

# Monash University

## FIT3152 - Data Analytics

### Assignment 1, Semester 1, 2024

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**Project:** Analysis of country-level predictors of pro-social behaviours to reduce the spread of COVID-19 during the early stages of the pandemic

**AI statement:** Generative AI was used in this assignment

### Task 1: Descriptive analysis and pre-processing

**1(a)** A condensed extract of the PsyCorona baseline study is contained in the file `PsyCoronaBaselineExtract.csv`.

We start by taking a unique sample of the data set based on my student ID, and attaching the data to the R search path for ease of variable use

```
rm(list = ls())
set.seed(31865224)
cvbase = read.csv("PsyCoronaBaselineExtract.csv")
cvbase <- cvbase[sample(nrow(cvbase), 40000), ]
attach(cvbase)
```

We will take assistance from a few libraries, so let's start by importing those.

```
library(ggplot2)
library(dplyr)
library(tidyr)
```

It is helpful to learn about a dataset's features and properties before working on it.

```
dim(cvbase)
as.data.frame(sapply(cvbase, class))
summary(cvbase, na.rm = TRUE)
```

In this case, we will run the dimensions method, to find out the data frame has 40,000 rows, given we have sampled it to be so when reading it in, and 52 columns.

The only text attributes in the dataframe appear to be `coded_country` and the `Rank Order of Life` columns, while the rest are integer data

According to the codebook extract, every column aside from `employstatus`, `gender`, `age`, `edu`, and `coded_country` contains ordinal numbers representing degrees of agreement for things like age group, education level, and level of agreement. Different `gender`, `age`, and `education` categories are coded by the integer values in their respective columns. Each record may only have a maximum of one `employstatus` column with a value of 1, indicating the employee's employment status.

We may infer that the numerical attributes have different ranges from the `summary()` output. Survey questions evaluating a two-sided degree of agreement vary from a negative number to its modulus, while those measuring a one-sided degree of agreement go from 1 to a larger positive number, such as 4, 5 or 6.

We are able to use the following, to understand `coded_country` better

```
sort(unique(cvbase$coded_country))
table(cvbase$coded_country)
max(table(cvbase$coded_country))
which(table(cvbase$coded_country) == max(table(cvbase$coded_country)))
```

```
min(table(cvbase$coded_country))
which(table(cvbase$coded_country) == min(table(cvbase$coded_country)))
```

Based on the outputs, there seems to be 110 unique countries inclusive of NA values, with each country having a widely different number of entries, the Croatia being the highest at 6987, and host of other countries having much less.

Missing values are present in all columns, however this is the norm as surveys of this nature do not require participants to answer all questions. The `employstatus` columns appear to be the biggest culprit, given each participant will only pick one out of the 10 categories. In this dataframe, `employstatus_3` seems to have the least missing values, while `employstatus_8` has the highest number. Potentially, this could imply that the majority of participants are working 40 hours or more, while a small number of people who are disabled may be out of work.

Another point to note is the mean age group in this dataframe amounts to 2.905, which indicates that the majority of participants are likely to be aged between 35-44 years. This could indicate working-class adults with concise lifestyle, and are studied accordingly to research the outcomes covid had on people.

## 1(b)

This dataset is relatively tidy and without too many missing values, hence preprocessing should not be required. However, the missing values in the `employstatus` column should be replaced with 0, as it would be easier to transform and process the data in binary format, which might be required for linear regression involving these attributes down the track.

```
cvbase[is.na(cvbase)] <- 0
```

## Task 2: Focus country vs all other countries as a group

### 2(a)

I will be analyzing Croatia in this assignment. We will start by creating bar charts for each group of countries, where the y-axis represents the survey questions, and the x-axis represents the mean of each questions' response. Below, we will create data frames for the mean values utilizing `ggplot2`, excluding non-numerical attributes such as `coded_country`.

```
croatia <- cvbase[cvbase$coded_country == "Croatia", ]
others <- anti_join(cvbase, croatia)

numeric_cols <- sapply(croatia, is.numeric)
means <- colMeans(croatia[, numeric_cols], na.rm = TRUE)

croatia_means <- data.frame(mean = means)

numeric_cols <- sapply(others, is.numeric)
```

```

others_means <- colMeans(others[, numeric_cols], na.rm = TRUE)

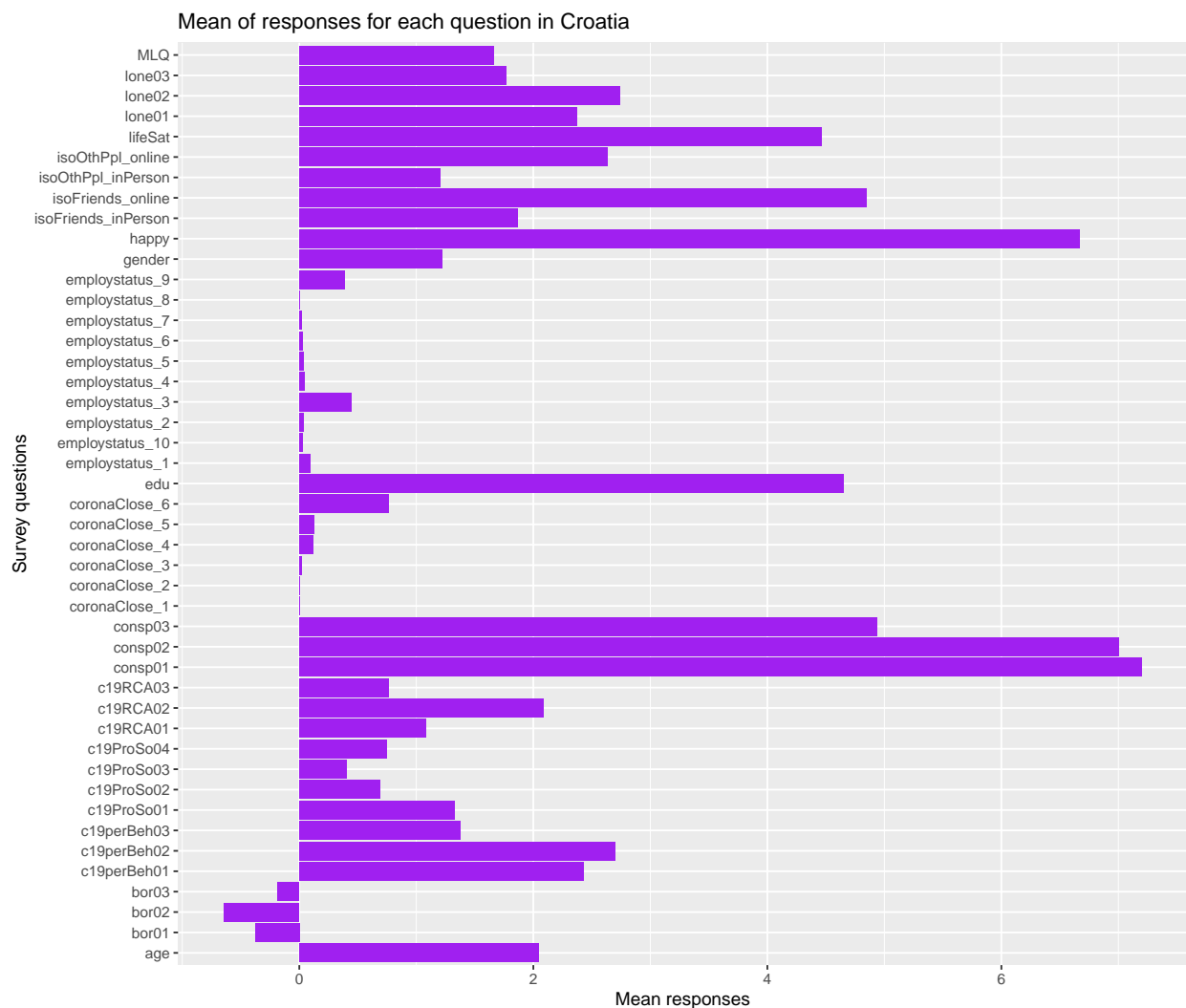
others_means <- data.frame(mean = others_means)

croatia_plotted <- ggplot(croatia_means) +
  geom_bar(mapping = aes(x = rownames(croatia_means), y = mean), stat = "identity",
    fill = "purple") +
  coord_flip() +
  labs(x = "Survey questions", y = "Mean responses",
    title = "Mean of responses for each question in Croatia")

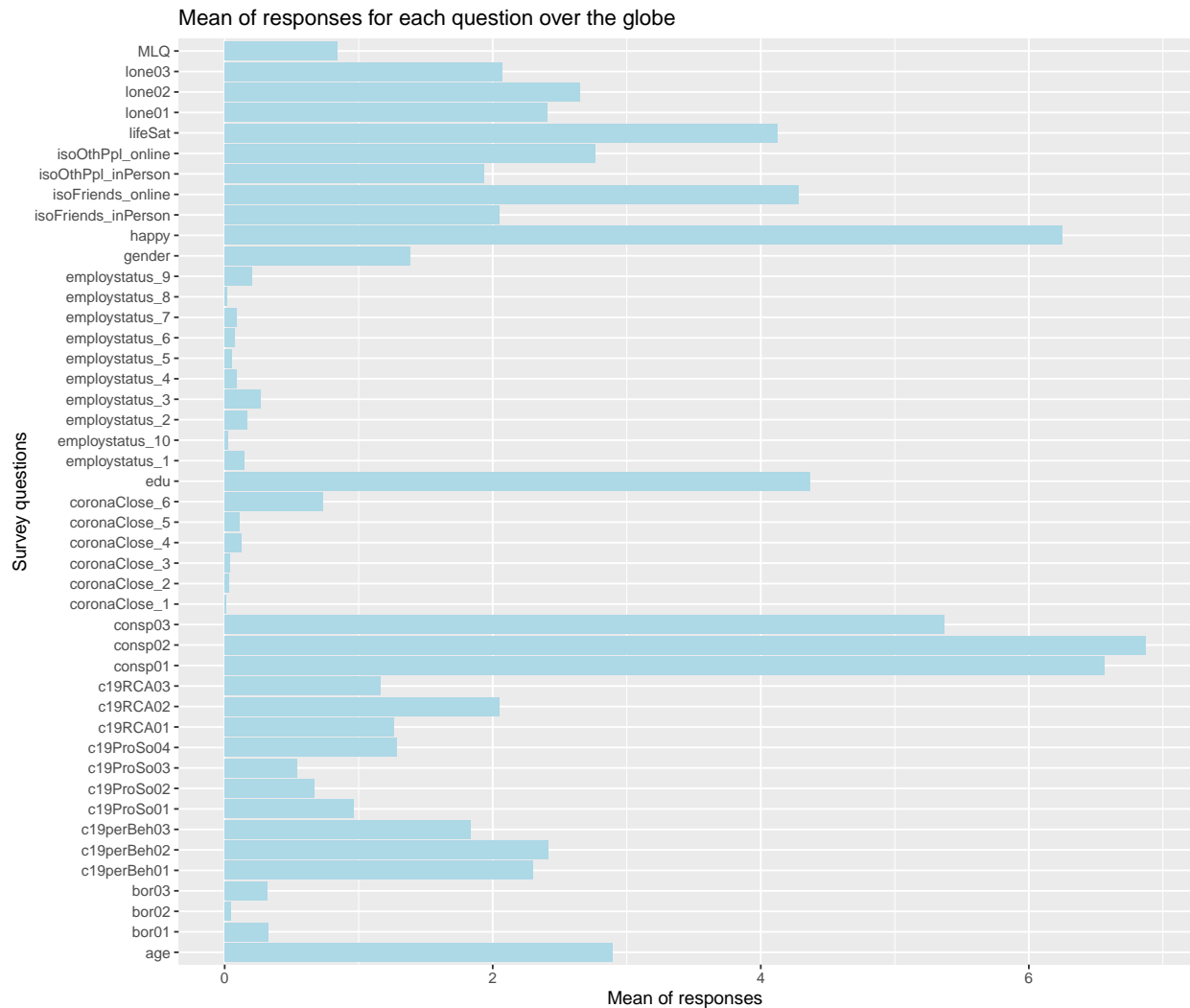
world_plotted <- ggplot(others_means) +
  geom_bar(mapping = aes(x = rownames(others_means), y = mean), stat = "identity",
    fill = "lightblue") +
  coord_flip() +
  labs(x = "Survey questions", y = "Mean of responses",
    title = "Mean of responses for each question over the globe")

croatia_plotted

```



world\_plotted



Looking at both graphs of Croatia, and all other countries in comparison, most responses seem to be quite similar, except for Boredom, `bor01`, `bor02` and `bor03`. While the worldwide mean is between 0 (Neither agree nor disagree) and 1 (Somewhat agree), in Croatia, the mean is negative and closer to 1 (Somewhat disagree). This leads us to believe people in Croatia could be less bored than other countries worldwide, albeit slightly. Additionally, there seems to be no Corona Proximity for participants themselves, as well as members of their family in this dataset.

## 2(b)

Let's start by taking a peek through the correlation of each predictor for pro-social attitude in Croatia. We can visualise the correlation matrix through a heatmap using `cor()`. While Croatia has a lower response rate than other highly populated countries, some operations might not have sufficient data to action.

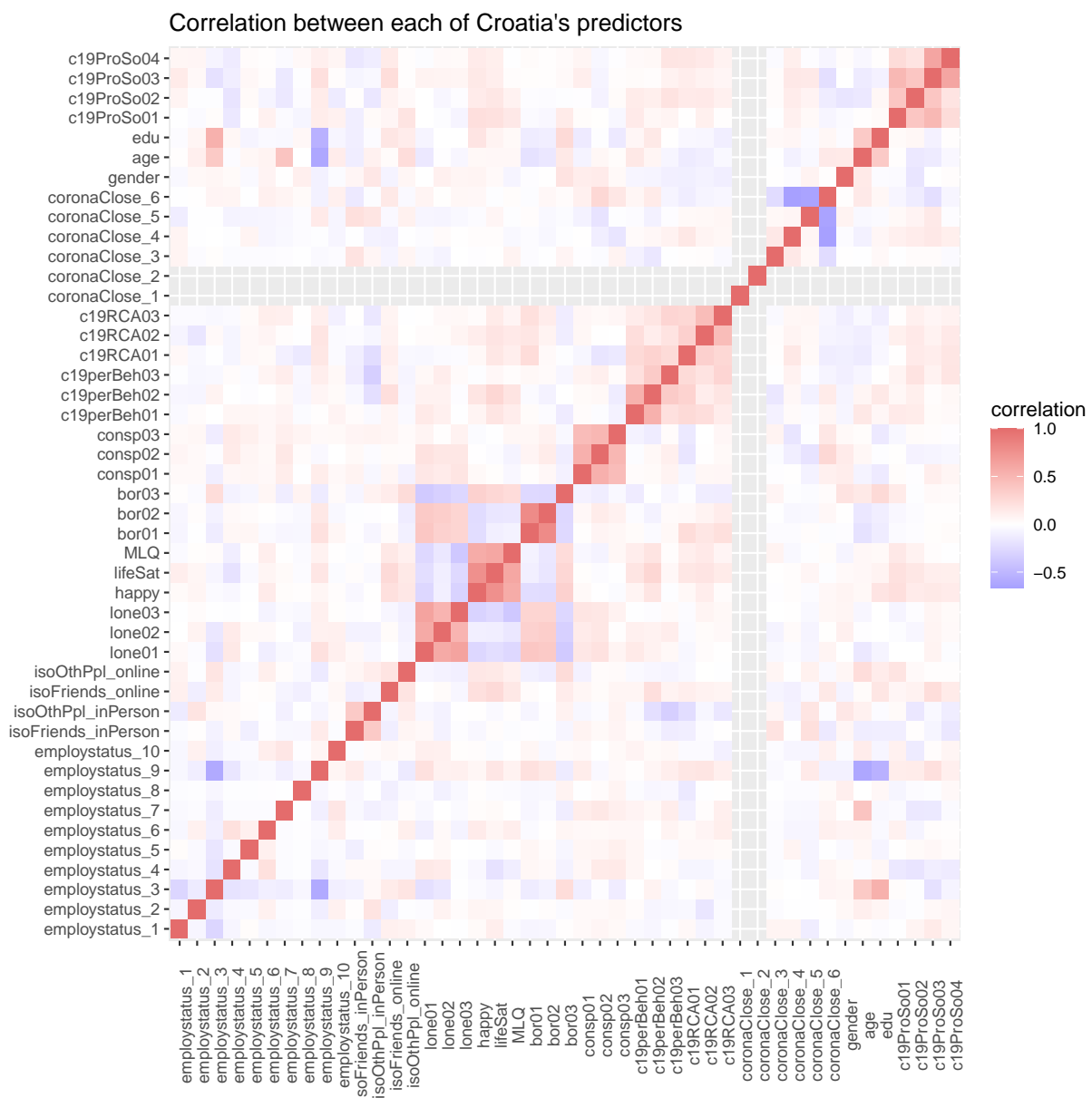
```
numeric_croatia <- croatia[sapply(croatia, is.numeric)]  
  
croatia_correlation <- cor(numeric_croatia, use = "complete.obs")
```

```
## Warning in cor(numeric_croatia, use = "complete.obs"): the standard deviation
## is zero
```

```
croatia_melted <- reshape2::melt(croatia_correlation, na.rm = TRUE)

croatia_correlation_plotted <- ggplot(data = croatia_melted, aes(x = Var1, y = Var2, fill = value)) +
  geom_tile() +
  scale_fill_gradient2(low = "#6b74ff", mid = "white", high = "#e46c6c", midpoint = 0) +
  labs(title = "Correlation between each of Croatia's predictors", x = "", y = "",
       fill = "correlation") +
  theme(axis.text.x = element_text(angle = 90))

croatia_correlation_plotted
```



Tiles that are red or blue denote positive or negative correlation, respectively, and turn white as correlation gets closer to zero. Numerous examples of substantial association between predictors can be seen in this heatmap; nevertheless, the portion displaying the correlation between pro-social views and all other traits is quite weak. This suggests that the characteristics might not be a very good indicator of pro-social sentiments in Croatia.

It is possible to determine how survey replies predict the pro-social attitude question through a linear regression model, fitted for each pro-social attitude based on the qualities. Once fitted, it is possible to find the most accurate predictions.

A linear model of each pro-social attitude versus the qualities is fitted by the code that follows. Each model's R-squared, significant predictors possessing a confidence level greater than 99.9%, summarising corresponding coefficients using a function and a for loop. The vectors `predictors` and `each_model` will be utilised in a subsequent table to compare the strong predictors for every model.

```
predictors <- NULL
each_model <- NULL

model_evaluated <- function(model) {
  rsquared <- summary(model)$r.squared
  adjusted_rsquared <- summary(model)$adj.r.squared
  sig <- which(summary(model)$coefficients[-1, 4] < 0.001) + 1
  predictor <- rownames(summary(model)$coefficients[sig, , drop = FALSE])
  coefficient <- summary(model)$coefficients[sig, 1]

  return(list(rsquared, adjusted_rsquared, predictor, coefficient))
}

fitted_croatia1 <- lm(c19ProSo01 ~ .,
  data = subset(croatia, select = -c(coded_country, c19ProSo02, c19ProSo03, c19ProSo04)))
fitted_croatia2 <- lm(c19ProSo02 ~ .,
  data = subset(croatia, select = -c(coded_country, c19ProSo01, c19ProSo03, c19ProSo04)))
fitted_croatia3 <- lm(c19ProSo03 ~ .,
  data = subset(croatia, select = -c(coded_country, c19ProSo01, c19ProSo02, c19ProSo04)))
fitted_croatia4 <- lm(c19ProSo04 ~ .,
  data = subset(croatia, select = -c(coded_country, c19ProSo01, c19ProSo02, c19ProSo03)))

cat("Pro-social attitudes in Croatia predictors model summary\n\n")
```

## Pro-social attitudes in Croatia predictors model summary

```
i <- 1
for (model in list(fitted_croatia1, fitted_croatia2, fitted_croatia3, fitted_croatia4)) {
  cat("C19ProSo0", i, "\n", sep = "")
  collection <- model_evaluated(model)
  cat("R-squared:", collection[[1]], "\n")
  cat("R-squared Adjusted:", collection[[2]], "\n")
  cat("99.9% confidence interval significant predictors:\n")
  cat(collection[[3]], "\n")
  cat("Coefficients of predictors:\n")
  cat(collection[[4]], "\n")
  cat("\n")
  for (each in collection[[3]]) {
    each_model <- c(each_model, paste0("Croatia_C19ProSo0", i))
  }
}
```

```

}
predictors <- c(predictors, collection[[3]])
i <- i + 1
}

## C19ProSo01
## R-squared: 0.4686053
## R-squared Adjusted: 0.2519858
## 99.9% confidence interval significant predictors:
##
## Coefficients of predictors:
##
##
## C19ProSo02
## R-squared: 0.3355854
## R-squared Adjusted: 0.06474127
## 99.9% confidence interval significant predictors:
##
## Coefficients of predictors:
##
##
## C19ProSo03
## R-squared: 0.4872678
## R-squared Adjusted: 0.278256
## 99.9% confidence interval significant predictors:
## isoFriends_online
## Coefficients of predictors:
## 0.1795645
##
## C19ProSo04
## R-squared: 0.3617789
## R-squared Adjusted: 0.1016124
## 99.9% confidence interval significant predictors:
## rankOrdLife_4D
## Coefficients of predictors:
## 6.462742

```

C19ProSo04 has the greatest adjusted R-squared at 0.278256 out of all the models, indicating that the responses best predict it. `disc02`, `MLQ`, `c19NormShould`, and `c19IsPunish` are its best predictors. The C19ProSo03 model has the least adjusted R-squared value at 0.08190663, and `PLRAC19`, `MLQ`, `c19NormShould`, `trustGovState`, and `edu` are its best predictors.

The fact that the majority of the survey items are deemed subjective makes the models' arguably low R-squared values predictable. For instance, different individuals interpret financial hardship differently and perceive various levels of serenity differently. Since Croatia is a large, populated nation with a wide range of living standards, its several regions are like independent nations with their own economies, healthcare systems, and general levels of satisfaction. Because of this, it is challenging to forecast the pro-social attitude reactions with consistency.

Although each model has a unique set of important predictors, some predictors can be regarded as generally more reliable because they are more frequently found in all of the models. The best illustration would be `c19NormShould`, a highly predictive variable for each of the models. During a pandemic, someone who is willing to assist society would want the best for it and would counsel individuals to isolate themselves and avoid social interactions.. The Centers for Disease Control and Prevention (CDC) in Croatia recommend

these steps to stop the spread of viruses, and since Croatia is a developed country with a highly educated populace, people who aspire to be pro-social generally abide by these recommendations. Conversely, a person devoid of pro-social attitudes would not care about adhering to new rules or showing any interest in societal behaviors. Those who disagree with social distancing policies and believe that doing so benefits society as a whole may also have an impact on the predictive power of `c19NormShould`. During the epidemic, lock down protests were prevalent in Croatia, demonstrating the validity of this viewpoint.

`disc02`, `MLQ`, and `trustGovState` are additional variables that predict three of the models effectively. People are more likely to be pro-social if they care about the future of society, if they have a purpose in life, and if they think society can come to an agreement on how to handle the pandemic.

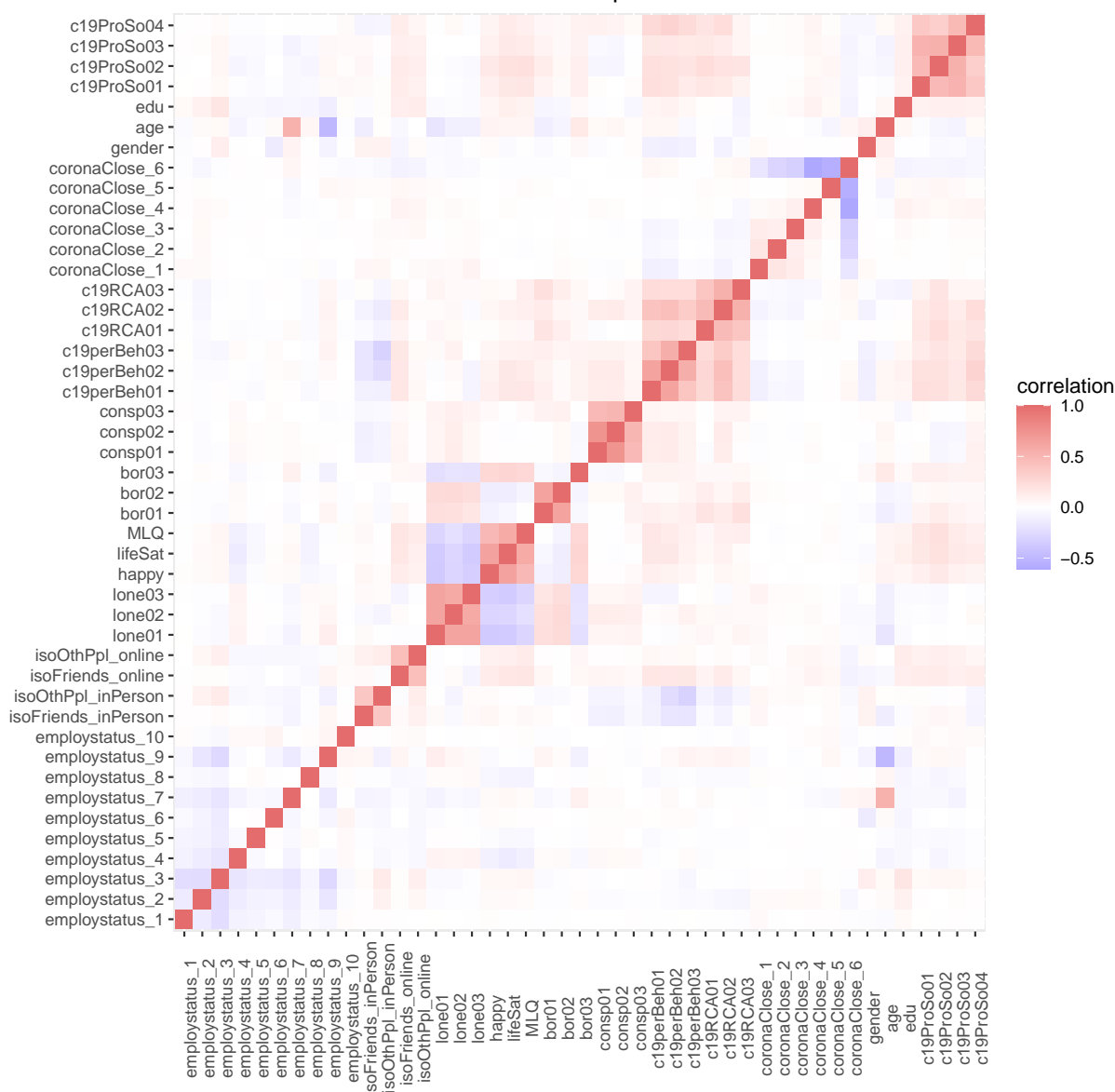
## 2(c)

The previous code blocks for 2(b) are modified, but with the `rem` data set instead of `croatia`, to produce a similar correlation matrix for the rest of the world. To keep the report concise, variants of code that have been modified further on, can be found in the **Appendix**.

```
global_correlation_plot
```



Correlation between each of the world's predictors



When we compare the two heatmaps we currently have, we see that `cro_cor_plot` has tiles coloured in a deeper shade of red, which suggests a larger overall correlation between the predictors. Apart from having lighter tiles, `rem_cor_plot` appears “cleaner” due to a reduced dispersion of coloured tiles. However, since the subsections in both plots appear fairly similar, focusing on the heatmap subsections that illustrate the association between pro-social attitudes and all other features, We can hypothesise that pro-social views should be predicted with somewhat equivalent performance by the attributes for both sets of data.

## Pro-social attitudes in the world predictors model summary

## C19ProSo01

## R-squared: 0.1280411

## Adjusted R-squared: 0.12646

## 99.9% confidence interval significant predictors:

## employstatus\_6 employstatus\_7 employstatus\_8 employstatus\_10 isoFriends\_inPerson isoOthPpl\_inPerson

```
## Coefficients of predictors:
## -0.09356577 -0.2272962 -0.1897203 0.3730428 0.01719855 0.02667376 0.01609172 0.01721033 0.0606518 -0.0
##
## C19ProSo02
## R-squared: 0.1766909
## Adjusted R-squared: 0.1751979
## 99.9% confidence interval significant predictors:
## employstatus_3 employstatus_4 employstatus_5 employstatus_8 employstatus_10 isoFriends_inPerson isoF
## Coefficients of predictors:
## 0.1072481 -0.1977689 -0.1317748 -0.3161566 0.2091906 0.03416122 0.0152765 0.02820841 0.05811839 -0.0
##
## C19ProSo03
## R-squared: 0.1199772
## Adjusted R-squared: 0.1183814
## 99.9% confidence interval significant predictors:
## employstatus_3 employstatus_7 employstatus_10 isoFriends_inPerson iso0thPpl_inPerson iso0thPpl_onlin
## Coefficients of predictors:
## 0.1555728 -0.2152103 0.3369801 0.02274039 0.02160123 0.02621581 0.066345 0.09423445 0.0588311 0.0282
##
## C19ProSo04
## R-squared: 0.17178
## Adjusted R-squared: 0.1702782
## 99.9% confidence interval significant predictors:
## employstatus_2 employstatus_3 employstatus_10 isoFriends_online lone02 lone03 lifeSat MLQ bor02 bor0
## Coefficients of predictors:
## 0.09869336 0.1272541 0.2820308 0.01248981 0.03724033 0.03827886 0.07587075 0.02828067 0.02557799 0.0
```

All four models had adjusted R-squared somewhere between 0.12 and 0.17, pointing to a smaller range than the comparable one for the Croatia data set (0.06 - 0.49), according to the summary for the rest of the world. The models' predictors are significantly more important than those of the `croatia` models. The four models are well predicted by `disc02`, `lifeSat`, `c19NormShould`, `c19NormDo`, and `trustGovState`. The majority of the predictors that performed well in all four of the `croatia` models, `c19NormShould`, `disc02`, and `trustGovState` are included in this set. As was already said, Croatia's sheer vastness and diversity make it seem like a collection of independent nations. It follows that strong predictors for Croatia would also apply to other nations collectively.

The table below displays the results of the strongest predictors for each pro-social behaviour for Croatia and the rest of the globe.

```
tables_combined <- table(predictors = predictors, models = each_model)

tables_combined <- tables_combined[, c("Croatia_C19ProSo03",
  "Croatia_C19ProSo04", "RoW_C19ProSo01", "RoW_C19ProSo02", "RoW_C19ProSo03",
  "RoW_C19ProSo04")]

tables_combined_plotted <- ggplot(data = as.data.frame(tables_combined)) +
  geom_tile(mapping = aes(x = models, y = predictors, fill = Freq, colour = "black")) +
  scale_fill_gradientn(colours = c("pink", "green")) +
  theme(legend.position = "none") +
  scale_x_discrete(position = "top") +
  scale_y_discrete(limits = rev) +
  labs(x = "Models", y = "Predictors",
    title = "Significant predictors for individual models")

tables_combined_plotted
```



### Task 3: Focus country vs cluster of similar countries

#### 3(a)

Some additional data is collected from external sources to supplement the indicators available in the sources mentioned in the references. Eight indicators make up the final data table I have compiled (in **Appendix**) for use in clustering: HDI, GHS, freedom, political\_stability, happiness, total\_vax\_per\_hundred, total\_cases\_per\_mil, and total\_deaths\_per\_mil. The **Appendix** contains information and explanations regarding each indicator as well as its sources.

Using k-means clustering, nations that are comparable to Croatia are found. For the `kmeans()` function to function, countries with NA values must first be eliminated. This has no bearing on our findings because the majority of these nations—such as Afghanistan and Syria—do not initially appear in the baseline data and differ greatly from Croatia in terms of development and data transparency. After scaling the data, we use a few random beginnings to carry out K-means clustering.

```
external <- read.csv("task3.csv")
cleaned_external <- na.omit(external)
cleaned_external[, 2:9] <- scale(cleaned_external[, 2:9])

kfit <- kmeans(cleaned_external[, 2:9], round(nrow(cleaned_external) / 5), nstart = 15)
clusters <- data.frame(country = cleaned_external[[1]], cluster = kfit$cluster)

target <- filter(clusters, country == "Croatia")$cluster
similar <- filter(clusters, cluster == target)

similar
```

```
##      country cluster
## 42   Croatia      24
## 76   Hungary      24
## 137  Poland       24
```

```
## 140 Romania      24
## 155 Slovakia     24
```

The clustering indicates that Hungary, Poland, Romania and Slovakia are comparable to Croatia.

### 3(b)

After removing the data from Croatia, the baseline data of the cluster's member nations are initially extracted by inner joining `cvbase` and `similar`. Finally, we visualize the given correlation matrix, in line with `croatia` and the rest of the globe.

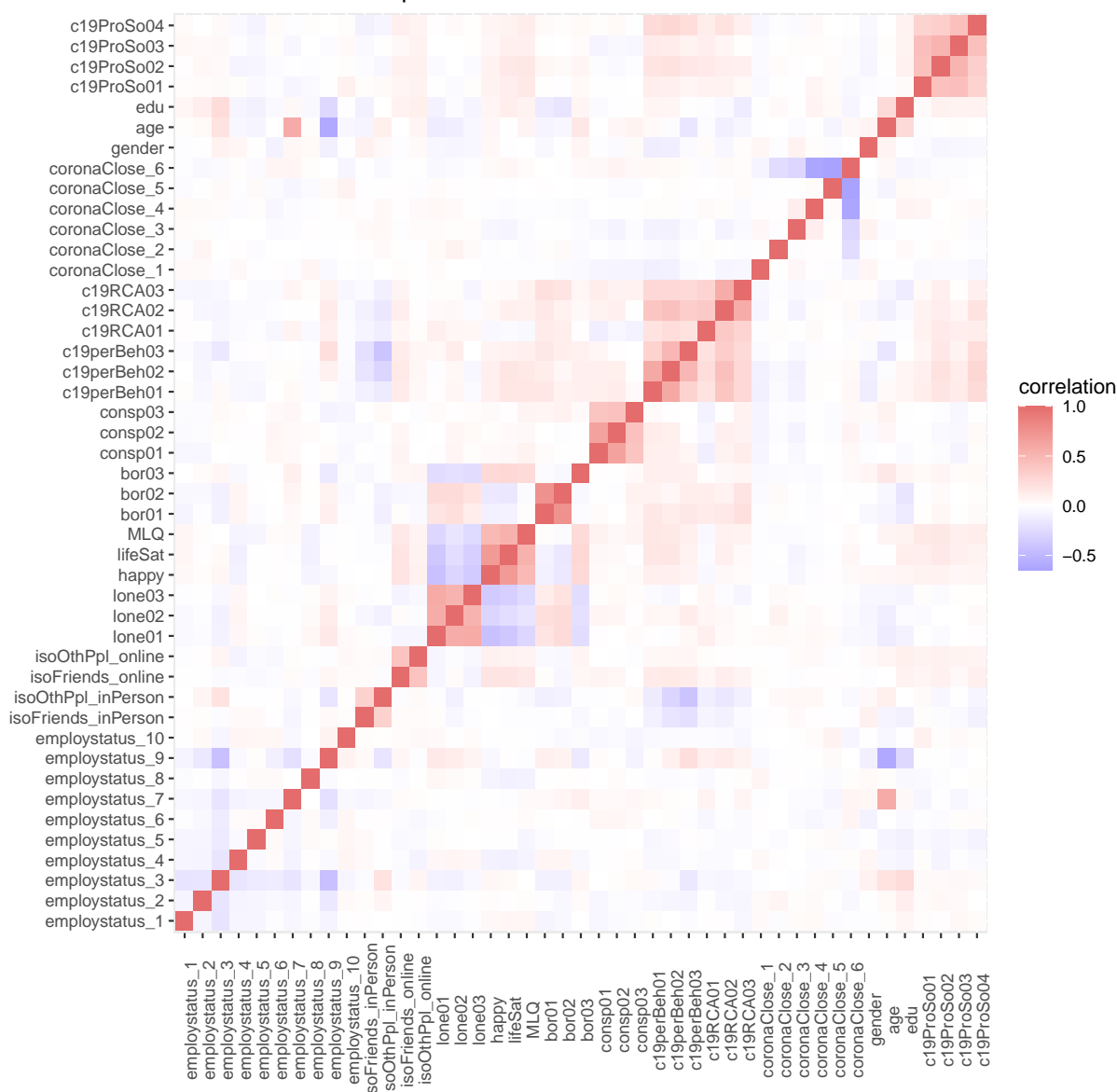
```
colnames(similar)[colnames(similar) == "country"] <- "coded_country"
common <- merge(cvbase, similar, by = "coded_country", all = FALSE)
common <- common[, -ncol(common)]
clustered <- filter(common, coded_country != "Croatia")

non_numeric_columns <- sapply(clustered, function(x) !is.numeric(x))
clustered_numeric <- subset(clustered, select = !non_numeric_columns)

clustered_correlation_matrix <- cor(clustered_numeric, use = "complete.obs")
clustered_melted <- reshape2::melt(clustered_correlation_matrix)
```

```
clustered_correlation_plotted
```

Correlation between predictors for countries similar to Croatia



This heat map's scatter of colored tiles is identical to the Croatia heat map's, showing how similar these two nations are. In comparison to the previous plots, the portion of tiles displaying the correlation between predictors and pro-social views is generally darker, suggesting the predictors related to the cluster in question may perform positively in terms of prediction than the data from the previous two groups.

Finally, repeating the code fragments from Task 2, b and c, we can output a structured summary for all models in order to determine how respondent answers can be a significant predictor of pro-social views pertaining to the similar countries cluster in question.

```
## Model Summary for countries similar to the Croatia to predict pro-social attitudes
```

```
## C19ProSo01
```

```
## R-squared: 0.1019308
```

```
## Adjusted R-squared: 0.07645638
```

```

## 99.9% confidence interval significant predictors:
## employstatus_10 MLQ rankOrdLife_3B c19RCA01
## Coefficients of predictors:
## 0.6937677 0.1364176 -0.6291484 0.05595581
##
## C19ProSo02
## R-squared: 0.1275736
## Adjusted R-squared: 0.1028265
## 99.9% confidence interval significant predictors:
## MLQ c19RCA01
## Coefficients of predictors:
## 0.1080792 0.07625105
##
## C19ProSo03
## R-squared: 0.1031383
## Adjusted R-squared: 0.07769807
## 99.9% confidence interval significant predictors:
## MLQ rankOrdLife_3C c19RCA01
## Coefficients of predictors:
## 0.09845237 -0.5655349 0.08508227
##
## C19ProSo04
## R-squared: 0.1595349
## Adjusted R-squared: 0.1356944
## 99.9% confidence interval significant predictors:
## MLQ rankOrdLife_1B rankOrdLife_1C rankOrdLife_1D rankOrdLife_1F rankOrdLife_3B c19perBeh01 c19perBeh02
## Coefficients of predictors:
## 0.0850501 1.498947 1.385919 1.365358 1.5909 -0.68414 0.1338745 0.1736953 0.1314914

```

Also check last sentence of next paragraph

Based on the results, the models for these comparable nations typically have adjusted R-squared values that are comparable to those of Croatia and all other nations combined. Similar to the Croatia models, C19ProSo04 seems to have the greatest adjusted R-squared value (0.1356944). Except for C19ProSo04, which has significant predictors including `disc02`, `MLQ`, `c19NormShould` and `c19IsPunish`, none of these models, in contrast to the preceding eight models, had significant predictors with p-values less than 0.001. In the Croatia model, `disc02` is also a very good predictor for C19ProSo04, but not for PFS02. However, `disc02`, `MLQ`, `c19NormShould` and `c19IsPunish` are all significant predictors over the rest of the globe model for C19ProSo04.

Consequently, the prediction of qualities for this cluster of countries is in no way particularly better off than Croatia or the rest of the globe, with comparable R-squared values and predictors with generally lower confidence intervals. The previously reported large correlation may have been insignificant sample size rather than representing genuine statistically significant links between pro-social attitudes and qualities.

We can define a strong predictor in relation to a model's total p-values for comparative purposes. For these novel cluster models, we characterize a strong predictor as one with a p-value of less than 0.05, which is a widely accepted threshold. A new visualization table is constructed and the `model_evaluated` function is changed in line with the model.

```
## Model Summary for countries similar to the Croatia to predict pro-social attitudes
```

```

## C19ProSo01
## R-squared: 0.1019308
## Adjusted R-squared: 0.07645638

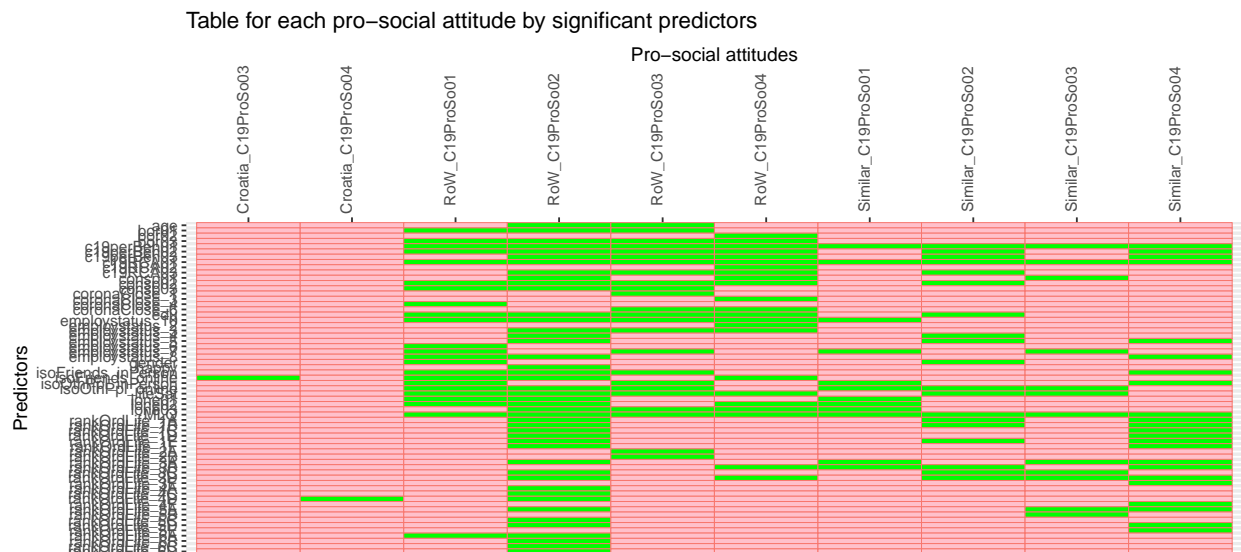
```

```

## 95% confidence interval significant predictors:
## employstatus_7 employstatus_10 iso0thPpl_inPerson iso0thPpl_online lone01 lone02 lone03 MLQ rankOrdL
## Coefficients of predictors:
## -0.4443775 0.6937677 0.03384447 0.033907 0.06722975 -0.0930139 0.09173 0.1364176 -0.5174174 -0.62914
##
## C19ProSo02
## R-squared: 0.1275736
## Adjusted R-squared: 0.1028265
## 95% confidence interval significant predictors:
## employstatus_4 employstatus_5 iso0thPpl_online lifeSat MLQ consp02 rankOrdLife_1A rankOrdLife_1B ran
## Coefficients of predictors:
## -0.2919775 -0.3600833 0.03217282 0.1372649 0.1080792 -0.04087629 1.069375 1.125655 0.8700702 -0.4339
##
## C19ProSo03
## R-squared: 0.1031383
## Adjusted R-squared: 0.07769807
## 95% confidence interval significant predictors:
## employstatus_7 iso0thPpl_online lifeSat MLQ consp01 rankOrdLife_3A rankOrdLife_3C rankOrdLife_3D ran
## Coefficients of predictors:
## -0.5393024 0.03719592 0.09921346 0.09845237 -0.04105437 -0.5538729 -0.5655349 -0.3214164 -0.4687776
##
## C19ProSo04
## R-squared: 0.1595349
## Adjusted R-squared: 0.1356944
## 95% confidence interval significant predictors:
## employstatus_5 employstatus_8 isoFriends_inPerson iso0thPpl_inPerson MLQ rankOrdLife_1A rankOrdLife_
## Coefficients of predictors:
## -0.4926586 0.5835967 -0.02775915 0.03682043 0.0850501 1.325203 1.498947 1.385919 1.365358 1.238381 1

```

summary\_table\_visualised\_2



We see that strongest predictors being distributed between the models of countries that are similar is closer to the Croatian models, with a few shared significant predictors (i.e., appearing quite as “sparse” as the Croatia models). Given more comparable p-values, the models from the group of all other nations have a great deal more significant predictors in common with the Croatian models. These models do, however, also contain a large number of powerful predictors that are absent from the Croatian models. Consequently,

the group of comparable nations may provide a better fit to the critical characteristics needed to predict pro-social sentiments. The smaller the confidence level, as well as less common strongest predictors included throughout those models may become insignificant with additional study or a larger sample size.

One explanation could be that, despite their similarities to Croatia, each country in the cluster varies slightly from the others in terms of socioeconomic factors that are not taken into account by the clustering indicators.. Their collective performance in forecasting pro-social attitudes differs substantially from Croatia alone when these small variations are taken into account. However, because Croatia's politics, culture, and other aspects of society are complicated, much like those of a group of many countries, its models have many strong predictors in common with the models pertaining to the cluster of all countries. The models may report multiple significant predictors that are not important because the cluster of all other countries could be too complicated or big.

## Appendix

### References

I acknowledge the use of [1] Grammarly (<https://app.grammarly.com/>) [2] to refine the academic language and accuracy of my own work. On 6 April, 2024 I submitted my entire report with the instruction to [3] "Improve the academic tone and accuracy of language, including grammatical structures, punctuation and vocabulary". [4] The output was then modified further to better represent my own tone and style of writing.

I acknowledge the use of [1] ChatGPT (<https://chat.openai.com/>) to [2] generate materials for background research and self-study in the drafting of this assessment. I entered the following prompts on 4 January 2023:

[3] Write basic R code to use ggplot to plot a correlation matrix from a data set [3] Write basic R code to fit a linear model

[4] The output from the generative artificial intelligence was adapted and modified for the final response.

ChatGPT was used to help model some code fragments in this assignment, including 2a, 2b, 2c, 3a and 3b. Prompts used, include the following

cvbase head, 1(b)

```
head(cvbase)
```

```
##      employstatus_1 employstatus_2 employstatus_3 employstatus_4
## 21475              0              1              0              0
## 3823               0              0              0              1
## 57606              0              1              0              0
## 49874              0              0              0              0
## 16726              1              1              1              0
## 23113              0              0              0              0
##      employstatus_5 employstatus_6 employstatus_7 employstatus_8
## 21475              0              0              0              0
## 3823               0              0              0              0
## 57606              0              0              0              0
## 49874              0              0              1              0
## 16726              0              0              0              0
## 23113              0              0              1              0
##      employstatus_9 employstatus_10 isoFriends_inPerson isoOthPpl_inPerson
## 21475              0              0              0              2
## 3823               0              0              1              0
## 57606              0              0              1              2
```



## 49874	0	0	1	1				
## 16726	0	0	3	2				
## 23113	0	0	0	0				
##	isoFriends_online	iso0thPpl_online	lone01	lone02	lone03	happy	lifeSat	MLQ
## 21475	6	1	1	1	1	9	5	2
## 3823	6	0	3	3	2	6	2	1
## 57606	4	4	2	2	1	7	4	1
## 49874	7	3	2	3	2	8	5	0
## 16726	7	4	3	3	4	9	5	3
## 23113	7	0	4	5	5	4	2	0
##	bor01	bor02	bor03	consp01	consp02	consp03	rankOrdLife_1	rankOrdLife_2
## 21475	1	1	-2	7	8	0	F	D
## 3823	-2	-1	1	6	1	2	C	E
## 57606	0	0	0	8	8	2	D	E
## 49874	-2	-2	3	10	8	0	F	D
## 16726	2	1	3	6	8	6	0	0
## 23113	0	0	-3	10	10	7	E	D
##	rankOrdLife_3	rankOrdLife_4	rankOrdLife_5	rankOrdLife_6	c19perBeh01			
## 21475	E	C	A	B	3			
## 3823	F	D	A	B	3			
## 57606	F	C	A	B	3			
## 49874	E	C	A	B	3			
## 16726	0	0	0	0	3			
## 23113	F	B	A	C	3			
##	c19perBeh02	c19perBeh03	c19RCA01	c19RCA02	c19RCA03	coronaClose_1		
## 21475	3	3	0	0	-2	0		
## 3823	2	2	0	3	2	0		
## 57606	3	1	1	2	-1	0		
## 49874	3	3	0	3	1	0		
## 16726	3	3	3	3	3	0		
## 23113	3	3	-3	-3	-3	0		
##	coronaClose_2	coronaClose_3	coronaClose_4	coronaClose_5	coronaClose_6			
## 21475	1	0	1	1	0			
## 3823	0	0	0	0	1			
## 57606	0	0	0	0	1			
## 49874	0	0	0	0	1			
## 16726	1	0	0	0	0			
## 23113	0	0	0	0	1			
##	gender	age	edu	coded_country	c19ProSo01	c19ProSo02	c19ProSo03	c19ProSo04
## 21475	1	3	5	Spain	2	2	-1	3
## 3823	1	3	6	Greece	1	-1	2	2
## 57606	2	4	4	Germany	2	2	1	1
## 49874	1	5	4	Canada	-2	1	1	3
## 16726	1	2	6	Indonesia	3	3	3	3
## 23113	2	6	5	France	0	-3	-3	0

others Correlation matrix, 2(c)

```

others <- anti_join(cvbase, croatia)

numeric_others <- others[sapply(others, is.numeric)]

global_correlation <- cor(numeric_others, use = "complete.obs")

```

```
global_melted <- reshape2::melt(global_correlation)

global_correlation_plot <- ggplot(data = global_melted) +
  geom_tile(mapping = aes(x = Var1, y = Var2, fill = value)) +
  scale_fill_gradient2(low = "#6b74ff", mid = "white", high = "#e46c6c", midpoint = 0) +
  labs(title = "Correlation between each of the world's predictors", x = "", y = "",
       fill = "correlation") +
  theme(axis.text.x = element_text(angle = 90))
```

others models, 2(c)

```
fitted_rest1 <- lm(c19ProSo01 ~ .,
  data = subset(others, select = -c(coded_country, c19ProSo02, c19ProSo03, c19ProSo04)))
fitted_rest2 <- lm(c19ProSo02 ~ .,
  data = subset(others, select = -c(coded_country, c19ProSo01, c19ProSo03, c19ProSo04)))
fitted_rest3 <- lm(c19ProSo03 ~ .,
  data = subset(others, select = -c(coded_country, c19ProSo01, c19ProSo02, c19ProSo04)))
fitted_rest4 <- lm(c19ProSo04 ~ .,
  data = subset(others, select = -c(coded_country, c19ProSo01, c19ProSo02, c19ProSo03)))

cat("Pro-social attitudes in the world predictors model summary\n\n")
res_counter <- 1
for (model in list(fitted_rest1, fitted_rest2, fitted_rest3, fitted_rest4)) {
  cat("C19ProSo0", res_counter, "\n", sep = "")
  res <- model_evaluated(model)
  cat("R-squared:", res[[1]], "\n")
  cat("Adjusted R-squared:", res[[2]], "\n")
  cat("99.9% confidence interval significant predictors:\n")
  cat(res[[3]], "\n")
  cat("Coefficients of predictors:\n")
  cat(res[[4]], "\n")
  cat("\n")
  for (pred in res[[3]]) {
    each_model <- c(each_model, paste0("RoW_C19ProSo0", res_counter))
  }
  predictors <- c(predictors, res[[3]])
  res_counter <- res_counter + 1
}
```

Clustering data, 3(a)

external

##	country	HDI	GHS	freedom	political_stability
## 1	Afghanistan	0.478	28.8	NA	-2.53
## 2	Albania	0.796	45.0	8.14	0.11
## 3	Algeria	0.745	26.2	5.26	-0.88
## 4	Andorra	0.858	34.7	NA	1.63
## 5	Angola	0.586	29.1	6.09	-0.71
## 6	Antigua and Barbuda	0.788	30.0	NA	0.96
## 7	Argentina	0.842	54.4	7.38	-0.11
## 8	Armenia	0.759	61.8	8.20	-0.84
## 9	Australia	0.951	71.1	8.84	0.85

## 10	Austria	0.916	56.9	8.67	0.91
## 11	Azerbaijan	0.745	34.7	6.16	-0.85
## 12	Bahamas	0.812	30.1	8.22	0.88
## 13	Bahrain	0.875	36.3	5.73	-0.51
## 14	Bangladesh	0.661	35.5	5.75	-0.97
## 15	Barbados	0.790	34.9	7.92	1.12
## 16	Belarus	0.808	43.9	6.73	-0.74
## 17	Belgium	0.937	59.3	8.61	0.61
## 18	Belize	0.683	29.7	7.64	0.46
## 19	Benin	0.525	25.4	7.32	-0.30
## 20	Bhutan	0.666	39.8	6.86	0.97
## 21	Bolivia	0.692	29.9	6.94	-0.32
## 22	Bosnia and Herzegovina	0.780	35.4	7.54	-0.38
## 23	Botswana	0.693	33.6	7.90	0.98
## 24	Brazil	0.754	51.2	7.22	-0.49
## 25	Brunei	0.829	43.5	6.46	1.17
## 26	Bulgaria	0.795	59.9	8.08	0.46
## 27	Burkina Faso	0.449	29.8	6.85	-1.64
## 28	Burundi	0.426	22.1	5.02	-1.36
## 29	Cape Verde	0.662	34.1	NA	0.90
## 30	Cambodia	0.593	31.1	6.47	-0.13
## 31	Cameroon	0.576	28.6	5.63	-1.41
## 32	Canada	0.936	69.8	8.85	0.94
## 33	Central African Republic	0.404	18.6	5.62	-2.10
## 34	Chad	0.394	23.9	5.57	-1.34
## 35	Chile	0.855	56.2	8.44	0.06
## 36	China	0.768	47.5	5.57	-0.48
## 37	Colombia	0.752	53.2	7.01	-0.91
## 38	Comoros	0.558	24.9	6.07	-0.23
## 39	Congo	0.571	26.3	5.55	-0.61
## 40	Costa Rica	0.809	40.8	8.25	0.87
## 41	Côte d'Ivoire	0.550	31.2	6.90	-0.95
## 42	Croatia	0.858	48.8	8.16	0.71
## 43	Cuba	0.764	30.5	NA	0.43
## 44	Cyprus	0.896	41.9	8.42	0.44
## 45	Czech Republic	0.889	52.8	8.61	0.96
## 46	D.R. Congo	0.479	26.1	5.62	-1.61
## 47	Denmark	0.948	64.4	8.98	0.95
## 48	Djibouti	0.509	25.2	5.84	-0.71
## 49	Dominica	0.720	26.4	NA	1.39
## 50	Dominican Republic	0.767	34.5	7.88	0.14
## 51	Ecuador	0.740	50.8	7.43	-0.27
## 52	Egypt	0.731	28.0	4.49	-1.02
## 53	El Salvador	0.675	40.8	7.39	-0.21
## 54	Equatorial Guinea	0.596	17.4	NA	-0.29
## 55	Eritrea	0.492	21.4	NA	-1.01
## 56	Estonia	0.890	55.5	8.91	0.76
## 57	Eswatini	0.597	29.3	5.79	-0.03
## 58	Ethiopia	0.498	37.8	5.95	-2.07
## 59	Fiji	0.730	25.8	7.36	0.67
## 60	Finland	0.940	70.9	8.85	0.98
## 61	France	0.903	61.9	8.34	0.37
## 62	Gabon	0.706	21.8	6.80	-0.09
## 63	Gambia	0.500	28.7	6.88	0.18

## 64	Georgia	0.802	52.6	8.20	-0.42
## 65	Germany	0.942	65.5	8.73	0.76
## 66	Ghana	0.632	34.3	7.49	0.07
## 67	Greece	0.887	51.5	7.86	0.15
## 68	Grenada	0.795	26.7	NA	1.04
## 69	Guatemala	0.627	29.1	7.63	-0.39
## 70	Guinea	0.465	26.8	5.82	-0.97
## 71	Guinea-Bissau	0.483	21.4	NA	-0.28
## 72	Guyana	0.714	30.8	7.49	-0.14
## 73	Haiti	0.535	30.4	7.21	-1.10
## 74	Honduras	0.621	26.2	7.09	-0.61
## 75	Hong Kong S.A.R.	0.952	NA	8.41	0.26
## 76	Hungary	0.846	54.4	7.73	0.86
## 77	Iceland	0.959	48.5	8.77	1.37
## 78	India	0.633	42.8	6.39	-0.62
## 79	Indonesia	0.705	50.4	7.10	-0.51
## 80	Iran	0.774	36.5	4.53	-1.62
## 81	Iraq	0.686	24.0	5.02	-2.40
## 82	Ireland	0.945	55.3	8.90	0.86
## 83	Israel	0.919	47.2	7.66	-1.06
## 84	Italy	0.895	51.9	8.49	0.58
## 85	Jamaica	0.709	31.8	7.91	0.22
## 86	Japan	0.925	60.5	8.73	1.03
## 87	Jordan	0.720	42.8	6.91	-0.28
## 88	Kazakhstan	0.811	46.1	6.77	-0.25
## 89	Kenya	0.575	38.8	6.73	-1.09
## 90	Kiribati	0.624	26.2	NA	1.19
## 91	Kuwait	0.831	36.8	6.34	0.30
## 92	Kyrgyzstan	0.692	42.4	7.18	-0.43
## 93	Laos	0.607	34.8	5.85	0.73
## 94	Latvia	0.863	61.9	8.67	0.69
## 95	Lebanon	0.706	33.4	6.76	-1.49
## 96	Lesotho	0.514	30.9	7.01	-0.22
## 97	Liberia	0.481	35.7	6.81	-0.24
## 98	Libya	0.718	25.3	5.05	-2.37
## 99	Liechtenstein	0.935	46.4	NA	1.64
## 100	Lithuania	0.875	59.5	8.68	0.82
## 101	Luxembourg	0.930	48.4	8.80	1.21
## 102	Madagascar	0.501	30.4	7.02	-0.64
## 103	Malawi	0.512	28.5	6.99	-0.11
## 104	Malaysia	0.803	56.4	7.17	0.14
## 105	Maldives	0.747	32.0	NA	0.50
## 106	Mali	0.428	29.0	6.25	-2.35
## 107	Malta	0.918	40.2	8.45	0.97
## 108	Marshall Islands	0.639	24.6	NA	0.61
## 109	Mauritania	0.556	26.2	5.73	-0.67
## 110	Mauritius	0.802	39.7	8.07	0.86
## 111	Mexico	0.758	57.0	6.92	-0.64
## 112	Micronesia	0.628	28.5	NA	1.11
## 113	Moldova	0.767	41.0	7.68	-0.21
## 114	Mongolia	0.739	41.0	8.00	0.65
## 115	Montenegro	0.832	44.1	7.88	-0.15
## 116	Morocco	0.683	33.6	5.90	-0.40
## 117	Mozambique	0.446	30.4	6.80	-1.23

## 118	Myanmar	0.585	38.3	5.78	-2.07
## 119	Namibia	0.615	30.3	7.56	0.55
## 120	Nepal	0.602	34.0	7.12	-0.24
## 121	Netherlands	0.941	64.7	8.78	0.92
## 122	New Zealand	0.937	62.5	9.01	1.44
## 123	Nicaragua	0.667	36.3	6.24	-0.47
## 124	Niger	0.400	28.7	6.41	-1.62
## 125	Nigeria	0.535	38.0	6.28	-1.78
## 126	North Macedonia	0.770	42.2	7.75	0.12
## 127	Norway	0.961	60.2	8.76	1.10
## 128	Oman	0.816	39.1	5.92	0.51
## 129	Pakistan	0.544	30.4	5.63	-1.67
## 130	Palau	0.767	25.5	NA	0.95
## 131	Palestine	0.715	NA	NA	NA
## 132	Panama	0.805	53.5	8.12	0.29
## 133	Papua New Guinea	0.558	25.0	7.17	-0.58
## 134	Paraguay	0.717	40.3	7.54	0.00
## 135	Peru	0.762	54.9	7.93	-0.41
## 136	Philippines	0.699	45.7	6.83	-0.93
## 137	Poland	0.876	55.7	7.96	0.51
## 138	Portugal	0.866	54.7	8.69	0.95
## 139	Qatar	0.855	48.7	6.15	0.96
## 140	Romania	0.821	45.7	8.33	0.53
## 141	Russia	0.822	49.1	6.23	-0.65
## 142	Rwanda	0.534	33.1	6.36	0.17
## 143	Saint Kitts and Nevis	0.777	31.7	NA	0.96
## 144	Saint Lucia	0.715	34.7	NA	0.85
## 145	Saint Vincent and the Grenadines	0.751	33.5	NA	1.04
## 146	Samoa	0.707	28.8	NA	1.11
## 147	San Marino	0.853	32.9	NA	0.91
## 148	Sao Tome and Principe	0.618	26.6	NA	0.60
## 149	Saudi Arabia	0.875	44.9	5.12	-0.58
## 150	Senegal	0.511	32.8	7.07	-0.17
## 151	Serbia	0.802	45.0	7.54	-0.13
## 152	Seychelles	0.785	31.8	7.84	0.76
## 153	Sierra Leone	0.477	32.7	6.70	-0.16
## 154	Singapore	0.939	57.4	7.98	1.49
## 155	Slovakia	0.848	54.4	8.21	0.56
## 156	Slovenia	0.918	67.8	8.37	0.76
## 157	Solomon Islands	0.564	23.3	NA	0.49
## 158	South Africa	0.713	45.8	7.30	-0.71
## 159	South Korea	0.925	65.4	8.39	0.66
## 160	South Sudan	0.385	21.3	NA	-2.30
## 161	Spain	0.905	60.9	8.56	0.58
## 162	Sri Lanka	0.782	34.1	6.58	-0.32
## 163	Sudan	0.508	28.3	4.48	-1.94
## 164	Suriname	0.730	35.0	7.64	0.37
## 165	Sweden	0.947	64.9	8.83	1.03
## 166	Switzerland	0.962	58.8	9.11	1.13
## 167	Syria	0.577	16.7	3.66	-2.66
## 168	Tajikistan	0.685	29.3	5.52	-0.61
## 169	Tanzania	0.549	31.3	6.48	-0.44
## 170	Thailand	0.800	68.2	6.89	-0.55
## 171	Timor-Leste	0.607	27.8	7.22	0.17

## 172	Togo	0.539	27.8	6.50	-0.80
## 173	Tonga	0.745	26.4	NA	1.07
## 174	Trinidad and Tobago	0.810	36.8	7.70	0.15
## 175	Tunisia	0.731	31.5	6.46	-0.70
## 176	Turkey	0.838	50.0	5.79	-1.10
## 177	Turkmenistan	0.745	31.9	NA	-0.32
## 178	Tuvalu	0.641	20.0	NA	1.28
## 179	Uganda	0.525	36.5	6.32	-0.86
## 180	Ukraine	0.773	38.9	6.86	-1.10
## 181	United Arab Emirates	0.911	39.6	6.06	0.65
## 182	United Kingdom	0.929	67.2	8.75	0.54
## 183	United States of America	0.921	75.9	8.73	0.00
## 184	Uruguay	0.809	40.3	8.36	1.05
## 185	Uzbekistan	0.727	39.0	NA	-0.24
## 186	Vanuatu	0.607	25.9	NA	0.79
## 187	Venezuela	0.691	20.9	4.03	-1.53
## 188	Vietnam	0.703	42.9	5.90	-0.11
## 189	Yemen	0.455	16.1	4.08	-2.59
## 190	Zambia	0.565	26.5	6.82	0.06
## 191	Zimbabwe	0.593	32.4	5.60	-1.03
##	happiness	total_vax_per_hundred	total_cases_per_mil	total_deaths_per_mil	
## 1	2.523	11.37	3843.027	178.853	
## 2	5.117	81.50	73495.999	1130.064	
## 3	4.887	27.94	4855.709	139.656	
## 4	NA	146.85	289593.327	1753.441	
## 5	NA	32.64	2157.605	49.369	
## 6	NA	129.19	45802.585	1269.036	
## 7	5.929	172.04	127015.620	2596.686	
## 8	5.283	58.51	124054.477	2867.139	
## 9	7.183	162.66	13850.033	92.790	
## 10	7.268	186.55	141452.592	1866.187	
## 11	5.171	109.54	59504.476	805.748	
## 12	NA	73.22	59699.163	1748.827	
## 13	6.647	219.14	191141.779	946.858	
## 14	5.025	62.26	9262.063	163.985	
## 15	NA	106.38	100516.251	923.145	
## 16	5.534	80.84	73162.372	583.222	
## 17	6.834	186.45	179883.824	2432.755	
## 18	NA	104.77	79122.099	1473.037	
## 19	5.045	13.28	1875.553	12.057	
## 20	NA	147.59	3399.548	3.834	
## 21	5.716	80.11	48410.298	1607.478	
## 22	5.813	48.06	89830.928	4152.737	
## 23	3.467	42.89	84421.169	932.213	
## 24	6.330	153.86	103401.940	2874.028	
## 25	NA	200.09	34454.190	135.857	
## 26	5.266	54.57	109746.821	4554.734	
## 27	4.834	4.65	777.639	14.025	
## 28	3.775	0.06	2370.131	1.086	
## 29	NA	96.29	68679.383	593.430	
## 30	4.830	181.64	7185.596	179.629	
## 31	5.142	3.65	3928.633	66.381	
## 32	7.103	179.01	54674.470	779.054	
## 33	NA	7.83	2232.240	18.103	

## 34	4.355	1.61	321.667	10.213
## 35	6.172	226.05	92058.065	1994.314
## 36	5.339	198.85	92.420	3.997
## 37	6.012	124.71	99059.263	2503.488
## 38	4.289	69.50	7785.770	187.623
## 39	5.342	12.71	3563.730	61.805
## 40	7.069	149.71	110206.152	1419.462
## 41	5.306	25.26	2419.910	25.284
## 42	5.882	117.35	176082.986	3099.722
## 43	NA	275.36	86117.905	742.227
## 44	6.223	172.00	180555.509	720.977
## 45	6.965	147.62	239885.878	3462.077
## 46	NA	0.34	800.655	12.372
## 47	7.620	203.62	133231.468	553.529
## 48	NA	5.77	12162.187	168.622
## 49	NA	78.40	93652.932	645.977
## 50	5.545	125.45	37160.446	378.134
## 51	5.764	153.14	30320.534	1870.396
## 52	4.283	47.59	3466.327	195.756
## 53	6.061	151.83	19212.981	603.340
## 54	NA	27.03	8185.485	104.483
## 55	NA	NA	2166.643	20.358
## 56	6.189	136.41	182347.157	1456.943
## 57	4.308	33.25	54783.303	1080.987
## 58	4.275	8.85	3367.185	56.136
## 59	NA	136.28	57360.484	750.724
## 60	7.842	173.57	47621.033	307.720
## 61	6.690	183.22	146728.723	1871.705
## 62	4.852	16.45	17496.045	120.553
## 63	5.051	10.89	3758.322	126.756
## 64	4.891	67.11	249638.058	3685.518
## 65	7.155	184.68	85942.734	1420.562
## 66	5.088	23.17	4364.905	39.013
## 67	5.723	168.22	112691.012	1994.035
## 68	NA	62.55	48406.252	1594.146
## 69	6.435	63.39	35119.817	902.380
## 70	4.984	21.30	2341.236	28.212
## 71	NA	19.66	3079.437	70.764
## 72	NA	88.50	48518.227	1299.573
## 73	3.615	1.70	2258.869	66.724
## 74	5.919	91.91	36379.485	1000.109
## 75	5.477	132.54	NA	NA
## 76	5.992	151.24	126053.645	3931.454
## 77	7.554	192.26	75853.506	96.540
## 78	3.819	102.24	24583.308	339.465
## 79	5.345	99.73	15472.592	523.025
## 80	4.721	131.24	69934.029	1485.840
## 81	4.854	31.78	47047.604	542.834
## 82	7.085	196.18	149793.912	1211.999
## 83	7.157	177.65	146252.196	874.061
## 84	6.483	188.66	101315.788	2324.744
## 85	6.309	42.75	33101.647	873.600
## 86	5.940	162.94	13983.875	148.388
## 87	4.395	73.24	94060.939	1118.212

## 88	6.152	90.22	55265.342	939.633
## 89	4.607	18.51	5409.043	99.505
## 90	NA	62.61	NA	NA
## 91	6.106	162.63	97597.125	578.137
## 92	5.744	34.01	27853.952	422.585
## 93	5.030	77.43	14616.420	47.812
## 94	6.032	138.09	149500.663	2469.397
## 95	4.584	79.78	131816.711	1658.001
## 96	3.512	37.21	12859.600	291.002
## 97	4.625	16.60	1241.634	54.123
## 98	5.410	39.34	56982.296	836.129
## 99	NA	160.12	159827.214	1753.272
## 100	6.255	150.25	190696.342	2689.761
## 101	7.324	166.23	158256.396	1412.907
## 102	4.208	2.51	1697.943	34.682
## 103	3.600	8.83	3636.356	115.411
## 104	5.384	170.46	81162.575	927.038
## 105	5.198	150.85	182704.019	500.193
## 106	4.723	4.68	914.861	29.123
## 107	6.602	201.07	98388.691	894.443
## 108	NA	NA	96.170	NA
## 109	4.227	40.90	8689.344	182.216
## 110	6.049	156.75	70100.456	604.858
## 111	6.317	116.71	31644.640	2382.841
## 112	NA	NA	NA	NA
## 113	5.766	54.28	114812.345	3137.495
## 114	5.677	157.15	203809.588	584.397
## 115	5.581	101.19	268446.551	3828.845
## 116	4.918	134.19	25656.966	396.284
## 117	4.794	44.64	5587.555	60.541
## 118	4.426	58.80	9797.725	355.634
## 119	4.574	24.55	57981.149	1419.932
## 120	5.269	71.98	27119.361	379.539
## 121	7.464	162.32	177345.164	1189.079
## 122	7.277	157.86	2650.961	9.836
## 123	5.972	112.04	1951.962	31.230
## 124	5.074	3.71	281.021	10.455
## 125	4.759	6.79	1105.114	13.865
## 126	5.101	83.83	107493.483	3803.963
## 127	7.392	180.14	72669.388	256.518
## 128	NA	133.69	66754.583	979.612
## 129	4.934	66.41	5490.774	122.638
## 130	NA	NA	552.975	NA
## 131	4.517	64.44	89580.227	939.224
## 132	6.180	140.49	111383.433	1684.215
## 133	NA	4.97	3564.955	58.170
## 134	5.653	100.78	68738.907	2451.648
## 135	5.840	150.06	67181.253	5949.676
## 136	5.880	93.92	24584.998	444.561
## 137	6.166	117.89	103098.230	2435.147
## 138	5.929	194.34	132070.771	1843.760
## 139	NA	193.15	92680.838	228.931
## 140	6.140	80.50	91927.269	2986.581
## 141	5.477	101.14	72557.126	2134.289



## 142	3.415	91.38	8024.998	97.919
## 143	NA	115.07	61198.381	587.236
## 144	NA	58.37	74903.265	1640.055
## 145	NA	58.87	57253.340	798.392
## 146	NA	118.35	8.993	NA
## 147	NA	160.11	244909.469	2938.557
## 148	NA	60.52	17049.777	250.667
## 149	6.494	139.79	15255.011	243.760
## 150	5.132	10.99	4323.634	109.145
## 151	6.078	119.91	188770.738	1846.455
## 152	NA	171.25	231371.634	1176.086
## 153	3.849	10.09	811.437	14.293
## 154	6.377	209.25	49505.040	146.709
## 155	6.331	88.61	149152.071	2947.662
## 156	6.461	130.29	218941.214	2891.252
## 157	NA	32.57	33.137	NA
## 158	4.956	46.59	57543.972	1520.372
## 159	5.845	200.63	12174.566	107.361
## 160	NA	2.46	1431.848	12.462
## 161	6.491	175.64	136797.480	1927.894
## 162	4.325	155.01	26898.175	686.098
## 163	NA	6.99	998.950	71.191
## 164	NA	79.25	84186.290	1923.805
## 165	7.363	167.00	124623.804	1453.644
## 166	7.571	158.42	152718.543	1363.885
## 167	NA	7.93	2270.845	130.756
## 168	5.466	66.37	1757.598	12.559
## 169	3.623	3.71	447.435	11.252
## 170	5.985	146.67	31011.538	302.635
## 171	NA	NA	14789.405	90.957
## 172	4.107	27.28	3408.749	28.027
## 173	NA	121.87	9.357	NA
## 174	NA	91.99	59324.918	1845.147
## 175	4.596	98.39	58743.540	2068.935
## 176	4.948	154.26	110635.410	962.067
## 177	5.066	0.80	NA	NA
## 178	NA	106.87	NA	NA
## 179	4.636	20.66	3019.518	69.778
## 180	4.875	71.68	92380.048	2415.486
## 181	6.561	237.33	80446.976	228.998
## 182	7.064	197.47	199109.448	2220.847
## 183	6.951	157.08	158249.753	2421.163
## 184	6.431	203.91	119875.973	1802.036
## 185	6.179	112.73	5744.052	42.885
## 186	NA	46.74	21.423	NA
## 187	4.892	106.18	15694.676	188.010
## 188	5.411	153.72	17464.069	327.620
## 189	3.658	1.62	300.505	58.878
## 190	4.073	8.64	12448.652	186.335
## 191	3.145	44.51	12973.101	306.179

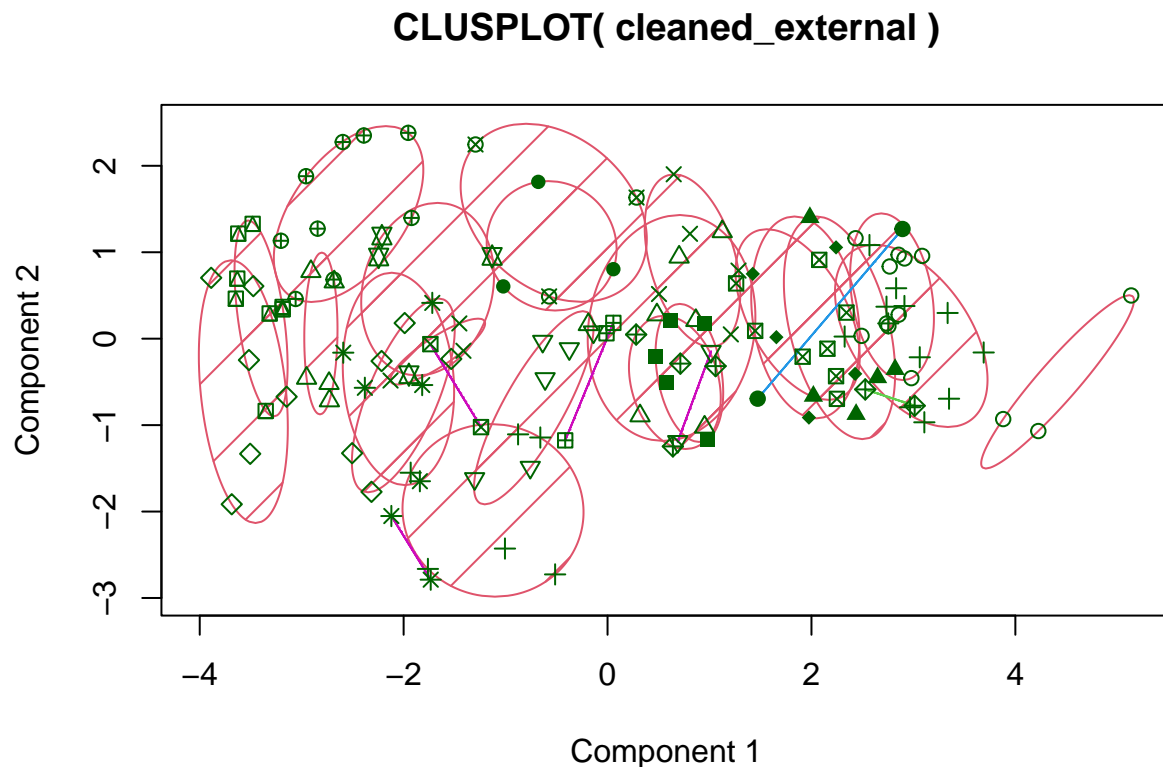
Clustering indicators, 3(a) - HDI: Human Development Index (2021); a value between 0 and 1 that measures average achievement in human development based on three dimensions - life expectancy, education and standard of living. (Source: Human Development Reports) - GHS: Global Health Security Index (2021); a value

between 0 and 100 that benchmarks a country's health security and preparedness in preventing, detecting and responding to health emergencies. (Source: Global Health Security Index: Reports and Data) - **freedom**: Human Freedom Index (2021); a value between 0 and 10 that assesses the level of human freedom in a country. Human freedom is a combination of two distinct dimensions - personal freedom (freedom of religion, speech, sexual orientation, etc.) and economic freedom (size of government, judicial impartiality, freedom to trade, etc.) (Source: World Population Review) - **political\_stability**: a value **approximately** between -2.5 and 2.5 that evaluates political stability and absence of violence/terrorism of each country in 2021. (Source: The World Bank Data Collections (and Governance Indicators)) - **happiness**: World Happiness Report score (2021); a value between 0 and 10 that represents happiness of a country's citizens based on several socioeconomic factors. (Source: World Happiness Report) - **total\_vax\_per\_hundred**: latest updated total number of COVID-19 vaccinations administered per 100 people before 2022. - **total\_cases\_per\_mil**: latest updated total number of COVID-19 cases per 1,000,000 people before 2022. - **total\_deaths\_per\_mil**: latest updated total number of COVID-19 cases per 1,000,000 people before 2022.

The final three indicators being sourced from Our World in Data's COVID-19 Github repository.

K-means clustering, 3(a)

```
library(cluster)
clusplot(cleaned_external, kfit$cluster, color = TRUE, shade = TRUE, labels = 0, lines = 0)
```



These two components explain 69.99 % of the point variability.

others correlation matrix, 3(b)

```
clustered_correlation_plotted <- ggplot(data = clustered_melted) +
  geom_tile(mapping = aes(x = Var1, y = Var2, fill = value)) +
  scale_fill_gradient2(low = "#6b74ff", mid = "white", high = "#e46c6c", midpoint = 0) +
  labs(title = "Correlation between predictors for countries similar to Croatia",
```

```
x = "", y = "", fill = "correlation") +
theme(axis.text.x = element_text(angle = 90))
```

clustered model, 3(b)

```
fitted_clus1 <- lm(c19ProSo01 ~ .,
  data = subset(clustered, select = -c(coded_country, c19ProSo02, c19ProSo03, c19ProSo04)))
fitted_clus2 <- lm(c19ProSo02 ~ .,
  data = subset(clustered, select = -c(coded_country, c19ProSo01, c19ProSo03, c19ProSo04)))
fitted_clus3 <- lm(c19ProSo03 ~ .,
  data = subset(clustered, select = -c(coded_country, c19ProSo01, c19ProSo02, c19ProSo04)))
fitted_clus4 <- lm(c19ProSo04 ~ .,
  data = subset(clustered, select = -c(coded_country, c19ProSo01, c19ProSo02, c19ProSo03)))

cat("Model Summary for countries similar to the Croatia to predict pro-social attitudes\n\n")
j <- 1
for (model in list(fitted_clus1, fitted_clus2, fitted_clus3, fitted_clus4)) {
  cat("C19ProSo0", j, "\n", sep = "")
  res <- model_evaluated(model)
  cat("R-squared:", res[[1]], "\n")
  cat("Adjusted R-squared:", res[[2]], "\n")
  cat("99.9% confidence interval significant predictors:\n")
  cat(res[[3]], "\n")
  cat("Coefficients of predictors:\n")
  cat(res[[4]], "\n")
  cat("\n")
  j <- j + 1
}
```

clustered models, updated model\_evaluated function with 95% confidence interval, 3(b)

```
model_evaluated_2 <- function(model) {
  rsqr <- summary(model)$r.squared
  a_rsqr <- summary(model)$adj.r.squared
  sig <- which(summary(model)$coefficients[-1, 4] < 0.05) + 1
  preds <- rownames(summary(model)$coefficients[sig, , drop = FALSE])
  coefs <- summary(model)$coefficients[sig, 1]

  return(list(rsqr, a_rsqr, preds, coefs))
}

cat("Model Summary for countries similar to the Croatia to predict pro-social attitudes\n\n")
counter <- 1
for (model in list(fitted_clus1, fitted_clus2, fitted_clus3, fitted_clus4)) {
  cat("C19ProSo0", counter, "\n", sep = "")
  res <- model_evaluated_2(model)
  cat("R-squared:", res[[1]], "\n")
  cat("Adjusted R-squared:", res[[2]], "\n")
  cat("95% confidence interval significant predictors:\n")
  cat(res[[3]], "\n")
  cat("Coefficients of predictors:\n")
  cat(res[[4]], "\n")
  cat("\n")
}
```

```

for (each in res[[3]]) {
  each_model <- c(each_model, paste0("Similar_C19ProSo0", counter))
}
predictors <- c(predictors, res[[3]])
counter <- counter + 1
}

```

croatia, others and clustered models strongest predictors, 3(b)

```

summary_table <- table(predictors = predictors, models = each_model)

summary_table <- summary_table[, c("Croatia_C19ProSo03",
  "Croatia_C19ProSo04", "RoW_C19ProSo01", "RoW_C19ProSo02", "RoW_C19ProSo03", "RoW_C19ProSo04",
  "Similar_C19ProSo01", "Similar_C19ProSo02", "Similar_C19ProSo03", "Similar_C19ProSo04"
)]

summary_table_visualised_2 <- ggplot(data = as.data.frame(summary_table)) +
  geom_tile(mapping = aes(x = models, y = predictors, fill = Freq, colour = "black")) +
  scale_fill_gradientn(colours = c("pink", "green")) +
  theme(legend.position = "none") +
  scale_x_discrete(position = "top") +
  scale_y_discrete(limits = rev) +
  labs(x = "Pro-social attitudes", y = "Predictors",
    title = "Table for each pro-social attitude by significant predictors ") +
  theme(axis.text.x = element_text(angle = 90))

```