Nighut.Project.Rmd

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Breast cancer sub-type classification using proteomic data

Problem statement : Luminal A, Luminal B, HER2, Basal-like are the molecular subtypes of breast cancer that are typically recognized. Each one is related to various prognoses, therapies, and treatments.

Objective : The main objective of this project is to perform classification on breast cancer dataset based on the proteomic expression dataset to identify the subtype of breast cancer. A collection of proteins produced by cancer cells is known as the breast cancer proteome.

I am examining if the cancer subtype can be correctly identified using only the proteome data for each patient. The target variable in the study is PAM50 mRNA which is used in breast cancer intrinsic subtyping based on gene expression. The variable is categorical presenting four subtypes (basal-like, HER2-enriched, Luminal A and Luminal B). PAMA50 mRNA proteins are my predictor variables.Using supervised ML classification, I am examining if the cancer subtype can be correctly identified using only the proteome data for each patient.

- Question 1 : where does the data come from?

This data collection includes 77 breast cancer samples from the Clinical Proteomic Tumor Analysis Consortium (NCI/NIH) that have had their iTRAQ proteome profiles published. For each sample, it comprises expression levels for around 12,000 proteins, with missing values present when a particular protein could not be measured. Kaggle URL : https://www.kaggle.com/datasets/piotrgrabo/breastcancerproteomes?resource=download

It has three different files : 77cancerproteomesCPTACitraq.csv, clinicaldatabreast_cancer.csv, PAM50_proteins.csv

1. File: 77cancerproteomesCPTACitraq.csv -RefSeqaccessionnumber: RefSeq protein ID (each protein has a unique ID in a RefSeq database) -gene_symbol: a symbol unique to each gene (every protein is encoded by some gene) -gene_name: a full name of that gene -Remaining columns: log2 iTRAQ ratios for each sample (protein expression data, most important), three last columns are from healthy individuals

2. File: clinicaldatabreast_cancer.csv -First column "Complete TCGA ID" is used to match the sample IDs in the main cancer proteomes file (see example script). -All other columns have self-explanatory names, contain data about the cancer classification of a given sample using different methods.

3. File: PAM50_proteins.csv -Contains the list of genes and proteins used by the PAM50 classification system. -The column RefSeqProteinID contains the protein IDs that can be matched with the IDs in the main protein expression data set.

- Provided installation statements for all packages
- Importing all required libraries

```r
# install.packages("stabs")
# install.packages("factoextra")
# install.packages("NbClust")
# install.packages("ggfortify")
# install.packages("glmnet")
# install.packages("foreign")
# install.packages("ggplot2")
# install.packages("MASS")
# install.packages("Hmisc")
# install.packages("reshape2")
# install.packages("randomForest")
# install.packages("data.table")
# install.packages("mlr")
# install.packages("caret")
# install.packages("dplyr") # data manipulation
# install.packages("readr") # data input and manipulation
# install.packages("MASS") # contains the data
# install.packages("DataExplorer") #data set visualization
# install.packages("nnet") # used for Multinomial Classification
# install.packages("readr") #assist with text manipulation
# install.packages("kernlab") #assist with SVM feature selection
# install.packages("class") # used for an object-oriented style of programmin
# install.packages("KernelKnn") # used for K- Nearest-Neighbors method
# install.packages("nnet") # Used for Neural Net
# install.packages("e1071") #supports vector machine algorithm
# install.packages("forecast") # for model prediction
# install.pacakges("rpart") #construct recursive partitions for classification
# install.packages("neuralnet")
# install.packages("NbClust")
# install.packages("psych")
# install.packages("pheatmap")
# install.packages("OneR")
# install.packages("naivebayes")
# install.packages("dplyr")
# install.packages("ggplot2")
# install.packages("psych")
# install.packages("tidyverse")
# install.packages("assertr")
# install.packages("knitr")
# install.packages("psych")
# install.packages("caret")
# install.packages("e1071")
# install.packages("C50")
# install.packages("gmodels")
# install.packages("pROC")
# install.packages("caTools")
#install.packages("tinytex")
#library(tinytex)
```

- Importing all required libraries

```r
#loading required libraries
library(stabs)
library(factoextra)
library(NbClust)
library(ggfortify)
library(glmnet)
library(foreign)
library(ggplot2)
library(MASS)
library(Hmisc)
library(reshape2)
library(randomForest)
library(data.table)
library(mlr)
library(caret)
library(dplyr) # data manipulation
library(readr) # data input and manipulation
library(caret) #select tuning parameters
library(MASS) # contains the data
library(DataExplorer) #data set visualization
library(nnet) # used for Multinomial Classification
library(readr) #assist with text manipulation
library(kernlab) #assist with SVM feature selection
library(class) # used for an object-oriented style of programmin
library(KernelKnn) # used for K- Nearest-Neighbors method
library(nnet) # Used for Neural Net
library(e1071) #supports vector machine algorithm
library(forecast) # for model prediction
library(rpart) #construct recursive partitions for classification
library(neuralnet)
library(NbClust)
library(psych)
library(pheatmap)
library(OneR)
library(naivebayes)
library(dplyr)
library(ggplot2)
library(psych)
library(pROC)
library(tidyverse)
library(assertr)
library(knitr)
library(psych)
library(caret)
library(e1071)
library(C50)
library(gmodels)
library(pROC)
library(caTools)
library(ggplot2)
library(GGally)
library(ipred)
```

1.Data Acquisition and manipulation

- for importing data, I used the read.csv() function
- Later, I combined all the datasets into one
- Converted the patients id to one format
- used the head(), str(), dim(), glimpse(), summary() to explore the dataset

Data import - PAM50_proteins.csv

First steps: importing the data and getting the data set into a workable format. list of genes and proteins

```
#Importing data which has list of genes and proteins
gene_proteins <- read.csv("/Users/sheetalnighut/Desktop/cancer-project/PAM50_proteins.csv")
# 100 rows and 4 columns
head(gene_proteins)
```

```
##   GeneSymbol RefSeqProteinID      Species
## 1        MIA       NP_006524 Homo sapiens
## 2      FGFR4       NP_002002 Homo sapiens
## 3      FGFR4       NP_998812 Homo sapiens
## 4      FGFR4       NP_075252 Homo sapiens
## 5     GPR160       NP_055188 Homo sapiens
## 6     ACTR3B       NP_065178 Homo sapiens
##                                         Gene.Name
## 1                    melanoma inhibitory activity
## 2             fibroblast growth factor receptor 4
## 3             fibroblast growth factor receptor 4
## 4             fibroblast growth factor receptor 4
## 5                  G protein-coupled receptor 160
## 6 ARP3 actin-related protein 3 homolog B (yeast)
```

```
tail(gene_proteins)
```

```
##     GeneSymbol RefSeqProteinID      Species
## 95        MDM2       NP_002383 Homo sapiens
## 96       FOXC1       NP_001444 Homo sapiens
## 97        GRB7    NP_001025173 Homo sapiens
## 98        GRB7       NP_005301 Homo sapiens
## 99        MELK       NP_055606 Homo sapiens
## 100      UBE2T       NP_054895 Homo sapiens
##                                      Gene.Name
## 95     Mdm2 p53 binding protein homolog (mouse)
## 96                             forkhead box C1
## 97       growth factor receptor-bound protein 7
## 98       growth factor receptor-bound protein 7
## 99     maternal embryonic leucine zipper kinase
## 100 ubiquitin-conjugating enzyme E2T (putative)
```

```
str(gene_proteins)
```

```
## 'data.frame':    100 obs. of  4 variables:
```

```
##  $ GeneSymbol     : chr  "MIA" "FGFR4" "FGFR4" "FGFR4" ...
##  $ RefSeqProteinID: chr  "NP_006524" "NP_002002" "NP_998812" "NP_075252" ...
##  $ Species        : chr  "Homo sapiens" "Homo sapiens" "Homo sapiens" "Homo sapiens" ...
##  $ Gene.Name      : chr  "melanoma inhibitory activity" "fibroblast growth factor receptor 4" "fibrol
```

```
dim(gene_proteins)
```

```
## [1] 100   4
```

```
glimpse(gene_proteins)
```

```
## Rows: 100
## Columns: 4
## $ GeneSymbol      <chr> "MIA", "FGFR4", "FGFR4", "FGFR4", "GPR160", "ACTR3B", ~
## $ RefSeqProteinID <chr> "NP_006524", "NP_002002", "NP_998812", "NP_075252", "N~
## $ Species         <chr> "Homo sapiens", "Homo sapiens", "Homo sapiens", "Homo ~
## $ Gene.Name       <chr> "melanoma inhibitory activity", "fibroblast growth fac~
```

```
summary(gene_proteins)
```

```
##   GeneSymbol        RefSeqProteinID      Species           Gene.Name        
##  Length:100         Length:100         Length:100         Length:100        
##  Class :character   Class :character   Class :character   Class :character  
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character  
```

Data import - clinicaldatabreast_cancer.csv

main cancer dataset (has information about patients suffering from each sub-type classified based on PAM50.mRNA)

```
clinical <- read.csv("/Users/sheetalnighut/Desktop/cancer-project/clinical_data_breast_cancer.csv")
# 105 obseravtions  and 30 columns
head(clinical)
```

```
##   Complete.TCGA.ID Gender Age.at.Initial.Pathologic.Diagnosis ER.Status
## 1     TCGA-A2-A0T2 FEMALE                                  66  Negative
## 2     TCGA-A2-A0CM FEMALE                                  40  Negative
## 3     TCGA-BH-A18V FEMALE                                  48  Negative
## 4     TCGA-BH-A18Q FEMALE                                  56  Negative
## 5     TCGA-BH-A0E0 FEMALE                                  38  Negative
## 6     TCGA-A7-A0CE FEMALE                                  57  Negative
##   PR.Status HER2.Final.Status Tumor Tumor..T1.Coded Node Node.Coded Metastasis
## 1  Negative          Negative    T3         T_Other   N3   Positive         M1
## 2  Negative          Negative    T2         T_Other   N0   Negative         M0
## 3  Negative          Negative    T2         T_Other   N1   Positive         M0
## 4  Negative          Negative    T2         T_Other   N1   Positive         M0
## 5  Negative          Negative    T3         T_Other   N3   Positive         M0
## 6  Negative          Negative    T2         T_Other   N0   Negative         M0
##   Metastasis.Coded AJCC.Stage Converted.Stage Survival.Data.Form Vital.Status
## 1         Positive   Stage IV    No_Conversion           followup     DECEASED
```

```
## 2        Negative  Stage IIA       Stage IIA          followup     DECEASED
## 3        Negative  Stage IIB   No_Conversion        enrollment     DECEASED
## 4        Negative  Stage IIB   No_Conversion        enrollment     DECEASED
## 5        Negative Stage IIIC   No_Conversion          followup       LIVING
## 6        Negative  Stage IIA       Stage IIA          followup       LIVING
##   Days.to.Date.of.Last.Contact Days.to.date.of.Death OS.event OS.Time
## 1                          240                   240        1     240
## 2                          754                   754        1     754
## 3                         1555                  1555        1    1555
## 4                         1692                  1692        1    1692
## 5                          133                    NA        0     133
## 6                          309                    NA        0     309
##   PAM50.mRNA SigClust.Unsupervised.mRNA SigClust.Intrinsic.mRNA miRNA.Clusters
## 1 Basal-like                          0                     -13              3
## 2 Basal-like                        -12                     -13              4
## 3 Basal-like                        -12                     -13              5
## 4 Basal-like                        -12                     -13              5
## 5 Basal-like                          0                     -13              5
## 6 Basal-like                          0                     -13              5
##   methylation.Clusters RPPA.Clusters CN.Clusters
## 1                    5         Basal           3
## 2                    4         Basal           4
## 3                    5         Basal           1
## 4                    5         Basal           1
## 5                    5         Basal           1
## 6                    5         Basal           1
##   Integrated.Clusters..with.PAM50. Integrated.Clusters..no.exp.
## 1                                2                            2
## 2                                2                            1
## 3                                2                            2
## 4                                2                            2
## 5                                2                            2
## 6                                2                            2
##   Integrated.Clusters..unsup.exp.
## 1                               2
## 2                               1
## 3                               2
## 4                               2
## 5                               2
## 6                               2
```

```
tail(clinical)
```

```
##     Complete.TCGA.ID Gender Age.at.Initial.Pathologic.Diagnosis ER.Status
## 100     TCGA-BH-A0BZ FEMALE                                  59  Positive
## 101     TCGA-BH-A0C7 FEMALE                                  48  Positive
## 102     TCGA-BH-A0DD   MALE                                  58  Positive
## 103     TCGA-C8-A12U FEMALE                                  46  Positive
## 104     TCGA-C8-A12W FEMALE                                  49  Positive
## 105     TCGA-E2-A15A FEMALE                                  45  Positive
##     PR.Status HER2.Final.Status Tumor Tumor..T1.Coded Node Node.Coded
## 100  Positive          Negative    T3         T_Other   N1   Positive
## 101  Negative          Positive    T2         T_Other   N1   Positive
## 102  Positive          Positive    T2         T_Other   N1   Positive
```

```
## 103  Positive          Negative    T2         T_Other   N1   Positive
## 104  Positive          Negative    T4         T_Other   N1   Positive
## 105  Positive          Negative    T2         T_Other   N3   Positive
##     Metastasis Metastasis.Coded AJCC.Stage Converted.Stage Survival.Data.Form
## 100         M0         Negative Stage IIIA      Stage IIIA         enrollment
## 101         M0         Negative  Stage IIB       Stage IIB         enrollment
## 102         M0         Negative  Stage IIB       Stage IIB         enrollment
## 103         M0         Negative   Stage IB       Stage IIB         enrollment
## 104         M0         Negative Stage IIIB      Stage IIIB         enrollment
## 105         M0         Negative Stage IIIC      Stage IIIC         enrollment
##     Vital.Status Days.to.Date.of.Last.Contact Days.to.date.of.Death OS.event
## 100       LIVING                         1492                    NA        0
## 101       LIVING                         1305                    NA        0
## 102       LIVING                         1393                    NA        0
## 103       LIVING                            0                    NA        0
## 104       LIVING                            0                    NA        0
## 105       LIVING                          502                    NA        0
##     OS.Time PAM50.mRNA SigClust.Unsupervised.mRNA SigClust.Intrinsic.mRNA
## 100    1492  Luminal B                         -5                      -2
## 101    1305  Luminal B                         -3                       0
## 102    1393  Luminal B                         -3                      -6
## 103       0  Luminal B                         -5                      -2
## 104       0  Luminal B                         -5                      -2
## 105     502  Luminal B                         -5                      -2
##     miRNA.Clusters methylation.Clusters RPPA.Clusters CN.Clusters
## 100              6                    4             X           4
## 101              4                    4        LumA/B           5
## 102              4                    4        LumA/B           3
## 103              5                    4         Basal           5
## 104              4                    4        ReacII           3
## 105              4                    4          Her2           4
##     Integrated.Clusters..with.PAM50. Integrated.Clusters..no.exp.
## 100                                4                            1
## 101                                4                            1
## 102                                4                            1
## 103                                4                            1
## 104                                4                            1
## 105                                4                            1
##     Integrated.Clusters..unsup.exp.
## 100                               1
## 101                               3
## 102                               3
## 103                               1
## 104                               1
## 105                               1
```

```
summary(clinical)
```

```
##  Complete.TCGA.ID      Gender          Age.at.Initial.Pathologic.Diagnosis
##  Length:105         Length:105         Min.   :30.00
##  Class :character   Class :character   1st Qu.:49.00
##  Mode  :character   Mode  :character   Median :58.00
##                                        Mean   :58.69
##                                        3rd Qu.:67.00
```

```
##                                     Max.   :88.00
##
##   ER.Status          PR.Status          HER2.Final.Status     Tumor
##  Length:105         Length:105         Length:105         Length:105
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##  Tumor..T1.Coded        Node            Node.Coded         Metastasis
##  Length:105         Length:105         Length:105         Length:105
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##  Metastasis.Coded    AJCC.Stage         Converted.Stage    Survival.Data.Form
##  Length:105         Length:105         Length:105         Length:105
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##  Vital.Status       Days.to.Date.of.Last.Contact Days.to.date.of.Death
##  Length:105         Min.   :   0.0               Min.   : 160.0
##  Class :character   1st Qu.: 240.0               1st Qu.: 947.5
##  Mode  :character   Median : 643.0               Median :1364.0
##                     Mean   : 788.4               Mean   :1254.5
##                     3rd Qu.:1288.0               3rd Qu.:1627.5
##                     Max.   :2850.0               Max.   :2483.0
##                                                  NA's   :94
##     OS.event         OS.Time        PAM50.mRNA
##  Min.   :0.0000   Min.   :   0.0   Length:105
##  1st Qu.:0.0000   1st Qu.: 240.0   Class :character
##  Median :0.0000   Median : 665.0   Mode  :character
##  Mean   :0.1048   Mean   : 817.6
##  3rd Qu.:0.0000   3rd Qu.:1305.0
##  Max.   :1.0000   Max.   :2850.0
##
##  SigClust.Unsupervised.mRNA SigClust.Intrinsic.mRNA miRNA.Clusters
##  Min.   :-12.000            Min.   :-13.000         Min.   :1
##  1st Qu.: -6.000            1st Qu.:-12.000         1st Qu.:3
##  Median : -5.000            Median : -6.000         Median :4
##  Mean   : -4.886            Mean   : -7.181         Mean   :4
##  3rd Qu.: -3.000            3rd Qu.: -2.000         3rd Qu.:5
##  Max.   :  0.000            Max.   :  0.000         Max.   :7
##
##  methylation.Clusters RPPA.Clusters       CN.Clusters
##  Min.   :1.000        Length:105         Min.   :1.00
##  1st Qu.:2.000        Class :character   1st Qu.:1.00
##  Median :4.000        Mode  :character   Median :3.00
```

```
##  Mean   :3.343                          Mean   :2.59
##  3rd Qu.:4.000                          3rd Qu.:3.00
##  Max.   :5.000                          Max.   :5.00
##
##  Integrated.Clusters..with.PAM50. Integrated.Clusters..no.exp.
##  Min.   :1.000                   Min.   :1.000
##  1st Qu.:2.000                   1st Qu.:1.000
##  Median :3.000                   Median :2.000
##  Mean   :2.743                   Mean   :1.981
##  3rd Qu.:4.000                   3rd Qu.:3.000
##  Max.   :4.000                   Max.   :4.000
##
##  Integrated.Clusters..unsup.exp.
##  Min.   :1.000
##  1st Qu.:1.000
##  Median :2.000
##  Mean   :2.352
##  3rd Qu.:3.000
##  Max.   :5.000
##
```

```
dim(clinical)
```

```
## [1] 105  30
```

```
clinical$PAM50.mRNA
```

```
##   [1] "Basal-like"    "Basal-like"    "Basal-like"    "Basal-like"
##   [5] "Basal-like"    "Basal-like"    "Basal-like"    "Basal-like"
##   [9] "Basal-like"    "Basal-like"    "Basal-like"    "Basal-like"
##  [13] "Basal-like"    "Basal-like"    "Basal-like"    "Basal-like"
##  [17] "Basal-like"    "Basal-like"    "Basal-like"    "Basal-like"
##  [21] "Basal-like"    "Basal-like"    "Basal-like"    "Basal-like"
##  [25] "Basal-like"    "HER2-enriched" "HER2-enriched" "HER2-enriched"
##  [29] "HER2-enriched" "HER2-enriched" "HER2-enriched" "HER2-enriched"
##  [33] "HER2-enriched" "HER2-enriched" "HER2-enriched" "HER2-enriched"
##  [37] "HER2-enriched" "HER2-enriched" "HER2-enriched" "HER2-enriched"
##  [41] "HER2-enriched" "HER2-enriched" "HER2-enriched" "Luminal A"
##  [45] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [49] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [53] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [57] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [61] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [65] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [69] "Luminal A"     "Luminal A"     "Luminal A"     "Luminal A"
##  [73] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
##  [77] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
##  [81] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
##  [85] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
##  [89] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
##  [93] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
##  [97] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
## [101] "Luminal B"     "Luminal B"     "Luminal B"     "Luminal B"
## [105] "Luminal B"
```

```r
str(clinical)
```

```
## 'data.frame':    105 obs. of  30 variables:
##  $ Complete.TCGA.ID                    : chr  "TCGA-A2-A0T2" "TCGA-A2-A0CM" "TCGA-BH-A18V" "TCGA-BH-A1
##  $ Gender                              : chr  "FEMALE" "FEMALE" "FEMALE" "FEMALE" ...
##  $ Age.at.Initial.Pathologic.Diagnosis: int  66 40 48 56 38 57 74 60 61 67 ...
##  $ ER.Status                           : chr  "Negative" "Negative" "Negative" "Negative" ...
##  $ PR.Status                           : chr  "Negative" "Negative" "Negative" "Negative" ...
##  $ HER2.Final.Status                   : chr  "Negative" "Negative" "Negative" "Negative" ...
##  $ Tumor                               : chr  "T3" "T2" "T2" "T2" ...
##  $ Tumor..T1.Coded                     : chr  "T_Other" "T_Other" "T_Other" "T_Other" ...
##  $ Node                                : chr  "N3" "N0" "N1" "N1" ...
##  $ Node.Coded                          : chr  "Positive" "Negative" "Positive" "Positive" ...
##  $ Metastasis                          : chr  "M1" "M0" "M0" "M0" ...
##  $ Metastasis.Coded                    : chr  "Positive" "Negative" "Negative" "Negative" ...
##  $ AJCC.Stage                          : chr  "Stage IV" "Stage IIA" "Stage IIB" "Stage IIB" ...
##  $ Converted.Stage                     : chr  "No_Conversion" "Stage IIA" "No_Conversion" "No_Conversi
##  $ Survival.Data.Form                  : chr  "followup" "followup" "enrollment" "enrollment" ...
##  $ Vital.Status                        : chr  "DECEASED" "DECEASED" "DECEASED" "DECEASED" ...
##  $ Days.to.Date.of.Last.Contact        : int  240 754 1555 1692 133 309 425 643 775 964 ...
##  $ Days.to.date.of.Death               : int  240 754 1555 1692 NA NA NA NA NA NA ...
##  $ OS.event                            : int  1 1 1 1 0 0 0 0 0 0 ...
##  $ OS.Time                             : int  240 754 1555 1692 133 309 425 643 775 964 ...
##  $ PAM50.mRNA                          : chr  "Basal-like" "Basal-like" "Basal-like" "Basal-like" ...
##  $ SigClust.Unsupervised.mRNA          : int  0 -12 -12 -12 0 0 0 -12 -12 -12 ...
##  $ SigClust.Intrinsic.mRNA             : int  -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 ...
##  $ miRNA.Clusters                      : int  3 4 5 5 5 5 3 5 2 5 ...
##  $ methylation.Clusters                : int  5 4 5 5 5 5 5 5 5 5 ...
##  $ RPPA.Clusters                       : chr  "Basal" "Basal" "Basal" "Basal" ...
##  $ CN.Clusters                         : int  3 4 1 1 1 1 1 1 1 3 ...
##  $ Integrated.Clusters..with.PAM50.   : int  2 2 2 2 2 2 2 2 2 2 ...
##  $ Integrated.Clusters..no.exp.       : int  2 1 2 2 2 2 2 2 2 2 ...
##  $ Integrated.Clusters..unsup.exp.    : int  2 1 2 2 2 2 2 2 2 2 ...
```

```r
summary(clinical)
```

```
##  Complete.TCGA.ID      Gender          Age.at.Initial.Pathologic.Diagnosis
##  Length:105         Length:105         Min.   :30.00
##  Class :character   Class :character   1st Qu.:49.00
##  Mode  :character   Mode  :character   Median :58.00
##                                        Mean   :58.69
##                                        3rd Qu.:67.00
##                                        Max.   :88.00
##
##   ER.Status          PR.Status         HER2.Final.Status     Tumor
##  Length:105         Length:105         Length:105         Length:105
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##  Tumor..T1.Coded        Node              Node.Coded         Metastasis
```

```
##  Length:105         Length:105         Length:105         Length:105        
##  Class :character   Class :character   Class :character   Class :character  
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character  
##                                                                             
##                                                                             
##                                                                             
##                                                                             
##  Metastasis.Coded    AJCC.Stage        Converted.Stage    Survival.Data.Form
##  Length:105         Length:105         Length:105         Length:105        
##  Class :character   Class :character   Class :character   Class :character  
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character  
##                                                                             
##                                                                             
##                                                                             
##                                                                             
##  Vital.Status       Days.to.Date.of.Last.Contact Days.to.date.of.Death
##  Length:105         Min.   :   0.0               Min.   : 160.0       
##  Class :character   1st Qu.: 240.0               1st Qu.: 947.5       
##  Mode  :character   Median : 643.0               Median :1364.0       
##                     Mean   : 788.4               Mean   :1254.5       
##                     3rd Qu.:1288.0               3rd Qu.:1627.5       
##                     Max.   :2850.0               Max.   :2483.0       
##                                                  NA's   :94           
##     OS.event         OS.Time        PAM50.mRNA       
##  Min.   :0.0000   Min.   :   0.0   Length:105        
##  1st Qu.:0.0000   1st Qu.: 240.0   Class :character  
##  Median :0.0000   Median : 665.0   Mode  :character  
##  Mean   :0.1048   Mean   : 817.6                     
##  3rd Qu.:0.0000   3rd Qu.:1305.0                     
##  Max.   :1.0000   Max.   :2850.0                     
##                                                      
##  SigClust.Unsupervised.mRNA SigClust.Intrinsic.mRNA miRNA.Clusters
##  Min.   :-12.000            Min.   :-13.000         Min.   :1     
##  1st Qu.: -6.000            1st Qu.:-12.000         1st Qu.:3     
##  Median : -5.000            Median : -6.000         Median :4     
##  Mean   : -4.886            Mean   : -7.181         Mean   :4     
##  3rd Qu.: -3.000            3rd Qu.: -2.000         3rd Qu.:5     
##  Max.   :  0.000            Max.   :  0.000         Max.   :7     
##                                                                   
##  methylation.Clusters RPPA.Clusters       CN.Clusters  
##  Min.   :1.000        Length:105         Min.   :1.00  
##  1st Qu.:2.000        Class :character   1st Qu.:1.00  
##  Median :4.000        Mode  :character   Median :3.00  
##  Mean   :3.343                           Mean   :2.59  
##  3rd Qu.:4.000                           3rd Qu.:3.00  
##  Max.   :5.000                           Max.   :5.00  
##                                                        
##  Integrated.Clusters..with.PAM50. Integrated.Clusters..no.exp.
##  Min.   :1.000                    Min.   :1.000               
##  1st Qu.:2.000                    1st Qu.:1.000               
##  Median :3.000                    Median :2.000               
##  Mean   :2.743                    Mean   :1.981               
##  3rd Qu.:4.000                    3rd Qu.:3.000               
##  Max.   :4.000                    Max.   :4.000               
```

```
##
##  Integrated.Clusters..unsup.exp.
##  Min.   :1.000
##  1st Qu.:1.000
##  Median :2.000
##  Mean   :2.352
##  3rd Qu.:3.000
##  Max.   :5.000
##
```

Data import - 77_cancer_proteomes_CPTAC_itraq.csv

The following datset has information about the protein expression data

```
proteomes <- read.csv("/Users/sheetalnighut/Desktop/cancer-project/77_cancer_proteomes_CPTAC_itraq.csv")
# 12553 observations(proteins) and 86 columns
head(proteomes)
```

```
##   RefSeq_accession_number gene_symbol          gene_name AO.A12D.01TCGA
## 1               NP_958782        PLEC  plectin isoform 1       1.096131
## 2               NP_958785        <NA> plectin isoform 1g       1.111370
## 3               NP_958786        PLEC plectin isoform 1a       1.111370
## 4               NP_000436        <NA> plectin isoform 1c       1.107561
## 5               NP_958781        <NA> plectin isoform 1e       1.115180
## 6               NP_958780        PLEC plectin isoform 1f       1.107561
##   C8.A131.01TCGA AO.A12B.01TCGA BH.A18Q.02TCGA C8.A130.02TCGA C8.A138.03TCGA
## 1       2.609943     -0.6598280      0.1953407     -0.4940596       2.765081
## 2       2.650422     -0.6487422      0.2154129     -0.5038992       2.779709
## 3       2.650422     -0.6542851      0.2154129     -0.5006193       2.779709
## 4       2.646374     -0.6321133      0.2053768     -0.5104589       2.797995
## 5       2.646374     -0.6404277      0.2154129     -0.5038992       2.787023
## 6       2.646374     -0.6542851      0.2154129     -0.5038992       2.779709
##   E2.A154.03TCGA C8.A12L.04TCGA A2.A0EX.04TCGA AO.A12D.05TCGA AN.A04A.05TCGA
## 1      0.8626593       1.407570       1.185108       1.100688      0.3845877
## 2      0.8701860       1.407570       1.192612       1.100688      0.3713928
## 3      0.8701860       1.410312       1.188860       1.100688      0.3713928
## 4      0.8664226       1.407570       1.185108       1.100688      0.3779903
## 5      0.8701860       1.413053       1.200116       1.093358      0.3746916
## 6      0.8701860       1.407570       1.188860       1.097023      0.3779903
##   BH.A0AV.05TCGA C8.A12T.06TCGA A8.A06Z.07TCGA A2.A0CM.07TCGA BH.A18U.08TCGA
## 1      0.3505357     -0.2049179     -0.4964091      0.6834035     -0.2650304
## 2      0.3674053     -0.1624185     -0.4985089      0.6944241     -0.2516423
## 3      0.3674053     -0.1666684     -0.4964091      0.6980976     -0.2516423
## 4      0.3606575     -0.1836682     -0.4922095      0.6870771     -0.2516423
## 5      0.3707793     -0.1666684     -0.4880099      0.6870771     -0.2516423
## 6      0.3674053     -0.1666684     -0.4964091      0.6980976     -0.2516423
##   A2.A0EQ.08TCGA AR.A0U4.09TCGA AO.A0J9.10TCGA AR.A1AP.11TCGA AN.A0FK.11TCGA
## 1     -0.9126703    -0.03322133    0.020007050      0.4610875      0.9735642
## 2     -0.9279787    -0.03021642    0.011955318      0.4610875      0.9774761
## 3     -0.9279787    -0.02721152    0.011955318      0.4610875      0.9774761
## 4     -0.9318057    -0.03021642    0.003903587      0.4610875      0.9696523
## 5     -0.9279787    -0.03021642    0.011955318      0.4610875      0.9852998
## 6     -0.9279787    -0.03021642    0.011955318      0.4610875      0.9774761
```

```
##   AO.A0J6.11TCGA A7.A13F.12TCGA BH.A0E1.12TCGA A7.A0CE.13TCGA A2.A0YC.13TCGA
## 1      0.8311317       1.279185      0.7620444      -1.123173      0.8188241
## 2      0.8565398       1.275167      0.7620444      -1.123173      0.8148772
## 3      0.8565398       1.275167      0.7663844      -1.116861      0.8148772
## 4      0.8367780       1.279185      0.7577045      -1.129486      0.7990900
## 5      0.8650092       1.279185      0.7663844      -1.129486      0.8188241
## 6      0.8565398       1.279185      0.7620444      -1.120017      0.8148772
##   AO.A0JC.14TCGA A8.A08Z.14TCGA AR.A0TX.14TCGA A8.A076.15TCGA AO.A126.15TCGA
## 1     -0.3072668      0.5688946     -0.5834286       1.873982      0.1958767
## 2     -0.3072668      0.5688946     -0.5725489       1.870383      0.1958767
## 3     -0.3072668      0.5688946     -0.5671090       1.870383      0.1958767
## 4     -0.3072668      0.5688946     -0.5834286       1.859587      0.2189346
## 5     -0.3010327      0.5688946     -0.5725489       1.870383      0.1997197
## 6     -0.3072668      0.5688946     -0.5779888       1.870383      0.1997197
##   BH.A0C1.16TCGA A2.A0EY.16TCGA AR.A1AW.17TCGA AR.A1AV.17TCGA C8.A135.17TCGA
## 1     -0.5183665       1.174881      0.5783087     -0.7598231       1.120502
## 2     -0.5100020       1.183209      0.5822129     -0.7598231       1.137618
## 3     -0.5072138       1.183209      0.5783087     -0.7491137       1.137618
## 4     -0.5183665       1.174881      0.5900212     -0.7357270       1.137618
## 5     -0.5127902       1.179045      0.5861170     -0.7491137       1.120502
## 6     -0.5072138       1.183209      0.5783087     -0.7437590       1.127348
##   A2.A0EV.18TCGA AN.A0AM.18TCGA D8.A142.18TCGA AN.A0FL.19TCGA BH.A0DG.19TCGA
## 1      0.4529859       1.501967      0.5385958       2.455138     -0.2056375
## 2      0.4725901       1.510348      0.5422105       2.480137     -0.2056375
## 3      0.4725901       1.501967      0.5422105       2.480137     -0.2056375
## 4      0.4585871       1.501967      0.5349810       2.461956     -0.2150062
## 5      0.4725901       1.501967      0.5422105       2.477864     -0.2056375
## 6      0.4725901       1.510348      0.5422105       2.471046     -0.2103218
##   AR.A0TV.20TCGA C8.A12Z.20TCGA AO.A0JJ.20TCGA AO.A0JE.21TCGA AN.A0AJ.21TCGA
## 1      -1.514278     -0.7871950      0.7571881      0.5597770     -0.4281815
## 2      -1.528285     -0.7559406      0.7808707      0.5634069     -0.4063780
## 3      -1.528285     -0.7559406      0.7741042      0.5597770     -0.4063780
## 4      -1.531087     -0.7746932      0.7639546      0.5416274     -0.4063780
## 5      -1.514278     -0.7715678      0.7707210      0.5597770     -0.4063780
## 6      -1.525484     -0.7715678      0.7774874      0.5597770     -0.4063780
##   A7.A0CJ.22TCGA AO.A12F.22TCGA A8.A079.23TCGA A2.A0T3.24TCGA A2.A0YD.24TCGA
## 1     -1.0012398      -1.947792       1.048959      0.5837133     0.06377853
## 2     -1.0046198      -1.952718       1.052257      0.5806231     0.09333637
## 3     -1.0046198      -1.955180       1.052257      0.5806231     0.08446902
## 4     -0.9978599      -1.947792       1.058852      0.5868034     0.06673431
## 5     -1.0012398      -1.957643       1.052257      0.5868034     0.08446902
## 6     -1.0012398      -1.955180       1.052257      0.5868034     0.09333637
##   AR.A0TR.25TCGA AO.A03O.25TCGA AO.A12E.26TCGA A8.A06N.26TCGA A2.A0YG.27TCGA
## 1      -1.101675       1.053225      0.2648591      0.2385471    -0.07820182
## 2      -1.108783       1.055948      0.2757113      0.2498182    -0.06805814
## 3      -1.108783       1.055948      0.2757113      0.2441826    -0.07143937
## 4      -1.096937       1.058671      0.2784244      0.2498182    -0.05791445
## 5      -1.111152       1.058671      0.2784244      0.2498182    -0.06467691
## 6      -1.106413       1.055948      0.2729983      0.2498182    -0.06805814
##   BH.A18N.27TCGA AN.A0AL.28TCGA A2.A0T6.29TCGA E2.A158.29TCGA E2.A15A.29TCGA
## 1       1.101261      0.3236627      0.7939756      -1.086529       2.180123
## 2       1.101261      0.3269726      0.8181815      -1.095492       2.180123
## 3       1.097767      0.3269726      0.8147235      -1.095492       2.180123
## 4       1.090779      0.3302826      0.8008915      -1.095492       2.180123
```

```
## 5       1.108248      0.3269726      0.8181815      -1.095492       2.180123
## 6       1.101261      0.3269726      0.8112655      -1.093252       2.180123
##   AO.A0JM.30TCGA C8.A12V.30TCGA A2.A0D2.31TCGA C8.A12U.31TCGA AR.A1AS.31TCGA
## 1       1.395247      0.6739047     0.10749090     -0.4815502       1.222507
## 2       1.408922      0.6887176     0.10416449     -0.4778898       1.218974
## 3       1.412341      0.6887176     0.10749090     -0.4815502       1.222507
## 4       1.408922      0.6776079     0.09751166     -0.4705692       1.204839
## 5       1.408922      0.6887176     0.10416449     -0.4815502       1.222507
## 6       1.412341      0.6887176     0.10416449     -0.4852105       1.218974
##   A8.A09G.32TCGA C8.A131.32TCGA C8.A134.32TCGA A2.A0YF.33TCGA BH.A0DD.33TCGA
## 1      -1.523343       2.707250      0.1401818      0.3113192     -0.6923158
## 2      -1.512646       2.733832      0.1260538      0.2961771     -0.6594687
## 3      -1.509972       2.737629      0.1331178      0.2961771     -0.6641611
## 4      -1.517995       2.733832      0.1119257      0.2961771     -0.6571224
## 5      -1.509972       2.752819      0.1260538      0.2961771     -0.6618149
## 6      -1.512646       2.737629      0.1260538      0.2961771     -0.6618149
##   BH.A0E9.33TCGA AR.A0TT.34TCGA AO.A12B.34TCGA A2.A0SW.35TCGA AO.A0JL.35TCGA
## 1       1.466665     -0.5114212     -0.9639039     -0.4877725       -0.10668
## 2       1.482283     -0.5260667     -0.9382095     -0.4877725       -0.10668
## 3       1.474474     -0.5260667     -0.9439194     -0.4877725       -0.10668
## 4       1.458856     -0.5333894     -0.9353546     -0.4877725       -0.10668
## 5       1.474474     -0.5297281     -0.9353546     -0.5038532       -0.10668
## 6       1.474474     -0.5297281     -0.9382095     -0.4877725       -0.10668
##   BH.A0BV.35TCGA A2.A0YM.36TCGA BH.A0C7.36TCGA A2.A0SX.36TCGA X263d3f.I.CPTAC
## 1    -0.06583842      0.6558497     -0.5522120     -0.3985598       0.5985845
## 2    -0.05589267      0.6581426     -0.5477494     -0.3926014       0.6066975
## 3    -0.06583842      0.6558497     -0.5522120     -0.3926014       0.6039931
## 4    -0.05589267      0.6558497     -0.5522120     -0.3926014       0.6039931
## 5    -0.06252317      0.6512639     -0.5566746     -0.3955806       0.6039931
## 6    -0.05589267      0.6581426     -0.5477494     -0.3926014       0.6066975
##   blcdb9.I.CPTAC c4155b.C.CPTAC
## 1     -0.1912845      0.5669753
## 2     -0.1839177      0.5787017
## 3     -0.1860225      0.5767473
## 4     -0.1860225      0.5767473
## 5     -0.1670792      0.5767473
## 6     -0.1839177      0.5787017
```

```
tail(proteomes)
```

```
##       RefSeq_accession_number gene_symbol
## 12548               NP_997203      OTUD6A
## 12549            NP_001191293        <NA>
## 12550               NP_775791        <NA>
## 12551               NP_004065       COX8A
## 12552               NP_068752        MIIP
## 12553               NP_219494    KIAA1737
##                                          gene_name AO.A12D.01TCGA
## 12548               OTU domain-containing protein 6A             NA
## 12549                      protein FAM24B precursor             NA
## 12550        putative uncharacterized protein C9orf62             NA
## 12551 cytochrome c oxidase subunit 8A, mitochondrial             NA
## 12552      migration and invasion-inhibitory protein     -0.6335172
## 12553               uncharacterized protein KIAA1737     12.6664882
```

```
##       C8.A131.01TCGA AO.A12B.01TCGA BH.A18Q.02TCGA C8.A130.02TCGA
## 12548             NA             NA      -8.111243    -1.75352923
## 12549             NA             NA     -16.029761     1.72969151
## 12550             NA             NA      -2.046065    -0.42518234
## 12551             NA             NA      -1.778435    -0.14967335
## 12552      4.8403254      -1.965192             NA             NA
## 12553      0.1407356      -2.854835      -3.069752    -0.04799742
##       C8.A138.03TCGA E2.A154.03TCGA C8.A12L.04TCGA A2.A0EX.04TCGA
## 12548       4.707022      -4.733495             NA             NA
## 12549       4.107251      -9.584499      -5.196859      -6.101005
## 12550      -3.203370      -4.786183             NA             NA
## 12551       1.971481      -3.103949      -0.933726      -1.726336
## 12552             NA             NA             NA             NA
## 12553             NA             NA             NA             NA
##       AO.A12D.05TCGA AN.A04A.05TCGA BH.A0AV.05TCGA C8.A12T.06TCGA
## 12548             NA             NA             NA             NA
## 12549     -2.5788279      0.9024874      -7.011385      -11.02102
## 12550             NA             NA             NA             NA
## 12551      1.2949255      1.7370646      -1.393788             NA
## 12552     -0.1893414      0.3614967      -3.057136             NA
## 12553     13.0664447      0.1437809             NA             NA
##       A8.A06Z.07TCGA A2.A0CM.07TCGA BH.A18U.08TCGA A2.A0EQ.08TCGA
## 12548             NA             NA      -11.55786      -6.373934
## 12549             NA             NA      -12.62890      -1.123160
## 12550             NA             NA             NA             NA
## 12551             NA             NA             NA             NA
## 12552             NA             NA             NA             NA
## 12553             NA             NA             NA             NA
##       AR.A0U4.09TCGA AO.A0J9.10TCGA AR.A1AP.11TCGA AN.A0FK.11TCGA
## 12548             NA             NA      -1.073848      -3.059596
## 12549             NA      3.4097859             NA             NA
## 12550             NA      1.7632069             NA             NA
## 12551             NA     -0.3382950             NA             NA
## 12552             NA      2.7012335             NA             NA
## 12553             NA      0.6560938      -1.177280      -3.266926
##       AO.A0J6.11TCGA A7.A13F.12TCGA BH.A0E1.12TCGA A7.A0CE.13TCGA
## 12548      -3.231339      0.9698297      -7.609707             NA
## 12549             NA             NA             NA             NA
## 12550             NA             NA             NA      -1.306238
## 12551             NA             NA             NA             NA
## 12552             NA     -1.3202008      -2.006840             NA
## 12553      -3.753616             NA             NA             NA
##       A2.A0YC.13TCGA AO.A0JC.14TCGA A8.A08Z.14TCGA AR.A0TX.14TCGA
## 12548             NA             NA             NA             NA
## 12549             NA             NA             NA             NA
## 12550       4.509094      2.6071730     0.48649433      -3.542726
## 12551             NA             NA             NA             NA
## 12552             NA      0.2912064    -0.05448119      -2.136516
## 12553             NA      0.5281020    -3.43647384     -10.008030
##       A8.A076.15TCGA AO.A126.15TCGA BH.A0C1.16TCGA A2.A0EY.16TCGA
## 12548             NA             NA      -9.512991       4.597606
## 12549             NA             NA      -6.217378       6.179888
## 12550             NA             NA             NA             NA
## 12551             NA             NA             NA             NA
```

```
## 12552      0.6720037     -6.0643526             NA             NA
## 12553      5.1056477      0.5648036             NA             NA
##        AR.A1AW.17TCGA AR.A1AV.17TCGA C8.A135.17TCGA A2.A0EV.18TCGA
## 12548      -1.201996      2.7849772     -11.185872    -12.2785457
## 12549       1.468461     -4.1439828     -13.630031    -10.3377293
## 12550      -1.475288     -0.5724091      -3.702775     -0.6532514
## 12551             NA             NA             NA             NA
## 12552             NA             NA             NA             NA
## 12553       1.113181     -5.3675279      -8.953951             NA
##        AN.A0AM.18TCGA D8.A142.18TCGA AN.A0FL.19TCGA BH.A0DG.19TCGA
## 12548    -5.42108597     -12.337110             NA             NA
## 12549    -1.27228306      -9.546530      -3.012765      -0.753707
## 12550     0.03521846      -4.066584             NA             NA
## 12551             NA             NA             NA             NA
## 12552             NA             NA             NA             NA
## 12553             NA             NA             NA             NA
##        AR.A0TV.20TCGA C8.A12Z.20TCGA AO.A0JJ.20TCGA AO.A0JE.21TCGA
## 12548             NA             NA             NA             NA
## 12549      -2.116583      -6.703657      0.8147029             NA
## 12550             NA             NA             NA      -1.494749
## 12551       2.040722      -4.375203     -0.2916098             NA
## 12552             NA             NA             NA             NA
## 12553             NA             NA             NA             NA
##        AN.A0AJ.21TCGA A7.A0CJ.22TCGA AO.A12F.22TCGA A8.A079.23TCGA
## 12548             NA             NA             NA             NA
## 12549             NA             NA             NA             NA
## 12550      -3.017946             NA             NA             NA
## 12551             NA             NA             NA      -1.351759
## 12552             NA             NA             NA       2.875880
## 12553             NA             NA             NA             NA
##        A2.A0T3.24TCGA A2.A0YD.24TCGA AR.A0TR.25TCGA AO.A03O.25TCGA
## 12548             NA             NA             NA             NA
## 12549     -12.265010      -7.677420       1.475930     -0.5997658
## 12550             NA             NA       0.528281      0.5276447
## 12551      -1.264179      -4.801442       1.492514      0.7536714
## 12552      -1.100403      -2.590516      -4.098615     -5.0113722
## 12553      -5.590348      -6.740437             NA             NA
##        AO.A12E.26TCGA A8.A06N.26TCGA A2.A0YG.27TCGA BH.A18N.27TCGA
## 12548             NA             NA     -10.245556      -9.481603
## 12549       1.716341    -0.02350419             NA             NA
## 12550             NA             NA      -1.254869       4.036092
## 12551             NA             NA             NA             NA
## 12552             NA             NA             NA             NA
## 12553             NA             NA             NA             NA
##        AN.A0AL.28TCGA A2.A0T6.29TCGA E2.A158.29TCGA E2.A15A.29TCGA
## 12548             NA             NA             NA             NA
## 12549       4.633196     -13.120988      0.3789715      -3.863634
## 12550             NA             NA             NA             NA
## 12551             NA             NA             NA             NA
## 12552             NA       1.181271      0.6657973       4.072432
## 12553             NA             NA             NA             NA
##        AO.A0JM.30TCGA C8.A12V.30TCGA A2.A0D2.31TCGA C8.A12U.31TCGA
## 12548     -10.289998      1.4960184      -8.324969     -2.1140524
## 12549      -9.920774      3.8697791      -4.679219      1.0557838
```

```
## 12550            NA            NA           NA            NA
## 12551     -2.375620    -0.3370729    -1.106650     1.0265012
## 12552            NA            NA           NA            NA
## 12553            NA            NA    -6.941181     0.7446567
##       AR.A1AS.31TCGA A8.A09G.32TCGA C8.A131.32TCGA C8.A134.32TCGA
## 12548      4.7986122            NA             NA             NA
## 12549      3.0529642     -9.744192      -2.130632      0.5392989
## 12550             NA            NA             NA             NA
## 12551      1.5405403            NA             NA             NA
## 12552             NA     -4.034527       2.027516     -1.2796861
## 12553      0.9327439            NA             NA             NA
##       A2.A0YF.33TCGA BH.A0DD.33TCGA BH.A0E9.33TCGA AR.A0TT.34TCGA
## 12548       1.412905      -5.987738      -8.482188             NA
## 12549             NA             NA             NA      -2.576435
## 12550             NA             NA             NA             NA
## 12551             NA             NA             NA             NA
## 12552             NA             NA             NA             NA
## 12553             NA             NA             NA      -1.983293
##       AO.A12B.34TCGA A2.A0SW.35TCGA AO.A0JL.35TCGA BH.A0BV.35TCGA
## 12548             NA             NA             NA             NA
## 12549       -6.66235             NA             NA             NA
## 12550             NA             NA             NA             NA
## 12551             NA             NA             NA             NA
## 12552             NA             NA             NA             NA
## 12553       -6.00286             NA             NA             NA
##       A2.A0YM.36TCGA BH.A0C7.36TCGA A2.A0SX.36TCGA X263d3f.I.CPTAC
## 12548             NA             NA             NA              NA
## 12549             NA             NA             NA     -8.02007140
## 12550             NA             NA             NA      0.04960831
## 12551             NA             NA             NA              NA
## 12552             NA             NA             NA      0.01986083
## 12553             NA             NA             NA              NA
##       blcdb9.I.CPTAC c4155b.C.CPTAC
## 12548             NA             NA
## 12549     -3.0938223     -4.6024175
## 12550     -0.6469766      0.2405902
## 12551             NA             NA
## 12552     -1.7183267     -0.3691832
## 12553             NA             NA
```

```
dim(proteomes)
```

```
## [1] 12553    86
```

Combining the datasets

- Two data sets need to be combined before analysis
- using the cbind()
- new column was formed in each data set
- the two data sets were connected based on this new column

```r
# Transposing the proteome matrix will result in rows rather than columns of observations.
## save rownames
# RefSeq_accession_number : ID of proteins
n <- proteomes$RefSeq_accession_number
#Transpose all columns except the first three
proteomes <- as.data.frame(t(proteomes[,4:86]))
colnames(proteomes) <- n
#Row names in the first column,
proteomes <- cbind(rownames(proteomes), data.frame(proteomes, row.names=NULL))
colnames(proteomes)[1] <- "Complete.TCGA.ID"
```

Manipulating the format

working with the Patient IDs : - Unfortunately, the patient IDs in the clinical dataset and the proteomic data set have different formats. - To enable combining of the two data sets on this variable, this piece of code reformats the id in the clinical data set. - defined the code which does the job - used sapply() to implement the function defined

```r
# To enable the combining of data sets, Complete.TCGA.ID is being reorganized into a clinical format.
# Defining the restructuring formula:

get.clinical.id <- function(proteome.id) {
  x = substr(proteome.id, 4, 7)
  y = substr(proteome.id, 0, 2)
  paste("TCGA",y,x,sep="-")
}

#sapply to proteomes' id column
proteomes$Complete.TCGA.ID <- sapply(proteomes$Complete.TCGA.ID, get.clinical.id)
proteomes_all <- proteomes
```

I have used plot intro() from the DataExplorer package to check if the missing values are present. There are 10% of missing values in the dataset.Discarded variables with more than 25% of the data missing because they wouldn't be significant for further research. Used the mean imputation method, imputed the NA values with the mean of a specific column for the remaining variables with missing data.

Exploring the dataset merging and manipulating the datasets

After merging and manipulating the datasets retrieved - The proteome data set is the final one and to be used in the further analysis using the head str dim glimpse summary functions, the dimensions of the data can be observed

```r
#head(proteomes)
#dim(proteomes)
#tail(proteomes)
#summary(proteomes)
#glimpse(proteomes)
#str(proteomes)
```

Data Exploration

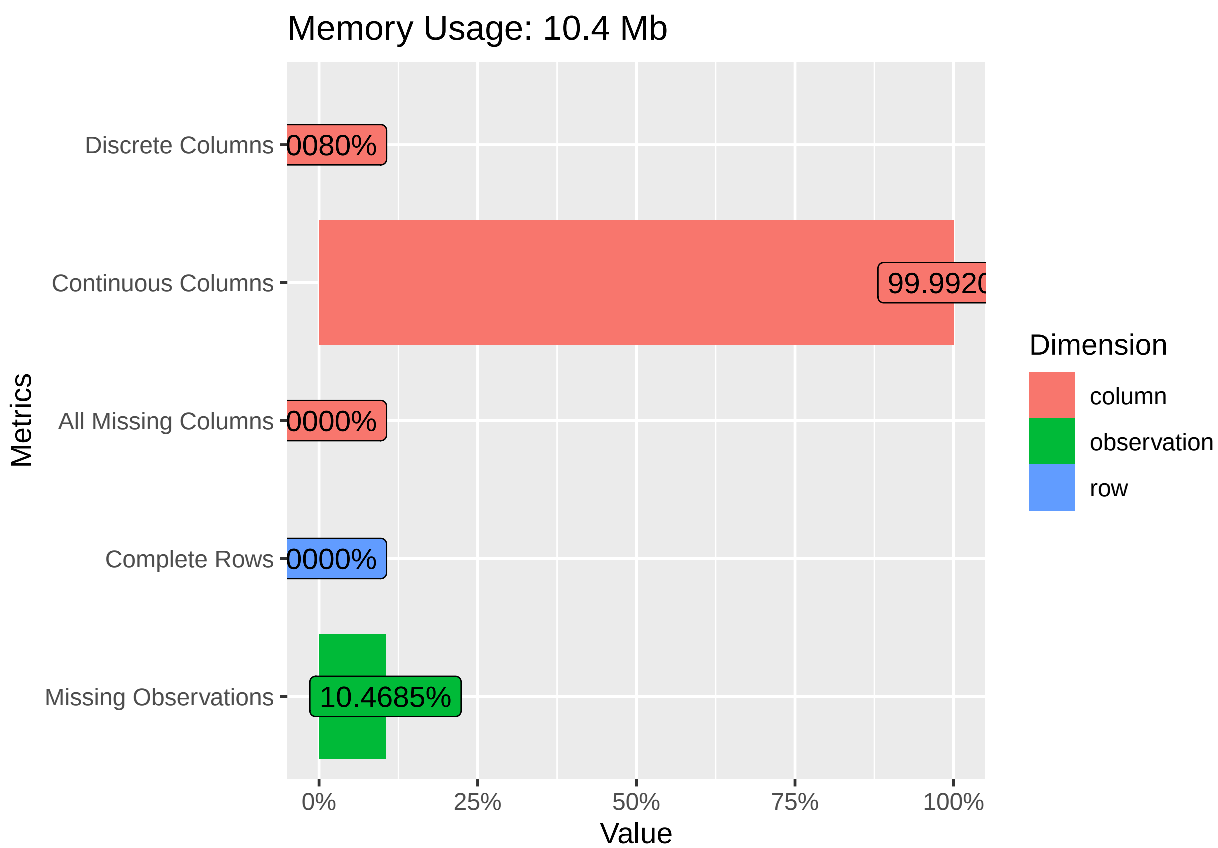
1. exploratory data plots - plot_intro(), ggplots after the feature selection
2. detection of outliers for continuous features - box(), defined outlier() to detect the outliers
3. correlation/collinearity/chi-squared analysis - cor(),
4. evaluation of distribution - barplots, histograms, boxplots for each subtype, pair.panels() plot

2. Data Exploration

- I have used plot_intro function from DataExplorer package
- plot_intro provides an insight of what type of data is present along with that it provides the information about missing values
- plotted a graph to show the proportion of missing data for each variable.
- Apart from that, I have used str and summary to understand the structure of the data present
- Discarded variables with more than 25% of the data missing because they wouldn't be significant for further research.
- Used the mean imputation method, imputed the NA values with the mean of a specific column for the remaining variables with missing data.
- After cleaning the data, using the ggplot() I have analyzed the distribution of each subtype in the dataset

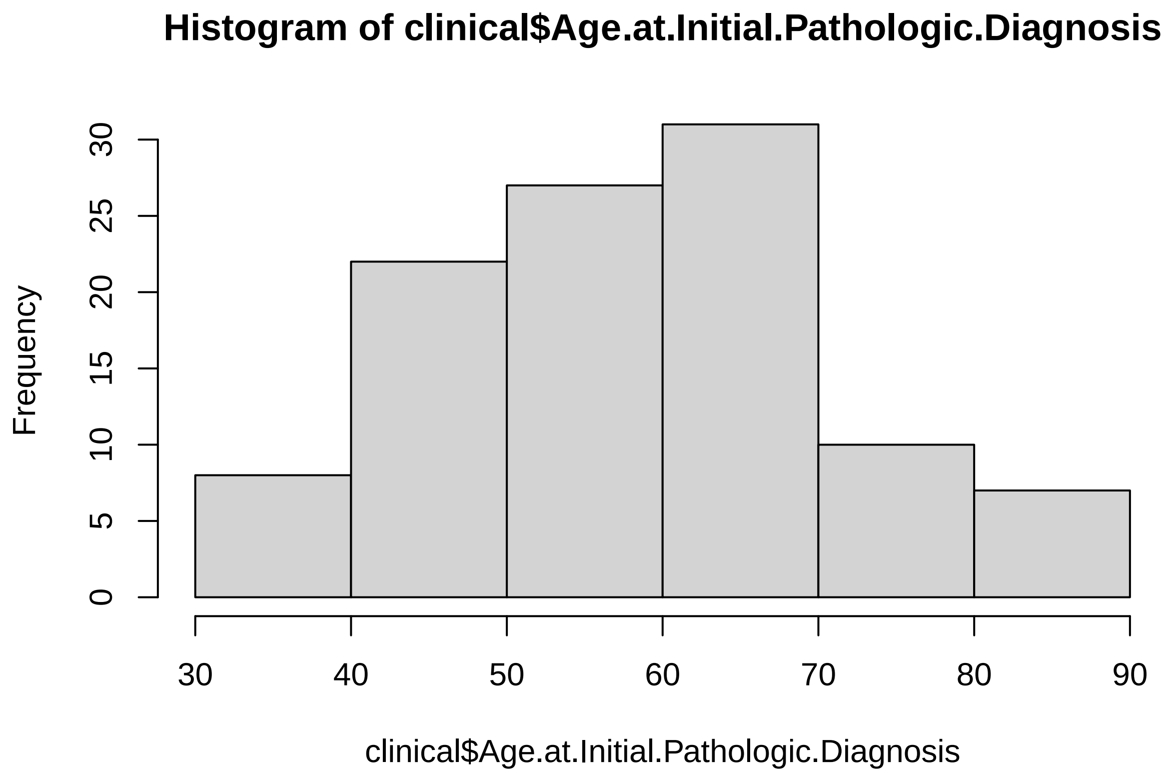
1. exploratory data plots: I used plot intro() from the DataExplorer package. plot intro gives an understanding of the sort of data present as well as information about missing values. In addition, I have used str() and summary() to comprehend the data's structure.

```
#Visualizing structure of the data set
plot_intro(proteomes)
```

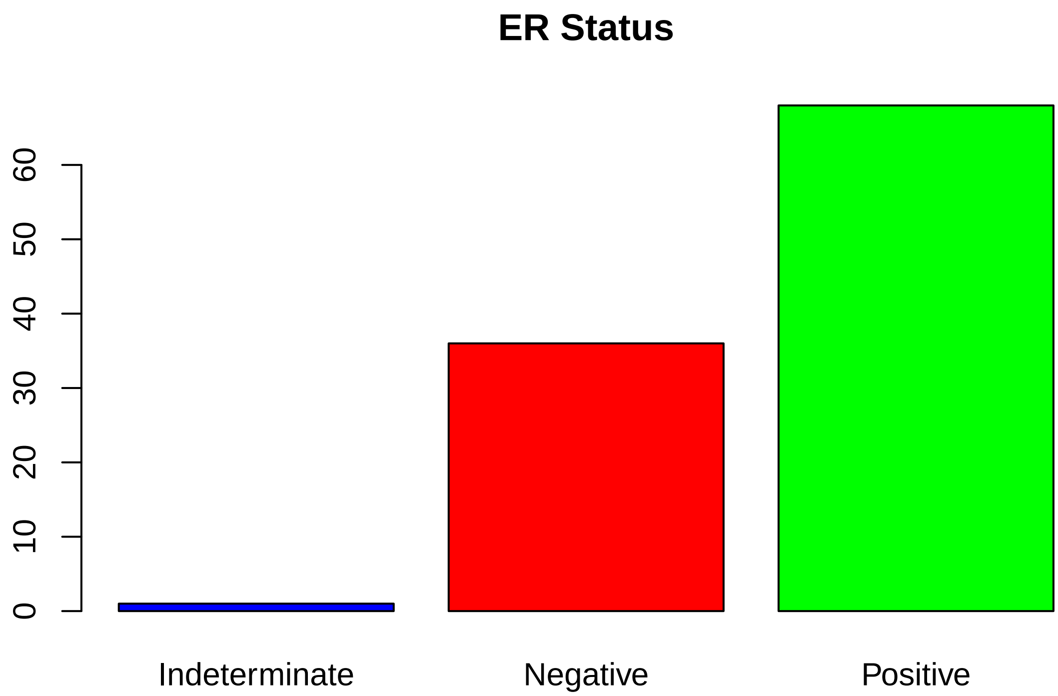


It is essential to explore the clinical dataset as it has all the information about the pateints

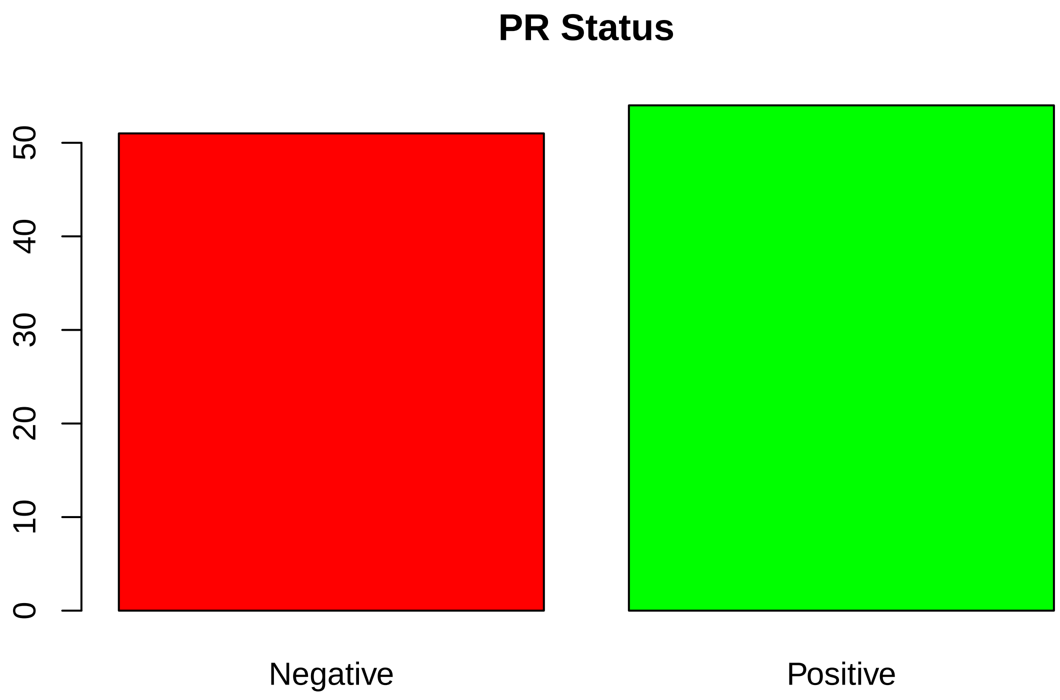
```
clinical$Age.at.Initial.Pathologic.Diagnosis <- as.numeric(clinical$Age.at.Initial.Pathologic.Diagnosis)
h1 <- hist(clinical$Age.at.Initial.Pathologic.Diagnosis)
```



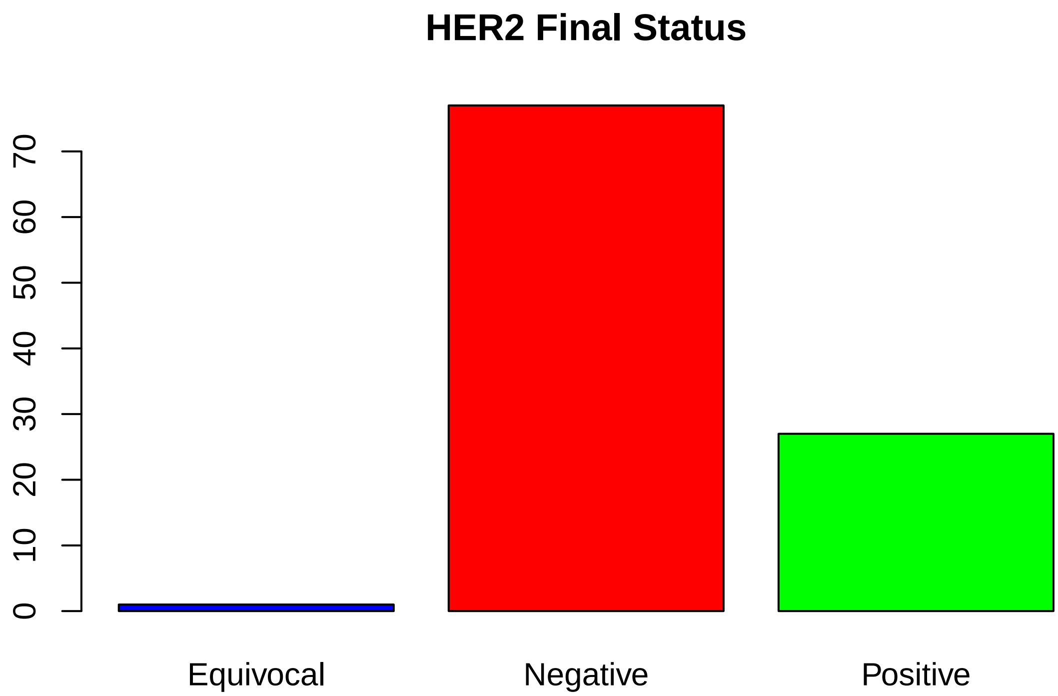

```
b1<- barplot(table(clinical$ER.Status), col=c("blue", "red", "green"), main = "ER Status")
```



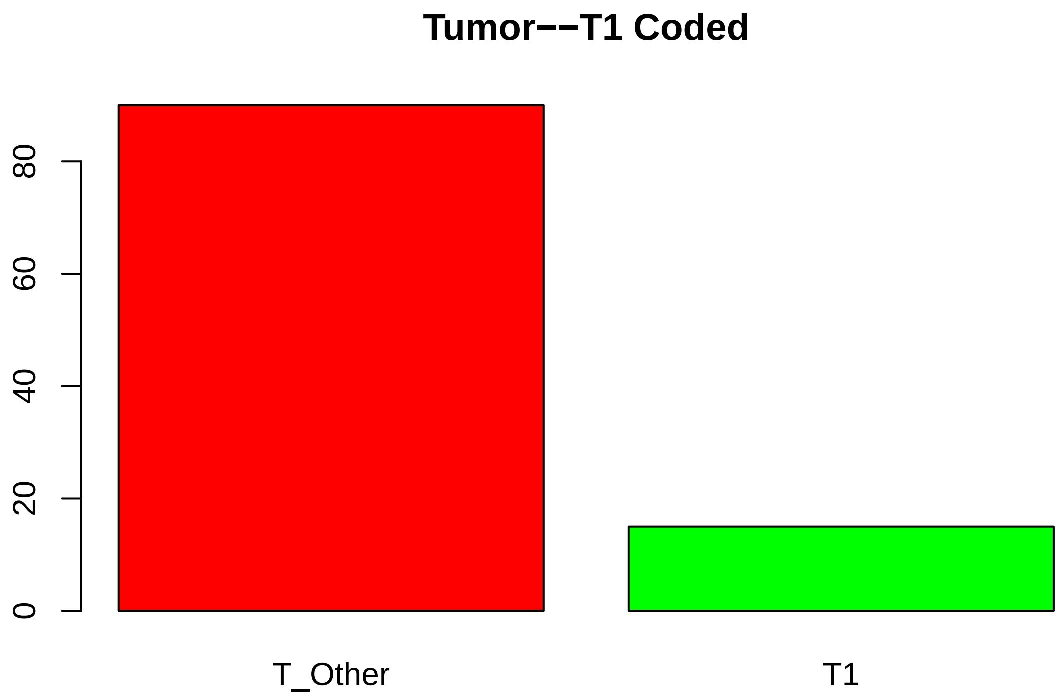

```
b2<- barplot(table(clinical$PR.Status), col=c("red", "green"), main = "PR Status")
```



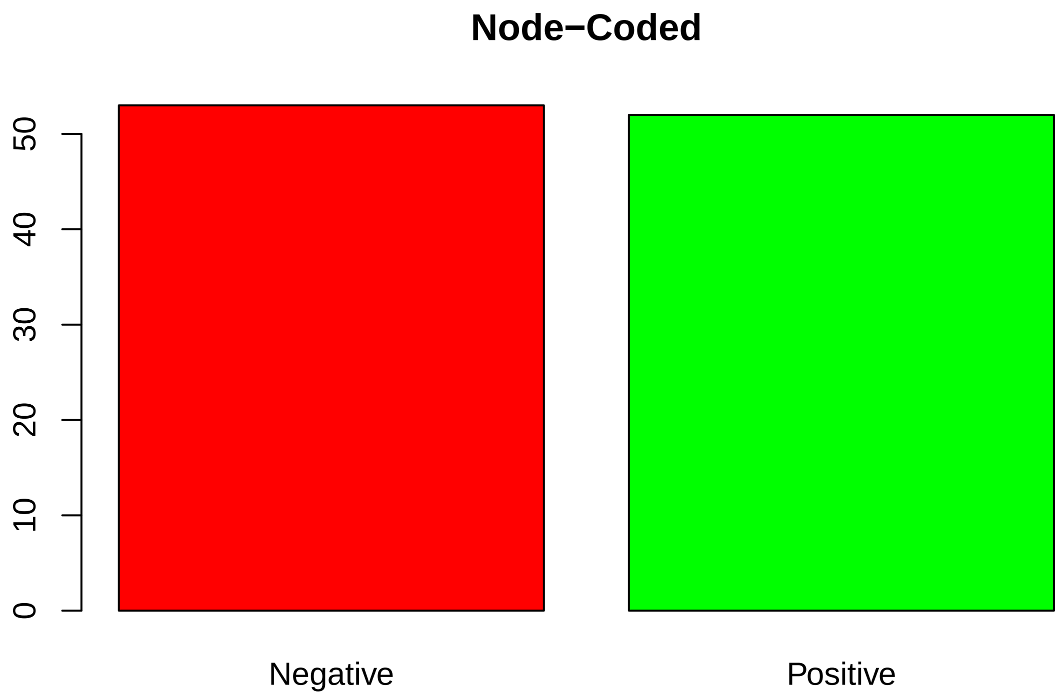

```
b3<- barplot(table(clinical$HER2.Final.Status), col=c("blue", "red", "green"), main = "HER2 Final Statu
```



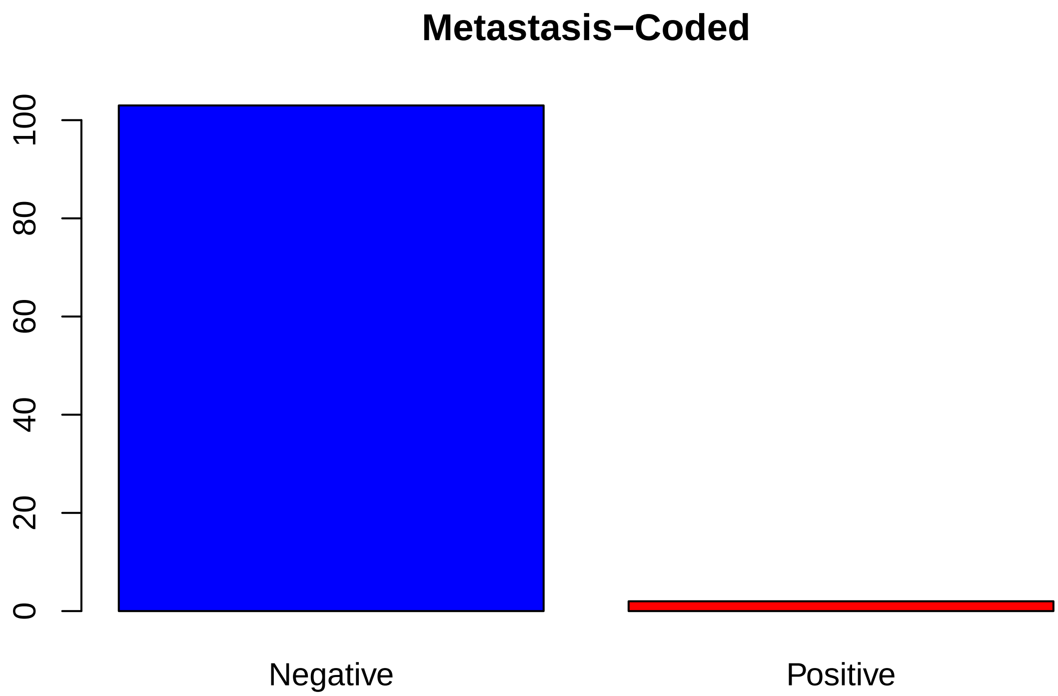

```
b4<- barplot(table(clinical$Tumor..T1.Coded), col=c("red", "green"), main = "Tumor--T1 Coded")
```



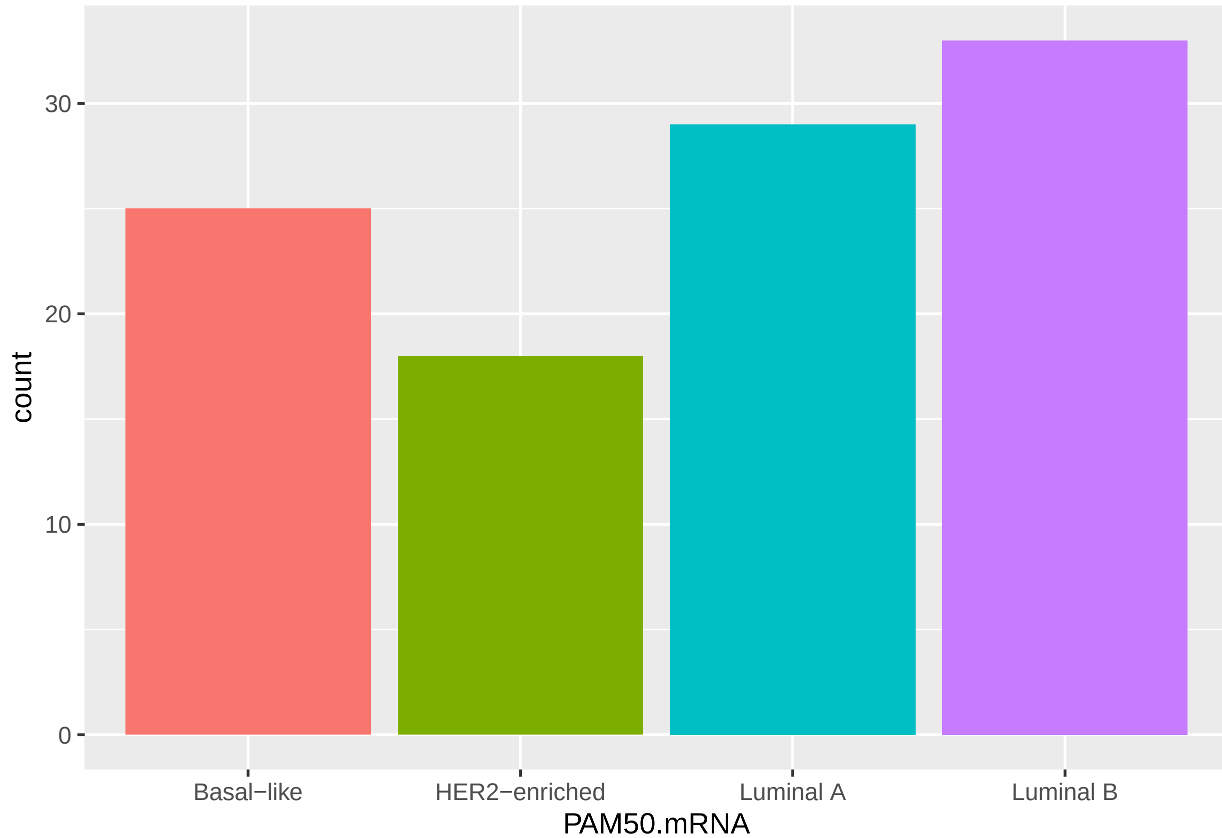

```
b5<- barplot(table(clinical$Node.Coded), col=c("red", "green"), main = "Node-Coded")
```




```
b6<- barplot(table(clinical$Metastasis.Coded), col=c("blue", "red", "green"), main = "Metastasis-Coded")
```




```
b7<- ggplot(clinical,aes(x= `PAM50.mRNA`,fill=`PAM50.mRNA`))+geom_bar()+theme(legend.position = "none")
b7
```



Missing Values

This plot_intro() plot shows that the dataset has missing observations. we can know the count of na's from summary() and also colSums()

```
colSums(is.na(proteomes))
```

```
## Complete.TCGA.ID        NP_958782        NP_958785        NP_958786
##                0                0                0                0
##        NP_000436        NP_958781        NP_958780        NP_958783
##                0                0                0                0
##        NP_958784        NP_112598        NP_001611        NP_076965
##                0                0                0                0
##        NP_001367        NP_036222     NP_001138241        NP_001714
##                0                0                0                0
##        NP_002464     NP_001073936        NP_061198     NP_001074248
##                0                0                0                0
##     NP_001074419        NP_056009        NP_036355     NP_001155291
##                0                0                0                0
##        NP_002462        NP_000248        NP_036467        NP_004989
##                0                0                0                0
##     NP_001243024        NP_149043        NP_067047        NP_002461
##                0                0               19                0
##        NP_060003        NP_003793        NP_060004        NP_005954
```

```
##            0            0            0            0
##    NP_002463    NP_689914 NP_001242941    NP_060227
##            0            0            0            9
##    NP_055796    NP_065935    NP_008974 NP_001156806
##            2            0            0           13
##    NP_000251 NP_001242970 NP_001094891    NP_057323
##           16            0           15           52
##    NP_002465    NP_005955 NP_001035202 NP_001070654
##            0            0            0            0
##    NP_079005    NP_000250    NP_878918    NP_892006
##            0            0            0            0
##    NP_149062 NP_001138722    NP_003118 NP_001123910
##            0           42            0            0
## NP_001182461 NP_001243000    NP_004406    NP_689916
##            0            0            0            0
##    NP_060124    NP_443141    NP_008835    NP_000375
##            0           41            0            0
##    NP_001447 NP_001157789    NP_001448    NP_001449
##            0            0            0            0
## NP_001120959    NP_003119    NP_842565 NP_001020029
##            0            0            0            0
##    NP_008877    NP_000338    NP_066022 NP_001243415
##            0            0            0            0
##    NP_004478 NP_001243417    NP_005742    NP_671714
##            0            0            0            0
##    NP_005520    NP_004360    NP_476507    NP_065816
##            0            0            0            0
##    NP_006280    NP_055874    NP_113584    NP_612482
##            0            0            0            0
##    NP_006176    NP_006258    NP_055185 NP_001137485
##            0            0            9            0
##    NP_005045    NP_872394 NP_001019628    NP_872634
##            0            0            0            0
##    NP_005029    NP_003128    NP_005720    NP_004095
##            0            0            0            0
##    NP_002017    NP_997647    NP_997639    NP_009055
##            0            0            0            0
##    NP_003997    NP_004005    NP_004007 NP_001164655
##            0            0            0           15
##    NP_000055    NP_002323    NP_061027    NP_065872
##            0            0            0            0
##    NP_006827    NP_003117    NP_612429    NP_003283
##            0            0            0            0
##    NP_054733    NP_000468    NP_004361    NP_004850
##            0            0            0            0
##    NP_009029    NP_003861    NP_006624    NP_839943
##            0            0            0            0
##    NP_002696    NP_002069 NP_001166184    NP_114141
##            0            0            0            0
## NP_001254479 NP_001091738    NP_596870    NP_663304
##            0            0            7            0
##    NP_003179 NP_001229542 NP_001138668 NP_001014364
##            0           59           60           53
##    NP_003741    NP_003080    NP_002895    NP_067051
```

```
##            0            0            0            0
##    NP_078873 NP_001166987    NP_065700    NP_055107
##            0            0            0            6
##    NP_002151    NP_061978    NP_006436    NP_006717
##            0            0            0            0
## NP_001186211    NP_056493    NP_004230    NP_510880
##            0            0            0            0
##    NP_004516    NP_579899    NP_038479 NP_001124459
##            0            0            0            0
## NP_001124453 NP_001229752 NP_001002029    NP_009224
##            0            0            0            0
##    NP_000543    NP_057336    NP_005551    NP_937762
##            0            0            0            0
##    NP_004437    NP_005900    NP_002364    NP_055987
##            0            0            0            0
##    NP_542417    NP_037450    NP_001264 NP_001005271
##            0            0            0            0
##    NP_056372 NP_001034679    NP_004645 NP_001008938
##            0            0            0            0
##    NP_005091    NP_942133    NP_001084    NP_004332
##            0            0            0            0
##    NP_002449 XP_003960896 XP_003960532    NP_203754
##            0            3           53            0
##    NP_001979 NP_001138599 NP_001072989 NP_001072990
##            0            2            0            0
##    NP_000005    NP_002855    NP_573566    NP_057427
##            0            0            0            0
##    NP_003364    NP_056083 NP_001123476    NP_001093
##            0            0            0            0
##    NP_004915 NP_001265272    NP_001095    NP_055426
##            0            0            0            0
##    NP_062536    NP_009131 NP_001257475 NP_001231509
##            0            0            0            0
##    NP_003557    NP_055710    NP_115645    NP_055872
##            0            5           31            0
##    NP_004362 NP_001091868    NP_006297    NP_004990
##            0            0            0            0
##    NP_056234    NP_056110 NP_001243194 NP_001243193
##            0            0            0            0
##    NP_006022    NP_000129    NP_001990    NP_000928
##            0            0            0            0
##    NP_940980    NP_068506    NP_003165    NP_001059
##           16            0            0            0
##    NP_001058    NP_066933    NP_005436    NP_066267
##            0            0            0            0
## NP_001191333 NP_001191332    NP_000028    NP_065210
##            0            0            0            0
##    NP_001139    NP_066187    NP_001140    NP_055458
##            0            0            0            1
##    NP_733821    NP_733822    NP_005563    NP_116126
##            0            0            0            0
##    NP_005564 NP_001185486    NP_009049 NP_001019831
##            0            0            0            0
##    NP_008995 NP_001135452    NP_444253    NP_444254
```

```
##            20            0            0            0
##     NP_444259    NP_004949    NP_005723    NP_000867
##             0            0            0            0
##     NP_001054    NP_002283    NP_031382    NP_000019
##             0            0           12            0
##     NP_060024 NP_001193937 NP_001035089    NP_002284
##             0            0            0            0
##     NP_006050    NP_996744    NP_006274    NP_852118
##             6            0            0            0
##     NP_055490 NP_001098677    NP_009057    NP_000457
##             0            0            0            0
##     NP_006787    NP_002524    NP_000278    NP_112593
##             0            0            0            0
##     NP_065871    NP_006819    NP_071374    NP_683692
##             0            0            0            0
##     NP_612378    NP_005327 NP_001230829    NP_056197
##             0            0            0            0
##     NP_115927 NP_001258898 NP_001017963    NP_003290
##            21            0            0            0
##     NP_057376    NP_001615 NP_001092693    NP_002408
##             0            0            0            0
##     NP_055873 NP_001009814    NP_002263    NP_003371
##             0            0            0            0
##     NP_872313    NP_778253    NP_006112    NP_005373
##             0            0            0            0
##     NP_000414    NP_006253    NP_006149    NP_002275
##             0            0            0            0
##     NP_066554    NP_002272 NP_001243211    NP_476429
##             0            0            0            0
##     NP_002046    NP_116116    NP_542785 NP_001099011
##             0            0            0            0
##     NP_057613    NP_778223    NP_005547    NP_149034
##             4            0            0            0
##     NP_258259    NP_778238    NP_775487    NP_149022
##             2            0            0           15
##     NP_001918    NP_000415    NP_005546    NP_005545
##             0            0            0            0
##     NP_004684    NP_787028    NP_001609 NP_001073867
##             0            0            0            0
##     NP_055816    NP_056069    NP_006603    NP_008985
##             0            0            0            0
##     NP_004789    NP_065810    NP_002245 NP_001092763
##             0            0            0            0
##     NP_878905    NP_005541    NP_065867    NP_659464
##             7            3           12           14
##     NP_078980    NP_055889    NP_071396 NP_001099038
##             0            0            0            0
##  NP_001186795    NP_004312    NP_036442    NP_904325
##             0            0            0            0
##     NP_036565    NP_005886    NP_003161    NP_003237
##             0            0            0            0
##     NP_003238    NP_002102    NP_006608    NP_056986
##             0            0            0            0
##     NP_062535    NP_003248    NP_783297    NP_004136
```

```
##            0            0            0            0
##      NP_008832    NP_001952    NP_001716    NP_004841
##            2            0            0            0
##      NP_005397 NP_001181875    NP_886553    NP_937887
##            0            0            0            0
##      NP_937885 NP_001185730 NP_001263347    NP_055681
##            0            0            0            0
##      NP_056193    NP_001511    NP_072174    NP_073585
##            0            0            0            0
##      NP_056134    NP_065821    NP_002282 NP_001193583
##            0            0            0            0
##      NP_006303    NP_006302    NP_569707    NP_570924
##            0            0            0            0
##      NP_002841    NP_002830    NP_663780    NP_056101
##            0            0            0            0
##      NP_000417 NP_001073291    NP_005550    NP_064505
##            0            0           12            0
##      NP_064506    NP_149072    NP_055968    NP_056121
##            0            0            0            0
##      NP_006026    NP_003598    NP_055641    NP_059995
##            0            0            0            0
## NP_001075031    NP_055907 XP_003960679 XP_003960702
##            1            0           10           20
## XP_003960698    NP_056993 NP_001157968    NP_078789
##           37            0           21            0
##      NP_006188    NP_003461    NP_000042    NP_705833
##            0            0            0            0
##      NP_055791    NP_000480    NP_612114    NP_060473
##            0            0            0            0
##      NP_055928    NP_006466 NP_001129406 NP_001129407
##            0            0            0            0
##      NP_597677    NP_002366    NP_001102    NP_056655
##            0            0            0            0
## NP_001234926    NP_937883    NP_115797 NP_001103132
##            0            0            0            0
##      NP_006411    NP_006412    NP_004753    NP_059431
##            0            0            0            0
##      NP_004218    NP_037517    NP_002215    NP_002214
##            0            3            0            0
## NP_001161744    NP_002213    NP_149129    NP_149130
##            0            0            0            0
##      NP_004333 NP_001124295    NP_001370    NP_056988
##            0            0            0            0
##      NP_002853    NP_002854    NP_005600    NP_001726
##            0            0            0            0
##      NP_060918 NP_001155971    NP_055847 NP_001093869
##            0            0            0            0
##      NP_003881    NP_001422 NP_001186318    NP_036439
##            0            0            0            0
## NP_001245258 NP_001159477    NP_818932    NP_004428
##            0            0            0            0
## NP_001245259 NP_001258928    NP_212132    NP_982272
##            0            0            0            0
##      NP_065863    NP_005517    NP_004497 NP_001035757
```

```
##            0            0            3           22
##    NP_004512    NP_004513    NP_004975    NP_002145
##            0            0            0            0
##    NP_006635    NP_055093    NP_005349    NP_056667
##            0            0            0            0
##    NP_065741    NP_115593    NP_060217    NP_078944
##            0            0            0            0
##    NP_005119 NP_001186871 NP_001073883    NP_057688
##            0           21            0            0
##    NP_060903    NP_940953    NP_001509 NP_001003795
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## NP_001014972    NP_009123    NP_005106    NP_055950
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##    NP_065972    NP_002435    NP_003370    NP_002897
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## NP_001193813    NP_001322 NP_001078935    NP_005378
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## NP_001186308    NP_004184 NP_001155901    NP_037506
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##   NP_005959    NP_001596    NP_002799    NP_115784
```

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##  NP_001013865    NP_055831    NP_005177    NP_001307
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## NP_001171730    NP_002448    NP_056107 NP_001171725
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##    NP_060676    NP_055915 NP_001181866 NP_001002843
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##    NP_060136    NP_006073    NP_116093    NP_005991
##            0            0            0            0
##    NP_997195    NP_061816    NP_079079 XP_003846706
##            0            0            0            0
## NP_001099032    NP_002068 NP_001263206 NP_001124330
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##    NP_003899    NP_056173    NP_003583    NP_003897
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##    NP_073744    NP_002476 NP_001073898    NP_065953
##            0            0            0            0
##    NP_001295    NP_942568    NP_055945    NP_071496
```

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## NP_001138818 NP_001158275    NP_055548 NP_001186090
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##    NP_078893 NP_001009881    NP_055805    NP_919277
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##    NP_065076    NP_054878    NP_000245    NP_060773
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##    NP_000286 NP_001137293 NP_001243399    NP_055839
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##    NP_075048    NP_115786    NP_056972    NP_056311
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##    NP_055048    NP_055994    NP_055637    NP_004913
##            0            0            0            0
##    NP_003133 NP_001116105    NP_056060    NP_690001
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##    NP_005582    NP_001743    NP_005817 NP_001095868
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##    NP_006363 NP_001153149    NP_065905    NP_055416
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##    NP_006786    NP_644670    NP_055415    NP_005768
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##    NP_891553 NP_001123579    NP_005543    NP_073733
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##    NP_079413    NP_065916    NP_945314    NP_055105
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## NP_001165780    NP_116178    NP_009293    NP_060549
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##            0            0            0            0
## NP_001182073    NP_056014    NP_775866 NP_001153705
```

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##    NP_942583    NP_982284    NP_002218    NP_003322
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##    NP_077719    NP_000426    NP_060087 XP_003960240
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##    NP_000030 NP_001003698    NP_005398    NP_612808
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##    NP_002826    NP_005104 NP_001127853 NP_001121113
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## NP_001107558    NP_058625    NP_005262    NP_036216
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##    NP_055692    NP_055680    NP_078799 NP_001257327
```

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##    NP_006477    NP_006476    NP_542164    NP_659412
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## NP_001098057    NP_653283    NP_002261    NP_038461
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## NP_001185463    NP_002493 NP_001070962    NP_002899
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##    NP_000866    NP_000199    NP_055030    NP_036424
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## NP_001245257    NP_055861    NP_006175    NP_036440
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##    NP_065813    NP_055665 NP_001258816 XP_003960178
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##    NP_852664    NP_005018    NP_852556    NP_003620
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##    NP_694985 NP_001191236    NP_060653 NP_001161328
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## NP_001093592 NP_001230368    NP_690868    NP_891554
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##    NP_009168    NP_787048    NP_060830    NP_005569
```

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## NP_001127870 NP_001001521    NP_006750    NP_060077
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## NP_001258547    NP_056969    NP_060686    NP_006245
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##    NP_001356    NP_003267 NP_001027454 NP_001027455
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##    NP_001340    NP_001646    NP_919254    NP_055869
```

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##     NP_060952    NP_003878    NP_004175    NP_002881
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##     NP_002944    NP_004577 NP_001006933    NP_055311
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##  NP_001124195 NP_001124194    NP_001684    NP_001683
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##     NP_976241    NP_061916    NP_056016 NP_001006635
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##  NP_001018003    NP_065731    NP_001075    NP_001141
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##     NP_001226    NP_004710    NP_008977    NP_004630
```

```
##            0            0            0            0
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## NP_001193826    NP_001610    NP_005151    NP_056477
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##    NP_005410    NP_006535    NP_061155 NP_001158886
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## NP_001158887    NP_002291    NP_659409    NP_002292
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##    NP_149972    NP_573441    NP_055852    NP_071415
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##    NP_056456    NP_055529    NP_065939 NP_001009571
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##    NP_003707    NP_899631    NP_064590    NP_570971
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##    NP_003306 NP_001138238    NP_067022    NP_982261
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##    NP_001957 NP_001188306    NP_001173 NP_001189333
```

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## NP_001123577    NP_112729    NP_150229    NP_003184
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##    NP_000510    NP_000550    NP_000175    NP_005321
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##    NP_057216    NP_002705 NP_001018079 NP_001018077
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##    NP_005913    NP_006517    NP_055465    NP_065704
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##    NP_872321    NP_067092    NP_660281 NP_001254645
##           14           21           19           30
## XP_003960003    NP_258429 NP_001230967    NP_057615
##            8            6           35           20
##    NP_612376 NP_001073886    NP_009069    NP_150376
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## NP_001070143    NP_612203 NP_001025168 NP_001034216
##           18           35           35           13
##    NP_065127    NP_001721    NP_004226    NP_005603
##           21           22           30           10
## XP_001715117 XP_003960812 NP_001243100    NP_009180
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##      NP_647537    NP_067013 NP_001231827 NP_001157260
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##   NP_001017962    NP_490597 NP_001186384    NP_031397
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##      NP_002429    NP_060272    NP_957516 NP_001005333
```

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##              0            0            0            0
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##      NP_002605    NP_689596 NP_001244210 NP_001026853
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##      NP_056990    NP_148980    NP_056506    NP_958850
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##      NP_056161    NP_055759    NP_599031    NP_599032
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##   NP_001193946 NP_001018494    NP_055491    NP_056132
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##      NP_065825    NP_596867    NP_391988    NP_000879
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##      NP_055523 NP_001093646    NP_000356    NP_073572
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##      NP_003130 NP_001243546 NP_001243547    NP_060828
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##      NP_005923    NP_056350 NP_001093894    NP_006313
##              0            0            0            0
##      NP_060458    NP_079426 NP_001258825 NP_001137474
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##      NP_001896 NP_001096078    NP_054727    NP_000687
##              0            6            0            0
##      NP_001317    NP_064551    NP_000081 NP_001107227
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##      NP_060867    NP_005733    NP_112223    NP_079029
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##      NP_075067    NP_057733    NP_065899    NP_055568
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##      NP_057507    NP_060082    NP_569829    NP_569831
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##      NP_000959    NP_000267    NP_005531    NP_861447
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##      NP_000161    NP_055211    NP_006793    NP_055684
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##   NP_001127854 NP_001104595 NP_001164209    NP_056047
##              0            0           10           10
##      NP_060264    NP_037528    NP_004276 NP_001254490
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##   NP_001254489    NP_001911    NP_008958    NP_000691
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##              0            0            0            0
##      NP_060628    NP_060496    NP_056012 NP_001254500
```

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##     NP_037386    NP_054721    NP_055542 NP_001184033
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##  NP_001129120 NP_001098714    NP_008981    NP_006339
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##     NP_075068    NP_002094    NP_068776    NP_060541
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##     NP_008982    NP_620137    NP_003225    NP_003218
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##     NP_612403    NP_277050    NP_078805    NP_004806
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##     NP_004597    NP_722516    NP_055336    NP_006829
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##     NP_003479    NP_003744    NP_009166    NP_075055
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##     NP_056348    NP_510965 NP_001258027    NP_055096
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##  NP_001258028    NP_060619    NP_955805    NP_003739
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##     NP_000924    NP_006199 NP_001124436    NP_006216
##             0            0            0            0
##  NP_001124432    NP_055453    NP_055983    NP_064578
```

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##    NP_056034   NP_054767   NP_065882 NP_001139784
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## NP_001257624 NP_001257628   NP_005920   NP_031394
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## NP_001001992 NP_001027582 NP_001193997 NP_001153239
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##    NP_056249   NP_061854   NP_055953   NP_002363
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##    NP_079436 NP_001108585   NP_004272   NP_115890
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##    NP_060555 NP_001121902   NP_000275 NP_001166927
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##    NP_005381   NP_000377 NP_001159583 NP_001122089
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##    NP_055527   NP_055863   NP_542414   NP_056464
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##    NP_079092   NP_065777   NP_060117   NP_003839
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##    NP_056155   NP_055758   NP_055850   NP_000364
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##   NP_001120792      NP_055662   NP_001245321      NP_006319
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##   NP_001185765      NP_003144   NP_001171551      NP_006712
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##   NP_006836   NP_115948   NP_002197 NP_001138468
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##   NP_065387   NP_004434   NP_004435   NP_004433
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##   NP_004431   NP_004429   NP_004432   NP_115285
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##   NP_079483 NP_001171821   NP_000523   NP_055929
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##   NP_036561   NP_203740   NP_777635   NP_001069
```

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##  NP_001008707 NP_001180197 NP_001186601 NP_001186600
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##     NP_056999    NP_542775    NP_004732    NP_057383
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##     NP_057421 NP_001230022    NP_004893 NP_001070819
```

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##    NP_997700    NP_002728    NP_002730 NP_001185688
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##    NP_002736    NP_002737    NP_002739    NP_002738
```

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##     NP_976227    NP_998801    NP_056377    NP_036364
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##     NP_066961    NP_057575    NP_002769 NP_001035930
##             0            0            0            0
##  NP_001035931    NP_005902    NP_000420    NP_071375
##             0            0            0            0
##     NP_001441    NP_061156    NP_940869    NP_060834
##             0            0            0            0
##     NP_149079    NP_065755    NP_002620    NP_000281
##             0            0            0            0
##  NP_001025062    NP_078849 NP_001244942 NP_001244944
##             0            0            0            0
##     NP_006357    NP_000475 NP_001129603    NP_006035
##             0            0            0            0
##     NP_149077    NP_005498    NP_619579    NP_003070
##             0            0            0            0
##     NP_000512    NP_065991    NP_073586 NP_001180449
##             0            0            0            3
##     NP_002071    NP_115824    NP_000099    NP_003189
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##     NP_006556    NP_001143    NP_001627    NP_001142
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##     NP_112581    NP_003749    NP_002892    NP_940916
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##     NP_056277    NP_009097    NP_055656    NP_002310
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##     NP_036244    NP_068751    NP_060627    NP_872363
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##  NP_001074324 NP_001230685    NP_079433    NP_057175
##             0            0            0            0
##     NP_775733    NP_001822    NP_078911    NP_683706
```

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##            1            0            0            0
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##    NP_079255    NP_689956    NP_003896    NP_000312
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## NP_001015001    NP_001816 XP_003960636    NP_071741
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##    NP_004688    NP_009103    NP_002257    NP_002703
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##    NP_036335    NP_055392    NP_056510    NP_001900
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##    NP_006812 NP_001032238    NP_689544    NP_116246
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##    NP_060457 NP_001032519 NP_001124181    NP_694955
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## NP_001035882 NP_001265154    NP_006378    NP_788276
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## NP_001244904    NP_003864    NP_005509 NP_001091742
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##    NP_003841 NP_001229281 NP_001020376    NP_775767
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##    NP_009135    NP_005745    NP_056211 NP_001253970
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##    NP_054873    NP_004444    NP_006089    NP_116294
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##    NP_002254    NP_001559 NP_001243307    NP_000022
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##    NP_004887    NP_443107    NP_006273    NP_006272
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## NP_001129490    NP_938074    NP_062828    NP_001814
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##    NP_001815    NP_001512    NP_036457    NP_036458
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##    NP_115687    NP_835237 NP_001013269    NP_002385
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##    NP_112506    NP_775752    NP_000128    NP_006416
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## NP_001139542    NP_996790    NP_006243    NP_055462
##            0            0            0            0
##    NP_113678    NP_001344 NP_001240837    NP_001345
##            0            0            0            0
## XP_003960903    NP_001809 NP_001177836    NP_036466
##            0            0            0            3
##    NP_004390    NP_690006    NP_006360    NP_003818
##           37            0            0            0
##    NP_071363 NP_001093326    NP_005227    NP_004665
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## NP_001248761    NP_004619    NP_036218 NP_001171114
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##            0            0            0            0
##    NP_002727    NP_062547    NP_057541    NP_002733
```

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##            0            0            0            0
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##    NP_002056 NP_001035919    NP_004131 NP_001186110
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## NP_001164187 NP_001164188 NP_001159450 NP_001120982
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##    NP_062817 NP_001243731    NP_001608    NP_689942
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## NP_001182484    NP_055481    NP_115825    NP_003361
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##    NP_005040 NP_001073901    NP_001212    NP_742126
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## NP_001189399    NP_001005    NP_006694    NP_068810
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## NP_001138610    NP_002950    NP_115515    NP_060422
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## NP_001003954 NP_001124163    NP_000935 NP_001135825
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##            0            0            0            8
##    NP_766638    NP_758962    NP_004987    NP_003777
##            2            0            0           10
##    NP_064693    NP_000343    NP_055875    NP_115683
##           19           23            0            0
##    NP_004466 NP_001171900    NP_005154    NP_001617
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##            0            0            0            0
##    NP_057023    NP_000043    NP_000044    NP_002083
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## NP_001091947    NP_003463    NP_060222 NP_001095896
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## NP_001077362    NP_055389 NP_001034966    NP_056244
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##    NP_006254    NP_788955    NP_003176    NP_005631
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## NP_001032242    NP_004505 NP_001032248 NP_001028755
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##    NP_005484    NP_065901    NP_001334 NP_001231800
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##    NP_001985    NP_002637    NP_003959    NP_937838
##            0            0            0            0
##    NP_004921 NP_001193469    NP_085133    NP_076417
##            0            0            0            0
##    NP_001427    NP_037522    NP_001290    NP_085059
```

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##    NP_003067 NP_001003801    NP_006581 NP_001243655
##            0            0            0            0
## NP_001243657    NP_057205    NP_612401    NP_056474
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## NP_001241652    NP_002716    NP_003923    NP_057213
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##    NP_068799    NP_036614    NP_073743    NP_872294
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##    NP_002107    NP_002108 NP_001229971    NP_005507
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## NP_001091949 XP_003961043    NP_002118    NP_001158
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## NP_001265362    NP_002726    NP_689799    NP_036585
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##    NP_064560    NP_109587    NP_002746    NP_115756
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## NP_001009555 NP_001122395    NP_055412    NP_003672
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## NP_001074295    NP_056513    NP_055956    NP_003785
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##    NP_001217    NP_003746 NP_001180289    NP_056355
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## NP_001159933 NP_001014436    NP_054782 NP_001116428
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##    NP_005558    NP_060650    NP_002328    NP_004679
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##    NP_004854    NP_714914 NP_001186011    NP_068813
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##    NP_061170    NP_004901    NP_004146    NP_109591
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##    NP_002631    NP_006208    NP_060392    NP_065799
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##    NP_057422    NP_055620    NP_005079    NP_068800
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##    NP_005909    NP_690869 NP_001128647    NP_055204
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## NP_001186170 NP_001028170    NP_006008 NP_001139322
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##    NP_003622 XP_003960526    NP_000119    NP_079478
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##    NP_077305    NP_005914 NP_001001671    NP_065994
##            0            0           11            0
## NP_001073981    NP_004752    NP_006257 NP_001034437
```

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##    NP_443111    NP_954658    NP_055772 NP_001029288
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##    NP_056451 NP_001073888 NP_001180317    NP_005267
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##    NP_006028 NP_001015053    NP_000963    NP_072047
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##    NP_057085    NP_076968    NP_005266    NP_742068
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## NP_001094058    NP_997657    NP_005479 NP_001129204
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## NP_001129201    NP_115791    NP_434700 NP_001248319
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## NP_001248324    NP_060688    NP_001406    NP_002070
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##    NP_065804    NP_065815    NP_000304    NP_004508
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## NP_001265370 NP_001139110    NP_037428    NP_001219
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## NP_001073594    NP_001388 NP_001124154    NP_690902
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##    NP_057300 NP_001078846    NP_002378    NP_003787
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## NP_001239570    NP_002887    NP_113680 NP_001185774
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##    NP_000662    NP_002371    NP_085072    NP_060150
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##    NP_002684    NP_005752 NP_001026895    NP_714916
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## NP_001121699 NP_001177317 NP_001107654 NP_001121100
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##    NP_003828    NP_899195 NP_001007562    NP_005875
```

```
##            0            0            0            0
##    NP_064553    NP_065074 NP_001124384    NP_006695
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## NP_001036038 NP_001020766    NP_055262    NP_037368
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## NP_001171846    NP_004298    NP_663722 NP_001002019
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##    NP_077734    NP_037395    NP_004929    NP_001339
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##    NP_055141    NP_000145    NP_055630 NP_001127696
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##    NP_055958    NP_065881    NP_001973 NP_001248340
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##    NP_056520    NP_065823    NP_003440    NP_808821
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##    NP_002697 NP_001028729    NP_808907    NP_036256
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##    NP_005383    NP_055922 NP_001171826    NP_055299
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##    NP_000526    NP_872578    NP_056516    NP_786924
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##    NP_060495    NP_003357    NP_009109 NP_001104262
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## NP_001156907    NP_004535    NP_060341 NP_001001976
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##    NP_008972    NP_005908    NP_064520    NP_852608
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## NP_001017973    NP_061848    NP_073713    NP_001320
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## NP_001012632    NP_001319    NP_002309    NP_112180
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##    NP_001113 NP_001012533    NP_005008 NP_001156736
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##    NP_036361    NP_060939 NP_001034662    NP_006566
```

```
##           0           3           0           0
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##   NP_003819 NP_001138422   NP_000433   NP_060501
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##   NP_060679   NP_006092   NP_065132   NP_002694
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##   NP_001269   NP_055735 NP_001229314   NP_954592
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##   NP_058632 NP_001248337   NP_005990   NP_055246
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## NP_001243125   NP_004324   NP_006779   NP_061877
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##   NP_058431   NP_005197   NP_004625   NP_997198
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##   NP_002035   NP_001473   NP_150644   NP_036356
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##   NP_631961   NP_004951   NP_002604   NP_055531
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## NP_001245308   NP_002330   NP_005409   NP_056504
```

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##    NP_055461    NP_057164    NP_116219    NP_060615
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##    NP_001156    NP_005566    NP_787116    NP_006316
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## NP_001245244    NP_004783    NP_006215    NP_036531
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##    NP_001600    NP_006209 NP_001157207    NP_065941
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##    NP_005237    NP_001996    NP_055362    NP_055363
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## NP_001257972 NP_001177666    NP_002492    NP_005587
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##    NP_005586    NP_060037    NP_002632    NP_065206
```

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##    NP_002601    NP_002602    NP_055918 NP_001248342
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##    NP_004815    NP_004816    NP_004671    NP_055534
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##    NP_002722 NP_001229787    NP_002723    NP_066272
##            0            0            0            0
##    NP_001101    NP_000962    NP_057122    NP_955392
##            0            0            0            0
##    NP_955393    NP_003278    NP_071905    NP_653296
```

```
##           0           0           0           0
##   NP_006861 XP_001717731 NP_001164014 NP_001164015
##           0           0           0           0
##   NP_002884   NP_005601 NP_001185648 NP_001128727
##           0           0           0           0
## NP_001128728  NP_059990   NP_000925   NP_061961
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##   NP_055866   NP_071682   NP_612477   NP_775882
##           0           0          31           0
##   NP_056290   NP_000933   NP_003895   NP_056147
##           0           0           0           0
##   NP_060220   NP_006259   NP_689928   NP_055639
##           0           0           0           0
## NP_001265099  NP_003430   NP_009080 NP_001128650
##           6           0           4           6
## NP_001265104  NP_689688 NP_001008401  NP_008886
##           6           6           2           6
##   NP_009084 NP_001103159 NP_001018854  NP_008900
##          18           3           3           0
##   NP_079038 NP_001131080 NP_001240728 NP_001123992
##           0           0          14           6
## NP_001013768 NP_001191385  NP_899061   NP_055604
##           8           3           6           6
## NP_001075949 NP_001078837  NP_065838 NP_001001662
##           6          29           0           3
##   NP_942596 NP_001258777 NP_001243582  NP_940859
##           5           3          30          19
##   NP_056936   NP_116217   NP_612383   NP_689816
##          27           9           0           6
##   NP_003407 NP_001166109  NP_872330 NP_001035275
##          11          15           3           2
## NP_001004301 NP_001166161  NP_612143 NP_001070146
##           0           0           8          21
## NP_001252526  NP_065906   NP_061983 NP_001265048
##           6          18          18           7
##   NP_008887   NP_116313 NP_001018855 NP_001001668
##           0           0          15          15
##   NP_443084   NP_003416   NP_066971   NP_689839
##           3          16          12           6
## NP_001166142 NP_001092096  NP_689570 NP_001138461
##          26          18          18           0
##   NP_112234   NP_003406   NP_666019   NP_689697
##          42           6          49           6
## NP_001008801  NP_848639   NP_008922 XP_003846493
##           0           8           7          16
##   NP_055532 NP_001008727 NP_001018857 NP_001129971
##          34           0           4           8
##   NP_997216 XP_003960942 NP_001121695  NP_149350
##           0           2           6           6
##   NP_848618   NP_008890 NP_001007249   NP_008889
##           2           6           6           7
##   NP_689668   NP_009076 NP_001096127   NP_079009
##          29           0          10           3
## NP_001229609 NP_001138906  NP_862828 NP_001191747
```

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##           3          12          14           1
##   NP_003399   NP_065708 NP_001156863   NP_699189
##           7           6           7           9
## NP_001265102  NP_597730   NP_689475   NP_116078
##           6          34           8           0
##   NP_055333   NP_872415   NP_940941   NP_694563
##          34          16           0           6
##   NP_597717   NP_005764 NP_001129507   NP_065156
##           6           6           0           0
##   NP_060297 NP_001026971   NP_005560   NP_619634
##           0           0           0           0
##   NP_004270   NP_065861   NP_000300   NP_056114
##           0           0           0           0
##   NP_065392   NP_009201   NP_000700 NP_001258395
##           0           0           0           0
##   NP_005474   NP_055238   NP_068746   NP_055871
##           0           0           0           0
##   NP_002336   NP_031377   NP_002681   NP_001659
##           0           0           0           0
## NP_001184254  NP_055677 NP_001026976   NP_000685
##           0          27           0           6
##   NP_000682   NP_000686   NP_002709   NP_060561
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##           0           0           3           0
##   NP_003747   NP_852478   NP_004292   NP_057272
##           0           0           0           0
##   NP_443122   NP_006615   NP_057594   NP_000033
##           0           0           0           0
##   NP_036266   NP_059982 NP_001119595   NP_056937
##           0           0           0           0
##   NP_004248   NP_056340   NP_116162 NP_001155251
##           0           6           0           0
##   NP_006288   NP_002824 NP_001013012   NP_000496
##           0           0           0           0
##   NP_001830   NP_004359   NP_002341 NP_001104567
##           0           0           0           0
##   NP_002101   NP_060919 NP_001121093   NP_057712
##           0           0           0           0
##   NP_567823   NP_055496   NP_004690   NP_036267
##           0           3           0           0
##   NP_000113 NP_001107563 NP_001095838   NP_000629
##           0           0           0           0
##   NP_002084   NP_063937   NP_001177   NP_001738
##           0           0           0           0
## NP_001185702  NP_001803   NP_060401   NP_060767
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##   NP_056210 NP_001138765   NP_006550   NP_006549
##           0           0           0           0
##   NP_689901   NP_079359   NP_003829 NP_001106279
##           0           0           0           0
##   NP_006491   NP_000511 NP_001124437 NP_001165415
##           0           0           0           0
## NP_001165416 NP_001107579  NP_055291 NP_001244892
```

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##              0            0            0            0
##      NP_005654    NP_060788 NP_001073919    NP_061973
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##      NP_060547    NP_078988 NP_001034813    NP_056123
##              0            0            0            0
##      NP_060579 NP_001243232 NP_001185867 NP_001185871
##              0            0            0            0
##      NP_000256    NP_075461 XP_003960990    NP_671704
##              0           43           58           52
##      NP_115758 NP_001138244    NP_054829 NP_001157685
##              0            0            0            0
##   NP_001230892    NP_004542    NP_006144 NP_001004720
##             19            0            0            0
##      NP_001074    NP_246273    NP_076982 NP_001180418
##              4            4            0            0
##   NP_001120686 NP_001096654 NP_001264242    NP_005882
##              0            0            0            0
##      NP_003791    NP_004138    NP_001379    NP_000176
##              0            0            0            0
##   NP_001171890 NP_001165908    NP_055883 NP_001171891
##              0            0            0            0
##   NP_001153651    NP_003194 NP_001188264    NP_000745
##              0            0           11            0
##      NP_443157    NP_056538    NP_004068    NP_057114
##              0            0            0            0
##      NP_004777    NP_036556    NP_443188    NP_000713
##              0            0            3            0
##      NP_002606    NP_002755    NP_002756    NP_008941
##              0            0            0            0
##      NP_071381    NP_003720    NP_079160    NP_001616
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##   NP_001186128    NP_055859    NP_619525    NP_037497
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##      NP_000960    NP_000427    NP_060273    NP_001598
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##      NP_003968    NP_056444    NP_149061    NP_071350
##              0            0            0            0
##      NP_054735    NP_001531    NP_060631    NP_004652
##              0            0            0            0
##      NP_005860    NP_775179    NP_060515    NP_060138
##              0            0            0            0
##      NP_110435    NP_001389    NP_076412    NP_003892
##              0            0            0            0
##      NP_055331    NP_006691    NP_277047 NP_001123544
##              0            0            0            0
##      NP_060427    NP_683723    NP_055779    NP_689725
##              0            0            0           54
##   NP_001159403    NP_056528    NP_056041 NP_001230332
##              0            0            0            0
##      NP_001216 NP_001129584 XP_003960209 NP_001096045
##              0            5            0            0
##      NP_443102    NP_002216    NP_057068 NP_001186190
##              0            0            0            0
##      NP_003725    NP_033720    NP_003375 NP_001074012
```

```
##             0            0            0            0
##     NP_057307 NP_001121700 NP_001139490 NP_001139488
##             0            0            0            0
##     NP_005834    NP_003464    NP_061940    NP_057231
##             0            0            0            0
##     NP_002175 NP_001171619 NP_001028219 NP_001171621
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##     NP_055686    NP_005198    NP_060139    NP_116764
##             0            0            9            0
##     NP_054745    NP_078894    NP_038466    NP_444295
##             0            0            0            0
##     NP_064516    NP_038472    NP_059509    NP_005556
##             0            0            5            0
##     NP_056170    NP_443094    NP_079012    NP_659731
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##     NP_002747    NP_002749 NP_001003962    NP_115706
##             0            0            0            0
##  NP_001171867    NP_065960    NP_060894    NP_444504
##             0            0            3            0
##     NP_001922    NP_066923    NP_055566    NP_612392
##             0            0            0            3
##     NP_005602    NP_624311    NP_060230    NP_078813
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##     NP_071760    NP_006633    NP_006704    NP_057195
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##     NP_064575    NP_114415 NP_001139632    NP_570602
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##     NP_002004    NP_055965    NP_037415    NP_060334
##             0            0            0            0
##  NP_001099026    NP_055752    NP_060873    NP_438171
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##     NP_002442    NP_006107    NP_036421    NP_998734
##             0            0            0            0
##     NP_006139    NP_006384 NP_001258537 NP_001120675
##             0            0            0            0
##     NP_078930 NP_001012321    NP_006828    NP_008921
##             0            0            0            0
##     NP_006637    NP_003790    NP_536350 NP_001095856
##             1            0            0            0
##     NP_892023    NP_005263    NP_000163    NP_056994
##             0            0            0           22
##     NP_536351 NP_001070957    NP_006563    NP_002061
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##     NP_006487    NP_002060    NP_031379    NP_620073
##             0            0            0            0
##  NP_001035997    NP_891552    NP_057058    NP_060586
##             0            0            0            0
##  NP_001243461    NP_060640    NP_067038    NP_113626
##             0            0            0            0
##     NP_065949    NP_071908    NP_006539    NP_006538
##             0            0            0            3
##     NP_006537    NP_036519    NP_057317    NP_847884
##             8            0           16            0
##     NP_115796    NP_003360    NP_001279 NP_001076437
```

```
##            0            0            0            0
##    NP_057327    NP_057452    NP_002991    NP_976325
##            0            0            0            0
##    NP_149991 NP_001165131    NP_037390    NP_660183
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##    NP_006222    NP_002906    NP_005350    NP_006308
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##    NP_006532    NP_062539    NP_001731    NP_004920
##            0            0            0            0
##    NP_689588    NP_065952    NP_060498    NP_056404
##           25            0            0            0
##    NP_077748    NP_006266    NP_005617 NP_001034554
##            0            0            0            0
##    NP_001372    NP_536739    NP_006627    NP_001935
##            0            0            0           32
##    NP_573571 NP_001136022    NP_009106    NP_006450
##            0            0            0            0
## NP_001257449    NP_056160 NP_001188356    NP_000167
##            5            2            2            0
##    NP_000892    NP_002907    NP_002660 NP_001129695
##            8            0            0            0
##    NP_055971 NP_001129696    NP_683759    NP_006126
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##    NP_006127 NP_001071168    NP_078888    NP_006409
##            0            0            0            0
##    NP_006065    NP_065970 NP_001018146 NP_001018148
##            0            0            0            0
##    NP_937818 XP_003960919    NP_004628    NP_116189
##            0            0            0            0
##    NP_006138    NP_075392 NP_001070254    NP_005056
##            0            0            9            0
##    NP_065701    NP_775818    NP_060825    NP_031396
##            0            0           10            0
## NP_001123584    NP_073745 NP_001003722    NP_056473
##            0            0            0            0
##    NP_006187    NP_065389    NP_127501    NP_004286
##            0            0            0            0
##    NP_996667    NP_821068    NP_065751    NP_005158
##            0            0            0           22
##    NP_000150    NP_839946    NP_001875    NP_075378
##            0            0            2           12
## NP_001013455    NP_001649    NP_001650    NP_001651
##            0            0            0            0
##    NP_001653    NP_057660    NP_006868    NP_004044
##            0            0            0            0
##    NP_848018    NP_777568    NP_003894    NP_068806
##            0            0            0            0
##    NP_037453    NP_055886    NP_006076    NP_000535
##            0            6            0            0
##    NP_055099 NP_001014841 NP_001121187    NP_055795
##            0            0            0           35
## NP_001020424 NP_001020423    NP_057531 NP_001265299
##            0            0            0            3
##    NP_004337    NP_963293    NP_963294    NP_060177
```

```
##            0            0            0            0
##    NP_258261    NP_653232    NP_689473    NP_079055
##           28           45            1            0
##    NP_003064 NP_001007469    NP_001887 NP_001091990
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##    NP_001350    NP_055623    NP_066953 XP_003960097
##            0            0            0            0
## NP_001116540 NP_001137504 XP_003960579 XP_001129774
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## XP_001718975 XP_003960166    NP_036277    NP_064715
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##    NP_689481    NP_078954    NP_055203    NP_003869
##            0            0            0            0
##    NP_000254    NP_055985 NP_001155313    NP_778236
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##    NP_008937 NP_001244259 NP_001244258 NP_001076582
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##    NP_663318    NP_689862    NP_065393    NP_722550
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##    NP_997403    NP_001924    NP_068598    NP_066012
##            0            0            0            0
##    NP_004782 NP_001258685    NP_443108    NP_653254
##            0            0            0            6
## NP_001013009    NP_613258    NP_613075    NP_061119
##            0            0            0            0
##    NP_620707    NP_620634    NP_620448 NP_001265477
##            0            0            0            0
##    NP_008920    NP_005919 NP_001108086    NP_000058
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##    NP_689522    NP_002655    NP_005850 NP_001128119
##            0            0            0            0
##    NP_079517    NP_037511 NP_001132929    NP_000159
##            0            0            0           10
##    NP_005261    NP_005260 NP_001123484    NP_004776
##           40           29            0            0
## NP_001239002    NP_071354    NP_001272    NP_009141
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##    NP_004473 NP_001229811 NP_001245383    NP_056195
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##    NP_079152    NP_005650    NP_003644    NP_071896
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## NP_001189431    NP_003565    NP_919415    NP_004729
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##    NP_005948    NP_055892    NP_001542    NP_001227
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##    NP_001748    NP_056089    NP_219482    NP_443070
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##    NP_002679    NP_004565 NP_001009939    NP_015556
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##    NP_060599    NP_001474 NP_001189398    NP_006741
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##    NP_006460    NP_851853 NP_001137416    NP_001410
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##    NP_004423 NP_001138247    NP_068771    NP_115657
```

```
##            0            0            0           51
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##    NP_808227 NP_001243615    NP_004584    NP_037425
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## NP_001229825 NP_001229826    NP_005594    NP_077816
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##    NP_821074 NP_001230405    NP_821075    NP_055478
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##    NP_666533    NP_054894 NP_001190176    NP_004447
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##    NP_001982    NP_036513    NP_009193    NP_000053
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##    NP_110414    NP_076991    NP_055472    NP_001405
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##    NP_056437    NP_003365    NP_005653    NP_652759
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##    NP_652760    NP_009096    NP_005264    NP_002065
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##    NP_067642    NP_004274    NP_002860    NP_940892
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##    NP_057614    NP_006852    NP_057238    NP_002861
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##    NP_004569    NP_055303    NP_002857    NP_002858
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## NP_001071105    NP_942599    NP_112586 NP_001258967
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##    NP_612462    NP_741995    NP_004785    NP_941959
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##    NP_004152    NP_005361 NP_001020471    NP_112243
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##    NP_008838    NP_722546    NP_067045 NP_001032208
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##    NP_114152 NP_001137472 XP_003846541    NP_004611
```

```
##            0            8            8            0
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##    NP_079105 NP_001012768 NP_001171590 NP_001171587
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##    NP_005750    NP_002782    NP_620581    NP_001306
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##    NP_149082    NP_060895    NP_065733    NP_689853
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## NP_001139669    NP_005504    NP_000192    NP_036344
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##    NP_065194    NP_003304    NP_002731 NP_001166110
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## NP_001020767    NP_006552 NP_001020247    NP_699204
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##    NP_031401 NP_001177344    NP_003081 NP_001012426
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##    NP_612466 NP_001231737 NP_001231739 NP_001231744
##            0            0            0            0
##    NP_008816    NP_078997    NP_055979    NP_115521
##           10           24            0            0
## NP_001093165    NP_031399    NP_077024    NP_005996
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##    NP_003633    NP_004663    NP_036370 NP_001001484
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##    NP_060295    NP_689485    NP_003174    NP_079172
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## NP_001032209    NP_060708    NP_149974    NP_079348
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##    NP_852136    NP_071413    NP_060648    NP_060275
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##    NP_061072    NP_065789 NP_001258766    NP_005443
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##    NP_001505    NP_055899 NP_001248363 NP_001129514
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##    NP_055824    NP_115901    NP_569119    NP_002827
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##    NP_004394    NP_055282    NP_002757    NP_002758
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## NP_001230871    NP_005044 NP_001257291    NP_002865
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##    NP_005724    NP_060672    NP_003110    NP_037367
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##    NP_000622    NP_060268 NP_001166599    NP_689971
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##    NP_006600    NP_002392    NP_054879    NP_006442
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##    NP_877590    NP_899152    NP_006181    NP_004413
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##    NP_004412    NP_004414    NP_004083    NP_060762
##            6            0            0            0
##    NP_005710    NP_060382    NP_055421    NP_114431
```

```
##            0            6            8            0
##    NP_003724    NP_006312 NP_001015055    NP_149035
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##    NP_001846    NP_150093    NP_872407 NP_001180363
##            0            0            0            0
## NP_001029097    NP_003243    NP_071505    NP_002943
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##    NP_758515    NP_006864    NP_006087    NP_002783
##            0            0            0            0
##    NP_003757    NP_060026 NP_001019386 NP_001009552
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##    NP_002711    NP_002706    NP_114108    NP_078817
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##    NP_057562    NP_006088 NP_001138417    NP_006462
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##    XP_373042    NP_003468    NP_071414    NP_079498
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##    NP_000843    NP_065997    NP_061820 NP_001005741
##            0            0            0            0
## NP_001243692    NP_110424    NP_006800    NP_059118
##            0            0            0            0
##    NP_057572    NP_958923 NP_001137259    NP_694453
##            0            0            0            0
##    NP_000503    NP_005300    NP_597700    NP_057094
##            0            0            0            0
##    NP_005785    NP_878912    NP_073742 NP_001035830
##            0            0            0            0
##    NP_054742    NP_115517    NP_006454    NP_115867
##            0            0            0            0
##    NP_006500    NP_620693    NP_001884    NP_001885
##            0            0            0            0
##    NP_055563 NP_001253989    NP_005643    NP_001202
##            0            0            0           15
##    NP_057373    NP_112187    NP_848632    NP_004716
##            0            0           56            0
##    NP_647473 NP_001166171 NP_001139478 NP_001070736
##            0            6            0            0
##    NP_064576    NP_000121    NP_003760    NP_006523
##            0            7            0            0
## NP_001124335    NP_006200    NP_001804    NP_004897
##            0            0            0            0
## NP_001229510    NP_940873    NP_004993    NP_056386
##            0            0            0            9
##    NP_065705    NP_079467    NP_003817    NP_064583
##           11            0            0            0
##    NP_000062    NP_002031    NP_060829    NP_612357
##            0            0            0            0
## NP_001254523    NP_055712    NP_660149    NP_000384
##            0            0            3            0
##    NP_115580    NP_115717    NP_001734    NP_006283
##            0            0            0            0
##    NP_002077    NP_987102    NP_000910    NP_004453
##            0            0            8            0
##    NP_058651    NP_060353 NP_001159898    NP_004648
```

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##            0            0            0            0
##    NP_077015 NP_001002009 NP_001002010    NP_002297
##           12            0            0            0
##    NP_002490    NP_001975    NP_005255    NP_665736
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##    NP_056364    NP_076994    NP_067653    NP_076970
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##    NP_078958 NP_001161694    NP_689657    NP_066949
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##            0            0            0            0
##    NP_062555    NP_057086    NP_705690    NP_689659
##            0            0            0            0
##    NP_036587    NP_031375    NP_001687    NP_542384
##            0            0            0            0
##    NP_005307    NP_000381    NP_001812    NP_002955
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##    NP_112178    NP_060518    NP_065987 NP_001163931
##            0            0            0            0
##    NP_002586    NP_002587    NP_001976    NP_001560
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##    NP_005090    NP_079131    NP_075047    NP_004123
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##    NP_002347    NP_075385    NP_620124 NP_001028740
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##    NP_002877 NP_001258115    NP_066361    NP_006408
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## NP_001120690    NP_057071    NP_653176    NP_061004
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##    NP_075066    NP_001788    NP_006589    NP_057366
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##    NP_056648    NP_001103    NP_598368    NP_009133
##            0            0            0            0
##    NP_057038    NP_071739    NP_064587    NP_005836
##            0            0            0           32
##    NP_009119    NP_775829 XP_003960280    NP_073741
##            0            0            6            0
##    NP_056005    NP_006636    NP_945327    NP_006766
##            0            0            0            0
## NP_001190991    NP_036203    NP_995319    NP_006120
##            0            0            0            0
##    NP_036597    NP_036596    NP_060232    NP_073620
##           11           23            1            0
## NP_001008661    NP_004050    NP_036269    NP_055577
##            0            3            0            0
##    NP_000775    NP_055670    NP_002909    NP_602304
##            0            0            0           11
##    NP_000626    NP_060012    NP_000704    NP_612409
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##    NP_055199    NP_008830    NP_064530 NP_001121181
##            0            0            0            0
##    NP_005333    NP_000117 NP_001121188    NP_006796
##            0            0            0            0
## NP_001139443    NP_057390 NP_001137299 NP_001137298
```

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##              0            0            0            0
##      NP_775102    NP_055785    NP_116759    NP_057132
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##              0            0           13           13
##   NP_001230228    NP_000138 NP_001263181    NP_002956
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##   NP_001035998    NP_060197    NP_055744    NP_631908
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##   NP_001193988 NP_001008530    NP_000525 NP_001121616
##              0            0            6            6
##      NP_569120    NP_004705    NP_060671    NP_055332
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##      NP_002195    NP_006853 NP_001077433    NP_064595
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##              0            0            0            0
##      NP_003548 NP_001129108    NP_003549    NP_857593
##              0            0           14            0
##   NP_001027539    NP_055330    NP_003289    NP_005780
##              0            0            0            0
##   NP_001025055    NP_000116    NP_690852    NP_057537
##             24            0            0            0
##      NP_775840    NP_002583 NP_001035787    NP_003307
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##      NP_004102    NP_115818 NP_001026897    NP_861448
##              0            3            0            0
##      NP_006206    NP_659486    NP_001729    NP_078859
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##      NP_057444 XP_003960482    NP_001280    NP_005538
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##      NP_056651    NP_036534    NP_065114    NP_060052
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##      NP_775740    NP_000368    NP_006406    NP_001789
##              0            0            0            0
##      NP_001777    NP_001249    NP_036557    NP_733779
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##      NP_663736    NP_004791    NP_056235    NP_003303
##              0            0            0            0
##      NP_060245    NP_071324    NP_060228    NP_006218
##              0            0            0            0
##      NP_001961 NP_001137232    NP_065123    NP_055095
##              0            0            0            0
##      NP_036234 NP_001136040 NP_001263215    NP_003013
##              0            0            9            0
##      NP_002932 NP_001122401    NP_079107    NP_998776
##             10           36            3            0
##      NP_004926    NP_003150    NP_036434    NP_055736
##              0           18            3           37
##      NP_000447    NP_940876 NP_001129511 NP_001185808
##              0            0            0            0
##      NP_004880    NP_899064    NP_863654    NP_863655
```

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##             0            0            0            0
##     NP_056273    NP_003807    NP_060559    NP_036270
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##     NP_057030    NP_064632    NP_000893    NP_775949
##             0            0            2            0
##  NP_001123498    NP_694953    NP_060317    NP_002018
##             0           19            0            0
##     NP_001899    NP_114110    NP_008929    NP_001052
##             0            0            0            0
##  NP_001138612 XP_003960877 NP_001107590    NP_001231
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##  NP_001026890    NP_079194    NP_006234    NP_078889
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##     NP_077286 NP_001264125    NP_940915    NP_116119
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##     NP_060544    NP_065921    NP_689763 NP_001092759
##             0            0           35           49
##     NP_060497    NP_055938 NP_001257904 NP_001257906
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##     NP_006808 NP_001137532    NP_116164 NP_001123617
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##  NP_001181973    NP_006097    NP_057386    NP_066983
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##     NP_006075    NP_002779    NP_996892    NP_000008
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##     NP_991403 NP_001247418    NP_004610    NP_003291
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##     NP_056182    NP_006320    NP_064709    NP_064512
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##  NP_001119809    NP_076413    NP_689876    NP_060517
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##     NP_003394    NP_996806 NP_001116698    NP_003482
##             0            0            5            0
##     NP_116082    NP_113673    NP_005917    NP_060761
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##     NP_113668    NP_002724    NP_057287    NP_059127
##             0            0            0           43
##     NP_031373 NP_001193581 NP_001193580 NP_001193582
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##     NP_056461    NP_002875    NP_008896 NP_001186743
##             0            0            0           14
##     NP_689567 NP_001123468    NP_037493    NP_065858
##            44           39           32           43
##     NP_037530    NP_085137 NP_001027544 NP_001076804
##            32            6           24            4
##     NP_037494    NP_659570    NP_689650    NP_852466
##            34           30           25            5
##     NP_958357    NP_005885    NP_001439    NP_005699
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##     NP_055908    NP_006068    NP_000020    NP_006281
```

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##     NP_067643    NP_789847    NP_001432    NP_071440
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##     NP_005717 NP_001139013    NP_079139    NP_525129
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##     NP_003192    NP_061857    NP_203747    NP_775922
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##     NP_976225 NP_001238978    NP_055660    NP_057260
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##  NP_001078926 XP_003960503    NP_671717 NP_001186621
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##     NP_963868    NP_005524 NP_001184224    NP_055717
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##     NP_892118    NP_057407    NP_060244    NP_787050
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##     NP_055439    NP_055313    NP_004555    NP_004986
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##     NP_056480    NP_004614    NP_002022 NP_001184147
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##  NP_001184149 NP_001098101    NP_006194 NP_001032417
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##     NP_004228    NP_073591    NP_112233    NP_036345
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##     NP_071933    NP_002200 NP_001116080    NP_001883
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##  NP_001258670 NP_001258671    NP_660204    NP_068811
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##     NP_002948    NP_005225    NP_003288    NP_008848
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##             0            0           16            0
##     NP_996895    NP_006794    NP_945344    NP_000966
```

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##            0            0           10            0
##  NP_001186731    NP_003646    NP_079087 NP_001136037
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##     NP_116249    NP_057041 NP_001153416    NP_006296
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##  NP_001119575    NP_055764    NP_387506 NP_001186779
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##     NP_001004    NP_068749 NP_001028693    NP_000467
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##     NP_777283    NP_061981    NP_000115 NP_001263987
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##     NP_057070    NP_079431    NP_002785 NP_001186708
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##  NP_001186709    NP_005779 NP_001138639    NP_110396
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##  NP_001153408    NP_002506    NP_002507    NP_006294
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##     NP_149075    NP_060366    NP_002572    NP_006232
##            6            0           24            0
##     NP_076415 NP_001139016    NP_000961    NP_003969
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##     NP_060092 NP_001153803 NP_001004439    NP_116262
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##     NP_061834    NP_149975    NP_003680    NP_036199
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##     NP_056272    NP_037505 NP_001171953    NP_004636
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##     NP_037524    NP_689794    NP_004314    NP_002574
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##     NP_003363    NP_057314    NP_065080    NP_851851
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##  NP_001017526 NP_001185650 NP_001028733    NP_060726
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##     NP_775738 NP_001073948 NP_001231293    NP_001931
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##     NP_115689    NP_705902    NP_078870    NP_683878
##            0            0            0            0
##     NP_059120 NP_001171564    NP_005495 NP_001171565
```

```
##            0            0            0            0
##    NP_036392    NP_001869    NP_001892 NP_001003652
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##    NP_065773 NP_001017405    NP_005165 NP_001001973
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## NP_001096645    NP_000916 NP_001191066    NP_057039
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##    NP_006388    NP_055706    NP_055926 NP_001070993
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## NP_001036083    NP_064519    NP_001801    NP_006346
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## NP_001001669    NP_002784    NP_000124    NP_149098
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## NP_001036182    NP_054699    NP_003678    NP_849193
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##    NP_057021    NP_060417    NP_071447    NP_068594
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##    NP_660341    NP_055323    NP_612467 NP_001165774
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##    NP_116233    NP_056142    NP_000598    NP_000599
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## NP_001008219    NP_066188    NP_057392    NP_004587
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##    NP_937863    NP_057117    NP_071439    NP_060421
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##    NP_060221 NP_001139130    NP_055900    NP_073617
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##    NP_036555    NP_075567    NP_060018    NP_078969
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##    NP_110425    NP_079223    NP_932157    NP_055829
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##    NP_003734    NP_055832    NP_777565    NP_061905
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##    NP_008975 NP_001014402 NP_001020331    NP_038475
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##    NP_570711    NP_002570    NP_056167    NP_996531
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##    NP_004459 NP_001092264    NP_037458    NP_058132
```

```
##           0           0           0           0
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##   NP_938204 NP_001164221   NP_006298   NP_006585
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## NP_001015881 NP_001230726   NP_006010 NP_001006934
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## NP_001265432   NP_057439 NP_001138304 NP_001106962
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##   NP_570899   NP_057060   NP_060158   NP_056131
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## NP_001230575   NP_056345   NP_060703   NP_076956
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## NP_001186744 NP_001186745 NP_001180237 NP_001123237
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##   NP_079148 NP_001138347 NP_001138348   NP_037498
```

```
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## NP_001191732 NP_001136151    NP_066284    NP_932349
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##    NP_789782    NP_005616 NP_001007070 NP_001092084
##            0            0            0           10
##    NP_057037    NP_689545    NP_060563    NP_076952
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##    NP_690866    NP_001834    NP_000098    NP_004290
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##    NP_942600    NP_060286    NP_006527    NP_004172
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##    NP_005861    NP_068750    NP_060106    NP_663615
##            0            0            3            0
##    NP_060140    NP_112485    NP_055138    NP_114440
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##    NP_005099 NP_001035374 NP_001165276    NP_003120
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##    NP_899646    NP_057584    NP_058634    NP_828847
##            0            0            0           15
## NP_001020092    NP_077306    NP_000285 NP_001245388
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##    NP_002416    NP_002413    NP_009214    NP_056399
##            2            0            0            0
##    NP_872282    NP_057665    NP_758454    NP_001400
##            0            0            0            6
##    NP_079108    NP_612451    NP_004119 NP_001257817
##            0            0            0            0
## NP_001257882    NP_077321 NP_001123952    NP_758961
##            0            0            0            0
##    NP_006865    NP_973728    NP_001412    NP_056326
##            0            0           17            0
##    NP_006315    NP_001352    NP_060654    NP_620150
##            0            0            0            0
##    NP_031385    NP_071941    NP_659453 NP_001180500
##            0            0            0            0
##    NP_001312    NP_064508    NP_000095    NP_002475
##            0            0            7            0
##    NP_003600 NP_001184252    NP_002834 NP_001189488
```

```
##             0            0            0            0
##     NP_002019 NP_001190992    NP_075050    NP_542199
##             0            0            0            0
##     NP_000382    NP_006103    NP_982281 NP_001018119
##             0            0            0            0
##  XP_003846661    NP_000066    NP_057301    NP_004872
##             0            0            0            0
##     NP_001638    NP_005964    NP_060850    NP_085131
##             0            0            0            0
##     NP_663612    NP_004077    NP_612373    NP_115737
##             0           50            0            0
##  NP_001092315 NP_001035173    NP_689594 NP_001186072
##             0            0            0           46
##  NP_001258762    NP_079177    NP_006811    NP_055161
##             0            0            0            0
##  NP_001139287    NP_003004    NP_004640    NP_036539
##             0            0            0            0
##     NP_775813 NP_001001974    NP_004830    NP_004263
##             0            0            3            0
##     NP_005814    NP_037536    NP_000178    NP_001303
##            53           53            0            0
##  NP_001257766    NP_000172    NP_057111    NP_777571
##             0            0            0            0
##     NP_001433    NP_002668    NP_000108    NP_004888
##             0            0            0            0
##     NP_079527    NP_443115    NP_057637    NP_002778
##            15            7            0            0
##     NP_055488    NP_006758    NP_001446    NP_002006
##             0            0            0            5
##     NP_005929 XP_002342143 XP_003960170    NP_002183
##            20            8            8            0
##  NP_001116293    NP_003002 NP_001234930    NP_115547
##             0            0            0            3
##  NP_001070667    NP_060616    NP_002788 NP_001124197
##             0            0            0            0
##     NP_009171 NP_001128659    NP_000299    NP_004773
##             0            0            0            0
##     NP_076983    NP_003695    NP_003266    NP_037485
##             0            8            0           45
##     NP_060376    NP_005527    NP_005993 NP_001135442
##             0            0            0            0
##     NP_055682    NP_149989    NP_009125    NP_665861
##             9            0            0            0
##     NP_060826    NP_060423    NP_079150    NP_005302
##             0            0            0            3
##     NP_008879    NP_612441    NP_004881    NP_001000
##             0            0            0            0
##     NP_005567    NP_113608    NP_060864    NP_000953
##             0            0            0            0
##     NP_003721    NP_064711    NP_653324    NP_064535
##             0            0            0            0
##  NP_001028675    NP_071446 NP_001129465    NP_694943
##             0            0            0            0
##     NP_000395    NP_078782    NP_598001 NP_001159643
```

```
##             0             0             0             0
##  NP_001159639     NP_002072     NP_003783     NP_694880
##             0             0             0             0
##     NP_002564     NP_001519     NP_005031     NP_003976
##             0             0             0             4
##  NP_001099009     NP_076418     NP_037462     NP_932076
##             3             3             0             0
##     NP_079217     NP_064555  NP_001035517     NP_005317
##             0             0             0             0
##     NP_060176     NP_115575     NP_689821     NP_060851
##             0            14             0             0
##     NP_061153     NP_005013     NP_000430     NP_004481
##             0             0            54            10
##     NP_000037  NP_001033073     NP_005340     NP_055091
##             0             8             0            16
##     NP_003965     NP_490647     NP_006727     NP_660157
##             0             0             0            16
##     NP_078974     NP_113669     NP_660186     NP_036443
##             0             0             0             0
##     NP_003674     NP_006708  NP_001010862  NP_001006682
##             0             0             0            16
##     NP_054892     NP_060874     NP_006860     NP_037520
##             0             0             0             0
##  NP_001136028     NP_000779     NP_037478     NP_003786
##             3             0             0             0
##     NP_000876     NP_003732     NP_872349     NP_067027
##             0            22             0             0
##     NP_004115     NP_004868     NP_056381     NP_006862
##             0             0            11             0
##     NP_006417  NP_001263199     NP_055690     NP_005462
##             8             3            21             0
##     NP_612208  NP_001257810     NP_001612     NP_000588
##             0             0             0             0
##     NP_060190  NP_001013863     NP_004829     NP_064621
##             0             0             0             0
##     NP_000024     NP_005155     NP_000182     NP_001046
##             0            36             0             0
##  XP_003960686     NP_001045     NP_803880     NP_057267
##             0             0             0             0
##     NP_005330     NP_067077     NP_006347     NP_658988
##             0             0             0             9
##     NP_695003     NP_002012     NP_060813  NP_001015877
##             0            14             0             0
##     NP_689759     NP_004790  NP_001243359     NP_004049
##             3            11             3             0
##     NP_814444     NP_004596     NP_006464  NP_001152862
##             0             0             3             0
##  NP_001229768  NP_001229769     NP_000844     NP_002801
##             0             0             0             0
##     NP_003366     NP_005958     NP_005957     NP_003115
##             0             0             7             0
##     NP_073753     NP_001655     NP_786886     NP_004031
##             3             0             0             0
##     NP_055503     NP_066959     NP_996734     NP_060481
```

```
##            3            0            6            0
##    NP_001074930    NP_114409    NP_057724    NP_006399
##            0            0            0            0
##      NP_789783    NP_115727    NP_003381 NP_001035982
##            0            0            8           17
##  NP_001245297 NP_001245299    NP_060947    NP_079510
##           17           23            0            0
##      NP_000971    NP_612450    NP_056139    NP_001613
##            0            3            0            0
##      NP_056338    NP_039268    NP_073606    NP_112601
##            0            0            0            0
##      NP_001660 NP_001011719    NP_000038    NP_008925
##           24           48           59            0
##      NP_008979    NP_660215    NP_008978    NP_060543
##            0            3           16           25
##      NP_001723    NP_006757    NP_036462    NP_055410
##           15            3            0            0
##      NP_003918    NP_000969 NP_001155133    NP_001670
##            0            0            0            0
##      NP_056534    NP_060733    NP_085135    NP_060601
##            0            0           24            2
##      NP_005432    NP_002805    NP_005207 NP_001034669
##            6            0            0           20
##      NP_005656    NP_037379    NP_659540    NP_444272
##            5            0            0            0
##      NP_079222    NP_065828    NP_006061    NP_057087
##            0            1            0            0
##  NP_001028691 NP_001098016 NP_001258933    NP_056445
##            0            0            2           26
##  NP_001007238    NP_071801    NP_003392    NP_060528
##           11            0            0            0
##      NP_006573    NP_036516    NP_149073    NP_004379
##            0            0            0            0
##      NP_783195    NP_543151    NP_057691    NP_004323
##            5            5            0            0
##      NP_005116    NP_005063    NP_005126 NP_001128243
##            0            3            9           14
##      NP_000294    NP_002667    NP_055418 NP_001041675
##            0            0            2            0
##      NP_005994    NP_066972    NP_872620    NP_003433
##            0            0            0            0
##      NP_003418    NP_056509 NP_001041631    NP_741996
##           13           30           41           57
##      NP_002959 NP_001004309    NP_000358 NP_001172023
##           56           35            0            0
##      NP_001230    NP_056125    NP_001011    NP_659484
##            0           18            0            0
##      NP_996668    NP_060277    NP_443080    NP_689953
##            5            0            0            0
##  NP_001035937    NP_689891 NP_001001794 NP_001243893
##            0            0           27            0
##      NP_115744    NP_071935    NP_057166    NP_937784
##            0            0            3           24
##      NP_057097    NP_002410    NP_653172    NP_056270
```

```
##            0           3           0           1
##    NP_060340 NP_001107000   NP_072045 NP_001191819
##            0           0           0           0
##    NP_001001   NP_954976   NP_061913   NP_002848
##            0           0           0           0
##    NP_003738   NP_079511   NP_002664 NP_001156729
##            8          17          10          58
##    NP_060909 NP_001138430 NP_001026866   NP_001363
##            0           0           0           0
## NP_001264044   NP_775899 NP_001070913   NP_056103
##            0           0           5           1
##    NP_955352   NP_073210   NP_079463 NP_001189367
##           58           0           0           4
##    NP_005975 NP_001243463   NP_037499   NP_002954
##            0           0           0           0
##    NP_789793   NP_110438   NP_065728   NP_005912
##            0           0           0          15
##    NP_940852 NP_001027536 XP_003846351   NP_877439
##            0           0           2           3
## NP_001254711   NP_001864   NP_071412 NP_001028255
##           13           5           0           0
##    NP_071902 NP_001139267 NP_001265618   NP_078940
##            2           0           0           0
##    NP_620148   NP_003559   NP_116186   NP_659434
##            0           0           0           9
##    NP_658985 NP_001010867   NP_036249   NP_057671
##            0           0           0           0
## NP_001120700 NP_001138349   NP_060383   NP_077001
##            0           0           0           0
##    NP_002412 XP_003960188   NP_001451   NP_789794
##            2          11          22           7
##    NP_000938   NP_057270   NP_077084   NP_002627
##            0           0           0           0
## NP_001165081   NP_009009 NP_001073583 NP_001165082
##            2           2           2          27
##    NP_001921 NP_001193903   NP_078925   NP_002790
##            0           0           1           0
##    NP_060380   NP_003745 NP_001027451   NP_003211
##            0           0           0           0
## NP_001035890   NP_003213   NP_003212   NP_848643
##            0           0           0           0
##    NP_758438   NP_116196   NP_065691 NP_001014305
##            3           0           0           6
##    NP_115677   NP_003788 NP_001231634   NP_997242
##            0           0           0          51
##    NP_057292   NP_057705   NP_060810   NP_055552
##            0           3           0           0
##    NP_114412   NP_003012 NP_001253975   NP_006582
##            0           0           1           0
##    NP_116098   NP_115500   NP_037457   NP_612385
##           10           0           0           0
##    NP_057303   NP_115698   NP_005497 NP_001191184
##            0           0           0           0
##    NP_036380   NP_060156   NP_000968   NP_004840
```

```
##            0            0            0            0
##    NP_066973    NP_542391    NP_061863    NP_085130
##            5            0            0            0
## NP_001170854 NP_001171608    NP_055727    NP_742128
##            0            0            0            0
##    NP_003627 NP_001186791    NP_003462    NP_683710
##            0            0            5            0
## NP_001138836    NP_689618    NP_116114 NP_001153208
##            0            5            0            0
## NP_001026880    NP_997229    NP_078922    NP_115690
##           22            0            0            0
##    NP_037533 NP_001099040    NP_004126    NP_777358
##            0            0            0            0
##    NP_061832    NP_588613    NP_079355    NP_997243
##            0            8            0           22
##    NP_203748 NP_001010888    NP_078887    NP_065778
##           14           17           17            6
##    NP_919299    NP_061896 NP_001171753    NP_005819
##            0            1            1            0
##    NP_006501    NP_004984    NP_060293    NP_036220
##            0            0            0            0
##    NP_055031    NP_060866    NP_859076    NP_009104
##            0            0            0            0
##    NP_002086    NP_849189    NP_055224    NP_056094
##            0            0            0            9
##    NP_598399    NP_821077 NP_001191435    NP_690618
##            0            4            9           11
## NP_001087194    NP_976049    NP_057710    NP_115622
##            0            0            5            5
##    NP_000584    NP_006055    NP_006561 NP_001161067
##            0            0            0            0
##    NP_976316    NP_005633    NP_071909    NP_031368
##            2            0            0            0
##    NP_003121    NP_079470    NP_036515    NP_060647
##            0            0            0            4
##    NP_001006    NP_005310    NP_005312    NP_005311
##            0            0            0            0
##    NP_005313    NP_005316    NP_005314    NP_000311
##            0            0            0            0
##    NP_443183    NP_064695 NP_001074007    NP_003336
##            0            0            0            0
## NP_001160163    NP_004319    NP_000137    NP_061139
##           13            0            0            0
##    NP_000378    NP_115885    NP_060930 NP_001243111
##            0            0            0           11
##    NP_056023    NP_000590 NP_001013416    NP_077078
##           15            0            0            0
##    NP_003285    NP_001654    NP_001647 NP_001186558
##            0            0            0            0
##    NP_066299    NP_524147    NP_000249 NP_001002841
##            0            0            0           21
##    NP_524144    NP_077310    NP_444251 NP_001129508
##            0            0            0           36
##    NP_004862 NP_001007026    NP_055819    NP_009139
```

```
##             0            0            0            0
##     NP_612444    NP_001562 NP_001184051    NP_002078
##             0            0            0            0
##     NP_003840    NP_056526    NP_073570 NP_001030312
##             0           10            0            0
##  NP_001240693    NP_057113    NP_036337    NP_071918
##             0            0            0           11
##     NP_006327 NP_001032726    NP_001198    NP_004682
##             3            0            0            0
##     NP_689778    NP_004681 NP_001257448    NP_055387
##             0            4            9           43
##     NP_005021    NP_002939 NP_001240313    NP_002422
##             8            0            0            0
##     NP_006160    NP_008976    NP_001008    NP_005702
##             0            0            0           28
##     NP_055814    NP_060386 NP_001244119 NP_001092885
##             0            0            0            0
##  NP_001177779    NP_077007    NP_055880    NP_005554
##             0            0           31            0
##     NP_008960    NP_055268    NP_114143    NP_071357
##             0            0            0            0
##     NP_036313 NP_001185727 NP_001185728    NP_000323
##             0            0            0            0
##     NP_079007    NP_006528 NP_001265612    NP_057095
##             0            0            4            0
##     NP_004291    NP_009030    NP_113663    NP_112486
##             0            0            6            0
##     NP_037364 NP_001012777    NP_055513 XP_003960281
##             0            0            1            0
##  XP_003960282    NP_612404    NP_055112    NP_588614
##             0            0            0           11
##  NP_001093214    NP_055538    NP_001786    NP_808818
##             0            3            0            0
##     NP_003109    NP_005189    NP_666499    NP_036212
##             0            0            0            0
##  NP_001171606    NP_653337    NP_660306    NP_001240
##             0            0           14            3
##     NP_004634 NP_001186793    NP_006616 XP_003960063
##             0            0            0            0
##     NP_542781    NP_036379    NP_057491    NP_038478
##             0            0            0           13
##  NP_001137498    NP_002786    NP_003711    NP_005393
##             0            0            0            0
##     NP_002872    NP_079202 NP_001243439    NP_000104
##             0            2            0            0
##  NP_001078816 NP_001238947    NP_835368    NP_058626
##             0            5            3            0
##     NP_056226 NP_001035934    NP_002712    NP_056347
##             0            0            0            0
##  NP_001018100    NP_057218    NP_067639    NP_689787
##             0            0            0            0
##     NP_060962    NP_055755    NP_000301    NP_078895
##             0            0            0            0
##     NP_115910 NP_001177396    NP_000495    NP_783322
```

```
##            0            0            0            0
##    NP_071761 NP_001182177    NP_778243    NP_004499
##            0            0            0            0
##    NP_150286    NP_006699    NP_006547    NP_689494
##            3            0            0            0
##    NP_056238 NP_001017926 NP_001025041    NP_079472
##            0            0           46            0
## NP_001103447    NP_055545    NP_057104    NP_006205
##           11            0            0            0
##    NP_071424    NP_443169    NP_008933    NP_006749
##            0            0            0            0
## NP_001020374    NP_659424    NP_065894 NP_001177386
##            0            0           23            0
##    NP_113631 NP_001025006    NP_000207    NP_004674
##            0            0           18           12
##    NP_000362    NP_001907    NP_004369    NP_002023
##            0            0            0            0
##    NP_001327    NP_001919    NP_037408    NP_000811
##            0            0            0            0
##    NP_001793    NP_004112    NP_002937    NP_057147
##            4            0            0            0
##    NP_077295    NP_006345    NP_065683    NP_002781
##            0            0           22            0
## NP_001129224 NP_001129225    NP_002873    NP_848604
##            0            0            0            0
##    NP_056982    NP_776185    NP_002966    NP_001863
##            0            0            0            0
##    NP_003244    NP_000572    NP_003155    NP_116201
##           12            0            0            0
##    NP_060309    NP_006545    NP_054893    NP_954994
##            0            0            0            0
##    NP_079422 NP_001129294    NP_001995    NP_009167
##            0            0            0            0
##    NP_115873 NP_001159743 NP_001166951    NP_056135
##            0            5           32           35
##    NP_694999    NP_954664    NP_004890    NP_053733
##            0            0            0            0
## NP_001010883    NP_001080    NP_061985    NP_079066
##            0           32           22           14
##    NP_001679    NP_062559    NP_079368    NP_006305
##            0            0            1            0
## NP_001092906    NP_001614    NP_004838    NP_056117
##            0            0            0            0
##    NP_060551 NP_001157814    NP_116181    NP_000469
##            0            2           18            0
##    NP_005014    NP_659436    NP_444284    NP_689775
##            0           12            6           12
##    NP_003077    NP_006824 NP_001034702    NP_112496
##            6            0            0            0
## NP_001036189    NP_002847    NP_005848    NP_803882
##            0            0            0            0
##    NP_660331    NP_665877    NP_005708 NP_001073331
##           19            0            0            0
## NP_001192048 NP_001258965    NP_065998 NP_001013728
```

```
##            0            0            0           14
##    NP_004055    NP_003780    NP_115553    NP_064536
##            0            0            0            0
##    NP_000895 NP_001265233    NP_149023    NP_057001
##            0            0            0            0
##    NP_066564    NP_003875    NP_005693    NP_004556
##            0           14            0            0
##    NP_060848    NP_114160    NP_066960    NP_849194
##            0            0            0            0
##    NP_848659    NP_077297    NP_001375    NP_005931
##            0            0            0            0
##    NP_055952    NP_005689    NP_542397    NP_443160
##            0            0            0           19
## NP_001003891    NP_065955    NP_775745    NP_057457
##            0           22            0            0
##    NP_976035    NP_006626    NP_775751 XP_003960920
##            0            0           58            8
##    NP_659413    NP_003408 NP_001124317    NP_998763
##           58            2           31            0
##    NP_710155    NP_115919    NP_067040    NP_060122
##            6            9           33            9
##    NP_659448    NP_114068    NP_055603    NP_077003
##           36            2            0            0
##    NP_932332    NP_004177    NP_057055    NP_003301
##            0           17            0            0
## NP_001093634    NP_620602    NP_689628 NP_001164432
##            0            0            0           17
##    NP_055921    NP_116264    NP_036289    NP_002890
##           23           14           32            0
## NP_001124464    NP_004802    NP_036307    NP_612361
##            0            0            0            0
## NP_001071087    NP_001893    NP_859526    NP_057224
##            0            0            0            0
##    NP_116259    NP_065107 NP_001108488    NP_620156
##            0            0            6            0
## NP_001171649    NP_004121    NP_006744 NP_001265871
##            0            0            0            9
##    NP_002677    NP_000422    NP_003338    NP_004273
##            0            0            0            0
##    NP_002843    NP_000428    NP_000091    NP_055991
##            0            3            0            0
##    NP_064524    NP_064533    NP_005763 NP_001010853
##            0            3            0            1
##    NP_003595    NP_004963    NP_004956    NP_001364
##           54            6            1            3
##    NP_579917    NP_036226    NP_113664    NP_056970
##            2            0            0           49
## NP_001091977 NP_001027464    NP_009191    NP_997320
##            0            0            0            0
## NP_001243404    NP_115587    NP_898871    NP_005245
##           35           50            0            0
##    NP_002032    NP_963839 NP_001129671    NP_001031
##            2            0            1            0
##    NP_612452    NP_115814    NP_003014    NP_055760
```

```
##            0           6           3           0
##  NP_001095871   NP_570721   NP_068597   NP_115528
##            5           0           0          11
##    NP_002640   NP_004627   NP_006014   NP_002643
##            8           5           0           0
##    NP_110394   NP_001688   NP_620130   NP_689600
##           11           0           2           6
##    NP_079351   NP_006244 XP_003960220   NP_056356
##            0           0           0          33
##    NP_700356   NP_112574   NP_056176   NP_055740
##           54           0           4           9
##    NP_057384   NP_001713   NP_064507   NP_054891
##           21           0           0           0
##  NP_001129333   NP_000388   NP_060590 NP_001193594
##            0           0           0           0
##  NP_001094346   NP_777593   NP_003759   NP_112217
##            0           0           0          14
##    NP_002124   NP_065118   NP_653182   NP_065207
##            0           0           0           3
##    NP_443149   NP_653168   NP_055634   NP_660095
##           22           0           0           9
##    NP_003005   NP_000437   NP_000931   NP_004070
##            0           0           0           0
##    NP_000537   NP_612393   NP_060389   NP_689786
##            9           0           0          16
##  NP_001002836   NP_055037   NP_000253 NP_001139400
##            0           0           0           3
##    NP_005081 NP_001108104   NP_057090   NP_004539
##            0           0           0           0
##    NP_065128   NP_006109 NP_001018238   NP_060036
##            0           0           0           0
##    NP_067026   NP_002922   NP_009143   NP_064528
##            0           0           0           0
##    NP_054786 NP_001005339   NP_057651   NP_510868
##            0           0           0           0
##  NP_001006618   NP_001258   NP_004454   NP_055431
##            0           0           2          18
##    NP_002576   NP_002577   NP_006186   NP_079521
##            0           0           0          47
##    NP_997227   NP_006558   NP_055100   NP_057726
##            0           0           0           0
##    NP_060633   NP_149080   NP_000582   NP_004662
##            0           0           0           0
##    NP_057250 XP_003960206 XP_003960203   NP_077005
##            0           3           3           0
##  NP_001193769 NP_001030331   NP_005810   NP_003756
##            6           0           0           0
##  NP_001258538 NP_001243549 NP_001243548   NP_004759
##            0           3           3           0
##    NP_055969 NP_001171940   NP_113614   NP_060104
##            0           5           0           0
##    NP_000615   NP_006212   NP_003249   NP_112240
##            0           0           0           0
##    NP_008826   NP_068744   NP_000967   NP_060241
```

```
##            0            0            0            0
##    NP_001902    NP_997244    NP_006051 NP_001207695
##            0           29            0            0
##    NP_057344    NP_071910    NP_038474    NP_005655
##            4            7            0           11
##    NP_115766    NP_071895    NP_057558    NP_004568
##            0            3            0            0
##    NP_005863    NP_002688 NP_001193954    NP_055167
##            0            0            0            0
## NP_001035784    NP_620149    NP_892117    NP_001435
##           17            0            0            0
## NP_001161726    NP_004996    NP_056140    NP_003670
##            0            0           20           26
##    NP_005460 NP_001071131 NP_001071132    NP_056299
##            0            1            1            0
##    NP_055059 NP_001265576    NP_055058    NP_078914
##           19           30           49            0
##    NP_116199    NP_002792    NP_005092    NP_937872
##            0            0            0           10
##    NP_060609    NP_057258    NP_689478    NP_003409
##            6            1            0            0
## NP_001120665 NP_001120664    NP_055984 NP_001128529
##            0            0            0            0
##    NP_002353 NP_001011543    NP_004979 NP_001159872
##           11           53           43           43
##    NP_722517    NP_079130    NP_612461 NP_001010854
##            0            3            0            5
##    NP_116558    NP_055178    NP_005774    NP_004903
##            0           10            0            9
##    NP_067075 NP_001243340    NP_001078    NP_055020
##            0            0            0            0
##    NP_055070 NP_001116224    NP_851939 NP_001030024
##            0            3            0           10
##    NP_006330    NP_114140    NP_003378    NP_775781
##            0            0            0            3
##    NP_055567 NP_001032354    NP_057226    NP_060933
##            0            0            0            0
##    NP_005925    NP_003078    NP_003076 NP_001243384
##            0            0            0            0
##    NP_075387    NP_114091    NP_002155 NP_001258975
##            7            2            4           33
##    NP_008850    NP_002965    NP_060283 NP_001116801
##           51           50            0           14
##    NP_006658    NP_006311 NP_001002295    NP_116027
##            0            0            0            0
##    NP_002043    NP_536721    NP_851996    NP_000606
##            2            2           44           44
##    NP_116204    NP_060368    NP_073583    NP_060285
##            0            0            0            0
##    NP_055646    NP_036432    NP_378663 NP_001243785
##            7            3            7            6
##    NP_004595    NP_055502    NP_036311    NP_055482
##            0            5            0            0
## NP_001121691    NP_060521    NP_075394    NP_000777
```

```
##            0          11           0           3
##    NP_061845   NP_002544   NP_054888   NP_066552
##            0           3           0           0
##    NP_036204   NP_036595   NP_006471   NP_000185
##            0           3           2           0
##    NP_065928   NP_803173   NP_115700 NP_001070914
##            8           0           0           0
##    NP_060453   NP_079345   NP_116161   NP_056465
##            0           0          24           0
## NP_001009894   NP_071926 XP_003119578 NP_001029366
##            0          18           0           0
##    NP_060023   NP_115729   NP_000937   NP_057480
##           17           0           0           0
##    NP_055731   NP_689939   NP_112597   NP_005391
##            0           0           4           0
##    NP_006246   NP_542398   NP_006053   NP_060480
##            0           0           0           3
##    NP_060545 NP_001191763 NP_001191761   NP_787103
##            0           0           0           0
##    NP_940887   NP_114429   NP_001870   NP_624302
##            2           3           0           0
## NP_001027019   NP_071441   NP_057490   NP_065108
##            0           0           0           0
##    NP_055610 NP_001167567   NP_005709 NP_001185722
##            0          52           0           0
## XP_003960151   NP_004672   NP_851808 NP_001229344
##            0           0           1          12
##    NP_443723 NP_001138501   NP_060379   NP_056091
##            3           0           0           0
## NP_001138545   NP_958443   NP_055250   NP_006784
##            5          31           0           0
## NP_001157567 NP_001172110   NP_056020   NP_006629
##            0           0          16           0
##    NP_000046   NP_065142   NP_059993   NP_954590
##            0           0           0           0
##    NP_006684 NP_001123357   NP_005855   NP_115719
##            0          57           3           0
##    NP_848591   NP_006434   NP_954653 NP_001265280
##            0           0           0          29
##    NP_004801   NP_060745   NP_056284   NP_060846
##            0           0           0          15
##    NP_002008 NP_001161153 NP_001129626 NP_001257939
##            2           2          13           2
## NP_001129627   NP_059991 NP_001020419 NP_001122080
##           13          36           0          22
##    NP_000296   NP_653265   NP_689873 NP_001137384
##            0           0           2           2
##    NP_060089   NP_004090   NP_005987   NP_005985
##            0           0           0           0
## NP_001182665 NP_001186506   NP_570115   NP_000970
##            0           0           0           0
##    NP_060849 NP_001035540   NP_036606   NP_113620
##            0           2           0           0
##    NP_116172   NP_065851 NP_001026882   NP_006001
```

```
##           0           3           3           0
## NP_001129206   NP_689706   NP_055288   NP_076959
##           0           4           0           0
## NP_001034937   NP_061989   NP_003253   NP_056325
##           0           0           0           0
##    NP_665807   NP_004547   NP_006369   NP_055585
##           0           0           8           3
## NP_001116244   NP_057269 NP_001002033   NP_689505
##           2           0           0           1
##    NP_000987   NP_653210   NP_057118   NP_068779
##           0           0           0           0
##    NP_056256   NP_872293   NP_003917   NP_085148
##           0          26           0           0
##    NP_055533   NP_612366   NP_612142   NP_085151
##          17           0           0           0
##    NP_073571   NP_808807   NP_665858   NP_036359
##           3           1           0           0
##    NP_003816   NP_115584   NP_477520   NP_116032
##           0           0          28           0
##    NP_061158   NP_689518   NP_003934   NP_037438
##           0           0           0           0
##    NP_000190   NP_056144   NP_060445   NP_054808
##           6           0           0           0
##    NP_006338   NP_116265   NP_443089   NP_036231
##           0           8           0           0
##    NP_056061   NP_443148   NP_061895 NP_001138503
##           0          12           0           0
##    NP_659477   NP_060242   NP_443204   NP_057358
##           0           0           0           2
##    NP_002308   NP_919424   NP_077284   NP_056950
##           0           0           0          21
##    NP_036363   NP_073567   NP_068572   NP_444252
##          21           0           0           0
##    NP_002619 NP_001002294   NP_079428   NP_775099
##           0          55           0           7
##    NP_001131   NP_775106   NP_060560   NP_056324
##          34           3           0           0
##    NP_000975   NP_006135 NP_001238968   NP_004153
##           0           0           0           0
## NP_001238965 NP_001231630   NP_008818   NP_004917
##           0           0           0           0
##    NP_001656   NP_061485   NP_002863   NP_005043
##           0           0           0           0
##    NP_001782   NP_426359   NP_036381   NP_065714
##           0           0           0           0
## NP_001001563   NP_004647   NP_620412   NP_733839
##           0          14           0           0
##    NP_002433   NP_076943   NP_060017   NP_057034
##           0           0           0           0
##    NP_005677   NP_008871 NP_001139291   NP_036610
##           4          26          26           0
##    NP_057154   NP_057152 NP_001002913   NP_073581
##           0           0           0           3
##    NP_057616   NP_056137   NP_005508 NP_001188292
```

```
##             0            5            0            3
##     NP_006344    NP_004233 NP_001188291    NP_001536
##             6            3            3            0
##     NP_787117 NP_001138467 NP_001185624    NP_006285
##             0            3            0            0
##  NP_001186904    NP_055547    NP_002804 NP_001161212
##             0            0            0            0
##     NP_077304    NP_057110 NP_001186752    NP_006147
##             0            0            0            0
##  NP_001186750    NP_116193    NP_776186    NP_954673
##             0            0            0            0
##     NP_003341 NP_001027459    NP_068823 NP_001244324
##             0            0            0            0
##  NP_001244326    NP_954580 NP_001123556    NP_003456
##             0           27            5           48
##     NP_009129    NP_060372    NP_689449    NP_078976
##             0            0            0            0
##     NP_060338 NP_001020279    NP_002052    NP_057731
##             3            9            0            0
##     NP_005172    NP_000144 NP_001138582    NP_060758
##             0            0           48            0
##     NP_006080    NP_079106    NP_060069    NP_002446
##             9            0            9            0
##  NP_001108224    NP_004381    NP_612377    NP_075566
##             0            0            3            0
##     NP_689488    NP_689730    NP_005555    NP_055730
##             7            7            0            0
##     NP_612486    NP_000845    NP_004209    NP_004654
##            13            0            0            0
##     NP_003977    NP_065109    NP_001879    NP_004214
##            20            0            2            0
##     NP_003152    NP_003286    NP_997305    NP_004315
##             0            0            0            0
##  NP_001138792 NP_001186284    NP_057479    NP_000478
##            25            0            0            0
##     NP_056028    NP_659410 NP_001122400    NP_997263
##             1            6            0            9
##     NP_055557    NP_057107    NP_006782    NP_996670
##             0            0            0            0
##  NP_001135891    NP_612505    NP_065228    NP_689968
##             0            0           36            0
##     NP_005680 NP_001136202 NP_001245151 NP_001123466
##             4            0            0            0
##     NP_689608    NP_115725 NP_001165377    NP_694950
##             0            0            0            0
##     NP_663781    NP_001545 NP_001073982    NP_001013
##             0            0            0            0
##     NP_002563    NP_149163 NP_001107609 NP_001107607
##             0           18            2            2
##     NP_078846    NP_008987    NP_919261 NP_001243370
##             0            3           12            0
##     NP_003038    NP_060116    NP_001689    NP_005477
##             4            3            0            0
##     NP_065843 NP_001013679    NP_114430    NP_002140
```

```
##            0            0            0            0
##    NP_061882    NP_005435    NP_000601    NP_057042
##            0            0            0            0
##    NP_115898    NP_694587    NP_055836    NP_116245
##            0            3           15            1
##    NP_056494    NP_003901    NP_998766    NP_006822
##            0            0            0            0
## NP_001124198 NP_001123553    NP_002653    NP_006469
##            3           26           26            2
##    NP_071942    NP_036373 NP_001229756    NP_065095
##            0            0            0            0
##    NP_689741    NP_663729 NP_001035350    NP_208382
##            0            0            7           56
## XP_003960218    NP_057128    NP_955368 NP_001186102
##            0            0            0            0
##    NP_733468    NP_055685 NP_001092198    NP_001506
##            0           16            0            0
##    NP_003784    NP_061720    NP_060292    NP_057047
##            0            3            3            3
##    NP_060085    NP_113638    NP_037541    NP_065090
##            8            0            3            0
##    NP_937802 NP_001171896    NP_006512 NP_001161299
##            0            3            3            0
##    NP_060093    NP_663786    NP_001010    NP_006067
##            2            0            0            0
##    NP_277037    NP_679211    NP_057569    NP_115721
##           27            3            0            0
## NP_001137325    NP_061326    NP_002370    NP_115598
##            0            0           58           36
## NP_001076047    NP_061193    NP_006322    NP_057673
##            0            0            0            0
##    NP_036330    NP_006735    NP_001912    NP_005015
##            0            0            0            2
##    NP_055321 NP_001131147    NP_619649    NP_003003
##            0            0            0            0
##    NP_056054    NP_689549    NP_000305    NP_055939
##            3           55            0            5
##    NP_689619    NP_060667    NP_955459    NP_065177
##            1            5            5            0
##    NP_005772 NP_001010938    NP_694946    NP_000594
##            8            8            4           12
##    NP_003851    NP_003423 NP_001177203 NP_001015052
##            0            8            1            0
##    NP_006806    NP_061901    NP_056151    NP_620162
##            0            0            6            0
##    NP_149014    NP_057044    NP_000982 NP_001129606
##           23            0            0            0
##    NP_004093 NP_001185986    NP_004848    NP_004822
##            0            0           12            0
##    NP_612423    NP_112182    NP_543023 NP_001026854
##            0            0           14            0
##    NP_003008    NP_859067    NP_000851    NP_005185
##            0            0            0            0
##    NP_059980    NP_872353    NP_694942 NP_001001890
```

```
##           0           0          21           0
## NP_001019801 NP_001026850   NP_055053   NP_004130
##           0           0          10           0
## NP_001108225 NP_001231319   NP_078838   NP_003148
##           0           0          15          36
##   NP_055565   NP_060009   NP_443167   NP_000651
##           9           3           3           0
##   NP_003229   NP_001981   NP_002686 NP_001005498
##           3           0           0           6
##   NP_078875   NP_005608   NP_115813 NP_001003681
##           6           0          20           7
##   NP_000262   NP_004335   NP_004057   NP_085153
##           3           0           6           0
##   NP_002014   NP_004375 NP_001257502   NP_071331
##           0           4           4           3
##   NP_001310   NP_079091   NP_775965   NP_003874
##           4           0          17           0
##   NP_006834   NP_116253   NP_006261   NP_036382
##           0           0           0           0
##   NP_076998   NP_065945   NP_001250   NP_009152
##           0          10           0           0
## NP_001186583   NP_002344   NP_116321   NP_055515
##           0           0           0           3
##   NP_714913   NP_060818   NP_005898   NP_003493
##           0           5           0           8
##   NP_219484   NP_699179   NP_056136   NP_115568
##           0           2           0           0
## XP_003846564   NP_061967   NP_060629   NP_054758
##           0           0           0           0
## NP_001009880   NP_056442   NP_000147   NP_064708
##           0           0           0           0
##   NP_060670   NP_076425   NP_005473 NP_001166038
##           0           0           0           0
##   NP_001136   NP_694968   NP_000597   NP_057487
##           0           0           0           0
##   NP_690000 NP_001025067   NP_954655   NP_001135
##           0           0           0           8
##   NP_076990   NP_037359   NP_001271 NP_001264003
##           3           9           0           0
##   NP_653317   NP_078832   NP_079353   NP_115736
##           0           0           0           0
##   NP_001747   NP_001928   NP_036613   NP_777553
##           0           0           4           0
## NP_001136271   NP_006768 NP_001177809   NP_056286
##           0           7           0           0
##   NP_006847   NP_001871 NP_001243020   NP_037392
##           0           0           0           0
##   NP_002487   NP_060510   NP_056481   NP_002415
##           0           0           3          14
##   NP_055383 NP_001020330   NP_004346 NP_001182237
##          17           0           0           0
## NP_001128658   NP_057512   NP_061919   NP_115514
##           0           0           0           7
##   NP_690867 NP_001164606   NP_005359   NP_003401
```

```
##           9           0           0           6
##   NP_003402   NP_068838   NP_057134   NP_001116
##           6          31           0           0
##   NP_003007   NP_054783   NP_079111   NP_000146
##           0           0           7           0
##   NP_003269   NP_110439   NP_000952   NP_115742
##           0          10           0           0
## NP_001035250   NP_036271   NP_056453 NP_001185619
##           0           1          14           0
##   NP_060605   NP_061984 XP_003846515 XP_003120317
##           0           0           0           0
##   NP_060611   NP_057026   NP_066285   NP_005645
##           0           3           0           2
## NP_001138627   NP_066300   NP_005743 NP_001231684
##           0           7           0           0
##   NP_056369   NP_006805   NP_057279 NP_001230707
##          25           0          17           0
## NP_001159715   NP_001299   NP_631918   NP_115735
##           0           0           3           0
##   NP_073582   NP_734467   NP_996898   NP_000972
##           0           0           8           0
##   NP_076962   NP_003205   NP_068780 NP_001243589
##           0           0           0           0
##   NP_003204   NP_003246   NP_004660 NP_001036065
##           0           0           0           4
##   NP_057329   NP_004522   NP_001510   NP_001488
##           0           0          17           0
##   NP_004767   NP_001027   NP_004857   NP_001493
##           7           4           0           0
##   NP_073576 NP_001186776   NP_065162   NP_057185
##           0           6           6           0
##   NP_006560 NP_001159713   NP_006321 NP_001266289
##           3          37           0           0
## NP_001266288   NP_065969   NP_060897   NP_003093
##           0          13           8           0
##   NP_000366   NP_057474   NP_775811   NP_919258
##           0           3           0           3
## NP_001108479   NP_116575   NP_116231   NP_005315
##           3          30           5           0
##   NP_003520   NP_066403 NP_001013721   NP_000036
##           0           0           0          17
##   NP_004242   NP_055643 NP_001073899   NP_055544
##           0           0           0          12
## NP_001092268   NP_002417   NP_001026   NP_000531
##           3          16          27          17
##   NP_005792   NP_005866   NP_653244   NP_004283
##           0           0          12           8
##   NP_001361   NP_112242   NP_036357   NP_057033
##           6           0           0           0
##   NP_006690   NP_055671   NP_001374   NP_067052
##           7           3           0           6
##   NP_060786 NP_001185787 XP_003119309   NP_072049
##          10          54           0           0
##   NP_002115 NP_001230894 XP_003846510   NP_002116
```

```
##             0            0            0            0
##  NP_001230890    NP_002112 NP_001230891    NP_079225
##             3            0            3            6
##     NP_060911 NP_001093136    NP_078852    NP_006705
##             0            0            0            2
##     NP_060832    NP_004655    NP_071448    NP_002529
##             0            0            0            0
##  NP_001001795    NP_689880    NP_002680    NP_075046
##             0            0            6            0
##     NP_001154    NP_005494    NP_065995    NP_065912
##             5           10           14            5
##     NP_005756    NP_940983    NP_009027    NP_001824
##             0            0            0            0
##     NP_113611    NP_057253    NP_057692    NP_055148
##             8            0            3            0
##  NP_001020272    NP_002376    NP_055135    NP_004461
##             0            4            0            0
##     NP_004467    NP_710163 NP_001020787    NP_112595
##            46           57            2            5
##     NP_077025    NP_003657    NP_005331    NP_112235
##             0            6            0            0
##     NP_059128    NP_000048    NP_000782 NP_001182572
##             5            0            0            3
##     NP_079514    NP_060267    NP_258412    NP_002820
##             1            4            0           25
##  NP_001171829 NP_001106678    NP_056006 NP_001229774
##             0            0           23            0
##  NP_001128245    NP_003754 NP_001001433    NP_115810
##             0            0            0           16
##     NP_597719    NP_001601    NP_055157    NP_003230
##             5            0            0            2
##     NP_006597    NP_001847    NP_065101    NP_004168
##             0            0            0            0
##     NP_006328    NP_056485    NP_001267    NP_056518
##            21            0           43            0
##     NP_060613    NP_003019 NP_001263990 NP_001263991
##             3           14            0            0
##     NP_037468    NP_076999    NP_776152 NP_001136336
##             0            0           16           23
##     NP_653171    NP_003355    NP_003912    NP_689805
##             0            0            0           33
##     NP_036553    NP_775821    NP_060259    NP_006818
##            31           23            8            0
##     NP_001544    NP_620775    NP_006432 NP_001186689
##             0            5            0            0
##     NP_037481    NP_000995    NP_000994    NP_006336
##             0            0            0            6
##     NP_002504    NP_056251    NP_612426 NP_001107803
##             0            0            0            6
##     NP_733746 NP_001138740    NP_006233    NP_054765
##             0            4            0            0
##     NP_009039    NP_996896 NP_001254652    NP_056245
##             0            0            0           20
##     NP_612430    NP_612432    NP_000425    NP_996925
```

```
##            6           11            0            0
##    NP_006619    NP_996928    NP_619727    NP_006859
##            0            0           15            0
##    NP_065724    NP_005773    NP_006521 NP_001139643
##            0            0            0            0
##    NP_150280    NP_055302    NP_000132 NP_001138385
##            4            0           11           11
## NP_001138387 NP_001167538    NP_002002 NP_001156685
##           11            9           11            8
##    NP_659547    NP_003815    NP_877429    NP_653180
##            0            0            0            2
##    NP_859070    NP_055753 NP_001138947 NP_001008712
##            0            7           23            0
## NP_001008710    NP_919248    NP_004598 NP_001231496
##            0            0            0            0
##    NP_075565    NP_003560    NP_077002    NP_667339
##            0            0            0            0
##    NP_115644    NP_848613    NP_064582    NP_065726
##           53            5            0            1
##    NP_079437    NP_065191    NP_057714    NP_004271
##           20            0            0            0
##    NP_004837 NP_001124439    NP_055230    NP_001630
##            0            0           23            0
##    NP_054781    NP_689813    NP_057698 NP_001265409
##            0            0            0            7
## NP_001094896    NP_061159    NP_065104    NP_001553
##           11           38            0            0
##    NP_060218    NP_002203    NP_058642    NP_037374
##            3            0            0            0
## NP_001092872    NP_003860    NP_690049    NP_775786
##            0            0            0           27
## NP_001230631    NP_665741    NP_291022    NP_056511
##            6            5            0            0
##    NP_001968    NP_937859    NP_000978    NP_057177
##           11            0            0            0
##    NP_848599    NP_741999    NP_001861    NP_065137
##            0            0            0            0
##    NP_004468 XP_003846787 XP_001721838 XP_002343932
##            0            6            6            6
## XP_003403890    NP_653218    NP_071936    NP_071898
##            6            0            0            0
##    NP_002791    NP_116229    NP_115647    NP_004992
##            0            0            3            0
##    NP_005176    NP_057600    NP_620048    NP_004873
##            0            6           44            2
## NP_001034782    NP_085139    NP_005701    NP_652766
##            0           10            0            0
##    NP_296373    NP_057399 NP_001026883    NP_006379
##            2            0            0            9
##    NP_872418    NP_055494 NP_001230705    NP_057228
##            0            3            3            0
##    NP_006577    NP_004976    NP_203524    NP_002515
##            0            0            0            0
##    NP_005334    NP_057623    NP_113641    NP_004948
```

```
##           0            0            0            0
##   NP_002154    NP_006113    NP_542937    NP_004383
##          11           11            3            3
##   NP_444511    NP_060255    NP_775826    NP_033665
##          26           29            3            0
## NP_001035167    NP_071906    NP_003300 NP_001094089
##           0            2            0            2
##   NP_001941    NP_001942    NP_950245    NP_000203
##           0            3            0           13
##   NP_942590    NP_002566    NP_057494    NP_113651
##           0           44            0            0
##   NP_056410    NP_612510    NP_054797    NP_002401
##          34            0            0           17
##   NP_036411    NP_002832    NP_057524    NP_071766
##           0           12            3            0
##   NP_004796 NP_001035111 XP_003403776    NP_061026
##           0            0            0            3
##   NP_006056    NP_055703    NP_055097    NP_997187
##           3            0            0            0
##   NP_997176    NP_997175    NP_060858    NP_055851
##           0            0            0            0
##   NP_463460    NP_000716 NP_001193844    NP_954855
##           0            4            6            4
##   NP_963891    NP_963890    NP_000717    NP_009130
##          19           19            4           46
##   NP_078975 NP_001164267    NP_710156    NP_006605
##           0            0            3           25
##   NP_116023 NP_001120650    NP_079480    NP_001974
##           8           24            4            1
##   NP_065822    NP_002823    NP_963922 NP_001018000
##          17            0            0            0
## NP_001074002    NP_005139    NP_077307    NP_060793
##           0            0            0            9
##   NP_055259    NP_478144    NP_079090    NP_115560
##           5           25            0            8
## NP_001003819 NP_001003818    NP_777549    NP_115724
##           0           27            0           15
## NP_001138732    NP_775956    NP_000206    NP_003214
##          27            0           20            0
##   NP_060482    NP_056471    NP_002220 NP_001185890
##          27           51            0            0
##   NP_057222    NP_078943    NP_001825    NP_009028
##           0            0            0            0
##   NP_689996    NP_849157    NP_219485    NP_003359
##           0           25            0            4
##   NP_001284    NP_065943 NP_001035807    NP_002096
##           0            2            0            0
##   NP_003503    NP_778235    NP_002097    NP_619541
##           0            0            0            0
##   NP_079350    NP_061888    NP_899050    NP_071925
##           1           34            0           37
##   NP_689729    NP_001865    NP_115726    NP_001508
##           0            4            3            0
## NP_001239051 NP_001239053 NP_001252543    NP_919247
```

```
##           14          14           6           8
##  NP_001035247   NP_000387   NP_002397   NP_002735
##            0           0           2           0
##     NP_060739   NP_852480   NP_775782   NP_612435
##            0           0           3           0
##  NP_001171597   NP_003921   NP_060357   NP_001007
##            0           0           0           0
##     NP_078822   NP_116296 NP_001252518  NP_006045
##           23           0           0           0
##     NP_078982 NP_001120716  NP_115646   NP_079337
##           10          16          30          31
##  NP_001127948   NP_004487   NP_004488 NP_001263236
##           12           0           0           0
##  NP_001263248 NP_001171986  NP_004260 NP_001240811
##            0           0           0           0
##     NP_055210   NP_690876 NP_001098673  NP_055143
##            0           0           5           3
##  NP_001265157   NP_057310   NP_476528   NP_853553
##            5           0           0           0
##     NP_114408   NP_695005   NP_997715   NP_954699
##            2           0           0           0
##  NP_001137381   NP_056385   NP_056227 NP_001011713
##            0           6           0           0
##     NP_001346 NP_001138403  NP_689629   NP_003339
##            0           0           0           0
##  NP_001258558 NP_001165365  NP_005578 NP_001180276
##            0           6           6           6
##     NP_002388   NP_057455   NP_061867   NP_060674
##            6           0           8          26
##     NP_036294   NP_006485 NP_001138784  NP_005231
##            6           0          12          47
##     NP_036250   NP_060741   NP_059116   NP_787071
##           27          13          17           6
##     NP_694992   NP_002519   NP_031388   NP_005080
##            0           0           0           2
##     NP_003089   NP_079140   NP_057517   NP_079356
##            3           3           0           0
##     NP_056278 NP_001078906  NP_079137   NP_612367
##            0          25          29           0
##     NP_005844   NP_150366   NP_077312   NP_077313
##            0           3           3           3
##  NP_001265562   NP_060342   NP_079021   NP_061856
##            3           0          20           0
##     NP_060738   NP_057088   NP_056502   NP_077733
##            5           7           1           0
##     NP_006546   NP_036308   NP_059107 NP_001026849
##            0           0           0           0
##     NP_490595   NP_001766   NP_002612   NP_057136
##            0           0           0           0
##     NP_056492   NP_055679   NP_065850   NP_001203
##           10           0           2           0
##     NP_000973   NP_078912 XP_003960227 NP_001238994
##            0           0           0          21
##     NP_444281   NP_115498   NP_060923   NP_036463
```

```
##            0            0            0            0
##    NP_061036    NP_005841 NP_001138785 NP_001025030
##            9            0           43            0
## NP_001171172 NP_001007528    NP_775858 NP_001207417
##            0           12            3            0
## NP_001073005    NP_079504 NP_001153880    NP_004154
##            0            9            1            0
##    NP_899058 NP_001129673 NP_001129674 NP_001032895
##            0            0            0            9
## NP_001002926    NP_055113    NP_060516 NP_001026887
##            0            0           12            0
##    NP_005988    NP_002787    NP_005928 NP_001036046
##            0            0            6            0
##    NP_061029 NP_001186673    NP_954630    NP_110381
##            0            0            0            0
## NP_001120852 NP_001035147    NP_000573 NP_001035149
##            3            0            0            0
## NP_001026881    NP_008966    NP_005611    NP_057230
##            0            0            0            0
## NP_001005505    NP_000371    NP_079198    NP_003834
##           37            0            9           10
##    NP_659001 NP_001154178    NP_115522    NP_110386
##           10           10            0            0
##    NP_001852    NP_055501    NP_005379    NP_078800
##            0           17            0           26
##    NP_002654 NP_001007524    NP_009146    NP_071409
##           23            0            0            0
## NP_001258570    NP_009197    NP_057049    NP_054779
##            3            0            0            0
##    NP_570981    NP_115861    NP_056263    NP_006592
##            0            0            0            0
##    NP_003705    NP_665683    NP_000837    NP_000838
##            0            0            0           13
##    NP_714543    NP_037470    NP_002345    NP_060714
##           13            0            0            0
##    NP_066932    NP_066926    NP_064580 NP_001001548
##            0            0            0            0
##    NP_060310    NP_444280    NP_054899    NP_055153
##            0            0            0            0
##    NP_002403    NP_055190    NP_060263    NP_004424
##            0            0            0            0
## NP_001193545    NP_068577    NP_057543 NP_001165161
##            2            3            0            0
## NP_001001414    NP_001285    NP_037486 NP_001108072
##            0            3            0            0
##    NP_001903    NP_000026    NP_000518    NP_660308
##            0            0           32            0
##    NP_112487    NP_057395    NP_569055    NP_006058
##            0            0           25            0
##    NP_009101    NP_055728    NP_116211    NP_443109
##           22           17            0            0
##    NP_001009    NP_003621    NP_006105    NP_055891
##            0            2            0            6
##    NP_001251    NP_006415 NP_001171469    NP_068766
```

```
##             9           40           39            0
##  NP_001003789    NP_009013    NP_057059    NP_003178
##             0            0            0            0
##     NP_056346    NP_057174    NP_000051 NP_001073906
##            21            0            0           24
##     NP_036296    NP_112199    NP_064703 NP_001157940
##             2            4            2            0
##  NP_001008240    NP_659492    NP_079469    NP_006850
##             0            0           24           10
##  NP_001010923    NP_077718    NP_689837 NP_001152850
##            22            0            6            0
##  NP_001152849 NP_001152852    NP_060308    NP_054905
##             0            0            0            0
##     NP_060378 NP_001243338    NP_258257    NP_005362
##             6            5            9            0
##     NP_075422    NP_001168    NP_060734 NP_001138912
##            15            0           19           30
##     NP_067036    NP_056265 NP_001026870 NP_001010982
##             0            5            8            0
##     NP_660358    NP_689497    NP_000980 NP_001005340
##             0            0            0            0
##  NP_001243353    NP_599030    NP_005536    NP_116120
##            12            0            0            0
##     NP_004256    NP_008950    NP_054885    NP_114172
##             3            0            0            6
##     NP_079204    NP_002075    NP_004713    NP_569057
##             6            0            8           15
##  NP_001092741    NP_075388    NP_002888    NP_058520
##            17            0            0            0
##     NP_002889 NP_001003793    NP_071344    NP_057092
##             0            0            0           13
##     NP_003991    NP_001543    NP_008846    NP_116254
##            53            0            0           40
##     NP_653251    NP_055277    NP_055463    NP_001062
##            24            0            5            5
##     NP_059988    NP_003215    NP_068753    NP_006375
##             0            0            0            0
##  NP_001157650    NP_542407 NP_001028259 NP_001258804
##             5           23           48            0
##     NP_079349    NP_005649    NP_036524    NP_003055
##             0            5            0            6
##     NP_000812    NP_003960    NP_006043    NP_620152
##            10            0            0            0
##     NP_056163    NP_001813    NP_940888    NP_803877
##            38            9            0            0
##     NP_955469    NP_079224 NP_001036148    NP_057501
##            22            0            6            0
##     NP_057178 NP_001128712 NP_001078844    NP_037366
##             0            0            0            0
##     NP_060557    NP_000936    NP_671709    NP_872375
##             4            0            0            6
##     NP_443730 NP_001002837    NP_115488    NP_789762
##             0           26            0            0
##     NP_005673    NP_699163    NP_003234    NP_079058
```

```
##            0            0           18            0
##    NP_068759 NP_001037770    NP_478126    NP_057532
##            0            0            0           14
##    NP_055751    NP_848638    NP_003126    NP_001836
##            0           28            0            0
##    NP_203699    NP_000082    NP_612390    NP_061893
##            3            3            3           19
##    NP_000472    NP_003358 NP_001263302    NP_659500
##           54            0            0            0
##    NP_835739    NP_079048 NP_001254772 NP_001185882
##            8           10           21            0
##    NP_064550    NP_000085 NP_001167013 NP_001167014
##           12           23            6            6
## NP_001165358    NP_056448    NP_653247    NP_006536
##            0            0            0           12
##    NP_002486    NP_064543    NP_056312 NP_001103973
##            0            0            0            0
##    NP_219489    NP_006017    NP_115570 NP_001034444
##            0            0            6           11
## NP_001135865 NP_001230301    NP_776297 NP_001121371
##            0            4            4            8
##    NP_001821    NP_001827    NP_009042 NP_001171610
##           44            0            0           31
## NP_001073861 NP_001006659 XP_003960485    NP_878908
##           11           26            0            0
## NP_001156793    NP_444283    NP_078804 NP_001007532
##           14            0            0            0
##    NP_009014    NP_660207    NP_003668    NP_064631
##            6            0            0            3
## NP_001012772    NP_003320    NP_009172 NP_001096080
##            0            0            0           35
##    NP_003376    NP_036366    NP_115670 NP_001124151
##            0            0            5            0
##    NP_115710 XP_003960183    NP_055130    NP_079049
##            0            6            4           20
##    NP_006507    NP_060717 NP_001017970    NP_612355
##            2            8           52           13
##    NP_835227    NP_001954    NP_660289    NP_002420
##            0           43            6            8
##    NP_612410    NP_114111 NP_001154481 NP_001135942
##            0            0            0            0
##    NP_115722    NP_653287 NP_001138775    NP_443182
##            0            3            5            3
##    NP_059110 XP_001718697 NP_001121557    NP_004865
##            4            6           24            0
##    NP_078898    NP_060932 NP_001120708 NP_001120707
##           25            0            5            5
##    NP_037375 NP_001158729    NP_001444    NP_005242
##           30           28           41           48
##    NP_003101    NP_872319    NP_005552    NP_068595
##            3            0            0            0
##    NP_536856    NP_071327    NP_115992    NP_938020
##            0            0           27           22
##    NP_002438 NP_001003796    NP_006773    NP_061335
```

```
##            25            0            0            8
##  NP_001161771 NP_001161773    NP_001790    NP_004426
##             3           11            0            0
##     NP_009165    NP_149103    NP_003767    NP_940919
##             0            3            0            2
##     NP_005430 NP_001003701 NP_001137434    NP_981951
##             0            0           17            3
##     NP_113676    NP_060113 NP_001078956    NP_061881
##            29           18           19            5
##     NP_067017    NP_005169    NP_006734    NP_003575
##             3            0            0           10
##     NP_002513    NP_055856 NP_001154816 NP_001154819
##            37           11           22           22
##     NP_008961    NP_075561 NP_001159435    NP_000213
##             0            9           15            0
##  NP_001123500    NP_006371    NP_065811    NP_055867
##             3           18            1            4
##     NP_004208    NP_003591    NP_005679    NP_076971
##             8           18           59            0
##     NP_060816    NP_004336    NP_958928    NP_001169
##            22            0            1           19
##     NP_783859    NP_620132    NP_004169    NP_000977
##             0            0            0            0
##     NP_115728    NP_000156    NP_660286    NP_056287
##             0            8            1            0
##     NP_036274    NP_000303    NP_054884    NP_078812
##             3            0            0           19
##  NP_001004127 NP_001245235 NP_001231191    NP_536316
##            14           28           10            0
##     NP_003454    NP_938408    NP_619729    NP_002436
##             0            3           12           24
##     NP_077292    NP_001853    NP_008833    NP_038463
##             6            0            0           37
##     NP_703149    NP_006483    NP_116142    NP_057391
##            31           37           37            0
##  NP_001073930    NP_008913    NP_003915    NP_620689
##            20           37           28           34
##     NP_005160    NP_068745    NP_003021    NP_835471
##            31           37           37            0
##  NP_001186976    NP_689822    NP_877437 NP_001028204
##             0            8            0            0
##     NP_055683    NP_004251    NP_001275    NP_115997
##            17           18            0            0
##  NP_001010904    NP_690610    NP_690611    NP_002957
##            52            3           31            0
##     NP_005783    NP_060699    NP_036223    NP_004321
##             0            0           25            0
##     NP_056040 NP_001129277    NP_005005    NP_000679
##            23           43            0           33
##  NP_001106674    NP_006361    NP_612508 NP_001072987
##             0            0           17            0
##     NP_006003    NP_065120    NP_004575 XP_003960338
##             0            0            0            2
##     NP_060755    NP_005605    NP_612433    NP_057475
```

```
##            0            0           56            0
## NP_001243469    NP_000337    NP_008872    NP_055402
##            0            0            6           26
##    NP_060889    NP_065154    NP_055763    NP_079103
##           55           39           17           11
##    NP_003146    NP_000230    NP_036371    NP_057056
##           10            0            0            0
##    NP_689918    NP_079416    NP_112236    NP_659480
##            3            0            0            6
##    NP_060091    NP_742034    NP_055184    NP_004573
##            0            8            0            0
##    NP_057142 NP_001070818 NP_001034565    NP_064517
##            0            8           19            0
##    NP_005002    NP_964011    NP_005613    NP_004022
##            0           49           44            0
## NP_001036100    NP_062457 NP_001093097 NP_001161213
##            0            0            0            3
## NP_001010891 NP_001036013    NP_005093    NP_077288
##            0            0            0           31
##    NP_000272    NP_001758 NP_001121077 NP_001153865
##            0           12            0            0
##    NP_056166    NP_004580    NP_872584    NP_006085
##            0            0           19           24
##    NP_036576    NP_005862 NP_001004304    NP_003434
##           15            0            0           47
##    NP_057484 NP_001186814    NP_060123    NP_001735
##            0            0            3            6
##    NP_002382    NP_775930    NP_001910    NP_001454
##            0            3            0            5
##    NP_004223 NP_001129491    NP_958437    NP_001819
##           12            0            0            0
##    NP_689490    NP_079230    NP_078865 NP_001034796
##            0           38            5            0
##    NP_003964    NP_073607    NP_060886 NP_001013685
##            0            6            6            0
##    NP_001929    NP_060822 NP_001035088 NP_001014446
##            0            0           20            0
##    NP_004081    NP_006223    NP_002687    NP_115569
##            0            0            0            0
##    NP_004046    NP_060959    NP_001634    NP_852615
##           29           12            0            0
##    NP_114129    NP_079185 NP_001026892    NP_003661
##            5            0            3            6
##    NP_110389    NP_002205    NP_060603    NP_848597
##           16            6           21            3
##    NP_073614    NP_054740    NP_003607    NP_055215
##            0           29            0            0
##    NP_002105    NP_006725    NP_002561    NP_071393
##           20           28           38            4
##    NP_002615 NP_001035926    NP_002414    NP_001311
##            0            0            0            0
##    NP_115664    NP_523353    NP_001437 NP_001243727
##            2            9            0            0
##    NP_003778    NP_064617    NP_061982    NP_116244
```

```
##            2            0            0            8
##    NP_059105    NP_061824    NP_008828    NP_002139
##           21           24           15           21
##    NP_076922    NP_872604    NP_872606 NP_001230655
##           18            0            0            0
##    NP_002938    NP_115708    NP_536355    NP_060298
##            0            0            0            0
## XP_001718574    NP_055049 NP_001186136    NP_115976
##           24            0           26           43
##    NP_919255    NP_057163    NP_056997    NP_057547
##            0            0            0            6
##    NP_005501    NP_004605 NP_001258864    NP_061964
##           16            0            0            0
##    NP_000392 NP_001121369    NP_056087    NP_004058
##           19            0            0           45
##    NP_689795 NP_001019907    NP_065747    NP_112181
##           47            0            0           21
##    NP_378669    NP_065390    NP_004039 NP_001138528
##            0            0            0            0
##    NP_065161    NP_443192    NP_078942    NP_071343
##            0            0            0            1
##    NP_006795    NP_009046    NP_071738    NP_005660
##            1            0            0            0
##    NP_612638    NP_006387    NP_006457 XP_003118566
##            0            0            0            6
## XP_003403810    NP_005239    NP_003480    NP_002190
##            6            2           26            0
##    NP_002189 NP_001153620 NP_001153619 NP_001163873
##           20            5            5           52
##    NP_338599    NP_653190    NP_002613    NP_055419
##            1            0            0            0
##    NP_060016    NP_057302    NP_056146    NP_003353
##            0            7            0            0
##    NP_550433 NP_001160165    NP_005926    NP_001526
##            0           19           19           14
##    NP_071929    NP_550438 NP_001012241    NP_078916
##            8            0            0            0
##    NP_005244    NP_061974    NP_059965 NP_001137414
##            0            0            0            1
##    NP_694565    NP_003383    NP_110402    NP_031390
##            4           41           45            0
##    NP_065878 NP_001229430    NP_443082    NP_056106
##           11            0            0           19
##    NP_001016    NP_477517    NP_003256    NP_003191
##            0            0           26           11
##    NP_996919 NP_001230161 NP_001230156 NP_001230162
##            0            0            0            0
## NP_001129611 NP_001124435    NP_996923    NP_872431
##           16           41            0            0
##    NP_002759    NP_443161    NP_115604    NP_060311
##            0            3            9            0
##    NP_000212    NP_078960    NP_061332    NP_079184
##            2            0            3           27
##    NP_116145    NP_036452    NP_001098    NP_004744
```

```
##          51           0           0           0
##     NP_009151   NP_071384   NP_689557   NP_002346
##           2           0           0           0
##     NP_002928 NP_001265172 NP_001229840   NP_060896
##           0           6           0           2
##     NP_061944   NP_775891   NP_068590   NP_054895
##           4          11           2           0
##     NP_036332 NP_001035533 NP_001128573   NP_940863
##           8           4           0          46
##     NP_001658   NP_653219   NP_036360   NP_115909
##           0          11           0           0
##     NP_056327 NP_001003787 NP_001159441   NP_699166
##          37           0           0           0
##     NP_057709 NP_001258763   NP_004417 NP_001162580
##           0           0          12           0
##     NP_057510   NP_054762   NP_076423   NP_055289
##          29           0           0           6
##     NP_620419   NP_689498   NP_055962   NP_006692
##           0           2          17           0
##     NP_002789   NP_005481   NP_001736   NP_002494
##           0          19           1           0
##     NP_056298 NP_001138368   NP_055072   NP_055082
##           8           2           4           0
##     NP_005202   NP_057259   NP_005639   NP_060212
##           0          15           0          28
##     NP_938080   NP_115649   NP_113618   NP_056525
##          13           0          56          12
##     NP_055622   NP_689529   NP_004278   NP_116019
##          23           0           0           0
## NP_001092755 XP_001126659 XP_003119575   NP_079479
##           0           0           0          18
##     NP_056303   NP_072094 NP_001070867   NP_115712
##           3           3           6           6
##     NP_116242 NP_001026847   NP_776183   NP_115970
##          23           0           4           2
##     NP_059136   NP_055537   NP_056948   NP_002198
##          29          25          26          57
##     NP_660275   NP_055733   NP_787052 NP_001243750
##           1          25          35           0
##     NP_008843 NP_001243749   NP_055762   NP_004998
##           0           0           0           4
##     NP_689520   NP_060831   NP_057589   NP_001209
##           0           0           0           0
##     NP_060208   NP_054785   NP_001246   NP_689633
##           3           0          12           3
##     NP_078899   NP_036465   NP_775823 NP_001230261
##           9           0          35          43
##     NP_003343   NP_631917   NP_858057   NP_036549
##           0           5           0           0
##     NP_079541 NP_001165883 NP_001098065   NP_055104
##          35          15           0          16
##     NP_689506   NP_003943 NP_001181927   NP_775937
##          21           0          20           0
## NP_001189477 NP_001191019   NP_060843   NP_003717
```

```
##             0            11             0             5
##     NP_003920     NP_006825     NP_071732     NP_004991
##             0             0             0             0
##     NP_036588  NP_001005463     NP_076870  NP_001103984
##             0            47            42            47
##     NP_112570  NP_001002251     NP_061164  NP_001265309
##             3             0             0             0
##  NP_001138500  NP_001156787     NP_065880  NP_001034229
##            36            17            39             0
##     NP_005966     NP_061924     NP_066990     NP_000482
##             6             0             0             0
##     NP_005000     NP_996994     NP_149015     NP_055126
##             0            21             9             8
##     NP_071411     NP_000593     NP_110409     NP_006198
##             0             8             9             0
##     NP_060565     NP_002589     NP_056315     NP_115494
##             5             7            38             0
##     NP_660309  NP_001123201     NP_116184     NP_065723
##             0            17            11             0
##     NP_055452  NP_001138773  NP_001036193     NP_055131
##             0             4            16             0
##     NP_002765     NP_536737     NP_004641     NP_004918
##            36            36             0             0
##     NP_612449     NP_003255     NP_115675     NP_060753
##             0            56             3             0
##  NP_001073946  NP_001092286     NP_055068  NP_001116151
##            22             9            13            23
##     NP_060908     NP_000984  NP_001092047     NP_055619
##             0             0             0            10
##     NP_009118     NP_073746     NP_036526     NP_008990
##             0            17             0             0
##     NP_055688     NP_079163     NP_055029     NP_000228
##             0            58             2            43
##     NP_002349     NP_001220     NP_060315     NP_997716
##             0             0             0             0
##     NP_699205     NP_079081     NP_004879     NP_569730
##             0             0             0             0
##     NP_996846  XP_003960228     NP_055098     NP_071748
##             4             0            25             1
##     NP_006323     NP_000592     NP_004261     NP_570719
##             0            27             2             0
##     NP_660322     NP_079037     NP_054900     NP_919268
##            11             9             0            21
##     NP_057105  NP_001035859     NP_714923     NP_110382
##             6            22             0             0
##     NP_060573     NP_116139     NP_612122     NP_055050
##             3             0            16             0
##     NP_543012     NP_001602  NP_001180242  NP_001180240
##             0             0             9             9
##     NP_078959  NP_001139746  NP_001185458     NP_003193
##             3            11            11            16
##     NP_057353  NP_001159591     NP_112573  NP_001128323
##             8             8            28            16
##     NP_067547     NP_061980     NP_003872     NP_079097
```

```
##          30           0           0           0
##   NP_001229658   NP_055702   NP_000068   NP_004927
##          27           0           0           4
##      NP_071921 NP_001167618   NP_055294 NP_001207423
##           0          21          44           6
##      NP_002372   NP_004195   NP_116250   NP_077027
##          35          31          15           0
##      NP_006568 NP_001161937   NP_002846   NP_000974
##           8          48           5           0
##   NP_001093115   NP_077273 NP_001034792 XP_003960107
##           0           3           3           3
##   XP_003846583 XP_003960247   NP_899228   NP_060410
##          25          29          30          28
##   XP_003960241 XP_003846431   NP_065885   NP_060937
##          36           9          14           0
##      NP_775323   NP_003125   NP_061914 XP_003960982
##           8           0           3           2
##   NP_001087195   NP_071449   NP_056503   NP_078928
##           0          12          18          41
##      NP_079095   NP_079104 NP_001161047   NP_054907
##           0           0           0           0
##      NP_036453   NP_000193   NP_115676   NP_065978
##           0           4           3          53
##   NP_001092260   NP_004047   NP_055180   NP_878919
##           1           0           0           8
##      NP_056109   NP_036569   NP_000328   NP_000985
##          20           0           0           0
##      NP_660087   NP_003712   NP_001719   NP_940993
##           0           0           0           0
##      NP_689616   NP_110417   NP_003102   NP_055572
##          17           0           0          40
##      NP_892010   NP_000336   NP_056307 NP_001017928
##          15           0          20           0
##      NP_002173 NP_001161403   NP_078886   NP_003870
##          13          13          18          14
##   NP_001189446   NP_057413   NP_006484   NP_644812
##          31          33           0           0
##   NP_001180353   NP_002527   NP_149977   NP_067544
##          35          28           6          58
##   NP_001172019 NP_001172020   NP_066934   NP_061910
##          58          58          56           0
##      NP_057293   NP_689645   NP_110403 NP_001153890
##           0          28          26          26
##      NP_003656   NP_055316   NP_005629 NP_001172112
##           0           0           0           0
##      NP_055165   NP_054753   NP_060624   NP_079352
##           0           0           6           9
##   NP_001240804   NP_115715   NP_006604 NP_001035257
##           9           0           4          22
##      NP_004166   NP_060917   NP_061956   NP_057036
##           0           0          13           0
##      NP_443077   NP_056980   NP_000353   NP_006398
##           0          44           0           0
##      NP_689555 NP_001035972   NP_000979   NP_002903
```

```
##            8            0            0           15
##    NP_001053    NP_002886    NP_004699    NP_004811
##           28           45            0           50
##    NP_008854    NP_000534    NP_699196    NP_000233
##            0           14           26            7
##    NP_075383    NP_689866    NP_006348    NP_003332
##           19            0            0            0
##    NP_071736 NP_001002901    NP_694957    NP_660339
##            0           18            0            1
##    NP_009231    NP_004562    NP_071345    NP_569056
##           13            0           10           15
##    NP_653284    NP_612157    NP_620157    NP_789784
##           14            0            0           51
##    NP_003335    NP_006661    NP_071329    NP_071762
##            0            0           48            5
##    NP_002650 NP_001005376    NP_653213 NP_001008528
##            0            0           30            0
##    NP_940932 NP_001008529    NP_776158    NP_060774
##            0            0           15           59
##    NP_115495 NP_001245139    NP_065849 NP_001156946
##           36           10           50           26
##    NP_733787 NP_001182149    NP_036388 NP_001018121
##           46           43           43            3
## NP_001265234    NP_006732    NP_620074 NP_001017536
##            0           15           44           37
##    NP_954587 NP_001120836    NP_060494    NP_001174
##           29           29            3            0
##    NP_057204    NP_055223    NP_077270 NP_001092102
##            8            0            0            0
##    NP_003245    NP_076933 NP_001243614    NP_055606
##            0            0           33           35
##    NP_005345    NP_060416    NP_003029    NP_004163
##            0            0            0           20
##    NP_001854    NP_057670 NP_001026873    NP_659489
##            0            5            6            0
##    NP_056998    NP_005970    NP_000794    NP_000795
##           21            0            0           22
##    NP_056349    NP_060065    NP_758869    NP_002380
##           13            0            0            0
##    NP_758860    NP_002614    NP_006638    NP_060209
##            0            0           19           27
##    NP_002389    NP_064545    NP_663622    NP_055589
##            5           12           49           30
##    NP_004356    NP_009140    NP_054902    NP_076945
##            0            0            0           16
##    NP_000446    NP_003103    NP_057161    NP_060910
##            5            8            0            7
##    NP_055613    NP_113657    NP_683685    NP_061833
##            8            0            0           50
##    NP_004350    NP_000912 NP_001231612    NP_036514
##            1           39           39            0
##    NP_067640    NP_942559    NP_005084 NP_001185608
##            7           31           23           45
##    NP_005178    NP_004877    NP_060687    NP_671722
```

```
##          56           0          42          33
##   NP_036221   NP_003675   NP_116115   NP_060184
##           0          15          56           8
##   NP_476502 NP_001158220 NP_001008398  NP_056049
##          36          25           0          30
##   NP_079420   NP_542382   NP_003202   NP_006278
##          18           8          22          29
## NP_001027452  NP_061969   NP_004036   NP_003163
##          32          21           0           0
##   NP_660304   NP_065189   NP_055701 NP_001258594
##           0           3           0           6
##   NP_998814   NP_000308   NP_443168   NP_938023
##          11           3           1           0
## NP_001136060 NP_001136061  NP_057579 NP_001137438
##           0           0          18          18
##   NP_061871   NP_004144   NP_443076   NP_006225
##          21          44          11           0
##   NP_009199 NP_001244332  NP_055269   NP_653266
##           4           4          29          31
## NP_001258523  NP_060678   NP_004835   NP_002510
##          47          27           9          15
##   NP_038286   NP_006701   NP_937832   NP_002406
##          33           0           0           0
##   NP_000123   NP_000707   NP_002481   NP_066545
##           3           0           0           7
##   NP_060302   NP_003333   NP_064706 NP_001099043
##           3           0           8           3
##   NP_002927   NP_002996 NP_001017368   NP_000279
##          12          36          24           9
##   NP_653267   NP_001507 NP_001258796   NP_003556
##           8           0           0          45
##   NP_006396   NP_004891   NP_689639 NP_001180218
##           0          17           7          28
##   NP_878907   NP_665906   NP_665910   NP_653280
##          15           3           6          18
##   NP_057016   NP_000050   NP_068839   NP_055101
##           0          51           5          11
##   NP_078857 NP_001164263  NP_653314   NP_060182
##           2          17          17           0
##   NP_891549 NP_001177915  NP_115686 NP_001026879
##          16           0           0          15
##   NP_057143   NP_067010 NP_001186137   NP_001073
##           0          49          51          51
##   NP_076433   NP_006562   NP_775846   NP_003327
##          54           0          15           0
##   NP_003328   NP_036412   NP_803183 NP_001025056
##           0           0           0           6
## NP_001136113  NP_060411   NP_064577   NP_002940
##           8          17          20           0
##   NP_005787   NP_001268   NP_004543   NP_149105
##           0           0           0           0
##   NP_757345   NP_003909   NP_061861   NP_054880
##           0          26           6           0
##   NP_004137 NP_001119800  NP_612457   NP_073750
```

```
##            0       43        0        0
##    NP_005776 NP_001230618 NP_001017979    NP_115682
##            0        6        0        4
##    NP_057075    NP_115990    NP_005698    NP_835465
##            0        0       26       46
##    NP_085143    NP_005229 NP_001137292 NP_001243224
##           18        3       16       55
##    NP_078796    NP_068762    NP_005619    NP_000090
##            0        0        0        0
##    NP_689648    NP_114105 NP_001138600    NP_001760
##           56        0        6        0
##    NP_570968 NP_001098719 NP_001107593    NP_004385
##           11       44       43        0
##    NP_060343    NP_821066    NP_443131    NP_542776
##           24       44       44        9
##    NP_997719    NP_689622    NP_116213    NP_031370
##            0        0        2       50
## NP_001158101    NP_612639    NP_115883    NP_115946
##           19        0        0       43
##    NP_689592 NP_001153242    NP_631916    NP_002683
##           25        3        3       15
##    NP_872307    NP_036394    NP_036460    NP_055675
##            7       15       20        8
## NP_001078868    NP_777591    NP_057529    NP_003640
##            4        3       20       20
##    NP_004480    NP_940820    NP_001889 NP_001258862
##            3       24       39       10
##    NP_932343    NP_612464    NP_937875    NP_001015
##            6        0        0        0
##    NP_055182    NP_003796    NP_997002    NP_067000
##            0        0        0        0
##    NP_054752    NP_795361    NP_604391    NP_005162
##            0        0        0        0
##    NP_898829    NP_874389 NP_001230587    NP_003098
##            3        4        0       13
##    NP_003099    NP_008874    NP_005827 NP_001120729
##           20       28        0        5
##    NP_075568    NP_057141    NP_057149    NP_061865
##            3        0        0        6
##    NP_056168    NP_060943    NP_291027 NP_001074008
##           18        0       15        6
##    NP_068801    NP_077302    NP_078843    NP_060326
##           14        3       29        4
##    NP_060377    NP_037507    NP_065141 NP_001003803
##            0        0        0        0
##    NP_065184    NP_003466    NP_076955    NP_005322
##            6       44        0       22
##    NP_061945    NP_003801    NP_060316 NP_001028260
##            0        6        9       24
##    NP_064554    NP_002192    NP_059523    NP_079175
##            0        0       13       31
##    NP_078977    NP_653209    NP_056517    NP_006433
##           24        3       27        0
##    NP_066957    NP_115527 NP_001095146    NP_001324
```

```
##            0            0            2            6
##    NP_009044    NP_006488    NP_006667    NP_005180
##            3           18           19           21
## NP_001017395    NP_060287    NP_258441 NP_001243804
##            7           25           21           27
##    NP_542381    NP_000018 NP_001135764    NP_005496
##            0            0            0            8
##    NP_008924    NP_776171    NP_061872 NP_001092871
##            0            0           16           19
##    NP_076972    NP_004519    NP_689531    NP_066273
##            5            0            6            0
##    NP_004756    NP_001698    NP_036590    NP_115685
##            0            0            0            0
##    NP_001963 NP_001017921    NP_689695    NP_060281
##            0            0            0            0
## NP_001243725    NP_998760    NP_060836    NP_659473
##            0            0            0           21
## NP_001032402    NP_079341    NP_002844    NP_115613
##           51           33            0           25
##    NP_008840    NP_002882    NP_002405    NP_116307
##           39           18            0            2
## NP_001177655    NP_808880    NP_000981    NP_059973
##            2            3            0            0
##    NP_036593 NP_001077430    NP_085053    NP_073737
##           11           36            0           20
##    NP_060899    NP_001138    NP_004086    NP_004246
##           18           40            0            0
##    NP_733832    NP_064539    NP_115865    NP_945341
##           14            0            0           23
##    NP_036545    NP_065833    NP_891847 NP_001073986
##           20           16           31           17
##    NP_001121    NP_113612    NP_653229 NP_001166994
##            0           15            4           38
##    NP_009075    NP_005323    NP_006423    NP_004538
##            0            0            0            0
##    NP_079414    NP_665803 NP_001018082    NP_110446
##           27           25           34            0
##    NP_000223 NP_001183955 NP_001183956    NP_116028
##           35           26           33           33
## NP_001001551    NP_001014 NP_001107573    NP_005204
##            0            0            0            0
##    NP_612431    NP_852127    NP_056177 NP_001185838
##           17            0            0            0
##    NP_073593    NP_060596    NP_991330    NP_002088
##            0            3            0           19
##    NP_055067    NP_001253    NP_291028    NP_057578
##           23            0            0            0
## NP_001242954 NP_001230679    NP_116147    NP_001329
##           16            1            0           30
## NP_001193992    NP_056003    NP_055115 NP_001258848
##           38           30            0            0
##    NP_112577    NP_689450    NP_004393    NP_000220
##            0            5            7            9
##    NP_005215 NP_001017363    NP_003024    NP_008858
```

```
##           11           48            8           14
##    NP_001106878    NP_057158    NP_006224    NP_068805
##            0            0            0            0
##      NP_001019    NP_115548 NP_001243063    NP_002479
##            0           28            7            0
##      NP_079157    NP_005032    NP_057483    NP_055073
##            0           26            0           28
##      NP_004313    NP_064585    NP_071358 NP_001073863
##            0            0            0           26
##      NP_734465 NP_001193541    NP_775901    NP_054754
##           40            0           13            0
##      NP_003769    NP_997239    NP_068765 NP_001177875
##           24            2           60           43
##   NP_001020128    NP_060945    NP_060134    NP_009216
##            8            6           25            0
##      NP_009209    NP_113600    NP_065827 NP_001020280
##            0            0            0            3
##   NP_001193570    NP_443158    NP_945187 NP_001035362
##            0           33            0           42
##      NP_005697    NP_005195    NP_001302    NP_115605
##            0           16            0           50
##      NP_056382    NP_001905 NP_001139256 NP_001139255
##           14            0            0            0
##      NP_061108    NP_064628    NP_054887    NP_003185
##           24            0            3            9
##      NP_950248    NP_055365    NP_068834    NP_002153
##           14           25           28           21
##      NP_031376    NP_115982 NP_001139647    NP_115746
##            8            0            1            7
##      NP_002419    NP_060164    NP_612207 NP_001092287
##           30           11            9            6
##      NP_919257 NP_001186088    NP_068778    NP_525127
##            6            2            0            0
##   NP_001137291    NP_037504 NP_001178251    NP_071914
##           17            0            0            0
##      NP_002026    NP_542763    NP_116205    NP_060740
##            3            0           31            0
##      NP_620154    NP_055724    NP_057211    NP_005006
##           10           20           53            3
##      NP_001926    NP_699162    NP_060436    NP_079030
##           34           15            0           16
##      NP_775758    NP_004771    NP_005971    NP_938051
##            4            0            0           10
##      NP_938052    NP_777588    NP_001351    NP_076419
##           15            3            3           11
##      NP_115662    NP_001703    NP_004354    NP_001807
##            0            5           19           43
##      NP_057513    NP_647475    NP_064511 NP_001129245
##            0           28           35           36
##      NP_065764    NP_060567    NP_003789    NP_071398
##           36            5           44           26
##      NP_001228    NP_006214 NP_001008708    NP_056254
##           25            0            3            0
##   NP_001248760    NP_001366    NP_976033    NP_036527
```

```
##           32           0           6           2
##    NP_680544   NP_055022   NP_061331   NP_004498
##           17          48          35           0
##    NP_006840   NP_060441   NP_003722   NP_006005
##            3           0           0           0
##    NP_958834   NP_443125   NP_001691   NP_060062
##            8          34           2           0
##    NP_640335   NP_003124   NP_955452   NP_056052
##            7           0          10          22
##    NP_940929   NP_005309   NP_060479 NP_001167555
##            0           0           6          16
##    NP_683515   NP_064538   NP_003984   NP_001022
##            0          14          36           0
##    NP_078913   NP_699170   NP_443096   NP_004252
##           43           4           0           0
##    NP_079335   NP_938011   NP_055063   NP_644815
##           32          47           0           0
##    NP_620145   NP_001274   NP_005253   NP_689474
##            3           0           0           0
##    NP_150281   NP_006467   NP_078929   NP_004855
##            0           0           0          31
##    NP_057415   NP_777582   NP_077274   NP_005685
##           40          24           0           0
##    NP_937862 NP_001147057   NP_006011 NP_001002755
##            0           0          27           0
##    NP_835361 NP_001035492   NP_055476   NP_054736
##            6          11          28           0
##    NP_056164   NP_079423   NP_653177   NP_000568
##           47           3          20           0
## NP_001098717   NP_079018   NP_694988 NP_001001330
##            2           2          20           4
##    NP_150628   NP_005493   NP_057210   NP_060795
##           20          24           0          39
##    NP_115716   NP_057137   NP_004076   NP_055558
##            0           0           0          51
##    NP_054737 NP_001191215 NP_001018016 NP_001191217
##            0           0           0           0
##    NP_387467   NP_005612 NP_001014433   NP_059998
##           51           0           0           0
##    NP_219486   NP_775855 NP_001094288   NP_060403
##            0          11          35          38
##    NP_078851 NP_001120972 NP_001186802   NP_660205
##            0          34          25           4
##    NP_149101 NP_001158087   NP_060620   NP_003855
##            0          30           0           2
##    NP_004087   NP_075060   NP_059117   NP_064619
##            0          31           0           7
##    NP_000934   NP_009031   NP_073752 NP_001017964
##            0           0          20          32
##    NP_569735   NP_000646 NP_001241687   NP_060823
##           13           4          56          29
##    NP_997215   NP_787080   NP_940986   NP_079481
##           20          16           3           2
##    NP_004540   NP_115606   NP_660213   NP_112576
```

```
##            0          47           0           0
##  NP_001075223   NP_004441   NP_060691   NP_597998
##           18           0           0           2
##     NP_006601   NP_055569 NP_001001655   NP_068818
##           24           9          17           0
##     NP_057043 NP_001075955   NP_004813 NP_001161339
##            0          26          38           0
##     NP_859052   NP_060809 NP_001242959   NP_997251
##           35           0           5           0
##  NP_001122088 NP_001122087   NP_060129 NP_001011663
##           18          18          36          10
##     NP_065876   NP_060607   NP_149017   NP_061825
##           33          15          37          27
##     NP_005506   NP_073149   NP_055436   NP_076921
##           57          33          39          33
##     NP_062458   NP_076920   NP_002132   NP_004493
##           43          37          29          27
##     NP_055435   NP_002138   NP_061826   NP_004494
##           35          29          29          29
##     NP_115731   NP_003086   NP_778250 NP_001243042
##           30           0          14          16
##     NP_001478   NP_542161   NP_057525 NP_001093392
##            0           0          55           0
##     NP_060936   NP_004964   NP_001599   NP_478066
##            0          15          55          39
##     NP_006682   NP_115875 NP_001009996   NP_036323
##            2           0          14          30
##     NP_000557   NP_852100   NP_777572   NP_149074
##           26           0          26           0
##     NP_002399   NP_056955   NP_997717   NP_065690
##           39           0           0          12
##  NP_001245146   NP_004415 XP_003960943   NP_057206
##            2          42           4           6
##  NP_001127666   NP_612476   NP_783313   NP_004798
##           46          32           0          36
##  XP_003960581   NP_073749 NP_001244109   NP_004844
##           51          18           3           4
##     NP_112202   NP_000103   NP_057506   NP_067646
##            0          59          20          33
##     NP_660294   NP_077269   NP_060288   NP_077283
##           27           6          42          33
##     NP_036523   NP_079221 NP_001096034   NP_005867
##            3          16           0          26
##  NP_001166947 NP_001028741   NP_444269   NP_000135
##           37           7           0           0
##     NP_057197   NP_055739   NP_002351   NP_002350
##           24           8           6           3
##     NP_115904   NP_689895   NP_002644 NP_001191326
##           36           0          34          44
##     NP_001196   NP_116052   NP_009052 NP_001123573
##           12          28          33          40
##     NP_000607   NP_003302   NP_004919   NP_598395
##           11          26          16           0
##     NP_060189   NP_073728 NP_001137544   NP_115497
```

```
##          39          36          12           0
##   NP_002862   NP_065746 NP_001068566   NP_775498
##           0          47          31          43
##   NP_055698   NP_542408 NP_001032583   NP_079495
##          24           0           0           4
##   NP_443087   NP_060142   NP_002484   NP_004827
##           8          11           0          44
##   NP_056943   NP_848934   NP_058636 NP_001230072
##           0          24          16          32
##   NP_057443   NP_060336   NP_059139   NP_660160
##          32           0           0           6
##   NP_002880   NP_110413 NP_001036249 NP_001135757
##           0          16          33           0
##   NP_001017   NP_060727   NP_079133   NP_055228
##           0           9          15          28
##   NP_113679   NP_065139   NP_689565   NP_919442
##           6          54           3           0
##   NP_003498   NP_003496   NP_001457   NP_001997
##          13           8          14           1
##   NP_127490   NP_444278   NP_002590   NP_005530
##          24           0           0          36
##   NP_002418   NP_663768   NP_116016 NP_001243661
##          36           0           9           2
##   NP_114428   NP_004099   NP_036560   NP_055767
##          32          12           0          28
##   NP_066925   NP_054896   NP_000992   NP_066357
##           0          12           0           0
##   NP_113615   NP_000152   NP_036324 NP_001124396
##           0          48           0           5
## NP_001229338 NP_001122064 NP_001247441 NP_001254527
##          16           0           8           8
##   NP_000073   NP_114131 NP_001243635   NP_057251
##          35          17           0           0
##   NP_001528   NP_612434   NP_005784   NP_951032
##           0           0           8           0
##   NP_951033   NP_003334 NP_001034933   NP_872357
##           0           0          19           0
##   NP_057284 NP_001154829 NP_001026893 NP_001265239
##           0           9           9          36
##   NP_110429   NP_079305 NP_001078834   NP_444292
##          51           0           0           0
##   NP_002278   NP_689771   NP_110445   NP_068713
##           5          19          23          51
##   NP_036520   NP_115705 NP_001121054 NP_001155879
##           0           3           3          25
##   NP_065717   NP_071450   NP_060072   NP_115648
##          38          46          31           3
##   NP_079042 NP_001009944 NP_001001410   NP_000529
##          30          13           4          12
## NP_001265227   NP_068602   NP_057121   NP_067007
##          27          28           9          11
##   NP_653237   NP_079016   NP_002609   NP_543026
##           0          23          17          40
##   NP_694983   NP_057437   NP_057146 NP_001156002
```

```
##          11          51           0          53
##     NP_037416   NP_000989   NP_056045   NP_001325
##          42           0          12           0
##     NP_001438   NP_150596 NP_001073965   NP_005035
##           8           0          25           0
##     NP_116175 NP_001005291   NP_001424   NP_056276
##           0          51          54          54
##     NP_060375 NP_001013694   NP_203753   NP_694967
##          30          25           6           2
##     NP_004737   NP_006318   NP_036451   NP_478070
##          55           3          18           3
##     NP_005457   NP_078867   NP_057130   NP_996769
##           0           0           0           9
##     NP_057151   NP_002280 NP_001231681   NP_671728
##           0           0          29          34
##     NP_116062   NP_006618   NP_114401 NP_001034658
##          56           3           3          13
##     NP_004544   NP_001107   NP_057649 NP_001122307
##           0          57           0           0
##     NP_000396   NP_037372   NP_004285   NP_061891
##           0           0          27          32
##  NP_001026864   NP_036368   NP_004266   NP_002764
##          10          10           0           0
##  NP_001257323   NP_065835   NP_036528   NP_001678
##           0          49           0           0
##     NP_758455   NP_000485   NP_001503   NP_871629
##           0          35          10           0
##     NP_077268   NP_003638   NP_976249   NP_057184
##           0          33          11           0
##     NP_997219   NP_008964 NP_001258867 NP_001012987
##          37           0          38           6
##  NP_001152752   NP_061168   NP_115963   NP_002952
##           8           3           0           0
##     NP_116291   NP_976075   NP_059121   NP_000915
##          18           0          44          39
##  NP_001159447   NP_056190 XP_003960230 NP_001026862
##          39          52          40          38
##     NP_055443   NP_057144 NP_001107605   NP_057109
##           3          10          14          13
##  NP_001070648   NP_061921   NP_115899   NP_113662
##          18          40           3           2
##     NP_057588   NP_775872   NP_057488   NP_078924
##           0          14           0          24
##     NP_787098 NP_001098117   NP_001020 XP_003846586
##          24           5           0           0
##     NP_722541   NP_001314   NP_001436   NP_003000
##          32          22          50           0
##     NP_612480   NP_004724 NP_001177768   NP_057654
##          17          18           0           2
##     NP_078908   NP_004156   NP_005252   NP_054731
##           0          55          55          48
##     NP_002815   NP_115607   NP_000122   NP_065190
##           0           0           7           3
##     NP_660295   NP_003491   NP_073594   NP_036605
```

```
##            13            49            35             0
##     NP_775919     NP_000205     NP_004995     NP_004442
##            26            46             0             5
##     NP_004443  NP_001191455  NP_001017420     NP_542399
##            49             0            58            12
##     NP_076997     NP_067033     NP_002742     NP_057315
##             0             0             3             2
##     NP_005864     NP_068380     NP_114157     NP_006820
##            36            14             9             0
##     NP_057124     NP_060956  NP_001159894     NP_079375
##             0             7            42            57
##     NP_060351     NP_004994     NP_612448     NP_004365
##             0             0             0             0
##     NP_060797  NP_001093148     NP_055508     NP_115707
##            60            21            10            15
##     NP_776169     NP_003092  NP_001071639  NP_001071640
##            32             0             0             3
##  NP_001071641     NP_003907  NP_001107648  NP_001182760
##             0             0            26            26
##     NP_699198  NP_001107595  NP_001091110     NP_002025
##             8            16            41            41
##     NP_000141     NP_004060     NP_113601     NP_653192
##            41             0            21             0
##     NP_004657     NP_150592     NP_076957     NP_003603
##            34             9            26            32
##     NP_057179     NP_005759     NP_054890  NP_001017927
##             0             7             0             2
##  NP_001137530  XP_003403688     NP_057520     NP_003453
##            35            35            35            34
##     NP_065798     NP_064573     NP_003809     NP_620134
##            25             0             6             8
##     NP_115893     NP_057098     NP_849144     NP_079508
##            35            55            55             6
##     NP_073208     NP_851030  NP_001157915     NP_112174
##            25            25            42            53
##     NP_653198     NP_060109  NP_001136024     NP_059453
##             0            11            56             0
##  XP_001717815  NP_001157787  XP_003119912  XP_003960344
##            23            30            27            23
##  XP_003960355     NP_588609  NP_001177757  NP_001002274
##            28            49             0             0
##  NP_001257820  XP_003960691     NP_733745  YP_003024029
##             0             0            29             0
##     NP_006867     NP_057133  NP_001091081     NP_620133
##            27             0             1            29
##     NP_997264  NP_001161414     NP_071890     NP_001021
##             6             9             0             0
##     NP_057004     NP_004173     NP_997698     NP_065950
##             0             3            45            42
##     NP_079051     NP_113650     NP_065145     NP_004863
##             0             2             0            25
##     NP_055060     NP_689578     NP_115879  NP_001165419
##             0            14             0             0
##     NP_067652     NP_066979     NP_006173  NP_001265358
```

```
##          14           0          58          44
## NP_001265356 NP_001075106   NP_006856   NP_005865
##          47          16          55          35
## NP_001074919   NP_079203 NP_001004125   NP_065907
##          17          54          18          34
##   NP_116130   NP_065944 NP_001240605   NP_789744
##           3           0           5          50
##   NP_060108   NP_112578   NP_006020 NP_001191375
##           0          22          38           0
##   NP_689985   NP_061817   NP_006510 NP_001018060
##          31          29           0          10
##   NP_006518   NP_653201   NP_071894   NP_004217
##           9          48          32           0
##   NP_072088   NP_003122   NP_057485   NP_821158
##          42           3           0          38
##   NP_004770   NP_036592   NP_005793   NP_036351
##           6           0          58           5
##   NP_996261   NP_055239   NP_002505   NP_005082
##           0          24          41           9
##   NP_057283   NP_064574   NP_114403   NP_009011
##           0           0           0           0
##   NP_060553   NP_004282 NP_001161707 NP_001124336
##          34           2          37          47
## NP_001258448 NP_001129425 NP_001257965   NP_000560
##          53           2           0           0
## NP_001158243   NP_003036   NP_003755   NP_114413
##          32          34          21           1
##   NP_057461   NP_061859   NP_065974   NP_061118
##          45           0          41           0
##   NP_079231   NP_079526   NP_777579 NP_001006611
##          54          53           2          12
##   NP_005058   NP_001744   NP_115678 NP_001034761
##          19           0           0          13
##   NP_291035   NP_114124   NP_057550   NP_113640
##          22           4           6           0
## NP_001244030   NP_660143 NP_001099033   NP_067037
##          13           4          35          49
##   NP_112490 NP_001010989   NP_001628 NP_001170977
##          51           3          28          21
##   NP_000791   NP_078995   NP_116257   NP_057568
##           0          21          22           0
##   NP_899229   NP_055676   NP_004100   NP_060844
##          17          18           0           0
##   NP_940848   NP_055812   NP_066918   NP_004405
##           0          44          10          26
## NP_001238907 NP_001238911   NP_001776   NP_115656
##          27          44           0          58
##   NP_001541   NP_065078 NP_001138505   NP_061993
##          25           8           0          37
##   NP_061758   NP_061760   NP_061759   NP_061763
##          60          56          56          56
##   NP_061756   NP_061761   NP_061754   NP_056484
##          45          57          59          59
## NP_001129691   NP_963857   NP_001555   NP_060520
```

```
##            3            9           29           23
##    NP_056203    NP_006262    NP_079412 NP_001017989
##            0            0            6            6
##    NP_002719    NP_071319 NP_001093140    NP_001241
##            3           24            3           22
## NP_001074011 NP_001073379    NP_000900 NP_001128123
##           55           37           60            2
## NP_001032755 NP_001138536 NP_001138535    NP_005054
##            0           11           12            7
##    NP_620153    NP_004692    NP_659498    NP_620158
##           35           51           34            6
##    NP_005946    NP_060320    NP_659449    NP_071927
##           43           26            3           40
##    NP_689920    NP_477511 NP_001153777    NP_056475
##           27            0           43           56
##    NP_000456    NP_002342 NP_001025035    NP_004772
##           14            1            6            0
##    NP_055047    NP_060294    NP_757385    NP_057556
##            0           21            5            0
##    NP_005573    NP_775889    NP_079411    NP_055300
##           25            4           36            3
## NP_001008389    NP_742086    NP_067066 NP_001007468
##            0            0            0           25
##    NP_031367    NP_057131    NP_055668    NP_005688
##           22            0           20            0
##    NP_640339    NP_055580    NP_065727 NP_001015882
##           23            0           30           16
## NP_001180583    NP_057145    NP_872329    NP_665805
##            3            0            0           24
##    NP_055217    NP_001472    NP_002603    NP_057339
##            0           31            0           25
##    NP_006275    NP_612427    NP_063949    NP_000990
##            0           22            0            0
## NP_001001790    NP_036547 NP_001018864    NP_037431
##            0           60           31           25
##    NP_115680    NP_573438    NP_859056    NP_982293
##           32           37            0           45
##    NP_612446 NP_001171656    NP_055653    NP_061960
##           54           56           26            5
##    NP_542387    NP_004327    NP_997191    NP_076973
##            0           58            8            0
## NP_001026886    NP_859064    NP_057581    NP_006848
##            3           47            0            0
##    NP_443731    NP_060211    NP_060827    NP_776170
##            0            8           35            0
##    NP_061899    NP_060935 NP_001001683    NP_005995
##            3            0            3            0
## NP_001182225    NP_112494 NP_001252506    NP_085056
##           25           28           42            0
##    NP_733796    NP_068581 NP_001018024    NP_848602
##            3            5            0            5
## NP_001073966    NP_620777    NP_060489    NP_060921
##           31            0            0            7
##    NP_060915    NP_002560    NP_116195 NP_001093254
```

```
##            0          57          38          26
##    NP_818931   NP_612206   NP_653320   NP_002988
##            3           6           5           0
##    NP_037403   NP_001534 NP_001073921   NP_061977
##           46          29          18           5
## NP_001074260   NP_003159   NP_055616   NP_055976
##            0           0          16           0
##    NP_150597 NP_001167579   NP_009099   NP_525022
##            0          36          54          47
## NP_001026909 NP_001162002   NP_115871 NP_001182412
##           21          21          49          54
## NP_001229668   NP_114109   NP_003842   NP_112571
##           39           0           0          40
## NP_001182317   NP_079540   NP_775746   NP_056978
##           40          32          24          23
##    NP_115866   NP_690002   NP_775969   NP_036477
##            0           0          14          49
## NP_001138424 NP_001014765   NP_904320   NP_000234
##           48           3          11          11
##    NP_054701   NP_002285 NP_001229410   NP_001841
##            0           0           0          12
##    NP_722523   NP_078905   NP_620160   NP_067061
##           31          38          60          31
## NP_001107561   NP_055087 NP_001028222   NP_115789
##           47          44          44           0
##    NP_995325 NP_001185903 NP_001129970   NP_005098
##            3           6           3           0
##    NP_689733   NP_848026   NP_612395 NP_001159506
##           57           0           3          44
##    NP_079047 NP_001182399   NP_115733   NP_055608
##            6          51           0          35
##    NP_997397 NP_001180265 NP_001124334   NP_004656
##           40          51          41          48
##    NP_787077   NP_001842   NP_065157   NP_067032
##           46          38           2          45
##    NP_005405   NP_003944   NP_008868   NP_008867
##           52           5           0           0
## NP_001002255   NP_056321   NP_872114   NP_954988
##            0          43          31          26
##    NP_079146 NP_001128690   NP_003792   NP_060639
##           35          19           8          48
##    NP_059129   NP_112567   NP_057155   NP_002013
##           31          38           0          51
##    NP_872433   NP_937886   NP_000624 NP_001008749
##           35           0          20          14
##    NP_057046   NP_002384   NP_005515   NP_872309
##            4          49          14          46
##    NP_065068   NP_067673   NP_689947 NP_001120680
##           40          56           8           3
##    NP_006306   NP_919431   NP_787954   NP_054799
##           42          17           3          49
##    NP_004709   NP_659495   NP_996816   NP_002816
##            0           5          33          55
##    NP_115506   NP_003961   NP_006062   NP_203526
```

```
##           19          47          25           0
##    NP_003551   NP_000031   NP_078933   NP_055714
##           16           0           9          52
##    NP_004366   NP_835260   NP_060179   NP_002866
##           16          57          19          29
##    NP_003990   NP_078902   NP_005610   NP_689764
##           56           3          14          16
##    NP_060875   NP_056180 NP_001186069   NP_079143
##            0          23          34          18
##    NP_036586   NP_000988   NP_871615   NP_003330
##           37           3           0           0
##    NP_862821   NP_003329   NP_057067   NP_001105
##            0           0           0          34
##    NP_899200   NP_056085 NP_001186571   NP_940878
##           51          45          55          33
## NP_001074318   NP_004255   NP_001882   NP_059140
##            0           0          25           0
##    NP_874384   NP_036562   NP_057160   NP_057108
##            0          35           8           0
##    NP_000986   NP_057079   NP_112589   NP_002592
##            0          56          53           0
##    NP_940910   NP_003167   NP_005828 NP_001138450
##           11          33           0           6
## NP_001129580   NP_055514   NP_849163 NP_001035530
##            8          31          19           5
## NP_001158090   NP_004475   NP_003449   NP_689620
##           48          57          15           8
##    NP_115874   NP_002327   NP_002326 NP_001092257
##            7          36          29           5
##    NP_006567   NP_689948   NP_009188   NP_076931
##           37          37           2           0
##    NP_002990   NP_066011   NP_958802 XP_003960473
##            3           3          28          24
## NP_001131082   NP_203751 NP_001013453   NP_002219
##           45          41          58           6
##    NP_057139   NP_115487   NP_008869   NP_003752
##            0           0           0           0
##    NP_061178 NP_001137146   NP_066996   NP_003867
##           18           0          11           0
##    NP_002838   NP_570857   NP_789788   NP_703152
##           19          19           0          21
##    NP_003611   NP_057646 XP_003960602   NP_874364
##           58           0           0           7
##    NP_689677   NP_009000   NP_003970   NP_703151
##           22           5           3           5
##    NP_110448   NP_057053   NP_057678   NP_612455
##           23           0           0           5
##    NP_004751   NP_006770   NP_003071   NP_005973
##           25           6          46          52
##    NP_775931 NP_001231693   NP_694566   NP_004590
##           51          11          12          10
##    NP_001953 NP_001008396 NP_001243084   NP_006511
##           50           0          46           0
##    NP_036455   NP_055725 NP_001243794   NP_002768
```

```
##          23         47         13          0
##   NP_653191 NP_001248370  NP_003351  NP_057385
##          34         33          0          8
## NP_001157844  NP_004698  NP_078858 NP_001177908
##          14          0         58          4
## NP_001243333  NP_619527 NP_001191038 NP_001073893
##          13         37         54         36
##   NP_689699 NP_001245177  NP_000380  NP_115714
##          18         17         55         15
##   NP_005969  NP_003723  NP_620175 NP_001229476
##           2          3         17          0
##   NP_002109  NP_001636 NP_001017998  NP_004116
##           0          0          0          0
## NP_001171694 NP_001007023  NP_667338  NP_112190
##          48         48         43         58
##   NP_981942  NP_612402  NP_054889 NP_001004431
##          13          0         46         56
##   NP_060661  NP_001259 NP_001186048 NP_001186049
##          47         37          7          6
##   NP_067076  NP_071436  NP_057717  NP_689967
##          16         30          4          5
## NP_001034842  NP_064570 XP_003403836 NP_001008910
##          27         36         41         39
##   NP_055293  NP_002064  NP_789786  NP_919224
##          10         21         48         30
##   NP_079421 NP_001073918 NP_001091953  NP_733752
##          40         23         11         37
##   NP_006166  NP_919290  NP_060807  NP_006143
##          51         46         49         34
##   NP_060132 NP_001257313  NP_006263  NP_036577
##          38         60          0         16
##   NP_079001  NP_060934  NP_987091  NP_899243
##          59          0          0         27
##   NP_004066  NP_066940  NP_004551  NP_005003
##          27         46         45         48
## NP_001103224 NP_001193901  NP_006260  NP_004914
##          24         24         42         31
##   NP_006250  NP_067680  NP_003590  NP_055632
##           5         40         48         43
## NP_001124171 NP_001243055  NP_000423  NP_002468
##          59         25          7          7
## NP_001106997  NP_068767  NP_003667 NP_001026788
##          59         45         16          0
## NP_001002034  NP_036591  NP_060468  NP_061749
##          46          0         42         41
##   NP_061747  NP_061742  NP_061741  NP_061739
##          24         25         43         43
##   NP_003726  NP_061751  NP_061750  NP_061735
##          43         41         41         43
##   NP_061752  NP_002579  NP_061736  NP_061748
##          43         39         37         33
##   NP_061746  NP_061740  NP_061743  NP_061738
##          35         37         24         43
##   NP_061744  NP_006157  NP_005851  NP_149988
```

```
##           41           0          28          27
##    NP_066189   NP_478056   NP_073622 NP_001164982
##           27           0          38           0
##    NP_644808   NP_787083   NP_064571   NP_056183
##            0           6          31          26
##    NP_620168 NP_001171473 NP_001007227 NP_001001664
##           10          10          22           3
##    NP_002926   NP_005265   NP_079034   NP_699165
##           31           0          51          47
## XP_003960213   NP_872304   NP_036454   NP_001629
##           22           6           0           0
##    NP_002695 NP_001257365   NP_002113   NP_291032
##            0          13           0           0
##    NP_054769   NP_065869   NP_071939 NP_001138462
##            0          31          33          12
##    NP_002596   NP_003710   NP_061929   NP_877435
##           56          54           0          40
##    NP_060600   NP_008844   NP_060053   NP_055917
##           39          27          48          33
##    NP_071355   NP_037525 NP_001257870   NP_689835
##           57           8          19          45
##    NP_060020   NP_659399   NP_000474   NP_006403
##           61          38           0          22
## NP_001012745   NP_115554   NP_004633 NP_001229247
##           22           6           0          50
##    NP_066928   NP_077008   NP_060034   NP_003087
##           25          55          27           0
##    NP_057622   NP_036426   NP_006334   NP_653181
##           27          41           0           0
##    NP_002483   NP_954697   NP_055296   NP_066991
##            0          36          48          26
## NP_001138502   NP_116267 NP_001034624   NP_057388
##           54          34          33           0
##    NP_036238   NP_114432 NP_001138341   NP_065699
##            0          52          37           9
##    NP_077289   NP_543136   NP_054726   NP_001321
##           10          34          40          45
##    NP_065698   NP_065166 NP_001035521   NP_061821
##           24          53           0          57
##    NP_001891   NP_060519   NP_003460   NP_848543
##           42          38          41          61
##    NP_055154   NP_065749   NP_065853   NP_003206
##           28          57          35          21
##    NP_789776   NP_065148   NP_064633   NP_001771
##            0           2           0           0
##    NP_110442   NP_005249   NP_612213   NP_254274
##            0           0          33          40
## NP_001073910   NP_001023   NP_060771   NP_569082
##           59           0          53          59
##    NP_006849 NP_001231121 NP_001231118 NP_001231122
##            3          33          33          33
## NP_001121170 NP_001255973   NP_057183 NP_001008392
##           16           3          14          46
##    NP_000983   NP_036469   NP_055551 NP_001025160
```

```
##            0           20            3           10
##    NP_542378    NP_004419    NP_114107    NP_002169
##           48            9            0            4
##    NP_000945    NP_057232    NP_951009    NP_057538
##            0           44           53            0
## NP_001092255    NP_001817 NP_001034779    NP_036471
##            5            0           31            0
## NP_001171506    NP_004677 NP_001094284    NP_061180
##            0           31           12           45
##    NP_777555 NP_001139345    NP_068747    NP_000724
##           44           31            0           42
##    NP_002480    NP_689830    NP_061039    NP_078828
##            0           29           25            9
##    NP_919267 NP_001136156 NP_001034739    NP_872302
##            6           28           52           33
##    NP_061329    NP_061092    NP_077275    NP_071390
##            0           39            3            0
##    NP_085150    NP_006496    NP_005634 NP_001159968
##           45           16           29           11
##    NP_110416    NP_848697    NP_543010    NP_000118
##            3            6            3           37
##    NP_006755    NP_009192 NP_001034786 NP_001073905
##           56           17           41           19
##    NP_114427 NP_001015038    NP_997222    NP_003471
##           32            0            0            0
##    NP_991111    NP_694570 NP_001258837    NP_443714
##           15           29           29           18
## NP_001138845    NP_060328    NP_005825 NP_001161419
##           53           26            9            9
##    NP_057223    NP_076416 NP_001137453    NP_116295
##            0           58           58            0
## NP_001073988    NP_079193    NP_000352 NP_001092007
##           51           58           52           22
##    NP_942094 NP_001010974    NP_055974    NP_003085
##           46           46            0            0
##    NP_067041 NP_001001481    NP_065877    NP_002440
##            0           15           13           47
##    NP_006839    NP_037380    NP_835225 NP_001093859
##           28            0            8            6
## NP_001028774    NP_932342    NP_000341    NP_003298
##           24            0           49           25
## NP_001241667    NP_078907 NP_001034864    NP_078792
##           10           31           58           35
## XP_003960361    XP_291007    NP_653185    NP_064603
##           23           22           29           38
## NP_001253994 NP_001253996    NP_001988    NP_000291
##           34           59            0           12
##    NP_003135    NP_055132 NP_001092086    NP_710142
##            0           58           33           14
##    NP_783640    NP_055232    NP_055094 NP_001170858
##           44           12           10           44
##    NP_076422    NP_055519    NP_065868    NP_008955
##           44           18            3            0
##    NP_112561    NP_057701    NP_003477    NP_078983
```

```
##          14           0           6           3
##   NP_060972   NP_689755   NP_775816   NP_060173
##          33          54          45          43
##   NP_061189   NP_612635   NP_443197   NP_009144
##          56          52           0           0
##   NP_620128   NP_116221   NP_055278   NP_078970
##          57          50           0          52
##   NP_055722   NP_112592   NP_640338 NP_001008723
##           1          54          34          14
##   NP_112200   NP_115599   NP_619542   NP_001768
##           7          55          43           0
##   NP_536724   NP_005181   NP_002935 NP_001136235
##          30           0           9          24
## NP_001136243   NP_071937   NP_079452   NP_055749
##          54          55          34          34
##   NP_997186   NP_060169   NP_002428   NP_115740
##          12          55           8          41
##   NP_001186 NP_001265536   NP_001637   NP_115830
##          17          17          27          43
##   NP_004170   NP_705838   NP_002496   NP_000302
##          46           6           0           0
##   NP_006349 NP_001010870   NP_005606   NP_003794
##          40          11          18          53
## XP_003960229   NP_653252 NP_001092253   NP_000766
##           4          35          18          50
##   NP_002925   NP_075053 NP_001001660   NP_066921
##          34          17          17          46
##   NP_066919   NP_694941 NP_001078841   NP_002489
##          61           6           0          44
##   NP_057389   NP_001994 NP_001035887   NP_065695
##          18          30           3          14
##   NP_000542   NP_937799   NP_931045 NP_001265360
##           8          11          45          22
##   NP_000558   NP_065155   NP_006542 XP_003960392
##           7          47           3          39
## NP_001028174   NP_665698 NP_001193884   NP_783302
##          12           7          10          10
## NP_001010852 NP_001028284   NP_079119   NP_937983
##          45           0           6          16
## NP_001157413   NP_110433 NP_001098549   NP_060331
##          28           5          41          52
##   NP_071428   NP_036248   NP_005208 NP_001245249
##          41          58           0           9
##   NP_075051   NP_000012   NP_000438 NP_001121070
##          56          15          36           0
##   NP_478061   NP_065111   NP_060394   NP_612417
##           0          13           3           0
##   NP_056207   NP_065099   NP_945173   NP_002951
##          30          44           0          54
##   NP_079357   NP_689560 NP_001127835   NP_001984
##          43          46           6          41
##   NP_065744 NP_001025051   NP_115696   NP_976043
##          50          39          45           0
##   NP_003753   NP_068809 NP_001002759 NP_001004316
```

```
##          37          5          15          18
##   NP_060323  NP_005186   NP_000407   NP_525021
##          12         44          45          51
##   NP_004279  NP_079218 NP_001243342   NP_006071
##          28         40          25          20
##   NP_054796  NP_542172   NP_659494   NP_543011
##           2         28           3           6
##   NP_065186  NP_997246   NP_003587   NP_004420
##           6         20          53          53
##   NP_001856  NP_060229   NP_057725   NP_058649
##           0         37          42          39
## NP_001070665 NP_001070826   NP_061907 NP_001002292
##          42         45          56          27
##   NP_057150 NP_001257513   NP_009186   NP_005075
##          19         21          40          44
##   NP_660310 NP_001154970   NP_008862   NP_703150
##          25         41           5           8
##   NP_689521  NP_000431   NP_444513   NP_619639
##          43         43          11           3
## NP_001099129  NP_056343   NP_064608   NP_060035
##          35         45          54          47
##   NP_071383  NP_778230 NP_001035755   NP_775741
##           0         32          58          12
##   NP_112211  NP_004749   NP_861452   NP_861520
##          25         42          56           0
##   NP_004326  NP_660299   NP_660327 NP_001160072
##           0         39          36          36
##   NP_061908  NP_002333   NP_060174   NP_116191
##           2         56          20           2
## NP_001030013 NP_001070148   NP_113634   NP_060420
##           4          6          52          47
## NP_001230271  NP_006310   NP_002482   NP_006094
##          54         12           0           0
##   NP_002989  NP_057425   NP_006703 NP_001265319
##          39         61          51          47
##   NP_057400 NP_001186018 NP_001186021   NP_079512
##          17         21          29          51
##   NP_060665  NP_055510   NP_078827   NP_510870
##          27         41          55          43
## NP_001008216 NP_001157871   NP_859065   NP_003623
##           0         12          55          56
##   NP_690850  NP_066951   NP_127491 NP_001002261
##          44          0          50          40
##   NP_848930  NP_036229   NP_003084   NP_065983
##          11          8           0           0
##   NP_006393  NP_057367   NP_859060   NP_060662
##           0          5          34           0
##   NP_004861 NP_001098668   NP_057074   NP_001781
##           6         36          52          25
##   NP_061952  NP_065986   NP_055906 NP_001035545
##          33         31          38          28
##   NP_116000  NP_036397 NP_001158137   NP_861449
##          43         29          48          54
##   NP_689807  NP_006625   NP_078861 NP_001036096
```

```
##          54           5          13          49
##   NP_775798   NP_653249   NP_065824 NP_001188472
##          47          42          55          26
##   NP_008980 NP_001184162   NP_057017   NP_077296
##          36          36           0          15
##   NP_631957   NP_006197   NP_055455   NP_057394
##           0           2          35           3
##   NP_065199 NP_001011668 NP_001010922   NP_478072
##           9           9          59          57
##   NP_055804 XP_003846627   NP_002244   NP_008911
##          56          19           2          43
## YP_003024036   NP_620482   NP_065706 NP_001182555
##          31          28          29          31
##   NP_076946   NP_438169 NP_001073159 NP_001123990
##          59          29          31           0
##   NP_061060   NP_036213   NP_002498   NP_937756
##           3          33          40          14
## NP_001135419 NP_001017975   NP_056305   NP_001818
##          12          59           3           6
##   NP_003349 NP_001004298   NP_653269   NP_054778
##          38          35           0           5
##   NP_001376   NP_056505   NP_690865   NP_075601
##           0          36           5          56
## NP_001098991   NP_055964 NP_001092903   NP_653321
##          24          18           6           8
## NP_001018118   NP_066010   NP_006760   NP_004620
##           6          40          26           3
## NP_001243559   NP_115806   NP_954981 NP_001128476
##          28          25          47          49
## NP_001034451   NP_005642   NP_006724   NP_612362
##          54          55           0          49
##   NP_055543   NP_008875   NP_031363   NP_004474
##          25           5          13           0
## NP_001171938 NP_001153695   NP_919307   NP_112177
##          32          46          26           0
##   NP_004483   NP_478123   NP_542390   NP_110422
##           6          53          15           0
##   NP_000484 NP_001264262 NP_001121903   NP_006332
##          22          26          22          18
##   NP_004934   NP_057209   NP_004322   NP_004533
##          54          17          34           0
##   NP_005731   NP_073721 NP_001010875   NP_055240
##          26          58          57          48
## NP_001033729   NP_004348   NP_061946   NP_002610
##          29           6          53           6
##   NP_002611   NP_775760   NP_001179   NP_057162
##           6           8          13          16
##   NP_660344 NP_001159603 NP_001257935   NP_116166
##          19          35          17          40
##   NP_003697   NP_002546   NP_714542   NP_060103
##          55          44          43          32
## NP_001258769   NP_112192   NP_006809   NP_859075
##          43          14          48           0
##   NP_775107   NP_055438 NP_001229735   NP_001770
```

```
##           24           0           9          16
##    NP_036416   NP_004206   NP_277048   NP_055244
##           55           8          40          10
##    NP_060347   NP_803237   NP_006084   NP_001096
##            4           3          20          44
##    NP_004603   NP_005944   NP_783316   NP_005943
##           35           0           0           0
##    NP_005941   NP_789846   NP_005937   NP_065192
##            0           0           3          32
##    NP_004536   NP_277055 NP_001092688   NP_443099
##            1           0          32          44
##    NP_758872   NP_647479   NP_057608   NP_085128
##           52          53          50          48
##    NP_689912 NP_001138483   NP_065874   NP_714922
##           46          27          10          39
##    NP_001878 NP_001106853   NP_055273   NP_699202
##           42          27          35          56
##    NP_078957   NP_689613   NP_008853 NP_001229797
##           53          41          12          19
##    NP_071417   NP_852091   NP_054886 NP_001122084
##           17          15          50          33
##    NP_644809   NP_057551   NP_612437   NP_055324
##           36          38           6          60
##    NP_001072 NP_001005920   NP_055109 NP_001034201
##           56          46           4          31
## NP_001128522 XP_003846820   NP_477515   NP_689943
##           54          52          13          36
## NP_001070966   NP_004364   NP_116248   NP_057706
##           49           0          56          18
##    NP_659482 NP_001007795   NP_776190   NP_525023
##           13          37          29          33
## NP_001243624   NP_115800   NP_740753 NP_001120936
##           32           9           0          30
##    NP_542383   NP_003217   NP_004110   NP_775836
##           42          12           0          59
## NP_001229757   NP_061725 NP_001135772   NP_689736
##            0           9          10          10
## XP_001717260   NP_036211   NP_054775 NP_001103089
##            8          39           0           8
##    NP_612815   NP_004265   NP_005117 NP_001129595
##            0          54          54          30
##    NP_054766   NP_005224   NP_004430   NP_078962
##            3          20          28          30
##    NP_002222   NP_079022 NP_001120730   NP_149108
##           35          29          48          22
##    NP_116171   NP_443179 NP_001257589 NP_001171808
##           32          12          52          35
##    NP_663761   NP_060536 NP_001073904   NP_037433
##           56          26          59          50
##    NP_002980   NP_057083   NP_002702 NP_001129516
##           37          16          52          40
##    NP_085134   NP_006340   NP_000725   NP_619731
##           51          43          47          54
##    NP_932766   NP_715638   NP_071402   NP_078883
```

```
##            40           32           56           45
##     NP_065988    NP_065920    NP_065138 NP_001003940
##            32           19           18           39
##  NP_001129419    NP_620411    NP_000825 XP_001724434
##             1           38           50           32
##  XP_003959988 NP_001264237    NP_116129    NP_694854
##            22           27           12           47
##     NP_057355    NP_937761    NP_065089    NP_940891
##            36           49           13           42
##  NP_001121143    NP_690878    NP_009038    NP_005728
##            56           43            3            0
##     NP_078968    NP_073729    NP_055393    NP_071378
##            52            1           56           58
##     NP_067082 NP_001010906 NP_001171467    NP_002976
##            55           39           53           16
##  NP_001265665    NP_009098 NP_001041637 NP_001121897
##            24           57           60           60
##  NP_001254514    NP_054772    NP_006486    NP_150375
##            47           53           15           59
##     NP_065203    NP_932348    NP_006414 NP_001230696
##             3            0            0            4
##     NP_065806    NP_056496    NP_056979    NP_004330
##            10           50           49            3
##     NP_443155    NP_077010    NP_060790    NP_006842
##            52           45           25           56
##     NP_002553    NP_001159    NP_690909    NP_775735
##            53           18           56           41
##     NP_001532    NP_689597    NP_079400 NP_001129737
##            49           36           34           14
##  NP_001180386    NP_361012 NP_001241658    NP_036604
##            16           49           19           34
##     NP_065766    NP_071442    NP_004878    NP_055835
##            26           41           32           13
##     NP_000354 NP_001073949    NP_079503 NP_001139541
##            14           53           43           22
##     NP_055187 NP_001136272 NP_001017969    NP_775788
##            46            9           49            4
##     NP_116738    NP_542159    NP_149351 NP_001074020
##            21           41            0           60
##     NP_060887 NP_001017372    NP_076934 NP_001092275
##            31           50           27           45
##  NP_001167596    NP_001858    NP_006418 NP_001065243
##            30            0           31            0
##     NP_057576 NP_001171273    NP_078834    NP_055006
##            14           29           30           15
##     NP_066287    NP_006473    NP_940851 NP_001020539
##            15           22           55           45
##  NP_001020537    NP_870998    NP_689585    NP_775838
##            45           53           28           58
##     NP_112189    NP_110410    NP_004754    NP_689823
##            13           53           18           20
##     NP_065433    NP_001326    NP_060636    NP_000067
##            37           50           30           52
##     NP_872352    NP_000864    NP_998768    NP_036423
```

```
##          48          6         13         60
##   NP_862830 NP_001034485  NP_004526 NP_001128521
##          53         56         40         60
##   NP_775259  NP_056400  NP_112210  NP_004701
##          53          2         16          3
##   NP_008910  NP_037489 NP_001015508  NP_006279
##           9          0          0          0
##   NP_085125 NP_001035897 NP_001229303 NP_001264156
##          44         20         39          3
##   NP_002199  NP_055782  NP_078991  NP_054747
##          25         50         42         15
##   NP_659469  NP_060280  NP_056467 NP_001177693
##          36         37         42         33
##   NP_061166  NP_060694  NP_443079  NP_001373
##          54         48         12         36
##   NP_079057  NP_002761  NP_002760 XP_003960992
##          22         42         23         49
##   NP_058515  NP_057286  NP_003261 NP_001104753
##          57         58         12         13
##   NP_000609 NP_001129396  NP_001706  NP_207646
##          19         27         11         33
##   NP_653309  NP_056519  NP_149132 NP_001242914
##          28          7         29         45
##   NP_997255  NP_065743  NP_000822  NP_000821
##          14         51         30         32
##   NP_002011  NP_689624  NP_078868  NP_004262
##           2         42         32         51
##   NP_004117  NP_068774 NP_001185683  NP_002718
##          32         39         49         43
##   NP_660349 XP_003118897 XP_003119818  NP_150638
##          42         12         12          0
##   NP_006395  NP_003216 XP_003960722  NP_057619
##          16          5         12         33
## NP_001185947  NP_689663  NP_776195  NP_619646
##          25          7          2         25
## NP_001157196  NP_004870  NP_005661  NP_003311
##          55          9         18         48
##   NP_620126  NP_055377  NP_653188  NP_848595
##          59         50         46          3
##   NP_071400  NP_803875 NP_001074294  NP_060021
##          17         42         46          6
## NP_001129734  NP_006326 NP_001032852  NP_065185
##           0         40         24         36
##   NP_115666  NP_443090  NP_002079 NP_001127965
##           2         54         29          0
##   NP_004966  NP_997194 XP_003960637  NP_008957
##          42         55         27         32
##   NP_996879  NP_683513  NP_073619 NP_001104740
##          52         33         48         43
## NP_001074016  NP_659475  NP_071373  NP_112583
##          14         34         23         22
##   NP_061932  NP_078953 XP_001719673 YP_003024030
##          25         50         39          3
##   NP_878901  NP_006195  NP_004764 NP_001185879
```

```
##            3          9         22         36
##    NP_653170 NP_001264301  NP_981948  NP_004084
##           49         42         24         30
##    NP_004071  NP_938012  NP_116251 NP_001161693
##           12         29          6         54
## NP_001019845  NP_079040  NP_115512 NP_001165347
##           22         36          0         36
##    NP_005468  NP_066550  NP_071379 NP_001027535
##           48         53         11          6
## NP_001035546  NP_000187  NP_789790  NP_689630
##           34         51         21         50
##    NP_000918  NP_689986 NP_001015072  NP_848661
##           33         43         38         53
##    NP_001556  NP_060470 NP_001019978  NP_006276
##           16         55         11         53
##    NP_003586  NP_057032  NP_037454  NP_055370
##           58         56         55         35
##    NP_060792  NP_857596  NP_005235  NP_067021
##           34          1         52         43
##    NP_940969  NP_056074  NP_003398 NP_001013671
##           16         57         21         16
## NP_001030177 NP_001034589  NP_060247  NP_056323
##            6          6         13         36
##    NP_037469  NP_689480  NP_689801  NP_002821
##           20         42         29         31
## NP_001012986  NP_115536 NP_001029058  NP_078963
##           12         39          2         19
##    NP_945346  NP_005940  NP_110404 NP_001079990
##           52          6         56         17
##    NP_055489  NP_705841 NP_001005404  NP_115732
##           53         41         54          5
##    NP_077271  NP_056487 NP_001025125 NP_001139334
##            3         51         57         34
## NP_001264993  NP_064455  NP_060166  NP_008969
##           32          7         27         41
## NP_001073885  NP_476515  NP_004347 NP_001001436
##           22         61          0         53
## NP_001244220 NP_001139020 NP_001036075  NP_997001
##           49         62         25          8
##    NP_835463  NP_066362  NP_006426  NP_003632
##           47          0          9          9
## NP_001073970  NP_004885 NP_001120865 XP_003846622
##           48          4          4         33
##    NP_757351  NP_689656  NP_115693  NP_001479
##           45         10         39         46
## NP_001034636 NP_001129735 XP_003960882 XP_003846818
##           40         37         44         46
##    NP_848594  NP_006666 NP_001073954 NP_001243276
##           25         32         12         43
## NP_001033043  NP_219500  NP_067638  NP_078993
##           58         44         59          8
## NP_001071174  NP_115809  NP_057540  NP_689732
##           47         14         16         45
## NP_001136155 NP_001026904  NP_085127  NP_733828
```

```
##            4            3           54           47
##    NP_660312    NP_002537    NP_005447 XP_003960780
##           56           39           13           14
##    NP_524558    NP_689540 NP_001009923    NP_003924
##            0           22            9           31
## NP_001104768    NP_076426    NP_852610    NP_006040
##           21           15            6           51
## NP_001033796    NP_004043    NP_872434    NP_064629
##           33           57           36           24
##    NP_000824    NP_060689 NP_001180442    NP_598004
##           41           13           50            0
## NP_001096036    NP_619636    NP_207837    NP_940938
##           33           37            0            4
##    NP_002293 NP_001007560    NP_976054    NP_848642
##           48            0           25            4
## NP_001239225    NP_443142    NP_006167    NP_775886
##           27           22            9            5
##    NP_055214    NP_005025 NP_001164163    NP_995586
##            6            0           22           21
##    NP_954983    NP_149985    NP_203528    NP_054728
##           46           45           54           52
##    NP_055598    NP_000404    NP_004561    NP_055179
##           28           46           51            0
##    NP_002514    NP_004107    NP_001289    NP_004622
##           57           24           50           14
##    NP_689879    NP_005105    NP_689672    NP_001916
##           20            0           31           56
##    NP_003713 NP_001108451 NP_001012267    NP_064450
##            3           56           28           56
##    NP_005067 NP_001011657    NP_076985    NP_037490
##           44           50           41           34
##    NP_001189    NP_005406    NP_004532    NP_037519
##           20           19            6            0
##    NP_001195    NP_699192 NP_001156896    NP_079333
##           51           41           41           34
##    NP_612439 NP_001027006    NP_003838    NP_599023
##           18           45           46           38
##    NP_005051    NP_065198    XP_370934 NP_001034795
##           10           55           53           56
##    NP_002142    NP_852662 NP_001129467    NP_477521
##           12           50            7            0
##    NP_060804 NP_001025459    NP_689692 NP_001009993
##           39           31           20            2
## NP_001092302 NP_001177695    NP_002437    NP_001229
##           39           38           13           50
## NP_001025034 NP_001138904    NP_115688    NP_690008
##           47            0            0           23
##    NP_002968    NP_060838 NP_001025031    NP_115811
##           15            8           22           34
##    NP_000411    NP_037474    NP_057423    NP_056297
##           57           46           17           22
##    NP_872381 NP_001186978    NP_742105 NP_001120838
##           47           60           56            9
##    NP_852124    NP_002575    NP_002407    NP_000325
```

```
##           9           9          47          15
##   NP_009206   NP_005041   NP_663783   NP_004702
##           9          46          26          26
##   NP_116190 NP_001138776 NP_001012991  NP_859057
##          49          57           7          43
##   NP_079195   NP_653242 NP_001265374   NP_112566
##          29          55          47          37
## NP_001026915  NP_115799 XP_003960648   NP_653226
##          54           3           5          37
##   NP_996662   NP_872299   NP_066307   NP_714925
##          10           3          50          28
##   NP_000762   NP_000760   NP_003276 NP_001073895
##          33          49          54          34
##   NP_037451   NP_997329   NP_057263 NP_001254637
##          33          21          16           0
##   NP_004882 XP_003846609 NP_001106873  NP_037487
##           0          12          57           6
##   NP_660323   NP_031374   NP_689658   NP_722576
##          17          60          37          27
##   NP_055579   NP_002891 NP_001229243   NP_037471
##           2          37          17          60
##   NP_612641   NP_060534   NP_057560 NP_001258468
##          12          60          14          58
##   NP_976046 NP_001073929 NP_001167561  NP_115827
##          55          26           6          32
##   NP_002607   NP_006508   NP_000092 NP_001258745
##          57          46          11          26
## NP_001035197 NP_001073862 XP_003959997 XP_003403509
##          60          55          28          26
##   NP_775933 NP_001020118   NP_071768 YP_003024026
##          25           9          40           6
##   NP_001297   NP_689810   NP_115513   NP_000093
##           8          59           6          36
##   NP_057687   NP_114147   NP_115981   NP_955374
##          46          14          24           0
##   NP_776252   NP_071920   NP_976328   NP_056162
##          33           1          36          35
##   NP_061963   NP_055827 NP_001158502   NP_004097
##          54          18          18           1
##   NP_077817   NP_055213   NP_005859   NP_689829
##          53          49           2          36
## NP_001258781  NP_039258   NP_006324   NP_542403
##          48          50          46          47
##   NP_001224   NP_000833 NP_001002860 NP_001191335
##          58          32           8           5
##   NP_115501   NP_056179 NP_001154848 NP_001012276
##          44          43          53          48
## NP_001074299 NP_001035037  NP_848605   NP_064618
##          57          59          10          44
##   NP_955387   NP_003208   NP_001335   NP_005945
##          18          25          16          59
##   NP_055959   NP_055916   NP_000432   NP_775859
##          51          34          31          56
##   NP_694962 NP_001034450 NP_001038945 NP_001035100
```

```
##           57            26            55            58
##    NP_036396     NP_004254     NP_060385  NP_001191015
##           46             2            35            26
## NP_001191017     NP_005636  NP_001012338     NP_054760
##           26            18            54             6
##    NP_852607     NP_061909     NP_002509     NP_071742
##           51            11            49            24
##    NP_001940  NP_001071643  NP_001010868  XP_003960127
##           46            53            18            15
##    NP_848611     NP_060321     NP_982278     NP_005672
##           59            55            38            41
##    NP_068368     NP_001380     NP_000483  NP_001094827
##           54            52            42            11
##    NP_055893     NP_079533  NP_001010971     NP_004853
##           45            57            37            31
## NP_001026896  NP_001243210  NP_001106795     NP_075462
##           38            60            37            37
##    NP_620590     NP_002967     NP_000390     NP_003073
##            0            54            48            44
##    NP_065180     NP_079490     NP_277045  NP_001138466
##           60            25            33            57
##    NP_078919  NP_001171915     NP_940907     NP_004728
##            6            18            29            40
##    NP_689525     NP_055209     NP_660156  NP_001135389
##           59            13            10            52
## NP_001070731  NP_001139113     NP_683696     NP_705691
##           36            50            49            51
##    NP_872426     NP_004846     NP_060888     NP_998821
##           53             3            42            42
## NP_001244953  XP_003118768     NP_940912     NP_061157
##           39            13            48            29
##    NP_005718  NP_001265486     NP_064584     NP_003264
##           38            56            46            47
## NP_001254747  NP_001078940     NP_002149     NP_940684
##            2            45            43            40
##    NP_006064     NP_060019  NP_001027549     NP_060768
##           16            56            52            38
##    NP_000060  NP_001185521     NP_003467     NP_057359
##           18            56             0            40
##    NP_114113  NP_001258074     NP_060399  NP_001238774
##           56            27            60            29
##    NP_277040     NP_631902  NP_001092874  NP_001186728
##           10            20            15            29
##    NP_005537     NP_054858     NP_064562     NP_005439
##           51            15            59             0
## NP_001177658     NP_079534     NP_003629     NP_612369
##           20            58             7            52
## NP_001012520     NP_004869  NP_001091999  NP_001107047
##           46            16            51            32
## NP_001230678     NP_076938     NP_005972     NP_057617
##           43            43             6            57
## NP_001128627     NP_004638     NP_060835     NP_201575
##            5             5            48            57
##    NP_006505     NP_073623     NP_077272     NP_001501
```

```
##          15           36           53           58
##   NP_001838 NP_001035948 NP_001012301    NP_060251
##          21           20           28            4
##   NP_783866    NP_071445 NP_001123552    NP_036603
##          56           57           20           21
##   NP_002356    NP_004139    NP_775970    NP_060352
##          54           28           36           54
## NP_001071062    NP_008817    NP_006799 NP_001229434
##          10            3            6           46
##   NP_113623 NP_001092690    NP_006111 YP_003024028
##          57           27           27           10
##   NP_003027    NP_922932    NP_004935 NP_001159694
##          53           43           21           27
##   NP_003939 NP_001034976    NP_001197    NP_848658
##          40           55           17           50
## NP_001137236    NP_000705 NP_001017437    NP_056968
##          28           24           10           54
##   NP_699164    NP_071881    NP_000021 NP_001193602
##          21           54           52           48
##   NP_060271 NP_001123482 NP_001264282 XP_003960973
##          47           25           35           54
##   NP_689735    NP_002402 NP_001128504    NP_114106
##          58           45           30           35
##   NP_073732    NP_060135 NP_001171925    NP_004723
##           2           47           19           36
##   NP_073599    NP_001298    NP_940857    NP_775924
##          38            3           55           56
##   NP_008959    NP_005942    NP_115507 NP_001129624
##          27            3           53           22
##   NP_064610    NP_542119    NP_061927    NP_076947
##          61           13           46           23
## NP_001020775    NP_002092    NP_542786 NP_001159432
##           8           49           32            9
##   NP_115540    NP_065785    NP_997201    NP_997297
##          54           63           56           56
##   NP_660296 NP_001012418    NP_997210    NP_056963
##          20            3           57           60
##   NP_004618    NP_003250    NP_004787 NP_001258949
##          55           24           41           42
## NP_001128320 XP_001132754 NP_001131141 NP_001034463
##          44           28           58           39
## YP_003024031 NP_001157903    NP_689932 NP_001153505
##           7           54           42           53
##   NP_689737    NP_689482    NP_689598    NP_060656
##          53           57           44           57
## NP_001245344    NP_060363    NP_008940    NP_776155
##          58           55           21           27
##   NP_002137    NP_620129 NP_001158283 NP_001167594
##          44           58           46           36
##   NP_116174 NP_001011552    NP_998885    NP_115881
##          55           58            2           20
##   NP_695002 NP_001159349    NP_036321    NP_057682
##          47           15            3           58
##   NP_015564    NP_899230 NP_001034931    NP_005932
```

```
##           18           47           10            9
## NP_001258635    NP_060047    NP_201591 NP_001013716
##           24            0           42           29
##    NP_000360    NP_055507 XP_001716463    NP_775966
##           20           27            0           56
## NP_001008777    NP_064625 NP_001070142    NP_004824
##           51           20           39           10
##    NP_037412    NP_076869 NP_001170787    NP_002033
##           36            9           34           21
##    NP_777550    NP_149109    NP_056219    NP_954870
##           35            0           52            3
##    NP_954863    NP_689627    NP_060749    NP_079497
##            3           41           46           55
##    NP_114095    NP_059112    NP_062815 NP_001073887
##           46           29            0           54
##    NP_002771    NP_002775    NP_115753 NP_001103373
##           39           39            0           24
##    NP_078853    NP_115510    NP_694573    NP_542193
##           49           15           15           12
##    NP_005651    NP_612459    NP_004211    NP_061962
##           21            0           48           24
##    NP_001774    NP_003018    NP_659402    NP_000209
##           55            6           51           37
## XP_003960863    NP_114121    NP_004818 NP_001127846
##           59           52            8           22
##    NP_788954    NP_003323 NP_001092878 NP_001007793
##           29           40           19           57
## NP_001248364    NP_751897    NP_001130    NP_061846
##           14           54           11           16
##    NP_078848    NP_006681    NP_001445    NP_940918
##           34           40           44           30
## NP_001123470    NP_071434    NP_115695    NP_000740
##           50           26           46           57
##    NP_061722    NP_776245    NP_006821    NP_060512
##            8           12            0           28
## NP_001182719    NP_694571    NP_054876    NP_004852
##           21           49           37           27
## NP_001013049    NP_055989 NP_001003897    NP_060766
##           56           44           34           57
##    NP_075555 XP_003960164 NP_001153047    NP_002337
##           45           53           37           60
##    NP_543013    NP_005997    NP_775844    NP_065083
##           36           26           32            0
##    NP_006762    NP_003761    NP_056483    NP_114104
##            6            8           10           55
## NP_001171672 NP_001091997    NP_003836    NP_789791
##           22           56           62           23
## NP_001264129    NP_612412    NP_742093    NP_776194
##           13            7           57           59
## NP_001138482    NP_570124    NP_079321    NP_060946
##           32           60           39           52
##    NP_004874 NP_001035706 NP_001129131    NP_620072
##           47           17           58           58
##    NP_849158    NP_892030    NP_078936 NP_001034930
```

```
##            13            56            58            30
##  XP_003846812  NP_001034892  NP_001243528     NP_116136
##            56            14            34            24
##     NP_955777     NP_061831  NP_001180247     NP_004056
##            26            56            56            38
##     NP_005459     NP_067650     NP_109377     NP_653273
##            26            32            44            34
##     NP_775908     NP_659430     NP_775815     NP_803251
##            47            36            27            54
##     NP_005059  NP_001007091     NP_065394     NP_085076
##            44            47            24            47
##  NP_001159365     NP_001652     NP_443196     NP_071753
##            23             0            42             0
##     NP_060743     NP_443071     NP_001294     NP_057051
##            16            50             0            34
##     NP_002458     NP_005238     NP_060147     NP_835231
##            58            14            56            51
##  NP_001004432     NP_054729     NP_003314     NP_060926
##            58            26            54            31
##     NP_009157     NP_001421  NP_001035267     NP_006033
##            39            15             6            50
##     NP_473365     NP_003826     NP_076964     NP_002404
##            13            41            59            27
##     NP_057181  NP_001171532  NP_001071121     NP_002633
##            12            53            60            29
##     NP_000470  NP_001004489  NP_001138671     NP_036537
##            40             9            40            46
##     NP_060805     NP_057324     NP_067025  NP_001129042
##            47            61            15            49
##     NP_976223  NP_001137150     NP_003136     NP_000071
##            57            28            25             6
##     NP_963925     NP_689603  NP_001185839     NP_060330
##            26            57            23            51
##     NP_683691     NP_659411  XP_002344489     NP_695001
##            57            46            16            31
##     NP_002763     NP_116317     NP_055794     NP_004761
##            31            29            50            49
##  NP_001185837  NP_001027004  NP_001186907     NP_937790
##            23            48            53            13
##     NP_115923     NP_065775  NP_001129575  NP_001010903
##            36             0            24            37
##     NP_004378     NP_683684  NP_001159439     NP_057219
##            59            31            40            56
##  NP_001094348     NP_997254     NP_003386     NP_742055
##             0            23            26            53
##  NP_001181887     NP_055117  XP_003403796     NP_001514
##            62             4            45            55
##     NP_006059     NP_612424  NP_001177945  XP_001716411
##            58            19             8            57
##     NP_776159     NP_003562     NP_653303  NP_001245240
##            17            52            51            61
##  NP_001128130     NP_077017     NP_000184     NP_006570
##            57            14            47            35
##  XP_003961041  NP_001191125     NP_872333     NP_060307
```

```
##           19           51           25           12
##    NP_443118    NP_443724    NP_079273    NP_068775
##           43            3           50           27
##    NP_663696 NP_001139313    NP_778232    NP_699207
##           50           12           29           56
## XP_003960847 NP_001008536    NP_005418    NP_067003
##           54           48           15           56
##    NP_058644    NP_005240    NP_060370 NP_001177370
##           57           51           48           31
## NP_001035194    NP_671723 NP_001161362    NP_004952
##            9           39           34           15
## NP_001139108    NP_036386    NP_660329 NP_001017403
##           47            4           47           41
## NP_001017404    NP_076941    XP_373277    NP_116053
##           41           45           14           54
## XP_003846524 NP_001123885    NP_569157    NP_443175
##            0           43           51           29
##    NP_955369    NP_056002    NP_001857    NP_689975
##           13           11           15           37
##    NP_002176 NP_001164626    NP_443073 NP_001193949
##           36           44            0           50
##    NP_660352 NP_001138779    NP_037464    NP_443165
##           37           39           60           57
## NP_001121687    NP_115950 NP_001026907    NP_620169
##           12           24           39           42
##    NP_945193    NP_055281    NP_115743    NP_777569
##            5           49           55           27
##    NP_653326    NP_710141    NP_065954    NP_775806
##            1           47           45           45
## NP_001264236 NP_001243586 XP_001129515    NP_004786
##           56            4           41           59
##    NP_000991 NP_001093391    NP_002243    NP_542787
##           10           56           51           35
## NP_001164102    NP_689846    NP_057700    NP_001288
##           11           56           19           61
##    NP_000551    NP_742099    NP_002659    NP_071765
##           49           50           34           53
##    NP_078945    NP_940893    NP_055716    NP_115995
##           33           51           22           29
## XP_003960169    NP_006813    NP_777552    NP_542778
##           38           48           60           26
##    NP_115996    NP_849150 XP_003960895 NP_001124183
##           15           55           59           58
##    NP_699167 NP_001004456    NP_002034    NP_057156
##           15            0           23           53
## NP_001005234 NP_001017980 NP_001087199    NP_068575
##           47           53           17           43
##    NP_653322    NP_808211 NP_001093260    NP_005622
##           53           53           48           59
## NP_001138640    NP_006845 XP_003960233    NP_003262
##           55           57           24           57
## NP_001004339    NP_443116    NP_476509    NP_848648
##           52           54           42           58
##    NP_001792    NP_115928    NP_149040    NP_775928
```

```
##           17          23          27          24
##  NP_001185982 NP_001001850   NP_005369 NP_001013642
##           15          44          38          53
##     NP_073618   NP_848578   NP_996805 NP_001161940
##           22           3          33          22
##     NP_997625   NP_003270   NP_078879   NP_060152
##            0           0           4          23
##     NP_036314   NP_849155 NP_001012414   NP_612396
##           47          55          56          54
##  NP_001073947   NP_001486 NP_001013757 NP_001158162
##           58          22          47          42
##     NP_057655   NP_937858   NP_005363 XP_003118572
##            9          58          59          29
##  NP_001009606   NP_057125   NP_036318   NP_066009
##           59          28          47          25
##     NP_653179   NP_068741   NP_112590   NP_872416
##            5          21          40          47
##  NP_001007596   NP_002460   NP_115956   NP_006685
##           40          15          25          22
##     NP_004464   NP_036224 NP_001092808   NP_694948
##           47          37          13          22
##     NP_000610   NP_699178   NP_955523   NP_006140
##           10           3          46           6
##  NP_001138229   NP_068835   NP_001906   NP_112509
##           53           3          57          48
##     NP_065933   NP_872308   NP_055176   NP_997279
##           54          30          49          50
##     NP_060529 NP_001129479   NP_004051   NP_114404
##           50          37          40          55
##     NP_612382   NP_003927   NP_061841 NP_001014979
##           11          57          31          41
##     NP_848561   NP_000331   NP_690591 XP_003960234
##           11          52          52          45
##     NP_000237   NP_057387   NP_004187   NP_065087
##           59          28          47          46
##     NP_004953 NP_001034806   NP_065119   NP_110392
##           38          53          38          44
##     NP_620138   NP_062558 NP_001005163   NP_665813
##           63          27          52          10
##     NP_005279   NP_998761 YP_003024032 NP_001165887
##           36          51          53          22
##  NP_001010893   NP_872303   NP_000871   NP_690872
##           32          50          34          45
##     NP_683762   NP_060064   NP_699174 NP_001164045
##           26          47          27          44
##  NP_001193600   NP_061134   NP_932347   NP_003593
##           15          39          47          31
##     NP_997203 NP_001191293   NP_775791   NP_004065
##           54          34          58          60
##     NP_068752   NP_219494
##           55          57
```

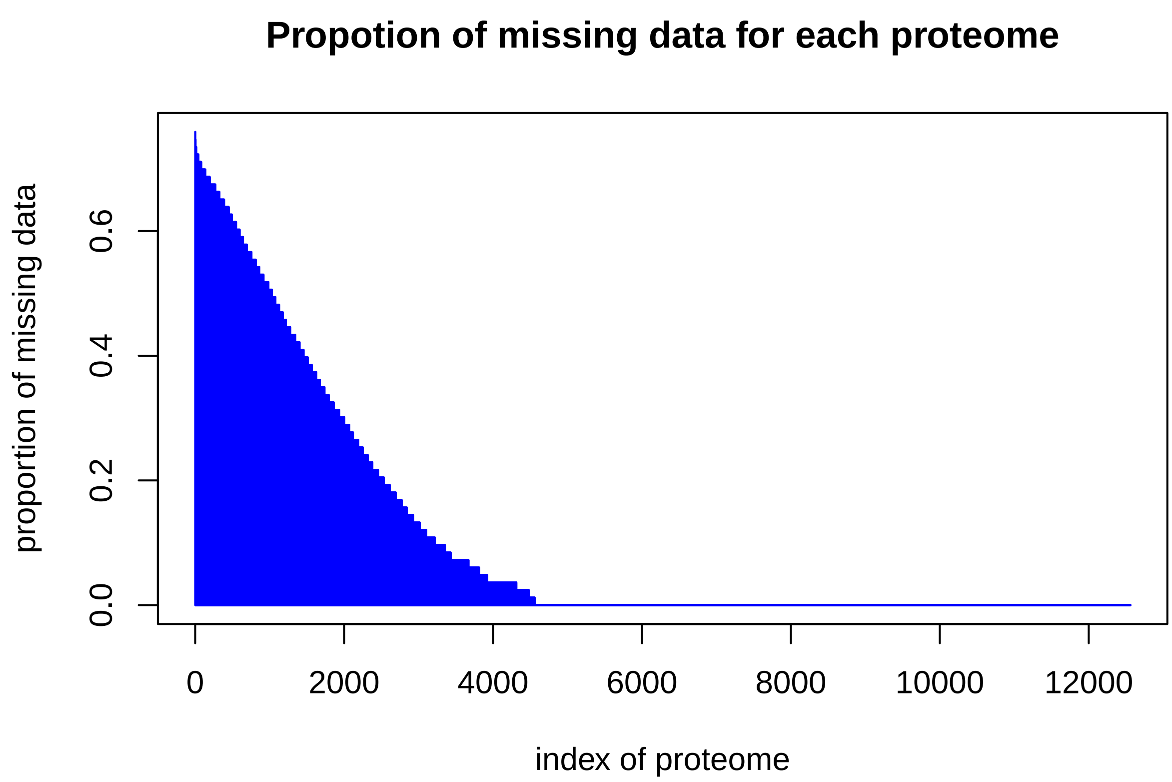
```r
# I have already used the sumarry() in the previous section
```

According to the plot we see that we have 10% of missing values in the dataset. Without suffering too much of a loss, we can exclude all variables with >25 percent missing data. Using the mean, the remaining missing data can be imputed (a more sophisticated form of imputation would be preferable but is quite computationally expensive and we dont have a huge amount of missing data, so I stuck with means in my analysis).

1. Discarded variables with more than 25% of the data missing because they wouldn't be significant for further research.
2. Used the mean imputation method, we impute the NA values with the mean of a specific column for the remaining variables with missing data. (for which i have implemented the for-loop which did the job)

Step 1 - Missing data : The code below counts missing data by column and plots a graph to show the proportion of missing data for each variable.

```
#looking for proteomes with many NAs
naCounts <- colSums(is.na(proteomes)) / nrow(proteomes)

#plotting missing data proportions

plot(sort(naCounts, decreasing = TRUE), col ="blue", type = 'h', xlab = "index of proteome", ylab="propo
```




```
#how many have more than 25% missing data
length(naCounts[naCounts>0.25])
```

```
## [1] 2251
```

Without suffering too much loss, we can exclude all variables with >25% missing data. Using the mean, the remaining missing data can be imputed (a more sophisticated form of imputation would be preferable but is quite computationally expensive and we dont have a huge amount of missing data, so I stuck with means in my analysis).

Step 2:

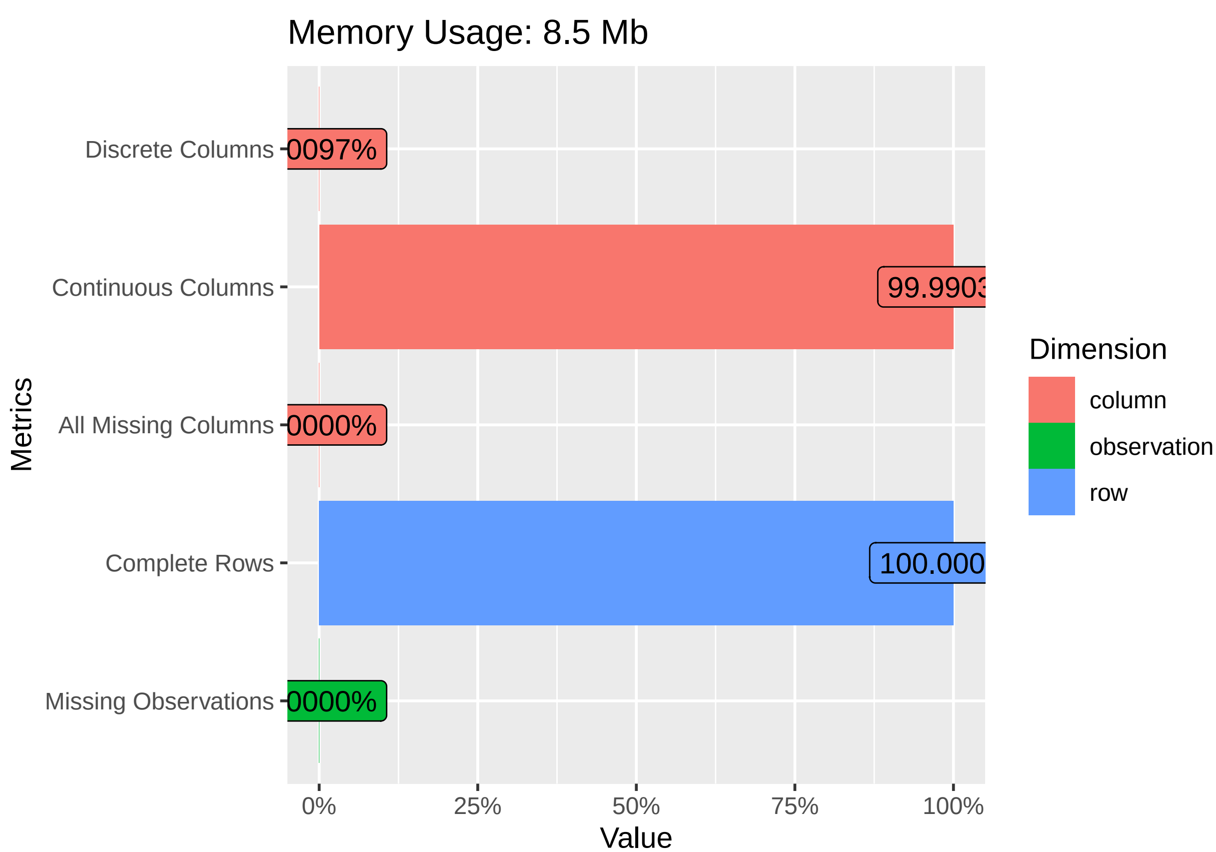
```
#remove variables with >25% missing data
proteomes <- proteomes[ , colSums(is.na(proteomes))  / nrow(proteomes) < 0.25] #removing variables with
#loop to impute means for remaining missing data
for (i in which(sapply(proteomes, is.numeric))) {
    proteomes[is.na(proteomes[, i]), i] <- mean(proteomes[, i],  na.rm = TRUE)
}
```

Now the dataset is clean, Lets explore if there are any missing values

```
dim(proteomes) # a total of 2251 variables are removed
```

```
## [1]    83 10303
```

```
plot_intro(proteomes)
```



The proteome dataset is now clean, Therefore, I have now joined the proteome dataset and clinical datset using inner_join() from dplyr package.

```r
#inner join on data to create full data set
data <-  inner_join(clinical, proteomes, by = "Complete.TCGA.ID")
#replacing lengthy col name
colnames(data)[3] <- "diag_age"
```

Exploring the final datset

```r
dim(data)
```

```
## [1]    80 10332
```

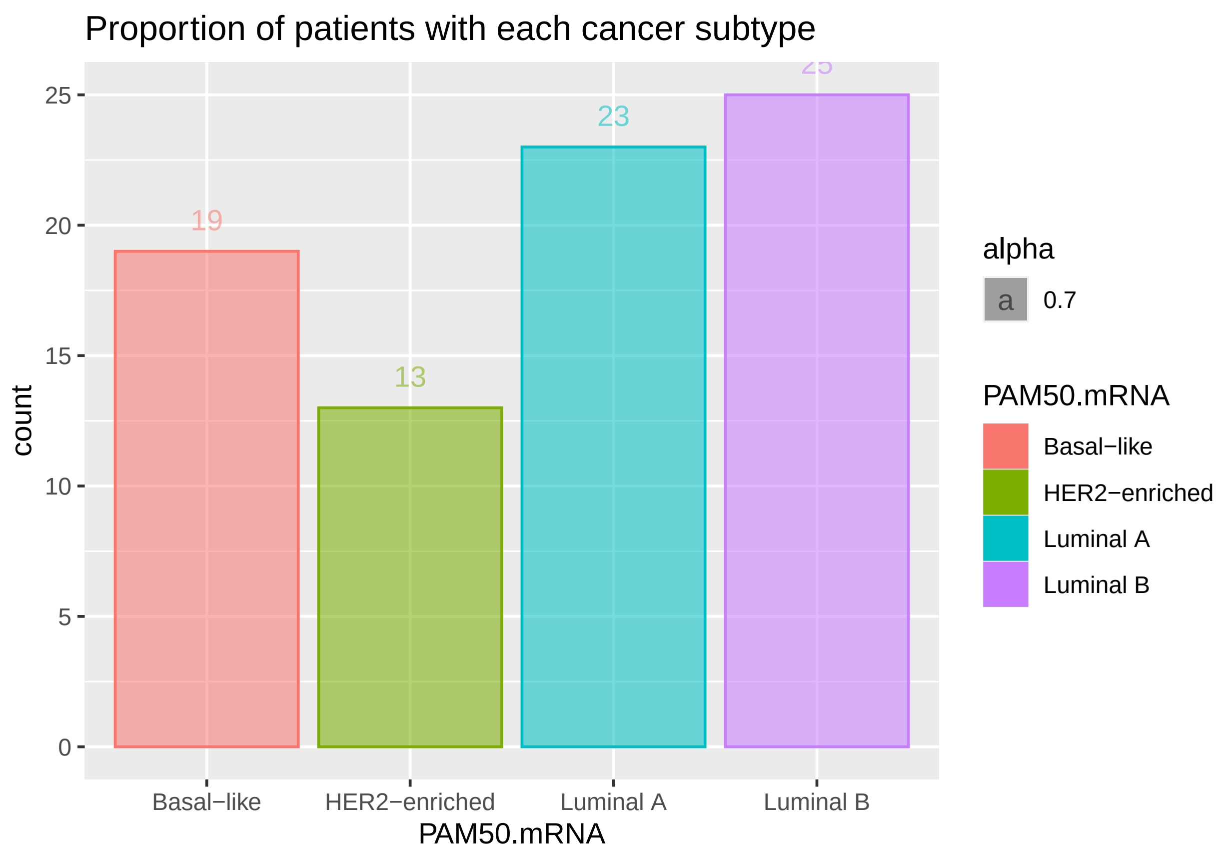
```r
#head(data)
#tail(data)
#str(data)
```

Evaluation of distribution

The main idea of the project is to check if the proteomic datset can classify the subtype of breast cancer.Therefore, it is important to check the number of observations in each subtype The plot below shows how many patients have each subtype of breast cancer.

```r
#Barplot of subtypes
ggplot(data, aes(PAM50.mRNA, col = PAM50.mRNA, fill = PAM50.mRNA, alpha=0.7)) + geom_bar() + ggtitle("P
```

```
## Warning: The dot-dot notation (‘..count..‘) was deprecated in ggplot2 3.4.0.
## i Please use ‘after_stat(count)‘ instead.
## This warning is displayed once every 8 hours.
## Call ‘lifecycle::last_lifecycle_warnings()‘ to see where this warning was
## generated.
```



Therefore , They are reasonably well balanced, although HER2 is slightly underrepresented.

3. Data Cleaning & Shaping

Data Imputation

- Data imputation is already done in previous chunks
- Mean imputation for proteome dataset is done

Proper Encoding of Data

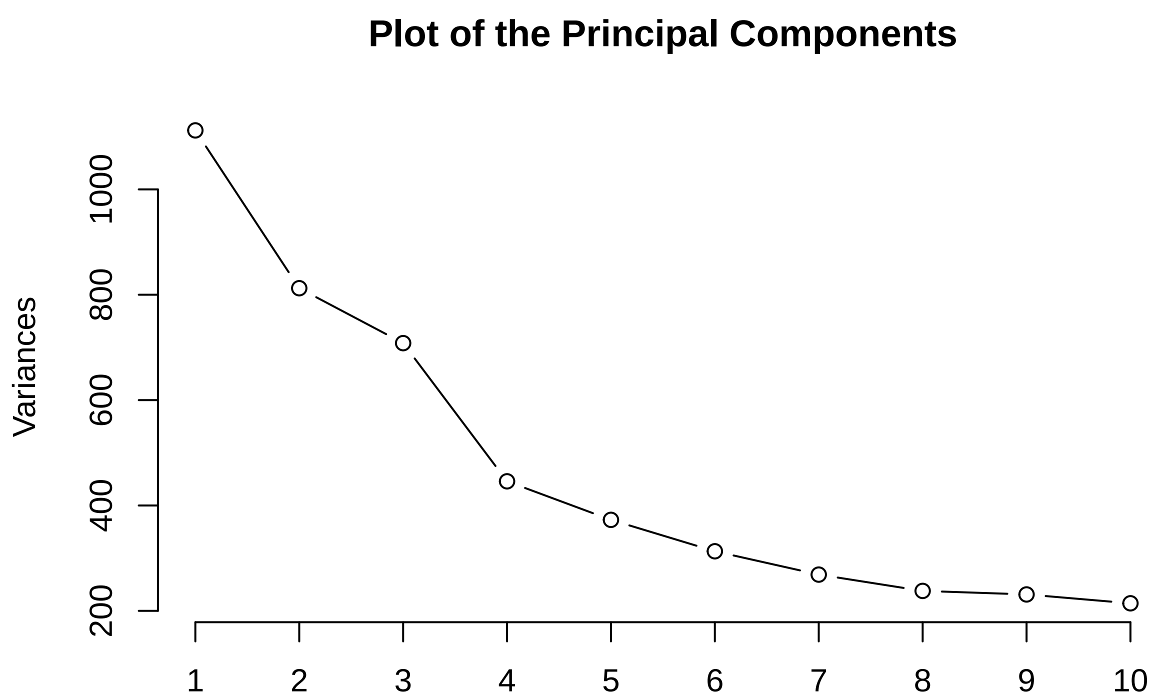
- Encoding was done for only PAM50.mRNA column
- PAM50.mRNA is categorized into four types "Basal.like", "HER2-enriched", "Luminal.A", "Luminal.B"

Normalization/Standardization

- Normalizing the data does not make any difference in the predictions as the protein expression data already ranges on -1 0 1 scale ### Feature engineering - PCA
- Principal component analysis is also done using prComp function
- Principal components are taken into consideration only when the cumulative variance is greater than 85%
- To get the cumulative variance of 85 or greater, I was forced to select 48 components

- But i want to know the list of features(proteins) important of the classification of breast cancer subtype, Because of this I haven't used Principal components for my models ### Feature selection - repeated lasso regression
- I selected variables using repeated lasso regression as my method. -A total of 30 proteins were selected over more than 20 times.
- These proteins are taken into consideration for further analysis
- Checked the distribution of cancer subtype using these proteins

```
################################
### Feature engineering: PCA ###
################################

#Performing PCA on the dataset
data_PCA <- prcomp(data[,31:ncol(data)], center = T, scale = T)
#Printing Principal components
#print(data_PCA)
#Summary of Principal components
#summary(data_PCA)
#str(data_PCA)
#Plotting variance plot of the Principal components
screeplot(data_PCA, type = "l", main = "Plot of the Principal Components")
```



Feature selection : repeated lasso regression

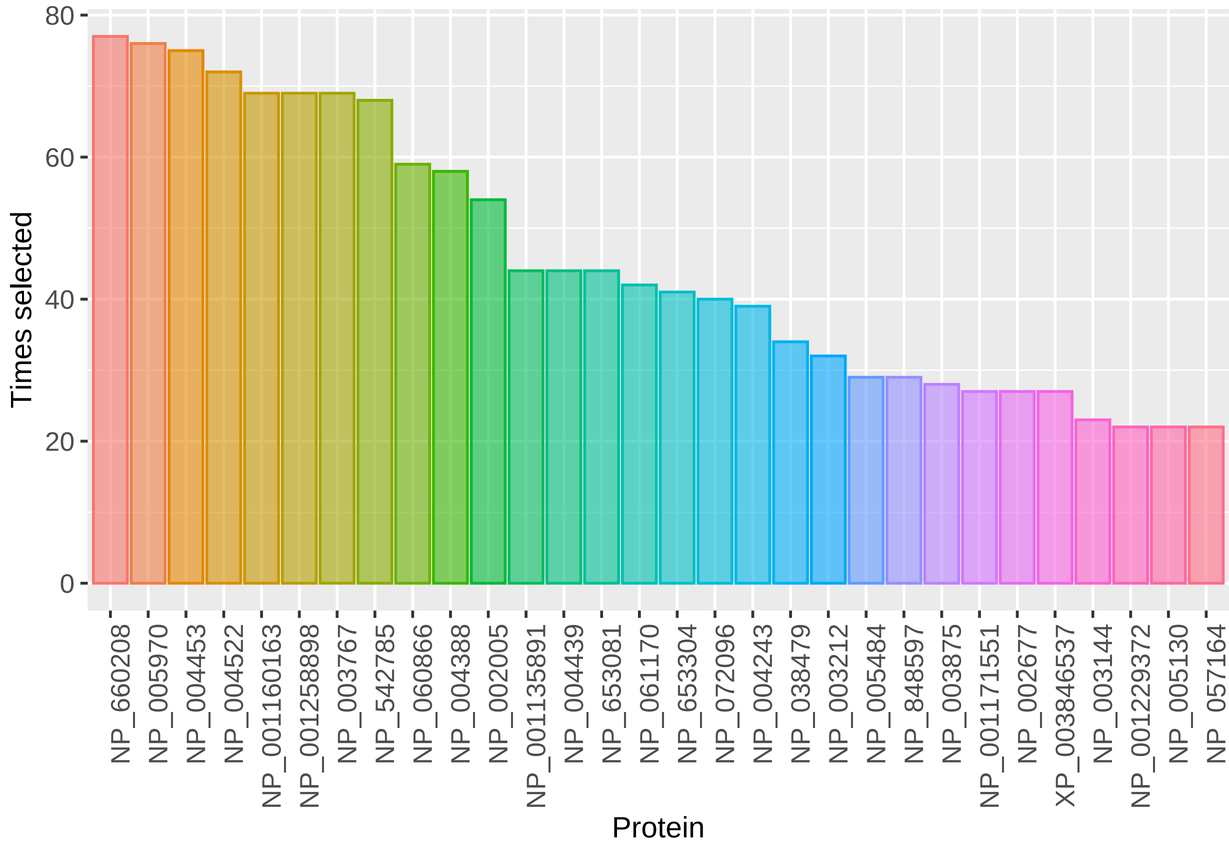
The PAM50 genetic test is used to identify the subtype of breast cancer. A list of proteins linked to the PAM50 genes is included in this data collection. Therefore, it would appear likely that these are the best factors to utilize when categorizing breast cancer subtypes. To test if machine learning techniques might be used to find a set of proteins with as good or higher prediction power at classifying cancer subtypes, I chose an approach that was independent of biology. I'm selecting variables using repeated lasso regression as my method. The data set is reduced via lasso regression, which also creates a sparse set of predictor variables. However, because of the stochastic nature of the reduction, the findings are not always reliable. To get around this, I conducted 100 iterations of the lasso regression and prioritized the variables according to how frequently they were used in the final model.

```
# Defining  a function that performs lasso regression again and returns the chosen model variables
LassoSub=function(k=1, Xdata, Ydata){
  set.seed(k)
  s=sample(nrow(data), size=0.8*nrow(data))
  Xsub=Xdata[s, ]
  Ysub=Ydata[s]
  model.sub=cv.glmnet(x=Xsub, y=Ysub, alpha=1, family="multinomial") #cross validated lasso
  coef.sub=coef(model.sub, s='lambda.1se')[-1] #using lambda +1se hyperparameter value for parsimony
  return(coef.sub)
}
```

```
options(warn = -1) #turn off warnings
#Run model 100 times and save results
niter=100
lasso.stab=sapply(1:niter, FUN=LassoSub, Xdata=as.matrix(data[,31:ncol(data)]), Ydata=as.matrix(data[,2

#create a matrix of all predictor variables
stability_matrix <- matrix(nrow=length(lasso.stab[[1]]),ncol=length(lasso.stab))
rownames(stability_matrix) <- rownames(lasso.stab[[1]])

#loop through to put list contents into matrix
for (i in 1:300){
  temp.data.frame <- as.matrix(lasso.stab[[i]])
  stability_matrix[,i] <- temp.data.frame
}

stability_matrix <- ifelse(stability_matrix != 0, 1, 0) #Replacing beta values with binary 1/0 (selecte
stability_matrix <- stability_matrix[2:nrow(stability_matrix),] #remove intercept value
stable_variables <- as.data.frame(rowSums(stability_matrix)) #create data frame with count of how many
stable_variables$protein <- rownames(stable_variables) #create column of variable names

colnames(stable_variables)[1] <- "times_selected" #assign appropriate column name
stable_variables <- stable_variables[!is.na(stable_variables$times_selected),]  #remove NAs
stable_variables <- stable_variables[stable_variables$times_selected != 0,] #remove all variables that a

stable_variables <- stable_variables[order(-stable_variables$times_selected),] #ordering by number of t
```

visualizing the selected features

```
#plotting stable variables
ggplot(stable_variables[1:30,], aes(x=reorder(as.factor(protein),-abs(times_selected),mean), y=times_sel
```




```
STABVARS <- stable_variables$protein[1:30]

STABVARS.ind <- which(colnames(data) %in% STABVARS)
```

We now have a collection of variables that the lasso regression repeatedly chose. Due to the size of the data set, instability still exists after 100 iterations, and only roughly 30 variables were chosen more frequently than 20% of the time. These are the factors that we will classify using.

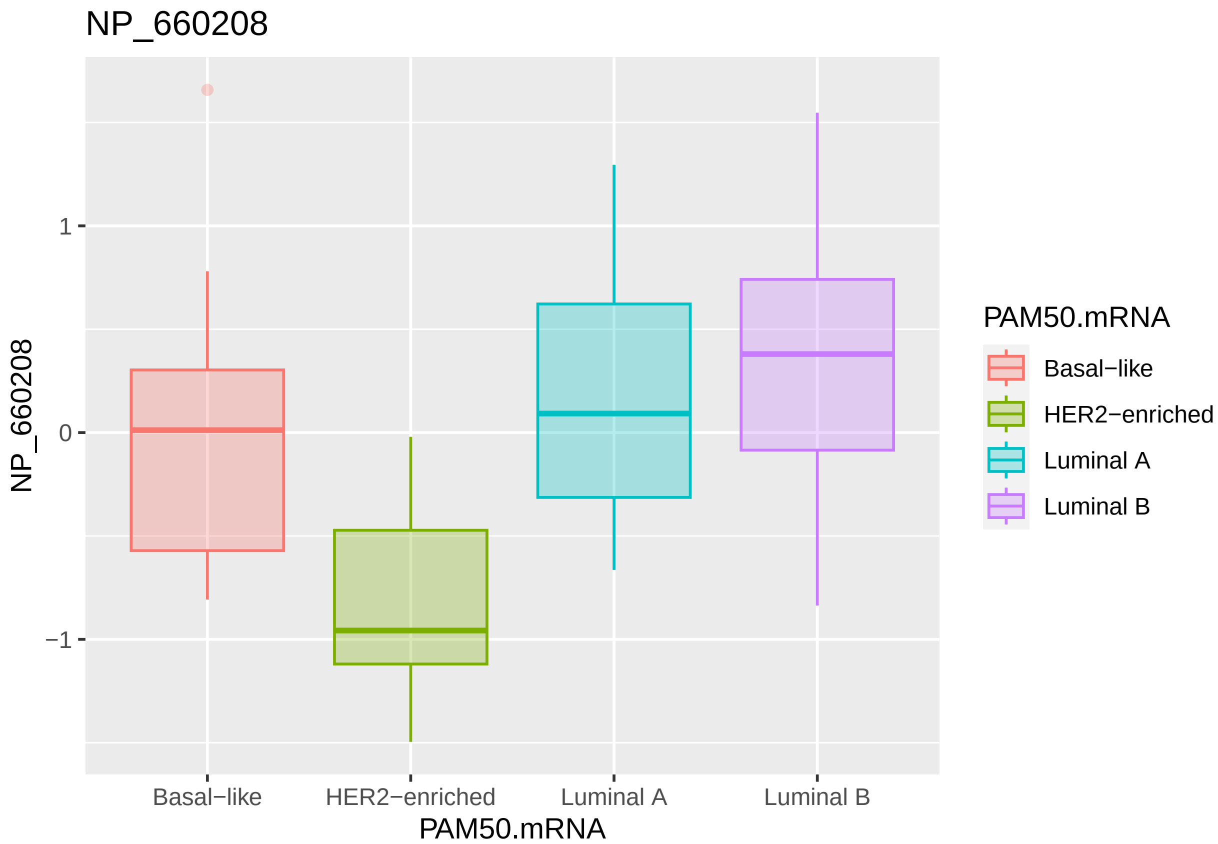
An indication of how well the chosen protein variables will be able to categorize the subtypes will be provided by visualizing the relative amounts of the most-selected protein in patients with each subtype of cancer:

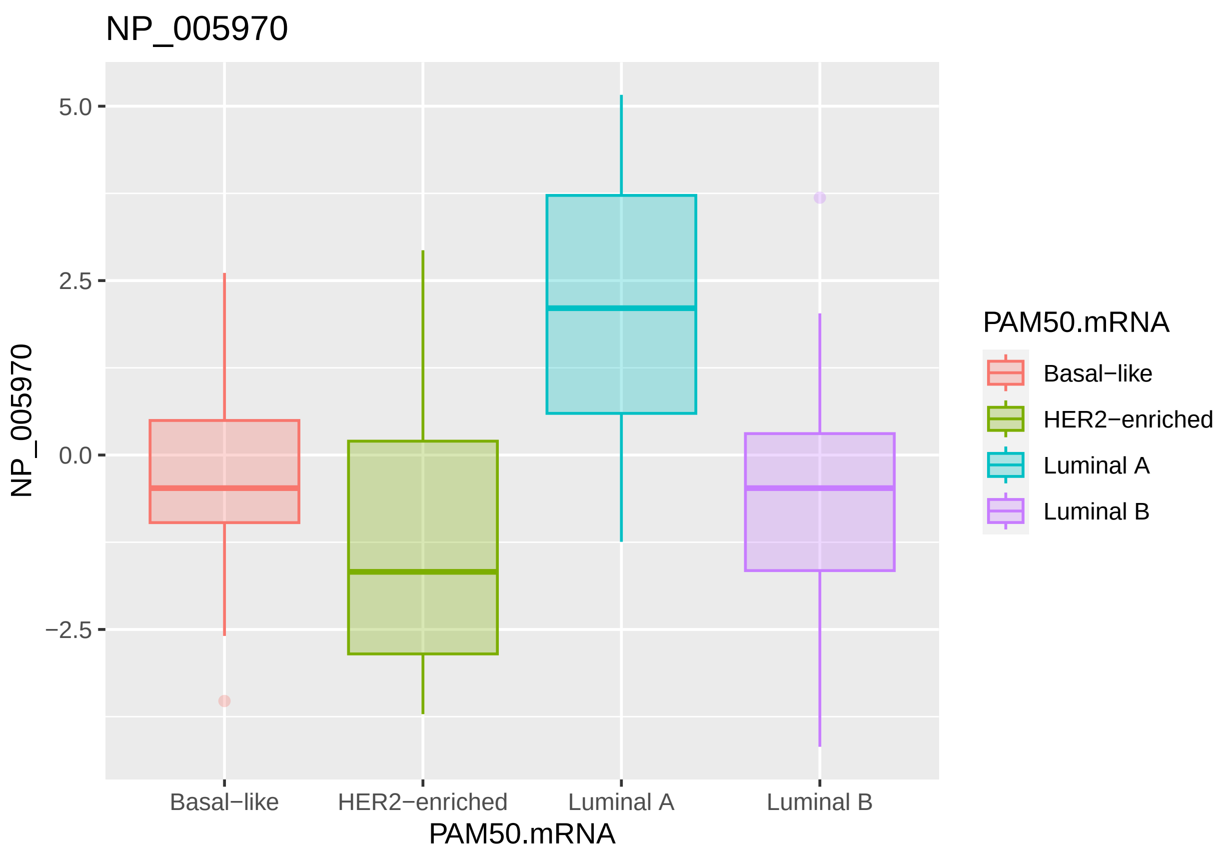
```
library(gridExtra)
```

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

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

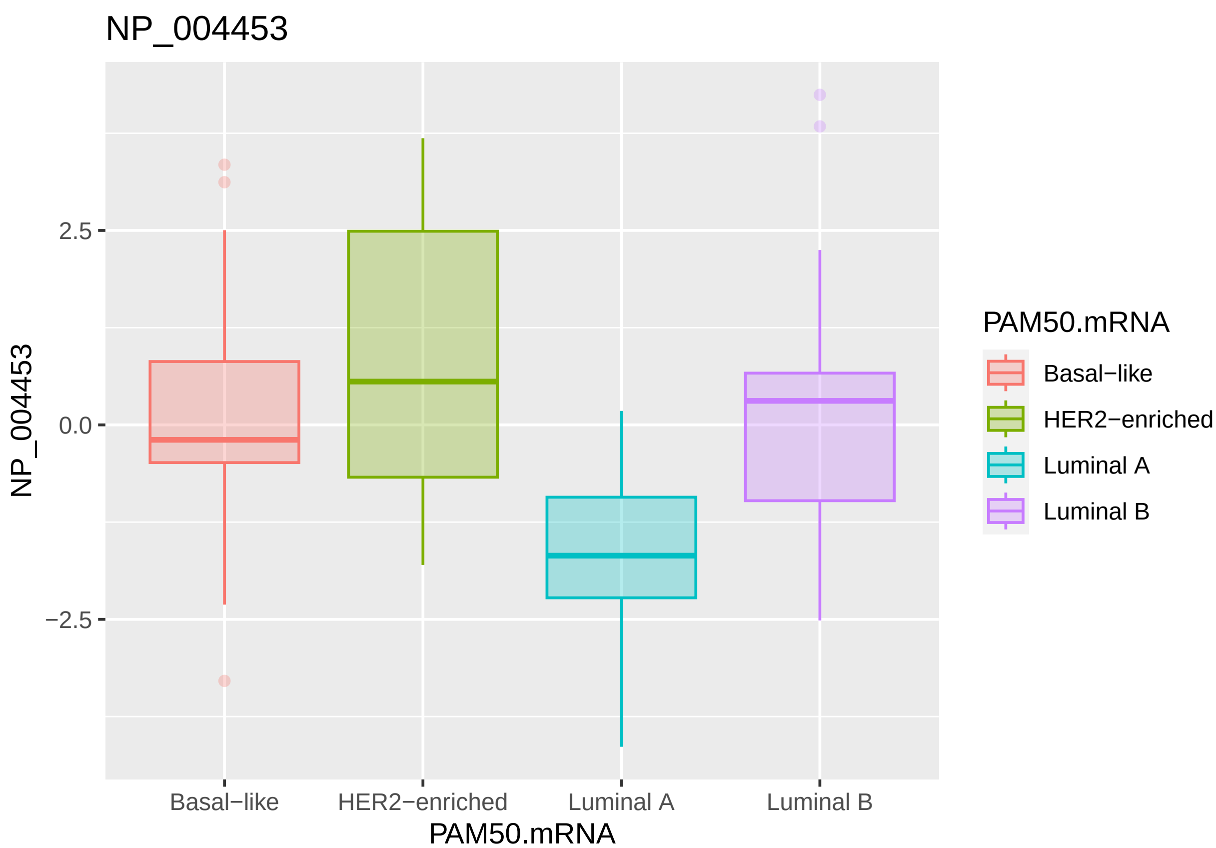
```
## The following object is masked from 'package:randomForest':
##
##     combine
```

```
for (i in 1:length(STABVARS[1:5])){
print(ggplot(data, aes_string("PAM50.mRNA", STABVARS[i], col="PAM50.mRNA", fill="PAM50.mRNA")) + geom_bo
}
```

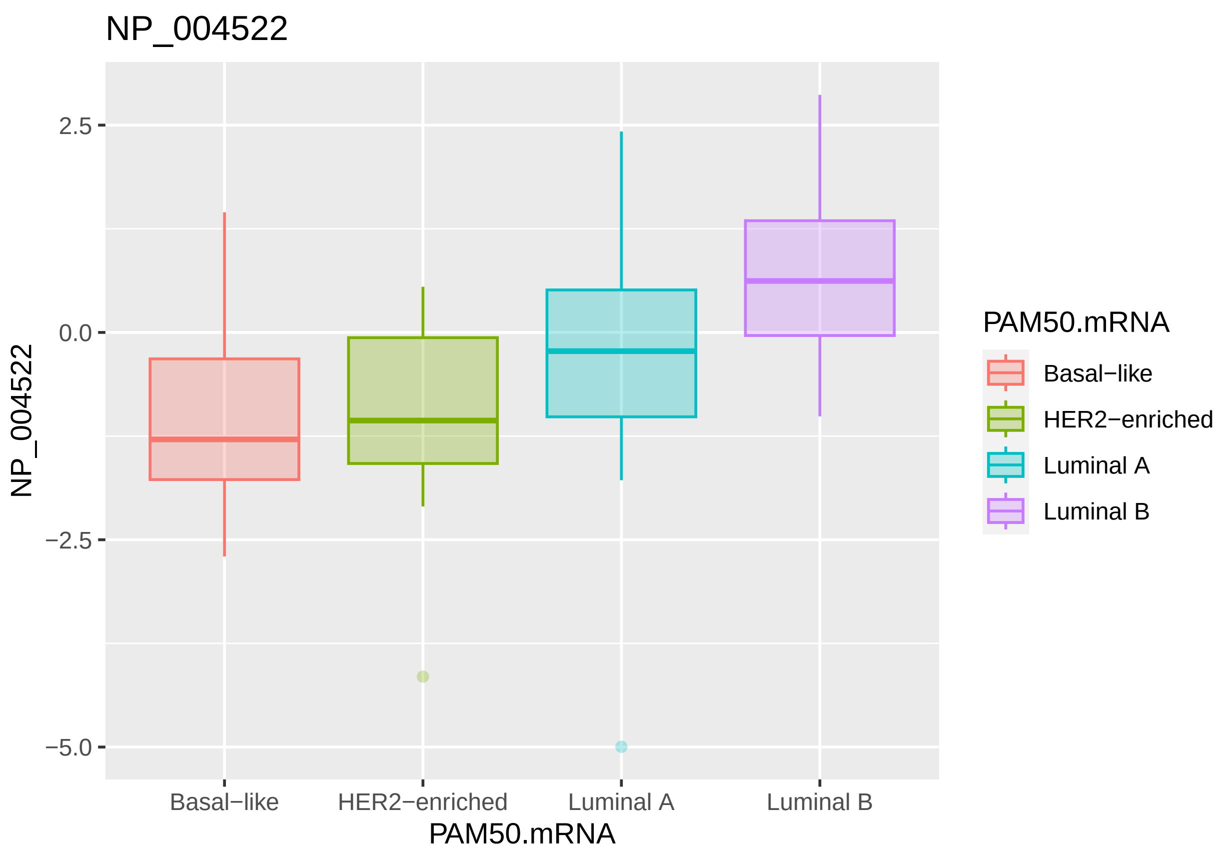




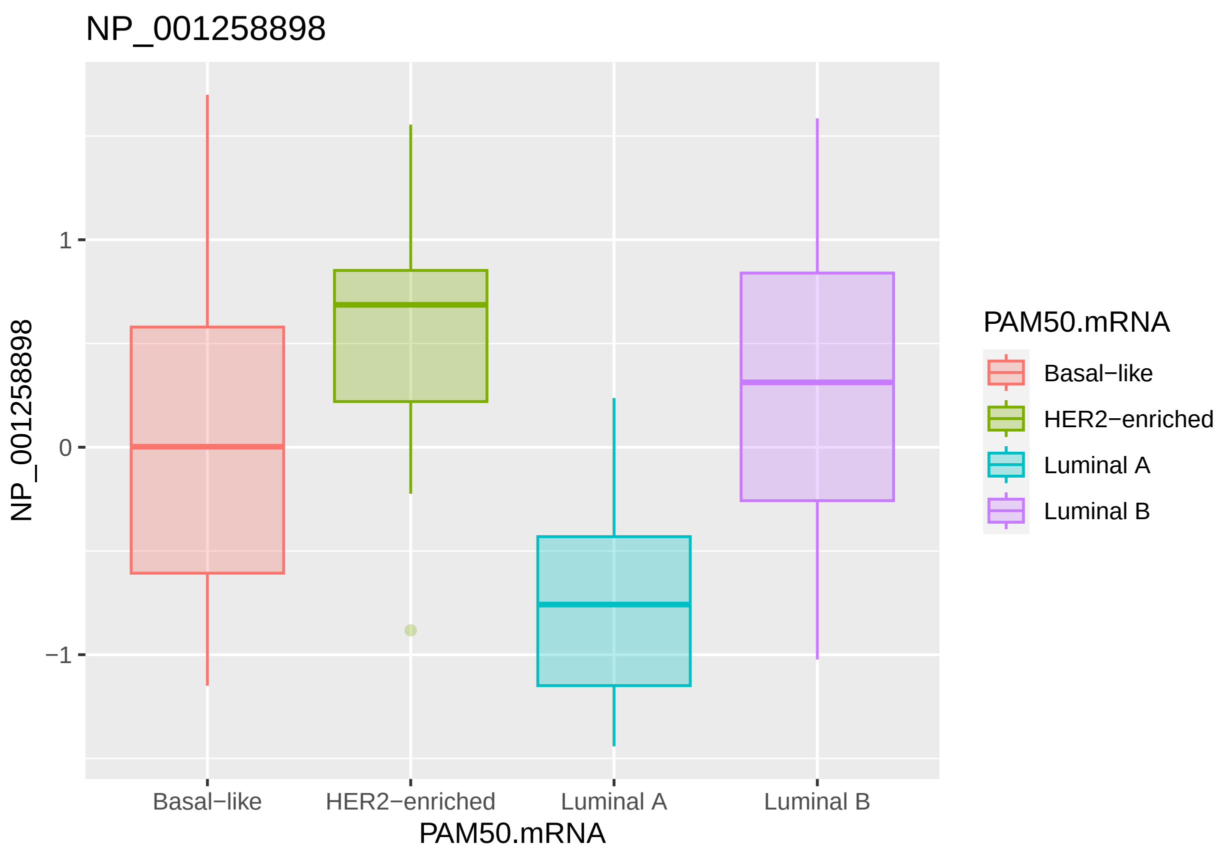
NP_005970
5.0
2.5
0.0
−2.5
NP_005970
Basal−like
HER2−enriched
Luminal A
Luminal B
PAM50.mRNA
PAM50.mRNA
Basal−like
HER2−enriched
Luminal A
Luminal B



NP_004453
2.5
0.0
−2.5
NP_004453
Basal−like
HER2−enriched
Luminal A
Luminal B
PAM50.mRNA
PAM50.mRNA
Basal−like
HER2−enriched
Luminal A
Luminal B



NP_004522
2.5
0.0
−2.5
−5.0
NP_004522
Basal−like
HER2−enriched
Luminal A
Luminal B
PAM50.mRNA
PAM50.mRNA
Basal−like
HER2−enriched
Luminal A
Luminal B



This is promising. There are clear differences in the levels of each of the selected proteins.

Now that i have slected the proteins, I am going to create a subset of data with the selected features(predictor variables) and response variable only and stored as final_data

```
final_data <- data[,c(21, STABVARS.ind)]
head(final_data)
```

```
##   PAM50.mRNA  NP_038479 NP_001258898   NP_542785  NP_002005 XP_003846537
## 1 Basal-like -0.3708959  -0.01456473  0.05890562 -2.1305106   -0.4957955
## 2 Basal-like -1.6044748  -0.51053492  3.17273051 -0.9688522   -0.6711132
## 3 Basal-like -3.0516640   0.53387720  3.71857004 -0.3435704   -0.3498830
## 4 Basal-like -1.0663490   1.69892745  2.96770134 -3.2821848   -0.4373841
## 5 Basal-like -0.3009396  -1.09705962  0.03501174 -1.2946781   -0.3376402
## 6 Basal-like  0.6787788  -0.70384668 -1.91679672 -2.7445377   -0.4103540
##     NP_660208 NP_004439  NP_004388 NP_001229372  NP_005130 NP_004243 NP_003144
## 1 -0.09170859 -4.419112  0.1691111    -3.004808  2.2373013 -3.717470 0.1948258
## 2 -0.51388030 -5.187379  0.4863889    -3.273820 -2.2066435 -2.905828 0.9748146
## 3  1.65751511 -3.099008 -0.7349499    -2.969601 -0.4698218 -3.076914 0.3539689
## 4 -0.70126018 -3.130366  0.7843981    -2.859260  3.8894601 -3.180972 0.3397851
## 5  0.78031558 -2.062567 -0.1823685    -1.774609 -0.2388310 -1.785901 1.5453813
## 6  0.41280109 -3.322351 -0.2659006    -2.127745 -0.6167161 -1.937433 1.4835906
##   NP_001171551  NP_072096   NP_005484   NP_061170  NP_653304  NP_653081
## 1    0.1948258 -0.5215101 -0.96600568 -1.41417478  0.5548304 -0.2753844
## 2    0.9547423 -0.5506795 -0.29643048 -2.19660738 -0.8751815  0.2890113
## 3    0.3508126  0.8747561  0.29399945 -3.01378855 -1.5334903 -1.4072388
```

```
## 4    0.3470145 -1.2145533 -0.11205750 -1.51096203  0.1301301  0.3723177
## 5    1.5990205  0.2693307  0.62504394  0.48671103 -1.4414803  0.6448058
## 6    1.5432063  0.3623570  0.07115731 -0.06412445 -2.9967579 -0.3690816
##    NP_057164  NP_004453    NP_003212    NP_060866 NP_001160163   NP_003875
## 1 -0.6243686 -2.3105130  0.007476375 -1.399480707  1.340963113  0.04810062
## 2  0.6034772 -0.3499566 -0.376719645 -1.457277986  0.740637896  1.71079864
## 3  1.8279546 -3.2915417 -0.476134402  0.335031167  2.493930969 -3.12110229
## 4 -0.1771228  1.3374534  0.159048035 -0.451843095  1.055503657 -0.82416136
## 5  1.4155177 -0.2021304 -1.819778494 -0.600190397  1.886978849  0.83677799
## 6  0.6375064  3.3454346 -2.334106568  0.002369978  0.002369978 -0.66257428
##   NP_002677 NP_001135891  NP_004522  NP_003767  NP_848597  NP_005970
## 1 -7.684869    0.9038146 -2.3839833 -0.3892635  0.3819222  0.8193237
## 2 -8.877335   -1.2933543 -0.7514024 -1.0558322 -0.7346755 -0.9655069
## 3 -7.479934   -0.4603530 -0.7412624 -1.0095468 -0.1952249  2.6107136
## 4 -7.963274   -1.7784528 -0.7771697 -0.7446371  0.2277281 -0.2638766
## 5 -4.388818    0.6306902  1.4493952 -0.5521973  1.9688493  1.8389858
## 6 -3.342988   -1.0913487  1.2864003  0.2889839 -0.5502216  1.5019339
```

```
dim(final_data)
```

```
## [1] 80 31
```

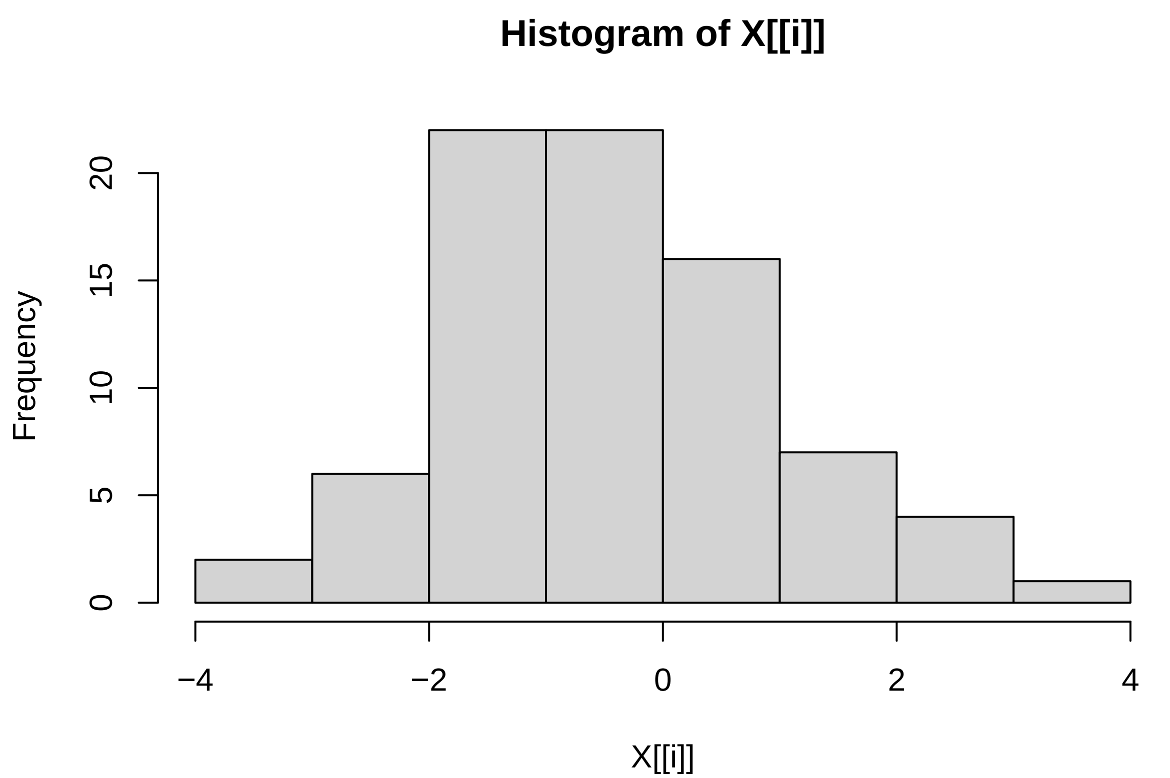
```
tail(final_data)
```

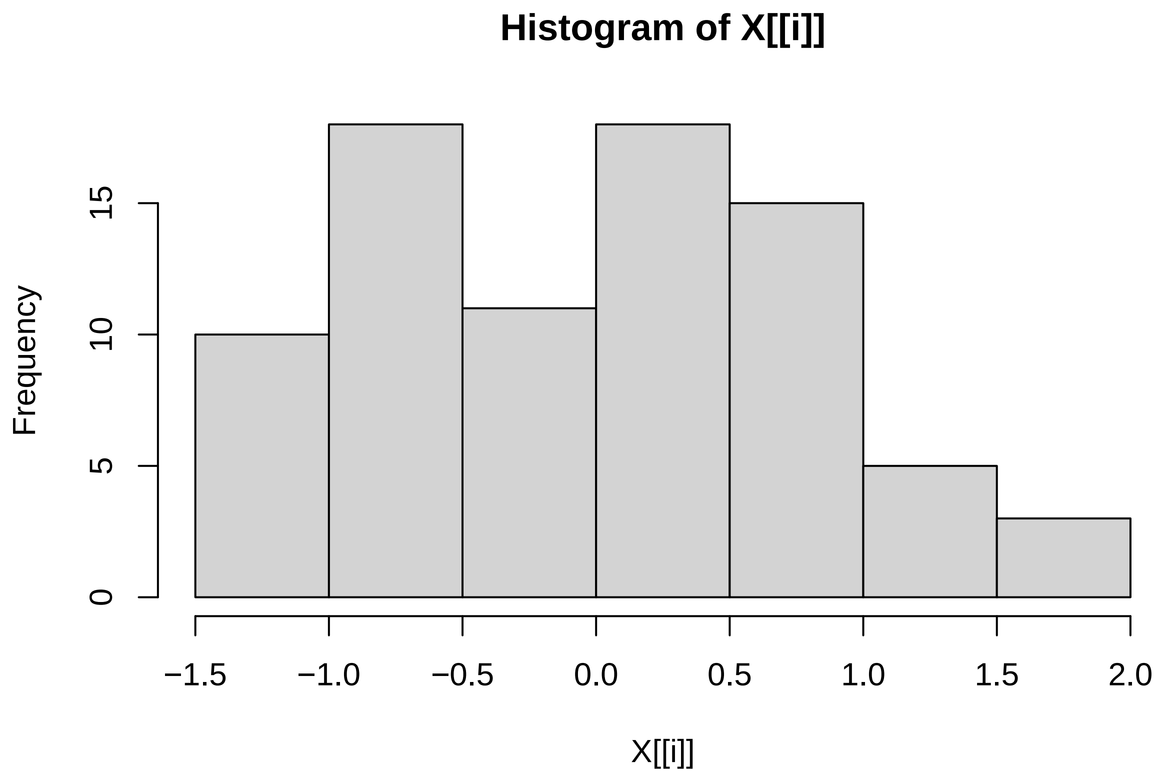
```
##    PAM50.mRNA  NP_038479 NP_001258898  NP_542785  NP_002005 XP_003846537
## 75  Luminal B -0.6318314    0.4327078 -5.5679315  0.8108994 -0.060341913
## 76  Luminal B -0.3073523   -0.7009215 -2.6553809 -0.8374660  0.624362546
## 77  Luminal B -2.5001368   -1.0230163 -2.3908031 -1.5362152 -0.001080874
## 78  Luminal B -1.5815337    0.8397669 -4.2961120 -0.4483087 -1.344565342
## 79  Luminal B -1.2355758    0.3127390 -3.2926750  3.4240101 -0.115518269
## 80  Luminal B  0.4533356    1.4196209  0.3012351 -0.1103309 -0.696365039
##     NP_660208  NP_004439   NP_004388 NP_001229372 NP_005130  NP_004243
## 75  0.3346582 -2.0577536  0.22820424    -1.704775 -5.100095 -1.6375408
## 76  1.0580919 -1.0382666 -0.41980067    -1.388998 -4.925767  0.7448429
## 77  0.5255059 -2.7790493  0.08370852    -2.292626 -2.281469  1.8062721
## 78  0.7435718  0.9922713  0.34940658     0.935962 -1.445453 -1.3633351
## 79 -0.1704231 -4.5628057 -0.77071534    -5.997651 -2.066468  5.6714458
## 80  0.4533356 -4.6822921  0.09097858    -6.543286 -4.404932  1.9922345
##      NP_003144 NP_001171551  NP_072096  NP_005484  NP_061170  NP_653304
## 75 -0.92317894  -0.92037752  0.1665730  0.6316086 -0.9427889  0.6456157
## 76 -0.11190639   0.04337942  0.6243625 -0.0931650  3.1383863 -1.2738726
## 77 -0.11487717  -0.11487717 -0.8869070  0.7419420  3.6292442 -0.6236136
## 78 -0.01660397   0.08662977  0.7060322  1.4286685 -0.7439326 -2.8344160
## 79 -0.30219453  -0.30219453 -0.6389439  0.2688152  5.6897474 -0.6096613
## 80  0.17597590   0.15360819 -0.2803255 -0.6874180 -2.5439384 -0.9066216
##      NP_653081    NP_057164  NP_004453   NP_003212 NP_060866 NP_001160163
## 75  0.53355890 -0.015519210  0.3150482 -3.45005881 0.2786298   1.29274343
## 76  0.16921448 -1.466641235 -0.1841946  0.01392866 0.4958501   0.06316141
## 77  0.03908252  1.083330908  1.3198487 -0.25544907 0.4451791   0.72632291
## 78 -0.19726303 -0.664161107  0.8045736  0.03970534 0.9993099   0.90546108
## 79 -1.01961703 -0.569397806  0.4591518 -1.41493146 2.9262067   0.05285640
## 80 -0.24901071 -0.007439371 -2.1413195 -1.23766378 0.1088728  -0.69636504
##      NP_003875   NP_002677 NP_001135891  NP_004522 NP_003767  NP_848597
```

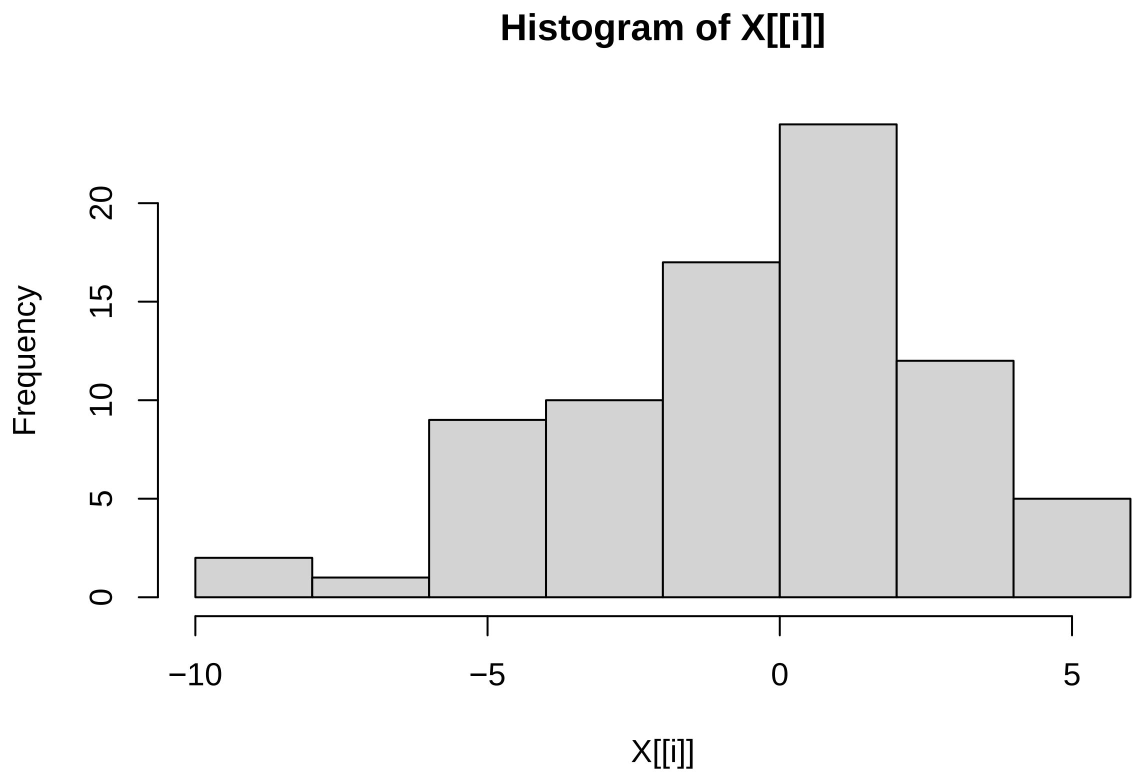
```
## 75  0.80809795  -4.1644206    0.9957930  1.9650840 1.4468215  0.9565732
## 76  0.04810062  -0.7973058   -1.0409439  0.2950495 2.6778835  3.2187065
## 77 -4.15353011  -5.7756852    0.3492332  1.6790880 0.4741860 -1.2930036
## 78 -4.17645469  -4.9108220   -0.7275091  0.8303820 1.1658917  0.2602502
## 79 -0.78535662 -10.4852016    0.2871168 -0.9720329 0.3127390 -0.7377725
## 80  0.78885134  -9.2050444    1.5493537  1.0796316 0.6054361 -0.9513570
##     NP_005970
## 75 -0.4749519
## 76 -1.2470992
## 77  0.2711377
## 78  1.2573943
## 79 -4.1821325
## 80  0.5696477
```

Checking the distribution of 30 proteins - built histogram using lapply()

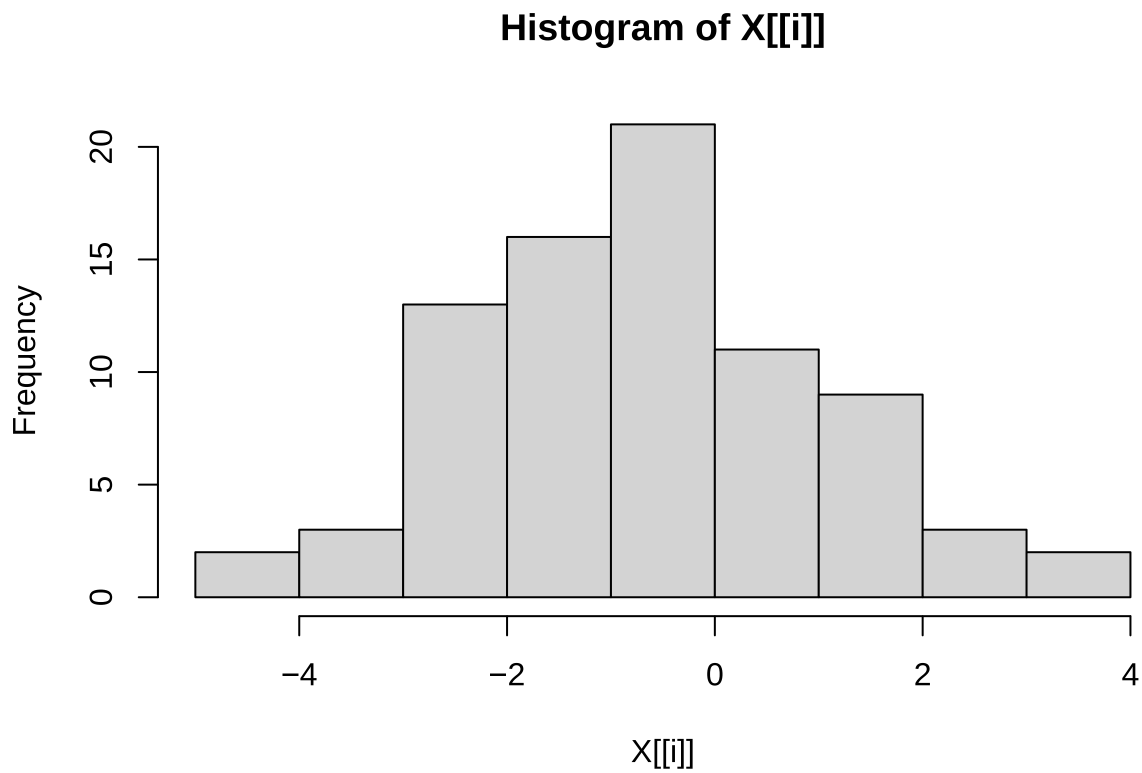
```
lapply(final_data[, 2:ncol(final_data)], hist)
```

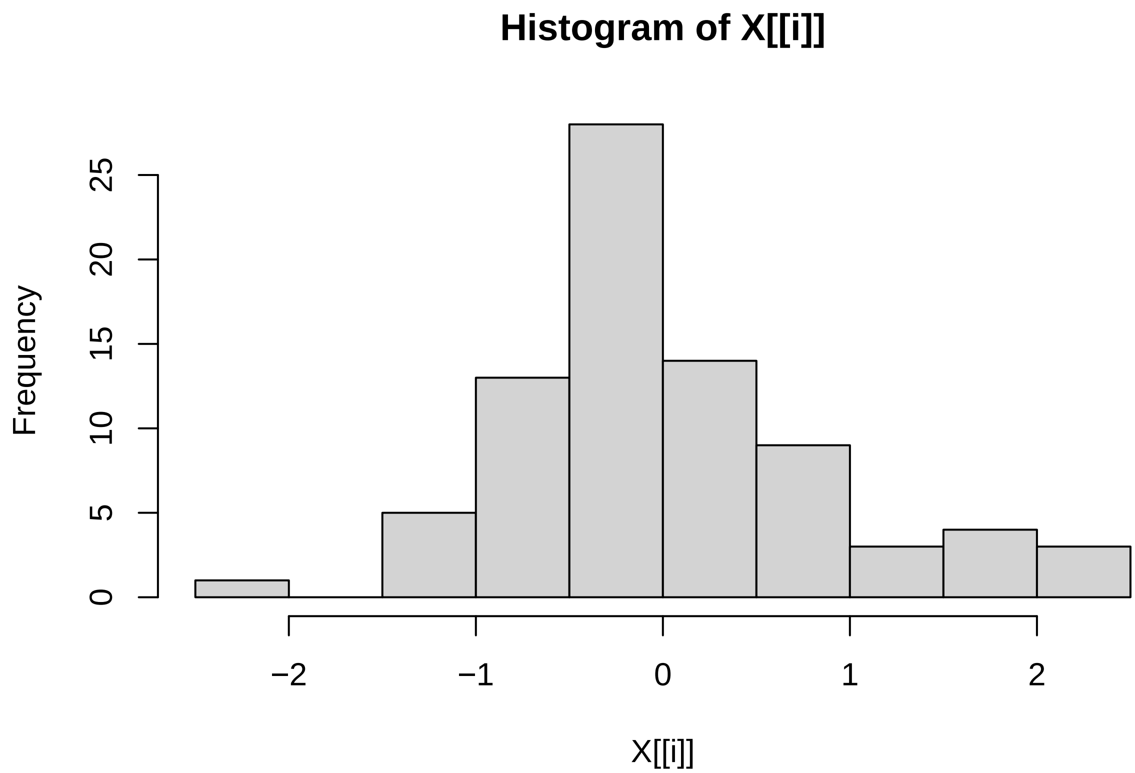


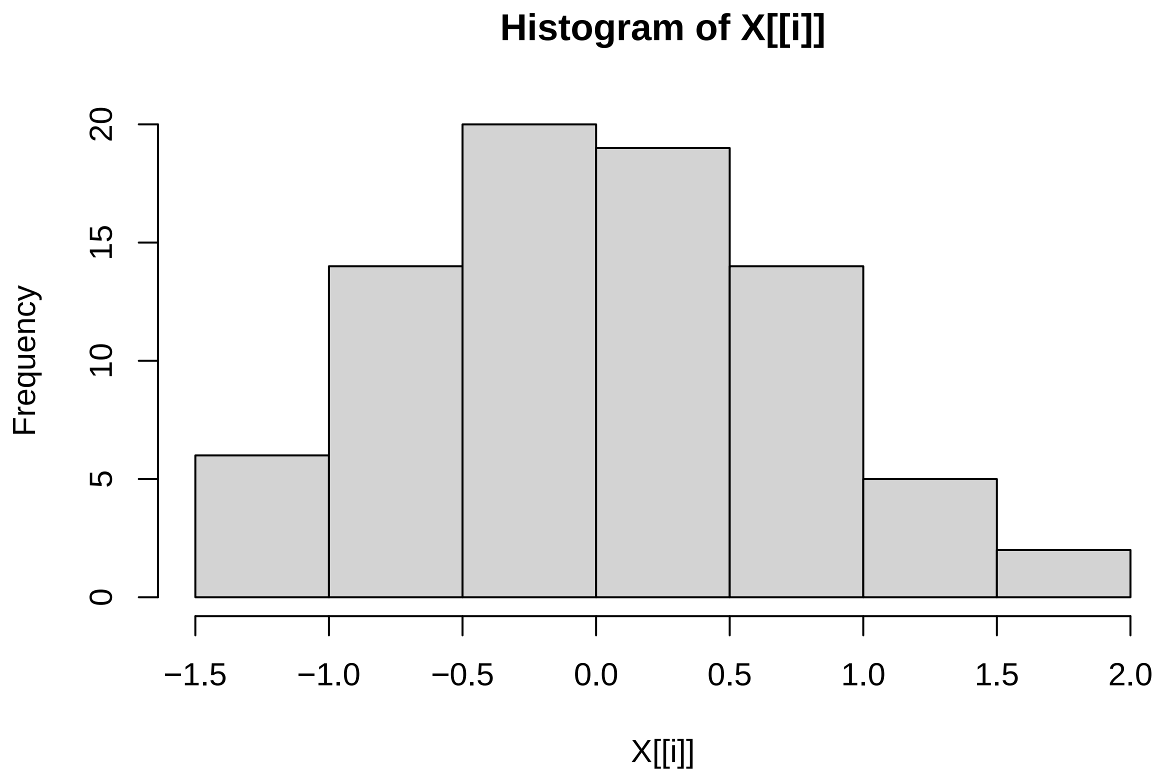

Histogram of X[[i]]
Frequency
0
5
10
15
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
X[[i]]

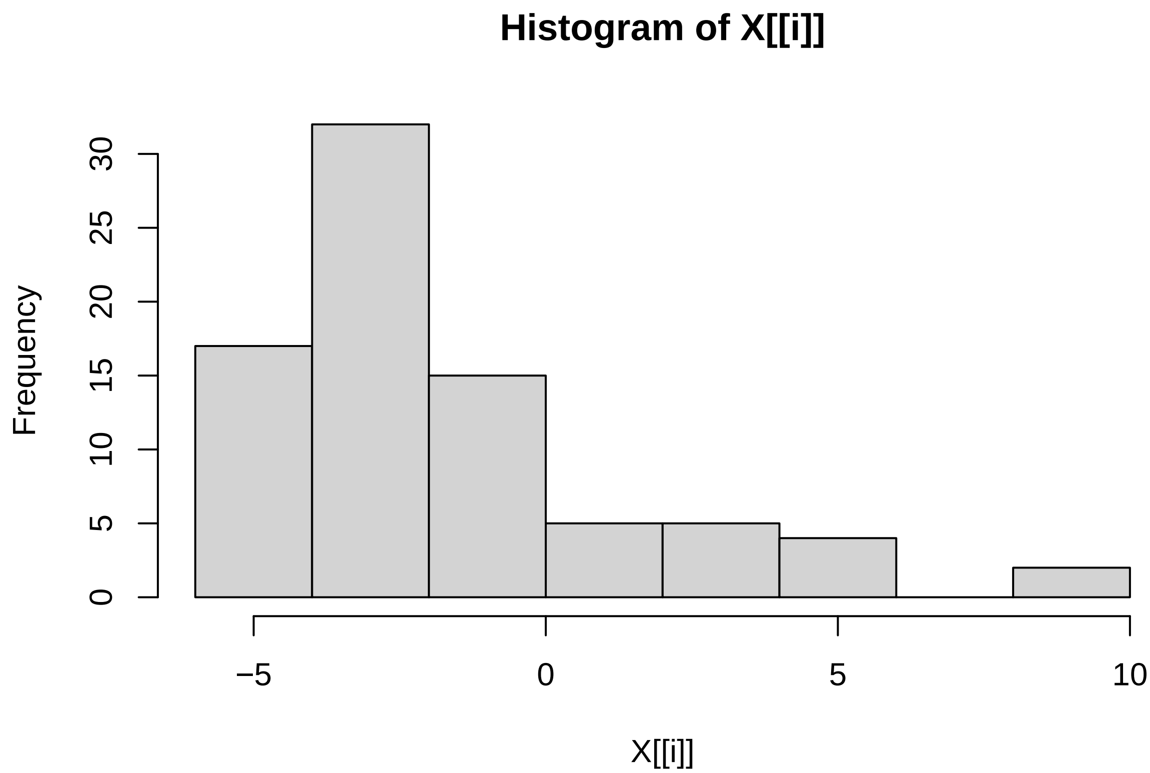


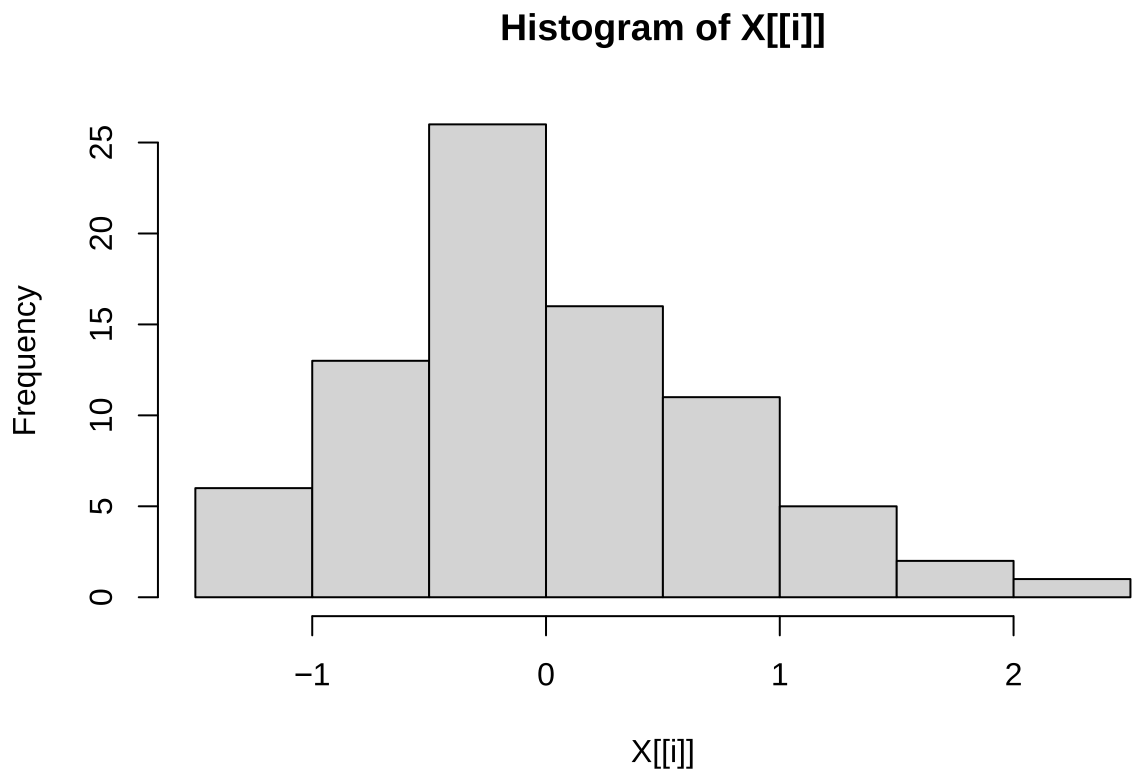
Histogram of X[[i]]
Frequency
0
5
10
15
20
−10
−5
0
5
X[[i]]


Histogram of X[[i]]
Frequency
0
5
10
15
20
−4
−2
0
2
4
X[[i]]

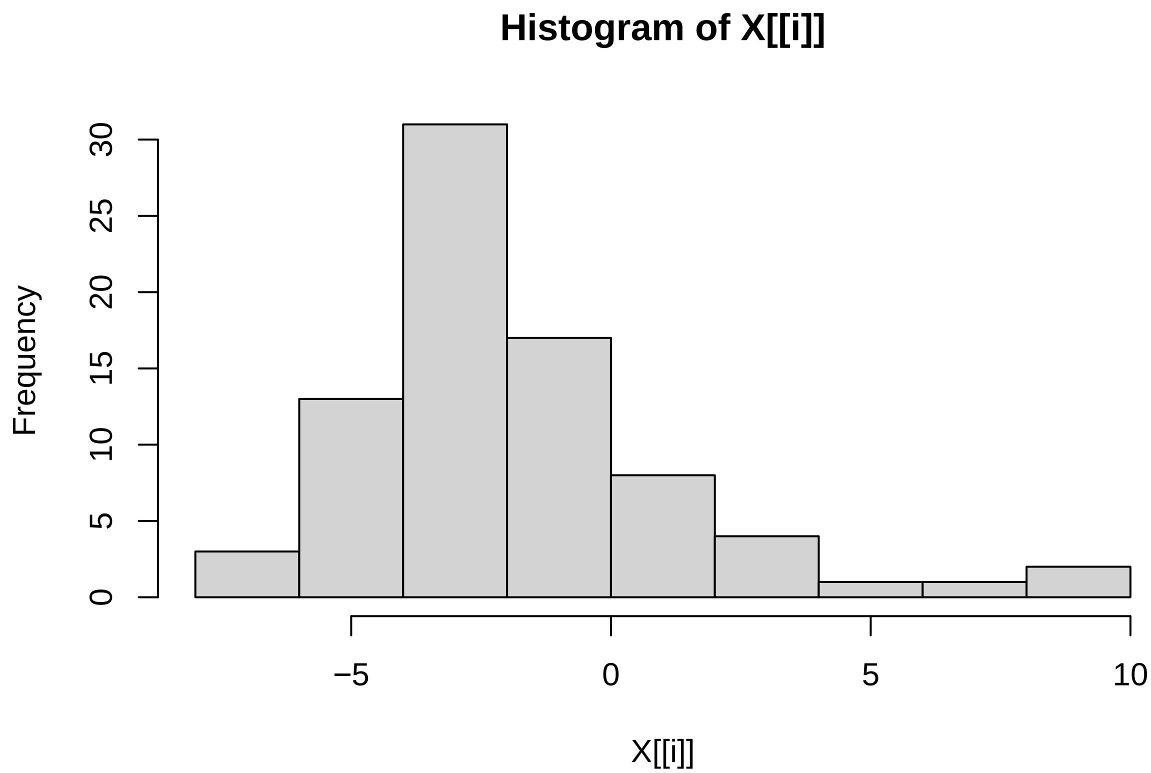

Histogram of X[[i]]
Frequency
0
5
10
15
20
25
−2
−1
0
1
2
X[[i]]

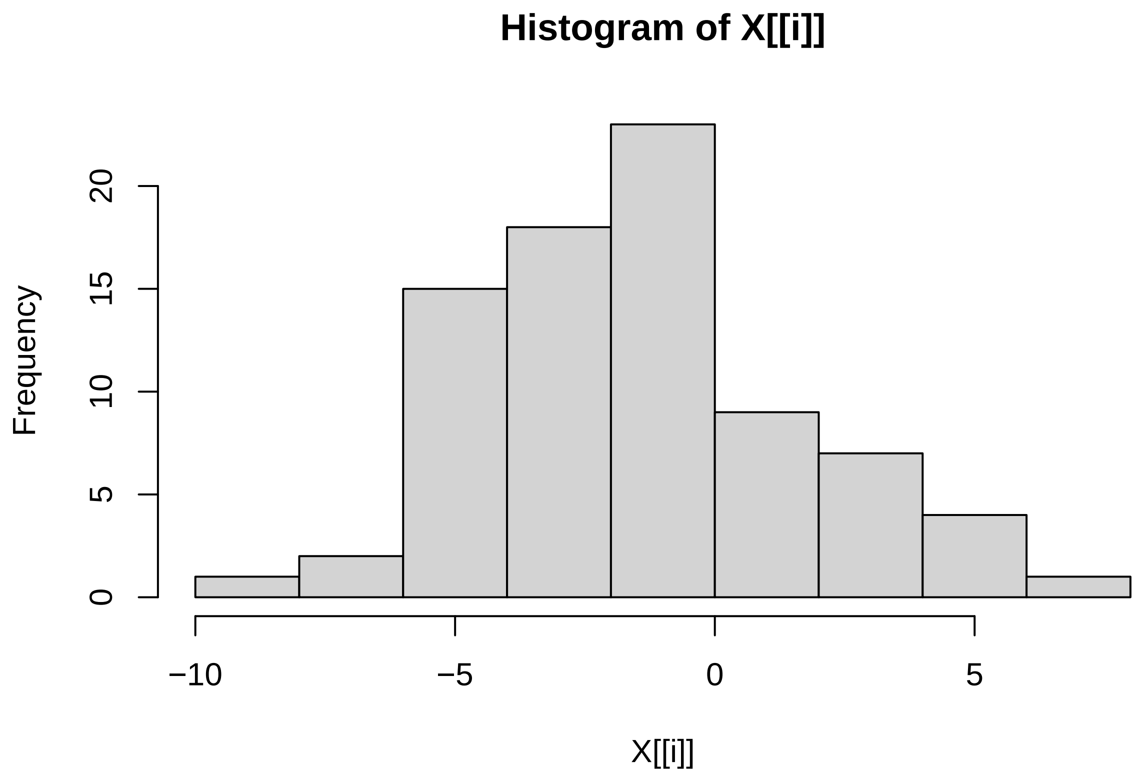

Histogram of X[[i]]
Frequency
0
5
10
15
20
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
X[[i]]

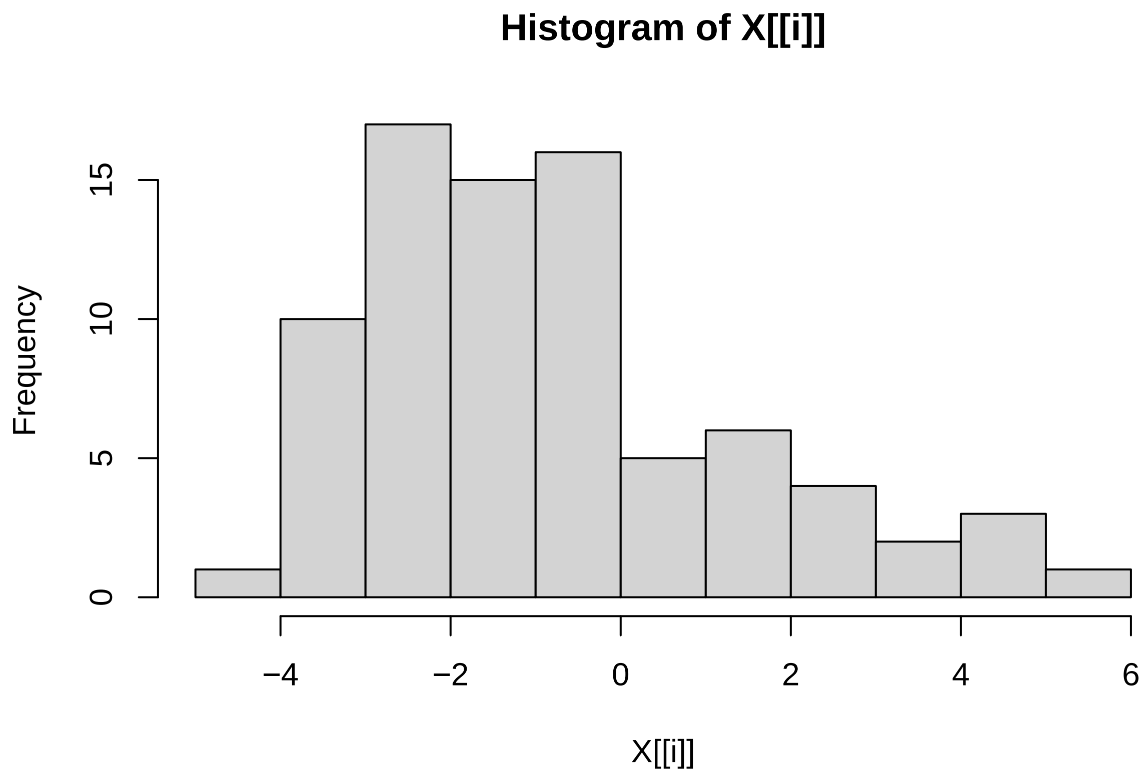

Histogram of X[[i]]
Frequency
0
5
10
15
20
25
30
−5
0
5
10
X[[i]]

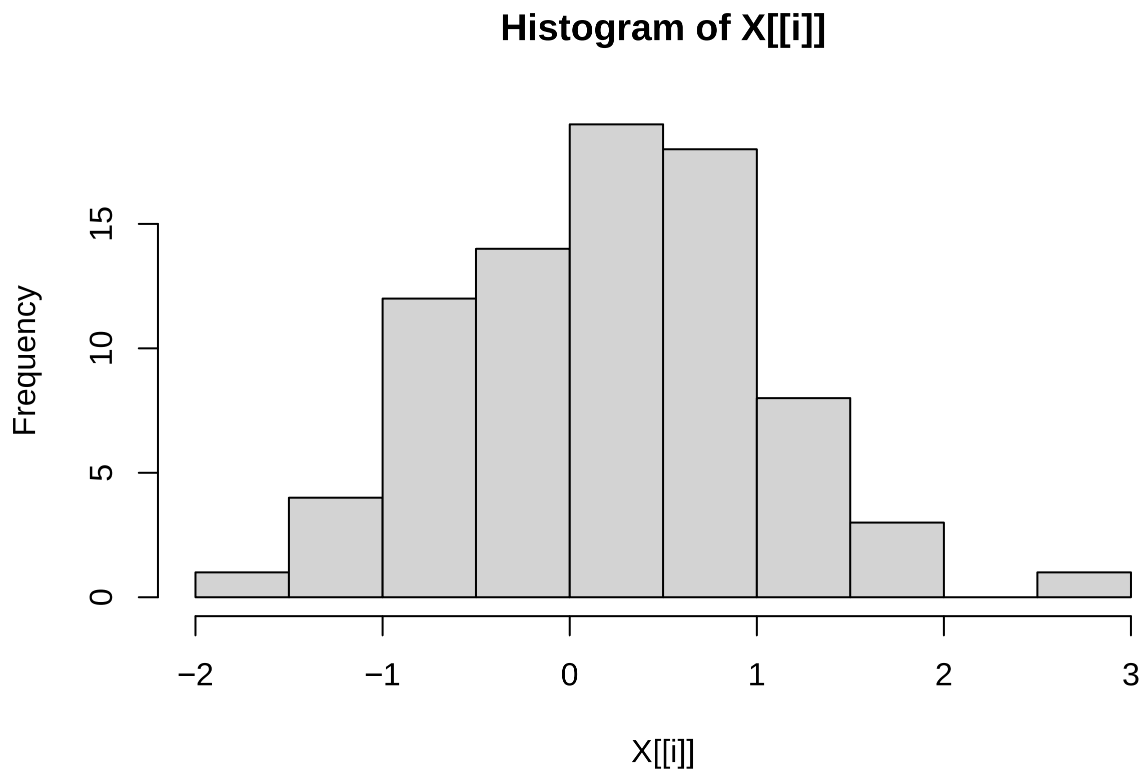


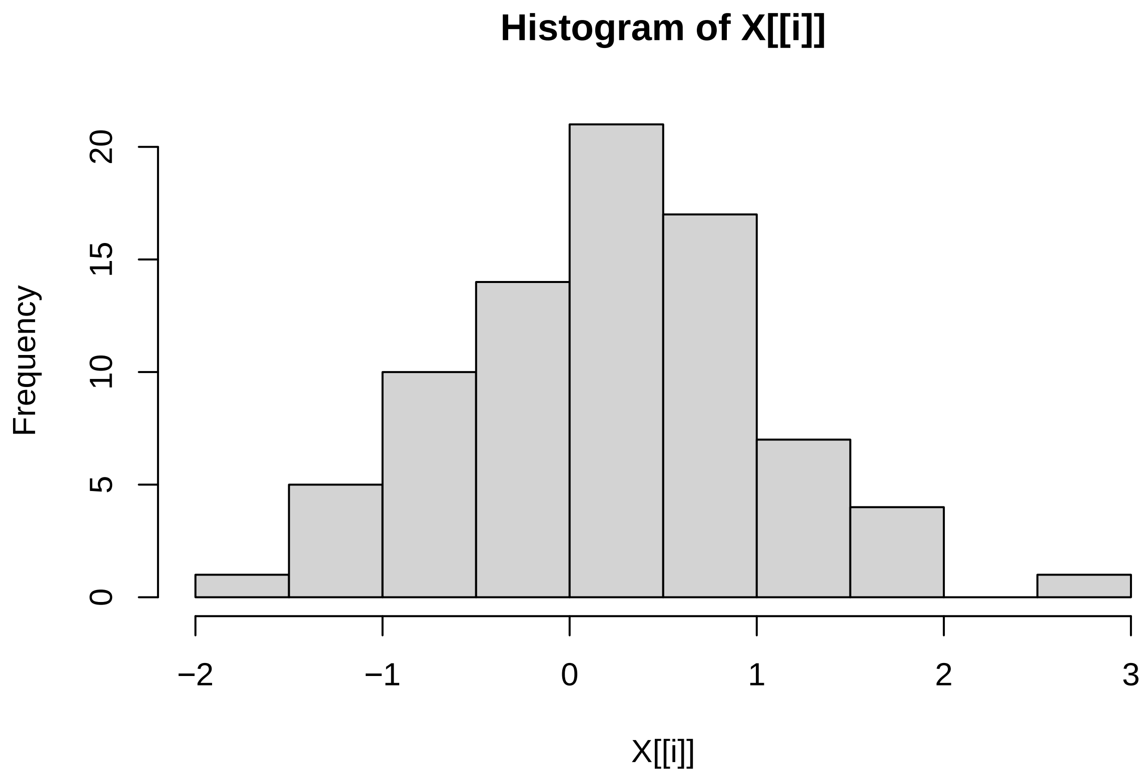
Histogram of X[[i]]
Frequency
0
5
10
15
20
25
−1
0
1
2
X[[i]]

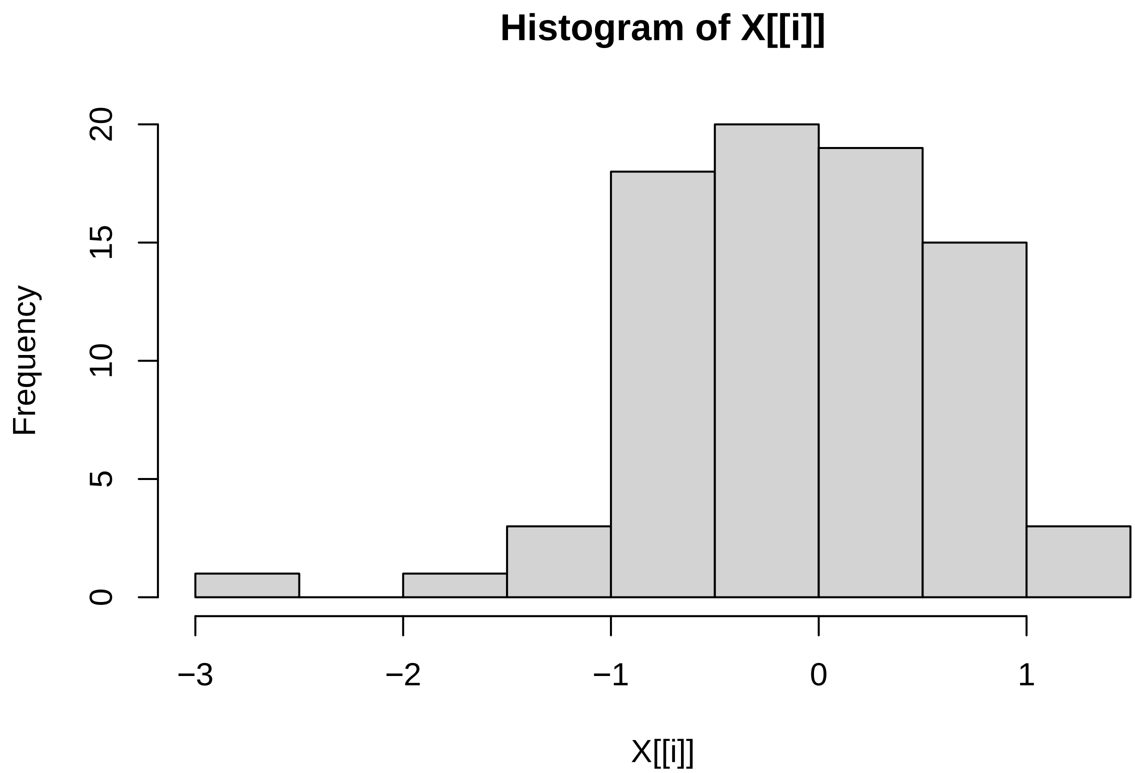

Histogram of X[[i]]
Frequency
0
5
10
15
20
25
30
−5
0
5
10
X[[i]]


Histogram of X[[i]]
Frequency
0
5
10
15
20
−10
−5
0
5
X[[i]]

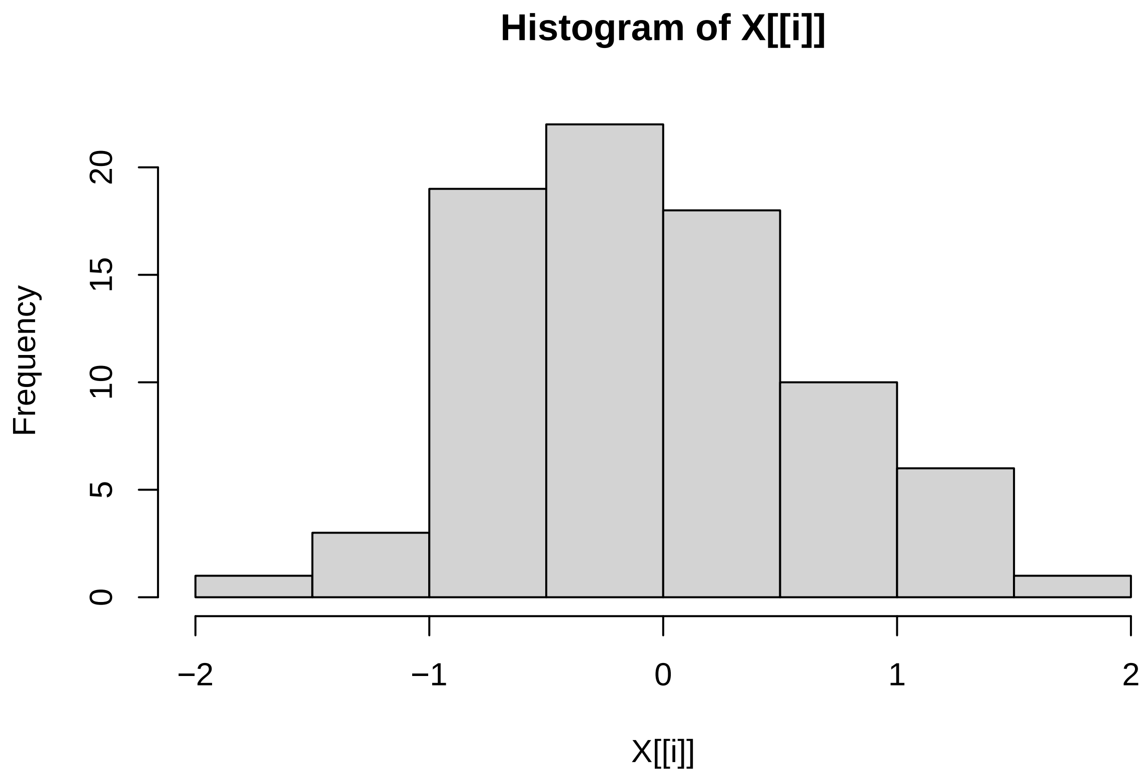

Histogram of X[[i]]
Frequency
0
5
10
15
−4
−2
0
2
4
6
X[[i]]


Histogram of X[[i]]
Frequency
0
5
10
15
−2
−1
0
1
2
3
X[[i]]

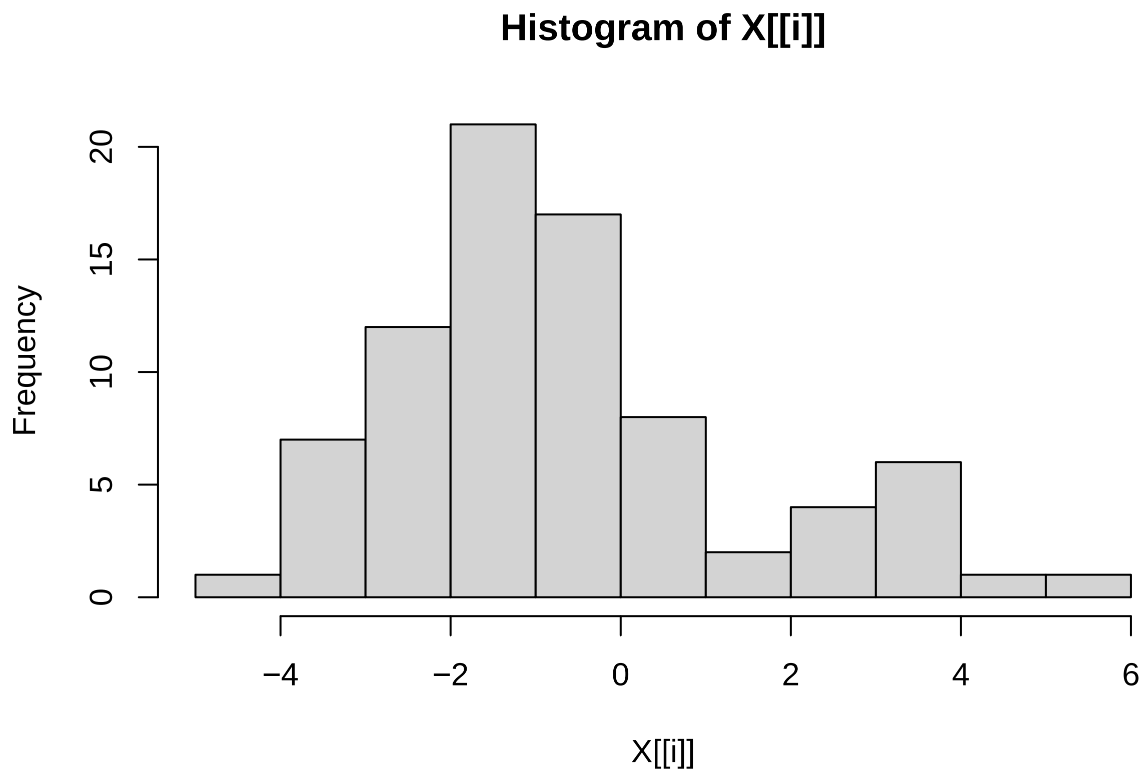

Histogram of X[[i]]
Frequency
0
5
10
15
20
−2
−1
0
1
2
3
X[[i]]

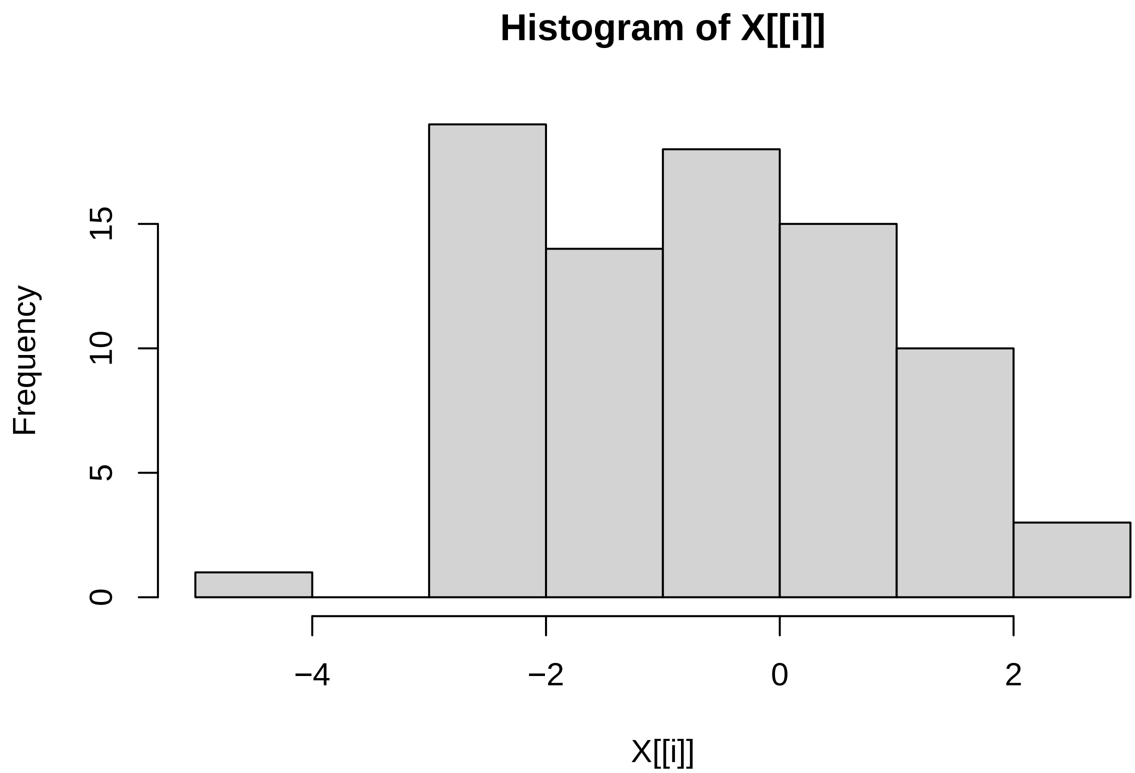


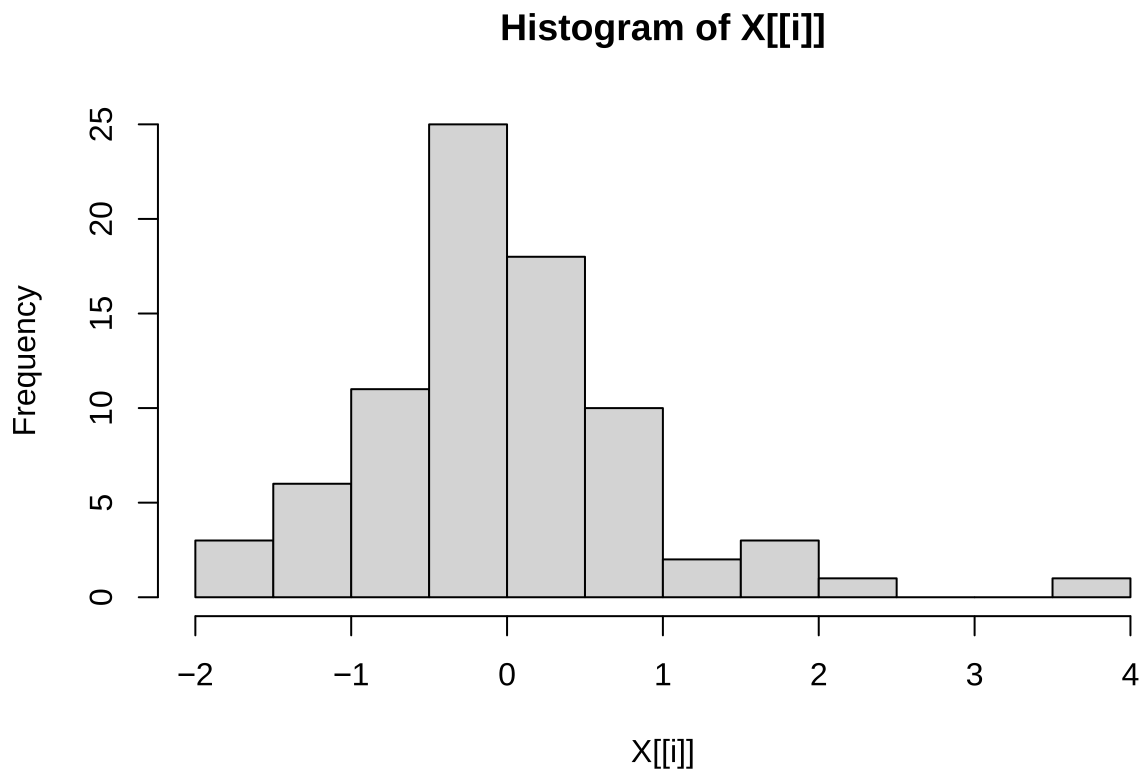
Histogram of X[[i]]
Frequency
0
5
10
15
20
−3
−2
−1
0
1
X[[i]]



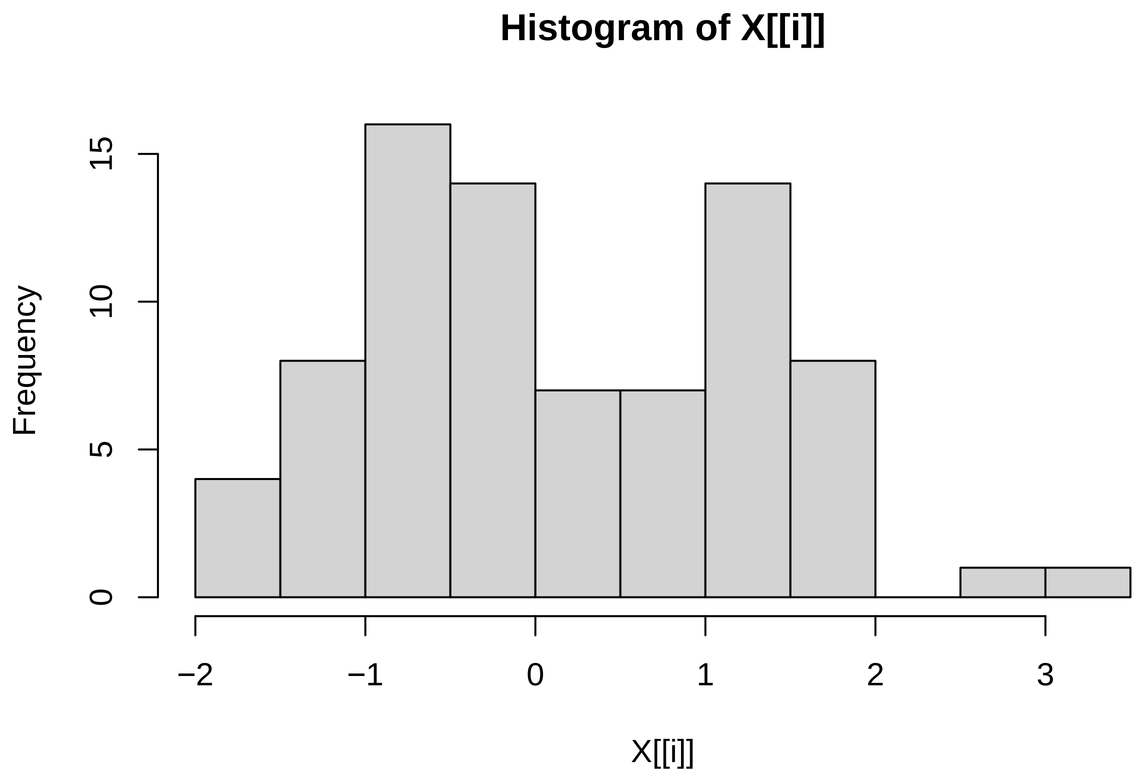
Histogram of X[[i]]
Frequency
0
5
10
15
20
−2
−1
0
1
2
X[[i]]

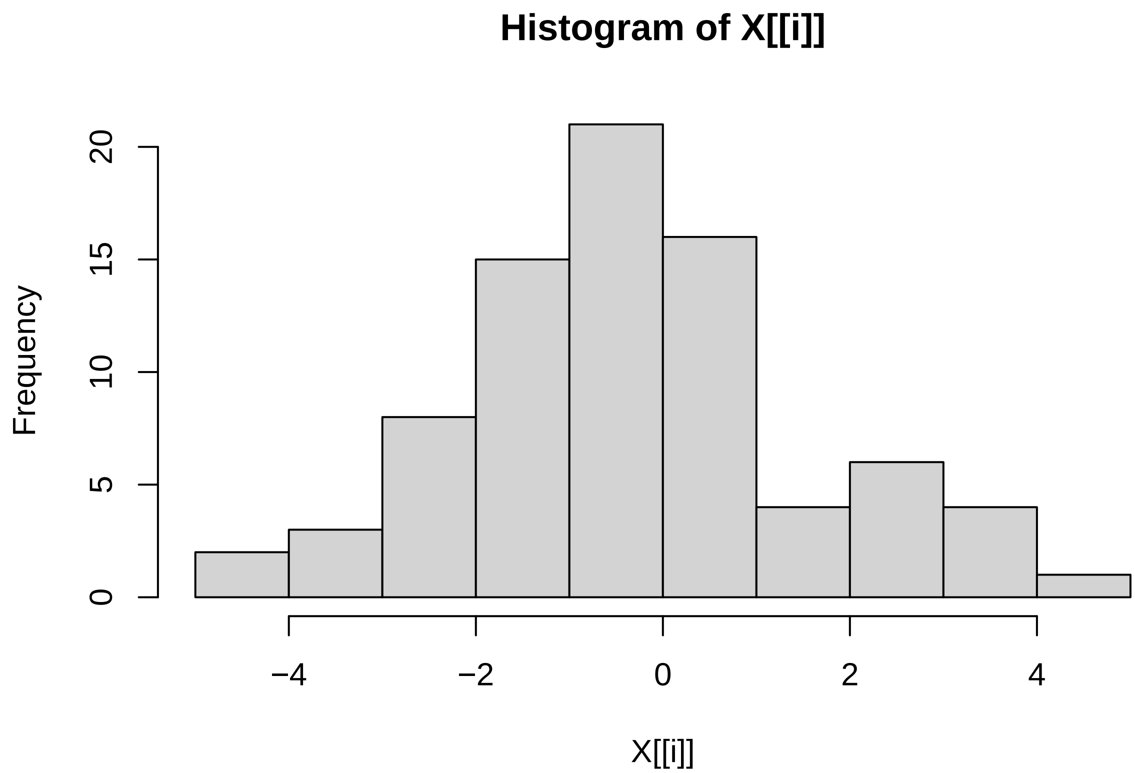

Histogram of X[[i]]
Frequency
0
5
10
15
20
−4
−2
0
2
4
6
X[[i]]

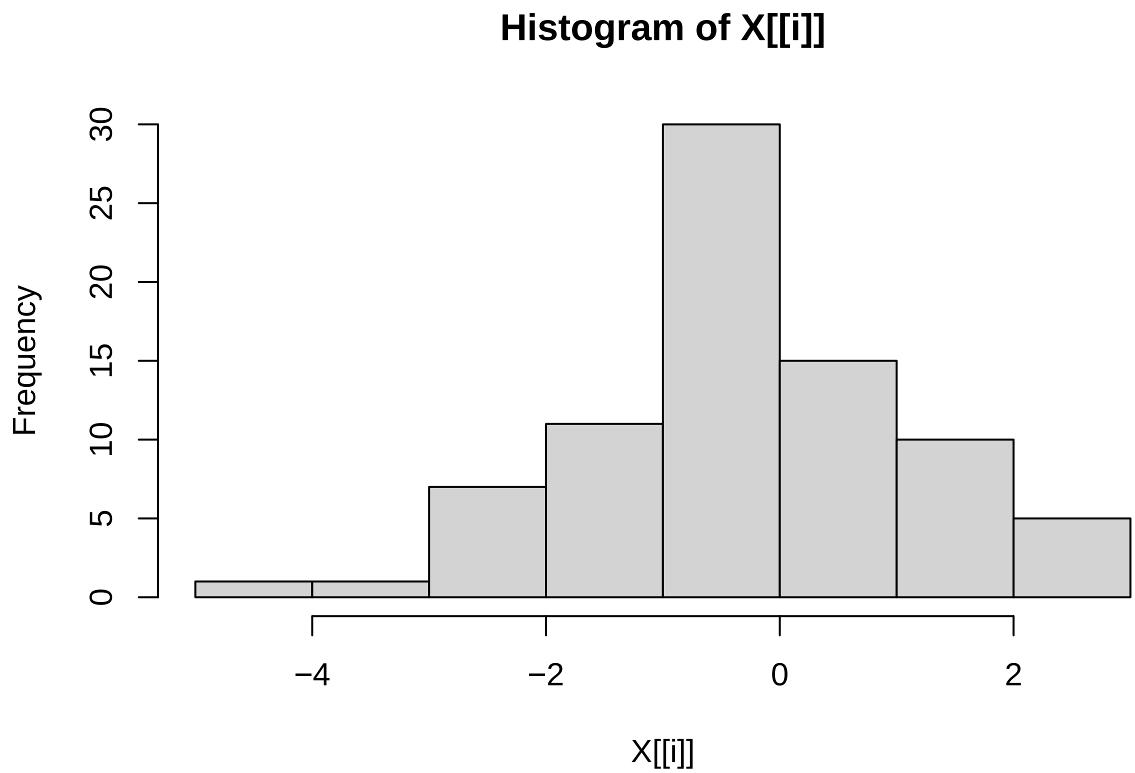

Histogram of X[[i]]
Frequency
0
5
10
15
−4
−2
0
2
X[[i]]

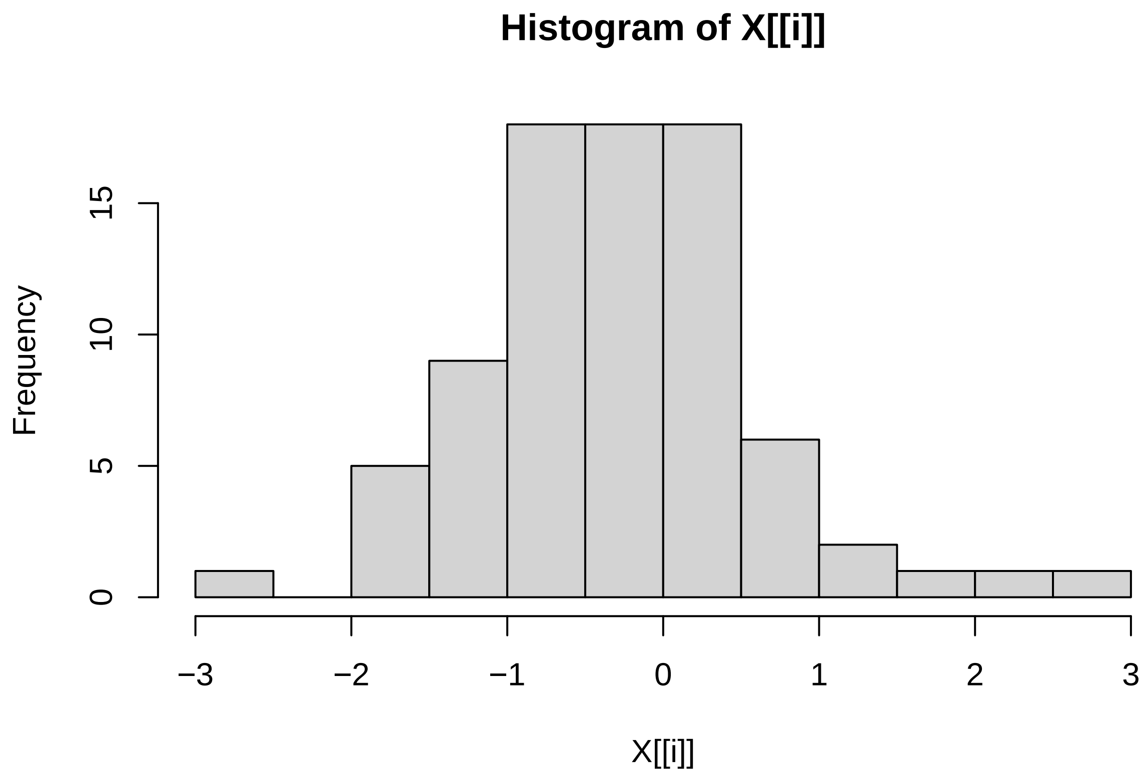


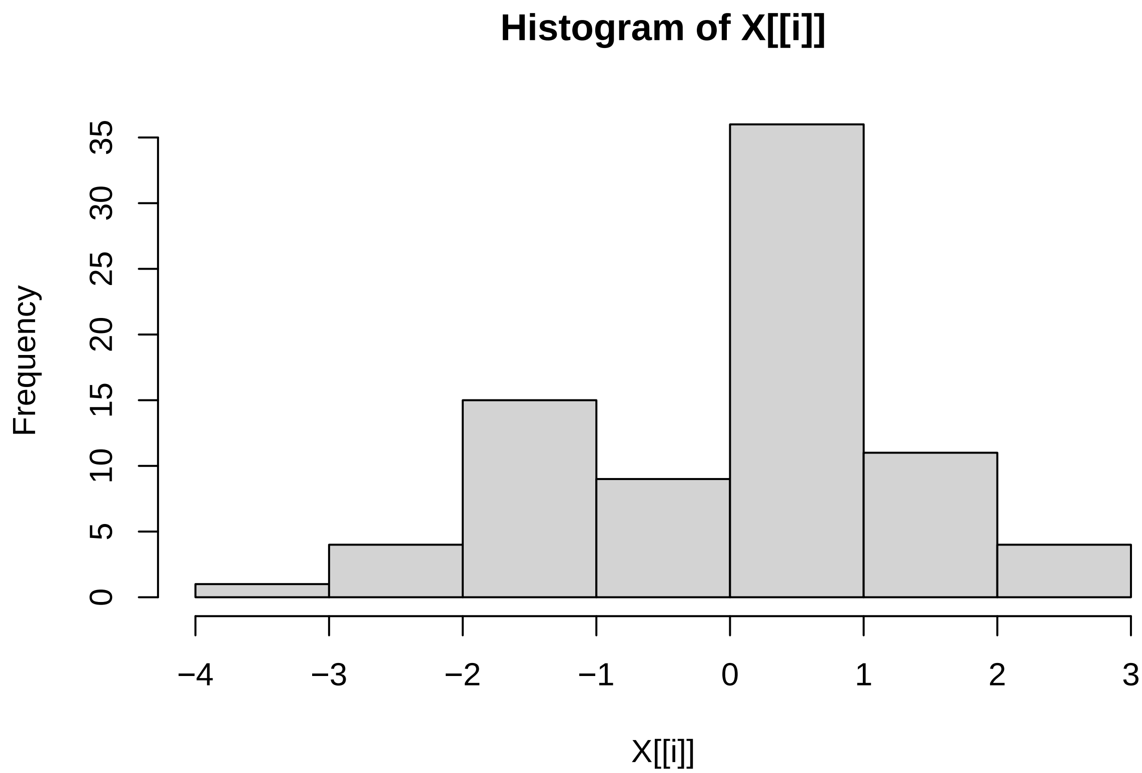
Histogram of X[[i]]
Frequency
0
5
10
15
20
25
−2
−1
0
1
2
3
4
X[[i]]


Histogram of X[[i]]
Frequency
0
5
10
15
−2
−1
0
1
2
3
X[[i]]

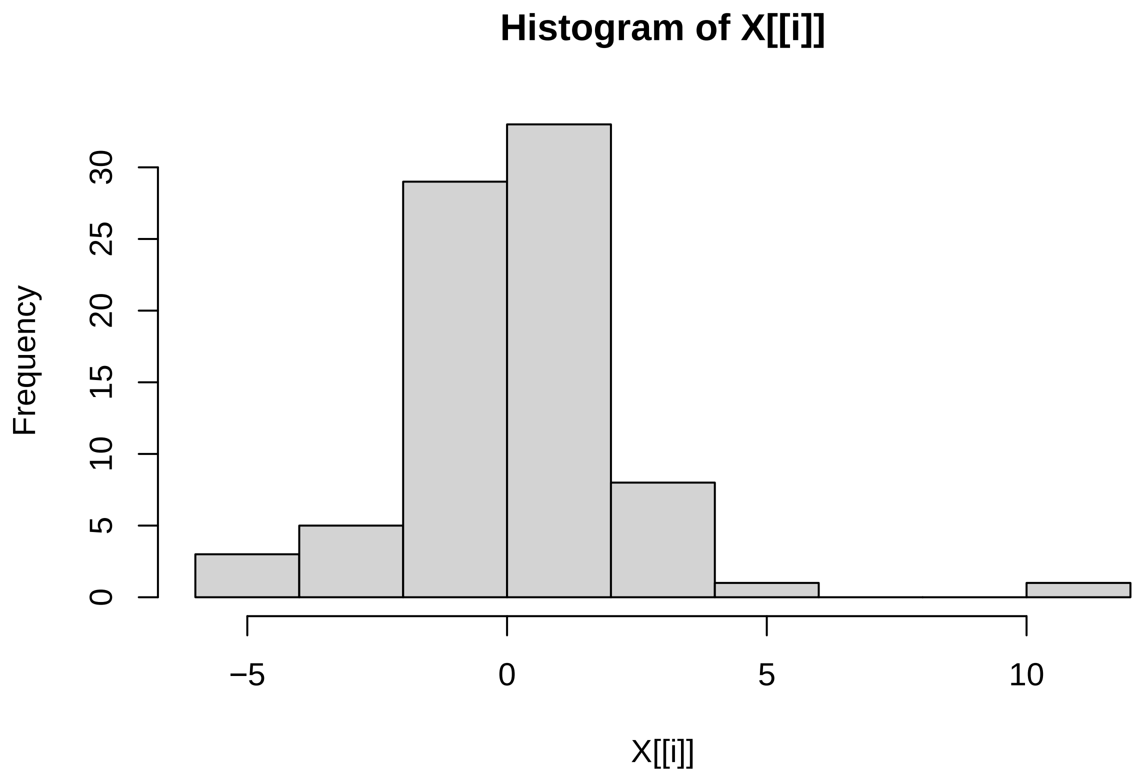

Histogram of X[[i]]
Frequency
0
5
10
15
20
−4
−2
0
2
4
X[[i]]


Histogram of X[[i]]
Frequency
30
25
20
15
10
5
0
−4
−2
0
2
X[[i]]

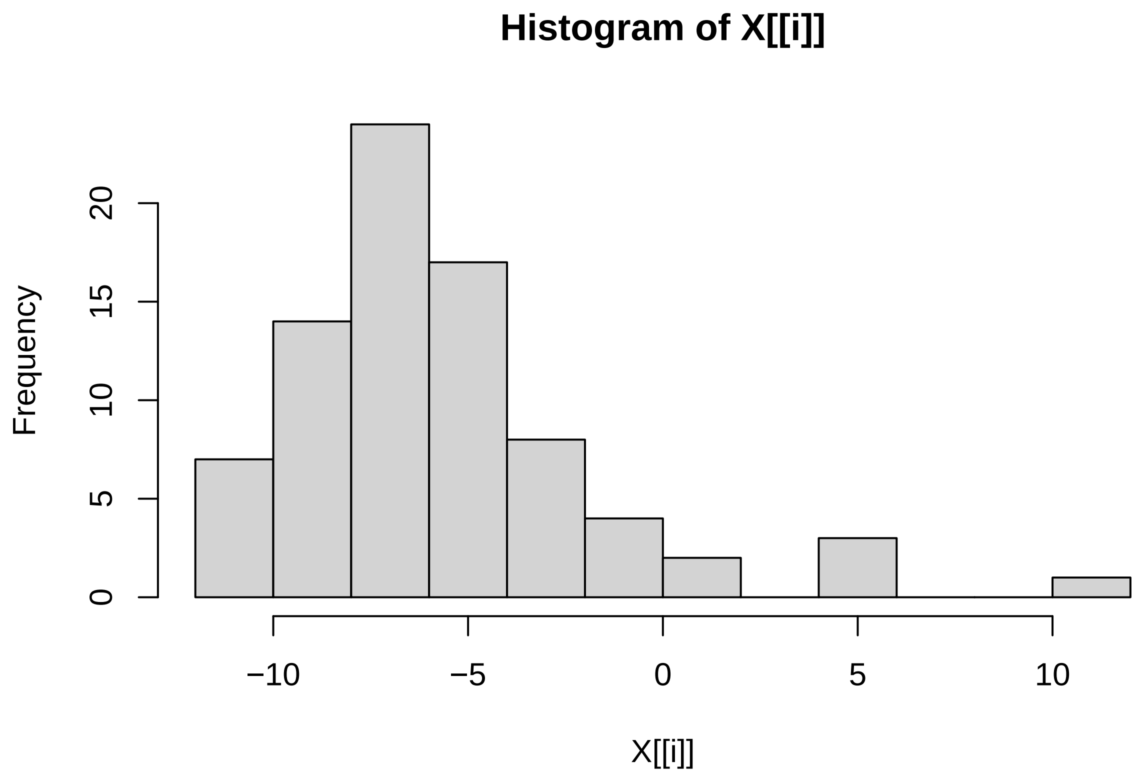

Histogram of X[[i]]
Frequency
0
5
10
15
−3
−2
−1
0
1
2
3
X[[i]]



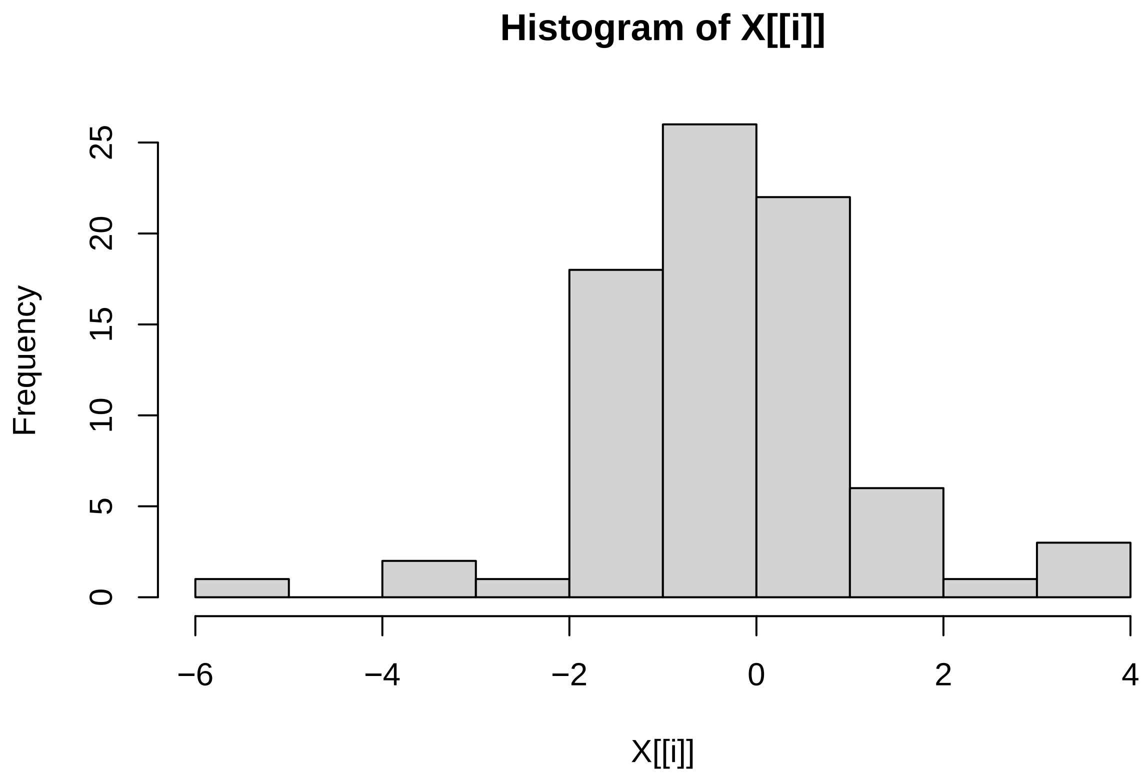
Histogram of X[[i]]
Frequency
0
5
10
15
20
25
30
35
−4
−3
−2
−1
0
1
2
3
X[[i]]

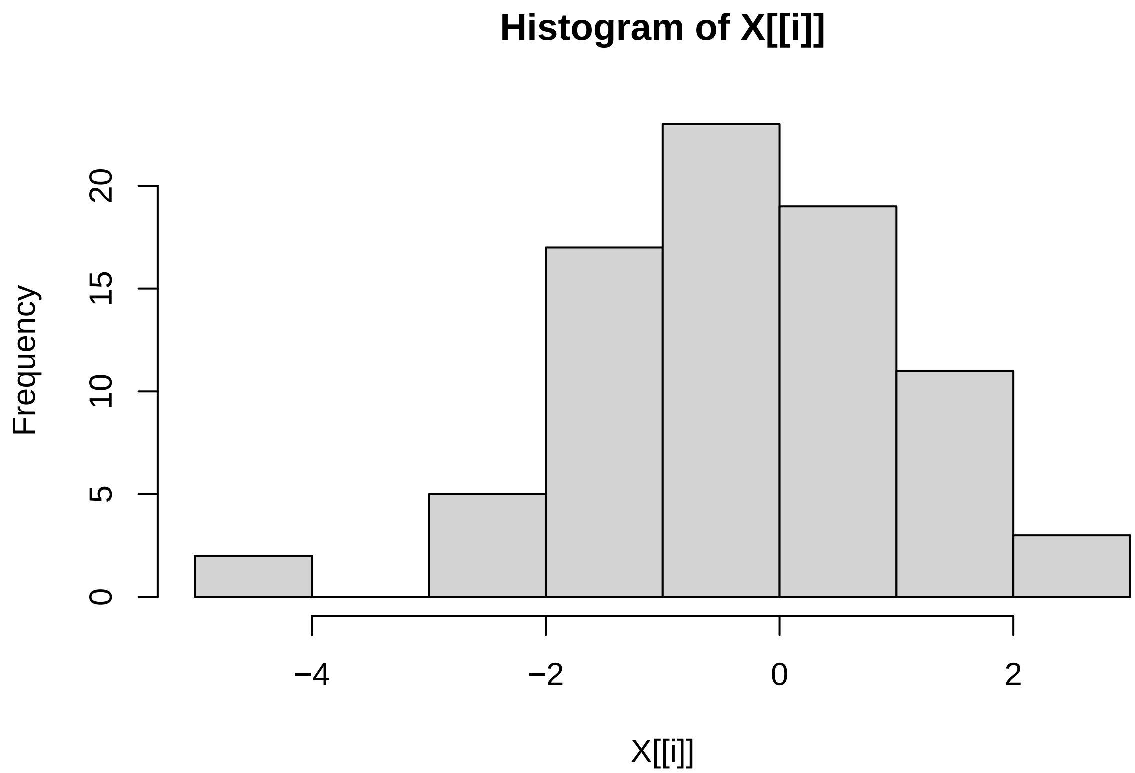


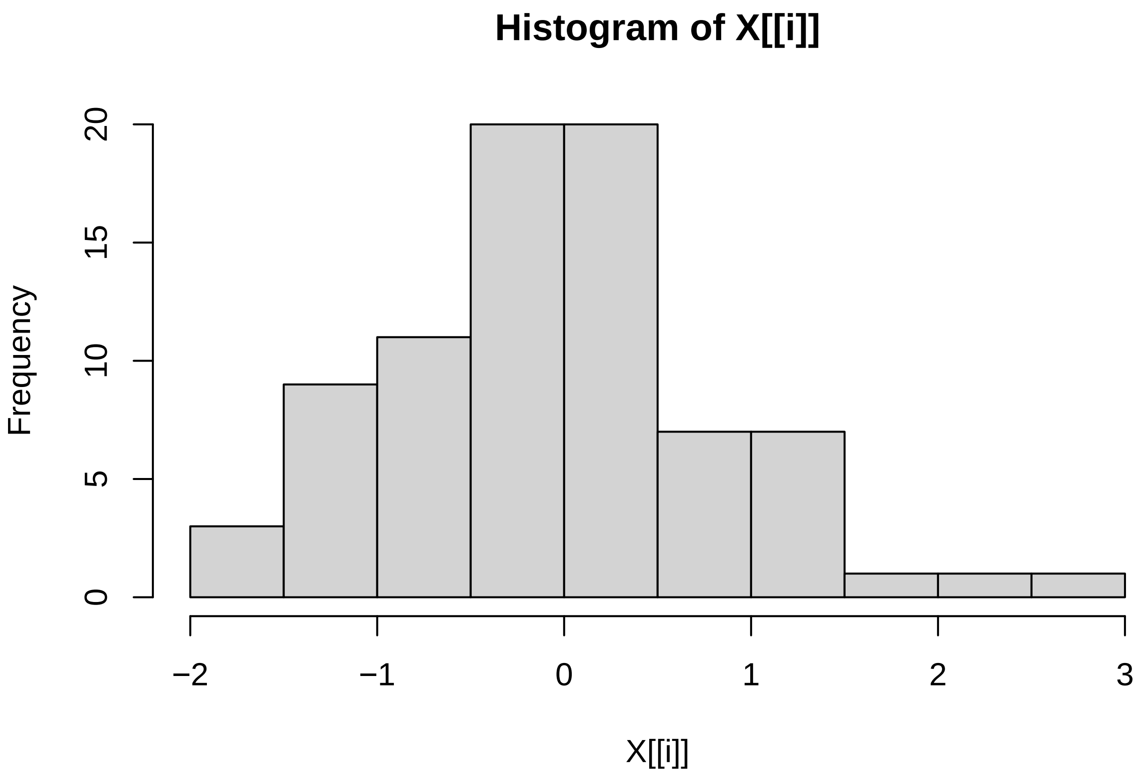
Histogram of X[[i]]
Frequency
0
5
10
15
20
25
30
−5
0
5
10
X[[i]]

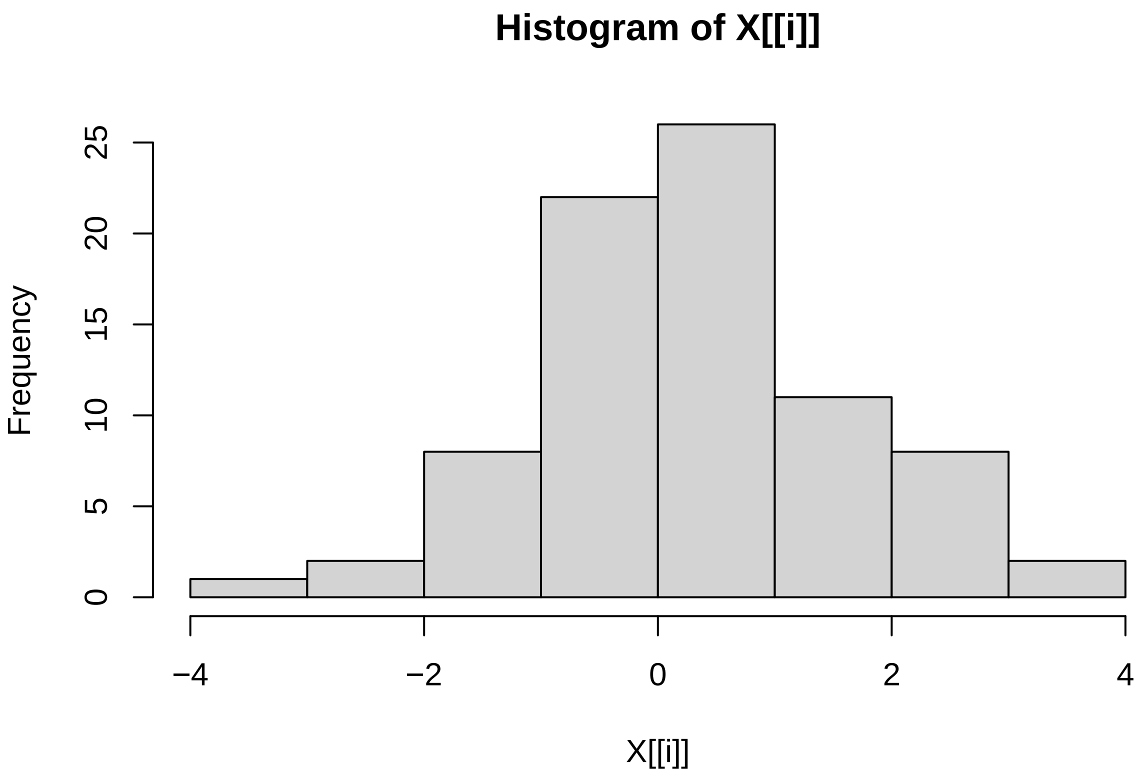


Histogram of X[[i]]
Frequency
0
5
10
15
20
−10
−5
0
5
10
X[[i]]

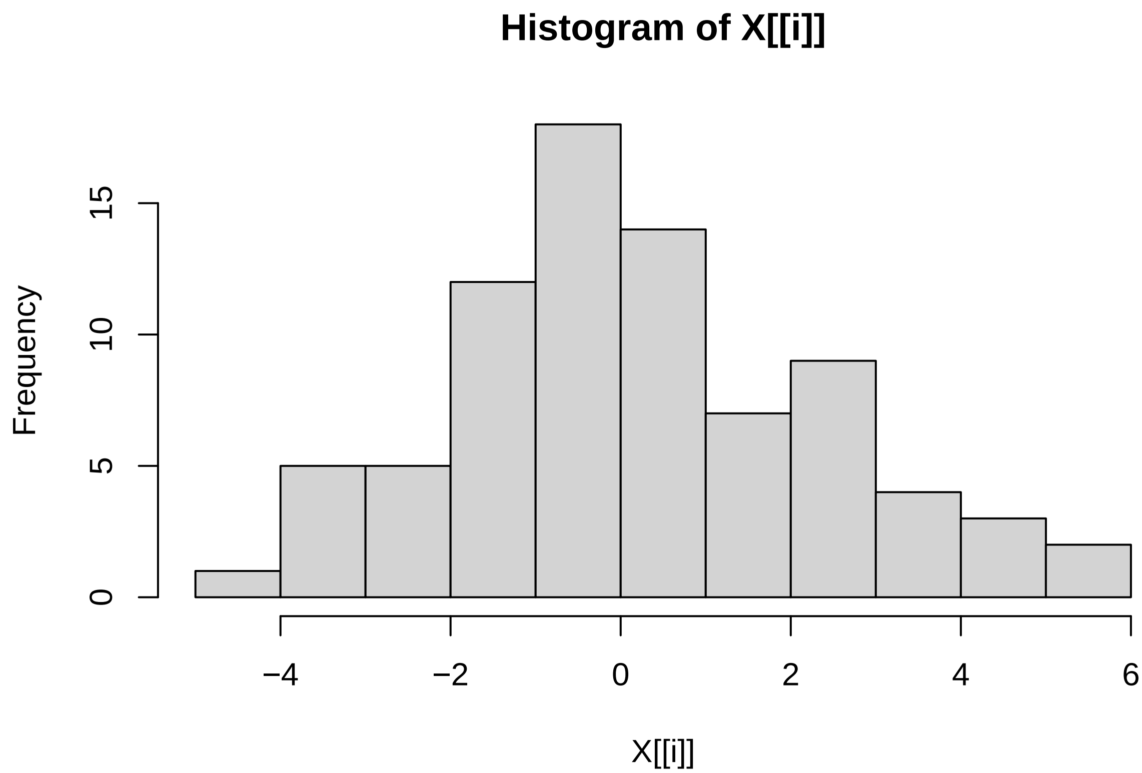

Histogram of X[[i]]
Frequency
0
5
10
15
20
25
−6
−4
−2
0
2
4
X[[i]]


Histogram of X[[i]]
Frequency
0
5
10
15
20
−4
−2
0
2
X[[i]]


Histogram of X[[i]]
Frequency
0
5
10
15
20
−2
−1
0
1
2
3
X[[i]]



Histogram of X[[i]]
Frequency
0
5
10
15
20
25
−4
−2
0
2
4
X[[i]]




```
## $NP_038479
## $breaks
## [1] -4 -3 -2 -1  0  1  2  3  4
##
## $counts
## [1]  2  6 22 22 16  7  4  1
##
## $density
## [1] 0.0250 0.0750 0.2750 0.2750 0.2000 0.0875 0.0500 0.0125
##
## $mids
## [1] -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_001258898
## $breaks
## [1] -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0
##
```

```
## $counts
## [1] 10 18 11 18 15  5  3
##
## $density
## [1] 0.250 0.450 0.275 0.450 0.375 0.125 0.075
##
## $mids
## [1] -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_542785
## $breaks
## [1] -10  -8  -6  -4  -2   0   2   4   6
##
## $counts
## [1]  2  1  9 10 17 24 12  5
##
## $density
## [1] 0.01250 0.00625 0.05625 0.06250 0.10625 0.15000 0.07500 0.03125
##
## $mids
## [1] -9 -7 -5 -3 -1  1  3  5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_002005
## $breaks
##  [1] -5 -4 -3 -2 -1  0  1  2  3  4
##
## $counts
## [1]  2  3 13 16 21 11  9  3  2
##
## $density
## [1] 0.0250 0.0375 0.1625 0.2000 0.2625 0.1375 0.1125 0.0375 0.0250
##
## $mids
## [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5
##
## $xname
```

```
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $XP_003846537
## $breaks
##  [1] -2.5 -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5
##
## $counts
##  [1]  1  0  5 13 28 14  9  3  4  3
##
## $density
##  [1] 0.025 0.000 0.125 0.325 0.700 0.350 0.225 0.075 0.100 0.075
##
## $mids
##  [1] -2.25 -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_660208
## $breaks
## [1] -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0
##
## $counts
## [1]  6 14 20 19 14  5  2
##
## $density
## [1] 0.150 0.350 0.500 0.475 0.350 0.125 0.050
##
## $mids
## [1] -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_004439
## $breaks
```

```
## [1] -6 -4 -2  0  2  4  6  8 10
##
## $counts
## [1] 17 32 15  5  5  4  0  2
##
## $density
## [1] 0.10625 0.20000 0.09375 0.03125 0.03125 0.02500 0.00000 0.01250
##
## $mids
## [1] -5 -3 -1  1  3  5  7  9
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_004388
## $breaks
## [1] -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5
##
## $counts
## [1]  6 13 26 16 11  5  2  1
##
## $density
## [1] 0.150 0.325 0.650 0.400 0.275 0.125 0.050 0.025
##
## $mids
## [1] -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_001229372
## $breaks
##  [1] -8 -6 -4 -2  0  2  4  6  8 10
##
## $counts
## [1]  3 13 31 17  8  4  1  1  2
##
## $density
## [1] 0.01875 0.08125 0.19375 0.10625 0.05000 0.02500 0.00625 0.00625 0.01250
##
## $mids
## [1] -7 -5 -3 -1  1  3  5  7  9
```

```
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_005130
## $breaks
##  [1] -10  -8  -6  -4  -2   0   2   4   6   8
##
## $counts
## [1]  1  2 15 18 23  9  7  4  1
##
## $density
## [1] 0.00625 0.01250 0.09375 0.11250 0.14375 0.05625 0.04375 0.02500 0.00625
##
## $mids
## [1] -9 -7 -5 -3 -1  1  3  5  7
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_004243
## $breaks
##  [1] -5 -4 -3 -2 -1  0  1  2  3  4  5  6
##
## $counts
##  [1]  1 10 17 15 16  5  6  4  2  3  1
##
## $density
##  [1] 0.0125 0.1250 0.2125 0.1875 0.2000 0.0625 0.0750 0.0500 0.0250 0.0375
## [11] 0.0125
##
## $mids
##  [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5  4.5  5.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
```

```
##
## $NP_003144
## $breaks
##  [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5  3.0
##
## $counts
##  [1]  1  4 12 14 19 18  8  3  0  1
##
## $density
##  [1] 0.025 0.100 0.300 0.350 0.475 0.450 0.200 0.075 0.000 0.025
##
## $mids
##  [1] -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_001171551
## $breaks
##  [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5  3.0
##
## $counts
##  [1]  1  5 10 14 21 17  7  4  0  1
##
## $density
##  [1] 0.025 0.125 0.250 0.350 0.525 0.425 0.175 0.100 0.000 0.025
##
## $mids
##  [1] -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_072096
## $breaks
##  [1] -3.0 -2.5 -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5
##
## $counts
## [1]  1  0  1  3 18 20 19 15  3
##
## $density
## [1] 0.025 0.000 0.025 0.075 0.450 0.500 0.475 0.375 0.075
```

```
##
## $mids
## [1] -2.75 -2.25 -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_005484
## $breaks
## [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0
##
## $counts
## [1]  1  3 19 22 18 10  6  1
##
## $density
## [1] 0.025 0.075 0.475 0.550 0.450 0.250 0.150 0.025
##
## $mids
## [1] -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_061170
## $breaks
##  [1] -5 -4 -3 -2 -1  0  1  2  3  4  5  6
##
## $counts
##  [1]  1  7 12 21 17  8  2  4  6  1  1
##
## $density
##  [1] 0.0125 0.0875 0.1500 0.2625 0.2125 0.1000 0.0250 0.0500 0.0750 0.0125
## [11] 0.0125
##
## $mids
##  [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5  4.5  5.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
```

```
##
## attr(,"class")
## [1] "histogram"
##
## $NP_653304
## $breaks
## [1] -5 -4 -3 -2 -1  0  1  2  3
##
## $counts
## [1]  1  0 19 14 18 15 10  3
##
## $density
## [1] 0.0125 0.0000 0.2375 0.1750 0.2250 0.1875 0.1250 0.0375
##
## $mids
## [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_653081
## $breaks
##  [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5  3.0  3.5  4.0
##
## $counts
##  [1]  3  6 11 25 18 10  2  3  1  0  0  1
##
## $density
##  [1] 0.075 0.150 0.275 0.625 0.450 0.250 0.050 0.075 0.025 0.000 0.000 0.025
##
## $mids
##  [1] -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75  3.25  3.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_057164
## $breaks
##  [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5  3.0  3.5
##
## $counts
##  [1]  4  8 16 14  7  7 14  8  0  1  1
```

```
##
## $density
##  [1] 0.100 0.200 0.400 0.350 0.175 0.175 0.350 0.200 0.000 0.025 0.025
##
## $mids
##  [1] -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75  3.25
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_004453
## $breaks
##  [1] -5 -4 -3 -2 -1  0  1  2  3  4  5
##
## $counts
##  [1]  2  3  8 15 21 16  4  6  4  1
##
## $density
##  [1] 0.0250 0.0375 0.1000 0.1875 0.2625 0.2000 0.0500 0.0750 0.0500 0.0125
##
## $mids
##  [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5  4.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_003212
## $breaks
## [1] -5 -4 -3 -2 -1  0  1  2  3
##
## $counts
## [1]  1  1  7 11 30 15 10  5
##
## $density
## [1] 0.0125 0.0125 0.0875 0.1375 0.3750 0.1875 0.1250 0.0625
##
## $mids
## [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5
##
## $xname
## [1] "X[[i]]"
##
```

```
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_060866
## $breaks
##  [1] -3.0 -2.5 -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5  3.0
##
## $counts
##  [1]  1  0  5  9 18 18 18  6  2  1  1  1
##
## $density
##  [1] 0.025 0.000 0.125 0.225 0.450 0.450 0.450 0.150 0.050 0.025 0.025 0.025
##
## $mids
##  [1] -2.75 -2.25 -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_001160163
## $breaks
## [1] -4 -3 -2 -1  0  1  2  3
##
## $counts
## [1]  1  4 15  9 36 11  4
##
## $density
## [1] 0.0125 0.0500 0.1875 0.1125 0.4500 0.1375 0.0500
##
## $mids
## [1] -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_003875
## $breaks
##  [1] -6 -4 -2  0  2  4  6  8 10 12
##
```

```
## $counts
## [1]  3  5 29 33  8  1  0  0  1
##
## $density
## [1] 0.01875 0.03125 0.18125 0.20625 0.05000 0.00625 0.00000 0.00000 0.00625
##
## $mids
## [1] -5 -3 -1  1  3  5  7  9 11
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_002677
## $breaks
##  [1] -12 -10  -8  -6  -4  -2   0   2   4   6   8  10  12
##
## $counts
##  [1]  7 14 24 17  8  4  2  0  3  0  0  1
##
## $density
##  [1] 0.04375 0.08750 0.15000 0.10625 0.05000 0.02500 0.01250 0.00000 0.01875
## [10] 0.00000 0.00000 0.00625
##
## $mids
##  [1] -11  -9  -7  -5  -3  -1   1   3   5   7   9  11
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_001135891
## $breaks
##  [1] -6 -5 -4 -3 -2 -1  0  1  2  3  4
##
## $counts
##  [1]  1  0  2  1 18 26 22  6  1  3
##
## $density
##  [1] 0.0125 0.0000 0.0250 0.0125 0.2250 0.3250 0.2750 0.0750 0.0125 0.0375
##
## $mids
##  [1] -5.5 -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5
##
```

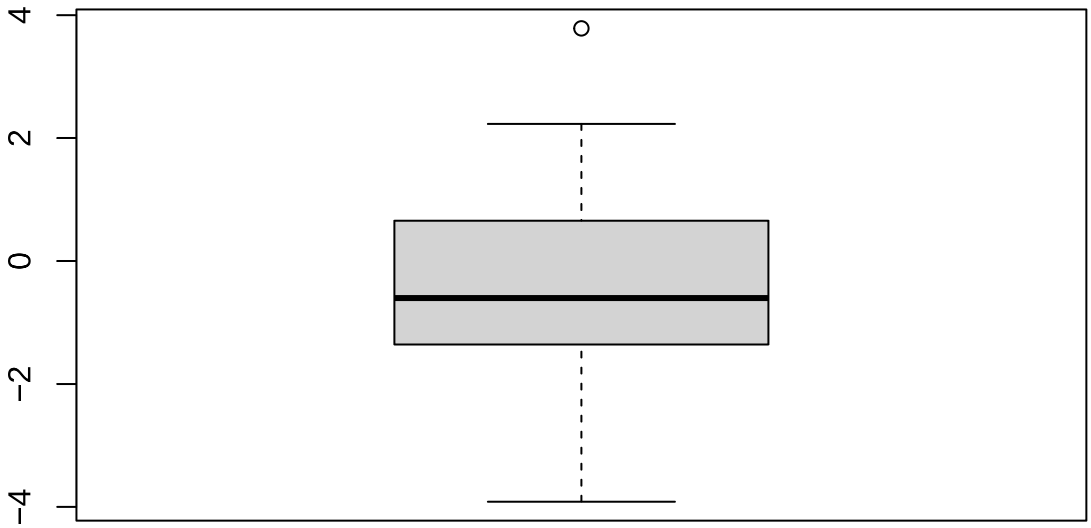
```
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_004522
## $breaks
## [1] -5 -4 -3 -2 -1  0  1  2  3
##
## $counts
## [1]  2  0  5 17 23 19 11  3
##
## $density
## [1] 0.0250 0.0000 0.0625 0.2125 0.2875 0.2375 0.1375 0.0375
##
## $mids
## [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_003767
## $breaks
##  [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5  3.0
##
## $counts
##  [1]  3  9 11 20 20  7  7  1  1  1
##
## $density
##  [1] 0.075 0.225 0.275 0.500 0.500 0.175 0.175 0.025 0.025 0.025
##
## $mids
##  [1] -1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_848597
```

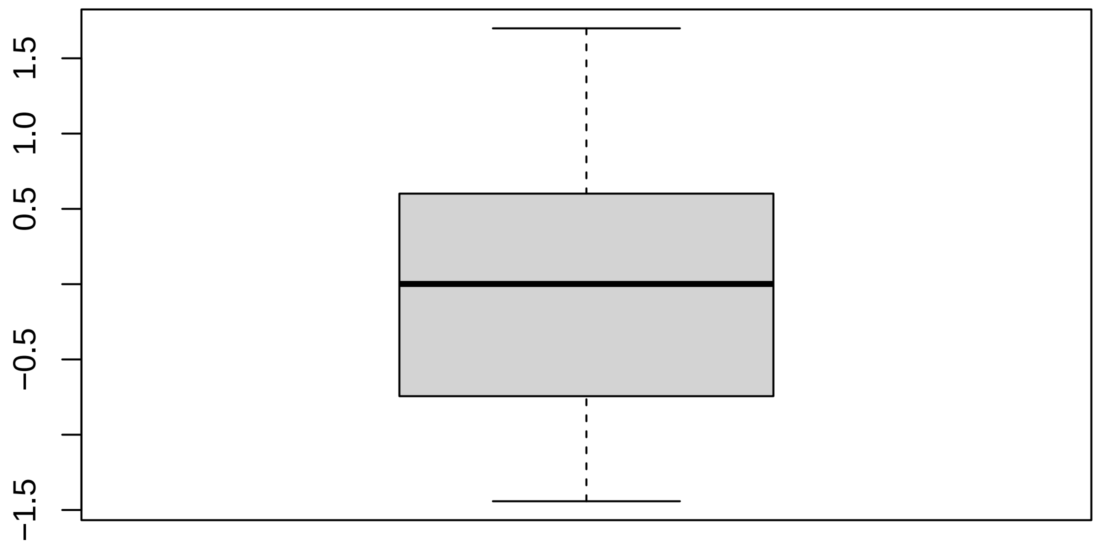
```
## $breaks
## [1] -4 -3 -2 -1  0  1  2  3  4
##
## $counts
## [1]  1  2  8 22 26 11  8  2
##
## $density
## [1] 0.0125 0.0250 0.1000 0.2750 0.3250 0.1375 0.1000 0.0250
##
## $mids
## [1] -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
##
## $NP_005970
## $breaks
##  [1] -5 -4 -3 -2 -1  0  1  2  3  4  5  6
##
## $counts
##  [1]  1  5  5 12 18 14  7  9  4  3  2
##
## $density
##  [1] 0.0125 0.0625 0.0625 0.1500 0.2250 0.1750 0.0875 0.1125 0.0500 0.0375
## [11] 0.0250
##
## $mids
##  [1] -4.5 -3.5 -2.5 -1.5 -0.5  0.5  1.5  2.5  3.5  4.5  5.5
##
## $xname
## [1] "X[[i]]"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
```

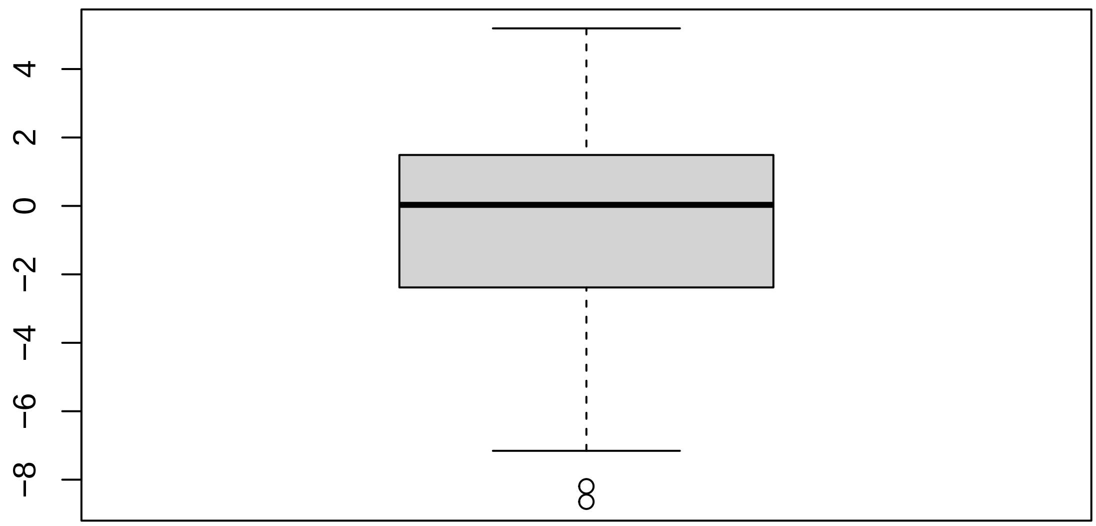
Detection of outliers and data imputation

- On observing the box plot of 30 column, I got to know that it has a few outliers
- I have also created the function which can identify the presence of outliers in each varaible
- I removed these outliers and imputed them with median value

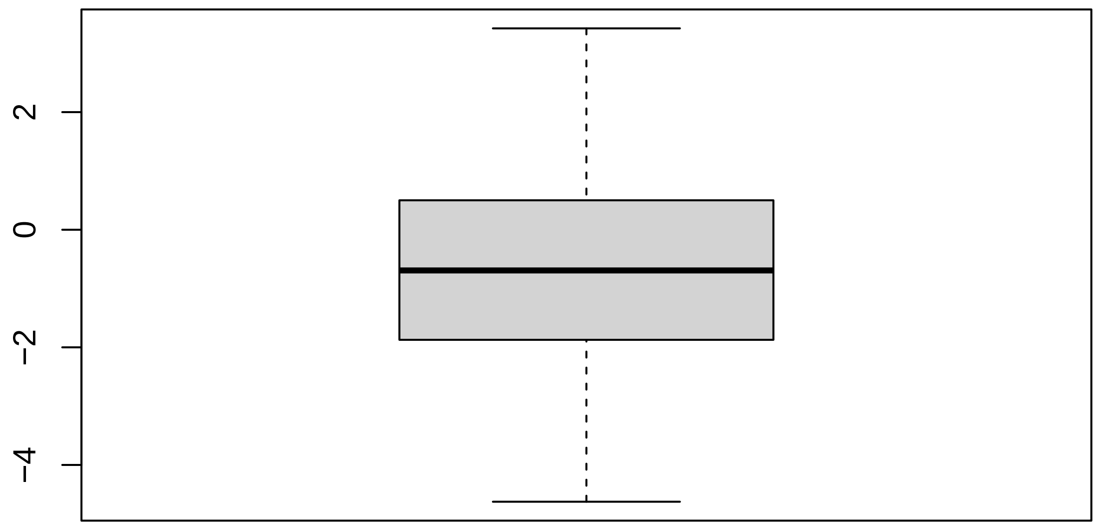
```
lapply(final_data[, 2:ncol(final_data)], boxplot)
```

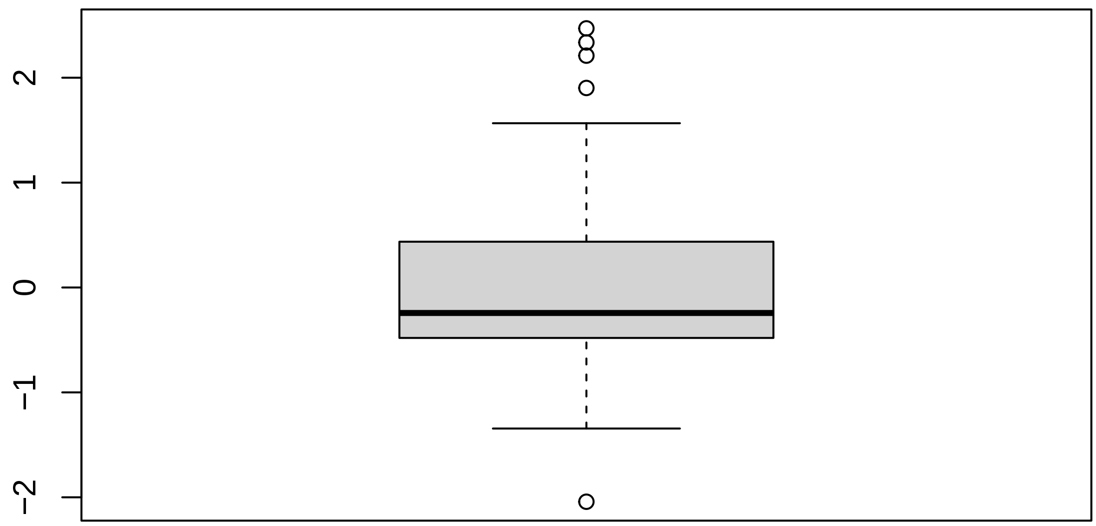

4
2
0
−2
−4

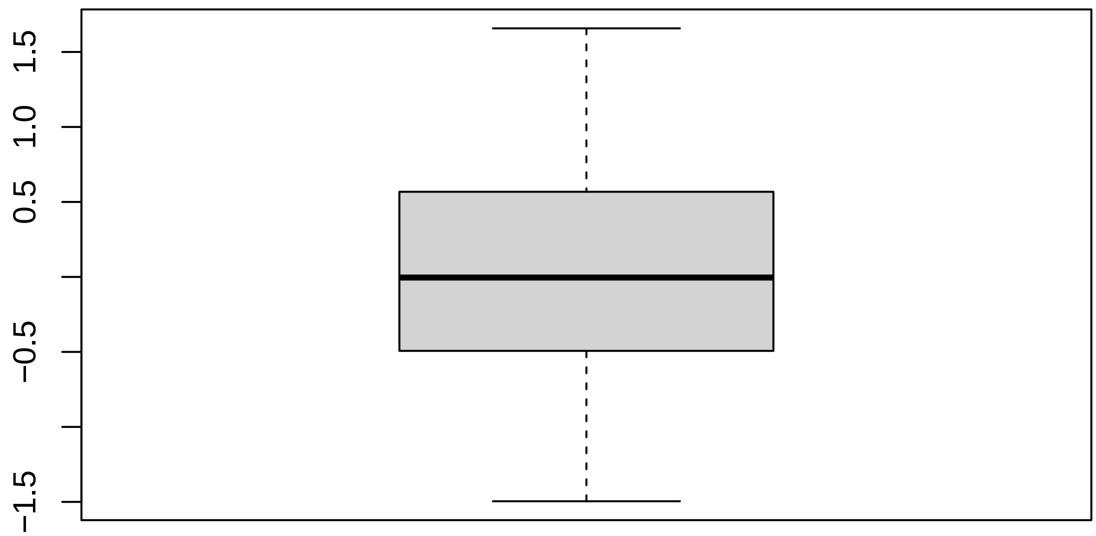

1.5
1.0
0.5
−0.5
−1.5

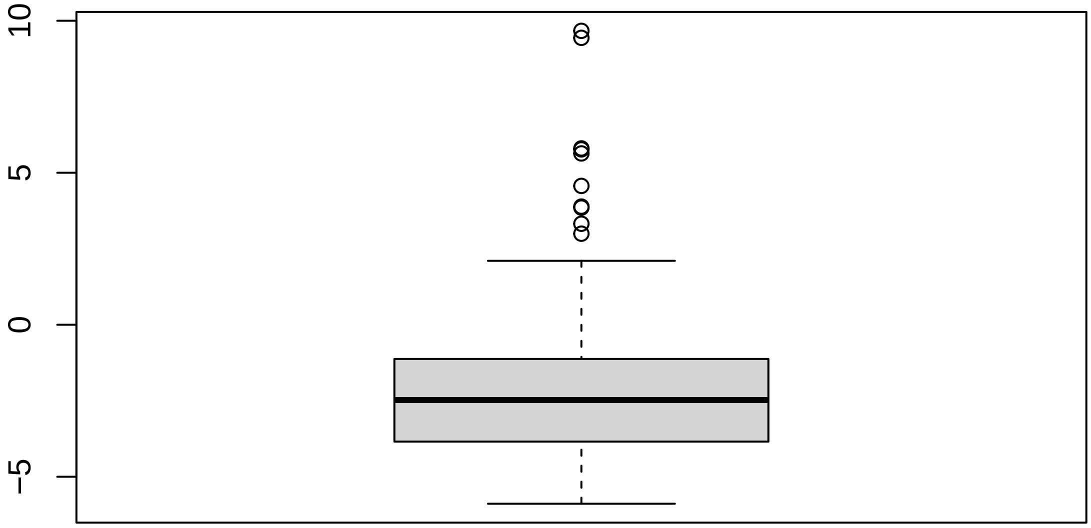


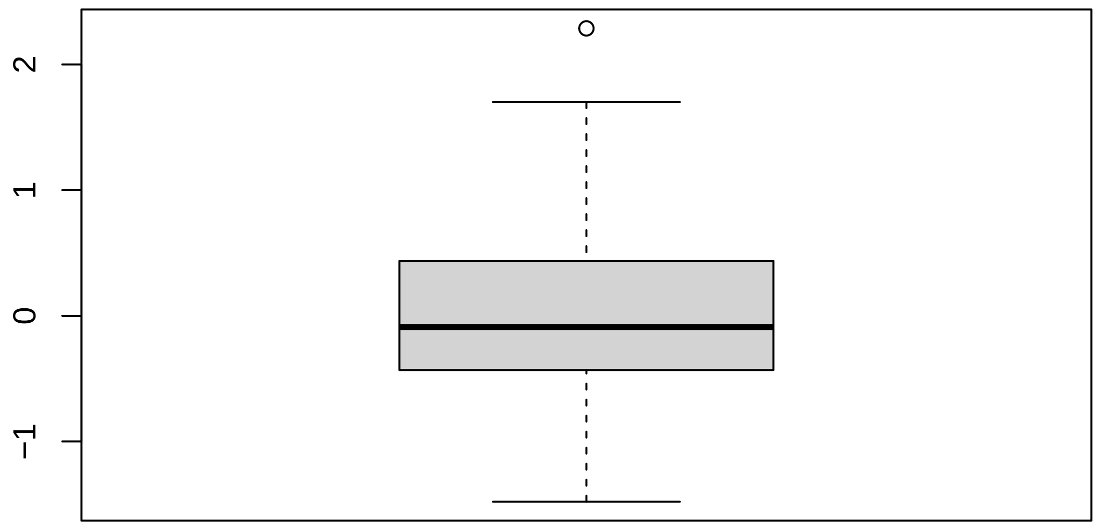
4
2
0
−2
−4
−6
−8

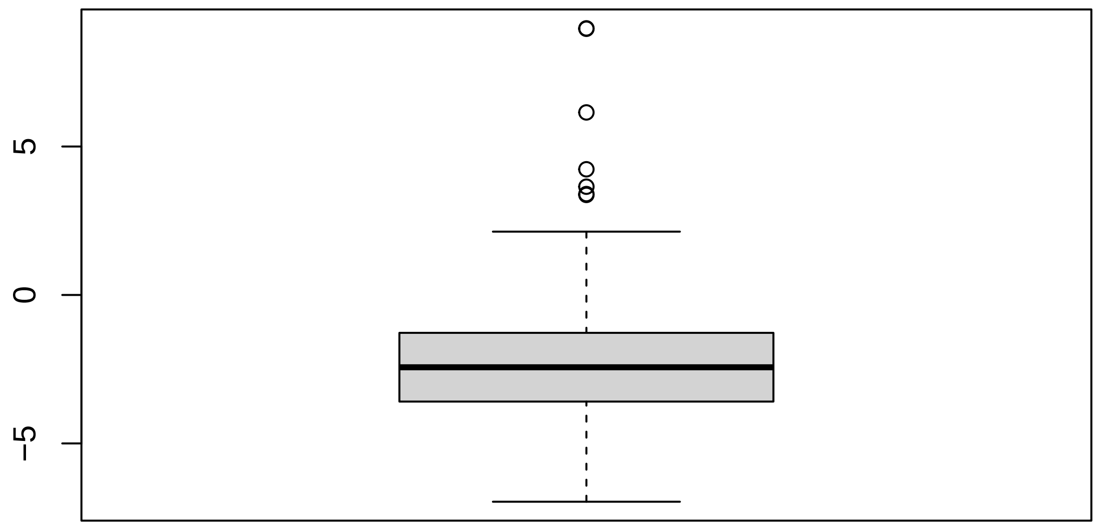

2
0
−2
−4


2
1
0
−1
−2

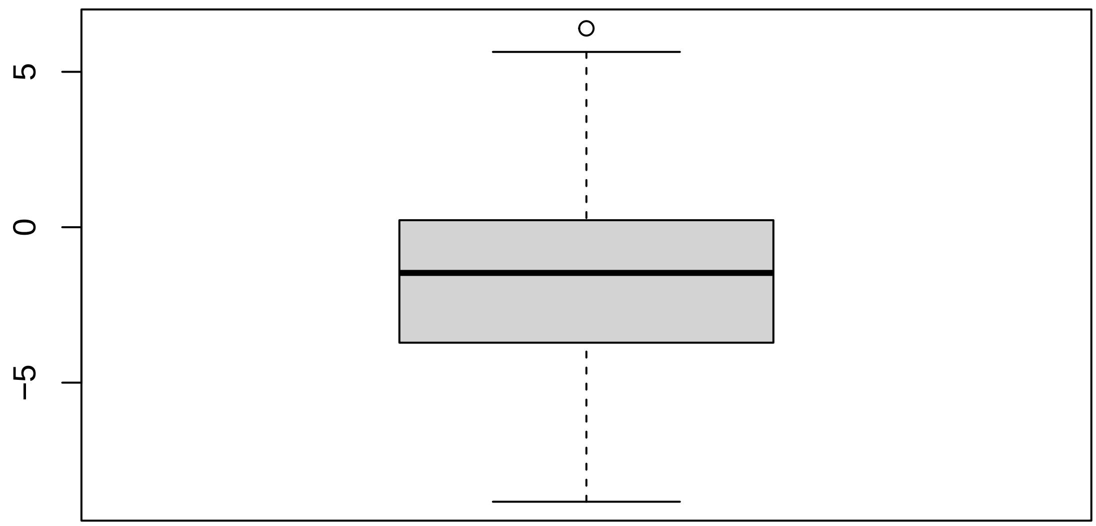

1.5
1.0
0.5
−0.5
−1.5

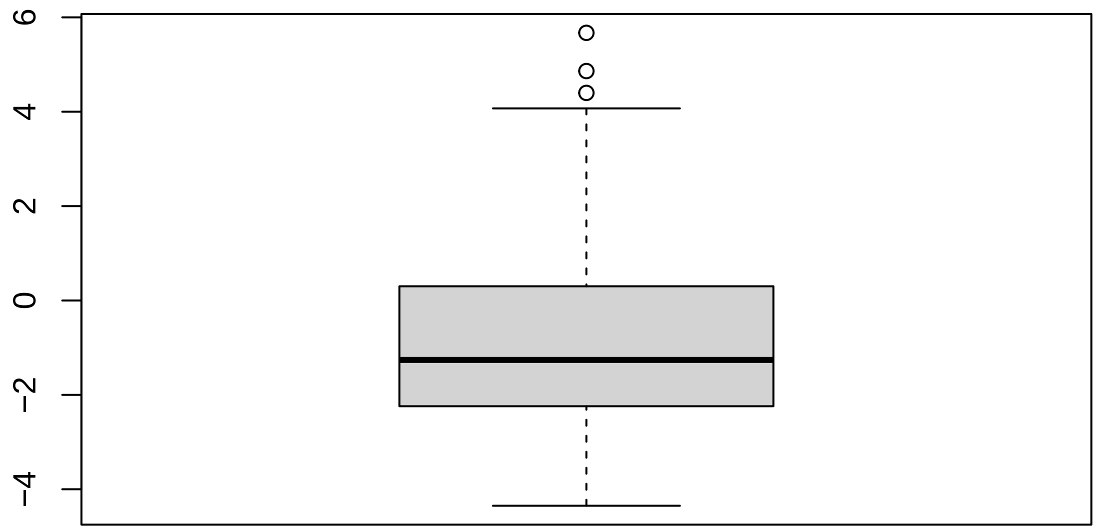

10
5
0
−5


2
1
0
−1

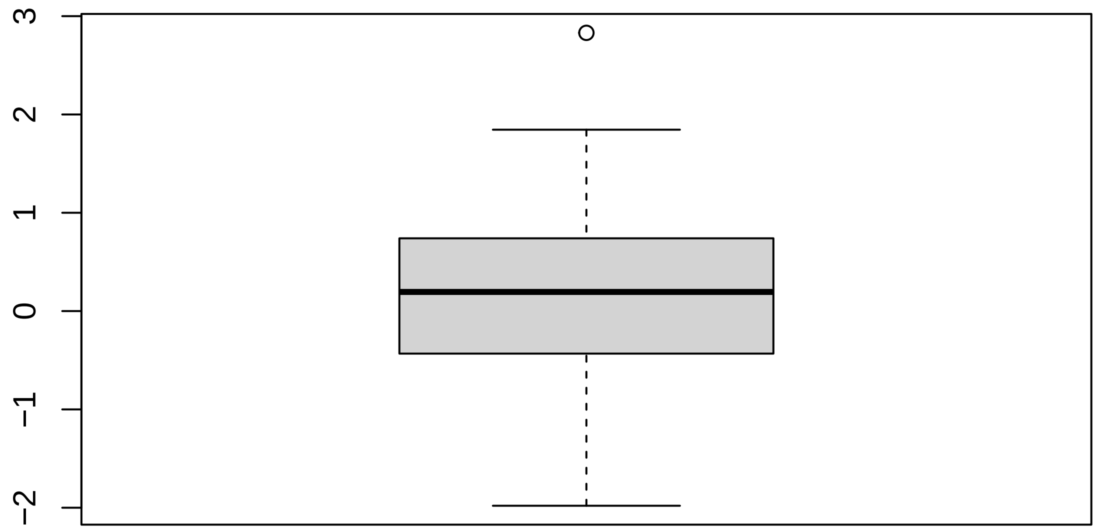


5
0
−5

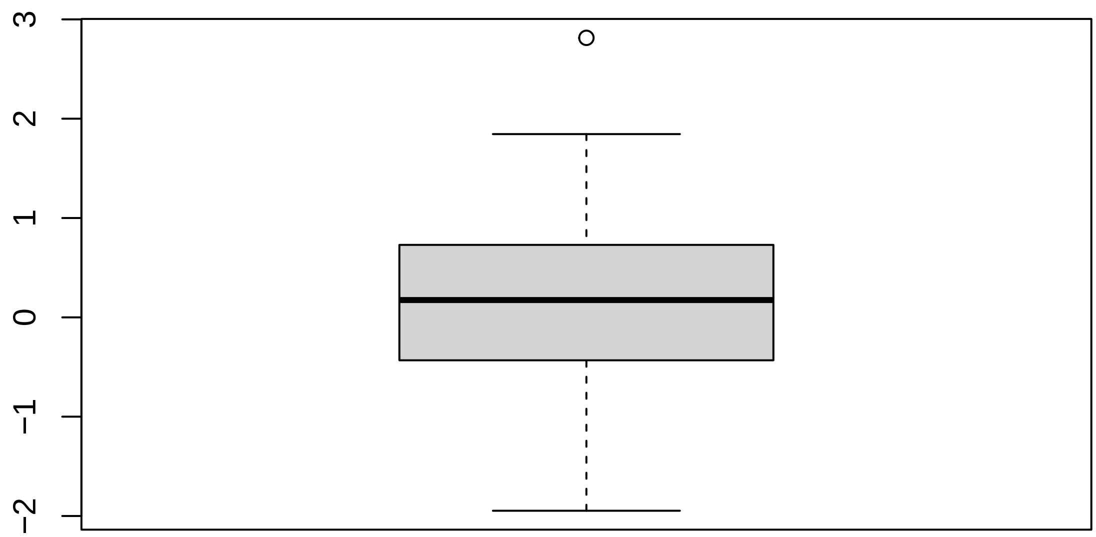

5
0
−5

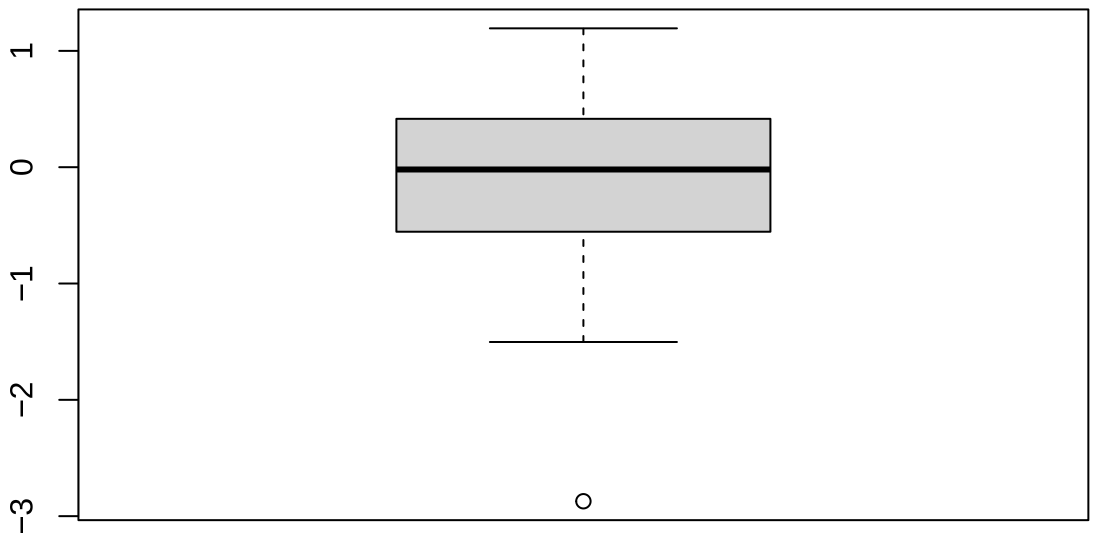


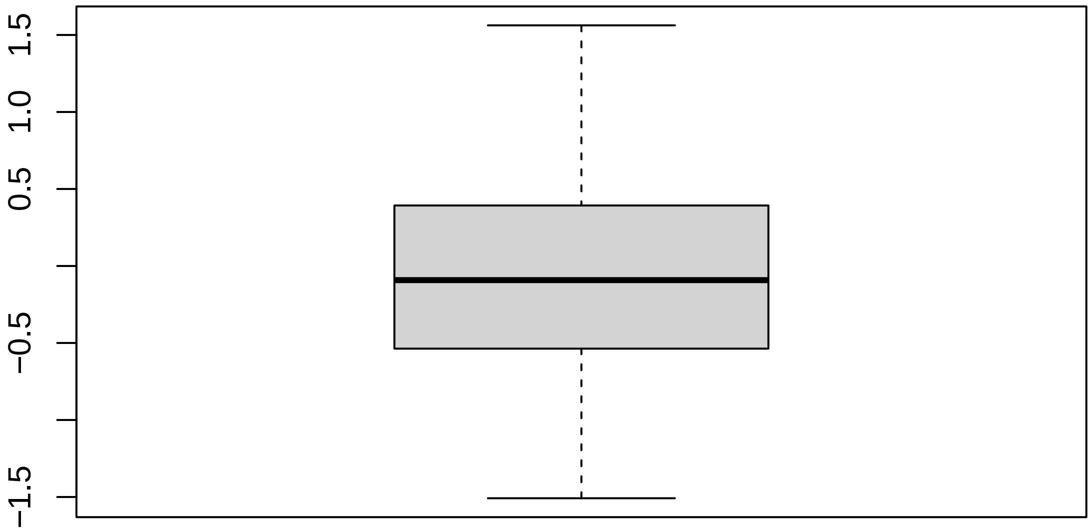
6
4
2
0
−2
−4

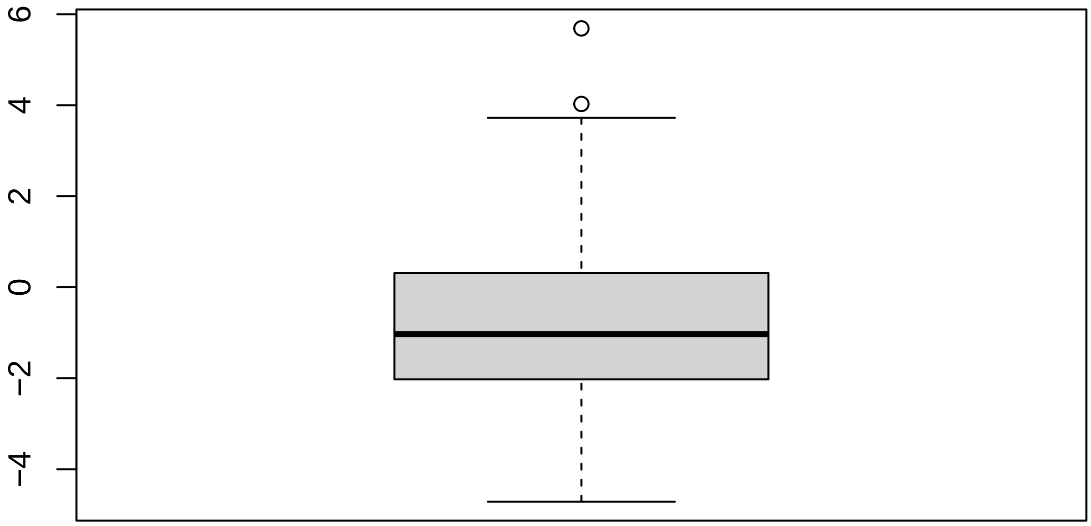


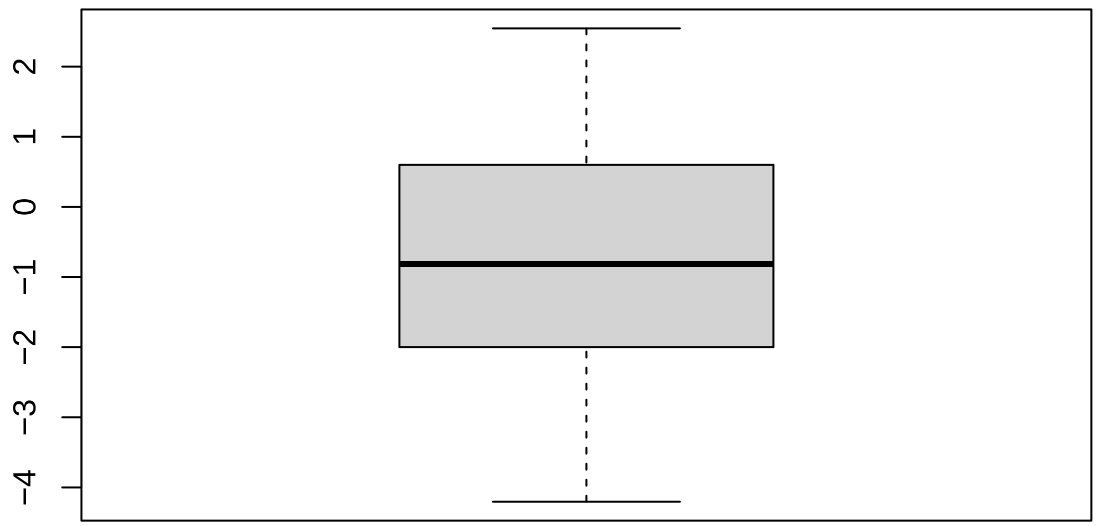
3
2
1
0
−1
−2


3
2
1
0
−1
−2

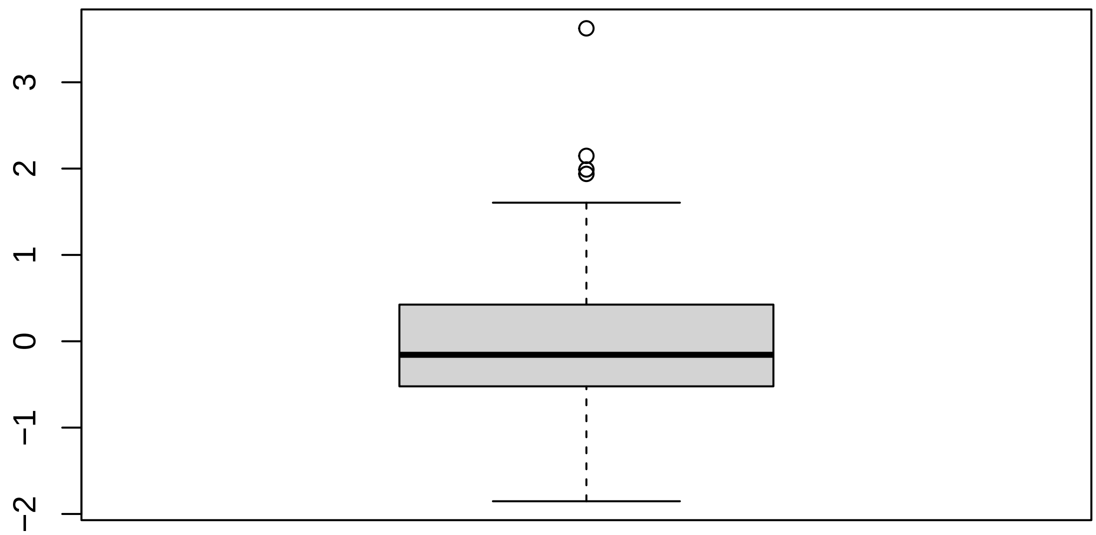

1
0
−1
−2
−3

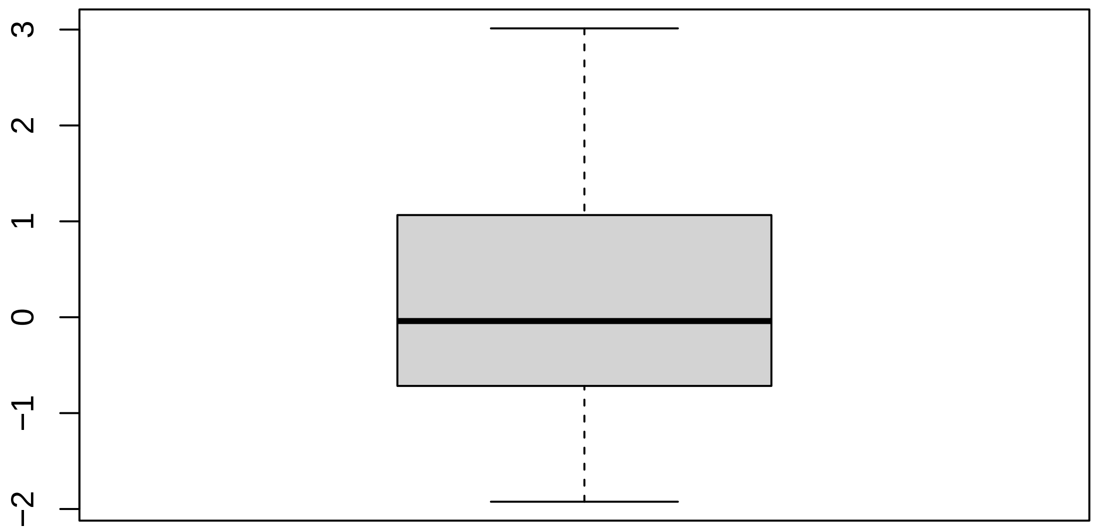

1.5
1.0
0.5
−0.5
−1.5

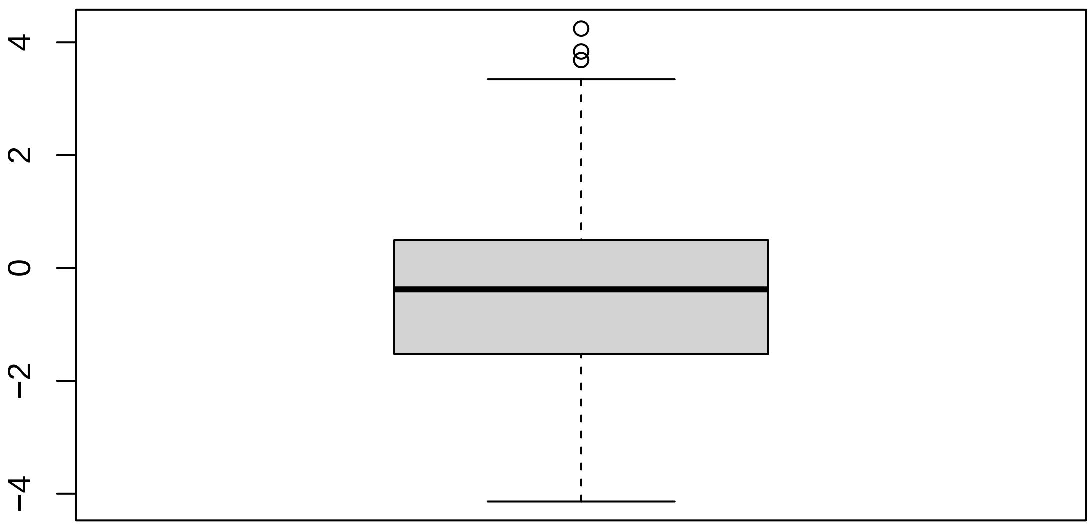

6
4
2
0
−2
−4

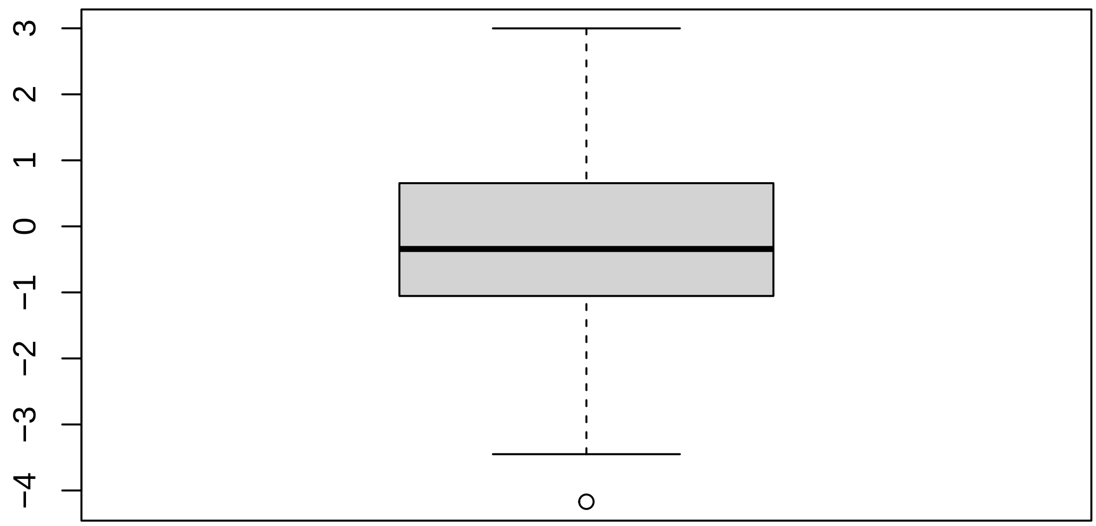


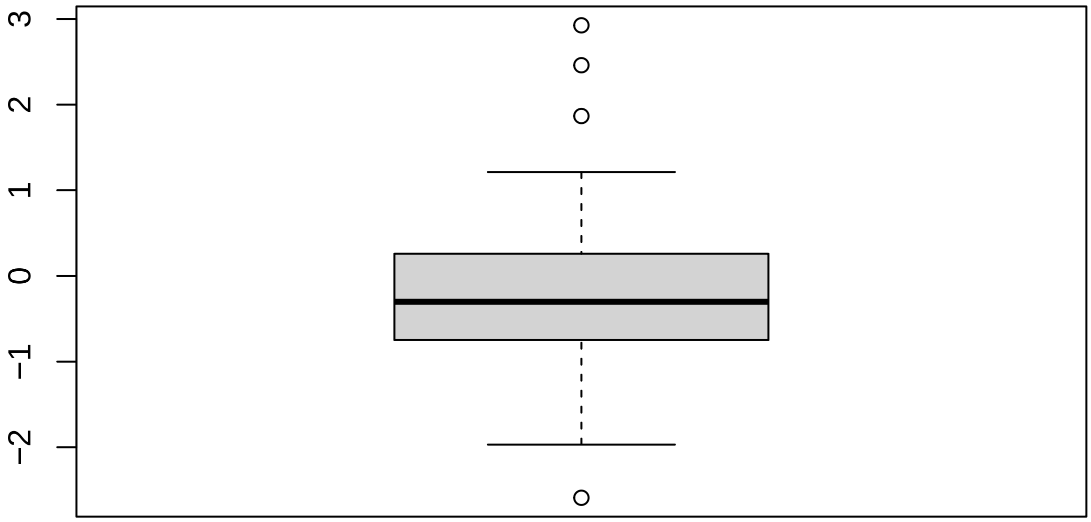
2
1
0
−1
−2
−3
−4

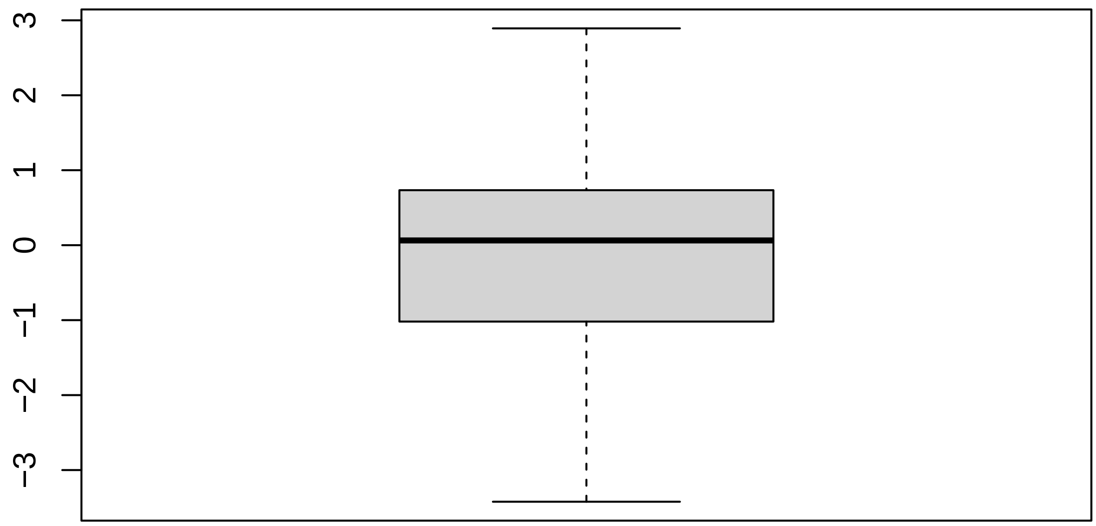

3
2
1
0
−1
−2

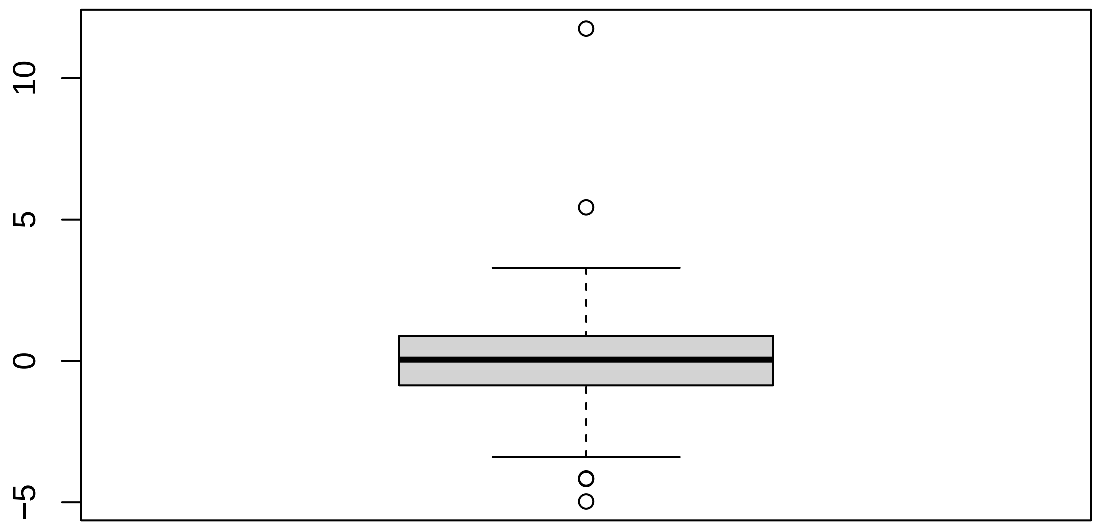

3
2
1
0
−1
−2

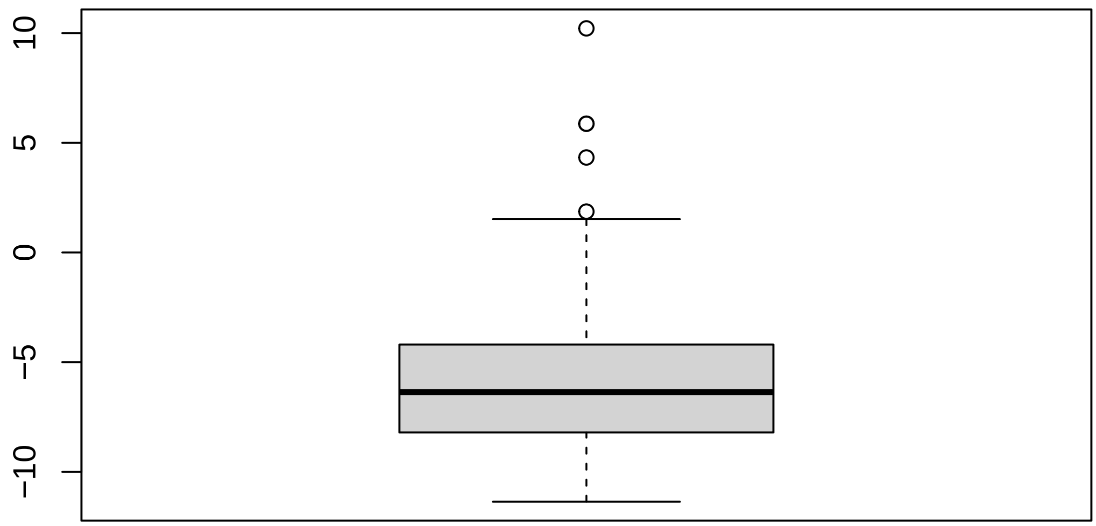

4
2
0
−2
−4

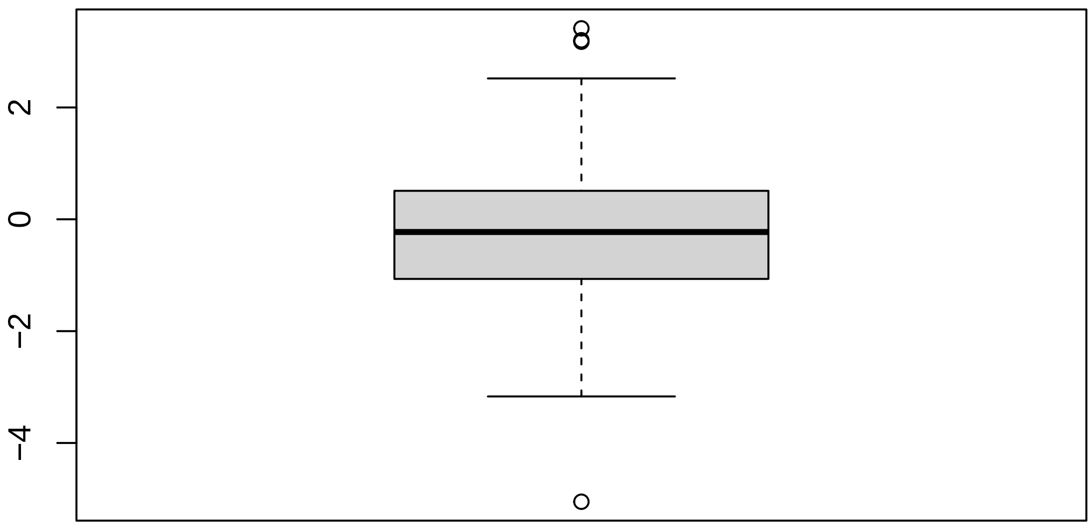

3
2
1
0
−1
−2
−3
−4

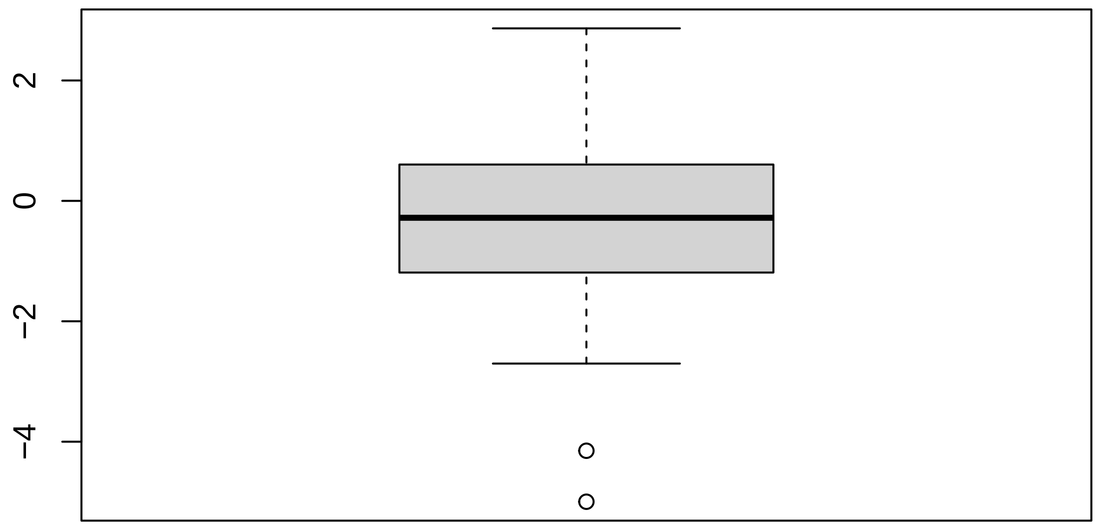

3
2
1
0
−1
−2

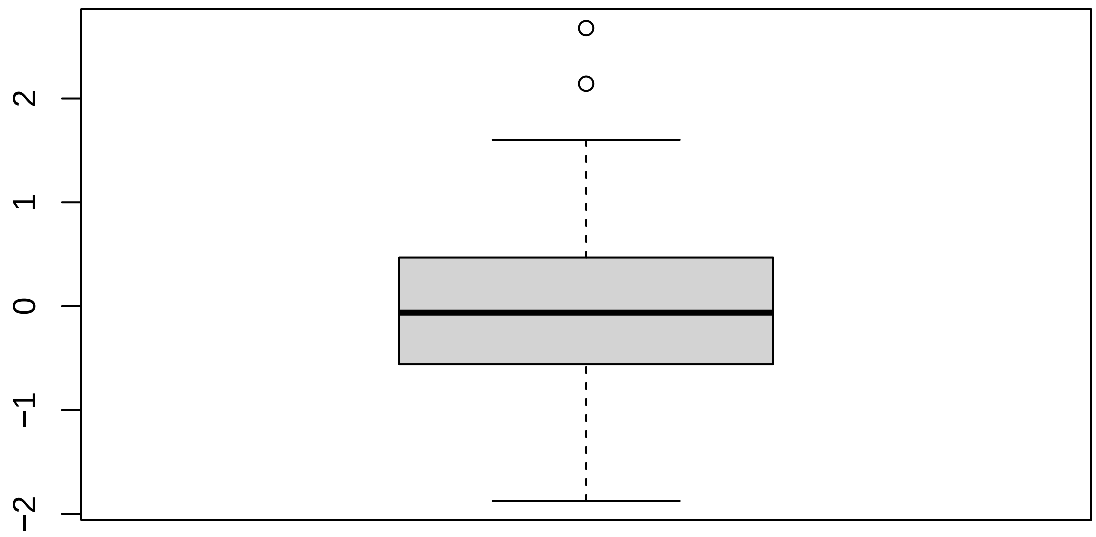

3
2
1
0
−1
−2
−3

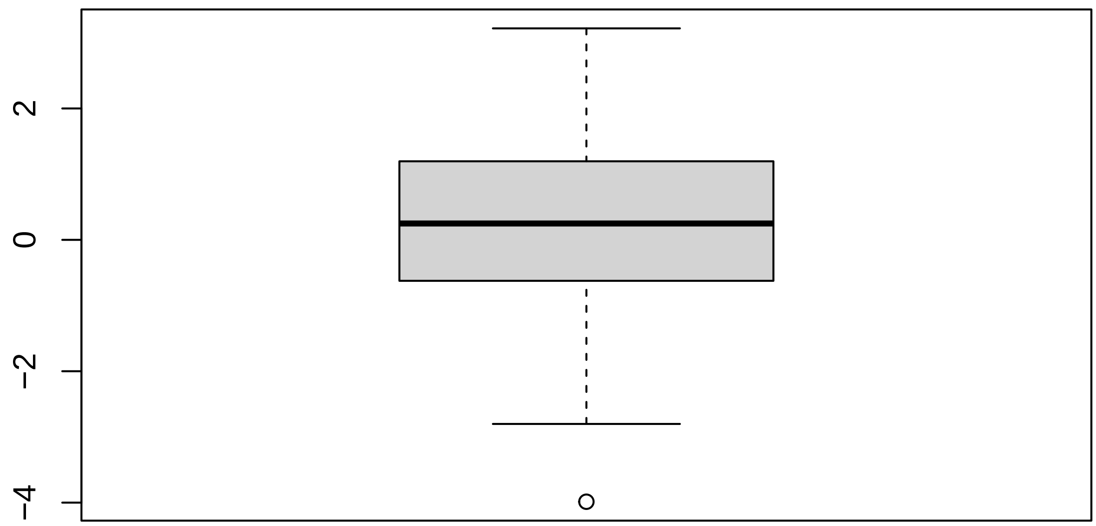

10
5
0
−5

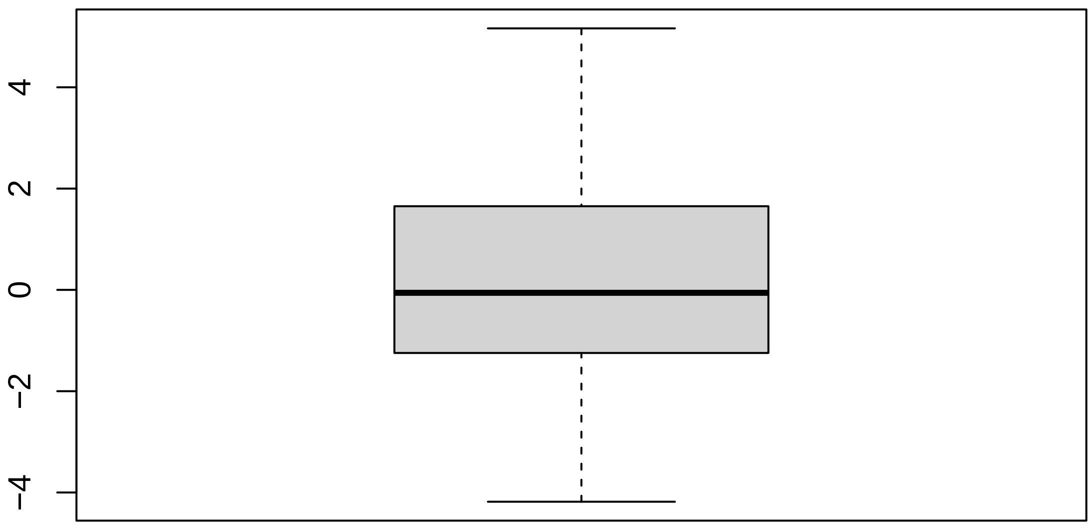

10
5
0
−5
−10


2
0
−2
−4


2
0
−2
−4


−2
−1
0
1
2


2
0
−2
−4




```
## $NP_038479
## $NP_038479$stats
##            [,1]
## [1,] -3.9159043
## [2,] -1.3588005
## [3,] -0.6057669
## [4,]  0.6575331
## [5,]  2.2302073
##
## $NP_038479$n
## [1] 80
##
## $NP_038479$conf
##            [,1]
## [1,] -0.9619510
## [2,] -0.2495829
##
## $NP_038479$out
## [1] 3.785229
##
## $NP_038479$group
## [1] 1
##
## $NP_038479$names
## [1] "1"
##
```

```
##
## $NP_001258898
## $NP_001258898$stats
##             [,1]
## [1,] -1.44190438
## [2,] -0.74414488
## [3,]  0.00129172
## [4,]  0.60125977
## [5,]  1.69892745
##
## $NP_001258898$n
## [1] 80
##
## $NP_001258898$conf
##            [,1]
## [1,] -0.2363732
## [2,]  0.2389566
##
## $NP_001258898$out
## numeric(0)
##
## $NP_001258898$group
## numeric(0)
##
## $NP_001258898$names
## [1] "1"
##
##
## $NP_542785
## $NP_542785$stats
##             [,1]
## [1,] -7.15625291
## [2,] -2.38215725
## [3,]  0.03094425
## [4,]  1.48903278
## [5,]  5.18818807
##
## $NP_542785$n
## [1] 80
##
## $NP_542785$conf
##            [,1]
## [1,] -0.6528990
## [2,]  0.7147875
##
## $NP_542785$out
## [1] -8.643742 -8.192980
##
## $NP_542785$group
## [1] 1 1
##
## $NP_542785$names
## [1] "1"
##
```

```
##
## $NP_002005
## $NP_002005$stats
##            [,1]
## [1,] -4.6253957
## [2,] -1.8720616
## [3,] -0.6925908
## [4,]  0.5003105
## [5,]  3.4240101
##
## $NP_002005$n
## [1] 80
##
## $NP_002005$conf
##            [,1]
## [1,] -1.1116688
## [2,] -0.2735127
##
## $NP_002005$out
## numeric(0)
##
## $NP_002005$group
## numeric(0)
##
## $NP_002005$names
## [1] "1"
##
##
## $XP_003846537
## $XP_003846537$stats
##            [,1]
## [1,] -1.3445653
## [2,] -0.4809037
## [3,] -0.2429975
## [4,]  0.4367871
## [5,]  1.5662875
##
## $XP_003846537$n
## [1] 80
##
## $XP_003846537$conf
##             [,1]
## [1,] -0.40510701
## [2,] -0.08088803
##
## $XP_003846537$out
## [1]  2.336572  1.902276  2.470569  2.210577 -2.042273
##
## $XP_003846537$group
## [1] 1 1 1 1 1
##
## $XP_003846537$names
## [1] "1"
##
```

```
##
## $NP_660208
## $NP_660208$stats
##              [,1]
## [1,] -1.495746821
## [2,] -0.493137518
## [3,] -0.004159959
## [4,]  0.567662746
## [5,]  1.657515110
##
## $NP_660208$n
## [1] 80
##
## $NP_660208$conf
##            [,1]
## [1,] -0.1915497
## [2,]  0.1832297
##
## $NP_660208$out
## numeric(0)
##
## $NP_660208$group
## numeric(0)
##
## $NP_660208$names
## [1] "1"
##
##
## $NP_004439
## $NP_004439$stats
##           [,1]
## [1,] -5.887760
## [2,] -3.844681
## [3,] -2.475620
## [4,] -1.124023
## [5,]  2.103030
##
## $NP_004439$n
## [1] 80
##
## $NP_004439$conf
##           [,1]
## [1,] -2.956223
## [2,] -1.995018
##
## $NP_004439$out
##  [1] 9.668177 9.438237 2.995443 3.853287 5.635589 3.886441 3.322970 5.767942
##  [9] 5.800973 4.567836
##
## $NP_004439$group
##  [1] 1 1 1 1 1 1 1 1 1 1
##
## $NP_004439$names
## [1] "1"
```

```
##
##
## $NP_004388
## $NP_004388$stats
##            [,1]
## [1,] -1.4793025
## [2,] -0.4315964
## [3,] -0.0896896
## [4,]  0.4370189
## [5,]  1.7005950
##
## $NP_004388$n
## [1] 80
##
## $NP_004388$conf
##             [,1]
## [1,] -0.24312994
## [2,]  0.06375073
##
## $NP_004388$out
## [1] 2.286965
##
## $NP_004388$group
## [1] 1
##
## $NP_004388$names
## [1] "1"
##
##
## $NP_001229372
## $NP_001229372$stats
##           [,1]
## [1,] -6.963267
## [2,] -3.590168
## [3,] -2.435468
## [4,] -1.275306
## [5,]  2.133122
##
## $NP_001229372$n
## [1] 80
##
## $NP_001229372$conf
##           [,1]
## [1,] -2.844387
## [2,] -2.026549
##
## $NP_001229372$out
## [1] 8.978604 8.965470 6.148162 3.646817 3.369828 3.398403 4.232799
##
## $NP_001229372$group
## [1] 1 1 1 1 1 1 1
##
## $NP_001229372$names
## [1] "1"
```

```
##
##
## $NP_005130
## $NP_005130$stats
##            [,1]
## [1,] -8.8307556
## [2,] -3.7147704
## [3,] -1.4701347
## [4,]  0.2255714
## [5,]  5.6405463
##
## $NP_005130$n
## [1] 80
##
## $NP_005130$conf
##            [,1]
## [1,] -2.1661936
## [2,] -0.7740758
##
## $NP_005130$out
## [1] 6.397391
##
## $NP_005130$group
## [1] 1
##
## $NP_005130$names
## [1] "1"
##
##
## $NP_004243
## $NP_004243$stats
##            [,1]
## [1,] -4.3493525
## [2,] -2.2404093
## [3,] -1.2588643
## [4,]  0.3011927
## [5,]  4.0708722
##
## $NP_004243$n
## [1] 80
##
## $NP_004243$conf
##            [,1]
## [1,] -1.7078367
## [2,] -0.8098919
##
## $NP_004243$out
## [1] 4.399083 4.861847 5.671446
##
## $NP_004243$group
## [1] 1 1 1
##
## $NP_004243$names
## [1] "1"
```

```
##
##
## $NP_003144
## $NP_003144$stats
##            [,1]
## [1,] -1.9798402
## [2,] -0.4325426
## [3,]  0.1947012
## [4,]  0.7404052
## [5,]  1.8449029
##
## $NP_003144$n
## [1] 80
##
## $NP_003144$conf
##             [,1]
## [1,] -0.01249928
## [2,]  0.40190170
##
## $NP_003144$out
## [1] 2.830061
##
## $NP_003144$group
## [1] 1
##
## $NP_003144$names
## [1] "1"
##
##
## $NP_001171551
## $NP_001171551$stats
##            [,1]
## [1,] -1.9470415
## [2,] -0.4322866
## [3,]  0.1742170
## [4,]  0.7294963
## [5,]  1.8449029
##
## $NP_001171551$n
## [1] 80
##
## $NP_001171551$conf
##             [,1]
## [1,] -0.03101126
## [2,]  0.37944520
##
## $NP_001171551$out
## [1] 2.813958
##
## $NP_001171551$group
## [1] 1
##
## $NP_001171551$names
## [1] "1"
```

```
##
##
## $NP_072096
## $NP_072096$stats
##             [,1]
## [1,] -1.50276929
## [2,] -0.55484927
## [3,] -0.01969573
## [4,]  0.41592377
## [5,]  1.19362341
##
## $NP_072096$n
## [1] 80
##
## $NP_072096$conf
##            [,1]
## [1,] -0.1911822
## [2,]  0.1517907
##
## $NP_072096$out
## [1] -2.871865
##
## $NP_072096$group
## [1] 1
##
## $NP_072096$names
## [1] "1"
##
##
## $NP_005484
## $NP_005484$stats
##             [,1]
## [1,] -1.50816552
## [2,] -0.53675374
## [3,] -0.09190035
## [4,]  0.39283208
## [5,]  1.56245999
##
## $NP_005484$n
## [1] 80
##
## $NP_005484$conf
##             [,1]
## [1,] -0.25611110
## [2,]  0.07231039
##
## $NP_005484$out
## numeric(0)
##
## $NP_005484$group
## numeric(0)
##
## $NP_005484$names
## [1] "1"
```

```
##
##
## $NP_061170
## $NP_061170$stats
##           [,1]
## [1,] -4.712975
## [2,] -2.025168
## [3,] -1.033795
## [4,]  0.311528
## [5,]  3.724644
##
## $NP_061170$n
## [1] 80
##
## $NP_061170$conf
##            [,1]
## [1,] -1.4465707
## [2,] -0.6210191
##
## $NP_061170$out
## [1] 4.029373 5.689747
##
## $NP_061170$group
## [1] 1 1
##
## $NP_061170$names
## [1] "1"
##
##
## $NP_653304
## $NP_653304$stats
##            [,1]
## [1,] -4.2030116
## [2,] -1.9997588
## [3,] -0.8129121
## [4,]  0.6002230
## [5,]  2.5447948
##
## $NP_653304$n
## [1] 80
##
## $NP_653304$conf
##            [,1]
## [1,] -1.2721972
## [2,] -0.3536269
##
## $NP_653304$out
## numeric(0)
##
## $NP_653304$group
## numeric(0)
##
## $NP_653304$names
## [1] "1"
```

```
##
##
## $NP_653081
## $NP_653081$stats
##            [,1]
## [1,] -1.8526870
## [2,] -0.5220216
## [3,] -0.1564469
## [4,]  0.4245559
## [5,]  1.6049629
##
## $NP_653081$n
## [1] 80
##
## $NP_653081$conf
##             [,1]
## [1,] -0.32365917
## [2,]  0.01076545
##
## $NP_653081$out
## [1] 2.147486 1.989637 3.624280 1.938567
##
## $NP_653081$group
## [1] 1 1 1 1
##
## $NP_653081$names
## [1] "1"
##
##
## $NP_057164
## $NP_057164$stats
##             [,1]
## [1,] -1.92397415
## [2,] -0.71653848
## [3,] -0.03968425
## [4,]  1.06566335
## [5,]  3.01239495
##
## $NP_057164$n
## [1] 80
##
## $NP_057164$conf
##            [,1]
## [1,] -0.3545091
## [2,]  0.2751406
##
## $NP_057164$out
## numeric(0)
##
## $NP_057164$group
## numeric(0)
##
## $NP_057164$names
## [1] "1"
```

```
##
##
## $NP_004453
## $NP_004453$stats
##            [,1]
## [1,] -4.1386672
## [2,] -1.5225765
## [3,] -0.3784592
## [4,]  0.4924532
## [5,]  3.3454346
##
## $NP_004453$n
## [1] 80
##
## $NP_004453$conf
##             [,1]
## [1,] -0.73441287
## [2,] -0.02250543
##
## $NP_004453$out
## [1] 3.686225 3.837949 4.243675
##
## $NP_004453$group
## [1] 1 1 1
##
## $NP_004453$names
## [1] "1"
##
##
## $NP_003212
## $NP_003212$stats
##            [,1]
## [1,] -3.4500588
## [2,] -1.0539582
## [3,] -0.3422749
## [4,]  0.6543596
## [5,]  2.9986201
##
## $NP_003212$n
## [1] 80
##
## $NP_003212$conf
##             [,1]
## [1,] -0.64404820
## [2,] -0.04050166
##
## $NP_003212$out
## [1] -4.1699
##
## $NP_003212$group
## [1] 1
##
## $NP_003212$names
## [1] "1"
```

```
##
##
## $NP_060866
## $NP_060866$stats
##            [,1]
## [1,] -1.9687931
## [2,] -0.7490088
## [3,] -0.3001057
## [4,]  0.2604499
## [5,]  1.2134275
##
## $NP_060866$n
## [1] 80
##
## $NP_060866$conf
##            [,1]
## [1,] -0.4784260
## [2,] -0.1217855
##
## $NP_060866$out
## [1] -2.589974  2.460358  1.867033  2.926207
##
## $NP_060866$group
## [1] 1 1 1 1
##
## $NP_060866$names
## [1] "1"
##
##
## $NP_001160163
## $NP_001160163$stats
##             [,1]
## [1,] -3.42210803
## [2,] -1.01917050
## [3,]  0.06316141
## [4,]  0.73348041
## [5,]  2.89217103
##
## $NP_001160163$n
## [1] 80
##
## $NP_001160163$conf
##            [,1]
## [1,] -0.2464433
## [2,]  0.3727661
##
## $NP_001160163$out
## numeric(0)
##
## $NP_001160163$group
## numeric(0)
##
## $NP_001160163$names
## [1] "1"
```

```
##
##
## $NP_003875
## $NP_003875$stats
##             [,1]
## [1,] -3.39803927
## [2,] -0.86429123
## [3,]  0.04810062
## [4,]  0.88773048
## [5,]  3.29279523
##
## $NP_003875$n
## [1] 80
##
## $NP_003875$conf
##            [,1]
## [1,] -0.2613929
## [2,]  0.3575941
##
## $NP_003875$out
## [1] -4.970156  5.432549 11.755122 -4.153530 -4.176455
##
## $NP_003875$group
## [1] 1 1 1 1 1
##
## $NP_003875$names
## [1] "1"
##
##
## $NP_002677
## $NP_002677$stats
##            [,1]
## [1,] -11.361115
## [2,]  -8.205643
## [3,]  -6.362650
## [4,]  -4.197724
## [5,]   1.516256
##
## $NP_002677$n
## [1] 80
##
## $NP_002677$conf
##           [,1]
## [1,] -7.070647
## [2,] -5.654654
##
## $NP_002677$out
## [1]  4.331248  1.864520  5.868250 10.215922  5.871759
##
## $NP_002677$group
## [1] 1 1 1 1 1
##
## $NP_002677$names
## [1] "1"
```

```
##
##
## $NP_001135891
## $NP_001135891$stats
##            [,1]
## [1,] -3.1680635
## [2,] -1.0661463
## [3,] -0.2271340
## [4,]  0.5092675
## [5,]  2.5193274
##
## $NP_001135891$n
## [1] 80
##
## $NP_001135891$conf
##             [,1]
## [1,] -0.50542981
## [2,]  0.05116191
##
## $NP_001135891$out
## [1] -5.050298  3.201698  3.175491  3.414158
##
## $NP_001135891$group
## [1] 1 1 1 1
##
## $NP_001135891$names
## [1] "1"
##
##
## $NP_004522
## $NP_004522$stats
##            [,1]
## [1,] -2.7021650
## [2,] -1.1902918
## [3,] -0.2807051
## [4,]  0.6040038
## [5,]  2.8653784
##
## $NP_004522$n
## [1] 80
##
## $NP_004522$conf
##             [,1]
## [1,] -0.59766633
## [2,]  0.03625606
##
## $NP_004522$out
## [1] -4.150392 -4.996855
##
## $NP_004522$group
## [1] 1 1
##
## $NP_004522$names
## [1] "1"
```

```
##
##
## $NP_003767
## $NP_003767$stats
##              [,1]
## [1,] -1.87517546
## [2,] -0.55882109
## [3,] -0.06146679
## [4,]  0.46892980
## [5,]  1.60169464
##
## $NP_003767$n
## [1] 80
##
## $NP_003767$conf
##             [,1]
## [1,] -0.2430183
## [2,]  0.1200848
##
## $NP_003767$out
## [1] 2.142263 2.677884
##
## $NP_003767$group
## [1] 1 1
##
## $NP_003767$names
## [1] "1"
##
##
## $NP_848597
## $NP_848597$stats
##             [,1]
## [1,] -2.8023343
## [2,] -0.6238947
## [3,]  0.2488007
## [4,]  1.1953659
## [5,]  3.2187065
##
## $NP_848597$n
## [1] 80
##
## $NP_848597$conf
##              [,1]
## [1,] -0.07257056
## [2,]  0.57017190
##
## $NP_848597$out
## [1] -3.986077
##
## $NP_848597$group
## [1] 1
##
## $NP_848597$names
## [1] "1"
```

```
##
##
## $NP_005970
## $NP_005970$stats
##              [,1]
## [1,] -4.18213251
## [2,] -1.24546089
## [3,] -0.05750858
## [4,]  1.65100594
## [5,]  5.16274745
##
## $NP_005970$n
## [1] 80
##
## $NP_005970$conf
##            [,1]
## [1,] -0.5691676
## [2,]  0.4541505
##
## $NP_005970$out
## numeric(0)
##
## $NP_005970$group
## numeric(0)
##
## $NP_005970$names
## [1] "1"
```

```
# function for detection of outliers in each column
outliers <- function(x)
{
  for(i in 1:ncol(x))
  {
    sd_i <- sd(x[,i])
    mean_i <- mean(x[,i])

    out = x[x[,i] > 3*sd_i+mean_i | x[,i] < mean_i-3*sd_i, ]
    if(nrow(out) > 0)
    {
      print(colnames(x)[i])
      paste("The outliers are -", out)
    }else
    {
      print(paste("No outliers for",colnames(x)[i]))
    }
  }
}
```

```
# Detecting outliers in the dataset
outliers(final_data[,c(2:ncol(final_data))])
```

```
## [1] "NP_038479"
## [1] "No outliers for NP_001258898"
```

```
## [1] "No outliers for NP_542785"
## [1] "No outliers for NP_002005"
## [1] "No outliers for XP_003846537"
## [1] "No outliers for NP_660208"
## [1] "NP_004439"
## [1] "No outliers for NP_004388"
## [1] "NP_001229372"
## [1] "No outliers for NP_005130"
## [1] "No outliers for NP_004243"
## [1] "NP_003144"
## [1] "NP_001171551"
## [1] "NP_072096"
## [1] "No outliers for NP_005484"
## [1] "No outliers for NP_061170"
## [1] "No outliers for NP_653304"
## [1] "NP_653081"
## [1] "No outliers for NP_057164"
## [1] "No outliers for NP_004453"
## [1] "No outliers for NP_003212"
## [1] "NP_060866"
## [1] "No outliers for NP_001160163"
## [1] "NP_003875"
## [1] "NP_002677"
## [1] "NP_001135891"
## [1] "NP_004522"
## [1] "NP_003767"
## [1] "NP_848597"
## [1] "No outliers for NP_005970"
```

```r
# replacing outliers with median imputation
outlier <- function(x) {
 x[x < quantile(x,0.25) - 1.5 * IQR(x) | x > quantile(x,0.75) + 1.5 * IQR(x)] <- median(x)
 x
}
```

```r
data_out <- as.data.frame(lapply(final_data[,c(2:ncol(final_data))], outlier))
data_norm <- data_out
data_norm$PAM50.mRNA <- final_data$PAM50.mRNA
```

Feature Engineering -

I have not derived new features. - converted the PAM50.mRNA as a factor type as this is a response variable. for this I have used factor()

```r
# changing the names
data_norm$PAM50.mRNA[which(data_norm$PAM50.mRNA == "Basal-like")] = "Basal.like"
data_norm$PAM50.mRNA[which(data_norm$PAM50.mRNA == "HER2-enriched")] = "HER2.enriched"
data_norm$PAM50.mRNA[which(data_norm$PAM50.mRNA == "Luminal A")] = "Luminal.A"
data_norm$PAM50.mRNA[which(data_norm$PAM50.mRNA == "Luminal B")] = "Luminal.B"
```

```r
# converting PAM50.mRNA to a factor type
data_norm$PAM50.mRNA <- factor(data_norm$PAM50.mRNA)
```

Correlation/Collinearity analysis

- Numerical data is required for calculating correlation, so I have used only numerical variables to interpret the correlation
- Correlation plot is shown for whole data
- I have shown the plot of correlation between numeric features
- I also tried pairs.panels function for correlation but since there are more than 15 features. Plots are not clearly visible pairs.panels(data_n)
- Thefore, build a plot with top ten features
- I cannot apply chi-square test as the datapoints should be non-zero and non-negative

```r
#Creating a correlation plot of whole dataset
cormat <- round(cor(data_norm[,1:30]),2)
cormat
```

```
##              NP_038479 NP_001258898 NP_542785 NP_002005 XP_003846537 NP_660208
## NP_038479         1.00        -0.41      0.20     -0.14         0.33     -0.05
## NP_001258898     -0.41         1.00     -0.04      0.33        -0.30     -0.13
## NP_542785         0.20        -0.04      1.00     -0.34         0.07     -0.35
## NP_002005        -0.14         0.33     -0.34      1.00         0.09      0.18
## XP_003846537      0.33        -0.30      0.07      0.09         1.00      0.06
## NP_660208        -0.05        -0.13     -0.35      0.18         0.06      1.00
## NP_004439         0.13         0.05      0.07      0.06        -0.05     -0.03
## NP_004388        -0.45         0.56      0.07      0.03        -0.22     -0.10
## NP_001229372      0.09         0.06      0.13      0.00         0.00     -0.07
## NP_005130         0.05        -0.04      0.42     -0.49        -0.09     -0.18
## NP_004243         0.01         0.12     -0.39      0.64         0.17      0.24
## NP_003144         0.36        -0.51      0.16     -0.24         0.19      0.13
## NP_001171551      0.35        -0.53      0.16     -0.25         0.19      0.14
## NP_072096         0.12        -0.16     -0.29      0.07        -0.04      0.52
## NP_005484        -0.36         0.34     -0.15      0.02        -0.18     -0.08
## NP_061170        -0.01        -0.04      0.06      0.01         0.17     -0.08
## NP_653304        -0.25         0.53      0.09      0.17        -0.05     -0.21
## NP_653081         0.05         0.18      0.15      0.09         0.02     -0.28
## NP_057164         0.11        -0.51     -0.01      0.06         0.26      0.35
## NP_004453        -0.13         0.32      0.07      0.07        -0.19     -0.25
## NP_003212        -0.22         0.23      0.23     -0.08        -0.05     -0.38
## NP_060866        -0.02         0.18     -0.32      0.32        -0.01      0.28
## NP_001160163     -0.40         0.46     -0.03     -0.11        -0.37     -0.05
## NP_003875         0.34        -0.30     -0.18     -0.01         0.15      0.09
## NP_002677        -0.04         0.09     -0.03      0.02        -0.14      0.13
## NP_001135891     -0.03         0.18     -0.17      0.34         0.04     -0.04
## NP_004522         0.00        -0.08     -0.33      0.27         0.08      0.26
## NP_003767        -0.19         0.06     -0.30      0.36        -0.11      0.25
## NP_848597         0.38        -0.36     -0.03      0.18         0.26      0.23
## NP_005970         0.27        -0.41      0.10     -0.15         0.21      0.28
##              NP_004439 NP_004388 NP_001229372 NP_005130 NP_004243 NP_003144
## NP_038479         0.13     -0.45         0.09      0.05      0.01      0.36
## NP_001258898      0.05      0.56         0.06     -0.04      0.12     -0.51
## NP_542785         0.07      0.07         0.13      0.42     -0.39      0.16
## NP_002005         0.06      0.03         0.00     -0.49      0.64     -0.24
## XP_003846537     -0.05     -0.22         0.00     -0.09      0.17      0.19
## NP_660208        -0.03     -0.10        -0.07     -0.18      0.24      0.13
```

```
## NP_004439         1.00      0.06         0.78      0.01      0.05     -0.04
## NP_004388         0.06      1.00         0.19      0.16     -0.09     -0.48
## NP_001229372      0.78      0.19         1.00      0.09     -0.04     -0.04
## NP_005130         0.01      0.16         0.09      1.00     -0.49      0.05
## NP_004243         0.05     -0.09        -0.04     -0.49      1.00     -0.04
## NP_003144        -0.04     -0.48        -0.04      0.05     -0.04      1.00
## NP_001171551     -0.05     -0.48        -0.05      0.05     -0.04      1.00
## NP_072096        -0.01     -0.17        -0.10     -0.10      0.15      0.17
## NP_005484         0.13      0.30         0.17      0.02      0.02     -0.37
## NP_061170         0.06     -0.02         0.13     -0.17      0.13     -0.10
## NP_653304         0.15      0.67         0.22      0.02      0.10     -0.58
## NP_653081         0.05      0.25         0.16      0.22      0.14     -0.23
## NP_057164        -0.13     -0.36        -0.17     -0.01      0.15      0.49
## NP_004453         0.17      0.22         0.29     -0.05      0.06     -0.28
## NP_003212         0.10      0.28         0.13      0.20     -0.15     -0.17
## NP_060866         0.03      0.12         0.07     -0.28      0.37     -0.17
## NP_001160163      0.01      0.38         0.07      0.11     -0.20     -0.33
## NP_003875        -0.13     -0.21        -0.13     -0.13      0.11      0.23
## NP_002677         0.38      0.23         0.41      0.12      0.03     -0.02
## NP_001135891     -0.13      0.00        -0.14     -0.16      0.27     -0.16
## NP_004522         0.01     -0.16        -0.12     -0.21      0.38      0.14
## NP_003767         0.23      0.07         0.15     -0.27      0.41     -0.24
## NP_848597         0.10     -0.26         0.13     -0.05      0.23      0.20
## NP_005970        -0.16     -0.20        -0.10      0.14      0.00      0.47
##              NP_001171551 NP_072096 NP_005484 NP_061170 NP_653304 NP_653081
## NP_038479            0.35      0.12     -0.36     -0.01     -0.25      0.05
## NP_001258898        -0.53     -0.16      0.34     -0.04      0.53      0.18
## NP_542785            0.16     -0.29     -0.15      0.06      0.09      0.15
## NP_002005           -0.25      0.07      0.02      0.01      0.17      0.09
## XP_003846537         0.19     -0.04     -0.18      0.17     -0.05      0.02
## NP_660208            0.14      0.52     -0.08     -0.08     -0.21     -0.28
## NP_004439           -0.05     -0.01      0.13      0.06      0.15      0.05
## NP_004388           -0.48     -0.17      0.30     -0.02      0.67      0.25
## NP_001229372        -0.05     -0.10      0.17      0.13      0.22      0.16
## NP_005130            0.05     -0.10      0.02     -0.17      0.02      0.22
## NP_004243           -0.04      0.15      0.02      0.13      0.10      0.14
## NP_003144            1.00      0.17     -0.37     -0.10     -0.58     -0.23
## NP_001171551         1.00      0.18     -0.37     -0.08     -0.59     -0.23
## NP_072096            0.18      1.00     -0.14     -0.18     -0.29     -0.19
## NP_005484           -0.37     -0.14      1.00      0.18      0.26      0.04
## NP_061170           -0.08     -0.18      0.18      1.00      0.13      0.18
## NP_653304           -0.59     -0.29      0.26      0.13      1.00      0.40
## NP_653081           -0.23     -0.19      0.04      0.18      0.40      1.00
## NP_057164            0.50      0.31     -0.33     -0.13     -0.50     -0.19
## NP_004453           -0.29     -0.25      0.36      0.25      0.24      0.22
## NP_003212           -0.18     -0.32      0.24     -0.01      0.23      0.16
## NP_060866           -0.18      0.11      0.14      0.14      0.16      0.04
## NP_001160163        -0.32      0.03      0.33     -0.02      0.30      0.14
## NP_003875            0.22      0.06     -0.30     -0.15     -0.18     -0.08
## NP_002677            0.00      0.10      0.23      0.04      0.06      0.18
## NP_001135891        -0.16     -0.03     -0.06      0.01      0.13      0.14
## NP_004522            0.15      0.13      0.18      0.14     -0.23     -0.08
## NP_003767           -0.21      0.07     -0.08      0.14      0.18      0.09
## NP_848597            0.22      0.27     -0.28     -0.15     -0.23      0.10
```

```
## NP_005970           0.48      0.28     -0.22     -0.16     -0.43     -0.11
##              NP_057164 NP_004453 NP_003212 NP_060866 NP_001160163 NP_003875
## NP_038479         0.11     -0.13     -0.22     -0.02        -0.40      0.34
## NP_001258898     -0.51      0.32      0.23      0.18         0.46     -0.30
## NP_542785        -0.01      0.07      0.23     -0.32        -0.03     -0.18
## NP_002005         0.06      0.07     -0.08      0.32        -0.11     -0.01
## XP_003846537      0.26     -0.19     -0.05     -0.01        -0.37      0.15
## NP_660208         0.35     -0.25     -0.38      0.28        -0.05      0.09
## NP_004439        -0.13      0.17      0.10      0.03         0.01     -0.13
## NP_004388        -0.36      0.22      0.28      0.12         0.38     -0.21
## NP_001229372     -0.17      0.29      0.13      0.07         0.07     -0.13
## NP_005130        -0.01     -0.05      0.20     -0.28         0.11     -0.13
## NP_004243         0.15      0.06     -0.15      0.37        -0.20      0.11
## NP_003144         0.49     -0.28     -0.17     -0.17        -0.33      0.23
## NP_001171551      0.50     -0.29     -0.18     -0.18        -0.32      0.22
## NP_072096         0.31     -0.25     -0.32      0.11         0.03      0.06
## NP_005484        -0.33      0.36      0.24      0.14         0.33     -0.30
## NP_061170        -0.13      0.25     -0.01      0.14        -0.02     -0.15
## NP_653304        -0.50      0.24      0.23      0.16         0.30     -0.18
## NP_653081        -0.19      0.22      0.16      0.04         0.14     -0.08
## NP_057164         1.00     -0.47     -0.24     -0.16        -0.37      0.14
## NP_004453        -0.47      1.00     -0.01      0.20         0.26     -0.25
## NP_003212        -0.24     -0.01      1.00     -0.14        -0.08     -0.16
## NP_060866        -0.16      0.20     -0.14      1.00        -0.01      0.14
## NP_001160163     -0.37      0.26     -0.08     -0.01         1.00     -0.38
## NP_003875         0.14     -0.25     -0.16      0.14        -0.38      1.00
## NP_002677        -0.06      0.20      0.07      0.06         0.20     -0.12
## NP_001135891     -0.09      0.03     -0.09      0.22         0.19     -0.04
## NP_004522         0.22      0.02     -0.19      0.20        -0.07     -0.01
## NP_003767         0.04      0.08     -0.17      0.23        -0.05      0.01
## NP_848597         0.36     -0.29     -0.17      0.06        -0.35      0.20
## NP_005970         0.56     -0.45     -0.21     -0.15        -0.20      0.25
##              NP_002677 NP_001135891 NP_004522 NP_003767 NP_848597 NP_005970
## NP_038479        -0.04        -0.03      0.00     -0.19      0.38      0.27
## NP_001258898      0.09         0.18     -0.08      0.06     -0.36     -0.41
## NP_542785        -0.03        -0.17     -0.33     -0.30     -0.03      0.10
## NP_002005         0.02         0.34      0.27      0.36      0.18     -0.15
## XP_003846537     -0.14         0.04      0.08     -0.11      0.26      0.21
## NP_660208         0.13        -0.04      0.26      0.25      0.23      0.28
## NP_004439         0.38        -0.13      0.01      0.23      0.10     -0.16
## NP_004388         0.23         0.00     -0.16      0.07     -0.26     -0.20
## NP_001229372      0.41        -0.14     -0.12      0.15      0.13     -0.10
## NP_005130         0.12        -0.16     -0.21     -0.27     -0.05      0.14
## NP_004243         0.03         0.27      0.38      0.41      0.23      0.00
## NP_003144        -0.02        -0.16      0.14     -0.24      0.20      0.47
## NP_001171551      0.00        -0.16      0.15     -0.21      0.22      0.48
## NP_072096         0.10        -0.03      0.13      0.07      0.27      0.28
## NP_005484         0.23        -0.06      0.18     -0.08     -0.28     -0.22
## NP_061170         0.04         0.01      0.14      0.14     -0.15     -0.16
## NP_653304         0.06         0.13     -0.23      0.18     -0.23     -0.43
## NP_653081         0.18         0.14     -0.08      0.09      0.10     -0.11
## NP_057164        -0.06        -0.09      0.22      0.04      0.36      0.56
## NP_004453         0.20         0.03      0.02      0.08     -0.29     -0.45
## NP_003212         0.07        -0.09     -0.19     -0.17     -0.17     -0.21
```

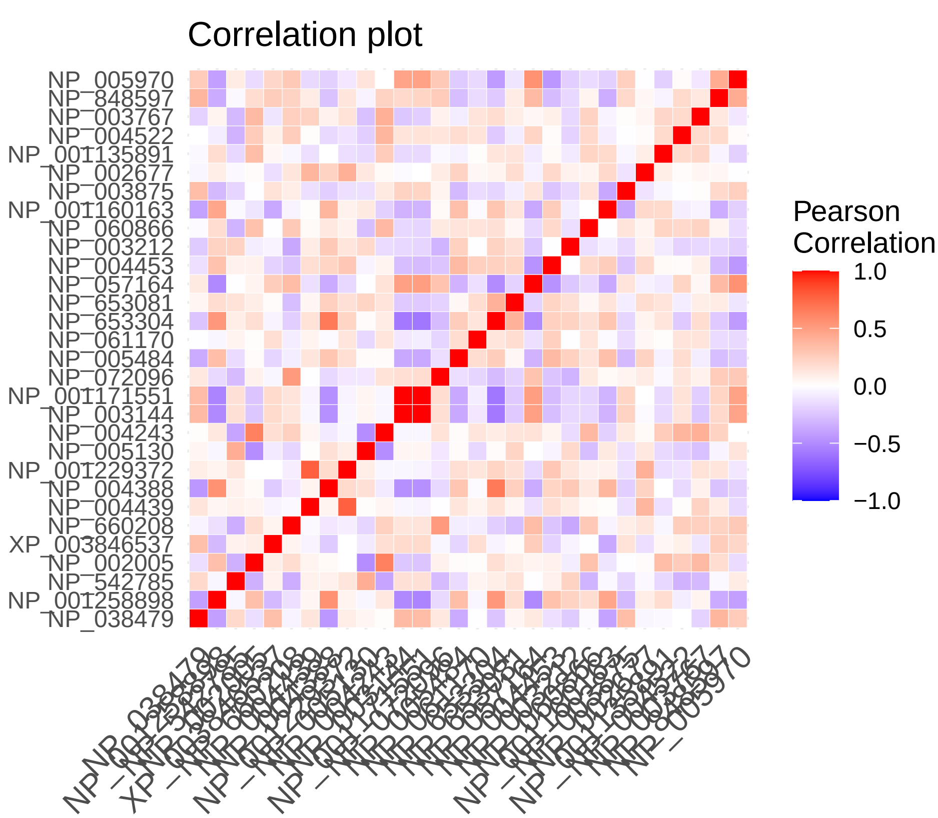
```
## NP_060866          0.06          0.22        0.20        0.23        0.06       -0.15
## NP_001160163       0.20          0.19       -0.07       -0.05       -0.35       -0.20
## NP_003875         -0.12         -0.04       -0.01        0.01        0.20        0.25
## NP_002677          1.00          0.09        0.02        0.05        0.04       -0.01
## NP_001135891       0.09          1.00        0.19        0.21       -0.05       -0.20
## NP_004522          0.02          0.19        1.00        0.19        0.19        0.02
## NP_003767          0.05          0.21        0.19        1.00        0.12       -0.10
## NP_848597          0.04         -0.05        0.19        0.12        1.00        0.43
## NP_005970         -0.01         -0.20        0.02       -0.10        0.43        1.00
```

We can say that the proteins are not highly correlated

```
melted_cormat <- reshape2::melt(cormat)
```

Visualizing the correlation plot

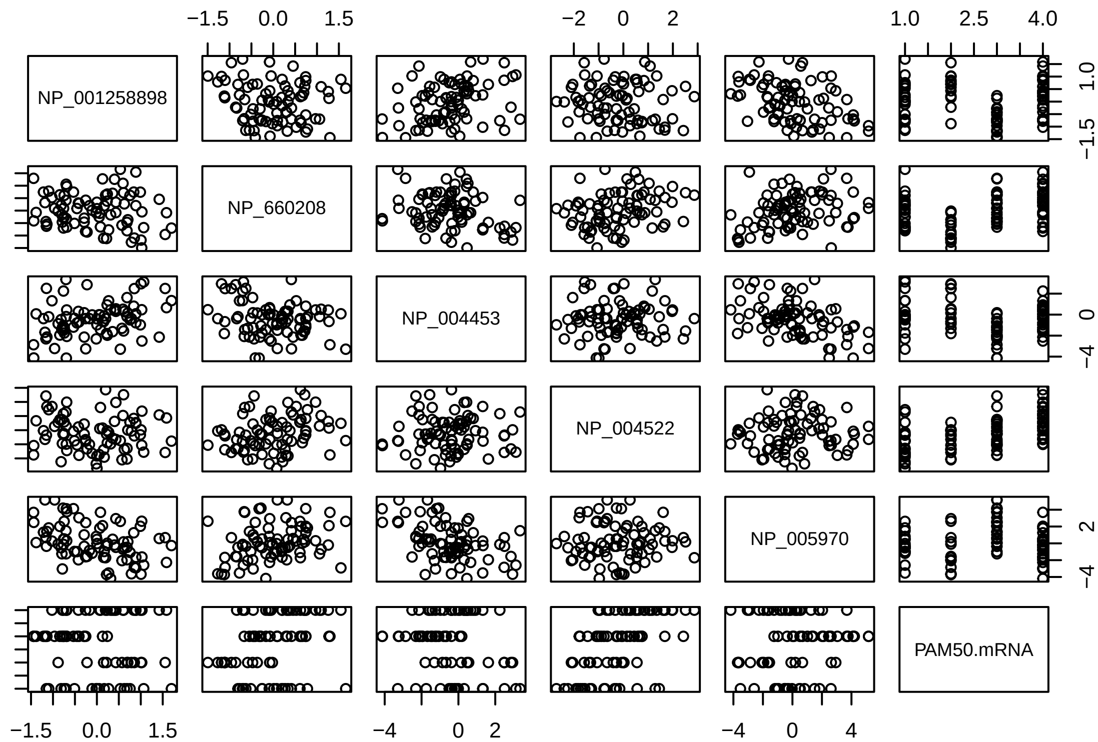
```
ggplot(data = melted_cormat, aes(Var2, Var1, fill = value))+
 geom_tile(color = "white")+
 scale_fill_gradient2(low = "blue", high = "red", mid = "white",
   midpoint = 0, limit = c(-1,1), space = "Lab",
   name="Pearson\nCorrelation") +
  theme_minimal()+
 theme(axis.text.x = element_text(angle = 45, vjust = 1,
    size = 12, hjust = 1))+
 coord_fixed()+xlab("")+ylab("")+ggtitle("Correlation plot")
```



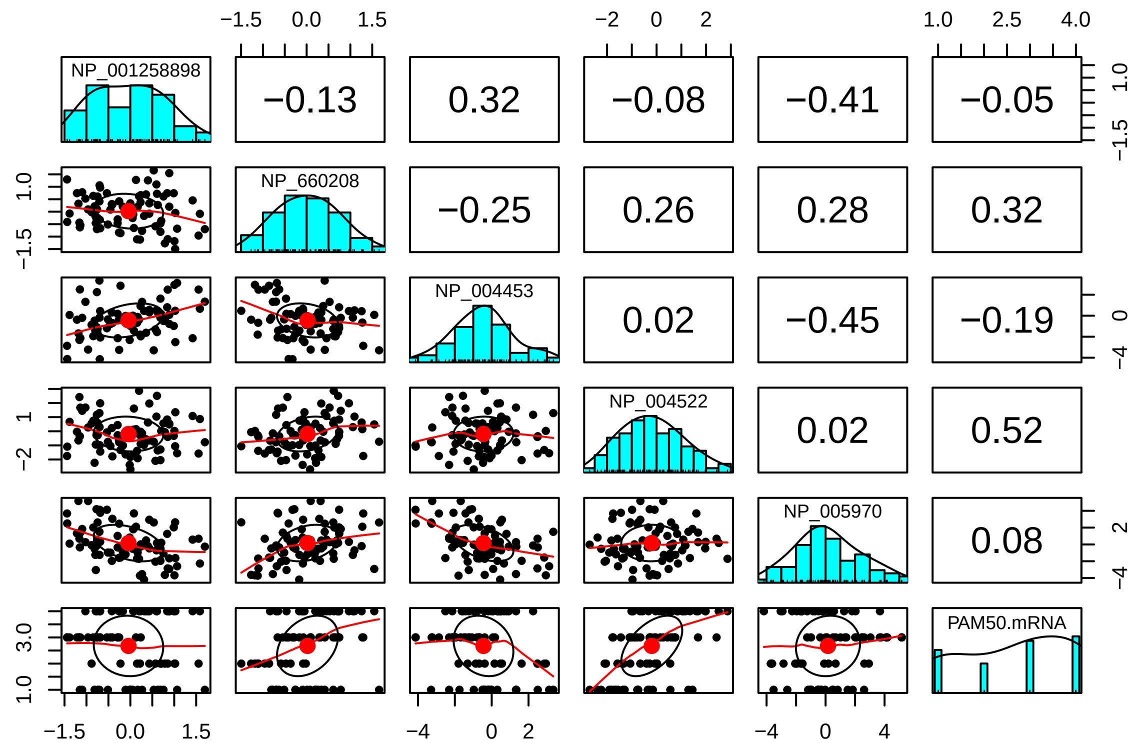
Top 5 variables and response variable

```
top_variables <- c("PAM50.mRNA", "NP_660208", "NP_005970", "NP_004453", "NP_004522", "NP_001258898")

#"NP_001160163", "NP_003767", "NP_542785", "NP_060866", "NP_004388"

data_viz= data_norm[,(names(data_norm) %in% top_variables)]
```

```
pairs(data_viz)
```

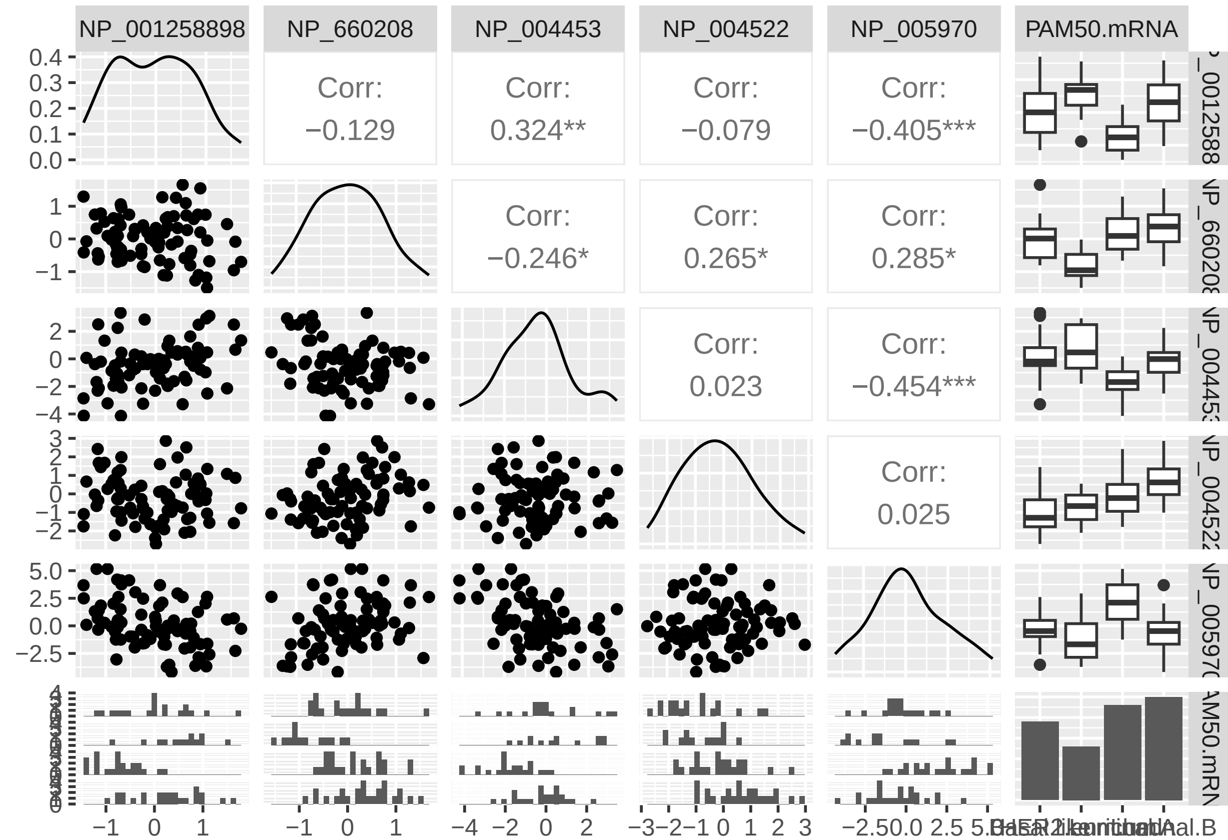



```
pairs.panels(data_viz)
```




```
ggpairs(data_viz)
```

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



The variable names are displayed on the outer edges of the matrix. The boxes along the diagonals display the density plot for each variable. The boxes in the lower left corner display the scatterplot between each variable. The boxes in the upper right corner display the Pearson correlation coefficient between each variable. The variables are not correlated but according to the distribution they have normal distribution

4. Model Construction & Evaluation ##

As this is a multi-class classification, I am going to use SVM, Neural Networks, Decison tree and Naive Baye's. 1. SVM : I chose this algorithm as it does complex data transformations depending on the selected kernel function and based on that transformations, it tries to maximize the separation boundaries between the data points depending on the labels or classes defined. SVM works well for binary classification. But, For multi-class classification, the same principle for binary classfication is utilized after breaking down the multiclassification problem into multiple binary classification problems. The main reason behind choosing this alogirthm is it works well with expression data. As I am dealing with the protein expression data, this algorithm will work well and compatiable with the features in the data-set. The kernel function is used where the complexity of the problem is high and data is linearly separable. where it adds multiple polynomial features at a very high degree this way it prevents the computational complexity or burden that comes along adding multiple features to data. The dependencies of the variable are always taken into consideration

2. Neural Networks : I chose this algorithm as this works well with complex datset. The output layer contains one neuron per class rather than just one neuron. If the dataset contains four classes, then the output layer has four neurons. Therefore, it works well with multi class classfication problems.

3. Random Forests : I chose this algorithm as this a classifier is a systematic approach for multiclass classification. It poses a set of questions to the dataset (related to its attributes/features). The benefit of this method is that it can handle missing values and maintains accuracy for missing data. It won't over fit the model. t handles dataset with higher dimensionality

4. Naive bayes : I chose naive bayes algorithm as this is highly compatiable for protein expression datset and the calculations of the probabilities for each class are simplified to make their calculations tractable.

As this is a classification problem, Classification Metrics are :Confusion Matrix, Precision, Recall, F1-score and AUC I chose these metrics as it is a well-balanced datasetand these metrics works well.

Creation of training & validation subsets

- Data splitting is done in 70:20 ratio
- Partition is created using createDataPartition function

Construction of at least three related models

- I built 4 models which are as follows:
  - Support Vector Machine (svm())
  - Neural Network (neuralnet())
  - Naive Bayes (naive_bayes())
  - Random Forest (randomForest())

Evaluation of fit of models with holdout method

- For model evaluation,I have calculated accuracy of each model using the confusionMatrix function. I have also compared the sensitivity, specificity, precision, recall and AUC of classification models

For a balanced dataset, we use a confusion matrix and the derived performance metrics; accuracy, precision, recall, F1-score and AUC

```
#creating test/train split index
set.seed(1000)
samp <- createDataPartition(data_norm$PAM50.mRNA, p = 0.7, list = FALSE)
train <- data_norm[samp, ]
test<- data_norm[-samp, ]
```

```
#exploring training dataset
head(train)
```

```
##    NP_038479 NP_001258898   NP_542785  NP_002005 XP_003846537   NP_660208
## 1 -0.3708959  -0.01456473  0.05890562 -2.1305106   -0.4957955 -0.09170859
## 2 -1.6044748  -0.51053492  3.17273051 -0.9688522   -0.6711132 -0.51388030
## 3 -3.0516640   0.53387720  3.71857004 -0.3435704   -0.3498830  1.65751511
## 4 -1.0663490   1.69892745  2.96770134 -3.2821848   -0.4373841 -0.70126018
## 5 -0.3009396  -1.09705962  0.03501174 -1.2946781   -0.3376402  0.78031558
## 6  0.6787788  -0.70384668 -1.91679672 -2.7445377   -0.4103540  0.41280109
##   NP_004439  NP_004388 NP_001229372  NP_005130 NP_004243 NP_003144 NP_001171551
## 1 -4.419112  0.1691111    -3.004808  2.2373013 -3.717470 0.1948258    0.1948258
## 2 -5.187379  0.4863889    -3.273820 -2.2066435 -2.905828 0.9748146    0.9547423
## 3 -3.099008 -0.7349499    -2.969601 -0.4698218 -3.076914 0.3539689    0.3508126
## 4 -3.130366  0.7843981    -2.859260  3.8894601 -3.180972 0.3397851    0.3470145
## 5 -2.062567 -0.1823685    -1.774609 -0.2388310 -1.785901 1.5453813    1.5990205
## 6 -3.322351 -0.2659006    -2.127745 -0.6167161 -1.937433 1.4835906    1.5432063
```

```
##    NP_072096   NP_005484   NP_061170  NP_653304  NP_653081  NP_057164
## 1 -0.5215101 -0.96600568 -1.41417478  0.5548304 -0.2753844 -0.6243686
## 2 -0.5506795 -0.29643048 -2.19660738 -0.8751815  0.2890113  0.6034772
## 3  0.8747561  0.29399945 -3.01378855 -1.5334903 -1.4072388  1.8279546
## 4 -1.2145533 -0.11205750 -1.51096203  0.1301301  0.3723177 -0.1771228
## 5  0.2693307  0.62504394  0.48671103 -1.4414803  0.6448058  1.4155177
## 6  0.3623570  0.07115731 -0.06412445 -2.9967579 -0.3690816  0.6375064
##    NP_004453    NP_003212    NP_060866 NP_001160163   NP_003875 NP_002677
## 1 -2.3105130  0.007476375 -1.399480707  1.340963113  0.04810062 -7.684869
## 2 -0.3499566 -0.376719645 -1.457277986  0.740637896  1.71079864 -8.877335
## 3 -3.2915417 -0.476134402  0.335031167  2.493930969 -3.12110229 -7.479934
## 4  1.3374534  0.159048035 -0.451843095  1.055503657 -0.82416136 -7.963274
## 5 -0.2021304 -1.819778494 -0.600190397  1.886978849  0.83677799 -4.388818
## 6  3.3454346 -2.334106568  0.002369978  0.002369978 -0.66257428 -3.342988
##   NP_001135891  NP_004522  NP_003767  NP_848597  NP_005970 PAM50.mRNA
## 1    0.9038146 -2.3839833 -0.3892635  0.3819222  0.8193237 Basal.like
## 2   -1.2933543 -0.7514024 -1.0558322 -0.7346755 -0.9655069 Basal.like
## 3   -0.4603530 -0.7412624 -1.0095468 -0.1952249  2.6107136 Basal.like
## 4   -1.7784528 -0.7771697 -0.7446371  0.2277281 -0.2638766 Basal.like
## 5    0.6306902  1.4493952 -0.5521973  1.9688493  1.8389858 Basal.like
## 6   -1.0913487  1.2864003  0.2889839 -0.5502216  1.5019339 Basal.like
```

```
dim(train)
```

```
## [1] 59 31
```

```
head(test)
```

```
##     NP_038479 NP_001258898  NP_542785 NP_002005 XP_003846537   NP_660208
## 7  -1.6621615    0.6862870  1.2085340 -1.994803   -0.4081033 -0.80727303
## 12 -1.0424112   -0.1083678 -1.0174124 -1.919639   -0.5742532  0.01208057
## 14 -1.3904136   -0.7426185  1.6022647 -2.311497   -0.8640801 -0.25677221
## 17  0.9718405    0.1667926  1.4009461 -3.102765   -0.6610396  0.19337440
## 18 -1.9684279    0.7547515  1.3304690 -4.288958   -0.2695313  0.60993907
## 23 -2.0569715    0.2201496 -0.3960125 -2.099070   -0.8055116 -1.11933337
##    NP_004439   NP_004388 NP_001229372  NP_005130 NP_004243  NP_003144
## 7  -5.421010 -0.05217698    -4.053853 -1.0833654 -3.112478 -0.9070655
## 12 -1.396939 -0.08968960    -1.969637  3.2369163 -0.967415 -0.4265335
## 14 -1.532119  0.38764892    -0.766236 -0.3748599 -4.349352  0.9274781
## 17 -3.383772 -0.27750263    -2.685051  4.9629030 -3.679969 -0.6914187
## 18 -4.140614  1.20684870    -5.323837  0.7264954 -3.681453 -0.9794653
## 23 -2.795601 -0.11280757    -2.902759  3.5956468 -2.114378  0.5645881
##    NP_001171551  NP_072096   NP_005484  NP_061170  NP_653304   NP_653081
## 7    -0.9070655 -0.4779580  0.48670214 -0.8804541  0.1241230  0.35031915
## 12   -0.4333513  0.2938844 -0.20609014 -0.5850009  2.3551430  0.05071496
## 14    0.9072345  0.3910229 -0.72574885 -1.5624841 -2.3182450 -0.26014614
## 17   -0.6800265 -0.3306662  0.36805459 -3.4103538 -0.6154708 -0.23193388
## 18   -0.9335491  1.0302482  0.65232319  0.5710870  1.2598288 -0.58741219
## 23    0.5684152 -0.8131658 -0.05540115 -4.7129749 -0.7902033 -0.29650809
##     NP_057164   NP_004453  NP_003212  NP_060866 NP_001160163   NP_003875
## 7  -0.7074806 -0.19188638  1.3183057  0.2571795   2.08670742 -0.07878830
## 12  0.1188933 -0.02428122  0.8756729 -0.9151449  -1.36284939  2.66194558
## 14  0.4146404 -1.74805043 -0.3141291 -0.7729839   0.72504218  0.04810062
```

```
## 17 -1.1850801 -0.11421462 -0.1825677 -0.6686344   0.87690557 -1.37115250
## 18 -1.8271476 -0.49911195 -0.4143437 -1.1030856   2.35475182 -0.94061315
## 23 -0.4074938 -1.80055616  2.9986201 -0.5414421   0.06316141 -0.41897511
##    NP_002677 NP_001135891  NP_004522    NP_003767  NP_848597  NP_005970
## 7  -7.080890    0.4667437 -1.2896031 -1.359457807 -1.7752596 -0.4746316
## 12 -3.814997   -0.2879042 -1.6423806  1.077935362 -1.1696774 -1.1787679
## 14 -5.732665   -1.7446765 -0.2837637  0.006394535  0.6676853  0.5226062
## 17 -9.444415   -0.8850859 -1.9103826 -1.731905061 -0.1977573 -0.9724260
## 18 -9.745913   -1.5481188  0.5569589 -1.254962003 -0.5838802 -1.0818935
## 23 -3.737066    0.4957004 -0.2807051 -0.503171187 -0.6639091 -3.7141033
##       PAM50.mRNA
## 7     Basal.like
## 12    Basal.like
## 14    Basal.like
## 17    Basal.like
## 18    Basal.like
## 23 HER2.enriched
```

```r
dim(test)
```

```
## [1] 21 31
```

Model building

As this is a multi-class classification, I am implement 4 models - SVM, Neural Networks, Naive Baye's and Random forests

SVM linear classifier

Support Vector Machines are generalized extension of a maximal margin classifier, SVM are intended for the binary classification setting when there are two classes. However, this designed intention does not disqualify from using the SVM method with cases of more than two classes. SVM determines the best line separator by identifying closest points in Convex hull, a hyperplane bisects the closest point to the convex hull. The support vector classifies a test observation depending on which side of a plane it lies; this is based on boundaries-support vectors. SVM method allows some observations to be on the incorrect side of the margin and in some cases the incorrect side of the hyperplane in the interest of performing better in classifying the remaining observations further away from the hydroplane. This is known as a soft margin classifier; training observations can violate this area. Advantages of using a SVM model are; can be adapted to work well with nonlinear boundaries, uses kernels, less overfitting of data, performs well with clear margin of separation among data. The kernel function is used where the complexity of the problem is high and data is linearly separable. where it adds multiple polynomial features at a very high degree this way it prevents the computational complexity or burden that comes along adding multiple features to data. The dependencies of the variable are always taken into consideration

```r
svm_model1 <- svm(PAM50.mRNA~., data= train, type="C-classification", kernel = 'linear')
svm_model1
```

```
##
## Call:
## svm(formula = PAM50.mRNA ~ ., data = train, type = "C-classification",
```

```
##     kernel = "linear")
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  linear
##        cost:  1
##
## Number of Support Vectors:  41
```

```
svm_pred <- predict(svm_model1, newdata = test)
confusionMatrix(svm_pred, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             5             0         0         2
##   HER2.enriched          0             2         0         0
##   Luminal.A              0             0         6         1
##   Luminal.B              0             1         0         4
##
## Overall Statistics
##
##                Accuracy : 0.8095
##                  95% CI : (0.5809, 0.9455)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 1.026e-05
##
##                   Kappa : 0.7399
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     1.0000              0.66667           1.0000
## Specificity                     0.8750              1.00000           0.9333
## Pos Pred Value                  0.7143              1.00000           0.8571
## Neg Pred Value                  1.0000              0.94737           1.0000
## Precision                       0.7143              1.00000           0.8571
## Recall                          1.0000              0.66667           1.0000
## F1                              0.8333              0.80000           0.9231
## Prevalence                      0.2381              0.14286           0.2857
## Detection Rate                  0.2381              0.09524           0.2857
## Detection Prevalence            0.3333              0.09524           0.3333
## Balanced Accuracy               0.9375              0.83333           0.9667
##                      Class: Luminal.B
## Sensitivity                    0.5714
## Specificity                    0.9286
## Pos Pred Value                 0.8000
## Neg Pred Value                 0.8125
## Precision                      0.8000
## Recall                         0.5714
```

```
## F1                          0.6667
## Prevalence                  0.3333
## Detection Rate              0.1905
## Detection Prevalence        0.2381
## Balanced Accuracy           0.7500
```

```
accuracy_svm <-confusionMatrix(test$PAM50.mRNA, svm_pred)$overall["Accuracy"]
```

Model evaluation for SVM:

1. Accuracy : The overall model accuracy of SVM model is 81%
2. Precision,Recall,F1 : The Precision,Recall,F1 for Basal.like class is 0.7143, 1.0000, 0.8333 The Precision,Recall,F1 for HER2.enriched class is 1.00000, 0.33333 , 0.80000
   The Precision,Recall,F1 for Luminal.A class is 0.8571, 1.0000, 0.9231 The Precision,Recall,F1 for Luminal.B class is 0.8000, 0.5714, 0.6667
3. Sensitivity and Specificity: The Sensitivity and Specificity for Basal.like class is 1.0000 and 0.8750 The Sensitivity and Specificity for HER2.enriched class is 0.66667 and 1.00000 The Sensitivity and Specificity for Luminal.A is 1.0000 and 0.9333 The Sensitivity and Specificity for Luminal.B class is 0.5714 and 0.9286
4. The Kappa statistic: The kappa value for this model is 0.7399 which states that it is a good agreement.

Macro-averaged Metrics : The per-class metrics can be averaged over all the classes resulting in macro-averaged precision, recall and F-1.

```
# macro-averaged precision
precision_svm <- c(0.7143, 1.00000,0.8571, 0.8000)
macro_precision_svm <- mean(precision_svm)
# macro-averaged recall
recall_svm <- c(1.0000, 0.66667, 1.0000, 0.5714)
macro_recall_svm <- mean(recall_svm)
# macro-averaged F-1
F1_svm<- c(0.8333,0.80000, 0.9231, 0.6667)
macroF1_svm <- mean(F1_svm)
macro_avg_svm <- data.frame( macro_precision_svm, macro_recall_svm, macroF1_svm)
macro_avg_svm
```

```
##   macro_precision_svm macro_recall_svm macroF1_svm
## 1             0.84285        0.8095175    0.805775
```

AUC for SVM

```
svm_auc <- multiclass.roc(test$PAM50.mRNA, as.ordered(svm_pred))
auc(svm_auc)
```

```
## Multi-class area under the curve: 0.7897
```

The AUC of SVM model is : 0.7897

```
Name_metrics <- c("Accuracy", "Precision", "Recall", "F-1", "AUC", "Kappa")
values_svm <- c(0.8095 , 0.84285,   0.8095175,  0.805775,0.7897, 0.7399  )
metrics_svm <- data.frame(Name_metrics, values_svm)
print (metrics_svm)
```

```
##   Name_metrics values_svm
## 1     Accuracy  0.8095000
## 2    Precision  0.8428500
## 3       Recall  0.8095175
## 4          F-1  0.8057750
## 5          AUC  0.7897000
## 6        Kappa  0.7399000
```

Neural Networks

Inspired by biological neural networks, the Neural Network method is a supervised machine learning algorithm which consists of units arranged in layers which coverts an input vector (independent variable) into a prediction/classification. "The algorithm learns a function by training on a dataset without prior knowledge about the dataset."

```
# I have tried out many hidden layers but got optimal results with hidden layer = 5
neuralnet_model2 <- train(PAM50.mRNA~., data= train, hidden = 5, method = "nnet")
```

```
## # weights:  39
## initial  value 90.443203
## iter  10 value 33.522949
## iter  20 value 29.081551
## iter  30 value 25.631000
## iter  40 value 25.517964
## iter  50 value 25.395198
## iter  60 value 25.275651
## iter  70 value 25.125594
## iter  80 value 25.083164
## iter  90 value 25.080908
## iter 100 value 25.080875
## final  value 25.080875
## stopped after 100 iterations
## # weights:  109
## initial  value 95.605172
## iter  10 value 31.720806
## iter  20 value 21.847426
## iter  30 value 18.902135
## iter  40 value 16.921231
## iter  50 value 16.448390
## iter  60 value 14.611413
## iter  70 value 14.256455
## iter  80 value 13.923560
## iter  90 value 4.786360
## iter 100 value 4.500853
## final  value 4.500853
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 115.225552
## iter  10 value 16.288091
## iter  20 value 4.194251
## iter  30 value 0.250901
## iter  40 value 0.023452
## iter  50 value 0.010547
## iter  60 value 0.002400
## iter  70 value 0.000788
## iter  80 value 0.000229
## iter  90 value 0.000140
## final  value 0.000085
## converged
## # weights:  39
## initial  value 99.122639
## iter  10 value 55.167500
## iter  20 value 44.898518
## iter  30 value 41.116677
## iter  40 value 40.029601
## iter  50 value 38.251906
## iter  60 value 36.067644
## iter  70 value 34.828721
## iter  80 value 34.678452
## final  value 34.678386
## converged
## # weights:  109
## initial  value 125.755935
## iter  10 value 49.563245
## iter  20 value 30.684360
## iter  30 value 17.693543
## iter  40 value 13.908672
## iter  50 value 13.614344
## iter  60 value 13.433069
## iter  70 value 13.086003
## iter  80 value 11.668672
## iter  90 value 11.218409
## iter 100 value 11.214485
## final  value 11.214485
## stopped after 100 iterations
## # weights:  179
## initial  value 91.656334
## iter  10 value 33.201743
## iter  20 value 12.681427
## iter  30 value 9.869531
## iter  40 value 9.214958
## iter  50 value 9.131412
## iter  60 value 9.066018
## iter  70 value 8.996023
## iter  80 value 8.895696
## iter  90 value 8.776035
## iter 100 value 8.769974
## final  value 8.769974
## stopped after 100 iterations
## # weights:  39
## initial  value 87.201502
```

```
## iter  10 value 41.199495
## iter  20 value 38.238237
## iter  30 value 37.143784
## iter  40 value 35.524119
## iter  50 value 35.018233
## iter  60 value 34.042314
## iter  70 value 28.906279
## iter  80 value 26.316558
## iter  90 value 25.287137
## iter 100 value 23.321447
## final  value 23.321447
## stopped after 100 iterations
## # weights:  109
## initial  value 83.188527
## iter  10 value 28.268240
## iter  20 value 21.936391
## iter  30 value 20.065399
## iter  40 value 18.630961
## iter  50 value 17.981643
## iter  60 value 7.789546
## iter  70 value 3.318506
## iter  80 value 1.922637
## iter  90 value 0.182460
## iter 100 value 0.162306
## final  value 0.162306
## stopped after 100 iterations
## # weights:  179
## initial  value 88.663771
## iter  10 value 11.817962
## iter  20 value 4.425132
## iter  30 value 4.356586
## iter  40 value 4.330111
## iter  50 value 3.455265
## iter  60 value 1.619989
## iter  70 value 1.546958
## iter  80 value 1.538854
## iter  90 value 1.520210
## iter 100 value 0.157354
## final  value 0.157354
## stopped after 100 iterations
## # weights:  39
## initial  value 94.783065
## iter  10 value 53.592345
## iter  20 value 47.413612
## iter  30 value 47.405922
## final  value 47.405898
## converged
## # weights:  109
## initial  value 87.084715
## iter  10 value 26.023255
## iter  20 value 10.114774
## iter  30 value 6.342580
## iter  40 value 2.451402
## iter  50 value 0.385441
```

```
## iter  60 value 0.004775
## final  value 0.000074
## converged
## # weights:  179
## initial  value 97.163515
## iter  10 value 2.318107
## iter  20 value 0.034487
## iter  30 value 0.003940
## iter  40 value 0.000306
## final  value 0.000056
## converged
## # weights:  39
## initial  value 86.806419
## iter  10 value 75.907903
## iter  20 value 54.688468
## iter  30 value 50.443480
## iter  40 value 46.229664
## iter  50 value 45.961644
## final  value 45.958668
## converged
## # weights:  109
## initial  value 85.421652
## iter  10 value 36.382018
## iter  20 value 18.181113
## iter  30 value 13.355138
## iter  40 value 12.954718
## iter  50 value 12.933512
## iter  60 value 12.932679
## iter  70 value 12.932642
## final  value 12.932639
## converged
## # weights:  179
## initial  value 83.841104
## iter  10 value 18.837481
## iter  20 value 11.161662
## iter  30 value 9.930130
## iter  40 value 9.566609
## iter  50 value 9.197280
## iter  60 value 9.032886
## iter  70 value 9.028200
## final  value 9.028183
## converged
## # weights:  39
## initial  value 84.493812
## iter  10 value 48.961837
## iter  20 value 47.120962
## iter  30 value 47.082685
## iter  40 value 47.041195
## iter  50 value 44.496628
## iter  60 value 41.900770
## iter  70 value 41.830721
## iter  80 value 41.820574
## iter  90 value 41.815581
## iter 100 value 39.414005
```

```
## final  value 39.414005
## stopped after 100 iterations
## # weights:  109
## initial  value 88.138094
## iter  10 value 21.747293
## iter  20 value 15.048828
## iter  30 value 4.739651
## iter  40 value 3.025010
## iter  50 value 0.208822
## iter  60 value 0.137060
## iter  70 value 0.124229
## iter  80 value 0.115481
## iter  90 value 0.102526
## iter 100 value 0.098002
## final  value 0.098002
## stopped after 100 iterations
## # weights:  179
## initial  value 91.373849
## iter  10 value 20.036539
## iter  20 value 16.034971
## iter  30 value 13.476093
## iter  40 value 8.681448
## iter  50 value 8.207185
## iter  60 value 8.184184
## iter  70 value 5.238894
## iter  80 value 0.161448
## iter  90 value 0.133480
## iter 100 value 0.121600
## final  value 0.121600
## stopped after 100 iterations
## # weights:  39
## initial  value 86.274487
## iter  10 value 54.969200
## iter  20 value 46.295371
## iter  30 value 43.451786
## iter  40 value 35.825560
## iter  50 value 30.188028
## iter  60 value 29.345814
## iter  70 value 29.332487
## iter  80 value 29.311485
## iter  90 value 28.577676
## iter 100 value 27.005402
## final  value 27.005402
## stopped after 100 iterations
## # weights:  109
## initial  value 80.318196
## iter  10 value 33.230696
## iter  20 value 29.954567
## iter  30 value 21.628038
## iter  40 value 19.174917
## iter  50 value 19.114320
## iter  60 value 19.108960
## iter  70 value 17.916892
## iter  80 value 17.492409
```

```
## iter  90 value 17.491062
## iter 100 value 16.469333
## final  value 16.469333
## stopped after 100 iterations
## # weights:  179
## initial  value 116.205737
## iter  10 value 25.710360
## iter  20 value 0.588619
## iter  30 value 0.001871
## iter  40 value 0.000492
## final  value 0.000041
## converged
## # weights:  39
## initial  value 85.707050
## iter  10 value 59.869708
## iter  20 value 50.880603
## iter  30 value 47.953242
## iter  40 value 47.821941
## iter  50 value 47.708402
## iter  60 value 45.499533
## iter  70 value 44.250236
## iter  80 value 44.003961
## final  value 44.003956
## converged
## # weights:  109
## initial  value 82.029705
## iter  10 value 43.266080
## iter  20 value 18.106270
## iter  30 value 14.673940
## iter  40 value 14.289562
## iter  50 value 14.087079
## iter  60 value 14.022807
## iter  70 value 14.002406
## iter  80 value 13.996983
## iter  90 value 13.817015
## iter 100 value 13.636175
## final  value 13.636175
## stopped after 100 iterations
## # weights:  179
## initial  value 98.834823
## iter  10 value 36.380523
## iter  20 value 16.515008
## iter  30 value 12.663731
## iter  40 value 10.549273
## iter  50 value 10.060107
## iter  60 value 9.870984
## iter  70 value 9.487019
## iter  80 value 9.401886
## iter  90 value 9.366593
## iter 100 value 9.363588
## final  value 9.363588
## stopped after 100 iterations
## # weights:  39
## initial  value 92.269604
```

```
## iter  10 value 45.213232
## iter  20 value 33.655342
## iter  30 value 25.408527
## iter  40 value 21.498229
## iter  50 value 19.126444
## iter  60 value 18.590005
## iter  70 value 17.211918
## iter  80 value 15.679628
## iter  90 value 15.526127
## iter 100 value 15.486981
## final  value 15.486981
## stopped after 100 iterations
## # weights:  109
## initial  value 86.556071
## iter  10 value 21.126144
## iter  20 value 12.730770
## iter  30 value 8.742250
## iter  40 value 5.295685
## iter  50 value 5.189397
## iter  60 value 2.870770
## iter  70 value 2.670501
## iter  80 value 2.568537
## iter  90 value 2.551319
## iter 100 value 2.543506
## final  value 2.543506
## stopped after 100 iterations
## # weights:  179
## initial  value 85.899796
## iter  10 value 19.404934
## iter  20 value 1.100866
## iter  30 value 0.267923
## iter  40 value 0.246658
## iter  50 value 0.208982
## iter  60 value 0.191439
## iter  70 value 0.169347
## iter  80 value 0.153511
## iter  90 value 0.131053
## iter 100 value 0.116548
## final  value 0.116548
## stopped after 100 iterations
## # weights:  39
## initial  value 85.430115
## iter  10 value 57.225354
## iter  20 value 53.384902
## iter  30 value 51.057077
## iter  40 value 50.925104
## iter  50 value 50.922126
## iter  60 value 50.921837
## iter  70 value 50.920673
## final  value 50.920351
## converged
## # weights:  109
## initial  value 85.167665
## iter  10 value 43.130540
```

```
## iter  20 value 23.554205
## iter  30 value 21.552252
## iter  40 value 20.071984
## iter  50 value 19.914447
## iter  60 value 19.901990
## iter  70 value 19.892129
## iter  80 value 18.423996
## iter  90 value 10.923661
## iter 100 value 10.823521
## final  value 10.823521
## stopped after 100 iterations
## # weights:  179
## initial  value 88.286280
## iter  10 value 4.681288
## iter  20 value 0.043541
## iter  30 value 0.018550
## iter  40 value 0.003462
## iter  50 value 0.001255
## final  value 0.000069
## converged
## # weights:  39
## initial  value 94.891027
## iter  10 value 55.411517
## iter  20 value 48.375786
## iter  30 value 46.518448
## iter  40 value 46.394271
## iter  50 value 46.219659
## iter  60 value 45.602768
## iter  70 value 45.547223
## final  value 45.547177
## converged
## # weights:  109
## initial  value 87.111745
## iter  10 value 30.400489
## iter  20 value 19.456495
## iter  30 value 14.712802
## iter  40 value 13.830381
## iter  50 value 13.701561
## iter  60 value 13.696985
## iter  70 value 13.696311
## iter  80 value 13.696173
## final  value 13.696161
## converged
## # weights:  179
## initial  value 104.196537
## iter  10 value 39.403897
## iter  20 value 17.959820
## iter  30 value 12.788810
## iter  40 value 10.185183
## iter  50 value 9.919076
## iter  60 value 9.778906
## iter  70 value 9.770507
## iter  80 value 9.770228
## iter  90 value 9.770166
```

```
## final  value 9.770163
## converged
## # weights:  39
## initial  value 88.889867
## iter  10 value 52.154530
## iter  20 value 47.815507
## iter  30 value 46.865824
## iter  40 value 46.568644
## iter  50 value 46.541225
## iter  60 value 45.921930
## iter  70 value 45.329138
## iter  80 value 45.327353
## iter  90 value 45.317866
## iter 100 value 45.312219
## final  value 45.312219
## stopped after 100 iterations
## # weights:  109
## initial  value 95.002202
## iter  10 value 28.105194
## iter  20 value 0.797318
## iter  30 value 0.283174
## iter  40 value 0.243165
## iter  50 value 0.213412
## iter  60 value 0.179481
## iter  70 value 0.158125
## iter  80 value 0.147890
## iter  90 value 0.138695
## iter 100 value 0.133685
## final  value 0.133685
## stopped after 100 iterations
## # weights:  179
## initial  value 94.277604
## iter  10 value 13.652133
## iter  20 value 4.123864
## iter  30 value 3.446456
## iter  40 value 3.020463
## iter  50 value 2.823368
## iter  60 value 2.772622
## iter  70 value 2.289223
## iter  80 value 1.651327
## iter  90 value 0.414348
## iter 100 value 0.227118
## final  value 0.227118
## stopped after 100 iterations
## # weights:  39
## initial  value 94.460149
## iter  10 value 51.389012
## iter  20 value 43.140962
## iter  30 value 33.502693
## iter  40 value 27.848324
## iter  50 value 26.824194
## iter  60 value 26.641870
## iter  70 value 26.620122
## iter  80 value 26.598139
```

```
## iter  90 value 26.588809
## iter 100 value 26.566875
## final  value 26.566875
## stopped after 100 iterations
## # weights:  109
## initial  value 90.391599
## iter  10 value 7.930567
## iter  20 value 3.633502
## iter  30 value 3.526730
## iter  40 value 3.443888
## iter  50 value 2.982633
## iter  60 value 0.006821
## iter  70 value 0.002643
## iter  80 value 0.000379
## iter  90 value 0.000223
## iter 100 value 0.000128
## final  value 0.000128
## stopped after 100 iterations
## # weights:  179
## initial  value 87.133673
## iter  10 value 12.481079
## iter  20 value 3.318230
## iter  30 value 1.831807
## iter  40 value 0.056883
## iter  50 value 0.013627
## iter  60 value 0.006736
## iter  70 value 0.003355
## iter  80 value 0.001945
## iter  90 value 0.001460
## iter 100 value 0.000847
## final  value 0.000847
## stopped after 100 iterations
## # weights:  39
## initial  value 88.563420
## iter  10 value 47.640507
## iter  20 value 44.315735
## iter  30 value 42.430785
## iter  40 value 41.526490
## iter  50 value 41.412117
## iter  60 value 40.455560
## iter  70 value 40.143907
## final  value 40.139625
## converged
## # weights:  109
## initial  value 85.979869
## iter  10 value 37.610561
## iter  20 value 18.706558
## iter  30 value 14.114685
## iter  40 value 13.069311
## iter  50 value 12.948879
## iter  60 value 12.924478
## iter  70 value 12.920273
## iter  80 value 12.843811
## iter  90 value 12.714612
```

```
## iter 100 value 12.711120
## final  value 12.711120
## stopped after 100 iterations
## # weights:  179
## initial  value 87.609021
## iter  10 value 29.697635
## iter  20 value 11.896680
## iter  30 value 9.670379
## iter  40 value 9.141076
## iter  50 value 9.085234
## iter  60 value 9.072865
## iter  70 value 9.072378
## iter  80 value 9.072302
## final  value 9.072299
## converged
## # weights:  39
## initial  value 84.685863
## iter  10 value 61.851769
## iter  20 value 42.560284
## iter  30 value 41.078396
## iter  40 value 40.657067
## iter  50 value 40.600519
## iter  60 value 40.594214
## iter  70 value 40.592003
## iter  80 value 40.580621
## iter  90 value 37.091250
## iter 100 value 34.069179
## final  value 34.069179
## stopped after 100 iterations
## # weights:  109
## initial  value 86.006150
## iter  10 value 12.014673
## iter  20 value 8.523674
## iter  30 value 4.504624
## iter  40 value 3.986184
## iter  50 value 3.940254
## iter  60 value 3.464024
## iter  70 value 3.362368
## iter  80 value 3.345236
## iter  90 value 3.301024
## iter 100 value 3.275223
## final  value 3.275223
## stopped after 100 iterations
## # weights:  179
## initial  value 91.636387
## iter  10 value 19.423609
## iter  20 value 2.315661
## iter  30 value 0.213472
## iter  40 value 0.181507
## iter  50 value 0.164156
## iter  60 value 0.143868
## iter  70 value 0.129505
## iter  80 value 0.119260
## iter  90 value 0.108010
```

```
## iter 100 value 0.101534
## final  value 0.101534
## stopped after 100 iterations
## # weights:  39
## initial  value 96.098385
## iter  10 value 39.375213
## iter  20 value 37.798208
## iter  30 value 37.538787
## iter  40 value 35.200980
## iter  50 value 33.220584
## iter  60 value 33.181591
## iter  70 value 33.164383
## iter  80 value 33.125503
## iter  90 value 33.024983
## iter 100 value 32.948634
## final  value 32.948634
## stopped after 100 iterations
## # weights:  109
## initial  value 100.613408
## iter  10 value 34.385032
## iter  20 value 22.629568
## iter  30 value 22.206673
## iter  40 value 22.099804
## iter  50 value 18.525970
## iter  60 value 18.522409
## final  value 18.522345
## converged
## # weights:  179
## initial  value 109.623683
## iter  10 value 18.936297
## iter  20 value 3.276659
## iter  30 value 2.780370
## iter  40 value 2.772626
## iter  50 value 2.772606
## final  value 2.772589
## converged
## # weights:  39
## initial  value 100.819689
## iter  10 value 66.110514
## iter  20 value 51.872886
## iter  30 value 47.839847
## iter  40 value 46.910582
## iter  50 value 44.477582
## iter  60 value 42.358120
## iter  70 value 42.182193
## iter  80 value 42.179317
## iter  90 value 42.113525
## iter 100 value 41.294815
## final  value 41.294815
## stopped after 100 iterations
## # weights:  109
## initial  value 83.972304
## iter  10 value 31.973653
## iter  20 value 18.513537
```

```
## iter  30 value 14.075397
## iter  40 value 13.374546
## iter  50 value 12.785221
## iter  60 value 11.878226
## iter  70 value 11.744054
## final  value 11.743838
## converged
## # weights:  179
## initial  value 75.849269
## iter  10 value 32.628312
## iter  20 value 14.725494
## iter  30 value 10.022148
## iter  40 value 9.189537
## iter  50 value 9.130171
## iter  60 value 9.080929
## iter  70 value 8.908773
## iter  80 value 8.841742
## final  value 8.841481
## converged
## # weights:  39
## initial  value 85.799499
## iter  10 value 43.617362
## iter  20 value 34.249951
## iter  30 value 31.305164
## iter  40 value 30.361464
## iter  50 value 30.290953
## iter  60 value 29.599607
## iter  70 value 28.454951
## iter  80 value 26.964471
## iter  90 value 26.503637
## iter 100 value 26.233916
## final  value 26.233916
## stopped after 100 iterations
## # weights:  109
## initial  value 84.346112
## iter  10 value 31.238751
## iter  20 value 24.851702
## iter  30 value 17.040986
## iter  40 value 16.468365
## iter  50 value 14.804808
## iter  60 value 14.706717
## iter  70 value 14.691450
## iter  80 value 9.232789
## iter  90 value 7.927592
## iter 100 value 5.251767
## final  value 5.251767
## stopped after 100 iterations
## # weights:  179
## initial  value 135.816014
## iter  10 value 28.633434
## iter  20 value 3.210789
## iter  30 value 0.332123
## iter  40 value 0.287206
## iter  50 value 0.267787
```

```
## iter  60 value 0.241176
## iter  70 value 0.204326
## iter  80 value 0.161111
## iter  90 value 0.131655
## iter 100 value 0.122657
## final  value 0.122657
## stopped after 100 iterations
## # weights:  39
## initial  value 84.555277
## iter  10 value 52.401706
## iter  20 value 46.716274
## iter  30 value 44.489603
## iter  40 value 41.728293
## iter  50 value 41.441091
## iter  60 value 40.317956
## iter  70 value 40.163857
## iter  80 value 40.090201
## iter  90 value 40.084586
## iter 100 value 40.084034
## final  value 40.084034
## stopped after 100 iterations
## # weights:  109
## initial  value 84.461243
## iter  10 value 25.676559
## iter  20 value 10.681158
## iter  30 value 10.241056
## iter  40 value 9.941434
## iter  50 value 9.937546
## iter  60 value 9.937409
## final  value 9.937406
## converged
## # weights:  179
## initial  value 85.647588
## iter  10 value 1.113502
## iter  20 value 0.015207
## iter  30 value 0.001123
## iter  40 value 0.000121
## final  value 0.000095
## converged
## # weights:  39
## initial  value 84.493059
## iter  10 value 55.337174
## iter  20 value 49.473363
## iter  30 value 45.855050
## iter  40 value 45.236948
## iter  50 value 45.231476
## final  value 45.231474
## converged
## # weights:  109
## initial  value 88.576805
## iter  10 value 47.901369
## iter  20 value 19.973965
## iter  30 value 16.340185
## iter  40 value 14.075666
```

```
## iter  50 value 13.241925
## iter  60 value 13.230843
## final  value 13.230825
## converged
## # weights:  179
## initial  value 96.244694
## iter  10 value 36.815255
## iter  20 value 16.444696
## iter  30 value 13.402294
## iter  40 value 10.660775
## iter  50 value 9.741046
## iter  60 value 9.718537
## iter  70 value 9.717106
## iter  80 value 9.717017
## iter  90 value 9.717015
## final  value 9.717014
## converged
## # weights:  39
## initial  value 87.527507
## iter  10 value 59.470647
## iter  20 value 54.261550
## iter  30 value 50.852477
## iter  40 value 43.821572
## iter  50 value 37.665862
## iter  60 value 34.906300
## iter  70 value 32.763432
## iter  80 value 30.381801
## iter  90 value 29.891834
## iter 100 value 29.415800
## final  value 29.415800
## stopped after 100 iterations
## # weights:  109
## initial  value 95.897478
## iter  10 value 19.551051
## iter  20 value 6.736674
## iter  30 value 0.306956
## iter  40 value 0.151007
## iter  50 value 0.130962
## iter  60 value 0.125228
## iter  70 value 0.119796
## iter  80 value 0.114569
## iter  90 value 0.104433
## iter 100 value 0.097994
## final  value 0.097994
## stopped after 100 iterations
## # weights:  179
## initial  value 92.894485
## iter  10 value 7.813962
## iter  20 value 2.245462
## iter  30 value 2.056088
## iter  40 value 1.739704
## iter  50 value 1.564316
## iter  60 value 1.539415
## iter  70 value 0.203462
```

```
## iter  80 value 0.147995
## iter  90 value 0.138873
## iter 100 value 0.119363
## final  value 0.119363
## stopped after 100 iterations
## # weights:  39
## initial  value 82.045220
## iter  10 value 50.460103
## iter  20 value 40.359635
## iter  30 value 39.868212
## iter  40 value 39.801420
## iter  50 value 39.796008
## iter  60 value 39.777249
## iter  70 value 39.744564
## iter  80 value 39.715944
## final  value 39.700617
## converged
## # weights:  109
## initial  value 93.497383
## iter  10 value 23.968601
## iter  20 value 11.199831
## iter  30 value 9.462070
## iter  40 value 9.142694
## iter  50 value 9.125637
## iter  60 value 9.124723
## iter  70 value 9.124622
## iter  80 value 9.124597
## final  value 9.124593
## converged
## # weights:  179
## initial  value 89.102480
## iter  10 value 2.568511
## iter  20 value 0.004981
## iter  30 value 0.000125
## final  value 0.000087
## converged
## # weights:  39
## initial  value 90.422485
## iter  10 value 55.439180
## iter  20 value 51.210726
## iter  30 value 49.466750
## iter  40 value 47.377306
## iter  50 value 46.510887
## iter  60 value 46.510403
## iter  70 value 46.505202
## iter  80 value 45.837614
## iter  90 value 44.594650
## final  value 44.551711
## converged
## # weights:  109
## initial  value 84.935148
## iter  10 value 40.757184
## iter  20 value 19.629173
## iter  30 value 15.348745
```

```
## iter  40 value 12.681702
## iter  50 value 12.199866
## iter  60 value 12.185067
## iter  70 value 12.184624
## iter  80 value 12.184611
## iter  80 value 12.184611
## iter  80 value 12.184611
## final  value 12.184611
## converged
## # weights:  179
## initial  value 83.910426
## iter  10 value 34.998274
## iter  20 value 15.773805
## iter  30 value 12.113621
## iter  40 value 10.561321
## iter  50 value 10.240869
## iter  60 value 10.221188
## iter  70 value 10.218426
## iter  80 value 10.217704
## iter  90 value 10.217680
## final  value 10.217679
## converged
## # weights:  39
## initial  value 87.161684
## iter  10 value 48.919987
## iter  20 value 37.120230
## iter  30 value 33.619473
## iter  40 value 31.964313
## iter  50 value 31.846112
## iter  60 value 31.833067
## iter  70 value 31.788296
## iter  80 value 31.785319
## iter  90 value 31.771949
## iter 100 value 31.770205
## final  value 31.770205
## stopped after 100 iterations
## # weights:  109
## initial  value 84.472374
## iter  10 value 24.637282
## iter  20 value 6.256709
## iter  30 value 3.710129
## iter  40 value 2.301791
## iter  50 value 0.196661
## iter  60 value 0.154112
## iter  70 value 0.142138
## iter  80 value 0.124443
## iter  90 value 0.110161
## iter 100 value 0.100825
## final  value 0.100825
## stopped after 100 iterations
## # weights:  179
## initial  value 86.311468
## iter  10 value 19.606938
## iter  20 value 0.175800
```

```
## iter  30 value 0.140464
## iter  40 value 0.127027
## iter  50 value 0.105444
## iter  60 value 0.088970
## iter  70 value 0.081223
## iter  80 value 0.078218
## iter  90 value 0.073560
## iter 100 value 0.068932
## final  value 0.068932
## stopped after 100 iterations
## # weights:  39
## initial  value 95.240893
## iter  10 value 54.335887
## iter  20 value 44.230801
## iter  30 value 40.626475
## iter  40 value 40.607851
## final  value 40.607827
## converged
## # weights:  109
## initial  value 91.822970
## iter  10 value 33.620848
## iter  20 value 21.077220
## iter  30 value 17.886135
## iter  40 value 10.304131
## iter  50 value 5.168990
## iter  60 value 3.379538
## iter  70 value 3.028947
## iter  80 value 3.017272
## iter  90 value 3.016402
## iter 100 value 3.014590
## final  value 3.014590
## stopped after 100 iterations
## # weights:  179
## initial  value 78.654200
## iter  10 value 21.477523
## iter  20 value 5.268091
## iter  30 value 2.269101
## iter  40 value 0.116834
## iter  50 value 0.041768
## iter  60 value 0.002297
## iter  70 value 0.000696
## iter  80 value 0.000405
## final  value 0.000078
## converged
## # weights:  39
## initial  value 88.612030
## iter  10 value 49.622789
## iter  20 value 46.781365
## iter  30 value 45.469918
## iter  40 value 44.221383
## iter  50 value 43.291555
## iter  60 value 42.952887
## iter  70 value 42.777442
## iter  80 value 41.746352
```

```
## iter  90 value 41.701759
## final  value 41.701757
## converged
## # weights:  109
## initial  value 112.009100
## iter  10 value 39.822394
## iter  20 value 18.341515
## iter  30 value 13.739736
## iter  40 value 12.873716
## iter  50 value 12.801245
## iter  60 value 12.730344
## iter  70 value 12.373070
## iter  80 value 12.300504
## final  value 12.300475
## converged
## # weights:  179
## initial  value 90.899929
## iter  10 value 25.380800
## iter  20 value 11.075211
## iter  30 value 9.434821
## iter  40 value 9.309890
## iter  50 value 9.293179
## iter  60 value 9.292766
## final  value 9.292761
## converged
## # weights:  39
## initial  value 84.660999
## iter  10 value 49.398835
## iter  20 value 38.087474
## iter  30 value 32.891198
## iter  40 value 32.856073
## iter  50 value 32.853953
## iter  60 value 32.842141
## iter  70 value 32.841166
## iter  80 value 32.535814
## iter  90 value 26.878177
## iter 100 value 22.543408
## final  value 22.543408
## stopped after 100 iterations
## # weights:  109
## initial  value 81.280071
## iter  10 value 20.730092
## iter  20 value 12.601547
## iter  30 value 10.933330
## iter  40 value 10.309970
## iter  50 value 10.261066
## iter  60 value 10.249574
## iter  70 value 10.232252
## iter  80 value 10.220140
## iter  90 value 9.715515
## iter 100 value 5.224129
## final  value 5.224129
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 92.642853
## iter  10 value 18.447145
## iter  20 value 1.291731
## iter  30 value 0.247518
## iter  40 value 0.176579
## iter  50 value 0.147135
## iter  60 value 0.125422
## iter  70 value 0.111623
## iter  80 value 0.098209
## iter  90 value 0.090113
## iter 100 value 0.085958
## final  value 0.085958
## stopped after 100 iterations
## # weights:  39
## initial  value 84.634485
## iter  10 value 60.329517
## iter  20 value 48.805937
## iter  30 value 47.747798
## iter  40 value 47.676858
## iter  50 value 47.667324
## iter  60 value 47.666017
## iter  70 value 47.665841
## final  value 47.665822
## converged
## # weights:  109
## initial  value 76.844182
## iter  10 value 12.473045
## iter  20 value 6.860033
## iter  30 value 6.482738
## iter  40 value 6.228858
## iter  50 value 5.926711
## iter  60 value 5.830242
## iter  70 value 5.713317
## iter  80 value 5.487873
## iter  90 value 5.035578
## iter 100 value 5.027107
## final  value 5.027107
## stopped after 100 iterations
## # weights:  179
## initial  value 97.227967
## iter  10 value 28.335348
## iter  20 value 13.570519
## iter  30 value 0.172348
## iter  40 value 0.008744
## iter  50 value 0.001066
## iter  60 value 0.000187
## final  value 0.000086
## converged
## # weights:  39
## initial  value 99.102172
## iter  10 value 62.321742
## iter  20 value 43.079288
## iter  30 value 41.755140
## iter  40 value 41.708582
```

```
## iter  50 value 41.345610
## iter  60 value 39.218102
## iter  70 value 38.196157
## iter  80 value 37.835824
## iter  90 value 37.425590
## iter 100 value 37.207597
## final  value 37.207597
## stopped after 100 iterations
## # weights:  109
## initial  value 79.457797
## iter  10 value 42.195002
## iter  20 value 23.916126
## iter  30 value 14.692237
## iter  40 value 13.636215
## iter  50 value 13.571933
## iter  60 value 13.570770
## final  value 13.570758
## converged
## # weights:  179
## initial  value 80.324008
## iter  10 value 26.593789
## iter  20 value 13.256101
## iter  30 value 10.056126
## iter  40 value 9.635744
## iter  50 value 9.599798
## iter  60 value 9.598230
## iter  70 value 9.598190
## final  value 9.598190
## converged
## # weights:  39
## initial  value 106.372760
## iter  10 value 50.764720
## iter  20 value 45.703467
## iter  30 value 45.118499
## iter  40 value 44.996638
## iter  50 value 44.977079
## iter  60 value 44.163350
## iter  70 value 44.138067
## iter  80 value 43.776471
## iter  90 value 42.809833
## iter 100 value 42.640595
## final  value 42.640595
## stopped after 100 iterations
## # weights:  109
## initial  value 94.368265
## iter  10 value 37.537841
## iter  20 value 9.237348
## iter  30 value 5.607793
## iter  40 value 3.957762
## iter  50 value 3.582007
## iter  60 value 3.457202
## iter  70 value 3.422662
## iter  80 value 3.420760
## iter  90 value 3.118261
```

```
## iter 100 value 2.963361
## final  value 2.963361
## stopped after 100 iterations
## # weights:  179
## initial  value 77.328495
## iter  10 value 6.997263
## iter  20 value 6.087295
## iter  30 value 2.731081
## iter  40 value 2.697898
## iter  50 value 2.625033
## iter  60 value 0.303728
## iter  70 value 0.196102
## iter  80 value 0.179382
## iter  90 value 0.170921
## iter 100 value 0.140077
## final  value 0.140077
## stopped after 100 iterations
## # weights:  39
## initial  value 87.726434
## iter  10 value 56.789121
## iter  20 value 51.328945
## iter  30 value 50.727551
## iter  40 value 50.565547
## iter  50 value 50.544471
## iter  60 value 50.541772
## iter  70 value 50.515839
## iter  80 value 50.493003
## final  value 50.492708
## converged
## # weights:  109
## initial  value 85.146082
## iter  10 value 17.247189
## iter  20 value 4.934125
## iter  30 value 1.789466
## iter  40 value 0.057120
## iter  50 value 0.001257
## iter  60 value 0.000343
## iter  70 value 0.000103
## iter  70 value 0.000091
## iter  70 value 0.000091
## final  value 0.000091
## converged
## # weights:  179
## initial  value 91.033007
## iter  10 value 31.708816
## iter  20 value 18.209857
## iter  30 value 13.518443
## iter  40 value 11.694392
## iter  50 value 6.317443
## iter  60 value 6.163341
## iter  70 value 5.380551
## iter  80 value 5.030062
## iter  90 value 4.782621
## iter 100 value 4.598614
```

```
## final  value 4.598614
## stopped after 100 iterations
## # weights:  39
## initial  value 90.979391
## iter  10 value 63.840346
## iter  20 value 52.615424
## iter  30 value 45.795996
## iter  40 value 43.481910
## iter  50 value 43.400406
## final  value 43.400337
## converged
## # weights:  109
## initial  value 94.210037
## iter  10 value 34.748607
## iter  20 value 17.477748
## iter  30 value 13.690121
## iter  40 value 13.313755
## iter  50 value 13.103820
## iter  60 value 12.300829
## iter  70 value 12.274187
## final  value 12.273916
## converged
## # weights:  179
## initial  value 107.781479
## iter  10 value 46.113231
## iter  20 value 19.705543
## iter  30 value 13.620713
## iter  40 value 11.207289
## iter  50 value 10.508540
## iter  60 value 10.257546
## iter  70 value 10.057342
## iter  80 value 9.993388
## iter  90 value 9.980311
## iter 100 value 9.979237
## final  value 9.979237
## stopped after 100 iterations
## # weights:  39
## initial  value 85.637996
## iter  10 value 51.653682
## iter  20 value 47.024852
## iter  30 value 46.141526
## iter  40 value 44.813804
## iter  50 value 43.907115
## iter  60 value 43.822581
## iter  70 value 41.708839
## iter  80 value 37.321334
## iter  90 value 37.051513
## iter 100 value 36.959961
## final  value 36.959961
## stopped after 100 iterations
## # weights:  109
## initial  value 101.922916
## iter  10 value 40.093598
## iter  20 value 26.172665
```

```
## iter  30 value 23.959575
## iter  40 value 22.213973
## iter  50 value 21.606453
## iter  60 value 20.313021
## iter  70 value 19.728464
## iter  80 value 19.198195
## iter  90 value 19.036258
## iter 100 value 18.552648
## final  value 18.552648
## stopped after 100 iterations
## # weights:  179
## initial  value 88.500525
## iter  10 value 16.236081
## iter  20 value 9.359549
## iter  30 value 9.170230
## iter  40 value 9.113127
## iter  50 value 9.100655
## iter  60 value 8.683629
## iter  70 value 7.743205
## iter  80 value 5.314661
## iter  90 value 3.824127
## iter 100 value 3.724713
## final  value 3.724713
## stopped after 100 iterations
## # weights:  39
## initial  value 85.504158
## iter  10 value 51.035108
## iter  20 value 39.313031
## iter  30 value 37.099374
## iter  40 value 32.067651
## iter  50 value 24.718211
## iter  60 value 23.044729
## iter  70 value 22.401147
## iter  80 value 21.508237
## iter  90 value 19.292912
## iter 100 value 17.854128
## final  value 17.854128
## stopped after 100 iterations
## # weights:  109
## initial  value 86.368387
## iter  10 value 19.955508
## iter  20 value 3.918924
## iter  30 value 3.866134
## iter  40 value 3.862093
## final  value 3.862085
## converged
## # weights:  179
## initial  value 93.404603
## iter  10 value 6.995081
## iter  20 value 0.032685
## iter  30 value 0.000865
## final  value 0.000054
## converged
## # weights:  39
```

```
## initial  value 88.314914
## iter  10 value 55.186139
## iter  20 value 48.766242
## iter  30 value 46.880364
## iter  40 value 44.863689
## iter  50 value 44.716557
## final  value 44.715521
## converged
## # weights:  109
## initial  value 84.554258
## iter  10 value 42.769099
## iter  20 value 23.746488
## iter  30 value 15.237052
## iter  40 value 13.910516
## iter  50 value 13.855195
## iter  60 value 13.498744
## iter  70 value 13.340045
## final  value 13.339054
## converged
## # weights:  179
## initial  value 89.700336
## iter  10 value 19.369542
## iter  20 value 14.319760
## iter  30 value 11.368265
## iter  40 value 10.238950
## iter  50 value 10.019604
## iter  60 value 9.545527
## iter  70 value 9.456907
## iter  80 value 9.454461
## final  value 9.454459
## converged
## # weights:  39
## initial  value 83.217860
## iter  10 value 72.301523
## iter  20 value 54.547624
## iter  30 value 52.650064
## iter  40 value 48.000310
## iter  50 value 43.628003
## iter  60 value 41.195167
## iter  70 value 40.590890
## iter  80 value 40.282709
## iter  90 value 40.247224
## iter 100 value 30.270018
## final  value 30.270018
## stopped after 100 iterations
## # weights:  109
## initial  value 88.484848
## iter  10 value 27.234702
## iter  20 value 21.714300
## iter  30 value 21.677894
## iter  40 value 21.668467
## iter  50 value 21.650414
## iter  60 value 17.602823
## iter  70 value 15.479977
```

```
## iter  80 value 12.035298
## iter  90 value 0.558783
## iter 100 value 0.324180
## final  value 0.324180
## stopped after 100 iterations
## # weights:  179
## initial  value 85.158137
## iter  10 value 12.325689
## iter  20 value 5.530979
## iter  30 value 5.478463
## iter  40 value 2.125036
## iter  50 value 0.324598
## iter  60 value 0.196629
## iter  70 value 0.176477
## iter  80 value 0.156427
## iter  90 value 0.135103
## iter 100 value 0.117536
## final  value 0.117536
## stopped after 100 iterations
## # weights:  39
## initial  value 86.135040
## iter  10 value 58.849612
## iter  20 value 58.394005
## iter  30 value 57.215602
## iter  40 value 57.133695
## iter  50 value 56.957008
## iter  60 value 56.945747
## iter  70 value 56.203676
## iter  80 value 56.199832
## final  value 56.199496
## converged
## # weights:  109
## initial  value 85.263801
## iter  10 value 27.988399
## iter  20 value 10.459206
## iter  30 value 7.577708
## iter  40 value 7.554635
## iter  50 value 7.553103
## iter  60 value 7.553016
## iter  70 value 7.552982
## iter  80 value 7.552955
## final  value 7.552946
## converged
## # weights:  179
## initial  value 83.454380
## iter  10 value 5.220893
## iter  20 value 0.029194
## iter  30 value 0.000437
## iter  40 value 0.000113
## final  value 0.000098
## converged
## # weights:  39
## initial  value 85.070266
## iter  10 value 54.291042
```

```
## iter  20 value 50.846707
## iter  30 value 48.493029
## iter  40 value 43.253338
## iter  50 value 40.909423
## iter  60 value 40.789941
## final  value 40.789597
## converged
## # weights:  109
## initial  value 94.846875
## iter  10 value 45.152128
## iter  20 value 20.695816
## iter  30 value 13.259740
## iter  40 value 12.642599
## iter  50 value 12.606915
## iter  60 value 12.605400
## final  value 12.605382
## converged
## # weights:  179
## initial  value 99.763452
## iter  10 value 25.733380
## iter  20 value 11.276527
## iter  30 value 9.864735
## iter  40 value 8.510892
## iter  50 value 8.339314
## iter  60 value 8.330291
## iter  70 value 8.330149
## final  value 8.330147
## converged
## # weights:  39
## initial  value 80.735696
## iter  10 value 38.502479
## iter  20 value 38.032847
## iter  30 value 36.681442
## iter  40 value 33.928201
## iter  50 value 31.669386
## iter  60 value 31.330738
## iter  70 value 31.319905
## iter  80 value 31.309715
## iter  90 value 31.302847
## iter 100 value 31.300733
## final  value 31.300733
## stopped after 100 iterations
## # weights:  109
## initial  value 88.127854
## iter  10 value 48.603377
## iter  20 value 24.800636
## iter  30 value 21.634161
## iter  40 value 15.351928
## iter  50 value 14.447558
## iter  60 value 12.132197
## iter  70 value 10.720194
## iter  80 value 10.443053
## iter  90 value 10.410678
## iter 100 value 10.360546
```

```
## final  value 10.360546
## stopped after 100 iterations
## # weights:  179
## initial  value 82.382368
## iter  10 value 3.335850
## iter  20 value 0.139071
## iter  30 value 0.126641
## iter  40 value 0.119501
## iter  50 value 0.110842
## iter  60 value 0.100903
## iter  70 value 0.092511
## iter  80 value 0.084827
## iter  90 value 0.079321
## iter 100 value 0.072681
## final  value 0.072681
## stopped after 100 iterations
## # weights:  39
## initial  value 88.569429
## iter  10 value 52.057311
## iter  20 value 49.489339
## iter  30 value 49.478717
## final  value 49.478695
## converged
## # weights:  109
## initial  value 85.658770
## iter  10 value 12.616459
## iter  20 value 9.979147
## iter  30 value 6.967466
## iter  40 value 5.472989
## iter  50 value 5.439773
## iter  60 value 5.436268
## iter  70 value 5.435758
## iter  80 value 5.435393
## iter  90 value 5.435109
## iter 100 value 5.435085
## final  value 5.435085
## stopped after 100 iterations
## # weights:  179
## initial  value 94.014756
## iter  10 value 9.614060
## iter  20 value 0.234099
## iter  30 value 0.022176
## iter  40 value 0.001376
## final  value 0.000092
## converged
## # weights:  39
## initial  value 87.228509
## iter  10 value 57.631346
## iter  20 value 51.427902
## iter  30 value 43.972267
## iter  40 value 40.559650
## iter  50 value 39.313782
## iter  60 value 39.002215
## iter  70 value 38.973746
```

```
## final  value 38.973734
## converged
## # weights:  109
## initial  value 84.306901
## iter  10 value 34.525259
## iter  20 value 20.977475
## iter  30 value 14.037339
## iter  40 value 13.771425
## iter  50 value 13.716870
## iter  60 value 13.671838
## iter  70 value 13.584142
## iter  80 value 13.559821
## iter  90 value 13.559421
## final  value 13.559420
## converged
## # weights:  179
## initial  value 92.205157
## iter  10 value 25.996815
## iter  20 value 10.571112
## iter  30 value 8.990252
## iter  40 value 8.840946
## iter  50 value 8.836100
## final  value 8.836079
## converged
## # weights:  39
## initial  value 96.536657
## iter  10 value 47.667920
## iter  20 value 40.664939
## iter  30 value 35.682169
## iter  40 value 32.022732
## iter  50 value 30.912800
## iter  60 value 28.485915
## iter  70 value 27.267841
## iter  80 value 24.395301
## iter  90 value 24.301131
## iter 100 value 23.949851
## final  value 23.949851
## stopped after 100 iterations
## # weights:  109
## initial  value 97.964712
## iter  10 value 16.029815
## iter  20 value 13.199702
## iter  30 value 8.474738
## iter  40 value 7.036124
## iter  50 value 6.135850
## iter  60 value 5.607218
## iter  70 value 5.568675
## iter  80 value 5.554491
## iter  90 value 4.605932
## iter 100 value 4.137162
## final  value 4.137162
## stopped after 100 iterations
## # weights:  179
## initial  value 110.375823
```

```
## iter  10 value 8.369583
## iter  20 value 5.567377
## iter  30 value 3.875420
## iter  40 value 2.057444
## iter  50 value 2.037662
## iter  60 value 2.021935
## iter  70 value 0.178508
## iter  80 value 0.114990
## iter  90 value 0.110359
## iter 100 value 0.105149
## final  value 0.105149
## stopped after 100 iterations
## # weights:  39
## initial  value 80.957537
## iter  10 value 50.055387
## iter  20 value 41.115415
## iter  30 value 40.857893
## final  value 40.857541
## converged
## # weights:  109
## initial  value 82.797846
## iter  10 value 14.267774
## iter  20 value 8.640742
## iter  30 value 8.491461
## iter  40 value 7.934376
## iter  50 value 6.920458
## iter  60 value 6.091865
## iter  70 value 5.895446
## iter  80 value 5.643293
## iter  90 value 5.091204
## iter 100 value 4.228674
## final  value 4.228674
## stopped after 100 iterations
## # weights:  179
## initial  value 101.835834
## iter  10 value 26.695753
## iter  20 value 0.251809
## iter  30 value 0.006019
## iter  40 value 0.001160
## iter  50 value 0.000163
## iter  50 value 0.000087
## iter  50 value 0.000087
## final  value 0.000087
## converged
## # weights:  39
## initial  value 89.748768
## iter  10 value 64.560955
## iter  20 value 56.987643
## iter  30 value 52.296687
## iter  40 value 48.628113
## iter  50 value 47.283428
## iter  60 value 46.072337
## iter  70 value 45.582333
## final  value 45.578561
```

```
## converged
## # weights:  109
## initial  value 101.878225
## iter  10 value 32.576616
## iter  20 value 17.956448
## iter  30 value 14.510480
## iter  40 value 13.695566
## iter  50 value 13.353246
## iter  60 value 13.340087
## iter  70 value 13.339678
## final  value 13.339662
## converged
## # weights:  179
## initial  value 104.304063
## iter  10 value 22.654255
## iter  20 value 11.808058
## iter  30 value 10.135618
## iter  40 value 9.584948
## iter  50 value 9.553848
## final  value 9.553761
## converged
## # weights:  39
## initial  value 89.619804
## iter  10 value 54.870380
## iter  20 value 50.080364
## iter  30 value 49.220888
## iter  40 value 46.067817
## iter  50 value 44.704431
## iter  60 value 44.500894
## iter  70 value 44.248418
## iter  80 value 43.983202
## iter  90 value 43.912536
## iter 100 value 43.897615
## final  value 43.897615
## stopped after 100 iterations
## # weights:  109
## initial  value 82.148497
## iter  10 value 18.504338
## iter  20 value 16.534819
## iter  30 value 12.146233
## iter  40 value 10.851083
## iter  50 value 3.146123
## iter  60 value 0.709989
## iter  70 value 0.331581
## iter  80 value 0.290400
## iter  90 value 0.274366
## iter 100 value 0.260629
## final  value 0.260629
## stopped after 100 iterations
## # weights:  179
## initial  value 90.879574
## iter  10 value 12.276186
## iter  20 value 0.175685
## iter  30 value 0.135455
```

```
## iter  40 value 0.118041
## iter  50 value 0.110250
## iter  60 value 0.099248
## iter  70 value 0.090586
## iter  80 value 0.086845
## iter  90 value 0.084314
## iter 100 value 0.079697
## final  value 0.079697
## stopped after 100 iterations
## # weights:  39
## initial  value 90.885403
## iter  10 value 50.235584
## iter  20 value 41.293811
## iter  30 value 32.253233
## iter  40 value 28.547413
## iter  50 value 28.050529
## iter  60 value 28.023540
## iter  70 value 27.246526
## iter  80 value 25.150358
## iter  90 value 24.836179
## iter 100 value 24.783391
## final  value 24.783391
## stopped after 100 iterations
## # weights:  109
## initial  value 90.689643
## iter  10 value 44.000867
## iter  20 value 21.982741
## iter  30 value 19.441264
## iter  40 value 18.373514
## iter  50 value 16.516993
## iter  60 value 16.281038
## iter  70 value 16.033907
## iter  80 value 15.667252
## iter  90 value 12.893773
## iter 100 value 6.852092
## final  value 6.852092
## stopped after 100 iterations
## # weights:  179
## initial  value 99.004364
## iter  10 value 13.336342
## iter  20 value 0.175991
## iter  30 value 0.001295
## final  value 0.000090
## converged
## # weights:  39
## initial  value 87.859719
## iter  10 value 55.557296
## iter  20 value 50.743608
## iter  30 value 46.335764
## iter  40 value 45.690365
## iter  50 value 45.687632
## iter  50 value 45.687632
## iter  50 value 45.687632
## final  value 45.687632
```

```
## converged
## # weights:  109
## initial  value 95.752011
## iter  10 value 33.296873
## iter  20 value 15.201010
## iter  30 value 13.355825
## iter  40 value 12.000015
## iter  50 value 11.969858
## final  value 11.969847
## converged
## # weights:  179
## initial  value 88.645177
## iter  10 value 35.025365
## iter  20 value 12.234525
## iter  30 value 10.146700
## iter  40 value 9.608180
## iter  50 value 9.576469
## iter  60 value 9.527474
## iter  70 value 9.500696
## final  value 9.500285
## converged
## # weights:  39
## initial  value 84.162095
## iter  10 value 45.208478
## iter  20 value 36.056182
## iter  30 value 35.668986
## iter  40 value 35.645635
## iter  50 value 35.635089
## iter  60 value 33.746947
## iter  70 value 33.132181
## iter  80 value 33.070633
## iter  90 value 30.685026
## iter 100 value 30.559358
## final  value 30.559358
## stopped after 100 iterations
## # weights:  109
## initial  value 98.288410
## iter  10 value 64.716515
## iter  20 value 27.328697
## iter  30 value 23.962148
## iter  40 value 16.745102
## iter  50 value 13.808241
## iter  60 value 12.895011
## iter  70 value 12.861148
## iter  80 value 12.841490
## iter  90 value 12.800089
## iter 100 value 10.496632
## final  value 10.496632
## stopped after 100 iterations
## # weights:  179
## initial  value 92.586932
## iter  10 value 5.577873
## iter  20 value 2.646779
## iter  30 value 1.578574
```

```
## iter  40 value 0.448454
## iter  50 value 0.287208
## iter  60 value 0.260006
## iter  70 value 0.207982
## iter  80 value 0.165087
## iter  90 value 0.153485
## iter 100 value 0.123694
## final  value 0.123694
## stopped after 100 iterations
## # weights:  39
## initial  value 82.285651
## iter  10 value 49.576909
## iter  20 value 43.496566
## iter  30 value 43.367276
## iter  40 value 41.968308
## iter  50 value 40.155264
## iter  60 value 40.150604
## final  value 40.150354
## converged
## # weights:  109
## initial  value 81.113319
## iter  10 value 15.710306
## iter  20 value 8.650494
## iter  30 value 6.481966
## iter  40 value 6.407040
## iter  50 value 6.401020
## iter  60 value 6.397249
## iter  70 value 6.394094
## iter  80 value 6.393849
## iter  90 value 6.392785
## iter 100 value 6.196127
## final  value 6.196127
## stopped after 100 iterations
## # weights:  179
## initial  value 74.165043
## iter  10 value 10.374266
## iter  20 value 2.205221
## iter  30 value 1.433166
## iter  40 value 1.388080
## iter  50 value 1.386627
## iter  60 value 1.386295
## final  value 1.386295
## converged
## # weights:  39
## initial  value 78.806613
## iter  10 value 50.157954
## iter  20 value 43.376447
## iter  30 value 42.305114
## iter  40 value 40.775328
## iter  50 value 39.388854
## iter  60 value 38.689967
## iter  70 value 38.656501
## final  value 38.656137
## converged
```

```
## # weights:  109
## initial  value 89.419148
## iter  10 value 41.428152
## iter  20 value 25.601646
## iter  30 value 17.834672
## iter  40 value 12.642926
## iter  50 value 11.595612
## iter  60 value 10.358117
## iter  70 value 10.321988
## iter  80 value 10.321725
## final  value 10.321724
## converged
## # weights:  179
## initial  value 83.130812
## iter  10 value 24.345634
## iter  20 value 10.714409
## iter  30 value 8.870532
## iter  40 value 8.533697
## iter  50 value 8.509163
## iter  60 value 8.497566
## iter  70 value 8.497112
## final  value 8.497104
## converged
## # weights:  39
## initial  value 82.915363
## iter  10 value 44.195114
## iter  20 value 39.187604
## iter  30 value 38.445664
## iter  40 value 38.413880
## iter  50 value 38.408266
## iter  60 value 38.391194
## iter  70 value 33.906355
## iter  80 value 33.198792
## iter  90 value 33.095255
## iter 100 value 33.006481
## final  value 33.006481
## stopped after 100 iterations
## # weights:  109
## initial  value 75.536522
## iter  10 value 24.378592
## iter  20 value 13.316891
## iter  30 value 11.949264
## iter  40 value 11.488736
## iter  50 value 11.146315
## iter  60 value 10.409760
## iter  70 value 10.014863
## iter  80 value 9.579057
## iter  90 value 5.923311
## iter 100 value 4.793947
## final  value 4.793947
## stopped after 100 iterations
## # weights:  179
## initial  value 91.459843
## iter  10 value 17.012083
```

```
## iter  20 value 0.383727
## iter  30 value 0.184435
## iter  40 value 0.145075
## iter  50 value 0.118865
## iter  60 value 0.095490
## iter  70 value 0.087759
## iter  80 value 0.083136
## iter  90 value 0.078991
## iter 100 value 0.075963
## final  value 0.075963
## stopped after 100 iterations
## # weights:  39
## initial  value 86.925422
## iter  10 value 75.089706
## iter  20 value 51.597660
## iter  30 value 50.322401
## iter  40 value 50.135663
## iter  50 value 49.890374
## iter  60 value 49.468568
## iter  70 value 48.244121
## iter  80 value 47.471842
## iter  90 value 45.438795
## iter 100 value 45.367848
## final  value 45.367848
## stopped after 100 iterations
## # weights:  109
## initial  value 80.216185
## iter  10 value 10.797088
## iter  20 value 0.492589
## iter  30 value 0.023043
## iter  40 value 0.003348
## iter  50 value 0.000462
## iter  60 value 0.000189
## final  value 0.000085
## converged
## # weights:  179
## initial  value 92.942133
## iter  10 value 18.558935
## iter  20 value 9.135916
## iter  30 value 7.594404
## iter  40 value 5.998985
## iter  50 value 4.516330
## iter  60 value 3.997780
## iter  70 value 3.901493
## iter  80 value 3.869751
## iter  90 value 3.838543
## iter 100 value 3.769553
## final  value 3.769553
## stopped after 100 iterations
## # weights:  39
## initial  value 95.099086
## iter  10 value 56.038815
## iter  20 value 46.996571
## iter  30 value 46.541976
```

```
## iter  40 value 45.899882
## iter  50 value 44.852815
## iter  60 value 44.247409
## iter  70 value 44.080407
## final  value 44.079338
## converged
## # weights:  109
## initial  value 114.807598
## iter  10 value 47.933184
## iter  20 value 30.095918
## iter  30 value 19.618417
## iter  40 value 14.888073
## iter  50 value 13.973251
## iter  60 value 13.450400
## iter  70 value 11.919411
## iter  80 value 11.834875
## iter  90 value 11.832884
## final  value 11.832580
## converged
## # weights:  179
## initial  value 103.989063
## iter  10 value 48.679498
## iter  20 value 16.529536
## iter  30 value 12.114281
## iter  40 value 11.247450
## iter  50 value 11.104977
## iter  60 value 11.098787
## iter  70 value 11.098566
## final  value 11.098552
## converged
## # weights:  39
## initial  value 84.167025
## iter  10 value 55.517782
## iter  20 value 52.204104
## iter  30 value 51.519064
## iter  40 value 50.648501
## iter  50 value 48.581665
## iter  60 value 48.538721
## iter  70 value 48.029915
## iter  80 value 47.688230
## iter  90 value 47.665156
## iter 100 value 47.593373
## final  value 47.593373
## stopped after 100 iterations
## # weights:  109
## initial  value 111.186645
## iter  10 value 23.941476
## iter  20 value 7.791402
## iter  30 value 5.995794
## iter  40 value 0.497591
## iter  50 value 0.340925
## iter  60 value 0.331554
## iter  70 value 0.320785
## iter  80 value 0.308540
```

```
## iter  90 value 0.301206
## iter 100 value 0.296787
## final  value 0.296787
## stopped after 100 iterations
## # weights:  179
## initial  value 79.230253
## iter  10 value 16.340692
## iter  20 value 1.058126
## iter  30 value 0.170543
## iter  40 value 0.151643
## iter  50 value 0.127515
## iter  60 value 0.112913
## iter  70 value 0.104021
## iter  80 value 0.099967
## iter  90 value 0.096261
## iter 100 value 0.091898
## final  value 0.091898
## stopped after 100 iterations
## # weights:  39
## initial  value 84.115611
## iter  10 value 51.888072
## iter  20 value 42.919513
## iter  30 value 40.510190
## iter  40 value 40.462647
## iter  50 value 40.461453
## final  value 40.461439
## converged
## # weights:  109
## initial  value 88.593368
## iter  10 value 43.543549
## iter  20 value 6.637161
## iter  30 value 0.038278
## iter  40 value 0.008543
## iter  50 value 0.001907
## iter  60 value 0.000242
## final  value 0.000093
## converged
## # weights:  179
## initial  value 84.414587
## iter  10 value 18.519580
## iter  20 value 3.546465
## iter  30 value 0.151060
## iter  40 value 0.002930
## iter  50 value 0.000135
## iter  50 value 0.000082
## iter  50 value 0.000082
## final  value 0.000082
## converged
## # weights:  39
## initial  value 90.958227
## iter  10 value 56.066105
## iter  20 value 48.316351
## iter  30 value 48.031360
## iter  40 value 46.327371
```

```
## iter  50 value 44.724163
## iter  60 value 44.620837
## final  value 44.620744
## converged
## # weights:  109
## initial  value 86.736202
## iter  10 value 34.612246
## iter  20 value 16.580279
## iter  30 value 13.804108
## iter  40 value 13.607868
## iter  50 value 13.260563
## iter  60 value 13.154417
## iter  70 value 13.025304
## iter  80 value 12.966463
## final  value 12.966462
## converged
## # weights:  179
## initial  value 101.403698
## iter  10 value 35.958371
## iter  20 value 15.177125
## iter  30 value 12.051414
## iter  40 value 10.679620
## iter  50 value 10.343655
## iter  60 value 10.304440
## iter  70 value 10.299128
## iter  80 value 10.298832
## iter  90 value 10.298806
## iter 100 value 10.298803
## final  value 10.298803
## stopped after 100 iterations
## # weights:  39
## initial  value 85.541371
## iter  10 value 40.462490
## iter  20 value 39.144683
## iter  30 value 38.120839
## iter  40 value 36.371696
## iter  50 value 31.631251
## iter  60 value 31.271470
## iter  70 value 31.226951
## iter  80 value 31.172060
## iter  90 value 31.108114
## iter 100 value 29.891872
## final  value 29.891872
## stopped after 100 iterations
## # weights:  109
## initial  value 89.328189
## iter  10 value 16.856487
## iter  20 value 9.407713
## iter  30 value 7.715865
## iter  40 value 7.699714
## iter  50 value 7.070750
## iter  60 value 3.108212
## iter  70 value 0.298989
## iter  80 value 0.142514
```

```
## iter  90 value 0.133465
## iter 100 value 0.128921
## final  value 0.128921
## stopped after 100 iterations
## # weights:  179
## initial  value 94.432791
## iter  10 value 19.139524
## iter  20 value 2.816546
## iter  30 value 1.594628
## iter  40 value 0.224761
## iter  50 value 0.206274
## iter  60 value 0.185097
## iter  70 value 0.155340
## iter  80 value 0.126522
## iter  90 value 0.113178
## iter 100 value 0.100636
## final  value 0.100636
## stopped after 100 iterations
## # weights:  39
## initial  value 95.581378
## iter  10 value 59.749052
## iter  20 value 53.598882
## iter  30 value 52.162214
## iter  40 value 50.862310
## iter  50 value 46.575284
## iter  60 value 46.371992
## iter  70 value 46.184034
## iter  80 value 45.930161
## iter  90 value 45.876062
## iter 100 value 45.867834
## final  value 45.867834
## stopped after 100 iterations
## # weights:  109
## initial  value 89.923919
## iter  10 value 29.004092
## iter  20 value 21.413658
## iter  30 value 19.603756
## iter  40 value 18.642277
## iter  50 value 18.152229
## iter  60 value 18.092563
## iter  70 value 18.065668
## iter  80 value 12.138861
## iter  90 value 4.764871
## iter 100 value 0.202869
## final  value 0.202869
## stopped after 100 iterations
## # weights:  179
## initial  value 90.315614
## iter  10 value 40.845016
## iter  20 value 17.904206
## iter  30 value 15.699832
## iter  40 value 9.098825
## iter  50 value 2.036497
## iter  60 value 0.033425
```

```
## iter  70 value 0.001418
## iter  80 value 0.000492
## final  value 0.000085
## converged
## # weights:  39
## initial  value 85.169125
## iter  10 value 64.972884
## iter  20 value 52.467356
## iter  30 value 46.753811
## iter  40 value 45.058500
## iter  50 value 43.553622
## iter  60 value 41.378322
## iter  70 value 40.437582
## iter  80 value 40.419734
## final  value 40.419730
## converged
## # weights:  109
## initial  value 89.255698
## iter  10 value 30.551451
## iter  20 value 15.049853
## iter  30 value 13.823229
## iter  40 value 12.961858
## iter  50 value 11.828680
## iter  60 value 11.727350
## iter  70 value 11.724338
## final  value 11.724324
## converged
## # weights:  179
## initial  value 92.643328
## iter  10 value 32.356206
## iter  20 value 12.043873
## iter  30 value 9.610067
## iter  40 value 9.171488
## iter  50 value 9.127067
## iter  60 value 9.126000
## final  value 9.125989
## converged
## # weights:  39
## initial  value 86.436602
## iter  10 value 51.324144
## iter  20 value 41.189983
## iter  30 value 36.271056
## iter  40 value 23.473972
## iter  50 value 19.037549
## iter  60 value 14.682916
## iter  70 value 10.087899
## iter  80 value 7.390502
## iter  90 value 7.352893
## iter 100 value 7.283568
## final  value 7.283568
## stopped after 100 iterations
## # weights:  109
## initial  value 92.446436
## iter  10 value 7.748643
```

```
## iter  20 value 3.646915
## iter  30 value 3.250936
## iter  40 value 3.020992
## iter  50 value 1.715864
## iter  60 value 1.639587
## iter  70 value 1.633453
## iter  80 value 1.602874
## iter  90 value 1.596140
## iter 100 value 1.583929
## final  value 1.583929
## stopped after 100 iterations
## # weights:  179
## initial  value 84.105863
## iter  10 value 28.459374
## iter  20 value 3.942282
## iter  30 value 2.747349
## iter  40 value 2.726469
## iter  50 value 2.700101
## iter  60 value 2.680525
## iter  70 value 1.644744
## iter  80 value 1.597143
## iter  90 value 0.338664
## iter 100 value 0.209367
## final  value 0.209367
## stopped after 100 iterations
## # weights:  39
## initial  value 87.885213
## iter  10 value 44.213304
## iter  20 value 42.301055
## iter  30 value 41.199692
## iter  40 value 39.422634
## iter  50 value 39.165472
## iter  60 value 39.099620
## iter  70 value 39.098662
## iter  80 value 39.098118
## iter  90 value 39.092692
## iter 100 value 38.860467
## final  value 38.860467
## stopped after 100 iterations
## # weights:  109
## initial  value 80.616963
## iter  10 value 24.804407
## iter  20 value 19.850656
## iter  30 value 19.548855
## iter  40 value 19.477124
## iter  50 value 15.694441
## iter  60 value 7.555785
## iter  70 value 7.320940
## iter  80 value 7.276279
## iter  90 value 4.503162
## iter 100 value 3.376580
## final  value 3.376580
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 87.602008
## iter  10 value 20.302238
## iter  20 value 7.532904
## iter  30 value 3.263114
## iter  40 value 2.996990
## iter  50 value 2.321430
## iter  60 value 1.393459
## iter  70 value 1.389881
## iter  80 value 1.388395
## iter  90 value 1.384602
## iter 100 value 1.155743
## final  value 1.155743
## stopped after 100 iterations
## # weights:  39
## initial  value 91.305407
## iter  10 value 58.618654
## iter  20 value 53.080022
## iter  30 value 52.363335
## iter  40 value 51.065755
## iter  50 value 50.313108
## iter  60 value 49.461887
## iter  70 value 47.284153
## iter  80 value 47.221814
## final  value 47.221812
## converged
## # weights:  109
## initial  value 92.760705
## iter  10 value 27.576014
## iter  20 value 17.265204
## iter  30 value 13.778948
## iter  40 value 13.131824
## iter  50 value 13.130236
## final  value 13.130235
## converged
## # weights:  179
## initial  value 96.355526
## iter  10 value 33.826390
## iter  20 value 16.460663
## iter  30 value 10.778998
## iter  40 value 10.302176
## iter  50 value 10.172901
## iter  60 value 9.645958
## iter  70 value 9.617659
## iter  80 value 9.616849
## final  value 9.616825
## converged
## # weights:  39
## initial  value 87.074427
## iter  10 value 71.008343
## iter  20 value 56.164297
## iter  30 value 49.275056
## iter  40 value 47.825219
## iter  50 value 47.780336
## iter  60 value 47.751163
```

```
## iter  70 value 47.695421
## iter  80 value 47.658673
## iter  90 value 47.651104
## iter 100 value 46.269704
## final  value 46.269704
## stopped after 100 iterations
## # weights:  109
## initial  value 77.269200
## iter  10 value 35.617660
## iter  20 value 10.169319
## iter  30 value 5.360920
## iter  40 value 3.211887
## iter  50 value 2.393310
## iter  60 value 0.700776
## iter  70 value 0.428502
## iter  80 value 0.359364
## iter  90 value 0.339497
## iter 100 value 0.323250
## final  value 0.323250
## stopped after 100 iterations
## # weights:  179
## initial  value 79.680889
## iter  10 value 3.807592
## iter  20 value 0.126699
## iter  30 value 0.090285
## iter  40 value 0.083949
## iter  50 value 0.077477
## iter  60 value 0.073347
## iter  70 value 0.064331
## iter  80 value 0.058672
## iter  90 value 0.056376
## iter 100 value 0.054383
## final  value 0.054383
## stopped after 100 iterations
## # weights:  39
## initial  value 88.012074
## iter  10 value 71.405366
## iter  20 value 56.100726
## iter  30 value 56.076457
## iter  40 value 55.954540
## iter  50 value 55.646566
## iter  60 value 55.507321
## iter  70 value 55.458438
## iter  80 value 48.353150
## iter  90 value 46.934789
## iter 100 value 43.826322
## final  value 43.826322
## stopped after 100 iterations
## # weights:  109
## initial  value 81.471815
## iter  10 value 36.050582
## iter  20 value 15.036087
## iter  30 value 10.437203
## iter  40 value 0.553493
```

```
## iter  50 value 0.013375
## iter  60 value 0.003862
## iter  70 value 0.000989
## iter  80 value 0.000699
## iter  90 value 0.000588
## iter 100 value 0.000207
## final  value 0.000207
## stopped after 100 iterations
## # weights:  179
## initial  value 109.870317
## iter  10 value 7.851044
## iter  20 value 2.072646
## iter  30 value 1.914825
## iter  40 value 1.909850
## iter  50 value 1.909558
## final  value 1.909545
## converged
## # weights:  39
## initial  value 82.532556
## iter  10 value 50.471275
## iter  20 value 48.589357
## iter  30 value 46.680328
## iter  40 value 43.489034
## iter  50 value 43.372329
## final  value 43.372243
## converged
## # weights:  109
## initial  value 83.301827
## iter  10 value 50.239755
## iter  20 value 40.670091
## iter  30 value 31.821810
## iter  40 value 24.198455
## iter  50 value 15.692491
## iter  60 value 14.007768
## iter  70 value 13.350579
## iter  80 value 13.095092
## iter  90 value 13.067776
## final  value 13.067539
## converged
## # weights:  179
## initial  value 122.642259
## iter  10 value 34.125404
## iter  20 value 15.284064
## iter  30 value 11.129062
## iter  40 value 10.331692
## iter  50 value 9.949609
## iter  60 value 9.896971
## iter  70 value 9.896053
## iter  80 value 9.895976
## final  value 9.895975
## converged
## # weights:  39
## initial  value 84.988710
## iter  10 value 53.414109
```

```
## iter  20 value 48.781218
## iter  30 value 46.450066
## iter  40 value 45.855967
## iter  50 value 45.504685
## iter  60 value 44.001229
## iter  70 value 43.582510
## iter  80 value 43.501098
## iter  90 value 43.483127
## iter 100 value 42.489067
## final  value 42.489067
## stopped after 100 iterations
## # weights:  109
## initial  value 78.544943
## iter  10 value 34.269147
## iter  20 value 9.851332
## iter  30 value 7.574756
## iter  40 value 6.818164
## iter  50 value 6.345905
## iter  60 value 6.322714
## iter  70 value 6.295090
## iter  80 value 6.154941
## iter  90 value 5.619595
## iter 100 value 5.451086
## final  value 5.451086
## stopped after 100 iterations
## # weights:  179
## initial  value 95.661557
## iter  10 value 39.354820
## iter  20 value 12.037084
## iter  30 value 7.005599
## iter  40 value 0.186445
## iter  50 value 0.146341
## iter  60 value 0.135677
## iter  70 value 0.130774
## iter  80 value 0.115389
## iter  90 value 0.110102
## iter 100 value 0.103114
## final  value 0.103114
## stopped after 100 iterations
## # weights:  39
## initial  value 84.890458
## iter  10 value 56.609915
## iter  20 value 44.507153
## iter  30 value 35.914186
## iter  40 value 30.905719
## iter  50 value 26.887704
## iter  60 value 26.560696
## iter  70 value 25.306715
## iter  80 value 24.792564
## iter  90 value 24.715344
## iter 100 value 24.710941
## final  value 24.710941
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 99.098165
## iter  10 value 28.786201
## iter  20 value 7.929812
## iter  30 value 0.031978
## iter  40 value 0.006280
## iter  50 value 0.002113
## final  value 0.000012
## converged
## # weights:  179
## initial  value 115.439256
## iter  10 value 7.128630
## iter  20 value 2.070233
## iter  30 value 1.945668
## iter  40 value 1.921497
## iter  50 value 1.678276
## iter  60 value 0.391117
## iter  70 value 0.076208
## iter  80 value 0.029519
## iter  90 value 0.010626
## iter 100 value 0.003848
## final  value 0.003848
## stopped after 100 iterations
## # weights:  39
## initial  value 103.705680
## iter  10 value 53.211195
## iter  20 value 47.834961
## iter  30 value 44.319229
## iter  40 value 41.892499
## iter  50 value 38.594866
## iter  60 value 37.469823
## iter  70 value 37.362836
## iter  70 value 37.362835
## iter  70 value 37.362835
## final  value 37.362835
## converged
## # weights:  109
## initial  value 80.405311
## iter  10 value 31.917459
## iter  20 value 16.169677
## iter  30 value 11.327703
## iter  40 value 10.814074
## iter  50 value 10.778966
## iter  60 value 10.778060
## final  value 10.778056
## converged
## # weights:  179
## initial  value 84.189209
## iter  10 value 26.108640
## iter  20 value 12.013497
## iter  30 value 9.373290
## iter  40 value 8.958735
## iter  50 value 8.943334
## iter  60 value 8.943022
## final  value 8.943015
```

```
## converged
## # weights:  39
## initial  value 84.540267
## iter  10 value 44.420054
## iter  20 value 41.305691
## iter  30 value 31.367397
## iter  40 value 31.061725
## iter  50 value 31.059840
## iter  60 value 31.056806
## iter  70 value 31.055420
## iter  80 value 31.053729
## iter  90 value 31.049046
## iter 100 value 29.998840
## final  value 29.998840
## stopped after 100 iterations
## # weights:  109
## initial  value 81.228345
## iter  10 value 24.272873
## iter  20 value 7.497484
## iter  30 value 6.753635
## iter  40 value 6.483648
## iter  50 value 6.352880
## iter  60 value 6.264558
## iter  70 value 4.403690
## iter  80 value 3.359493
## iter  90 value 3.333130
## iter 100 value 3.185023
## final  value 3.185023
## stopped after 100 iterations
## # weights:  179
## initial  value 113.126314
## iter  10 value 19.505697
## iter  20 value 8.627369
## iter  30 value 8.443156
## iter  40 value 6.717805
## iter  50 value 4.099864
## iter  60 value 0.224275
## iter  70 value 0.166034
## iter  80 value 0.153501
## iter  90 value 0.145471
## iter 100 value 0.122332
## final  value 0.122332
## stopped after 100 iterations
## # weights:  39
## initial  value 86.097523
## iter  10 value 49.936030
## iter  20 value 43.890027
## iter  30 value 42.729551
## iter  40 value 42.591851
## iter  50 value 42.572274
## iter  60 value 42.569087
## iter  70 value 42.568819
## final  value 42.568313
## converged
```

```
## # weights:  109
## initial  value 84.320196
## iter  10 value 23.041738
## iter  20 value 7.016379
## iter  30 value 4.522576
## iter  40 value 4.498505
## iter  50 value 4.257110
## iter  60 value 4.187923
## iter  70 value 4.187898
## final  value 4.187898
## converged
## # weights:  179
## initial  value 119.704908
## iter  10 value 8.974781
## iter  20 value 3.231054
## iter  30 value 2.202606
## iter  40 value 0.317631
## iter  50 value 0.119630
## iter  60 value 0.017991
## iter  70 value 0.001912
## iter  80 value 0.000749
## iter  90 value 0.000415
## iter 100 value 0.000260
## final  value 0.000260
## stopped after 100 iterations
## # weights:  39
## initial  value 96.359105
## iter  10 value 64.894576
## iter  20 value 51.891959
## iter  30 value 48.754777
## iter  40 value 47.959488
## final  value 47.954624
## converged
## # weights:  109
## initial  value 97.005897
## iter  10 value 33.293174
## iter  20 value 18.525335
## iter  30 value 14.925314
## iter  40 value 14.565280
## iter  50 value 14.506521
## iter  60 value 14.483830
## iter  70 value 14.464465
## iter  80 value 14.463810
## iter  90 value 14.463780
## iter  90 value 14.463780
## iter  90 value 14.463780
## final  value 14.463780
## converged
## # weights:  179
## initial  value 94.403785
## iter  10 value 32.147049
## iter  20 value 17.150787
## iter  30 value 11.956276
## iter  40 value 10.328922
```

```
## iter  50 value 10.071316
## iter  60 value 10.049796
## iter  70 value 10.049173
## iter  80 value 10.049164
## iter  80 value 10.049164
## iter  80 value 10.049164
## final  value 10.049164
## converged
## # weights:  39
## initial  value 90.472972
## iter  10 value 48.666843
## iter  20 value 43.194239
## iter  30 value 38.995691
## iter  40 value 35.596253
## iter  50 value 35.483457
## iter  60 value 35.475603
## iter  70 value 35.466387
## iter  80 value 35.464677
## iter  90 value 35.416961
## iter 100 value 35.104182
## final  value 35.104182
## stopped after 100 iterations
## # weights:  109
## initial  value 89.592870
## iter  10 value 31.275267
## iter  20 value 18.922981
## iter  30 value 17.684342
## iter  40 value 16.672120
## iter  50 value 16.448323
## iter  60 value 15.837622
## iter  70 value 15.764838
## iter  80 value 13.451522
## iter  90 value 12.335129
## iter 100 value 12.325324
## final  value 12.325324
## stopped after 100 iterations
## # weights:  179
## initial  value 84.851448
## iter  10 value 23.438295
## iter  20 value 5.866080
## iter  30 value 4.022276
## iter  40 value 0.939609
## iter  50 value 0.441182
## iter  60 value 0.306766
## iter  70 value 0.301015
## iter  80 value 0.278531
## iter  90 value 0.258664
## iter 100 value 0.233725
## final  value 0.233725
## stopped after 100 iterations
## # weights:  39
## initial  value 82.020546
## iter  10 value 64.805221
## iter  20 value 41.690696
```

```
## iter  30 value 40.074506
## iter  40 value 40.072438
## final  value 40.072432
## converged
## # weights:  109
## initial  value 79.821808
## iter  10 value 27.937265
## iter  20 value 1.938374
## iter  30 value 0.198284
## iter  40 value 0.013956
## iter  50 value 0.004000
## iter  60 value 0.002540
## iter  70 value 0.000539
## iter  80 value 0.000220
## final  value 0.000096
## converged
## # weights:  179
## initial  value 85.287590
## iter  10 value 2.195586
## iter  20 value 0.019398
## iter  30 value 0.001846
## final  value 0.000095
## converged
## # weights:  39
## initial  value 84.317257
## iter  10 value 57.682888
## iter  20 value 50.444700
## iter  30 value 45.846096
## iter  40 value 45.692229
## final  value 45.691802
## converged
## # weights:  109
## initial  value 83.435358
## iter  10 value 31.643228
## iter  20 value 16.735840
## iter  30 value 13.280159
## iter  40 value 11.678191
## iter  50 value 11.580044
## iter  60 value 11.576538
## iter  70 value 11.576507
## iter  70 value 11.576507
## iter  70 value 11.576507
## final  value 11.576507
## converged
## # weights:  179
## initial  value 84.465331
## iter  10 value 36.219337
## iter  20 value 19.878112
## iter  30 value 11.322392
## iter  40 value 9.252890
## iter  50 value 8.599707
## iter  60 value 8.567128
## iter  70 value 8.565120
## iter  80 value 8.564941
```

```
## final  value 8.564932
## converged
## # weights:  39
## initial  value 89.738634
## iter  10 value 58.493085
## iter  20 value 57.203495
## iter  30 value 56.970584
## iter  40 value 56.953117
## iter  50 value 51.550252
## iter  60 value 50.715648
## iter  70 value 50.710615
## iter  80 value 50.575978
## iter  90 value 47.144963
## iter 100 value 47.131241
## final  value 47.131241
## stopped after 100 iterations
## # weights:  109
## initial  value 96.567744
## iter  10 value 37.915738
## iter  20 value 0.404338
## iter  30 value 0.280086
## iter  40 value 0.202904
## iter  50 value 0.157915
## iter  60 value 0.135142
## iter  70 value 0.128417
## iter  80 value 0.121374
## iter  90 value 0.112813
## iter 100 value 0.105724
## final  value 0.105724
## stopped after 100 iterations
## # weights:  179
## initial  value 119.659448
## iter  10 value 37.063911
## iter  20 value 17.493135
## iter  30 value 7.844024
## iter  40 value 7.159135
## iter  50 value 7.141693
## iter  60 value 7.130486
## iter  70 value 5.518796
## iter  80 value 5.502201
## iter  90 value 5.117201
## iter 100 value 0.186663
## final  value 0.186663
## stopped after 100 iterations
## # weights:  179
## initial  value 91.203441
## iter  10 value 27.811912
## iter  20 value 16.551713
## iter  30 value 12.649276
## iter  40 value 11.288908
## iter  50 value 10.775554
## iter  60 value 10.626294
## iter  70 value 10.618773
## iter  80 value 10.509283
```

```
## iter  90 value 10.451275
## iter 100 value 10.448875
## final  value 10.448875
## stopped after 100 iterations
```

```r
nnpred_model2 <- predict(neuralnet_model2, newdata= data_norm[-samp,])
```

```r
#viewing confusion matrix
confusionMatrix(nnpred_model2, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                 Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             5             1         0         0
##   HER2.enriched          0             1         0         0
##   Luminal.A              0             0         6         2
##   Luminal.B              0             1         0         5
##
## Overall Statistics
##
##                Accuracy : 0.8095
##                  95% CI : (0.5809, 0.9455)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 1.026e-05
##
##                   Kappa : 0.7358
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     1.0000              0.33333           1.0000
## Specificity                     0.9375              1.00000           0.8667
## Pos Pred Value                  0.8333              1.00000           0.7500
## Neg Pred Value                  1.0000              0.90000           1.0000
## Precision                       0.8333              1.00000           0.7500
## Recall                          1.0000              0.33333           1.0000
## F1                              0.9091              0.50000           0.8571
## Prevalence                      0.2381              0.14286           0.2857
## Detection Rate                  0.2381              0.04762           0.2857
## Detection Prevalence            0.2857              0.04762           0.3810
## Balanced Accuracy               0.9688              0.66667           0.9333
##                      Class: Luminal.B
## Sensitivity                    0.7143
## Specificity                    0.9286
## Pos Pred Value                 0.8333
## Neg Pred Value                 0.8667
## Precision                      0.8333
## Recall                         0.7143
## F1                             0.7692
## Prevalence                     0.3333
```

```
## Detection Rate                     0.2381
## Detection Prevalence               0.2857
## Balanced Accuracy                  0.8214
```

Model evaluation for NN

1. Accuracy : The overall model accuracy of Neural network model is 81%

2. Precision, Recall, F-1 : The Precision,Recall,F1 for Basal.like class is 0.8333, 1.0000 , 0.9091 The Precision,Recall,F1 for HER2.enriched class is 1.00000, 0.33333 , 0.50000 The Precision,Recall,F1 for Luminal.A class is 0.7500, 1.0000, 0.8571 The Precision,Recall,F1 for Luminal.B class is 0.8333, 0.7143,0.7692

3. Sensitivity and Specificity The Sensitivity and Specificity for Basal.like class is 1.0000 and 0.9375 The Sensitivity and Specificity for HER2.enriched class is 0.33333 and 1.00000 The Sensitivity and Specificity for Luminal.A is 1.0000 and 0.8667 The Sensitivity and Specificity for Luminal.B class is 0.7143 and 0.9286

4. The Kappa statistic: The kappa value for this model is 0.7358 which states that it is a good agreement.

Macro-averaged Metrics : The per-class metrics can be averaged over all the classes resulting in macro-averaged precision, recall and F-1.

```r
# macro-averaged precision
precision_nn <- c(0.8333,1.00000, 0.7500, 0.8333)
macro_precision_nn <- mean(precision_nn)
# macro-averaged recall
recall_nn <- c(1.0000, 0.33333, 1.0000, 0.7143)
macro_recall_nn<- mean(recall_nn)
# macro-averaged F-1
F1_nn<- c(0.9091,0.50000,0.8571,0.7692)
macroF1_nn <- mean(F1_nn)
macro_average_nn <-data.frame(macro_precision_nn, macro_recall_nn, macroF1_nn)
macro_average_nn
```

```
##   macro_precision_nn macro_recall_nn macroF1_nn
## 1            0.85415       0.7619075    0.75885
```

AUC

```r
nn_auc <- multiclass.roc(test$PAM50.mRNA, as.ordered(nnpred_model2))
auc(nn_auc)
```

```
## Multi-class area under the curve: 0.8571
```

```r
Name_metrics <- c("Accuracy", "Precision", "Recall", "F-1", "AUC", "Kappa")
values_nn <- c(0.8095 , 0.85415, 0.7619075, 0.75885,0.8571,0.7358  )
metrics_nn <- data.frame(Name_metrics, values_nn)
print (metrics_nn)
```

```
##   Name_metrics values_nn
## 1     Accuracy 0.8095000
## 2    Precision 0.8541500
## 3       Recall 0.7619075
## 4          F-1 0.7588500
## 5          AUC 0.8571000
## 6        Kappa 0.7358000
```

Naive Baye's

The Naive Bayes Algorithm is a classifier based on applying Bayes theorem with independent assumptions between features. Meaning that all features in the data set are equally important and independent of one another. Bayesian probability Is rooted in the theory that the likelihood of an event should be based on the evidence across multiple trials. Naïve Bayes uses probabilities to classify groups based on prior probability. One advantage is that Naïve Bayes works with mixed data: nominal, continuous and ordinal variables. Naïve Bayes is fast and effective, handles missing and noisy data well, and requires few records for training and can also work well with large records. Disadvantages of Naïve Bayes is that it assumes that all the data predictors are independent when in data is far from this faulty assumption. Also, estimated probabilities are less reliable than predicted classes.

```
nb_model3 <- naive_bayes(PAM50.mRNA ~ ., data = train, usekernel = T)
nbpred_model3 <- predict(nb_model3, newdata= data_norm[-samp,])
#viewing confusion matrix
confusionMatrix(nbpred_model3 , factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                  Reference
## Prediction        Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like               3             1         0         0
##   HER2.enriched            1             2         0         0
##   Luminal.A                1             0         5         1
##   Luminal.B                0             0         1         6
##
## Overall Statistics
##
##                Accuracy : 0.7619
##                  95% CI : (0.5283, 0.9178)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 7.251e-05
##
##                   Kappa : 0.6729
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     0.6000              0.66667           0.8333
## Specificity                     0.9375              0.94444           0.8667
## Pos Pred Value                  0.7500              0.66667           0.7143
## Neg Pred Value                  0.8824              0.94444           0.9286
## Precision                       0.7500              0.66667           0.7143
```

```
## Recall                        0.6000            0.66667            0.8333
## F1                            0.6667            0.66667            0.7692
## Prevalence                    0.2381            0.14286            0.2857
## Detection Rate                0.1429            0.09524            0.2381
## Detection Prevalence          0.1905            0.14286            0.3333
## Balanced Accuracy             0.7688            0.80556            0.8500
##                        Class: Luminal.B
## Sensitivity                    0.8571
## Specificity                    0.9286
## Pos Pred Value                 0.8571
## Neg Pred Value                 0.9286
## Precision                      0.8571
## Recall                         0.8571
## F1                             0.8571
## Prevalence                     0.3333
## Detection Rate                 0.2857
## Detection Prevalence           0.3333
## Balanced Accuracy              0.8929
```

Model evaluation for NB:

1. Accuracy : The overall model accuracy of Naive Baye's model is 76. 2%
2. Precision,Recall,F1 : The Precision,Recall,F1 for Basal.like class is 0.7500, 0.60000, 0.6667 The Precision,Recall,F1 for HER2.enriched class is 0.6667, 0.6667, 0.6667 The Precision,Recall,F1 for Luminal.A class is 0.7143, 0.8333, 0.71692 The Precision,Recall,F1 for Luminal.B class is 0.8571, 0.8571, 0.8571

3. Sensitivity and Specificity The Sensitivity and Specificity for Basal.like class is 0.60000 and 0.9375 The Sensitivity and Specificity for HER2.enriched class is 0.66667 and 0.94444 The Sensitivity and Specificity for Luminal.A is 0.8333 and 0.8667 The Sensitivity and Specificity for Luminal.B class is 0.8571 and 0.9286
4. The Kappa statistic: The kappa value for this model is 0.6729 which states that it is a good agreement.

Macro-averaged Metrics : The per-class metrics can be averaged over all the classes resulting in macro-averaged precision, recall and F-1.

```r
# macro-averaged precision
precision_nb <- c(0.7500,0.66667,0.7143,0.8571)
macro_precision_nb <- mean(precision_nb)
# macro-averaged recall
recall_nb <- c(0.6000,0.66667,0.8333,0.8571)
macro_recall_nb<- mean(recall_nb)
# macro-averaged F-1
F1_nb<- c(0.6667,0.66667,0.7692,0.8571)
macroF1_nb <- mean(F1_nb)
macro_average_nb <-data.frame(macro_precision_nb, macro_recall_nb, macroF1_nb)
macro_average_nb
```

```
##   macro_precision_nb macro_recall_nb macroF1_nb
## 1          0.7470175       0.7392675  0.7399175
```

AUC

```r
nb_auc <- multiclass.roc(test$PAM50.mRNA, as.ordered(nbpred_model3))
auc(nb_auc)
```

```
## Multi-class area under the curve: 0.8857
```

```r
Name_metrics <- c("Accuracy", "Precision", "Recall", "F-1", "AUC", "Kappa")
values_nb <- c(0.7619, 0.7470175, 0.7392675,0.7399175, 0.8857, 0.6729 )
metrics_nb <- data.frame(Name_metrics, values_nb)
print (metrics_nb)
```

```
##   Name_metrics values_nb
## 1     Accuracy 0.7619000
## 2    Precision 0.7470175
## 3       Recall 0.7392675
## 4          F-1 0.7399175
## 5          AUC 0.8857000
## 6        Kappa 0.6729000
```

Random Forest

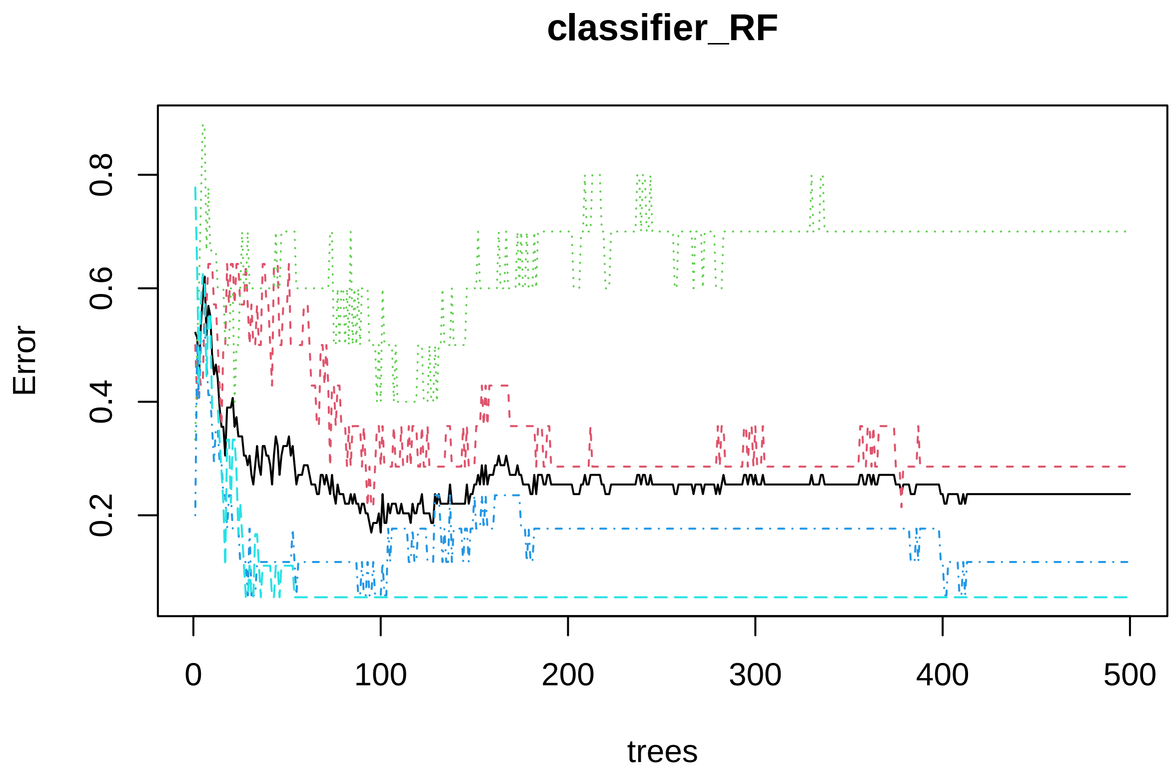
Random Forest is an ensemble of decision trees. It builds and combines multiple decision trees to get more accurate predictions. It's a non-linear classification algorithm. Each decision tree model is used when employed on its own. It works well with the multiclass classification.

```r
# Fitting Random Forest to the train dataset
set.seed(120)  # Setting seed
classifier_RF = randomForest(x = train[,1:30],
                             y = train$PAM50.mRNA,
                             ntree = 500)
RF_pred <- predict(classifier_RF, newdata = test)
confusionMatrix(RF_pred, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             4             1         1         1
##   HER2.enriched          0             1         0         0
##   Luminal.A              1             0         4         2
##   Luminal.B              0             1         1         4
##
## Overall Statistics
##
##                Accuracy : 0.619
##                  95% CI : (0.3844, 0.8189)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 0.006807
##
##                   Kappa : 0.4734
##
##  Mcnemar's Test P-Value : NA
```

```
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     0.8000              0.33333           0.6667
## Specificity                     0.8125              1.00000           0.8000
## Pos Pred Value                  0.5714              1.00000           0.5714
## Neg Pred Value                  0.9286              0.90000           0.8571
## Precision                       0.5714              1.00000           0.5714
## Recall                          0.8000              0.33333           0.6667
## F1                              0.6667              0.50000           0.6154
## Prevalence                      0.2381              0.14286           0.2857
## Detection Rate                  0.1905              0.04762           0.1905
## Detection Prevalence            0.3333              0.04762           0.3333
## Balanced Accuracy               0.8063              0.66667           0.7333
##                      Class: Luminal.B
## Sensitivity                    0.5714
## Specificity                    0.8571
## Pos Pred Value                 0.6667
## Neg Pred Value                 0.8000
## Precision                      0.6667
## Recall                         0.5714
## F1                             0.6154
## Prevalence                     0.3333
## Detection Rate                 0.1905
## Detection Prevalence           0.2857
## Balanced Accuracy              0.7143
```

```
# Plotting model
plot(classifier_RF)
```

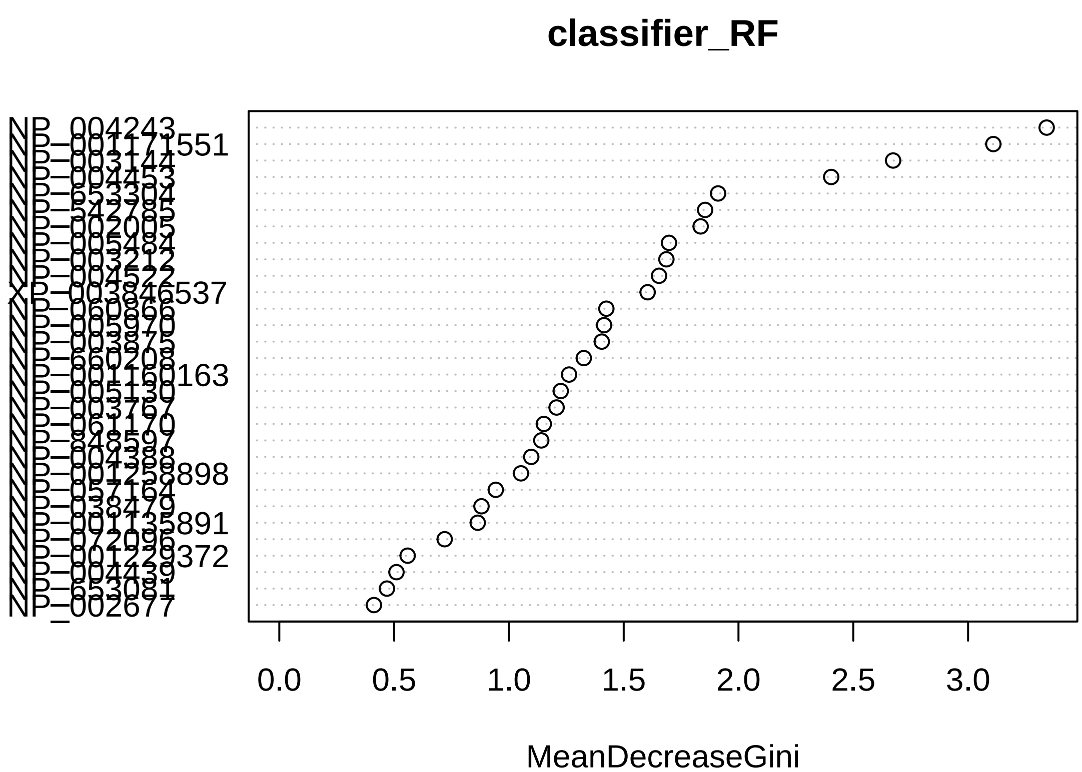



```
# Importance plot
importance(classifier_RF)
```

```
##              MeanDecreaseGini
## NP_038479           0.8805231
## NP_001258898        1.0524888
## NP_542785           1.8547260
## NP_002005           1.8352126
## XP_003846537        1.6043369
## NP_660208           1.3260767
## NP_004439           0.5102471
## NP_004388           1.0973934
## NP_001229372        0.5588631
## NP_005130           1.2257370
## NP_004243           3.3422886
## NP_003144           2.6735076
## NP_001171551        3.1100743
## NP_072096           0.7202323
## NP_005484           1.6973190
## NP_061170           1.1520539
## NP_653304           1.9111497
## NP_653081           0.4687590
## NP_057164           0.9427079
## NP_004453           2.4038736
## NP_003212           1.6859924
## NP_060866           1.4245630
```

```
## NP_001160163         1.2619327
## NP_003875            1.4044818
## NP_002677            0.4121577
## NP_001135891         0.8641273
## NP_004522            1.6539665
## NP_003767            1.2076640
## NP_848597            1.1409587
## NP_005970            1.4146192
```

```r
# Variable importance plot
varImpPlot(classifier_RF)
```



Model evaluation for RF: 1. Accuracy : The overall model accuracy of model is 61.9% 2. Precision,Recall,F1 : The Precision,Recall,F1 for Basal.like class is 0.5714 , 0.8000, 0.6667 The Precision,Recall,F1 for HER2.enriched class is 1.00000, 0.33333, 0.50000 The Precision,Recall,F1 for Luminal.A class is 0.5714, 0.6667, 0.6154 The Precision,Recall,F1 for Luminal.B class is 0.6667, 0.5714, 0.6154
3. Sensitivity and Specificity The Sensitivity and Specificity for Basal.like class is 0.80000 and 0.8125 The Sensitivity and Specificity for HER2.enriched class is 0.333333 and 1.00000 The Sensitivity and Specificity for Luminal.A is 0.6667 and 0.8000 The Sensitivity and Specificity for Luminal.B class is 0.5714 and 0.8571 4. The Kappa statistic: The kappa value for this model is 0.473 which states that it is a good agreement.

Macro-averaged Metrics : The per-class metrics can be averaged over all the classes resulting in macro-averaged precision, recall and F-1.

```r
# macro-averaged precision
precision_rf<- c(0.5714,1.00000, 0.5714, 0.6667)
macro_precision_rf <- mean(precision_rf)
```

```r
# macro-averaged recall
recall_rf <- c(0.8000, 0.33333,0.6667,0.5714)
macro_recall_rf<- mean(recall_rf)
# macro-averaged F-1
F1_rf<- c(0.6667, 0.50000, 0.6154,0.6154)
macroF1_rf <- mean(F1_rf)
macro_average_rf <-data.frame(macro_precision_rf, macro_recall_rf, macroF1_rf)
macro_average_rf
```

```
##   macro_precision_rf macro_recall_rf macroF1_rf
## 1           0.702375       0.5928575   0.599375
```

AUC

```r
rf_auc <- multiclass.roc(test$PAM50.mRNA, as.ordered(RF_pred))
auc(rf_auc)
```

```
## Multi-class area under the curve: 0.7388
```

```r
Name_metrics <- c("Accuracy", "Precision", "Recall", "F-1", "AUC", "Kappa")
values_rf <- c(0.619, 0.702375, 0.5928575, 0.599375, 0.7388, 0.4734)
metrics_rf <- data.frame(Name_metrics, values_rf)
print (metrics_rf)
```

```
##   Name_metrics values_rf
## 1     Accuracy 0.6190000
## 2    Precision 0.7023750
## 3       Recall 0.5928575
## 4          F-1 0.5993750
## 5          AUC 0.7388000
## 6        Kappa 0.4734000
```

Comparing models

By comparing accuracy, precision, recall, f-1, AUC and kappa , Both SVM and the Neural Network model works best for the given datset have approximate same accuracy, precision, recall, f-1, AUC and kappa

```r
#SVM
print(metrics_svm)
```

```
##   Name_metrics values_svm
## 1     Accuracy  0.8095000
## 2    Precision  0.8428500
## 3       Recall  0.8095175
## 4          F-1  0.8057750
## 5          AUC  0.7897000
## 6        Kappa  0.7399000
```

```r
#NN
print(metrics_nn)
```

```
##   Name_metrics values_nn
## 1     Accuracy 0.8095000
## 2    Precision 0.8541500
## 3       Recall 0.7619075
## 4          F-1 0.7588500
## 5          AUC 0.8571000
## 6        Kappa 0.7358000
```

```r
#NB
print(metrics_nb)
```

```
##   Name_metrics values_nb
## 1     Accuracy 0.7619000
## 2    Precision 0.7470175
## 3       Recall 0.7392675
## 4          F-1 0.7399175
## 5          AUC 0.8857000
## 6        Kappa 0.6729000
```

```r
#RF
print(metrics_rf)
```

```
##   Name_metrics values_rf
## 1     Accuracy 0.6190000
## 2    Precision 0.7023750
## 3       Recall 0.5928575
## 4          F-1 0.5993750
## 5          AUC 0.7388000
## 6        Kappa 0.4734000
```

Though the SVM and neural network model achieved an accuracy of 81%, the precision, recall, AUC, kappa, and f-1 scores of neural network model are higher than SVM

Evaluation with k-fold cross-validation

- k-Fold Cross Validation is done for the whole dataset
- I have used k = 10 which means 10 folds take place along with 10 repetitions
- For testing the data, I have used 3 models to test the k-fold CV
- Accuracy of each model is printed and based on the observation average accuracy is around 75-80%

K-fold Cross Validation

#Creating a train function for cross validation #We use k = 10 folds with repeated validation = 10

```r
fitControl <- trainControl(## 10-fold CV
                           method = "repeatedcv",
                           number = 10,repeats = 10,savePredictions = TRUE, summaryFunction = multiClass
## SVM
svm_fit <- train(PAM50.mRNA ~ ., data=data_norm, trControl= fitControl, method="svmLinear")
## NN
nn_fit <- train(PAM50.mRNA ~., data= data_norm,
                method = "nnet",
                trControl = fitControl)
```

```
## # weights:  39
## initial  value 104.299245
## iter  10 value 79.995263
## iter  20 value 68.794379
## iter  30 value 60.381853
## iter  40 value 59.388098
## iter  50 value 59.379352
## final  value 59.379337
## converged
## # weights:  109
## initial  value 116.362540
## iter  10 value 38.703189
## iter  20 value 27.949090
## iter  30 value 17.701280
## iter  40 value 14.439066
## iter  50 value 12.383683
## iter  60 value 6.794370
## iter  70 value 4.342562
## iter  80 value 4.115155
## iter  90 value 4.059620
## iter 100 value 4.025623
## final  value 4.025623
## stopped after 100 iterations
## # weights:  179
## initial  value 113.501953
## iter  10 value 25.731497
## iter  20 value 1.147697
## iter  30 value 0.007144
## iter  40 value 0.000410
## final  value 0.000094
## converged
## # weights:  39
## initial  value 106.824209
## iter  10 value 83.502515
## iter  20 value 68.645068
## iter  30 value 65.457292
## iter  40 value 61.513073
## iter  50 value 58.252483
## iter  60 value 57.896911
## final  value 57.894931
## converged
## # weights:  109
## initial  value 116.266962
```

```
## iter  10 value 51.596366
## iter  20 value 36.012333
## iter  30 value 21.950493
## iter  40 value 17.872911
## iter  50 value 17.036263
## iter  60 value 16.922137
## iter  70 value 16.914098
## final  value 16.913988
## converged
## # weights:  179
## initial  value 122.764369
## iter  10 value 38.320919
## iter  20 value 20.761799
## iter  30 value 14.930962
## iter  40 value 13.658736
## iter  50 value 12.792821
## iter  60 value 12.222951
## iter  70 value 12.160783
## iter  80 value 12.155308
## iter  90 value 12.155177
## final  value 12.155175
## converged
## # weights:  39
## initial  value 102.999903
## iter  10 value 71.735883
## iter  20 value 70.410970
## iter  30 value 70.294498
## iter  40 value 67.538440
## iter  50 value 66.281131
## iter  60 value 66.192468
## iter  70 value 66.108589
## iter  80 value 63.075431
## iter  90 value 61.652379
## iter 100 value 60.552969
## final  value 60.552969
## stopped after 100 iterations
## # weights:  109
## initial  value 99.973885
## iter  10 value 46.734583
## iter  20 value 31.972769
## iter  30 value 30.881697
## iter  40 value 28.947184
## iter  50 value 27.868078
## iter  60 value 25.366362
## iter  70 value 22.809570
## iter  80 value 22.590384
## iter  90 value 19.453428
## iter 100 value 17.415759
## final  value 17.415759
## stopped after 100 iterations
## # weights:  179
## initial  value 124.898739
## iter  10 value 26.580909
## iter  20 value 12.932771
```

```
## iter  30 value 8.485489
## iter  40 value 5.668525
## iter  50 value 2.874250
## iter  60 value 2.468289
## iter  70 value 2.187638
## iter  80 value 2.171960
## iter  90 value 2.141243
## iter 100 value 1.600863
## final  value 1.600863
## stopped after 100 iterations
## # weights:  39
## initial  value 107.534552
## iter  10 value 77.408126
## iter  20 value 62.583232
## iter  30 value 62.127657
## iter  40 value 61.841436
## iter  50 value 61.220112
## iter  60 value 59.870141
## iter  70 value 57.542284
## iter  80 value 57.195943
## iter  90 value 57.091503
## iter 100 value 56.912937
## final  value 56.912937
## stopped after 100 iterations
## # weights:  109
## initial  value 95.978593
## iter  10 value 27.730307
## iter  20 value 11.535128
## iter  30 value 9.429867
## iter  40 value 6.068945
## iter  50 value 2.907960
## iter  60 value 0.572396
## iter  70 value 0.260605
## iter  80 value 0.129128
## iter  90 value 0.055157
## iter 100 value 0.018479
## final  value 0.018479
## stopped after 100 iterations
## # weights:  179
## initial  value 110.151479
## iter  10 value 29.390762
## iter  20 value 12.489817
## iter  30 value 11.199421
## iter  40 value 11.006589
## iter  50 value 9.140846
## iter  60 value 8.864893
## iter  70 value 8.427249
## iter  80 value 8.014101
## iter  90 value 7.715628
## iter 100 value 7.291841
## final  value 7.291841
## stopped after 100 iterations
## # weights:  39
## initial  value 99.289685
```

```
## iter  10 value 74.506952
## iter  20 value 60.928284
## iter  30 value 56.968706
## iter  40 value 54.908474
## iter  50 value 54.781351
## final  value 54.781138
## converged
## # weights:  109
## initial  value 137.357072
## iter  10 value 46.207196
## iter  20 value 25.596747
## iter  30 value 17.876964
## iter  40 value 15.953225
## iter  50 value 15.860954
## iter  60 value 15.754487
## iter  70 value 15.742685
## final  value 15.742600
## converged
## # weights:  179
## initial  value 113.028811
## iter  10 value 51.580245
## iter  20 value 18.290789
## iter  30 value 13.097499
## iter  40 value 12.212833
## iter  50 value 12.004191
## iter  60 value 11.909150
## iter  70 value 11.650546
## iter  80 value 11.634106
## iter  90 value 11.633821
## final  value 11.633818
## converged
## # weights:  39
## initial  value 115.982494
## iter  10 value 67.485232
## iter  20 value 52.358131
## iter  30 value 49.659574
## iter  40 value 47.370464
## iter  50 value 46.753621
## iter  60 value 46.544948
## iter  70 value 46.539404
## iter  80 value 46.497780
## iter  90 value 46.492026
## iter 100 value 45.739199
## final  value 45.739199
## stopped after 100 iterations
## # weights:  109
## initial  value 130.792341
## iter  10 value 55.816138
## iter  20 value 31.748520
## iter  30 value 29.668303
## iter  40 value 26.709483
## iter  50 value 24.513221
## iter  60 value 22.782926
## iter  70 value 19.023683
```

```
## iter  80 value 16.658544
## iter  90 value 15.870652
## iter 100 value 14.728344
## final  value 14.728344
## stopped after 100 iterations
## # weights:  179
## initial  value 104.611807
## iter  10 value 22.178543
## iter  20 value 12.448488
## iter  30 value 10.927914
## iter  40 value 9.463426
## iter  50 value 7.778376
## iter  60 value 7.736431
## iter  70 value 7.716090
## iter  80 value 7.708813
## iter  90 value 7.688731
## iter 100 value 5.733465
## final  value 5.733465
## stopped after 100 iterations
## # weights:  39
## initial  value 106.172496
## iter  10 value 86.872725
## iter  20 value 57.511076
## iter  30 value 56.540269
## iter  40 value 56.439194
## iter  50 value 56.396876
## iter  60 value 56.391441
## iter  70 value 56.391033
## iter  80 value 56.385723
## final  value 56.385444
## converged
## # weights:  109
## initial  value 104.772786
## iter  10 value 55.672629
## iter  20 value 25.962566
## iter  30 value 21.773805
## iter  40 value 18.892384
## iter  50 value 18.247111
## iter  60 value 17.458875
## iter  70 value 16.139796
## iter  80 value 15.787836
## iter  90 value 15.538131
## iter 100 value 15.277635
## final  value 15.277635
## stopped after 100 iterations
## # weights:  179
## initial  value 111.814271
## iter  10 value 44.354336
## iter  20 value 10.307670
## iter  30 value 6.086850
## iter  40 value 5.348093
## iter  50 value 3.497817
## iter  60 value 2.820233
## iter  70 value 2.794453
```

```
## iter  80 value 2.780624
## iter  90 value 2.750278
## iter 100 value 1.436444
## final  value 1.436444
## stopped after 100 iterations
## # weights:  39
## initial  value 104.974226
## iter  10 value 80.474975
## iter  20 value 71.828073
## iter  30 value 63.278804
## iter  40 value 61.888456
## iter  50 value 59.784916
## iter  60 value 59.612207
## iter  70 value 59.417354
## iter  80 value 58.905914
## iter  90 value 58.677707
## iter 100 value 58.370532
## final  value 58.370532
## stopped after 100 iterations
## # weights:  109
## initial  value 106.528293
## iter  10 value 53.734265
## iter  20 value 30.959814
## iter  30 value 23.095271
## iter  40 value 18.686541
## iter  50 value 17.210192
## iter  60 value 16.941136
## iter  70 value 16.866421
## iter  80 value 16.860315
## iter  90 value 16.860243
## iter 100 value 16.860240
## final  value 16.860240
## stopped after 100 iterations
## # weights:  179
## initial  value 106.609535
## iter  10 value 63.899599
## iter  20 value 25.022424
## iter  30 value 15.515251
## iter  40 value 13.810678
## iter  50 value 12.793296
## iter  60 value 12.484983
## iter  70 value 12.334758
## iter  80 value 12.236790
## iter  90 value 12.231608
## iter 100 value 12.231195
## final  value 12.231195
## stopped after 100 iterations
## # weights:  39
## initial  value 101.251697
## iter  10 value 63.047555
## iter  20 value 57.734503
## iter  30 value 56.939382
## iter  40 value 55.426947
## iter  50 value 54.959000
```

```
## iter  60 value 54.590336
## iter  70 value 54.019167
## iter  80 value 54.010700
## iter  90 value 53.827956
## iter 100 value 53.528454
## final  value 53.528454
## stopped after 100 iterations
## # weights:  109
## initial  value 108.635563
## iter  10 value 48.039839
## iter  20 value 37.102114
## iter  30 value 29.573146
## iter  40 value 26.880421
## iter  50 value 23.348759
## iter  60 value 18.988447
## iter  70 value 16.018596
## iter  80 value 13.116881
## iter  90 value 9.794588
## iter 100 value 7.008114
## final  value 7.008114
## stopped after 100 iterations
## # weights:  179
## initial  value 100.607660
## iter  10 value 27.004845
## iter  20 value 7.453921
## iter  30 value 5.302572
## iter  40 value 4.961915
## iter  50 value 4.927429
## iter  60 value 4.364980
## iter  70 value 4.289189
## iter  80 value 4.283562
## iter  90 value 4.273091
## iter 100 value 3.210138
## final  value 3.210138
## stopped after 100 iterations
## # weights:  39
## initial  value 100.717327
## iter  10 value 64.985780
## iter  20 value 58.567277
## iter  30 value 55.655203
## iter  40 value 53.682472
## iter  50 value 51.761930
## iter  60 value 50.823441
## iter  70 value 49.179080
## iter  80 value 48.890284
## iter  90 value 48.568349
## iter 100 value 48.209384
## final  value 48.209384
## stopped after 100 iterations
## # weights:  109
## initial  value 113.829643
## iter  10 value 50.596999
## iter  20 value 23.609407
## iter  30 value 18.619909
```

```
## iter  40 value 17.125002
## iter  50 value 15.399086
## iter  60 value 14.399728
## iter  70 value 6.490757
## iter  80 value 3.972695
## iter  90 value 3.905719
## iter 100 value 3.870901
## final  value 3.870901
## stopped after 100 iterations
## # weights:  179
## initial  value 104.998431
## iter  10 value 22.333531
## iter  20 value 13.811587
## iter  30 value 9.801557
## iter  40 value 8.154785
## iter  50 value 7.284657
## iter  60 value 5.563999
## iter  70 value 4.660962
## iter  80 value 3.850569
## iter  90 value 3.826762
## iter 100 value 3.822120
## final  value 3.822120
## stopped after 100 iterations
## # weights:  39
## initial  value 105.049947
## iter  10 value 81.858467
## iter  20 value 73.393758
## iter  30 value 65.001082
## iter  40 value 60.848525
## iter  50 value 59.022501
## iter  60 value 58.300252
## iter  70 value 57.186428
## iter  80 value 56.598648
## iter  90 value 56.595445
## iter  90 value 56.595444
## iter  90 value 56.595444
## final  value 56.595444
## converged
## # weights:  109
## initial  value 107.200565
## iter  10 value 67.677230
## iter  20 value 36.521978
## iter  30 value 22.392395
## iter  40 value 17.668750
## iter  50 value 17.246634
## iter  60 value 17.121434
## iter  70 value 17.061321
## iter  80 value 17.009409
## iter  90 value 16.442363
## iter 100 value 16.308005
## final  value 16.308005
## stopped after 100 iterations
## # weights:  179
## initial  value 152.069661
```

```
## iter  10 value 61.784433
## iter  20 value 27.333358
## iter  30 value 17.521918
## iter  40 value 14.049912
## iter  50 value 12.613819
## iter  60 value 12.224530
## iter  70 value 12.202828
## iter  80 value 12.202575
## final  value 12.202574
## converged
## # weights:  39
## initial  value 100.626011
## iter  10 value 65.509069
## iter  20 value 58.342048
## iter  30 value 54.963527
## iter  40 value 54.552171
## iter  50 value 54.531254
## iter  60 value 54.501058
## iter  70 value 54.491701
## iter  80 value 54.471611
## iter  90 value 54.470959
## iter 100 value 54.464181
## final  value 54.464181
## stopped after 100 iterations
## # weights:  109
## initial  value 116.438720
## iter  10 value 26.557513
## iter  20 value 15.497749
## iter  30 value 10.841419
## iter  40 value 8.225107
## iter  50 value 7.381428
## iter  60 value 7.358426
## iter  70 value 7.346893
## iter  80 value 7.343231
## iter  90 value 7.337401
## iter 100 value 7.282426
## final  value 7.282426
## stopped after 100 iterations
## # weights:  179
## initial  value 110.390245
## iter  10 value 21.362538
## iter  20 value 4.026865
## iter  30 value 1.539409
## iter  40 value 0.173331
## iter  50 value 0.153800
## iter  60 value 0.136163
## iter  70 value 0.127874
## iter  80 value 0.120223
## iter  90 value 0.112015
## iter 100 value 0.106384
## final  value 0.106384
## stopped after 100 iterations
## # weights:  39
## initial  value 98.552367
```

```
## iter  10 value 67.855438
## iter  20 value 63.206718
## iter  30 value 62.068004
## iter  40 value 60.066793
## iter  50 value 58.205317
## iter  60 value 56.389512
## iter  70 value 54.260892
## iter  80 value 54.025613
## iter  90 value 53.933159
## iter 100 value 53.914166
## final  value 53.914166
## stopped after 100 iterations
## # weights:  109
## initial  value 107.177071
## iter  10 value 51.032188
## iter  20 value 29.849584
## iter  30 value 17.488955
## iter  40 value 16.283049
## iter  50 value 14.894966
## iter  60 value 14.787368
## iter  70 value 14.758977
## iter  80 value 14.753727
## iter  90 value 14.752571
## iter 100 value 14.750209
## final  value 14.750209
## stopped after 100 iterations
## # weights:  179
## initial  value 110.349521
## iter  10 value 24.671307
## iter  20 value 9.924925
## iter  30 value 5.793526
## iter  40 value 3.025711
## iter  50 value 2.306541
## iter  60 value 1.593979
## iter  70 value 1.384801
## iter  80 value 0.026944
## iter  90 value 0.004425
## iter 100 value 0.000988
## final  value 0.000988
## stopped after 100 iterations
## # weights:  39
## initial  value 117.025048
## iter  10 value 69.939157
## iter  20 value 62.618639
## iter  30 value 60.193304
## iter  40 value 56.433804
## iter  50 value 55.966883
## iter  60 value 55.787166
## iter  70 value 55.643447
## final  value 55.641012
## converged
## # weights:  109
## initial  value 107.239992
## iter  10 value 60.210263
```

```
## iter  20 value 33.247721
## iter  30 value 20.005296
## iter  40 value 16.829320
## iter  50 value 16.611187
## iter  60 value 16.585789
## iter  70 value 16.576311
## iter  80 value 16.575989
## iter  90 value 16.575887
## iter 100 value 16.570244
## final  value 16.570244
## stopped after 100 iterations
## # weights:  179
## initial  value 98.070342
## iter  10 value 40.086104
## iter  20 value 20.348670
## iter  30 value 14.270639
## iter  40 value 12.530497
## iter  50 value 12.316868
## iter  60 value 12.177518
## iter  70 value 12.115303
## iter  80 value 12.104557
## final  value 12.104504
## converged
## # weights:  39
## initial  value 100.912213
## iter  10 value 70.384471
## iter  20 value 52.876164
## iter  30 value 46.449586
## iter  40 value 43.333689
## iter  50 value 41.598764
## iter  60 value 40.001864
## iter  70 value 38.421120
## iter  80 value 37.921159
## iter  90 value 36.138026
## iter 100 value 34.847282
## final  value 34.847282
## stopped after 100 iterations
## # weights:  109
## initial  value 112.716553
## iter  10 value 52.125195
## iter  20 value 39.553309
## iter  30 value 37.208279
## iter  40 value 36.981957
## iter  50 value 36.923396
## iter  60 value 32.555804
## iter  70 value 32.026935
## iter  80 value 30.925919
## iter  90 value 30.219515
## iter 100 value 29.505104
## final  value 29.505104
## stopped after 100 iterations
## # weights:  179
## initial  value 118.677646
## iter  10 value 28.638221
```

```
## iter  20 value 15.491842
## iter  30 value 13.136416
## iter  40 value 12.318244
## iter  50 value 12.228116
## iter  60 value 12.050837
## iter  70 value 11.857411
## iter  80 value 11.816403
## iter  90 value 11.801960
## iter 100 value 11.759114
## final  value 11.759114
## stopped after 100 iterations
## # weights:  39
## initial  value 99.880365
## iter  10 value 57.961515
## iter  20 value 56.762476
## iter  30 value 56.721989
## final  value 56.721929
## converged
## # weights:  109
## initial  value 96.754578
## iter  10 value 34.799439
## iter  20 value 21.553847
## iter  30 value 18.274166
## iter  40 value 16.807931
## iter  50 value 16.266339
## iter  60 value 15.969466
## iter  70 value 15.861306
## iter  80 value 15.832816
## iter  90 value 15.760522
## iter 100 value 14.929405
## final  value 14.929405
## stopped after 100 iterations
## # weights:  179
## initial  value 103.676180
## iter  10 value 33.171005
## iter  20 value 13.314321
## iter  30 value 7.562079
## iter  40 value 5.631875
## iter  50 value 5.124174
## iter  60 value 5.056457
## iter  70 value 5.030734
## iter  80 value 5.023789
## iter  90 value 4.175961
## iter 100 value 4.164328
## final  value 4.164328
## stopped after 100 iterations
## # weights:  39
## initial  value 109.231542
## iter  10 value 81.919137
## iter  20 value 71.954902
## iter  30 value 61.252902
## iter  40 value 59.000512
## iter  50 value 58.645676
## iter  60 value 58.209515
```

```
## iter  70 value 57.945933
## iter  80 value 57.894637
## iter  90 value 57.824625
## iter 100 value 57.793450
## final  value 57.793450
## stopped after 100 iterations
## # weights:  109
## initial  value 107.791837
## iter  10 value 53.681348
## iter  20 value 36.243093
## iter  30 value 28.404314
## iter  40 value 22.999579
## iter  50 value 19.119749
## iter  60 value 17.219522
## iter  70 value 16.420321
## iter  80 value 16.287253
## iter  90 value 16.258708
## iter 100 value 16.248457
## final  value 16.248457
## stopped after 100 iterations
## # weights:  179
## initial  value 115.324174
## iter  10 value 40.915611
## iter  20 value 24.398844
## iter  30 value 16.096842
## iter  40 value 13.897308
## iter  50 value 13.622497
## iter  60 value 12.734113
## iter  70 value 12.536133
## iter  80 value 12.485224
## iter  90 value 12.460506
## iter 100 value 12.459113
## final  value 12.459113
## stopped after 100 iterations
## # weights:  39
## initial  value 101.757311
## iter  10 value 68.407113
## iter  20 value 63.642736
## iter  30 value 62.402660
## iter  40 value 55.957965
## iter  50 value 53.515893
## iter  60 value 51.354498
## iter  70 value 50.607363
## iter  80 value 49.028262
## iter  90 value 48.682382
## iter 100 value 47.838888
## final  value 47.838888
## stopped after 100 iterations
## # weights:  109
## initial  value 103.194169
## iter  10 value 52.745907
## iter  20 value 41.613003
## iter  30 value 39.727312
## iter  40 value 37.670857
```

```
## iter  50 value 32.824262
## iter  60 value 29.672714
## iter  70 value 28.608191
## iter  80 value 27.761329
## iter  90 value 27.553337
## iter 100 value 26.904029
## final  value 26.904029
## stopped after 100 iterations
## # weights:  179
## initial  value 110.863530
## iter  10 value 27.436186
## iter  20 value 14.791227
## iter  30 value 10.701541
## iter  40 value 9.301095
## iter  50 value 8.630477
## iter  60 value 7.591230
## iter  70 value 4.815392
## iter  80 value 4.761449
## iter  90 value 4.754500
## iter 100 value 4.738265
## final  value 4.738265
## stopped after 100 iterations
## # weights:  39
## initial  value 110.959131
## iter  10 value 63.465868
## iter  20 value 58.488543
## iter  30 value 57.203294
## iter  40 value 57.110512
## iter  50 value 57.007346
## iter  60 value 56.496470
## iter  70 value 56.462252
## iter  80 value 56.443633
## iter  90 value 56.390091
## iter 100 value 52.483490
## final  value 52.483490
## stopped after 100 iterations
## # weights:  109
## initial  value 108.824751
## iter  10 value 47.460205
## iter  20 value 26.905718
## iter  30 value 20.341997
## iter  40 value 16.560114
## iter  50 value 15.997722
## iter  60 value 15.915869
## iter  70 value 15.900989
## iter  80 value 15.893431
## iter  90 value 15.884524
## iter 100 value 15.883344
## final  value 15.883344
## stopped after 100 iterations
## # weights:  179
## initial  value 111.206377
## iter  10 value 25.127204
## iter  20 value 7.266960
```

```
## iter  30 value 4.714106
## iter  40 value 1.481820
## iter  50 value 1.406999
## iter  60 value 1.393125
## iter  70 value 1.389521
## iter  80 value 1.387649
## iter  90 value 1.386772
## iter 100 value 1.386590
## final  value 1.386590
## stopped after 100 iterations
## # weights:  39
## initial  value 100.917487
## iter  10 value 71.981814
## iter  20 value 60.175294
## iter  30 value 58.317043
## iter  40 value 57.186037
## iter  50 value 56.272042
## iter  60 value 55.872294
## iter  70 value 55.864496
## iter  80 value 55.862892
## iter  80 value 55.862892
## final  value 55.862892
## converged
## # weights:  109
## initial  value 104.944030
## iter  10 value 50.983381
## iter  20 value 31.509779
## iter  30 value 24.463671
## iter  40 value 18.705393
## iter  50 value 17.301566
## iter  60 value 16.273576
## iter  70 value 16.074725
## iter  80 value 15.446332
## iter  90 value 15.324312
## iter 100 value 15.322977
## final  value 15.322977
## stopped after 100 iterations
## # weights:  179
## initial  value 119.735846
## iter  10 value 58.348497
## iter  20 value 26.209849
## iter  30 value 15.392135
## iter  40 value 13.540317
## iter  50 value 13.085016
## iter  60 value 12.674765
## iter  70 value 12.249233
## iter  80 value 12.138040
## iter  90 value 12.062072
## iter 100 value 12.012855
## final  value 12.012855
## stopped after 100 iterations
## # weights:  39
## initial  value 106.136459
## iter  10 value 65.889177
```

```
## iter  20 value 57.929137
## iter  30 value 56.948422
## iter  40 value 56.669705
## iter  50 value 56.637367
## iter  60 value 56.634346
## iter  70 value 55.888021
## iter  80 value 54.384295
## iter  90 value 51.968513
## iter 100 value 51.953473
## final  value 51.953473
## stopped after 100 iterations
## # weights:  109
## initial  value 102.682068
## iter  10 value 27.112006
## iter  20 value 9.241030
## iter  30 value 5.248934
## iter  40 value 3.790089
## iter  50 value 3.768558
## iter  60 value 3.743937
## iter  70 value 3.664264
## iter  80 value 3.643307
## iter  90 value 3.630765
## iter 100 value 3.623009
## final  value 3.623009
## stopped after 100 iterations
## # weights:  179
## initial  value 132.329856
## iter  10 value 40.464593
## iter  20 value 7.703621
## iter  30 value 0.637454
## iter  40 value 0.282670
## iter  50 value 0.249801
## iter  60 value 0.235429
## iter  70 value 0.213995
## iter  80 value 0.199750
## iter  90 value 0.186244
## iter 100 value 0.170999
## final  value 0.170999
## stopped after 100 iterations
## # weights:  39
## initial  value 107.932002
## iter  10 value 82.114107
## iter  20 value 71.940654
## iter  30 value 64.243677
## iter  40 value 62.468894
## iter  50 value 61.935605
## iter  60 value 60.912114
## iter  70 value 59.416281
## iter  80 value 58.338382
## iter  90 value 58.285290
## iter 100 value 57.972039
## final  value 57.972039
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 98.842008
## iter  10 value 28.955405
## iter  20 value 19.944667
## iter  30 value 17.611146
## iter  40 value 10.582223
## iter  50 value 7.941031
## iter  60 value 6.535764
## iter  70 value 6.226752
## iter  80 value 4.861934
## iter  90 value 4.823937
## iter 100 value 4.796571
## final  value 4.796571
## stopped after 100 iterations
## # weights:  179
## initial  value 99.691223
## iter  10 value 16.235017
## iter  20 value 6.053412
## iter  30 value 0.050231
## iter  40 value 0.001047
## final  value 0.000067
## converged
## # weights:  39
## initial  value 100.342119
## iter  10 value 66.064036
## iter  20 value 63.202448
## iter  30 value 61.353635
## iter  40 value 58.557329
## iter  50 value 58.329317
## iter  60 value 58.185655
## iter  70 value 57.935024
## iter  80 value 57.929060
## final  value 57.929028
## converged
## # weights:  109
## initial  value 114.883864
## iter  10 value 60.194812
## iter  20 value 31.552175
## iter  30 value 21.947784
## iter  40 value 17.649294
## iter  50 value 17.059606
## iter  60 value 17.042136
## iter  70 value 17.041686
## iter  70 value 17.041685
## iter  70 value 17.041685
## final  value 17.041685
## converged
## # weights:  179
## initial  value 135.344635
## iter  10 value 62.292829
## iter  20 value 35.416389
## iter  30 value 25.528215
## iter  40 value 17.108175
## iter  50 value 15.490671
## iter  60 value 13.508727
```

```
## iter  70 value 12.997724
## iter  80 value 12.481864
## iter  90 value 12.450390
## iter 100 value 12.449450
## final  value 12.449450
## stopped after 100 iterations
## # weights:  39
## initial  value 96.281811
## iter  10 value 63.609748
## iter  20 value 57.973872
## iter  30 value 55.453585
## iter  40 value 55.411477
## iter  50 value 55.345670
## iter  60 value 55.256349
## iter  70 value 55.206647
## iter  80 value 53.726007
## iter  90 value 53.687086
## iter 100 value 53.647190
## final  value 53.647190
## stopped after 100 iterations
## # weights:  109
## initial  value 103.866339
## iter  10 value 38.025011
## iter  20 value 27.001563
## iter  30 value 21.842538
## iter  40 value 19.261342
## iter  50 value 19.003653
## iter  60 value 18.894927
## iter  70 value 18.811324
## iter  80 value 18.659426
## iter  90 value 18.477321
## iter 100 value 18.298549
## final  value 18.298549
## stopped after 100 iterations
## # weights:  179
## initial  value 115.247467
## iter  10 value 19.718212
## iter  20 value 2.403281
## iter  30 value 0.186954
## iter  40 value 0.161772
## iter  50 value 0.149354
## iter  60 value 0.134385
## iter  70 value 0.126576
## iter  80 value 0.115716
## iter  90 value 0.103181
## iter 100 value 0.096828
## final  value 0.096828
## stopped after 100 iterations
## # weights:  39
## initial  value 108.894872
## iter  10 value 73.916422
## iter  20 value 65.266602
## iter  30 value 62.575629
## iter  40 value 61.718241
```

```
## iter  50 value 61.590989
## iter  60 value 61.578241
## iter  70 value 61.574426
## iter  80 value 61.572429
## iter  90 value 61.571914
## iter 100 value 61.571797
## final  value 61.571797
## stopped after 100 iterations
## # weights:  109
## initial  value 102.560674
## iter  10 value 30.690458
## iter  20 value 14.741499
## iter  30 value 13.482866
## iter  40 value 12.212443
## iter  50 value 12.124849
## iter  60 value 10.814600
## iter  70 value 10.668416
## iter  80 value 10.577347
## iter  90 value 10.563861
## iter 100 value 10.560087
## final  value 10.560087
## stopped after 100 iterations
## # weights:  179
## initial  value 105.150326
## iter  10 value 20.393961
## iter  20 value 5.560496
## iter  30 value 3.471349
## iter  40 value 3.297772
## iter  50 value 3.295724
## iter  60 value 2.340438
## iter  70 value 1.909851
## final  value 1.909619
## converged
## # weights:  39
## initial  value 110.168234
## iter  10 value 73.003745
## iter  20 value 64.755496
## iter  30 value 64.610060
## iter  40 value 64.605490
## final  value 64.605478
## converged
## # weights:  109
## initial  value 113.847105
## iter  10 value 44.279322
## iter  20 value 27.604761
## iter  30 value 21.034629
## iter  40 value 18.344250
## iter  50 value 16.931710
## iter  60 value 16.760816
## iter  70 value 16.754013
## iter  80 value 16.753892
## final  value 16.753892
## converged
## # weights:  179
```

```
## initial  value 113.759595
## iter  10 value 43.098184
## iter  20 value 20.631854
## iter  30 value 15.325356
## iter  40 value 13.401510
## iter  50 value 12.720648
## iter  60 value 12.631544
## iter  70 value 12.608085
## iter  80 value 12.558423
## iter  90 value 12.493229
## iter 100 value 12.490125
## final  value 12.490125
## stopped after 100 iterations
## # weights:  39
## initial  value 113.229508
## iter  10 value 72.061956
## iter  20 value 57.918778
## iter  30 value 55.499836
## iter  40 value 52.932819
## iter  50 value 52.587012
## iter  60 value 52.578704
## iter  70 value 52.534078
## iter  80 value 51.803947
## iter  90 value 51.656701
## iter 100 value 51.644981
## final  value 51.644981
## stopped after 100 iterations
## # weights:  109
## initial  value 107.200968
## iter  10 value 46.784343
## iter  20 value 22.831097
## iter  30 value 8.638815
## iter  40 value 3.959222
## iter  50 value 2.488978
## iter  60 value 2.289492
## iter  70 value 2.250892
## iter  80 value 2.240761
## iter  90 value 2.226854
## iter 100 value 2.219139
## final  value 2.219139
## stopped after 100 iterations
## # weights:  179
## initial  value 147.812819
## iter  10 value 50.119464
## iter  20 value 15.137491
## iter  30 value 4.521312
## iter  40 value 0.406948
## iter  50 value 0.160106
## iter  60 value 0.143188
## iter  70 value 0.136240
## iter  80 value 0.127416
## iter  90 value 0.119076
## iter 100 value 0.106769
## final  value 0.106769
```

```
## stopped after 100 iterations
## # weights:  39
## initial  value 96.754508
## iter  10 value 63.341723
## iter  20 value 52.047592
## iter  30 value 47.012724
## iter  40 value 44.223938
## iter  50 value 42.665768
## iter  60 value 42.446280
## iter  70 value 42.385498
## iter  80 value 42.312469
## iter  90 value 42.296377
## iter 100 value 42.293163
## final  value 42.293163
## stopped after 100 iterations
## # weights:  109
## initial  value 107.598829
## iter  10 value 40.357649
## iter  20 value 4.992283
## iter  30 value 1.932641
## iter  40 value 1.388108
## iter  50 value 1.386534
## iter  60 value 1.386490
## iter  70 value 1.386341
## final  value 1.386341
## converged
## # weights:  179
## initial  value 130.835202
## iter  10 value 47.799740
## iter  20 value 28.302585
## iter  30 value 25.568887
## iter  40 value 24.101009
## iter  50 value 23.653895
## iter  60 value 23.487577
## iter  70 value 19.583634
## iter  80 value 14.318355
## iter  90 value 13.953269
## iter 100 value 13.219584
## final  value 13.219584
## stopped after 100 iterations
## # weights:  39
## initial  value 117.625333
## iter  10 value 84.737886
## iter  20 value 76.168626
## iter  30 value 70.701832
## iter  40 value 67.513769
## iter  50 value 66.968536
## iter  60 value 66.961837
## iter  70 value 66.961178
## final  value 66.961156
## converged
## # weights:  109
## initial  value 114.068774
## iter  10 value 44.952273
```

```
## iter  20 value 25.753066
## iter  30 value 19.603756
## iter  40 value 16.553390
## iter  50 value 16.409820
## iter  60 value 16.403952
## final  value 16.403938
## converged
## # weights:  179
## initial  value 104.955856
## iter  10 value 55.690905
## iter  20 value 24.103895
## iter  30 value 16.377522
## iter  40 value 13.678623
## iter  50 value 12.943146
## iter  60 value 12.451581
## iter  70 value 12.159373
## iter  80 value 12.017555
## iter  90 value 11.987827
## iter 100 value 11.985743
## final  value 11.985743
## stopped after 100 iterations
## # weights:  39
## initial  value 117.782625
## iter  10 value 64.787896
## iter  20 value 56.506052
## iter  30 value 51.372711
## iter  40 value 49.728805
## iter  50 value 46.880625
## iter  60 value 46.290194
## iter  70 value 45.209927
## iter  80 value 45.199754
## iter  90 value 40.538430
## iter 100 value 38.787199
## final  value 38.787199
## stopped after 100 iterations
## # weights:  109
## initial  value 105.848269
## iter  10 value 18.267208
## iter  20 value 3.891816
## iter  30 value 3.804844
## iter  40 value 3.630826
## iter  50 value 3.567384
## iter  60 value 3.531214
## iter  70 value 2.412683
## iter  80 value 1.512288
## iter  90 value 0.212810
## iter 100 value 0.139011
## final  value 0.139011
## stopped after 100 iterations
## # weights:  179
## initial  value 119.754249
## iter  10 value 19.431984
## iter  20 value 8.523413
## iter  30 value 4.887146
```

```
## iter  40 value 3.219610
## iter  50 value 2.285572
## iter  60 value 2.098373
## iter  70 value 2.056346
## iter  80 value 2.040285
## iter  90 value 2.032331
## iter 100 value 2.020975
## final  value 2.020975
## stopped after 100 iterations
## # weights:  39
## initial  value 104.764480
## iter  10 value 63.246282
## iter  20 value 61.323781
## iter  30 value 60.611185
## iter  40 value 60.519722
## iter  50 value 57.711113
## iter  60 value 54.692006
## iter  70 value 52.427619
## iter  80 value 51.925607
## iter  90 value 51.238294
## iter 100 value 50.944807
## final  value 50.944807
## stopped after 100 iterations
## # weights:  109
## initial  value 103.804462
## iter  10 value 47.808466
## iter  20 value 27.109549
## iter  30 value 25.265803
## iter  40 value 23.525787
## iter  50 value 23.256232
## iter  60 value 21.088757
## iter  70 value 20.795420
## iter  80 value 20.501748
## iter  90 value 19.992038
## iter 100 value 14.802605
## final  value 14.802605
## stopped after 100 iterations
## # weights:  179
## initial  value 114.975822
## iter  10 value 23.694777
## iter  20 value 10.433985
## iter  30 value 1.263466
## iter  40 value 0.058917
## iter  50 value 0.008678
## iter  60 value 0.003870
## iter  70 value 0.001816
## iter  80 value 0.001265
## iter  90 value 0.000424
## iter 100 value 0.000275
## final  value 0.000275
## stopped after 100 iterations
## # weights:  39
## initial  value 120.569025
## iter  10 value 71.814694
```

```
## iter  20 value 63.688957
## iter  30 value 61.620733
## iter  40 value 58.511222
## iter  50 value 57.961639
## iter  60 value 57.444182
## iter  70 value 57.377931
## iter  80 value 57.003371
## iter  90 value 56.434279
## iter 100 value 56.196210
## final  value 56.196210
## stopped after 100 iterations
## # weights:  109
## initial  value 103.408545
## iter  10 value 47.612621
## iter  20 value 28.336631
## iter  30 value 22.684814
## iter  40 value 18.948529
## iter  50 value 17.592884
## iter  60 value 16.588068
## iter  70 value 16.519867
## iter  80 value 16.518014
## final  value 16.518009
## converged
## # weights:  179
## initial  value 104.308140
## iter  10 value 50.166380
## iter  20 value 23.371493
## iter  30 value 14.335170
## iter  40 value 13.686882
## iter  50 value 13.601760
## iter  60 value 13.250208
## iter  70 value 12.900405
## iter  80 value 12.867244
## iter  90 value 12.820714
## iter 100 value 12.756087
## final  value 12.756087
## stopped after 100 iterations
## # weights:  39
## initial  value 120.621421
## iter  10 value 74.875171
## iter  20 value 56.586052
## iter  30 value 51.122404
## iter  40 value 47.262118
## iter  50 value 45.469478
## iter  60 value 45.313649
## iter  70 value 44.885905
## iter  80 value 44.826018
## iter  90 value 44.731641
## iter 100 value 44.687277
## final  value 44.687277
## stopped after 100 iterations
## # weights:  109
## initial  value 113.421039
## iter  10 value 31.834062
```

```
## iter  20 value 17.352883
## iter  30 value 12.351665
## iter  40 value 12.045616
## iter  50 value 11.909714
## iter  60 value 11.874033
## iter  70 value 11.648950
## iter  80 value 11.573960
## iter  90 value 11.526576
## iter 100 value 11.519786
## final  value 11.519786
## stopped after 100 iterations
## # weights:  179
## initial  value 91.351331
## iter  10 value 17.184451
## iter  20 value 0.628226
## iter  30 value 0.246212
## iter  40 value 0.230224
## iter  50 value 0.199532
## iter  60 value 0.175362
## iter  70 value 0.159984
## iter  80 value 0.150411
## iter  90 value 0.143870
## iter 100 value 0.138255
## final  value 0.138255
## stopped after 100 iterations
## # weights:  39
## initial  value 110.449141
## iter  10 value 67.797707
## iter  20 value 61.818435
## iter  30 value 61.011241
## iter  40 value 60.216677
## iter  50 value 55.241866
## iter  60 value 54.554785
## iter  70 value 54.089802
## iter  80 value 54.088596
## iter  90 value 54.083244
## iter 100 value 53.774009
## final  value 53.774009
## stopped after 100 iterations
## # weights:  109
## initial  value 102.533147
## iter  10 value 55.427692
## iter  20 value 34.586424
## iter  30 value 25.402713
## iter  40 value 19.138679
## iter  50 value 15.418337
## iter  60 value 13.841208
## iter  70 value 13.533989
## iter  80 value 13.353667
## iter  90 value 13.286907
## iter 100 value 11.271647
## final  value 11.271647
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 130.377959
## iter  10 value 32.501684
## iter  20 value 2.826998
## iter  30 value 0.052304
## iter  40 value 0.000183
## final  value 0.000081
## converged
## # weights:  39
## initial  value 104.728586
## iter  10 value 79.749280
## iter  20 value 67.331347
## iter  30 value 59.104183
## iter  40 value 56.931520
## iter  50 value 56.511163
## iter  60 value 56.263544
## iter  70 value 56.082933
## iter  80 value 56.010199
## final  value 56.009809
## converged
## # weights:  109
## initial  value 122.370198
## iter  10 value 58.603496
## iter  20 value 33.589782
## iter  30 value 21.254683
## iter  40 value 17.517895
## iter  50 value 15.869222
## iter  60 value 15.408248
## iter  70 value 15.372602
## iter  80 value 15.368923
## iter  90 value 15.368778
## final  value 15.368777
## converged
## # weights:  179
## initial  value 104.607661
## iter  10 value 38.735094
## iter  20 value 17.333637
## iter  30 value 13.194963
## iter  40 value 12.507821
## iter  50 value 12.387834
## iter  60 value 12.361019
## iter  70 value 12.359437
## iter  80 value 12.359250
## final  value 12.359247
## converged
## # weights:  39
## initial  value 101.726800
## iter  10 value 66.283439
## iter  20 value 57.303158
## iter  30 value 56.336324
## iter  40 value 55.237768
## iter  50 value 54.294321
## iter  60 value 53.968806
## iter  70 value 51.064280
## iter  80 value 50.433155
```

```
## iter  90 value 48.602883
## iter 100 value 48.401940
## final  value 48.401940
## stopped after 100 iterations
## # weights:  109
## initial  value 111.955568
## iter  10 value 78.479271
## iter  20 value 43.163637
## iter  30 value 27.507234
## iter  40 value 21.873629
## iter  50 value 20.352327
## iter  60 value 13.567628
## iter  70 value 13.514547
## iter  80 value 13.445732
## iter  90 value 12.894365
## iter 100 value 9.906976
## final  value 9.906976
## stopped after 100 iterations
## # weights:  179
## initial  value 107.997271
## iter  10 value 22.674823
## iter  20 value 6.362081
## iter  30 value 2.763221
## iter  40 value 2.717509
## iter  50 value 2.696336
## iter  60 value 2.465623
## iter  70 value 2.064416
## iter  80 value 1.260392
## iter  90 value 0.180732
## iter 100 value 0.156331
## final  value 0.156331
## stopped after 100 iterations
## # weights:  39
## initial  value 103.886470
## iter  10 value 67.344386
## iter  20 value 64.551048
## iter  30 value 63.754207
## iter  40 value 63.460116
## iter  50 value 63.426192
## iter  60 value 63.421501
## iter  70 value 63.421203
## iter  80 value 63.420945
## iter  90 value 63.420821
## final  value 63.420814
## converged
## # weights:  109
## initial  value 107.331717
## iter  10 value 34.019434
## iter  20 value 24.313956
## iter  30 value 19.528021
## iter  40 value 18.793440
## iter  50 value 15.316729
## iter  60 value 14.713690
## iter  70 value 11.631361
```

```
## iter  80 value 5.907635
## iter  90 value 4.947808
## iter 100 value 3.911174
## final  value 3.911174
## stopped after 100 iterations
## # weights:  179
## initial  value 119.341946
## iter  10 value 29.260662
## iter  20 value 10.545634
## iter  30 value 5.544076
## iter  40 value 3.055880
## iter  50 value 2.647555
## iter  60 value 0.096522
## iter  70 value 0.038207
## iter  80 value 0.013386
## iter  90 value 0.005843
## iter 100 value 0.001177
## final  value 0.001177
## stopped after 100 iterations
## # weights:  39
## initial  value 107.943692
## iter  10 value 73.184575
## iter  20 value 65.641014
## iter  30 value 63.547644
## iter  40 value 60.300469
## iter  50 value 60.049537
## iter  60 value 59.579250
## iter  70 value 59.106173
## iter  80 value 58.607341
## iter  90 value 57.949431
## iter 100 value 57.624258
## final  value 57.624258
## stopped after 100 iterations
## # weights:  109
## initial  value 103.475084
## iter  10 value 53.919216
## iter  20 value 29.723484
## iter  30 value 21.664634
## iter  40 value 19.160742
## iter  50 value 18.748583
## iter  60 value 18.602662
## iter  70 value 17.131767
## iter  80 value 16.901708
## iter  90 value 16.894407
## iter 100 value 16.892603
## final  value 16.892603
## stopped after 100 iterations
## # weights:  179
## initial  value 108.097968
## iter  10 value 48.924665
## iter  20 value 24.858059
## iter  30 value 15.815989
## iter  40 value 13.403120
## iter  50 value 12.614113
```

```
## iter  60 value 12.460090
## iter  70 value 12.450702
## iter  80 value 12.450540
## final  value 12.450536
## converged
## # weights:  39
## initial  value 115.454924
## iter  10 value 71.413989
## iter  20 value 62.974229
## iter  30 value 56.606915
## iter  40 value 53.905331
## iter  50 value 53.896478
## iter  60 value 53.892414
## iter  70 value 53.887586
## iter  80 value 52.767746
## iter  90 value 52.751001
## iter 100 value 52.748772
## final  value 52.748772
## stopped after 100 iterations
## # weights:  109
## initial  value 113.938518
## iter  10 value 35.060278
## iter  20 value 27.042466
## iter  30 value 13.422112
## iter  40 value 6.748367
## iter  50 value 5.740099
## iter  60 value 5.664929
## iter  70 value 5.614855
## iter  80 value 2.445752
## iter  90 value 2.275440
## iter 100 value 2.237137
## final  value 2.237137
## stopped after 100 iterations
## # weights:  179
## initial  value 118.218415
## iter  10 value 25.909847
## iter  20 value 12.803819
## iter  30 value 6.989589
## iter  40 value 6.510152
## iter  50 value 6.433263
## iter  60 value 6.398587
## iter  70 value 6.368572
## iter  80 value 5.617161
## iter  90 value 4.980381
## iter 100 value 4.918676
## final  value 4.918676
## stopped after 100 iterations
## # weights:  39
## initial  value 111.018778
## iter  10 value 62.708955
## iter  20 value 56.069550
## iter  30 value 54.005286
## iter  40 value 52.125736
## iter  50 value 51.234403
```

```
## iter  60 value 50.238066
## iter  70 value 49.805674
## iter  80 value 49.316203
## iter  90 value 47.410580
## iter 100 value 47.209908
## final  value 47.209908
## stopped after 100 iterations
## # weights:  109
## initial  value 117.907953
## iter  10 value 38.436704
## iter  20 value 24.825572
## iter  30 value 22.416180
## iter  40 value 20.491748
## iter  50 value 20.275935
## iter  60 value 20.234888
## iter  70 value 20.200826
## iter  80 value 20.161646
## iter  90 value 20.003843
## iter 100 value 19.884209
## final  value 19.884209
## stopped after 100 iterations
## # weights:  179
## initial  value 105.328276
## iter  10 value 20.402097
## iter  20 value 8.646863
## iter  30 value 7.759287
## iter  40 value 6.427525
## iter  50 value 6.329033
## iter  60 value 6.314727
## iter  70 value 5.947411
## iter  80 value 5.037935
## iter  90 value 4.757455
## iter 100 value 4.685897
## final  value 4.685897
## stopped after 100 iterations
## # weights:  39
## initial  value 107.950372
## iter  10 value 77.465959
## iter  20 value 72.231504
## iter  30 value 66.943362
## iter  40 value 59.435617
## iter  50 value 58.790556
## iter  60 value 58.583038
## iter  70 value 58.532780
## iter  80 value 58.528483
## final  value 58.528371
## converged
## # weights:  109
## initial  value 104.885899
## iter  10 value 44.535130
## iter  20 value 28.851385
## iter  30 value 20.433509
## iter  40 value 17.720537
## iter  50 value 17.073965
```

```
## iter  60 value 16.949024
## iter  70 value 16.627891
## iter  80 value 15.979658
## iter  90 value 15.968381
## final  value 15.968214
## converged
## # weights:  179
## initial  value 135.006360
## iter  10 value 40.221471
## iter  20 value 24.276930
## iter  30 value 15.254512
## iter  40 value 13.772375
## iter  50 value 12.933977
## iter  60 value 12.535304
## iter  70 value 12.415618
## iter  80 value 12.399639
## iter  90 value 12.398837
## final  value 12.398817
## converged
## # weights:  39
## initial  value 102.252185
## iter  10 value 57.893798
## iter  20 value 54.164271
## iter  30 value 52.992441
## iter  40 value 52.401022
## iter  50 value 51.459193
## iter  60 value 50.369926
## iter  70 value 49.350939
## iter  80 value 49.162610
## iter  90 value 48.353654
## iter 100 value 47.968038
## final  value 47.968038
## stopped after 100 iterations
## # weights:  109
## initial  value 115.785334
## iter  10 value 24.391870
## iter  20 value 12.769583
## iter  30 value 8.410923
## iter  40 value 8.189229
## iter  50 value 8.172680
## iter  60 value 8.155788
## iter  70 value 8.118178
## iter  80 value 8.074023
## iter  90 value 8.052222
## iter 100 value 8.044779
## final  value 8.044779
## stopped after 100 iterations
## # weights:  179
## initial  value 134.189972
## iter  10 value 52.438019
## iter  20 value 18.773631
## iter  30 value 12.852092
## iter  40 value 9.980223
## iter  50 value 9.801038
```

```
## iter  60 value 9.648594
## iter  70 value 9.624935
## iter  80 value 9.605365
## iter  90 value 9.567770
## iter 100 value 7.218887
## final  value 7.218887
## stopped after 100 iterations
## # weights:  39
## initial  value 104.866968
## iter  10 value 73.693383
## iter  20 value 68.395897
## iter  30 value 67.734504
## iter  40 value 67.081068
## iter  50 value 64.541466
## iter  60 value 62.515964
## iter  70 value 62.302233
## iter  80 value 61.067547
## iter  90 value 61.040022
## iter 100 value 61.018462
## final  value 61.018462
## stopped after 100 iterations
## # weights:  109
## initial  value 103.240359
## iter  10 value 39.397373
## iter  20 value 28.145510
## iter  30 value 22.790912
## iter  40 value 17.300874
## iter  50 value 13.603455
## iter  60 value 10.355601
## iter  70 value 6.048703
## iter  80 value 5.482557
## iter  90 value 5.443515
## iter 100 value 5.425352
## final  value 5.425352
## stopped after 100 iterations
## # weights:  179
## initial  value 107.657019
## iter  10 value 17.318848
## iter  20 value 4.847240
## iter  30 value 2.824152
## iter  40 value 1.899926
## iter  50 value 1.410387
## iter  60 value 0.014240
## iter  70 value 0.005613
## iter  80 value 0.002647
## iter  90 value 0.001600
## iter 100 value 0.001183
## final  value 0.001183
## stopped after 100 iterations
## # weights:  39
## initial  value 115.940116
## iter  10 value 80.433108
## iter  20 value 64.166528
## iter  30 value 60.732525
```

```
## iter  40 value 59.635453
## iter  50 value 59.078226
## iter  60 value 58.995451
## iter  70 value 58.780248
## iter  80 value 58.340267
## iter  90 value 58.153291
## iter 100 value 58.142893
## final  value 58.142893
## stopped after 100 iterations
## # weights:  109
## initial  value 109.906160
## iter  10 value 44.732187
## iter  20 value 32.476660
## iter  30 value 22.268931
## iter  40 value 18.126868
## iter  50 value 17.171169
## iter  60 value 17.071029
## iter  70 value 16.989255
## iter  80 value 16.714127
## iter  90 value 16.706393
## final  value 16.706373
## converged
## # weights:  179
## initial  value 121.964959
## iter  10 value 32.843419
## iter  20 value 18.458923
## iter  30 value 13.165546
## iter  40 value 12.555487
## iter  50 value 12.510685
## iter  60 value 12.493080
## iter  70 value 12.490919
## iter  80 value 12.490658
## iter  90 value 12.490643
## final  value 12.490642
## converged
## # weights:  39
## initial  value 100.338530
## iter  10 value 76.169395
## iter  20 value 70.448455
## iter  30 value 54.246536
## iter  40 value 48.802907
## iter  50 value 47.175589
## iter  60 value 47.107765
## iter  70 value 47.054691
## iter  80 value 47.026156
## iter  90 value 47.017621
## iter 100 value 47.010133
## final  value 47.010133
## stopped after 100 iterations
## # weights:  109
## initial  value 91.979990
## iter  10 value 30.707373
## iter  20 value 21.919875
## iter  30 value 17.714452
```

```
## iter  40 value 12.384744
## iter  50 value 9.426785
## iter  60 value 6.455048
## iter  70 value 6.057448
## iter  80 value 5.762124
## iter  90 value 5.474438
## iter 100 value 4.812094
## final  value 4.812094
## stopped after 100 iterations
## # weights:  179
## initial  value 90.186043
## iter  10 value 12.282116
## iter  20 value 1.873845
## iter  30 value 1.507811
## iter  40 value 0.473736
## iter  50 value 0.144523
## iter  60 value 0.123729
## iter  70 value 0.118167
## iter  80 value 0.112059
## iter  90 value 0.103234
## iter 100 value 0.095990
## final  value 0.095990
## stopped after 100 iterations
## # weights:  39
## initial  value 101.796799
## iter  10 value 72.835712
## iter  20 value 70.430026
## iter  30 value 70.013493
## iter  40 value 69.973718
## iter  50 value 69.968970
## iter  60 value 69.968507
## final  value 69.967893
## converged
## # weights:  109
## initial  value 114.626117
## iter  10 value 38.527097
## iter  20 value 24.571755
## iter  30 value 21.572643
## iter  40 value 20.168706
## iter  50 value 16.688986
## iter  60 value 12.992059
## iter  70 value 12.444683
## iter  80 value 11.546264
## iter  90 value 9.769672
## iter 100 value 7.153478
## final  value 7.153478
## stopped after 100 iterations
## # weights:  179
## initial  value 108.547980
## iter  10 value 27.010044
## iter  20 value 3.617901
## iter  30 value 1.928378
## iter  40 value 1.911100
## iter  50 value 1.909862
```

```
## iter  60 value 1.909543
## final  value 1.909543
## converged
## # weights:  39
## initial  value 100.239706
## iter  10 value 78.694682
## iter  20 value 67.427987
## iter  30 value 64.626249
## iter  40 value 61.717163
## iter  50 value 60.361951
## iter  60 value 60.288245
## final  value 60.288213
## converged
## # weights:  109
## initial  value 106.313650
## iter  10 value 43.068440
## iter  20 value 28.983081
## iter  30 value 22.984883
## iter  40 value 17.894523
## iter  50 value 17.235365
## iter  60 value 16.915588
## iter  70 value 16.358465
## iter  80 value 15.798334
## iter  90 value 15.794051
## final  value 15.794037
## converged
## # weights:  179
## initial  value 117.629130
## iter  10 value 41.854606
## iter  20 value 26.693568
## iter  30 value 18.463893
## iter  40 value 13.978631
## iter  50 value 12.741489
## iter  60 value 12.604487
## iter  70 value 12.585013
## iter  80 value 12.583861
## final  value 12.583839
## converged
## # weights:  39
## initial  value 103.631835
## iter  10 value 65.396030
## iter  20 value 54.768146
## iter  30 value 37.966065
## iter  40 value 35.718768
## iter  50 value 35.701729
## iter  60 value 35.688947
## iter  70 value 35.678597
## iter  80 value 35.666540
## iter  90 value 35.663116
## iter 100 value 35.660045
## final  value 35.660045
## stopped after 100 iterations
## # weights:  109
## initial  value 117.118302
```

```
## iter  10 value 35.340095
## iter  20 value 17.220076
## iter  30 value 14.223567
## iter  40 value 14.030370
## iter  50 value 13.894558
## iter  60 value 13.647213
## iter  70 value 13.204747
## iter  80 value 13.050662
## iter  90 value 12.963808
## iter 100 value 12.927217
## final  value 12.927217
## stopped after 100 iterations
## # weights:  179
## initial  value 101.943250
## iter  10 value 21.042763
## iter  20 value 5.771815
## iter  30 value 3.656828
## iter  40 value 3.471391
## iter  50 value 1.991635
## iter  60 value 1.603838
## iter  70 value 1.553675
## iter  80 value 1.546291
## iter  90 value 1.532753
## iter 100 value 1.520303
## final  value 1.520303
## stopped after 100 iterations
## # weights:  39
## initial  value 99.797558
## iter  10 value 65.945680
## iter  20 value 57.633580
## iter  30 value 54.165715
## iter  40 value 53.010454
## iter  50 value 51.946564
## iter  60 value 50.192761
## iter  70 value 48.545435
## iter  80 value 48.206089
## iter  90 value 48.070908
## iter 100 value 46.161606
## final  value 46.161606
## stopped after 100 iterations
## # weights:  109
## initial  value 97.850406
## iter  10 value 41.959992
## iter  20 value 10.897053
## iter  30 value 5.645714
## iter  40 value 5.108890
## iter  50 value 3.718183
## iter  60 value 3.521962
## iter  70 value 3.013266
## iter  80 value 2.338570
## iter  90 value 2.261968
## iter 100 value 2.256348
## final  value 2.256348
## stopped after 100 iterations
```

```
## # weights:  179
## initial  value 112.764363
## iter  10 value 23.686353
## iter  20 value 3.595541
## iter  30 value 2.243603
## iter  40 value 1.967209
## iter  50 value 1.914465
## iter  60 value 1.910244
## iter  70 value 1.513489
## iter  80 value 0.009331
## iter  90 value 0.003783
## iter 100 value 0.001051
## final  value 0.001051
## stopped after 100 iterations
## # weights:  39
## initial  value 115.324800
## iter  10 value 67.952091
## iter  20 value 63.175048
## iter  30 value 60.835177
## iter  40 value 58.722498
## iter  50 value 56.706761
## iter  60 value 56.624996
## iter  70 value 56.624357
## final  value 56.624349
## converged
## # weights:  109
## initial  value 108.072009
## iter  10 value 48.128830
## iter  20 value 30.797125
## iter  30 value 23.500813
## iter  40 value 17.361479
## iter  50 value 15.796159
## iter  60 value 15.355431
## iter  70 value 14.347636
## iter  80 value 14.254360
## final  value 14.254081
## converged
## # weights:  179
## initial  value 125.039959
## iter  10 value 30.179099
## iter  20 value 14.638748
## iter  30 value 12.198245
## iter  40 value 11.678432
## iter  50 value 11.606010
## iter  60 value 11.599622
## iter  70 value 11.599551
## final  value 11.599551
## converged
## # weights:  39
## initial  value 107.627648
## iter  10 value 65.001464
## iter  20 value 61.205110
## iter  30 value 57.776204
## iter  40 value 57.720982
```

```
## iter  50 value 57.706946
## iter  60 value 57.246885
## iter  70 value 56.640930
## iter  80 value 56.374022
## iter  90 value 55.642286
## iter 100 value 55.458651
## final  value 55.458651
## stopped after 100 iterations
## # weights:  109
## initial  value 108.253895
## iter  10 value 29.477915
## iter  20 value 22.458155
## iter  30 value 11.034093
## iter  40 value 10.664936
## iter  50 value 6.319931
## iter  60 value 5.367667
## iter  70 value 5.292838
## iter  80 value 5.271042
## iter  90 value 5.050436
## iter 100 value 4.658994
## final  value 4.658994
## stopped after 100 iterations
## # weights:  179
## initial  value 126.248823
## iter  10 value 17.031883
## iter  20 value 2.573441
## iter  30 value 2.423008
## iter  40 value 2.397704
## iter  50 value 2.382752
## iter  60 value 1.513084
## iter  70 value 0.350683
## iter  80 value 0.181818
## iter  90 value 0.172458
## iter 100 value 0.165108
## final  value 0.165108
## stopped after 100 iterations
## # weights:  39
## initial  value 99.092512
## iter  10 value 54.520354
## iter  20 value 52.461179
## iter  30 value 51.131887
## iter  40 value 51.123527
## iter  50 value 51.122706
## final  value 51.122704
## converged
## # weights:  109
## initial  value 104.389699
## iter  10 value 27.861184
## iter  20 value 16.934191
## iter  30 value 13.458953
## iter  40 value 11.705940
## iter  50 value 11.395266
## iter  60 value 10.838364
## iter  70 value 10.635716
```

```
## iter  80 value 10.235036
## iter  90 value 10.176873
## iter 100 value 10.115408
## final  value 10.115408
## stopped after 100 iterations
## # weights:  179
## initial  value 101.802878
## iter  10 value 25.946736
## iter  20 value 5.998618
## iter  30 value 2.284677
## iter  40 value 0.292031
## iter  50 value 0.024886
## iter  60 value 0.002933
## iter  70 value 0.000841
## iter  80 value 0.000362
## iter  90 value 0.000126
## iter  90 value 0.000079
## iter  90 value 0.000078
## final  value 0.000078
## converged
## # weights:  39
## initial  value 106.491510
## iter  10 value 81.936443
## iter  20 value 66.829675
## iter  30 value 58.211194
## iter  40 value 57.699985
## iter  50 value 57.166752
## iter  60 value 57.081910
## final  value 57.081874
## converged
## # weights:  109
## initial  value 112.703198
## iter  10 value 50.955553
## iter  20 value 34.678609
## iter  30 value 21.833766
## iter  40 value 16.577879
## iter  50 value 15.680038
## iter  60 value 15.480145
## iter  70 value 15.270827
## iter  80 value 15.266449
## final  value 15.266422
## converged
## # weights:  179
## initial  value 110.261485
## iter  10 value 40.124388
## iter  20 value 20.354962
## iter  30 value 13.681031
## iter  40 value 12.657736
## iter  50 value 12.231811
## iter  60 value 12.161312
## iter  70 value 12.081673
## iter  80 value 12.018442
## iter  90 value 12.017153
## final  value 12.017153
```

```
## converged
## # weights:  39
## initial  value 115.541619
## iter  10 value 69.763455
## iter  20 value 56.761979
## iter  30 value 56.176657
## iter  40 value 55.957916
## iter  50 value 55.542646
## iter  60 value 54.789151
## iter  70 value 54.609735
## iter  80 value 54.000936
## iter  90 value 53.884704
## iter 100 value 53.738417
## final  value 53.738417
## stopped after 100 iterations
## # weights:  109
## initial  value 101.441106
## iter  10 value 50.608195
## iter  20 value 29.747735
## iter  30 value 23.999537
## iter  40 value 22.719029
## iter  50 value 22.692488
## iter  60 value 22.288121
## iter  70 value 21.001114
## iter  80 value 20.706163
## iter  90 value 20.662388
## iter 100 value 20.626014
## final  value 20.626014
## stopped after 100 iterations
## # weights:  179
## initial  value 99.230238
## iter  10 value 26.101055
## iter  20 value 4.938801
## iter  30 value 1.932110
## iter  40 value 0.654283
## iter  50 value 0.330809
## iter  60 value 0.316019
## iter  70 value 0.297295
## iter  80 value 0.287927
## iter  90 value 0.271242
## iter 100 value 0.257000
## final  value 0.257000
## stopped after 100 iterations
## # weights:  39
## initial  value 104.669963
## iter  10 value 66.864078
## iter  20 value 57.140708
## iter  30 value 46.290808
## iter  40 value 42.824948
## iter  50 value 39.941510
## iter  60 value 39.464018
## iter  70 value 39.274388
## iter  80 value 39.192357
## iter  90 value 39.187777
```

```
## final  value 39.187680
## converged
## # weights:  109
## initial  value 102.806021
## iter  10 value 34.130442
## iter  20 value 18.861193
## iter  30 value 15.530283
## iter  40 value 14.860458
## iter  50 value 13.471909
## iter  60 value 12.538304
## iter  70 value 12.487603
## iter  80 value 12.454008
## iter  90 value 11.836627
## iter 100 value 10.357161
## final  value 10.357161
## stopped after 100 iterations
## # weights:  179
## initial  value 110.056506
## iter  10 value 29.548531
## iter  20 value 7.109959
## iter  30 value 0.138636
## iter  40 value 0.004803
## iter  50 value 0.000520
## final  value 0.000079
## converged
## # weights:  39
## initial  value 107.606755
## iter  10 value 64.890558
## iter  20 value 62.218865
## iter  30 value 60.288694
## iter  40 value 59.565045
## iter  50 value 59.470008
## iter  60 value 59.438217
## iter  70 value 59.288268
## iter  80 value 58.855666
## iter  90 value 58.387994
## iter 100 value 57.969991
## final  value 57.969991
## stopped after 100 iterations
## # weights:  109
## initial  value 103.328452
## iter  10 value 45.950875
## iter  20 value 27.123260
## iter  30 value 21.293860
## iter  40 value 18.066032
## iter  50 value 16.870077
## iter  60 value 16.818723
## iter  70 value 16.818030
## final  value 16.818018
## converged
## # weights:  179
## initial  value 113.379353
## iter  10 value 35.821643
## iter  20 value 19.753527
```

```
## iter  30 value 15.336133
## iter  40 value 13.298086
## iter  50 value 12.679920
## iter  60 value 12.258777
## iter  70 value 12.175820
## iter  80 value 11.870675
## iter  90 value 11.801158
## iter 100 value 11.799397
## final  value 11.799397
## stopped after 100 iterations
## # weights:  39
## initial  value 105.880894
## iter  10 value 72.160537
## iter  20 value 62.226050
## iter  30 value 60.131566
## iter  40 value 58.574585
## iter  50 value 58.315643
## iter  60 value 58.310338
## iter  70 value 57.111805
## iter  80 value 55.743800
## iter  90 value 54.941298
## iter 100 value 53.855418
## final  value 53.855418
## stopped after 100 iterations
## # weights:  109
## initial  value 105.445966
## iter  10 value 24.748807
## iter  20 value 8.480186
## iter  30 value 5.052165
## iter  40 value 3.145878
## iter  50 value 3.107283
## iter  60 value 3.086148
## iter  70 value 1.725250
## iter  80 value 0.248367
## iter  90 value 0.203523
## iter 100 value 0.188687
## final  value 0.188687
## stopped after 100 iterations
## # weights:  179
## initial  value 109.204451
## iter  10 value 39.441681
## iter  20 value 17.093497
## iter  30 value 12.699110
## iter  40 value 11.690340
## iter  50 value 11.587461
## iter  60 value 11.526514
## iter  70 value 11.380410
## iter  80 value 11.260593
## iter  90 value 10.969327
## iter 100 value 10.430343
## final  value 10.430343
## stopped after 100 iterations
## # weights:  39
## initial  value 98.363151
```

```
## iter  10 value 67.624509
## iter  20 value 60.633832
## iter  30 value 57.193424
## iter  40 value 56.093446
## iter  50 value 55.973291
## iter  60 value 55.956924
## iter  70 value 55.955302
## iter  80 value 55.954574
## iter  90 value 55.954275
## iter 100 value 55.954048
## final  value 55.954048
## stopped after 100 iterations
## # weights:  109
## initial  value 103.419247
## iter  10 value 46.156053
## iter  20 value 23.139476
## iter  30 value 13.198848
## iter  40 value 10.844448
## iter  50 value 2.336920
## iter  60 value 0.047963
## iter  70 value 0.011123
## iter  80 value 0.005462
## iter  90 value 0.003336
## iter 100 value 0.000468
## final  value 0.000468
## stopped after 100 iterations
## # weights:  179
## initial  value 106.351747
## iter  10 value 35.788512
## iter  20 value 21.996247
## iter  30 value 19.139947
## iter  40 value 18.227073
## iter  50 value 16.185335
## iter  60 value 14.453311
## iter  70 value 14.242484
## iter  80 value 13.906471
## iter  90 value 13.542946
## iter 100 value 12.614270
## final  value 12.614270
## stopped after 100 iterations
## # weights:  39
## initial  value 101.909049
## iter  10 value 83.815337
## iter  20 value 61.818776
## iter  30 value 58.439010
## iter  40 value 56.635246
## iter  50 value 55.989602
## iter  60 value 55.965725
## final  value 55.965721
## converged
## # weights:  109
## initial  value 113.992190
## iter  10 value 34.746678
## iter  20 value 19.581461
```

```
## iter  30 value 16.901982
## iter  40 value 16.466751
## iter  50 value 16.430641
## iter  60 value 16.430493
## iter  60 value 16.430493
## iter  60 value 16.430493
## final  value 16.430493
## converged
## # weights:  179
## initial  value 101.122494
## iter  10 value 40.285028
## iter  20 value 19.781269
## iter  30 value 13.669962
## iter  40 value 12.997945
## iter  50 value 12.772024
## iter  60 value 12.757873
## iter  70 value 12.753326
## iter  80 value 12.750597
## iter  90 value 12.737905
## iter 100 value 12.735693
## final  value 12.735693
## stopped after 100 iterations
## # weights:  39
## initial  value 98.298796
## iter  10 value 61.422001
## iter  20 value 58.642248
## iter  30 value 58.065218
## iter  40 value 58.046885
## iter  50 value 57.865301
## iter  60 value 57.552258
## iter  70 value 57.350447
## iter  80 value 57.061957
## iter  90 value 56.647747
## iter 100 value 56.521577
## final  value 56.521577
## stopped after 100 iterations
## # weights:  109
## initial  value 109.441374
## iter  10 value 49.270731
## iter  20 value 26.177021
## iter  30 value 21.712290
## iter  40 value 18.950270
## iter  50 value 18.532337
## iter  60 value 17.944845
## iter  70 value 17.750274
## iter  80 value 16.764428
## iter  90 value 14.358276
## iter 100 value 14.257871
## final  value 14.257871
## stopped after 100 iterations
## # weights:  179
## initial  value 107.599108
## iter  10 value 31.782188
## iter  20 value 11.582940
```

```
## iter  30 value 9.534893
## iter  40 value 8.602921
## iter  50 value 8.055574
## iter  60 value 6.349979
## iter  70 value 6.241851
## iter  80 value 6.199797
## iter  90 value 6.183823
## iter 100 value 6.172418
## final  value 6.172418
## stopped after 100 iterations
## # weights:  39
## initial  value 105.743871
## iter  10 value 54.754192
## iter  20 value 51.203334
## iter  30 value 50.923013
## iter  40 value 50.526202
## iter  50 value 49.996790
## iter  60 value 49.701227
## iter  70 value 49.551739
## iter  80 value 48.595680
## iter  90 value 48.542432
## iter 100 value 48.291619
## final  value 48.291619
## stopped after 100 iterations
## # weights:  109
## initial  value 98.378575
## iter  10 value 35.522758
## iter  20 value 19.777993
## iter  30 value 13.389981
## iter  40 value 12.625373
## iter  50 value 12.556115
## iter  60 value 10.750258
## iter  70 value 10.589091
## iter  80 value 10.133228
## iter  90 value 8.204474
## iter 100 value 8.166898
## final  value 8.166898
## stopped after 100 iterations
## # weights:  179
## initial  value 113.392088
## iter  10 value 32.077971
## iter  20 value 17.442423
## iter  30 value 13.508386
## iter  40 value 9.728473
## iter  50 value 6.937042
## iter  60 value 5.789156
## iter  70 value 4.576619
## iter  80 value 4.371211
## iter  90 value 3.133403
## iter 100 value 2.953968
## final  value 2.953968
## stopped after 100 iterations
## # weights:  39
## initial  value 110.298436
```

```
## iter  10 value 70.831364
## iter  20 value 61.775637
## iter  30 value 57.984538
## iter  40 value 57.599174
## final  value 57.592674
## converged
## # weights:  109
## initial  value 101.927428
## iter  10 value 46.247144
## iter  20 value 22.521389
## iter  30 value 17.588709
## iter  40 value 16.488760
## iter  50 value 16.460482
## iter  60 value 16.459684
## iter  70 value 16.183518
## iter  80 value 16.137454
## iter  90 value 16.137075
## final  value 16.137075
## converged
## # weights:  179
## initial  value 124.797322
## iter  10 value 45.810230
## iter  20 value 24.971244
## iter  30 value 17.316854
## iter  40 value 14.727914
## iter  50 value 12.960653
## iter  60 value 12.373773
## iter  70 value 12.074334
## iter  80 value 11.976357
## iter  90 value 11.968884
## iter 100 value 11.967812
## final  value 11.967812
## stopped after 100 iterations
## # weights:  39
## initial  value 101.612215
## iter  10 value 64.843294
## iter  20 value 57.960247
## iter  30 value 53.378408
## iter  40 value 50.908074
## iter  50 value 48.054990
## iter  60 value 48.041764
## iter  70 value 48.038991
## iter  80 value 48.035420
## iter  90 value 48.034289
## iter 100 value 48.032511
## final  value 48.032511
## stopped after 100 iterations
## # weights:  109
## initial  value 128.191366
## iter  10 value 55.618530
## iter  20 value 41.772728
## iter  30 value 31.440104
## iter  40 value 29.638258
## iter  50 value 26.358346
```

```
## iter  60 value 25.134567
## iter  70 value 24.992638
## iter  80 value 24.681812
## iter  90 value 24.003667
## iter 100 value 19.789404
## final  value 19.789404
## stopped after 100 iterations
## # weights:  179
## initial  value 100.306791
## iter  10 value 26.609017
## iter  20 value 13.561397
## iter  30 value 11.641858
## iter  40 value 9.221786
## iter  50 value 7.792442
## iter  60 value 6.398922
## iter  70 value 5.003299
## iter  80 value 4.919302
## iter  90 value 4.908787
## iter 100 value 2.475845
## final  value 2.475845
## stopped after 100 iterations
## # weights:  39
## initial  value 102.553626
## iter  10 value 70.148006
## iter  20 value 67.830716
## iter  30 value 67.439081
## iter  40 value 67.093759
## iter  50 value 66.560196
## iter  60 value 64.630462
## iter  70 value 64.624002
## iter  80 value 64.060551
## iter  90 value 64.000883
## iter 100 value 63.992481
## final  value 63.992481
## stopped after 100 iterations
## # weights:  109
## initial  value 97.286293
## iter  10 value 20.656260
## iter  20 value 11.181246
## iter  30 value 3.458362
## iter  40 value 3.367512
## iter  50 value 3.365139
## iter  60 value 3.365060
## final  value 3.365060
## converged
## # weights:  179
## initial  value 132.619398
## iter  10 value 22.534098
## iter  20 value 8.917627
## iter  30 value 3.969384
## iter  40 value 3.892390
## iter  50 value 3.888532
## iter  60 value 3.888307
## final  value 3.888307
```

```
## converged
## # weights:  39
## initial  value 109.991995
## iter  10 value 69.334335
## iter  20 value 60.102021
## iter  30 value 56.653929
## iter  40 value 56.310702
## iter  50 value 56.001484
## final  value 55.998821
## converged
## # weights:  109
## initial  value 107.568757
## iter  10 value 44.422833
## iter  20 value 27.715355
## iter  30 value 19.698976
## iter  40 value 16.187469
## iter  50 value 15.878375
## iter  60 value 15.710391
## iter  70 value 15.675832
## final  value 15.675699
## converged
## # weights:  179
## initial  value 165.953703
## iter  10 value 61.975633
## iter  20 value 20.955199
## iter  30 value 13.015305
## iter  40 value 12.076087
## iter  50 value 11.885068
## iter  60 value 11.828839
## iter  70 value 11.781080
## iter  80 value 11.776055
## iter  90 value 11.775850
## iter 100 value 11.775827
## final  value 11.775827
## stopped after 100 iterations
## # weights:  39
## initial  value 108.794921
## iter  10 value 71.007891
## iter  20 value 68.856002
## iter  30 value 68.210033
## iter  40 value 68.076816
## iter  50 value 67.987203
## iter  60 value 67.950347
## iter  70 value 67.938321
## iter  80 value 67.928479
## iter  90 value 67.923468
## iter 100 value 67.241571
## final  value 67.241571
## stopped after 100 iterations
## # weights:  109
## initial  value 107.900894
## iter  10 value 40.841989
## iter  20 value 21.071311
## iter  30 value 13.768799
```

```
## iter  40 value 12.782516
## iter  50 value 12.716668
## iter  60 value 12.250581
## iter  70 value 10.983509
## iter  80 value 10.752676
## iter  90 value 10.665352
## iter 100 value 10.636042
## final  value 10.636042
## stopped after 100 iterations
## # weights:  179
## initial  value 112.823429
## iter  10 value 36.415183
## iter  20 value 22.613074
## iter  30 value 19.019331
## iter  40 value 17.745161
## iter  50 value 17.402077
## iter  60 value 16.645010
## iter  70 value 15.959768
## iter  80 value 15.620836
## iter  90 value 15.604400
## iter 100 value 15.576921
## final  value 15.576921
## stopped after 100 iterations
## # weights:  39
## initial  value 108.629768
## iter  10 value 67.402471
## iter  20 value 58.695268
## iter  30 value 53.511530
## iter  40 value 49.684815
## iter  50 value 48.739748
## iter  60 value 48.677250
## iter  70 value 47.712642
## iter  80 value 46.707818
## iter  90 value 46.627675
## iter 100 value 46.606485
## final  value 46.606485
## stopped after 100 iterations
## # weights:  109
## initial  value 113.450153
## iter  10 value 46.638019
## iter  20 value 29.465079
## iter  30 value 27.548786
## iter  40 value 24.093047
## iter  50 value 22.343031
## iter  60 value 20.104562
## iter  70 value 14.460399
## iter  80 value 13.923829
## iter  90 value 12.317854
## iter 100 value 9.034738
## final  value 9.034738
## stopped after 100 iterations
## # weights:  179
## initial  value 113.906049
## iter  10 value 34.327061
```

```
## iter  20 value 5.716226
## iter  30 value 2.428107
## iter  40 value 1.931394
## iter  50 value 1.910801
## iter  60 value 1.909633
## iter  70 value 1.906771
## iter  80 value 1.387489
## iter  90 value 1.386314
## iter 100 value 1.386312
## final  value 1.386312
## stopped after 100 iterations
## # weights:  39
## initial  value 122.529973
## iter  10 value 79.396166
## iter  20 value 64.985604
## iter  30 value 62.206387
## iter  40 value 60.081526
## iter  50 value 59.708559
## final  value 59.706366
## converged
## # weights:  109
## initial  value 110.888675
## iter  10 value 54.470268
## iter  20 value 28.999347
## iter  30 value 20.760679
## iter  40 value 18.376026
## iter  50 value 16.044729
## iter  60 value 15.885068
## iter  70 value 15.884350
## final  value 15.884347
## converged
## # weights:  179
## initial  value 128.878174
## iter  10 value 56.205250
## iter  20 value 24.379722
## iter  30 value 16.468165
## iter  40 value 13.774095
## iter  50 value 13.161681
## iter  60 value 13.022688
## iter  70 value 12.972723
## iter  80 value 12.865362
## iter  90 value 12.769547
## iter 100 value 12.621778
## final  value 12.621778
## stopped after 100 iterations
## # weights:  39
## initial  value 112.224905
## iter  10 value 61.512202
## iter  20 value 56.892719
## iter  30 value 55.881156
## iter  40 value 55.852551
## iter  50 value 54.757422
## iter  60 value 52.780328
## iter  70 value 52.379012
```

```
## iter  80 value 52.361437
## iter  90 value 52.351697
## iter 100 value 52.348910
## final  value 52.348910
## stopped after 100 iterations
## # weights:  109
## initial  value 114.821735
## iter  10 value 35.898037
## iter  20 value 15.665394
## iter  30 value 13.078620
## iter  40 value 12.855718
## iter  50 value 12.697503
## iter  60 value 12.292885
## iter  70 value 12.177201
## iter  80 value 12.150601
## iter  90 value 12.114948
## iter 100 value 12.090412
## final  value 12.090412
## stopped after 100 iterations
## # weights:  179
## initial  value 112.748959
## iter  10 value 28.986174
## iter  20 value 8.680665
## iter  30 value 3.286974
## iter  40 value 3.007362
## iter  50 value 2.944428
## iter  60 value 2.938071
## iter  70 value 2.927772
## iter  80 value 2.870727
## iter  90 value 2.055352
## iter 100 value 2.048296
## final  value 2.048296
## stopped after 100 iterations
## # weights:  39
## initial  value 95.850764
## iter  10 value 62.453250
## iter  20 value 57.903188
## iter  30 value 50.615237
## iter  40 value 47.879036
## iter  50 value 47.216456
## iter  60 value 47.167493
## iter  70 value 46.902150
## iter  80 value 45.775966
## iter  90 value 45.761625
## iter 100 value 45.350463
## final  value 45.350463
## stopped after 100 iterations
## # weights:  109
## initial  value 115.113788
## iter  10 value 35.844141
## iter  20 value 18.404776
## iter  30 value 16.750748
## iter  40 value 16.243210
## iter  50 value 16.191514
```

```
## iter  60 value 16.188828
## iter  70 value 16.188421
## iter  80 value 16.188386
## final  value 16.188378
## converged
## # weights:  179
## initial  value 98.513063
## iter  10 value 11.027990
## iter  20 value 0.375485
## iter  30 value 0.003338
## final  value 0.000063
## converged
## # weights:  39
## initial  value 98.246345
## iter  10 value 75.637567
## iter  20 value 62.043113
## iter  30 value 61.098588
## iter  40 value 60.071421
## iter  50 value 57.564738
## iter  60 value 57.131452
## iter  70 value 56.347131
## iter  80 value 55.781382
## iter  90 value 55.752338
## final  value 55.752265
## converged
## # weights:  109
## initial  value 97.917261
## iter  10 value 49.815846
## iter  20 value 29.049349
## iter  30 value 18.481692
## iter  40 value 16.472866
## iter  50 value 16.343455
## iter  60 value 16.341053
## iter  70 value 16.341018
## iter  70 value 16.341018
## iter  70 value 16.341018
## final  value 16.341018
## converged
## # weights:  179
## initial  value 116.019447
## iter  10 value 34.449699
## iter  20 value 16.765738
## iter  30 value 12.384215
## iter  40 value 11.945279
## iter  50 value 11.793083
## iter  60 value 11.659182
## iter  70 value 11.654419
## iter  80 value 11.653949
## iter  90 value 11.653946
## final  value 11.653945
## converged
## # weights:  39
## initial  value 97.285276
## iter  10 value 56.132521
```

```
## iter  20 value 53.182804
## iter  30 value 52.474062
## iter  40 value 51.545756
## iter  50 value 51.254303
## iter  60 value 50.260952
## iter  70 value 47.860074
## iter  80 value 47.002980
## iter  90 value 43.680638
## iter 100 value 42.720709
## final  value 42.720709
## stopped after 100 iterations
## # weights:  109
## initial  value 110.367790
## iter  10 value 32.758854
## iter  20 value 24.553723
## iter  30 value 22.242126
## iter  40 value 18.200074
## iter  50 value 16.325706
## iter  60 value 14.797029
## iter  70 value 13.842307
## iter  80 value 13.463217
## iter  90 value 13.446519
## iter 100 value 13.436926
## final  value 13.436926
## stopped after 100 iterations
## # weights:  179
## initial  value 103.522266
## iter  10 value 24.327191
## iter  20 value 11.539824
## iter  30 value 5.156288
## iter  40 value 3.623096
## iter  50 value 3.258208
## iter  60 value 3.159337
## iter  70 value 2.602408
## iter  80 value 2.270124
## iter  90 value 2.239744
## iter 100 value 2.198266
## final  value 2.198266
## stopped after 100 iterations
## # weights:  39
## initial  value 104.273895
## iter  10 value 80.178196
## iter  20 value 66.431267
## iter  30 value 63.061843
## iter  40 value 59.589533
## iter  50 value 56.643400
## iter  60 value 53.768765
## iter  70 value 53.402926
## iter  80 value 53.359037
## iter  90 value 53.343772
## iter 100 value 53.340174
## final  value 53.340174
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 104.200368
## iter  10 value 21.243159
## iter  20 value 14.672576
## iter  30 value 13.342334
## iter  40 value 12.862696
## iter  50 value 12.394133
## iter  60 value 12.358633
## iter  70 value 12.247942
## iter  80 value 12.200295
## iter  90 value 12.022641
## iter 100 value 11.489501
## final  value 11.489501
## stopped after 100 iterations
## # weights:  179
## initial  value 111.120113
## iter  10 value 37.173051
## iter  20 value 13.196762
## iter  30 value 5.858393
## iter  40 value 3.103790
## iter  50 value 0.863028
## iter  60 value 0.317633
## iter  70 value 0.115295
## iter  80 value 0.021825
## iter  90 value 0.006982
## iter 100 value 0.001611
## final  value 0.001611
## stopped after 100 iterations
## # weights:  39
## initial  value 104.685204
## iter  10 value 75.140028
## iter  20 value 65.893640
## iter  30 value 64.216871
## iter  40 value 61.255605
## iter  50 value 59.087264
## iter  60 value 58.293563
## iter  70 value 58.015434
## iter  80 value 57.571189
## iter  90 value 57.133244
## iter 100 value 57.114779
## final  value 57.114779
## stopped after 100 iterations
## # weights:  109
## initial  value 105.860992
## iter  10 value 52.608029
## iter  20 value 26.844929
## iter  30 value 18.915280
## iter  40 value 16.107803
## iter  50 value 15.697892
## iter  60 value 15.682900
## iter  70 value 15.682415
## final  value 15.682415
## converged
## # weights:  179
## initial  value 100.267651
```

```
## iter  10 value 26.444931
## iter  20 value 16.495048
## iter  30 value 14.037741
## iter  40 value 13.412082
## iter  50 value 12.767397
## iter  60 value 12.364658
## iter  70 value 12.289889
## iter  80 value 12.274146
## iter  90 value 11.989018
## iter 100 value 11.937742
## final  value 11.937742
## stopped after 100 iterations
## # weights:  39
## initial  value 109.747464
## iter  10 value 56.331905
## iter  20 value 49.041478
## iter  30 value 46.397400
## iter  40 value 45.541175
## iter  50 value 45.428697
## iter  60 value 44.929897
## iter  70 value 44.795720
## iter  80 value 44.595521
## iter  90 value 44.015823
## iter 100 value 43.945282
## final  value 43.945282
## stopped after 100 iterations
## # weights:  109
## initial  value 113.605104
## iter  10 value 43.466165
## iter  20 value 13.322778
## iter  30 value 12.275673
## iter  40 value 3.683061
## iter  50 value 3.018197
## iter  60 value 2.891836
## iter  70 value 2.684194
## iter  80 value 2.670181
## iter  90 value 2.530119
## iter 100 value 1.568872
## final  value 1.568872
## stopped after 100 iterations
## # weights:  179
## initial  value 106.179434
## iter  10 value 20.801837
## iter  20 value 2.620206
## iter  30 value 0.302520
## iter  40 value 0.250760
## iter  50 value 0.228579
## iter  60 value 0.215545
## iter  70 value 0.203795
## iter  80 value 0.192144
## iter  90 value 0.184748
## iter 100 value 0.171009
## final  value 0.171009
## stopped after 100 iterations
```

```
## # weights:  39
## initial  value 100.973925
## iter  10 value 57.784520
## iter  20 value 52.654989
## iter  30 value 50.229106
## iter  40 value 50.017123
## iter  50 value 49.974248
## iter  60 value 49.956866
## iter  70 value 49.940940
## iter  80 value 49.937328
## iter  90 value 49.936365
## iter 100 value 49.925764
## final  value 49.925764
## stopped after 100 iterations
## # weights:  109
## initial  value 105.825365
## iter  10 value 76.407707
## iter  20 value 22.095252
## iter  30 value 18.100747
## iter  40 value 17.651635
## iter  50 value 17.234190
## iter  60 value 17.117495
## iter  70 value 16.987831
## iter  80 value 16.946128
## iter  90 value 16.910896
## iter 100 value 16.543400
## final  value 16.543400
## stopped after 100 iterations
## # weights:  179
## initial  value 142.362018
## iter  10 value 30.525406
## iter  20 value 15.346714
## iter  30 value 9.294052
## iter  40 value 8.462413
## iter  50 value 8.252972
## iter  60 value 7.937159
## iter  70 value 7.013596
## iter  80 value 5.452642
## iter  90 value 5.413474
## iter 100 value 5.398253
## final  value 5.398253
## stopped after 100 iterations
## # weights:  39
## initial  value 100.160587
## iter  10 value 76.431954
## iter  20 value 64.302241
## iter  30 value 60.977127
## iter  40 value 59.615263
## iter  50 value 58.452224
## iter  60 value 58.296665
## final  value 58.296647
## converged
## # weights:  109
## initial  value 103.178689
```

```
## iter  10 value 55.083940
## iter  20 value 35.274241
## iter  30 value 21.559043
## iter  40 value 16.599123
## iter  50 value 16.115686
## iter  60 value 15.885448
## iter  70 value 15.668320
## iter  80 value 15.658130
## final  value 15.658085
## converged
## # weights:  179
## initial  value 119.207751
## iter  10 value 35.043853
## iter  20 value 19.259180
## iter  30 value 14.215892
## iter  40 value 13.225754
## iter  50 value 12.315779
## iter  60 value 12.073245
## iter  70 value 12.054459
## iter  80 value 12.053437
## final  value 12.053428
## converged
## # weights:  39
## initial  value 102.870859
## iter  10 value 65.530454
## iter  20 value 57.153446
## iter  30 value 51.913187
## iter  40 value 51.479502
## iter  50 value 51.473677
## iter  60 value 51.472720
## iter  70 value 51.471604
## iter  80 value 51.463795
## iter  90 value 50.363243
## iter 100 value 46.940685
## final  value 46.940685
## stopped after 100 iterations
## # weights:  109
## initial  value 106.702826
## iter  10 value 39.530385
## iter  20 value 31.274918
## iter  30 value 28.143944
## iter  40 value 28.086041
## iter  50 value 28.029798
## iter  60 value 28.011869
## iter  70 value 27.902788
## iter  80 value 27.278051
## iter  90 value 22.609223
## iter 100 value 19.270466
## final  value 19.270466
## stopped after 100 iterations
## # weights:  179
## initial  value 131.102634
## iter  10 value 33.895810
## iter  20 value 15.953847
```

```
## iter  30 value 1.198414
## iter  40 value 0.281149
## iter  50 value 0.245686
## iter  60 value 0.220006
## iter  70 value 0.197431
## iter  80 value 0.173932
## iter  90 value 0.161048
## iter 100 value 0.145110
## final  value 0.145110
## stopped after 100 iterations
## # weights:  39
## initial  value 103.592126
## iter  10 value 79.208572
## iter  20 value 73.755657
## iter  30 value 72.896207
## iter  40 value 71.964296
## iter  50 value 71.126707
## iter  60 value 70.989323
## iter  70 value 70.785329
## iter  80 value 70.698559
## iter  90 value 69.205389
## iter 100 value 68.510788
## final  value 68.510788
## stopped after 100 iterations
## # weights:  109
## initial  value 106.964333
## iter  10 value 44.649207
## iter  20 value 21.816080
## iter  30 value 15.075309
## iter  40 value 14.089762
## iter  50 value 13.680062
## iter  60 value 13.633934
## iter  70 value 13.627799
## iter  80 value 13.627371
## iter  90 value 13.627071
## iter 100 value 13.626788
## final  value 13.626788
## stopped after 100 iterations
## # weights:  179
## initial  value 141.144873
## iter  10 value 54.513365
## iter  20 value 31.163049
## iter  30 value 18.840031
## iter  40 value 6.465195
## iter  50 value 0.491711
## iter  60 value 0.133729
## iter  70 value 0.035622
## iter  80 value 0.006694
## iter  90 value 0.002690
## iter 100 value 0.000853
## final  value 0.000853
## stopped after 100 iterations
## # weights:  39
## initial  value 100.055874
```

```
## iter  10 value 73.232858
## iter  20 value 64.678985
## iter  30 value 61.608996
## iter  40 value 56.456073
## iter  50 value 55.024790
## iter  60 value 54.999220
## final  value 54.999116
## converged
## # weights:  109
## initial  value 101.514721
## iter  10 value 45.969373
## iter  20 value 26.365913
## iter  30 value 21.266877
## iter  40 value 16.977484
## iter  50 value 16.230839
## iter  60 value 16.217339
## iter  70 value 16.209484
## iter  80 value 16.187465
## iter  90 value 16.169314
## iter 100 value 16.168323
## final  value 16.168323
## stopped after 100 iterations
## # weights:  179
## initial  value 104.303083
## iter  10 value 35.011912
## iter  20 value 19.831508
## iter  30 value 14.055075
## iter  40 value 12.933150
## iter  50 value 12.813755
## iter  60 value 12.306662
## iter  70 value 11.898152
## iter  80 value 11.837618
## iter  90 value 11.837181
## final  value 11.837157
## converged
## # weights:  39
## initial  value 96.801867
## iter  10 value 63.620322
## iter  20 value 57.892841
## iter  30 value 56.838873
## iter  40 value 56.219903
## iter  50 value 53.626096
## iter  60 value 49.140950
## iter  70 value 44.668155
## iter  80 value 40.548887
## iter  90 value 36.706260
## iter 100 value 36.109958
## final  value 36.109958
## stopped after 100 iterations
## # weights:  109
## initial  value 109.479868
## iter  10 value 32.572522
## iter  20 value 19.541014
## iter  30 value 18.301975
```

```
## iter  40 value 18.104545
## iter  50 value 18.074769
## iter  60 value 18.059927
## iter  70 value 17.614017
## iter  80 value 17.574021
## iter  90 value 16.286495
## iter 100 value 15.855222
## final  value 15.855222
## stopped after 100 iterations
## # weights:  179
## initial  value 111.920541
## iter  10 value 37.578512
## iter  20 value 12.645302
## iter  30 value 11.388523
## iter  40 value 9.620623
## iter  50 value 9.098781
## iter  60 value 8.992492
## iter  70 value 8.891099
## iter  80 value 8.697270
## iter  90 value 8.129159
## iter 100 value 4.823805
## final  value 4.823805
## stopped after 100 iterations
## # weights:  39
## initial  value 111.713833
## iter  10 value 79.246710
## iter  20 value 57.860666
## iter  30 value 56.787143
## iter  40 value 56.250428
## iter  50 value 55.686524
## iter  60 value 54.387649
## iter  70 value 53.317710
## iter  80 value 53.035131
## iter  90 value 51.536488
## iter 100 value 51.109565
## final  value 51.109565
## stopped after 100 iterations
## # weights:  109
## initial  value 120.647719
## iter  10 value 63.132511
## iter  20 value 36.602502
## iter  30 value 26.648292
## iter  40 value 23.688316
## iter  50 value 21.633203
## iter  60 value 21.402477
## iter  70 value 21.036864
## iter  80 value 20.353243
## iter  90 value 19.863080
## iter 100 value 18.247658
## final  value 18.247658
## stopped after 100 iterations
## # weights:  179
## initial  value 104.277310
## iter  10 value 23.973221
```

```
## iter  20 value 4.155488
## iter  30 value 2.297378
## iter  40 value 2.250008
## iter  50 value 2.249362
## final  value 2.249356
## converged
## # weights:  39
## initial  value 102.263714
## iter  10 value 72.966869
## iter  20 value 63.939617
## iter  30 value 57.829239
## iter  40 value 56.970629
## iter  50 value 56.742280
## iter  60 value 56.326926
## iter  70 value 55.708456
## iter  80 value 55.686515
## final  value 55.686510
## converged
## # weights:  109
## initial  value 110.621111
## iter  10 value 42.607705
## iter  20 value 22.965918
## iter  30 value 17.436947
## iter  40 value 16.868241
## iter  50 value 16.831300
## iter  60 value 16.829190
## iter  70 value 16.829109
## final  value 16.829108
## converged
## # weights:  179
## initial  value 136.559433
## iter  10 value 47.009197
## iter  20 value 26.503933
## iter  30 value 17.023482
## iter  40 value 13.653284
## iter  50 value 12.781369
## iter  60 value 12.629725
## iter  70 value 12.604546
## iter  80 value 12.602509
## iter  90 value 12.579541
## iter 100 value 12.572201
## final  value 12.572201
## stopped after 100 iterations
## # weights:  39
## initial  value 106.054116
## iter  10 value 68.605511
## iter  20 value 62.390504
## iter  30 value 60.442573
## iter  40 value 59.435690
## iter  50 value 54.401535
## iter  60 value 50.280244
## iter  70 value 48.810406
## iter  80 value 48.149396
## iter  90 value 47.956578
```

```
## iter 100 value 47.579645
## final  value 47.579645
## stopped after 100 iterations
## # weights:  109
## initial  value 112.321504
## iter  10 value 47.353748
## iter  20 value 26.897734
## iter  30 value 15.043379
## iter  40 value 12.644526
## iter  50 value 11.953823
## iter  60 value 11.673357
## iter  70 value 11.259692
## iter  80 value 10.991315
## iter  90 value 9.303511
## iter 100 value 9.209382
## final  value 9.209382
## stopped after 100 iterations
## # weights:  179
## initial  value 102.179906
## iter  10 value 18.568774
## iter  20 value 3.508090
## iter  30 value 0.655172
## iter  40 value 0.185853
## iter  50 value 0.167920
## iter  60 value 0.159749
## iter  70 value 0.144850
## iter  80 value 0.132991
## iter  90 value 0.117110
## iter 100 value 0.106324
## final  value 0.106324
## stopped after 100 iterations
## # weights:  39
## initial  value 111.480998
## iter  10 value 78.242925
## iter  20 value 73.444508
## iter  30 value 69.506263
## iter  40 value 68.014797
## iter  50 value 67.849233
## iter  60 value 67.828279
## iter  70 value 67.825893
## iter  80 value 67.825610
## iter  90 value 67.825386
## final  value 67.825338
## converged
## # weights:  109
## initial  value 114.175458
## iter  10 value 50.689604
## iter  20 value 37.328890
## iter  30 value 31.590767
## iter  40 value 31.457850
## iter  50 value 31.296538
## iter  60 value 31.213510
## iter  70 value 31.197732
## iter  80 value 31.146990
```

```
## iter  90 value 31.111700
## iter 100 value 31.104484
## final  value 31.104484
## stopped after 100 iterations
## # weights:  179
## initial  value 136.031181
## iter  10 value 29.466597
## iter  20 value 15.446634
## iter  30 value 11.987605
## iter  40 value 9.698625
## iter  50 value 7.126129
## iter  60 value 6.087501
## iter  70 value 5.762533
## iter  80 value 5.549954
## iter  90 value 5.427731
## iter 100 value 4.661472
## final  value 4.661472
## stopped after 100 iterations
## # weights:  39
## initial  value 108.610709
## iter  10 value 92.176523
## iter  20 value 70.321851
## iter  30 value 62.516397
## iter  40 value 61.273200
## iter  50 value 61.262374
## final  value 61.262364
## converged
## # weights:  109
## initial  value 142.176533
## iter  10 value 75.274168
## iter  20 value 47.143641
## iter  30 value 34.925998
## iter  40 value 22.069397
## iter  50 value 17.370080
## iter  60 value 16.839116
## iter  70 value 16.697302
## iter  80 value 16.679119
## iter  90 value 16.678242
## iter 100 value 16.678227
## final  value 16.678227
## stopped after 100 iterations
## # weights:  179
## initial  value 114.377077
## iter  10 value 39.244631
## iter  20 value 18.233864
## iter  30 value 15.055457
## iter  40 value 13.744873
## iter  50 value 13.089238
## iter  60 value 12.959814
## iter  70 value 12.677389
## iter  80 value 12.619670
## iter  90 value 12.618037
## final  value 12.618011
## converged
```

```
## # weights:  39
## initial  value 107.724661
## iter  10 value 71.430965
## iter  20 value 66.711827
## iter  30 value 65.020372
## iter  40 value 64.229349
## iter  50 value 64.141627
## iter  60 value 61.321387
## iter  70 value 60.498816
## iter  80 value 60.093404
## iter  90 value 59.423075
## iter 100 value 59.098253
## final  value 59.098253
## stopped after 100 iterations
## # weights:  109
## initial  value 108.904984
## iter  10 value 45.818045
## iter  20 value 27.374777
## iter  30 value 15.843102
## iter  40 value 13.368509
## iter  50 value 11.419267
## iter  60 value 11.068134
## iter  70 value 11.043306
## iter  80 value 11.002143
## iter  90 value 10.786482
## iter 100 value 10.781322
## final  value 10.781322
## stopped after 100 iterations
## # weights:  179
## initial  value 105.547978
## iter  10 value 24.652374
## iter  20 value 1.721313
## iter  30 value 0.317535
## iter  40 value 0.284089
## iter  50 value 0.245125
## iter  60 value 0.226665
## iter  70 value 0.197506
## iter  80 value 0.179818
## iter  90 value 0.160245
## iter 100 value 0.142763
## final  value 0.142763
## stopped after 100 iterations
## # weights:  39
## initial  value 120.645515
## iter  10 value 61.637485
## iter  20 value 53.123121
## iter  30 value 48.896885
## iter  40 value 48.715487
## iter  50 value 48.714829
## iter  60 value 48.714706
## iter  60 value 48.714706
## iter  60 value 48.714706
## final  value 48.714706
## converged
```

```
## # weights:  109
## initial  value 106.861698
## iter  10 value 22.601379
## iter  20 value 10.206481
## iter  30 value 9.499900
## iter  40 value 9.433939
## iter  50 value 9.424377
## iter  60 value 9.366633
## iter  70 value 9.326111
## iter  80 value 9.274295
## iter  90 value 9.232818
## iter 100 value 9.212769
## final  value 9.212769
## stopped after 100 iterations
## # weights:  179
## initial  value 98.938722
## iter  10 value 17.703871
## iter  20 value 9.831781
## iter  30 value 6.229459
## iter  40 value 5.584642
## iter  50 value 5.555802
## iter  60 value 3.320211
## iter  70 value 3.293532
## iter  80 value 3.166623
## iter  90 value 3.147293
## iter 100 value 3.143740
## final  value 3.143740
## stopped after 100 iterations
## # weights:  39
## initial  value 109.335008
## iter  10 value 79.676130
## iter  20 value 66.874308
## iter  30 value 62.342386
## iter  40 value 61.042051
## iter  50 value 59.267353
## iter  60 value 58.817616
## iter  70 value 58.812712
## final  value 58.812628
## converged
## # weights:  109
## initial  value 145.111699
## iter  10 value 86.303677
## iter  20 value 48.857213
## iter  30 value 25.180625
## iter  40 value 17.647507
## iter  50 value 16.928808
## iter  60 value 16.404409
## iter  70 value 16.274914
## iter  80 value 16.247700
## iter  90 value 16.237129
## iter 100 value 16.233919
## final  value 16.233919
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 120.650479
## iter  10 value 35.934519
## iter  20 value 18.102816
## iter  30 value 14.347485
## iter  40 value 12.788833
## iter  50 value 12.095441
## iter  60 value 11.909278
## iter  70 value 11.804437
## iter  80 value 11.793172
## iter  90 value 11.792811
## iter 100 value 11.792798
## final  value 11.792798
## stopped after 100 iterations
## # weights:  39
## initial  value 105.058638
## iter  10 value 78.685765
## iter  20 value 61.916126
## iter  30 value 59.164554
## iter  40 value 59.156549
## iter  50 value 59.109079
## iter  60 value 58.005356
## iter  70 value 57.790018
## iter  80 value 57.758283
## iter  90 value 57.725367
## iter 100 value 55.973502
## final  value 55.973502
## stopped after 100 iterations
## # weights:  109
## initial  value 100.919183
## iter  10 value 46.992471
## iter  20 value 8.827525
## iter  30 value 8.555688
## iter  40 value 8.535719
## iter  50 value 8.516062
## iter  60 value 8.502384
## iter  70 value 8.491016
## iter  80 value 8.483104
## iter  90 value 8.477313
## iter 100 value 8.471856
## final  value 8.471856
## stopped after 100 iterations
## # weights:  179
## initial  value 103.582615
## iter  10 value 28.582405
## iter  20 value 9.640441
## iter  30 value 6.065557
## iter  40 value 5.002357
## iter  50 value 4.290514
## iter  60 value 4.179204
## iter  70 value 4.111332
## iter  80 value 4.068451
## iter  90 value 4.041857
## iter 100 value 4.032621
## final  value 4.032621
```

```
## stopped after 100 iterations
## # weights:  39
## initial  value 101.782962
## iter  10 value 63.538181
## iter  20 value 57.534621
## iter  30 value 52.627096
## iter  40 value 51.794453
## iter  50 value 51.261330
## iter  60 value 51.258879
## iter  70 value 50.643786
## iter  80 value 50.086664
## iter  90 value 50.083176
## iter 100 value 50.080439
## final  value 50.080439
## stopped after 100 iterations
## # weights:  109
## initial  value 129.743763
## iter  10 value 37.640433
## iter  20 value 25.819287
## iter  30 value 21.980830
## iter  40 value 20.449987
## iter  50 value 19.446402
## iter  60 value 18.715112
## iter  70 value 17.642275
## iter  80 value 14.590593
## iter  90 value 14.309223
## iter 100 value 14.074484
## final  value 14.074484
## stopped after 100 iterations
## # weights:  179
## initial  value 105.748942
## iter  10 value 52.283717
## iter  20 value 12.942157
## iter  30 value 9.968846
## iter  40 value 8.587177
## iter  50 value 7.526196
## iter  60 value 5.213605
## iter  70 value 1.773347
## iter  80 value 0.122413
## iter  90 value 0.045164
## iter 100 value 0.016591
## final  value 0.016591
## stopped after 100 iterations
## # weights:  39
## initial  value 107.914127
## iter  10 value 75.450615
## iter  20 value 62.906812
## iter  30 value 60.135136
## iter  40 value 57.707300
## iter  50 value 57.538580
## iter  60 value 57.025217
## iter  70 value 56.121082
## iter  80 value 55.252240
## iter  90 value 54.211762
```

```
## iter 100 value 54.207165
## final  value 54.207165
## stopped after 100 iterations
## # weights:  109
## initial  value 112.021578
## iter  10 value 53.765593
## iter  20 value 29.344986
## iter  30 value 19.989816
## iter  40 value 16.226424
## iter  50 value 15.447024
## iter  60 value 15.249666
## iter  70 value 15.247884
## iter  80 value 15.247825
## final  value 15.247824
## converged
## # weights:  179
## initial  value 100.916432
## iter  10 value 29.115380
## iter  20 value 15.897803
## iter  30 value 13.455035
## iter  40 value 12.771820
## iter  50 value 12.035579
## iter  60 value 11.874778
## iter  70 value 11.860929
## iter  80 value 11.860628
## final  value 11.860625
## converged
## # weights:  39
## initial  value 109.489056
## iter  10 value 79.237084
## iter  20 value 56.231497
## iter  30 value 53.489126
## iter  40 value 51.955535
## iter  50 value 51.353479
## iter  60 value 50.026939
## iter  70 value 49.197584
## iter  80 value 49.014764
## iter  90 value 48.677395
## iter 100 value 47.770908
## final  value 47.770908
## stopped after 100 iterations
## # weights:  109
## initial  value 114.920171
## iter  10 value 35.067807
## iter  20 value 22.209082
## iter  30 value 21.535110
## iter  40 value 18.112931
## iter  50 value 17.587471
## iter  60 value 17.548903
## iter  70 value 17.539604
## iter  80 value 17.525455
## iter  90 value 17.512473
## iter 100 value 17.500743
## final  value 17.500743
```

```
## stopped after 100 iterations
## # weights:  179
## initial  value 114.293964
## iter  10 value 20.980641
## iter  20 value 7.444786
## iter  30 value 5.627587
## iter  40 value 5.029160
## iter  50 value 2.918532
## iter  60 value 2.632264
## iter  70 value 2.579031
## iter  80 value 0.671726
## iter  90 value 0.321176
## iter 100 value 0.287104
## final  value 0.287104
## stopped after 100 iterations
## # weights:  39
## initial  value 104.998400
## iter  10 value 65.387418
## iter  20 value 55.477505
## iter  30 value 52.459363
## iter  40 value 49.830521
## iter  50 value 47.659870
## iter  60 value 46.665998
## iter  70 value 46.366990
## iter  80 value 46.350113
## iter  90 value 46.330118
## iter 100 value 45.724295
## final  value 45.724295
## stopped after 100 iterations
## # weights:  109
## initial  value 102.743289
## iter  10 value 30.690013
## iter  20 value 20.372395
## iter  30 value 18.373636
## iter  40 value 15.410071
## iter  50 value 14.657767
## iter  60 value 8.497372
## iter  70 value 7.810610
## iter  80 value 7.086149
## iter  90 value 7.039267
## iter 100 value 7.030767
## final  value 7.030767
## stopped after 100 iterations
## # weights:  179
## initial  value 113.419119
## iter  10 value 15.849269
## iter  20 value 0.460053
## iter  30 value 0.002249
## final  value 0.000091
## converged
## # weights:  39
## initial  value 109.775895
## iter  10 value 82.341835
## iter  20 value 72.463490
```

```
## iter  30 value 68.560593
## iter  40 value 63.323000
## iter  50 value 59.900773
## iter  60 value 56.980065
## iter  70 value 56.732388
## final  value 56.732046
## converged
## # weights:  109
## initial  value 107.624634
## iter  10 value 60.097713
## iter  20 value 31.943296
## iter  30 value 20.570084
## iter  40 value 17.380692
## iter  50 value 17.148130
## iter  60 value 17.143968
## final  value 17.143850
## converged
## # weights:  179
## initial  value 113.279239
## iter  10 value 31.886952
## iter  20 value 17.598580
## iter  30 value 14.606289
## iter  40 value 12.420506
## iter  50 value 12.121150
## iter  60 value 11.972272
## iter  70 value 11.961330
## iter  80 value 11.960746
## iter  90 value 11.960684
## final  value 11.960682
## converged
## # weights:  39
## initial  value 104.642163
## iter  10 value 80.124375
## iter  20 value 68.035844
## iter  30 value 63.527875
## iter  40 value 61.474930
## iter  50 value 58.870838
## iter  60 value 58.119046
## iter  70 value 58.111727
## iter  80 value 58.081951
## iter  90 value 58.059267
## iter 100 value 58.056581
## final  value 58.056581
## stopped after 100 iterations
## # weights:  109
## initial  value 118.713302
## iter  10 value 35.495847
## iter  20 value 23.053432
## iter  30 value 17.678575
## iter  40 value 13.383633
## iter  50 value 6.403850
## iter  60 value 5.774992
## iter  70 value 5.147307
## iter  80 value 5.109554
```

```
## iter  90 value 5.074664
## iter 100 value 5.051312
## final  value 5.051312
## stopped after 100 iterations
## # weights:  179
## initial  value 136.136052
## iter  10 value 46.161538
## iter  20 value 32.615980
## iter  30 value 28.986056
## iter  40 value 27.673266
## iter  50 value 24.785597
## iter  60 value 22.698249
## iter  70 value 21.600201
## iter  80 value 21.481798
## iter  90 value 21.318503
## iter 100 value 21.205923
## final  value 21.205923
## stopped after 100 iterations
## # weights:  39
## initial  value 113.350016
## iter  10 value 70.729232
## iter  20 value 62.349199
## iter  30 value 59.609717
## iter  40 value 59.014316
## iter  50 value 57.435928
## iter  60 value 54.055970
## iter  70 value 53.599324
## iter  80 value 53.577901
## iter  90 value 53.560959
## iter 100 value 53.490420
## final  value 53.490420
## stopped after 100 iterations
## # weights:  109
## initial  value 104.944288
## iter  10 value 30.882796
## iter  20 value 11.783503
## iter  30 value 8.486227
## iter  40 value 7.040081
## iter  50 value 7.038859
## iter  60 value 6.989847
## iter  70 value 6.968175
## iter  80 value 6.968151
## iter  90 value 6.968106
## iter 100 value 6.967826
## final  value 6.967826
## stopped after 100 iterations
## # weights:  179
## initial  value 112.800098
## iter  10 value 26.388570
## iter  20 value 5.599708
## iter  30 value 1.552520
## iter  40 value 1.399780
## iter  50 value 1.386405
## iter  60 value 1.386349
```

```
## iter  70 value 1.386321
## iter  80 value 1.386313
## final  value 1.386312
## converged
## # weights:  39
## initial  value 112.669379
## iter  10 value 93.971481
## iter  20 value 77.797487
## iter  30 value 66.077188
## iter  40 value 62.868417
## iter  50 value 60.977595
## iter  60 value 59.630071
## iter  70 value 59.126414
## iter  80 value 58.868170
## iter  90 value 58.682021
## iter 100 value 58.462834
## final  value 58.462834
## stopped after 100 iterations
## # weights:  109
## initial  value 97.018452
## iter  10 value 55.793926
## iter  20 value 30.563067
## iter  30 value 19.111092
## iter  40 value 17.362120
## iter  50 value 17.196488
## iter  60 value 17.187790
## iter  70 value 17.187614
## final  value 17.187614
## converged
## # weights:  179
## initial  value 110.573094
## iter  10 value 41.750471
## iter  20 value 22.404796
## iter  30 value 14.663886
## iter  40 value 12.767774
## iter  50 value 12.070395
## iter  60 value 11.977927
## iter  70 value 11.968827
## iter  80 value 11.968221
## final  value 11.968218
## converged
## # weights:  39
## initial  value 102.668271
## iter  10 value 76.222737
## iter  20 value 71.120357
## iter  30 value 70.002522
## iter  40 value 66.179119
## iter  50 value 63.429924
## iter  60 value 62.301242
## iter  70 value 61.205275
## iter  80 value 59.872349
## iter  90 value 59.411723
## iter 100 value 59.345851
## final  value 59.345851
```

```
## stopped after 100 iterations
## # weights:  109
## initial  value 106.120849
## iter  10 value 32.403149
## iter  20 value 18.474979
## iter  30 value 13.088859
## iter  40 value 11.447226
## iter  50 value 8.970656
## iter  60 value 8.864178
## iter  70 value 8.804195
## iter  80 value 8.642453
## iter  90 value 7.001615
## iter 100 value 4.944231
## final  value 4.944231
## stopped after 100 iterations
## # weights:  179
## initial  value 106.316868
## iter  10 value 23.770381
## iter  20 value 11.783803
## iter  30 value 9.676904
## iter  40 value 8.118733
## iter  50 value 7.545715
## iter  60 value 7.511021
## iter  70 value 7.446200
## iter  80 value 7.423943
## iter  90 value 7.412165
## iter 100 value 7.341176
## final  value 7.341176
## stopped after 100 iterations
## # weights:  39
## initial  value 105.344985
## iter  10 value 60.114813
## iter  20 value 52.056150
## iter  30 value 48.603365
## iter  40 value 47.673760
## iter  50 value 47.586850
## iter  60 value 47.504725
## iter  70 value 47.190988
## iter  80 value 46.176918
## iter  90 value 46.047269
## iter 100 value 45.007590
## final  value 45.007590
## stopped after 100 iterations
## # weights:  109
## initial  value 100.276078
## iter  10 value 43.295442
## iter  20 value 25.915349
## iter  30 value 23.194969
## iter  40 value 21.158903
## iter  50 value 19.133764
## iter  60 value 17.733614
## iter  70 value 14.300281
## iter  80 value 7.969243
## iter  90 value 6.214430
```

```
## iter 100 value 5.944171
## final  value 5.944171
## stopped after 100 iterations
## # weights:  179
## initial  value 97.761042
## iter  10 value 17.154700
## iter  20 value 7.829067
## iter  30 value 3.227378
## iter  40 value 2.747947
## iter  50 value 0.046889
## iter  60 value 0.015875
## iter  70 value 0.006553
## iter  80 value 0.003962
## iter  90 value 0.002762
## iter 100 value 0.001081
## final  value 0.001081
## stopped after 100 iterations
## # weights:  39
## initial  value 101.671479
## iter  10 value 70.382295
## iter  20 value 62.066615
## iter  30 value 59.764257
## iter  40 value 59.088796
## iter  50 value 58.916054
## iter  60 value 58.834693
## iter  70 value 58.832265
## final  value 58.832239
## converged
## # weights:  109
## initial  value 107.998837
## iter  10 value 60.476972
## iter  20 value 45.654734
## iter  30 value 31.672688
## iter  40 value 20.794969
## iter  50 value 18.011520
## iter  60 value 16.053407
## iter  70 value 15.741586
## iter  80 value 15.728957
## iter  90 value 15.728822
## final  value 15.728820
## converged
## # weights:  179
## initial  value 123.720915
## iter  10 value 40.468597
## iter  20 value 25.862052
## iter  30 value 17.573230
## iter  40 value 14.579384
## iter  50 value 13.731864
## iter  60 value 13.452821
## iter  70 value 12.803875
## iter  80 value 12.559815
## iter  90 value 12.364204
## iter 100 value 12.345274
## final  value 12.345274
```

```
## stopped after 100 iterations
## # weights:  39
## initial  value 104.100554
## iter  10 value 66.890695
## iter  20 value 56.156042
## iter  30 value 51.173877
## iter  40 value 46.797223
## iter  50 value 44.345010
## iter  60 value 44.239260
## iter  70 value 43.372173
## iter  80 value 43.302501
## iter  90 value 42.916799
## iter 100 value 42.882276
## final  value 42.882276
## stopped after 100 iterations
## # weights:  109
## initial  value 110.092708
## iter  10 value 44.928603
## iter  20 value 32.047071
## iter  30 value 28.337515
## iter  40 value 27.179591
## iter  50 value 26.412786
## iter  60 value 24.532276
## iter  70 value 24.468793
## iter  80 value 22.672416
## iter  90 value 21.936651
## iter 100 value 21.866777
## final  value 21.866777
## stopped after 100 iterations
## # weights:  179
## initial  value 117.480129
## iter  10 value 26.056083
## iter  20 value 14.870582
## iter  30 value 10.580739
## iter  40 value 10.144600
## iter  50 value 9.985516
## iter  60 value 9.963580
## iter  70 value 9.921848
## iter  80 value 9.782611
## iter  90 value 8.005353
## iter 100 value 6.558581
## final  value 6.558581
## stopped after 100 iterations
## # weights:  39
## initial  value 98.626120
## iter  10 value 79.910268
## iter  20 value 68.317892
## iter  30 value 65.890290
## iter  40 value 62.895747
## iter  50 value 59.481191
## iter  60 value 57.686874
## iter  70 value 57.410912
## iter  80 value 57.292111
## iter  90 value 57.276122
```

```
## iter 100 value 57.271064
## final  value 57.271064
## stopped after 100 iterations
## # weights:  109
## initial  value 144.941972
## iter  10 value 77.123106
## iter  20 value 24.284521
## iter  30 value 19.662510
## iter  40 value 18.675218
## iter  50 value 15.764644
## iter  60 value 15.015242
## iter  70 value 14.918402
## iter  80 value 14.830300
## iter  90 value 14.784867
## iter 100 value 14.764151
## final  value 14.764151
## stopped after 100 iterations
## # weights:  179
## initial  value 104.057813
## iter  10 value 15.322900
## iter  20 value 2.267731
## iter  30 value 1.440125
## iter  40 value 1.386743
## final  value 1.386299
## converged
## # weights:  39
## initial  value 103.571185
## iter  10 value 70.173304
## iter  20 value 63.246199
## iter  30 value 60.504459
## iter  40 value 60.162146
## iter  50 value 59.895116
## iter  60 value 59.401383
## iter  70 value 58.845643
## final  value 58.844214
## converged
## # weights:  109
## initial  value 114.942385
## iter  10 value 47.235792
## iter  20 value 31.410793
## iter  30 value 23.149571
## iter  40 value 18.383528
## iter  50 value 16.339475
## iter  60 value 16.044604
## iter  70 value 15.984868
## iter  80 value 15.739692
## iter  90 value 15.726611
## iter 100 value 15.726518
## final  value 15.726518
## stopped after 100 iterations
## # weights:  179
## initial  value 114.203579
## iter  10 value 30.198653
## iter  20 value 17.327694
```

```
## iter  30 value 13.825932
## iter  40 value 12.743544
## iter  50 value 12.296795
## iter  60 value 12.202201
## iter  70 value 12.167712
## iter  80 value 12.164789
## iter  90 value 12.164686
## final  value 12.164678
## converged
## # weights:  39
## initial  value 105.847642
## iter  10 value 81.982261
## iter  20 value 64.064822
## iter  30 value 63.955642
## iter  40 value 63.954360
## iter  50 value 63.948536
## iter  60 value 63.917226
## iter  70 value 59.457800
## iter  80 value 58.373205
## iter  90 value 58.039035
## iter 100 value 57.125163
## final  value 57.125163
## stopped after 100 iterations
## # weights:  109
## initial  value 106.936039
## iter  10 value 37.802223
## iter  20 value 19.992552
## iter  30 value 11.378917
## iter  40 value 10.923480
## iter  50 value 6.559896
## iter  60 value 5.622549
## iter  70 value 5.569587
## iter  80 value 5.503688
## iter  90 value 0.296169
## iter 100 value 0.243515
## final  value 0.243515
## stopped after 100 iterations
## # weights:  179
## initial  value 126.812508
## iter  10 value 19.841783
## iter  20 value 0.682379
## iter  30 value 0.171284
## iter  40 value 0.151431
## iter  50 value 0.141022
## iter  60 value 0.126759
## iter  70 value 0.120292
## iter  80 value 0.113210
## iter  90 value 0.103905
## iter 100 value 0.100037
## final  value 0.100037
## stopped after 100 iterations
## # weights:  39
## initial  value 102.331851
## iter  10 value 77.118741
```

```
## iter  20 value 75.645531
## iter  30 value 74.549658
## iter  40 value 73.721185
## iter  50 value 73.186026
## iter  60 value 71.937590
## iter  70 value 68.867118
## iter  80 value 65.978751
## iter  90 value 65.755511
## iter 100 value 65.744870
## final  value 65.744870
## stopped after 100 iterations
## # weights:  109
## initial  value 108.028265
## iter  10 value 49.317289
## iter  20 value 35.085843
## iter  30 value 27.572547
## iter  40 value 24.487502
## iter  50 value 19.450828
## iter  60 value 13.490997
## iter  70 value 12.074980
## iter  80 value 11.645751
## iter  90 value 11.542920
## iter 100 value 11.367370
## final  value 11.367370
## stopped after 100 iterations
## # weights:  179
## initial  value 104.751551
## iter  10 value 29.066701
## iter  20 value 7.801708
## iter  30 value 6.297922
## iter  40 value 6.172064
## iter  50 value 5.233750
## iter  60 value 4.792694
## iter  70 value 4.782133
## iter  80 value 4.781743
## iter  90 value 4.781042
## iter 100 value 4.780859
## final  value 4.780859
## stopped after 100 iterations
## # weights:  39
## initial  value 103.743076
## iter  10 value 76.126151
## iter  20 value 63.917704
## iter  30 value 60.665179
## iter  40 value 59.454249
## iter  50 value 57.937774
## iter  60 value 57.913853
## final  value 57.913845
## converged
## # weights:  109
## initial  value 104.302171
## iter  10 value 48.039656
## iter  20 value 31.112935
## iter  30 value 23.007944
```

```
## iter  40 value 17.853326
## iter  50 value 17.175604
## iter  60 value 17.133322
## iter  70 value 17.132918
## final  value 17.132917
## converged
## # weights:  179
## initial  value 127.097661
## iter  10 value 48.790091
## iter  20 value 24.244372
## iter  30 value 14.552219
## iter  40 value 12.402271
## iter  50 value 12.250747
## iter  60 value 12.235741
## iter  70 value 12.233540
## iter  80 value 12.233358
## final  value 12.233354
## converged
## # weights:  39
## initial  value 101.214908
## iter  10 value 57.856495
## iter  20 value 49.857730
## iter  30 value 45.087983
## iter  40 value 42.571795
## iter  50 value 41.809917
## iter  60 value 41.786536
## iter  70 value 41.766615
## iter  80 value 41.749285
## iter  90 value 41.726401
## iter 100 value 41.717331
## final  value 41.717331
## stopped after 100 iterations
## # weights:  109
## initial  value 114.460738
## iter  10 value 26.376054
## iter  20 value 14.035897
## iter  30 value 5.341266
## iter  40 value 4.259323
## iter  50 value 4.086854
## iter  60 value 1.732333
## iter  70 value 0.225387
## iter  80 value 0.194067
## iter  90 value 0.178984
## iter 100 value 0.164494
## final  value 0.164494
## stopped after 100 iterations
## # weights:  179
## initial  value 100.455778
## iter  10 value 19.326568
## iter  20 value 2.203497
## iter  30 value 2.046491
## iter  40 value 2.032757
## iter  50 value 1.496368
## iter  60 value 0.157461
```

```
## iter  70 value 0.113411
## iter  80 value 0.107761
## iter  90 value 0.104948
## iter 100 value 0.098663
## final  value 0.098663
## stopped after 100 iterations
## # weights:  39
## initial  value 112.864063
## iter  10 value 62.462087
## iter  20 value 55.510725
## iter  30 value 52.142977
## iter  40 value 50.505459
## iter  50 value 48.869881
## iter  60 value 48.618819
## iter  70 value 47.891296
## iter  80 value 46.751051
## iter  90 value 45.436151
## iter 100 value 45.029035
## final  value 45.029035
## stopped after 100 iterations
## # weights:  109
## initial  value 118.942175
## iter  10 value 29.365561
## iter  20 value 13.913647
## iter  30 value 11.398030
## iter  40 value 9.533676
## iter  50 value 9.114137
## iter  60 value 9.023862
## iter  70 value 8.885840
## iter  80 value 8.826751
## iter  90 value 8.616269
## iter 100 value 8.140201
## final  value 8.140201
## stopped after 100 iterations
## # weights:  179
## initial  value 114.418584
## iter  10 value 27.335317
## iter  20 value 1.596331
## iter  30 value 0.059301
## iter  40 value 0.003534
## iter  50 value 0.000353
## iter  60 value 0.000242
## final  value 0.000083
## converged
## # weights:  39
## initial  value 100.799018
## iter  10 value 69.652839
## iter  20 value 62.652819
## iter  30 value 60.119425
## iter  40 value 59.945466
## iter  50 value 59.475821
## iter  60 value 58.757868
## iter  70 value 58.432540
## iter  80 value 58.424767
```

```
## final  value 58.424747
## converged
## # weights:  109
## initial  value 103.169973
## iter  10 value 55.363697
## iter  20 value 28.392282
## iter  30 value 20.062653
## iter  40 value 18.759972
## iter  50 value 18.545062
## iter  60 value 18.255249
## iter  70 value 17.149311
## iter  80 value 16.855155
## iter  90 value 16.027953
## iter 100 value 15.929266
## final  value 15.929266
## stopped after 100 iterations
## # weights:  179
## initial  value 111.943346
## iter  10 value 49.714763
## iter  20 value 28.826984
## iter  30 value 16.145633
## iter  40 value 13.411749
## iter  50 value 12.947011
## iter  60 value 12.718059
## iter  70 value 12.537811
## iter  80 value 12.517755
## iter  90 value 12.516124
## iter 100 value 12.515708
## final  value 12.515708
## stopped after 100 iterations
## # weights:  39
## initial  value 103.759376
## iter  10 value 66.053519
## iter  20 value 57.723898
## iter  30 value 57.338882
## iter  40 value 56.280778
## iter  50 value 56.245932
## iter  60 value 56.226694
## iter  70 value 55.121251
## iter  80 value 53.917501
## iter  90 value 52.696280
## iter 100 value 52.632124
## final  value 52.632124
## stopped after 100 iterations
## # weights:  109
## initial  value 118.250672
## iter  10 value 33.272180
## iter  20 value 19.501960
## iter  30 value 14.308341
## iter  40 value 12.284254
## iter  50 value 10.582490
## iter  60 value 10.508805
## iter  70 value 10.421194
## iter  80 value 8.035947
```

```
## iter  90 value 7.806725
## iter 100 value 7.793478
## final  value 7.793478
## stopped after 100 iterations
## # weights:  179
## initial  value 148.202269
## iter  10 value 56.558341
## iter  20 value 26.479386
## iter  30 value 19.184836
## iter  40 value 16.191693
## iter  50 value 13.420992
## iter  60 value 12.697412
## iter  70 value 11.523216
## iter  80 value 9.176712
## iter  90 value 7.463419
## iter 100 value 5.642809
## final  value 5.642809
## stopped after 100 iterations
## # weights:  39
## initial  value 102.418690
## iter  10 value 71.055217
## iter  20 value 67.158590
## iter  30 value 66.769307
## iter  40 value 64.429575
## iter  50 value 58.258543
## iter  60 value 57.853237
## iter  70 value 56.986039
## iter  80 value 55.328486
## iter  90 value 54.955551
## iter 100 value 54.930910
## final  value 54.930910
## stopped after 100 iterations
## # weights:  109
## initial  value 107.352464
## iter  10 value 47.984754
## iter  20 value 33.645589
## iter  30 value 16.722743
## iter  40 value 14.057835
## iter  50 value 13.439273
## iter  60 value 12.480599
## iter  70 value 8.984974
## iter  80 value 7.746744
## iter  90 value 5.408461
## iter 100 value 5.285482
## final  value 5.285482
## stopped after 100 iterations
## # weights:  179
## initial  value 108.400527
## iter  10 value 29.485720
## iter  20 value 13.479316
## iter  30 value 6.086225
## iter  40 value 2.366902
## iter  50 value 1.943584
## iter  60 value 1.925195
```

```
## iter  70 value 1.918077
## iter  80 value 1.911607
## iter  90 value 1.910946
## iter 100 value 1.910351
## final  value 1.910351
## stopped after 100 iterations
## # weights:  39
## initial  value 100.498558
## iter  10 value 72.863891
## iter  20 value 65.038302
## iter  30 value 62.552814
## iter  40 value 59.521106
## iter  50 value 58.275421
## iter  60 value 57.626380
## iter  70 value 57.549974
## final  value 57.549638
## converged
## # weights:  109
## initial  value 116.104385
## iter  10 value 37.909599
## iter  20 value 26.356494
## iter  30 value 21.022665
## iter  40 value 17.201416
## iter  50 value 16.109427
## iter  60 value 16.071303
## final  value 16.071091
## converged
## # weights:  179
## initial  value 104.956466
## iter  10 value 36.318322
## iter  20 value 20.596644
## iter  30 value 14.937412
## iter  40 value 13.056861
## iter  50 value 12.407184
## iter  60 value 12.159840
## iter  70 value 11.921136
## iter  80 value 11.794267
## iter  90 value 11.777995
## iter 100 value 11.777649
## final  value 11.777649
## stopped after 100 iterations
## # weights:  39
## initial  value 101.454706
## iter  10 value 83.182233
## iter  20 value 65.771691
## iter  30 value 65.682662
## iter  40 value 64.496918
## iter  50 value 63.703936
## iter  60 value 63.678678
## iter  70 value 63.670216
## iter  80 value 63.664699
## iter  90 value 63.660486
## iter 100 value 63.142506
## final  value 63.142506
```

```
## stopped after 100 iterations
## # weights:  109
## initial  value 107.794895
## iter  10 value 39.211013
## iter  20 value 17.750283
## iter  30 value 14.292229
## iter  40 value 13.848316
## iter  50 value 13.789629
## iter  60 value 13.739810
## iter  70 value 13.630570
## iter  80 value 13.455568
## iter  90 value 10.859825
## iter 100 value 7.800682
## final  value 7.800682
## stopped after 100 iterations
## # weights:  179
## initial  value 103.415146
## iter  10 value 24.953071
## iter  20 value 6.832968
## iter  30 value 4.254160
## iter  40 value 3.998683
## iter  50 value 3.900428
## iter  60 value 3.819728
## iter  70 value 3.667355
## iter  80 value 3.623497
## iter  90 value 3.448991
## iter 100 value 3.207144
## final  value 3.207144
## stopped after 100 iterations
## # weights:  39
## initial  value 103.877719
## iter  10 value 64.147785
## iter  20 value 51.995981
## iter  30 value 51.241590
## iter  40 value 51.212248
## iter  50 value 51.176162
## iter  60 value 50.635572
## iter  70 value 50.487205
## final  value 50.487088
## converged
## # weights:  109
## initial  value 104.283856
## iter  10 value 32.515271
## iter  20 value 12.151861
## iter  30 value 9.025931
## iter  40 value 8.576796
## iter  50 value 8.055914
## iter  60 value 7.802891
## iter  70 value 7.287348
## iter  80 value 7.229932
## iter  90 value 7.218098
## iter 100 value 7.209661
## final  value 7.209661
## stopped after 100 iterations
```

```
## # weights:  179
## initial  value 144.903137
## iter  10 value 44.076925
## iter  20 value 17.596644
## iter  30 value 15.087289
## iter  40 value 14.563269
## iter  50 value 10.337919
## iter  60 value 6.468374
## iter  70 value 5.629895
## iter  80 value 5.545960
## iter  90 value 5.545622
## iter 100 value 5.545402
## final  value 5.545402
## stopped after 100 iterations
## # weights:  39
## initial  value 101.783259
## iter  10 value 83.271780
## iter  20 value 63.992951
## iter  30 value 58.957729
## iter  40 value 58.767410
## iter  50 value 58.764643
## final  value 58.764475
## converged
## # weights:  109
## initial  value 100.139730
## iter  10 value 43.931145
## iter  20 value 23.671386
## iter  30 value 17.530501
## iter  40 value 16.050389
## iter  50 value 15.651794
## iter  60 value 15.617358
## final  value 15.617284
## converged
## # weights:  179
## initial  value 102.106877
## iter  10 value 34.941892
## iter  20 value 17.666120
## iter  30 value 13.932899
## iter  40 value 13.055006
## iter  50 value 12.705135
## iter  60 value 12.620219
## iter  70 value 12.591342
## iter  80 value 12.582013
## iter  90 value 12.581567
## final  value 12.581563
## converged
## # weights:  39
## initial  value 103.317784
## iter  10 value 76.721712
## iter  20 value 61.428351
## iter  30 value 58.273222
## iter  40 value 56.857703
## iter  50 value 54.590488
## iter  60 value 53.882256
```

```
## iter  70 value 53.662349
## iter  80 value 53.332954
## iter  90 value 52.778608
## iter 100 value 52.734339
## final  value 52.734339
## stopped after 100 iterations
## # weights:  109
## initial  value 129.941677
## iter  10 value 60.195476
## iter  20 value 27.532384
## iter  30 value 10.376122
## iter  40 value 5.788687
## iter  50 value 4.397872
## iter  60 value 3.877862
## iter  70 value 3.761546
## iter  80 value 3.743188
## iter  90 value 3.721730
## iter 100 value 3.685009
## final  value 3.685009
## stopped after 100 iterations
## # weights:  179
## initial  value 111.463558
## iter  10 value 18.731761
## iter  20 value 7.272737
## iter  30 value 4.765955
## iter  40 value 3.170226
## iter  50 value 2.994089
## iter  60 value 2.974798
## iter  70 value 2.967666
## iter  80 value 1.626395
## iter  90 value 1.569963
## iter 100 value 0.207179
## final  value 0.207179
## stopped after 100 iterations
## # weights:  39
## initial  value 100.126293
## iter  10 value 68.405075
## iter  20 value 55.765061
## iter  30 value 55.032503
## iter  40 value 51.629556
## iter  50 value 47.032138
## iter  60 value 42.576347
## iter  70 value 41.546640
## iter  80 value 41.468662
## iter  90 value 41.435321
## iter 100 value 41.415153
## final  value 41.415153
## stopped after 100 iterations
## # weights:  109
## initial  value 106.303020
## iter  10 value 48.377013
## iter  20 value 22.074398
## iter  30 value 17.603824
## iter  40 value 17.158453
```

```
## iter  50 value 17.116159
## iter  60 value 17.102256
## iter  70 value 17.092050
## iter  80 value 17.088361
## iter  90 value 16.883673
## iter 100 value 16.865443
## final  value 16.865443
## stopped after 100 iterations
## # weights:  179
## initial  value 105.622444
## iter  10 value 22.276828
## iter  20 value 11.035662
## iter  30 value 7.575096
## iter  40 value 7.254733
## iter  50 value 7.188539
## iter  60 value 6.943245
## iter  70 value 5.324949
## iter  80 value 2.551888
## iter  90 value 0.290725
## iter 100 value 0.036278
## final  value 0.036278
## stopped after 100 iterations
## # weights:  39
## initial  value 103.204839
## iter  10 value 70.888866
## iter  20 value 64.854832
## iter  30 value 60.505710
## iter  40 value 59.323505
## iter  50 value 59.110164
## iter  60 value 59.051548
## iter  70 value 59.035015
## iter  70 value 59.035015
## iter  70 value 59.035015
## final  value 59.035015
## converged
## # weights:  109
## initial  value 128.849614
## iter  10 value 61.938800
## iter  20 value 36.552475
## iter  30 value 22.405648
## iter  40 value 17.283416
## iter  50 value 16.586665
## iter  60 value 16.515742
## iter  70 value 16.477041
## iter  80 value 16.466998
## iter  90 value 16.466202
## final  value 16.466183
## converged
## # weights:  179
## initial  value 110.271610
## iter  10 value 50.180700
## iter  20 value 31.554709
## iter  30 value 17.315662
## iter  40 value 12.944208
```

```
## iter  50 value 12.251342
## iter  60 value 12.159385
## iter  70 value 12.150538
## iter  80 value 12.149933
## iter  90 value 12.149916
## final  value 12.149915
## converged
## # weights:  39
## initial  value 116.089303
## iter  10 value 67.748410
## iter  20 value 61.994831
## iter  30 value 59.615635
## iter  40 value 58.915516
## iter  50 value 58.520884
## iter  60 value 58.472508
## iter  70 value 58.370575
## iter  80 value 58.324050
## iter  90 value 58.128299
## iter 100 value 57.032730
## final  value 57.032730
## stopped after 100 iterations
## # weights:  109
## initial  value 115.247747
## iter  10 value 54.195659
## iter  20 value 26.147525
## iter  30 value 11.149365
## iter  40 value 7.042787
## iter  50 value 5.315439
## iter  60 value 5.068685
## iter  70 value 2.995200
## iter  80 value 2.918379
## iter  90 value 0.724086
## iter 100 value 0.227656
## final  value 0.227656
## stopped after 100 iterations
## # weights:  179
## initial  value 120.202035
## iter  10 value 24.849869
## iter  20 value 5.699435
## iter  30 value 2.140725
## iter  40 value 0.298732
## iter  50 value 0.233885
## iter  60 value 0.218877
## iter  70 value 0.201590
## iter  80 value 0.185795
## iter  90 value 0.166678
## iter 100 value 0.154123
## final  value 0.154123
## stopped after 100 iterations
## # weights:  39
## initial  value 111.245106
## iter  10 value 66.224925
## iter  20 value 58.223940
## iter  30 value 56.860679
```

```
## iter  40 value 56.397640
## iter  50 value 55.970450
## iter  60 value 55.966223
## iter  70 value 55.957568
## iter  80 value 55.952434
## iter  90 value 55.949370
## iter 100 value 54.594722
## final  value 54.594722
## stopped after 100 iterations
## # weights:  109
## initial  value 123.392432
## iter  10 value 45.416071
## iter  20 value 36.055904
## iter  30 value 31.993854
## iter  40 value 30.507479
## iter  50 value 29.519126
## iter  60 value 28.094554
## iter  70 value 25.689313
## iter  80 value 25.554940
## iter  90 value 24.832351
## iter 100 value 23.627305
## final  value 23.627305
## stopped after 100 iterations
## # weights:  179
## initial  value 105.709171
## iter  10 value 43.103155
## iter  20 value 14.170640
## iter  30 value 12.900424
## iter  40 value 12.833486
## iter  50 value 12.823268
## iter  60 value 12.821913
## final  value 12.821723
## converged
## # weights:  39
## initial  value 105.265412
## iter  10 value 81.937971
## iter  20 value 70.282207
## iter  30 value 62.482980
## iter  40 value 59.963098
## iter  50 value 59.667168
## final  value 59.663345
## converged
## # weights:  109
## initial  value 105.580125
## iter  10 value 63.714006
## iter  20 value 35.025028
## iter  30 value 21.801435
## iter  40 value 17.655637
## iter  50 value 16.452754
## iter  60 value 16.089910
## iter  70 value 15.963306
## iter  80 value 15.961979
## final  value 15.961975
## converged
```

```
## # weights:  179
## initial  value 114.650738
## iter  10 value 41.052686
## iter  20 value 21.329416
## iter  30 value 14.684476
## iter  40 value 13.090797
## iter  50 value 12.767833
## iter  60 value 12.689669
## iter  70 value 12.600563
## iter  80 value 12.503758
## iter  90 value 12.409280
## iter 100 value 12.210580
## final  value 12.210580
## stopped after 100 iterations
## # weights:  39
## initial  value 115.811519
## iter  10 value 79.337877
## iter  20 value 58.080930
## iter  30 value 57.255951
## iter  40 value 57.123048
## iter  50 value 56.103605
## iter  60 value 55.394270
## iter  70 value 53.976233
## iter  80 value 53.766231
## iter  90 value 53.249351
## iter 100 value 52.797949
## final  value 52.797949
## stopped after 100 iterations
## # weights:  109
## initial  value 117.923969
## iter  10 value 24.646291
## iter  20 value 14.026214
## iter  30 value 9.177271
## iter  40 value 5.924326
## iter  50 value 5.483767
## iter  60 value 5.135246
## iter  70 value 4.958604
## iter  80 value 4.928025
## iter  90 value 4.906942
## iter 100 value 4.661015
## final  value 4.661015
## stopped after 100 iterations
## # weights:  179
## initial  value 116.128278
## iter  10 value 42.986851
## iter  20 value 14.446667
## iter  30 value 11.459803
## iter  40 value 8.716805
## iter  50 value 8.694895
## iter  60 value 8.657438
## iter  70 value 8.621765
## iter  80 value 8.574368
## iter  90 value 8.551392
## iter 100 value 8.529180
```

```
## final  value 8.529180
## stopped after 100 iterations
## # weights:  39
## initial  value 107.340911
## iter  10 value 72.660866
## iter  20 value 66.396492
## iter  30 value 65.011520
## iter  40 value 64.354710
## iter  50 value 64.190403
## iter  60 value 64.042831
## iter  70 value 62.320274
## iter  80 value 62.147468
## iter  90 value 62.050015
## iter 100 value 61.795247
## final  value 61.795247
## stopped after 100 iterations
## # weights:  109
## initial  value 103.874866
## iter  10 value 23.723727
## iter  20 value 18.175229
## iter  30 value 16.711179
## iter  40 value 16.525947
## iter  50 value 15.656980
## iter  60 value 15.653166
## iter  70 value 15.652339
## iter  80 value 11.944017
## iter  90 value 11.854378
## iter 100 value 11.849322
## final  value 11.849322
## stopped after 100 iterations
## # weights:  179
## initial  value 113.038569
## iter  10 value 32.378972
## iter  20 value 8.421653
## iter  30 value 4.424333
## iter  40 value 3.355625
## iter  50 value 3.324319
## iter  60 value 3.139607
## iter  70 value 3.034021
## iter  80 value 3.014223
## final  value 3.014210
## converged
## # weights:  39
## initial  value 99.041836
## iter  10 value 67.109224
## iter  20 value 60.501539
## iter  30 value 59.480042
## iter  40 value 59.323734
## iter  50 value 59.118990
## iter  60 value 59.041670
## iter  70 value 59.004644
## iter  80 value 59.000747
## iter  90 value 59.000643
## iter  90 value 59.000642
```

```
## iter  90 value 59.000642
## final  value 59.000642
## converged
## # weights:  109
## initial  value 101.656206
## iter  10 value 54.337202
## iter  20 value 35.092868
## iter  30 value 20.243122
## iter  40 value 17.059275
## iter  50 value 16.739259
## iter  60 value 16.728669
## iter  70 value 16.728506
## final  value 16.728505
## converged
## # weights:  179
## initial  value 123.961804
## iter  10 value 43.347079
## iter  20 value 23.015554
## iter  30 value 15.211703
## iter  40 value 13.614319
## iter  50 value 13.066238
## iter  60 value 12.610179
## iter  70 value 12.497111
## iter  80 value 12.479448
## iter  90 value 12.479088
## final  value 12.479084
## converged
## # weights:  39
## initial  value 108.017094
## iter  10 value 65.099989
## iter  20 value 59.685023
## iter  30 value 57.108309
## iter  40 value 56.280465
## iter  50 value 55.785627
## iter  60 value 55.453078
## iter  70 value 55.036672
## iter  80 value 53.334857
## iter  90 value 52.551259
## iter 100 value 52.147789
## final  value 52.147789
## stopped after 100 iterations
## # weights:  109
## initial  value 116.672782
## iter  10 value 41.651438
## iter  20 value 27.238467
## iter  30 value 23.052093
## iter  40 value 19.017861
## iter  50 value 17.616272
## iter  60 value 12.500732
## iter  70 value 11.516223
## iter  80 value 10.583411
## iter  90 value 10.446586
## iter 100 value 10.261042
## final  value 10.261042
```

```
## stopped after 100 iterations
## # weights:  179
## initial  value 94.282572
## iter  10 value 22.961099
## iter  20 value 7.777698
## iter  30 value 0.681871
## iter  40 value 0.224789
## iter  50 value 0.192345
## iter  60 value 0.176125
## iter  70 value 0.165881
## iter  80 value 0.152975
## iter  90 value 0.143282
## iter 100 value 0.134875
## final  value 0.134875
## stopped after 100 iterations
## # weights:  39
## initial  value 110.021643
## iter  10 value 68.212301
## iter  20 value 59.550413
## iter  30 value 59.481303
## iter  40 value 59.392364
## iter  50 value 59.143030
## iter  60 value 57.941421
## iter  70 value 57.452159
## iter  80 value 57.352490
## iter  90 value 57.315204
## iter 100 value 50.270674
## final  value 50.270674
## stopped after 100 iterations
## # weights:  109
## initial  value 102.449494
## iter  10 value 44.123670
## iter  20 value 39.494611
## iter  30 value 36.662272
## iter  40 value 36.340838
## iter  50 value 36.287414
## iter  60 value 29.409074
## iter  70 value 26.102623
## iter  80 value 23.830512
## iter  90 value 23.335620
## iter 100 value 22.892945
## final  value 22.892945
## stopped after 100 iterations
## # weights:  179
## initial  value 109.368167
## iter  10 value 32.193699
## iter  20 value 7.439406
## iter  30 value 6.206705
## iter  40 value 6.078528
## iter  50 value 5.561726
## iter  60 value 5.463710
## iter  70 value 5.024072
## iter  80 value 5.023187
## iter  90 value 5.022420
```

```
## iter 100 value 5.022298
## final  value 5.022298
## stopped after 100 iterations
## # weights:  39
## initial  value 109.439745
## iter  10 value 73.986853
## iter  20 value 63.028384
## iter  30 value 62.211043
## iter  40 value 60.641053
## iter  50 value 58.404440
## iter  60 value 58.245921
## final  value 58.245131
## converged
## # weights:  109
## initial  value 107.880325
## iter  10 value 53.370218
## iter  20 value 26.541850
## iter  30 value 18.213279
## iter  40 value 16.622744
## iter  50 value 15.745120
## iter  60 value 15.589815
## iter  70 value 15.571255
## iter  80 value 15.570163
## final  value 15.570148
## converged
## # weights:  179
## initial  value 111.497857
## iter  10 value 43.211401
## iter  20 value 19.413065
## iter  30 value 13.084488
## iter  40 value 12.228906
## iter  50 value 11.910745
## iter  60 value 11.877340
## iter  70 value 11.811154
## iter  80 value 11.695662
## iter  90 value 11.690528
## iter 100 value 11.690448
## final  value 11.690448
## stopped after 100 iterations
## # weights:  39
## initial  value 103.125773
## iter  10 value 71.451501
## iter  20 value 61.829624
## iter  30 value 56.122091
## iter  40 value 53.219752
## iter  50 value 52.470908
## iter  60 value 52.453926
## iter  70 value 52.418181
## iter  80 value 52.376890
## iter  90 value 52.374963
## iter 100 value 52.367397
## final  value 52.367397
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 99.332307
## iter  10 value 37.815508
## iter  20 value 21.659869
## iter  30 value 14.800785
## iter  40 value 10.486945
## iter  50 value 9.263875
## iter  60 value 8.688339
## iter  70 value 8.304383
## iter  80 value 7.822464
## iter  90 value 7.776147
## iter 100 value 7.460304
## final  value 7.460304
## stopped after 100 iterations
## # weights:  179
## initial  value 121.814606
## iter  10 value 38.978621
## iter  20 value 13.983112
## iter  30 value 6.622315
## iter  40 value 4.770961
## iter  50 value 3.860275
## iter  60 value 3.551931
## iter  70 value 3.525396
## iter  80 value 3.501125
## iter  90 value 3.465392
## iter 100 value 3.421909
## final  value 3.421909
## stopped after 100 iterations
## # weights:  39
## initial  value 102.174818
## iter  10 value 67.613526
## iter  20 value 59.602468
## iter  30 value 56.104884
## iter  40 value 52.593574
## iter  50 value 50.422135
## iter  60 value 48.705385
## iter  70 value 46.473854
## iter  80 value 45.935970
## iter  90 value 44.882264
## iter 100 value 42.778872
## final  value 42.778872
## stopped after 100 iterations
## # weights:  109
## initial  value 123.849203
## iter  10 value 44.407363
## iter  20 value 27.265906
## iter  30 value 25.611426
## iter  40 value 24.241634
## iter  50 value 23.730479
## iter  60 value 23.511143
## iter  70 value 23.332134
## iter  80 value 23.039610
## iter  90 value 23.029608
## iter 100 value 23.028797
## final  value 23.028797
```

```
## stopped after 100 iterations
## # weights:  179
## initial  value 102.813888
## iter  10 value 10.676891
## iter  20 value 3.874461
## iter  30 value 0.197353
## iter  40 value 0.022392
## iter  50 value 0.006858
## iter  60 value 0.003255
## iter  70 value 0.002284
## iter  80 value 0.000879
## iter  90 value 0.000760
## iter 100 value 0.000644
## final  value 0.000644
## stopped after 100 iterations
## # weights:  39
## initial  value 114.315697
## iter  10 value 76.631101
## iter  20 value 63.977421
## iter  30 value 60.801777
## iter  40 value 58.862362
## iter  50 value 58.805680
## final  value 58.805662
## converged
## # weights:  109
## initial  value 106.364714
## iter  10 value 51.340241
## iter  20 value 31.023406
## iter  30 value 23.868594
## iter  40 value 21.237593
## iter  50 value 17.254159
## iter  60 value 15.957460
## iter  70 value 15.783566
## iter  80 value 15.782541
## final  value 15.782540
## converged
## # weights:  179
## initial  value 118.194570
## iter  10 value 49.684520
## iter  20 value 26.817583
## iter  30 value 18.452851
## iter  40 value 16.126790
## iter  50 value 15.198806
## iter  60 value 13.817211
## iter  70 value 12.730359
## iter  80 value 12.569357
## iter  90 value 12.555857
## iter 100 value 12.555210
## final  value 12.555210
## stopped after 100 iterations
## # weights:  39
## initial  value 104.093704
## iter  10 value 87.064566
## iter  20 value 73.034495
```

```
## iter  30 value 64.654843
## iter  40 value 62.123316
## iter  50 value 60.579700
## iter  60 value 56.961239
## iter  70 value 56.298580
## iter  80 value 56.235444
## iter  90 value 56.112641
## iter 100 value 55.676192
## final  value 55.676192
## stopped after 100 iterations
## # weights:  109
## initial  value 105.599813
## iter  10 value 33.900488
## iter  20 value 20.542418
## iter  30 value 16.328696
## iter  40 value 12.349470
## iter  50 value 11.675740
## iter  60 value 11.176623
## iter  70 value 10.955957
## iter  80 value 10.919434
## iter  90 value 10.482479
## iter 100 value 10.197780
## final  value 10.197780
## stopped after 100 iterations
## # weights:  179
## initial  value 121.186413
## iter  10 value 30.571532
## iter  20 value 10.703225
## iter  30 value 6.003909
## iter  40 value 4.975763
## iter  50 value 4.935455
## iter  60 value 4.291221
## iter  70 value 2.088793
## iter  80 value 2.057112
## iter  90 value 0.267156
## iter 100 value 0.168442
## final  value 0.168442
## stopped after 100 iterations
## # weights:  39
## initial  value 110.877185
## iter  10 value 76.407135
## iter  20 value 72.348556
## iter  30 value 69.966259
## iter  40 value 69.547092
## iter  50 value 69.498840
## iter  60 value 69.495193
## iter  70 value 69.493092
## iter  80 value 69.492085
## iter  90 value 69.491702
## iter 100 value 69.491507
## final  value 69.491507
## stopped after 100 iterations
## # weights:  109
## initial  value 105.196367
```

```
## iter  10 value 37.023872
## iter  20 value 17.167431
## iter  30 value 9.115900
## iter  40 value 8.242091
## iter  50 value 7.888245
## iter  60 value 7.738698
## iter  70 value 7.644838
## iter  80 value 6.979559
## iter  90 value 6.708106
## iter 100 value 6.190028
## final  value 6.190028
## stopped after 100 iterations
## # weights:  179
## initial  value 106.516563
## iter  10 value 20.375429
## iter  20 value 5.266175
## iter  30 value 3.049322
## iter  40 value 0.101922
## iter  50 value 0.018552
## iter  60 value 0.006890
## iter  70 value 0.001468
## iter  80 value 0.000607
## iter  90 value 0.000303
## iter 100 value 0.000223
## final  value 0.000223
## stopped after 100 iterations
## # weights:  39
## initial  value 101.404151
## iter  10 value 77.673161
## iter  20 value 64.204767
## iter  30 value 60.219105
## iter  40 value 58.820615
## iter  50 value 56.904625
## iter  60 value 56.388151
## iter  70 value 56.328674
## final  value 56.328205
## converged
## # weights:  109
## initial  value 101.292210
## iter  10 value 50.777953
## iter  20 value 29.976999
## iter  30 value 22.164987
## iter  40 value 17.258583
## iter  50 value 17.016999
## iter  60 value 16.955515
## iter  70 value 16.954735
## iter  70 value 16.954735
## iter  70 value 16.954735
## final  value 16.954735
## converged
## # weights:  179
## initial  value 104.055174
## iter  10 value 47.348492
## iter  20 value 23.581423
```

```
## iter  30 value 15.088989
## iter  40 value 13.470877
## iter  50 value 12.780743
## iter  60 value 12.646527
## iter  70 value 12.619079
## iter  80 value 12.615867
## iter  90 value 12.615342
## final  value 12.615286
## converged
## # weights:  39
## initial  value 113.953935
## iter  10 value 74.348849
## iter  20 value 64.698372
## iter  30 value 60.667436
## iter  40 value 55.076760
## iter  50 value 54.340462
## iter  60 value 53.604334
## iter  70 value 52.059013
## iter  80 value 51.691377
## iter  90 value 51.024556
## iter 100 value 49.925475
## final  value 49.925475
## stopped after 100 iterations
## # weights:  109
## initial  value 105.875971
## iter  10 value 30.724684
## iter  20 value 20.858453
## iter  30 value 20.198774
## iter  40 value 20.147281
## iter  50 value 20.127714
## iter  60 value 19.977439
## iter  70 value 18.689845
## iter  80 value 18.636513
## iter  90 value 18.600274
## iter 100 value 14.984050
## final  value 14.984050
## stopped after 100 iterations
## # weights:  179
## initial  value 113.916567
## iter  10 value 22.879010
## iter  20 value 19.433213
## iter  30 value 16.111486
## iter  40 value 14.549640
## iter  50 value 14.292218
## iter  60 value 14.033920
## iter  70 value 13.727135
## iter  80 value 13.401281
## iter  90 value 13.208178
## iter 100 value 13.044966
## final  value 13.044966
## stopped after 100 iterations
## # weights:  39
## initial  value 101.336606
## iter  10 value 58.713996
```

```
## iter  20 value 53.202679
## iter  30 value 50.970440
## iter  40 value 46.339869
## iter  50 value 45.662357
## iter  60 value 45.654508
## iter  70 value 45.654307
## iter  80 value 45.654286
## iter  80 value 45.654286
## iter  80 value 45.654286
## final  value 45.654286
## converged
## # weights:  109
## initial  value 113.403331
## iter  10 value 34.088838
## iter  20 value 16.824174
## iter  30 value 9.719780
## iter  40 value 7.304369
## iter  50 value 4.207232
## iter  60 value 3.889979
## iter  70 value 3.739514
## iter  80 value 3.640510
## iter  90 value 3.387003
## iter 100 value 3.362435
## final  value 3.362435
## stopped after 100 iterations
## # weights:  179
## initial  value 102.553090
## iter  10 value 30.479127
## iter  20 value 20.209764
## iter  30 value 14.850936
## iter  40 value 12.200090
## iter  50 value 9.978704
## iter  60 value 9.364917
## iter  70 value 9.270627
## iter  80 value 9.179702
## iter  90 value 8.941796
## iter 100 value 8.651415
## final  value 8.651415
## stopped after 100 iterations
## # weights:  39
## initial  value 123.515370
## iter  10 value 83.153644
## iter  20 value 70.419076
## iter  30 value 64.038411
## iter  40 value 62.308386
## iter  50 value 59.468454
## iter  60 value 58.712067
## iter  70 value 58.678013
## final  value 58.677908
## converged
## # weights:  109
## initial  value 109.985406
## iter  10 value 51.749223
## iter  20 value 35.665648
```

```
## iter  30 value 25.664766
## iter  40 value 21.912126
## iter  50 value 19.258182
## iter  60 value 17.923731
## iter  70 value 17.399123
## iter  80 value 17.054677
## iter  90 value 17.008316
## iter 100 value 16.999392
## final  value 16.999392
## stopped after 100 iterations
## # weights:  179
## initial  value 109.986602
## iter  10 value 40.930350
## iter  20 value 23.371774
## iter  30 value 15.478120
## iter  40 value 12.919731
## iter  50 value 12.301632
## iter  60 value 12.187109
## iter  70 value 12.177108
## iter  80 value 12.174443
## iter  90 value 12.174280
## final  value 12.174272
## converged
## # weights:  39
## initial  value 106.896869
## iter  10 value 75.647908
## iter  20 value 62.928572
## iter  30 value 60.338873
## iter  40 value 56.850236
## iter  50 value 54.587161
## iter  60 value 52.077018
## iter  70 value 49.267671
## iter  80 value 46.899490
## iter  90 value 46.375950
## iter 100 value 46.048647
## final  value 46.048647
## stopped after 100 iterations
## # weights:  109
## initial  value 104.227153
## iter  10 value 49.408174
## iter  20 value 33.398251
## iter  30 value 26.351524
## iter  40 value 21.805631
## iter  50 value 20.833091
## iter  60 value 20.257008
## iter  70 value 20.185132
## iter  80 value 20.135941
## iter  90 value 20.071287
## iter 100 value 20.016161
## final  value 20.016161
## stopped after 100 iterations
## # weights:  179
## initial  value 132.382320
## iter  10 value 67.797836
```

```
## iter  20 value 45.232275
## iter  30 value 22.550630
## iter  40 value 11.521243
## iter  50 value 9.066594
## iter  60 value 8.286383
## iter  70 value 7.339770
## iter  80 value 7.113598
## iter  90 value 7.090570
## iter 100 value 7.044105
## final  value 7.044105
## stopped after 100 iterations
## # weights:  39
## initial  value 106.255009
## iter  10 value 66.829748
## iter  20 value 61.989661
## iter  30 value 60.600386
## iter  40 value 59.364435
## iter  50 value 58.857610
## iter  60 value 58.583840
## iter  70 value 56.685758
## iter  80 value 55.652771
## iter  90 value 54.303317
## iter 100 value 54.088777
## final  value 54.088777
## stopped after 100 iterations
## # weights:  109
## initial  value 95.237205
## iter  10 value 46.263256
## iter  20 value 14.889634
## iter  30 value 9.748428
## iter  40 value 7.481966
## iter  50 value 6.447576
## iter  60 value 6.247395
## iter  70 value 6.246110
## iter  80 value 6.244189
## iter  90 value 6.243411
## iter 100 value 6.243190
## final  value 6.243190
## stopped after 100 iterations
## # weights:  179
## initial  value 103.675430
## iter  10 value 29.037170
## iter  20 value 10.186919
## iter  30 value 5.119725
## iter  40 value 2.403088
## iter  50 value 0.084057
## iter  60 value 0.012795
## iter  70 value 0.001608
## iter  80 value 0.000367
## iter  90 value 0.000108
## iter  90 value 0.000093
## iter  90 value 0.000093
## final  value 0.000093
## converged
```

```
## # weights:  39
## initial  value 101.282811
## iter  10 value 68.911659
## iter  20 value 65.579028
## iter  30 value 63.183165
## iter  40 value 60.489143
## iter  50 value 58.956900
## iter  60 value 58.877260
## iter  70 value 58.853650
## iter  80 value 58.814921
## iter  90 value 58.812273
## final  value 58.812269
## converged
## # weights:  109
## initial  value 115.216886
## iter  10 value 50.025580
## iter  20 value 28.517549
## iter  30 value 20.338125
## iter  40 value 16.609221
## iter  50 value 16.169486
## iter  60 value 16.134992
## iter  70 value 16.134684
## final  value 16.134684
## converged
## # weights:  179
## initial  value 116.085321
## iter  10 value 30.954048
## iter  20 value 18.705041
## iter  30 value 15.362583
## iter  40 value 13.987375
## iter  50 value 12.235154
## iter  60 value 11.987891
## iter  70 value 11.935045
## iter  80 value 11.889550
## iter  90 value 11.814101
## iter 100 value 11.698297
## final  value 11.698297
## stopped after 100 iterations
## # weights:  39
## initial  value 110.172818
## iter  10 value 66.795218
## iter  20 value 56.627134
## iter  30 value 55.113840
## iter  40 value 53.916655
## iter  50 value 53.513457
## iter  60 value 53.429708
## iter  70 value 53.424925
## iter  80 value 53.409361
## iter  90 value 53.323718
## iter 100 value 52.026737
## final  value 52.026737
## stopped after 100 iterations
## # weights:  109
## initial  value 105.943214
```

```
## iter  10 value 61.305445
## iter  20 value 46.566526
## iter  30 value 45.255248
## iter  40 value 44.839251
## iter  50 value 44.365837
## iter  60 value 43.802265
## iter  70 value 42.893714
## iter  80 value 42.582211
## iter  90 value 41.538761
## iter 100 value 41.511259
## final  value 41.511259
## stopped after 100 iterations
## # weights:  179
## initial  value 114.208948
## iter  10 value 13.133927
## iter  20 value 0.377683
## iter  30 value 0.206190
## iter  40 value 0.182578
## iter  50 value 0.161110
## iter  60 value 0.137105
## iter  70 value 0.126345
## iter  80 value 0.118637
## iter  90 value 0.111652
## iter 100 value 0.104741
## final  value 0.104741
## stopped after 100 iterations
## # weights:  39
## initial  value 97.141722
## iter  10 value 63.657723
## iter  20 value 56.257900
## iter  30 value 50.666105
## iter  40 value 43.475527
## iter  50 value 39.802194
## iter  60 value 38.635474
## iter  70 value 38.446019
## iter  80 value 38.401404
## iter  90 value 38.375354
## iter 100 value 38.361117
## final  value 38.361117
## stopped after 100 iterations
## # weights:  109
## initial  value 109.996305
## iter  10 value 22.052461
## iter  20 value 17.123695
## iter  30 value 16.218858
## iter  40 value 15.686875
## iter  50 value 14.917486
## iter  60 value 14.028244
## iter  70 value 12.434591
## iter  80 value 12.181066
## iter  90 value 10.251471
## iter 100 value 10.249067
## final  value 10.249067
## stopped after 100 iterations
```

```
## # weights:  179
## initial  value 130.458739
## iter  10 value 47.501540
## iter  20 value 23.194329
## iter  30 value 17.354249
## iter  40 value 16.618484
## iter  50 value 14.646119
## iter  60 value 14.325470
## iter  70 value 14.278478
## iter  80 value 14.225292
## iter  90 value 14.137936
## iter 100 value 14.071084
## final  value 14.071084
## stopped after 100 iterations
## # weights:  39
## initial  value 108.177681
## iter  10 value 72.116776
## iter  20 value 64.391265
## iter  30 value 60.224527
## iter  40 value 57.103019
## iter  50 value 55.732328
## iter  60 value 55.658225
## final  value 55.657593
## converged
## # weights:  109
## initial  value 106.246967
## iter  10 value 40.889581
## iter  20 value 27.603289
## iter  30 value 17.852300
## iter  40 value 16.264181
## iter  50 value 16.007933
## iter  60 value 15.766623
## iter  70 value 15.270261
## iter  80 value 14.501568
## iter  90 value 14.486939
## final  value 14.486893
## converged
## # weights:  179
## initial  value 100.280449
## iter  10 value 44.011581
## iter  20 value 22.418312
## iter  30 value 15.536459
## iter  40 value 13.070783
## iter  50 value 12.258427
## iter  60 value 11.768666
## iter  70 value 11.601077
## iter  80 value 11.450492
## iter  90 value 11.432543
## iter 100 value 11.409719
## final  value 11.409719
## stopped after 100 iterations
## # weights:  39
## initial  value 100.902533
## iter  10 value 69.495457
```

```
## iter  20 value 56.489412
## iter  30 value 52.155389
## iter  40 value 49.536678
## iter  50 value 47.961094
## iter  60 value 46.255032
## iter  70 value 45.697391
## iter  80 value 45.109502
## iter  90 value 44.840550
## iter 100 value 43.631604
## final  value 43.631604
## stopped after 100 iterations
## # weights:  109
## initial  value 105.241944
## iter  10 value 18.004443
## iter  20 value 13.521945
## iter  30 value 11.639554
## iter  40 value 11.310311
## iter  50 value 11.252484
## iter  60 value 11.203879
## iter  70 value 11.133833
## iter  80 value 11.101025
## iter  90 value 11.046984
## iter 100 value 11.000440
## final  value 11.000440
## stopped after 100 iterations
## # weights:  179
## initial  value 97.749766
## iter  10 value 25.020107
## iter  20 value 10.201067
## iter  30 value 8.053348
## iter  40 value 7.415986
## iter  50 value 6.991348
## iter  60 value 2.739974
## iter  70 value 2.432719
## iter  80 value 0.218547
## iter  90 value 0.202425
## iter 100 value 0.180217
## final  value 0.180217
## stopped after 100 iterations
## # weights:  39
## initial  value 102.074074
## iter  10 value 76.071231
## iter  20 value 71.110618
## iter  30 value 69.010607
## iter  40 value 68.620046
## iter  50 value 68.575700
## iter  60 value 68.571629
## iter  70 value 68.570057
## iter  80 value 68.569106
## iter  90 value 68.568971
## final  value 68.568960
## converged
## # weights:  109
## initial  value 107.852459
```

```
## iter  10 value 59.224926
## iter  20 value 39.232537
## iter  30 value 36.123722
## iter  40 value 33.782371
## iter  50 value 33.393436
## iter  60 value 32.708590
## iter  70 value 32.305549
## iter  80 value 31.866234
## iter  90 value 31.567093
## iter 100 value 31.051610
## final  value 31.051610
## stopped after 100 iterations
## # weights:  179
## initial  value 122.246607
## iter  10 value 26.359998
## iter  20 value 16.447792
## iter  30 value 15.652143
## iter  40 value 15.491780
## iter  50 value 14.761786
## iter  60 value 14.753042
## iter  70 value 14.729595
## iter  80 value 12.965682
## iter  90 value 12.848481
## iter 100 value 12.845797
## final  value 12.845797
## stopped after 100 iterations
## # weights:  39
## initial  value 117.616004
## iter  10 value 70.091623
## iter  20 value 61.919012
## iter  30 value 60.350121
## iter  40 value 59.883131
## iter  50 value 59.557645
## iter  60 value 58.750542
## final  value 58.738443
## converged
## # weights:  109
## initial  value 110.271079
## iter  10 value 57.231152
## iter  20 value 29.598527
## iter  30 value 19.980459
## iter  40 value 17.459025
## iter  50 value 17.018922
## iter  60 value 16.885743
## iter  70 value 16.687703
## iter  80 value 16.614984
## iter  90 value 16.613148
## iter  90 value 16.613148
## iter  90 value 16.613148
## final  value 16.613148
## converged
## # weights:  179
## initial  value 108.148610
## iter  10 value 60.864418
```

```
## iter  20 value 26.107739
## iter  30 value 14.821464
## iter  40 value 12.936570
## iter  50 value 12.488586
## iter  60 value 12.399275
## iter  70 value 12.387366
## iter  80 value 12.384074
## iter  90 value 12.384002
## final  value 12.384000
## converged
## # weights:  39
## initial  value 99.672219
## iter  10 value 66.668741
## iter  20 value 56.541865
## iter  30 value 49.647541
## iter  40 value 46.983637
## iter  50 value 46.436520
## iter  60 value 45.291575
## iter  70 value 45.036242
## iter  80 value 45.023579
## iter  90 value 44.410058
## iter 100 value 42.803474
## final  value 42.803474
## stopped after 100 iterations
## # weights:  109
## initial  value 106.520235
## iter  10 value 39.520266
## iter  20 value 23.039909
## iter  30 value 15.670569
## iter  40 value 12.580631
## iter  50 value 9.704793
## iter  60 value 8.520717
## iter  70 value 8.176335
## iter  80 value 8.106534
## iter  90 value 7.807544
## iter 100 value 7.434241
## final  value 7.434241
## stopped after 100 iterations
## # weights:  179
## initial  value 94.639251
## iter  10 value 26.432558
## iter  20 value 11.694838
## iter  30 value 3.620085
## iter  40 value 2.811757
## iter  50 value 0.331177
## iter  60 value 0.255240
## iter  70 value 0.232505
## iter  80 value 0.219530
## iter  90 value 0.207084
## iter 100 value 0.187687
## final  value 0.187687
## stopped after 100 iterations
## # weights:  39
## initial  value 101.955099
```

```
## iter  10 value 58.547455
## iter  20 value 56.096916
## iter  30 value 55.576029
## iter  40 value 54.694568
## iter  50 value 54.276457
## iter  60 value 54.085698
## iter  70 value 54.055668
## iter  80 value 54.048491
## iter  90 value 54.047021
## final  value 54.047018
## converged
## # weights:  109
## initial  value 113.799929
## iter  10 value 50.605766
## iter  20 value 39.075051
## iter  30 value 15.877394
## iter  40 value 6.633256
## iter  50 value 5.607312
## iter  60 value 5.581716
## iter  70 value 5.581393
## iter  80 value 5.581202
## final  value 5.581199
## converged
## # weights:  179
## initial  value 102.433560
## iter  10 value 27.630212
## iter  20 value 8.169679
## iter  30 value 4.015954
## iter  40 value 3.823980
## iter  50 value 3.819553
## iter  60 value 3.819135
## iter  70 value 3.819110
## iter  80 value 3.819096
## final  value 3.819095
## converged
## # weights:  39
## initial  value 104.894651
## iter  10 value 67.222319
## iter  20 value 60.939577
## iter  30 value 58.827110
## iter  40 value 58.535081
## iter  50 value 58.276064
## iter  60 value 58.231354
## iter  70 value 57.967052
## final  value 57.964173
## converged
## # weights:  109
## initial  value 103.171180
## iter  10 value 53.155911
## iter  20 value 31.112623
## iter  30 value 19.107940
## iter  40 value 16.822459
## iter  50 value 16.317978
## iter  60 value 16.198758
```

```
## iter  70 value 15.755214
## iter  80 value 15.643074
## final  value 15.642186
## converged
## # weights:  179
## initial  value 126.716014
## iter  10 value 37.553336
## iter  20 value 18.808806
## iter  30 value 14.720767
## iter  40 value 12.824745
## iter  50 value 12.308859
## iter  60 value 11.965359
## iter  70 value 11.946654
## iter  80 value 11.945785
## final  value 11.945778
## converged
## # weights:  39
## initial  value 106.506137
## iter  10 value 63.483543
## iter  20 value 58.251297
## iter  30 value 56.306057
## iter  40 value 56.193543
## iter  50 value 55.944139
## iter  60 value 55.099116
## iter  70 value 54.762976
## iter  80 value 54.051169
## iter  90 value 53.387555
## iter 100 value 53.237653
## final  value 53.237653
## stopped after 100 iterations
## # weights:  109
## initial  value 100.743883
## iter  10 value 43.836289
## iter  20 value 28.798707
## iter  30 value 11.310145
## iter  40 value 6.674740
## iter  50 value 6.303535
## iter  60 value 6.007749
## iter  70 value 4.920568
## iter  80 value 4.839844
## iter  90 value 4.343286
## iter 100 value 4.327982
## final  value 4.327982
## stopped after 100 iterations
## # weights:  179
## initial  value 108.255633
## iter  10 value 37.536592
## iter  20 value 14.056476
## iter  30 value 10.499864
## iter  40 value 9.325585
## iter  50 value 9.181399
## iter  60 value 9.132712
## iter  70 value 9.108987
## iter  80 value 9.085355
```

```
## iter  90 value 9.001335
## iter 100 value 8.989747
## final  value 8.989747
## stopped after 100 iterations
## # weights:  39
## initial  value 113.983098
## iter  10 value 87.441127
## iter  20 value 79.352612
## iter  30 value 78.066712
## iter  40 value 76.671679
## iter  50 value 74.432980
## iter  60 value 73.952666
## iter  70 value 73.838108
## iter  80 value 73.819343
## iter  90 value 73.813846
## iter 100 value 73.812058
## final  value 73.812058
## stopped after 100 iterations
## # weights:  109
## initial  value 107.889333
## iter  10 value 40.854062
## iter  20 value 25.007905
## iter  30 value 19.239009
## iter  40 value 18.638793
## iter  50 value 18.518591
## iter  60 value 18.311120
## iter  70 value 17.976175
## iter  80 value 17.963642
## iter  90 value 17.959310
## iter 100 value 17.948484
## final  value 17.948484
## stopped after 100 iterations
## # weights:  179
## initial  value 113.977287
## iter  10 value 48.286552
## iter  20 value 20.015456
## iter  30 value 12.575581
## iter  40 value 7.679967
## iter  50 value 5.951121
## iter  60 value 4.206847
## iter  70 value 4.181080
## iter  80 value 4.172679
## iter  90 value 4.165677
## iter 100 value 4.164398
## final  value 4.164398
## stopped after 100 iterations
## # weights:  39
## initial  value 104.295824
## iter  10 value 75.210877
## iter  20 value 63.048352
## iter  30 value 58.488840
## iter  40 value 57.414507
## iter  50 value 57.394265
## final  value 57.394232
```

```
## converged
## # weights:  109
## initial  value 115.381280
## iter  10 value 48.512886
## iter  20 value 40.417664
## iter  30 value 33.541293
## iter  40 value 24.289052
## iter  50 value 18.641956
## iter  60 value 17.361724
## iter  70 value 17.056913
## iter  80 value 16.948316
## iter  90 value 16.947875
## final  value 16.947873
## converged
## # weights:  179
## initial  value 110.424543
## iter  10 value 31.157217
## iter  20 value 17.932690
## iter  30 value 14.527502
## iter  40 value 13.163494
## iter  50 value 12.950152
## iter  60 value 12.634455
## iter  70 value 12.527285
## iter  80 value 12.366793
## iter  90 value 12.354188
## iter 100 value 12.351244
## final  value 12.351244
## stopped after 100 iterations
## # weights:  39
## initial  value 104.133840
## iter  10 value 74.176563
## iter  20 value 62.253660
## iter  30 value 60.173528
## iter  40 value 57.933405
## iter  50 value 56.549344
## iter  60 value 52.659860
## iter  70 value 51.759683
## iter  80 value 51.599303
## iter  90 value 49.616761
## iter 100 value 49.371199
## final  value 49.371199
## stopped after 100 iterations
## # weights:  109
## initial  value 94.492022
## iter  10 value 37.476186
## iter  20 value 28.270609
## iter  30 value 26.324287
## iter  40 value 24.945171
## iter  50 value 23.881297
## iter  60 value 23.683917
## iter  70 value 23.582756
## iter  80 value 23.558394
## iter  90 value 23.492785
## iter 100 value 23.404812
```

```
## final  value 23.404812
## stopped after 100 iterations
## # weights:  179
## initial  value 103.884269
## iter  10 value 26.365540
## iter  20 value 7.869652
## iter  30 value 3.692560
## iter  40 value 3.132682
## iter  50 value 2.959503
## iter  60 value 2.929386
## iter  70 value 2.909333
## iter  80 value 2.426242
## iter  90 value 2.099608
## iter 100 value 2.074604
## final  value 2.074604
## stopped after 100 iterations
## # weights:  39
## initial  value 106.952758
## iter  10 value 72.637910
## iter  20 value 62.074466
## iter  30 value 58.996568
## iter  40 value 58.164663
## iter  50 value 58.095806
## iter  60 value 56.929747
## iter  70 value 55.880715
## iter  80 value 55.867418
## iter  90 value 55.839945
## iter 100 value 55.825475
## final  value 55.825475
## stopped after 100 iterations
## # weights:  109
## initial  value 105.912788
## iter  10 value 48.835434
## iter  20 value 25.377404
## iter  30 value 17.550656
## iter  40 value 12.536803
## iter  50 value 10.418910
## iter  60 value 9.738811
## iter  70 value 9.701508
## iter  80 value 9.591408
## iter  90 value 9.534155
## iter 100 value 9.446017
## final  value 9.446017
## stopped after 100 iterations
## # weights:  179
## initial  value 106.309196
## iter  10 value 26.936341
## iter  20 value 7.188706
## iter  30 value 2.016982
## iter  40 value 1.726872
## iter  50 value 1.394768
## iter  60 value 1.391318
## iter  70 value 1.388821
## iter  80 value 1.387579
```

```
## iter  90 value 1.387342
## iter 100 value 1.386729
## final  value 1.386729
## stopped after 100 iterations
## # weights:  39
## initial  value 106.758200
## iter  10 value 68.060533
## iter  20 value 58.827192
## iter  30 value 57.217470
## iter  40 value 56.801505
## iter  50 value 56.488998
## iter  60 value 56.361462
## iter  70 value 56.355441
## final  value 56.355432
## converged
## # weights:  109
## initial  value 104.347575
## iter  10 value 35.032481
## iter  20 value 19.578919
## iter  30 value 17.474573
## iter  40 value 17.185165
## iter  50 value 16.163480
## iter  60 value 15.653149
## iter  70 value 15.468152
## iter  80 value 14.948157
## iter  90 value 14.942889
## final  value 14.942880
## converged
## # weights:  179
## initial  value 116.380740
## iter  10 value 37.487523
## iter  20 value 17.297219
## iter  30 value 13.261150
## iter  40 value 11.801239
## iter  50 value 11.587774
## iter  60 value 11.573982
## iter  70 value 11.573726
## final  value 11.573721
## converged
## # weights:  39
## initial  value 110.591086
## iter  10 value 79.701509
## iter  20 value 66.051565
## iter  30 value 63.311775
## iter  40 value 60.188671
## iter  50 value 57.665481
## iter  60 value 56.028626
## iter  70 value 53.021714
## iter  80 value 52.584545
## iter  90 value 50.528819
## iter 100 value 49.187377
## final  value 49.187377
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 111.225988
## iter  10 value 55.032260
## iter  20 value 31.243901
## iter  30 value 21.242487
## iter  40 value 20.853761
## iter  50 value 20.505548
## iter  60 value 20.263619
## iter  70 value 19.955041
## iter  80 value 19.906153
## iter  90 value 19.825165
## iter 100 value 19.805037
## final  value 19.805037
## stopped after 100 iterations
## # weights:  179
## initial  value 108.085848
## iter  10 value 43.059980
## iter  20 value 4.622010
## iter  30 value 0.277884
## iter  40 value 0.233860
## iter  50 value 0.202374
## iter  60 value 0.177374
## iter  70 value 0.154542
## iter  80 value 0.146888
## iter  90 value 0.133103
## iter 100 value 0.128138
## final  value 0.128138
## stopped after 100 iterations
## # weights:  39
## initial  value 111.614371
## iter  10 value 67.853567
## iter  20 value 56.814323
## iter  30 value 53.091755
## iter  40 value 53.069044
## iter  50 value 53.067391
## iter  60 value 53.067199
## iter  70 value 53.067139
## final  value 53.067093
## converged
## # weights:  109
## initial  value 114.080231
## iter  10 value 58.374017
## iter  20 value 42.452250
## iter  30 value 29.675842
## iter  40 value 25.644864
## iter  50 value 25.331905
## iter  60 value 21.333729
## iter  70 value 20.307710
## iter  80 value 20.270711
## iter  90 value 20.264074
## iter 100 value 20.263155
## final  value 20.263155
## stopped after 100 iterations
## # weights:  179
## initial  value 105.586240
```

```
## iter  10 value 18.053246
## iter  20 value 5.637791
## iter  30 value 0.318545
## iter  40 value 0.009110
## iter  50 value 0.000690
## iter  60 value 0.000199
## iter  70 value 0.000102
## final  value 0.000100
## converged
## # weights:  39
## initial  value 103.785528
## iter  10 value 67.873462
## iter  20 value 63.564800
## iter  30 value 61.075913
## iter  40 value 60.650053
## iter  50 value 60.141771
## iter  60 value 58.677670
## iter  70 value 58.158505
## iter  80 value 57.980523
## iter  90 value 57.961032
## iter  90 value 57.961032
## iter  90 value 57.961032
## final  value 57.961032
## converged
## # weights:  109
## initial  value 116.856886
## iter  10 value 47.658898
## iter  20 value 31.980101
## iter  30 value 20.532882
## iter  40 value 18.388903
## iter  50 value 17.760540
## iter  60 value 17.506323
## iter  70 value 16.928798
## iter  80 value 16.607733
## iter  90 value 16.529480
## iter 100 value 16.513202
## final  value 16.513202
## stopped after 100 iterations
## # weights:  179
## initial  value 125.097607
## iter  10 value 54.197389
## iter  20 value 30.854924
## iter  30 value 21.855689
## iter  40 value 16.674901
## iter  50 value 14.312230
## iter  60 value 12.945907
## iter  70 value 12.813269
## iter  80 value 12.806684
## final  value 12.806602
## converged
## # weights:  39
## initial  value 109.454281
## iter  10 value 68.489554
## iter  20 value 58.051799
```

```
## iter  30 value 53.950597
## iter  40 value 50.492012
## iter  50 value 50.267121
## iter  60 value 50.249982
## iter  70 value 50.183703
## iter  80 value 50.142698
## iter  90 value 50.139174
## iter 100 value 50.124259
## final  value 50.124259
## stopped after 100 iterations
## # weights:  109
## initial  value 104.158381
## iter  10 value 29.158508
## iter  20 value 15.290944
## iter  30 value 13.104837
## iter  40 value 12.508605
## iter  50 value 12.405232
## iter  60 value 12.358646
## iter  70 value 12.026993
## iter  80 value 11.813131
## iter  90 value 11.798816
## iter 100 value 11.765708
## final  value 11.765708
## stopped after 100 iterations
## # weights:  179
## initial  value 126.750437
## iter  10 value 62.013794
## iter  20 value 56.182839
## iter  30 value 53.208551
## iter  40 value 52.784011
## iter  50 value 52.647743
## iter  60 value 52.524650
## iter  70 value 52.113067
## iter  80 value 51.703608
## iter  90 value 50.046333
## iter 100 value 48.482687
## final  value 48.482687
## stopped after 100 iterations
## # weights:  39
## initial  value 102.783425
## iter  10 value 63.566598
## iter  20 value 59.943813
## iter  30 value 59.019441
## iter  40 value 58.120556
## iter  50 value 52.672595
## iter  60 value 51.869770
## iter  70 value 50.866956
## iter  80 value 50.633918
## iter  90 value 49.237394
## iter 100 value 49.172407
## final  value 49.172407
## stopped after 100 iterations
## # weights:  109
## initial  value 101.225242
```

```
## iter  10 value 56.818837
## iter  20 value 30.455290
## iter  30 value 17.238070
## iter  40 value 8.748559
## iter  50 value 8.702947
## iter  60 value 8.599904
## iter  70 value 8.040919
## iter  80 value 7.187679
## iter  90 value 6.759235
## iter 100 value 6.757061
## final  value 6.757061
## stopped after 100 iterations
## # weights:  179
## initial  value 138.253773
## iter  10 value 47.350613
## iter  20 value 32.195540
## iter  30 value 18.590606
## iter  40 value 17.754454
## iter  50 value 17.452344
## iter  60 value 17.294295
## iter  70 value 11.162064
## iter  80 value 7.278059
## iter  90 value 6.718116
## iter 100 value 6.681113
## final  value 6.681113
## stopped after 100 iterations
## # weights:  39
## initial  value 105.595506
## iter  10 value 70.007793
## iter  20 value 63.735123
## iter  30 value 60.656865
## iter  40 value 58.436173
## iter  50 value 58.376796
## final  value 58.376740
## converged
## # weights:  109
## initial  value 104.408190
## iter  10 value 54.812636
## iter  20 value 33.437008
## iter  30 value 26.143288
## iter  40 value 19.021726
## iter  50 value 16.400660
## iter  60 value 15.749509
## iter  70 value 15.735730
## iter  80 value 15.734676
## final  value 15.734656
## converged
## # weights:  179
## initial  value 144.306136
## iter  10 value 67.928940
## iter  20 value 34.866184
## iter  30 value 21.767936
## iter  40 value 15.933002
## iter  50 value 13.188490
```

```
## iter  60 value 11.904032
## iter  70 value 11.687760
## iter  80 value 11.676570
## iter  90 value 11.676338
## final  value 11.676334
## converged
## # weights:  39
## initial  value 100.249235
## iter  10 value 79.316363
## iter  20 value 54.146303
## iter  30 value 51.926509
## iter  40 value 50.587084
## iter  50 value 50.489573
## iter  60 value 50.474210
## iter  70 value 50.458626
## iter  80 value 50.450965
## iter  90 value 50.444014
## iter 100 value 50.426712
## final  value 50.426712
## stopped after 100 iterations
## # weights:  109
## initial  value 102.457680
## iter  10 value 30.173731
## iter  20 value 23.577067
## iter  30 value 19.575446
## iter  40 value 18.388200
## iter  50 value 18.086073
## iter  60 value 17.781574
## iter  70 value 17.762747
## iter  80 value 17.523431
## iter  90 value 17.007868
## iter 100 value 16.837788
## final  value 16.837788
## stopped after 100 iterations
## # weights:  179
## initial  value 107.763843
## iter  10 value 12.222938
## iter  20 value 4.833238
## iter  30 value 2.547389
## iter  40 value 2.506760
## iter  50 value 2.465933
## iter  60 value 2.446618
## iter  70 value 2.429134
## iter  80 value 2.414251
## iter  90 value 2.039411
## iter 100 value 0.211096
## final  value 0.211096
## stopped after 100 iterations
## # weights:  39
## initial  value 104.472068
## iter  10 value 65.134966
## iter  20 value 58.039746
## iter  30 value 51.529865
## iter  40 value 46.482814
```

```
## iter  50 value 45.560272
## iter  60 value 45.233478
## iter  70 value 45.166909
## iter  80 value 45.128088
## iter  90 value 45.123443
## iter 100 value 45.121269
## final  value 45.121269
## stopped after 100 iterations
## # weights:  109
## initial  value 98.200797
## iter  10 value 22.463152
## iter  20 value 12.801040
## iter  30 value 8.665100
## iter  40 value 8.131949
## iter  50 value 6.254631
## iter  60 value 3.792582
## iter  70 value 3.665075
## iter  80 value 3.583041
## iter  90 value 3.501858
## iter 100 value 3.476684
## final  value 3.476684
## stopped after 100 iterations
## # weights:  179
## initial  value 106.456868
## iter  10 value 19.267289
## iter  20 value 4.937744
## iter  30 value 2.268550
## iter  40 value 2.250703
## iter  50 value 2.249501
## iter  60 value 2.249382
## iter  70 value 2.249351
## final  value 2.249341
## converged
## # weights:  39
## initial  value 103.966156
## iter  10 value 67.868376
## iter  20 value 63.303665
## iter  30 value 61.969825
## iter  40 value 61.070824
## iter  50 value 60.274006
## iter  60 value 58.627562
## iter  70 value 57.704211
## iter  80 value 57.312106
## iter  90 value 57.223031
## iter 100 value 57.126860
## final  value 57.126860
## stopped after 100 iterations
## # weights:  109
## initial  value 103.489716
## iter  10 value 56.695186
## iter  20 value 34.519226
## iter  30 value 21.327647
## iter  40 value 19.725156
## iter  50 value 19.147502
```

```
## iter  60 value 18.786956
## iter  70 value 16.128017
## iter  80 value 16.006829
## iter  90 value 16.004455
## final  value 16.004440
## converged
## # weights:  179
## initial  value 127.364733
## iter  10 value 55.537825
## iter  20 value 35.271283
## iter  30 value 19.268067
## iter  40 value 16.335774
## iter  50 value 14.685336
## iter  60 value 12.903358
## iter  70 value 12.752868
## iter  80 value 12.577489
## iter  90 value 12.198395
## iter 100 value 12.115448
## final  value 12.115448
## stopped after 100 iterations
## # weights:  39
## initial  value 109.354850
## iter  10 value 67.274959
## iter  20 value 61.111110
## iter  30 value 59.295381
## iter  40 value 58.688705
## iter  50 value 58.659685
## iter  60 value 58.177136
## iter  70 value 57.532969
## iter  80 value 57.032554
## iter  90 value 56.404495
## iter 100 value 55.235029
## final  value 55.235029
## stopped after 100 iterations
## # weights:  109
## initial  value 106.031369
## iter  10 value 33.048027
## iter  20 value 18.252925
## iter  30 value 13.226675
## iter  40 value 6.668048
## iter  50 value 5.953257
## iter  60 value 5.894459
## iter  70 value 5.854195
## iter  80 value 5.835521
## iter  90 value 4.823775
## iter 100 value 3.728382
## final  value 3.728382
## stopped after 100 iterations
## # weights:  179
## initial  value 113.749683
## iter  10 value 37.107881
## iter  20 value 9.860052
## iter  30 value 4.308719
## iter  40 value 3.625436
```

```
## iter  50 value 3.538512
## iter  60 value 1.664658
## iter  70 value 1.603890
## iter  80 value 1.589111
## iter  90 value 1.566951
## iter 100 value 0.461612
## final  value 0.461612
## stopped after 100 iterations
## # weights:  39
## initial  value 110.703885
## iter  10 value 80.488171
## iter  20 value 58.409982
## iter  30 value 55.031395
## iter  40 value 54.701676
## iter  50 value 54.433406
## iter  60 value 54.427639
## iter  70 value 54.390842
## iter  80 value 53.572547
## iter  90 value 53.355908
## iter 100 value 52.636314
## final  value 52.636314
## stopped after 100 iterations
## # weights:  109
## initial  value 112.777157
## iter  10 value 35.777908
## iter  20 value 14.676191
## iter  30 value 8.127686
## iter  40 value 6.662476
## iter  50 value 6.064842
## iter  60 value 5.332021
## iter  70 value 3.351237
## iter  80 value 3.299404
## iter  90 value 3.296430
## iter 100 value 3.295842
## final  value 3.295842
## stopped after 100 iterations
## # weights:  179
## initial  value 114.786911
## iter  10 value 37.376245
## iter  20 value 31.019746
## iter  30 value 30.268802
## iter  40 value 29.571426
## iter  50 value 28.070073
## iter  60 value 27.156619
## iter  70 value 26.394960
## iter  80 value 25.183531
## iter  90 value 24.321861
## iter 100 value 24.315693
## final  value 24.315693
## stopped after 100 iterations
## # weights:  39
## initial  value 102.442172
## iter  10 value 77.450999
## iter  20 value 71.361642
```

```
## iter  30 value 65.028247
## iter  40 value 59.644186
## iter  50 value 58.821794
## iter  60 value 58.733068
## iter  70 value 58.293790
## iter  80 value 58.185515
## iter  90 value 58.183982
## iter  90 value 58.183981
## iter  90 value 58.183981
## final  value 58.183981
## converged
## # weights:  109
## initial  value 117.453113
## iter  10 value 51.873481
## iter  20 value 30.692088
## iter  30 value 21.786803
## iter  40 value 17.152029
## iter  50 value 16.807359
## iter  60 value 16.761771
## iter  70 value 16.760704
## final  value 16.760703
## converged
## # weights:  179
## initial  value 97.760439
## iter  10 value 40.313885
## iter  20 value 18.795398
## iter  30 value 14.296333
## iter  40 value 12.979477
## iter  50 value 12.715987
## iter  60 value 12.525710
## iter  70 value 12.495610
## iter  80 value 12.494957
## final  value 12.494950
## converged
## # weights:  39
## initial  value 106.384231
## iter  10 value 86.192459
## iter  20 value 64.956486
## iter  30 value 63.513229
## iter  40 value 62.674825
## iter  50 value 62.053816
## iter  60 value 62.050996
## iter  70 value 62.036129
## iter  80 value 62.029184
## iter  90 value 62.025271
## iter 100 value 60.741352
## final  value 60.741352
## stopped after 100 iterations
## # weights:  109
## initial  value 105.295497
## iter  10 value 49.988130
## iter  20 value 35.420163
## iter  30 value 11.650889
## iter  40 value 2.601046
```

```
## iter  50 value 0.811794
## iter  60 value 0.701504
## iter  70 value 0.628957
## iter  80 value 0.517797
## iter  90 value 0.478542
## iter 100 value 0.439401
## final  value 0.439401
## stopped after 100 iterations
## # weights:  179
## initial  value 96.208628
## iter  10 value 22.444190
## iter  20 value 6.249756
## iter  30 value 4.750947
## iter  40 value 4.134210
## iter  50 value 3.953896
## iter  60 value 3.583218
## iter  70 value 3.565410
## iter  80 value 3.527629
## iter  90 value 3.495411
## iter 100 value 3.286140
## final  value 3.286140
## stopped after 100 iterations
## # weights:  39
## initial  value 99.113616
## iter  10 value 72.921939
## iter  20 value 65.653703
## iter  30 value 65.557822
## iter  40 value 65.356098
## iter  50 value 64.570840
## iter  60 value 64.547269
## iter  70 value 64.545236
## iter  80 value 64.540920
## iter  90 value 64.540150
## iter  90 value 64.540149
## iter  90 value 64.540149
## final  value 64.540149
## converged
## # weights:  109
## initial  value 100.265026
## iter  10 value 32.744203
## iter  20 value 9.347204
## iter  30 value 6.459242
## iter  40 value 6.445520
## iter  50 value 6.435164
## iter  60 value 6.108671
## final  value 6.108652
## converged
## # weights:  179
## initial  value 107.617677
## iter  10 value 20.094854
## iter  20 value 4.197975
## iter  30 value 2.568063
## iter  40 value 2.503684
## iter  50 value 2.502390
```

```
## iter  60 value 2.502017
## iter  70 value 2.502013
## iter  70 value 2.502013
## iter  70 value 2.502013
## final  value 2.502013
## converged
## # weights:  39
## initial  value 101.922734
## iter  10 value 67.704235
## iter  20 value 60.938457
## iter  30 value 60.304342
## iter  40 value 57.859377
## iter  50 value 57.228095
## iter  60 value 57.071092
## iter  70 value 56.961622
## iter  80 value 56.853297
## iter  90 value 56.844005
## iter 100 value 56.121219
## final  value 56.121219
## stopped after 100 iterations
## # weights:  109
## initial  value 114.608044
## iter  10 value 48.681598
## iter  20 value 27.725466
## iter  30 value 20.921050
## iter  40 value 17.400910
## iter  50 value 16.832208
## iter  60 value 16.247031
## iter  70 value 15.821144
## iter  80 value 15.776211
## iter  90 value 15.775778
## final  value 15.775777
## converged
## # weights:  179
## initial  value 108.577470
## iter  10 value 45.492580
## iter  20 value 19.062566
## iter  30 value 13.571778
## iter  40 value 12.130881
## iter  50 value 11.818093
## iter  60 value 11.708886
## iter  70 value 11.704983
## iter  80 value 11.704270
## iter  90 value 11.704177
## final  value 11.704174
## converged
## # weights:  39
## initial  value 118.384405
## iter  10 value 63.061188
## iter  20 value 56.866506
## iter  30 value 52.918963
## iter  40 value 48.782648
## iter  50 value 47.685378
## iter  60 value 46.647754
```

```
## iter  70 value 46.547462
## iter  80 value 46.498774
## iter  90 value 46.468622
## iter 100 value 46.441623
## final  value 46.441623
## stopped after 100 iterations
## # weights:  109
## initial  value 100.523905
## iter  10 value 49.667985
## iter  20 value 32.272071
## iter  30 value 28.077417
## iter  40 value 24.766138
## iter  50 value 22.748340
## iter  60 value 17.034307
## iter  70 value 16.156846
## iter  80 value 14.613581
## iter  90 value 13.986368
## iter 100 value 12.983057
## final  value 12.983057
## stopped after 100 iterations
## # weights:  179
## initial  value 110.598998
## iter  10 value 16.468345
## iter  20 value 6.948654
## iter  30 value 5.736880
## iter  40 value 5.412081
## iter  50 value 2.780738
## iter  60 value 2.073711
## iter  70 value 2.064831
## iter  80 value 2.039632
## iter  90 value 2.028936
## iter 100 value 2.015563
## final  value 2.015563
## stopped after 100 iterations
## # weights:  39
## initial  value 107.272666
## iter  10 value 82.800546
## iter  20 value 60.398541
## iter  30 value 54.001731
## iter  40 value 50.788222
## iter  50 value 44.272933
## iter  60 value 41.151978
## iter  70 value 40.323128
## iter  80 value 39.398607
## iter  90 value 38.842088
## iter 100 value 38.661066
## final  value 38.661066
## stopped after 100 iterations
## # weights:  109
## initial  value 100.410174
## iter  10 value 50.415440
## iter  20 value 32.138839
## iter  30 value 24.851638
## iter  40 value 19.395535
```

```
## iter  50 value 16.168833
## iter  60 value 14.631217
## iter  70 value 14.210980
## iter  80 value 12.372002
## iter  90 value 12.245508
## iter 100 value 12.077968
## final  value 12.077968
## stopped after 100 iterations
## # weights:  179
## initial  value 118.142310
## iter  10 value 30.004293
## iter  20 value 7.019661
## iter  30 value 5.051398
## iter  40 value 3.789894
## iter  50 value 3.669587
## iter  60 value 3.648646
## iter  70 value 1.503231
## iter  80 value 1.415385
## iter  90 value 1.389252
## iter 100 value 1.387698
## final  value 1.387698
## stopped after 100 iterations
## # weights:  39
## initial  value 97.008143
## iter  10 value 72.247719
## iter  20 value 62.286870
## iter  30 value 59.569785
## iter  40 value 59.020275
## iter  50 value 57.718665
## iter  60 value 57.447456
## iter  70 value 57.445067
## final  value 57.445063
## converged
## # weights:  109
## initial  value 124.568072
## iter  10 value 62.224584
## iter  20 value 37.463481
## iter  30 value 23.894316
## iter  40 value 18.082286
## iter  50 value 17.401659
## iter  60 value 17.057359
## iter  70 value 16.524935
## iter  80 value 16.427424
## iter  90 value 16.422662
## iter 100 value 16.421379
## final  value 16.421379
## stopped after 100 iterations
## # weights:  179
## initial  value 114.851308
## iter  10 value 53.512838
## iter  20 value 25.344277
## iter  30 value 14.305521
## iter  40 value 13.132389
## iter  50 value 12.439838
```

```
## iter  60 value 12.248077
## iter  70 value 12.170287
## iter  80 value 12.157901
## iter  90 value 12.154942
## iter 100 value 12.154343
## final  value 12.154343
## stopped after 100 iterations
## # weights:  39
## initial  value 102.543893
## iter  10 value 67.145239
## iter  20 value 59.782776
## iter  30 value 57.414551
## iter  40 value 56.409475
## iter  50 value 55.935739
## iter  60 value 55.707111
## iter  70 value 54.681224
## iter  80 value 54.117416
## iter  90 value 53.978357
## iter 100 value 53.874841
## final  value 53.874841
## stopped after 100 iterations
## # weights:  109
## initial  value 109.860170
## iter  10 value 39.899647
## iter  20 value 16.202797
## iter  30 value 11.704230
## iter  40 value 11.233258
## iter  50 value 11.019408
## iter  60 value 10.904546
## iter  70 value 10.880054
## iter  80 value 6.812379
## iter  90 value 6.619221
## iter 100 value 6.581932
## final  value 6.581932
## stopped after 100 iterations
## # weights:  179
## initial  value 112.124048
## iter  10 value 24.134817
## iter  20 value 9.305798
## iter  30 value 6.521452
## iter  40 value 6.345559
## iter  50 value 6.243299
## iter  60 value 5.923184
## iter  70 value 5.867447
## iter  80 value 5.829981
## iter  90 value 5.761198
## iter 100 value 5.163069
## final  value 5.163069
## stopped after 100 iterations
## # weights:  39
## initial  value 110.634912
## iter  10 value 68.182465
## iter  20 value 56.377025
## iter  30 value 52.504603
```

```
## iter  40 value 52.058771
## iter  50 value 52.026436
## iter  60 value 52.021981
## iter  70 value 50.963324
## iter  80 value 50.921062
## iter  90 value 50.920852
## iter 100 value 50.920761
## final  value 50.920761
## stopped after 100 iterations
## # weights:  109
## initial  value 113.358653
## iter  10 value 38.396240
## iter  20 value 14.639965
## iter  30 value 10.721241
## iter  40 value 7.707064
## iter  50 value 7.699491
## iter  60 value 7.544705
## iter  70 value 7.092438
## iter  80 value 6.215390
## iter  90 value 6.214786
## iter 100 value 6.214691
## final  value 6.214691
## stopped after 100 iterations
## # weights:  179
## initial  value 107.994989
## iter  10 value 13.797898
## iter  20 value 2.024231
## iter  30 value 1.396996
## iter  40 value 1.393423
## iter  50 value 1.390854
## iter  60 value 1.389382
## iter  70 value 1.388439
## iter  80 value 1.387100
## iter  90 value 1.386784
## iter 100 value 1.385549
## final  value 1.385549
## stopped after 100 iterations
## # weights:  39
## initial  value 114.138293
## iter  10 value 68.792427
## iter  20 value 65.723801
## iter  30 value 64.272385
## iter  40 value 62.146904
## iter  50 value 60.602517
## iter  60 value 60.202512
## iter  70 value 60.199203
## final  value 60.199192
## converged
## # weights:  109
## initial  value 105.992930
## iter  10 value 53.257733
## iter  20 value 32.496133
## iter  30 value 22.352638
## iter  40 value 17.205258
```

```
## iter  50 value 16.997841
## iter  60 value 16.760333
## iter  70 value 16.740466
## final  value 16.740360
## converged
## # weights:  179
## initial  value 105.287521
## iter  10 value 46.482191
## iter  20 value 20.111151
## iter  30 value 14.254839
## iter  40 value 13.770123
## iter  50 value 13.301561
## iter  60 value 12.872573
## iter  70 value 12.610167
## iter  80 value 12.587757
## iter  90 value 12.581930
## iter 100 value 12.580992
## final  value 12.580992
## stopped after 100 iterations
## # weights:  39
## initial  value 100.356291
## iter  10 value 63.710645
## iter  20 value 59.115044
## iter  30 value 57.022947
## iter  40 value 52.301288
## iter  50 value 50.694020
## iter  60 value 50.668459
## iter  70 value 50.654261
## iter  80 value 50.650035
## iter  90 value 50.638297
## iter 100 value 50.609486
## final  value 50.609486
## stopped after 100 iterations
## # weights:  109
## initial  value 114.680992
## iter  10 value 32.293269
## iter  20 value 19.073418
## iter  30 value 12.460581
## iter  40 value 11.133690
## iter  50 value 10.905723
## iter  60 value 9.751756
## iter  70 value 8.308948
## iter  80 value 6.792270
## iter  90 value 6.630285
## iter 100 value 4.685427
## final  value 4.685427
## stopped after 100 iterations
## # weights:  179
## initial  value 107.312952
## iter  10 value 46.890948
## iter  20 value 26.889055
## iter  30 value 10.683660
## iter  40 value 7.244474
## iter  50 value 4.646879
```

```
## iter  60 value 3.150502
## iter  70 value 3.090480
## iter  80 value 2.910468
## iter  90 value 2.601603
## iter 100 value 2.470557
## final  value 2.470557
## stopped after 100 iterations
## # weights:  39
## initial  value 101.962831
## iter  10 value 61.687403
## iter  20 value 49.229500
## iter  30 value 47.237994
## iter  40 value 43.575805
## iter  50 value 42.249117
## iter  60 value 41.237781
## iter  70 value 40.361657
## iter  80 value 40.248338
## iter  90 value 40.098623
## iter 100 value 39.221909
## final  value 39.221909
## stopped after 100 iterations
## # weights:  109
## initial  value 121.703694
## iter  10 value 34.681561
## iter  20 value 18.935310
## iter  30 value 13.556597
## iter  40 value 9.527864
## iter  50 value 8.961804
## iter  60 value 7.128828
## iter  70 value 6.990757
## iter  80 value 6.856523
## iter  90 value 6.824144
## iter 100 value 4.347021
## final  value 4.347021
## stopped after 100 iterations
## # weights:  179
## initial  value 107.825514
## iter  10 value 19.419906
## iter  20 value 4.785055
## iter  30 value 3.048851
## iter  40 value 2.986383
## iter  50 value 2.874263
## iter  60 value 2.872770
## iter  70 value 2.872438
## iter  80 value 2.871881
## iter  90 value 2.871440
## iter 100 value 2.870835
## final  value 2.870835
## stopped after 100 iterations
## # weights:  39
## initial  value 103.157614
## iter  10 value 79.007399
## iter  20 value 63.890503
## iter  30 value 57.914178
```

```
## iter  40 value 57.381019
## iter  50 value 57.274709
## iter  60 value 57.274391
## iter  70 value 57.273781
## iter  80 value 57.225736
## iter  90 value 57.010591
## iter 100 value 56.997700
## final  value 56.997700
## stopped after 100 iterations
## # weights:  109
## initial  value 129.036942
## iter  10 value 90.194555
## iter  20 value 53.933354
## iter  30 value 31.591529
## iter  40 value 23.068586
## iter  50 value 21.534505
## iter  60 value 19.908995
## iter  70 value 19.499698
## iter  80 value 17.482025
## iter  90 value 17.081348
## iter 100 value 16.889400
## final  value 16.889400
## stopped after 100 iterations
## # weights:  179
## initial  value 117.924008
## iter  10 value 40.720678
## iter  20 value 19.860861
## iter  30 value 14.092558
## iter  40 value 13.261610
## iter  50 value 12.914291
## iter  60 value 12.834171
## iter  70 value 12.536180
## iter  80 value 12.278690
## iter  90 value 12.145686
## iter 100 value 12.130243
## final  value 12.130243
## stopped after 100 iterations
## # weights:  39
## initial  value 105.515112
## iter  10 value 64.161986
## iter  20 value 58.085071
## iter  30 value 55.082193
## iter  40 value 53.278238
## iter  50 value 52.878081
## iter  60 value 52.718081
## iter  70 value 51.289594
## iter  80 value 51.239049
## iter  90 value 50.490691
## iter 100 value 50.476307
## final  value 50.476307
## stopped after 100 iterations
## # weights:  109
## initial  value 107.663158
## iter  10 value 30.395845
```

```
## iter  20 value 16.338048
## iter  30 value 10.750987
## iter  40 value 9.989274
## iter  50 value 9.895840
## iter  60 value 9.882751
## iter  70 value 9.872846
## iter  80 value 6.462267
## iter  90 value 6.131068
## iter 100 value 6.067874
## final  value 6.067874
## stopped after 100 iterations
## # weights:  179
## initial  value 108.517010
## iter  10 value 17.789334
## iter  20 value 3.311656
## iter  30 value 2.230421
## iter  40 value 2.189777
## iter  50 value 2.159703
## iter  60 value 2.131966
## iter  70 value 2.106793
## iter  80 value 2.091404
## iter  90 value 2.076319
## iter 100 value 2.065186
## final  value 2.065186
## stopped after 100 iterations
## # weights:  39
## initial  value 108.925966
## iter  10 value 72.821162
## iter  20 value 61.877328
## iter  30 value 57.854829
## iter  40 value 56.727041
## iter  50 value 53.732413
## iter  60 value 52.935870
## iter  70 value 52.856231
## iter  80 value 52.832364
## iter  90 value 52.819567
## iter 100 value 52.813237
## final  value 52.813237
## stopped after 100 iterations
## # weights:  109
## initial  value 106.074296
## iter  10 value 49.431645
## iter  20 value 29.766269
## iter  30 value 26.193697
## iter  40 value 25.362006
## iter  50 value 22.372311
## iter  60 value 21.124044
## iter  70 value 20.134364
## iter  80 value 19.631727
## iter  90 value 19.582088
## iter 100 value 19.536727
## final  value 19.536727
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 94.748098
## iter  10 value 18.101053
## iter  20 value 5.988878
## iter  30 value 2.600707
## iter  40 value 2.520008
## iter  50 value 2.503619
## iter  60 value 2.502046
## iter  70 value 2.502038
## final  value 2.502015
## converged
## # weights:  39
## initial  value 100.336601
## iter  10 value 77.676649
## iter  20 value 65.451032
## iter  30 value 60.880861
## iter  40 value 59.277350
## iter  50 value 58.744266
## iter  60 value 58.620230
## final  value 58.619144
## converged
## # weights:  109
## initial  value 105.408318
## iter  10 value 60.048458
## iter  20 value 40.369959
## iter  30 value 22.700958
## iter  40 value 19.381992
## iter  50 value 17.120847
## iter  60 value 15.918277
## iter  70 value 15.797804
## iter  80 value 15.797072
## final  value 15.797070
## converged
## # weights:  179
## initial  value 108.402575
## iter  10 value 46.928294
## iter  20 value 22.986062
## iter  30 value 14.016179
## iter  40 value 12.312959
## iter  50 value 12.193953
## iter  60 value 12.067436
## iter  70 value 12.032158
## iter  80 value 12.026064
## iter  90 value 12.025564
## iter 100 value 12.025479
## final  value 12.025479
## stopped after 100 iterations
## # weights:  39
## initial  value 106.397803
## iter  10 value 74.343234
## iter  20 value 69.506666
## iter  30 value 69.422174
## iter  40 value 69.295797
## iter  50 value 68.019008
## iter  60 value 67.694889
```

```
## iter  70 value 67.367767
## iter  80 value 67.334361
## iter  90 value 67.272162
## iter 100 value 67.232091
## final  value 67.232091
## stopped after 100 iterations
## # weights:  109
## initial  value 99.335807
## iter  10 value 36.136154
## iter  20 value 22.185656
## iter  30 value 11.520518
## iter  40 value 11.246073
## iter  50 value 10.694692
## iter  60 value 9.918221
## iter  70 value 9.873059
## iter  80 value 9.855063
## iter  90 value 9.830773
## iter 100 value 9.211932
## final  value 9.211932
## stopped after 100 iterations
## # weights:  179
## initial  value 103.370245
## iter  10 value 17.600029
## iter  20 value 0.818697
## iter  30 value 0.209391
## iter  40 value 0.185497
## iter  50 value 0.167523
## iter  60 value 0.152191
## iter  70 value 0.142294
## iter  80 value 0.134822
## iter  90 value 0.126952
## iter 100 value 0.116865
## final  value 0.116865
## stopped after 100 iterations
## # weights:  39
## initial  value 118.386989
## iter  10 value 70.272344
## iter  20 value 63.872142
## iter  30 value 61.895551
## iter  40 value 59.146511
## iter  50 value 58.699191
## iter  60 value 58.658716
## iter  70 value 58.453669
## iter  80 value 56.263080
## iter  90 value 54.110197
## iter 100 value 53.226084
## final  value 53.226084
## stopped after 100 iterations
## # weights:  109
## initial  value 124.802183
## iter  10 value 66.778583
## iter  20 value 44.573250
## iter  30 value 36.478326
## iter  40 value 35.292182
```

```
## iter  50 value 34.896069
## iter  60 value 33.868053
## iter  70 value 33.196597
## iter  80 value 30.605350
## iter  90 value 29.558017
## iter 100 value 27.928307
## final  value 27.928307
## stopped after 100 iterations
## # weights:  179
## initial  value 117.588671
## iter  10 value 27.697363
## iter  20 value 13.736849
## iter  30 value 10.406576
## iter  40 value 7.989163
## iter  50 value 7.711119
## iter  60 value 6.906016
## iter  70 value 6.821782
## iter  80 value 6.806915
## iter  90 value 6.797513
## iter 100 value 6.797121
## final  value 6.797121
## stopped after 100 iterations
## # weights:  39
## initial  value 103.102643
## iter  10 value 76.090873
## iter  20 value 68.032499
## iter  30 value 63.185168
## iter  40 value 56.705649
## iter  50 value 55.388693
## iter  60 value 55.286144
## iter  70 value 55.283618
## final  value 55.283611
## converged
## # weights:  109
## initial  value 102.712415
## iter  10 value 53.974792
## iter  20 value 33.187841
## iter  30 value 20.496184
## iter  40 value 16.985953
## iter  50 value 16.768001
## iter  60 value 16.717314
## iter  70 value 16.713962
## final  value 16.713956
## converged
## # weights:  179
## initial  value 117.899601
## iter  10 value 42.196434
## iter  20 value 21.850921
## iter  30 value 16.212846
## iter  40 value 13.845541
## iter  50 value 13.620207
## iter  60 value 13.570854
## iter  70 value 13.508730
## iter  80 value 13.508508
```

```
## iter  80 value 13.508508
## iter  80 value 13.508508
## final  value 13.508508
## converged
## # weights:  39
## initial  value 98.204453
## iter  10 value 66.925777
## iter  20 value 62.607699
## iter  30 value 60.918802
## iter  40 value 59.954112
## iter  50 value 57.280458
## iter  60 value 54.676078
## iter  70 value 52.782712
## iter  80 value 50.191143
## iter  90 value 50.087293
## iter 100 value 50.061071
## final  value 50.061071
## stopped after 100 iterations
## # weights:  109
## initial  value 105.241956
## iter  10 value 33.231360
## iter  20 value 12.857632
## iter  30 value 12.093625
## iter  40 value 11.859150
## iter  50 value 11.594309
## iter  60 value 11.401037
## iter  70 value 10.979020
## iter  80 value 10.574763
## iter  90 value 10.165482
## iter 100 value 10.058526
## final  value 10.058526
## stopped after 100 iterations
## # weights:  179
## initial  value 102.444457
## iter  10 value 31.587908
## iter  20 value 11.404162
## iter  30 value 8.266415
## iter  40 value 6.359106
## iter  50 value 3.739210
## iter  60 value 2.219378
## iter  70 value 1.224901
## iter  80 value 0.445671
## iter  90 value 0.363417
## iter 100 value 0.340866
## final  value 0.340866
## stopped after 100 iterations
## # weights:  39
## initial  value 98.605406
## iter  10 value 57.210617
## iter  20 value 52.106117
## iter  30 value 46.303226
## iter  40 value 41.827345
## iter  50 value 40.113776
## iter  60 value 40.058649
```

```
## iter  70 value 39.924372
## iter  80 value 39.252612
## iter  90 value 39.239602
## iter 100 value 39.238164
## final  value 39.238164
## stopped after 100 iterations
## # weights:  109
## initial  value 106.906179
## iter  10 value 54.206539
## iter  20 value 21.737477
## iter  30 value 12.047800
## iter  40 value 6.739788
## iter  50 value 4.526163
## iter  60 value 3.875355
## iter  70 value 3.691428
## iter  80 value 3.080167
## iter  90 value 2.676606
## iter 100 value 2.600660
## final  value 2.600660
## stopped after 100 iterations
## # weights:  179
## initial  value 112.221956
## iter  10 value 46.916463
## iter  20 value 40.083478
## iter  30 value 38.383812
## iter  40 value 36.751141
## iter  50 value 33.822764
## iter  60 value 32.927865
## iter  70 value 31.263953
## iter  80 value 25.110353
## iter  90 value 15.158420
## iter 100 value 11.506238
## final  value 11.506238
## stopped after 100 iterations
## # weights:  39
## initial  value 107.494255
## iter  10 value 82.514884
## iter  20 value 67.480589
## iter  30 value 59.585368
## iter  40 value 56.144077
## iter  50 value 55.831848
## iter  60 value 55.823251
## final  value 55.823237
## converged
## # weights:  109
## initial  value 113.692212
## iter  10 value 37.322898
## iter  20 value 23.714628
## iter  30 value 17.691700
## iter  40 value 16.320294
## iter  50 value 15.954147
## iter  60 value 15.930955
## iter  70 value 15.929962
## iter  80 value 15.929845
```

```
## final  value 15.929841
## converged
## # weights:  179
## initial  value 118.587377
## iter  10 value 32.762435
## iter  20 value 16.464925
## iter  30 value 13.269555
## iter  40 value 12.109244
## iter  50 value 11.565279
## iter  60 value 11.388141
## iter  70 value 11.359954
## iter  80 value 11.358902
## final  value 11.358894
## converged
## # weights:  39
## initial  value 101.267206
## iter  10 value 66.116622
## iter  20 value 60.371914
## iter  30 value 60.075559
## iter  40 value 58.924149
## iter  50 value 57.124919
## iter  60 value 57.090024
## iter  70 value 56.411338
## iter  80 value 55.576740
## iter  90 value 55.573734
## iter 100 value 55.291518
## final  value 55.291518
## stopped after 100 iterations
## # weights:  109
## initial  value 113.510219
## iter  10 value 19.640264
## iter  20 value 14.613993
## iter  30 value 14.115658
## iter  40 value 14.045824
## iter  50 value 14.005903
## iter  60 value 13.979677
## iter  70 value 13.963240
## iter  80 value 13.911020
## iter  90 value 12.171198
## iter 100 value 11.978153
## final  value 11.978153
## stopped after 100 iterations
## # weights:  179
## initial  value 119.859131
## iter  10 value 20.329641
## iter  20 value 3.312294
## iter  30 value 0.480520
## iter  40 value 0.320359
## iter  50 value 0.263547
## iter  60 value 0.205837
## iter  70 value 0.185068
## iter  80 value 0.155443
## iter  90 value 0.139788
## iter 100 value 0.123685
```

```
## final  value 0.123685
## stopped after 100 iterations
## # weights:  39
## initial  value 101.812966
## iter  10 value 76.264657
## iter  20 value 65.880441
## iter  30 value 63.269674
## iter  40 value 62.040211
## iter  50 value 60.670281
## iter  60 value 58.861143
## iter  70 value 56.116332
## iter  80 value 54.090716
## iter  90 value 53.300410
## iter 100 value 52.969216
## final  value 52.969216
## stopped after 100 iterations
## # weights:  109
## initial  value 112.752655
## iter  10 value 56.817290
## iter  20 value 47.929750
## iter  30 value 43.441166
## iter  40 value 40.165341
## iter  50 value 39.680246
## iter  60 value 39.069894
## iter  70 value 38.901033
## iter  80 value 38.321340
## iter  90 value 38.206297
## iter 100 value 38.188447
## final  value 38.188447
## stopped after 100 iterations
## # weights:  179
## initial  value 102.980192
## iter  10 value 28.642033
## iter  20 value 7.009092
## iter  30 value 2.326874
## iter  40 value 1.920285
## iter  50 value 1.910080
## iter  60 value 1.909703
## iter  70 value 1.909601
## iter  80 value 1.909547
## iter  90 value 1.909543
## final  value 1.909543
## converged
## # weights:  39
## initial  value 108.018927
## iter  10 value 76.035250
## iter  20 value 70.182287
## iter  30 value 67.485350
## iter  40 value 64.979569
## iter  50 value 64.693036
## final  value 64.691271
## converged
## # weights:  109
## initial  value 110.894363
```

```
## iter  10 value 58.984149
## iter  20 value 34.711324
## iter  30 value 18.901614
## iter  40 value 16.341994
## iter  50 value 16.147388
## iter  60 value 16.139168
## iter  70 value 16.139106
## final  value 16.139106
## converged
## # weights:  179
## initial  value 110.622216
## iter  10 value 45.906126
## iter  20 value 18.942056
## iter  30 value 13.363754
## iter  40 value 12.971982
## iter  50 value 12.732662
## iter  60 value 12.534867
## iter  70 value 12.325362
## iter  80 value 12.154454
## iter  90 value 12.088094
## iter 100 value 11.968421
## final  value 11.968421
## stopped after 100 iterations
## # weights:  39
## initial  value 123.917267
## iter  10 value 59.369905
## iter  20 value 52.682245
## iter  30 value 51.632216
## iter  40 value 50.580369
## iter  50 value 49.876959
## iter  60 value 49.408513
## iter  70 value 49.205991
## iter  80 value 48.987359
## iter  90 value 46.115187
## iter 100 value 45.996281
## final  value 45.996281
## stopped after 100 iterations
## # weights:  109
## initial  value 123.525921
## iter  10 value 36.797560
## iter  20 value 14.696041
## iter  30 value 10.193233
## iter  40 value 7.424524
## iter  50 value 6.384277
## iter  60 value 6.321771
## iter  70 value 6.309662
## iter  80 value 6.299372
## iter  90 value 6.288918
## iter 100 value 6.275993
## final  value 6.275993
## stopped after 100 iterations
## # weights:  179
## initial  value 119.617561
## iter  10 value 10.701262
```

```
## iter  20 value 3.743690
## iter  30 value 3.512921
## iter  40 value 3.498513
## iter  50 value 3.473922
## iter  60 value 3.012627
## iter  70 value 0.283244
## iter  80 value 0.165764
## iter  90 value 0.156894
## iter 100 value 0.146648
## final  value 0.146648
## stopped after 100 iterations
## # weights:  39
## initial  value 101.343288
## iter  10 value 68.317580
## iter  20 value 61.609850
## iter  30 value 60.310510
## iter  40 value 58.972025
## iter  50 value 58.260087
## iter  60 value 56.263435
## iter  70 value 55.072481
## iter  80 value 53.620025
## iter  90 value 47.219951
## iter 100 value 45.520513
## final  value 45.520513
## stopped after 100 iterations
## # weights:  109
## initial  value 104.532899
## iter  10 value 35.538587
## iter  20 value 21.006508
## iter  30 value 18.979016
## iter  40 value 17.966696
## iter  50 value 17.896766
## iter  60 value 17.884063
## iter  70 value 17.846440
## iter  80 value 17.828289
## iter  90 value 17.816807
## iter 100 value 17.805054
## final  value 17.805054
## stopped after 100 iterations
## # weights:  179
## initial  value 119.528535
## iter  10 value 31.080294
## iter  20 value 12.244218
## iter  30 value 8.298214
## iter  40 value 6.722363
## iter  50 value 3.319663
## iter  60 value 0.371075
## iter  70 value 0.080728
## iter  80 value 0.008454
## iter  90 value 0.002261
## iter 100 value 0.000759
## final  value 0.000759
## stopped after 100 iterations
## # weights:  39
```

```
## initial  value 103.907486
## iter  10 value 78.223618
## iter  20 value 67.520408
## iter  30 value 61.734353
## iter  40 value 60.454840
## iter  50 value 59.330377
## iter  60 value 59.231196
## final  value 59.230475
## converged
## # weights:  109
## initial  value 100.840781
## iter  10 value 64.015531
## iter  20 value 36.767201
## iter  30 value 21.924690
## iter  40 value 18.761530
## iter  50 value 18.154767
## iter  60 value 17.188100
## iter  70 value 16.781006
## iter  80 value 16.707305
## iter  90 value 16.705089
## iter 100 value 16.704761
## final  value 16.704761
## stopped after 100 iterations
## # weights:  179
## initial  value 140.442939
## iter  10 value 65.830523
## iter  20 value 34.889380
## iter  30 value 19.035935
## iter  40 value 13.909923
## iter  50 value 12.793348
## iter  60 value 12.179300
## iter  70 value 12.051163
## iter  80 value 12.044959
## iter  90 value 12.044676
## final  value 12.044675
## converged
## # weights:  39
## initial  value 104.845205
## iter  10 value 68.660742
## iter  20 value 66.842425
## iter  30 value 66.341481
## iter  40 value 65.556342
## iter  50 value 64.031416
## iter  60 value 63.760341
## iter  70 value 63.007520
## iter  80 value 59.758458
## iter  90 value 58.836889
## iter 100 value 57.158233
## final  value 57.158233
## stopped after 100 iterations
## # weights:  109
## initial  value 113.894407
## iter  10 value 34.451271
## iter  20 value 21.274297
```

```
## iter  30 value 19.963719
## iter  40 value 18.595310
## iter  50 value 18.331691
## iter  60 value 16.834385
## iter  70 value 14.696309
## iter  80 value 13.042089
## iter  90 value 12.921985
## iter 100 value 12.671066
## final  value 12.671066
## stopped after 100 iterations
## # weights:  179
## initial  value 102.311419
## iter  10 value 28.973385
## iter  20 value 10.704907
## iter  30 value 6.771526
## iter  40 value 6.551950
## iter  50 value 6.507542
## iter  60 value 6.469068
## iter  70 value 6.436236
## iter  80 value 2.923132
## iter  90 value 2.611452
## iter 100 value 2.501461
## final  value 2.501461
## stopped after 100 iterations
## # weights:  39
## initial  value 108.875625
## iter  10 value 69.392753
## iter  20 value 58.759166
## iter  30 value 53.945300
## iter  40 value 50.712878
## iter  50 value 49.909091
## iter  60 value 49.811994
## iter  70 value 49.799894
## iter  80 value 49.796642
## iter  90 value 49.793880
## iter 100 value 49.793101
## final  value 49.793101
## stopped after 100 iterations
## # weights:  109
## initial  value 109.152712
## iter  10 value 51.267875
## iter  20 value 27.524327
## iter  30 value 24.488584
## iter  40 value 18.540232
## iter  50 value 17.193639
## iter  60 value 13.980719
## iter  70 value 13.089069
## iter  80 value 13.075474
## iter  90 value 11.481078
## iter 100 value 9.438517
## final  value 9.438517
## stopped after 100 iterations
## # weights:  179
## initial  value 101.701451
```

```
## iter  10 value 13.721538
## iter  20 value 3.396775
## iter  30 value 0.056290
## iter  40 value 0.004440
## iter  50 value 0.000872
## iter  60 value 0.000669
## iter  70 value 0.000135
## final  value 0.000098
## converged
## # weights:  39
## initial  value 111.190148
## iter  10 value 76.789437
## iter  20 value 61.225167
## iter  30 value 58.633997
## iter  40 value 57.665096
## iter  50 value 57.512190
## iter  60 value 57.506280
## final  value 57.506275
## converged
## # weights:  109
## initial  value 108.894507
## iter  10 value 53.697986
## iter  20 value 32.308356
## iter  30 value 19.677219
## iter  40 value 17.305521
## iter  50 value 17.273404
## iter  60 value 17.215712
## iter  70 value 17.196846
## final  value 17.196768
## converged
## # weights:  179
## initial  value 101.106225
## iter  10 value 34.196886
## iter  20 value 23.177652
## iter  30 value 15.454677
## iter  40 value 12.687252
## iter  50 value 12.105685
## iter  60 value 12.067431
## iter  70 value 12.066501
## final  value 12.066480
## converged
## # weights:  39
## initial  value 109.381752
## iter  10 value 72.643184
## iter  20 value 56.692340
## iter  30 value 55.597493
## iter  40 value 54.487736
## iter  50 value 51.299320
## iter  60 value 50.347516
## iter  70 value 46.912685
## iter  80 value 45.439339
## iter  90 value 45.050521
## iter 100 value 44.822432
## final  value 44.822432
```

```
## stopped after 100 iterations
## # weights:  109
## initial  value 109.943663
## iter  10 value 24.163936
## iter  20 value 17.127179
## iter  30 value 13.224191
## iter  40 value 11.606982
## iter  50 value 11.501437
## iter  60 value 11.244020
## iter  70 value 11.109880
## iter  80 value 10.837208
## iter  90 value 10.815140
## iter 100 value 10.395669
## final  value 10.395669
## stopped after 100 iterations
## # weights:  179
## initial  value 121.821713
## iter  10 value 32.238282
## iter  20 value 12.867662
## iter  30 value 10.981383
## iter  40 value 10.736350
## iter  50 value 10.689823
## iter  60 value 10.489605
## iter  70 value 8.674168
## iter  80 value 8.029012
## iter  90 value 7.941209
## iter 100 value 7.480538
## final  value 7.480538
## stopped after 100 iterations
## # weights:  39
## initial  value 99.698071
## iter  10 value 75.609142
## iter  20 value 56.276058
## iter  30 value 50.798012
## iter  40 value 49.171610
## iter  50 value 49.167365
## iter  60 value 47.619038
## iter  70 value 47.592538
## iter  80 value 47.588570
## iter  90 value 47.208361
## iter 100 value 45.883212
## final  value 45.883212
## stopped after 100 iterations
## # weights:  109
## initial  value 112.228710
## iter  10 value 50.031829
## iter  20 value 25.358033
## iter  30 value 22.199277
## iter  40 value 19.918972
## iter  50 value 19.823441
## iter  60 value 19.659080
## iter  70 value 16.520345
## iter  80 value 15.443672
## iter  90 value 15.062297
```

```
## iter 100 value 14.954324
## final  value 14.954324
## stopped after 100 iterations
## # weights:  179
## initial  value 103.322567
## iter  10 value 42.959707
## iter  20 value 25.348399
## iter  30 value 19.913674
## iter  40 value 17.998578
## iter  50 value 17.644034
## iter  60 value 14.539256
## iter  70 value 14.177409
## iter  80 value 14.117585
## iter  90 value 14.091361
## iter 100 value 14.054103
## final  value 14.054103
## stopped after 100 iterations
## # weights:  39
## initial  value 102.325985
## iter  10 value 75.244761
## iter  20 value 65.196442
## iter  30 value 59.542263
## iter  40 value 57.397302
## iter  50 value 57.323707
## final  value 57.323341
## converged
## # weights:  109
## initial  value 114.712539
## iter  10 value 69.088881
## iter  20 value 41.515291
## iter  30 value 25.744990
## iter  40 value 19.023144
## iter  50 value 17.314570
## iter  60 value 16.517578
## iter  70 value 16.355615
## iter  80 value 16.335146
## iter  90 value 16.333710
## final  value 16.333697
## converged
## # weights:  179
## initial  value 116.393871
## iter  10 value 44.575309
## iter  20 value 22.774751
## iter  30 value 16.367071
## iter  40 value 13.689312
## iter  50 value 12.410021
## iter  60 value 12.303035
## iter  70 value 12.291042
## iter  80 value 12.289979
## iter  90 value 12.289947
## final  value 12.289947
## converged
## # weights:  39
## initial  value 108.579175
```

```
## iter  10 value 70.042935
## iter  20 value 65.978343
## iter  30 value 62.711364
## iter  40 value 62.315902
## iter  50 value 62.028357
## iter  60 value 61.367452
## iter  70 value 58.288987
## iter  80 value 57.072904
## iter  90 value 55.597004
## iter 100 value 55.121204
## final  value 55.121204
## stopped after 100 iterations
## # weights:  109
## initial  value 110.054935
## iter  10 value 37.239104
## iter  20 value 22.093682
## iter  30 value 21.206249
## iter  40 value 21.051862
## iter  50 value 20.654159
## iter  60 value 19.862357
## iter  70 value 18.192534
## iter  80 value 17.827389
## iter  90 value 17.544070
## iter 100 value 17.447609
## final  value 17.447609
## stopped after 100 iterations
## # weights:  179
## initial  value 107.010114
## iter  10 value 28.645337
## iter  20 value 15.560719
## iter  30 value 5.357644
## iter  40 value 3.887256
## iter  50 value 3.044751
## iter  60 value 2.508667
## iter  70 value 2.436001
## iter  80 value 2.424734
## iter  90 value 2.413475
## iter 100 value 2.400548
## final  value 2.400548
## stopped after 100 iterations
## # weights:  39
## initial  value 111.748781
## iter  10 value 82.362494
## iter  20 value 56.491317
## iter  30 value 54.013211
## iter  40 value 52.297034
## iter  50 value 49.645258
## iter  60 value 48.590780
## iter  70 value 47.176091
## iter  80 value 45.335375
## iter  90 value 45.079646
## iter 100 value 44.855973
## final  value 44.855973
## stopped after 100 iterations
```

```
## # weights:  109
## initial  value 100.959771
## iter  10 value 43.658244
## iter  20 value 14.136724
## iter  30 value 8.297663
## iter  40 value 4.640538
## iter  50 value 3.628200
## iter  60 value 3.187873
## iter  70 value 3.168525
## iter  80 value 3.038511
## iter  90 value 3.030469
## iter 100 value 3.022261
## final  value 3.022261
## stopped after 100 iterations
## # weights:  179
## initial  value 106.894923
## iter  10 value 14.562593
## iter  20 value 3.970936
## iter  30 value 2.851469
## iter  40 value 2.217390
## iter  50 value 0.212860
## iter  60 value 0.010088
## iter  70 value 0.004685
## iter  80 value 0.002399
## iter  90 value 0.001474
## iter 100 value 0.000656
## final  value 0.000656
## stopped after 100 iterations
## # weights:  39
## initial  value 108.294662
## iter  10 value 71.543210
## iter  20 value 63.169549
## iter  30 value 60.248837
## iter  40 value 59.703745
## iter  50 value 59.093686
## iter  60 value 58.940329
## iter  70 value 58.934163
## final  value 58.934057
## converged
## # weights:  109
## initial  value 107.229510
## iter  10 value 66.099796
## iter  20 value 39.788575
## iter  30 value 29.661846
## iter  40 value 21.603026
## iter  50 value 19.549133
## iter  60 value 17.516138
## iter  70 value 16.866239
## iter  80 value 16.152605
## iter  90 value 15.990962
## iter 100 value 15.980538
## final  value 15.980538
## stopped after 100 iterations
## # weights:  179
```

```
## initial  value 110.630154
## iter  10 value 35.885232
## iter  20 value 18.442221
## iter  30 value 14.937750
## iter  40 value 13.635050
## iter  50 value 13.154991
## iter  60 value 13.100098
## iter  70 value 13.096890
## iter  80 value 13.096741
## final  value 13.096741
## converged
## # weights:  39
## initial  value 103.937202
## iter  10 value 56.209423
## iter  20 value 54.194496
## iter  30 value 53.315345
## iter  40 value 53.307815
## iter  50 value 52.983382
## iter  60 value 52.686854
## iter  70 value 52.680336
## iter  80 value 52.648043
## iter  90 value 52.026765
## iter 100 value 52.000255
## final  value 52.000255
## stopped after 100 iterations
## # weights:  109
## initial  value 147.810753
## iter  10 value 70.247415
## iter  20 value 31.141529
## iter  30 value 16.301170
## iter  40 value 11.499538
## iter  50 value 11.207524
## iter  60 value 9.839623
## iter  70 value 9.784450
## iter  80 value 9.502959
## iter  90 value 9.335818
## iter 100 value 9.049286
## final  value 9.049286
## stopped after 100 iterations
## # weights:  179
## initial  value 108.066521
## iter  10 value 53.924505
## iter  20 value 23.229850
## iter  30 value 19.255641
## iter  40 value 17.431977
## iter  50 value 17.086157
## iter  60 value 16.632460
## iter  70 value 16.386048
## iter  80 value 15.729020
## iter  90 value 15.317498
## iter 100 value 14.715191
## final  value 14.715191
## stopped after 100 iterations
## # weights:  39
```

```
## initial  value 109.455309
## iter  10 value 66.527842
## iter  20 value 53.468029
## iter  30 value 51.838740
## iter  40 value 51.615120
## iter  50 value 51.578367
## iter  60 value 51.565644
## iter  70 value 51.554775
## iter  80 value 51.551139
## iter  90 value 51.550316
## final  value 51.549851
## converged
## # weights:  109
## initial  value 108.655688
## iter  10 value 22.018061
## iter  20 value 8.796169
## iter  30 value 7.486149
## iter  40 value 3.371172
## iter  50 value 3.274088
## iter  60 value 2.821294
## iter  70 value 1.489517
## iter  80 value 1.405045
## iter  90 value 1.393802
## iter 100 value 1.390219
## final  value 1.390219
## stopped after 100 iterations
## # weights:  179
## initial  value 105.730242
## iter  10 value 32.262044
## iter  20 value 16.254203
## iter  30 value 14.906651
## iter  40 value 14.175998
## iter  50 value 10.740408
## iter  60 value 10.615139
## iter  70 value 10.138088
## iter  80 value 8.776170
## iter  90 value 5.449129
## iter 100 value 5.399181
## final  value 5.399181
## stopped after 100 iterations
## # weights:  39
## initial  value 107.824745
## iter  10 value 79.775394
## iter  20 value 74.062589
## iter  30 value 69.690795
## iter  40 value 68.069902
## iter  50 value 64.858011
## iter  60 value 62.511352
## iter  70 value 61.000444
## iter  80 value 60.220219
## iter  90 value 58.613317
## iter 100 value 58.053867
## final  value 58.053867
## stopped after 100 iterations
```

```
## # weights:  109
## initial  value 114.409881
## iter  10 value 57.420147
## iter  20 value 36.971835
## iter  30 value 22.084784
## iter  40 value 17.102821
## iter  50 value 16.310995
## iter  60 value 15.984661
## iter  70 value 15.940944
## iter  80 value 15.936295
## final  value 15.936265
## converged
## # weights:  179
## initial  value 112.395813
## iter  10 value 52.080574
## iter  20 value 22.718329
## iter  30 value 15.330558
## iter  40 value 13.498730
## iter  50 value 13.191362
## iter  60 value 12.890545
## iter  70 value 12.800024
## iter  80 value 12.744077
## iter  90 value 12.567801
## iter 100 value 12.551310
## final  value 12.551310
## stopped after 100 iterations
## # weights:  39
## initial  value 101.427263
## iter  10 value 63.673330
## iter  20 value 60.020893
## iter  30 value 59.354847
## iter  40 value 56.511763
## iter  50 value 56.441490
## iter  60 value 56.399558
## iter  70 value 56.360969
## iter  80 value 56.359130
## iter  90 value 56.350939
## iter 100 value 56.127369
## final  value 56.127369
## stopped after 100 iterations
## # weights:  109
## initial  value 101.887861
## iter  10 value 26.488203
## iter  20 value 6.914291
## iter  30 value 4.085094
## iter  40 value 3.625470
## iter  50 value 1.756450
## iter  60 value 0.695353
## iter  70 value 0.277666
## iter  80 value 0.271941
## iter  90 value 0.268344
## iter 100 value 0.263530
## final  value 0.263530
## stopped after 100 iterations
```

```
## # weights:  179
## initial  value 95.704309
## iter  10 value 23.349842
## iter  20 value 10.814138
## iter  30 value 8.715380
## iter  40 value 8.624406
## iter  50 value 8.533033
## iter  60 value 8.464953
## iter  70 value 8.437404
## iter  80 value 8.044356
## iter  90 value 6.388405
## iter 100 value 6.197112
## final  value 6.197112
## stopped after 100 iterations
## # weights:  39
## initial  value 104.296667
## iter  10 value 77.025851
## iter  20 value 62.629354
## iter  30 value 59.263841
## iter  40 value 57.642381
## iter  50 value 57.372222
## iter  60 value 57.333348
## iter  70 value 57.323559
## iter  80 value 57.321180
## iter  90 value 57.321057
## iter  90 value 57.321057
## iter  90 value 57.321057
## final  value 57.321057
## converged
## # weights:  109
## initial  value 107.296511
## iter  10 value 25.362223
## iter  20 value 14.993591
## iter  30 value 13.715812
## iter  40 value 12.261899
## iter  50 value 11.039153
## iter  60 value 10.227968
## iter  70 value 8.794011
## iter  80 value 7.557490
## iter  90 value 7.485686
## iter 100 value 7.377319
## final  value 7.377319
## stopped after 100 iterations
## # weights:  179
## initial  value 125.510522
## iter  10 value 45.391295
## iter  20 value 21.017046
## iter  30 value 19.516528
## iter  40 value 15.217016
## iter  50 value 12.013463
## iter  60 value 11.718623
## iter  70 value 11.502177
## iter  80 value 11.417523
## iter  90 value 11.254036
```

```
## iter 100 value 11.158928
## final  value 11.158928
## stopped after 100 iterations
## # weights:  39
## initial  value 99.286956
## iter  10 value 67.852828
## iter  20 value 62.961531
## iter  30 value 62.703163
## iter  40 value 62.682730
## iter  50 value 62.682466
## iter  50 value 62.682465
## iter  50 value 62.682465
## final  value 62.682465
## converged
## # weights:  109
## initial  value 107.072646
## iter  10 value 50.341556
## iter  20 value 31.801284
## iter  30 value 23.948510
## iter  40 value 18.150609
## iter  50 value 16.220409
## iter  60 value 15.753133
## iter  70 value 15.729246
## iter  80 value 15.728865
## final  value 15.728861
## converged
## # weights:  179
## initial  value 111.970236
## iter  10 value 34.372965
## iter  20 value 18.064936
## iter  30 value 13.361749
## iter  40 value 12.541324
## iter  50 value 12.154801
## iter  60 value 12.017273
## iter  70 value 12.001270
## iter  80 value 12.000691
## iter  90 value 12.000637
## final  value 12.000636
## converged
## # weights:  39
## initial  value 103.559374
## iter  10 value 70.010312
## iter  20 value 57.156874
## iter  30 value 53.927386
## iter  40 value 53.572091
## iter  50 value 53.278302
## iter  60 value 53.036635
## iter  70 value 52.943403
## iter  80 value 52.145052
## iter  90 value 52.130708
## iter 100 value 51.258997
## final  value 51.258997
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 114.608400
## iter  10 value 48.672642
## iter  20 value 24.157843
## iter  30 value 15.504033
## iter  40 value 13.165696
## iter  50 value 11.207615
## iter  60 value 10.470547
## iter  70 value 10.403654
## iter  80 value 10.360412
## iter  90 value 10.240423
## iter 100 value 10.218823
## final  value 10.218823
## stopped after 100 iterations
## # weights:  179
## initial  value 105.433065
## iter  10 value 28.523213
## iter  20 value 0.728495
## iter  30 value 0.132762
## iter  40 value 0.115776
## iter  50 value 0.103897
## iter  60 value 0.097216
## iter  70 value 0.090305
## iter  80 value 0.083757
## iter  90 value 0.077559
## iter 100 value 0.073939
## final  value 0.073939
## stopped after 100 iterations
## # weights:  39
## initial  value 100.250715
## iter  10 value 59.500949
## iter  20 value 52.254535
## iter  30 value 48.504939
## iter  40 value 47.572323
## iter  50 value 46.667285
## iter  60 value 46.640032
## iter  70 value 46.616998
## iter  80 value 46.501457
## iter  90 value 46.288017
## iter 100 value 44.485807
## final  value 44.485807
## stopped after 100 iterations
## # weights:  109
## initial  value 116.473182
## iter  10 value 34.273330
## iter  20 value 24.480114
## iter  30 value 22.813100
## iter  40 value 21.449908
## iter  50 value 20.306050
## iter  60 value 18.465852
## iter  70 value 17.300470
## iter  80 value 13.137020
## iter  90 value 10.812836
## iter 100 value 10.416064
## final  value 10.416064
```

```
## stopped after 100 iterations
## # weights:  179
## initial  value 107.453799
## iter  10 value 16.614371
## iter  20 value 7.011421
## iter  30 value 4.143610
## iter  40 value 4.008715
## iter  50 value 3.960556
## iter  60 value 3.822503
## iter  70 value 3.591918
## iter  80 value 3.436005
## iter  90 value 3.191878
## iter 100 value 3.043064
## final  value 3.043064
## stopped after 100 iterations
## # weights:  39
## initial  value 103.320865
## iter  10 value 85.209593
## iter  20 value 66.694613
## iter  30 value 61.823827
## iter  40 value 60.877568
## iter  50 value 58.201353
## iter  60 value 56.594871
## iter  70 value 56.391773
## iter  80 value 56.389858
## iter  80 value 56.389858
## iter  80 value 56.389858
## final  value 56.389858
## converged
## # weights:  109
## initial  value 116.342391
## iter  10 value 56.166226
## iter  20 value 25.635515
## iter  30 value 17.279527
## iter  40 value 16.507618
## iter  50 value 16.292501
## iter  60 value 16.283223
## iter  70 value 16.283039
## final  value 16.283037
## converged
## # weights:  179
## initial  value 113.283764
## iter  10 value 32.569562
## iter  20 value 20.150417
## iter  30 value 14.426061
## iter  40 value 13.634122
## iter  50 value 13.336895
## iter  60 value 13.030421
## iter  70 value 12.758627
## iter  80 value 12.650265
## iter  90 value 12.607596
## iter 100 value 12.469816
## final  value 12.469816
## stopped after 100 iterations
```

```
## # weights:  39
## initial  value 105.736386
## iter  10 value 63.246322
## iter  20 value 52.470727
## iter  30 value 47.456754
## iter  40 value 46.813960
## iter  50 value 46.603013
## iter  60 value 45.795324
## iter  70 value 45.737515
## iter  80 value 45.709524
## iter  90 value 45.703775
## iter 100 value 45.693047
## final  value 45.693047
## stopped after 100 iterations
## # weights:  109
## initial  value 93.959235
## iter  10 value 36.519949
## iter  20 value 31.426332
## iter  30 value 30.366494
## iter  40 value 28.880434
## iter  50 value 24.959311
## iter  60 value 17.032263
## iter  70 value 16.729534
## iter  80 value 16.718429
## iter  90 value 16.709041
## iter 100 value 16.481585
## final  value 16.481585
## stopped after 100 iterations
## # weights:  179
## initial  value 101.788902
## iter  10 value 23.731147
## iter  20 value 10.237795
## iter  30 value 7.849354
## iter  40 value 4.345500
## iter  50 value 2.331597
## iter  60 value 2.168719
## iter  70 value 0.696743
## iter  80 value 0.290112
## iter  90 value 0.260853
## iter 100 value 0.244932
## final  value 0.244932
## stopped after 100 iterations
## # weights:  39
## initial  value 104.458268
## iter  10 value 70.222783
## iter  20 value 64.231165
## iter  30 value 62.155540
## iter  40 value 60.875710
## iter  50 value 60.857825
## iter  60 value 60.817928
## iter  70 value 60.809706
## iter  80 value 60.806563
## iter  90 value 60.805694
## final  value 60.805681
```

```
## converged
## # weights:  109
## initial  value 103.642164
## iter  10 value 24.228438
## iter  20 value 9.452049
## iter  30 value 3.720791
## iter  40 value 3.301987
## iter  50 value 3.295931
## iter  60 value 3.295837
## final  value 3.295837
## converged
## # weights:  179
## initial  value 105.704381
## iter  10 value 46.549555
## iter  20 value 20.491579
## iter  30 value 12.353323
## iter  40 value 8.130833
## iter  50 value 7.473297
## iter  60 value 7.131419
## iter  70 value 5.787543
## iter  80 value 4.733511
## iter  90 value 4.254214
## iter 100 value 4.203936
## final  value 4.203936
## stopped after 100 iterations
## # weights:  39
## initial  value 106.121089
## iter  10 value 74.692239
## iter  20 value 65.606413
## iter  30 value 64.297653
## iter  40 value 61.825284
## iter  50 value 60.633845
## iter  60 value 60.423170
## iter  70 value 60.214923
## iter  80 value 60.105598
## iter  90 value 60.104647
## iter  90 value 60.104646
## iter  90 value 60.104646
## final  value 60.104646
## converged
## # weights:  109
## initial  value 109.253145
## iter  10 value 57.025161
## iter  20 value 28.112607
## iter  30 value 21.195361
## iter  40 value 18.930384
## iter  50 value 17.568698
## iter  60 value 16.655916
## iter  70 value 15.690664
## iter  80 value 15.524600
## iter  90 value 15.521253
## iter 100 value 15.521152
## final  value 15.521152
## stopped after 100 iterations
```

```
## # weights:  179
## initial  value 138.039064
## iter  10 value 46.598751
## iter  20 value 24.260296
## iter  30 value 18.303595
## iter  40 value 14.067750
## iter  50 value 12.918251
## iter  60 value 12.589741
## iter  70 value 12.541442
## iter  80 value 12.538303
## iter  90 value 12.538141
## final  value 12.538140
## converged
## # weights:  39
## initial  value 106.356336
## iter  10 value 68.452015
## iter  20 value 65.416227
## iter  30 value 63.947799
## iter  40 value 63.916571
## iter  50 value 61.834987
## iter  60 value 61.669176
## iter  70 value 61.377194
## iter  80 value 61.286656
## iter  90 value 59.476084
## iter 100 value 58.962861
## final  value 58.962861
## stopped after 100 iterations
## # weights:  109
## initial  value 100.263011
## iter  10 value 66.357584
## iter  20 value 59.432815
## iter  30 value 50.924436
## iter  40 value 46.109702
## iter  50 value 44.394994
## iter  60 value 41.968917
## iter  70 value 40.515400
## iter  80 value 40.426876
## iter  90 value 40.005181
## iter 100 value 25.214026
## final  value 25.214026
## stopped after 100 iterations
## # weights:  179
## initial  value 109.625086
## iter  10 value 25.068673
## iter  20 value 13.760215
## iter  30 value 10.734845
## iter  40 value 10.147620
## iter  50 value 10.012784
## iter  60 value 7.201230
## iter  70 value 6.831791
## iter  80 value 6.823528
## iter  90 value 6.809467
## iter 100 value 6.797800
## final  value 6.797800
```

```
## stopped after 100 iterations
## # weights:  39
## initial  value 112.072423
## iter  10 value 65.034174
## iter  20 value 51.979473
## iter  30 value 45.653229
## iter  40 value 44.830322
## iter  50 value 43.150441
## iter  60 value 42.872868
## iter  70 value 42.767344
## iter  80 value 40.026993
## iter  90 value 38.340814
## iter 100 value 36.697940
## final  value 36.697940
## stopped after 100 iterations
## # weights:  109
## initial  value 112.390586
## iter  10 value 39.394985
## iter  20 value 13.491987
## iter  30 value 10.534286
## iter  40 value 10.441899
## iter  50 value 10.383337
## iter  60 value 10.338878
## iter  70 value 10.329045
## iter  80 value 10.317242
## iter  90 value 10.186622
## iter 100 value 10.000181
## final  value 10.000181
## stopped after 100 iterations
## # weights:  179
## initial  value 124.045733
## iter  10 value 29.267607
## iter  20 value 13.154668
## iter  30 value 6.242953
## iter  40 value 3.889525
## iter  50 value 3.797358
## iter  60 value 3.706932
## iter  70 value 0.021693
## iter  80 value 0.005182
## iter  90 value 0.002696
## iter 100 value 0.000481
## final  value 0.000481
## stopped after 100 iterations
## # weights:  39
## initial  value 106.405441
## iter  10 value 63.861865
## iter  20 value 58.574330
## iter  30 value 57.998185
## iter  40 value 57.624896
## iter  50 value 57.561700
## iter  60 value 57.551188
## iter  70 value 57.343096
## iter  80 value 57.263553
## final  value 57.262028
```

```
## converged
## # weights:  109
## initial  value 108.289289
## iter  10 value 60.864303
## iter  20 value 34.687795
## iter  30 value 18.546353
## iter  40 value 16.316635
## iter  50 value 16.182487
## iter  60 value 16.128697
## iter  70 value 16.127198
## iter  80 value 16.127105
## final  value 16.127102
## converged
## # weights:  179
## initial  value 115.851488
## iter  10 value 57.360759
## iter  20 value 22.508297
## iter  30 value 15.326321
## iter  40 value 12.045208
## iter  50 value 11.703389
## iter  60 value 11.673999
## iter  70 value 11.673336
## final  value 11.673335
## converged
## # weights:  39
## initial  value 108.643417
## iter  10 value 68.845729
## iter  20 value 55.584263
## iter  30 value 49.940049
## iter  40 value 49.388662
## iter  50 value 48.814768
## iter  60 value 48.567797
## iter  70 value 48.290483
## iter  80 value 48.277640
## iter  90 value 48.274796
## iter 100 value 48.272581
## final  value 48.272581
## stopped after 100 iterations
## # weights:  109
## initial  value 111.395285
## iter  10 value 36.710399
## iter  20 value 22.028561
## iter  30 value 13.310092
## iter  40 value 9.271770
## iter  50 value 6.308208
## iter  60 value 5.562658
## iter  70 value 4.058193
## iter  80 value 3.634185
## iter  90 value 2.946320
## iter 100 value 2.494842
## final  value 2.494842
## stopped after 100 iterations
## # weights:  179
## initial  value 110.287686
```

```
## iter  10 value 23.977702
## iter  20 value 16.030259
## iter  30 value 10.950104
## iter  40 value 10.844199
## iter  50 value 9.432056
## iter  60 value 6.767434
## iter  70 value 4.632996
## iter  80 value 3.787226
## iter  90 value 0.381152
## iter 100 value 0.298794
## final  value 0.298794
## stopped after 100 iterations
## # weights:  39
## initial  value 104.104121
## iter  10 value 94.632851
## iter  20 value 82.104303
## iter  30 value 71.771913
## iter  40 value 68.250404
## iter  50 value 64.508450
## iter  60 value 58.117662
## iter  70 value 56.510342
## iter  80 value 53.399022
## iter  90 value 52.584196
## iter 100 value 52.136980
## final  value 52.136980
## stopped after 100 iterations
## # weights:  109
## initial  value 102.660668
## iter  10 value 32.782329
## iter  20 value 29.072581
## iter  30 value 24.595833
## iter  40 value 20.424164
## iter  50 value 15.258176
## iter  60 value 14.370692
## iter  70 value 14.328550
## iter  80 value 14.294252
## iter  90 value 9.913291
## iter 100 value 9.026074
## final  value 9.026074
## stopped after 100 iterations
## # weights:  179
## initial  value 100.913089
## iter  10 value 23.433515
## iter  20 value 2.742041
## iter  30 value 0.098064
## iter  40 value 0.005778
## iter  50 value 0.001027
## final  value 0.000055
## converged
## # weights:  39
## initial  value 119.429726
## iter  10 value 77.705077
## iter  20 value 67.193284
## iter  30 value 62.468116
```

```
## iter  40 value 58.138880
## iter  50 value 57.973718
## final  value 57.973633
## converged
## # weights:  109
## initial  value 101.372172
## iter  10 value 48.227120
## iter  20 value 33.567402
## iter  30 value 26.726559
## iter  40 value 20.620389
## iter  50 value 17.158583
## iter  60 value 16.425468
## iter  70 value 16.318073
## iter  80 value 16.311307
## final  value 16.311173
## converged
## # weights:  179
## initial  value 108.628410
## iter  10 value 62.030342
## iter  20 value 25.043421
## iter  30 value 13.672449
## iter  40 value 12.820465
## iter  50 value 12.536611
## iter  60 value 12.191646
## iter  70 value 12.142232
## iter  80 value 12.138215
## iter  90 value 12.137719
## iter 100 value 12.137587
## final  value 12.137587
## stopped after 100 iterations
## # weights:  39
## initial  value 116.154045
## iter  10 value 72.039430
## iter  20 value 55.630344
## iter  30 value 51.128362
## iter  40 value 49.381377
## iter  50 value 47.825646
## iter  60 value 47.400660
## iter  70 value 47.133355
## iter  80 value 46.504331
## iter  90 value 45.181297
## iter 100 value 43.575820
## final  value 43.575820
## stopped after 100 iterations
## # weights:  109
## initial  value 101.979893
## iter  10 value 50.640612
## iter  20 value 15.700287
## iter  30 value 9.068393
## iter  40 value 8.678117
## iter  50 value 8.561636
## iter  60 value 8.532056
## iter  70 value 8.292066
## iter  80 value 7.796292
```

```
## iter  90 value 7.600462
## iter 100 value 7.237641
## final  value 7.237641
## stopped after 100 iterations
## # weights:  179
## initial  value 116.458597
## iter  10 value 38.761667
## iter  20 value 18.181590
## iter  30 value 7.199160
## iter  40 value 4.105810
## iter  50 value 3.607261
## iter  60 value 3.573308
## iter  70 value 3.548072
## iter  80 value 2.955874
## iter  90 value 2.945030
## iter 100 value 2.925716
## final  value 2.925716
## stopped after 100 iterations
## # weights:  39
## initial  value 102.902944
## iter  10 value 95.117534
## iter  20 value 77.992387
## iter  30 value 59.882523
## iter  40 value 51.135631
## iter  50 value 50.046115
## iter  60 value 50.042183
## iter  70 value 50.041889
## iter  70 value 50.041889
## iter  70 value 50.041889
## final  value 50.041889
## converged
## # weights:  109
## initial  value 115.267663
## iter  10 value 58.436888
## iter  20 value 47.112767
## iter  30 value 41.952219
## iter  40 value 39.953380
## iter  50 value 38.487833
## iter  60 value 37.859163
## iter  70 value 36.411762
## iter  80 value 33.682640
## iter  90 value 33.407897
## iter 100 value 32.331523
## final  value 32.331523
## stopped after 100 iterations
## # weights:  179
## initial  value 100.684060
## iter  10 value 20.204483
## iter  20 value 10.006904
## iter  30 value 6.390664
## iter  40 value 5.958816
## iter  50 value 4.871629
## iter  60 value 4.310071
## iter  70 value 3.993092
```

```
## iter  80 value 3.893582
## iter  90 value 3.134830
## iter 100 value 2.911010
## final  value 2.911010
## stopped after 100 iterations
## # weights:  39
## initial  value 112.928870
## iter  10 value 71.810066
## iter  20 value 60.569788
## iter  30 value 58.130220
## iter  40 value 57.674019
## iter  50 value 56.638793
## iter  60 value 55.707852
## iter  70 value 55.699390
## iter  80 value 55.682629
## iter  90 value 55.531367
## iter 100 value 55.501614
## final  value 55.501614
## stopped after 100 iterations
## # weights:  109
## initial  value 132.454427
## iter  10 value 75.339895
## iter  20 value 51.015371
## iter  30 value 42.506734
## iter  40 value 31.643265
## iter  50 value 20.287321
## iter  60 value 17.622962
## iter  70 value 17.331452
## iter  80 value 17.257635
## iter  90 value 17.194176
## iter 100 value 17.139717
## final  value 17.139717
## stopped after 100 iterations
## # weights:  179
## initial  value 109.431568
## iter  10 value 28.271596
## iter  20 value 14.086766
## iter  30 value 12.745537
## iter  40 value 12.577017
## iter  50 value 12.399960
## iter  60 value 12.338756
## iter  70 value 12.333465
## final  value 12.333432
## converged
## # weights:  39
## initial  value 100.913687
## iter  10 value 68.321926
## iter  20 value 62.361350
## iter  30 value 58.081019
## iter  40 value 57.146854
## iter  50 value 56.980564
## iter  60 value 55.674254
## iter  70 value 54.617339
## iter  80 value 54.531221
```

```
## iter  90 value 54.403796
## iter 100 value 54.392980
## final  value 54.392980
## stopped after 100 iterations
## # weights:  109
## initial  value 99.323085
## iter  10 value 43.400727
## iter  20 value 29.610046
## iter  30 value 28.215557
## iter  40 value 25.187744
## iter  50 value 19.465281
## iter  60 value 16.566440
## iter  70 value 15.217661
## iter  80 value 13.945526
## iter  90 value 13.729266
## iter 100 value 12.485691
## final  value 12.485691
## stopped after 100 iterations
## # weights:  179
## initial  value 121.662153
## iter  10 value 33.659989
## iter  20 value 5.332921
## iter  30 value 0.551199
## iter  40 value 0.139551
## iter  50 value 0.130606
## iter  60 value 0.125440
## iter  70 value 0.115584
## iter  80 value 0.109488
## iter  90 value 0.103554
## iter 100 value 0.100060
## final  value 0.100060
## stopped after 100 iterations
## # weights:  39
## initial  value 103.035516
## iter  10 value 67.202549
## iter  20 value 58.454661
## iter  30 value 57.810290
## iter  40 value 56.269647
## iter  50 value 53.340897
## iter  60 value 52.388565
## iter  70 value 49.889024
## iter  80 value 49.094247
## iter  90 value 43.482376
## iter 100 value 42.437101
## final  value 42.437101
## stopped after 100 iterations
## # weights:  109
## initial  value 98.606029
## iter  10 value 43.828124
## iter  20 value 25.446274
## iter  30 value 23.327318
## iter  40 value 22.973550
## iter  50 value 22.861771
## iter  60 value 22.585122
```

```
## iter  70 value 22.361625
## iter  80 value 22.339547
## iter  90 value 22.329942
## iter 100 value 22.313089
## final  value 22.313089
## stopped after 100 iterations
## # weights:  179
## initial  value 116.721945
## iter  10 value 21.158818
## iter  20 value 11.175851
## iter  30 value 10.507747
## iter  40 value 10.179368
## iter  50 value 10.032285
## iter  60 value 6.687856
## iter  70 value 5.955981
## iter  80 value 5.818288
## iter  90 value 5.228004
## iter 100 value 5.216850
## final  value 5.216850
## stopped after 100 iterations
## # weights:  39
## initial  value 102.506497
## iter  10 value 81.787259
## iter  20 value 64.685533
## iter  30 value 60.413218
## iter  40 value 58.380602
## iter  50 value 58.173716
## iter  60 value 58.165468
## iter  70 value 57.826261
## iter  80 value 57.746568
## iter  90 value 57.744660
## final  value 57.744659
## converged
## # weights:  109
## initial  value 126.906785
## iter  10 value 75.492805
## iter  20 value 46.356830
## iter  30 value 23.509959
## iter  40 value 18.760807
## iter  50 value 17.803642
## iter  60 value 17.494282
## iter  70 value 17.189129
## iter  80 value 17.119594
## iter  90 value 17.119079
## final  value 17.119077
## converged
## # weights:  179
## initial  value 125.422441
## iter  10 value 49.803856
## iter  20 value 30.976175
## iter  30 value 19.400579
## iter  40 value 15.109142
## iter  50 value 12.935283
## iter  60 value 12.372935
```

```
## iter  70 value 12.210302
## iter  80 value 12.150268
## iter  90 value 12.138439
## iter 100 value 12.138117
## final  value 12.138117
## stopped after 100 iterations
## # weights:  39
## initial  value 105.568778
## iter  10 value 65.287381
## iter  20 value 61.661921
## iter  30 value 59.188873
## iter  40 value 58.762466
## iter  50 value 57.473034
## iter  60 value 56.486467
## iter  70 value 56.288190
## iter  80 value 56.213802
## iter  90 value 54.381165
## iter 100 value 52.789144
## final  value 52.789144
## stopped after 100 iterations
## # weights:  109
## initial  value 111.525584
## iter  10 value 46.274228
## iter  20 value 25.018974
## iter  30 value 22.193350
## iter  40 value 18.413932
## iter  50 value 18.067061
## iter  60 value 18.047277
## iter  70 value 18.036309
## iter  80 value 15.720196
## iter  90 value 14.508135
## iter 100 value 14.415528
## final  value 14.415528
## stopped after 100 iterations
## # weights:  179
## initial  value 142.483354
## iter  10 value 80.870178
## iter  20 value 70.300416
## iter  30 value 67.024735
## iter  40 value 54.827190
## iter  50 value 40.970285
## iter  60 value 40.772169
## iter  70 value 40.761883
## iter  80 value 37.455967
## iter  90 value 37.043444
## iter 100 value 35.975129
## final  value 35.975129
## stopped after 100 iterations
## # weights:  39
## initial  value 106.375245
## iter  10 value 61.477491
## iter  20 value 51.579410
## iter  30 value 46.683733
## iter  40 value 46.577219
```

```
## iter  50 value 46.576626
## final  value 46.576594
## converged
## # weights:  109
## initial  value 109.682889
## iter  10 value 53.976210
## iter  20 value 25.163669
## iter  30 value 23.454847
## iter  40 value 22.771648
## iter  50 value 22.558459
## iter  60 value 21.639478
## iter  70 value 21.590591
## iter  80 value 21.587522
## iter  90 value 21.357415
## iter 100 value 16.525865
## final  value 16.525865
## stopped after 100 iterations
## # weights:  179
## initial  value 126.896091
## iter  10 value 26.618382
## iter  20 value 17.197097
## iter  30 value 14.435782
## iter  40 value 12.924168
## iter  50 value 12.652586
## iter  60 value 9.981097
## iter  70 value 8.878792
## iter  80 value 6.371991
## iter  90 value 1.452116
## iter 100 value 0.264262
## final  value 0.264262
## stopped after 100 iterations
## # weights:  39
## initial  value 135.096055
## iter  10 value 76.609294
## iter  20 value 65.883392
## iter  30 value 59.641980
## iter  40 value 58.993143
## iter  50 value 58.771664
## iter  60 value 58.393686
## iter  70 value 57.922598
## iter  80 value 57.906495
## final  value 57.906494
## converged
## # weights:  109
## initial  value 117.493313
## iter  10 value 66.028895
## iter  20 value 34.052163
## iter  30 value 21.372445
## iter  40 value 18.469352
## iter  50 value 17.637266
## iter  60 value 17.389107
## iter  70 value 17.362444
## iter  80 value 17.352768
## iter  90 value 17.352390
```

```
## iter 100 value 17.352227
## final  value 17.352227
## stopped after 100 iterations
## # weights:  179
## initial  value 141.970467
## iter  10 value 42.564692
## iter  20 value 23.248382
## iter  30 value 15.557352
## iter  40 value 13.332413
## iter  50 value 12.920563
## iter  60 value 12.735156
## iter  70 value 12.526042
## iter  80 value 12.494029
## iter  90 value 12.482295
## iter 100 value 12.480921
## final  value 12.480921
## stopped after 100 iterations
## # weights:  39
## initial  value 104.043870
## iter  10 value 85.293057
## iter  20 value 75.115480
## iter  30 value 69.764047
## iter  40 value 67.298602
## iter  50 value 66.038954
## iter  60 value 61.247612
## iter  70 value 58.185033
## iter  80 value 51.620265
## iter  90 value 48.196567
## iter 100 value 46.004115
## final  value 46.004115
## stopped after 100 iterations
## # weights:  109
## initial  value 107.342746
## iter  10 value 41.088781
## iter  20 value 19.871015
## iter  30 value 19.145624
## iter  40 value 19.110781
## iter  50 value 19.083913
## iter  60 value 19.058351
## iter  70 value 19.019856
## iter  80 value 18.981652
## iter  90 value 17.728183
## iter 100 value 16.666359
## final  value 16.666359
## stopped after 100 iterations
## # weights:  179
## initial  value 99.458461
## iter  10 value 22.889092
## iter  20 value 3.951857
## iter  30 value 0.800651
## iter  40 value 0.211433
## iter  50 value 0.184478
## iter  60 value 0.178162
## iter  70 value 0.162257
```

```
## iter  80 value 0.148402
## iter  90 value 0.139573
## iter 100 value 0.128653
## final  value 0.128653
## stopped after 100 iterations
## # weights:  39
## initial  value 116.998611
## iter  10 value 66.983932
## iter  20 value 61.799025
## iter  30 value 61.003114
## iter  40 value 59.892893
## iter  50 value 57.741088
## iter  60 value 57.686713
## iter  70 value 57.570713
## iter  80 value 57.433687
## iter  90 value 53.139768
## iter 100 value 51.618662
## final  value 51.618662
## stopped after 100 iterations
## # weights:  109
## initial  value 117.964956
## iter  10 value 34.259599
## iter  20 value 16.807223
## iter  30 value 9.643818
## iter  40 value 8.987129
## iter  50 value 8.308468
## iter  60 value 8.193778
## iter  70 value 8.055228
## iter  80 value 8.027582
## iter  90 value 8.018946
## iter 100 value 8.014011
## final  value 8.014011
## stopped after 100 iterations
## # weights:  179
## initial  value 119.662556
## iter  10 value 17.294015
## iter  20 value 2.497720
## iter  30 value 1.914160
## iter  40 value 1.909786
## iter  50 value 1.909551
## final  value 1.909548
## converged
## # weights:  39
## initial  value 105.830669
## iter  10 value 69.251233
## iter  20 value 65.584326
## iter  30 value 62.058325
## iter  40 value 58.951676
## iter  50 value 58.196204
## iter  60 value 57.888591
## iter  70 value 57.696740
## iter  80 value 57.659527
## final  value 57.659311
## converged
```

```
## # weights:  109
## initial  value 96.087951
## iter  10 value 36.653478
## iter  20 value 25.450749
## iter  30 value 20.252368
## iter  40 value 19.021345
## iter  50 value 18.586706
## iter  60 value 18.134710
## iter  70 value 17.807973
## iter  80 value 17.553251
## iter  90 value 17.194438
## iter 100 value 16.794678
## final  value 16.794678
## stopped after 100 iterations
## # weights:  179
## initial  value 128.862280
## iter  10 value 51.729388
## iter  20 value 29.209093
## iter  30 value 18.841753
## iter  40 value 14.122869
## iter  50 value 13.008250
## iter  60 value 12.489594
## iter  70 value 12.336610
## iter  80 value 12.333355
## iter  90 value 12.333115
## final  value 12.333106
## converged
## # weights:  39
## initial  value 104.183800
## iter  10 value 63.136261
## iter  20 value 57.728559
## iter  30 value 55.069733
## iter  40 value 53.686989
## iter  50 value 53.514579
## iter  60 value 53.438881
## iter  70 value 52.214352
## iter  80 value 51.869493
## iter  90 value 51.749341
## iter 100 value 51.620893
## final  value 51.620893
## stopped after 100 iterations
## # weights:  109
## initial  value 110.258659
## iter  10 value 37.486723
## iter  20 value 15.789122
## iter  30 value 9.000416
## iter  40 value 5.245511
## iter  50 value 3.157589
## iter  60 value 3.104749
## iter  70 value 3.094253
## iter  80 value 3.074371
## iter  90 value 3.033486
## iter 100 value 0.893676
## final  value 0.893676
```

```
## stopped after 100 iterations
## # weights:  179
## initial  value 118.203115
## iter  10 value 24.695646
## iter  20 value 15.585488
## iter  30 value 12.046722
## iter  40 value 10.907912
## iter  50 value 9.025767
## iter  60 value 8.921963
## iter  70 value 8.239355
## iter  80 value 7.672052
## iter  90 value 7.550155
## iter 100 value 7.456083
## final  value 7.456083
## stopped after 100 iterations
## # weights:  39
## initial  value 105.082330
## iter  10 value 89.250841
## iter  20 value 55.053026
## iter  30 value 54.537456
## iter  40 value 54.536669
## final  value 54.536667
## converged
## # weights:  109
## initial  value 103.218517
## iter  10 value 25.488058
## iter  20 value 12.656920
## iter  30 value 11.459115
## iter  40 value 4.611962
## iter  50 value 4.515429
## iter  60 value 4.038720
## iter  70 value 3.852779
## iter  80 value 3.836705
## iter  90 value 3.756311
## iter 100 value 3.384470
## final  value 3.384470
## stopped after 100 iterations
## # weights:  179
## initial  value 103.608427
## iter  10 value 26.686248
## iter  20 value 5.952020
## iter  30 value 2.505683
## iter  40 value 1.452198
## iter  50 value 1.420127
## iter  60 value 1.409060
## iter  70 value 1.397836
## iter  80 value 1.392284
## iter  90 value 1.388814
## iter 100 value 1.387729
## final  value 1.387729
## stopped after 100 iterations
## # weights:  39
## initial  value 105.100112
## iter  10 value 79.815206
```

```
## iter  20 value 76.877191
## iter  30 value 72.711150
## iter  40 value 68.563403
## iter  50 value 65.585533
## iter  60 value 65.327313
## iter  70 value 64.694537
## iter  80 value 64.670858
## final  value 64.670794
## converged
## # weights:  109
## initial  value 107.917549
## iter  10 value 42.563395
## iter  20 value 24.146781
## iter  30 value 17.251261
## iter  40 value 16.814284
## iter  50 value 16.779971
## iter  60 value 16.778538
## iter  70 value 16.774396
## iter  80 value 16.624766
## iter  90 value 16.470744
## iter 100 value 16.441429
## final  value 16.441429
## stopped after 100 iterations
## # weights:  179
## initial  value 117.939171
## iter  10 value 29.243039
## iter  20 value 15.473215
## iter  30 value 13.352784
## iter  40 value 12.871967
## iter  50 value 12.801351
## iter  60 value 12.779367
## iter  70 value 12.734912
## iter  80 value 12.733841
## final  value 12.733839
## converged
## # weights:  39
## initial  value 103.095073
## iter  10 value 64.405363
## iter  20 value 62.998348
## iter  30 value 62.165910
## iter  40 value 61.457724
## iter  50 value 53.992488
## iter  60 value 49.790345
## iter  70 value 48.978211
## iter  80 value 48.621253
## iter  90 value 47.788137
## iter 100 value 46.255589
## final  value 46.255589
## stopped after 100 iterations
## # weights:  109
## initial  value 107.104233
## iter  10 value 45.795587
## iter  20 value 27.037214
## iter  30 value 25.324404
```

```
## iter  40 value 18.295890
## iter  50 value 17.929887
## iter  60 value 15.635469
## iter  70 value 15.613910
## iter  80 value 15.480294
## iter  90 value 15.100108
## iter 100 value 15.089462
## final  value 15.089462
## stopped after 100 iterations
## # weights:  179
## initial  value 118.595524
## iter  10 value 9.228820
## iter  20 value 2.031334
## iter  30 value 1.542707
## iter  40 value 1.520213
## iter  50 value 1.512758
## iter  60 value 1.505597
## iter  70 value 1.497186
## iter  80 value 1.493245
## iter  90 value 1.473857
## iter 100 value 0.155949
## final  value 0.155949
## stopped after 100 iterations
## # weights:  39
## initial  value 102.403787
## iter  10 value 71.052825
## iter  20 value 59.423164
## iter  30 value 59.009155
## iter  40 value 57.553719
## iter  50 value 57.306851
## iter  60 value 56.834353
## iter  70 value 56.046658
## iter  80 value 55.694162
## iter  90 value 55.003883
## iter 100 value 51.635742
## final  value 51.635742
## stopped after 100 iterations
## # weights:  109
## initial  value 113.248935
## iter  10 value 30.123739
## iter  20 value 19.919473
## iter  30 value 14.442042
## iter  40 value 13.044798
## iter  50 value 12.681620
## iter  60 value 12.310089
## iter  70 value 11.836379
## iter  80 value 11.452948
## iter  90 value 11.383149
## iter 100 value 11.191757
## final  value 11.191757
## stopped after 100 iterations
## # weights:  179
## initial  value 110.001748
## iter  10 value 52.973058
```

```
## iter  20 value 24.542659
## iter  30 value 20.327671
## iter  40 value 15.764696
## iter  50 value 12.767575
## iter  60 value 11.057664
## iter  70 value 10.765844
## iter  80 value 10.345875
## iter  90 value 9.781062
## iter 100 value 9.661580
## final  value 9.661580
## stopped after 100 iterations
## # weights:  39
## initial  value 107.747973
## iter  10 value 79.727757
## iter  20 value 66.926899
## iter  30 value 61.571105
## iter  40 value 59.733704
## iter  50 value 58.496842
## iter  60 value 57.872977
## iter  70 value 57.590424
## iter  80 value 57.414424
## iter  90 value 57.407494
## final  value 57.407487
## converged
## # weights:  109
## initial  value 115.641531
## iter  10 value 50.739236
## iter  20 value 28.280328
## iter  30 value 20.508272
## iter  40 value 18.338220
## iter  50 value 16.100876
## iter  60 value 15.716135
## iter  70 value 15.687606
## iter  80 value 15.686209
## iter  90 value 15.686146
## final  value 15.686145
## converged
## # weights:  179
## initial  value 121.731627
## iter  10 value 54.072596
## iter  20 value 22.979033
## iter  30 value 14.531366
## iter  40 value 12.499999
## iter  50 value 12.058427
## iter  60 value 12.048304
## iter  70 value 12.047228
## iter  80 value 12.030373
## iter  90 value 11.834911
## iter 100 value 11.637256
## final  value 11.637256
## stopped after 100 iterations
## # weights:  39
## initial  value 103.681866
## iter  10 value 59.304041
```

```
## iter  20 value 57.324948
## iter  30 value 56.343407
## iter  40 value 55.373041
## iter  50 value 55.365170
## iter  60 value 54.616544
## iter  70 value 53.684371
## iter  80 value 53.680127
## iter  90 value 53.201999
## iter 100 value 52.734436
## final  value 52.734436
## stopped after 100 iterations
## # weights:  109
## initial  value 106.838757
## iter  10 value 51.870309
## iter  20 value 47.948553
## iter  30 value 45.257253
## iter  40 value 27.247696
## iter  50 value 21.938159
## iter  60 value 21.333904
## iter  70 value 20.717468
## iter  80 value 20.325719
## iter  90 value 19.370170
## iter 100 value 19.209037
## final  value 19.209037
## stopped after 100 iterations
## # weights:  179
## initial  value 105.674945
## iter  10 value 22.027455
## iter  20 value 6.654449
## iter  30 value 5.701856
## iter  40 value 5.564341
## iter  50 value 5.509316
## iter  60 value 4.990982
## iter  70 value 4.018605
## iter  80 value 1.881191
## iter  90 value 1.765851
## iter 100 value 1.742856
## final  value 1.742856
## stopped after 100 iterations
## # weights:  39
## initial  value 112.869840
## iter  10 value 72.876987
## iter  20 value 61.547193
## iter  30 value 60.758307
## iter  40 value 59.498691
## iter  50 value 58.710423
## iter  60 value 57.084085
## iter  70 value 55.639031
## iter  80 value 54.606390
## iter  90 value 54.458178
## iter 100 value 54.055820
## final  value 54.055820
## stopped after 100 iterations
## # weights:  109
```

```
## initial  value 126.900732
## iter  10 value 57.223975
## iter  20 value 36.585155
## iter  30 value 21.758450
## iter  40 value 10.124769
## iter  50 value 9.390520
## iter  60 value 9.267269
## iter  70 value 9.147667
## iter  80 value 9.113864
## iter  90 value 9.095141
## iter 100 value 8.959246
## final  value 8.959246
## stopped after 100 iterations
## # weights:  179
## initial  value 104.283855
## iter  10 value 20.758754
## iter  20 value 11.884268
## iter  30 value 11.178848
## iter  40 value 10.693612
## iter  50 value 10.635022
## iter  60 value 10.495920
## iter  70 value 10.433809
## iter  80 value 10.222676
## iter  90 value 10.208508
## iter 100 value 10.093986
## final  value 10.093986
## stopped after 100 iterations
## # weights:  39
## initial  value 106.704691
## iter  10 value 77.931973
## iter  20 value 65.162515
## iter  30 value 61.752405
## iter  40 value 59.647890
## iter  50 value 58.439908
## iter  60 value 58.134947
## iter  70 value 57.999753
## iter  80 value 57.484664
## iter  90 value 57.465099
## final  value 57.465084
## converged
## # weights:  109
## initial  value 101.281788
## iter  10 value 52.614419
## iter  20 value 28.933868
## iter  30 value 18.307748
## iter  40 value 17.591372
## iter  50 value 17.427833
## iter  60 value 17.423486
## iter  70 value 17.423402
## final  value 17.423398
## converged
## # weights:  179
## initial  value 112.107421
## iter  10 value 40.687887
```

```
## iter  20 value 19.017303
## iter  30 value 14.149128
## iter  40 value 12.888287
## iter  50 value 12.503109
## iter  60 value 12.410647
## iter  70 value 12.407067
## iter  80 value 12.406993
## final  value 12.406989
## converged
## # weights:  39
## initial  value 102.966885
## iter  10 value 63.608194
## iter  20 value 56.201441
## iter  30 value 52.428983
## iter  40 value 51.147780
## iter  50 value 51.134441
## iter  60 value 51.122064
## iter  70 value 51.076005
## iter  80 value 51.051720
## iter  90 value 51.042610
## iter 100 value 51.035130
## final  value 51.035130
## stopped after 100 iterations
## # weights:  109
## initial  value 113.610656
## iter  10 value 46.467633
## iter  20 value 35.301876
## iter  30 value 30.066421
## iter  40 value 29.601282
## iter  50 value 25.609261
## iter  60 value 17.983663
## iter  70 value 16.647743
## iter  80 value 11.502619
## iter  90 value 8.308751
## iter 100 value 7.566426
## final  value 7.566426
## stopped after 100 iterations
## # weights:  179
## initial  value 93.727114
## iter  10 value 17.982797
## iter  20 value 5.874062
## iter  30 value 4.320749
## iter  40 value 4.294416
## iter  50 value 4.274965
## iter  60 value 4.253659
## iter  70 value 3.822169
## iter  80 value 3.416225
## iter  90 value 3.400944
## iter 100 value 1.669066
## final  value 1.669066
## stopped after 100 iterations
## # weights:  39
## initial  value 111.071494
## iter  10 value 81.917978
```

```
## iter  20 value 66.752529
## iter  30 value 63.269597
## iter  40 value 58.737222
## iter  50 value 55.648921
## iter  60 value 54.526295
## iter  70 value 49.330782
## iter  80 value 48.587899
## iter  90 value 46.533615
## iter 100 value 46.066413
## final  value 46.066413
## stopped after 100 iterations
## # weights:  109
## initial  value 107.089943
## iter  10 value 55.234740
## iter  20 value 22.389060
## iter  30 value 20.367074
## iter  40 value 19.609503
## iter  50 value 18.494994
## iter  60 value 17.263878
## iter  70 value 17.038706
## iter  80 value 16.872584
## iter  90 value 16.527268
## iter 100 value 16.402375
## final  value 16.402375
## stopped after 100 iterations
## # weights:  179
## initial  value 103.652883
## iter  10 value 24.167727
## iter  20 value 9.953042
## iter  30 value 8.492294
## iter  40 value 7.065062
## iter  50 value 5.199502
## iter  60 value 5.189567
## iter  70 value 5.158476
## iter  80 value 5.141893
## iter  90 value 5.127208
## iter 100 value 5.127034
## final  value 5.127034
## stopped after 100 iterations
## # weights:  39
## initial  value 107.242423
## iter  10 value 69.668594
## iter  20 value 62.957453
## iter  30 value 60.293402
## iter  40 value 60.078461
## iter  50 value 59.938452
## iter  60 value 59.513597
## iter  70 value 59.165025
## iter  80 value 59.112118
## final  value 59.112044
## converged
## # weights:  109
## initial  value 115.412115
## iter  10 value 73.212100
```

```
## iter  20 value 49.088261
## iter  30 value 23.155727
## iter  40 value 18.003186
## iter  50 value 16.879399
## iter  60 value 16.798870
## iter  70 value 16.781864
## iter  80 value 16.742496
## iter  90 value 16.738341
## iter 100 value 16.738237
## final  value 16.738237
## stopped after 100 iterations
## # weights:  179
## initial  value 121.281352
## iter  10 value 35.370770
## iter  20 value 21.488152
## iter  30 value 16.066384
## iter  40 value 13.597310
## iter  50 value 12.605599
## iter  60 value 12.278221
## iter  70 value 12.251660
## iter  80 value 12.251127
## iter  90 value 12.251106
## final  value 12.251106
## converged
## # weights:  39
## initial  value 104.544298
## iter  10 value 64.526224
## iter  20 value 50.388044
## iter  30 value 40.914239
## iter  40 value 38.582250
## iter  50 value 37.377838
## iter  60 value 36.922364
## iter  70 value 36.221697
## iter  80 value 36.174226
## iter  90 value 36.061043
## iter 100 value 36.019991
## final  value 36.019991
## stopped after 100 iterations
## # weights:  109
## initial  value 111.341716
## iter  10 value 41.008508
## iter  20 value 19.711727
## iter  30 value 12.263611
## iter  40 value 6.314696
## iter  50 value 5.384759
## iter  60 value 5.212949
## iter  70 value 4.847233
## iter  80 value 4.745915
## iter  90 value 4.600531
## iter 100 value 4.182227
## final  value 4.182227
## stopped after 100 iterations
## # weights:  179
## initial  value 121.416140
```

```
## iter  10 value 17.285821
## iter  20 value 7.404485
## iter  30 value 5.593378
## iter  40 value 5.517382
## iter  50 value 5.495217
## iter  60 value 5.325117
## iter  70 value 5.272660
## iter  80 value 5.152960
## iter  90 value 5.139879
## iter 100 value 5.122328
## final  value 5.122328
## stopped after 100 iterations
## # weights:  39
## initial  value 101.176678
## iter  10 value 64.942117
## iter  20 value 60.189055
## iter  30 value 59.479518
## iter  40 value 59.208528
## iter  50 value 59.171348
## iter  60 value 59.166573
## iter  70 value 59.164137
## iter  80 value 59.163955
## iter  80 value 59.163954
## final  value 59.163954
## converged
## # weights:  109
## initial  value 104.413824
## iter  10 value 42.854235
## iter  20 value 19.182867
## iter  30 value 9.740929
## iter  40 value 6.772130
## iter  50 value 6.440887
## iter  60 value 6.272804
## iter  70 value 6.272079
## iter  80 value 5.934192
## iter  90 value 5.592700
## iter 100 value 5.407909
## final  value 5.407909
## stopped after 100 iterations
## # weights:  179
## initial  value 127.217693
## iter  10 value 22.643510
## iter  20 value 6.696243
## iter  30 value 2.929428
## iter  40 value 2.774617
## iter  50 value 2.772779
## iter  60 value 2.772590
## iter  60 value 2.772590
## iter  60 value 2.772590
## final  value 2.772590
## converged
## # weights:  39
## initial  value 103.130121
## iter  10 value 73.534905
```

```
## iter  20 value 65.080629
## iter  30 value 60.105258
## iter  40 value 59.068942
## iter  50 value 58.569938
## iter  60 value 58.541653
## final  value 58.541651
## converged
## # weights:  109
## initial  value 110.493544
## iter  10 value 55.135778
## iter  20 value 25.915758
## iter  30 value 19.037411
## iter  40 value 16.209721
## iter  50 value 15.725766
## iter  60 value 15.703111
## iter  70 value 15.701788
## iter  80 value 15.701748
## iter  80 value 15.701748
## iter  80 value 15.701748
## final  value 15.701748
## converged
## # weights:  179
## initial  value 106.481457
## iter  10 value 43.837386
## iter  20 value 25.044892
## iter  30 value 16.600008
## iter  40 value 12.913796
## iter  50 value 12.234388
## iter  60 value 12.095502
## iter  70 value 12.084205
## iter  80 value 12.083223
## iter  90 value 12.083188
## final  value 12.083188
## converged
## # weights:  39
## initial  value 111.716414
## iter  10 value 60.088700
## iter  20 value 45.960138
## iter  30 value 36.906685
## iter  40 value 36.697115
## iter  50 value 36.695805
## iter  60 value 36.690875
## iter  70 value 36.675566
## iter  80 value 36.485801
## iter  90 value 36.339357
## iter 100 value 36.130272
## final  value 36.130272
## stopped after 100 iterations
## # weights:  109
## initial  value 115.061469
## iter  10 value 42.919828
## iter  20 value 7.646608
## iter  30 value 1.946823
## iter  40 value 1.557959
```

```
## iter  50 value 1.545121
## iter  60 value 1.535179
## iter  70 value 1.529208
## iter  80 value 1.517635
## iter  90 value 1.505588
## iter 100 value 1.499133
## final  value 1.499133
## stopped after 100 iterations
## # weights:  179
## initial  value 110.006198
## iter  10 value 22.072325
## iter  20 value 5.538083
## iter  30 value 4.070544
## iter  40 value 4.054390
## iter  50 value 4.030999
## iter  60 value 4.013053
## iter  70 value 4.005433
## iter  80 value 4.000324
## iter  90 value 2.717009
## iter 100 value 1.505916
## final  value 1.505916
## stopped after 100 iterations
## # weights:  39
## initial  value 100.615696
## iter  10 value 70.908875
## iter  20 value 62.751346
## iter  30 value 62.623699
## iter  40 value 62.138530
## iter  50 value 61.813073
## iter  60 value 61.674940
## iter  70 value 61.658481
## iter  80 value 61.655601
## final  value 61.655160
## converged
## # weights:  109
## initial  value 98.295046
## iter  10 value 28.535016
## iter  20 value 16.738147
## iter  30 value 10.518791
## iter  40 value 9.740156
## iter  50 value 9.713299
## iter  60 value 9.712616
## iter  70 value 9.712360
## iter  80 value 9.712324
## iter  80 value 9.712324
## iter  80 value 9.712324
## final  value 9.712324
## converged
## # weights:  179
## initial  value 141.452737
## iter  10 value 53.685731
## iter  20 value 32.433635
## iter  30 value 10.730215
## iter  40 value 6.465200
```

```
## iter  50 value 6.420496
## iter  60 value 6.419668
## iter  60 value 6.419668
## iter  70 value 6.419661
## iter  70 value 6.419661
## iter  70 value 6.419661
## final  value 6.419661
## converged
## # weights:  39
## initial  value 120.204565
## iter  10 value 77.903940
## iter  20 value 69.317038
## iter  30 value 63.987192
## iter  40 value 57.967338
## iter  50 value 56.541860
## iter  60 value 56.213978
## iter  70 value 56.191838
## final  value 56.191761
## converged
## # weights:  109
## initial  value 98.917610
## iter  10 value 52.279871
## iter  20 value 25.291209
## iter  30 value 19.246674
## iter  40 value 17.625722
## iter  50 value 16.587821
## iter  60 value 15.734542
## iter  70 value 15.531989
## iter  80 value 14.800242
## iter  90 value 14.701720
## iter 100 value 14.701363
## final  value 14.701363
## stopped after 100 iterations
## # weights:  179
## initial  value 101.512058
## iter  10 value 27.811450
## iter  20 value 16.304479
## iter  30 value 14.120042
## iter  40 value 12.382638
## iter  50 value 11.901144
## iter  60 value 11.770871
## iter  70 value 11.753453
## iter  80 value 11.712876
## iter  90 value 11.644096
## iter 100 value 11.642399
## final  value 11.642399
## stopped after 100 iterations
## # weights:  39
## initial  value 108.666967
## iter  10 value 57.735899
## iter  20 value 55.543966
## iter  30 value 52.538535
## iter  40 value 51.607325
## iter  50 value 50.763428
```

```
## iter  60 value 50.319685
## iter  70 value 49.824164
## iter  80 value 49.105104
## iter  90 value 47.942290
## iter 100 value 45.078175
## final  value 45.078175
## stopped after 100 iterations
## # weights:  109
## initial  value 108.529147
## iter  10 value 38.569147
## iter  20 value 22.200431
## iter  30 value 19.489820
## iter  40 value 18.875881
## iter  50 value 18.553504
## iter  60 value 18.253283
## iter  70 value 17.943530
## iter  80 value 17.566034
## iter  90 value 17.267717
## iter 100 value 15.671424
## final  value 15.671424
## stopped after 100 iterations
## # weights:  179
## initial  value 111.860137
## iter  10 value 23.551875
## iter  20 value 15.385911
## iter  30 value 12.002694
## iter  40 value 9.867249
## iter  50 value 8.245328
## iter  60 value 6.836921
## iter  70 value 5.985680
## iter  80 value 5.896484
## iter  90 value 5.886520
## iter 100 value 4.085010
## final  value 4.085010
## stopped after 100 iterations
## # weights:  39
## initial  value 125.381831
## iter  10 value 59.430396
## iter  20 value 54.499055
## iter  30 value 53.870191
## iter  40 value 50.254981
## iter  50 value 48.537299
## iter  60 value 45.884392
## iter  70 value 44.670564
## iter  80 value 43.130402
## iter  90 value 42.215533
## iter 100 value 41.757088
## final  value 41.757088
## stopped after 100 iterations
## # weights:  109
## initial  value 99.277951
## iter  10 value 30.409227
## iter  20 value 22.269757
## iter  30 value 21.168598
```

```
## iter  40 value 20.948904
## iter  50 value 20.228458
## iter  60 value 19.645830
## iter  70 value 19.170533
## iter  80 value 18.687912
## iter  90 value 17.856895
## iter 100 value 17.586790
## final  value 17.586790
## stopped after 100 iterations
## # weights:  179
## initial  value 117.691961
## iter  10 value 24.356242
## iter  20 value 4.174138
## iter  30 value 2.542639
## iter  40 value 1.987332
## iter  50 value 1.921058
## iter  60 value 1.398859
## iter  70 value 1.336290
## iter  80 value 0.128721
## iter  90 value 0.028904
## iter 100 value 0.014181
## final  value 0.014181
## stopped after 100 iterations
## # weights:  39
## initial  value 103.734468
## iter  10 value 82.434762
## iter  20 value 76.419268
## iter  30 value 74.340681
## iter  40 value 66.736398
## iter  50 value 60.171751
## iter  60 value 59.261387
## iter  70 value 59.160117
## iter  80 value 59.153974
## iter  90 value 59.149758
## final  value 59.149371
## converged
## # weights:  109
## initial  value 117.087569
## iter  10 value 54.563837
## iter  20 value 29.708833
## iter  30 value 20.466822
## iter  40 value 16.553459
## iter  50 value 16.027797
## iter  60 value 15.908921
## iter  70 value 15.904742
## final  value 15.904707
## converged
## # weights:  179
## initial  value 133.017919
## iter  10 value 51.055854
## iter  20 value 26.825720
## iter  30 value 17.235838
## iter  40 value 14.839835
## iter  50 value 13.504617
```

```
## iter  60 value 13.143227
## iter  70 value 13.070481
## iter  80 value 13.065182
## iter  90 value 13.064800
## final  value 13.064796
## converged
## # weights:  39
## initial  value 111.560022
## iter  10 value 61.382274
## iter  20 value 59.144678
## iter  30 value 57.434150
## iter  40 value 56.551149
## iter  50 value 56.196886
## iter  60 value 56.191776
## iter  70 value 56.178702
## iter  80 value 56.173533
## iter  90 value 56.171754
## iter 100 value 53.370592
## final  value 53.370592
## stopped after 100 iterations
## # weights:  109
## initial  value 105.656784
## iter  10 value 29.579034
## iter  20 value 17.022579
## iter  30 value 11.998677
## iter  40 value 11.604007
## iter  50 value 10.964531
## iter  60 value 10.483137
## iter  70 value 10.140855
## iter  80 value 6.376229
## iter  90 value 2.614649
## iter 100 value 1.586401
## final  value 1.586401
## stopped after 100 iterations
## # weights:  179
## initial  value 130.620688
## iter  10 value 18.945212
## iter  20 value 5.478681
## iter  30 value 0.324880
## iter  40 value 0.264315
## iter  50 value 0.248031
## iter  60 value 0.226667
## iter  70 value 0.199510
## iter  80 value 0.184890
## iter  90 value 0.166567
## iter 100 value 0.145279
## final  value 0.145279
## stopped after 100 iterations
## # weights:  39
## initial  value 132.634666
## iter  10 value 66.432181
## iter  20 value 59.978997
## iter  30 value 57.184030
## iter  40 value 55.396428
```

```
## iter  50 value 55.266661
## iter  60 value 54.554297
## iter  70 value 54.413852
## iter  80 value 51.479047
## iter  90 value 50.611921
## iter 100 value 50.152796
## final  value 50.152796
## stopped after 100 iterations
## # weights:  109
## initial  value 112.325222
## iter  10 value 45.065819
## iter  20 value 41.828079
## iter  30 value 40.897232
## iter  40 value 38.441083
## iter  50 value 37.514907
## iter  60 value 37.398270
## iter  70 value 37.294575
## iter  80 value 36.842715
## iter  90 value 35.247142
## iter 100 value 34.866592
## final  value 34.866592
## stopped after 100 iterations
## # weights:  179
## initial  value 117.848681
## iter  10 value 38.381277
## iter  20 value 12.627887
## iter  30 value 11.528537
## iter  40 value 3.852755
## iter  50 value 1.475339
## iter  60 value 1.407523
## iter  70 value 1.392995
## iter  80 value 1.390037
## iter  90 value 1.387114
## iter 100 value 1.386871
## final  value 1.386871
## stopped after 100 iterations
## # weights:  39
## initial  value 101.476665
## iter  10 value 65.977246
## iter  20 value 58.949671
## iter  30 value 57.805392
## iter  40 value 57.360984
## iter  50 value 57.352099
## iter  60 value 57.186211
## iter  70 value 57.150682
## final  value 57.150674
## converged
## # weights:  109
## initial  value 113.489608
## iter  10 value 45.925595
## iter  20 value 28.292826
## iter  30 value 21.638044
## iter  40 value 16.787323
## iter  50 value 16.024587
```

```
## iter  60 value 16.015320
## final  value 16.015268
## converged
## # weights:  179
## initial  value 121.361312
## iter  10 value 47.459172
## iter  20 value 18.961341
## iter  30 value 13.396851
## iter  40 value 12.608863
## iter  50 value 12.338122
## iter  60 value 12.238220
## iter  70 value 12.212839
## iter  80 value 12.156551
## iter  90 value 12.149355
## iter 100 value 12.133294
## final  value 12.133294
## stopped after 100 iterations
## # weights:  39
## initial  value 109.661937
## iter  10 value 77.565882
## iter  20 value 62.761738
## iter  30 value 59.549675
## iter  40 value 59.533504
## iter  50 value 59.529589
## iter  60 value 59.521517
## iter  70 value 59.514869
## iter  80 value 59.508767
## iter  90 value 59.507936
## iter 100 value 59.503015
## final  value 59.503015
## stopped after 100 iterations
## # weights:  109
## initial  value 101.397478
## iter  10 value 23.124885
## iter  20 value 16.422129
## iter  30 value 11.303697
## iter  40 value 8.889958
## iter  50 value 7.892528
## iter  60 value 7.706374
## iter  70 value 7.518262
## iter  80 value 7.096966
## iter  90 value 7.020792
## iter 100 value 6.995361
## final  value 6.995361
## stopped after 100 iterations
## # weights:  179
## initial  value 119.905231
## iter  10 value 23.534014
## iter  20 value 7.603594
## iter  30 value 6.242536
## iter  40 value 6.148501
## iter  50 value 6.118216
## iter  60 value 6.016889
## iter  70 value 5.903810
```

```
## iter  80 value 5.801547
## iter  90 value 5.774574
## iter 100 value 5.743757
## final  value 5.743757
## stopped after 100 iterations
## # weights:  39
## initial  value 104.365260
## iter  10 value 63.392815
## iter  20 value 54.505861
## iter  30 value 53.204722
## iter  40 value 53.054473
## iter  50 value 53.047051
## iter  60 value 53.046884
## iter  70 value 53.046021
## iter  80 value 52.591980
## iter  90 value 51.817189
## iter 100 value 51.253995
## final  value 51.253995
## stopped after 100 iterations
## # weights:  109
## initial  value 102.003652
## iter  10 value 65.106586
## iter  20 value 59.726281
## iter  30 value 37.507071
## iter  40 value 34.600436
## iter  50 value 34.201005
## iter  60 value 34.095931
## iter  70 value 33.862198
## iter  80 value 33.703301
## iter  90 value 33.345903
## iter 100 value 33.319580
## final  value 33.319580
## stopped after 100 iterations
## # weights:  179
## initial  value 104.296831
## iter  10 value 24.826703
## iter  20 value 9.417795
## iter  30 value 3.751953
## iter  40 value 1.430296
## iter  50 value 1.390428
## iter  60 value 1.386499
## iter  70 value 1.386319
## final  value 1.386309
## converged
## # weights:  39
## initial  value 112.249720
## iter  10 value 82.377741
## iter  20 value 65.225815
## iter  30 value 61.082804
## iter  40 value 60.321273
## iter  50 value 59.766642
## iter  60 value 59.460017
## iter  70 value 59.275278
## iter  80 value 59.269600
```

```
## final  value 59.269597
## converged
## # weights:  109
## initial  value 98.417431
## iter  10 value 46.763227
## iter  20 value 27.148624
## iter  30 value 19.624904
## iter  40 value 17.051812
## iter  50 value 16.866195
## iter  60 value 16.850877
## iter  70 value 16.816337
## iter  80 value 16.815395
## iter  80 value 16.815395
## iter  80 value 16.815395
## final  value 16.815395
## converged
## # weights:  179
## initial  value 109.204876
## iter  10 value 31.394152
## iter  20 value 18.959073
## iter  30 value 13.412071
## iter  40 value 12.603279
## iter  50 value 12.299192
## iter  60 value 12.246947
## iter  70 value 12.235987
## iter  80 value 12.235343
## final  value 12.235338
## converged
## # weights:  39
## initial  value 102.465655
## iter  10 value 67.804516
## iter  20 value 59.106721
## iter  30 value 58.414318
## iter  40 value 58.092958
## iter  50 value 58.033480
## iter  60 value 57.403092
## iter  70 value 57.350592
## iter  80 value 56.985867
## iter  90 value 56.605511
## iter 100 value 54.338919
## final  value 54.338919
## stopped after 100 iterations
## # weights:  109
## initial  value 107.082272
## iter  10 value 44.120119
## iter  20 value 32.415559
## iter  30 value 24.105333
## iter  40 value 22.052746
## iter  50 value 21.362405
## iter  60 value 21.258356
## iter  70 value 20.308673
## iter  80 value 19.719476
## iter  90 value 18.645346
## iter 100 value 16.289253
```

```
## final  value 16.289253
## stopped after 100 iterations
## # weights:  179
## initial  value 100.450887
## iter  10 value 27.959970
## iter  20 value 9.859642
## iter  30 value 7.553618
## iter  40 value 7.406723
## iter  50 value 5.801167
## iter  60 value 5.518197
## iter  70 value 2.177248
## iter  80 value 2.063836
## iter  90 value 0.184993
## iter 100 value 0.151403
## final  value 0.151403
## stopped after 100 iterations
## # weights:  39
## initial  value 100.013615
## iter  10 value 72.787279
## iter  20 value 63.070146
## iter  30 value 59.665286
## iter  40 value 53.093199
## iter  50 value 48.811437
## iter  60 value 47.399302
## iter  70 value 47.354606
## iter  80 value 47.353988
## iter  90 value 47.353938
## iter 100 value 47.353815
## final  value 47.353815
## stopped after 100 iterations
## # weights:  109
## initial  value 102.732668
## iter  10 value 25.540886
## iter  20 value 17.464998
## iter  30 value 14.543454
## iter  40 value 12.149225
## iter  50 value 12.079522
## iter  60 value 12.017035
## iter  70 value 11.977124
## iter  80 value 11.957405
## iter  90 value 11.828919
## iter 100 value 7.848346
## final  value 7.848346
## stopped after 100 iterations
## # weights:  179
## initial  value 101.654034
## iter  10 value 24.646667
## iter  20 value 12.122785
## iter  30 value 7.874649
## iter  40 value 4.285113
## iter  50 value 2.226407
## iter  60 value 1.742910
## iter  70 value 1.450928
## iter  80 value 1.404949
```

```
## iter  90 value 1.393107
## iter 100 value 1.388056
## final  value 1.388056
## stopped after 100 iterations
## # weights:  39
## initial  value 107.346384
## iter  10 value 79.371858
## iter  20 value 67.848347
## iter  30 value 61.103750
## iter  40 value 58.935888
## iter  50 value 58.887047
## iter  60 value 58.807020
## iter  70 value 58.636979
## iter  80 value 58.630905
## final  value 58.630798
## converged
## # weights:  109
## initial  value 105.446120
## iter  10 value 52.118723
## iter  20 value 34.099337
## iter  30 value 25.456442
## iter  40 value 19.012629
## iter  50 value 16.690469
## iter  60 value 16.368163
## iter  70 value 16.290256
## iter  80 value 16.275549
## iter  90 value 16.275493
## iter  90 value 16.275492
## iter  90 value 16.275492
## final  value 16.275492
## converged
## # weights:  179
## initial  value 113.423118
## iter  10 value 39.074852
## iter  20 value 20.573736
## iter  30 value 15.891826
## iter  40 value 15.059643
## iter  50 value 14.109002
## iter  60 value 13.536565
## iter  70 value 13.480627
## iter  80 value 13.388071
## iter  90 value 13.367145
## iter 100 value 13.367023
## final  value 13.367023
## stopped after 100 iterations
## # weights:  39
## initial  value 99.011014
## iter  10 value 67.534745
## iter  20 value 54.632320
## iter  30 value 42.330114
## iter  40 value 38.200964
## iter  50 value 37.347592
## iter  60 value 37.089102
## iter  70 value 37.064313
```

```
## iter  80 value 37.050889
## iter  90 value 37.041796
## iter 100 value 37.034643
## final  value 37.034643
## stopped after 100 iterations
## # weights:  109
## initial  value 124.201139
## iter  10 value 63.366108
## iter  20 value 36.294349
## iter  30 value 29.860287
## iter  40 value 23.996252
## iter  50 value 21.145933
## iter  60 value 20.633198
## iter  70 value 18.287842
## iter  80 value 15.414426
## iter  90 value 14.510657
## iter 100 value 14.006058
## final  value 14.006058
## stopped after 100 iterations
## # weights:  179
## initial  value 110.248930
## iter  10 value 29.247711
## iter  20 value 6.927468
## iter  30 value 3.937428
## iter  40 value 0.771298
## iter  50 value 0.540617
## iter  60 value 0.495624
## iter  70 value 0.454813
## iter  80 value 0.429972
## iter  90 value 0.398909
## iter 100 value 0.347456
## final  value 0.347456
## stopped after 100 iterations
## # weights:  39
## initial  value 101.112182
## iter  10 value 69.163739
## iter  20 value 64.403387
## iter  30 value 63.118340
## iter  40 value 61.958518
## iter  50 value 59.887506
## iter  60 value 57.873803
## iter  70 value 56.737777
## iter  80 value 55.862088
## iter  90 value 55.199492
## iter 100 value 55.130159
## final  value 55.130159
## stopped after 100 iterations
## # weights:  109
## initial  value 114.873206
## iter  10 value 48.086287
## iter  20 value 25.003243
## iter  30 value 8.093000
## iter  40 value 7.262369
## iter  50 value 7.232718
```

```
## iter  60 value 7.192405
## iter  70 value 7.177739
## iter  80 value 7.170389
## iter  90 value 7.170080
## iter 100 value 7.168865
## final  value 7.168865
## stopped after 100 iterations
## # weights:  179
## initial  value 112.545934
## iter  10 value 25.580178
## iter  20 value 4.309494
## iter  30 value 0.679900
## iter  40 value 0.020290
## iter  50 value 0.001472
## final  value 0.000067
## converged
## # weights:  39
## initial  value 100.628925
## iter  10 value 84.191757
## iter  20 value 64.405217
## iter  30 value 60.069852
## iter  40 value 59.206315
## iter  50 value 58.696651
## iter  60 value 58.386407
## iter  70 value 58.077664
## iter  80 value 57.963999
## iter  90 value 57.746401
## iter 100 value 57.656410
## final  value 57.656410
## stopped after 100 iterations
## # weights:  109
## initial  value 102.712319
## iter  10 value 57.271088
## iter  20 value 32.577705
## iter  30 value 21.161682
## iter  40 value 19.056265
## iter  50 value 18.537374
## iter  60 value 17.898509
## iter  70 value 17.072957
## iter  80 value 16.342303
## iter  90 value 15.862463
## iter 100 value 15.845592
## final  value 15.845592
## stopped after 100 iterations
## # weights:  179
## initial  value 144.385534
## iter  10 value 65.453418
## iter  20 value 30.082407
## iter  30 value 19.865822
## iter  40 value 14.870588
## iter  50 value 13.052061
## iter  60 value 12.660293
## iter  70 value 12.633034
## iter  80 value 12.629903
```

```
## iter  90 value 12.629522
## iter 100 value 12.629374
## final  value 12.629374
## stopped after 100 iterations
## # weights:  39
## initial  value 119.248779
## iter  10 value 81.651733
## iter  20 value 64.698356
## iter  30 value 61.569624
## iter  40 value 60.096654
## iter  50 value 58.277669
## iter  60 value 57.227449
## iter  70 value 55.308972
## iter  80 value 54.032072
## iter  90 value 52.164846
## iter 100 value 51.954529
## final  value 51.954529
## stopped after 100 iterations
## # weights:  109
## initial  value 97.029798
## iter  10 value 29.309002
## iter  20 value 20.818587
## iter  30 value 15.780611
## iter  40 value 9.409803
## iter  50 value 7.279160
## iter  60 value 6.842011
## iter  70 value 3.296708
## iter  80 value 2.129853
## iter  90 value 1.710250
## iter 100 value 0.408592
## final  value 0.408592
## stopped after 100 iterations
## # weights:  179
## initial  value 112.177852
## iter  10 value 23.286637
## iter  20 value 8.737599
## iter  30 value 4.669394
## iter  40 value 4.021378
## iter  50 value 3.949291
## iter  60 value 0.281557
## iter  70 value 0.167801
## iter  80 value 0.154585
## iter  90 value 0.146027
## iter 100 value 0.139926
## final  value 0.139926
## stopped after 100 iterations
## # weights:  39
## initial  value 118.519049
## iter  10 value 61.501998
## iter  20 value 55.210430
## iter  30 value 52.539765
## iter  40 value 48.348728
## iter  50 value 46.697769
## iter  60 value 46.550681
```

```
## iter  70 value 46.435832
## iter  80 value 46.293176
## iter  90 value 46.292450
## iter 100 value 46.227850
## final  value 46.227850
## stopped after 100 iterations
## # weights:  109
## initial  value 108.280884
## iter  10 value 60.686264
## iter  20 value 25.029261
## iter  30 value 14.629653
## iter  40 value 10.722690
## iter  50 value 6.349507
## iter  60 value 5.936056
## iter  70 value 5.929903
## final  value 5.929868
## converged
## # weights:  179
## initial  value 108.176733
## iter  10 value 27.574741
## iter  20 value 14.631122
## iter  30 value 8.158751
## iter  40 value 6.909229
## iter  50 value 6.300621
## iter  60 value 5.723525
## iter  70 value 5.421021
## iter  80 value 5.369928
## iter  90 value 5.331157
## iter 100 value 2.061337
## final  value 2.061337
## stopped after 100 iterations
## # weights:  39
## initial  value 115.232971
## iter  10 value 69.758693
## iter  20 value 64.761897
## iter  30 value 61.181257
## iter  40 value 59.399406
## iter  50 value 58.995393
## iter  60 value 57.818405
## iter  70 value 57.360523
## iter  80 value 57.345151
## final  value 57.345145
## converged
## # weights:  109
## initial  value 108.911437
## iter  10 value 61.028015
## iter  20 value 35.752664
## iter  30 value 21.891819
## iter  40 value 18.258882
## iter  50 value 16.936475
## iter  60 value 16.436822
## iter  70 value 16.271295
## iter  80 value 16.261078
## iter  90 value 16.251588
```

```
## iter 100 value 16.251409
## final  value 16.251409
## stopped after 100 iterations
## # weights:  179
## initial  value 119.041526
## iter  10 value 49.206682
## iter  20 value 22.421851
## iter  30 value 13.948967
## iter  40 value 12.814434
## iter  50 value 12.341171
## iter  60 value 12.268220
## iter  70 value 12.229556
## iter  80 value 12.197191
## iter  90 value 12.174379
## iter 100 value 12.157878
## final  value 12.157878
## stopped after 100 iterations
## # weights:  39
## initial  value 97.215681
## iter  10 value 70.697269
## iter  20 value 64.682495
## iter  30 value 64.362166
## iter  40 value 64.350124
## iter  50 value 64.313232
## iter  60 value 64.065389
## iter  70 value 64.009461
## iter  80 value 63.876952
## iter  90 value 61.527064
## iter 100 value 60.714226
## final  value 60.714226
## stopped after 100 iterations
## # weights:  109
## initial  value 106.258342
## iter  10 value 39.982607
## iter  20 value 13.739876
## iter  30 value 9.679355
## iter  40 value 9.108804
## iter  50 value 8.798725
## iter  60 value 8.674726
## iter  70 value 8.638131
## iter  80 value 8.121258
## iter  90 value 8.043704
## iter 100 value 8.016082
## final  value 8.016082
## stopped after 100 iterations
## # weights:  179
## initial  value 119.048084
## iter  10 value 27.697311
## iter  20 value 9.322368
## iter  30 value 3.989614
## iter  40 value 2.970221
## iter  50 value 2.897294
## iter  60 value 2.888727
## iter  70 value 2.880495
```

```
## iter  80 value 2.870163
## iter  90 value 2.860033
## iter 100 value 2.853257
## final  value 2.853257
## stopped after 100 iterations
## # weights:  39
## initial  value 111.149016
## iter  10 value 59.249574
## iter  20 value 56.799885
## iter  30 value 55.768447
## iter  40 value 53.866826
## iter  50 value 53.638322
## iter  60 value 52.619169
## iter  70 value 52.563062
## iter  80 value 51.690572
## iter  90 value 50.205577
## iter 100 value 50.113594
## final  value 50.113594
## stopped after 100 iterations
## # weights:  109
## initial  value 120.478818
## iter  10 value 67.833659
## iter  20 value 41.302787
## iter  30 value 21.157903
## iter  40 value 16.454311
## iter  50 value 12.549225
## iter  60 value 12.479356
## iter  70 value 12.460694
## iter  80 value 10.364233
## iter  90 value 10.364117
## final  value 10.363928
## converged
## # weights:  179
## initial  value 114.454145
## iter  10 value 16.939293
## iter  20 value 4.300866
## iter  30 value 3.082681
## iter  40 value 2.905748
## iter  50 value 2.885898
## iter  60 value 2.877612
## iter  70 value 2.875402
## iter  80 value 2.706516
## iter  90 value 2.051878
## iter 100 value 1.903445
## final  value 1.903445
## stopped after 100 iterations
## # weights:  39
## initial  value 100.387194
## iter  10 value 70.217411
## iter  20 value 60.755226
## iter  30 value 58.459146
## iter  40 value 58.395455
## iter  50 value 58.393270
## iter  60 value 58.392859
```

```
## iter  70 value 58.384166
## iter  80 value 58.139540
## iter  90 value 57.940436
## iter 100 value 57.734953
## final  value 57.734953
## stopped after 100 iterations
## # weights:  109
## initial  value 100.236716
## iter  10 value 57.664173
## iter  20 value 40.208650
## iter  30 value 34.571060
## iter  40 value 31.554027
## iter  50 value 30.273822
## iter  60 value 23.253135
## iter  70 value 18.033571
## iter  80 value 16.815295
## iter  90 value 16.413356
## iter 100 value 16.372940
## final  value 16.372940
## stopped after 100 iterations
## # weights:  179
## initial  value 105.599145
## iter  10 value 35.419437
## iter  20 value 21.509726
## iter  30 value 13.699850
## iter  40 value 12.722746
## iter  50 value 12.410336
## iter  60 value 12.237326
## iter  70 value 12.208050
## iter  80 value 12.205368
## iter  90 value 12.205307
## final  value 12.205307
## converged
## # weights:  39
## initial  value 104.021162
## iter  10 value 67.735671
## iter  20 value 54.975114
## iter  30 value 51.190925
## iter  40 value 49.416031
## iter  50 value 46.811495
## iter  60 value 46.023158
## iter  70 value 46.014531
## iter  80 value 46.012534
## iter  90 value 46.011122
## iter 100 value 46.009466
## final  value 46.009466
## stopped after 100 iterations
## # weights:  109
## initial  value 103.029809
## iter  10 value 37.001603
## iter  20 value 26.585757
## iter  30 value 25.544211
## iter  40 value 22.505798
## iter  50 value 21.856027
```

```
## iter  60 value 21.575999
## iter  70 value 20.677717
## iter  80 value 19.759467
## iter  90 value 19.398965
## iter 100 value 19.169482
## final  value 19.169482
## stopped after 100 iterations
## # weights:  179
## initial  value 121.796246
## iter  10 value 16.741709
## iter  20 value 7.182538
## iter  30 value 6.069735
## iter  40 value 5.904265
## iter  50 value 3.445190
## iter  60 value 3.197906
## iter  70 value 3.174851
## iter  80 value 3.168265
## iter  90 value 3.159825
## iter 100 value 2.033817
## final  value 2.033817
## stopped after 100 iterations
## # weights:  39
## initial  value 99.835018
## iter  10 value 64.139714
## iter  20 value 59.136419
## iter  30 value 58.351445
## iter  40 value 56.894510
## iter  50 value 56.145388
## iter  60 value 55.849724
## iter  70 value 55.343415
## iter  80 value 54.062536
## iter  90 value 48.673703
## iter 100 value 46.916919
## final  value 46.916919
## stopped after 100 iterations
## # weights:  109
## initial  value 103.989234
## iter  10 value 25.531325
## iter  20 value 14.618317
## iter  30 value 11.585792
## iter  40 value 10.808705
## iter  50 value 10.686602
## iter  60 value 10.681725
## iter  70 value 10.681480
## iter  80 value 10.681342
## final  value 10.681337
## converged
## # weights:  179
## initial  value 103.651941
## iter  10 value 20.573670
## iter  20 value 7.258001
## iter  30 value 6.427372
## iter  40 value 5.321906
## iter  50 value 5.038971
```

```
## iter  60 value 3.341356
## iter  70 value 1.419256
## iter  80 value 1.398305
## iter  90 value 1.389625
## iter 100 value 1.387501
## final  value 1.387501
## stopped after 100 iterations
## # weights:  39
## initial  value 118.101022
## iter  10 value 74.528816
## iter  20 value 66.073868
## iter  30 value 63.539119
## iter  40 value 62.167036
## iter  50 value 59.977259
## iter  60 value 58.359113
## iter  70 value 57.095552
## iter  80 value 57.085091
## final  value 57.085072
## converged
## # weights:  109
## initial  value 128.313116
## iter  10 value 45.443998
## iter  20 value 30.975705
## iter  30 value 22.556465
## iter  40 value 19.120438
## iter  50 value 16.689159
## iter  60 value 16.033363
## iter  70 value 15.971582
## iter  80 value 15.970670
## final  value 15.970669
## converged
## # weights:  179
## initial  value 125.929231
## iter  10 value 35.058444
## iter  20 value 22.100637
## iter  30 value 15.814520
## iter  40 value 13.818183
## iter  50 value 12.628284
## iter  60 value 12.358238
## iter  70 value 12.307827
## iter  80 value 12.306101
## final  value 12.306096
## converged
## # weights:  39
## initial  value 99.326396
## iter  10 value 82.216544
## iter  20 value 64.939521
## iter  30 value 63.908722
## iter  40 value 62.587678
## iter  50 value 60.093618
## iter  60 value 59.953121
## iter  70 value 58.524183
## iter  80 value 57.793594
## iter  90 value 57.700791
```

```
## iter 100 value 57.542937
## final  value 57.542937
## stopped after 100 iterations
## # weights:  109
## initial  value 105.851003
## iter  10 value 48.300781
## iter  20 value 29.207361
## iter  30 value 23.583296
## iter  40 value 16.083089
## iter  50 value 10.835569
## iter  60 value 7.312926
## iter  70 value 6.845018
## iter  80 value 3.670466
## iter  90 value 0.329788
## iter 100 value 0.255631
## final  value 0.255631
## stopped after 100 iterations
## # weights:  179
## initial  value 111.053173
## iter  10 value 28.161055
## iter  20 value 15.727787
## iter  30 value 12.524916
## iter  40 value 8.331890
## iter  50 value 5.706022
## iter  60 value 2.626522
## iter  70 value 0.709088
## iter  80 value 0.201203
## iter  90 value 0.176543
## iter 100 value 0.161353
## final  value 0.161353
## stopped after 100 iterations
## # weights:  39
## initial  value 97.771886
## iter  10 value 71.802876
## iter  20 value 48.792172
## iter  30 value 42.675303
## iter  40 value 41.464500
## iter  50 value 41.022904
## iter  60 value 40.919862
## iter  70 value 36.891380
## iter  80 value 36.585855
## iter  90 value 36.344996
## iter 100 value 36.162141
## final  value 36.162141
## stopped after 100 iterations
## # weights:  109
## initial  value 96.353102
## iter  10 value 41.644640
## iter  20 value 22.653758
## iter  30 value 20.355682
## iter  40 value 19.091654
## iter  50 value 14.810236
## iter  60 value 12.822762
## iter  70 value 12.321664
```

```
## iter  80 value 12.189900
## iter  90 value 12.129413
## iter 100 value 9.589919
## final  value 9.589919
## stopped after 100 iterations
## # weights:  179
## initial  value 130.062787
## iter  10 value 24.911806
## iter  20 value 0.176277
## iter  30 value 0.002512
## iter  40 value 0.000823
## iter  50 value 0.000186
## final  value 0.000099
## converged
## # weights:  39
## initial  value 111.723343
## iter  10 value 89.499088
## iter  20 value 70.174704
## iter  30 value 59.073672
## iter  40 value 57.701416
## iter  50 value 56.914247
## iter  60 value 56.825340
## iter  70 value 56.822534
## iter  80 value 56.555027
## iter  90 value 56.527851
## final  value 56.527762
## converged
## # weights:  109
## initial  value 123.109595
## iter  10 value 67.009656
## iter  20 value 46.738516
## iter  30 value 30.910552
## iter  40 value 22.322239
## iter  50 value 17.473176
## iter  60 value 16.721120
## iter  70 value 16.681969
## iter  80 value 16.679929
## final  value 16.679916
## converged
## # weights:  179
## initial  value 105.469595
## iter  10 value 50.454871
## iter  20 value 26.553241
## iter  30 value 15.000018
## iter  40 value 12.786934
## iter  50 value 12.580253
## iter  60 value 12.548610
## iter  70 value 12.519697
## iter  80 value 12.498324
## iter  90 value 12.494423
## iter 100 value 12.493171
## final  value 12.493171
## stopped after 100 iterations
## # weights:  39
```

```
## initial  value 102.425049
## iter  10 value 80.706777
## iter  20 value 75.749902
## iter  30 value 75.720012
## iter  40 value 75.717355
## iter  50 value 75.706752
## iter  60 value 73.783920
## iter  70 value 73.745947
## iter  80 value 70.673941
## iter  90 value 68.181006
## iter 100 value 67.532559
## final  value 67.532559
## stopped after 100 iterations
## # weights:  109
## initial  value 105.762316
## iter  10 value 17.454759
## iter  20 value 13.722771
## iter  30 value 13.084458
## iter  40 value 8.736795
## iter  50 value 8.163552
## iter  60 value 8.144101
## iter  70 value 8.120489
## iter  80 value 8.105753
## iter  90 value 8.093288
## iter 100 value 8.082557
## final  value 8.082557
## stopped after 100 iterations
## # weights:  179
## initial  value 105.951267
## iter  10 value 20.900748
## iter  20 value 4.647714
## iter  30 value 3.801717
## iter  40 value 2.498879
## iter  50 value 2.473813
## iter  60 value 2.129036
## iter  70 value 2.074289
## iter  80 value 1.601208
## iter  90 value 1.586765
## iter 100 value 1.565705
## final  value 1.565705
## stopped after 100 iterations
## # weights:  39
## initial  value 102.364770
## iter  10 value 66.870295
## iter  20 value 57.882774
## iter  30 value 53.996184
## iter  40 value 53.496150
## iter  50 value 53.003373
## iter  60 value 52.249269
## iter  70 value 52.041397
## iter  80 value 51.505918
## iter  90 value 50.585210
## iter 100 value 50.381898
## final  value 50.381898
```

```
## stopped after 100 iterations
## # weights:  109
## initial  value 103.884128
## iter  10 value 52.189002
## iter  20 value 29.958777
## iter  30 value 29.284701
## iter  40 value 28.206434
## iter  50 value 28.154988
## iter  60 value 28.099348
## iter  70 value 26.716358
## iter  80 value 26.563167
## iter  90 value 25.397694
## iter 100 value 24.784647
## final  value 24.784647
## stopped after 100 iterations
## # weights:  179
## initial  value 115.288821
## iter  10 value 31.923634
## iter  20 value 4.685420
## iter  30 value 3.262050
## iter  40 value 2.869201
## iter  50 value 2.593985
## iter  60 value 1.388662
## iter  70 value 1.386920
## iter  80 value 1.384117
## iter  90 value 0.005584
## iter 100 value 0.001629
## final  value 0.001629
## stopped after 100 iterations
## # weights:  39
## initial  value 104.469913
## iter  10 value 66.610632
## iter  20 value 61.101961
## iter  30 value 60.470194
## iter  40 value 60.456492
## iter  50 value 60.455696
## final  value 60.455694
## converged
## # weights:  109
## initial  value 139.026525
## iter  10 value 71.763978
## iter  20 value 58.340810
## iter  30 value 42.122214
## iter  40 value 31.121239
## iter  50 value 21.540366
## iter  60 value 18.029692
## iter  70 value 17.033527
## iter  80 value 16.776304
## iter  90 value 16.747919
## iter 100 value 16.730891
## final  value 16.730891
## stopped after 100 iterations
## # weights:  179
## initial  value 108.681361
```

```
## iter  10 value 49.770746
## iter  20 value 25.196775
## iter  30 value 15.789021
## iter  40 value 13.325940
## iter  50 value 12.731487
## iter  60 value 12.389203
## iter  70 value 12.237870
## iter  80 value 12.230403
## iter  90 value 12.229750
## iter 100 value 12.229739
## final  value 12.229739
## stopped after 100 iterations
## # weights:  39
## initial  value 103.781789
## iter  10 value 69.854091
## iter  20 value 64.478612
## iter  30 value 64.455133
## iter  40 value 64.447088
## iter  50 value 64.246679
## iter  60 value 63.881565
## iter  70 value 60.092897
## iter  80 value 58.720131
## iter  90 value 58.498487
## iter 100 value 58.404287
## final  value 58.404287
## stopped after 100 iterations
## # weights:  109
## initial  value 110.858254
## iter  10 value 29.001877
## iter  20 value 16.789302
## iter  30 value 7.506211
## iter  40 value 6.219350
## iter  50 value 6.161001
## iter  60 value 4.058854
## iter  70 value 3.465726
## iter  80 value 3.435017
## iter  90 value 3.427261
## iter 100 value 3.378623
## final  value 3.378623
## stopped after 100 iterations
## # weights:  179
## initial  value 110.282140
## iter  10 value 28.800328
## iter  20 value 6.689439
## iter  30 value 4.789840
## iter  40 value 4.408558
## iter  50 value 4.382627
## iter  60 value 4.362895
## iter  70 value 4.331593
## iter  80 value 4.256715
## iter  90 value 4.217943
## iter 100 value 4.196763
## final  value 4.196763
## stopped after 100 iterations
```

```
## # weights:  39
## initial  value 104.199667
## iter  10 value 97.135992
## iter  20 value 56.562187
## iter  30 value 53.550246
## iter  40 value 52.804511
## iter  50 value 52.711283
## iter  60 value 51.891958
## final  value 51.890736
## converged
## # weights:  109
## initial  value 105.783987
## iter  10 value 36.051260
## iter  20 value 22.872095
## iter  30 value 20.441291
## iter  40 value 18.904560
## iter  50 value 16.815147
## iter  60 value 14.170339
## iter  70 value 13.722262
## iter  80 value 13.485008
## iter  90 value 12.752384
## iter 100 value 12.445195
## final  value 12.445195
## stopped after 100 iterations
## # weights:  179
## initial  value 96.573742
## iter  10 value 12.426671
## iter  20 value 2.603671
## iter  30 value 1.917845
## iter  40 value 1.910446
## iter  50 value 1.909701
## iter  60 value 1.909643
## iter  70 value 1.909593
## iter  80 value 1.909558
## final  value 1.909547
## converged
## # weights:  39
## initial  value 101.891132
## iter  10 value 69.822588
## iter  20 value 61.578350
## iter  30 value 60.159555
## iter  40 value 60.018445
## iter  50 value 59.867250
## iter  60 value 59.428107
## iter  70 value 58.797566
## iter  80 value 58.706134
## final  value 58.706132
## converged
## # weights:  109
## initial  value 110.075670
## iter  10 value 34.387351
## iter  20 value 24.792969
## iter  30 value 17.717945
## iter  40 value 16.213801
```

```
## iter  50 value 16.092456
## iter  60 value 16.084662
## iter  70 value 16.047551
## iter  80 value 16.037774
## iter  90 value 16.037331
## final  value 16.037330
## converged
## # weights:  179
## initial  value 115.708334
## iter  10 value 42.720787
## iter  20 value 20.745700
## iter  30 value 14.462041
## iter  40 value 12.080624
## iter  50 value 11.655244
## iter  60 value 11.635620
## iter  70 value 11.635378
## final  value 11.635378
## converged
## # weights:  39
## initial  value 106.069473
## iter  10 value 60.522302
## iter  20 value 54.527704
## iter  30 value 52.284471
## iter  40 value 52.245304
## iter  50 value 52.220860
## iter  60 value 52.217541
## iter  70 value 52.211214
## iter  80 value 52.199208
## iter  90 value 52.196297
## iter 100 value 51.913042
## final  value 51.913042
## stopped after 100 iterations
## # weights:  109
## initial  value 100.772932
## iter  10 value 29.274090
## iter  20 value 14.998718
## iter  30 value 9.514034
## iter  40 value 5.471462
## iter  50 value 3.668145
## iter  60 value 1.707526
## iter  70 value 1.358848
## iter  80 value 1.097257
## iter  90 value 0.500683
## iter 100 value 0.317909
## final  value 0.317909
## stopped after 100 iterations
## # weights:  179
## initial  value 131.203469
## iter  10 value 5.399975
## iter  20 value 1.865071
## iter  30 value 1.654823
## iter  40 value 1.633759
## iter  50 value 1.616382
## iter  60 value 0.897033
```

```
## iter  70 value 0.375729
## iter  80 value 0.288597
## iter  90 value 0.269607
## iter 100 value 0.244287
## final  value 0.244287
## stopped after 100 iterations
## # weights:  39
## initial  value 106.725442
## iter  10 value 67.053000
## iter  20 value 56.918741
## iter  30 value 46.879204
## iter  40 value 44.334662
## iter  50 value 42.518050
## iter  60 value 40.093905
## iter  70 value 38.287855
## iter  80 value 38.150847
## iter  90 value 38.133194
## iter 100 value 36.249628
## final  value 36.249628
## stopped after 100 iterations
## # weights:  109
## initial  value 99.236726
## iter  10 value 44.895310
## iter  20 value 21.492675
## iter  30 value 17.203205
## iter  40 value 13.691410
## iter  50 value 13.238657
## iter  60 value 13.165587
## iter  70 value 13.120692
## iter  80 value 13.095084
## iter  90 value 13.040587
## iter 100 value 12.719417
## final  value 12.719417
## stopped after 100 iterations
## # weights:  179
## initial  value 111.511383
## iter  10 value 18.072316
## iter  20 value 5.464337
## iter  30 value 3.728225
## iter  40 value 2.450666
## iter  50 value 2.253851
## iter  60 value 0.037557
## iter  70 value 0.012284
## iter  80 value 0.006360
## iter  90 value 0.004647
## iter 100 value 0.001742
## final  value 0.001742
## stopped after 100 iterations
## # weights:  39
## initial  value 100.861818
## iter  10 value 84.419478
## iter  20 value 67.939160
## iter  30 value 60.947374
## iter  40 value 57.497592
```

```
## iter  50 value 57.031336
## iter  60 value 56.438293
## iter  70 value 56.277625
## iter  80 value 55.725951
## iter  90 value 55.380211
## iter 100 value 54.795571
## final  value 54.795571
## stopped after 100 iterations
## # weights:  109
## initial  value 104.752870
## iter  10 value 44.024183
## iter  20 value 20.712667
## iter  30 value 19.062730
## iter  40 value 18.680577
## iter  50 value 18.546841
## iter  60 value 17.398069
## iter  70 value 15.545792
## iter  80 value 15.291764
## iter  90 value 15.287046
## final  value 15.287042
## converged
## # weights:  179
## initial  value 102.107527
## iter  10 value 41.754701
## iter  20 value 21.796409
## iter  30 value 14.222965
## iter  40 value 12.493327
## iter  50 value 11.733633
## iter  60 value 11.502781
## iter  70 value 11.442943
## iter  80 value 11.436353
## iter  90 value 11.435682
## iter 100 value 11.435662
## final  value 11.435662
## stopped after 100 iterations
## # weights:  39
## initial  value 108.891915
## iter  10 value 63.108813
## iter  20 value 55.576404
## iter  30 value 50.921987
## iter  40 value 50.207962
## iter  50 value 47.339085
## iter  60 value 44.101764
## iter  70 value 43.799553
## iter  80 value 43.781128
## iter  90 value 42.887774
## iter 100 value 39.391811
## final  value 39.391811
## stopped after 100 iterations
## # weights:  109
## initial  value 110.952063
## iter  10 value 37.488567
## iter  20 value 30.185653
## iter  30 value 29.821775
```

```
## iter  40 value 29.396215
## iter  50 value 27.824730
## iter  60 value 26.626490
## iter  70 value 22.601767
## iter  80 value 15.114563
## iter  90 value 12.849792
## iter 100 value 11.744827
## final  value 11.744827
## stopped after 100 iterations
## # weights:  179
## initial  value 99.249948
## iter  10 value 32.736158
## iter  20 value 3.701963
## iter  30 value 2.149204
## iter  40 value 2.120049
## iter  50 value 2.102357
## iter  60 value 2.084592
## iter  70 value 2.069249
## iter  80 value 2.057716
## iter  90 value 2.036711
## iter 100 value 1.525674
## final  value 1.525674
## stopped after 100 iterations
## # weights:  39
## initial  value 103.216005
## iter  10 value 74.740566
## iter  20 value 60.956468
## iter  30 value 57.996336
## iter  40 value 56.196639
## iter  50 value 55.792579
## iter  60 value 55.737553
## iter  70 value 55.725442
## iter  80 value 55.723004
## iter  90 value 55.722208
## iter 100 value 55.722007
## final  value 55.722007
## stopped after 100 iterations
## # weights:  109
## initial  value 99.992490
## iter  10 value 29.219300
## iter  20 value 18.717110
## iter  30 value 13.955319
## iter  40 value 9.876809
## iter  50 value 3.625289
## iter  60 value 2.583629
## iter  70 value 2.287593
## iter  80 value 2.020923
## iter  90 value 1.968255
## iter 100 value 1.942548
## final  value 1.942548
## stopped after 100 iterations
## # weights:  179
## initial  value 110.017516
## iter  10 value 21.954782
```

```
## iter  20 value 4.025205
## iter  30 value 0.244185
## iter  40 value 0.026057
## iter  50 value 0.012078
## iter  60 value 0.004545
## iter  70 value 0.001621
## iter  80 value 0.000755
## iter  90 value 0.000383
## iter 100 value 0.000196
## final  value 0.000196
## stopped after 100 iterations
## # weights:  39
## initial  value 107.890868
## iter  10 value 78.820789
## iter  20 value 72.753054
## iter  30 value 67.916754
## iter  40 value 61.769060
## iter  50 value 59.796060
## iter  60 value 58.088283
## iter  70 value 58.019691
## final  value 58.019672
## converged
## # weights:  109
## initial  value 111.946860
## iter  10 value 48.955522
## iter  20 value 26.266252
## iter  30 value 18.749171
## iter  40 value 17.163630
## iter  50 value 16.666293
## iter  60 value 16.574378
## iter  70 value 16.568674
## final  value 16.568664
## converged
## # weights:  179
## initial  value 120.143642
## iter  10 value 33.821112
## iter  20 value 21.411552
## iter  30 value 14.814050
## iter  40 value 13.566355
## iter  50 value 12.211218
## iter  60 value 11.840829
## iter  70 value 11.834729
## iter  80 value 11.834604
## final  value 11.834603
## converged
## # weights:  39
## initial  value 99.321827
## iter  10 value 64.839847
## iter  20 value 55.493800
## iter  30 value 47.528062
## iter  40 value 43.593625
## iter  50 value 41.135095
## iter  60 value 40.483243
## iter  70 value 39.581304
```

```
## iter  80 value 37.838061
## iter  90 value 37.656369
## iter 100 value 37.570374
## final  value 37.570374
## stopped after 100 iterations
## # weights:  109
## initial  value 98.614268
## iter  10 value 35.386405
## iter  20 value 27.307056
## iter  30 value 10.182678
## iter  40 value 6.478055
## iter  50 value 5.518186
## iter  60 value 5.451787
## iter  70 value 5.337542
## iter  80 value 5.246091
## iter  90 value 5.140308
## iter 100 value 5.127438
## final  value 5.127438
## stopped after 100 iterations
## # weights:  179
## initial  value 104.556780
## iter  10 value 28.861421
## iter  20 value 16.359042
## iter  30 value 12.171576
## iter  40 value 9.095570
## iter  50 value 7.948036
## iter  60 value 6.018241
## iter  70 value 4.617890
## iter  80 value 3.994089
## iter  90 value 3.685409
## iter 100 value 2.244748
## final  value 2.244748
## stopped after 100 iterations
## # weights:  39
## initial  value 108.809362
## iter  10 value 82.282259
## iter  20 value 79.054473
## iter  30 value 76.648013
## iter  40 value 73.668901
## iter  50 value 68.440640
## iter  60 value 64.459789
## iter  70 value 62.144726
## iter  80 value 61.681476
## iter  90 value 59.713979
## iter 100 value 57.597446
## final  value 57.597446
## stopped after 100 iterations
## # weights:  109
## initial  value 105.132695
## iter  10 value 28.650164
## iter  20 value 13.742007
## iter  30 value 10.921882
## iter  40 value 10.882696
## iter  50 value 10.882002
```

```
## iter  60 value 10.881369
## iter  70 value 10.229645
## iter  80 value 10.227415
## final  value 10.227413
## converged
## # weights:  179
## initial  value 109.845005
## iter  10 value 60.807257
## iter  20 value 26.762643
## iter  30 value 16.621174
## iter  40 value 13.121425
## iter  50 value 6.581694
## iter  60 value 6.020114
## iter  70 value 5.716047
## iter  80 value 5.370451
## iter  90 value 5.183341
## iter 100 value 5.062079
## final  value 5.062079
## stopped after 100 iterations
## # weights:  39
## initial  value 105.537692
## iter  10 value 69.110092
## iter  20 value 62.716633
## iter  30 value 60.195828
## iter  40 value 59.201423
## iter  50 value 58.486384
## iter  60 value 58.282276
## iter  70 value 57.819131
## final  value 57.808905
## converged
## # weights:  109
## initial  value 105.149562
## iter  10 value 51.660696
## iter  20 value 34.190558
## iter  30 value 24.122861
## iter  40 value 18.121648
## iter  50 value 17.216555
## iter  60 value 17.125182
## iter  70 value 16.624064
## iter  80 value 16.427706
## iter  90 value 16.333064
## iter 100 value 16.318269
## final  value 16.318269
## stopped after 100 iterations
## # weights:  179
## initial  value 121.698118
## iter  10 value 57.422570
## iter  20 value 26.810319
## iter  30 value 16.653453
## iter  40 value 14.301596
## iter  50 value 13.403715
## iter  60 value 12.803918
## iter  70 value 12.610607
## iter  80 value 12.594299
```

```
## iter  90 value 12.589890
## iter 100 value 12.588611
## final  value 12.588611
## stopped after 100 iterations
## # weights:  39
## initial  value 106.626626
## iter  10 value 74.087800
## iter  20 value 62.536005
## iter  30 value 55.653646
## iter  40 value 51.206462
## iter  50 value 47.699505
## iter  60 value 47.402029
## iter  70 value 47.358950
## iter  80 value 47.354316
## iter  90 value 47.353375
## iter 100 value 47.352791
## final  value 47.352791
## stopped after 100 iterations
## # weights:  109
## initial  value 97.909507
## iter  10 value 32.940182
## iter  20 value 16.448580
## iter  30 value 11.752310
## iter  40 value 10.351766
## iter  50 value 9.826335
## iter  60 value 8.395386
## iter  70 value 8.121411
## iter  80 value 7.872950
## iter  90 value 7.622426
## iter 100 value 7.601647
## final  value 7.601647
## stopped after 100 iterations
## # weights:  179
## initial  value 110.939234
## iter  10 value 18.896341
## iter  20 value 6.357458
## iter  30 value 5.017966
## iter  40 value 3.604925
## iter  50 value 3.498478
## iter  60 value 3.478419
## iter  70 value 2.912485
## iter  80 value 2.137087
## iter  90 value 2.104090
## iter 100 value 2.090416
## final  value 2.090416
## stopped after 100 iterations
## # weights:  39
## initial  value 107.431463
## iter  10 value 94.081265
## iter  20 value 74.152160
## iter  30 value 73.072557
## iter  40 value 70.888174
## iter  50 value 68.016665
## iter  60 value 66.639831
```

```
## iter  70 value 63.516880
## iter  80 value 63.171766
## iter  90 value 61.495808
## iter 100 value 59.995399
## final  value 59.995399
## stopped after 100 iterations
## # weights:  109
## initial  value 119.777607
## iter  10 value 38.426096
## iter  20 value 13.419502
## iter  30 value 12.927932
## iter  40 value 12.715735
## iter  50 value 10.333617
## iter  60 value 10.017043
## iter  70 value 7.726759
## iter  80 value 6.774761
## iter  90 value 6.772998
## iter 100 value 6.771732
## final  value 6.771732
## stopped after 100 iterations
## # weights:  179
## initial  value 103.608488
## iter  10 value 13.368798
## iter  20 value 0.634417
## iter  30 value 0.012090
## final  value 0.000063
## converged
## # weights:  39
## initial  value 99.676914
## iter  10 value 66.641104
## iter  20 value 61.282028
## iter  30 value 59.915630
## iter  40 value 59.679407
## iter  50 value 58.891108
## iter  60 value 58.070548
## iter  70 value 57.102715
## iter  80 value 56.908231
## iter  90 value 56.904636
## final  value 56.904624
## converged
## # weights:  109
## initial  value 111.619633
## iter  10 value 64.198248
## iter  20 value 40.050037
## iter  30 value 27.964938
## iter  40 value 18.581947
## iter  50 value 16.362594
## iter  60 value 15.816053
## iter  70 value 15.632172
## iter  80 value 15.613596
## iter  90 value 15.612880
## iter 100 value 15.612768
## final  value 15.612768
## stopped after 100 iterations
```

```
## # weights:  179
## initial  value 119.434561
## iter  10 value 33.830236
## iter  20 value 16.722051
## iter  30 value 13.713529
## iter  40 value 13.425083
## iter  50 value 13.070572
## iter  60 value 12.398017
## iter  70 value 12.326190
## iter  80 value 12.324373
## final  value 12.324340
## converged
## # weights:  39
## initial  value 111.185498
## iter  10 value 67.513777
## iter  20 value 59.708386
## iter  30 value 56.224334
## iter  40 value 55.837657
## iter  50 value 55.779602
## iter  60 value 55.668235
## iter  70 value 55.571100
## iter  80 value 55.510241
## iter  90 value 54.473456
## iter 100 value 54.270318
## final  value 54.270318
## stopped after 100 iterations
## # weights:  109
## initial  value 95.403886
## iter  10 value 25.218678
## iter  20 value 9.718044
## iter  30 value 9.239404
## iter  40 value 9.204647
## iter  50 value 9.115589
## iter  60 value 9.005080
## iter  70 value 8.971842
## iter  80 value 8.826012
## iter  90 value 8.819669
## iter 100 value 8.651898
## final  value 8.651898
## stopped after 100 iterations
## # weights:  179
## initial  value 124.887593
## iter  10 value 34.242865
## iter  20 value 12.542742
## iter  30 value 11.147125
## iter  40 value 10.449822
## iter  50 value 5.400074
## iter  60 value 2.663995
## iter  70 value 2.576466
## iter  80 value 2.536311
## iter  90 value 2.496369
## iter 100 value 1.724131
## final  value 1.724131
## stopped after 100 iterations
```

```
## # weights:  39
## initial  value 108.058228
## iter  10 value 66.576457
## iter  20 value 59.831923
## iter  30 value 55.867867
## iter  40 value 55.145270
## iter  50 value 54.504772
## iter  60 value 53.764548
## iter  70 value 53.190536
## iter  80 value 52.611701
## iter  90 value 51.919836
## iter 100 value 51.599137
## final  value 51.599137
## stopped after 100 iterations
## # weights:  109
## initial  value 108.108231
## iter  10 value 34.286724
## iter  20 value 21.783733
## iter  30 value 16.753120
## iter  40 value 12.993237
## iter  50 value 10.432529
## iter  60 value 10.348284
## iter  70 value 10.342349
## iter  80 value 10.341741
## iter  90 value 10.341601
## iter 100 value 10.341580
## final  value 10.341580
## stopped after 100 iterations
## # weights:  179
## initial  value 109.183174
## iter  10 value 26.022158
## iter  20 value 6.976148
## iter  30 value 6.169617
## iter  40 value 6.159280
## iter  50 value 5.085312
## iter  60 value 2.777677
## iter  70 value 2.774322
## iter  80 value 2.773398
## iter  90 value 2.770616
## iter 100 value 1.910968
## final  value 1.910968
## stopped after 100 iterations
## # weights:  39
## initial  value 104.882029
## iter  10 value 79.226375
## iter  20 value 66.130154
## iter  30 value 62.480330
## iter  40 value 60.452157
## iter  50 value 59.870426
## iter  60 value 59.529400
## iter  70 value 59.512856
## iter  80 value 59.372217
## iter  90 value 59.074648
## iter 100 value 59.011622
```

```
## final  value 59.011622
## stopped after 100 iterations
## # weights:  109
## initial  value 108.260308
## iter  10 value 71.546898
## iter  20 value 46.979786
## iter  30 value 25.038661
## iter  40 value 18.233025
## iter  50 value 17.165942
## iter  60 value 17.103759
## iter  70 value 17.097545
## iter  80 value 17.097418
## final  value 17.097416
## converged
## # weights:  179
## initial  value 108.514646
## iter  10 value 40.516515
## iter  20 value 17.317074
## iter  30 value 13.212413
## iter  40 value 12.735248
## iter  50 value 12.601368
## iter  60 value 12.534321
## iter  70 value 12.439698
## iter  80 value 12.402127
## iter  90 value 12.401633
## final  value 12.401632
## converged
## # weights:  39
## initial  value 107.236716
## iter  10 value 61.606762
## iter  20 value 54.433158
## iter  30 value 51.623683
## iter  40 value 51.602323
## iter  50 value 51.592410
## iter  60 value 51.582496
## iter  70 value 51.579357
## iter  80 value 51.568045
## iter  90 value 51.566858
## iter 100 value 51.561059
## final  value 51.561059
## stopped after 100 iterations
## # weights:  109
## initial  value 110.666515
## iter  10 value 55.952169
## iter  20 value 20.488263
## iter  30 value 7.286823
## iter  40 value 4.323604
## iter  50 value 4.307191
## iter  60 value 4.289647
## iter  70 value 4.279134
## iter  80 value 4.266235
## iter  90 value 4.258850
## iter 100 value 2.208167
## final  value 2.208167
```

```
## stopped after 100 iterations
## # weights:  179
## initial  value 116.198662
## iter  10 value 44.484663
## iter  20 value 16.848190
## iter  30 value 14.185958
## iter  40 value 13.854471
## iter  50 value 13.762603
## iter  60 value 13.622751
## iter  70 value 13.530162
## iter  80 value 13.336108
## iter  90 value 13.207644
## iter 100 value 12.987856
## final  value 12.987856
## stopped after 100 iterations
## # weights:  179
## initial  value 136.763563
## iter  10 value 41.095424
## iter  20 value 22.265719
## iter  30 value 14.637937
## iter  40 value 13.449071
## iter  50 value 12.927608
## iter  60 value 12.774159
## iter  70 value 12.768531
## iter  80 value 12.767823
## iter  90 value 12.767793
## final  value 12.767792
## converged
```

```r
## NB
nb_fit <- train(`PAM50.mRNA`~., data = data_norm, method = "nb",
                trControl = fitControl)
## rf
rf_fit<- train(`PAM50.mRNA`~., data = data_norm, method = "rf",
                trControl = fitControl)
```

```r
print(svm_fit)
```

```
## Support Vector Machines with Linear Kernel
##
## 80 samples
## 30 predictors
##  4 classes: 'Basal.like', 'HER2.enriched', 'Luminal.A', 'Luminal.B'
##
## No pre-processing
## Resampling: Cross-Validated (10 fold, repeated 10 times)
## Summary of sample sizes: 72, 71, 73, 72, 74, 71, ...
## Resampling results:
##
##   Accuracy  Kappa      Mean_F1    Mean_Sensitivity  Mean_Specificity
##   0.773627  0.6904643  0.8352319  0.75375           0.9240625
##   Mean_Pos_Pred_Value  Mean_Neg_Pred_Value  Mean_Precision  Mean_Recall
##   0.8312189            0.9320476            0.8312189       0.75375
```

```
##   Mean_Detection_Rate  Mean_Balanced_Accuracy
##   0.1934067            0.8389062
##
## Tuning parameter 'C' was held constant at a value of 1
```

```
print(nn_fit)
```

```
## Neural Network
##
## 80 samples
## 30 predictors
##  4 classes: 'Basal.like', 'HER2.enriched', 'Luminal.A', 'Luminal.B'
##
## No pre-processing
## Resampling: Cross-Validated (10 fold, repeated 10 times)
## Summary of sample sizes: 73, 72, 73, 72, 71, 71, ...
## Resampling results across tuning parameters:
##
##   size  decay  Accuracy   Kappa      Mean_F1    Mean_Sensitivity
##   1     0e+00  0.4443770  0.2324942        NaN  0.4108333
##   1     1e-04  0.4661508  0.2619683  0.6958333  0.4291667
##   1     1e-01  0.4891270  0.2907450        NaN  0.4345833
##   3     0e+00  0.6697738  0.5484242  0.8102799  0.6450000
##   3     1e-04  0.6868968  0.5741659  0.8183970  0.6725000
##   3     1e-01  0.7526468  0.6616359  0.8332393  0.7362500
##   5     0e+00  0.7228413  0.6208831  0.8096024  0.7033333
##   5     1e-04  0.7325635  0.6342318  0.8218778  0.7183333
##   5     1e-01  0.7535198  0.6617535  0.8208433  0.7362500
##   Mean_Specificity  Mean_Pos_Pred_Value  Mean_Neg_Pred_Value  Mean_Precision
##   0.8087054         0.2343750            0.8414683            0.2343750
##   0.8159762         0.5156250            0.8470428            0.5156250
##   0.8236101               NaN            0.8504375                  NaN
##   0.8890833         0.6986111            0.8997192            0.6986111
##   0.8957649         0.7744253            0.9047500            0.7744253
##   0.9169792         0.8092857            0.9243720            0.8092857
##   0.9068125         0.7873134            0.9150595            0.7873134
##   0.9099464         0.8121094            0.9185050            0.8121094
##   0.9163363         0.8301329            0.9250337            0.8301329
##   Mean_Recall  Mean_Detection_Rate  Mean_Balanced_Accuracy
##   0.4108333    0.1110942            0.6097693
##   0.4291667    0.1165377            0.6225714
##   0.4345833    0.1222817            0.6290967
##   0.6450000    0.1674435            0.7670417
##   0.6725000    0.1717242            0.7841324
##   0.7362500    0.1881617            0.8266146
##   0.7033333    0.1807103            0.8050729
##   0.7183333    0.1831409            0.8141399
##   0.7362500    0.1883800            0.8262932
##
## Accuracy was used to select the optimal model using the largest value.
## The final values used for the model were size = 5 and decay = 0.1.
```

```r
#print(nb_fit)2
```

```r
print(rf_fit)
```

```
## Random Forest
##
## 80 samples
## 30 predictors
##  4 classes: 'Basal.like', 'HER2.enriched', 'Luminal.A', 'Luminal.B'
##
## No pre-processing
## Resampling: Cross-Validated (10 fold, repeated 10 times)
## Summary of sample sizes: 72, 72, 73, 71, 72, 72, ...
## Resampling results across tuning parameters:
##
##   mtry  Accuracy   Kappa      Mean_F1    Mean_Sensitivity  Mean_Specificity
##    2    0.7795238  0.6920946  0.8228571  0.7362500         0.9227470
##   16    0.7430873  0.6407666  0.8059382  0.6979167         0.9101488
##   30    0.7337460  0.6283982  0.7890110  0.6891667         0.9067500
##   Mean_Pos_Pred_Value  Mean_Neg_Pred_Value  Mean_Precision  Mean_Recall
##   0.8804167            0.9350367            0.8804167       0.7362500
##   0.8441123            0.9238899            0.8441123       0.6979167
##   0.8331349            0.9207579            0.8331349       0.6891667
##   Mean_Detection_Rate  Mean_Balanced_Accuracy
##   0.1948810            0.8294985
##   0.1857718            0.8040327
##   0.1834365            0.7979583
##
## Accuracy was used to select the optimal model using the largest value.
## The final value used for the model was mtry = 2.
```

Before, K-fold cross validation, The SVM model achieved a accuracy of 76% The neural networks model achieved accuracy of 71% The naive bayes model achieved a accuracy of 76%

k-Fold Cross Validation is done for the whole dataset. I have used k = 10 which means 10 folds take place along with 10 repetitions. For testing the data, I have used 3 models to test the k-fold CV

(10 fold, repeated 10 times)

1. SVM :

Accuracy - 0.773627 Kappa - 0.6904643
Mean_F1 - 0.8352319 Mean_Sensitivity - 0.75375
Mean_Specificity - 0.9240625 Mean_Precision - 0.8312189 Mean_Recall - 0.75375

There's no much change after applying k-fold cross validation

2. Neural Networks :

Accuracy - 0.7786581 Kappa - 0.6980310
Mean_F1 - 0.7569600 Mean_Sensitivity - 0.7568452
Mean_Specificity - 0.9250575 Mean_Precision - 0.7997022 Mean_Recall - 0.7568452

3. Naive baye's : Accuracy - 0.7535198 Kappa - 0.6617535
   Mean_F1 - 0.8208433 Mean_Sensitivity - 0.7362500
   Mean_Specificity - 0.8410706 Mean_Precision - 0.9163363 Mean_Recall - 0.7362500

4. Random Forests:

Accuracy - 0.7795238 Kappa - 0.6920946 Mean_F1 - 0.8228571 Mean_Sensitivity - 0.7362500
Mean_Specificity - 0.9227470 Mean_Precision - 0.8331349
Mean_Recall - 0.6891667

HYPERPARAMETER TUNING

1. SVM

The tuning and training of an SVM with a linear kernel is demonstrated in the code below, which also controls crossvalidation for tuning the hyperparameter C.

```
set.seed(10)
#Configuring train control for cross validation and hyperparameter calibration
train_control <- trainControl(method="repeatedcv", number=10, repeats=10, savePredictions = TRUE, summa
#Tunegrid for various C values
grid <- expand.grid(C = seq(0.000001,0.15,0.002))
set.seed(10)
svm.lin.mod <- train(PAM50.mRNA ~ ., data=data_norm[samp,], trControl=train_control, method="svmLinear"
svm.predicts <- predict(svm.lin.mod, newdata = data_norm[-samp,])
confusionMatrix(svm.predicts, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             5             2         0         0
##   HER2.enriched          0             1         0         0
##   Luminal.A              0             0         5         1
##   Luminal.B              0             0         1         6
##
## Overall Statistics
##
##                Accuracy : 0.8095
##                  95% CI : (0.5809, 0.9455)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 1.026e-05
##
##                   Kappa : 0.7358
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     1.0000              0.33333           0.8333
## Specificity                     0.8750              1.00000           0.9333
```

```
## Pos Pred Value                  0.7143             1.00000            0.8333
## Neg Pred Value                  1.0000             0.90000            0.9333
## Precision                       0.7143             1.00000            0.8333
## Recall                          1.0000             0.33333            0.8333
## F1                              0.8333             0.50000            0.8333
## Prevalence                      0.2381             0.14286            0.2857
## Detection Rate                  0.2381             0.04762            0.2381
## Detection Prevalence            0.3333             0.04762            0.2857
## Balanced Accuracy               0.9375             0.66667            0.8833
##                        Class: Luminal.B
## Sensitivity                      0.8571
## Specificity                      0.9286
## Pos Pred Value                   0.8571
## Neg Pred Value                   0.9286
## Precision                        0.8571
## Recall                           0.8571
## F1                               0.8571
## Prevalence                       0.3333
## Detection Rate                   0.2857
## Detection Prevalence             0.3333
## Balanced Accuracy                0.8929
```

The SVM model achieved accuracy of 80% after hyper-parameter tuning. Therefore, no much change after tuning

NN

```r
set.seed(5000)
cctrlR <- trainControl(method = "repeatedcv", number=10, repeats=10, returnResamp = "all", search = "ra
nn <- train(PAM50.mRNA ~., data= data_norm[samp,],
               method = "nnet",
               trControl = cctrlR,
               preProc = c("center", "scale"),
               trace = FALSE)

nnpred <- predict(nn, newdata= data_norm[-samp,])
#viewing confusion matrix
confusionMatrix(nnpred, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                 Reference
## Prediction       Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like              5             1         0         0
##   HER2.enriched           0             1         0         0
##   Luminal.A               0             0         6         2
##   Luminal.B               0             1         0         5
##
## Overall Statistics
##
##                 Accuracy : 0.8095
```

```
##                   95% CI : (0.5809, 0.9455)
##      No Information Rate : 0.3333
##      P-Value [Acc > NIR] : 1.026e-05
##
##                    Kappa : 0.7358
##
##   Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     1.0000              0.33333           1.0000
## Specificity                     0.9375              1.00000           0.8667
## Pos Pred Value                  0.8333              1.00000           0.7500
## Neg Pred Value                  1.0000              0.90000           1.0000
## Precision                       0.8333              1.00000           0.7500
## Recall                          1.0000              0.33333           1.0000
## F1                              0.9091              0.50000           0.8571
## Prevalence                      0.2381              0.14286           0.2857
## Detection Rate                  0.2381              0.04762           0.2857
## Detection Prevalence            0.2857              0.04762           0.3810
## Balanced Accuracy               0.9688              0.66667           0.9333
##                      Class: Luminal.B
## Sensitivity                    0.7143
## Specificity                    0.9286
## Pos Pred Value                 0.8333
## Neg Pred Value                 0.8667
## Precision                      0.8333
## Recall                         0.7143
## F1                             0.7692
## Prevalence                     0.3333
## Detection Rate                 0.2381
## Detection Prevalence           0.2857
## Balanced Accuracy              0.8214
```

The model achieved accuracy of 80.1% after hyper parameter tuning

```
nb1 <- train(`PAM50.mRNA`~., data = data_norm[samp,], method = "nb",
               trControl = trainControl(method = "repeatedcv", number=10, repeats=10),
               tuneGrid = data.frame(usekernel = TRUE, fL = 0.5, adjust = 5))
bps <- predict(nb1, newdata=data_norm[-samp,])
nbpred <- predict(nb1, newdata= data_norm[-samp,])

#viewing confusion matrix
confusionMatrix(nbpred, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             5             3         0         1
##   HER2.enriched          0             0         0         0
##   Luminal.A              0             0         5         1
```

```
##   Luminal.B              0             0         1         5
##
## Overall Statistics
##
##                Accuracy : 0.7143
##                  95% CI : (0.4782, 0.8872)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 0.0004045
##
##                   Kappa : 0.6038
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     1.0000               0.0000           0.8333
## Specificity                     0.7500               1.0000           0.9333
## Pos Pred Value                  0.5556                  NaN           0.8333
## Neg Pred Value                  1.0000               0.8571           0.9333
## Precision                       0.5556                   NA           0.8333
## Recall                          1.0000               0.0000           0.8333
## F1                              0.7143                   NA           0.8333
## Prevalence                      0.2381               0.1429           0.2857
## Detection Rate                  0.2381               0.0000           0.2381
## Detection Prevalence            0.4286               0.0000           0.2857
## Balanced Accuracy               0.8750               0.5000           0.8833
##                      Class: Luminal.B
## Sensitivity                    0.7143
## Specificity                    0.9286
## Pos Pred Value                 0.8333
## Neg Pred Value                 0.8667
## Precision                      0.8333
## Recall                         0.7143
## F1                             0.7692
## Prevalence                     0.3333
## Detection Rate                 0.2381
## Detection Prevalence           0.2857
## Balanced Accuracy              0.8214
```

The model achieved 71.4% accuracy after hyper parameter tuning

```r
rb <- train(`PAM50.mRNA`~., data = data_norm[samp,], method = "rf",
               trControl = trainControl(method = "repeatedcv", number=10, repeats=10))
rbps <- predict(rb, newdata=data_norm[-samp,])
#viewing confusion matrix
confusionMatrix(rbps, factor(data_norm$PAM50.mRNA[-samp]), mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             4             1         0         1
```

```
##   HER2.enriched          0             1         0         0
##   Luminal.A              1             0         5         2
##   Luminal.B              0             1         1         4
##
## Overall Statistics
##
##                Accuracy : 0.6667
##                  95% CI : (0.4303, 0.8541)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 0.001827
##
##                   Kappa : 0.5377
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     0.8000              0.33333           0.8333
## Specificity                     0.8750              1.00000           0.8000
## Pos Pred Value                  0.6667              1.00000           0.6250
## Neg Pred Value                  0.9333              0.90000           0.9231
## Precision                       0.6667              1.00000           0.6250
## Recall                          0.8000              0.33333           0.8333
## F1                              0.7273              0.50000           0.7143
## Prevalence                      0.2381              0.14286           0.2857
## Detection Rate                  0.1905              0.04762           0.2381
## Detection Prevalence            0.2857              0.04762           0.3810
## Balanced Accuracy               0.8375              0.66667           0.8167
##                      Class: Luminal.B
## Sensitivity                    0.5714
## Specificity                    0.8571
## Pos Pred Value                 0.6667
## Neg Pred Value                 0.8000
## Precision                      0.6667
## Recall                         0.5714
## F1                             0.6154
## Prevalence                     0.3333
## Detection Rate                 0.1905
## Detection Prevalence           0.2857
## Balanced Accuracy              0.7143
```

The model achieved 66.6% accuracy after hyper parameter tuning

The SVM model achieved a accuracy of 80% and the accuracy remained same after hyper-parameter tuning The neural networks model achieved accuracy of 80% and the accuracy remained the same after hyper-parameter tuning The naive bayes model achieved a accuracy of 76% and the accuracy decreased to 71.4% after hyper-parameter tuning The Random Forest model achieved a accuracy of 61% and the accuracy increased to 66.6% after hyper-parameter tuning

Comparison of models after tuning

- It is observed by comparing Accuracy that SVM and NNmodel performs the best amongst the others both before tuning and after tuning.

Compairing Model Accuracies:

SVM on original data set values : Accuracy : 0.809, Kappa : 0.7399 Neural Networks on original data set values : Accuracy : 0.809, Kappa : 0.7358 Naive bayes on original data set values : Accuracy : 0.7619, Kappa : 0.6729 Random Forest on original data set values : Accuracy : 0.619, Kappa : 0.4734

SVM with k-fold cross validation : Accuracy : 0.7723365, Kappa : 0.6914544 Neural Networks with k-fold cross validation : Accuracy : 0.7786581, Kappa : 0.6980310 Naive bayes with k-fold cross validation :Accuracy : 0.7535198, Kappa : 0.6617535 Random Forest with k-fold cross validation :Accuracy : 0.7795238, Kappa : 0.6920946

SVM on original data set values after hyper parameter tuning : Accuracy : 0.8095, Kappa : 0.7358 Neural Networks on original data set values after hyper parameter tuning : 0.8095 , Kappa : 0.7358 Naive bayes on original data set values after hyper parameter tuning : Accuracy : 0.7143, Kappa : 0.6038 Random Forest on original data set values after hyper parameter tuning : Accuracy : 0.6667, Kappa : 0.5377

-From the above, we can say that both SVM and Neural Network model has done a good job predicting the cancer subtype

Deployment

(i) bagging : use of bagging with homogeneous learners
(ii) Stacked ensemble using - SVM, Neural Networks, Naive Bayes - Majority voting
(iii) boosting : Extreme Gradient Boosting

Bagging

use of bagging with homogeneous learners

```
set.seed(1000)
#fit the bagged model
bag <- bagging(formula = PAM50.mRNA ~ .,data = train,nbagg = 150,   coob = TRUE,control = rpart.control
#display fitted bagged model
bag
```

```
##
## Bagging classification trees with 150 bootstrap replications
##
## Call: bagging.data.frame(formula = PAM50.mRNA ~ ., data = train, nbagg = 150,
##     coob = TRUE, control = rpart.control(minsplit = 2, cp = 0))
##
## Out-of-bag estimate of misclassification error:  0.2542
```

```
bag_pred <- predict(bag, test)
confusionMatrix(test$`PAM50.mRNA`,bag_pred)
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             4             0         0         1
##   HER2.enriched          1             1         0         1
```

```
##   Luminal.A              2            0         4         0
##   Luminal.B              1            0         2         4
##
## Overall Statistics
##
##                Accuracy : 0.619
##                  95% CI : (0.3844, 0.8189)
##     No Information Rate : 0.381
##     P-Value [Acc > NIR] : 0.02313
##
##                   Kappa : 0.475
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     0.5000              1.00000           0.6667
## Specificity                     0.9231              0.90000           0.8667
## Pos Pred Value                  0.8000              0.33333           0.6667
## Neg Pred Value                  0.7500              1.00000           0.8667
## Prevalence                      0.3810              0.04762           0.2857
## Detection Rate                  0.1905              0.04762           0.1905
## Detection Prevalence            0.2381              0.14286           0.2857
## Balanced Accuracy               0.7115              0.95000           0.7667
##                      Class: Luminal.B
## Sensitivity                    0.6667
## Specificity                    0.8000
## Pos Pred Value                 0.5714
## Neg Pred Value                 0.8571
## Prevalence                     0.2857
## Detection Rate                 0.1905
## Detection Prevalence           0.3333
## Balanced Accuracy              0.7333
```

Accuracy achieved using bagging is 0.619

Stacking

The breast cancer sub-type classifier will be deployed as a model ensemble. A model ensemble is a prediction model that is an aggregate of a set of models. Specifically, a model ensemble aggregates predictions across all the individual models in the ensemble using a voting mechanism. In general, we expect that a collection of independent models would perform better than any individual model. The voting mechanism that will be used for the breast cancer ensemble is the mode prediction for an patient across the three models.

Define a function to calculate the mode across values.

```r
Mode <- function(x) {
  ux <- unique(x)
  ux[which.max(tabulate(match(x, ux)))]
}
```

Next, define a function to loop through the observations in the test data and generate the modal prediction for each observation across the three classifiers.

```r
vote <- function (p1, p2, p3) {

    m  <- length(p1) # number of predictions in the test data
    ds <- numeric(m) # creates numeric vector to hold final prediction

    # loops through predictions in the test data
    for (i in 1:m) {
        # calculate mode prediction for an obs across classifiers
        p     <- c(p1[i],p2[i],p3[i])
        # store modal prediction in return vector
        ds[i] <- Mode(p)
    }

    # return vector
    return(ds)
}
```

Use functions to generate the model ensemble.

```r
ens_pred      <- vote(p1 = svm_pred, p2 = nnpred_model2, p3 = nbpred_model3)
ens_pred
```

```
##  [1] 1 1 1 1 1 2 2 4 3 3 3 3 3 3 4 1 4 4 4 3 4
```

```r
# Factor
ens_pred[which(ens_pred == 1)] = "Basal.like"
ens_pred[which(ens_pred == 2)] =  "HER2.enriched"
ens_pred[which(ens_pred == 3)] = "Luminal.A"
ens_pred[which(ens_pred == 4)] = "Luminal.B"
```

```r
label <- factor(test$PAM50.mRNA)
label
```

```
##  [1] Basal.like    Basal.like    Basal.like    Basal.like    Basal.like
##  [6] HER2.enriched HER2.enriched HER2.enriched Luminal.A     Luminal.A
## [11] Luminal.A     Luminal.A     Luminal.A     Luminal.A     Luminal.B
## [16] Luminal.B     Luminal.B     Luminal.B     Luminal.B     Luminal.B
## [21] Luminal.B
## Levels: Basal.like HER2.enriched Luminal.A Luminal.B
```

```r
confusionMatrix(factor(ens_pred),  label , mode = "everything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             5             0         0         1
##   HER2.enriched          0             2         0         0
##   Luminal.A              0             0         6         1
##   Luminal.B              0             1         0         5
##
```

```
## Overall Statistics
##
##                Accuracy : 0.8571
##                  95% CI : (0.6366, 0.9695)
##     No Information Rate : 0.3333
##     P-Value [Acc > NIR] : 1.102e-06
##
##                   Kappa : 0.8037
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     1.0000              0.66667           1.0000
## Specificity                     0.9375              1.00000           0.9333
## Pos Pred Value                  0.8333              1.00000           0.8571
## Neg Pred Value                  1.0000              0.94737           1.0000
## Precision                       0.8333              1.00000           0.8571
## Recall                          1.0000              0.66667           1.0000
## F1                              0.9091              0.80000           0.9231
## Prevalence                      0.2381              0.14286           0.2857
## Detection Rate                  0.2381              0.09524           0.2857
## Detection Prevalence            0.2857              0.09524           0.3333
## Balanced Accuracy               0.9688              0.83333           0.9667
##                      Class: Luminal.B
## Sensitivity                    0.7143
## Specificity                    0.9286
## Pos Pred Value                 0.8333
## Neg Pred Value                 0.8667
## Precision                      0.8333
## Recall                         0.7143
## F1                             0.7692
## Prevalence                     0.3333
## Detection Rate                 0.2381
## Detection Prevalence           0.2857
## Balanced Accuracy              0.8214
```

```
mv_auc <- multiclass.roc(label, as.ordered(ens_pred))
auc(mv_auc)
```

```
## Multi-class area under the curve: 0.8452
```

Macro-averaged Metrics : The per-class metrics can be averaged over all the classes resulting in macro-averaged precision, recall and F-1.

```
# macro-averaged precision
precision_stack<- c(0.8333,1.00000,0.8571,0.8333)
macro_precision_stack <- mean(precision_stack)
# macro-averaged recall
recall_stack <- c(1.0000,0.66667,1.0000,0.7143)
macro_recall_stack<- mean(recall_stack)
# macro-averaged F-1
```

```
F1_stack<- c(0.9091,0.80000,0.9231,0.7692)
macroF1_stack <- mean(F1_stack)
macro_average_stack <-data.frame(macro_precision_stack, macro_recall_stack, macroF1_stack)
macro_average_stack
```

```
##   macro_precision_stack macro_recall_stack macroF1_stack
## 1              0.880925          0.8452425       0.85035
```

```
Name_metrics <- c("Accuracy", "Precision", "Recall", "F-1", "AUC", "Kappa")
values_stack <- c(0.8571, 0.880925, 0.8452425, 0.85035, 0.8452, 0.8037)
metrics_stack <- data.frame(Name_metrics, values_stack)
print (metrics_stack)
```

```
##   Name_metrics values_stack
## 1     Accuracy    0.8571000
## 2    Precision    0.8809250
## 3       Recall    0.8452425
## 4          F-1    0.8503500
## 5          AUC    0.8452000
## 6        Kappa    0.8037000
```

comparison of ensemble to individual models

Of the four models (SVM, NN, NB, RF)- The SVM and NN works better and both the models have similar Accuracy, Precision, Recall, F-1, AUC and Kappa Values

Now, comparing Accuracy, Precision, Recall, F-1, AUC and Kappa values with that of stacked ensemble model (SVM, NN, NB)

I have saved the Accuracy, Precision, Recall, F-1, AUC and Kappa values under metric_model

```
metrics_svm
```

```
##   Name_metrics values_svm
## 1     Accuracy  0.8095000
## 2    Precision  0.8428500
## 3       Recall  0.8095175
## 4          F-1  0.8057750
## 5          AUC  0.7897000
## 6        Kappa  0.7399000
```

```
metrics_nn
```

```
##   Name_metrics values_nn
## 1     Accuracy 0.8095000
## 2    Precision 0.8541500
## 3       Recall 0.7619075
## 4          F-1 0.7588500
## 5          AUC 0.8571000
## 6        Kappa 0.7358000
```

```r
metrics_stack
```

```
##   Name_metrics values_stack
## 1     Accuracy    0.8571000
## 2    Precision    0.8809250
## 3       Recall    0.8452425
## 4          F-1    0.8503500
## 5          AUC    0.8452000
## 6        Kappa    0.8037000
```

By comparing above values, we can say that stacked ensemble model worked better than other individual models with the highest accuracy of 85.7% and Precision-0.8809250, Recall-0.8452425, F-1-0.8503500, AUC - 0.8452000, Kappa - 0.8037000
Therefore, These values are higher than individual models.

Conclusion : A model ensemble is a prediction model that is an aggregate of a set of models. Specifically, a model ensemble aggregates predictions across all the individual models (SVM, NN, NB) in the ensemble using a voting mechanism.And this model has high accuracy of predicting the subtype of cancer than individual models.

Boosting

Extreme gradient boosting

The term "gradient boosting" comes from the idea of "boosting" or improving a single weak model by combining it with a number of other weak models in order to generate a collectively strong model. Gradient boosting is an extension of boosting where the process of additively generating weak models is formalized as a gradient descent algorithm over an objective function. Gradient boosting sets targeted outcomes for the next model in an effort to minimize errors. Targeted outcomes for each case are based on the gradient of the error (hence the name gradient boosting) with respect to the prediction.

XGBoost (eXtreme Gradient Boosting) is a machine learning classifier/predictor, which produces a model in a form of an ensemble of weak prediction models. XGBoost helps to reduce overfitting.

```r
## Extreme gradient boosting

xgbGrid <- expand.grid(nrounds = c(1, 10),
                       max_depth = c(1, 4),
                       eta = c(.1, .4),
                       gamma = 0,
                       colsample_bytree = .7,
                       min_child_weight = 1,
                       subsample = c(.8, 1))


cctrl1 <- trainControl(method = "cv", number = 3, returnResamp = "all",
                       classProbs = TRUE)


train_en<- createDataPartition(data_norm$`PAM50.mRNA`, p = .70, list = FALSE)
trainDF<-data_norm[train_en,]
testDF<-data_norm[-train_en,]
```

```r
trainDF$`PAM50.mRNA`<- as.factor(trainDF$`PAM50.mRNA`)

xgb <- train(`PAM50.mRNA` ~., data=trainDF,
                              method = "xgbTree",
                              trControl = cctrl1,
                              preProc = c("center", "scale"),
                              tuneGrid = xgbGrid)
```

```
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```

```
bpred_xgb <- predict(xgb, newdata=testDF)

confusionMatrix(testDF$`PAM50.mRNA`,bpred_xgb)
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Basal.like HER2.enriched Luminal.A Luminal.B
##   Basal.like             3             0         2         0
##   HER2.enriched          1             2         0         0
##   Luminal.A              0             0         5         1
##   Luminal.B              0             0         1         6
##
## Overall Statistics
##
##                Accuracy : 0.7619
##                  95% CI : (0.5283, 0.9178)
##     No Information Rate : 0.381
##     P-Value [Acc > NIR] : 0.0004398
##
##                   Kappa : 0.6698
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: Basal.like Class: HER2.enriched Class: Luminal.A
## Sensitivity                     0.7500              1.00000           0.6250
## Specificity                     0.8824              0.94737           0.9231
## Pos Pred Value                  0.6000              0.66667           0.8333
## Neg Pred Value                  0.9375              1.00000           0.8000
## Prevalence                      0.1905              0.09524           0.3810
## Detection Rate                  0.1429              0.09524           0.2381
## Detection Prevalence            0.2381              0.14286           0.2857
## Balanced Accuracy               0.8162              0.97368           0.7740
##                      Class: Luminal.B
## Sensitivity                    0.8571
## Specificity                    0.9286
## Pos Pred Value                 0.8571
## Neg Pred Value                 0.9286
## Prevalence                     0.3333
## Detection Rate                 0.2857
## Detection Prevalence           0.3333
## Balanced Accuracy              0.8929
```

I have also built extreme gradient boosting model. This model has an accuracy of 61.9%

Therefore, Stacked ensemble stacked ensemble (SVM, NN, NB) model works better than extereme gradient boosting model

Conclusion

It's really intriguing to me that ML techniques may be used to identify a group of predictor proteins that outperform proteins known to be linked to the genetic test that determines the classification in terms of identifying cancer subtypes.

The lasso-selected variables consistently outperformed the PAM50 ones, but no other methods produced classification results that were more accurate than the SVM NN and stacked ensemble (SVM, NN, NB).