2854 1269  364  931  660  577 3247 2486  313   84  588
## [241]  215  907 4285  275  786  501 1884  519  908  376  242 1004  904 1935 2515
## [256] 3035 1325  611 3094 1210  767 1927 1032  974  475 1272 2541  666  547 1688
## [271] 1321  622  437 6456  300   49  551 2991 2629  658  524 1523 1047 1417  726
## [286]  423 2207 1007 1266 2296 2128  450 2248  424 3519 2911  511 1780  943  439
## [301] 1140  477  160  289  565   24  200 4267 2559  574  954 3941 3017  791 3945
## [316]  707  541 2573 1871 3342 2109 2142 1547  379 1640  702 1563   21 1642  915
## [331]  635 3316 1139  532  470  404  371 2041 1133 3226 1561  533 3361 1759  584
## [346] 2469  921 2124 1692 2197  368 2192  216 2707 1644   70 1920  703 1683 1051
## [361] 1286  762 1217   51  694  576  441 2246 3709  213 2636 1471  225   -7 1836
## [376] 2012 1270  614 3172 1063 1010  879  752 2417  224  243 2140 1732 2373  644
## [391] 4005 1569  408  345  370 1467  214  973 2330  620  706 1820 2009 1388 2709
## [406] 2372  878  675 3030  339  252 3004  548 1842   64 2311 2767 3159  618  926
## [421]  455 2868 2289 1914  651 1006 1167 2288 1233 3472 1365  382 5176 1101  659
## [436] 2513  428  217 1120 2164 1545 7126   19  820   52 3409 1132 1864 2535  865
## [451] 1699 3430  366  250 3807  398 3204 1800  724 1229 2489 1351  523  626  362
## [466] 2798 2184 3126 1639  336 2193 1781 1572  513  549 1224 4088 2361 2596   40
## [481] 1156  163   78  495    1 5156  509 1248  709  867  343   11  679  596   80
## [496]  976  777 3063   16 1152 2856  158  952  646 1251 1359  467  572  197  414
## [511] 1887  525   26  989 3456 3364 2048    7 4361 3283 1873 1005  395  222 2612
## [526] 1119 3202 2838 1596  259 1291 3009 1275 2759 3248 2712 2483 1439  458 1712
## [541]  738  433  409 1072  715  522 2695  837  755 2426  698  461  516 1324 3959
## [556]  476 1449  967 1179 1206 2976 1347 3287 1519  710 1631  373 3112 1099 1027
## [571] 3102   79 1742  883  643  571 1186 3926 1926 3873 1853 3660  890 3506 2477
## [586] 1612 1437  723 1277 2273 2127 5739  172 2770 1066 2442  380 3669  803  430
## [601]   72 1127 2721  239 2650 2278  328  568  463  545 4894  725 2306 2385 1035
## [616] 4929 3462  839  607  968  822 2072 2263   54 1074  468 2590  959 8605  627
## [631]  210  997  392  393 1363  806 1162 3957  701  923  566 2920 1508  631  116
## [646]  363  798 3091  662  648 4159  598  295  334  425  748  664  405 1148 2348
## [661]  472  629  681  529 2335 1900 2953 2605  972  431  440  819 3021  683 1141
## [676] 1158  413  456 1532 2813   76 3152  274  899  567  912  227  590 1542  677
## [691]  749 2406  990 5042  360 1516 1106  530 1793  317  594  761 3607  466 8008
## [706] 2362  987  573 1232 1534 1546  488   NA 1492 1528 1988  348 1882  811 2097
## [721] 2558 1208  639 1876 2155 1189 8391 2371  231 1476 1042  187 2653 2161 3015
## [736] 3022  293  680  471 1548 1993 1461  347  434  377 1613 2136 1866 3011  678
## [751] 1648  760   92 2222 1138  984 1434 1686 2403  502 2082 1694    8  852 1550
## [766] 1000 1556  718 1025 1165 1614 1326  672  508 1085  186  418 3121  482 2031
## [781] 4047  825 1009 5062 1468 1430  606 1288  196  847  546  297 4080  412  496
## [796] 1150 1161  323 1247 2551  350  722  417  411 1191 1448 3461 2971 1925  255
## [811]    9  149 1330 3261 1505 2231 1079 1682 1812 1928 2033 2108  337
##
##   -7    0    1    5    7    8    9   10   11   16   19   21   24   26   30   31
##    1   21    4    3    1    1    1   15    1    1    1    1    1    1    5    4
```

```
##   34   40   49   51   52   54   59   64   70   72   76   78   79   80   84   90
##    3    1    1    1    1    1    1    1    1    1    1    3    1    1    1    1
##   92   98  116  118  134  149  158  160  162  163  170  172  178  186  187  196
##    1    2    1    1    2    1    1    2    1    1    2    2    2    1    1    1
##  197  200  210  213  214  215  216  217  218  222  224  225  227  231  239  242
##    1    2    1    1    1    1    1    1    1    1    2    2    2    1    1    2
##  243  250  252  255  258  259  266  273  274  275  285  287  288  289  293  295
##    1    1    1    1    1    1    2    2    1    4    1    1    1    1    2    1
##  297  300  302  303  304  307  313  317  320  322  323  326  328  332  334  336
##    1    1    2    2    4    1    2    2    2    3    1    1    1    1    1    3
##  337  339  343  345  347  348  350  352  358  360  362  363  364  365  366  368
##    1    1    2    2    1    2    1    1    3    1    1    1    1    7    2    1
##  370  371  373  375  376  377  379  380  381  382  383  385  392  393  394  395
##    1    2    3    5    2    1    1    2    2    1    2    7    1    2    3    1
##  396  397  398  402  403  404  405  408  409  410  411  412  413  414  416  417
##    5    1    1    1    2    1    1    2    1    2    1    1    1    1    1    1
##  418  421  423  424  425  426  428  430  431  433  434  435  437  439  440  441
##    1    1    2    2    1    3    2    1    2    1    1    1    1    3    1    3
##  446  447  448  450  451  454  455  456  457  458  461  463  466  467  468  470
##    2    3    2    3    2    1    1    1    1    1    2    2    1    1    2    1
##  471  472  475  476  477  480  482  488  489  492  495  496  499  501  502  503
##    1    1    1    2    4    1    1    2    1    1    2    2    2    3    1    1
##  504  506  508  509  510  511  513  516  518  519  521  522  523  524  525  526
##    2    1    1    1    1    1    1    1    3    2    1    1    1    1    1    1
##  528  529  530  531  532  533  538  541  545  546  547  548  549  551  552  554
##    2    1    2    1    3    2    2    2    1    1    1    1    1    1    2    5
##  558  562  563  565  566  567  568  571  572  573  574  575  576  577  579  584
##    1    2    2    1    1    1    1    1    1    2    4    1    5    2    4
##  585  586  588  590  591  594  595  596  598  600  606  607  608  611  612  614
##    1    1    3    1    1    1    2    1    1    1    1    2    2    2    4    5
##  616  618  620  622  624  626  627  629  630  631  635  639  640  641  643  644
##    3    1    3    2    1    2    3    1    2    1    3    2    2    1    2    1
##  646  647  648  651  652  655  658  659  660  661  662  664  666  672  675  677
##    1    1    1    1    1    1    1    2    2    2    1    1    2    1    2    1
##  678  679  680  681  683  694  698  701  702  703  706  707  709  710  714  715
##    2    2    1    1    1    2    1    1    2    1    1    3    1    2    2    2
##  718  722  723  724  725  726  727  728  734  738  742  745  747  748  749  752
##    3    1    1    1    1    1    3    1    1    2    1    1    3    1    1    2
##  754  755  759  760  761  762  765  767  769  777  783  785  786  788  789  791
##    3    1    2    2    1    3    2    2    1    2    1    3    2    1    1    1
##  792  795  798  803  806  811  812  819  820  821  822  825  829  837  839  847
##    4    1    1    1    1    2    2    1    1    1    1    1    1    1    1    1
##  849  852  856  858  860  865  867  875  878  879  881  883  889  890  899  904
##    1    1    1    1    2    2    1    1    2    1    1    2    1    1    1    1
##  907  908  911  912  915  918  921  923  926  931  942  943  952  954  959  965
##    1    1    1    3    1    1    2    1    1    2    1    4    1    3    2    4
##  967  968  972  973  974  975  976  984  987  989  990  991  996  997 1000 1001
##    1    1    1    1    3    2    2    1    1    1    1    2    2    1    2    3
## 1004 1005 1006 1007 1009 1010 1013 1015 1025 1026 1027 1032 1034 1035 1039 1042
##    4    2    1    4    3    1    1    1    1    2    1    1    4    1    1    1
## 1043 1047 1048 1051 1059 1062 1063 1066 1072 1074 1079 1085 1088 1093 1099 1101
##    3    1    1    3    1    2    1    1    2    2    2    1    1    2    1    2
## 1102 1104 1106 1112 1119 1120 1121 1124 1127 1132 1133 1138 1139 1140 1141 1142
##    1    1    1    2    1    3    1    1    1    2    1    1    2    1    1    2
```

```
## 1148 1150 1152 1156 1157 1158 1161 1162 1163 1165 1167 1174 1179 1185 1186 1189
##    2    1    1    3    1    1    1    1    1    1    1    3    1    1    1    1
## 1191 1196 1198 1203 1206 1208 1210 1217 1219 1220 1224 1229 1232 1233 1234 1239
##    1    1    1    3    1    2    1    1    1    2    2    2    1    1    3    1
## 1246 1247 1248 1251 1266 1269 1270 1272 1275 1277 1285 1286 1288 1291 1301 1308
##    1    2    1    1    2    1    2    1    1    1    1    2    1    1    1    3
## 1309 1318 1321 1324 1325 1326 1330 1347 1351 1359 1363 1365 1369 1371 1388 1411
##    2    1    1    1    1    1    1    1    1    1    2    1    1    2    2    1
## 1417 1419 1430 1434 1437 1439 1448 1449 1461 1463 1467 1468 1471 1474 1476 1477
##    3    1    1    1    1    1    1    2    1    1    2    1    1    2    1    1
## 1492 1505 1508 1516 1519 1522 1523 1528 1532 1534 1535 1542 1545 1546 1547 1548
##    1    1    1    1    2    1    1    1    1    1    1    1    1    1    1    1
## 1550 1556 1561 1563 1569 1572 1587 1596 1604 1611 1612 1613 1614 1616 1620 1631
##    1    3    1    3    2    1    1    1    3    4    1    1    1    1    2    1
## 1639 1640 1642 1644 1648 1649 1662 1673 1682 1683 1686 1688 1692 1694 1699 1712
##    1    1    3    2    1    1    1    3    1    1    1    3    4    2    1    1
## 1728 1732 1742 1759 1780 1781 1783 1793 1800 1812 1820 1836 1842 1847 1853 1855
##    2    1    1    2    1    1    1    1    1    1    1    2    1    1    1    1
## 1864 1866 1871 1873 1876 1882 1884 1887 1900 1914 1919 1920 1925 1926 1927 1928
##    1    1    1    1    2    1    1    1    1    2    2    1    1    1    2    1
## 1935 1953 1972 1980 1988 1993 1996 2009 2012 2019 2031 2033 2041 2048 2064 2072
##    2    1    1    1    1    1    1    2    1    1    1    1    2    1    2    1
## 2082 2091 2097 2108 2109 2124 2127 2128 2136 2140 2142 2155 2156 2161 2164 2184
##    1    1    1    1    1    1    2    1    2    2    1    1    1    1    1    1
## 2190 2191 2192 2193 2197 2207 2222 2231 2236 2240 2246 2248 2255 2263 2273 2278
##    2    1    2    1    1    2    1    1    1    1    1    1    5    1    3    1
## 2282 2288 2289 2296 2306 2311 2329 2330 2335 2348 2361 2362 2365 2371 2372 2373
##    1    1    1    1    2    1    2    1    1    1    1    1    2    2    2    1
## 2381 2383 2385 2403 2406 2417 2426 2442 2469 2477 2483 2486 2489 2513 2515 2520
##    2    1    1    2    1    1    1    2    1    1    2    2    1    1    1    2
## 2534 2535 2541 2551 2558 2559 2573 2590 2596 2605 2612 2618 2629 2632 2636 2645
##    2    1    1    1    1    2    1    1    2    1    2    1    1    2    1    2
## 2650 2653 2654 2695 2707 2709 2712 2721 2759 2763 2767 2770 2798 2813 2838 2854
##    1    1    1    1    1    2    1    1    2    2    1    1    2    1    1    1
## 2856 2866 2868 2911 2920 2953 2965 2971 2976 2989 2991 3001 3004 3009 3011 3015
##    1    1    1    1    1    1    4    1    1    1    2    1    1    1    1    1
## 3017 3021 3022 3030 3035 3063 3088 3091 3094 3102 3112 3121 3126 3128 3152 3159
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 3172 3202 3203 3204 3226 3247 3248 3256 3261 3262 3276 3283 3286 3287 3296 3307
##    1    1    1    1    1    2    1    1    1    1    1    2    1    1    1    1
## 3316 3342 3361 3364 3409 3430 3456 3461 3462 3472 3506 3519 3603 3607 3660 3669
##    1    2    1    1    1    1    1    1    2    2    1    1    1    1    1    2
## 3709 3807 3873 3926 3941 3945 3957 3959 4005 4047 4080 4088 4159 4233 4267 4275
##    1    1    1    1    1    1    1    2    1    1    1    1    1    1    1    1
## 4285 4354 4361 4456 4894 4929 5042 5062 5156 5176 5739 6292 6456 6593 7106 7126
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
## 7455 7777 8008 8391 8556 8605 <NA>
##    1    1    1    1    1    1    4
##
## === follow_ups_disease_response ===
## [1] "TF-Tumor Free" "WT-With Tumor" NA              "Unknown"
##
## TF-Tumor Free       Unknown WT-With Tumor          <NA>
##           994            20           140            77
```

19

```
## 
## === race ===
## [1] "black or african american"        "white"
## [3] "not reported"                      "asian"
## [5] "american indian or alaska native" NA
## 
## american indian or alaska native                           asian
##                                1                              62
##         black or african american                    not reported
##                              191                              96
##                            white                            <NA>
##                              880                               1
## 
## === gender ===
## [1] "female" "male"   NA
## 
## female    male    <NA>
##    1217      13       1
## 
## === ethnicity ===
## [1] "not hispanic or latino" "not reported"           "hispanic or latino"
## [4] "Unknown"                NA
## 
##     hispanic or latino not hispanic or latino           not reported
##                     39                    991                    192
##                Unknown                   <NA>
##                      8                      1
## 
## === vital_status ===
## [1] "Alive" "Dead"  NA
## 
## Alive   Dead   <NA>
##  1029    201       1
## 
## === age_at_index ===
##  [1] 41 48 45 66 72 56 57 64 62 42 46 65 54 80 88 53 47 63 50 39 36 51 43 69 79
## [26] 38 84 67 52 58 85 68 61 40 44 73 55 49 74 59 77 71 82 89 87 78 29 33 70 81
## [51] 83 60 28 37 86 26 34 76 75 35 30 32 31 27 NA
## 
##   26   27   28   29   30   31   32   33   34   35   36   37   38   39   40   41
##    2    1    1    6    3    6    2    1   11    8    9    8   13   15   27   22
##   42   43   44   45   46   47   48   49   50   51   52   53   54   55   56   57
##   15   18   20   33   32   29   32   30   36   34   30   27   35   26   40   18
##   58   59   60   61   62   63   64   65   66   67   68   69   70   71   72   73
##   37   34   27   35   57   43   29   25   28   22   27   22   19   23   15   19
##   74   75   76   77   78   79   80   81   82   83   84   85   86   87   88   89
##   17   13   13   14   19   22   19    8    6    6   10    5    1    4    7   14
## <NA>
##    1
## 
## === days_to_birth ===
##    [1] -15302 -17702 -16511 -24137 -26588 -20629 -21183 -23628 -22858 -16658
##   [11] -15369     NA -24017 -19846 -19781 -29345 -21002 -32208 -19723 -17440
##   [21] -23358 -18433 -14503 -29474 -13458 -17807 -18694 -15837 -25345 -15780
```

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##    [31] -28981 -14122 -17332 -30742 -24788 -19298 -17689 -21294 -17229 -23108
##    [41] -17539 -31351 -29529 -19160 -15533 -19629 -28940 -16911 -18584 -25089
##    [51] -18334 -22449 -16458 -14894 -16109 -27028 -19570 -23021 -26693 -15625
##    [61] -16363 -20401 -17637 -18014 -20347 -27389 -24075 -14383 -22686 -18684
##    [71] -16824 -20625 -27106 -18520 -26548 -17465 -17529 -15166 -17172 -21898
##    [81] -28233 -19028 -21230 -26141 -16971 -19731 -24029 -21837 -17474 -15602
##    [91] -20471 -16719 -26883 -20678 -14264 -24439 -17523 -15393 -23065 -23423
##   [101] -21857 -21428 -13445 -19027 -22751 -21910 -17652 -24779 -30125 -18733
##   [111] -14883 -23686 -22958 -32842 -19415 -31805 -23318 -24891 -25475 -28495
##   [121] -20820 -19031 -19478 -23150 -17699 -15812 -21623 -23928 -29444 -23008
##   [131] -10832 -25259 -32478 -19187 -21479 -25350 -28621 -22800 -25186 -29125
##   [141] -22377 -20152 -12142 -25966 -16854 -23653 -24877 -26052 -22629 -24219
##   [151] -10898 -19152 -17640 -15720 -24319 -17224 -20425 -22688 -15216 -18152
##   [161] -22411 -18628 -25830 -22788 -22995 -17070 -29751 -24999 -16377 -28923
##   [171] -19805 -19900 -22849 -16955 -30407 -22344 -17080 -23948 -20719 -23230
##   [181] -17468 -27163 -23404 -16084 -18507 -30196 -25678 -13307 -22052 -32872
##   [191] -22900 -21369 -24841 -10564 -17779 -20332 -26535 -24660 -28855 -26186
##   [201] -20764 -21628 -22199 -28609 -24923 -20930 -25770 -20694 -14316 -15052
##   [211] -18524 -18151 -22976 -20495 -15122 -17300 -20585 -25110 -13671 -18401
##   [221] -21397 -24813 -23031 -22833 -18059 -25714 -29335 -31748  -9706 -14175
##   [231] -30489 -27392 -14906 -14272 -19309 -23851 -20227 -17624 -19479 -21640
##   [241] -24155 -17026 -20900 -18038 -23855 -22448 -16642 -20574 -18296 -19035
##   [251] -21014 -15027 -32295 -21386 -22672 -17490 -27160 -16022 -15989 -14669
##   [261] -25558 -21514 -22896 -23168 -19413 -13243 -23266 -25867 -27241 -26407
##   [271] -17580 -15774 -19989 -15969 -26723 -21613 -26484 -26845 -19607 -24262
##   [281] -23000 -28664 -30958 -24232 -20497 -22942 -28715 -12528 -23058 -25477
##   [291] -16174 -19706 -20717 -16817 -21793 -18759 -18985 -23576 -23753 -19123
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##   [341] -20713 -15593 -21343 -26274 -23646 -23395 -22997 -22922 -24442 -19802
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##   [361] -23972 -26426 -30984 -19778 -22497 -24230 -30757 -15820 -21750 -19250
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##   [381] -22962 -27627 -23041 -19822 -17715 -31223 -22238 -22222 -15540 -20675
##   [391] -19767 -22966 -23229 -12525 -19169 -22524 -21309 -28529 -26248 -14250
##   [401] -28177 -21895 -19464 -23682 -30339 -17879 -18621 -28003 -15996 -22583
##   [411] -26221 -27063 -19131 -22707 -13483 -32462 -27121 -20381 -15705 -21465
##   [421] -22746 -23225 -23103 -30711 -17815 -19746 -14854 -25747 -23006 -23926
##   [431] -26550 -18084 -18936 -12006 -24831 -26239 -19216 -24803 -27977 -26998
##   [441] -16757 -23570 -21047 -24380 -20080 -18538 -23380 -17921 -19117 -23397
##   [451] -23300 -14853 -17314 -29331 -28416 -19314 -28974 -16289 -17221 -22656
##   [461] -18942 -22325 -29113 -23347 -25282 -19030 -13238 -17456 -27287 -13409
##   [471] -21555 -18870 -19237 -22625 -17871 -16887 -25825 -26281 -17588 -29131
##   [481] -27191 -14564 -29006 -25959 -16688 -24719 -24519 -18025 -27455 -21622
##   [491] -23922 -16504 -26278 -24279 -21865 -28706 -30085 -16508 -22905 -21228
##   [501] -25097 -30590 -18900 -27489 -16689 -16736 -25957 -18852 -22179 -18594
##   [511] -16138 -22710 -22539 -24353 -21426 -23642 -23560 -18839 -23741 -24875
##   [521] -21122 -23684 -19836 -29199 -18806 -18991 -18514 -19596 -19591 -12601
##   [531] -20072 -26423 -15085 -15284 -28198 -18508 -24139 -14626 -22798 -25136
##   [541] -14653 -26941 -27705 -24266 -21344 -15158 -22723 -16310 -21338 -20795
##   [551] -25771 -26902 -22690 -17438 -27605 -23366 -25659 -22341 -25693 -15980
##   [561] -20774 -15507 -14858 -14115 -13039 -16370 -20664 -23209 -10869 -24692
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##    [571] -19563 -22544 -28375 -14755 -22703 -14134 -20504 -18434 -29406 -26823
##    [581] -22096 -21918 -20092 -16101 -23927 -32750 -20107 -27837 -17022 -25944
##    [591] -23650 -21731 -29014 -12840 -23883 -29144 -19758 -18659 -17363 -26684
##    [601] -18384 -18177 -17727 -26466 -18506 -29330 -22115 -21949 -10812 -16702
##    [611] -24541 -15524 -21488 -18501 -20715 -21348 -18060 -20374 -23011 -16882
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##    [631] -22842 -18695 -17346 -17981 -29858 -15670 -20210 -26021 -27521 -18002
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##    [661] -15942 -20048 -16195 -29555 -17372 -22587 -22928 -22280 -28699 -16750
##    [671] -18346 -17969 -17420 -19533 -16623 -18345 -20483 -18214 -29800 -22554
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## [1201] "TCGA-A8-A06X-01A" "TCGA-A7-A3RF-01A" "TCGA-A2-A0YI-01A"
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## [1225] "TCGA-E2-A1IU-01A" "TCGA-D8-A1XS-01A"
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## TCGA-AO-A03P-01A TCGA-AO-A03R-01A TCGA-AO-A03T-01A TCGA-AO-A03U-01B
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## TCGA-AO-A03V-01A TCGA-AO-A0J2-01A TCGA-AO-A0J3-01A TCGA-AO-A0J4-01A
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## TCGA-AO-A0J5-01A TCGA-AO-A0J6-01A TCGA-AO-A0J7-01A TCGA-AO-A0J8-01A
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## TCGA-AO-A0J9-01A TCGA-AO-A0JA-01A TCGA-AO-A0JB-01A TCGA-AO-A0JC-01A
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## TCGA-AO-A0JI-01A TCGA-AO-A0JJ-01A TCGA-AO-A0JL-01A TCGA-AO-A0JM-01A
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## TCGA-AO-A124-01A TCGA-AO-A125-01A TCGA-AO-A126-01A TCGA-AO-A128-01A
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## TCGA-AO-A129-01A TCGA-AO-A12A-01A TCGA-AO-A12B-01A TCGA-AO-A12C-01A
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## TCGA-AO-A12D-01A TCGA-AO-A12E-01A TCGA-AO-A12F-01A TCGA-AO-A12G-01A
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## TCGA-AO-A12H-01A TCGA-AO-A1KO-01A TCGA-AO-A1KP-01A TCGA-AO-A1KQ-01A
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## TCGA-AO-A1KR-01A TCGA-AO-A1KS-01A TCGA-AO-A1KT-01A TCGA-AQ-A04H-01B
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## TCGA-AQ-A04J-01A TCGA-AQ-A04L-01B TCGA-AQ-A0Y5-01A TCGA-AQ-A1H2-01A
##               1              1              1              1
## TCGA-AQ-A1H3-01A TCGA-AQ-A54N-01A TCGA-AQ-A54O-01A TCGA-AQ-A7U7-01A
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37

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## TCGA-AR-A0TP-01A TCGA-AR-A0TQ-01A TCGA-AR-A0TR-01A TCGA-AR-A0TS-01A
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## TCGA-AR-A0TT-01A TCGA-AR-A0TU-01A TCGA-AR-A0TV-01A TCGA-AR-A0TW-01A
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## TCGA-AR-A0TX-01A TCGA-AR-A0TY-01A TCGA-AR-A0TZ-01A TCGA-AR-A0U0-01A
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## TCGA-AR-A0U2-01A TCGA-AR-A0U3-01A TCGA-AR-A0U4-01A TCGA-AR-A1AH-01A
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## TCGA-AR-A1AI-01A TCGA-AR-A1AJ-01A TCGA-AR-A1AK-01A TCGA-AR-A1AL-01A
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## TCGA-AR-A1AM-01A TCGA-AR-A1AN-01A TCGA-AR-A1AO-01A TCGA-AR-A1AP-01A
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## TCGA-AR-A24M-01A TCGA-AR-A24N-01A TCGA-AR-A24O-01A TCGA-AR-A24P-01A
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## TCGA-AR-A24Q-01A TCGA-AR-A24R-01A TCGA-AR-A24S-01A TCGA-AR-A24T-01A
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## TCGA-AR-A24U-01A TCGA-AR-A24V-01A TCGA-AR-A24W-01A TCGA-AR-A24X-01A
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## TCGA-AR-A24Z-01A TCGA-AR-A250-01A TCGA-AR-A251-01A TCGA-AR-A252-01A
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## TCGA-B6-A0RL-01A TCGA-B6-A0RM-01A TCGA-B6-A0RN-01A TCGA-B6-A0RO-01A
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## TCGA-B6-A0RP-01A TCGA-B6-A0RQ-01A TCGA-B6-A0RS-01A TCGA-B6-A0RT-01A
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## TCGA-B6-A0WV-01A TCGA-B6-A0WW-01A TCGA-B6-A0WX-01A TCGA-B6-A0WY-01A
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## TCGA-BH-A0AY-11A TCGA-BH-A0AZ-01A TCGA-BH-A0AZ-11A TCGA-BH-A0B0-01A
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## TCGA-BH-A0B1-01A TCGA-BH-A0B2-01A TCGA-BH-A0B3-01A TCGA-BH-A0B3-11B
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## TCGA-BH-A0BM-11A TCGA-BH-A0BO-01A TCGA-BH-A0BP-01A TCGA-BH-A0BQ-01A
##                1                1                1                1
## TCGA-BH-A0BQ-11A TCGA-BH-A0BR-01A TCGA-BH-A0BS-01A TCGA-BH-A0BS-11A
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## TCGA-BH-A0DV-11A TCGA-BH-A0DX-01A TCGA-BH-A0DZ-01A TCGA-BH-A0DZ-11A
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## TCGA-BH-A0E0-01A TCGA-BH-A0E0-11A TCGA-BH-A0E1-01A TCGA-BH-A0E1-11A
##                1                1                1                1
## TCGA-BH-A0E2-01A TCGA-BH-A0E6-01A TCGA-BH-A0E7-01A TCGA-BH-A0E9-01B
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## TCGA-BH-A0EA-01A TCGA-BH-A0EB-01A TCGA-BH-A0EE-01A TCGA-BH-A0EI-01A
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## TCGA-BH-A0W3-01A TCGA-BH-A0W4-01A TCGA-BH-A0W5-01A TCGA-BH-A0W7-01A
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## TCGA-BH-A18R-11A TCGA-BH-A18S-01A TCGA-BH-A18S-11A TCGA-BH-A18T-01A
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## TCGA-BH-A18U-01A TCGA-BH-A18U-11A TCGA-BH-A18V-01A TCGA-BH-A18V-06A
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## TCGA-BH-A18V-11A TCGA-BH-A1EN-01A TCGA-BH-A1EN-11A TCGA-BH-A1EO-01A
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## TCGA-BH-A1EO-11A TCGA-BH-A1ES-01A TCGA-BH-A1ES-06A TCGA-BH-A1ET-01A
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## TCGA-BH-A1EY-01A TCGA-BH-A1F0-01A TCGA-BH-A1F0-11B TCGA-BH-A1F2-01A
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## TCGA-BH-A1F2-11A TCGA-BH-A1F5-01A TCGA-BH-A1F6-01A TCGA-BH-A1F6-11B
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## TCGA-BH-A1F8-01A TCGA-BH-A1F8-11B TCGA-BH-A1FB-01A TCGA-BH-A1FB-11A
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## TCGA-BH-A1FC-01A TCGA-BH-A1FC-11A TCGA-BH-A1FD-01A TCGA-BH-A1FD-11B
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## TCGA-BH-A1FE-01A TCGA-BH-A1FE-06A TCGA-BH-A1FE-11B TCGA-BH-A1FG-01A
##               1               1               1               1
## TCGA-BH-A1FG-11B TCGA-BH-A1FH-01A TCGA-BH-A1FH-11B TCGA-BH-A1FJ-01A
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## TCGA-BH-A1FJ-11B TCGA-BH-A1FL-01A TCGA-BH-A1FM-01A TCGA-BH-A1FM-11B
```

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## TCGA-BH-A1FN-01A TCGA-BH-A1FN-11A TCGA-BH-A1FR-01A TCGA-BH-A1FR-11B
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## TCGA-C8-A12Q-01A TCGA-C8-A12T-01A TCGA-C8-A12U-01A TCGA-C8-A12V-01A
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## TCGA-D8-A1JH-01A TCGA-D8-A1JI-01A TCGA-D8-A1JJ-01A TCGA-D8-A1JK-01A
##                1                1                1                1
## TCGA-D8-A1JL-01A TCGA-D8-A1JM-01A TCGA-D8-A1JN-01A TCGA-D8-A1JP-01A
##                1                1                1                1
## TCGA-D8-A1JS-01A TCGA-D8-A1JT-01A TCGA-D8-A1JU-01A TCGA-D8-A1X5-01A
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##                  1             1             1             1
## TCGA-D8-A1X6-01A TCGA-D8-A1X7-01A TCGA-D8-A1X8-01A TCGA-D8-A1X9-01A
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## TCGA-D8-A1XA-01A TCGA-D8-A1XB-01A TCGA-D8-A1XC-01A TCGA-D8-A1XD-01A
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## TCGA-D8-A27E-01A TCGA-D8-A27F-01A TCGA-D8-A27G-01A TCGA-D8-A27H-01A
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## TCGA-D8-A27I-01A TCGA-D8-A27K-01A TCGA-D8-A27L-01A TCGA-D8-A27M-01A
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## TCGA-D8-A27N-01A TCGA-D8-A27P-01A TCGA-D8-A27R-01A TCGA-D8-A27T-01A
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## TCGA-D8-A27V-01A TCGA-D8-A27W-01A TCGA-D8-A3Z5-01A TCGA-D8-A3Z6-01A
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## TCGA-D8-A4Z1-01A TCGA-D8-A73U-01A TCGA-D8-A73W-01A TCGA-D8-A73X-01A
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## TCGA-E2-A105-01A TCGA-E2-A106-01A TCGA-E2-A107-01A TCGA-E2-A108-01A
##                  1             1             1             1
## TCGA-E2-A109-01A TCGA-E2-A10A-01A TCGA-E2-A10B-01A TCGA-E2-A10C-01A
##                  1             1             1             1
## TCGA-E2-A10E-01A TCGA-E2-A10F-01A TCGA-E2-A14N-01A TCGA-E2-A14O-01A
##                  1             1             1             1
## TCGA-E2-A14P-01A TCGA-E2-A14Q-01A TCGA-E2-A14R-01A TCGA-E2-A14S-01A
##                  1             1             1             1
## TCGA-E2-A14T-01A TCGA-E2-A14U-01A TCGA-E2-A14V-01A TCGA-E2-A14W-01A
##                  1             1             1             1
## TCGA-E2-A14X-01A TCGA-E2-A14Y-01A TCGA-E2-A14Z-01A TCGA-E2-A150-01A
##                  1             1             1             1
## TCGA-E2-A152-01A TCGA-E2-A153-01A TCGA-E2-A153-11A TCGA-E2-A154-01A
##                  1             1             1             1
## TCGA-E2-A155-01A TCGA-E2-A156-01A TCGA-E2-A158-01A TCGA-E2-A158-11A
##                  1             1             1             1
## TCGA-E2-A159-01A TCGA-E2-A15A-01A TCGA-E2-A15A-06A TCGA-E2-A15C-01A
##                  1             1             1             1
## TCGA-E2-A15D-01A TCGA-E2-A15E-01A TCGA-E2-A15E-06A TCGA-E2-A15F-01A
##                  1             1             1             1
## TCGA-E2-A15G-01A TCGA-E2-A15H-01A TCGA-E2-A15I-01A TCGA-E2-A15I-11A
##                  1             1             1             1
## TCGA-E2-A15J-01A TCGA-E2-A15K-01A TCGA-E2-A15K-06A TCGA-E2-A15K-11A
##                  1             1             1             1
## TCGA-E2-A15L-01A TCGA-E2-A15M-01A TCGA-E2-A15M-11A TCGA-E2-A15O-01A
##                  1             1             1             1
## TCGA-E2-A15P-01A TCGA-E2-A15R-01A TCGA-E2-A15S-01A TCGA-E2-A15T-01A
##                  1             1             1             1
## TCGA-E2-A1AZ-01A TCGA-E2-A1B0-01A TCGA-E2-A1B1-01A TCGA-E2-A1B4-01A
```

```
##                   1                1                1                1
## TCGA-E2-A1B5-01A TCGA-E2-A1B6-01A TCGA-E2-A1BC-01A TCGA-E2-A1BC-11A
##                   1                1                1                1
## TCGA-E2-A1BD-01A TCGA-E2-A1IE-01A TCGA-E2-A1IF-01A TCGA-E2-A1IG-01A
##                   1                1                1                1
## TCGA-E2-A1IG-11A TCGA-E2-A1IH-01A TCGA-E2-A1II-01A TCGA-E2-A1IJ-01A
##                   1                1                1                1
## TCGA-E2-A1IK-01A TCGA-E2-A1IL-01A TCGA-E2-A1IN-01A TCGA-E2-A1IO-01A
##                   1                1                1                1
## TCGA-E2-A1IU-01A TCGA-E2-A1L6-01A TCGA-E2-A1L7-01A TCGA-E2-A1L7-11A
##                   1                1                1                1
## TCGA-E2-A1L8-01A TCGA-E2-A1L9-01A TCGA-E2-A1LA-01A TCGA-E2-A1LB-01A
##                   1                1                1                1
## TCGA-E2-A1LB-11A TCGA-E2-A1LE-01A TCGA-E2-A1LG-01A TCGA-E2-A1LH-01A
##                   1                1                1                1
## TCGA-E2-A1LH-11A TCGA-E2-A1LI-01A TCGA-E2-A1LK-01A TCGA-E2-A1LL-01A
##                   1                1                1                1
## TCGA-E2-A1LS-01A TCGA-E2-A1LS-11A TCGA-E2-A2P5-01A TCGA-E2-A2P6-01A
##                   1                1                1                1
## TCGA-E2-A3DX-01A TCGA-E2-A56Z-01A TCGA-E2-A570-01A TCGA-E2-A572-01A
##                   1                1                1                1
## TCGA-E2-A573-01A TCGA-E2-A574-01A TCGA-E2-A576-01A TCGA-E2-A9RU-01A
##                   1                1                1                1
## TCGA-E9-A1N3-01A TCGA-E9-A1N4-01A TCGA-E9-A1N4-11A TCGA-E9-A1N5-01A
##                   1                1                1                1
## TCGA-E9-A1N5-11A TCGA-E9-A1N6-01A TCGA-E9-A1N6-11A TCGA-E9-A1N8-01A
##                   1                1                1                1
## TCGA-E9-A1N9-01A TCGA-E9-A1N9-11A TCGA-E9-A1NA-01A TCGA-E9-A1NA-11A
##                   1                1                1                1
## TCGA-E9-A1NC-01A TCGA-E9-A1ND-01A TCGA-E9-A1ND-11A TCGA-E9-A1NE-01A
##                   1                1                1                1
## TCGA-E9-A1NF-01A TCGA-E9-A1NF-11A TCGA-E9-A1NG-01A TCGA-E9-A1NG-11A
##                   1                1                1                1
## TCGA-E9-A1NH-01A TCGA-E9-A1NI-01A TCGA-E9-A1QZ-01A TCGA-E9-A1R0-01A
##                   1                1                1                1
## TCGA-E9-A1R2-01A TCGA-E9-A1R3-01A TCGA-E9-A1R4-01A TCGA-E9-A1R5-01A
##                   1                1                1                1
## TCGA-E9-A1R6-01A TCGA-E9-A1R7-01A TCGA-E9-A1R7-11A TCGA-E9-A1RA-01A
##                   1                1                1                1
## TCGA-E9-A1RB-01A TCGA-E9-A1RB-11A TCGA-E9-A1RC-01A TCGA-E9-A1RC-11A
##                   1                1                1                1
## TCGA-E9-A1RD-01A TCGA-E9-A1RD-11A TCGA-E9-A1RE-01A TCGA-E9-A1RF-01A
##                   1                1                1                1
## TCGA-E9-A1RF-11A TCGA-E9-A1RG-01A TCGA-E9-A1RH-01A TCGA-E9-A1RH-11A
##                   1                1                1                1
## TCGA-E9-A1RI-01A TCGA-E9-A1RI-11A TCGA-E9-A226-01A TCGA-E9-A227-01A
##                   1                1                1                1
## TCGA-E9-A228-01A TCGA-E9-A229-01A TCGA-E9-A22A-01A TCGA-E9-A22B-01A
##                   1                1                1                1
## TCGA-E9-A22D-01A TCGA-E9-A22E-01A TCGA-E9-A22G-01A TCGA-E9-A22H-01A
##                   1                1                1                1
## TCGA-E9-A243-01A TCGA-E9-A244-01A TCGA-E9-A245-01A TCGA-E9-A247-01A
##                   1                1                1                1
## TCGA-E9-A248-01A TCGA-E9-A249-01A TCGA-E9-A24A-01A TCGA-E9-A295-01A
```

```
##                1               1               1               1
## TCGA-E9-A2JS-01A TCGA-E9-A2JT-01A TCGA-E9-A3H0-01A TCGA-E9-A3Q9-01A
##                1               1               1               1
## TCGA-E9-A3QA-01A TCGA-E9-A3X8-01A TCGA-E9-A54X-01A TCGA-E9-A54Y-01A
##                1               1               1               1
## TCGA-E9-A5FK-01A TCGA-E9-A5FL-01A TCGA-E9-A5UO-01A TCGA-E9-A5UP-01A
##                1               1               1               1
## TCGA-E9-A6HE-01A TCGA-EW-A1IW-01A TCGA-EW-A1IX-01A TCGA-EW-A1IY-01A
##                1               1               1               1
## TCGA-EW-A1IZ-01A TCGA-EW-A1J1-01A TCGA-EW-A1J2-01A TCGA-EW-A1J3-01A
##                1               1               1               1
## TCGA-EW-A1J5-01A TCGA-EW-A1J6-01A TCGA-EW-A1OV-01A TCGA-EW-A1OW-01A
##                1               1               1               1
## TCGA-EW-A1OX-01A TCGA-EW-A1OY-01A TCGA-EW-A1OZ-01A TCGA-EW-A1P0-01A
##                1               1               1               1
## TCGA-EW-A1P1-01A TCGA-EW-A1P3-01A TCGA-EW-A1P4-01A TCGA-EW-A1P5-01A
##                1               1               1               1
## TCGA-EW-A1P6-01A TCGA-EW-A1P7-01A TCGA-EW-A1P8-01A TCGA-EW-A1PA-01A
##                1               1               1               1
## TCGA-EW-A1PB-01A TCGA-EW-A1PC-01B TCGA-EW-A1PD-01A TCGA-EW-A1PE-01A
##                1               1               1               1
## TCGA-EW-A1PF-01A TCGA-EW-A1PG-01A TCGA-EW-A1PH-01A TCGA-EW-A2FR-01A
##                1               1               1               1
## TCGA-EW-A2FS-01A TCGA-EW-A2FV-01A TCGA-EW-A2FW-01A TCGA-EW-A3E8-01B
##                1               1               1               1
## TCGA-EW-A3U0-01A TCGA-EW-A423-01A TCGA-EW-A424-01A TCGA-EW-A6S9-01A
##                1               1               1               1
## TCGA-EW-A6SA-01A TCGA-EW-A6SB-01A TCGA-EW-A6SC-01A TCGA-EW-A6SD-01A
##                1               1               1               1
## TCGA-GI-A2C8-01A TCGA-GI-A2C8-11A TCGA-GI-A2C9-01A TCGA-GI-A2C9-11A
##                1               1               1               1
## TCGA-GM-A2D9-01A TCGA-GM-A2DA-01A TCGA-GM-A2DB-01A TCGA-GM-A2DC-01A
##                1               1               1               1
## TCGA-GM-A2DD-01A TCGA-GM-A2DF-01A TCGA-GM-A2DH-01A TCGA-GM-A2DI-01A
##                1               1               1               1
## TCGA-GM-A2DK-01A TCGA-GM-A2DL-01A TCGA-GM-A2DM-01A TCGA-GM-A2DN-01A
##                1               1               1               1
## TCGA-GM-A2DO-01A TCGA-GM-A3NW-01A TCGA-GM-A3NY-01A TCGA-GM-A3XG-01A
##                1               1               1               1
## TCGA-GM-A3XL-01A TCGA-GM-A3XN-01A TCGA-GM-A4E0-01A TCGA-GM-A5PV-01A
##                1               1               1               1
## TCGA-GM-A5PX-01A TCGA-HN-A2NL-01A TCGA-HN-A2OB-01A TCGA-JL-A3YW-01A
##                1               1               1               1
## TCGA-JL-A3YX-01A TCGA-LD-A66U-01A TCGA-LD-A74U-01A TCGA-LD-A7W5-01A
##                1               1               1               1
## TCGA-LD-A7W6-01A TCGA-LD-A9QF-01A TCGA-LL-A440-01A TCGA-LL-A441-01A
##                1               1               1               1
## TCGA-LL-A442-01A TCGA-LL-A50Y-01A TCGA-LL-A5YL-01A TCGA-LL-A5YM-01A
##                1               1               1               1
## TCGA-LL-A5YN-01A TCGA-LL-A5YO-01A TCGA-LL-A5YP-01A TCGA-LL-A6FP-01A
##                1               1               1               1
## TCGA-LL-A6FQ-01A TCGA-LL-A6FR-01A TCGA-LL-A73Y-01A TCGA-LL-A73Z-01A
##                1               1               1               1
## TCGA-LL-A740-01A TCGA-LL-A7SZ-01A TCGA-LL-A7T0-01A TCGA-LL-A8F5-01A
```

```
##               1               1               1               1
## TCGA-LL-A9Q3-01A TCGA-LQ-A4E4-01A TCGA-MS-A51U-01A TCGA-OK-A5Q2-01A
##               1               1               1               1
## TCGA-OL-A5D6-01A TCGA-OL-A5D7-01A TCGA-OL-A5D8-01A TCGA-OL-A5DA-01A
##               1               1               1               1
## TCGA-OL-A5RU-01A TCGA-OL-A5RV-01A TCGA-OL-A5RW-01A TCGA-OL-A5RX-01A
##               1               1               1               1
## TCGA-OL-A5RY-01A TCGA-OL-A5RZ-01A TCGA-OL-A5S0-01A TCGA-OL-A66H-01A
##               1               1               1               1
## TCGA-OL-A66I-01A TCGA-OL-A66J-01A TCGA-OL-A66K-01A TCGA-OL-A66L-01A
##               1               1               1               1
## TCGA-OL-A66N-01A TCGA-OL-A66O-01A TCGA-OL-A66P-01A TCGA-OL-A6VO-01A
##               1               1               1               1
## TCGA-OL-A6VQ-01A TCGA-OL-A6VR-01A TCGA-OL-A97C-01A TCGA-PE-A5DC-01A
##               1               1               1               1
## TCGA-PE-A5DD-01A TCGA-PE-A5DE-01A TCGA-PL-A8LV-01A TCGA-PL-A8LX-01A
##               1               1               1               1
## TCGA-PL-A8LY-01A TCGA-PL-A8LZ-01A TCGA-S3-A6ZF-01A TCGA-S3-A6ZG-01A
##               1               1               1               1
## TCGA-S3-A6ZH-01A TCGA-S3-AA0Z-01A TCGA-S3-AA10-01A TCGA-S3-AA11-01A
##               1               1               1               1
## TCGA-S3-AA12-01A TCGA-S3-AA14-01A TCGA-S3-AA15-01A TCGA-S3-AA17-01A
##               1               1               1               1
## TCGA-UL-AAZ6-01A TCGA-UU-A93S-01A TCGA-V7-A7HQ-01A TCGA-W8-A86G-01A
##               1               1               1               1
## TCGA-WT-AB41-01A TCGA-WT-AB44-01A TCGA-XX-A899-01A TCGA-XX-A89A-01A
##               1               1               1               1
## TCGA-Z7-A8R5-01A TCGA-Z7-A8R6-01A
##               1               1
##
## === primary_site ===
## [[1]]
## [1] "Breast"
##
## table() skipped: column is list
##
## === disease_type ===
## [[1]]
## [1] "Adenomas and Adenocarcinomas"
## [2] "Adnexal and Skin Appendage Neoplasms"
## [3] "Fibroepithelial Neoplasms"
## [4] "Ductal and Lobular Neoplasms"
## [5] "Squamous Cell Neoplasms"
## [6] "Cystic, Mucinous and Serous Neoplasms"
## [7] "Complex Epithelial Neoplasms"
## [8] "Basal Cell Neoplasms"
## [9] "Epithelial Neoplasms, NOS"
##
## table() skipped: column is list
```

Matrice de confusion :

```r
x <- clinical_data[, c("age_at_diagnosis",
                       "initial_weight",
                       "classification_of_tumor",
```

```r
                           "morphology")]
y <- clinical_data$vital_status
model_data <- data.frame(x, vital_status = factor(y))
model_data <- na.omit(model_data) # retire les observations incomplètes
model_data$vital_status <- droplevels(model_data$vital_status)

# Modèle logistique
model <- glm(vital_status ~ ., data = model_data, family = binomial)

# Prédiction
pred <- predict(model, type = "response")
positive_class <- levels(model_data$vital_status)[2]
pred_class <- ifelse(pred > 0.5, positive_class, levels(model_data$vital_status)[1])
pred_class <- factor(pred_class, levels = levels(model_data$vital_status))

# Matrice de confusion sans caret
conf_mat <- table(Predicted = pred_class, Observed = model_data$vital_status)
conf_mat
```

```
##          Observed
## Predicted Alive Dead
##     Alive   957  148
##     Dead     15   43
```
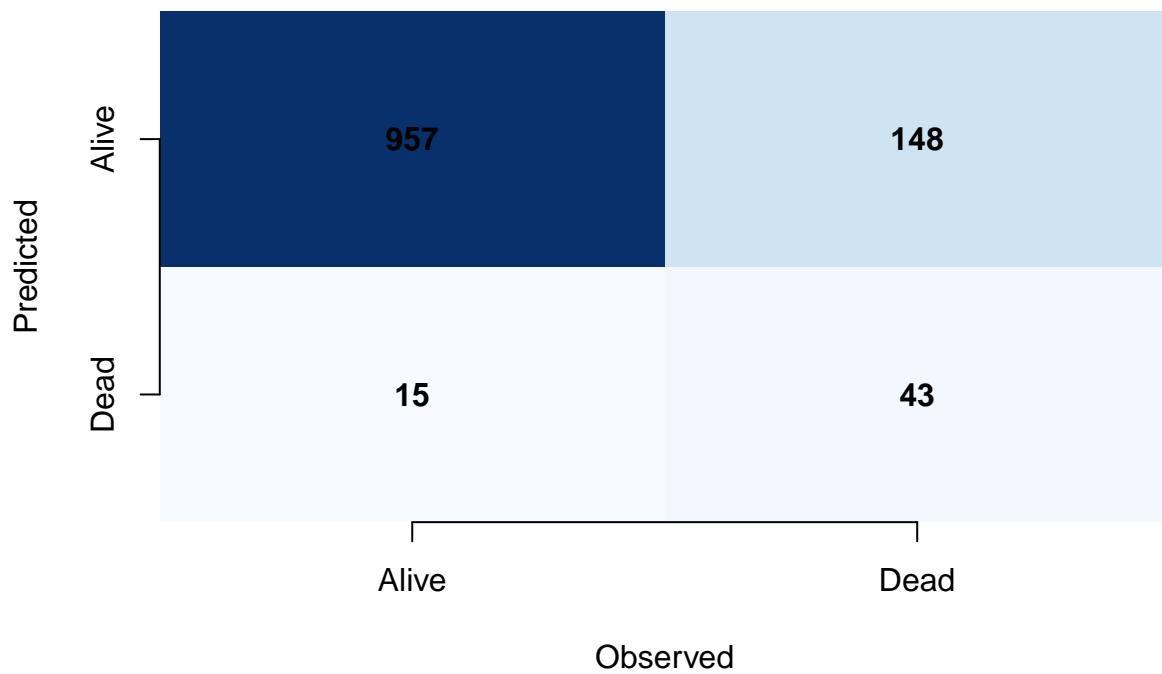
```r
# Indicateurs simples
accuracy <- sum(diag(conf_mat)) / sum(conf_mat)
cat(sprintf("\nAccuracy: %.3f\n", accuracy))
```

```
##
## Accuracy: 0.860
```

```r
# Visualisation de la matrice de confusion
conf_mat_matrix <- as.matrix(conf_mat)
image(t(conf_mat_matrix[nrow(conf_mat_matrix):1, ]),
  axes = FALSE,
  col = colorRampPalette(c("#f7fbff", "#6baed6", "#08306b"))(64),
  xlab = "Observed",
  ylab = "Predicted",
  main = "Confusion Matrix")
axis(1, at = seq(0, 1, length.out = ncol(conf_mat_matrix)), labels = colnames(conf_mat_matrix))
axis(2, at = seq(0, 1, length.out = nrow(conf_mat_matrix)), labels = rev(rownames(conf_mat_matrix)))
text(rep(seq(0, 1, length.out = ncol(conf_mat_matrix)), each = nrow(conf_mat_matrix)),
     rep(seq(0, 1, length.out = nrow(conf_mat_matrix)), times = ncol(conf_mat_matrix)),
     labels = as.vector(conf_mat_matrix[rev(seq_len(nrow(conf_mat_matrix))), ]),
     col = "black", font = 2)
```

Confusion Matrix

Data analysis

But : prédire la donnée clinique vie/mort. Donc on veut utiliser des modèles de classification : - KNN avec $k = 2$ - kmeans avec $k = 2$ - régression logistique - groupe-lasso ? - elastic net ? - lasso, ridge ? - stepwise

Genes

Pour la tableau de gènes, traçons un premier plot pour chaque gène avec la distribution gaussienne de mort/vivant pour chaque gène. Ensuite nous pouvons prendre la moyenne de ce graphe. Et ensuite tracer toutes les moyennes correspondant à chaque gène dans un graphe commun et vérifier lesquels varient fortement de la médiane (la médiane des moyennes)

Et ensuite LASSO pour réduire la dimension

Clinical data