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# Basics of R

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Tutorial by Moritz Berg & Luïc Damian



# What is R?

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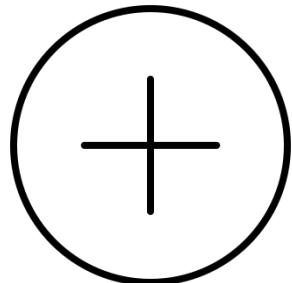
a programming language

used by **ecologists** around the globe

especially useful for statistics

# What is R?

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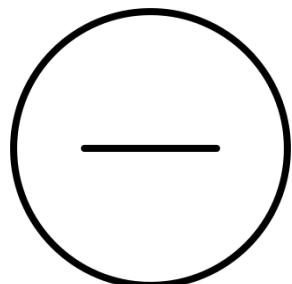
useful for **statistics**

enables making



**graphs**

lot of **packages** with useful pre-written code



sucks for very large data sets

relatively slow computation

not super easy to learn but rewarding!

# R & RStudio

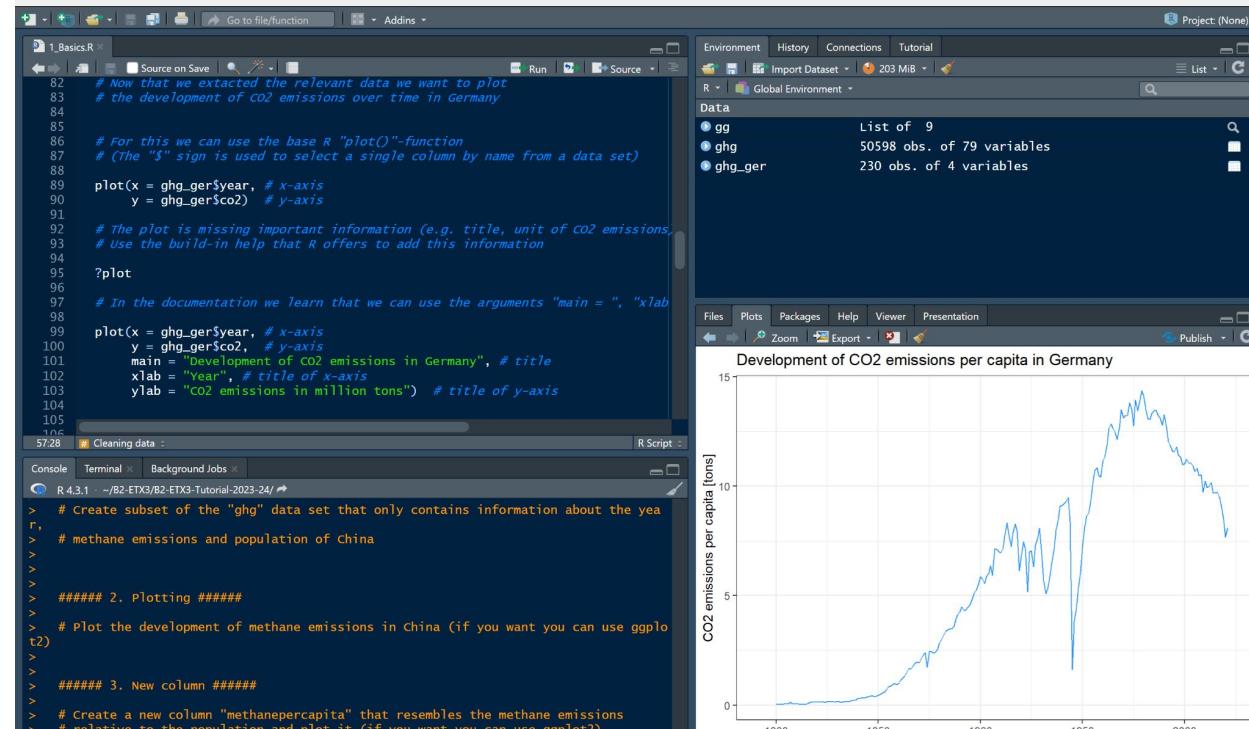
R = **language**

RStudio = **IDE** (language environment)

Think PDF & Adobe Reader

german & Germany

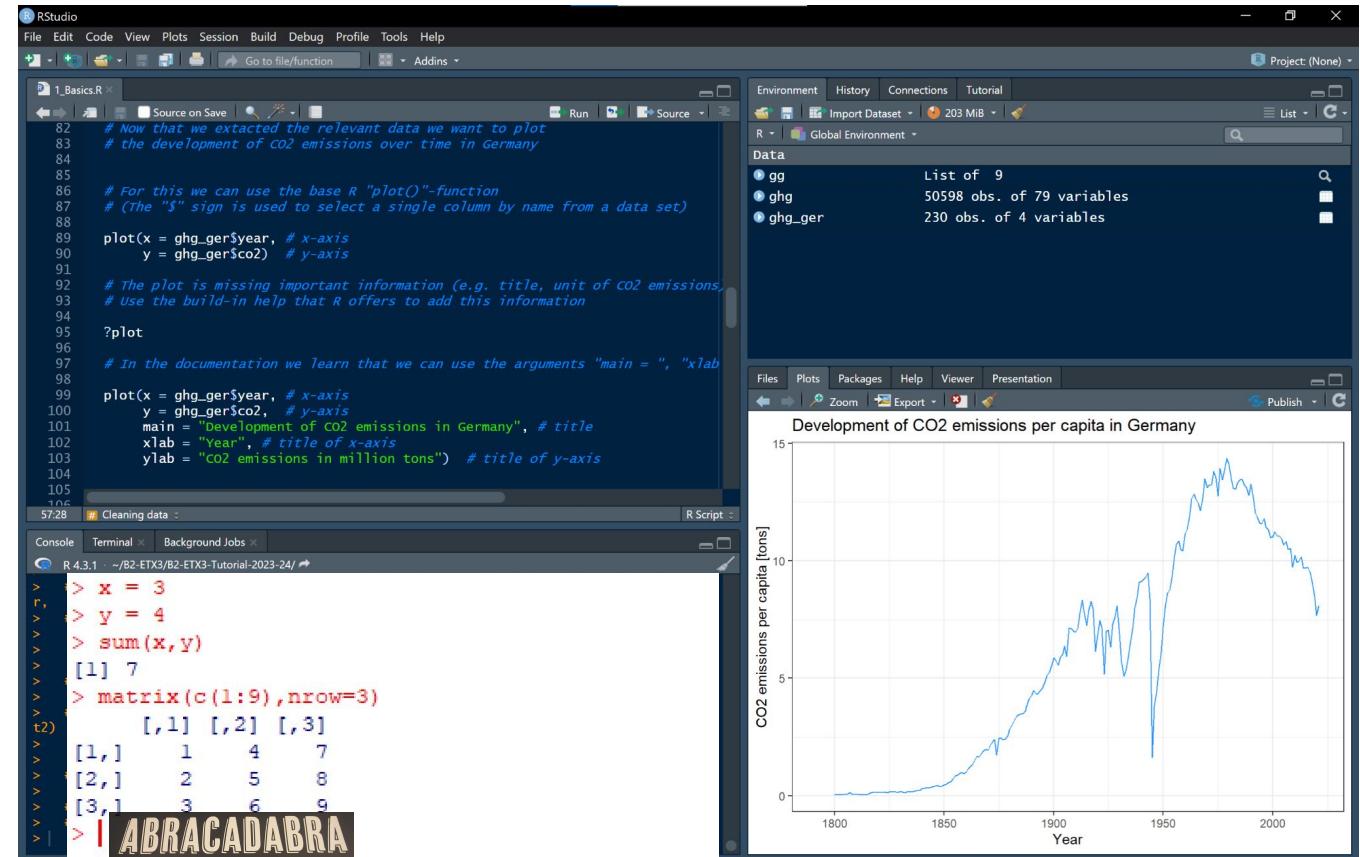
```
> x = 3
> y = 4
> sum(x, y)
[1] 7
> matrix(c(1:9), nrow=3)
      [,1] [,2] [,3]
[1,]    1    4    7
[2,]    2    5    8
[3,]    3    6    9
> |
```



# Where the magic happens!

```
> x = 3  
> y = 4  
> sum(x,y)  
[1] 7  
> matrix(c(1:9),nrow=3)  
      [,1] [,2] [,3]  
[1,]    1    4    7  
[2,]    2    5    8  
[3,]    3    6    9
```

> ABRACADABRA

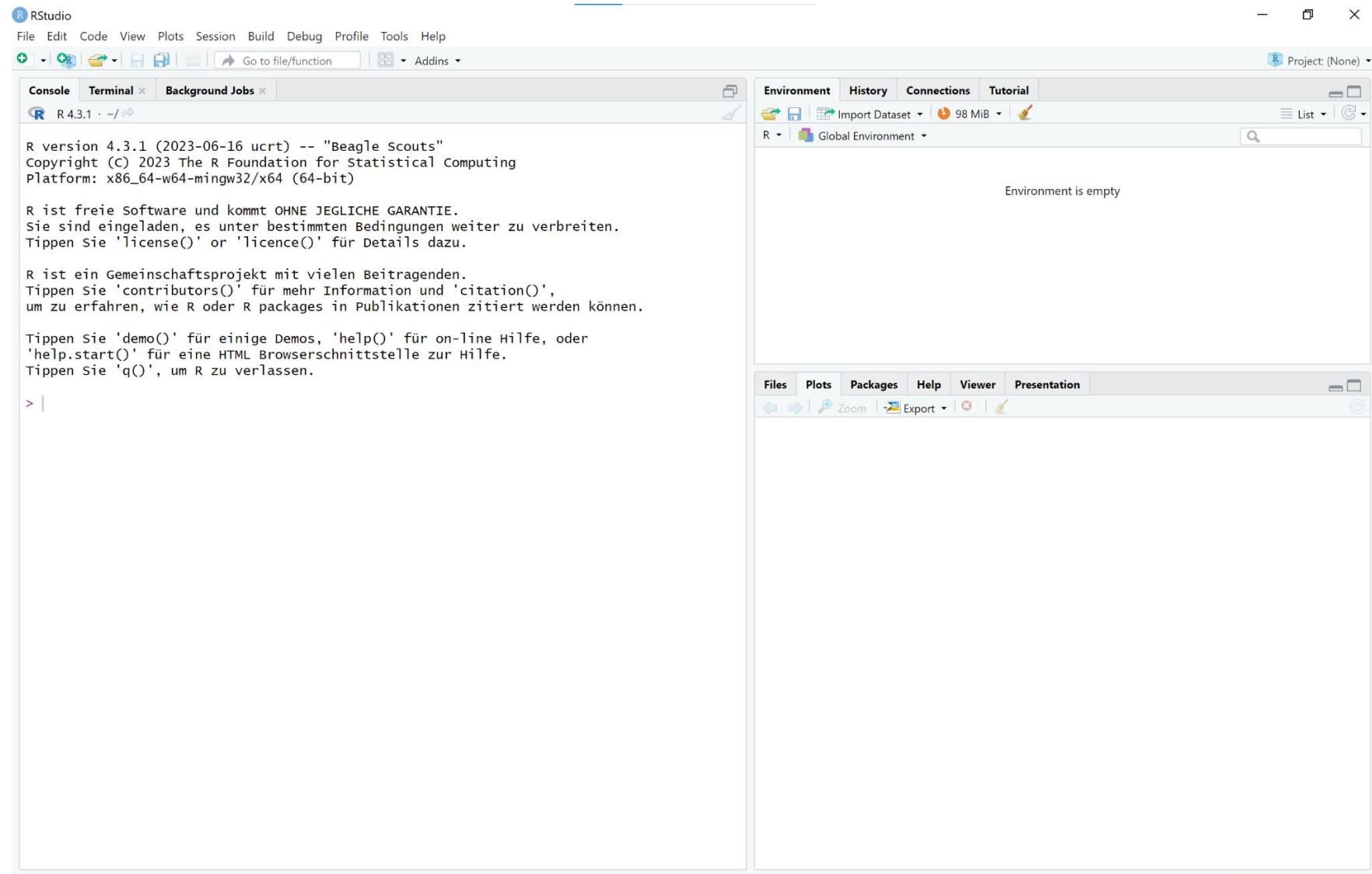


# The IDE

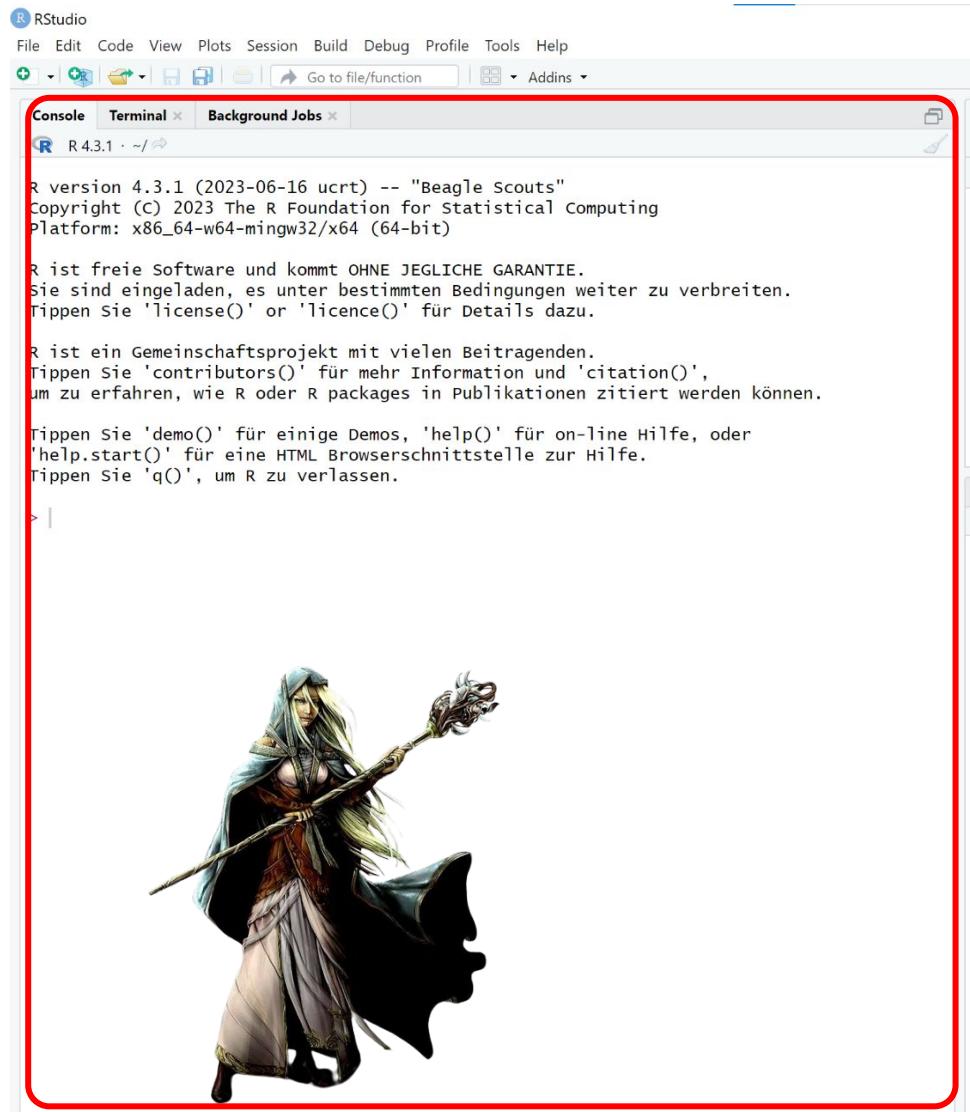
The screenshot shows the RStudio interface with the following components:

- Script Editor:** The left pane displays the code for "1\_Basics.R". The code includes comments explaining the extraction of relevant data and the use of the base R `plot()` function to visualize CO2 emissions over time in Germany.
- Environment Browser:** The top right pane shows the global environment with three objects:
  - `gg`: A list of 9 items.
  - `ghg`: 50598 obs. of 79 variables.
  - `ghg_ger`: 230 obs. of 4 variables.
- Plot Viewer:** The bottom right pane displays a line graph titled "Development of CO2 emissions per capita in Germany". The y-axis is labeled "CO2 emissions per capita [tons]" and ranges from 0 to 15. The x-axis is labeled "Year" and ranges from 1800 to 2000. The plot shows a general upward trend with significant fluctuations, particularly a sharp increase starting around 1900 and another rise after 1950.

# The IDE



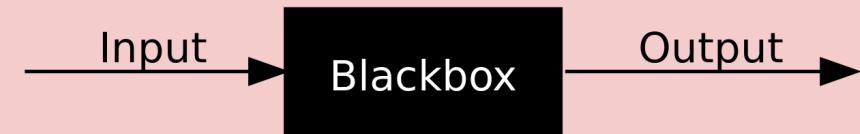
# The IDE



## THE CONSOLE

type in commands in textform

get output in textform



# The IDE

The screenshot shows the RStudio IDE interface. The top navigation bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help, and Addins. Below the menu is a toolbar with icons for file operations like Open, Save, and Print, along with Go to file/function and Addins dropdowns. The main window has tabs for Console, Terminal, and Background Jobs, with Console currently selected. A red dashed box highlights the Environment tab in the top navigation bar of the main panel. The Environment panel displays the Global Environment with the message "Environment is empty." A large illustration of a bearded, balding man with a long white beard, wearing a brown tunic and carrying a large backpack with a lantern, stands next to the text. The bottom of the panel shows a toolbar with File, Plots, Packages, Help, Viewer, and Presentation buttons, and a zoom/export icon.

## THE ENVIRONMENT

look into everything saved

variables, tables, matrices, objects, ...

(also **History** of input commands)



A large, semi-transparent illustration of a female wizard or sorceress is positioned at the bottom left of the slide. She has long, flowing blonde hair and is wearing a blue and gold robe. She holds a long, ornate staff with a dragon's head at the top. Her shadow is cast onto the surface below her.

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# The IDE

The screenshot shows the RStudio IDE interface. On the left, the Console tab displays the R startup message:

```
R version 4.3.1 (2023-06-16 ucrt) -- "Beagle Scouts"  
Copyright (C) 2023 The R Foundation for Statistical Computing  
Platform: x86_64-w64-mingw32/x64 (64-bit)  
  
R ist freie Software und kommt OHNE JEGLICHE GARANTIE.  
Sie sind eingeladen, es unter bestimmten Bedingungen weiter zu verbreiten.  
Tippen Sie 'license()' or 'licence()' für Details dazu.  
  
R ist ein Gemeinschaftsprojekt mit vielen Beitragenden.  
Tippen Sie 'contributors()' für mehr Information und 'citation()',  
um zu erfahren, wie R oder R packages in Publikationen zitiert werden können.  
  
Tippen Sie 'demo()' für einige Demos, 'help()' für on-line Hilfe, oder  
'help.start()' für eine HTML Browserschnittstelle zur Hilfe.  
Tippen Sie 'q()', um R zu verlassen.
```

The Environment pane (top right) shows a Beagle Scout character with the message "Environment is empty". The Plots pane (bottom right) shows a painter character with the message "Plots is empty".

## THE PLOTS

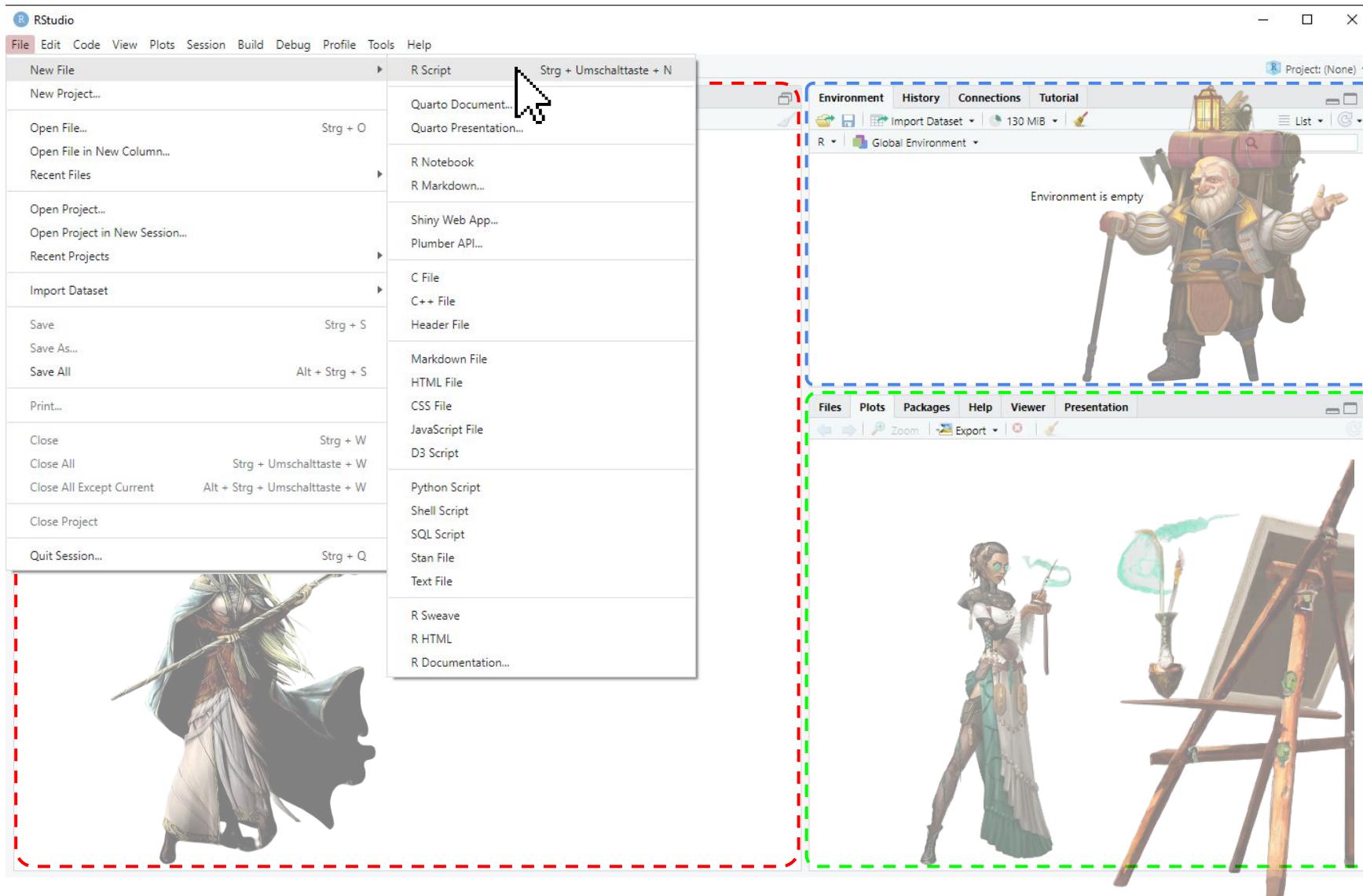
storage/slideshow of all graphs

export graphs as .png or PDF

also **Helper**, directory **File** structure, **Packages** list

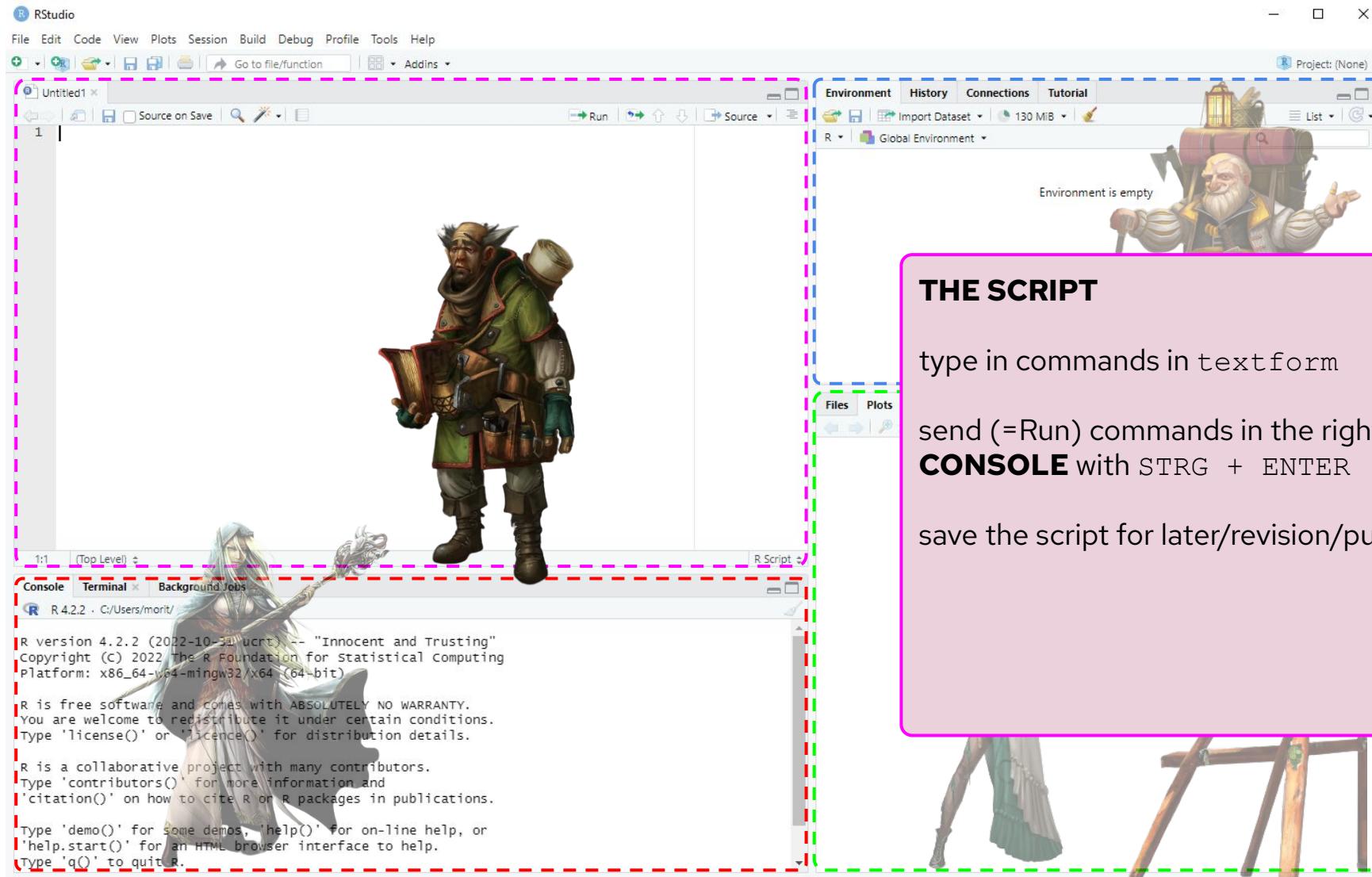
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# The IDE



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# The IDE



## THE SCRIPT

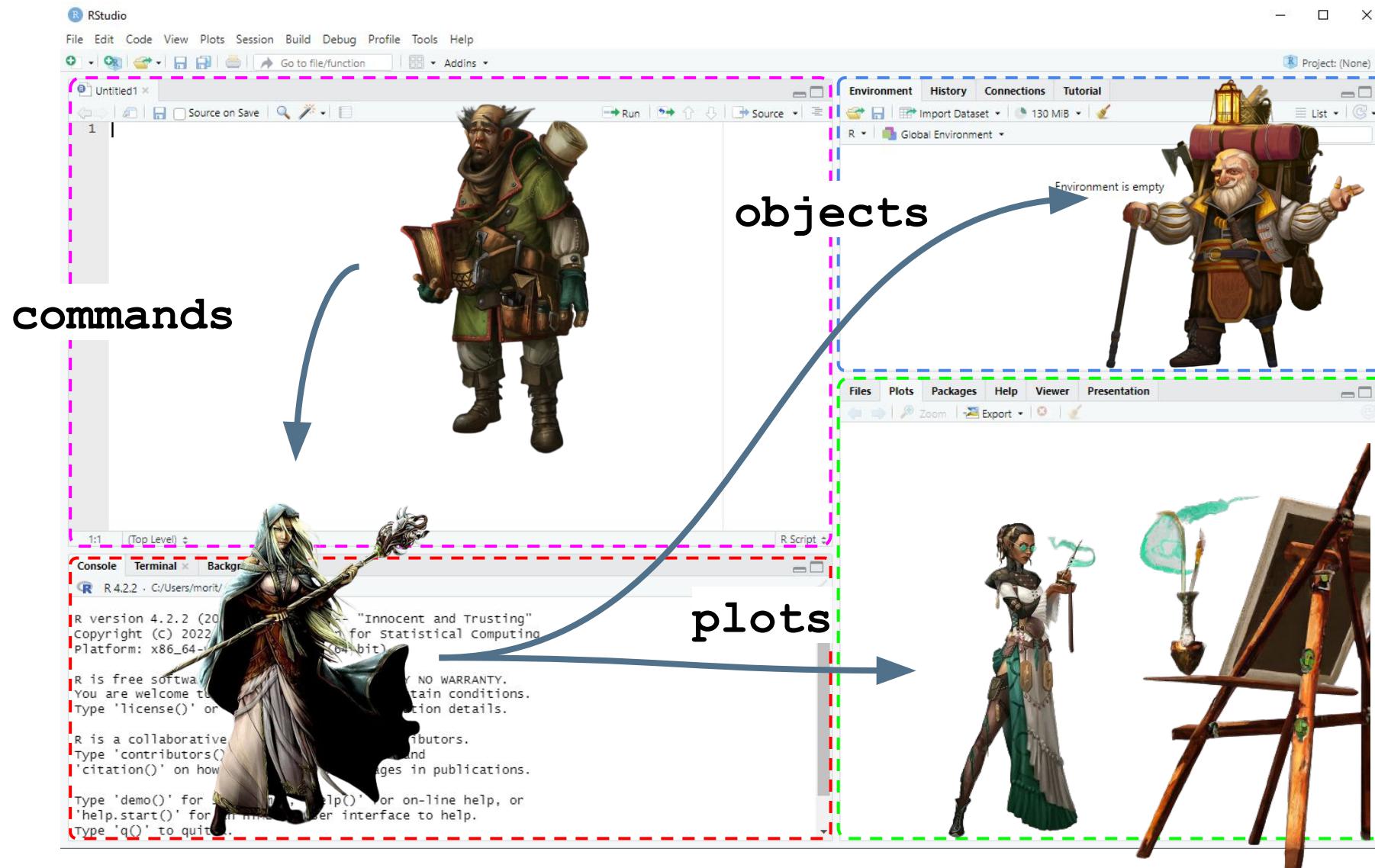
type in commands in textform

send (=Run) commands in the right order to the  
**CONSOLE** with STRG + ENTER

save the script for later/revision/publication

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# The IDE



**x = 10**

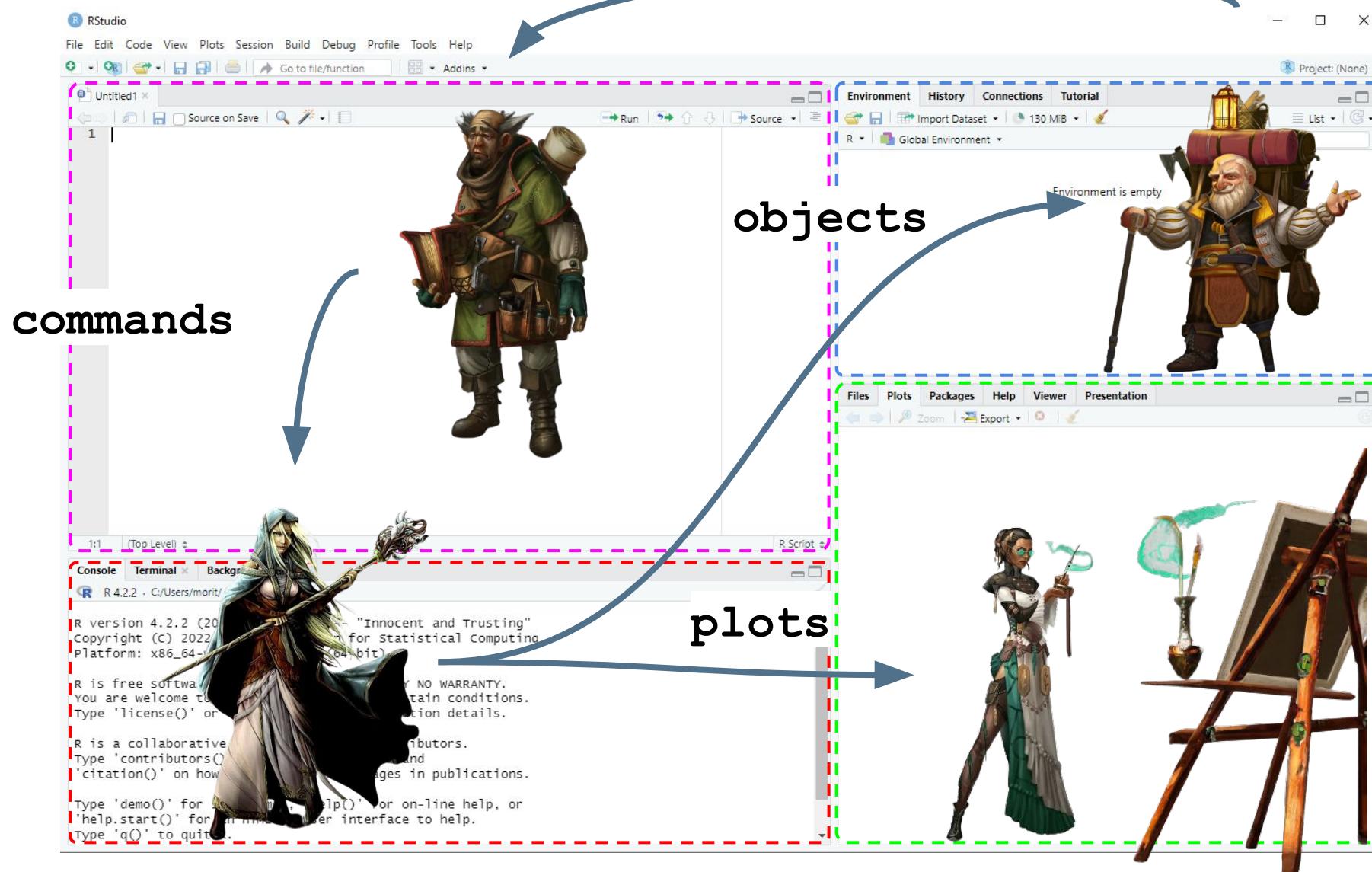
<b>A</b>	<b>2</b>	<b>l_1</b>
<b>B</b>	<b>4</b>	<b>o_2</b>
<b>C</b>	<b>1</b>	<b>xx</b>

**type: kmz**  
**meta: author:**  
u23  
**data: values:**  
1,4,3,1,2,...

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# The IDE

objects to be commanded



## The Goblin Hunt

The queen of *Eastern Ecologica* pays you a gold coin for every goblin head you bring after the hunting season.

Where should you go:

*The carnivore caverns* or *The wilder woods*

A scout visited both areas a couple times and recorded the amount of goblins seen. It is up to you and your group of heroes to decide where to go in the goblin hunting season.



Create a list with  
the two areas  
and a list with the  
amount of  
goblins

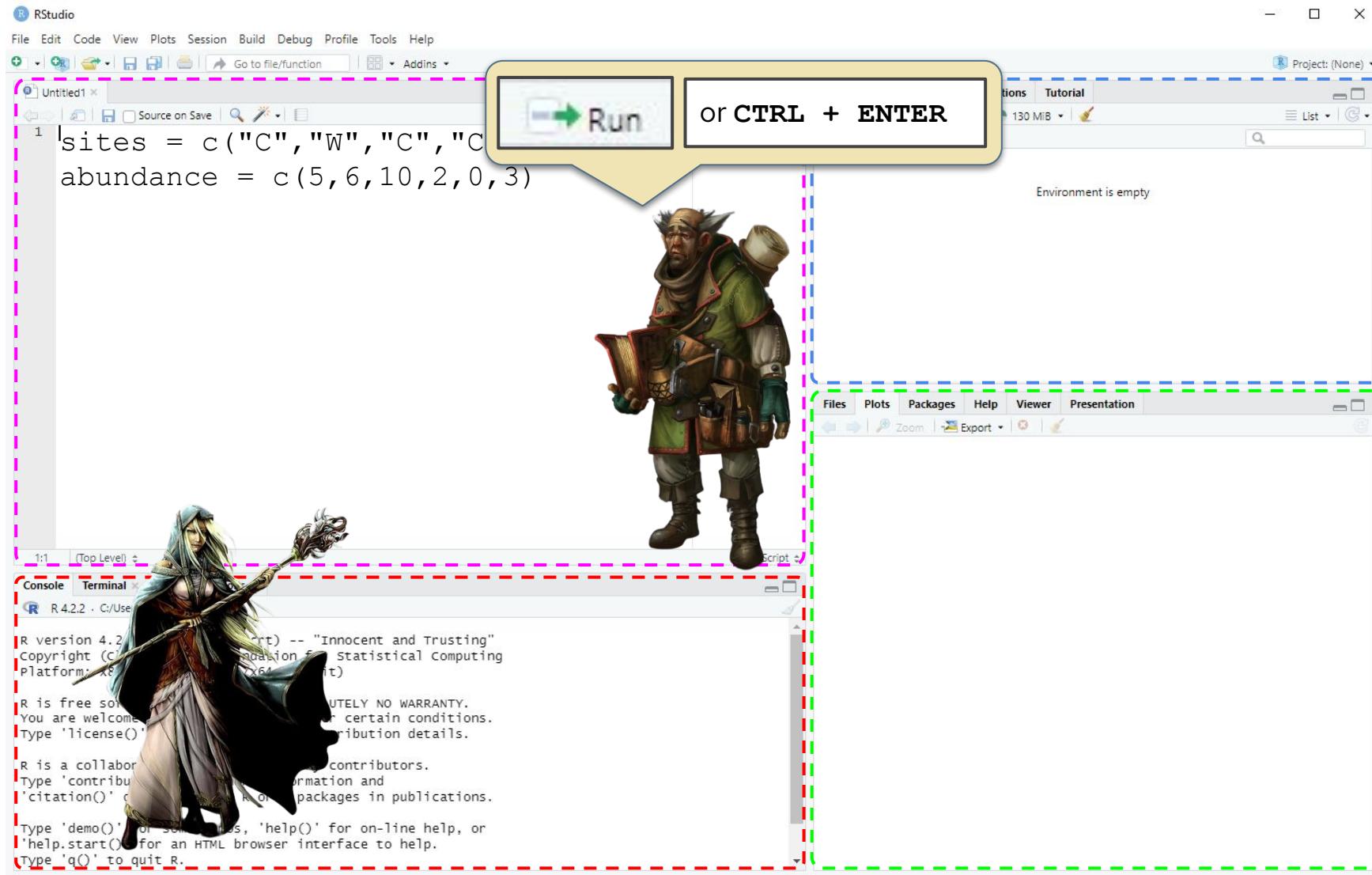
Store the two  
lists

Ok.



# *The Goblin Hunt*

## Running lines of code



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# *The Goblin Hunt*

## - Using functions

use `t.test` to identify if one of the areas is significantly more crowded with goblins.

Ok. These are the results: ...

Here are the objects.



```
Welch Two Sample t-test
data: abundance by sites
t = 0.91766, df = 3.6907, p-value = 0.4
alternative hypothesis: true difference
95 percent confidence interval:
-19.11.008
  estimate
mean in group w
-3.000000
```



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# The Goblin Hunt

# Plotting

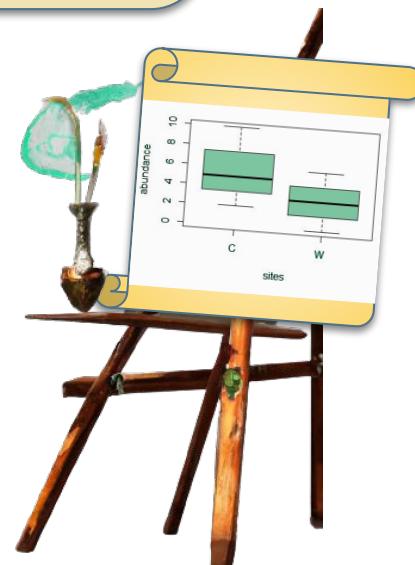
Use *boxplot* to show the difference the difference of goblin counts in the two areas

Draw this boxplot for me.

Here are the objects.



Ok.



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# *The Goblin Hunt*

# - Working Directory

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## *The Goblin Hunt* - Working Directory

Place where the Sorceress expects its  
objects/data/... to be

DO THIS FIRST!

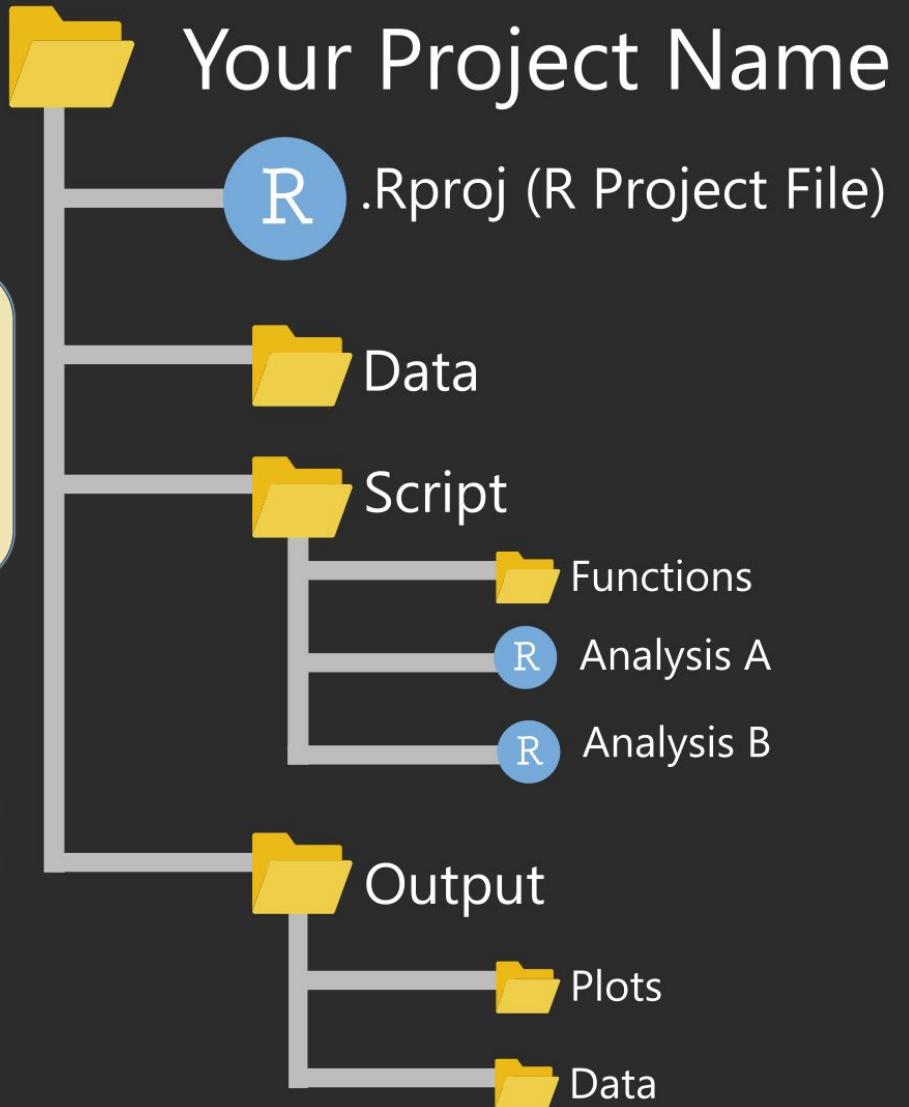
There is nothing:  
No such file  
or directory

can be manually adjusted with  
`setwd("C:/user/...")`

care for "\\" and "/" confusion



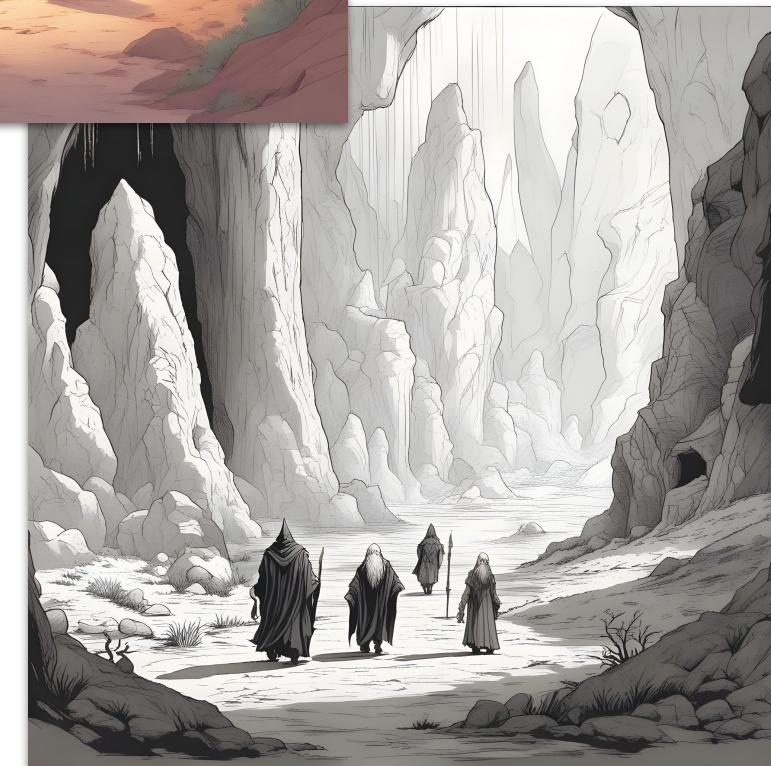
# A basic R project set up

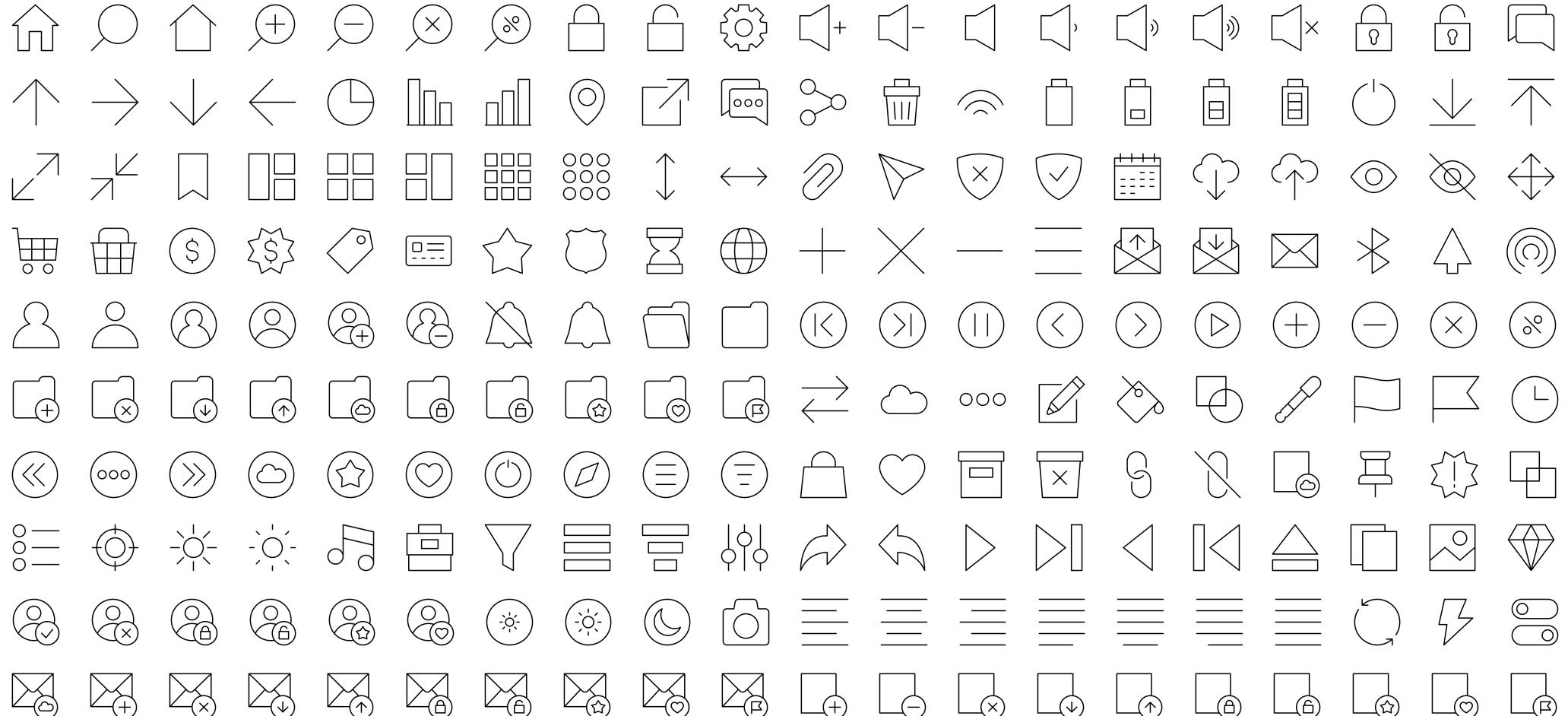


## The Goblin Hunt - Final Chapter

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As the crimson sun dipped below the horizon, casting long shadows across the rugged terrain of *Eastern Ecologica*, our group of valiant heroes stood at the mouth of the *Carnivore Cavern*. Clad in armor adorned with the symbols of their valorous exploits, they bore weapons forged from the heart of their kingdom's enduring spirit. The queen's promise of a bounteous reward echoed in their minds, but it was not merely the allure of riches that drove them. It was their unwavering dedication to the realm, the unity of their fellowship, and their shared sense of duty that propelled them into the darkness of the cavern's gaping maw. The goblin hunting season had arrived, and with every echoing footprint, the heroes ventured deeper, ready to face the challenges that awaited. For in the heart of the *Carnivore Cavern*, they knew that destiny would carve their legend, and the kingdom of *Eastern Ecologica* would forever honor their courageous souls.





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