Studying Economics - Data Lab 1

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Learning Outcomes

This Data Lab is for you to experience some very basic functionality in R/RStudio.

In particular this is for you

- to explore the RStudio interface
- to learn how to search for help
- to not be scared by error messages
- to know how to load libraries
- to upload a datafile
- to explore the contents of this datafile
- to learn what functions do
- to learn about data types
- to undertake some basic data manipulation

This Data Lab assumes that you have R and RStudio installed on your computer. If not, you will have to do that first. See, for instance, the advice on ECLR. Alternatively you can work on a University Computer Lab (like in the Arthur Lewis Building or Humanities Bridgeford Street building which have R and RStudio already installed). The third alternative is that you get yourself an RStudio/Posit Cloud account (https://posit.cloud/). The free account is sufficient to get started.

Prepare your Workspace

Before you start you should create a space (i.e. a folder) on your computer from where you are planning to do all your R work. Make sure you understand where that folder is and that you know the path to that folder (Apple users, if you do not know how to find the path to a particular folder, then look at this Piazza post @28. If you are using a computer lab computer you should create a folder for your R work on the P drive. This will be accessible to you whenever you log on to a University computer, or from anywhere via this link.

Let's say you named your folder `Rwork` directly on the P drive and in that folder created a subfolder for this unit `SE` , then the path to your folder will be `P:\Rwork\SE`.

For this computer lab we are using exactly the same data as for the data lecture. So please make sure that you have the datafile `STATS19_GM_AccData.csv` in the folder you just created and want to work from. It will also be useful to have the Data Dictionary ready.

Exploring RStudio and searching

RStudio is a software which makes working with the actual statistical software R easier. In fact, once you followed the installation advice and have R and RStudio installed, you will never really have to worry about R anymore. Just start RStudio.

When you load RStudio for the first time you should see something like this.

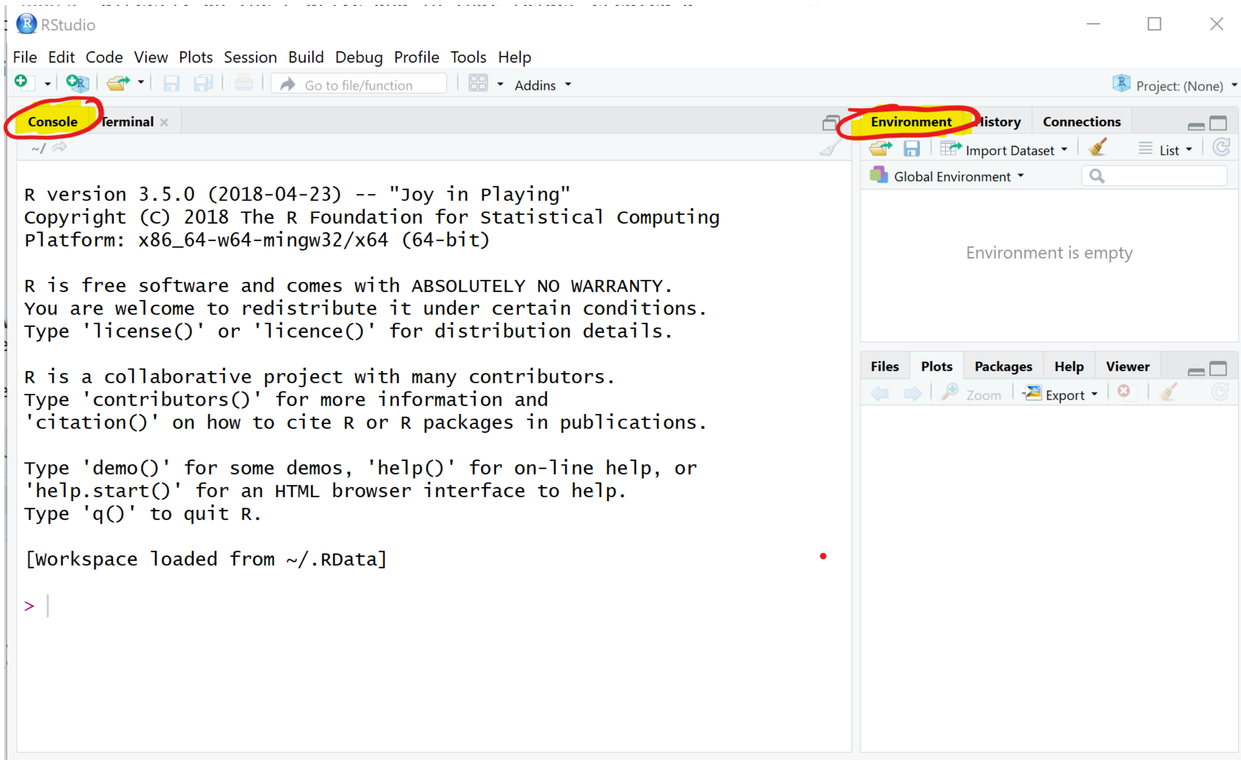


Figure 1: RStudio when loading for the first time

There are two important areas on that screen, the Console and the Environment. The Console is something like your main computational area. In there you can see some information but at the end an “>”. This indicates that RStudio is standing ready to do whatever you want it to do.

Say you want to calculate 3+4 … yes, trivial but let’s start small. Type 3+4 into the console (behind the “>” sign) and press enter. Yes you should see the correct result.

```
3+4
```

```
## [1] 7
```

That was easy, let’s see whether you can get R to calculate 13^2, $\sqrt{7569}$, e^5 and $ln(5)$. The first you achieve as follows:

```
13^2
```

```
## [1] 169
```

What about the others. Well, at this stage we will introduce you to two of the most inportant programming techniques there are

1. Just try it. Do you have a hunch how to do it? Test it. I am yet to hear that someone broke their computer by entering an incorrect command in RStudio.
2. searching on the Web (say in Google, Bing, Baidu or DuckDuckGo)! For instance if you want to know how to calculate a square root in R you may want to search for “how to calculate a square root in R” and you should find the appropriate advice. Practice your search technique to calculate the above solutions. Check against your calculator.

Functions

Functions are important building blocks of any programming language. You just used your first function. Hopefully you found out that the way to calculate $\sqrt{7569}$ was to type

```
sqrt(7569)
```

```
## [1] 87
```

Giving you the result 87. What you used here is a function, namely the `sqrt` function which some clever programmer wrote in order to calculate a square root. The anatomy of a function is `function_name(input)`. Think of a function as a drink machine.

Figure 2: RStudio when loading for the first time

Most functions require some input. Our function, the `sqrt` function needs a number of which to take the square root. The output in our example, 87, is then returned. In our case it is returned to be printed in the Console window.

> Extension: To those of you who have significant coding experence already, you can try and find out how to write your own functions in R. (If any of the above was new to you then ignore this extension!!!)

Creating variables

So far you have learned that R can be used as a glorified calculator. Let's start to explore why R is way more powerful that that. You can save the results of as many calculations as you want and you can easily reuse the results of some calculations in later calculations.

Type "a<-12/4" into the console (without the quotation marks) and press enter

```
a <- 12/4
```

You will see that in the console the correct result does not show, but in the Environment pane of your RStudio window you should now see an entry

What did the command "a<-12/4" actually do? In words: "Calculate 12/4 and assign (<-) the result to a variable called `a`."

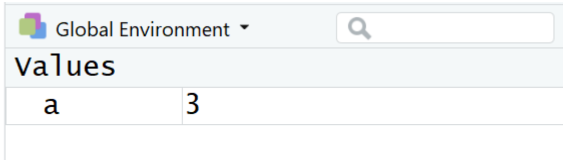


Figure 3: RStudio Environment saves variables

With that in mind implement the following: "Calculate 11*11 and assign (<-) the result to a variable called `A`."

You should now see two variables in your Environment pane. Let's add another: "Calculate the square root of 64 and assign (<-) the result to a variable called `b`."

Note that we used the `sqrt` function again, but this time the output was not send to be printed in the Console, but instead it was send to the new variable `b`. If you have done everything right your Environment panel should now look as follows

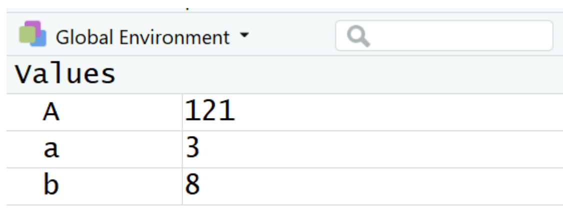


Figure 4: RStudio Environment saves variables

Note that `a` and `A` are different variables, so R is case-sensitive! All the variables listed in the Environment can be re-used for further calculations. For example:

```
d <- A - a + 2*b
```

Let's perform another calculation in which we use the result of the last calculation:

```
e <- D - 3*a
```

```
## Error in D - 3 * a: non-numeric argument to binary operator
```

You will see R throwing an error message at you: "Error in D - 3 * a : non-numeric argument to binary operator". Ehmmm … what does this mean? Actually not a lot. In the first instance this tells you that something went wrong in that command. Can you see what the problem is? Remember R is trying to perform the calculation to the right of `<-` and then assign this to a new variable `e`. Does it have all the info on the right hand side? Check your list of variables in the Environment panel. Recall that R is case sensitive.

An important lesson with respect to error messages

- You will see them ALL THE TIME, and that is fine
- You cannot break the computer with any errors in R, so don't worry, just try.
- Re-read what you typed, is it actually what you wanted to do.
- Read the error message. Sometimes it will give you a clue as to what the problem is … unfortunately not here!

So, we have done a bit of work so far. Let's take a short break. Please close RStudio and click "Don't Save" when you get the message in the next image.

Get up, stretch your legs and get yourself a glass to drink. Then come back and open RStudio again so that we can continue our work.

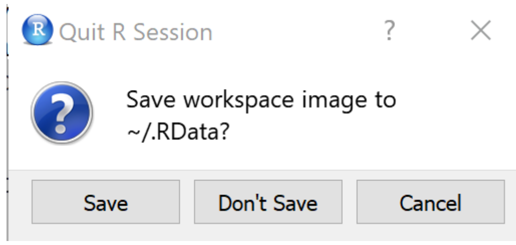


Figure 5: RStudio Environment saves variables

As you open you should get exactly the same initial layout as before … What value did `e` have again???? (125 if you managed to correct the above error) Where are our calculations??? Unless you worked in a script file, all your work is gone now. The next section is to teach you the right workflow such that this does not happen with your important work.

Preparing your script file and libraries

For all significant work you want to make sure that you save the work you have done, such that you do not have to re-type things which you did yesterday … or just before I asked you to get a glass of water. The way to ensure that is to save all your work in a script file. A script file is basically a text file which saves all your commands (and comments - see below) and from where RStudio can easily execute these commands.

Let's create a script file. Via the RStudio menu (FILE - NEW FILE - R SCRIPT) open a new script file and safe it in the folder from which you want to work (see above).

Start by creating a comment line at the top of that file which may say something like

```
# File for first SE Data Lab
# October 2023
# exciting!!!
```

> Note: Adding comments to your code is absolutely vital if you want to understand tomorrow what you did today. I am not joking, adding comments to explain to your future self what you are doing is absolutly critical. Everything which follows the `#` sign is a comment and is effectively ignored by R. It is written not for R but for your future self!

If not mentioned otherwise all the following code should be added to that script file and executed from there. Save that file and make sure you know where you save it as, next week, you may want to continue to work on this.

Next, you should ensure that you set the working directory to the directory where your scriptfile and datafile is in. If your folder was `P:\Rwork\QM` then the command below should read `setwd("P:/Rwork/QM")`. Note that all backward slashes (`\`) have to be replaced by forward slashes (`/`). Don't ask why, just accept ;-).

```
setwd("XXXX:/XXXX")    # replace the XXXX with your drive and path
```

> Note; If you are having trouble finding the location of your script file, or how to formally write it down, this is a trick. In the menu to RStudio click on teh following: "Session" - "Set Working Directory" - "To Source File Location". RStudio will find the path to your script and will execute the command. You can then copy the command from the console into your script such that you have it saved for next time.

Load the libraries which we want to use.

```
library(tidyverse)     # for almost all data handling tasks
library(ggplot2)       # to produce nice graphiscs
```

Note: Libraries are collections of functions which add great functionality. They are not included in the base R installation and hence need to be added to your computer (see installation advice for packages below - this only has to be done once on each computer). However, even once they are installed on you need to make this new functionality available to your code. This is what the `library` functions do. This has to be done at the beginning of every script file in which you want to use the respective functionality.

By just typing these commands into the script file nothing is actually happening. If you want R to execute any of the commands in your script file you have to do one of the following:

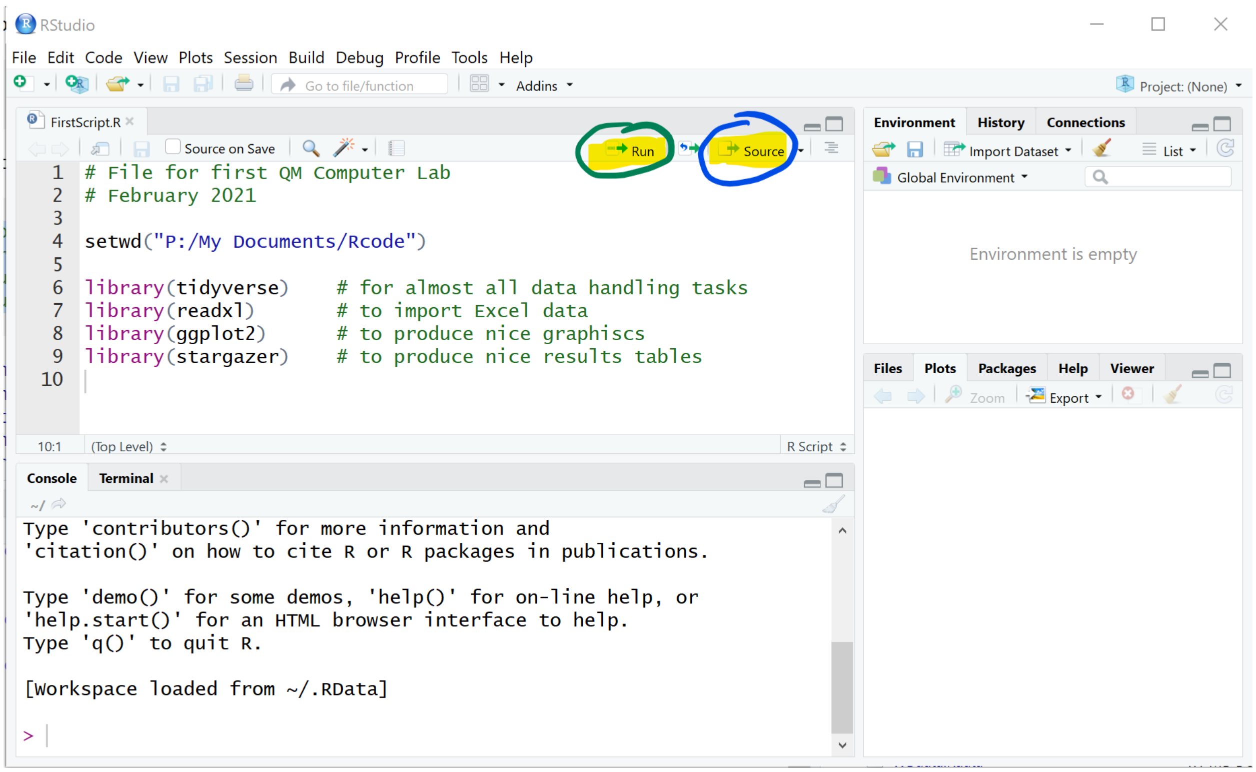


Figure 6: RStudio Environment saves variables

1. Press the "Source" button, in which case R will execute all commands in the script file
2. Press the "Run" button, in which case R will run the command in which the curser currently is
3. Press the "CTRL"+"ENTER" on the keyboard (COMMAND + ENTER on a mac), in which case R will run the command in which the curser currently is
4. Highlight several lines and press "CTRL"+"ENTER" on the keyboard (COMMAND + ENTER on a mac), in which case R will run the commands in the highlighted lines

If RStudio tells you that one or more of these libraries are not installed then install these (not any others) on the machine you are working from. For instance, if `ggplot2` was not installed you would receive an error message like "Error in library(ggplot2) : there is no package called 'ggplot2' ", and in that case you should run:

```
install.packages("ggplot2")
```

You can run this straight from the command/console or you could instead install the package via the packages tab on the right hand side. **Do not do this on computer lab computers as these packages should be pre-installed**.

You will need to do this only once on your computer and once you have done that you can call `library(ggplot2)` again without running into problems.

Data Upload

Make sure you have set the working directory to the directory in which you saved your script file and the data file (see above). As we are dealing with data in a csv file we will use the `read.csv` function to load the data. We are lucky that this datafile has no missing data, meaning that it has no empty cells. Missing information all appear to be coded up as a special category in each of the variables. See the Data Dictionary to confirm that for the `RoadType` variable a 9 represents "Unknown".

```
accdata <- read.csv("STATS19_GM_AccData.csv")
```

It is well possible that you receive the following error message as you execute this command "Error: `path` does not exist: 'STATS19_GM_AccData.csv' ". The most likely reason for this is that the "STATS19_GM_AccData.csv" is not saved in your working directory. Make sure you download that file from Blackboard and save it in the working directory you created earlier and you used in the `setwd()` command. Also make sure that the file name used in the command here matches exactly the file name in your folder.

Make sure that your data upload is successful. You should see an object `accdata` in your environment. You can also run the `str` (structure) function.

```
str(accdata)  # prints some basic info on variables
```

```
## 'data.frame':    42624 obs. of  27 variables:
##  $ Accident.Index               : num  1.02e+11 1.02e+11 1.02e+11 1.07e+11 1.14e+11 ...
##  $ Year                         : int  2010 2010 2010 2010 2010 2010 2010 2010 2010 2010 ...
##  $ Severity                     : int  3 3 3 3 3 3 3 3 3 3 ...
##  $ NumberVehicles               : int  2 2 2 3 1 1 1 2 2 1 ...
##  $ NumberCasualties             : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ OutputDate                   : chr  "01/01/2010" "01/01/2010" "01/01/2010" "01/01/2010" ...
##  $ Day                          : int  6 6 6 6 6 6 7 7 7 7 ...
##  $ OutputTime                   : chr  "13:10" "11:10" "17:30" "13:49" ...
##  $ Easting                      : int  382347 381892 385840 377762 355982 362380 365767 381775 38386
##  $ Northing                     : int  390025 390582 403134 403302 404620 407476 405672 410735 39406
##  $ LocalAuthority               : int  102 102 102 107 114 114 100 101 102 102 ...
##  $ Road1Class                   : int  5 7 4 4 4 5 4 5 4 6 ...
##  $ Road1Number                  : int  5166 0 664 666 577 5239 58 6221 5103 0 ...
##  $ CarriagewayType              : int  3 6 3 3 6 6 6 6 3 6 ...
##  $ SpeedLimit                   : int  50 30 30 30 30 30 30 30 40 30 ...
##  $ JunctionDetail               : int  6 3 3 3 0 0 3 3 6 3 ...
##  $ JunctionControl              : int  2 4 4 4 0 0 2 4 2 4 ...
##  $ Road2Class                   : int  3 7 7 1 0 0 5 7 4 7 ...
##  $ Road2Number                  : int  5103 0 0 60 0 0 5235 0 6010 0 ...
##  $ PedCrossingHumanControl      : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PedCrossingPhysicalFacilities: int  0 0 0 0 0 0 5 0 5 0 ...
##  $ LightingCondition            : int  1 1 4 3 7 4 4 1 4 4 ...
##  $ WeatherCondition             : int  1 1 1 9 9 1 1 3 3 8 ...
##  $ RoadSurface                  : int  4 4 2 1 1 4 4 3 2 4 ...
##  $ SpecialConditions            : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ CarriagewayHazard            : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ PlaceReported                : int  1 1 2 2 2 1 1 2 1 1 ...
```

You should now see the `accdata` object in your Environment (right hand pane).

There are 42624 observations, each representing one recorded accident in Greater Manchester (GM) between 2010 and 2020. Each accident has some variables which characterise the accident.

The following variables will be important for the analysis here:

- `Accident.Index`, this is a unique identifier for each accident

- `Year`, gives the year in which the accident happened
- `Severity`, a variable coding the severity of the accident, although we are unsure how this is coded
- `NumberVehicles`, number of vehicles involved in the accident
- `NumberCasualties`, number of casualties involved in the accident
- `LightingCondition`, Lighting conditions at time and location of accident
- `WeatherCondition`, Weather conditions at time and location of accident
- `Road1Class`, lower numbers indicating more major roads, 1 = Motorway
- `RoadSurface`, indicator of whether the road surface was dry wet or icy at the time and place of the accident

You wrote your first script. It is time to have another break. Make sure you save your script and then close RStudio (you don't need to do that in general, but please do it at this point to help me demonstrate the value of scripts). After relaxing for a few minutes and telling your flatmate that you are on your way to become an expert data analyst, come back and re-open RStudio. Load the script file (if it wasn't loaded automatically). The environment should, at this stage be empty, but if you click on the "Source" button then R will automatically execute all the commands you had in your script and `accdata` should be available in the Environment panel.

So that is the value of scripts! You can easily pick up where you left your work, no need to redo anything.

Accessing data

The `accdata` item in your environment basically contains the entire spreadsheet of data. You can look at the entire spreadsheet by clicking on the tiny spreadsheet in the `accdata` line. This will open a new tab with the spreadsheet. Have a look and then close the tab again.

It is important to know how you can access subsets of data. Run through the following commands to see what happens. Perhaps also experiment a bit by changing the commands and predicting what the outcome should be.

```
accdata[1,]
accdata[,2]
accdata[3,4]
accdata[,4:6]
accdata[4:6]
accdata[2:4,5:10]
accdata$SpeedLimit
accdata$SpeedLimit[1:5]
accdata[c("SpeedLimit","Road1Class")]
```

These are all different ways to select particular observations (rows in a spreadsheet) and variables (columns in a spreadsheet). There were two particular techniques which are important

- `accdata$SpeedLimit` did address the `SpeedLimit` variable in the `accdata` dataset (`DATASET$VARIABLE`).
- `c("SpeedLimit","Road1Class")` allowed us to access two very particular variables, ignoring all other 25 variables. It is useful to know what `c("SpeedLimit","Road1Class")` actually does.

```
c("SpeedLimit","Road1Class")
```

```
## [1] "SpeedLimit" "Road1Class"
```

It creates a list with two elements, here two text strings. But you can also create lists with numbers.

```
c(3.5,2/3)
```

```
## [1] 3.5000000 0.6666667
```

In fact you could even create lists which mixed datatypes.

```
c("Countries in the EU", 28-1, ":-(")
```

```
## [1] "Countries in the EU" "27"                  ":-("
```

Lists are quite fundamental to the way how R stores data. If you assigned any of the above to a variable, for instance

```
silly_list <- c("Countries in the EU", 28-1, ":-(")
```

you would have saved it in the Environment and could re-use it.

All the commands in this section were really only to explore the functionality of R. There is no need to save these in your script file. But no harm either as none of these actually changed the values of the data in `accdata`.

Do not change your original data sheet (here the csv file)

An important principle of working with data here is that you should never change your original datafile, which in this case the `STATS19_GM_AccData.csv` file. As you can see from our work so far we merely upload the csv file and then use the data here in R, but we will not go back to the original csv file and change anything in there. And that is very important. In that way you can always start again with your analysis from your original data.

If you were to make any changes in your csv file, these changes would be irreversible.

Investigate Data 1

Let's find out what the severity coding is like. The usual advice would be to go to the data dictionary and check the coding, but all we can see on the form is the following

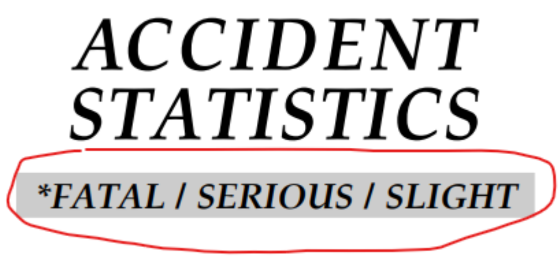


Figure 7: RStudio when loading for the first time

But does a 1 in the `Severity` variable indicate a fatal or a slight accident. We will have to check from the data itself. I am sure you could come up with different ways of checking.

Presumably there will be mostly slight accidents and very few fatal ones. So if we look up the number of accidents in each category it seems reasonable to assume that the category with the largest number of observations is the slight one.

The easiest way to look at this is to use the `table` function on the `Severity` variable

```
table(accdata$Severity)
```

```
##
##     1     2     3
##   582  6519 35523
```

Judging from here it is apparent that category 1 is likely to be the severe accident category and category 3 the slight one.

Data Formats

We can see (from the output to `str(accdata)`) that almost all variables are integer (`int`) variables, i.e. the software will treat them as whole numbers. Only the date and time variables are text (character, `chr`) variables and the `AAcidentIndex` is a `num` variable. Also numeric but not restricted to whole numbers like `int`.

Recall that for most of the variables the numbers actually represent categories. Like for the `Severity` variable where we previously established that 1 = fatal, 2 = serious and 3 = slight. For later it will be convenient to have `Severity` coded as a variable which is not numeric, but a categorical variables. In other words a variable which recognises that there are only limited possible outcomes (here 3).

In R such variables are called `factor` variables. Hence we will create a new variables, `Severityf` which contains the same info, but just in a way easier to understand.

```
accdata$Severityf <- as.factor(accdata$Severity)  # translates a variable into a factor variable
levels(accdata$Severityf) <- c("Fatal","Serious","Slight") # changes the names of the categories
table(accdata$Severityf)
```

```
##
##   Fatal Serious  Slight
##     582    6519   35523
```

There are a number of important elements in these lines

- `accdata$Severityf <-` creates a new variable in the `accdata` object, called `Severityf`. `<-` is called the assignment operator and it assigns some value to that new variable. It will assign whatever comes to the right hand side of `<-`
- `as.factor()` is a function called `as.factor`. If you want to find out what a function does you can call the help function `?as.factor`. This one creates a variable as a factor (categorical) variable. But it requires an input (Whatever comes inside the parenthesis). Here we ask R to change the `int` variable `accdata$Severity` into a factor variable.
- `levels(accdata$Severityf) <- c("Fatal","Serious","Slight")` then changes the names of the levels (categories) into sensible names. Here we use again the assignment operator `<-`. The order matters, but we learn from the earlier analysis that: 1 = fatal, 2 = serious and 3 = slight. As `Severity` is a numerical (`int`) variable it will order the categories in numerical order, 1 first and 3 last. In doubt you will have to check that you have used the right ordering by comparing the `Severity` and `Severityf` variable.

Now create two new variables `WeatherConditionf` and `RoadSurfacef` which achieve the same for the `WeatherCondition` and `RoadSurface` variables. Replace the `XXXX` to make this code work. You will have to check the data dictionary for the right ordering. The general structure of the lines will be:

```
accdata$XXXX <- as.factor(XXXX$XXXX)
XXXX(accdata$XXXXf) XXXX c(XXXX)
```

And let's also check the number of accidents in the different weather conditions and for different road surface conditions.

You did it right if you find that there were 246 accidents in "Snow, no winds" condition as well as 31 accidents on flooded roads.

Make sure you save your script file and for next week's exercise you will pick up from this point.

Investigate Data 2

We previously used the `table` function to characterise the distribution of one variable. We can also use this function to analyse the joint distribution of two variables (where we use the factor variables we created previously).

```
table(accdata$WeatherConditionf,accdata$Severityf)
```

```
##
##                  Fatal Serious Slight
##   Fine, no winds   458    5232  26845
##   Rain, no winds    67     786   5144
##   Snow, no winds     3      19    224
##   Fine, winds        9      56    339
##   Rain, winds       14     109    582
##   Snow, winds        1      12     52
##   Fog or mist        4      14     78
##   Other              6      63    790
##   Unknown           20     228   1469
```

So you can see, for instance, that there were 9 fatal accidents when the weather was fine with winds. It is often more instructive to look at proportions rather than numbers. That is easily achieved by wrapping the above line of code into the `prop.table` function.

```
prop.table(table(accdata$WeatherConditionf,accdata$Severityf))
```

```
##
##                         Fatal      Serious       Slight
##   Fine, no winds 1.074512e-02 1.227477e-01 6.298095e-01
##   Rain, no winds 1.571884e-03 1.844032e-02 1.206832e-01
##   Snow, no winds 7.038288e-05 4.457583e-04 5.255255e-03
##   Fine, winds    2.111486e-04 1.313814e-03 7.953266e-03
##   Rain, winds    3.284535e-04 2.557245e-03 1.365428e-02
##   Snow, winds    2.346096e-05 2.815315e-04 1.219970e-03
##   Fog or mist    9.384384e-05 3.284535e-04 1.829955e-03
##   Other          1.407658e-04 1.478041e-03 1.853416e-02
##   Unknown        4.692192e-04 5.349099e-03 3.446415e-02
```

Clearly this looks just a little too messy with the long numbers. You can control in which format R outputs numbers

```
options(digits = 2, scipen = 10)  # use ?options to understand what it does or just
                                  # experiment with different values
```

Let's re-run the same line of code.

```
prop.table(table(accdata$WeatherConditionf,accdata$Severity))
```

```
##
##                         1        2        3
##   Fine, no winds 0.010745 0.122748 0.629809
##   Rain, no winds 0.001572 0.018440 0.120683
##   Snow, no winds 0.000070 0.000446 0.005255
##   Fine, winds    0.000211 0.001314 0.007953
##   Rain, winds    0.000328 0.002557 0.013654
##   Snow, winds    0.000023 0.000282 0.001220
##   Fog or mist    0.000094 0.000328 0.001830
##   Other          0.000141 0.001478 0.018534
```

```
## 	Unknown 	0.000469 0.005349 0.034464
```

You can now see that 63% of all accidents are slight accidents which happen in fine weather with no winds. If you add up all these proportions you will get 1.

This is still only moderatly insightful. Let's try the following:

```
prop.table(table(accdata$WeatherConditionf,accdata$Severity),2)
```

```
##
##                       1      2      3
##   Fine, no winds 0.7869 0.8026 0.7557
##   Rain, no winds 0.1151 0.1206 0.1448
##   Snow, no winds 0.0052 0.0029 0.0063
##   Fine, winds    0.0155 0.0086 0.0095
##   Rain, winds    0.0241 0.0167 0.0164
##   Snow, winds    0.0017 0.0018 0.0015
##   Fog or mist    0.0069 0.0021 0.0022
##   Other          0.0103 0.0097 0.0222
##   Unknown        0.0344 0.0350 0.0414
```

You can now see that the proportions are calculated conditionally on the severity of the accident. This is achieved by adding the "2" as an optional input into the `prop.table` function. This tells the function to calculate proportions conditional on the values in the 2nd dimension (which are the columns).

Check what happens if you change the "2" to a "1".

```
prop.table(table(accdata$WeatherConditionf,accdata$Severity),1)
```

```
##
##                      1     2     3
##   Fine, no winds 0.014 0.161 0.825
##   Rain, no winds 0.011 0.131 0.858
##   Snow, no winds 0.012 0.077 0.911
##   Fine, winds    0.022 0.139 0.839
##   Rain, winds    0.020 0.155 0.826
##   Snow, winds    0.015 0.185 0.800
##   Fog or mist    0.042 0.146 0.812
##   Other          0.007 0.073 0.920
##   Unknown        0.012 0.133 0.856
```

Does there seem to be any relation between the weather conditions and the severity of the accident?

If you are looking at categorical variables only then looking at tables of frequencies or proportions, as above, is the right way to go. However, when you are interested in outcomes of variables which are truly numerical, meaning that the actual number has a meaning (like the number of vehicles and casualties involved), then looking at numbers of frequencies may not be the best way to look at the variables. It may make sense to look at some summary statistics like, means, medians and standard deviations.

Let's perform some such analysis and apply `group_by` and `summarise` functions. Splitting up the data into sensible subcategories and calculating means or other summary statistics conditional on these subcategories is one of the simplest, yet most powerful, techniques.

Look at the code used previously:

```
Tab1 <- accdata %>%
  group_by(WeatherCondition) %>%
  summarise(mean_veh = mean(NumberVehicles), mean_cas = mean(NumberCasualties)) %>%
  print()
```

```
## # A tibble: 9 x 3
##   WeatherCondition mean_veh mean_cas
##              <int>    <dbl>    <dbl>
## 1                1     1.87     1.38
## 2                2     1.87     1.41
## 3                3     1.98     1.43
## 4                4     1.87     1.33
## 5                5     1.82     1.40
## 6                6     2.06     1.51
## 7                7     1.95     1.35
## 8                8     1.86     1.32
## 9                9     1.79     1.30
```

Now it is your job to calculate the following statistics

1) Mean `NumberVehicles` involved in accidents
2) Mean `NumberCausalities` involved in accidents
3) Median `SpeedLimit` at the place of the accident

Calculate these statistics for all the different `RoadSurfacef` categories.

We havn't sown yet how you calculate a median. You will have to search how to do that. You could use the following search term "R calculate median". In Statistics you will learn more about the median. In simple terms it is the middle value, the value for which half are larger and half are smaller.

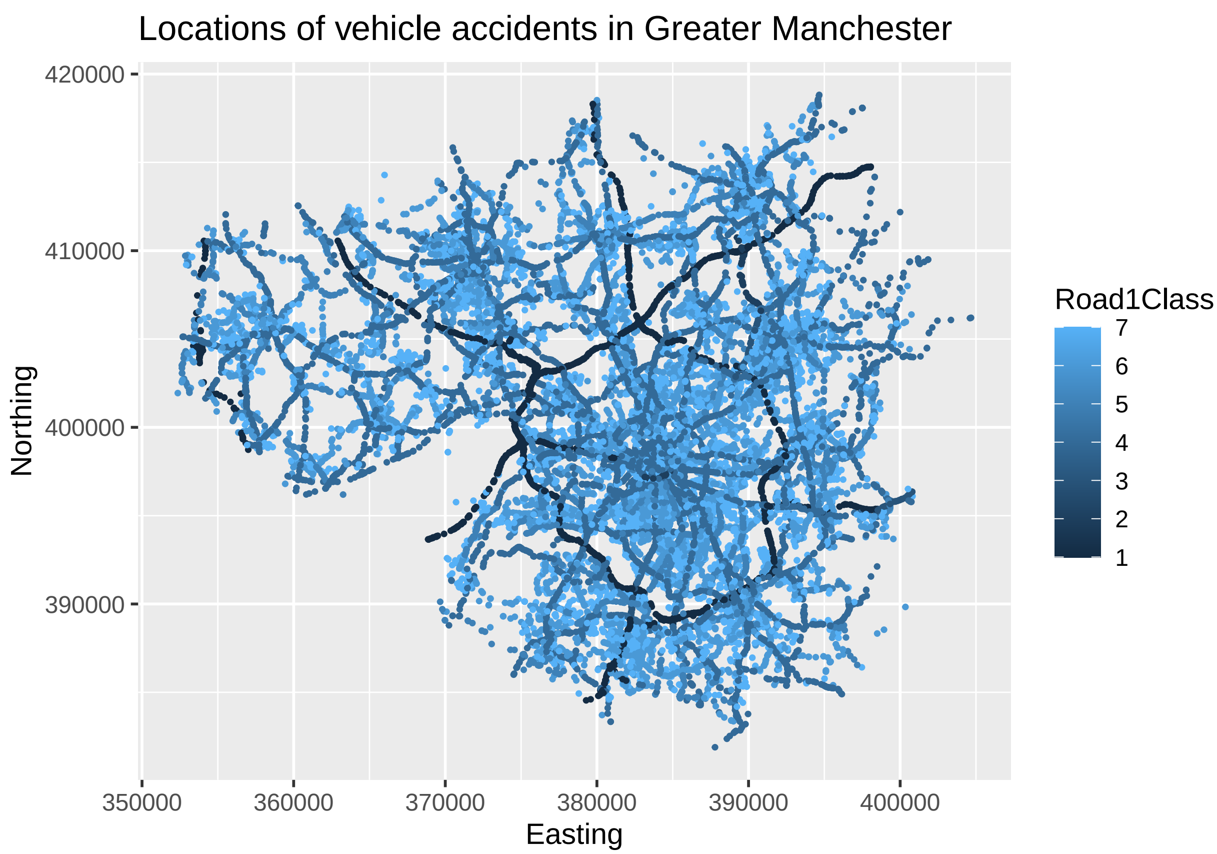
This is the output you should get.

```
## # A tibble: 5 x 4
##   RoadSurfacef mean_veh mean_cas medSL
##   <fct>           <dbl>    <dbl> <dbl>
## 1 Dry              1.87     1.36    30
## 2 Wet/Damp         1.87     1.41    30
## 3 Snow             2.02     1.5     30
## 4 Frost/Ice        1.89     1.44    30
## 5 Flood            1.81     1.42    60
```

Even more spectacular plots

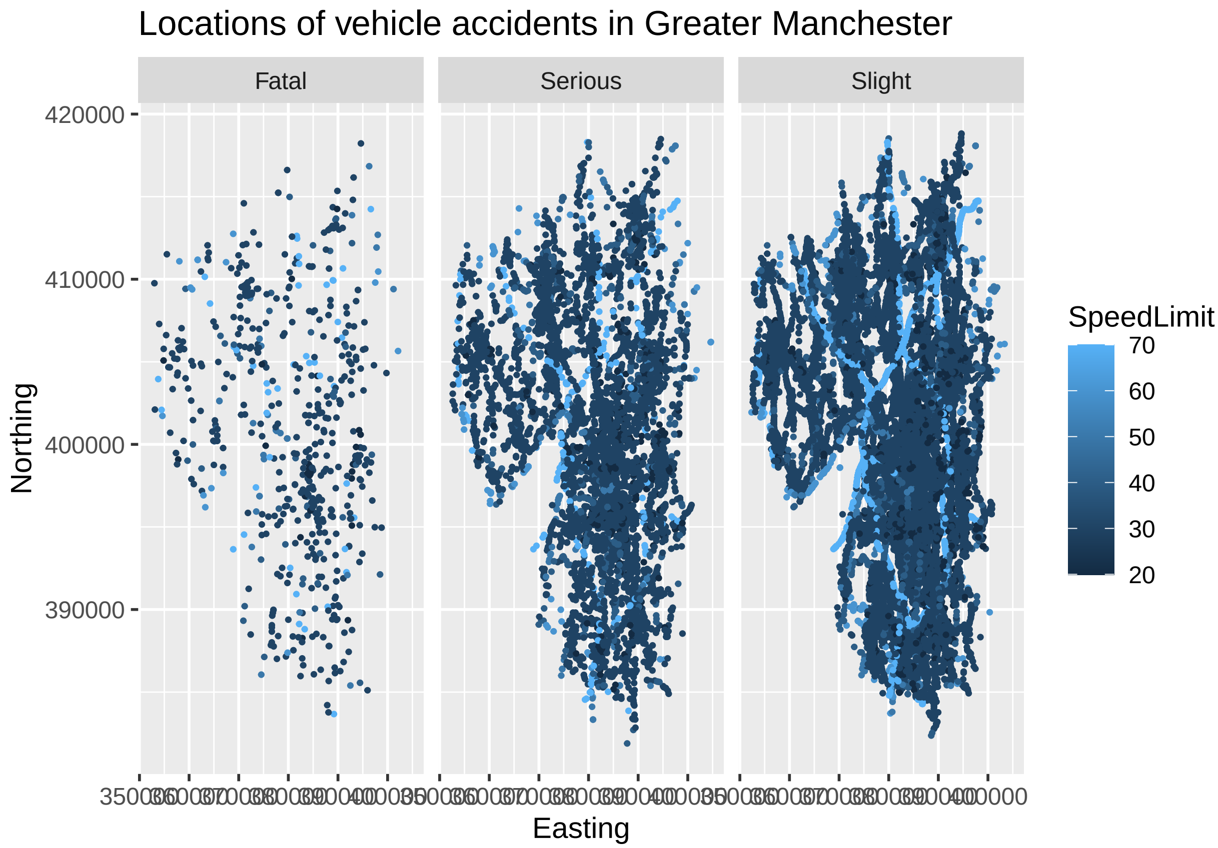
We previously looked at a scatter plot of accident locations using different colours for different road types.

```
ggplot(accdata, aes(x = Easting, y=Northing,color = Road1Class)) +
  geom_point(size=0.5) +
  ggtitle("Locations of vehicle accidents in Greater Manchester")
```



Now we will add

```
ggplot(accdata, aes(x = Easting, y=Northing,color = SpeedLimit)) +
  geom_point(size=0.5) +
  facet_wrap(. ~ Severityf) +
  ggtitle("Locations of vehicle accidents in Greater Manchester")
```



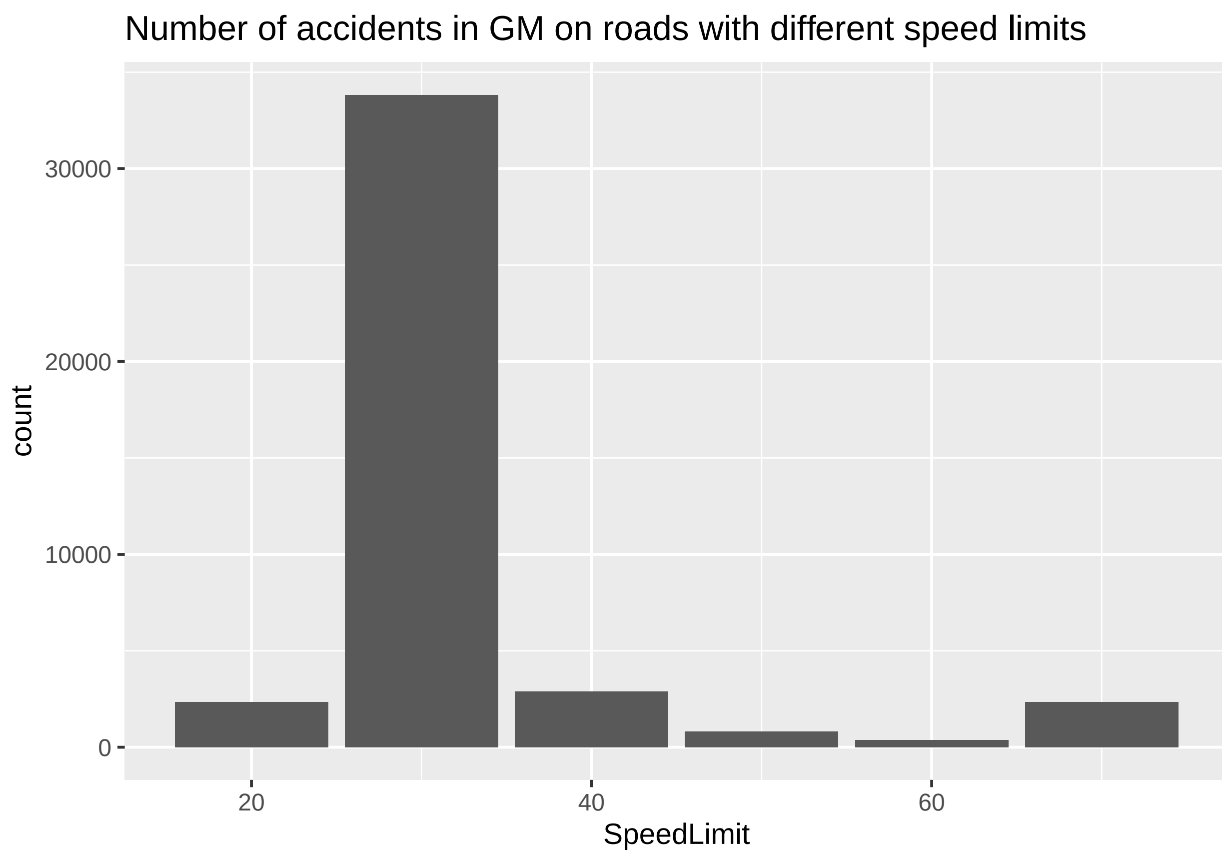
Perhaps you can see that, proportionally, higher speed limits are associated with more serious accidents.

A very useful resource for buddying data analysts are the fantastic cheatsheets produced by RStudio. There you will find one on `ggplot` which is great as it shows you the type of plots that can be produced.

The last task for you is to produce a bar plot. This is a challenging task as I will not give you detailed guidance. I want you to struggle and find help, guidance and support yourself. The ggplot cheatsheet may be a good start but you may also want to search the internet, for instance for "R example bar graph ggplot". Below is just a skeleton code which you will have to complete.

```
ggplot(XXXX, aes(x = XXXX)) +
  geom_XXXX() +
  XXXX("Number of accidents in GM on roads with different speed limits")
```

You should get a result which looks like this.



Should you conclude from this that zones with speed limit 30 should be abolished?