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0.1 Introduction

##talk about the importance of hacking, percentage of data loss link it with the data collected

0.2 stats about data breach

Multiple institutions have been a target of increasingly more disruptive or destructive cyber attacks over the last few years which has lead to government action.

The data used in my work was collected yearly by the uk government department for Digital, Culture, Media and Sport (DCMS) with the purpose of helping the government understand the importance cyber security

for British institutions, better shape policy regarding cyber security, create schemes to increase awareness for such problems and better protect institutions form cyber security threats.

The data collected contains information detailing the attacked institutions, the countermeasures in placed before and after the attack, the type of attack and it's affects on the company.

As such this analysis will investigate the relationship between how institutions protect themselves from cyber attacks and the affect of said attacks on these institutions in the last 5 years.

0.3 Objectives of this report:

-Creating of a new tidy data set for each of the years including recompiled variables for the management, policing and rules implemented to protect the organisation, the type of attack that affected the institution and its respective outcomes.

-Utilizing Multiple Imputation by Chained Equations (Mice), to replace the missing data.

-Do hypothesis testing on my new fitted models to compare how the size of an institution will affect the time needed to restore business operations.

-Mention the limitations of this analysis.

-Conclusion with recommendation for future research.

0.4 Report structure

This report will be structure in the following order, firstly I will be describing the data set in more detail and my tidying process, secondly I will talk about my methodology for data analysis, afterwards in my results I will be displaying a visual analysis of the data, test results and it's meaning, afterwards I will discuss the limitations of my data and lastly conclude discussing the implications of my results for future research and the industry.

0.5 Data set

The data sets contain the data used for the statistical analysis done by the uk government DCMS department, they were collected and published in the uk data service, however they have not been made completely public and require a request and its approval to obtain access to each of the data sets.

Each one of these data sets contain the data associated to institutions affected by cyber attack with its multitude of implications for costs, business downtime, reporting and outcome as well as a detailed description of the policies, rules and investment in security measures to counter such security threats and some key parameters to describe the institution such as size, market sector and better contextualize the data.

Initial data wrangling:

Due to the untidy state of the data collect via the random probability telephone survey, these data sets containing between 421 to 462 variables have to been clean up into 21 easily comparable variables.

The clean up process consisted of computing new variables utilizing the multiple subcategories of answers to the survey questions, grouping them into more flexible options while adjusting missing values to allow for such computation maintaining the original binary design and increasing the scale of the size variable to

produce better grouping and latter on better imputations due to the data sets didn't had the distinction between the intervals [250, 999] and [1000, ∞] that was present in the survey.

I also had to remove a few results from each year data set because these institutions still had their systems down after being attacks and since I don't have the information of the data of the attack and the data of the survey for those particular institutions it is impossible for me to quantify the time for restoring their systems, creating this way data that doesn't give us any possible information about the topic but is not missing, so it should not be replaced with missing data for computation.

There was also a further cleaning of the data sets by removing variables that were unused and not relevant to my my hypothesis and its associated testing

The data sets were previously compiled and run in SPSS which is a statistical software developed by IBM for data analysis, therefore all the data in the data sets were in SPSS data structures that needed to be converted to R structures such as numeric and factor to allow for imputation and model fitting.

0.6 Methodology

The process of the methodology will be starting with a simpler hypothesis test based on mean comparison to discovers the relationship between size and restoration and how much it varies compared to my null hypothesis. Afterwards I will check the p-values to understand how likely it is that the relationship described if the null hypothesis of no relationship is true. If the test is more likely than the null hypothesis, I can infer that exists a statistically significant relationship between size and restoration time. If the test however is less likely than the null hypothesis, I can infer that there is no statisitcally significant relationship (Bevans 2022)

0.7 Results

0.8 Missing data

It can be observed a significant degree of missing data on my data sets coming from multiple sources, the main source of missing data is derived from a limitation of the data collected, the lack of reporting channels in institutions leads to the majority of the missing values that lead to direct missing data in the data sets collected and indirect missing data by institutions answering that they do not know the answer to some of the questions in the survey. Lastly there is missing values associated to the type of attacks by institutions refusing to answer the question regarding the type of attack inflicted in their respective institution.

The missing data will have to be imputed using Multiple Imputation by Chained Equations on each of the data sets, for this I will be using the R library mice created by professor Stef Van Buuren.

For the imputation we had the consider the 3 following parameters, number of imputations, number of iterations per imputation and method for imputation.

The number of imputations was chosen following two rules, the first one is Relative Efficiency (RE) is lower with a higher number of imputations according to Rubin's formula RE=1/(1+(FMI/m)), where FMI is approximately equal to the percentage of missing data and m the number of missing data. (Rubin 1975) The second was a rule of thumb described in the book "Multiple imputation using chained equations: Issues and guidance for practice" where they recommended to equate the number of imputations to the percentage of missing data in each of the data sets which is what I will be using. (White, Royston, and Wood 2010)

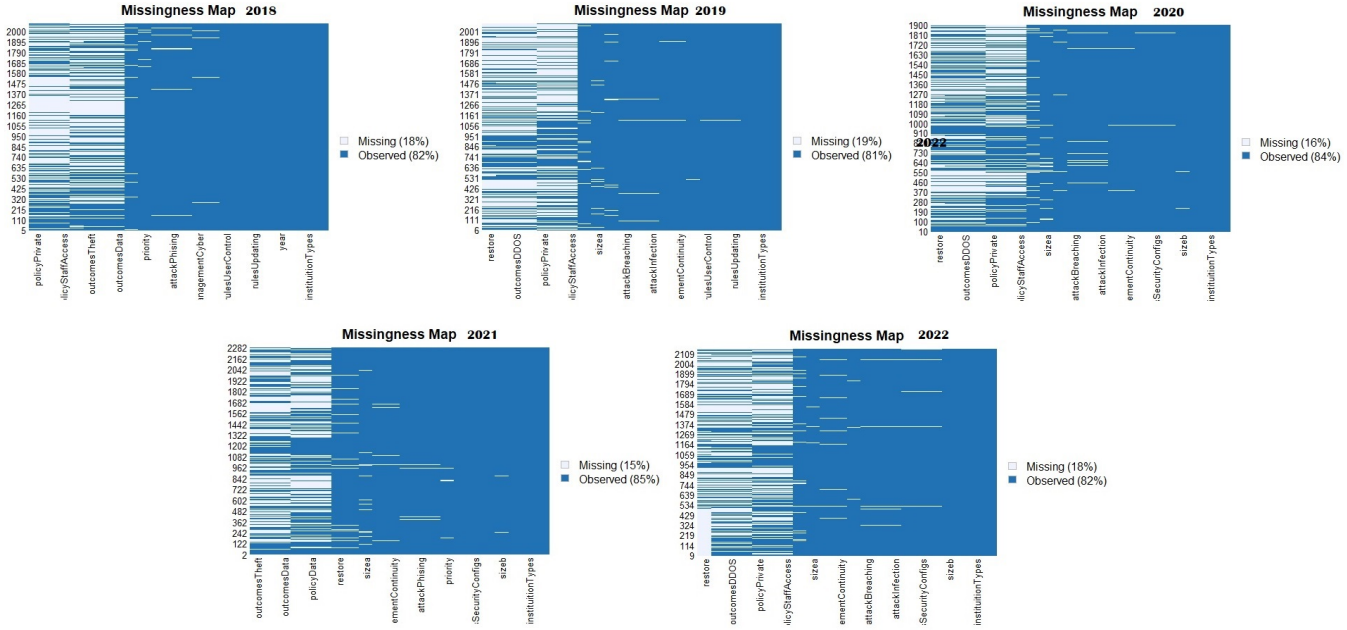

Figure 1: Missingness Map from 2018 to 2022

The number of iterations was chosen based on the convergence, that is when plotting the imputations the variance between the imputation chains is close to the variance of the chained imputations which is an indicator of an healthy convergence, this convergence was achieved after multiple trials with different numbers of iteration. (“Book_MI.knit” 2022)

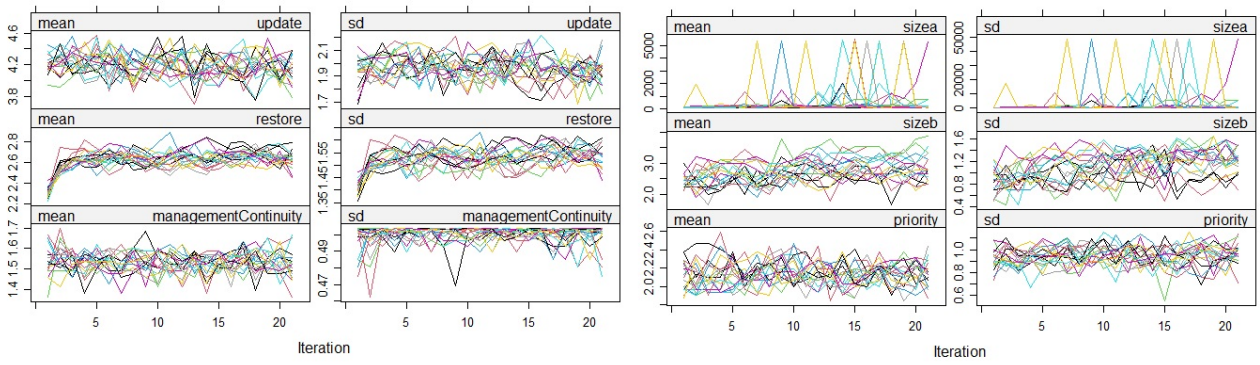

Figure 2: Healthy convergence plot

The prediction matrix is a matrix which tells mice which variables can be used to predict missingness in the other variables. Mice by default uses the correlation between and the proportion of usable cases. For the prediction of the exact number of employee however prediction based only on the scale of size of the institution to avoid predicting values outside of the already known scale level of the institution when imputing the missing values.

Lastly for the method of imputation I choose not to use the default method ppm which is more appropriate for continuous data, most of the variables were imputed with the method of logical regression “logreg” due to the nature of the majority of the values being dichotomous binary variables, the numerical variable

was instead imputed with the method of polynomial regression "polyreg" because size has a discrete finite number of values. ("Book_MI.knit" 2022)

0.9 Visual analyses

After dealing with the missing data and having a complete data set we can start our exploratory analysis. This analysis require us to first visualize the data to find any obvious patterns or groupings. Given the nature of the data a box plot will the most effective at displaying the concentration of

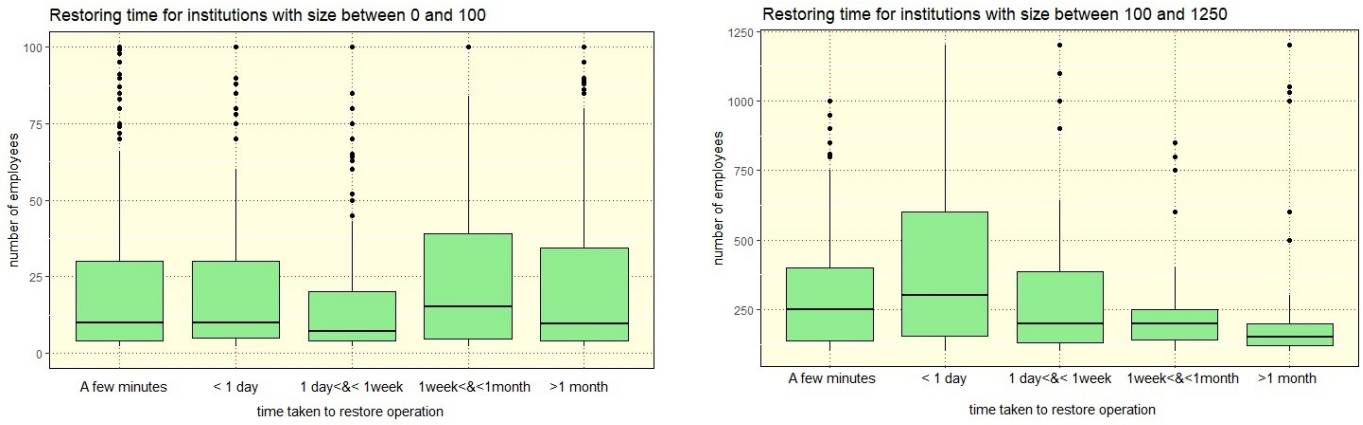

Figure 3: Institution size compared to restoringtime in BoxPlot

0.10 hypothesis testing

To test my hypothesis I started with a simple mean comparison test between the size of the company and each of possible times it took to restore business operations.

Since the restoring time is recorded in multiple scales I cannot use a normal t-test, so I have chosen to use the Analysis of Variance (ANOVA) test to prove my hypothesis. Anova is a statistical test that compares the mean of multiple groups, in this case I have used one-way ANOVA since I am only comparing one one categorical independent variable with 5 levels that is the restoring time take and one quantitative dependent variable, the size of the organisation.

ANOVA output explains how much variation in the dependable variable can be explained by the independent variable, so how much does the time taken to restore affects the size the of the company.

0.11 TODO TABLE WITH ANOVA RESULTS

0.12 Limitations

There are multiple limitations to my analysis to be noted. Firstly, the data collected is limited to cyber attacks that were detected, there is variety of attacks that have gone unnoticed and therefore the data has a systematic tendency to underestimate the real level of breach attacks, it is highly likely that the amount

of cyber attacks is much higher since it is only possible to report the discovered cyber attacks.(Department For Digital 2020)

Secondly, the missing data generated by imputation is biased since not all data is missing completely at random, mainly due to smaller and less staffed institution not having IT professionals and as such they don't have the infrastructure to detect, assess and report cyber attacks. Another source of missing data is from the employees who participates in this survey and exercised their right to not answer some of the questions.

Furthermore the amount of missing data in each of the data sets is significant enough that if the imputed values were replaced with the real data the results could be considerably different because imputed data is not real data and does not account for any biased missing data contributing factor.

Lastly it would be possible to compensate for some bias related to the size of the institutions by implementing weighting to better represent the proportion of the smaller institutions.

0.13 Conclusion and recommendations

Due to the low correlation of this data

```
library(haven)
library(tidyverse)
```

```
-- Attaching packages --------------------------------------- tidyverse 1.3.2 --
v ggplot2 3.3.6      v purrr   0.3.4
v tibble  3.1.8      v dplyr   1.0.10
v tidyr   1.2.1      v stringr 1.4.1
v readr   2.1.3      v forcats 0.5.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
```

```
library(dplyr)
library(geometry)
library(formatR)
#install.packages("VIM")
library(Amelia)
```

```
Loading required package: Rcpp
##
## Amelia II: Multiple Imputation
## (Version 1.8.0, built: 2021-05-26)
## Copyright (C) 2005-2022 James Honaker, Gary King and Matthew Blackwell
## Refer to http://gking.harvard.edu/amelia/ for more information
##
```

```r
library(mice)
```

```
Attaching package: 'mice'

The following object is masked from 'package:stats':

    filter

The following objects are masked from 'package:base':

    cbind, rbind
```

```r
library(VIM)
```

```
Warning: package 'VIM' was built under R version 4.2.2

Loading required package: colorspace
Loading required package: grid
VIM is ready to use.

Suggestions and bug-reports can be submitted at: https://github.com/statistikat/VIM/issues

Attaching package: 'VIM'

The following object is masked from 'package:datasets':

    sleep
```

```r
library(labelled)
library(GGally)
```

```
Registered S3 method overwritten by 'GGally':
  method from
  +.gg   ggplot2
```

```r
library(mgcv)
```

```
Loading required package: nlme

Attaching package: 'nlme'

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

```
    collapse
```

```
This is mgcv 1.8-40. For overview type 'help("mgcv-package")'.
```

```
library(ggplot2)
library(ggthemes)
library(sjPlot)
```

```
Warning: package 'sjPlot' was built under R version 4.2.2
```

```
## Very important documentation for the 2018 data set //it is a
## surprise toll that will help us later
technicalAnnex2018 = "https://doc.ukdataservice.ac.uk/doc/8406/mrdoc/pdf/8406_cyber_security_b

## this is the loading the first year of this level of survey data set
## after burning my entire brain, replacing it with the backup one and
## also burning that one I discovered that it is just these lines that
## aren't being formatted in pdf because they are absolutely huge but
## at least it works for the other ones #FicaADica I assume it was
## thanks to formatR ?? I won't bother to redo every single bloody step
## again, enough pain and stack for the day
dataCyberSecuritySurvey2018 = read_spss("C:/AppliedDataScienceAndStatistics/Applied-Data-Scien

## adding the variable year because none of the data sets have any
## proper way to distinguish between the years of each survey
dataCyberSecuritySurvey2018$year = "2018"
```

0.14 Now we do the same for the other years before we merge them

```
## loading the second year of this level of survey data set
dataCyberSecuritySurvey2019 = read_spss("C:/AppliedDataScienceAndStatistics/Applied-Data-Scien

## adding the variable year because none of the data sets have any
## proper way to distinguish between the years of each survey
dataCyberSecuritySurvey2019$year = "2019"
```

```
## loading the third year of this level of survey data set
dataCyberSecuritySurvey2020 = read_spss("C:/AppliedDataScienceAndStatistics/Applied-Data-Scien

## adding the variable year because none of the data sets have any
## proper way to distinguish between the years of each survey
dataCyberSecuritySurvey2020$year = "2020"
```

```r
## loading the forth year of this level of survey data set
dataCyberSecuritySurvey2021 = read_spss("C:/AppliedDataScienceAndStatistics/Applied-Data-Scien

## adding the variable year because none of the data sets have any
## proper way to distinguish between the years of each survey
dataCyberSecuritySurvey2021$year = "2021"
```

```r
## loading the fifth and final year of this level of survey data set
dataCyberSecuritySurvey2022 = read_spss("C:/AppliedDataScienceAndStatistics/Applied-Data-Scien

## adding the variable year because none of the data sets have any
## proper way to distinguish between the years of each survey
dataCyberSecuritySurvey2022$year = "2022"
```

```r
## Now that we have all data loaded lets start by tidying up data set
## by data set start from 2018


## for some sweet sweet documentation about the questions starting from
## page 26 TODO comment in case of fire or debugging
## browseURL(technicalAnnex2018)
```

```r
## This entire code snippet is tidying up the type of organisation for
## the 2018 survey renaming the bloody variables to a more java like
## name

dataCyberSecuritySurvey2018TidyName = rename(dataCyberSecuritySurvey2018,
    instituitionTypes = "samptype")

## if instituitionTypes is 1 it is a business if it is 2 it is a
## charity and in the future 3 is for schools and education


## daily reminder that there is a boolean type but it is called logical
## Numeric -\tSet of all real numbers Integer -\tSet of all integers, Z
## Logical - -\tTRUE and FALSE Complex -\tSet of complex numbers
## Character -\t"a", "b", "c", …, "ç", "#", "~", …., "1", "2", …etc


## it is a string so lets make it a proper numeric code

dataCyberSecuritySurvey2018TidyName$instituitionTypes = as.integer(dataCyberSecuritySurvey2018


## typex is 1-2 for businesses and 3 for charities so redundant and can
## be removed
```

```r
dataCyberSecuritySurvey2018TidyName = dataCyberSecuritySurvey2018TidyName %>%
    select(-typex)


## dataCyberSecuritySurvey2018TidyName never forget if R can't show all
## displayed text from a computation it breaks both the rendering and
## ##the refreshing of the rendered code for some reason ¯/_( )_/¯
## future edit anything and everything breaks for no reason at all,
## just kill it and reopen refer to the first NOTE TO SELF for more
## information
```

```r
## see questioner documentation start from page 27

technicalAnnex2019 = "https://assets.publishing.service.gov.uk/government/uploads/system/uploa
## TODO comment in case of fire or debugging
## browseURL(technicalAnnex2019)
```

```r
## see questioner documentation start from page 31

technicalAnnex2020 = "https://assets.publishing.service.gov.uk/government/uploads/system/uploa

## TODO comment in case of fire or debugging
## browseURL(technicalAnnex2020)
```

```r
## see questioner documentation start from page 28

technicalAnnex2021 = "https://assets.publishing.service.gov.uk/government/uploads/system/uploa

## TODO comment in case of fire or debugging
## browseURL(technicalAnnex2021)
```

```r
## see questioner documentation start from page 36

technicalAnnex2022 = "https://assets.publishing.service.gov.uk/government/uploads/system/uploa

## TODO comment in case of fire or debugging
## browseURL(technicalAnnex2022)

## trying not to get arrested for DDoSing the uk goverment by making a
## request to all the pdfs after rendering the page for the nth because
## I can't code nor debug (challenge impossible) bonus points if I get
## an exeter ip banned because of it
```

```r
## time to recycle the code for the 2018 survey that gets a 'neat' code
## of the institution types
```

```
## This entire code snippet is tidying up the type of organisation for
## the 2019 survey renaming the bloody variables to a more java like
## name

dataCyberSecuritySurvey2019TidyName = rename(dataCyberSecuritySurvey2019,
    instituitionTypes = "samptype")

dataCyberSecuritySurvey2019TidyName$instituitionTypes = as.integer(dataCyberSecuritySurvey2019

str(dataCyberSecuritySurvey2019TidyName$instituitionTypes)
```

```
int [1:2080] 1 1 1 1 1 1 1 1 1 1 ...
```

```
## typex is redundant be we already have an indentifies for each type
## of institution and can be removed same for questtype since this
## questioner has more redundancy than amazon and google data centers
## combined

dataCyberSecuritySurvey2019TidyName = dataCyberSecuritySurvey2019TidyName %>%
    select(-one_of("typex", "questtype"))
```

```
## I continue to save the planet by recycling as much as I can, mostly
## recycled code from the previous snippet today though this time we do
## have the concept of education institutions as our code just annoy me
## after I thought they should be converted to boolean like a getter in
## java

dataCyberSecuritySurvey2020TidyName = rename(dataCyberSecuritySurvey2020,
    instituitionTypes = "samptype")

dataCyberSecuritySurvey2020TidyName$instituitionTypes = as.integer(dataCyberSecuritySurvey2020

str(dataCyberSecuritySurvey2020TidyName$instituitionTypes)
```

```
int [1:1900] 1 1 1 1 1 1 1 1 1 1 ...
```

```
## typex is redundant be we already have an indentifies for each type
## of institution and can be removed same for questtype since this
## questioner has more redundancy than amazon and google data centers
## combined

dataCyberSecuritySurvey2020TidyName = dataCyberSecuritySurvey2020TidyName %>%
    select(-one_of("typex", "questtype"))
```

```
## saving the planet one recycled snippet of code at a time


dataCyberSecuritySurvey2021TidyName = rename(dataCyberSecuritySurvey2021,
    instituitionTypes = "samptype")

dataCyberSecuritySurvey2021TidyName$instituitionTypes = as.integer(dataCyberSecuritySurvey2021

str(dataCyberSecuritySurvey2021TidyName$instituitionTypes)
```

```
int [1:2284] 1 1 1 1 1 1 1 1 1 1 ...
```

```
## typex is redundant be we already have an indentifies for each type
## of institution and can be removed same for questtype since this
## questioner has more redundancy than amazon and google data centers
## combined

dataCyberSecuritySurvey2021TidyName = dataCyberSecuritySurvey2021TidyName %>%
    select(-one_of("typex", "questtype"))
```

```
## this comment was already dealt by the garbage collector unlike the
## previous ones

dataCyberSecuritySurvey2022TidyName = rename(dataCyberSecuritySurvey2022,
    instituitionTypes = "samptype")

dataCyberSecuritySurvey2022TidyName$instituitionTypes = as.integer(dataCyberSecuritySurvey2022

str(dataCyberSecuritySurvey2022TidyName$instituitionTypes)
```

```
int [1:2157] 1 1 1 1 1 1 1 1 1 1 ...
```

```
## questtype is redundant be we already have an indentifies for each
## type of institution and can be removed

dataCyberSecuritySurvey2022TidyName = dataCyberSecuritySurvey2022TidyName %>%
    select(-questtype)
```

```
## now that we have started the data wrangling we will categorize all
## institutions by size remember that for some wicked reason they use
## -97 for missing values for anything without a proper missing value
## code for each question I will start by simply nulling every single
## -97 so we can see how much is missing and then possibly make a table
## with custom missing values for each like I did in C (remember to
## start from -1000 to -1999 like standard ACLs)
```

```
############################################## 2018
############################################## ##############################################
numberOfCycles = length(dataCyberSecuritySurvey2018TidyName$sizea)

dataCyberSecuritySurvey2018TidyNameSize = dataCyberSecuritySurvey2018TidyName

## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2018TidyNameSize$sizea[i] == -97) {
        dataCyberSecuritySurvey2018TidyNameSize$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2018TidyNameSize$sizeb[i] == -97) {
        dataCyberSecuritySurvey2018TidyNameSize$sizeb[i] = NA
    }

}

############################################## 2019
############################################## ##############################################

numberOfCycles = length(dataCyberSecuritySurvey2019TidyName$sizea)

dataCyberSecuritySurvey2019TidyNameSize = dataCyberSecuritySurvey2019TidyName

## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2019TidyNameSize$sizea[i] == -97) {
        dataCyberSecuritySurvey2019TidyNameSize$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2019TidyNameSize$sizeb[i] == -97) {
        dataCyberSecuritySurvey2019TidyNameSize$sizeb[i] = NA
    }

}

############################################## 2020
############################################## ##############################################

numberOfCycles = length(dataCyberSecuritySurvey2020TidyName$sizea)

dataCyberSecuritySurvey2020TidyNameSize = dataCyberSecuritySurvey2020TidyName

## apparently we have to be careful because an already inserted NA on
## the variable breaks the
```

```
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2020TidyNameSize$sizea[i] == -97) {
        dataCyberSecuritySurvey2020TidyNameSize$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2020TidyNameSize$sizeb[i] == -97) {
        dataCyberSecuritySurvey2020TidyNameSize$sizeb[i] = NA
    }
}

############################################## 2021
############################################## ##############################################

numberOfCycles = length(dataCyberSecuritySurvey2021TidyName$sizea)

dataCyberSecuritySurvey2021TidyNameSize = dataCyberSecuritySurvey2021TidyName

## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2021TidyNameSize$sizea[i] == -97) {
        dataCyberSecuritySurvey2021TidyNameSize$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2021TidyNameSize$sizeb[i] == -97) {
        dataCyberSecuritySurvey2021TidyNameSize$sizeb[i] = NA
    }
}

############################################## 2022
############################################## ##############################################

numberOfCycles = length(dataCyberSecuritySurvey2022TidyName$sizea)

dataCyberSecuritySurvey2022TidyNameSize = dataCyberSecuritySurvey2022TidyName

## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2022TidyNameSize$sizea[i] == -97) {
        dataCyberSecuritySurvey2022TidyNameSize$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2022TidyNameSize$sizeb[i] == -97) {
        dataCyberSecuritySurvey2022TidyNameSize$sizeb[i] = NA
    }
}
```

```
## we don't need neither the combined regions (since those are for
## business analyzes and we don't do those) same for sector_comb1 and
```

```r
## 2.

## region_comb? throw it in the trash. sector_comb1? throw it in the
## trash. sector_comb2? throw it in the trash.

############################################## 2018
############################################## ##############################################

dataCyberSecuritySurvey2018TidyNameSize = dataCyberSecuritySurvey2018TidyNameSize %>%
    select(-one_of("region_comb", "sector_comb1", "sector_comb2"))

############################################## 2019
############################################## ##############################################

dataCyberSecuritySurvey2019TidyNameSize = dataCyberSecuritySurvey2019TidyNameSize %>%
    select(-one_of("region_comb", "sector_comb2"))

############################################## 2020
############################################## ##############################################

dataCyberSecuritySurvey2020TidyNameSize = dataCyberSecuritySurvey2020TidyNameSize %>%
    select(-one_of("region_comb", "sector_comb2"))

############################################## 2021
############################################## ##############################################

dataCyberSecuritySurvey2021TidyNameSize = dataCyberSecuritySurvey2021TidyNameSize %>%
    select(-one_of("region_comb", "sector_comb2"))

############################################## 2022
############################################## ##############################################

dataCyberSecuritySurvey2022TidyNameSize = dataCyberSecuritySurvey2022TidyNameSize %>%
    select(-one_of("region_comb", "sector_comb2"))
```

```r
## removing social media questions that are irrelevant because they are
## absolutely terrible metrics to understand the digitalization of an
## institution Note to self: if I have time get all of these type of
## functions in try catch because them breaking up with the select
## error is no good and it makes me cry every time I have to manually
## run a part of the snippet and see which is one the bad one
## https://r-lang.com/r-trycatch-function/ ## #FicaADica

############################################## 2018
############################################## ##############################################

dataCyberSecuritySurvey2018TidyNameSize = dataCyberSecuritySurvey2018TidyNameSize %>%
```

```
    select(-(online1:online11))

############################################### 2019
############################################### ###############################################

dataCyberSecuritySurvey2019TidyNameSize = dataCyberSecuritySurvey2019TidyNameSize %>%
    select(-(online1:online11))

############################################### 2020
############################################### ###############################################

dataCyberSecuritySurvey2020TidyNameSize = dataCyberSecuritySurvey2020TidyNameSize %>%
    select(-(online1:online11))

############################################### 2021
############################################### ###############################################

dataCyberSecuritySurvey2021TidyNameSize = dataCyberSecuritySurvey2021TidyNameSize %>%
    select(-(online1:online11))

############################################### 2022
############################################### ###############################################

dataCyberSecuritySurvey2022TidyNameSize = dataCyberSecuritySurvey2022TidyNameSize %>%
    select(-(online1:online14))
```

```
## removing the question about the mobile usage because it also is a
## terrible indicator of a company digitalization

############################################### 2018
############################################### ###############################################

dataCyberSecuritySurvey2018TidyNameSize = dataCyberSecuritySurvey2018TidyNameSize %>%
    select(-mobile)

############################################### 2019
############################################### ###############################################

dataCyberSecuritySurvey2019TidyNameSize = dataCyberSecuritySurvey2019TidyNameSize %>%
    select(-mobile)

############################################### 2020
############################################### ###############################################

dataCyberSecuritySurvey2020TidyNameSize = dataCyberSecuritySurvey2020TidyNameSize %>%
    select(-mobile)
```

```
############################################## 2021
############################################## ##############################################

dataCyberSecuritySurvey2021TidyNameSize = dataCyberSecuritySurvey2021TidyNameSize %>%
    select(-mobile)

############################################## 2022
############################################## ##############################################

dataCyberSecuritySurvey2022TidyNameSize = dataCyberSecuritySurvey2022TidyNameSize %>%
    select(-mobile)
```

```
## question about the attitude and outsourcing of cyber security have
## been removed the the surveys starting from 2020 so it doesn't make
## sense to keep them in the 2018 and 2019 data set

## I will start doing some proper garbage collection and this time I am
## not just taking myself out I will only ever have the original data
## and the most recent modified one


############################################## 2018
############################################## ##############################################

dataCyberSecuritySurvey2018TidyNameSize = dataCyberSecuritySurvey2018TidyNameSize %>%
    select(-(outsource:attitude4))

############################################## 2019
############################################## ##############################################

dataCyberSecuritySurvey2019TidyNameSize = dataCyberSecuritySurvey2019TidyNameSize %>%
    select(-(outsource:attitude4))
```

```
## since we want to have access to some proper data we will tidy the
## questions about how big of a priority is cyber security and how
## often are the higher ups updated about it this could really use some
## try catches because for the some weird reason -97 == NA does not
## return true or false, this is like javascript levels of bad

## also excepting this very first one the removals will be at the end
## so they are computed as if they were a transaction because try and
## catch is a lie to sell more lines of codes

## thanks to a blessing for our lord not finding the object only gives
## a warning and we ignore those as long as it still lets run the rest
## of the code
```

```r
rm(dataCyberSecuritySurvey2018TidyName)
rm(dataCyberSecuritySurvey2019TidyName)
rm(dataCyberSecuritySurvey2020TidyName)
rm(dataCyberSecuritySurvey2021TidyName)
rm(dataCyberSecuritySurvey2022TidyName)

############################################## 2018
############################################## ##############################################
numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSize$priority)

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSize

## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$priority[i] == -97) {
        dataCyberSecuritySurvey2018TidyNameSizeCyber$priority[i] = NA
    }
    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$update[i] == -97) {
        dataCyberSecuritySurvey2018TidyNameSizeCyber$update[i] = NA
    }

}

############################################## 2019
############################################## ##############################################

numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSize$priority)

dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSize


## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$priority[i] == -97) {
        dataCyberSecuritySurvey2019TidyNameSizeCyber$priority[i] = NA
    }
    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$update[i] == -97) {
        dataCyberSecuritySurvey2019TidyNameSizeCyber$update[i] = NA
    }

}

############################################## 2020
############################################## ##############################################
```

```
numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSize$priority)

dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSize


## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$priority[i] == -97) {
        dataCyberSecuritySurvey2020TidyNameSizeCyber$priority[i] = NA
    }
    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$update[i] == -97) {
        dataCyberSecuritySurvey2020TidyNameSizeCyber$update[i] = NA
    }
}

################################################ 2021
################################################ ################################################

numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSize$priority)

dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSize


## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$priority[i] == -97) {
        dataCyberSecuritySurvey2021TidyNameSizeCyber$priority[i] = NA
    }
    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$update[i] == -97) {
        dataCyberSecuritySurvey2021TidyNameSizeCyber$update[i] = NA
    }
}

################################################ 2022
################################################ ################################################

numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSize$priority)

dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSize


## apparently we have to be careful because an already inserted NA on
## the variable breaks the
for (i in 1:numberOfCycles) {
    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$priority[i] == -97) {
```

```
        dataCyberSecuritySurvey2022TidyNameSizeCyber$priority[i] = NA
    }
    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$update[i] == -97) {
        dataCyberSecuritySurvey2022TidyNameSizeCyber$update[i] = NA
    }
}

## garbage man? Well, of course I know him. He is me.

rm(dataCyberSecuritySurvey2018TidyNameSize)
rm(dataCyberSecuritySurvey2019TidyNameSize)
rm(dataCyberSecuritySurvey2020TidyNameSize)
rm(dataCyberSecuritySurvey2021TidyNameSize)
rm(dataCyberSecuritySurvey2022TidyNameSize)
```

```
## questions about reason of investment in cybersecuirty were removed
## form the pre-pilot survey in 2020

################################################ 2018
################################################ ################################################

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(reason1:reason27))

################################################ 2019
################################################ ################################################

dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(reason1:reason28))

## the rest were already deleted
```

```
## removing the cyber security insurance claims because they don't give
## us relevant data to what we are analyzing in the data set pro tip:
## having insurance does not make you more or less likely to be
## targeted nor does it change the costs of the attack

################################################ 2018
################################################ ################################################

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(insurex:noinsure19))

################################################ 2019
################################################ ################################################
```

```r
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(insurex:noinsure19))

############################################## 2020
############################################## ##############################################

dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(insurex:claim))

############################################## 2021
############################################## ##############################################

dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(insurex:claim))

############################################## 2022
############################################## ##############################################

dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(insurex:claim))
```

```r
## we are removing the questions about asking for info, advice,
## guidance about cyber security or government schemes

############################################## 2018
############################################## ##############################################

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(info1:trainwho7))

############################################## 2019
############################################## ##############################################

dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(info1:trainwho7))

############################################## 2020
############################################## ##############################################

dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(info1:scheme5))

############################################## 2021
############################################## ##############################################

dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(info1:scheme5))
```

```
################################################ 2022
################################################ ################################################

## here we have more that we need to remove because they introduced
## questions similar to the ones that we are removing but with the
## government as a source for reason to make implementations which we
## are also not interested in

dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(info1:govtact44))
```

0.15 adjusting the size scales

```
######################################################## 2022
######################################################## ########################################

## here we are adding the scale 5 that is missing from the questionary
## and by doing this we will get both better imputations and better
## scaling for the graphics

dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb = as.numeric(dataCyberSecuritySurvey2022Tid
dataCyberSecuritySurvey2022TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2022Tid

##
for (i in 1:nrow(dataCyberSecuritySurvey2022TidyNameSizeCyber)) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$sizea[i] = replace_na(dataCyberSecuritySurvey
        -10004)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb[i] = replace_na(dataCyberSecuritySurvey
        -10004)

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$sizea[i] > 999) {
        dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb[i] = 5
    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$sizea[i] == -10004) {
        dataCyberSecuritySurvey2022TidyNameSizeCyber$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb[i] == -10004) {
        dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb[i] = NA
    }


}
```

```r
dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2022Tidy


######################################################## 2021
######################################################## ######################################

## here we are adding the scale 5 that is missing from the questionary
## and by doing this we will get both better imputations and better
## scaling for the graphics

dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb = as.numeric(dataCyberSecuritySurvey2021Tid
dataCyberSecuritySurvey2021TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2021Tid

##
for (i in 1:nrow(dataCyberSecuritySurvey2021TidyNameSizeCyber)) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$sizea[i] = replace_na(dataCyberSecuritySurvey
        -10004)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb[i] = replace_na(dataCyberSecuritySurvey
        -10004)

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$sizea[i] > 999) {
        dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb[i] = 5
    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$sizea[i] == -10004) {
        dataCyberSecuritySurvey2021TidyNameSizeCyber$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb[i] == -10004) {
        dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb[i] = NA
    }


}

dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2021Tidy

######################################################## 2020
######################################################## ######################################

## here we are adding the scale 5 that is missing from the questionary
## and by doing this we will get both better imputations and better
## scaling for the graphics

dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb = as.numeric(dataCyberSecuritySurvey2020Tid
dataCyberSecuritySurvey2020TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2020Tid
```

```r
##
for (i in 1:nrow(dataCyberSecuritySurvey2020TidyNameSizeCyber)) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$sizea[i] = replace_na(dataCyberSecuritySurvey
        -10004)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb[i] = replace_na(dataCyberSecuritySurvey
        -10004)

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$sizea[i] > 999) {
        dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb[i] = 5
    }

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$sizea[i] == -10004) {
        dataCyberSecuritySurvey2020TidyNameSizeCyber$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb[i] == -10004) {
        dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb[i] = NA
    }


}

dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2020Tidy


######################################################## 2019
######################################################## ########################################

## here we are adding the scale 5 that is missing from the questionary
## and by doing this we will get both better imputations and better
## scaling for the graphics

dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb = as.numeric(dataCyberSecuritySurvey2019Tid
dataCyberSecuritySurvey2019TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2019Tid

##
for (i in 1:nrow(dataCyberSecuritySurvey2019TidyNameSizeCyber)) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$sizea[i] = replace_na(dataCyberSecuritySurvey
        -10004)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb[i] = replace_na(dataCyberSecuritySurvey
        -10004)

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$sizea[i] > 999) {
        dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb[i] = 5
    }
```

```
    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$sizea[i] == -10004) {
        dataCyberSecuritySurvey2019TidyNameSizeCyber$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb[i] == -10004) {
        dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb[i] = NA
    }


}

dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2019Tidy


########################################################## 2018
########################################################## ########################################

## here we are adding the scale 5 that is missing from the questionary
## and by doing this we will get both better imputations and better
## scaling for the graphics

dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb = as.numeric(dataCyberSecuritySurvey2018Tid
dataCyberSecuritySurvey2018TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2018Tid

##
for (i in 1:nrow(dataCyberSecuritySurvey2018TidyNameSizeCyber)) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$sizea[i] = replace_na(dataCyberSecuritySurvey
        -10004)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb[i] = replace_na(dataCyberSecuritySurvey
        -10004)

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$sizea[i] > 999) {
        dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb[i] = 5
    }

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$sizea[i] == -10004) {
        dataCyberSecuritySurvey2018TidyNameSizeCyber$sizea[i] = NA
    }
    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb[i] == -10004) {
        dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb[i] = NA
    }


}

dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2018Tidy
```

0.16 Management - now is when the policies and procedures are evaluated

```
## manage 1 - Board members/trustees with responsibility for cyber
## security manage 2 - outsourcing cyber security manage 3 - formal
## policy or policies in place covering cyber security risks manage 4 -
## Business Continuity Plan manage 5 - Staff members whose job role
## includes information security or governance //it stopped being used
## after the 2020 survey manage 6 - don't know/missing data manage 7 -
## absolutely nothings, good luck have fun (rip bozzo) manage 8 -
## written list of what is critical to protect (only exists in the
## survey of 2022 not to be used)

## altura de me desemerdar que esta aqui esta mesmo grossa não faz
## frio, nem orvalho, está a chover para caralho converting the final
## value to a collection so I can append all the values //facepalm this
## is where the coping begins, thank goodness no one will ever know
## what I had done here before refactoring and optimising the code

## managementContinuity - there is a business continuity plan (manage
## 4) or there are formal policies implemented (outcome 3)
## managementCyber - board members or trustees have cyber security
## responsibilities (manage 1) or cyber security is being outsourced
## (manage 2) (also known as the at least they tried but no matter how
## funny it is terrible variable name)

######################################################## 2018
######################################################## ########################################

numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$manage1)

dataCyberSecuritySurvey2018TidyNameSizeCyber$managementContinuity = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$managementCyber = 0


for (i in 1:numberOfCycles) {

    ## at least this time I am not starting from the last so I don't
    ## have to wait the 10 minutes for my computer to fry some eggs
    ## while it compiles

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$manage1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1 or 2

        dataCyberSecuritySurvey2018TidyNameSizeCyber$managementCyber[i] = 1

    }
```

```
    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$manage3[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 3 or 4

        dataCyberSecuritySurvey2018TidyNameSizeCyber$managementContinuity[i] = 1

    }

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$manage6[i] == 1) {

        dataCyberSecuritySurvey2018TidyNameSizeCyber$managementCyber[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$managementContinuity[i] = NA

    }

}



######################################################## 2019
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$manage1)

dataCyberSecuritySurvey2019TidyNameSizeCyber$managementContinuity = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$managementCyber = 0


for (i in 1:numberOfCycles) {

    ## at least this time I am not starting from the last so I don't
    ## have to wait the 10 minutes for my computer to fry some eggs
    ## while it compiles

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$manage1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1 or 2

        dataCyberSecuritySurvey2019TidyNameSizeCyber$managementCyber[i] = 1

    }

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$manage3[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 3 or 4
```

```
        dataCyberSecuritySurvey2019TidyNameSizeCyber$managementContinuity[i] = 1

    }

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$manage6[i] == 1) {

        dataCyberSecuritySurvey2019TidyNameSizeCyber$managementCyber[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$managementContinuity[i] = NA

    }
}



######################################################## 2020
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$manage1)

dataCyberSecuritySurvey2020TidyNameSizeCyber$managementContinuity = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$managementCyber = 0


for (i in 1:numberOfCycles) {

    ## at least this time I am not starting from the last so I don't
    ## have to wait the 10 minutes for my computer to fry some eggs
    ## while it compiles

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$manage1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1 or 2

        dataCyberSecuritySurvey2020TidyNameSizeCyber$managementCyber[i] = 1

    }

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$manage3[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 3 or 4

        dataCyberSecuritySurvey2020TidyNameSizeCyber$managementContinuity[i] = 1

    }

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$manage6[i] == 1) {
```

```
        dataCyberSecuritySurvey2020TidyNameSizeCyber$managementCyber[i] = NA
        dataCyberSecuritySurvey2020TidyNameSizeCyber$managementContinuity[i] = NA

    }
}


######################################################## 2021
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$manage1)

dataCyberSecuritySurvey2021TidyNameSizeCyber$managementContinuity = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$managementCyber = 0


for (i in 1:numberOfCycles) {

    ## at least this time I am not starting from the last so I don't
    ## have to wait the 10 minutes for my computer to fry some eggs
    ## while it compiles

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$manage1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1 or 2

        dataCyberSecuritySurvey2021TidyNameSizeCyber$managementCyber[i] = 1

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$manage3[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 3 or 4

        dataCyberSecuritySurvey2021TidyNameSizeCyber$managementContinuity[i] = 1

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$manage6[i] == 1) {

        dataCyberSecuritySurvey2021TidyNameSizeCyber$managementCyber[i] = NA
        dataCyberSecuritySurvey2021TidyNameSizeCyber$managementContinuity[i] = NA

    }
}
```

```
##################################################### 2022
##################################################### ########################################


numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$manage1)

dataCyberSecuritySurvey2022TidyNameSizeCyber$managementContinuity = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$managementCyber = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage1[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage2[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage3[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage4[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage5[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage6[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage7[i] = replace_na(dataCyberSecuritySurv
        -10001)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$manage8[i] = replace_na(dataCyberSecuritySurv
        -10001)

    ## at least this time I am not starting from the last so I don't
    ## have to wait the 10 minutes for my computer to fry some eggs
    ## while it compiles

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$manage1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1 or 2

        dataCyberSecuritySurvey2022TidyNameSizeCyber$managementCyber[i] = 1

    } else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$manage1[i] == -10001 &&
        dataCyberSecuritySurvey2022TidyNameSizeCyber$manage2[i] == -10001) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$managementCyber[i] = NA
    }
```

```
    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$manage3[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 3 or 4

        dataCyberSecuritySurvey2022TidyNameSizeCyber$managementContinuity[i] = 1

    } else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$manage3[i] == -10001 &&
        dataCyberSecuritySurvey2022TidyNameSizeCyber$manage4[i] == -10001) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$managementCyber[i] = NA
    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$manage6[i] == 1) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$managementCyber[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$managementContinuity[i] = NA

    }
}



dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(manage1:manage7))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(manage1:manage7))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(manage1:manage7))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(manage1:manage7))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(manage1:manage8))
```

```
## now we are removing the reasons why they don't have the appropriate
## measures because we are more interested in the questions about
## security after these ones also it was deleted after 2019

## that is a catch 22
dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(nopol1:nopol22))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(nopol1:nopol22))
```

```
## sadly all the questions about measures done in the last 12 moths
## have changes quite a bit during the years which makes it impossible
## to have a good year to year analysis when we aren't comparing the
```

```r
## same thing

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(ident1:ident8))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(ident1:ident8))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(ident1:ident11))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(ident1:ident11))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(ident1:ident7))

## this only exists in 2022 so it makes no sense to look at
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(comply1:audit))
```

0.17 Rules for company policies

```r
## This is where the fun begins with some proper policies simping for
## incremental backups


## rule 1 - applying software updates rule 2 - up to date maleware
## protection rule 3 - well configured firewalls rule 4 - proper
## permission configuration rule 5 - monitoring user activity rule 6 -
## encrypting personal data // only used in 2018 rule 7 - security
## controls on company devices rule 8 - only allowing access from
## company devices rule 9 - segregated guest wireless / so basically a
## DMZ rule 10 - don't know rule 11 - none (YOLO) rule 12 - strong
## passwords //only used in 2018 rule 13 - backup data to the cloud
## (diskette robots in data center go brrrrrrr) rule 14 - backup the
## data to another place that isn't the cloud rule 15 - storing and
## moving data/files securely //wasn't used in 2018 rule 16 - 2 factor
## authentication // only used in 2019 rule 17 - policy for strong
## passwords //not til 2020 rule 18 - VPN (virtual private network)
## //only in 2022 rule 19 - phishing procedure // only in 2022 rule 20
## - authentication when accessing the network // only in 2022


## TODO TODO TODO TODO unduck this mess as well because I just don't
## know anymore good news is that I have a solution, bad news is that
## it is not a perfect solution at least I won't be able to cause a
## stack overflow because with a precision of 53 bits, and represents
## to that precision a range of absolute values from about 2e-308 to
## 2e+308
```

```
## Rules grouping for optimisation

## TODO might have too much in common and separate both security confs
## and updating with .baks

## rulesUpdating - keeping spftware and maleware protection up to date
## (rule 1 and 2) and baking up information ( rule 13, 14 and 15(not in
## 2018 ) ) rulesSecurityConfigs - well configured firewalls and
## permission (rule 3 and 4), DMZ (rule 9) and strong passwords (rule
## 17 not in 2018) rulesUserControl - monitoring user activity (rule 5)
## as well as good security control and access control (rule 7 and rule
## 8)


######################################################## 2018
######################################################## ########################################



numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$rules1)

dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUpdating = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesSecurityConfigs = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUserControl = 0


for (i in 1:numberOfCycles) {

    ## the code is now be faster and other hilarious jokes you can tell
    ## yourself

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$rules1[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2018TidyNameSizeCyber$rules13[i] == 1 ||
        dataCyberSecuritySurvey2018TidyNameSizeCyber$rules14[i] == 1  #dataCyberSecuritySurvey
) {
        ## either 1,2,13,14 and 15 after 2018

        dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUpdating[i] = 1

    }
    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$rules3[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2018TidyNameSizeCyber$rules9[i] == 1  #dataCyberSecuritySu
) {
        ## either 3,4,9 and 17 after 2018

        dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesSecurityConfigs[i] = 1
```

```
    }

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$rules5[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2018TidyNameSizeCyber$rules8[i] == 1) {
        ## either 5,7,8

        dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUserControl[i] = 1

    }

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$rules10[i] == 1) {

        dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUserControl[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesSecurityConfigs[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUpdating[i] = NA

    }


}


##################################################### 2019
##################################################### ########################################




numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$rules1)

dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUpdating = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesSecurityConfigs = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUserControl = 0


for (i in 1:numberOfCycles) {

    ## the code is now be faster and other hilarious jokes you can tell
    ## yourself

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$rules1[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2019TidyNameSizeCyber$rules13[i] == 1 ||
        dataCyberSecuritySurvey2019TidyNameSizeCyber$rules14[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1,2,13,14 and 15

        dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUpdating[i] = 1
```

```
    }
    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$rules3[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2019TidyNameSizeCyber$rules9[i] == 1  #dataCyberSecuritySu
) {
        ## either 3,4,9 and 17 after 2019

        dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesSecurityConfigs[i] = 1

    }

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$rules5[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2019TidyNameSizeCyber$rules8[i] == 1) {
        ## either 5,7,8

        dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUserControl[i] = 1

    }

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$rules10[i] == 1) {

        dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUserControl[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesSecurityConfigs[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUpdating[i] = NA

    }


}



######################################################## 2020
######################################################## ########################################



numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$rules1)

dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUpdating = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesSecurityConfigs = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUserControl = 0


for (i in 1:numberOfCycles) {

    ## the code is now be faster and other hilarious jokes you can tell
    ## yourself
```

```
    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$rules1[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2020TidyNameSizeCyber$rules13[i] == 1 ||
        dataCyberSecuritySurvey2020TidyNameSizeCyber$rules14[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1,2,13,14 and 15

        dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUpdating[i] = 1

    }
    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$rules3[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2020TidyNameSizeCyber$rules9[i] == 1 ||
        dataCyberSecuritySurvey2020TidyNameSizeCyber$rules17[i] == 1) {
        ## either 3,4,9 and 17

        dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesSecurityConfigs[i] = 1

    }

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$rules5[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2020TidyNameSizeCyber$rules8[i] == 1) {
        ## either 5,7,8

        dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUserControl[i] = 1

    }

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$rules10[i] == 1) {

        dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUserControl[i] = NA
        dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesSecurityConfigs[i] = NA
        dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUpdating[i] = NA

    }


}

######################################################## 2021
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$rules1)

dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUpdating = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesSecurityConfigs = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUserControl = 0
```

```r
for (i in 1:numberOfCycles) {

    ## the code is now be faster and other hilarious jokes you can tell
    ## yourself

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$rules1[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2021TidyNameSizeCyber$rules13[i] == 1 ||
        dataCyberSecuritySurvey2021TidyNameSizeCyber$rules14[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1,2,13,14 and 15

        dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUpdating[i] = 1

    }
    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$rules3[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2021TidyNameSizeCyber$rules9[i] == 1 ||
        dataCyberSecuritySurvey2021TidyNameSizeCyber$rules17[i] == 1) {
        ## either 3,4,9 and 17

        dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesSecurityConfigs[i] = 1

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$rules5[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2021TidyNameSizeCyber$rules8[i] == 1) {
        ## either 5,7,8

        dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUserControl[i] = 1

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$rules10[i] == 1) {

        dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUserControl[i] = NA
        dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesSecurityConfigs[i] = NA
        dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUpdating[i] = NA

    }


}


######################################################## 2022
######################################################## ########################################
```

```r
numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$rules1)

dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUpdating = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesSecurityConfigs = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUserControl = 0


for (i in 1:numberOfCycles) {

    ## oh my ducking god just why, this error message was worse then
    ## c++ apparently if you have a missing value on an if with more
    ## than 1 parameter it shows that the missing value error is on the
    ## first parameter so in this case was rule 5, i swear not even
    ## with enough crying and praying I would have gotten there, this
    ## bull crap

    dataCyberSecuritySurvey2022TidyNameSizeCyber$rules8[i] = replace_na(dataCyberSecuritySurve
        -10004)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$rules9[i] = replace_na(dataCyberSecuritySurve
        -10004)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$rules12[i] = replace_na(dataCyberSecuritySurv
        -10004)

    ## the code is now be faster and other hilarious jokes you can tell
    ## yourself

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$rules1[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2022TidyNameSizeCyber$rules13[i] == 1 ||
        dataCyberSecuritySurvey2022TidyNameSizeCyber$rules14[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 1,2,13,14 and 15

        dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUpdating[i] = 1

    }
    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$rules3[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2022TidyNameSizeCyber$rules9[i] == 1 ||
        dataCyberSecuritySurvey2022TidyNameSizeCyber$rules17[i] == 1) {
        ## either 3,4,9 and 17

        dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesSecurityConfigs[i] = 1

    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$rules5[i] == 1 || dataCyberSecuritySurvey
        1 || dataCyberSecuritySurvey2022TidyNameSizeCyber$rules8[i] == 1) {
        ## either 5,7,8
```

```
        dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUserControl[i] = 1

    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$rules10[i] == 1) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUserControl[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesSecurityConfigs[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUpdating[i] = NA

    }


}


## now we can remove all those rules columns that we are no longer
## using

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(rules1:rules14))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(rules1:rules16))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(rules1:rules17))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(rules1:rules17))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(rules1:rules20))
```

0.18 Policies

```
## we do a little policing but sadly not the one QoS type on cisco
## servers to be fair it would be as painful to debug


## policy 1 - what can be stored in the removable devices policy 2 -
## remote working policy 3 - what staff are permitted to do on your
## organisations IT devices policy 4 - use of personally-owned devices
## for business activities policy 5 - Use of new digital technologies
## such as cloud computing (seriously what the hell is this question
## smh) policy 6 - data classification policy 7 - a Document Management
## System policy 8 - don't know (estudasses) policy 9 - none of these
## (YOLO) policies 10,11 and 12 were only made in 2022 but since they
## started using policy 11 and 12 instead of the policy 6 and 7 they
## will replace them policy 11 - SaS (software as a service) policy 12
```

```
## - how to store data



## TODO TODO TODO TODO unduck this mess as well because I just don't
## know anymore good news is that I have a solution, bad news is that
## it is not a perfect solution at least I won't be able to cause a
## stack overflow because with a precision of 53 bits, and represents
## to that precision a range of absolute values from about 2e-308 to
## 2e+308

## even better news I have a better solution that will make the code
## run with two legs instead of just half a leg

## policyStaffAccess - staff who is allowed to work remotely (policy
## 2), policing of what staff are permited to do om company devices
## (policy 3) and cloud computing (policy 5) policyData -
## classification of data (policy 6) and document management system
## (policy 7) policyPrivate - staff is not allowed to work on personal
## devices (policy 4) and cannot just store anything on removable
## devices (policy 1)




########################################################## 2018
########################################################## ########################################

## at this point I don't know what my code is more, poorly optimized,
## spaghetti or just straight up cringe

numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$policy1)

dataCyberSecuritySurvey2018TidyNameSizeCyber$policyStaffAccess = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$policyData = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$policyPrivate = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$policy1[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$policy2[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$policy3[i] = replace_na(dataCyberSecuritySurv
        -10005)
```

```
dataCyberSecuritySurvey2018TidyNameSizeCyber$policy4[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2018TidyNameSizeCyber$policy5[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2018TidyNameSizeCyber$policy6[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2018TidyNameSizeCyber$policy7[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2018TidyNameSizeCyber$policy8[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2018TidyNameSizeCyber$policy9[i] = replace_na(dataCyberSecuritySurv
    -10005)

if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy2[i] == 1 || dataCyberSecuritySurve
    1 || dataCyberSecuritySurvey2018TidyNameSizeCyber$policy5[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2018TidyNameSizeCyber$policyStaffAccess[i] = 1

} else if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy2[i] == -10005 &&
    dataCyberSecuritySurvey2018TidyNameSizeCyber$policy3[i] == -10005 &&
    dataCyberSecuritySurvey2018TidyNameSizeCyber$policy5[i] == -10005) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$policyStaffAccess[i] = NA

}

if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy6[i] == 1 || dataCyberSecuritySurve
    1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2018TidyNameSizeCyber$policyData[i] = 1

} else if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy6[i] == -10005 &&
    dataCyberSecuritySurvey2018TidyNameSizeCyber$policy7[i] == -10005) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$policyData[i] = NA

}

if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy1[i] == 1 || dataCyberSecuritySurve
    1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2018TidyNameSizeCyber$policyPrivate[i] = 1

} else if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy1[i] == -10005 &&
```

```
        dataCyberSecuritySurvey2018TidyNameSizeCyber$policy4[i] == -10005) {

        dataCyberSecuritySurvey2018TidyNameSizeCyber$policyPrivate[i] = NA

    }

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$policy8[i] == 1) {
        ## NA

        dataCyberSecuritySurvey2018TidyNameSizeCyber$policyPrivate[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$policyData[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$policyStaffAccess[i] = NA

    }

}


######################################################## 2019
######################################################## ########################################



## at this point I don't know what my code is more, poorly optimized,
## spaghetti or just straight up cringe

numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$policy1)

dataCyberSecuritySurvey2019TidyNameSizeCyber$policyStaffAccess = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$policyData = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$policyPrivate = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy1[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy2[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy3[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy4[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy5[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy6[i] = replace_na(dataCyberSecuritySurv
        -10005)
```

```
dataCyberSecuritySurvey2019TidyNameSizeCyber$policy7[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2019TidyNameSizeCyber$policy8[i] = replace_na(dataCyberSecuritySurv
    -10005)
dataCyberSecuritySurvey2019TidyNameSizeCyber$policy9[i] = replace_na(dataCyberSecuritySurv
    -10005)

if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy2[i] == 1 || dataCyberSecuritySurve
    1 || dataCyberSecuritySurvey2019TidyNameSizeCyber$policy5[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policyStaffAccess[i] = 1

} else if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy2[i] == -10005 &&
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy3[i] == -10005 &&
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy5[i] == -10005) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policyStaffAccess[i] = NA

}

if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy6[i] == 1 || dataCyberSecuritySurve
    1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policyData[i] = 1

} else if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy6[i] == -10005 &&
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy7[i] == -10005) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policyData[i] = NA

}

if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy1[i] == 1 || dataCyberSecuritySurve
    1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policyPrivate[i] = 1

} else if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy1[i] == -10005 &&
    dataCyberSecuritySurvey2019TidyNameSizeCyber$policy4[i] == -10005) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$policyPrivate[i] = NA

}
```

```
    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$policy8[i] == 1) {
        ## NA

        dataCyberSecuritySurvey2019TidyNameSizeCyber$policyPrivate[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$policyData[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$policyStaffAccess[i] = NA

    }

}


######################################################## 2020
######################################################## ########################################



## at this point I don't know what my code is more, poorly optimized,
## spaghetti or just straight up cringe

numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$policy1)

dataCyberSecuritySurvey2020TidyNameSizeCyber$policyStaffAccess = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$policyData = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$policyPrivate = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy1[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy2[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy3[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy4[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy5[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy6[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy7[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy8[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy9[i] = replace_na(dataCyberSecuritySurv
        -10005)
```

```
if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy2[i] == 1 || dataCyberSecuritySurve
    1 || dataCyberSecuritySurvey2020TidyNameSizeCyber$policy5[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyStaffAccess[i] = 1

} else if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy2[i] == -10005 &&
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy3[i] == -10005 &&
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy5[i] == -10005) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyStaffAccess[i] = NA

}

if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy6[i] == 1 || dataCyberSecuritySurve
    1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyData[i] = 1

} else if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy6[i] == -10005 &&
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy7[i] == -10005) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyData[i] = NA

}

if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy1[i] == 1 || dataCyberSecuritySurve
    1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyPrivate[i] = 1

} else if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy1[i] == -10005 &&
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policy4[i] == -10005) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyPrivate[i] = NA

}

if (dataCyberSecuritySurvey2020TidyNameSizeCyber$policy8[i] == 1) {
    ## NA

    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyPrivate[i] = NA
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyData[i] = NA
    dataCyberSecuritySurvey2020TidyNameSizeCyber$policyStaffAccess[i] = NA
```

```
    }

}

######################################################## 2021
######################################################## ########################################



## at this point I don't know what my code is more, poorly optimized,
## spaghetti or just straight up cringe

numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$policy1)

dataCyberSecuritySurvey2021TidyNameSizeCyber$policyStaffAccess = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$policyData = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$policyPrivate = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy1[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy2[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy3[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy4[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy5[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy6[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy7[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy8[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$policy9[i] = replace_na(dataCyberSecuritySurv
        -10005)

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy2[i] == 1 || dataCyberSecuritySurve
        1 || dataCyberSecuritySurvey2021TidyNameSizeCyber$policy5[i] == 1) {
        ## either 2,3,4

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyStaffAccess[i] = 1

    } else if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy2[i] == -10005 &&
```

```
        dataCyberSecuritySurvey2021TidyNameSizeCyber$policy3[i] == -10005 &&
        dataCyberSecuritySurvey2021TidyNameSizeCyber$policy5[i] == -10005) {

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyStaffAccess[i] = NA

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy6[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 2,3,4

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyData[i] = 1

    } else if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy6[i] == -10005 &&
        dataCyberSecuritySurvey2021TidyNameSizeCyber$policy7[i] == -10005) {

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyData[i] = NA

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 2,3,4

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyPrivate[i] = 1

    } else if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy1[i] == -10005 &&
        dataCyberSecuritySurvey2021TidyNameSizeCyber$policy4[i] == -10005) {

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyPrivate[i] = NA

    }

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$policy8[i] == 1) {
        ## NA

        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyPrivate[i] = NA
        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyData[i] = NA
        dataCyberSecuritySurvey2021TidyNameSizeCyber$policyStaffAccess[i] = NA

    }

}


##################################################### 2022
##################################################### ########################################
```

```r
## at this point I don't know what my code is more, poorly optimized,
## spaghetti or just straight up cringe

numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$policy1)

dataCyberSecuritySurvey2022TidyNameSizeCyber$policyStaffAccess = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$policyData = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$policyPrivate = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy1[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy2[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy3[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy4[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy5[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy11[i] = replace_na(dataCyberSecuritySur
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy12[i] = replace_na(dataCyberSecuritySur
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy8[i] = replace_na(dataCyberSecuritySurv
        -10005)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$policy9[i] = replace_na(dataCyberSecuritySurv
        -10005)

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy2[i] == 1 || dataCyberSecuritySurve
        1 || dataCyberSecuritySurvey2022TidyNameSizeCyber$policy5[i] == 1) {
        ## either 2,3,4

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyStaffAccess[i] = 1

    } else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy2[i] == -10005 &&
        dataCyberSecuritySurvey2022TidyNameSizeCyber$policy3[i] == -10005 &&
        dataCyberSecuritySurvey2022TidyNameSizeCyber$policy5[i] == -10005) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyStaffAccess[i] = NA

    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy11[i] == 1 ||
```

```
        dataCyberSecuritySurvey2022TidyNameSizeCyber$policy12[i] == 1) {
        ## either 2,3,4

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyData[i] = 1

    } else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy11[i] ==
        -10005 && dataCyberSecuritySurvey2022TidyNameSizeCyber$policy12[i] ==
        -10005) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyData[i] = NA

    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy1[i] == 1 || dataCyberSecuritySurve
        1) {
        ## either 2,3,4

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyPrivate[i] = 1

    } else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy1[i] == -10005 &&
        dataCyberSecuritySurvey2022TidyNameSizeCyber$policy4[i] == -10005) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyPrivate[i] = NA

    }

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$policy8[i] == 1) {
        ## NA

        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyPrivate[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyData[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$policyStaffAccess[i] = NA

    }

}


## another day of garbage collection of unused columns

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(policy1:policy9))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(policy1:policy9))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(policy1:policy9))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
```

```
    select(-(policy1:policy9))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(policy1:policy12))
```

```
## taking care of the columns that are only in the 2018 survey

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(doc1:doc6))

## removing the question about if they know about the 10 steps for
## cyber security Spoiler alert: knowing about it doesnt mean you apply
## it and you can learn about it from other sources either way
## https://www.ncsc.gov.uk/collection/10-steps/risk-management

## same for the next question about the cyber essential scheme

## nevermind they removed all the rest of the questions until business
## standard on 2019 and 2020 (Q43)

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(tensteps:implemb))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(tensteps:implemb))

## TODO: think if I should keep the review of cyber security
## documentation colum removing it since i don't have it on 2018 and I
## don't think I will be using it

dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-review)
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-review)
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-review)
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-review)

## in 2022 they asked some proper questions about cyber security
## training and cyber security strategy that will be removed for lack
## of comparrison with the other years

dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(trained:corprisk))


## Removing the question about cyber security conserns in the suppliers
## because 1 - most institutions evaluated here won't be in a scale
```

```
## where that is an important question 2 - if you were a big
## institution you would just have taken of most of the inside managed
## and now would worry about the suppliers on that level you will just
## get multiple suppliers in case your main supplier fails removing the
## SPOF(single point of failure) that way like what would they do
## anyway such a poorly written question, just hire me to write next
## year survey instead

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-supply)

dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-supply)

dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(supplyrisk1:supplyrisk2))

dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(supplyrisk1:supplyrisk2))

dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(supplyrisk1:supplyrisk2))

## questions about supplier standards were deleted after 2019

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(adhere1:cloud))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(adhere1:cloud))

## only asked in 2022 so not relevant for comparrison

dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(barrier1:barrier8))
```

##Type of attacks

```
##type of attacks that targetted the institution
##type 01 - ramsomware infection
##type 02 - spyware, malware or other type of infection
##type 03 - DDOS (distributed denial of service)
##type 04 - hacking online bank accounts
##type 05 - phising - impersonating your organisation
##type 06 - phising - fraudulent emails or website targetting staff
##type 07 - unauthorized access by internal staff members
##type 08 - unauthorized access by outsiders
##type 09 - other type of cyber attacks
##type 10 - don't know
```

```r
##type 11 - (don't care) none of these
##type 12 - refused to answer
##type 13 - unauthorized access by students (to be merged with type 7) // only used starting f
## type 15 and 16 were only collect in 2022 so not to be compared and type 14 just does not ex

##time to some non-git merges on the variables

##attackInfection - ramsomware infection (type 1), spyware, malware and other types (type 2),
##attackPhising - hacking online bank accounts (type 4), phising - impersonating organisation
##attackBreaching - unauthorized access internal staff (type 7), unauthorized access outsiders
##remember that type 10 and 12 is missing data


######################################################## 2018 ###################################

numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$type1)

dataCyberSecuritySurvey2018TidyNameSizeCyber$attackInfection = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$attackPhising = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$attackBreaching = 0

for (i in 1:numberOfCycles) {


    if(dataCyberSecuritySurvey2018TidyNameSizeCyber$type1[i] == 1 || dataCyberSecuritySurvey20

      dataCyberSecuritySurvey2018TidyNameSizeCyber$attackInfection[i] = 1

    }

      if(dataCyberSecuritySurvey2018TidyNameSizeCyber$type4[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2018TidyNameSizeCyber$attackPhising[i] = 1

      }

      if(dataCyberSecuritySurvey2018TidyNameSizeCyber$type7[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2018TidyNameSizeCyber$attackBreaching[i] = 1

      }


      if(
        ##dataCyberSecuritySurvey2018TidyNameSizeCyber$type1[i] == 9 ||
        dataCyberSecuritySurvey2018TidyNameSizeCyber$type10[i] == 1 || dataCyberSecuritySurvey
```

```
      dataCyberSecuritySurvey2018TidyNameSizeCyber$attackPhising[i] = NA
      dataCyberSecuritySurvey2018TidyNameSizeCyber$attackBreaching[i] = NA
      dataCyberSecuritySurvey2018TidyNameSizeCyber$attackInfection[i] = NA

      }

      ## basically if we only know they got other type of attacks (policy 9 then we know the t


}


######################################################## 2019 ###################################


numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$type1)

dataCyberSecuritySurvey2019TidyNameSizeCyber$attackInfection = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$attackPhising = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$attackBreaching = 0

for (i in 1:numberOfCycles) {


    if(dataCyberSecuritySurvey2019TidyNameSizeCyber$type1[i] == 1 || dataCyberSecuritySurvey20

      dataCyberSecuritySurvey2019TidyNameSizeCyber$attackInfection[i] = 1

    }

      if(dataCyberSecuritySurvey2019TidyNameSizeCyber$type4[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2019TidyNameSizeCyber$attackPhising[i] = 1

      }

      if(dataCyberSecuritySurvey2019TidyNameSizeCyber$type7[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2019TidyNameSizeCyber$attackBreaching[i] = 1

      }


      if(
        ##dataCyberSecuritySurvey2019TidyNameSizeCyber$type1[i] == 9 ||
        dataCyberSecuritySurvey2019TidyNameSizeCyber$type10[i] == 1 || dataCyberSecuritySurvey
```

```
      dataCyberSecuritySurvey2019TidyNameSizeCyber$attackPhising[i] = NA
      dataCyberSecuritySurvey2019TidyNameSizeCyber$attackBreaching[i] = NA
      dataCyberSecuritySurvey2019TidyNameSizeCyber$attackInfection[i] = NA

      }

      ## basically if we only know they got other type of attacks (policy 9 then we know the t


}


######################################################## 2020 ###################################


numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$type1)

dataCyberSecuritySurvey2020TidyNameSizeCyber$attackInfection = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$attackPhising = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$attackBreaching = 0

for (i in 1:numberOfCycles) {


    if(dataCyberSecuritySurvey2020TidyNameSizeCyber$type1[i] == 1 || dataCyberSecuritySurvey20

      dataCyberSecuritySurvey2020TidyNameSizeCyber$attackInfection[i] = 1

    }

      if(dataCyberSecuritySurvey2020TidyNameSizeCyber$type4[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2020TidyNameSizeCyber$attackPhising[i] = 1

      }

      if(dataCyberSecuritySurvey2020TidyNameSizeCyber$type7[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2020TidyNameSizeCyber$attackBreaching[i] = 1

      }


      if(
        ##dataCyberSecuritySurvey2020TidyNameSizeCyber$type1[i] == 9 ||
        dataCyberSecuritySurvey2020TidyNameSizeCyber$type10[i] == 1 || dataCyberSecuritySurvey
```

```
      dataCyberSecuritySurvey2020TidyNameSizeCyber$attackPhising[i] = NA
      dataCyberSecuritySurvey2020TidyNameSizeCyber$attackBreaching[i] = NA
      dataCyberSecuritySurvey2020TidyNameSizeCyber$attackInfection[i] = NA

      }

      ## basically if we only know they got other type of attacks (policy 9 then we know the t


}


######################################################## 2021 ###################################


numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$type1)

dataCyberSecuritySurvey2021TidyNameSizeCyber$attackInfection = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$attackPhising = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$attackBreaching = 0

for (i in 1:numberOfCycles) {


    if(dataCyberSecuritySurvey2021TidyNameSizeCyber$type1[i] == 1 || dataCyberSecuritySurvey20

      dataCyberSecuritySurvey2021TidyNameSizeCyber$attackInfection[i] = 1

    }

      if(dataCyberSecuritySurvey2021TidyNameSizeCyber$type4[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2021TidyNameSizeCyber$attackPhising[i] = 1

      }

      if(dataCyberSecuritySurvey2021TidyNameSizeCyber$type7[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2021TidyNameSizeCyber$attackBreaching[i] = 1

      }


      if(
        ##dataCyberSecuritySurvey2020TidyNameSizeCyber$type1[i] == 9 ||
        dataCyberSecuritySurvey2021TidyNameSizeCyber$type10[i] == 1 || dataCyberSecuritySurvey
```

```
      dataCyberSecuritySurvey2021TidyNameSizeCyber$attackPhising[i] = NA
      dataCyberSecuritySurvey2021TidyNameSizeCyber$attackBreaching[i] = NA
      dataCyberSecuritySurvey2021TidyNameSizeCyber$attackInfection[i] = NA

      }

      ## basically if we only know they got other type of attacks (policy 9 then we know the t


}


######################################################## 2022 ###################################

numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$type1)

dataCyberSecuritySurvey2022TidyNameSizeCyber$attackInfection = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$attackPhising = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$attackBreaching = 0

for (i in 1:numberOfCycles) {


    if(dataCyberSecuritySurvey2022TidyNameSizeCyber$type1[i] == 1 || dataCyberSecuritySurvey20

      dataCyberSecuritySurvey2022TidyNameSizeCyber$attackInfection[i] = 1

    }

      if(dataCyberSecuritySurvey2022TidyNameSizeCyber$type4[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2022TidyNameSizeCyber$attackPhising[i] = 1

      }

      if(dataCyberSecuritySurvey2022TidyNameSizeCyber$type7[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2022TidyNameSizeCyber$attackBreaching[i] = 1

      }


      if(
        ##dataCyberSecuritySurvey2020TidyNameSizeCyber$type1[i] == 9 ||
        dataCyberSecuritySurvey2022TidyNameSizeCyber$type10[i] == 1 || dataCyberSecuritySurvey

      dataCyberSecuritySurvey2022TidyNameSizeCyber$attackPhising[i] = NA
```

```
      dataCyberSecuritySurvey2022TidyNameSizeCyber$attackBreaching[i] = NA
      dataCyberSecuritySurvey2022TidyNameSizeCyber$attackInfection[i] = NA

      }

      ## basically if we only know they got other type of attacks (policy 9 then we know the t


}


dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>


## i think I will also remove the frequency of the attack since I won't be using them for anyt

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>

## now to register both outcome and impact
```

0.19 Outcomes - we check for each of the attack outcoems and group them

```
## for the frequency of attacks in the last 12 months I am not sure if
## I am interested in that data TODO I am temporary removing them if I
## can add thhem back if needed (more interested in the outcome of the
## attacks)

## outcomes from the attacks outcome 01 - Software or systems were
## corrupted or damaged (permanent DDOS) outcome 02 - Personal data was
## altered, destroyed or taken outcome 03 - Permanent loss of files
## (other than personal data) outcome 04 - Temporary loss of access to
## files or networks outcome 05 - Lost or stolen assets, trade secrets
## or intellectual property outcome 06 - Money was stolen outcome 07 -
## (DDOS) website or online services were taken down or made slower
## outcome 08 - Lost access to any third-party services you rely on
## outcome 09 - Don't know (NA) outcome 10 - none of these outcome
## 11,12 and 13 are only present in 2022 so we won't use them to make
## comparisons
```

```
## as the lord and savior Dr Mark Kelson has preached to me on you
## shall merge the multiple outcomes into smaller ones to have better
## correlations If you are reading this one mark don't forget my extra
## points for that one time I had to turn on the system in the computer
## lab because it was turned off the the professors assistants weren't
## there yet to comment it all its ctr+shift+c #FicaADica

## outcomesData - is a combination of personal data was altered
## (outcome2), temporary or permanent loss of access to files (outcome
## 3 and 4) outcomesDDOS - websites or online service was taken down or
## made slower (outcome 7), lost access to any third party services
## (outcome 8) and software or system corruption and damaged (permanent
## DDOS) (outcome1) outcomesTheft - lost or stolen assets, trade
## secrets or intellectual property (outcome 5) and stolen money
## (outcome 6)



########################################################## 2018
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome1)

dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesData = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesDDOS = 0
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesTheft = 0



for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome1[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome2[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome3[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome4[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome5[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome6[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome7[i] = replace_na(dataCyberSecuritySur
```

```
    -10007)
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome8[i] = replace_na(dataCyberSecuritySur
    -10007)
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome10[i] = replace_na(dataCyberSecuritySu
    -10007)
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome9[i] = replace_na(dataCyberSecuritySur
    -10007)

## my probably pathetic attempt to optimize my loops to not get a
## 10 minute compilation #my toast runs slower than a toaster, and
## toasters don't even have legs to run

if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome1[i] == 1 ||
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome7[i] == 1 ||
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome8[i] == 1) {
    ## either 1,7,8

    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesDDOS[i] = 1

} else if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome1[i] ==
    -10007 && dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome7[i] ==
    -10007 && dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome8[i] ==
    -10007) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesDDOS[i] = NA
}

if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome2[i] == 1 ||
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome3[i] == 1 ||
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome4[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesData[i] = 1

} else if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome2[i] ==
    -10007 && dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome3[i] ==
    -10007 && dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome4[i] ==
    -10007) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesData[i] = NA
}

if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome5[i] == 1 ||
    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome6[i] == 1) {
    ## either 5 or 6

    dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesTheft[i] = 1
```

```
    } else if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome5[i] ==
        -10007 && dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome6[i] ==
        -10007) {

        dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesTheft[i] = NA
    }

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$outcome9[i] == 1) {

        dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesTheft[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesData[i] = NA
        dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesDDOS[i] = NA
    }

}




########################################################## 2019
########################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome1)

dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesData = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesDDOS = 0
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesTheft = 0

for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome1[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome2[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome3[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome4[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome5[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome6[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome7[i] = replace_na(dataCyberSecuritySur
        -10007)
```

```
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome8[i] = replace_na(dataCyberSecuritySur
    -10007)
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome9[i] = replace_na(dataCyberSecuritySur
    -10007)
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome10[i] = replace_na(dataCyberSecuritySu
    -10007)

## my probably pathetic attempt to optimize my loops to not get a
## 10 minute compilation #my toast runs slower than a toaster, and
## toasters don't even have legs to run

if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome1[i] == 1 ||
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome7[i] == 1 ||
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome8[i] == 1) {
    ## either 1,7,8

    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesDDOS[i] = 1

} else if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome1[i] ==
    -10007 && dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome7[i] ==
    -10007 && dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome8[i] ==
    -10007) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesDDOS[i] = NA
}

if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome2[i] == 1 ||
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome3[i] == 1 ||
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome4[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesData[i] = 1

} else if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome2[i] ==
    -10007 && dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome3[i] ==
    -10007 && dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome4[i] ==
    -10007) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesData[i] = NA
}

if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome5[i] == 1 ||
    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome6[i] == 1) {
    ## either 5 or 6

    dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesTheft[i] = 1
```

```
    } else if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome5[i] ==
        -10007 && dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome6[i] ==
        -10007) {

        dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesTheft[i] = NA
    }

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$outcome9[i] == 1) {

        dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesTheft[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesData[i] = NA
        dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesDDOS[i] = NA
    }


}

######################################################## 2020
######################################################## ########################################

numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome1)

dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesData = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesDDOS = 0
dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesTheft = 0

for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome1[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome2[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome3[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome4[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome5[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome6[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome7[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome8[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome9[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome10[i] = replace_na(dataCyberSecuritySu
```

```
    -10007)

## my probably pathetic attempt to optimize my loops to not get a
## 10 minute compilation #my toast runs slower than a toaster, and
## toasters don't even have legs to run

if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome1[i] == 1 ||
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome7[i] == 1 ||
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome8[i] == 1) {
    ## either 1,7,8

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesDDOS[i] = 1

} else if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome1[i] ==
    -10007 && dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome7[i] ==
    -10007 && dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome8[i] ==
    -10007) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesDDOS[i] = NA
}

if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome2[i] == 1 ||
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome3[i] == 1 ||
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome4[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesData[i] = 1

} else if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome2[i] ==
    -10007 && dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome3[i] ==
    -10007 && dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome4[i] ==
    -10007) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesData[i] = NA
}

if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome5[i] == 1 ||
    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome6[i] == 1) {
    ## either 5 or 6

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesTheft[i] = 1

} else if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome5[i] ==
    -10007 && dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome6[i] ==
    -10007) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesTheft[i] = NA
```

```
    }
    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$outcome9[i] == 1) {

        dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesTheft[i] = NA
        dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesData[i] = NA
        dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesDDOS[i] = NA
    }

}


##################################################### 2021
##################################################### ########################################


numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome1)

dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS = 0
dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft = 0
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod = 0


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome1[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome2[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome3[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome4[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome5[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome6[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome7[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome8[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome9[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome10[i] = replace_na(dataCyberSecuritySu
        -10007)

    ## my probably pathetic attempt to optimize my loops to not get a
```

```
## 10 minute compilation #my toast runs slower than a toaster, and
## toasters don't even have legs to run

if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome1[i] == 1 ||
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome7[i] == 1 ||
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome8[i] == 1) {
    ## either 1,7,8

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i] = 1

} else if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome1[i] ==
    -10007 && dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome7[i] ==
    -10007 && dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome8[i] ==
    -10007) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i] = NA
}

if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome2[i] == 1 ||
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome3[i] == 1 ||
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome4[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i] = 1

} else if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome2[i] ==
    -10007 && dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome3[i] ==
    -10007 && dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome4[i] ==
    -10007) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i] = NA
}

if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome5[i] == 1 ||
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome6[i] == 1) {
    ## either 5 or 6

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i] = 1

} else if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome5[i] ==
    -10007 && dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome6[i] ==
    -10007) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i] = NA
}
if (dataCyberSecuritySurvey2021TidyNameSizeCyber$outcome9[i] == 1) {
```

```
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i] = NA
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i] = NA
    dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i] = NA
}

## this data set is not yet lost  using the same principle as the
## chmod for linux permissions since we only have 3 final outcomes
## (thank god past me) we will use the values 1, 2 and 4 for
## outcomesData, outcomesDDOS and outcomesTheft respectively and
## then we derive the outcome thanks to the sum of those 3 which
## are all unique I am now a defenestration expert after throw so
## much things out of the window after realising none of my
## solutions work

# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i] =
# replace_na(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i],
# -10007)
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i] =
# replace_na(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i],
# -10007)
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i] =
# replace_na(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i],
# -10007)
# if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i]
# == 1) {
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] =
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] + 1
# } if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i]
# == 1) {
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] =
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] + 2
# }
# if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i]
# == 1) {
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] =
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] + 4
# }
# if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i]
# == -10007 &&
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS ==
# -10007 &&
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i] ==
# -10007) {
# dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesChmod[i] =
# NA }
# if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i]
# == -10007) {
```

```
    # dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft[i] =
    # NA }
    # if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i]
    # == -10007) {
    # dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData[i] = NA
    # } if(dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i]
    # == -10007) {
    # dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS[i] = NA
    # }

}




########################################################## 2022
########################################################## ########################################



numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome1)

dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesData = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesDDOS = 0
dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesTheft = 0

for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome1[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome2[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome3[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome4[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome5[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome6[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome7[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome8[i] = replace_na(dataCyberSecuritySur
        -10007)
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome9[i] = replace_na(dataCyberSecuritySur
        -10007)
```

```
dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome10[i] = replace_na(dataCyberSecuritySu
    -10007)

## my probably pathetic attempt to optimize my loops to not get a
## 10 minute compilation #my toast runs slower than a toaster, and
## toasters don't even have legs to run if anyone asks yes I
## started from bottom to top but I can and I love see my pc dying
## compiling my poorly optimized code

if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome1[i] == 1 ||
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome7[i] == 1 ||
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome8[i] == 1) {
    ## either 1,7,8

    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesDDOS[i] = 1

} else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome1[i] ==
    -10007 && dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome7[i] ==
    -10007 && dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome8[i] ==
    -10007) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesDDOS[i] = NA
}

if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome2[i] == 1 ||
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome3[i] == 1 ||
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome4[i] == 1) {
    ## either 2,3,4

    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesData[i] = 1

} else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome2[i] ==
    -10007 && dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome3[i] ==
    -10007 && dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome4[i] ==
    -10007) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesData[i] = NA
}

if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome5[i] == 1 ||
    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome6[i] == 1) {
    ## either 5 or 6

    dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesTheft[i] = 1

} else if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome5[i] ==
    -10007 && dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome6[i] ==
```

```
        -10007) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesTheft[i] = NA
    }
    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$outcome9[i] == 1) {

        dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesTheft[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesData[i] = NA
        dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesDDOS[i] = NA
    }

}



dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(outcome1:outcome10))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(outcome1:outcome10))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(outcome1:outcome10))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(outcome1:outcome10))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(outcome1:outcome13))
```

0.20 Time take for restoring the systems

```
## there is already some missing data in the form of -97 so remember to
## replace the missing data to the -97 code instead

## also remember the scale restore = 1 - no time at all taken to
## restore the business operation back to normal restore = 2 - less
## than a day taken to restore the business operation back to normal
## restore = 3 - between one day and a week taken to restore the
## business operation back to normal restore = 4 - between one week and
## a month taken to restore the business operation back to normal
## restore = 5 - one or more months taken to restore the business
## operation back to normal restore = 6 - still not back to normal
## restore = -97 or 7(in 2018) - don't know

## we will have to remove the data entries where the system is still
## not back on (restore = 6) because we cannot quantify it in terms of
## times taken and we don't want those entries to have a negative
## effect in both our imputation and correlation
```

```
## checking the labels of the variable restore to see what if there was
## any other value for missing data besides -97 but apparently didn't
## know was not a specific option you could select like in the other
## cleaned variables
val_labels(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore)
```

```
                     Don't know                    No time at all
                             -97                                 1
                Less than a day    Between a day and under a week
                              2                                 3
Between a week and under a month                One month or more
                              4                                 5
        Still not back to normal
                              6
```

```
######################################################## 2018
######################################################## ########################################

numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i] = replace_na(dataCyberSecuritySurv
        7)


}

## there is an awfully weird behaviour if you remove rows in for loop
## with a static constant variable because R does not increment i++
## when removing rows or something weird like that meaning if you
## remove rows it will never reach the end of

## for even the most wicked reasons this only works the second time I
## do it so I am just going to run a try and catch on this one

try(for (i in 1:nrow(dataCyberSecuritySurvey2018TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSize
            ]
```

```
    }

  })
```

```
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                              label
   -97                         Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                              label
   -97                         Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                              label
   -97                         Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                              label
   -97                         Don't know
     1                    No time at all
     2                   Less than a day
```

```
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
```

```
     4 Between a week and under a month
     5                One month or more
     6         Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                One month or more
     6         Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                One month or more
     6         Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                One month or more
     6         Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatic
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
```

```
     5                One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                             label
   -97                        Don't know
     1                     No time at all
     2                    Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                One month or more
     6          Still not back to normal
Error in vec_slice(x, i) : Can't subset elements past the end.
i Location 2076 doesn't exist.
i There are only 2075 elements.
```

```
for (i in 1:nrow(dataCyberSecuritySurvey2018TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSize
            ]

    }

}


numberOfCycles = length(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    ## it has to be this order because of the NA comparison problem

    if (dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i] == 7) {
        dataCyberSecuritySurvey2018TidyNameSizeCyber$restore[i] = NA

    }


}
```

```
##################################################### 2019
##################################################### ########################################

numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i] = replace_na(dataCyberSecuritySurv
        -97)


}

## there is an awfully weird behaviour if you remove rows in for loop
## with a static constant variable because R does not increment i++
## when removing rows or something weird like that meaning if you
## remove rows it will never reach the end of

## for even the most wicked reasons this only works the second time I
## do it so I am just going to run a try and catch on this one

try(for (i in 1:nrow(dataCyberSecuritySurvey2019TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSize
            ]

    }

})
```

```
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                             label
   -97                       Don't know
     1                     No time at all
     2                    Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
```

```
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
Error in vec_slice(x, i) : Can't subset elements past the end.
i Location 2077 doesn't exist.
i There are only 2076 elements.
```

```
for (i in 1:nrow(dataCyberSecuritySurvey2019TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i])
```

```
        dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSize
            ]

    }

}


numberOfCycles = length(dataCyberSecuritySurvey2019TidyNameSizeCyber$restore)

for (i in 1:numberOfCycles) {

    ## it has to be this order because of the NA comparison problem

    if (dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i] == -97) {
        dataCyberSecuritySurvey2019TidyNameSizeCyber$restore[i] = NA

    }


}









######################################################## 2020
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i] = replace_na(dataCyberSecuritySurv
        -97)


}

## there is an awfully weird behaviour if you remove rows in for loop
## with a static constant variable because R does not increment i++
## when removing rows or something weird like that meaning if you
## remove rows it will never reach the end of
```

```r
## for even the most wicked reasons this only works the second time I
## do it so I am just going to run a try and catch on this one

try(for (i in 1:nrow(dataCyberSecuritySurvey2020TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSize
            ]

    }

})

for (i in 1:nrow(dataCyberSecuritySurvey2020TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSize
            ]

    }

}


numberOfCycles = length(dataCyberSecuritySurvey2020TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    ## it has to be this order because of the NA comparison problem

    if (dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i] == -97) {
        dataCyberSecuritySurvey2020TidyNameSizeCyber$restore[i] = NA

    }


}



########################################################## 2021
########################################################## ########################################
```

```r
numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i] = replace_na(dataCyberSecuritySurv
        -97)


}

## there is an awfully weird behaviour if you remove rows in for loop
## with a static constant variable because R does not increment i++
## when removing rows or something weird like that meaning if you
## remove rows it will never reach the end of

## for even the most wicked reasons this only works the second time I
## do it so I am just going to run a try and catch on this one

try(for (i in 1:nrow(dataCyberSecuritySurvey2021TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSize
            ]

    }

})
```

```
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                             label
   -97                       Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6         Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
```

```
 value                             label
   -97                       Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6         Still not back to normal
Error in vec_slice(x, i) : Can't subset elements past the end.
i Location 2283 doesn't exist.
i There are only 2282 elements.
```

```
for (i in 1:nrow(dataCyberSecuritySurvey2021TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSize
            ]

    }

}


numberOfCycles = length(dataCyberSecuritySurvey2021TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    ## it has to be this order because of the NA comparison problem

    if (dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i] == -97) {
        dataCyberSecuritySurvey2021TidyNameSizeCyber$restore[i] = NA

    }


}


######################################################## 2022
######################################################## ########################################


numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$restore)
```

```r
for (i in 1:numberOfCycles) {

    dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i] = replace_na(dataCyberSecuritySurv
        -97)


}

## there is an awfully weird behaviour if you remove rows in for loop
## with a static constant variable because R does not increment i++
## when removing rows or something weird like that meaning if you
## remove rows it will never reach the end of

## for even the most wicked reasons this only works the second time I
## do it so I am just going to run a try and catch on this one

try(for (i in 1:nrow(dataCyberSecuritySurvey2022TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSize
            ]

    }

})
```

```
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6          Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                            label
   -97                       Don't know
     1                    No time at all
     2                   Less than a day
```

```
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6         Still not back to normal
<labelled<double>[1]>: Q71 How long, if any time at all, did it take to restore business operatio
[1] 6

Labels:
 value                             label
   -97                       Don't know
     1                    No time at all
     2                   Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6         Still not back to normal
Error in vec_slice(x, i) : Can't subset elements past the end.
i Location 2155 doesn't exist.
i There are only 2154 elements.
```

```
for (i in 1:nrow(dataCyberSecuritySurvey2022TidyNameSizeCyber)) {

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i] == 6) {

        print(dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i])
        dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSize
            ]

    }

}


numberOfCycles = length(dataCyberSecuritySurvey2022TidyNameSizeCyber$restore)


for (i in 1:numberOfCycles) {

    ## it has to be this order because of the NA comparison problem

    if (dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i] == -97) {
        dataCyberSecuritySurvey2022TidyNameSizeCyber$restore[i] = NA

    }


}
```

0.21 Removing unused variables

```
## we have now finished checking the outcome of these attacks as the
## last relevant parameter we will analyse so we will now cleanse the
## dataset of all the other unnecessary data

## the costs have too much in different and missing data, it is better
## not to use them, no way josé


## removing the costs here as well, not opening another Pandora box so
## close to the deadline also leaving the restore that is hidden in the
## middle here
dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(impact1:conting))
dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(deala:weight))

dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(impact1:intent))
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-(deala:weight))

dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(impact1:identb24))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-(boardrep:weight))

dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(impact1:disrupta13))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(boardrep:weight))


dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(impact1:disrupta13))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(reporta:Sum10Steps))


dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-(halfa:weight))


## we also won't be looking at which country inside the uk the
## charities belong
```

```
dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-country)
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-country)
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-country)
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-country)
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-country)

## we also won't be using the charity income data


dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-income)
dataCyberSecuritySurvey2019TidyNameSizeCyber = dataCyberSecuritySurvey2019TidyNameSizeCyber %>
    select(-one_of("income", "income2"))
dataCyberSecuritySurvey2020TidyNameSizeCyber = dataCyberSecuritySurvey2020TidyNameSizeCyber %>
    select(-one_of("income", "income2"))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-one_of("income", "income2"))
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-one_of("income", "income2"))

## cleaning 2018 specific

dataCyberSecuritySurvey2018TidyNameSizeCyber = dataCyberSecuritySurvey2018TidyNameSizeCyber %>
    select(-(charityo:core))

## removing last year specific
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-title)

## hold up why do I bother having typex when any of the others years
## don't dataCyberSecuritySurvey2022TidyNameSizeCyber$typex =
## as.factor(dataCyberSecuritySurvey2022TidyNameSizeCyber$typex)
dataCyberSecuritySurvey2022TidyNameSizeCyber = dataCyberSecuritySurvey2022TidyNameSizeCyber %>
    select(-typex)

## recorded time of death 22:53 9/11/2022, cause : realized I had the
## 2021 variable pointing to the 2020 file this entire time this is
## what we call being dumber than a door #estudasses

dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(title1:title19))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
```

```
    select(-(online12:online13))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-(scheme6:outcome13))
dataCyberSecuritySurvey2021TidyNameSizeCyber = dataCyberSecuritySurvey2021TidyNameSizeCyber %>
    select(-covpri)
```

0.22 Labelling Conversion

```
## Now we have all the data wrangled ready we will preparing for it to
## be imputated


summary(dataCyberSecuritySurvey2018TidyNameSizeCyber)
```

```
     imid        instituitionTypes     sizea           sizeb
Min.   :100018   Min.   :1.000     Min.   :    2.0   1   :782
1st Qu.:122882   1st Qu.:1.000     1st Qu.:    5.0   2   :596
Median :146255   Median :1.000     Median :   16.0   3   :380
Mean   :154655   Mean   :1.271     Mean   :  293.8   4   :225
3rd Qu.:153511   3rd Qu.:2.000     3rd Qu.:   80.0   5   : 89
Max.   :260174   Max.   :2.000     Max.   :69035.0   NA's:  3
                                   NA's   :58
   priority         update         restore          year
Min.   :1.000   Min.   :1.000   Min.   :1.000   Length:2075
1st Qu.:1.000   1st Qu.:3.000   1st Qu.:1.000   Class :character
Median :2.000   Median :4.000   Median :1.000   Mode  :character
Mean   :1.897   Mean   :4.177   Mean   :1.558
3rd Qu.:2.000   3rd Qu.:5.000   3rd Qu.:2.000
Max.   :4.000   Max.   :9.000   Max.   :5.000
NA's   :26                      NA's   :1156
managementContinuity managementCyber  rulesUpdating    rulesSecurityConfigs
Min.   :0.0000       Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000       1st Qu.:0.0000   1st Qu.:1.0000   1st Qu.:1.0000
Median :1.0000       Median :1.0000   Median :1.0000   Median :1.0000
Mean   :0.6109       Mean   :0.6474   Mean   :0.9594   Mean   :0.9444
3rd Qu.:1.0000       3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.0000       Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
NA's   :19           NA's   :19       NA's   :5        NA's   :5
rulesUserControl policyStaffAccess   policyData     policyPrivate
Min.   :0.000    Min.   :0.000     Min.   :0.0000   Min.   :0.0000
1st Qu.:1.000    1st Qu.:1.000     1st Qu.:0.0000   1st Qu.:1.0000
Median :1.000    Median :1.000     Median :1.0000   Median :1.0000
Mean   :0.857    Mean   :0.954     Mean   :0.7446   Mean   :0.8426
3rd Qu.:1.000    3rd Qu.:1.000     3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.000    Max.   :1.000     Max.   :1.0000   Max.   :1.0000
NA's   :5        NA's   :1249      NA's   :1249     NA's   :1249
```

```
attackInfection  attackPhising    attackBreaching    outcomesData
Min.   :0.0000   Min.   :0.0000   Min.   :0.00000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.0000
Median :0.0000   Median :0.0000   Median :0.00000   Median :0.0000
Mean   :0.2169   Mean   :0.4176   Mean   :0.09454   Mean   :0.2659
3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:1.0000
Max.   :1.0000   Max.   :1.0000   Max.   :1.00000   Max.   :1.0000
NA's   :23       NA's   :23       NA's   :23        NA's   :1101
 outcomesDDOS    outcomesTheft
Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000
Median :0.0000   Median :0.0000
Mean   :0.2628   Mean   :0.0637
3rd Qu.:1.0000   3rd Qu.:0.0000
Max.   :1.0000   Max.   :1.0000
NA's   :1101     NA's   :1101
```

```
summary(dataCyberSecuritySurvey2019TidyNameSizeCyber)
```

```
     imid        instituitionTypes     sizea          sizeb
Min.   :100008   Min.   :1.000     Min.   :    2.0   1   :869
1st Qu.:105148   1st Qu.:1.000     1st Qu.:    5.0   2   :529
Median :110652   Median :1.000     Median :   14.0   3   :416
Mean   :152875   Mean   :1.224     Mean   :  193.8   4   :190
3rd Qu.:115574   3rd Qu.:1.000     3rd Qu.:   72.0   5   : 68
Max.   :401174   Max.   :2.000     Max.   :34000.0   NA's:  4
                                   NA's   :68
   priority         update         restore          year
Min.   :1.000   Min.   :1.000   Min.   :1.000   Length:2076
1st Qu.:1.000   1st Qu.:3.000   1st Qu.:1.000   Class :character
Median :2.000   Median :4.000   Median :1.000   Mode  :character
Mean   :1.698   Mean   :4.255   Mean   :1.501
3rd Qu.:2.000   3rd Qu.:5.000   3rd Qu.:2.000
Max.   :4.000   Max.   :8.000   Max.   :5.000
NA's   :32      NA's   :110     NA's   :1286
managementContinuity managementCyber  rulesUpdating    rulesSecurityConfigs
Min.   :0.0000       Min.   :0.0000   Min.   :0.0000   Min.   :0.000
1st Qu.:0.0000       1st Qu.:0.0000   1st Qu.:1.0000   1st Qu.:1.000
Median :1.0000       Median :1.0000   Median :1.0000   Median :1.000
Mean   :0.6498       Mean   :0.6926   Mean   :0.9701   Mean   :0.959
3rd Qu.:1.0000       3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:1.000
Max.   :1.0000       Max.   :1.0000   Max.   :1.0000   Max.   :1.000
NA's   :23           NA's   :23       NA's   :3        NA's   :3
rulesUserControl policyStaffAccess   policyData     policyPrivate
Min.   :0.0000   Min.   :0.0000    Min.   :0.0000   Min.   :0.0000
1st Qu.:1.0000   1st Qu.:1.0000    1st Qu.:1.0000   1st Qu.:1.0000
Median :1.0000   Median :1.0000    Median :1.0000   Median :1.0000
```

```
Mean   :0.8736   Mean   :0.9601    Mean   :0.8129   Mean   :0.8661
3rd Qu.:1.0000   3rd Qu.:1.0000    3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.0000   Max.   :1.0000    Max.   :1.0000   Max.   :1.0000
NA's   :3        NA's   :1098      NA's   :1098     NA's   :1098
attackInfection  attackPhising    attackBreaching    outcomesData
Min.   :0.0000   Min.   :0.0000   Min.   :0.00000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.0000
Median :0.0000   Median :0.0000   Median :0.00000   Median :0.0000
Mean   :0.1504   Mean   :0.3647   Mean   :0.06494   Mean   :0.2034
3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:0.0000
Max.   :1.0000   Max.   :1.0000   Max.   :1.00000   Max.   :1.0000
NA's   :28       NA's   :28       NA's   :28        NA's   :1260
 outcomesDDOS    outcomesTheft
Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000
Median :0.0000   Median :0.0000
Mean   :0.2181   Mean   :0.0637
3rd Qu.:0.0000   3rd Qu.:0.0000
Max.   :1.0000   Max.   :1.0000
NA's   :1260     NA's   :1260
```

```r
summary(dataCyberSecuritySurvey2020TidyNameSizeCyber)
```

```
     imid        instituitionTypes     sizea           sizeb
Min.   :100059   Min.   :1.00      Min.   :     2.0   1   :731
1st Qu.:135624   1st Qu.:1.00      1st Qu.:     5.0   2   :491
Median :169565   Median :1.00      Median :    16.0   3   :369
Mean   :212340   Mean   :1.39      Mean   :   577.8   4   :208
3rd Qu.:231585   3rd Qu.:2.00      3rd Qu.:    84.0   5   : 97
Max.   :600019   Max.   :3.00      Max.   :300000.0   NA's:  4
                                   NA's   :79
   priority         update         restore          year
Min.   :1.000   Min.   :1.000   Min.   :1.000   Length:1900
1st Qu.:1.000   1st Qu.:3.000   1st Qu.:1.000   Class :character
Median :1.000   Median :4.000   Median :1.000   Mode  :character
Mean   :1.626   Mean   :4.275   Mean   :1.416
3rd Qu.:2.000   3rd Qu.:5.000   3rd Qu.:2.000
Max.   :4.000   Max.   :8.000   Max.   :5.000
NA's   :38      NA's   :193     NA's   :934
managementContinuity managementCyber  rulesUpdating    rulesSecurityConfigs
Min.   :0.0000       Min.   :0.0000   Min.   :0.0000   Min.   :0.000
1st Qu.:0.0000       1st Qu.:0.0000   1st Qu.:1.0000   1st Qu.:1.000
Median :1.0000       Median :1.0000   Median :1.0000   Median :1.000
Mean   :0.7164       Mean   :0.7111   Mean   :0.9746   Mean   :0.973
3rd Qu.:1.0000       3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:1.000
Max.   :1.0000       Max.   :1.0000   Max.   :1.0000   Max.   :1.000
NA's   :24           NA's   :24       NA's   :8        NA's   :8
```

```
rulesUserControl policyStaffAccess   policyData     policyPrivate
Min.   :0.0000   Min.   :0.0000    Min.   :0.0000   Min.   :0.0000
1st Qu.:1.0000   1st Qu.:1.0000    1st Qu.:1.0000   1st Qu.:1.0000
Median :1.0000   Median :1.0000    Median :1.0000   Median :1.0000
Mean   :0.8864   Mean   :0.9536    Mean   :0.8087   Mean   :0.8617
3rd Qu.:1.0000   3rd Qu.:1.0000    3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.0000   Max.   :1.0000    Max.   :1.0000   Max.   :1.0000
NA's   :8        NA's   :823       NA's   :823      NA's   :823
attackInfection  attackPhising    attackBreaching    outcomesData
Min.   :0.0000   Min.   :0.0000   Min.   :0.00000   Min.   :0.000
1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.000
Median :0.0000   Median :1.0000   Median :0.00000   Median :0.000
Mean   :0.1337   Mean   :0.5153   Mean   :0.06817   Mean   :0.168
3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:0.000
Max.   :1.0000   Max.   :1.0000   Max.   :1.00000   Max.   :1.000
NA's   :37       NA's   :37       NA's   :37        NA's   :900
 outcomesDDOS   outcomesTheft
Min.   :0.000   Min.   :0.000
1st Qu.:0.000   1st Qu.:0.000
Median :0.000   Median :0.000
Mean   :0.112   Mean   :0.062
3rd Qu.:0.000   3rd Qu.:0.000
Max.   :1.000   Max.   :1.000
NA's   :900     NA's   :900
```

```
summary(dataCyberSecuritySurvey2021TidyNameSizeCyber)
```

```
    imid           instituitionTypes     sizea           sizeb
Length:2282        Min.   :1.000     Min.   :    0.0   1   :886
Class :character   1st Qu.:1.000     1st Qu.:    5.0   2   :539
Mode  :character   Median :1.000     Median :   17.0   3   :487
                   Mean   :1.531     Mean   :  222.8   4   :273
                   3rd Qu.:2.000     3rd Qu.:  100.0   5   : 89
                   Max.   :3.000     Max.   :30000.0   NA's:  8
                                     NA's   :83
   priority         update         restore          year
Min.   :1.000   Min.   :1.000   Min.   :1.000   Length:2282
1st Qu.:1.000   1st Qu.:3.000   1st Qu.:1.000   Class :character
Median :2.000   Median :4.000   Median :1.000   Mode  :character
Mean   :1.688   Mean   :4.082   Mean   :1.454
3rd Qu.:2.000   3rd Qu.:5.000   3rd Qu.:2.000
Max.   :4.000   Max.   :8.000   Max.   :5.000
NA's   :28      NA's   :136     NA's   :1282
managementContinuity managementCyber  rulesUpdating    rulesSecurityConfigs
Min.   :0.000        Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
1st Qu.:0.000        1st Qu.:0.0000   1st Qu.:1.0000   1st Qu.:1.0000
Median :1.000        Median :1.0000   Median :1.0000   Median :1.0000
```

```
Mean   :0.643        Mean   :0.7045   Mean   :0.9455   Mean   :0.9455
3rd Qu.:1.000        3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.000        Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
NA's   :55           NA's   :55       NA's   :8        NA's   :8
rulesUserControl policyStaffAccess   policyData   policyPrivate
Min.   :0.0000   Min.   :0.0000    Min.   :0      Min.   :0.0000
1st Qu.:1.0000   1st Qu.:1.0000    1st Qu.:0      1st Qu.:1.0000
Median :1.0000   Median :1.0000    Median :0      Median :1.0000
Mean   :0.8522   Mean   :0.9521    Mean   :0      Mean   :0.8636
3rd Qu.:1.0000   3rd Qu.:1.0000    3rd Qu.:0      3rd Qu.:1.0000
Max.   :1.0000   Max.   :1.0000    Max.   :0      Max.   :1.0000
NA's   :8        NA's   :1072      NA's   :1072   NA's   :1072
attackInfection  attackPhising    attackBreaching   outcomesData
Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000
Median :0.0000   Median :0.0000   Median :0.0000   Median :0.0000
Mean   :0.1059   Mean   :0.4324   Mean   :0.0427   Mean   :0.1099
3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.0000   3rd Qu.:0.0000
Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
NA's   :34       NA's   :34       NA's   :34       NA's   :1245
 outcomesDDOS    outcomesTheft
Min.   :0.0000   Min.   :0.000
1st Qu.:0.0000   1st Qu.:0.000
Median :0.0000   Median :0.000
Mean   :0.1215   Mean   :0.054
3rd Qu.:0.0000   3rd Qu.:0.000
Max.   :1.0000   Max.   :1.000
NA's   :1245     NA's   :1245
```

```r
summary(dataCyberSecuritySurvey2022TidyNameSizeCyber)
```

```
    imid           instituitionTypes     sizea           sizeb
Length:2154        Min.   :1.000     Min.   :     2.0   1   :808
Class :character   1st Qu.:1.000     1st Qu.:     5.0   2   :544
Mode  :character   Median :1.000     Median :    19.0   3   :470
                   Mean   :1.642     Mean   :   689.2   4   :217
                   3rd Qu.:2.000     3rd Qu.:   100.0   5   :106
                   Max.   :3.000     Max.   :450000.0   NA's:  9
                                     NA's   :86
   priority         update         restore          year
Min.   :1.000   Min.   :1.000   Min.   :1.000   Length:2154
1st Qu.:1.000   1st Qu.:3.000   1st Qu.:1.000   Class :character
Median :1.000   Median :4.000   Median :1.000   Mode  :character
Mean   :1.631   Mean   :4.308   Mean   :1.427
3rd Qu.:2.000   3rd Qu.:5.000   3rd Qu.:2.000
Max.   :4.000   Max.   :8.000   Max.   :5.000
NA's   :32      NA's   :122     NA's   :1446
```

```
managementContinuity managementCyber  rulesUpdating    rulesSecurityConfigs
Min.   :0.0000       Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000       1st Qu.:0.0000   1st Qu.:1.0000   1st Qu.:1.0000
Median :1.0000       Median :1.0000   Median :1.0000   Median :1.0000
Mean   :0.6093       Mean   :0.5261   Mean   :0.9584   Mean   :0.9495
3rd Qu.:1.0000       3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.0000       Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
NA's   :63           NA's   :63       NA's   :16       NA's   :16
rulesUserControl policyStaffAccess   policyData     policyPrivate
Min.   :0.0000   Min.   :0.0000    Min.   :0.0000   Min.   :0.0000
1st Qu.:1.0000   1st Qu.:1.0000    1st Qu.:1.0000   1st Qu.:1.0000
Median :1.0000   Median :1.0000    Median :1.0000   Median :1.0000
Mean   :0.8316   Mean   :0.9394    Mean   :0.8931   Mean   :0.8459
3rd Qu.:1.0000   3rd Qu.:1.0000    3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.0000   Max.   :1.0000    Max.   :1.0000   Max.   :1.0000
NA's   :16       NA's   :1031      NA's   :1031     NA's   :1031
attackInfection attackPhising    attackBreaching    outcomesData
Min.   :0.000   Min.   :0.0000   Min.   :0.00000   Min.   :0.0000
1st Qu.:0.000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.0000
Median :0.000   Median :0.0000   Median :0.00000   Median :0.0000
Mean   :0.113   Mean   :0.4656   Mean   :0.04143   Mean   :0.1215
3rd Qu.:0.000   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:0.0000
Max.   :1.000   Max.   :1.0000   Max.   :1.00000   Max.   :1.0000
NA's   :30      NA's   :30       NA's   :30        NA's   :1117
 outcomesDDOS    outcomesTheft
Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000
Median :0.0000   Median :0.0000
Mean   :0.1437   Mean   :0.0415
3rd Qu.:0.0000   3rd Qu.:0.0000
Max.   :1.0000   Max.   :1.0000
NA's   :1117     NA's   :1117
```

```
## I want to cry but at least I have a solution that will just take me
## a few more hours to implement we will have to delabbel and then
## clean most of the labels from the maybe I over reacted a bit, maybe
```

0.23 R data structures

```
######################################################## 2022
######################################################## ########################################

## everyday I am unlabelling

remove_var_label(dataCyberSecuritySurvey2022TidyNameSizeCyber$restore)
```

```
<labelled<double>[2154]>
   [1] NA NA NA  1 NA  1  1 NA NA NA  1 NA  3  1 NA NA  1  1 NA  1 NA NA NA NA
  [25] NA NA NA  2 NA NA  5  2 NA NA NA NA  1  3 NA NA  1  2 NA NA  1 NA NA NA
  [49]  1  1  2  1 NA  1 NA  1 NA NA  1 NA  1 NA  1 NA NA  1 NA NA NA NA NA NA
  [73]  1 NA NA  1 NA  1  1 NA  1  2 NA NA  1 NA NA NA NA  1  2 NA NA  2 NA NA
  [97] NA NA  1  2  1 NA NA NA NA NA NA NA NA NA  3  1 NA NA NA NA  1 NA  1  1
 [121] NA  2  1 NA NA NA  2  1 NA NA  1 NA NA  1  1 NA  1 NA  2 NA NA NA NA NA
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 [169]  1 NA NA  1 NA NA NA  3  2 NA  1  1 NA NA  1  2  1 NA NA NA  1 NA NA  2
 [193] NA  1 NA NA NA NA  1  1 NA  1  1 NA NA  1 NA NA  1  1  1  1 NA  1 NA  2
 [217]  1  1  1 NA NA  1  1  1 NA  1 NA NA  1  1  1 NA  1  2 NA  1 NA NA  5 NA
 [241] NA  2 NA  2  1 NA  1  1 NA NA NA NA  2 NA NA NA NA NA  1 NA NA NA  1  1
 [265] NA  1 NA NA  1  1 NA NA NA  1  1  1  2 NA NA NA NA NA  1 NA NA NA  1  1
 [289]  1  2  1 NA  1 NA  3 NA NA NA NA NA NA  1 NA NA  3 NA NA  2 NA NA  1 NA
 [313] NA  2 NA  1  1 NA  1 NA  1  1 NA NA NA  3 NA NA NA NA  1 NA NA  1 NA NA
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 [361] NA NA NA  1  1 NA NA NA NA NA NA NA NA  1  1  1 NA NA NA NA NA NA NA  1
 [385] NA NA NA NA NA NA NA NA NA NA NA NA  1 NA NA NA  1 NA NA NA  1 NA  1 NA
 [409] NA NA  2 NA  1 NA  2 NA NA NA  1 NA  1 NA NA  1 NA NA NA NA NA  2  1  1
 [433] NA NA NA  2 NA  1 NA NA NA  1 NA NA NA NA NA NA  1 NA NA  2 NA NA NA  3
 [457] NA NA NA NA NA  1 NA NA NA  1 NA  1  2 NA NA  3  2 NA  1 NA NA  1  1 NA
 [481]  1  1 NA NA  2 NA  1 NA NA NA  1  2 NA NA NA  1  1  1 NA NA  1  4  1  1
 [505] NA  1 NA  1  2  1 NA NA  1  3 NA NA  2 NA  1 NA  2  1  1  4 NA  2  1  1
 [529] NA  1 NA NA NA  1  1 NA NA NA NA NA NA NA NA  1 NA  1 NA NA  2 NA NA NA
 [553] NA  3  1  1  3 NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA  1 NA
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 [601] NA NA NA NA NA  1 NA  1 NA NA  3 NA  2 NA  3  1 NA NA NA  2 NA NA  1  1
 [625] NA NA NA NA NA  1 NA NA NA NA  1 NA NA  1 NA  1 NA NA NA NA NA NA  1 NA
 [649]  1  2 NA  4  1 NA NA  3 NA NA  1 NA NA NA  2 NA  1  2 NA  1  1 NA  1 NA
 [673] NA NA NA  1  3 NA NA NA NA NA NA NA NA NA NA NA  1  1 NA NA NA NA  1  1
 [697] NA NA NA NA  1  1 NA  2  1  1 NA  1 NA  2  1  1 NA NA  1 NA  1 NA  1 NA
 [721]  1  1  1 NA  1  2 NA NA NA NA  2 NA NA NA  3 NA NA NA NA  1  1  1 NA NA
 [745]  1  2  1  2  3 NA  1 NA NA NA  1  2  1  1  1 NA  1 NA NA NA NA NA  1 NA
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 [865]  1 NA NA NA  1 NA  1 NA NA  2 NA NA NA NA NA NA  2 NA NA NA NA NA NA  2
 [889] NA NA  1 NA  1  2  3 NA  1 NA  1  3 NA NA NA NA NA  1 NA NA  2 NA NA NA
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 [961]  2  1  2  2 NA  1 NA  1 NA  1  2  1 NA  1 NA  2  1 NA NA NA NA NA  2  1
 [985]  1 NA  2 NA NA NA NA NA  1  1  1 NA NA  1  1 NA NA NA  1 NA NA  1 NA NA
[1009] NA  2  1  1  1 NA  1 NA  2  1 NA NA NA  1  1 NA NA NA  1  1 NA NA  1 NA
[1033] NA  3  3 NA NA  1  2  1 NA  2  2 NA  1 NA  1  1 NA  1 NA  2 NA NA NA  1
[1057] NA NA  1  1 NA  1  1  1  1  1 NA NA NA NA NA NA  1  1  1  4 NA  3 NA  1
[1081]  4  1 NA  1  2 NA NA NA NA  3 NA  1 NA  1  1  1 NA NA NA  5 NA  1  1  1
[1105]  2 NA  2  1 NA  1  1  1 NA NA  1  2 NA  1  1  1  1  1  2  1  1  2  2 NA
[1129]  3 NA  1  1 NA NA NA  1 NA  3 NA NA  3  1  1  1 NA NA  1  1  1 NA  1 NA
```

```
[1153]  1 NA NA NA  2 NA  1  1  2 NA  1 NA  5 NA NA  1  1  1  1  1  3  1 NA  2
[1177]  3 NA NA NA  1  2  1  1  2 NA NA NA  1 NA NA  2  2  1  3  2  1 NA NA NA
[1201]  1  1  2 NA  2 NA  2  1 NA NA  1  1 NA  1  1 NA NA NA  1  1  1  2  1 NA
[1225]  1  1  1  1  1  3  1 NA  1 NA  1  4  1 NA  2  2 NA NA NA NA NA NA NA NA
[1249] NA  1 NA NA  1 NA NA NA NA NA NA  1 NA  1 NA  1  2 NA NA NA NA NA  1 NA
[1273]  3 NA NA NA  1 NA  1 NA NA NA  1 NA NA  1  5 NA  2 NA NA NA NA NA NA NA
[1297] NA NA NA NA NA  2  1  1 NA NA  3 NA NA  1 NA NA  1  1 NA NA NA NA  2  1
[1321]  1 NA NA NA NA NA NA NA NA  1 NA  3 NA NA  1 NA NA  2 NA NA NA  3 NA NA
[1345] NA  1  1 NA  1 NA  1 NA NA NA  1 NA NA  1 NA  1 NA NA  1 NA  1 NA NA NA
[1369]  2 NA  2  1  3  1 NA  1 NA NA  1 NA NA NA  1 NA  1 NA NA NA NA NA  1 NA
[1393]  1 NA NA NA NA NA NA  1  1  1 NA NA NA NA NA  1 NA NA NA  1 NA  1  1 NA
[1417] NA  1 NA NA  1 NA  2 NA NA NA NA NA  2 NA NA NA  1 NA NA NA NA  2 NA NA
[1441] NA  1  2 NA NA NA NA NA NA NA NA NA NA NA NA  1 NA NA NA  1  2  1 NA NA
[1465]  1 NA  1 NA NA  1 NA  1 NA NA NA  1 NA NA NA  1  1  1 NA NA  1 NA  1 NA
[1489] NA NA NA NA NA NA  1  1 NA NA  1 NA NA NA  1  1 NA  1 NA NA  1 NA  4 NA
[1513] NA  1  1 NA  1  1  1  2  1 NA  1  1 NA NA  1 NA  1 NA NA NA NA  1  1 NA
[1537] NA NA  1  1 NA  3 NA NA  1  2 NA  1 NA NA  1 NA  2  1 NA  1  3  1  1 NA
[1561]  3 NA  1  2 NA NA NA NA  1 NA NA  1  2  1 NA  1 NA  2  1  5  1  5 NA NA
[1585]  1  3  1  1  4 NA  1  1  1 NA  2  1 NA  1  2  1 NA  1 NA  1  1 NA  3  3
[1609]  1 NA NA  1 NA  1  1  1 NA  1 NA NA  1  3 NA  1 NA  1 NA  1  1 NA NA NA
[1633]  2  3  1 NA NA NA  1  1 NA  1  1  1 NA  2  3  1 NA  2  1 NA  1  2 NA NA
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[1825] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
[1849] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
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[2137] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA

Labels:
 value                             label
   -97                        Don't know
     1                     No time at all
     2                    Less than a day
     3   Between a day and under a week
```

```
4 Between a week and under a month
5                 One month or more
6          Still not back to normal
```

```
remove_val_labels(dataCyberSecuritySurvey2022TidyNameSizeCyber$restore)
```

```
  [1] NA NA NA  1 NA  1  1 NA NA NA  1 NA  3  1 NA NA  1  1 NA  1 NA NA NA NA
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[2137] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
```

```
attr(,"label")
[1] "Q71 How long, if any time at all, did it take to restore business operations back to normal
attr(,"format.spss")
[1] "F8.0"
attr(,"display_width")
[1] 10
```

```
dataCyberSecuritySurvey2022TidyNameSizeCyber$restore = as.factor(dataCyberSecuritySurvey2022Ti


## perfect factorizationa and numeric conversion removing all the
## problematic labels for imputation
dataCyberSecuritySurvey2022TidyNameSizeCyber$instituitionTypes = as.factor(dataCyberSecuritySu

dataCyberSecuritySurvey2022TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2022Tid

dataCyberSecuritySurvey2022TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2022Tidy

dataCyberSecuritySurvey2022TidyNameSizeCyber$priority = as.factor(dataCyberSecuritySurvey2022T

dataCyberSecuritySurvey2022TidyNameSizeCyber$update = as.factor(dataCyberSecuritySurvey2022Tid

dataCyberSecuritySurvey2022TidyNameSizeCyber$restore = as_factor(dataCyberSecuritySurvey2022Ti

dataCyberSecuritySurvey2022TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2022TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2022TidyNameSizeCyber$year = as.numeric(dataCyberSecuritySurvey2022Tidy

dataCyberSecuritySurvey2022TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2022TidyNameSizeCyber$managementCyber = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUpdating = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesUserControl = as.factor(dataCyberSecuritySur
dataCyberSecuritySurvey2022TidyNameSizeCyber$rulesSecurityConfigs = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2022TidyNameSizeCyber$policyStaffAccess = as.factor(dataCyberSecuritySu
dataCyberSecuritySurvey2022TidyNameSizeCyber$policyData = as.factor(dataCyberSecuritySurvey202
dataCyberSecuritySurvey2022TidyNameSizeCyber$policyPrivate = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2022TidyNameSizeCyber$attackInfection = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2022TidyNameSizeCyber$attackPhising = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2022TidyNameSizeCyber$attackBreaching = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesData = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesDDOS = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2022TidyNameSizeCyber$outcomesTheft = as.factor(dataCyberSecuritySurvey
```

```
  str(dataCyberSecuritySurvey2022TidyNameSizeCyber)
```

```
tibble [2,154 x 22] (S3: tbl_df/tbl/data.frame)
 $ imid                : chr [1:2154] "191876DGRU" "149212ENSE" "134827SVYQ" "169906ZTQZ" ...
  ..- attr(*, "label")= chr "Unique ID not linked to IDBR or any other sample frames"
  ..- attr(*, "format.spss")= chr "A30"
  ..- attr(*, "display_width")= int 10
 $ instituitionTypes   : Factor w/ 3 levels "1","2","3": 1 1 1 1 1 1 1 1 1 1 ...
 $ sizea               : num [1:2154] 3 4 3 8 6 2 5 4 4 5 ...
 $ sizeb               : Factor w/ 5 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ priority            : Factor w/ 4 levels "1","2","3","4": 1 2 2 1 2 1 1 1 2 2 ...
 $ update              : Factor w/ 8 levels "1","2","3","4",..: 7 1 3 5 6 7 6 6 3 1 ...
 $ restore             : Factor w/ 5 levels "1","2","3","4",..: NA NA NA 1 NA 1 1 NA NA NA ...
 $ year                : num [1:2154] 2022 2022 2022 2022 2022 ...
 $ managementContinuity: Factor w/ 2 levels "0","1": 2 2 1 2 1 1 2 2 1 1 ...
 $ managementCyber     : Factor w/ 2 levels "0","1": 2 2 1 1 1 2 1 2 2 1 ...
 $ rulesUpdating       : Factor w/ 2 levels "0","1": 2 2 2 2 NA 2 2 1 2 2 ...
 $ rulesSecurityConfigs: Factor w/ 2 levels "0","1": 2 2 2 2 NA 2 2 2 2 2 ...
 $ rulesUserControl    : Factor w/ 2 levels "0","1": 2 1 1 2 NA 2 2 1 1 1 ...
 $ policyStaffAccess   : Factor w/ 2 levels "0","1": 1 1 NA 2 NA NA 2 1 NA NA ...
 $ policyData          : Factor w/ 2 levels "0","1": 2 1 NA 2 NA NA 2 2 NA NA ...
 $ policyPrivate       : Factor w/ 2 levels "0","1": 2 1 NA 2 NA NA 2 1 NA NA ...
 $ attackInfection     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ attackPhising       : Factor w/ 2 levels "0","1": 1 1 1 2 1 2 2 1 1 1 ...
 $ attackBreaching     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ outcomesData        : Factor w/ 2 levels "0","1": NA NA NA 1 NA 1 1 NA NA NA ...
 $ outcomesDDOS        : Factor w/ 2 levels "0","1": NA NA NA 1 NA 1 1 NA NA NA ...
 $ outcomesTheft       : Factor w/ 2 levels "0","1": NA NA NA 1 NA 1 1 NA NA NA ...
```

```
  ########################################################## 2021
  ########################################################## ########################################

  ## everyday I am unlabelling

  remove_var_label(dataCyberSecuritySurvey2021TidyNameSizeCyber$restore)
```

```
<labelled<double>[2282]>
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  [25]  1  1 NA  1  2 NA NA  2 NA NA  1  2  1  1  1 NA NA  1 NA  1  2 NA NA NA
  [49] NA NA NA  1 NA NA  1  2 NA  3 NA NA NA  1 NA  1  1  2 NA NA NA  1  4 NA
  [73] NA  1 NA NA  1  1 NA NA  1  1  1 NA NA NA NA NA  1  1 NA NA NA  1  1 NA
  [97]  1 NA  1 NA  1 NA NA NA NA NA  5 NA NA NA NA NA NA  1  1  2 NA NA  1 NA
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 [145]  1 NA NA  1 NA  1 NA NA NA  1 NA NA NA NA NA NA NA NA NA NA NA  1 NA NA
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 [193]  1 NA  1 NA NA  2 NA  1  5 NA NA  1 NA NA  1 NA NA NA NA NA  2  1  1  2
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```
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[1129]  1 NA  1  1 NA  1  1  1 NA  3  1  1  2  1  1  2 NA  1  2  1  1  1  1  1
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[1177] NA NA NA  1  1 NA  1  2  1  1 NA NA  1  1  2 NA NA NA  1  1  1 NA NA NA
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[1345] NA NA NA NA NA NA  2 NA NA  1  1  2  1 NA  1  1  1 NA  2  1  2 NA NA  2
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[1489] NA NA NA NA NA NA NA  1  1 NA NA NA  1 NA  1 NA NA NA NA  1 NA  1 NA NA
[1513] NA NA NA NA NA NA NA NA NA NA NA NA NA  1 NA  1 NA NA NA NA NA NA NA NA
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[1561]  1 NA  1  1 NA NA NA NA NA  3  1 NA NA NA  1 NA NA NA  1 NA  1  1  1 NA
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[1705] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA  2  1  2 NA  2  2 NA  1
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[1825] NA  1 NA NA NA NA NA NA  1  1 NA  2  1  1 NA  1  2 NA NA  1 NA  3  1  1
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[1873]  2  2  1  1 NA NA  2 NA  1 NA  1 NA  1  5 NA  1 NA NA NA NA  2 NA NA  3
[1897]  1  3 NA  1 NA  1  1  1 NA NA  1 NA NA NA NA NA NA NA NA  1 NA NA NA  1
[1921]  1  1 NA NA  1 NA NA NA NA NA NA NA NA NA NA  2 NA  1 NA NA  2 NA NA NA
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[2209]  1  2  1 NA  1  2  1  1  1  1  1  3 NA  1 NA  1  1  3  1 NA NA  3  1 NA
[2233]  3 NA  4 NA  1  1  4 NA  1  2  1  1  1 NA  2  2  3  1  1 NA NA  2 NA  2
[2257]  1  1  4 NA NA  1  1  2  1  5  1  2  3  3  2  1  1  3  1  1  1  1  4  1
[2281]  2  1

Labels:
 value                          label
    -97                     Don't know
      1                   No time at all
      2                  Less than a day
      3   Between a day and under a week
      4 Between a week and under a month
      5                 One month or more
      6         Still not back to normal
```

```
remove_val_labels(dataCyberSecuritySurvey2021TidyNameSizeCyber$restore)
```

```
   [1]  1 NA NA NA  1  1 NA  1 NA NA  1 NA  1 NA  1 NA NA NA  1 NA NA NA  1 NA
  [25]  1  1 NA  1  2 NA NA  2 NA NA  1  2  1  1  1 NA NA  1 NA  1  2 NA NA NA
  [49] NA NA NA  1 NA NA  1  2 NA  3 NA NA NA  1 NA  1  1  2 NA NA NA  1  4 NA
  [73] NA  1 NA NA  1  1 NA NA  1  1  1 NA NA NA NA NA  1  1 NA NA NA  1  1 NA
  [97]  1 NA  1 NA  1 NA NA NA NA NA  5 NA NA NA NA NA NA  1  1  2 NA NA  1 NA
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```

```
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[1225] NA  1 NA  1  1  1  1  2 NA NA  1 NA NA  1  1  1  1  1 NA  2  1  1  3  1
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[1273] NA  1  2  1  1 NA NA  1  3  1  1  1  1 NA  2 NA  1 NA NA  1  1  2 NA  1
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[1321]  3  1  2  1 NA  2  1  1  3 NA  2  1  1 NA NA  2  3  1  3 NA  2 NA NA  2
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[1537] NA NA NA NA NA NA NA NA NA NA NA NA NA NA  1 NA NA NA NA NA NA NA  2  1
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[1585]  1  3 NA  2 NA  2  1  1 NA  1  1 NA NA NA NA NA NA NA  2 NA NA NA NA  1
[1609]  1 NA NA NA NA  1  1 NA NA  1  1 NA  1 NA NA  1  1  1  5 NA NA NA NA NA
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[2041] NA  3  2 NA  2 NA NA NA NA NA NA  3  1  2 NA  1  1  1  2  1  2  1 NA  2
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[2089]  2  1 NA  1  1  1  1 NA  1  2 NA NA NA NA  1  1 NA NA NA  3 NA  1  1 NA
[2113]  1  1  1 NA NA NA NA NA  5  2 NA  3  1  1 NA NA  1  2 NA NA  2 NA  5 NA
[2137] NA NA NA  1  2 NA  1  2  2  1  1  1  1  2 NA NA NA  3 NA NA NA NA NA NA
[2161]  1  1 NA NA  2  4 NA  1  1  1  1 NA  1  1  1  2  1 NA  2 NA  1 NA  1  1
[2185] NA NA  2  3  2  3  3 NA  2 NA  3  2  1 NA NA  1  2 NA  2  2  1  1  2  1
[2209]  1  2  1 NA  1  2  1  1  1  1  1  3 NA  1 NA  1  1  3  1 NA NA  3  1 NA
[2233]  3 NA  4 NA  1  1  4 NA  1  2  1  1  1 NA  2  2  3  1  1 NA NA  2 NA  2
[2257]  1  1  4 NA NA  1  1  2  1  5  1  2  3  3  2  1  1  3  1  1  1  1  4  1
```

```
[2281]  2  1
attr(,"label")
[1] "Q71 How long, if any time at all, did it take to restore business operations back to normal
attr(,"format.spss")
[1] "F8.2"
attr(,"display_width")
[1] 10
```

```
dataCyberSecuritySurvey2021TidyNameSizeCyber$restore = as.factor(dataCyberSecuritySurvey2021Ti


## perfect factorizationa and numeric conversion removing all the
## problematic labels for imputation
dataCyberSecuritySurvey2021TidyNameSizeCyber$instituitionTypes = as.factor(dataCyberSecuritySu

dataCyberSecuritySurvey2021TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2021Tid

dataCyberSecuritySurvey2021TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2021Tidy

dataCyberSecuritySurvey2021TidyNameSizeCyber$priority = as.factor(dataCyberSecuritySurvey2021T

dataCyberSecuritySurvey2021TidyNameSizeCyber$update = as.factor(dataCyberSecuritySurvey2021Tid

dataCyberSecuritySurvey2021TidyNameSizeCyber$restore = as.factor(dataCyberSecuritySurvey2021Ti

dataCyberSecuritySurvey2021TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2021TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2021TidyNameSizeCyber$year = as.numeric(dataCyberSecuritySurvey2021Tidy

dataCyberSecuritySurvey2021TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2021TidyNameSizeCyber$managementCyber = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUpdating = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesUserControl = as.factor(dataCyberSecuritySur
dataCyberSecuritySurvey2021TidyNameSizeCyber$rulesSecurityConfigs = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2021TidyNameSizeCyber$policyStaffAccess = as.factor(dataCyberSecuritySu
dataCyberSecuritySurvey2021TidyNameSizeCyber$policyData = as.factor(dataCyberSecuritySurvey202
dataCyberSecuritySurvey2021TidyNameSizeCyber$policyPrivate = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2021TidyNameSizeCyber$attackInfection = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2021TidyNameSizeCyber$attackPhising = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2021TidyNameSizeCyber$attackBreaching = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesData = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesDDOS = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2021TidyNameSizeCyber$outcomesTheft = as.factor(dataCyberSecuritySurvey
```

```
  str(dataCyberSecuritySurvey2021TidyNameSizeCyber)
```

```
tibble [2,282 x 22] (S3: tbl_df/tbl/data.frame)
 $ imid                : chr [1:2282] "182150YKXT" "117166AEHW" "145903ZCHA" "171710NODP" ...
  ..- attr(*, "label")= chr "Unique ID"
  ..- attr(*, "format.spss")= chr "A30"
  ..- attr(*, "display_width")= int 26
 $ instituitionTypes   : Factor w/ 3 levels "1","2","3": 1 1 1 1 1 1 1 1 1 1 ...
 $ sizea               : num [1:2282] 9 6 2 3 7 2 7 3 6 3 ...
 $ sizeb               : Factor w/ 5 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ priority            : Factor w/ 4 levels "1","2","3","4": 3 3 1 1 2 2 1 2 1 1 ...
 $ update              : Factor w/ 8 levels "1","2","3","4",..: 4 4 7 5 3 5 3 6 4 8 ...
 $ restore             : Factor w/ 8 levels "1","2","3","4",..: 4 4 7 5 3 5 3 6 4 8 ...
 $ year                : num [1:2282] 2021 2021 2021 2021 2021 ...
 $ managementContinuity: Factor w/ 2 levels "0","1": 2 1 1 1 2 1 1 2 2 2 ...
 $ managementCyber     : Factor w/ 2 levels "0","1": 2 2 1 2 2 2 2 2 2 2 ...
 $ rulesUpdating       : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ rulesSecurityConfigs: Factor w/ 2 levels "0","1": 2 2 1 2 2 2 2 2 2 2 ...
 $ rulesUserControl    : Factor w/ 2 levels "0","1": 1 2 2 1 2 2 2 2 2 2 ...
 $ policyStaffAccess   : Factor w/ 2 levels "0","1": 2 NA NA NA 2 NA NA 2 2 2 ...
 $ policyData          : Factor w/ 1 level "0": 1 NA NA NA 1 NA NA 1 1 1 ...
 $ policyPrivate       : Factor w/ 2 levels "0","1": 2 NA NA NA 2 NA NA 2 2 1 ...
 $ attackInfection     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ attackPhising       : Factor w/ 2 levels "0","1": 2 1 1 1 2 2 1 2 1 2 ...
 $ attackBreaching     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ outcomesData        : Factor w/ 2 levels "0","1": 1 NA NA NA 1 1 NA 1 NA 1 ...
 $ outcomesDDOS        : Factor w/ 2 levels "0","1": 1 NA NA NA 1 1 NA 1 NA 1 ...
 $ outcomesTheft       : Factor w/ 2 levels "0","1": 1 NA NA NA 2 1 NA 1 NA 1 ...
```

```
  ########################################################## 2020
  ########################################################## ########################################

  ## everyday I am unlabelling

  remove_var_label(dataCyberSecuritySurvey2020TidyNameSizeCyber$restore)
```

```
<labelled<double>[1900]>
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  [25]  1 NA NA NA NA  1  1 NA NA NA  1 NA NA  3  2  2 NA NA NA NA NA NA  1 NA
  [49]  1 NA NA  1 NA  2  1 NA  2 NA NA NA NA  1  1 NA NA  2  2 NA  1 NA  1 NA
  [73] NA  2 NA NA NA  1  1  3  1 NA NA NA  1 NA NA NA  1  1 NA NA NA NA  1  2
  [97]  1 NA  1  5 NA  2 NA NA NA NA NA  2 NA  1 NA NA NA  1 NA  1  1 NA NA NA
 [121] NA  1 NA NA NA  1  1  1 NA NA NA NA NA NA  1 NA NA NA NA  3  2 NA NA  3
 [145] NA NA NA NA  1 NA NA NA  1 NA  1 NA  2 NA NA NA NA  1 NA NA NA NA  2  1
 [169]  1  1 NA NA  1 NA  1 NA  1  1 NA NA  1 NA NA  1 NA NA NA NA NA  1  1  1
 [193]  2  1 NA NA NA NA NA  1 NA  1 NA  1 NA  3 NA NA NA  3 NA  1  1  1  1  1
```

```
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 [265] NA  1  1 NA  3  1  1  1 NA  2 NA  2  5 NA NA NA NA  1 NA NA NA  2 NA NA
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 [361] NA NA  2 NA NA  1 NA NA  1  1 NA  1  1  4  1 NA  1 NA NA NA NA  1  1 NA
 [385]  1  2  1 NA  1  1 NA NA  1  1  3  1 NA NA NA NA  1  1 NA NA  1  1 NA NA
 [409] NA NA  1 NA  1 NA NA NA NA NA  1  3 NA NA NA  1  1 NA  2 NA  1 NA  1  1
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 [841] NA  4  1  1 NA  1  2  1  2  1  1 NA  1  1  1 NA  1  1  1  1 NA  4  1 NA
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[1009]  1 NA  1  1  1  3  1  2  1 NA  1 NA  1  1  2  1  1  1 NA  1 NA NA NA NA
[1033] NA NA NA NA NA NA NA NA  2  1  1 NA NA NA NA  1  2 NA  1 NA  1  1  1  1
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[1177]  1  2 NA NA  1 NA  2 NA  1  1  1 NA  2  1 NA  1 NA NA NA NA  3  1 NA  1
[1201]  1  2  2  1  2  1  1  1 NA  2 NA  2 NA  1 NA  1  1 NA  1 NA  2  1  1  3
[1225]  1  2  3  1  1  1  2  1  2  1 NA NA NA  1  1  1  1 NA  1 NA NA NA NA  1
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[1321]  1  1 NA  1  3  1  3 NA  2 NA  1 NA  1  1  1 NA  1  1  1  2  2  1  1 NA
[1345]  1  1  1 NA NA NA  1  1  1  1  1  1 NA NA NA NA NA NA NA NA NA  2 NA NA
[1369] NA NA NA NA NA NA NA NA NA NA NA NA  2 NA NA NA NA NA NA NA  3  1 NA  5
```

```
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[1633]  1 NA  1  2 NA NA  1  1 NA  2 NA  2  1 NA  1 NA  3  1 NA  2  1 NA  3  1
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[1681]  1 NA NA  1  1 NA NA NA NA NA NA  1 NA NA  1 NA NA  1  1 NA  2 NA  1  1
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[1825]  1  2  1 NA NA  1  1  1  2  2  2 NA NA  1  1  1  1  1 NA  2 NA  2  1 NA
[1849]  1 NA NA  1  1  1  1 NA  3  1  1 NA  1  2  1  4 NA NA  1  1 NA  1  2  2
[1873]  1  1 NA NA  2 NA  3 NA  2  4  2 NA  1  1  1 NA NA  1  1  2  2  2  2  1
[1897]  1 NA  3  2

Labels:
 value                           label
   -97                      Don't know
     1                  No time at all
     2                 Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6         Still not back to normal
```

```
remove_val_labels(dataCyberSecuritySurvey2020TidyNameSizeCyber$restore)
```

```
  [1]  1 NA  1 NA NA  1  1 NA  1 NA  1 NA NA NA NA  1 NA NA NA NA NA NA  1  1
 [25]  1 NA NA NA NA  1  1 NA NA NA  1 NA NA  3  2  2 NA NA NA NA NA NA  1 NA
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 [97]  1 NA  1  5 NA  2 NA NA NA NA NA  2 NA  1 NA NA NA  1 NA  1  1 NA NA NA
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```

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 [577] NA  1 NA  3 NA NA  1  1 NA  1 NA NA  1  1 NA NA  1  1 NA NA NA NA NA NA
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 [817] NA NA NA  2 NA NA NA NA NA NA  2 NA  1  1  1  1 NA  1  1 NA NA NA NA  2
 [841] NA  4  1  1 NA  1  2  1  2  1  1 NA  1  1  1 NA  1  1  1  1 NA  4  1 NA
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 [985]  2  1  1  2  1 NA  3 NA  1  1 NA  1 NA  1  1  1  2  1 NA NA NA NA NA NA
[1009]  1 NA  1  1  1  3  1  2  1 NA  1 NA  1  1  2  1  1  1 NA  1 NA NA NA NA
[1033] NA NA NA NA NA NA NA NA  2  1  1 NA NA NA NA  1  2 NA  1 NA  1  1  1  1
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[1153] NA  1 NA NA  1  1  2  1  1 NA  1  1  1  1  2  1 NA NA  2 NA  1  1  1 NA
[1177]  1  2 NA NA  1 NA  2 NA  1  1  1 NA  2  1 NA  1 NA NA NA NA  3  1 NA  1
[1201]  1  2  2  1  2  1  1  1 NA  2 NA  2 NA  1 NA  1  1 NA  1 NA  2  1  1  3
[1225]  1  2  3  1  1  1  2  1  2  1 NA NA NA  1  1  1  1 NA  1 NA NA NA NA  1
[1249]  1  1  2  1  1  2  2  1  1 NA  2  1  1 NA  2  1  1 NA  1  1  1  1 NA  1
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[1297]  1 NA  2  2  3  1 NA NA NA  1  1  2  1  1 NA NA  1  3  1  1  1  1  2  1
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```

```
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[1585]  1 NA  1  1  2 NA  2 NA NA NA  1  1  1 NA NA  1 NA  1  2  1  2 NA  1 NA
[1609] NA  1  3  1 NA NA  1 NA  1 NA  1  1 NA NA  3 NA  2  4  1  1  1  1 NA NA
[1633]  1 NA  1  2 NA NA  1  1 NA  2 NA  2  1 NA  1 NA  3  1 NA  2  1 NA  3  1
[1657] NA NA  5 NA NA  1 NA  1 NA  1  1  1  2  1  1  1  4  2  1  1  3 NA NA  2
[1681]  1 NA NA  1  1 NA NA NA NA NA NA  1 NA NA  1 NA NA  1  1 NA  2 NA  1  1
[1705]  1 NA  1  1 NA NA  1  1 NA NA NA  3  1 NA  1  1 NA  1 NA  1 NA  2 NA NA
[1729] NA  1 NA  1 NA  3 NA NA NA  1  2  1 NA NA NA NA  1  2  2  2 NA NA NA NA
[1753]  1 NA NA  1 NA  2 NA NA NA  1 NA  1 NA  1 NA NA NA NA  3 NA NA NA  1  1
[1777] NA NA  3 NA  1 NA NA NA  2  1 NA NA  3 NA NA  3 NA  2 NA  1  1  2  3 NA
[1801] NA NA  2  1  1 NA NA  1  1 NA  1  3  1 NA  3 NA  1  1  1 NA  1  1  2  2
[1825]  1  2  1 NA NA  1  1  1  2  2  2 NA NA  1  1  1  1  1 NA  2 NA  2  1 NA
[1849]  1 NA NA  1  1  1  1 NA  3  1  1 NA  1  2  1  4 NA NA  1  1 NA  1  2  2
[1873]  1  1 NA NA  2 NA  3 NA  2  4  2 NA  1  1  1 NA NA  1  1  2  2  2  2  1
[1897]  1 NA  3  2
attr(,"label")
[1] "Q71 How long, if any time at all, did it take to restore business operations back to normal
attr(,"format.spss")
[1] "F8.2"
attr(,"display_width")
[1] 10
```

```
dataCyberSecuritySurvey2020TidyNameSizeCyber$restore = as.factor(dataCyberSecuritySurvey2020Ti


## perfect factorizationa and numeric conversion removing all the
## problematic labels for imputation
dataCyberSecuritySurvey2020TidyNameSizeCyber$instituitionTypes = as.factor(dataCyberSecuritySu

dataCyberSecuritySurvey2020TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2020Tid

dataCyberSecuritySurvey2020TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2020Tidy

dataCyberSecuritySurvey2020TidyNameSizeCyber$priority = as.factor(dataCyberSecuritySurvey2020T

dataCyberSecuritySurvey2020TidyNameSizeCyber$update = as.factor(dataCyberSecuritySurvey2020Tid

dataCyberSecuritySurvey2020TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2020TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2020TidyNameSizeCyber$year = as.numeric(dataCyberSecuritySurvey2020Tidy
```

```
dataCyberSecuritySurvey2020TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2020TidyNameSizeCyber$managementCyber = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUpdating = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesUserControl = as.factor(dataCyberSecuritySur
dataCyberSecuritySurvey2020TidyNameSizeCyber$rulesSecurityConfigs = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2020TidyNameSizeCyber$policyStaffAccess = as.factor(dataCyberSecuritySu
dataCyberSecuritySurvey2020TidyNameSizeCyber$policyData = as.factor(dataCyberSecuritySurvey202
dataCyberSecuritySurvey2020TidyNameSizeCyber$policyPrivate = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2020TidyNameSizeCyber$attackInfection = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2020TidyNameSizeCyber$attackPhising = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2020TidyNameSizeCyber$attackBreaching = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesData = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesDDOS = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2020TidyNameSizeCyber$outcomesTheft = as.factor(dataCyberSecuritySurvey


str(dataCyberSecuritySurvey2020TidyNameSizeCyber)
```

```
tibble [1,900 x 22] (S3: tbl_df/tbl/data.frame)
 $ imid                : num [1:1900] 1e+05 1e+05 1e+05 1e+05 1e+05 ...
  ..- attr(*, "label")= chr "Unique ID not linked to IDBR"
  ..- attr(*, "format.spss")= chr "F8.2"
  ..- attr(*, "display_width")= int 10
 $ instituitionTypes   : Factor w/ 3 levels "1","2","3": 1 1 1 1 1 1 1 1 1 1 ...
 $ sizea               : num [1:1900] 2 5 8 2 2 2 3 3 7 8 ...
 $ sizeb               : Factor w/ 5 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ priority            : Factor w/ 4 levels "1","2","3","4": 1 1 2 3 1 4 1 1 2 1 ...
 $ update              : Factor w/ 8 levels "1","2","3","4",..: 7 6 4 3 7 1 7 5 4 3 ...
 $ restore             : Factor w/ 5 levels "1","2","3","4",..: 1 NA 1 NA NA 1 1 NA 1 NA ...
 $ year                : num [1:1900] 2020 2020 2020 2020 2020 2020 2020 2020 2020 2020 ...
 $ managementContinuity: Factor w/ 2 levels "0","1": 2 1 1 1 2 1 2 1 2 2 ...
 $ managementCyber     : Factor w/ 2 levels "0","1": 2 2 2 1 2 1 2 2 2 2 ...
 $ rulesUpdating       : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ rulesSecurityConfigs: Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ rulesUserControl    : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ policyStaffAccess   : Factor w/ 2 levels "0","1": 2 NA NA NA NA NA 1 NA NA 2 ...
 $ policyData          : Factor w/ 2 levels "0","1": 2 NA NA NA NA NA 2 NA NA 2 ...
 $ policyPrivate       : Factor w/ 2 levels "0","1": 2 NA NA NA NA NA 1 NA NA 1 ...
 $ attackInfection     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ attackPhising       : Factor w/ 2 levels "0","1": 2 1 2 1 1 2 2 1 2 1 ...
 $ attackBreaching     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ outcomesData        : Factor w/ 2 levels "0","1": 1 NA 1 NA NA 1 1 NA 1 NA ...
 $ outcomesDDOS        : Factor w/ 2 levels "0","1": 1 NA 1 NA NA 1 1 NA 1 NA ...
 $ outcomesTheft       : Factor w/ 2 levels "0","1": 1 NA 1 NA NA 1 1 NA 1 NA ...
```

```
  ######################################################## 2019
  ######################################################## ########################################

  ## everyday I am unlabelling

  remove_var_label(dataCyberSecuritySurvey2019TidyNameSizeCyber$restore)
```

```
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  [49] NA NA  4  1 NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA  1  1  1 NA  1  2
  [73]  2 NA NA NA NA NA NA NA NA NA NA NA NA  2 NA NA NA  2 NA NA NA NA NA NA
  [97]  1 NA  1 NA  1 NA NA  3 NA NA  2  4  1 NA NA NA NA NA  1 NA NA NA NA NA
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 [145] NA NA NA  1 NA  2 NA NA NA NA  1 NA NA NA NA NA NA  1 NA NA NA NA NA NA
 [169] NA NA NA NA  2  1 NA NA  2 NA NA NA NA NA NA NA  1 NA  1 NA NA NA NA NA
 [193] NA NA NA  1 NA NA  1 NA NA  3 NA  4 NA NA  1 NA NA NA NA  2 NA NA NA NA
 [217]  2 NA  1 NA NA NA  3 NA  2 NA NA  1 NA NA NA  1 NA NA  4 NA  1 NA  1 NA
 [241] NA NA NA NA NA NA NA  1  1 NA NA NA NA  1 NA NA  1  4 NA  1 NA NA  1 NA
 [265] NA NA  1 NA NA NA NA  1 NA NA NA NA  1  1 NA  1 NA NA NA  1 NA  1 NA NA
 [289] NA NA NA NA NA NA NA  2  2 NA  1 NA  1 NA  1  4 NA NA  1 NA NA NA NA  1
 [313] NA NA NA NA NA NA NA  1 NA  1  1  4  1  3 NA NA NA NA  1 NA  1 NA NA NA
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 [385] NA  1 NA  1 NA NA  2 NA NA NA  5  1 NA NA NA NA NA  3 NA NA NA NA NA NA
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 [433]  3  2 NA NA NA  3  2 NA  1 NA NA NA NA NA NA NA NA NA NA NA NA NA  2 NA
 [457] NA  1 NA  2 NA NA NA  1  2 NA NA NA NA NA NA NA NA NA NA NA NA  1 NA NA
 [481] NA NA NA  1 NA NA NA  3 NA NA NA  1  1 NA  1  1 NA NA NA  3 NA NA NA NA
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```
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[1345]  1 NA  1  1 NA  1  2  2 NA NA  1 NA  1  1 NA NA  1  3 NA NA NA  2  1  2
[1369]  1  2  1 NA  2 NA  1  2 NA  1  2  2  4  1  2 NA NA  1 NA  1  1  2  1  4
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[1969]  1 NA NA NA  1 NA  3  3 NA  2 NA NA  1  1  1 NA  2 NA NA  1 NA NA NA  1
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[2017]  1  1  1 NA NA NA NA  2 NA NA NA NA  3  2  3  2  2 NA  1 NA  1 NA  1  3
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[2065]  1  2  1 NA  4 NA  1 NA NA  2  3 NA

Labels:
```

```
value                            label
  -97                        Don't know
    1                     No time at all
    2                    Less than a day
    3   Between a day and under a week
    4 Between a week and under a month
    5                  One month or more
    6          Still not back to normal
```

```
remove_val_labels(dataCyberSecuritySurvey2019TidyNameSizeCyber$restore)
```

```
  [1] NA NA  1 NA NA NA NA NA NA NA NA NA  1  2 NA NA NA  2 NA NA NA NA NA NA
 [25] NA NA NA  2 NA  2 NA NA NA NA NA  1  3 NA NA NA  1 NA NA NA NA  1 NA NA
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 [97]  1 NA  1 NA  1 NA NA  3 NA NA  2  4  1 NA NA NA NA NA  1 NA NA NA NA NA
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[601] NA NA NA NA  1  2 NA NA  2 NA NA NA  2 NA  2  1 NA NA NA NA NA NA  1  1
[625] NA NA  1 NA NA NA  1  2 NA  1 NA NA  1 NA NA NA NA NA  1 NA  3 NA NA NA
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```

```
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 [913] NA NA NA NA NA NA NA  1 NA NA NA  1  2 NA  1  1 NA NA NA NA NA NA  4  3
 [937]  1  1  3  1  1 NA  2  1  1 NA  2 NA  1 NA NA NA  1  1 NA  1  2  2  1 NA
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[1057] NA NA NA NA NA  1 NA NA NA  1  2  1 NA NA  1 NA  1 NA NA NA NA  1  1  1
[1081]  1 NA  1  1 NA NA NA NA  1 NA NA NA NA  2  1  1  1 NA NA  2 NA  1 NA NA
[1105]  1  1 NA NA NA  1  1 NA  1 NA NA  2  1  1 NA NA  2 NA NA  1 NA  3 NA  1
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[1177]  1  2 NA NA  1 NA  1 NA NA NA  2 NA NA  1  1  1  2 NA  1 NA NA  2 NA  1
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[1249]  1 NA  1  2 NA NA  1  1 NA  3 NA  1  1 NA  1  1 NA NA  3  1 NA NA NA  1
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[1825]  1 NA  3 NA NA NA NA  2  2 NA NA NA NA NA NA  2 NA  1  1  1 NA NA NA  2
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[1873]  3 NA NA NA NA NA NA  1  1  1 NA NA  2  1 NA NA  2 NA  2 NA  2 NA NA  2
[1897] NA NA NA  1  1  1  3 NA NA  1  1  1  4  1 NA  3 NA NA NA  1 NA  2 NA NA
[1921]  1  1  1  1  2  1  3  1  1  1 NA NA NA  2 NA NA NA  1  2 NA NA  1 NA  1
[1945]  2 NA NA NA NA  1 NA  1  1  1  1  2 NA NA NA NA  2 NA  1 NA  1 NA  1  1
[1969]  1 NA NA NA  1 NA  3  3 NA  2 NA NA  1  1  1 NA  2 NA NA  1 NA NA NA  1
[1993]  4  3  2  1 NA NA  3  1 NA NA NA  2  5 NA NA NA  3  1  1  2 NA NA  1  2
[2017]  1  1  1 NA NA NA NA  2 NA NA NA NA  3  2  3  2  2 NA  1 NA  1 NA  1  3
```

```
[2041]  1  1 NA NA NA NA NA NA NA  2 NA  2 NA  1  2 NA  1 NA  5  1  1  2 NA  2
[2065]  1  2  1 NA  4 NA  1 NA NA  2  3 NA
attr(,"label")
[1] "Q71 How long, if any time at all, did it take to restore business operations back to normal
attr(,"format.spss")
[1] "F8.2"
attr(,"display_width")
[1] 10
```

```
dataCyberSecuritySurvey2019TidyNameSizeCyber$restore = as.factor(dataCyberSecuritySurvey2019Ti

## perfect factorizationa and numeric conversion removing all the
## problematic labels for imputation
dataCyberSecuritySurvey2019TidyNameSizeCyber$instituitionTypes = as.factor(dataCyberSecuritySu

dataCyberSecuritySurvey2019TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2019Tid

dataCyberSecuritySurvey2019TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2019Tidy

dataCyberSecuritySurvey2019TidyNameSizeCyber$priority = as.factor(dataCyberSecuritySurvey2019T

dataCyberSecuritySurvey2019TidyNameSizeCyber$update = as.factor(dataCyberSecuritySurvey2019Tid

dataCyberSecuritySurvey2019TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2019TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2019TidyNameSizeCyber$year = as.numeric(dataCyberSecuritySurvey2019Tidy

dataCyberSecuritySurvey2019TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2019TidyNameSizeCyber$managementCyber = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUpdating = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesUserControl = as.factor(dataCyberSecuritySur
dataCyberSecuritySurvey2019TidyNameSizeCyber$rulesSecurityConfigs = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2019TidyNameSizeCyber$policyStaffAccess = as.factor(dataCyberSecuritySu
dataCyberSecuritySurvey2019TidyNameSizeCyber$policyData = as.factor(dataCyberSecuritySurvey201
dataCyberSecuritySurvey2019TidyNameSizeCyber$policyPrivate = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2019TidyNameSizeCyber$attackInfection = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2019TidyNameSizeCyber$attackPhising = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2019TidyNameSizeCyber$attackBreaching = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesData = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesDDOS = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2019TidyNameSizeCyber$outcomesTheft = as.factor(dataCyberSecuritySurvey


str(dataCyberSecuritySurvey2019TidyNameSizeCyber)
```

```
tibble [2,076 x 22] (S3: tbl_df/tbl/data.frame)
```

```
 $ imid                : num [1:2076] 1e+05 1e+05 1e+05 1e+05 1e+05 ...
  ..- attr(*, "label")= chr "Unique ID not linked to IDBR"
  ..- attr(*, "format.spss")= chr "F8.2"
  ..- attr(*, "display_width")= int 10
 $ instituitionTypes   : Factor w/ 2 levels "1","2": 1 1 1 1 1 1 1 1 1 1 ...
 $ sizea               : num [1:2076] 6 4 4 2 4 5 2 5 5 6 ...
 $ sizeb               : Factor w/ 5 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ priority            : Factor w/ 4 levels "1","2","3","4": 3 NA 2 3 1 1 1 1 2 1 ...
 $ update              : Factor w/ 8 levels "1","2","3","4",..: 1 NA 1 1 1 4 7 4 7 8 ...
 $ restore             : Factor w/ 5 levels "1","2","3","4",..: NA NA 1 NA NA NA NA NA NA NA ...
 $ year                : num [1:2076] 2019 2019 2019 2019 2019 ...
 $ managementContinuity: Factor w/ 2 levels "0","1": 1 1 1 1 2 2 2 1 1 2 ...
 $ managementCyber     : Factor w/ 2 levels "0","1": 1 1 1 1 2 2 2 2 2 2 ...
 $ rulesUpdating       : Factor w/ 2 levels "0","1": 2 2 2 1 2 2 2 2 2 2 ...
 $ rulesSecurityConfigs: Factor w/ 2 levels "0","1": 2 2 2 1 2 2 2 1 1 2 ...
 $ rulesUserControl    : Factor w/ 2 levels "0","1": 1 2 2 1 2 2 2 1 1 2 ...
 $ policyStaffAccess   : Factor w/ 2 levels "0","1": NA NA NA NA 2 NA 2 NA NA 1 ...
 $ policyData          : Factor w/ 2 levels "0","1": NA NA NA NA 2 NA 2 NA NA 1 ...
 $ policyPrivate       : Factor w/ 2 levels "0","1": NA NA NA NA 2 NA 2 NA NA 1 ...
 $ attackInfection     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 2 1 1 1 ...
 $ attackPhising       : Factor w/ 2 levels "0","1": 1 1 2 1 1 1 2 1 1 1 ...
 $ attackBreaching     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
 $ outcomesData        : Factor w/ 2 levels "0","1": NA NA 1 NA NA NA 1 NA NA NA ...
 $ outcomesDDOS        : Factor w/ 2 levels "0","1": NA NA 1 NA NA NA 1 NA NA NA ...
 $ outcomesTheft       : Factor w/ 2 levels "0","1": NA NA 1 NA NA NA 1 NA NA NA ...
```

```
 ######################################################## 2018
 ######################################################## ########################################


 ## everyday I am unlabelling

 remove_var_label(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore)
```

```
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  [49] NA NA  1 NA NA NA NA NA  1 NA NA NA  1  2  1 NA  1  2 NA  2  1 NA  1 NA
  [73] NA NA NA NA NA  3 NA NA  2  2  1 NA NA NA  1 NA NA NA NA NA  2  1  2 NA
  [97] NA  1  2  1 NA NA NA  1 NA  1  2 NA NA NA NA  2 NA  1 NA NA  1 NA NA  1
 [121]  1  1 NA NA NA  1 NA NA NA NA NA NA  2 NA NA NA  1 NA  3  1  3  1  1 NA
 [145] NA NA NA NA  1  1 NA NA NA NA NA NA NA NA NA  1  1  1  1 NA  1 NA NA  1 NA
 [169]  1  1 NA NA NA NA NA NA  1  1 NA NA  4 NA  1 NA NA  1 NA NA NA  1 NA  1
 [193] NA  1 NA  2 NA NA NA  2 NA NA NA NA NA NA NA NA  1  1 NA NA  4  1  1 NA
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 [265] NA  1 NA NA  1 NA  1 NA  2 NA  1 NA  2 NA NA  2  4  2 NA  1 NA NA  1  1
```

```
 [289]  1 NA  2 NA NA NA  1 NA NA  1  1 NA  3 NA NA  1  2 NA  4  1 NA  1 NA  1
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 [409] NA NA  2 NA NA NA NA  3 NA NA  1 NA NA  1  2 NA  1 NA NA NA  1 NA NA  1
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 [457] NA  1  2  1 NA NA NA NA  1  1 NA NA NA NA  2  1  1 NA NA NA NA NA NA NA
 [481] NA NA NA NA NA NA  1 NA  1 NA  1 NA  1  1 NA NA  3 NA NA  2  2 NA  1 NA
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 [529]  5 NA NA  1 NA NA  3 NA NA  1 NA NA  2 NA  2 NA  2 NA NA NA NA NA NA NA
 [553]  1 NA  1 NA NA NA NA NA  1 NA  1 NA NA  2  1  1 NA NA NA NA  3  1 NA  3
 [577]  2  1 NA NA  1  1 NA NA NA NA NA  2  1 NA  1 NA NA  2 NA NA  1  1 NA NA
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 [721] NA NA NA NA  1 NA NA NA NA NA NA NA NA  1 NA  1 NA NA NA  1 NA NA NA  1
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 [769]  1 NA NA NA NA  3  3 NA NA NA  2 NA NA NA NA NA NA NA NA NA NA NA NA NA
 [793] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA  1 NA NA NA NA NA NA NA NA
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[1297] NA NA  2 NA  4  1 NA NA NA  1  1 NA NA NA NA NA NA NA  3 NA  2 NA NA  1
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[1441] NA NA NA  2 NA NA  1  2  1 NA  1  2 NA  1 NA  4 NA  2  2 NA NA  1 NA NA
```

```
[1465]  1  3  2  2 NA NA  2  4 NA NA  2  1 NA  1 NA  1  3 NA NA  4  1  3 NA NA
[1489] NA  1  3  1 NA NA NA  2 NA  1 NA  1 NA NA  2  3 NA NA  1 NA NA NA NA NA
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[1561] NA  1 NA NA  1 NA NA  1  1  3 NA NA  2 NA NA  1  1 NA  3 NA  1  1  2  1
[1585]  1  1  2 NA NA NA  1  3 NA NA  1  1  1  1  1 NA NA  1 NA  1 NA  3  1 NA
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[1753]  1  1  2  1 NA  1  3  2  2  1  3 NA  1 NA  3 NA  1  1 NA  1  3 NA  2 NA
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[1873] NA  1  1 NA  3 NA NA  1  1  1  2  1  2  1  1 NA  2  1  1  1  3  2  2 NA
[1897] NA  1 NA  1  1  1  1  1  2  1 NA  1  1  1  1  1 NA  2 NA NA NA  1  4  1
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[1945]  1  1 NA  1 NA  2  1  1  1  4 NA  1  1  1 NA  1 NA  1  2  1 NA  2  1  1
[1969]  1  1  1  1  1  1  1  1 NA  1 NA  1  2  1  2  1 NA NA  2  1  1  2 NA  4
[1993]  2  2  1  1  3  1 NA  2  1  3  1  1  1  1  2  1  2  3  1 NA  2 NA  1  1
[2017] NA  3  1  1 NA  1  1  2  2  1  1  1 NA NA  1  1 NA NA  1  2  1 NA  1 NA
[2041]  2 NA  3  1  1  2  3 NA  1  1  1  2  2 NA  1  1  1 NA NA  1  2  1  2 NA
[2065]  1 NA  2  4  2 NA  3 NA  1  3  1

Labels:
 value                           label
   -97                      Don't know
     1                   No time at all
     2                  Less than a day
     3   Between a day and under a week
     4 Between a week and under a month
     5                 One month or more
     6         Still not back to normal
```

```
remove_val_labels(dataCyberSecuritySurvey2018TidyNameSizeCyber$restore)
```

```
  [1]  1  4 NA  2 NA  1 NA  2  1 NA NA  3 NA NA NA  1 NA  1 NA NA  1 NA NA  1
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 [49] NA NA  1 NA NA NA NA NA  1 NA NA NA  1  2  1 NA  1  2 NA  2  1 NA  1 NA
 [73] NA NA NA NA NA  3 NA NA  2  2  1 NA NA NA  1 NA NA NA NA NA  2  1  2 NA
 [97] NA  1  2  1 NA NA NA  1 NA  1  2 NA NA NA NA  2 NA  1 NA NA  1 NA NA  1
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[145] NA NA NA NA  1  1 NA NA NA NA NA NA NA NA  1  1  1  1 NA  1 NA NA  1 NA
[169]  1  1 NA NA NA NA NA NA  1  1 NA NA  4 NA  1 NA NA  1 NA NA NA  1 NA  1
```

```
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 [577]  2  1 NA NA  1  1 NA NA NA NA NA  2  1 NA  1 NA NA  2 NA NA  1  1 NA NA
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 [625]  1  3 NA NA NA NA  3 NA  3  1 NA NA NA NA NA  1  1 NA NA NA NA  1 NA  1
 [649]  4 NA  1 NA NA  1  1 NA  1 NA NA NA NA NA  1 NA NA NA  1 NA NA NA NA  3
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 [697] NA NA  1  1 NA NA NA NA NA NA  1 NA NA  1 NA  1 NA NA NA NA NA  1 NA NA
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 [745] NA NA NA  1  3 NA NA NA NA NA  4 NA NA NA NA  3 NA  3  1 NA NA NA NA NA
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[1129] NA NA NA  2 NA NA  2  1  1 NA NA  1  3  1  1  2 NA  1 NA  1 NA NA NA NA
[1153] NA NA NA  1 NA NA NA  1  3 NA NA NA  1  1 NA NA NA NA NA NA NA  1 NA  1
[1177] NA NA  1 NA NA NA  1 NA NA NA NA NA NA NA NA NA NA  2  1 NA NA  3 NA  1  1
[1201]  4  1  2 NA  2  1  1 NA NA  2 NA NA  1 NA  1  2  1 NA NA NA  1  2 NA NA
[1225] NA NA  1 NA  1 NA  1  3  1 NA NA NA NA NA  1  4 NA NA  1 NA NA NA  1 NA
[1249] NA NA NA NA NA  1  1 NA NA NA NA NA NA NA NA  1 NA NA  2 NA NA NA  1  5 NA
[1273] NA  2 NA NA NA NA NA NA NA NA  1 NA  2 NA  2  4 NA  1  1 NA NA NA NA NA  2
[1297] NA NA  2 NA  4  1 NA NA NA  1  1 NA NA NA NA NA NA NA  3 NA  2 NA NA  1
[1321]  3  3 NA  3  2  1  1 NA NA  1 NA NA  1 NA NA  1 NA NA  1  3  1  1 NA  4
[1345]  1 NA NA NA NA  1 NA  1 NA  1 NA NA NA NA NA NA  1  1 NA NA NA  2  2  3
```

```
[1369] NA  1 NA  1  3 NA  1  2  2 NA NA NA NA NA NA NA  1  1  4 NA  3 NA  2  2
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[1633] NA NA NA NA NA  4 NA NA  3  1 NA NA NA NA  2  1  1 NA  1  3  1 NA NA NA
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[1681] NA NA NA NA  2  4  4  1 NA  1 NA  1  1  3  1  1  2  1  2  1  1  1  1 NA
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[1753]  1  1  2  1 NA  1  3  2  2  1  3 NA  1 NA  3 NA  1  1 NA  1  3 NA  2 NA
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[1825]  2  1  3  1 NA NA  1  1 NA  1  1  1  2  2  2  1  1  1  2  1  2  1 NA  1
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[1921] NA  1 NA  1  1  2 NA  1  1  3  2  2  1  1  1  1 NA  1  1  1  1  1  1 NA
[1945]  1  1 NA  1 NA  2  1  1  1  4 NA  1  1  1 NA  1 NA  1  2  1 NA  2  1  1
[1969]  1  1  1  1  1  1  1  1 NA  1 NA  1  2  1  2  1 NA NA  2  1  1  2 NA  4
[1993]  2  2  1  1  3  1 NA  2  1  3  1  1  1  1  2  1  2  3  1 NA  2 NA  1  1
[2017] NA  3  1  1 NA  1  1  2  2  1  1  1 NA NA  1  1 NA NA  1  2  1 NA  1 NA
[2041]  2 NA  3  1  1  2  3 NA  1  1  1  2  2 NA  1  1  1 NA NA  1  2  1  2 NA
[2065]  1 NA  2  4  2 NA  3 NA  1  3  1
attr(,"label")
[1] "Q71 How long, if any time at all, did it take to restore business operations back to normal
attr(,"format.spss")
[1] "F8.0"
attr(,"display_width")
[1] 10
```

```
dataCyberSecuritySurvey2018TidyNameSizeCyber$restore = as.factor(dataCyberSecuritySurvey2018Ti

## perfect factorizationa and numeric conversion removing all the
## problematic labels for imputation
dataCyberSecuritySurvey2018TidyNameSizeCyber$instituitionTypes = as.factor(dataCyberSecuritySu

dataCyberSecuritySurvey2018TidyNameSizeCyber$sizea = as.numeric(dataCyberSecuritySurvey2018Tid

dataCyberSecuritySurvey2018TidyNameSizeCyber$sizeb = as.factor(dataCyberSecuritySurvey2018Tidy
```

```
dataCyberSecuritySurvey2018TidyNameSizeCyber$priority = as.factor(dataCyberSecuritySurvey2018T

dataCyberSecuritySurvey2018TidyNameSizeCyber$update = as.factor(dataCyberSecuritySurvey2018Tid

dataCyberSecuritySurvey2018TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2018TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit

dataCyberSecuritySurvey2018TidyNameSizeCyber$year = as.numeric(dataCyberSecuritySurvey2018Tidy

dataCyberSecuritySurvey2018TidyNameSizeCyber$managementContinuity = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2018TidyNameSizeCyber$managementCyber = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUpdating = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesUserControl = as.factor(dataCyberSecuritySur
dataCyberSecuritySurvey2018TidyNameSizeCyber$rulesSecurityConfigs = as.factor(dataCyberSecurit
dataCyberSecuritySurvey2018TidyNameSizeCyber$policyStaffAccess = as.factor(dataCyberSecuritySu
dataCyberSecuritySurvey2018TidyNameSizeCyber$policyData = as.factor(dataCyberSecuritySurvey201
dataCyberSecuritySurvey2018TidyNameSizeCyber$policyPrivate = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2018TidyNameSizeCyber$attackInfection = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2018TidyNameSizeCyber$attackPhising = as.factor(dataCyberSecuritySurvey
dataCyberSecuritySurvey2018TidyNameSizeCyber$attackBreaching = as.factor(dataCyberSecuritySurv
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesData = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesDDOS = as.factor(dataCyberSecuritySurvey2
dataCyberSecuritySurvey2018TidyNameSizeCyber$outcomesTheft = as.factor(dataCyberSecuritySurvey


str(dataCyberSecuritySurvey2018TidyNameSizeCyber)
```

```
tibble [2,075 x 22] (S3: tbl_df/tbl/data.frame)
 $ imid                : num [1:2075] 100065 100075 100304 100318 100779 ...
  ..- attr(*, "label")= chr "Unique ID not linked to IDBR"
  ..- attr(*, "format.spss")= chr "F8.0"
  ..- attr(*, "display_width")= int 10
 $ instituitionTypes   : Factor w/ 2 levels "1","2": 1 1 1 1 1 1 1 1 1 1 ...
 $ sizea               : num [1:2075] 60 13 4 100 3 70 50 60 80 NA ...
 $ sizeb               : Factor w/ 5 levels "1","2","3","4",..: 3 2 1 3 1 3 3 3 3 4 ...
 $ priority            : Factor w/ 4 levels "1","2","3","4": 1 1 1 2 2 2 2 2 2 1 ...
 $ update              : Factor w/ 9 levels "1","2","3","4",..: 9 4 9 4 5 9 6 5 3 6 ...
 $ restore             : Factor w/ 5 levels "1","2","3","4",..: 1 4 NA 2 NA 1 NA 2 1 NA ...
 $ year                : num [1:2075] 2018 2018 2018 2018 2018 ...
 $ managementContinuity: Factor w/ 2 levels "0","1": 2 2 1 2 2 2 2 2 2 2 ...
 $ managementCyber     : Factor w/ 2 levels "0","1": 1 2 2 2 2 2 2 2 1 2 ...
 $ rulesUpdating       : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ rulesSecurityConfigs: Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ rulesUserControl    : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
 $ policyStaffAccess   : Factor w/ 2 levels "0","1": NA NA NA 2 2 2 2 2 NA 2 ...
 $ policyData          : Factor w/ 2 levels "0","1": NA NA NA 2 1 2 2 2 NA 2 ...
 $ policyPrivate       : Factor w/ 2 levels "0","1": NA NA NA 1 2 2 2 2 NA 2 ...
```

```
$ attackInfection     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
$ attackPhising       : Factor w/ 2 levels "0","1": 2 2 1 1 1 2 1 2 2 1 ...
$ attackBreaching     : Factor w/ 2 levels "0","1": 1 1 1 2 1 1 1 1 1 1 ...
$ outcomesData        : Factor w/ 2 levels "0","1": 1 1 NA 1 NA 1 NA 1 1 NA ...
$ outcomesDDOS        : Factor w/ 2 levels "0","1": 1 2 NA 1 NA 1 NA 1 1 NA ...
$ outcomesTheft       : Factor w/ 2 levels "0","1": 1 1 NA 1 NA 1 NA 1 1 NA ...
```

```
## remember we must make the imputations before we merge the data of
## all the years


## m= number of imputations maxit = number of iterations

## ppm is for continuous missing data loreg is for dichotomous missing
## data //dichotomous two mutuallu exclusive groups polyreg is for
## categorical missing data // categorical variable can be one of a
## limited, and usually fixed number of values aka its discrete norm is
## Bayesian linear regression without predictive mean matching TODO
## maybe write this one the report

## ok so we should have maxit(number of iterations) around 20-30
## (preferably less) but tweak it so the plot(generated by the
## iterations have a good convergence otherwise it will be inaccurate)
## // when the lines reach a value and fluctuate slightly around it,
## convergence has been achieved

## iteration 0 - per imputed dataset at iteration number 0 values are
## randomly drawn iteration 1 - At this step the first variable values
## are set back to missing. Subsequently, a linear regression model is
## applied in the available data iteration 2 - the same procedure is
## repeated for the next variable and so on
```

(“Book_MI.knit” 2022)

```
## as we can see in Rubin's works the larger the number of data sets
## the larger the error will meaning a finite number of imputations is
## favorable to an infinite number of imputations RE=1/(1+(FMI/m))
```

(Rubin 1975)

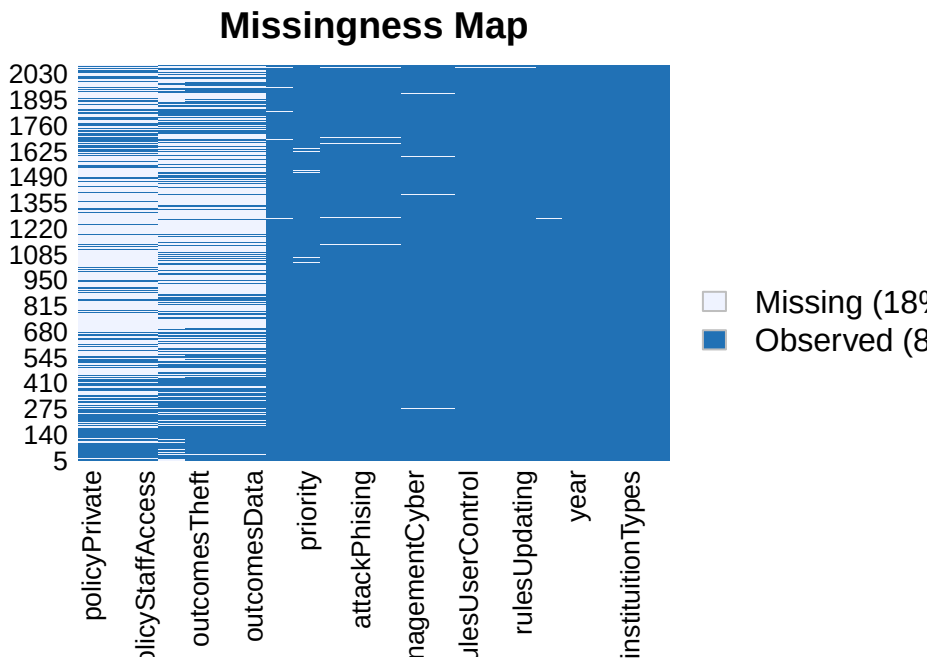
```
## in White, Royston, and Wood book "Multiple imputation using chained
## equations: Issues and guidance for practice' they proposed the rule
## of equating the number of imputations to the percentage of missing
## data in each of the data sets which is what I will be using
```

(White, Royston, and Wood 2010)

```
missmap(dataCyberSecuritySurvey2018TidyNameSizeCyber)  ## 18% missing data
```

```
Warning: Unknown or uninitialised column: `arguments`.
Unknown or uninitialised column: `arguments`.

Warning: Unknown or uninitialised column: `imputations`.
```

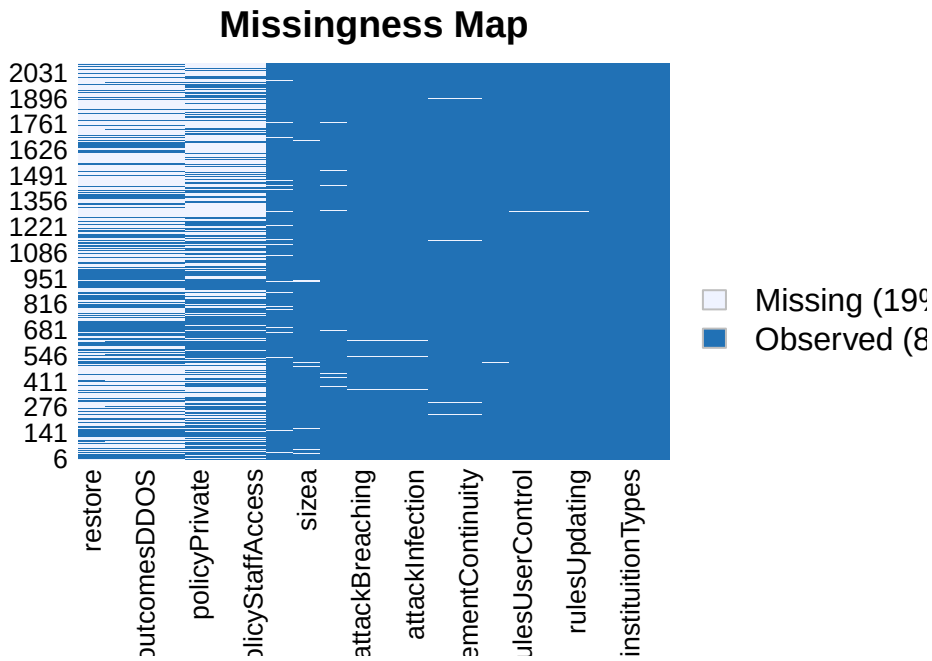



```
missmap(dataCyberSecuritySurvey2019TidyNameSizeCyber)  ## 19% missing data
```

```
Warning: Unknown or uninitialised column: `arguments`.

Warning: Unknown or uninitialised column: `arguments`.

Warning: Unknown or uninitialised column: `imputations`.
```

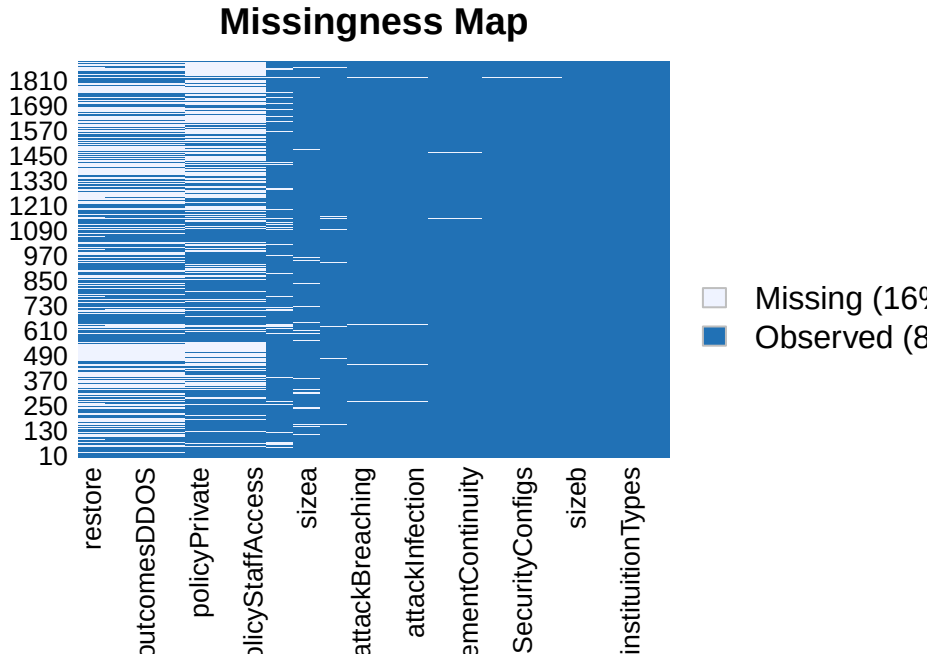



```
missmap(dataCyberSecuritySurvey2020TidyNameSizeCyber)  ## 16% missing data
```

```
Warning: Unknown or uninitialised column: `arguments`.
```

```
Warning: Unknown or uninitialised column: `arguments`.
```

```
Warning: Unknown or uninitialised column: `imputations`.
```

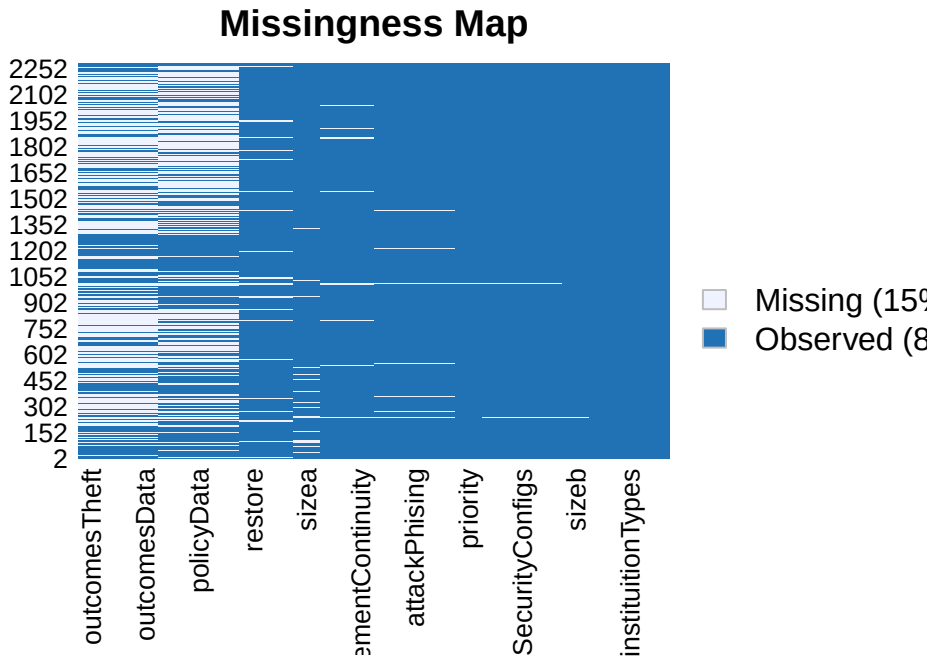


```
missmap(dataCyberSecuritySurvey2021TidyNameSizeCyber)  ## 15% missing data
```

```
Warning: Unknown or uninitialised column: `arguments`.
```

```
Warning: Unknown or uninitialised column: `arguments`.
```

```
Warning: Unknown or uninitialised column: `imputations`.
```

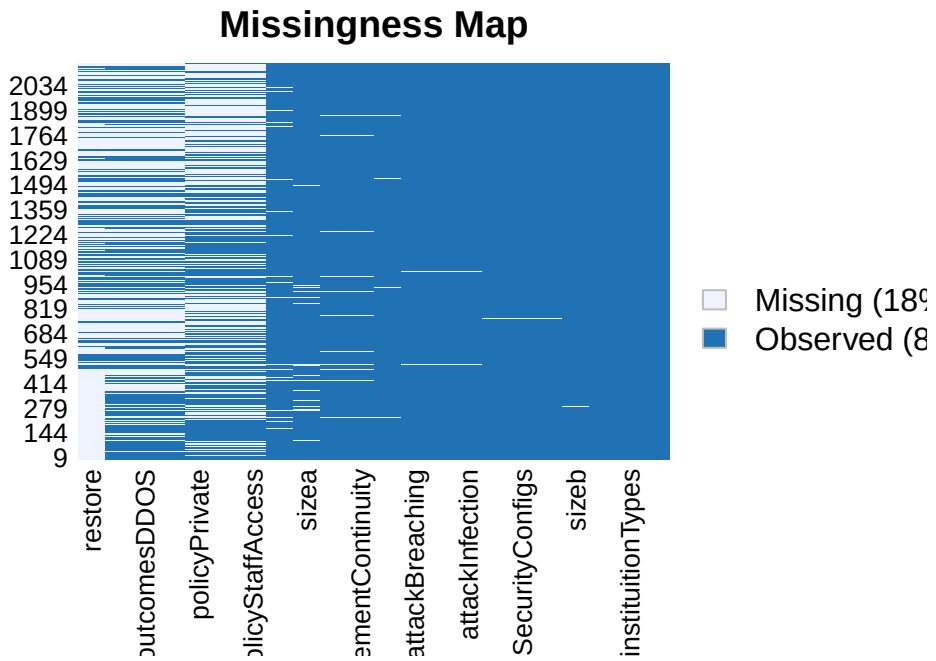



```
missmap(dataCyberSecuritySurvey2022TidyNameSizeCyber)  ## 18% missing data
```

```
Warning: Unknown or uninitialised column: `arguments`.
```

```
Warning: Unknown or uninitialised column: `arguments`.
```

```
Warning: Unknown or uninitialised column: `imputations`.
```




```
## doing one imp one maxit just so I have access to the predictor
## matrix for the proper imputation

imp2022 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 1, maxit = 1)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
Warning: Number of logged events: 6
```

```
imp2021 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 1, maxit = 1)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
Warning: Number of logged events: 6
```

```
imp2020 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 1, maxit = 1)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
Warning: Number of logged events: 6
```

```
  imp2019 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 1, maxit = 1)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
Warning: Number of logged events: 6
```

```
  imp2018 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 1, maxit = 1)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
Warning: Number of logged events: 6
```

##setting up the prediciton Matrix

```
  ########################################################## 2022
  ########################################################## ########################################

  ## here we will change the predictor matrix so the only predictor for
  ## the sizea, the real size has the scale of sizeb as its only
  ## predictor which is already on by default

  predictorMatrix2022 = imp2022$predictorMatrix

  predictorMatrix2022["imid", "sizea"] = 0
  predictorMatrix2022["instituitionTypes", "sizea"] = 0
  predictorMatrix2022["priority", "sizea"] = 0
  predictorMatrix2022["update", "sizea"] = 0
  predictorMatrix2022["restore", "sizea"] = 0
  predictorMatrix2022["year", "sizea"] = 0
  predictorMatrix2022["managementContinuity", "sizea"] = 0
  predictorMatrix2022["managementCyber", "sizea"] = 0
  predictorMatrix2022["rulesUpdating", "sizea"] = 0
  predictorMatrix2022["rulesSecurityConfigs", "sizea"] = 0
  predictorMatrix2022["rulesUserControl", "sizea"] = 0
  predictorMatrix2022["policyStaffAccess", "sizea"] = 0
  predictorMatrix2022["policyData", "sizea"] = 0
  predictorMatrix2022["policyPrivate", "sizea"] = 0
  predictorMatrix2022["attackInfection", "sizea"] = 0
  predictorMatrix2022["attackPhising", "sizea"] = 0
  predictorMatrix2022["attackBreaching", "sizea"] = 0
  predictorMatrix2022["outcomesDDOS", "sizea"] = 0
  predictorMatrix2022["outcomesData", "sizea"] = 0
  predictorMatrix2022["outcomesTheft", "sizea"] = 0
```

```
predictorMatrix2022
```

```
                    imid instituitionTypes sizea sizeb priority update restore
imid                   0                 1     0     1        1      1       1
instituitionTypes      0                 0     0     1        1      1       1
sizea                  0                 1     0     1        1      1       1
sizeb                  0                 1     1     0        1      1       1
priority               0                 1     0     1        0      1       1
update                 0                 1     0     1        1      0       1
restore                0                 1     0     1        1      1       0
year                   0                 1     0     1        1      1       1
managementContinuity   0                 1     0     1        1      1       1
managementCyber        0                 1     0     1        1      1       1
rulesUpdating          0                 1     0     1        1      1       1
rulesSecurityConfigs   0                 1     0     1        1      1       1
rulesUserControl       0                 1     0     1        1      1       1
policyStaffAccess      0                 1     0     1        1      1       1
policyData             0                 1     0     1        1      1       1
policyPrivate          0                 1     0     1        1      1       1
attackInfection        0                 1     0     1        1      1       1
attackPhising          0                 1     0     1        1      1       1
attackBreaching        0                 1     0     1        1      1       1
outcomesData           0                 1     0     1        1      1       1
outcomesDDOS           0                 1     0     1        1      1       1
outcomesTheft          0                 1     0     1        1      1       1
                    year managementContinuity managementCyber rulesUpdating
imid                   0                    1               1             1
instituitionTypes      0                    1               1             1
sizea                  0                    1               1             1
sizeb                  0                    1               1             1
priority               0                    1               1             1
update                 0                    1               1             1
restore                0                    1               1             1
year                   0                    1               1             1
managementContinuity   0                    0               1             1
managementCyber        0                    1               0             1
rulesUpdating          0                    1               1             0
rulesSecurityConfigs   0                    1               1             1
rulesUserControl       0                    1               1             1
policyStaffAccess      0                    1               1             1
policyData             0                    1               1             1
policyPrivate          0                    1               1             1
attackInfection        0                    1               1             1
attackPhising          0                    1               1             1
attackBreaching        0                    1               1             1
outcomesData           0                    1               1             1
outcomesDDOS           0                    1               1             1
```

outcomesTheft	0	1	1	1

	rulesSecurityConfigs	rulesUserControl	policyStaffAccess
imid	1	1	1
instituitionTypes	1	1	1
sizea	1	1	1
sizeb	1	1	1
priority	1	1	1
update	1	1	1
restore	1	1	1
year	1	1	1
managementContinuity	1	1	1
managementCyber	1	1	1
rulesUpdating	1	1	1
rulesSecurityConfigs	0	1	1
rulesUserControl	1	0	1
policyStaffAccess	1	1	0
policyData	1	1	1
policyPrivate	1	1	1
attackInfection	1	1	1
attackPhising	1	1	1
attackBreaching	1	1	1
outcomesData	1	1	1
outcomesDDOS	1	1	1
outcomesTheft	1	1	1

	policyData	policyPrivate	attackInfection	attackPhising
imid	1	1	1	1
instituitionTypes	1	1	1	1
sizea	1	1	1	1
sizeb	1	1	1	1
priority	1	1	1	1
update	1	1	1	1
restore	1	1	1	1
year	1	1	1	1
managementContinuity	1	1	1	1
managementCyber	1	1	1	1
rulesUpdating	1	1	1	1
rulesSecurityConfigs	1	1	1	1
rulesUserControl	1	1	1	1
policyStaffAccess	1	1	1	1
policyData	0	1	1	1
policyPrivate	1	0	1	1
attackInfection	1	1	0	1
attackPhising	1	1	1	0
attackBreaching	1	1	1	1
outcomesData	1	1	1	1
outcomesDDOS	1	1	1	1
outcomesTheft	1	1	1	1

	attackBreaching	outcomesData	outcomesDDOS	outcomesTheft
imid	1	1	1	1

instituitionTypes	1	1	1	1
sizea	1	1	1	1
sizeb	1	1	1	1
priority	1	1	1	1
update	1	1	1	1
restore	1	1	1	1
year	1	1	1	1
managementContinuity	1	1	1	1
managementCyber	1	1	1	1
rulesUpdating	1	1	1	1
rulesSecurityConfigs	1	1	1	1
rulesUserControl	1	1	1	1
policyStaffAccess	1	1	1	1
policyData	1	1	1	1
policyPrivate	1	1	1	1
attackInfection	1	1	1	1
attackPhising	1	1	1	1
attackBreaching	0	1	1	1
outcomesData	1	0	1	1
outcomesDDOS	1	1	0	1
outcomesTheft	1	1	1	0

```
########################################################## 2021
############################################################ ########################################

## here we will change the predictor matrix so the only predictor for
## the sizea, the real size has the scale of sizeb as its only
## predictor which is already on by default

predictorMatrix2021 = imp2021$predictorMatrix

predictorMatrix2021["imid", "sizea"] = 0
predictorMatrix2021["instituitionTypes", "sizea"] = 0
predictorMatrix2021["priority", "sizea"] = 0
predictorMatrix2021["update", "sizea"] = 0
predictorMatrix2021["restore", "sizea"] = 0
predictorMatrix2021["year", "sizea"] = 0
predictorMatrix2021["managementContinuity", "sizea"] = 0
predictorMatrix2021["managementCyber", "sizea"] = 0
predictorMatrix2021["rulesUpdating", "sizea"] = 0
predictorMatrix2021["rulesSecurityConfigs", "sizea"] = 0
predictorMatrix2021["rulesUserControl", "sizea"] = 0
predictorMatrix2021["policyStaffAccess", "sizea"] = 0
predictorMatrix2021["policyData", "sizea"] = 0
predictorMatrix2021["policyPrivate", "sizea"] = 0
predictorMatrix2021["attackInfection", "sizea"] = 0
predictorMatrix2021["attackPhising", "sizea"] = 0
predictorMatrix2021["attackBreaching", "sizea"] = 0
```

```
predictorMatrix2021["outcomesDDOS", "sizea"] = 0
predictorMatrix2021["outcomesData", "sizea"] = 0
predictorMatrix2021["outcomesTheft", "sizea"] = 0

predictorMatrix2021
```

```
                    imid instituitionTypes sizea sizeb priority update restore
imid                   0                 1     0     1        1      1       1
instituitionTypes      0                 0     0     1        1      1       1
sizea                  0                 1     0     1        1      1       1
sizeb                  0                 1     1     0        1      1       1
priority               0                 1     0     1        0      1       1
update                 0                 1     0     1        1      0       1
restore                0                 1     0     1        1      1       0
year                   0                 1     0     1        1      1       1
managementContinuity   0                 1     0     1        1      1       1
managementCyber        0                 1     0     1        1      1       1
rulesUpdating          0                 1     0     1        1      1       1
rulesSecurityConfigs   0                 1     0     1        1      1       1
rulesUserControl       0                 1     0     1        1      1       1
policyStaffAccess      0                 1     0     1        1      1       1
policyData             0                 1     0     1        1      1       1
policyPrivate          0                 1     0     1        1      1       1
attackInfection        0                 1     0     1        1      1       1
attackPhising          0                 1     0     1        1      1       1
attackBreaching        0                 1     0     1        1      1       1
outcomesData           0                 1     0     1        1      1       1
outcomesDDOS           0                 1     0     1        1      1       1
outcomesTheft          0                 1     0     1        1      1       1
                    year managementContinuity managementCyber rulesUpdating
imid                   0                    1                1            1
instituitionTypes      0                    1                1            1
sizea                  0                    1                1            1
sizeb                  0                    1                1            1
priority               0                    1                1            1
update                 0                    1                1            1
restore                0                    1                1            1
year                   0                    1                1            1
managementContinuity   0                    0                1            1
managementCyber        0                    1                0            1
rulesUpdating          0                    1                1            0
rulesSecurityConfigs   0                    1                1            1
rulesUserControl       0                    1                1            1
policyStaffAccess      0                    1                1            1
policyData             0                    1                1            1
policyPrivate          0                    1                1            1
attackInfection        0                    1                1            1
attackPhising          0                    1                1            1
```

attackBreaching	0	1	1	1
outcomesData	0	1	1	1
outcomesDDOS	0	1	1	1
outcomesTheft	0	1	1	1

	rulesSecurityConfigs	rulesUserControl	policyStaffAccess
imid	1	1	1
instituitionTypes	1	1	1
sizea	1	1	1
sizeb	1	1	1
priority	1	1	1
update	1	1	1
restore	1	1	1
year	1	1	1
managementContinuity	1	1	1
managementCyber	1	1	1
rulesUpdating	1	1	1
rulesSecurityConfigs	0	1	1
rulesUserControl	1	0	1
policyStaffAccess	1	1	0
policyData	1	1	1
policyPrivate	1	1	1
attackInfection	1	1	1
attackPhising	1	1	1
attackBreaching	1	1	1
outcomesData	1	1	1
outcomesDDOS	1	1	1
outcomesTheft	1	1	1

	policyData	policyPrivate	attackInfection	attackPhising
imid	1	1	1	1
instituitionTypes	1	1	1	1
sizea	1	1	1	1
sizeb	1	1	1	1
priority	1	1	1	1
update	1	1	1	1
restore	1	1	1	1
year	1	1	1	1
managementContinuity	1	1	1	1
managementCyber	1	1	1	1
rulesUpdating	1	1	1	1
rulesSecurityConfigs	1	1	1	1
rulesUserControl	1	1	1	1
policyStaffAccess	1	1	1	1
policyData	0	1	1	1
policyPrivate	1	0	1	1
attackInfection	1	1	0	1
attackPhising	1	1	1	0
attackBreaching	1	1	1	1
outcomesData	1	1	1	1
outcomesDDOS	1	1	1	1

```
outcomesTheft                 1             1               1             1
                    attackBreaching outcomesData outcomesDDOS outcomesTheft
imid                              1            1            1             1
instituitionTypes                 1            1            1             1
sizea                             1            1            1             1
sizeb                             1            1            1             1
priority                          1            1            1             1
update                            1            1            1             1
restore                           1            1            1             1
year                              1            1            1             1
managementContinuity              1            1            1             1
managementCyber                   1            1            1             1
rulesUpdating                     1            1            1             1
rulesSecurityConfigs              1            1            1             1
rulesUserControl                  1            1            1             1
policyStaffAccess                 1            1            1             1
policyData                        1            1            1             1
policyPrivate                     1            1            1             1
attackInfection                   1            1            1             1
attackPhising                     1            1            1             1
attackBreaching                   0            1            1             1
outcomesData                      1            0            1             1
outcomesDDOS                      1            1            0             1
outcomesTheft                     1            1            1             0
```

```
########################################################## 2021
########################################################## ########################################

## here we will change the predictor matrix so the only predictor for
## the sizea, the real size has the scale of sizeb as its only
## predictor which is already on by default

predictorMatrix2020 = imp2020$predictorMatrix

predictorMatrix2020["imid", "sizea"] = 0
predictorMatrix2020["instituitionTypes", "sizea"] = 0
predictorMatrix2020["priority", "sizea"] = 0
predictorMatrix2020["update", "sizea"] = 0
predictorMatrix2020["restore", "sizea"] = 0
predictorMatrix2020["year", "sizea"] = 0
predictorMatrix2020["managementContinuity", "sizea"] = 0
predictorMatrix2020["managementCyber", "sizea"] = 0
predictorMatrix2020["rulesUpdating", "sizea"] = 0
predictorMatrix2020["rulesSecurityConfigs", "sizea"] = 0
predictorMatrix2020["rulesUserControl", "sizea"] = 0
predictorMatrix2020["policyStaffAccess", "sizea"] = 0
predictorMatrix2020["policyData", "sizea"] = 0
predictorMatrix2020["policyPrivate", "sizea"] = 0
```

```
predictorMatrix2020["attackInfection", "sizea"] = 0
predictorMatrix2020["attackPhising", "sizea"] = 0
predictorMatrix2020["attackBreaching", "sizea"] = 0
predictorMatrix2020["outcomesDDOS", "sizea"] = 0
predictorMatrix2020["outcomesData", "sizea"] = 0
predictorMatrix2020["outcomesTheft", "sizea"] = 0

predictorMatrix2020
```

```
                    imid instituitionTypes sizea sizeb priority update restore
imid                   0                 1     0     1        1      1       1
instituitionTypes      0                 0     0     1        1      1       1
sizea                  0                 1     0     1        1      1       1
sizeb                  0                 1     1     0        1      1       1
priority               0                 1     0     1        0      1       1
update                 0                 1     0     1        1      0       1
restore                0                 1     0     1        1      1       0
year                   0                 1     0     1        1      1       1
managementContinuity   0                 1     0     1        1      1       1
managementCyber        0                 1     0     1        1      1       1
rulesUpdating          0                 1     0     1        1      1       1
rulesSecurityConfigs   0                 1     0     1        1      1       1
rulesUserControl       0                 1     0     1        1      1       1
policyStaffAccess      0                 1     0     1        1      1       1
policyData             0                 1     0     1        1      1       1
policyPrivate          0                 1     0     1        1      1       1
attackInfection        0                 1     0     1        1      1       1
attackPhising          0                 1     0     1        1      1       1
attackBreaching        0                 1     0     1        1      1       1
outcomesData           0                 1     0     1        1      1       1
outcomesDDOS           0                 1     0     1        1      1       1
outcomesTheft          0                 1     0     1        1      1       1
                    year managementContinuity managementCyber rulesUpdating
imid                   0                    1               1             1
instituitionTypes      0                    1               1             1
sizea                  0                    1               1             1
sizeb                  0                    1               1             1
priority               0                    1               1             1
update                 0                    1               1             1
restore                0                    1               1             1
year                   0                    1               1             1
managementContinuity   0                    0               1             1
managementCyber        0                    1               0             1
rulesUpdating          0                    1               1             0
rulesSecurityConfigs   0                    1               1             1
rulesUserControl       0                    1               1             1
policyStaffAccess      0                    1               1             1
policyData             0                    1               1             1
```

policyPrivate	0	1	1	1
attackInfection	0	1	1	1
attackPhising	0	1	1	1
attackBreaching	0	1	1	1
outcomesData	0	1	1	1
outcomesDDOS	0	1	1	1
outcomesTheft	0	1	1	1

	rulesSecurityConfigs	rulesUserControl	policyStaffAccess
imid	1	1	1
instituitionTypes	1	1	1
sizea	1	1	1
sizeb	1	1	1
priority	1	1	1
update	1	1	1
restore	1	1	1
year	1	1	1
managementContinuity	1	1	1
managementCyber	1	1	1
rulesUpdating	1	1	1
rulesSecurityConfigs	0	1	1
rulesUserControl	1	0	1
policyStaffAccess	1	1	0
policyData	1	1	1
policyPrivate	1	1	1
attackInfection	1	1	1
attackPhising	1	1	1
attackBreaching	1	1	1
outcomesData	1	1	1
outcomesDDOS	1	1	1
outcomesTheft	1	1	1

	policyData	policyPrivate	attackInfection	attackPhising
imid	1	1	1	1
instituitionTypes	1	1	1	1
sizea	1	1	1	1
sizeb	1	1	1	1
priority	1	1	1	1
update	1	1	1	1
restore	1	1	1	1
year	1	1	1	1
managementContinuity	1	1	1	1
managementCyber	1	1	1	1
rulesUpdating	1	1	1	1
rulesSecurityConfigs	1	1	1	1
rulesUserControl	1	1	1	1
policyStaffAccess	1	1	1	1
policyData	0	1	1	1
policyPrivate	1	0	1	1
attackInfection	1	1	0	1
attackPhising	1	1	1	0

```
attackBreaching               1             1               1             1
outcomesData                  1             1               1             1
outcomesDDOS                  1             1               1             1
outcomesTheft                 1             1               1             1
                    attackBreaching outcomesData outcomesDDOS outcomesTheft
imid                              1            1            1             1
instituitionTypes                 1            1            1             1
sizea                             1            1            1             1
sizeb                             1            1            1             1
priority                          1            1            1             1
update                            1            1            1             1
restore                           1            1            1             1
year                              1            1            1             1
managementContinuity              1            1            1             1
managementCyber                   1            1            1             1
rulesUpdating                     1            1            1             1
rulesSecurityConfigs              1            1            1             1
rulesUserControl                  1            1            1             1
policyStaffAccess                 1            1            1             1
policyData                        1            1            1             1
policyPrivate                     1            1            1             1
attackInfection                   1            1            1             1
attackPhising                     1            1            1             1
attackBreaching                   0            1            1             1
outcomesData                      1            0            1             1
outcomesDDOS                      1            1            0             1
outcomesTheft                     1            1            1             0
```

```
############################################################ 2019
############################################################ ########################################

## here we will change the predictor matrix so the only predictor for
## the sizea, the real size has the scale of sizeb as its only
## predictor which is already on by default

predictorMatrix2019 = imp2019$predictorMatrix

predictorMatrix2019["imid", "sizea"] = 0
predictorMatrix2019["instituitionTypes", "sizea"] = 0
predictorMatrix2019["priority", "sizea"] = 0
predictorMatrix2019["update", "sizea"] = 0
predictorMatrix2019["restore", "sizea"] = 0
predictorMatrix2019["year", "sizea"] = 0
predictorMatrix2019["managementContinuity", "sizea"] = 0
predictorMatrix2019["managementCyber", "sizea"] = 0
predictorMatrix2019["rulesUpdating", "sizea"] = 0
predictorMatrix2019["rulesSecurityConfigs", "sizea"] = 0
predictorMatrix2019["rulesUserControl", "sizea"] = 0
```

```
predictorMatrix2019["policyStaffAccess", "sizea"] = 0
predictorMatrix2019["policyData", "sizea"] = 0
predictorMatrix2019["policyPrivate", "sizea"] = 0
predictorMatrix2019["attackInfection", "sizea"] = 0
predictorMatrix2019["attackPhising", "sizea"] = 0
predictorMatrix2019["attackBreaching", "sizea"] = 0
predictorMatrix2019["outcomesDDOS", "sizea"] = 0
predictorMatrix2019["outcomesData", "sizea"] = 0
predictorMatrix2019["outcomesTheft", "sizea"] = 0

predictorMatrix2019
```

```
                   imid instituitionTypes sizea sizeb priority update restore
imid                  0                 1     0     1        1      1       1
instituitionTypes     0                 0     0     1        1      1       1
sizea                 0                 1     0     1        1      1       1
sizeb                 0                 1     1     0        1      1       1
priority              0                 1     0     1        0      1       1
update                0                 1     0     1        1      0       1
restore               0                 1     0     1        1      1       0
year                  0                 1     0     1        1      1       1
managementContinuity  0                 1     0     1        1      1       1
managementCyber       0                 1     0     1        1      1       1
rulesUpdating         0                 1     0     1        1      1       1
rulesSecurityConfigs  0                 1     0     1        1      1       1
rulesUserControl      0                 1     0     1        1      1       1
policyStaffAccess     0                 1     0     1        1      1       1
policyData            0                 1     0     1        1      1       1
policyPrivate         0                 1     0     1        1      1       1
attackInfection       0                 1     0     1        1      1       1
attackPhising         0                 1     0     1        1      1       1
attackBreaching       0                 1     0     1        1      1       1
outcomesData          0                 1     0     1        1      1       1
outcomesDDOS          0                 1     0     1        1      1       1
outcomesTheft         0                 1     0     1        1      1       1
                   year managementContinuity managementCyber rulesUpdating
imid                  0                    1               1             1
instituitionTypes     0                    1               1             1
sizea                 0                    1               1             1
sizeb                 0                    1               1             1
priority              0                    1               1             1
update                0                    1               1             1
restore               0                    1               1             1
year                  0                    1               1             1
managementContinuity  0                    0               1             1
managementCyber       0                    1               0             1
rulesUpdating         0                    1               1             0
rulesSecurityConfigs  0                    1               1             1
```

rulesUserControl	0	1	1	1
policyStaffAccess	0	1	1	1
policyData	0	1	1	1
policyPrivate	0	1	1	1
attackInfection	0	1	1	1
attackPhising	0	1	1	1
attackBreaching	0	1	1	1
outcomesData	0	1	1	1
outcomesDDOS	0	1	1	1
outcomesTheft	0	1	1	1

	rulesSecurityConfigs	rulesUserControl	policyStaffAccess
imid	1	1	1
instituitionTypes	1	1	1
sizea	1	1	1
sizeb	1	1	1
priority	1	1	1
update	1	1	1
restore	1	1	1
year	1	1	1
managementContinuity	1	1	1
managementCyber	1	1	1
rulesUpdating	1	1	1
rulesSecurityConfigs	0	1	1
rulesUserControl	1	0	1
policyStaffAccess	1	1	0
policyData	1	1	1
policyPrivate	1	1	1
attackInfection	1	1	1
attackPhising	1	1	1
attackBreaching	1	1	1
outcomesData	1	1	1
outcomesDDOS	1	1	1
outcomesTheft	1	1	1

	policyData	policyPrivate	attackInfection	attackPhising
imid	1	1	1	1
instituitionTypes	1	1	1	1
sizea	1	1	1	1
sizeb	1	1	1	1
priority	1	1	1	1
update	1	1	1	1
restore	1	1	1	1
year	1	1	1	1
managementContinuity	1	1	1	1
managementCyber	1	1	1	1
rulesUpdating	1	1	1	1
rulesSecurityConfigs	1	1	1	1
rulesUserControl	1	1	1	1
policyStaffAccess	1	1	1	1
policyData	0	1	1	1

```
policyPrivate                1              0              1              1
attackInfection              1              1              0              1
attackPhising                1              1              1              0
attackBreaching              1              1              1              1
outcomesData                 1              1              1              1
outcomesDDOS                 1              1              1              1
outcomesTheft                1              1              1              1
                    attackBreaching outcomesData outcomesDDOS outcomesTheft
imid                              1            1            1             1
instituitionTypes                 1            1            1             1
sizea                             1            1            1             1
sizeb                             1            1            1             1
priority                          1            1            1             1
update                            1            1            1             1
restore                           1            1            1             1
year                              1            1            1             1
managementContinuity              1            1            1             1
managementCyber                   1            1            1             1
rulesUpdating                     1            1            1             1
rulesSecurityConfigs              1            1            1             1
rulesUserControl                  1            1            1             1
policyStaffAccess                 1            1            1             1
policyData                        1            1            1             1
policyPrivate                     1            1            1             1
attackInfection                   1            1            1             1
attackPhising                     1            1            1             1
attackBreaching                   0            1            1             1
outcomesData                      1            0            1             1
outcomesDDOS                      1            1            0             1
outcomesTheft                     1            1            1             0
```

```
############################################################ 2018
############################################################ ######################################

## here we will change the predictor matrix so the only predictor for
## the sizea, the real size has the scale of sizeb as its only
## predictor which is already on by default

predictorMatrix2018 = imp2018$predictorMatrix

predictorMatrix2018["imid", "sizea"] = 0
predictorMatrix2018["instituitionTypes", "sizea"] = 0
predictorMatrix2018["priority", "sizea"] = 0
predictorMatrix2018["update", "sizea"] = 0
predictorMatrix2018["restore", "sizea"] = 0
predictorMatrix2018["year", "sizea"] = 0
predictorMatrix2018["managementContinuity", "sizea"] = 0
predictorMatrix2018["managementCyber", "sizea"] = 0
```

```
predictorMatrix2018["rulesUpdating", "sizea"] = 0
predictorMatrix2018["rulesSecurityConfigs", "sizea"] = 0
predictorMatrix2018["rulesUserControl", "sizea"] = 0
predictorMatrix2018["policyStaffAccess", "sizea"] = 0
predictorMatrix2018["policyData", "sizea"] = 0
predictorMatrix2018["policyPrivate", "sizea"] = 0
predictorMatrix2018["attackInfection", "sizea"] = 0
predictorMatrix2018["attackPhising", "sizea"] = 0
predictorMatrix2018["attackBreaching", "sizea"] = 0
predictorMatrix2018["outcomesDDOS", "sizea"] = 0
predictorMatrix2018["outcomesData", "sizea"] = 0
predictorMatrix2018["outcomesTheft", "sizea"] = 0

predictorMatrix2018
```

```
                   imid instituitionTypes sizea sizeb priority update restore
imid                  0                 1     0     1        1      1       1
instituitionTypes     0                 0     0     1        1      1       1
sizea                 0                 1     0     1        1      1       1
sizeb                 0                 1     1     0        1      1       1
priority              0                 1     0     1        0      1       1
update                0                 1     0     1        1      0       1
restore               0                 1     0     1        1      1       0
year                  0                 1     0     1        1      1       1
managementContinuity  0                 1     0     1        1      1       1
managementCyber       0                 1     0     1        1      1       1
rulesUpdating         0                 1     0     1        1      1       1
rulesSecurityConfigs  0                 1     0     1        1      1       1
rulesUserControl      0                 1     0     1        1      1       1
policyStaffAccess     0                 1     0     1        1      1       1
policyData            0                 1     0     1        1      1       1
policyPrivate         0                 1     0     1        1      1       1
attackInfection       0                 1     0     1        1      1       1
attackPhising         0                 1     0     1        1      1       1
attackBreaching       0                 1     0     1        1      1       1
outcomesData          0                 1     0     1        1      1       1
outcomesDDOS          0                 1     0     1        1      1       1
outcomesTheft         0                 1     0     1        1      1       1
                   year managementContinuity managementCyber rulesUpdating
imid                  0                    1               1             1
instituitionTypes     0                    1               1             1
sizea                 0                    1               1             1
sizeb                 0                    1               1             1
priority              0                    1               1             1
update                0                    1               1             1
restore               0                    1               1             1
year                  0                    1               1             1
managementContinuity  0                    0               1             1
```

managementCyber	0	1	0	1
rulesUpdating	0	1	1	0
rulesSecurityConfigs	0	1	1	1
rulesUserControl	0	1	1	1
policyStaffAccess	0	1	1	1
policyData	0	1	1	1
policyPrivate	0	1	1	1
attackInfection	0	1	1	1
attackPhising	0	1	1	1
attackBreaching	0	1	1	1
outcomesData	0	1	1	1
outcomesDDOS	0	1	1	1
outcomesTheft	0	1	1	1

	rulesSecurityConfigs	rulesUserControl	policyStaffAccess
imid	1	1	1
instituitionTypes	1	1	1
sizea	1	1	1
sizeb	1	1	1
priority	1	1	1
update	1	1	1
restore	1	1	1
year	1	1	1
managementContinuity	1	1	1
managementCyber	1	1	1
rulesUpdating	1	1	1
rulesSecurityConfigs	0	1	1
rulesUserControl	1	0	1
policyStaffAccess	1	1	0
policyData	1	1	1
policyPrivate	1	1	1
attackInfection	1	1	1
attackPhising	1	1	1
attackBreaching	1	1	1
outcomesData	1	1	1
outcomesDDOS	1	1	1
outcomesTheft	1	1	1

	policyData	policyPrivate	attackInfection	attackPhising
imid	1	1	1	1
instituitionTypes	1	1	1	1
sizea	1	1	1	1
sizeb	1	1	1	1
priority	1	1	1	1
update	1	1	1	1
restore	1	1	1	1
year	1	1	1	1
managementContinuity	1	1	1	1
managementCyber	1	1	1	1
rulesUpdating	1	1	1	1
rulesSecurityConfigs	1	1	1	1

```
rulesUserControl                1                1                1                1
policyStaffAccess               1                1                1                1
policyData                      0                1                1                1
policyPrivate                   1                0                1                1
attackInfection                 1                1                0                1
attackPhising                   1                1                1                0
attackBreaching                 1                1                1                1
outcomesData                    1                1                1                1
outcomesDDOS                    1                1                1                1
outcomesTheft                   1                1                1                1
                    attackBreaching outcomesData outcomesDDOS outcomesTheft
imid                              1            1            1             1
instituitionTypes                 1            1            1             1
sizea                             1            1            1             1
sizeb                             1            1            1             1
priority                          1            1            1             1
update                            1            1            1             1
restore                           1            1            1             1
year                              1            1            1             1
managementContinuity              1            1            1             1
managementCyber                   1            1            1             1
rulesUpdating                     1            1            1             1
rulesSecurityConfigs              1            1            1             1
rulesUserControl                  1            1            1             1
policyStaffAccess                 1            1            1             1
policyData                        1            1            1             1
policyPrivate                     1            1            1             1
attackInfection                   1            1            1             1
attackPhising                     1            1            1             1
attackBreaching                   0            1            1             1
outcomesData                      1            0            1             1
outcomesDDOS                      1            1            0             1
outcomesTheft                     1            1            1             0
```

0.24 Data Imputation

```
## absolute chad that I am saving
## https://stats.stackexchange.com/questions/219013/how-do-the-number-of-imputations-the-maxim

## we will release the krakens after all the testing and debuggins

## we actually don't want to specify the method here because mice will
## automatically choose between logression and polyregression for the
## values depending on the R data structure and is simpler then doing
## it manually while giving the same result

## remember mice does not support haven_labell so they all have to be
```

```
## removed and converted to another data structure in native R

## first step of the imputation workflow
## //https://stefvanbuuren.name/fimd/workflow.html

imp2022 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 18, maxit = 21,
    predictorMatrix = predictorMatrix2022)
imp2021 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 19, maxit = 22,
    predictorMatrix = predictorMatrix2021)
imp2020 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 16, maxit = 21,
    predictorMatrix = predictorMatrix2020)
imp2019 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 15, maxit = 21,
    predictorMatrix = predictorMatrix2019)
imp2018 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 18, maxit = 21,
    predictorMatrix = predictorMatrix2018)
```

```
## just so the rendering of the pdf doesn't take more than 1 hour of
## imputations alone I will leave 3 imputations here for rendering
## purposes since if I just turned off that code chunk I wouldn't be
## able to run the rest and I just couldn't save the load the
## imputations has a csv

imp2022 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 3, maxit = 21,
    predictorMatrix = predictorMatrix2022)
```

```
iter imp variable
 1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 1   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 1   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 2   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 2   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 2   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 3   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 3   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 3   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 4   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 4   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 4   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 5   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 5   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 5   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 6   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 6   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 6   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 7   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 7   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 7   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
 8   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 8   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 8   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
10   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
10   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
10   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
17   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
17   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
17   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
18   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
18   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
18   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
19   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
19   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
19   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
20   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
20   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
20   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
21   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
21   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
21   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
```

```
Warning: Number of logged events: 252
```

```
imp2021 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 3, maxit = 22,
    predictorMatrix = predictorMatrix2021)
```

iter	imp	variable							
1	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
1	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
1	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
2	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
2	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
2	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
3	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
3	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
3	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
4	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
4	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
4	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
5	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
5	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
5	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
6	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
6	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
6	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
7	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
7	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
7	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
8	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
8	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
8	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
9	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
9	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
9	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
10	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
10	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
10	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
11	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
11	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
11	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
12	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
12	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
12	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
13	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
13	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
13	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
14	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
14	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
14	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
15	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
15	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
15	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
16	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
16	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
16	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp

```
 17   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 17   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 17   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 18   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 18   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 18   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 19   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 19   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 19   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 20   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 20   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 20   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 21   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 21   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 21   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 22   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 22   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 22   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
```

```
Warning: Number of logged events: 264
```

```
imp2020 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 3, maxit = 21,
    predictorMatrix = predictorMatrix2020)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  1   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  1   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  2   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  2   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  2   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  3   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  3   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  3   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  4   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  4   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  4   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  5   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  5   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  5   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  6   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  6   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  6   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  7   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  7   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  7   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  8   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

```
 8   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 8   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
10   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
10   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
10   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
17   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
17   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
17   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
18   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
18   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
18   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
19   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
19   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
19   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
20   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
20   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
20   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
21   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
21   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
21   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
```

```
Warning: Number of logged events: 252
```

```
imp2019 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 3, maxit = 21,
    predictorMatrix = predictorMatrix2019)
```

```
iter imp variable
 1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 1   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 1   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 2   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 2   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 2   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 3   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 3   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 3   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 4   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 4   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 4   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 5   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 5   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 5   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 6   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 6   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 6   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 7   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 7   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 7   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 8   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 8   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 8   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
 9   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
10   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
10   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
10   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
11   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
12   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
13   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
14   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
15   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
16   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
```

```
 17   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 17   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 17   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 18   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 18   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 18   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 19   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 19   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 19   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 20   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 20   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 20   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 21   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 21   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp
 21   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUp

Warning: Number of logged events: 252
```

```r
imp2018 = mice(dataCyberSecuritySurvey2022TidyNameSizeCyber, m = 3, maxit = 21,
    predictorMatrix = predictorMatrix2018)
```

```
 iter imp variable
  1   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  1   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  1   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  2   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  2   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  2   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  3   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  3   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  3   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  4   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  4   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  4   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  5   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  5   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  5   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  6   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  6   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  6   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  7   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  7   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  7   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  8   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  8   2  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  8   3  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
  9   1  sizea  sizeb  priority  update  restore  managementContinuity  managementCyber  rulesUpd
```

9	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
9	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUpd
10	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
10	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
10	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
11	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
11	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
11	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
12	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
12	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
12	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
13	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
13	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
13	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
14	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
14	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
14	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
15	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
15	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
15	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
16	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
16	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
16	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
17	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
17	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
17	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
18	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
18	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
18	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
19	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
19	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
19	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
20	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
20	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
20	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
21	1	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
21	2	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp
21	3	sizea	sizeb	priority	update	restore	managementContinuity	managementCyber	rulesUp

```
Warning: Number of logged events: 252
```

0.25 Convergence and method checking

```
## checking all the methods are correct
imp2022$method
```

```
                imid    instituitionTypes                sizea
```

```
            ""                 ""              "pmm"
         sizeb           priority              update
    "polyreg"          "polyreg"           "polyreg"
       restore               year managementContinuity
    "polyreg"                 ""              "logreg"
managementCyber      rulesUpdating rulesSecurityConfigs
    "logreg"          "logreg"            "logreg"
rulesUserControl  policyStaffAccess          policyData
    "logreg"          "logreg"            "logreg"
  policyPrivate    attackInfection       attackPhising
    "logreg"          "logreg"            "logreg"
attackBreaching      outcomesData        outcomesDDOS
    "logreg"          "logreg"            "logreg"
  outcomesTheft
    "logreg"
```

```
imp2021$method
```

```
            imid  instituitionTypes              sizea
              ""                 ""              "pmm"
         sizeb           priority              update
    "polyreg"          "polyreg"           "polyreg"
       restore               year managementContinuity
    "polyreg"                 ""              "logreg"
managementCyber      rulesUpdating rulesSecurityConfigs
    "logreg"          "logreg"            "logreg"
rulesUserControl  policyStaffAccess          policyData
    "logreg"          "logreg"            "logreg"
  policyPrivate    attackInfection       attackPhising
    "logreg"          "logreg"            "logreg"
attackBreaching      outcomesData        outcomesDDOS
    "logreg"          "logreg"            "logreg"
  outcomesTheft
    "logreg"
```

```
imp2020$method
```

```
            imid  instituitionTypes              sizea
              ""                 ""              "pmm"
         sizeb           priority              update
    "polyreg"          "polyreg"           "polyreg"
       restore               year managementContinuity
    "polyreg"                 ""              "logreg"
managementCyber      rulesUpdating rulesSecurityConfigs
    "logreg"          "logreg"            "logreg"
rulesUserControl  policyStaffAccess          policyData
```

```
      "logreg"           "logreg"           "logreg"
policyPrivate    attackInfection      attackPhising
      "logreg"           "logreg"           "logreg"
attackBreaching      outcomesData       outcomesDDOS
      "logreg"           "logreg"           "logreg"
outcomesTheft
      "logreg"
```

```
imp2019$method
```

```
            imid instituitionTypes              sizea
              ""                ""              "pmm"
           sizeb          priority             update
        "polyreg"         "polyreg"          "polyreg"
         restore              year managementContinuity
        "polyreg"                ""            "logreg"
  managementCyber     rulesUpdating rulesSecurityConfigs
         "logreg"           "logreg"            "logreg"
 rulesUserControl policyStaffAccess          policyData
         "logreg"           "logreg"            "logreg"
    policyPrivate    attackInfection      attackPhising
         "logreg"           "logreg"            "logreg"
  attackBreaching      outcomesData       outcomesDDOS
         "logreg"           "logreg"            "logreg"
    outcomesTheft
         "logreg"
```

```
imp2018$method
```

```
            imid instituitionTypes              sizea
              ""                ""              "pmm"
           sizeb          priority             update
        "polyreg"         "polyreg"          "polyreg"
         restore              year managementContinuity
        "polyreg"                ""            "logreg"
  managementCyber     rulesUpdating rulesSecurityConfigs
         "logreg"           "logreg"            "logreg"
 rulesUserControl policyStaffAccess          policyData
         "logreg"           "logreg"            "logreg"
    policyPrivate    attackInfection      attackPhising
         "logreg"           "logreg"            "logreg"
  attackBreaching      outcomesData       outcomesDDOS
         "logreg"           "logreg"            "logreg"
    outcomesTheft
         "logreg"
```

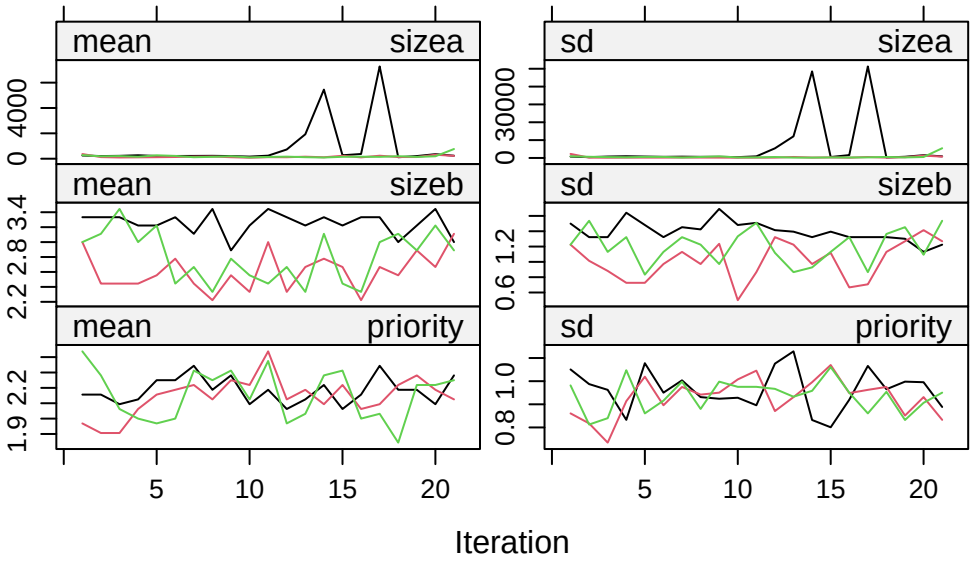
```
## don't forget
## https://stats.stackexchange.com/questions/76488/error-system-is-computationally-singular-wh

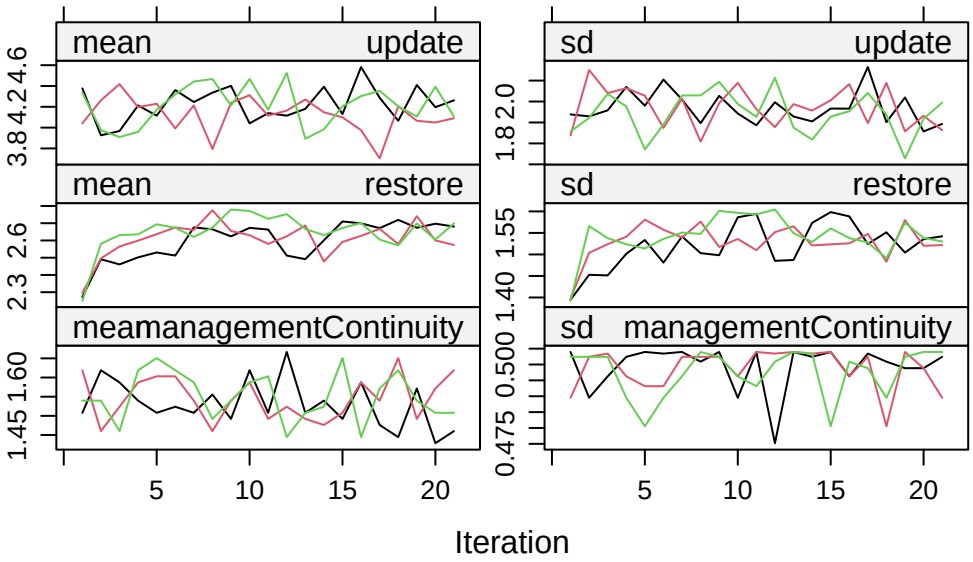
## from this day on I will pray and offer a candle to my new god,
## professor Martijn W Heymans
## https://missingdatasolutions.rbind.io/contact/

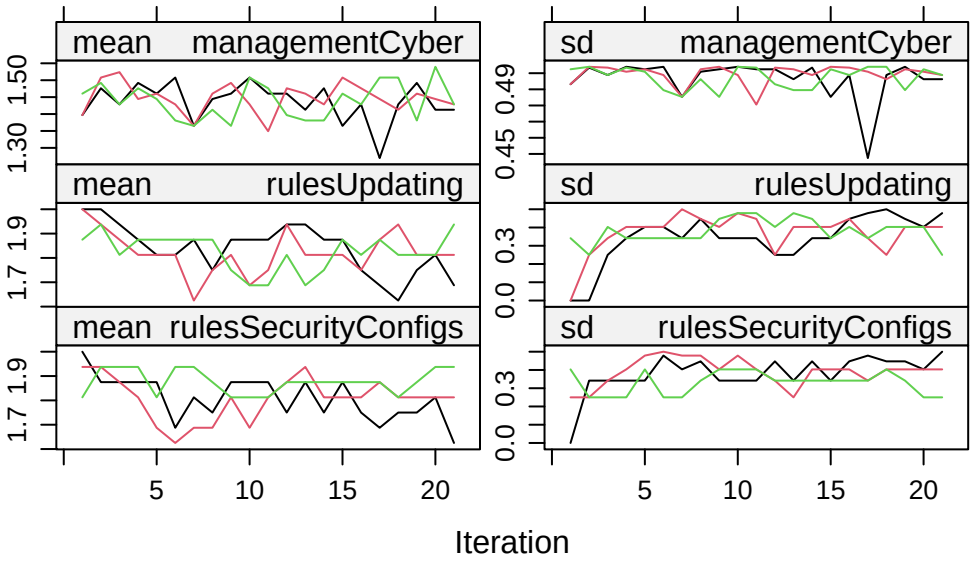
## truly a blessing from the lord

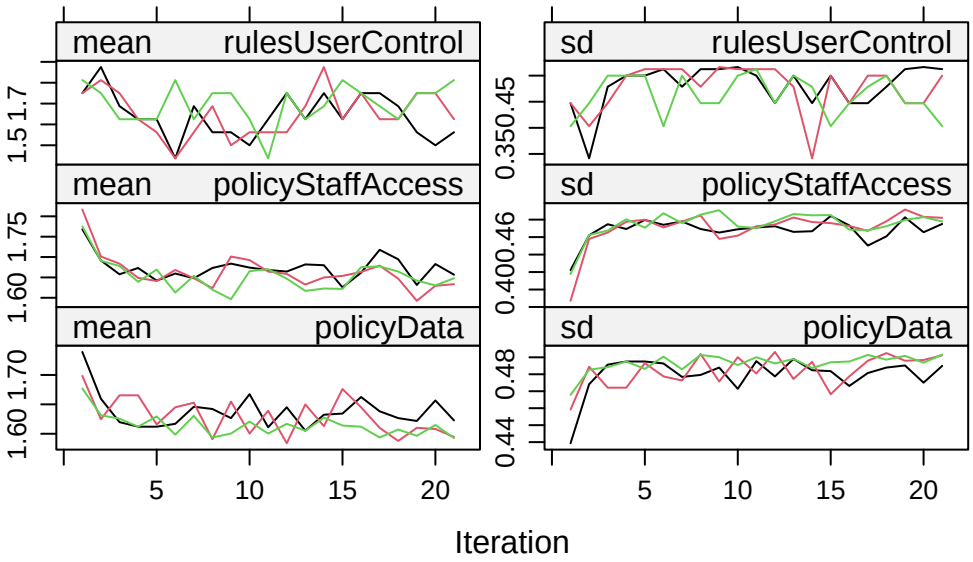

## after some tests and even more trial and error we can see that 21
## iterations have a pretty good convergence

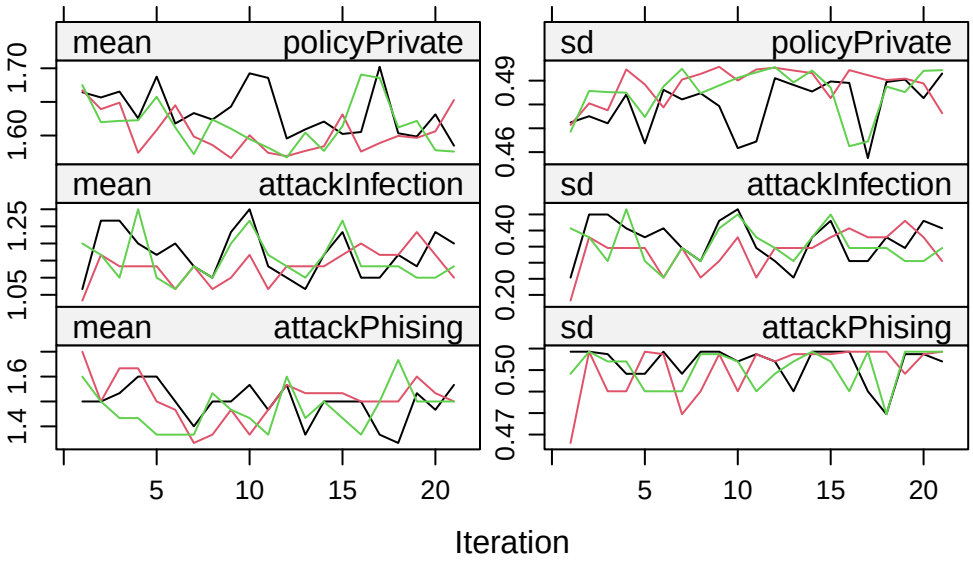
plot(imp2022)
```

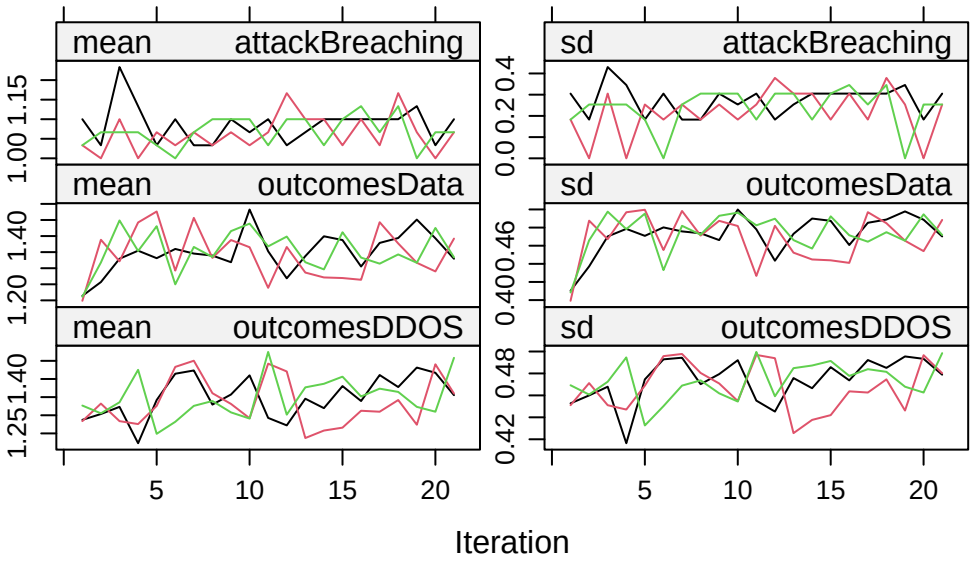


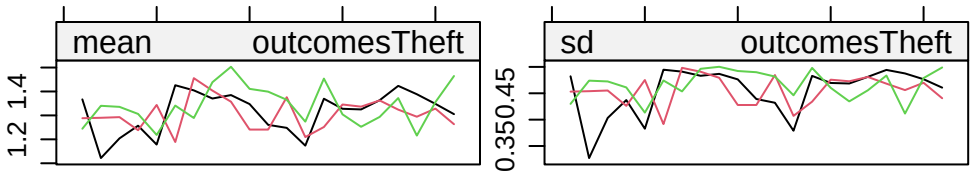

mean update
sd update
mean restore
sd restore
meamanagementContinuity
sd managementContinuity
Iteration


mean managementCyber
sd managementCyber
mean rulesUpdating
sd rulesUpdating
mean rulesSecurityConfigs
sd rulesSecurityConfigs
Iteration


mean
rulesUserControl
sd
rulesUserControl
mean
policyStaffAccess
sd
policyStaffAccess
mean
policyData
sd
policyData
1.5 1.7
1.60 1.75
1.60 1.70
0.35 0.45
0.40 0.46
0.44 0.48
5
10
15
20
Iteration

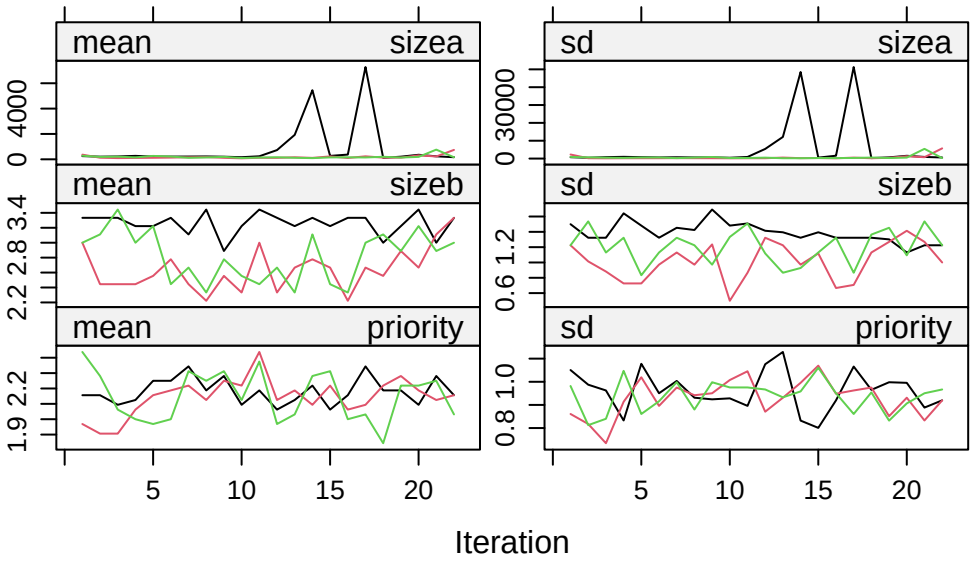

mean
policyPrivate
sd
policyPrivate
mean
attackInfection
sd
attackInfection
mean
attackPhising
sd
attackPhising
1.60 1.70
1.05 1.25
1.4 1.6
0.46 0.49
0.20 0.40
0.47 0.50
5
10
15
20
Iteration

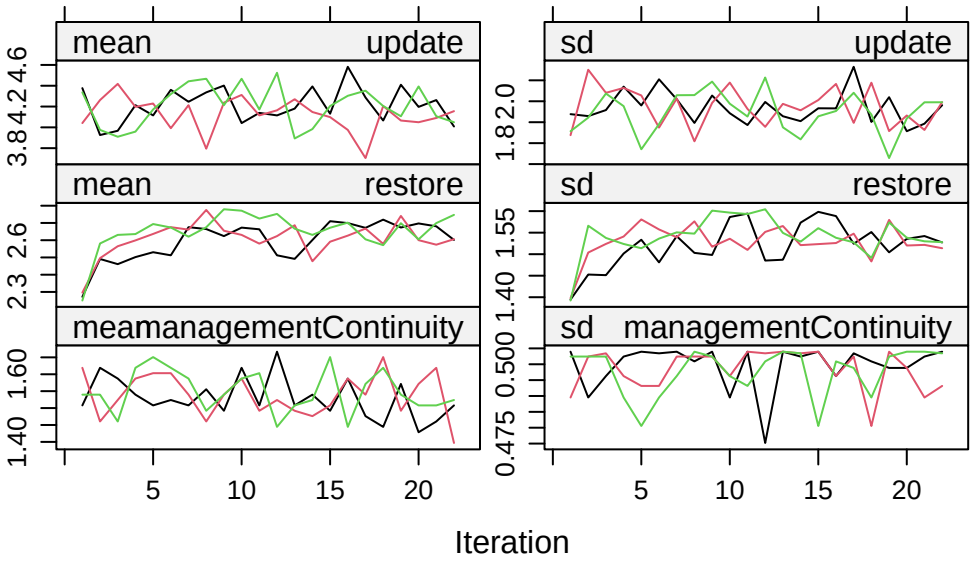


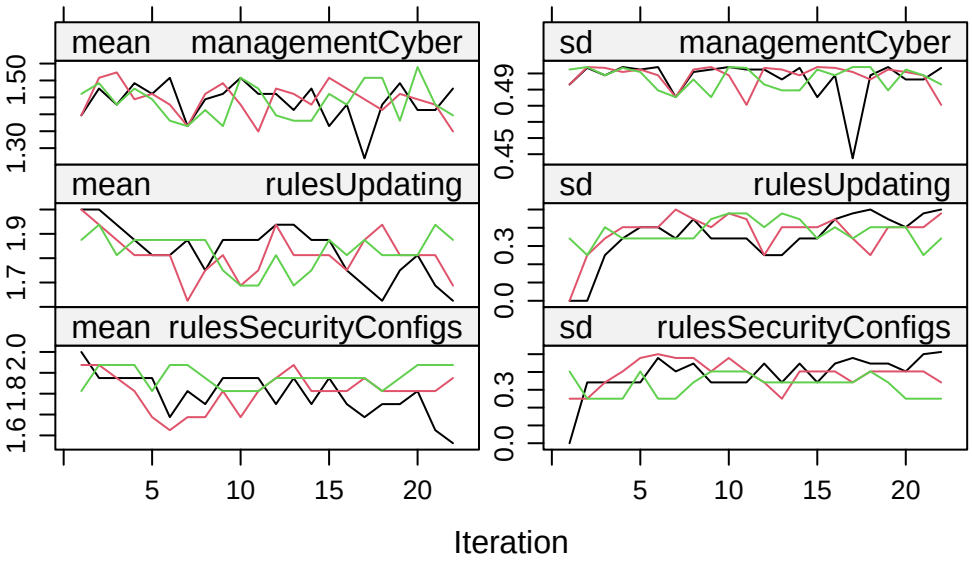


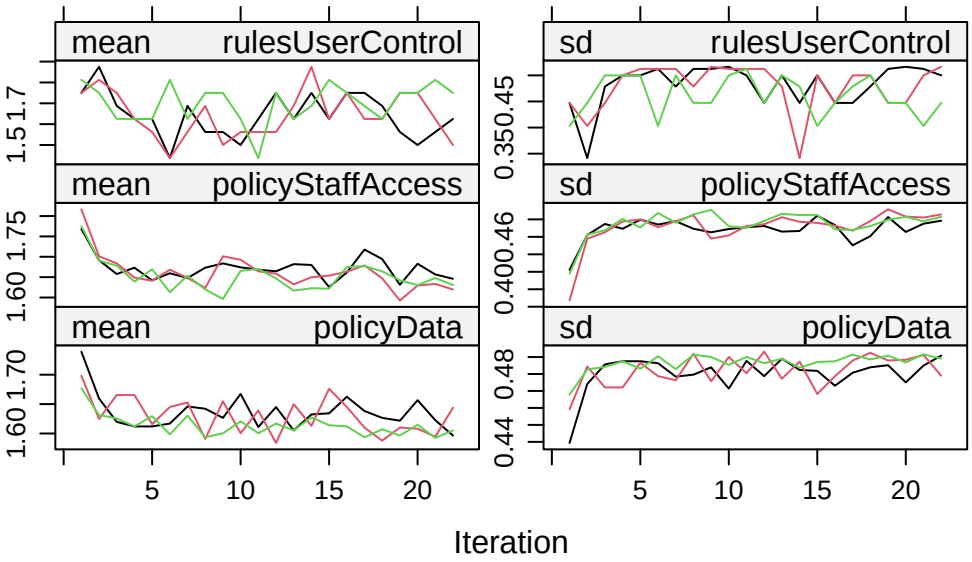
Iteration

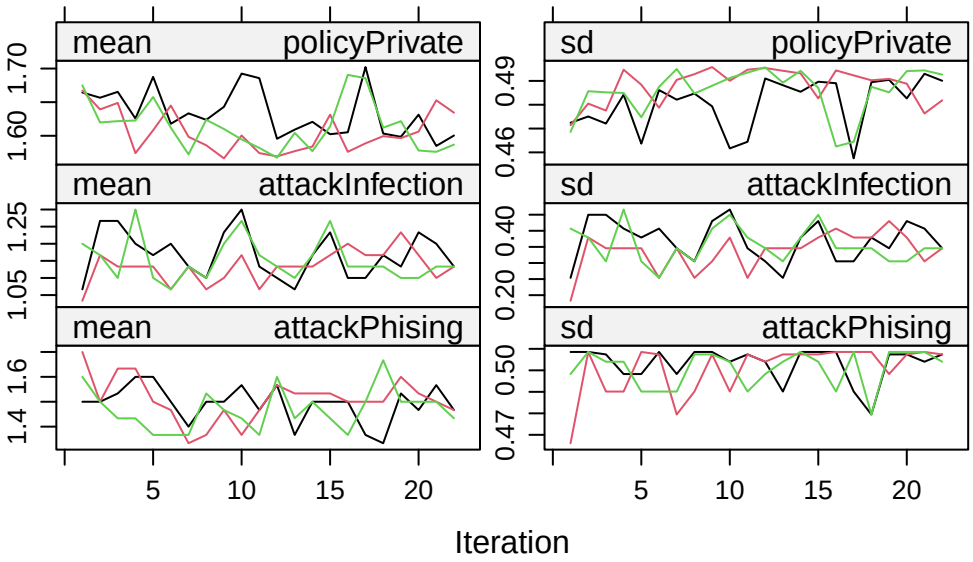
```
plot(imp2021)
```

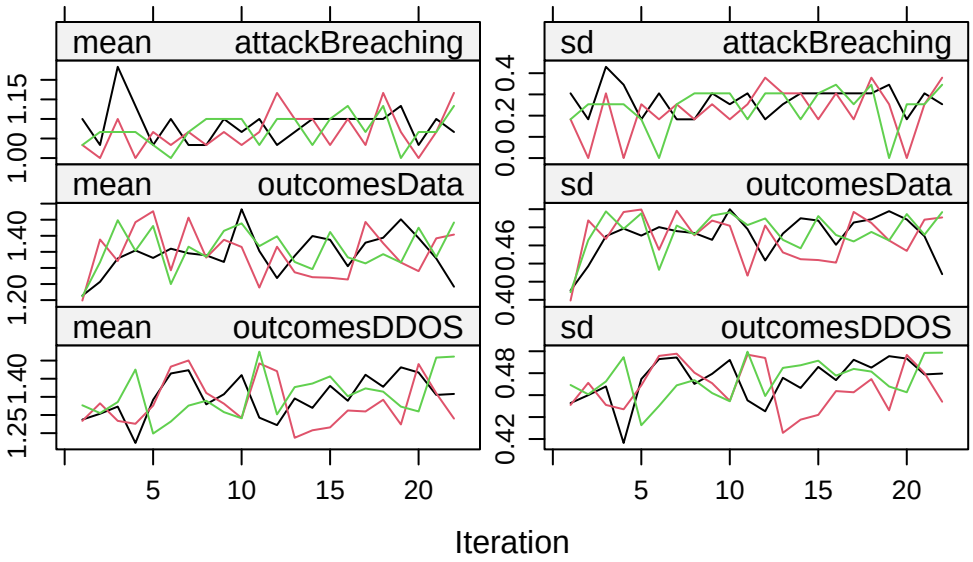

mean
sizea
sd
sizea
mean
sizeb
sd
sizeb
mean
priority
sd
priority
Iteration

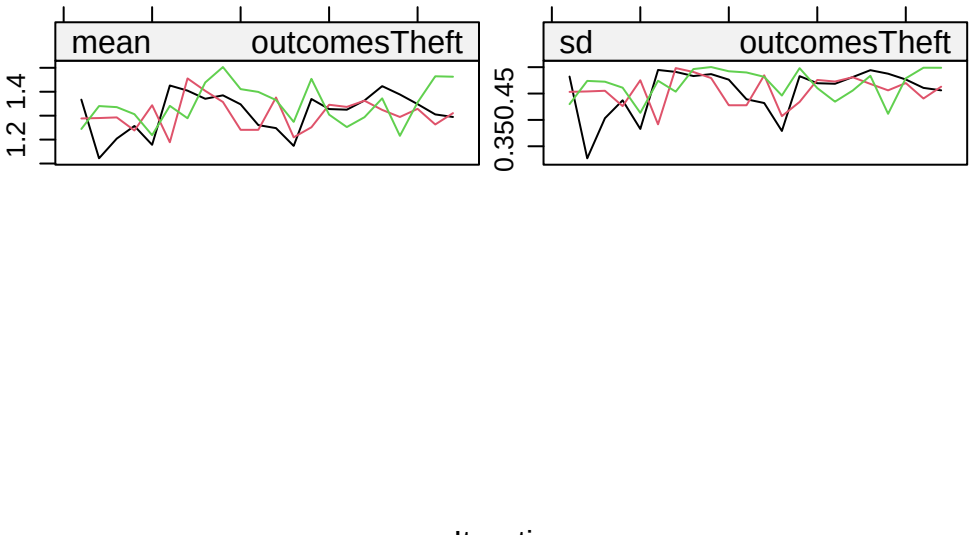

mean
update
sd
update
mean
restore
sd
restore
meamanagementContinuity
sd
managementContinuity
Iteration


mean managementCyber
sd managementCyber
mean rulesUpdating
sd rulesUpdating
mean rulesSecurityConfigs
sd rulesSecurityConfigs
Iteration

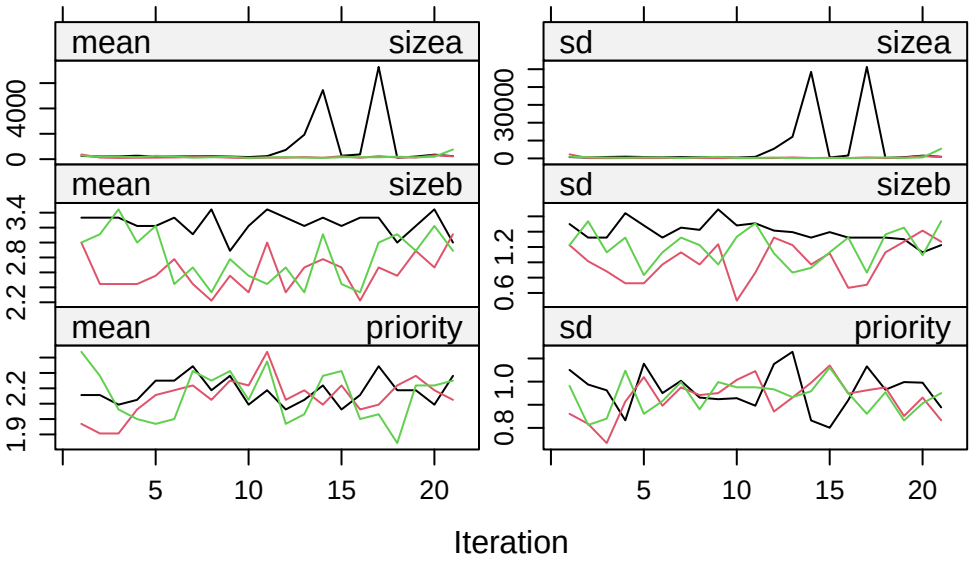

mean rulesUserControl
sd rulesUserControl
mean policyStaffAccess
sd policyStaffAccess
mean policyData
sd policyData
Iteration

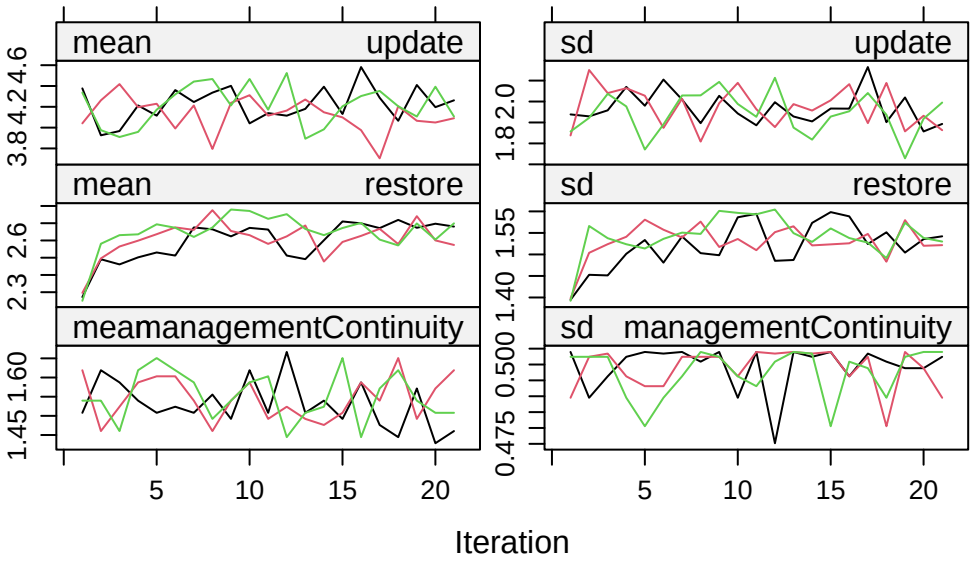

mean
policyPrivate
sd
policyPrivate
mean
attackInfection
sd
attackInfection
mean
attackPhising
sd
attackPhising
Iteration

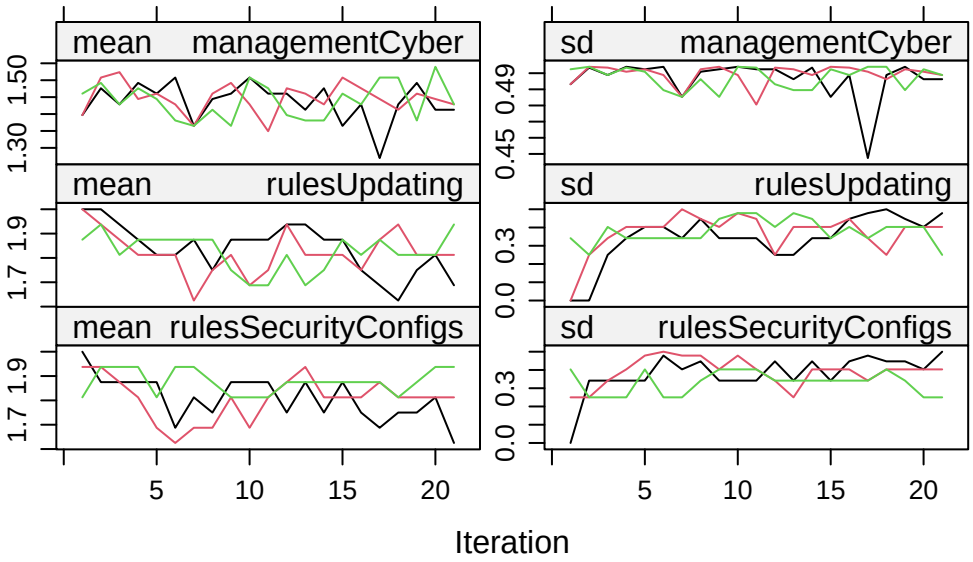

mean
attackBreaching
sd
attackBreaching
mean
outcomesData
sd
outcomesData
mean
outcomesDDOS
sd
outcomesDDOS
Iteration

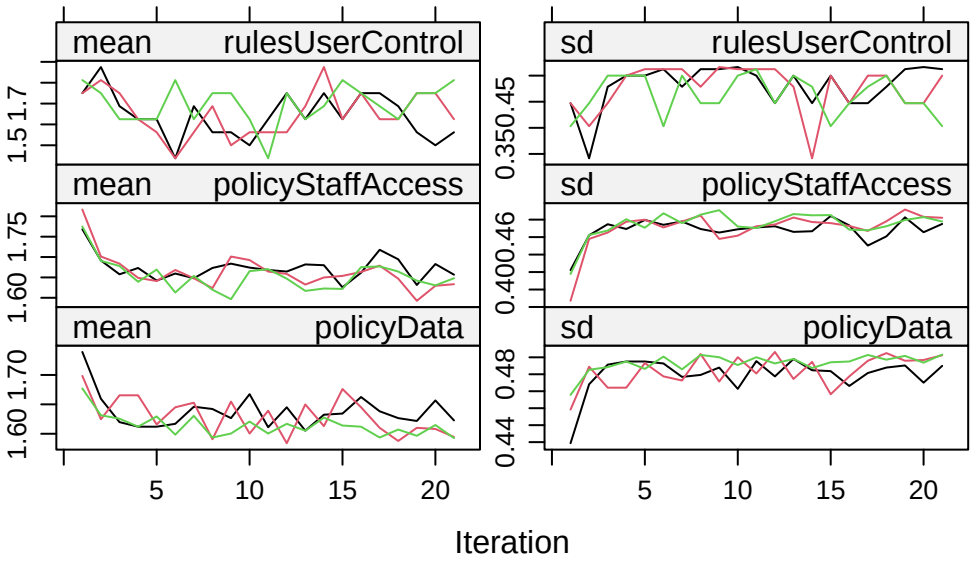


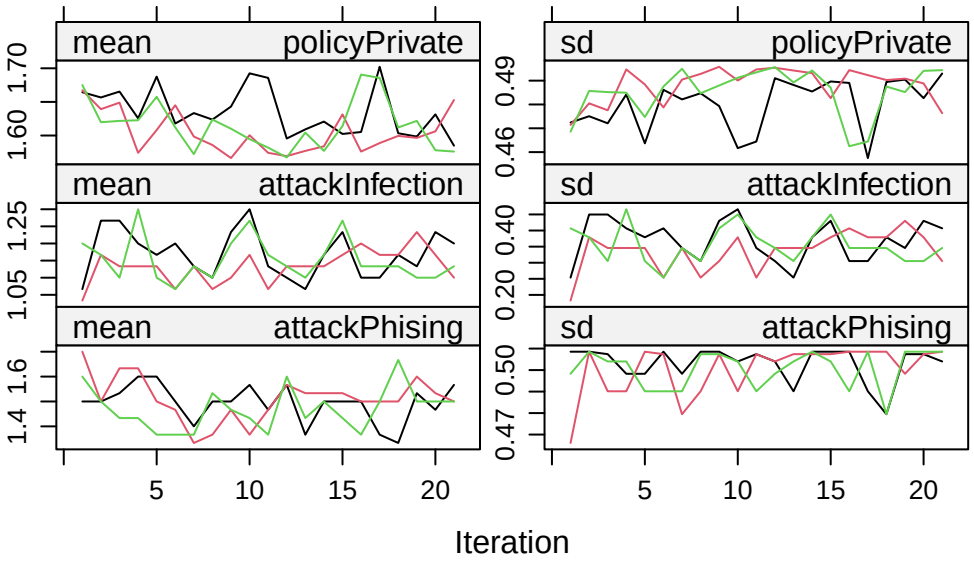

```
plot(imp2020)
```

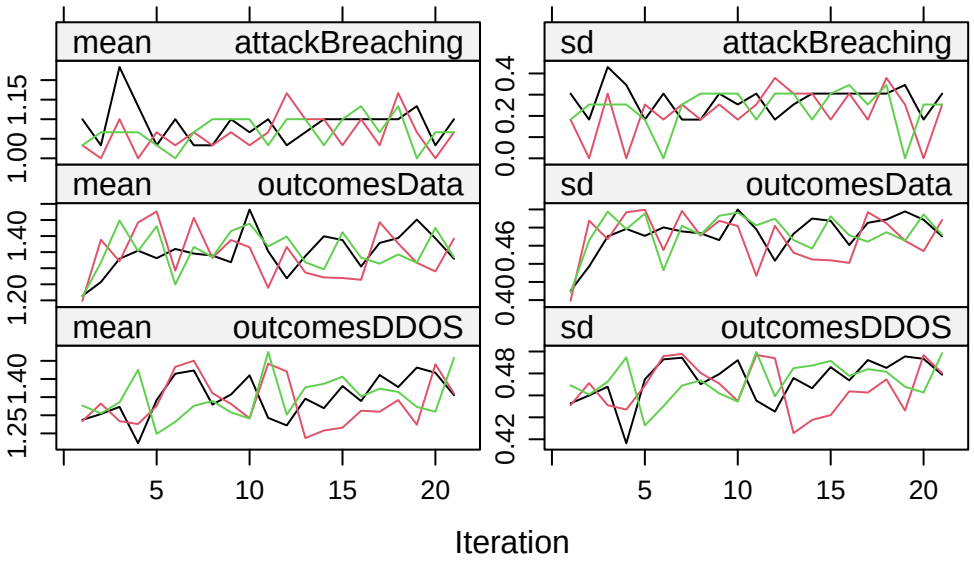


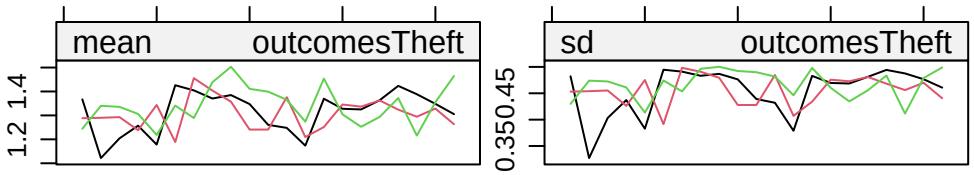

mean update
sd update
mean restore
sd restore
meamanagementContinuity
sd managementContinuity
Iteration


mean managementCyber
sd managementCyber
mean rulesUpdating
sd rulesUpdating
mean rulesSecurityConfigs
sd rulesSecurityConfigs
Iteration


mean
rulesUserControl
sd
rulesUserControl
mean
policyStaffAccess
sd
policyStaffAccess
mean
policyData
sd
policyData
1.5 1.7
1.60 1.75
1.60 1.70
0.35 0.45
0.40 0.46
0.44 0.48
5
10
15
20
Iteration

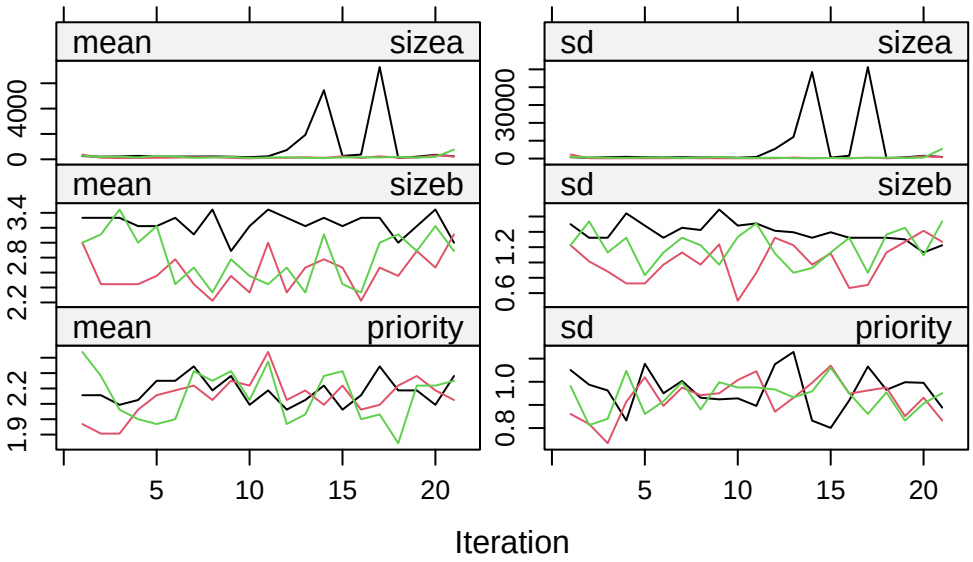

mean
policyPrivate
sd
policyPrivate
mean
attackInfection
sd
attackInfection
mean
attackPhising
sd
attackPhising
1.60 1.70
1.05 1.25
1.4 1.6
0.46 0.49
0.20 0.40
0.47 0.50
5
10
15
20
Iteration

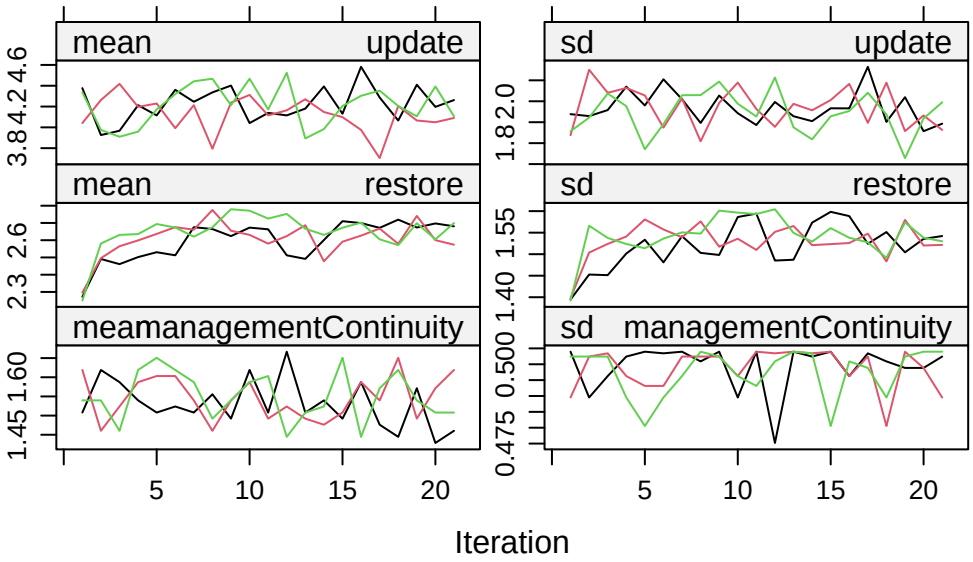


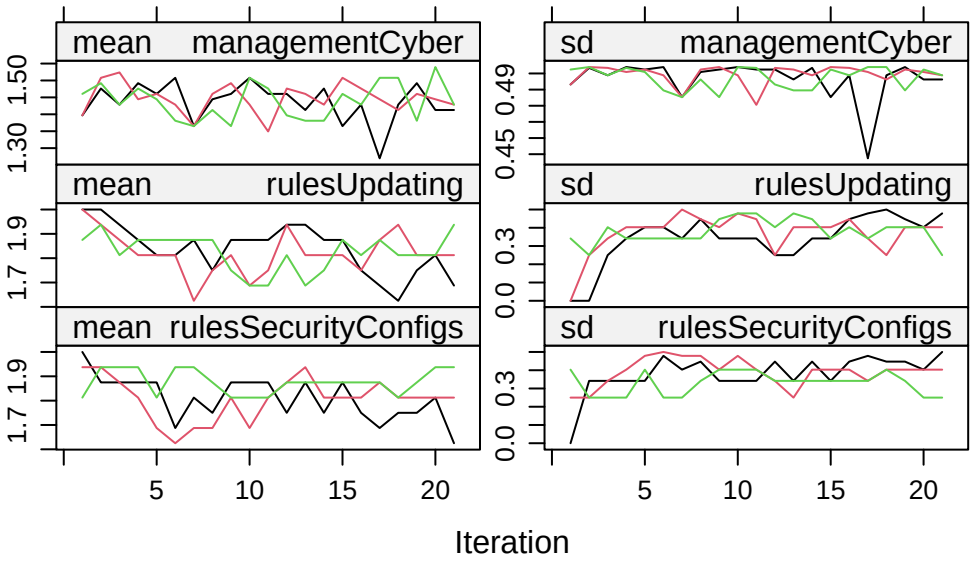


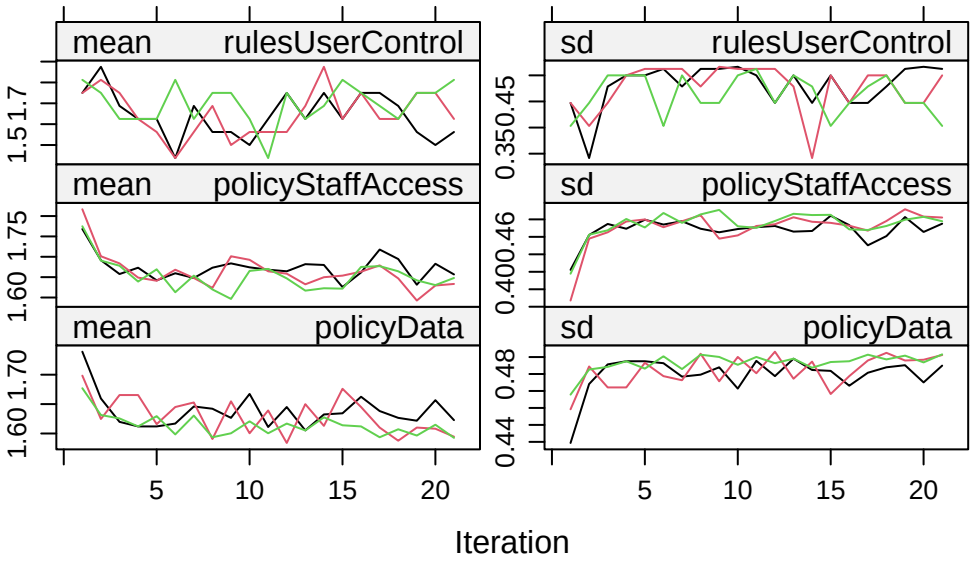
Iteration

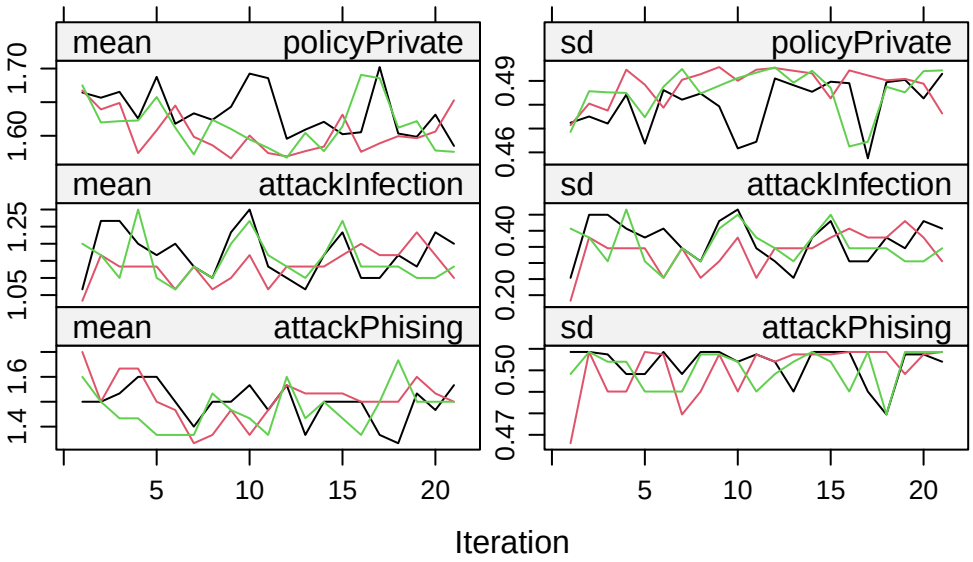
```
plot(imp2019)
```

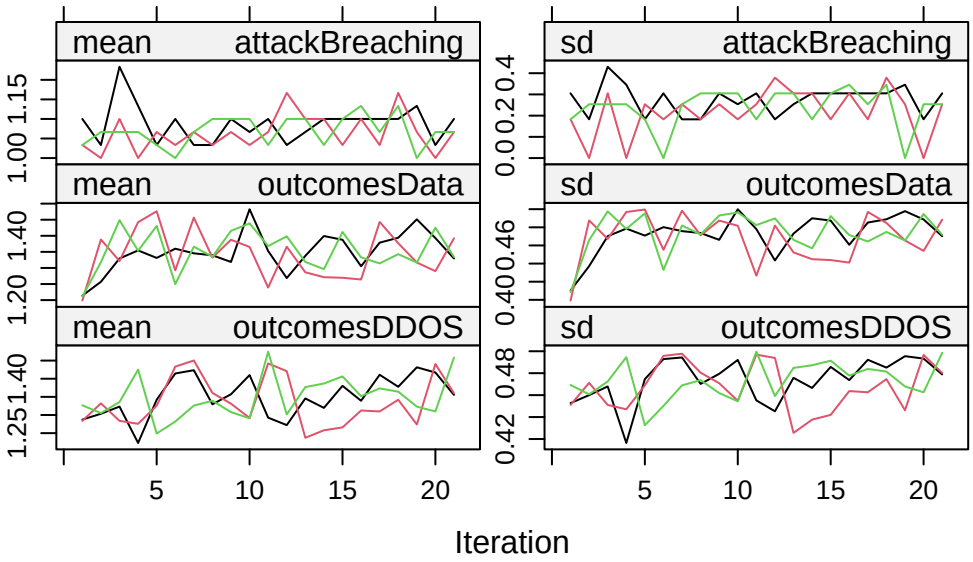

mean
sizea
sd
sizea
mean
sizeb
sd
sizeb
mean
priority
sd
priority
Iteration

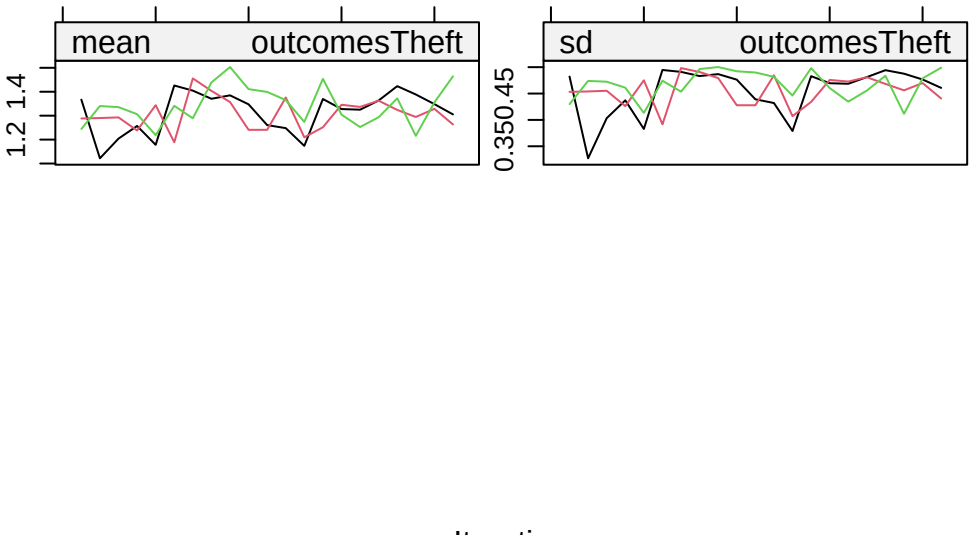

mean
update
sd
update
mean
restore
sd
restore
meamanagementContinuity
sd
managementContinuity
Iteration


mean managementCyber
sd managementCyber
mean rulesUpdating
sd rulesUpdating
mean rulesSecurityConfigs
sd rulesSecurityConfigs
Iteration

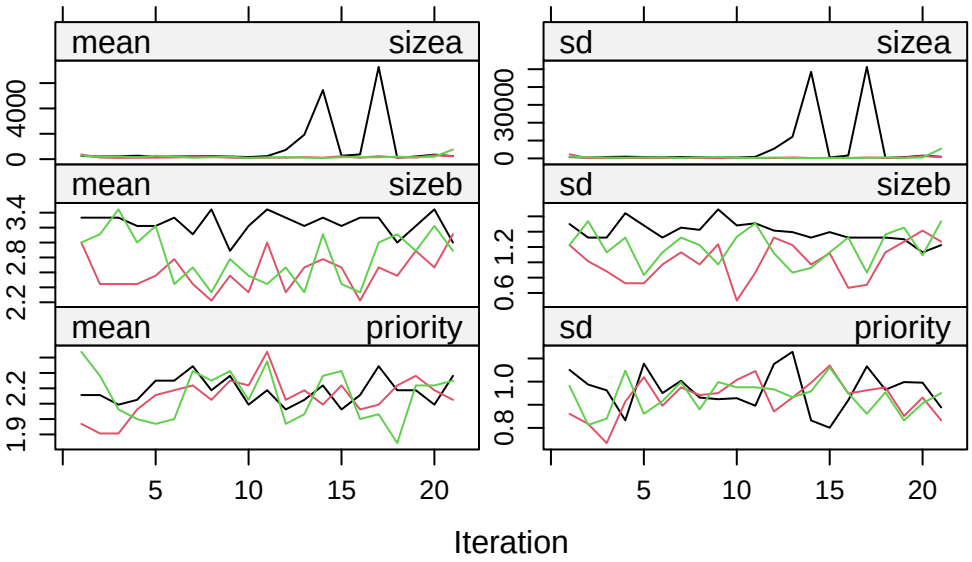

mean rulesUserControl
sd rulesUserControl
mean policyStaffAccess
sd policyStaffAccess
mean policyData
sd policyData
Iteration

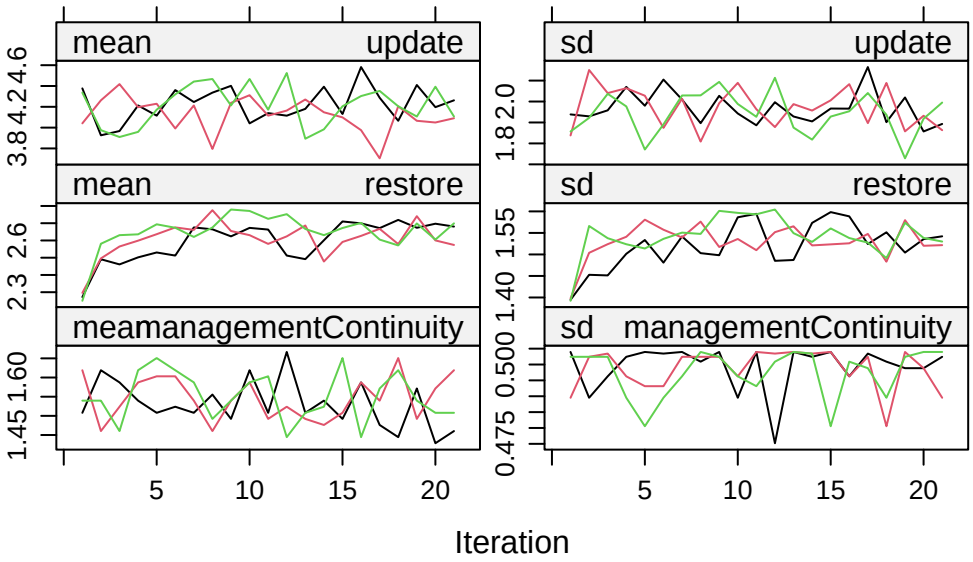

mean
policyPrivate
mean
attackInfection
mean
attackPhising
sd
policyPrivate
sd
attackInfection
sd
attackPhising
1.70
1.60
1.25
1.05
1.6
1.4
0.49
0.46
0.40
0.20
0.50
0.47
5
10
15
20
Iteration

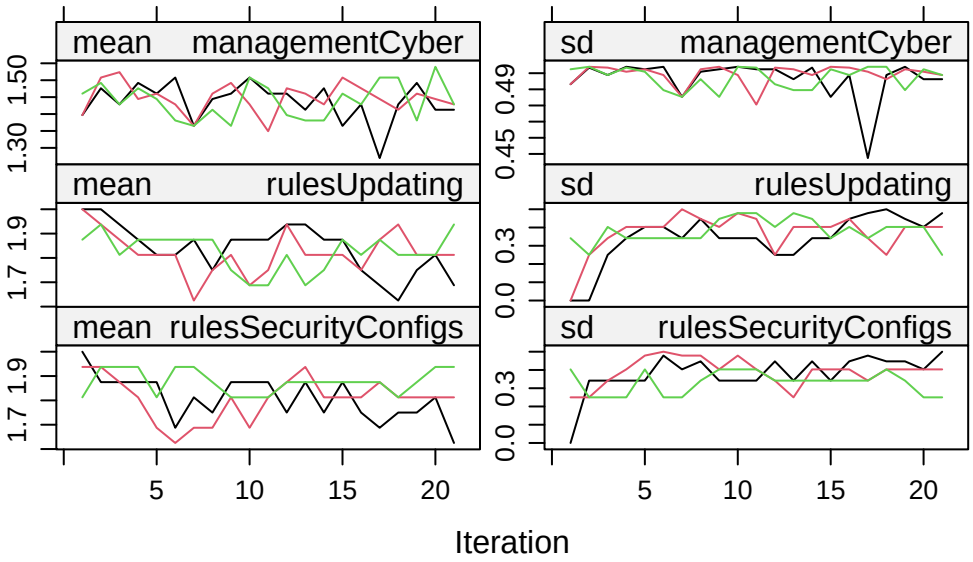

mean
attackBreaching
mean
outcomesData
mean
outcomesDDOS
sd
attackBreaching
sd
outcomesData
sd
outcomesDDOS
1.15
1.00
1.40
1.20
1.40
1.25
0.4
0.0
0.46
0.40
0.48
0.42
5
10
15
20
Iteration

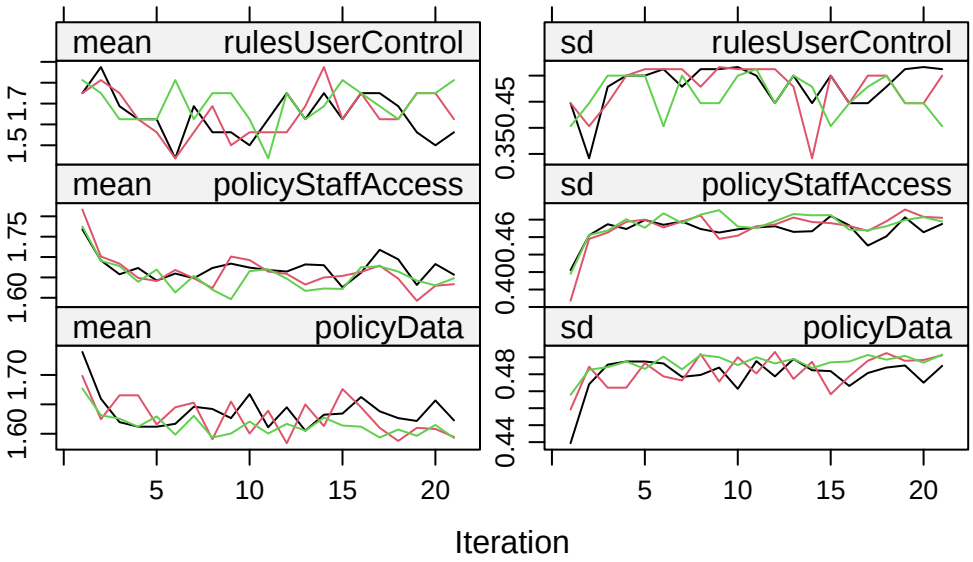


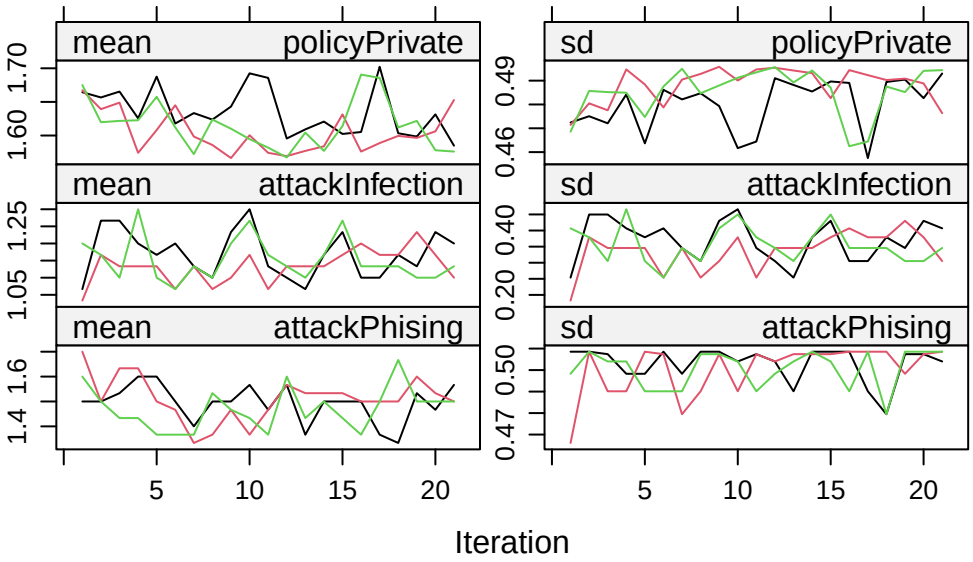

```
plot(imp2018)
```

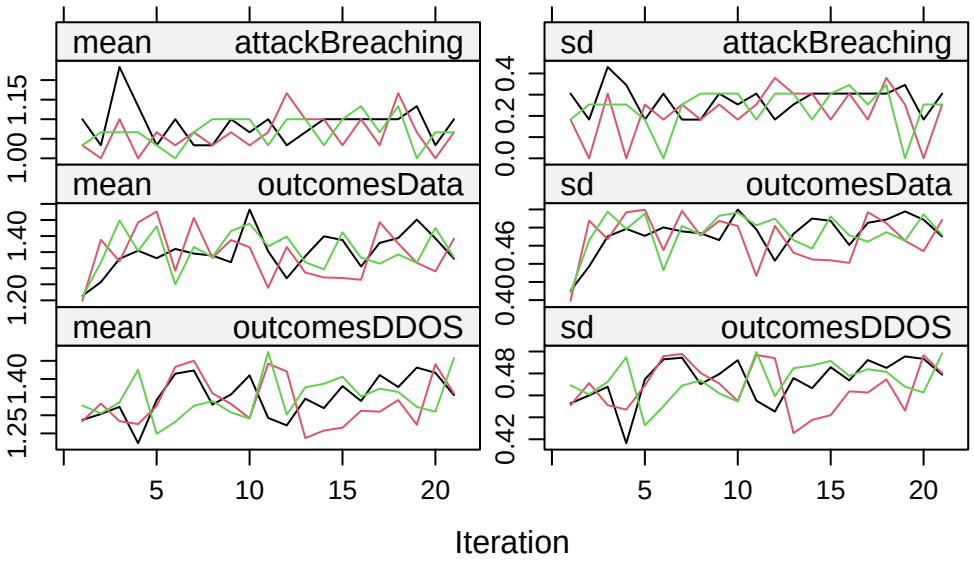


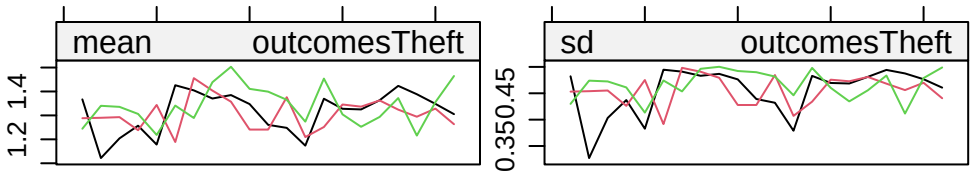

mean update
sd update
mean restore
sd restore
meamanagementContinuity
sd managementContinuity
Iteration


mean managementCyber
sd managementCyber
mean rulesUpdating
sd rulesUpdating
mean rulesSecurityConfigs
sd rulesSecurityConfigs
Iteration


mean
rulesUserControl
sd
rulesUserControl
mean
policyStaffAccess
sd
policyStaffAccess
mean
policyData
sd
policyData
1.5 1.7
1.60 1.75
1.60 1.70
0.35 0.45
0.40 0.46
0.44 0.48
5
10
15
20
Iteration


mean
policyPrivate
sd
policyPrivate
mean
attackInfection
sd
attackInfection
mean
attackPhising
sd
attackPhising
1.60 1.70
1.05 1.25
1.4 1.6
0.46 0.49
0.20 0.40
0.47 0.50
5
10
15
20
Iteration





Iteration

```
## convergence is achieved when after plotting the variance between the
## imputation chains is an aproximate to the variance of the chained
## imputions, this behavor is an indicator of an healthy convergence.
```

("Book_MI.knit" 2022)

0.26 Fitting the model after the imputations

```
## continuing from here because otherwise the reference won't work

## the mice library already turned on the relevant variable for the
## imputation modelling turning only the imid(unique id) and year
## variable which is not useful for the imputations done on a year to
## year basis therefore I don't need to tweak it manually using pred
## <-imp$predictorMatrix

## I might disable the size, priority or updates if needed though but
## they seemed to be needed since they make the amount missing values
## depends on these (basically auxiliary variables)


## https://stefvanbuuren.name/fimd/workflow.html // go to 5.1 mice
## documentation is *chef's kiss*


## the imputations are done so now we will use the with function from
## mice to fit the model 2nd workflow step

## hypotheses bigger organisations take longer to recover from cyber
## attack due to the sheer volume of data in their possession

fitModelBase = with(imp2022, lm(sizea ~ restore))


## now lets test with all the variables

## the with function has 2 functions, fill the missing value and then
## do the analysis, this way we avoid having to use complete function
## to gather all the data and then use the lappy to fit he model
`?`(with)
```

```
starting httpd help server ... done
```

```
fitModelAll2022 = with(imp2022, lm(sizea ~ restore + attackBreaching + attackPhising +
    attackInfection + managementCyber + managementCyber + rulesSecurityConfigs +
    rulesUserControl + rulesUpdating + policyPrivate + policyData + policyStaffAccess))

fitModelAll2021 = with(imp2021, lm(sizea ~ restore + attackBreaching + attackPhising +
    attackInfection + managementCyber + managementCyber + rulesSecurityConfigs +
    rulesUserControl + rulesUpdating + policyPrivate + policyData + policyStaffAccess))

fitModelAll2020 = with(imp2020, lm(sizea ~ restore + attackBreaching + attackPhising +
    attackInfection + managementCyber + managementCyber + rulesSecurityConfigs +
```

```
    rulesUserControl + rulesUpdating + policyPrivate + policyData + policyStaffAccess))

fitModelAll2019 = with(imp2019, lm(sizea ~ restore + attackBreaching + attackPhising +
    attackInfection + managementCyber + managementCyber + rulesSecurityConfigs +
    rulesUserControl + rulesUpdating + policyPrivate + policyData + policyStaffAccess))

fitModelAll2018 = with(imp2018, lm(sizea ~ restore + attackBreaching + attackPhising +
    attackInfection + managementCyber + managementCyber + rulesSecurityConfigs +
    rulesUserControl + rulesUpdating + policyPrivate + policyData + policyStaffAccess))




## conditioning based on all variables is reasonable on these type of
## data sets because of the relatively small amount of variables after
## cleaning.  As a rule of thumb using every available information
## created imputations with minimal bias and maximum efficiency
```

(Collins, Schafer, and Kam 2001)

0.27 Merging the imputations iteractions

```
## the mice function automatically detects and removes predictore from
## the model they are stored in the variable loggedEvents


# est0 = pool(fitModelBase)

est2022 = pool(fitModelAll2022)
est2021 = pool(fitModelAll2021)
est2020 = pool(fitModelAll2020)
est2019 = pool(fitModelAll2019)
est2018 = pool(fitModelAll2018)

# summary(est0)

summary(est2022)
```

```
                  term  estimate std.error  statistic         df   p.value
1          (Intercept) -553.2587 1390.3528 -0.3979268 2126.35707 0.6907241
2             restore2 -523.9663  698.5060 -0.7501242  612.46811 0.4534679
3             restore3  157.8316  948.1713  0.1664589   23.29946 0.8692319
4             restore4 -419.0578 1198.6314 -0.3496136  378.23837 0.7268233
5             restore5  665.6704  824.2148  0.8076418 2128.94531 0.4193870
```

```
6       attackBreaching1  140.6028 1224.8220  0.1147945 2116.92180 0.9086189
7         attackPhising1  811.2021  624.4787  1.2990069  984.04028 0.1942459
8       attackInfection1  661.6079  822.0568  0.8048202 2011.86162 0.4210185
9       managementCyber1  646.4499  501.5691  1.2888552 2026.25286 0.1975956
10 rulesSecurityConfigs1 -234.2617 1334.7760 -0.1755064 2101.42419 0.8606987
11     rulesUserControl1 -119.5997  815.1875 -0.1467143 2076.12941 0.8833717
12        rulesUpdating1  259.9526 1456.3999  0.1784898 2126.57497 0.8583553
13        policyPrivate1  130.5753  760.6000  0.1716740   55.06294 0.8643232
14           policyData1  322.7348  793.3531  0.4067984  480.26802 0.6843373
15    policyStaffAccess1  202.4352  901.1772  0.2246342 1432.90495 0.8222959
```

```
summary(est2021)
```

```
                   term   estimate std.error   statistic        df   p.value
1           (Intercept) -492.75029 1386.9374 -0.35527941 2130.9677 0.7224154
2              restore2 -545.39338  691.8593 -0.78830105  899.9773 0.4307282
3              restore3  159.87190  802.6433  0.19918175  899.9851 0.8421656
4              restore4 -420.85941 1171.3672 -0.35928906 2034.7596 0.7194161
5              restore5  664.28911  827.4975  0.80276870 2028.1709 0.4222025
6       attackBreaching1  194.38752 1218.2366  0.15956467 2134.9337 0.8732391
7         attackPhising1  827.09448  611.3145  1.35297710 1897.6408 0.1762241
8       attackInfection1  685.06958  822.4894  0.83292205 2117.1390 0.4049826
9       managementCyber1  653.78542  502.0193  1.30231124 1937.4165 0.1929648
10 rulesSecurityConfigs1  -93.14538 1334.5063 -0.06979763 1960.9663 0.9443618
11     rulesUserControl1  -67.19108  831.1749 -0.08083868  354.2735 0.9356159
12        rulesUpdating1  200.59994 1431.1948  0.14016257 2136.4657 0.8885448
13        policyPrivate1  122.63221  700.6997  0.17501395  456.5130 0.8611463
14           policyData1  117.51269  792.8834  0.14820931  269.4359 0.8822884
15    policyStaffAccess1  167.18488  888.4419  0.18817760  781.8260 0.8507863
```

```
summary(est2020)
```

```
                   term  estimate std.error  statistic         df   p.value
1           (Intercept) -553.2587 1390.3528 -0.3979268 2126.35707 0.6907241
2              restore2 -523.9663  698.5060 -0.7501242  612.46811 0.4534679
3              restore3  157.8316  948.1713  0.1664589   23.29946 0.8692319
4              restore4 -419.0578 1198.6314 -0.3496136  378.23837 0.7268233
5              restore5  665.6704  824.2148  0.8076418 2128.94531 0.4193870
6       attackBreaching1  140.6028 1224.8220  0.1147945 2116.92180 0.9086189
7         attackPhising1  811.2021  624.4787  1.2990069  984.04028 0.1942459
8       attackInfection1  661.6079  822.0568  0.8048202 2011.86162 0.4210185
9       managementCyber1  646.4499  501.5691  1.2888552 2026.25286 0.1975956
10 rulesSecurityConfigs1 -234.2617 1334.7760 -0.1755064 2101.42419 0.8606987
11     rulesUserControl1 -119.5997  815.1875 -0.1467143 2076.12941 0.8833717
12        rulesUpdating1  259.9526 1456.3999  0.1784898 2126.57497 0.8583553
13        policyPrivate1  130.5753  760.6000  0.1716740   55.06294 0.8643232
```

```
14           policyData1  322.7348  793.3531  0.4067984  480.26802 0.6843373
15    policyStaffAccess1  202.4352  901.1772  0.2246342 1432.90495 0.8222959
```

```
summary(est2019)
```

```
                   term  estimate std.error  statistic         df   p.value
1           (Intercept) -553.2587 1390.3528 -0.3979268 2126.35707 0.6907241
2              restore2 -523.9663  698.5060 -0.7501242  612.46811 0.4534679
3              restore3  157.8316  948.1713  0.1664589   23.29946 0.8692319
4              restore4 -419.0578 1198.6314 -0.3496136  378.23837 0.7268233
5              restore5  665.6704  824.2148  0.8076418 2128.94531 0.4193870
6       attackBreaching1  140.6028 1224.8220  0.1147945 2116.92180 0.9086189
7         attackPhising1  811.2021  624.4787  1.2990069  984.04028 0.1942459
8       attackInfection1  661.6079  822.0568  0.8048202 2011.86162 0.4210185
9       managementCyber1  646.4499  501.5691  1.2888552 2026.25286 0.1975956
10 rulesSecurityConfigs1 -234.2617 1334.7760 -0.1755064 2101.42419 0.8606987
11     rulesUserControl1 -119.5997  815.1875 -0.1467143 2076.12941 0.8833717
12        rulesUpdating1  259.9526 1456.3999  0.1784898 2126.57497 0.8583553
13        policyPrivate1  130.5753  760.6000  0.1716740   55.06294 0.8643232
14           policyData1  322.7348  793.3531  0.4067984  480.26802 0.6843373
15    policyStaffAccess1  202.4352  901.1772  0.2246342 1432.90495 0.8222959
```

```
summary(est2018)
```

```
                   term  estimate std.error  statistic         df   p.value
1           (Intercept) -553.2587 1390.3528 -0.3979268 2126.35707 0.6907241
2              restore2 -523.9663  698.5060 -0.7501242  612.46811 0.4534679
3              restore3  157.8316  948.1713  0.1664589   23.29946 0.8692319
4              restore4 -419.0578 1198.6314 -0.3496136  378.23837 0.7268233
5              restore5  665.6704  824.2148  0.8076418 2128.94531 0.4193870
6       attackBreaching1  140.6028 1224.8220  0.1147945 2116.92180 0.9086189
7         attackPhising1  811.2021  624.4787  1.2990069  984.04028 0.1942459
8       attackInfection1  661.6079  822.0568  0.8048202 2011.86162 0.4210185
9       managementCyber1  646.4499  501.5691  1.2888552 2026.25286 0.1975956
10 rulesSecurityConfigs1 -234.2617 1334.7760 -0.1755064 2101.42419 0.8606987
11     rulesUserControl1 -119.5997  815.1875 -0.1467143 2076.12941 0.8833717
12        rulesUpdating1  259.9526 1456.3999  0.1784898 2126.57497 0.8583553
13        policyPrivate1  130.5753  760.6000  0.1716740   55.06294 0.8643232
14           policyData1  322.7348  793.3531  0.4067984  480.26802 0.6843373
15    policyStaffAccess1  202.4352  901.1772  0.2246342 1432.90495 0.8222959
```

```
# tab_model(est2022, title = 'Models of each year') tab_model(est2021,
# title = 'Models of each year')

## chose the one with the lowest aic and bic for the model anova()
```

0.28 Creating a new completed imputation to graph

```
# completed for graphs
displayed2022 = complete(imp2022, 1)


## we have to do this to catch a 1 or two values that doesn't perfectly
## fit the scale after the imputation for when both sizea and sizeb are
## missing

for (i in 1:nrow(displayed2022)) {

    if (displayed2022$sizea[i] < 10) {
        displayed2022$sizeb[i] = 1
    }

    if (displayed2022$sizea[i] > 9 && displayed2022$sizea[i] < 50) {
        displayed2022$sizeb[i] = 2
    }
    if (displayed2022$sizea[i] > 49 && displayed2022$sizea[i] < 250) {
        displayed2022$sizeb[i] = 3
    }
    if (displayed2022$sizea[i] > 249) {
        displayed2022$sizeb[i] = 4
    }
    if (displayed2022$sizea[i] > 999) {
        displayed2022$sizeb[i] = 5
    }


}
```

0.29 One-way ANOVA testing between each of the scales of company sizes

```
## https://www.scribbr.com/statistics/one-way-anova/


## hypothesis testing

mod = aov(sizea ~ restore, data = displayed2022)

summary(mod)
```

```
              Df    Sum Sq   Mean Sq F value Pr(>F)
restore        4 2.071e+08  51768980   0.438  0.781
Residuals   2149 2.538e+11 118117849
```

```
## anova output explains how much variation in the dependable variable
## (size) can be explained by the independent variable (restore), so
## how much does the time taken to restore affects the size the of the
## company

## the Sum sq (sum of squares) (aka total variation) between the group
## means and the entire mean of the variable

## F-value is the independent variable divided by the mean square of
## each of the residuals ( the bigger this value the more likely it is
## that the variation is real and not due to chance)

## p-value is how likely it is for the test to run on the null
## hypothesis
```

0.30 Graphing the correlation between size and restoring time

```
##ok so i need to adjust the predictor of sizea so it is only predicted by sizeb

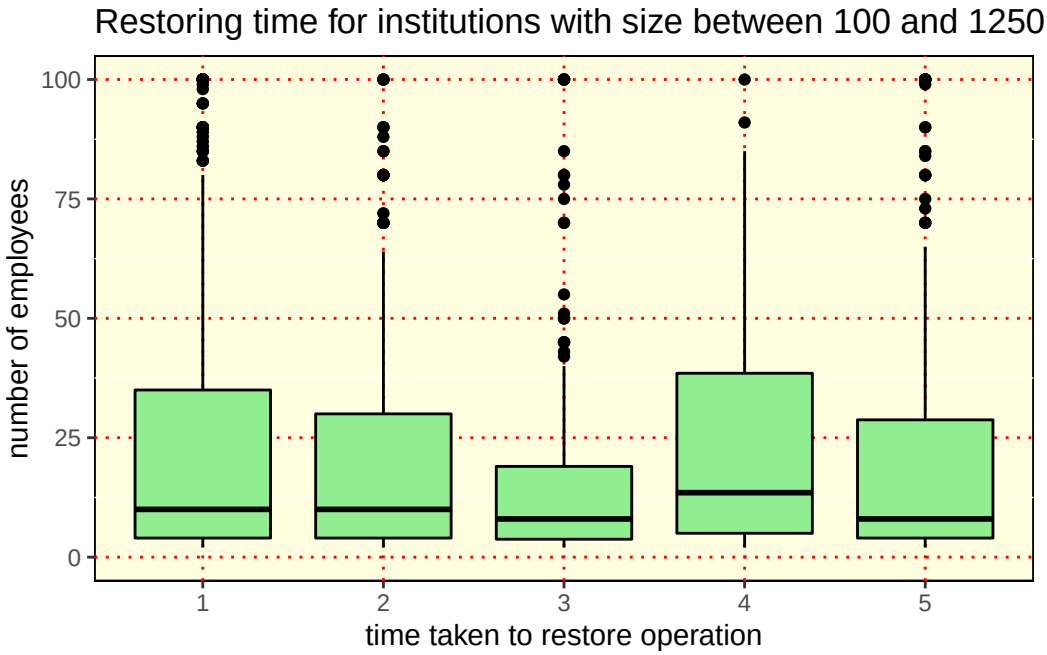
# ggplot(displayed2022, aes(x=sizea, y= restore)) + # ggplot with the desired data
#   geom_boxplot(fill='lightgreen',colour='black') + # Specifying boxplot
#   labs(x="size",y="restore") +# Axes labels
#   #facet_wrap(~sizeb, scale="free_x") +
#   xlim(0,100)

##new favourite font https://jrnold.github.io/ggthemes/reference/theme_wsj.html

boxPlot1 = ggplot(displayed2022, aes(y=sizea, x= restore)) + # ggplot with the desired data
  geom_boxplot(fill='lightgreen',colour='black') + # Specifying boxplot
  #facet_wrap(~sizeb, scale="free_x") +
  ylim(0,100)+
  ggtitle('Restoring time for institutions with size between 100 and 1250') +
  xlab("time taken to restore operation") +
  ylab("number of employees")

boxPlot1 + theme(panel.background = element_rect(fill = 'lightyellow', color = 'black'),
                 panel.grid.major = element_line(color = 'red', linetype = 'dotted'))
```

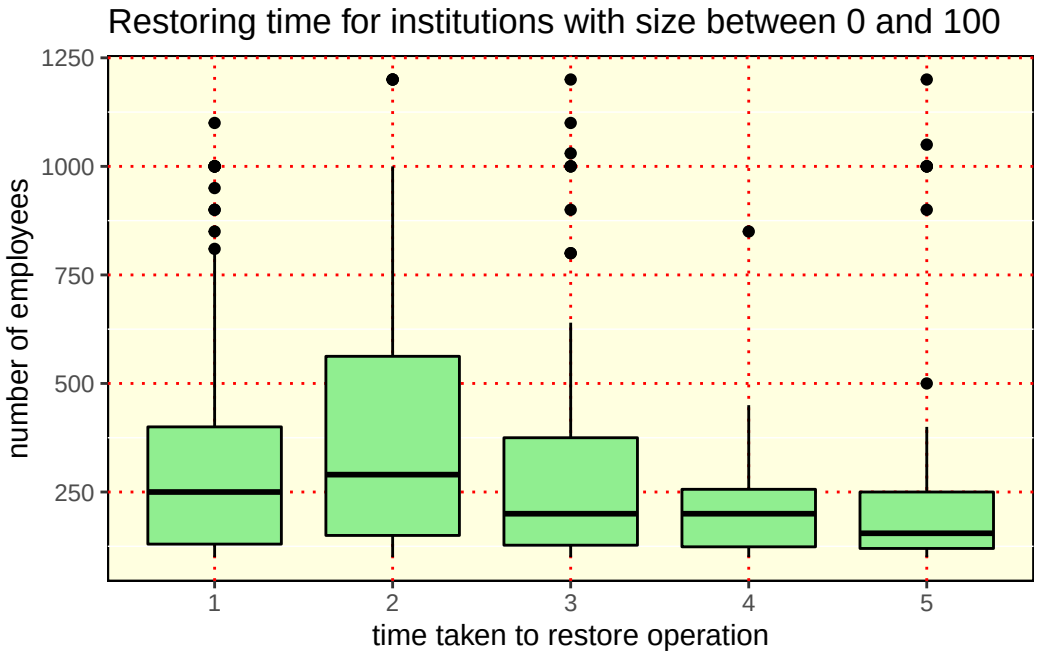
```
Warning: Removed 516 rows containing non-finite values (stat_boxplot).
```




```
boxPlot2 =ggplot(displayed2022, aes(y=sizea, x= restore)) + # ggplot with the desired data
  geom_boxplot(fill='lightgreen',colour='black') + # Specifying boxplot
  #facet_wrap(~sizeb, scale="free_x") +
  ylim(100,1200)

boxPlot2 + theme(panel.background = element_rect(fill = 'lightyellow', color = 'black'),
                 panel.grid.major = element_line(color = 'red', linetype = 'dotted'))+
  ylab("number of employees")+
  ggtitle('Restoring time for institutions with size between 0 and 100') +
  xlab("time taken to restore operation")
```

```
Warning: Removed 1673 rows containing non-finite values (stat_boxplot).
```




```
## no clear visual trend in terms of time taken to restore business and size
```

```
1 + 1
```

```
[1] 2
```

```
1 + 1
```

```
[1] 2
```

```
1 + 1
```

```
[1] 2
```

```
1 + 1
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```
[1] 2
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1 + 1
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[1] 2
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1 + 1
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1 + 1
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[1] 2
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1 + 1
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[1] 2
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```
1 + 1
```

```
[1] 2
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```
1 + 1
```

```
[1] 2
```

```
1 + 1
```

```
[1] 2
```

```
1 + 1
```

```
[1] 2
```

0.31 Quarto

Quarto enables you to weave together content and executable code into a finished document. To learn more about Quarto see https://quarto.org.

0.32 Running Code

When you click the **Render** button a document will be generated that includes both content and the output of embedded code. You can embed code like this:

```
1 + 1
```

```
[1] 2
```

You can add options to executable code like this

```
[1] 4
```

The `echo: false` option disables the printing of code (only output is displayed).

Bevans, Rebecca. 2022. "Choosing the Right Statistical Test: Types &Amp; Examples." *Scribbr*. https://www.scribbr.com/statistics/statistical-tests/.

"Book_MI.knit." 2022. *Home*. https://bookdown.org/mwheymans/bookmi/.

Collins, L M, J L Schafer, and C M Kam. 2001. "A Comparison of Inclusive and Restrictive Strategies in Modern Missing Data Procedures." *Psychol. Methods* 6 (4): 330–51.

Department For Digital, Culture. 2020. "Cyber Security Breaches Survey, 2020." UK Data Service. https://doi.org/10.5255/UKDA-SN-8638-1.

Rubin, Donald B. 1975. "Biometrika 63 (3): 581–90." In *Inference and Missing Data*. Verlag nicht ermittelbar.

White, Ian R., Patrick Royston, and Angela M. Wood. 2010. "Multiple Imputation Using Chained Equations: Issues and Guidance for Practice." *Statistics in Medicine* 30 (4): 377–99. https://doi.org/10.1002/sim.4067.