Welcome to EAES 494!

Data Science & Statistics

Gavin McNicol


UIC

Dr. Gavin McNicol

McNicol Lab @ UIC

Data science

- Data science is an exciting discipline that allows you to turn raw data into understanding, insight, and knowledge.
- We're going to learn to do this in a tidy way -- more on that later!
- This is a course on introduction to data science, with an emphasis on statistical thinking.

Q - What data science background does this course assume?
A - None.

Q - Is this an intro stat course?
A - While statistics $\neq$ data science, they are very closely related and have tremendous of overlap. Hence, this course is a great way to get started with statistics. However this course is *not* your typical high school statistics course.

Q - Will we be doing computing?
A - Yes.

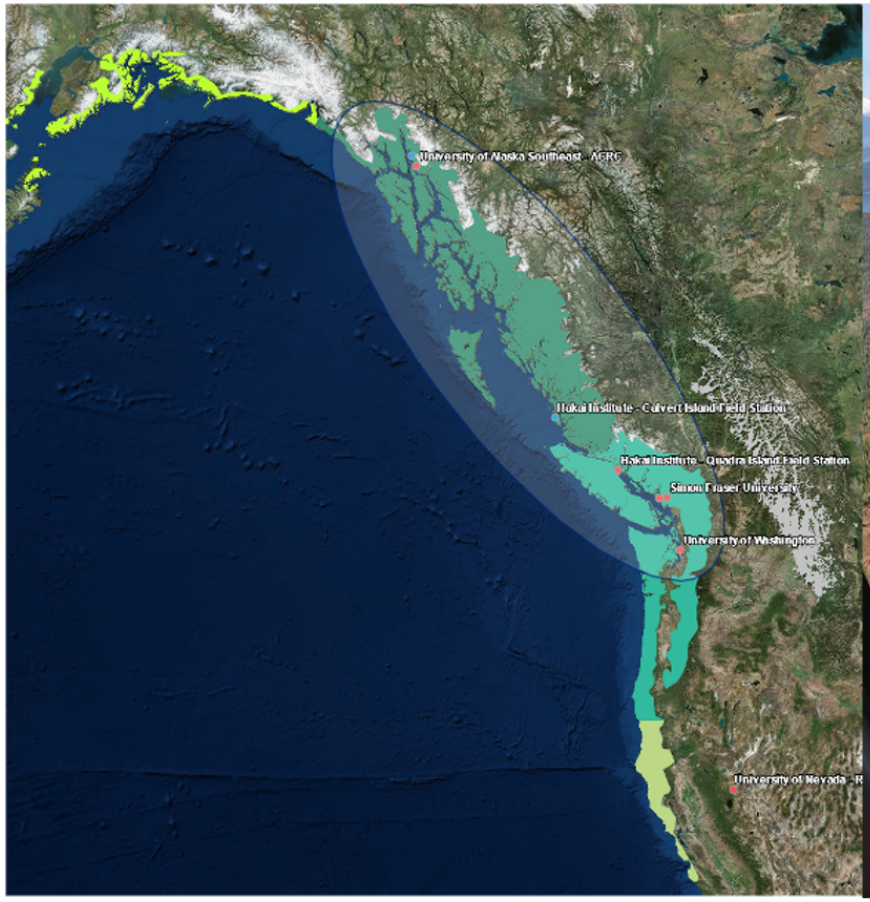
Q - Will we be working with EaESy Data?
A - *Yes!*

Q - Is this an intro CS course?
A - No, but many themes are shared.

Q - What computing language will we learn?
A - R.

Q: Why not language X?
A: We can discuss that over ☕ .

Software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Hakai Institute - Calvert Island Field Station
Hakai Institute - Quadra Island Field Station
Simon Fraser University
University of Washington
University of Nevada -R


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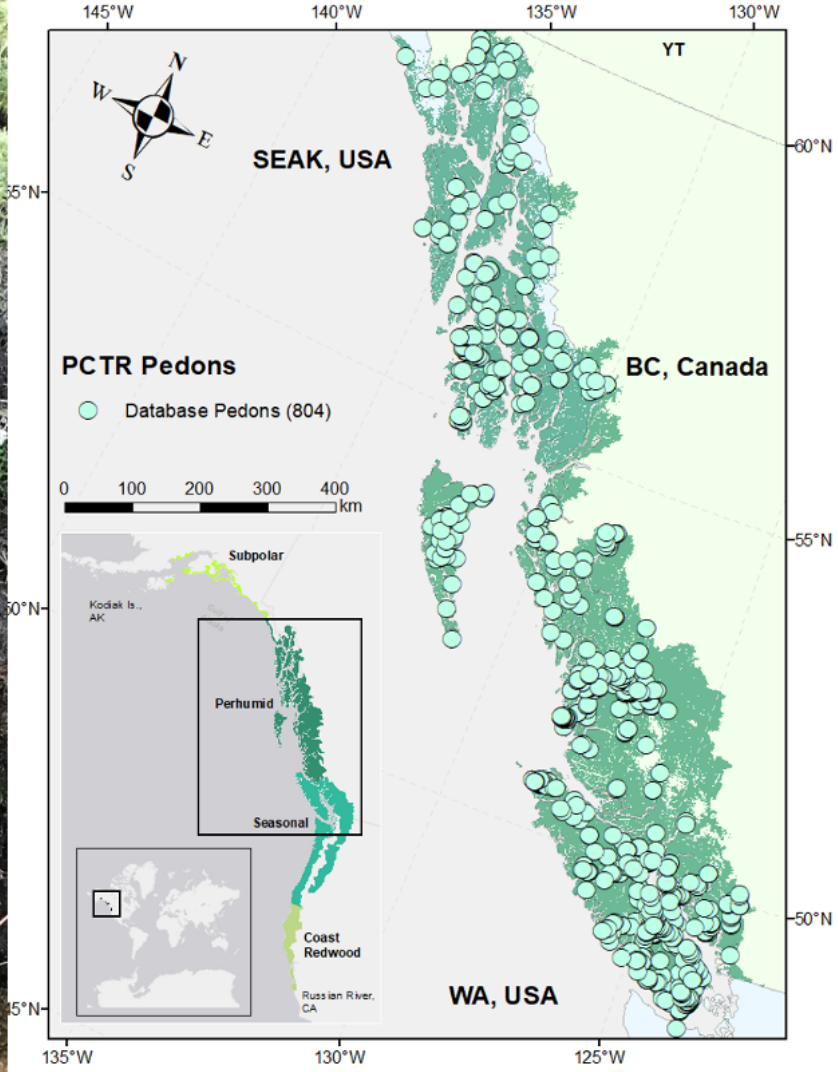
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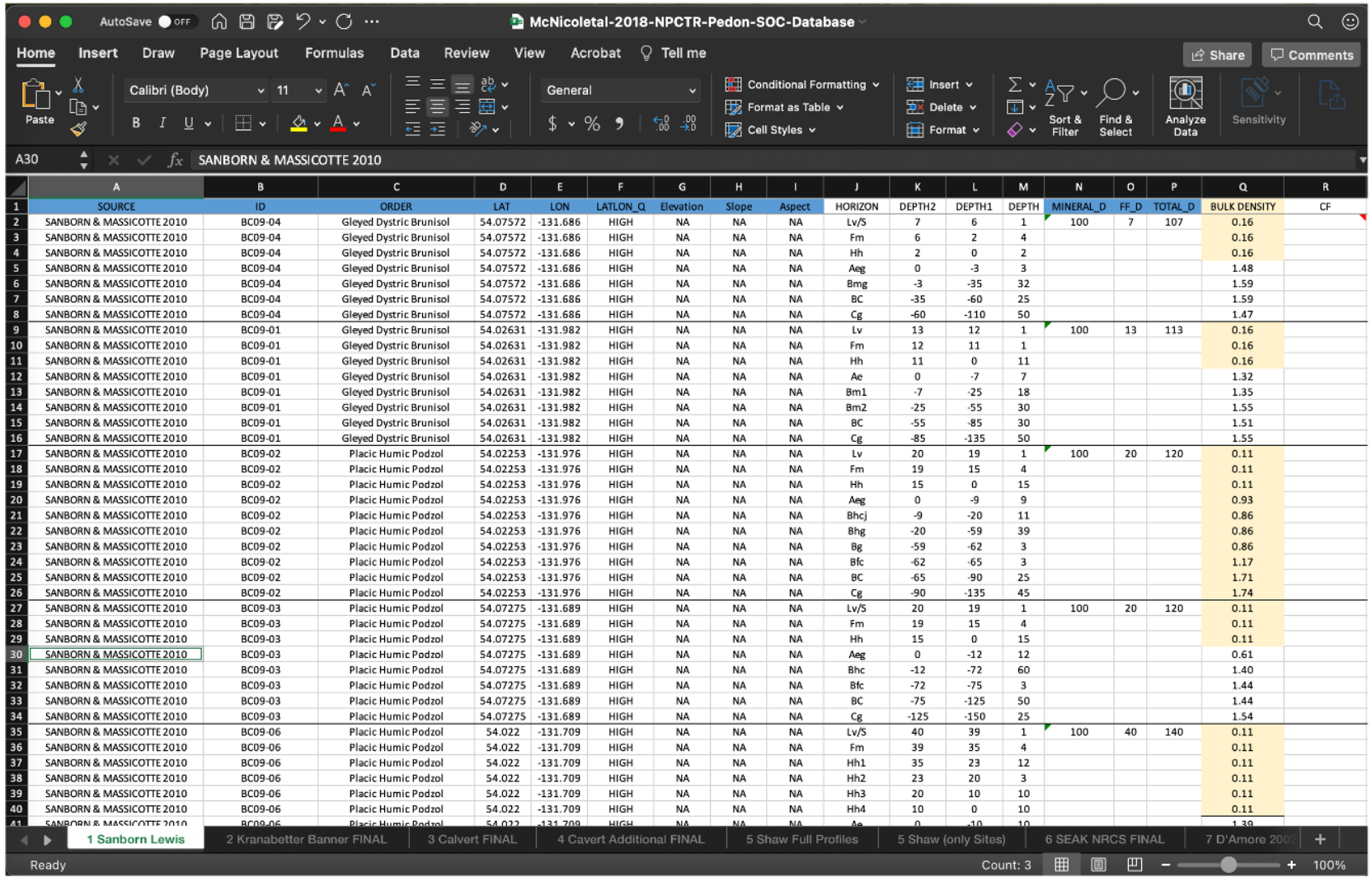

McNicoletal-2018-NPCTR-Pedon-SOC-Database

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A30 SANBORN & MASSICOTTE 2010

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	SOURCE	ID	ORDER	LAT	LON	LATLON_Q	Elevation	Slope	Aspect	HORIZON	DEPTH2	DEPTH1	DEPTH	MINERAL_D	FF_D	TOTAL_D	BULK DENSITY	CF
2	SANBORN & MASSICOTTE 2010	BC09-04	Gleyed Dystric Brunisol	54.07572	-131.686	HIGH	NA	NA	NA	Lv/S	7	6	1	100	7	107	0.16	
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5	SANBORN & MASSICOTTE 2010	BC09-04	Gleyed Dystric Brunisol	54.07572	-131.686	HIGH	NA	NA	NA	Aeg	0	-3	3				1.48	
6	SANBORN & MASSICOTTE 2010	BC09-04	Gleyed Dystric Brunisol	54.07572	-131.686	HIGH	NA	NA	NA	Bmg	-3	-35	32				1.59	
7	SANBORN & MASSICOTTE 2010	BC09-04	Gleyed Dystric Brunisol	54.07572	-131.686	HIGH	NA	NA	NA	BC	-35	-60	25				1.59	
8	SANBORN & MASSICOTTE 2010	BC09-04	Gleyed Dystric Brunisol	54.07572	-131.686	HIGH	NA	NA	NA	Cg	-60	-110	50				1.47	
9	SANBORN & MASSICOTTE 2010	BC09-01	Gleyed Dystric Brunisol	54.02631	-131.982	HIGH	NA	NA	NA	Lv	13	12	1	100	13	113	0.16	
10	SANBORN & MASSICOTTE 2010	BC09-01	Gleyed Dystric Brunisol	54.02631	-131.982	HIGH	NA	NA	NA	Fm	12	11	1				0.16	
11	SANBORN & MASSICOTTE 2010	BC09-01	Gleyed Dystric Brunisol	54.02631	-131.982	HIGH	NA	NA	NA	Hh	11	0	11				0.16	
12	SANBORN & MASSICOTTE 2010	BC09-01	Gleyed Dystric Brunisol	54.02631	-131.982	HIGH	NA	NA	NA	Ae	0	-7	7				1.32	
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16	SANBORN & MASSICOTTE 2010	BC09-01	Gleyed Dystric Brunisol	54.02631	-131.982	HIGH	NA	NA	NA	Cg	-85	-135	50				1.55	
17	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	Lv	20	19	1	100	20	120	0.11	
18	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	Fm	19	15	4				0.11	
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22	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	Bhg	-20	-59	39				0.86	
23	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	Bg	-59	-62	3				0.86	
24	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	Bfc	-62	-65	3				1.17	
25	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	BC	-65	-90	25				1.71	
26	SANBORN & MASSICOTTE 2010	BC09-02	Placic Humic Podzol	54.02253	-131.976	HIGH	NA	NA	NA	Cg	-90	-135	45				1.74	
27	SANBORN & MASSICOTTE 2010	BC09-03	Placic Humic Podzol	54.07275	-131.689	HIGH	NA	NA	NA	Lv/S	20	19	1	100	20	120	0.11	
28	SANBORN & MASSICOTTE 2010	BC09-03	Placic Humic Podzol	54.07275	-131.689	HIGH	NA	NA	NA	Fm	19	15	4				0.11	
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41	SANBORN & MASSICOTTE 2010	BC09-06	Placic Humic Podzol	54.022	-131.709	HIGH	NA	NA	NA	Ae	0	-10	10				1.39	

1 Sanborn Lewis | 2 Kranabetter Banner FINAL | 3 Calvert FINAL | 4 Cavert Additional FINAL | 5 Shaw Full Profiles | 5 Shaw (only Sites) | 6 SEAK NRCS FINAL | 7 D'Amore 200

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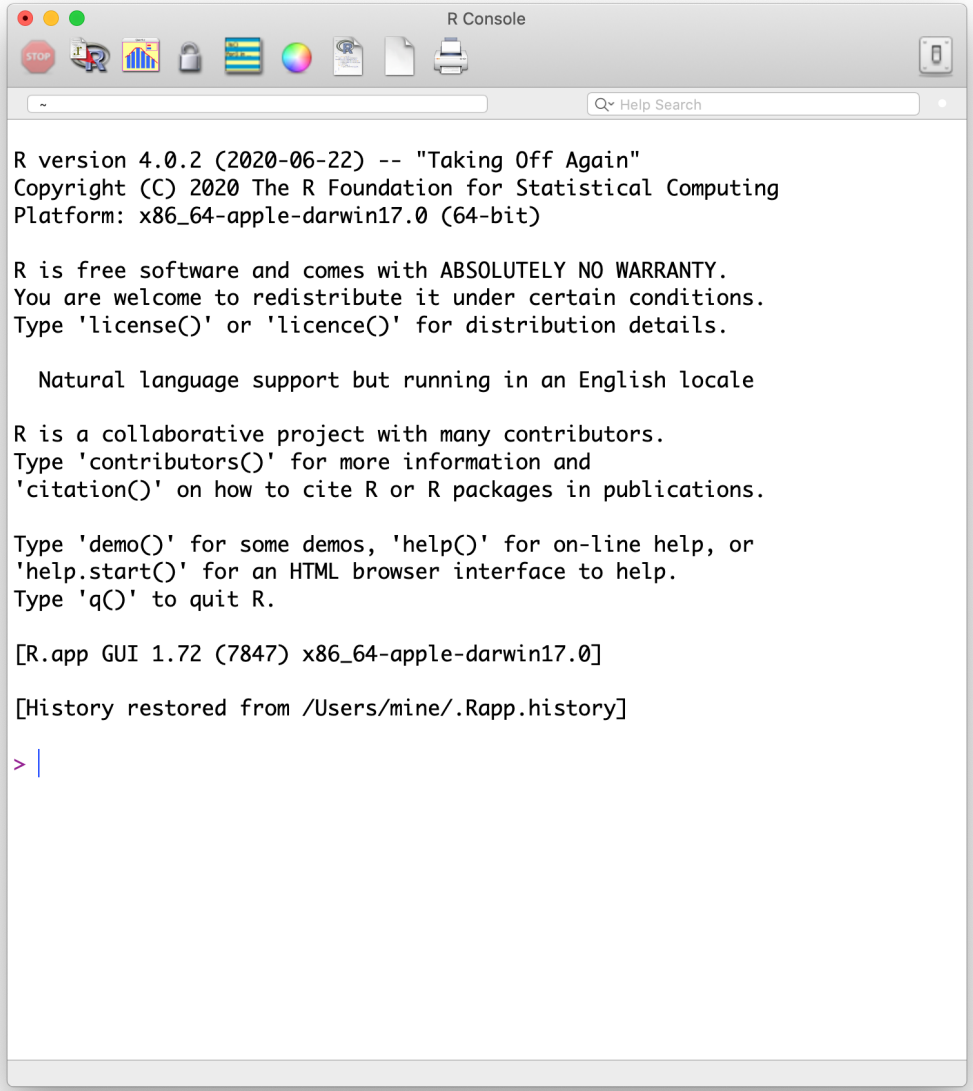
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Copyright (C) 2020 The R Foundation for Statistical Computing
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R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
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R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
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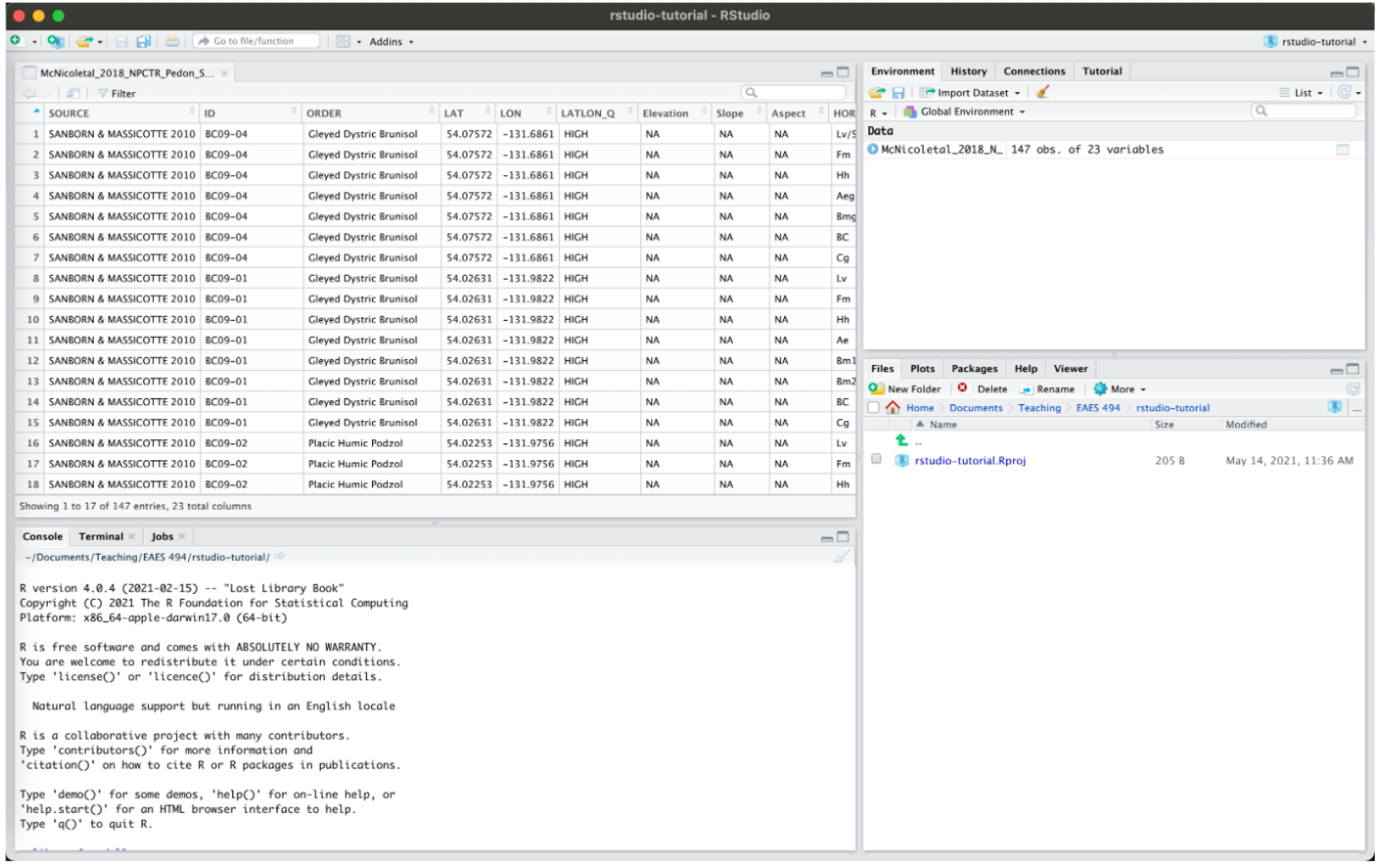
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8 SANBORN & MASSICOTTE 2010 BC09-01 Gleyed Dystric Brunisol 54.02631 -131.9822 HIGH NA NA NA Lv
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11 SANBORN & MASSICOTTE 2010 BC09-01 Gleyed Dystric Brunisol 54.02631 -131.9822 HIGH NA NA NA Ae
12 SANBORN & MASSICOTTE 2010 BC09-01 Gleyed Dystric Brunisol 54.02631 -131.9822 HIGH NA NA NA Bm1
13 SANBORN & MASSICOTTE 2010 BC09-01 Gleyed Dystric Brunisol 54.02631 -131.9822 HIGH NA NA NA Bm2
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16 SANBORN & MASSICOTTE 2010 BC09-02 Placic Humic Podzol 54.02253 -131.9756 HIGH NA NA NA Lv
17 SANBORN & MASSICOTTE 2010 BC09-02 Placic Humic Podzol 54.02253 -131.9756 HIGH NA NA NA Fm
18 SANBORN & MASSICOTTE 2010 BC09-02 Placic Humic Podzol 54.02253 -131.9756 HIGH NA NA NA Hh
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Copyright (C) 2021 The R Foundation for Statistical Computing
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R is free software and comes with ABSOLUTELY NO WARRANTY.
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Type 'license()' or 'licence()' for distribution details.
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R is a collaborative project with many contributors.
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Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
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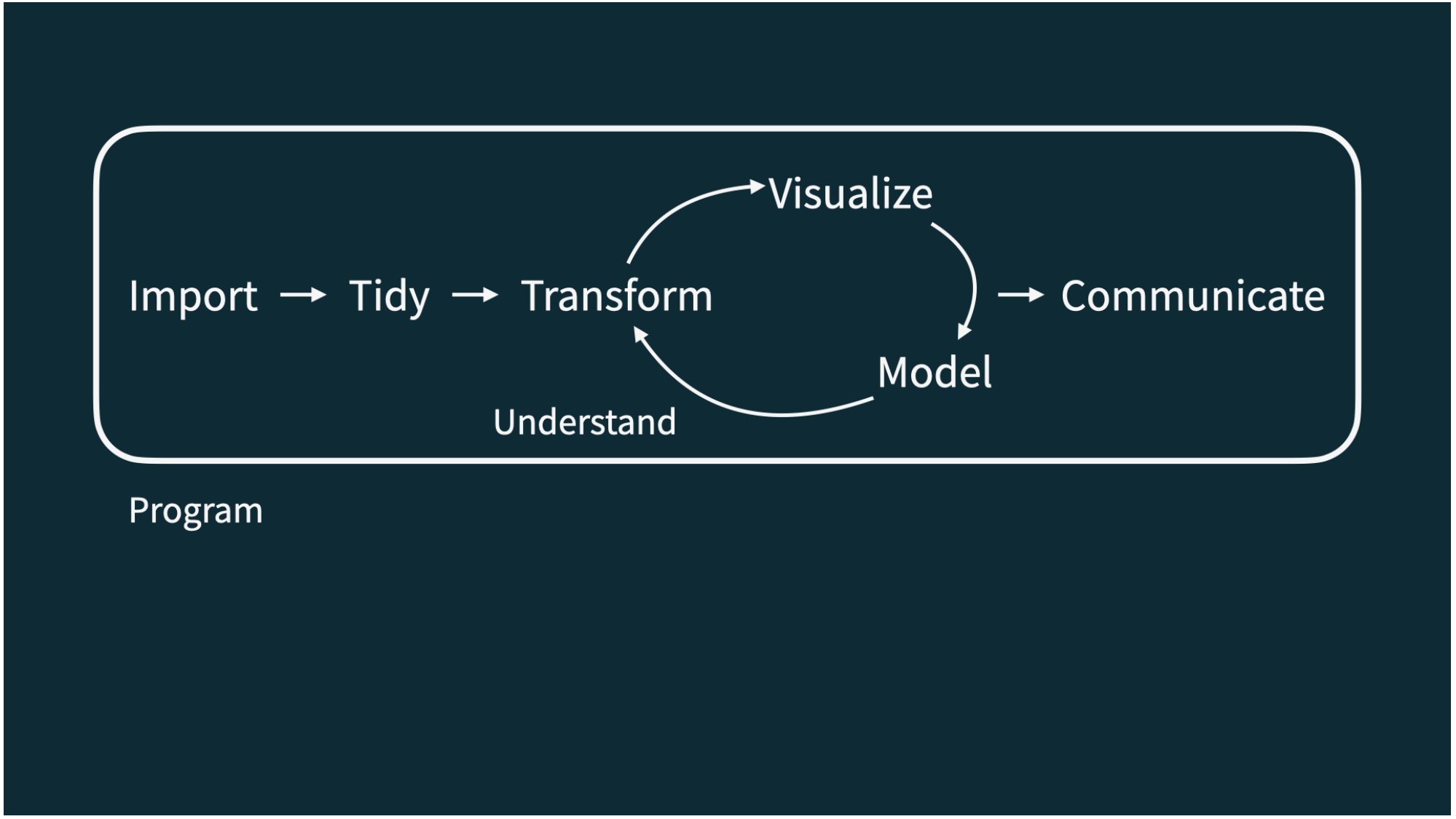
Data science life cycle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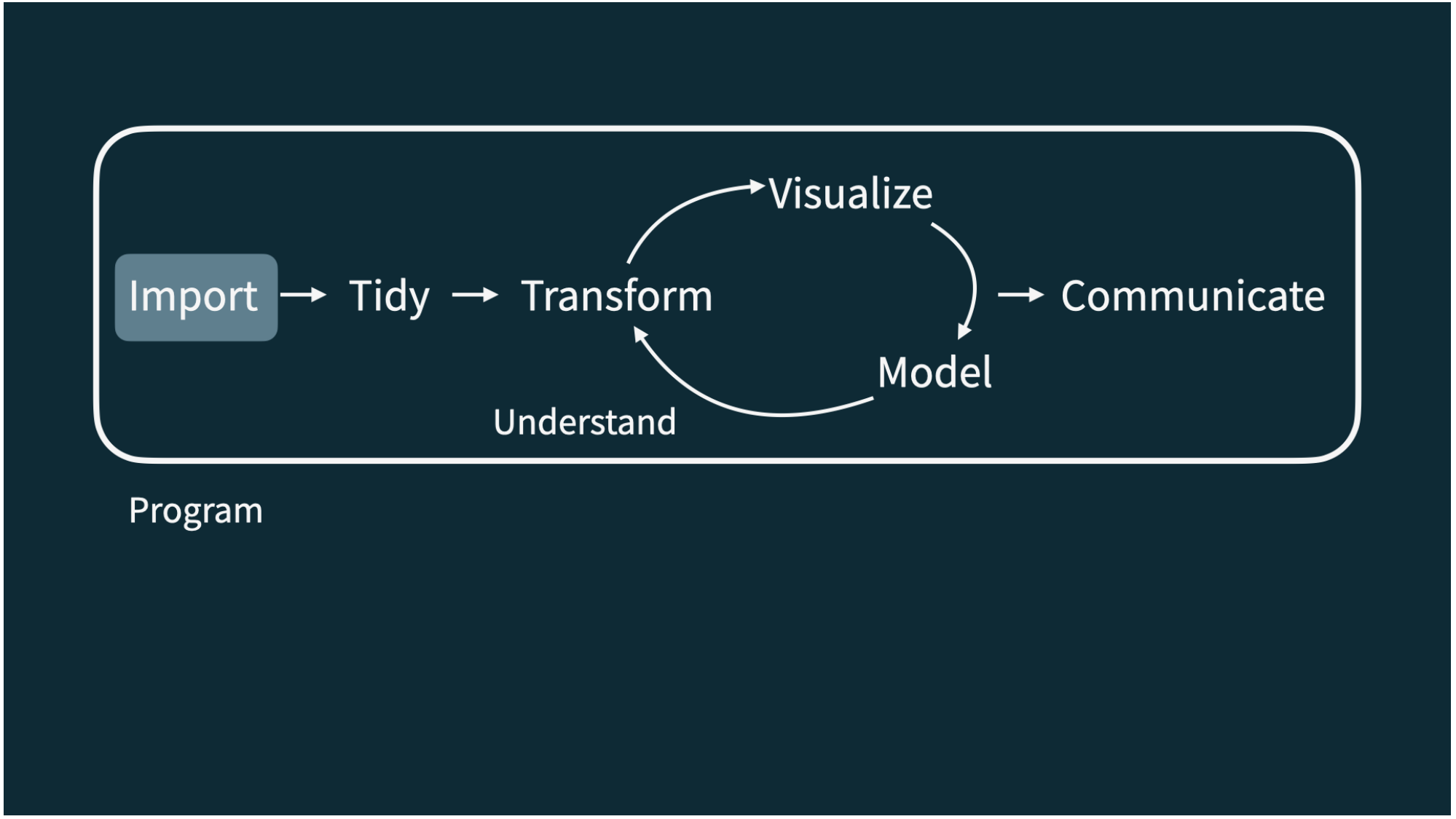
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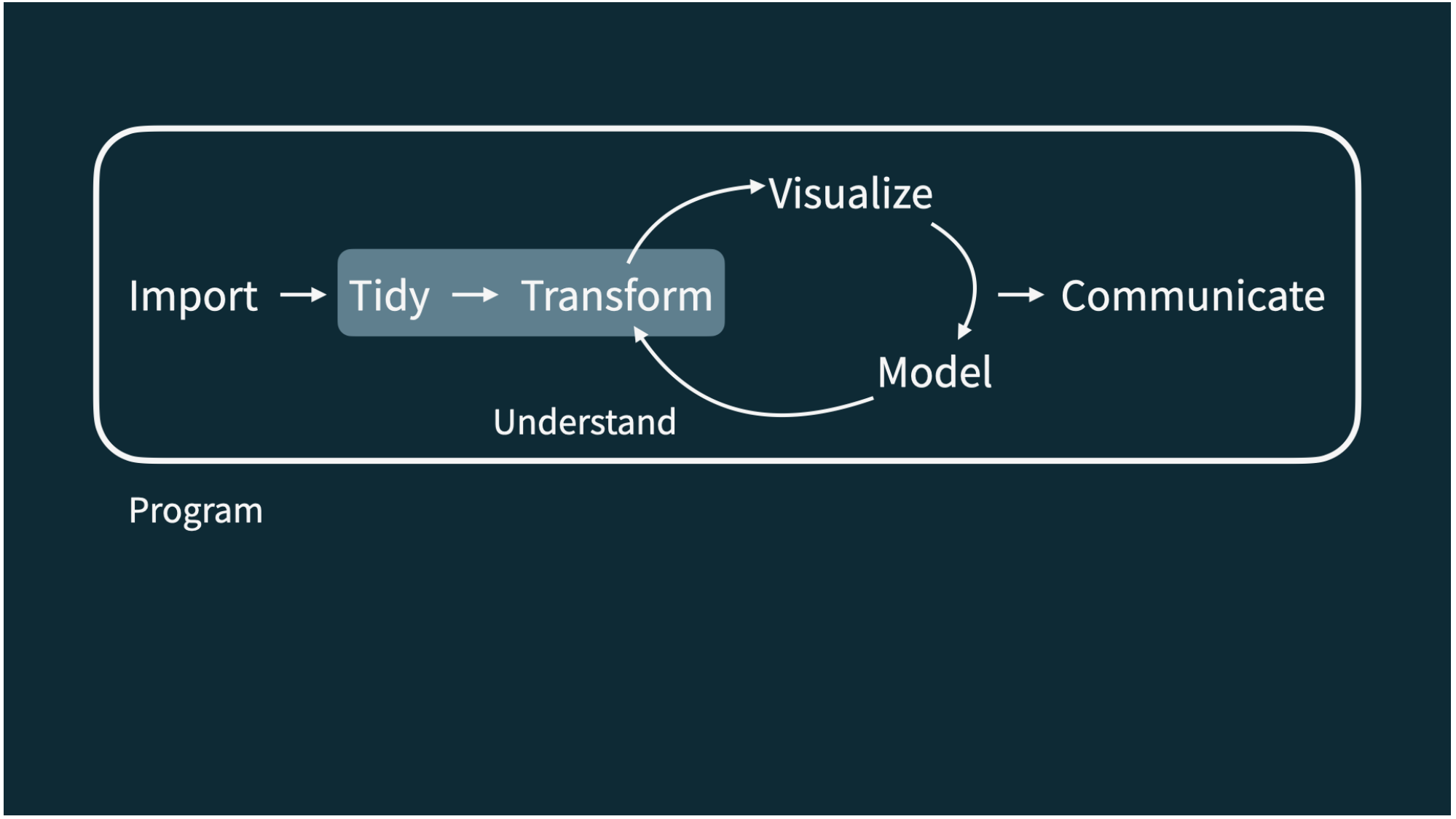
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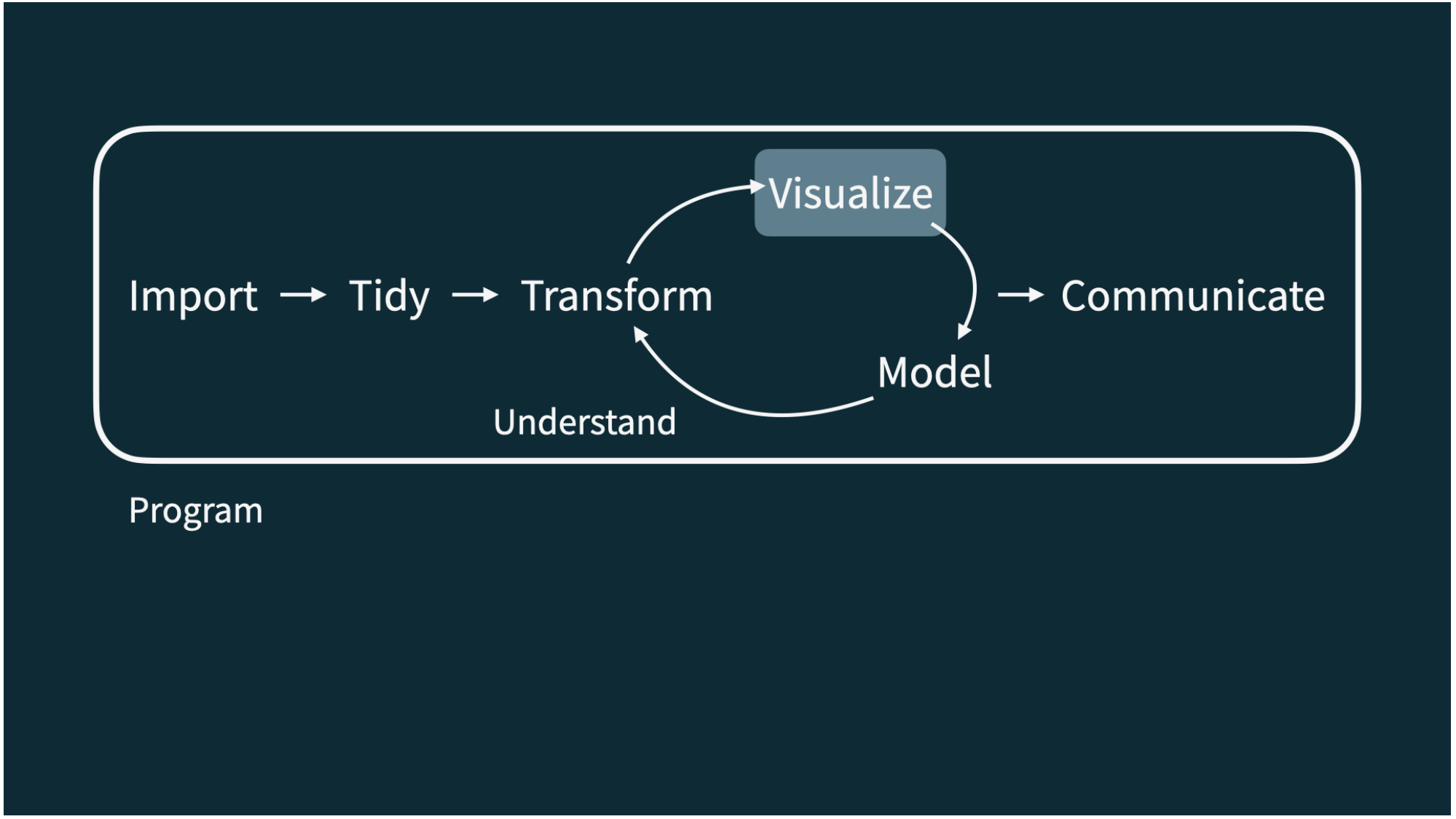
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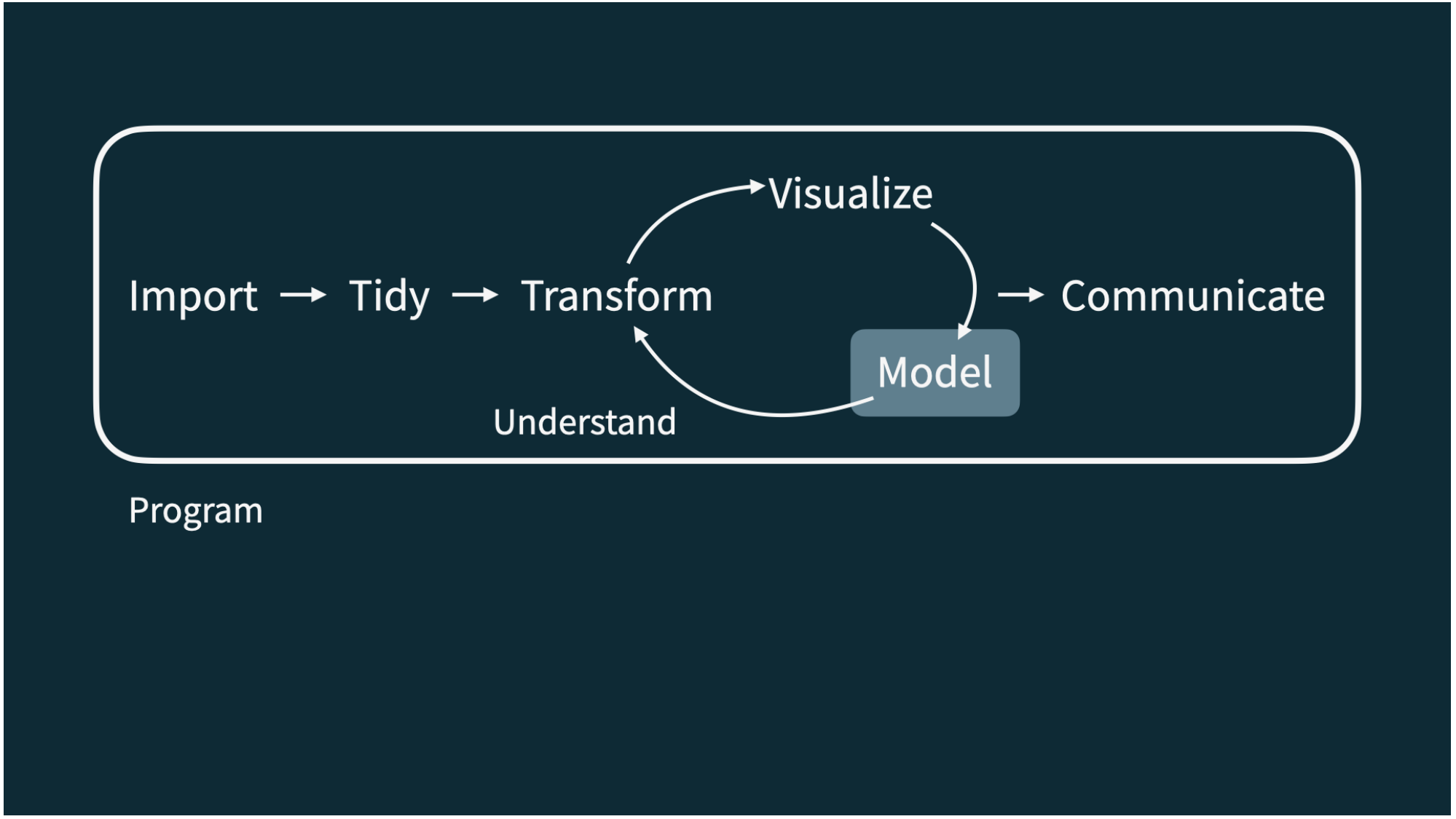
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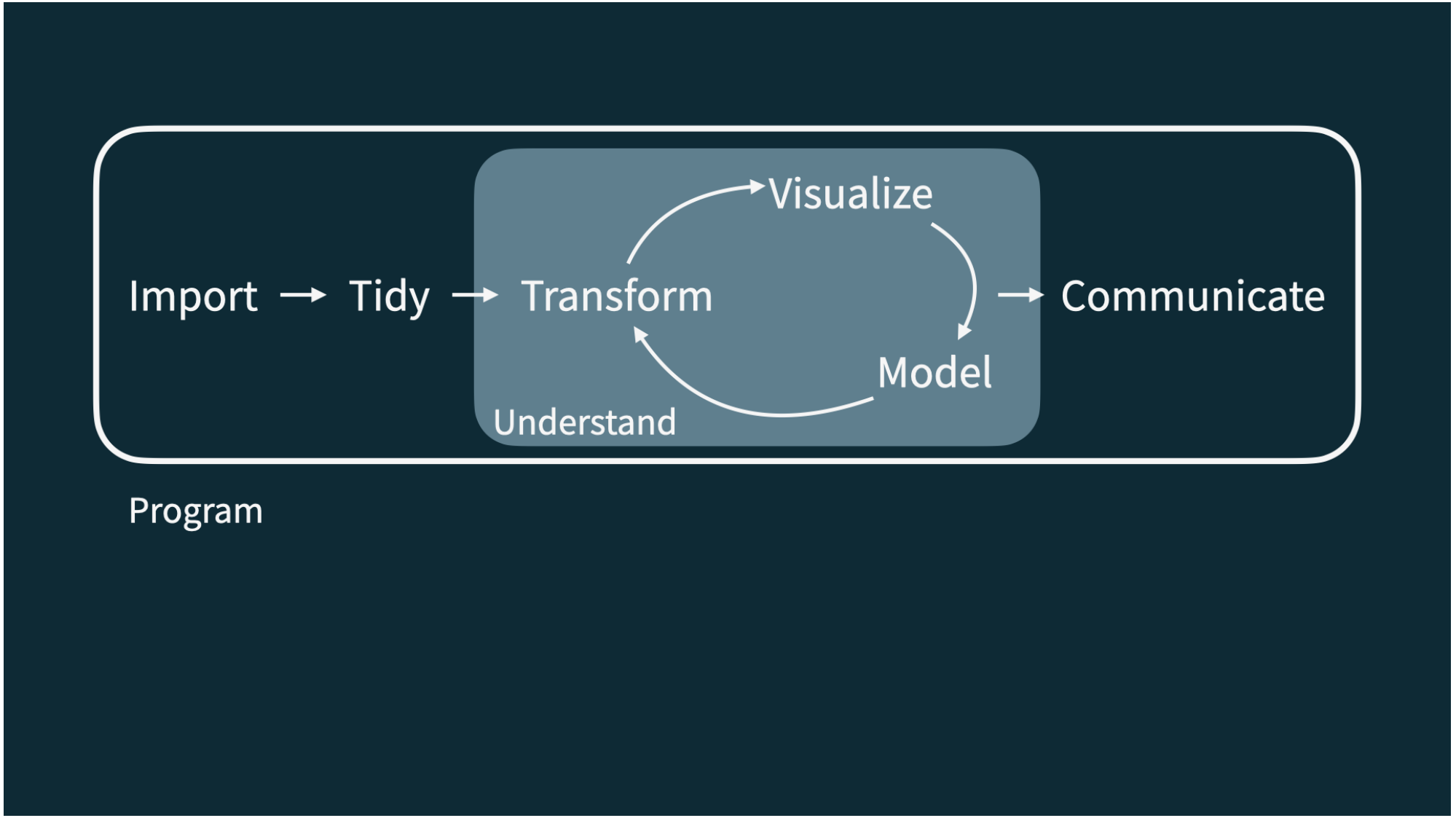
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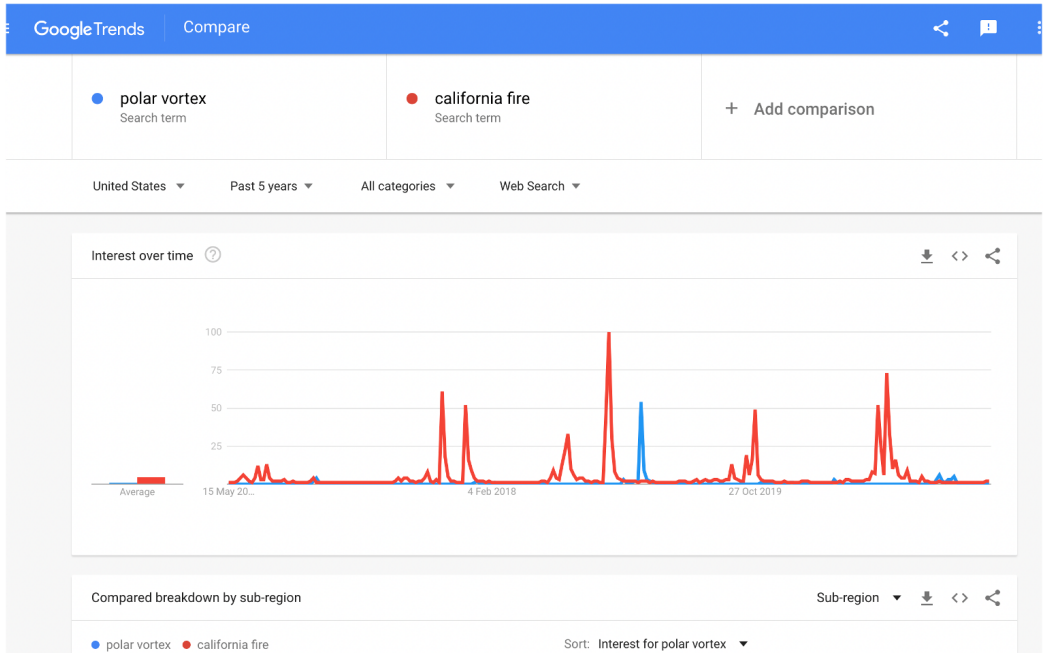
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Past 5 years
All categories
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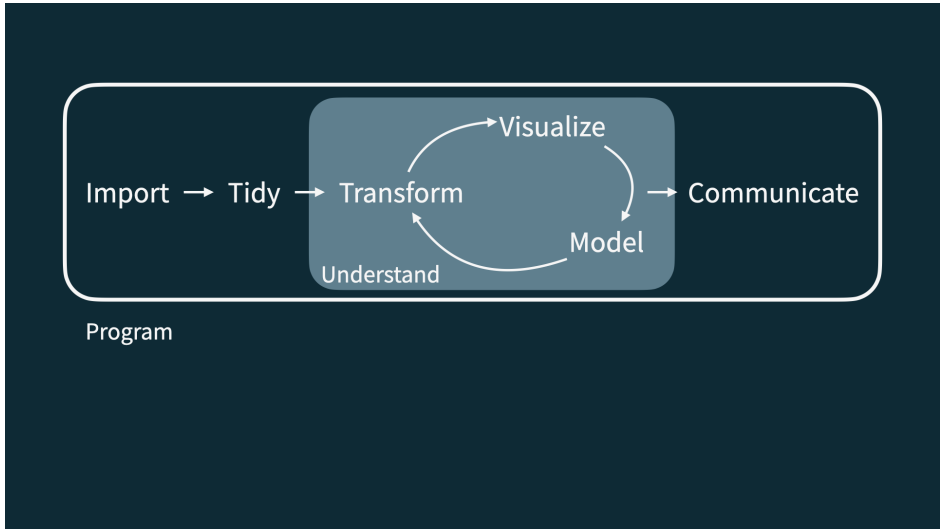
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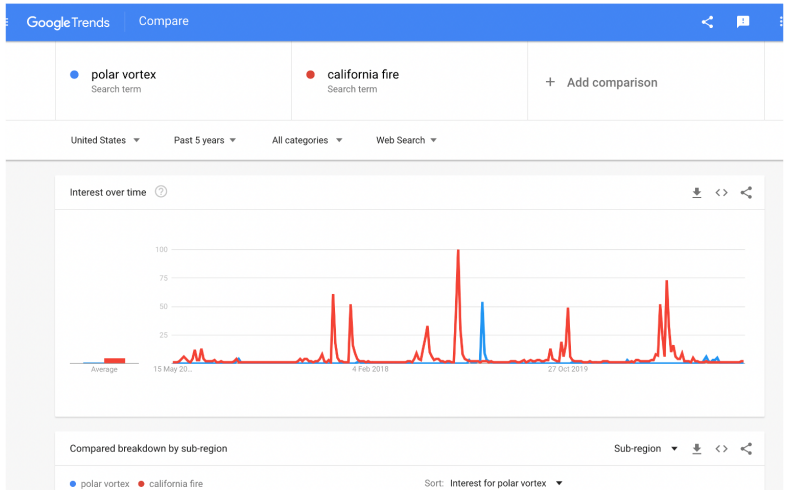

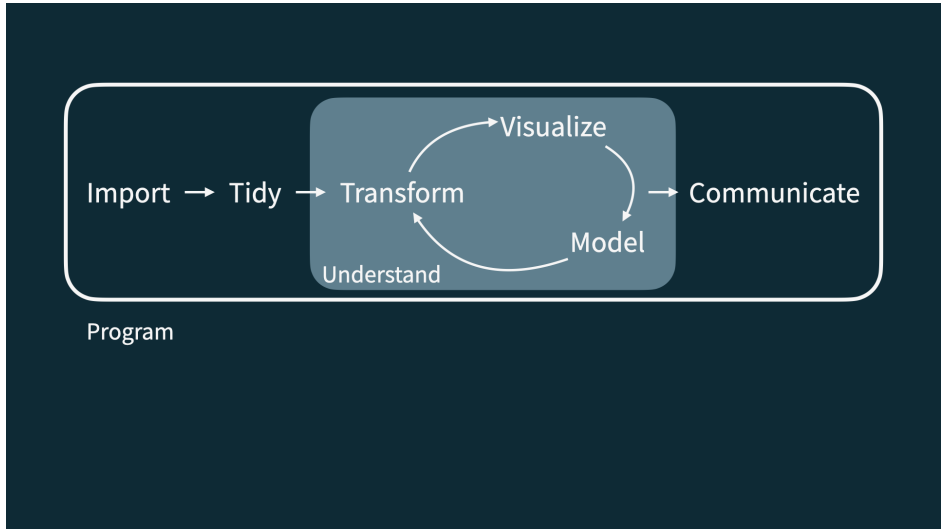


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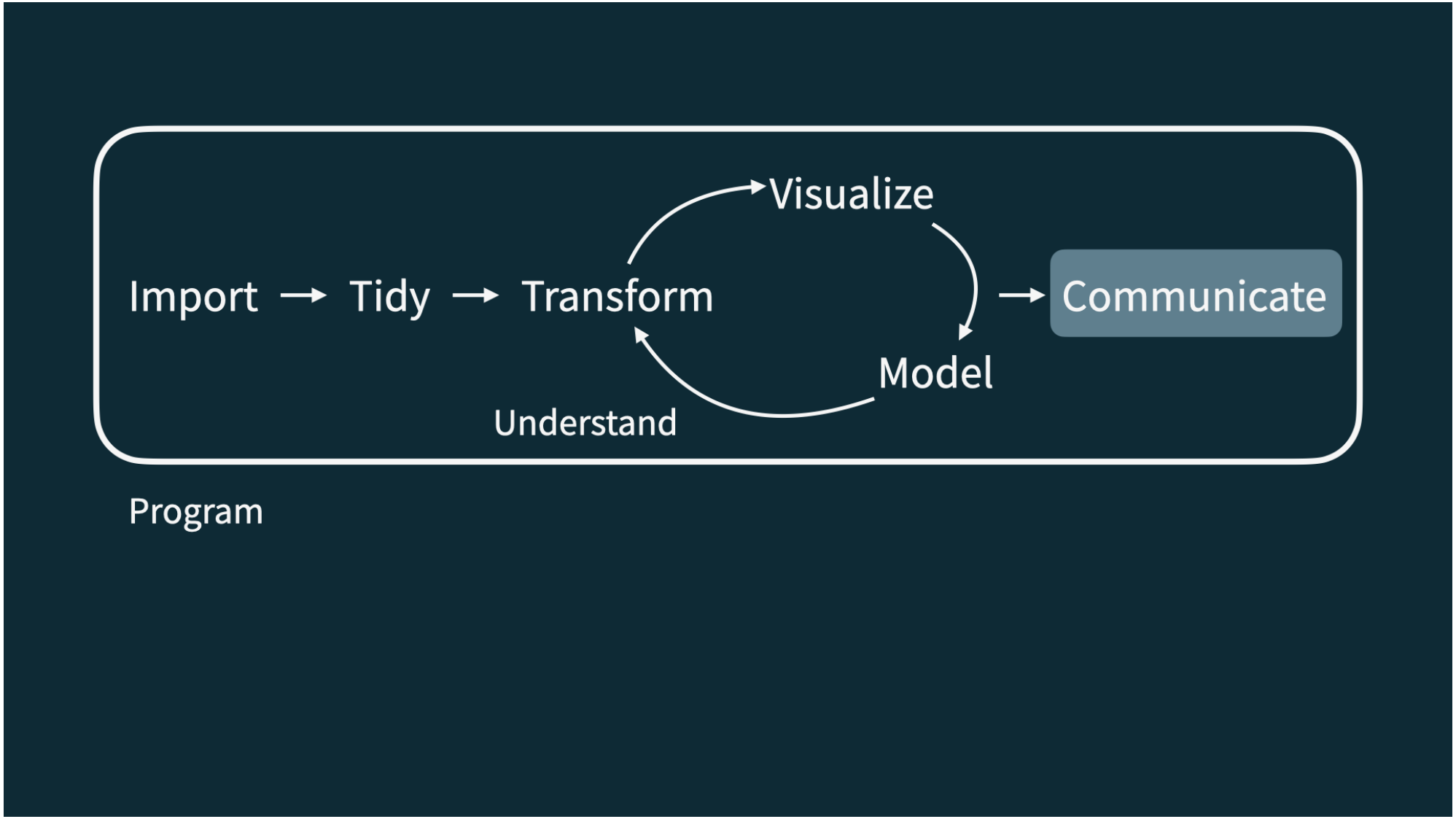
## # A tibble: 5 x 2
##   date             season
##   <chr>            <chr>
## 1 23 January 2017  winter
## 2 4 March 2017     spring
## 3 14 June 2017     summer
## 4 1 September 2017 fall
## 5 ...              ...
```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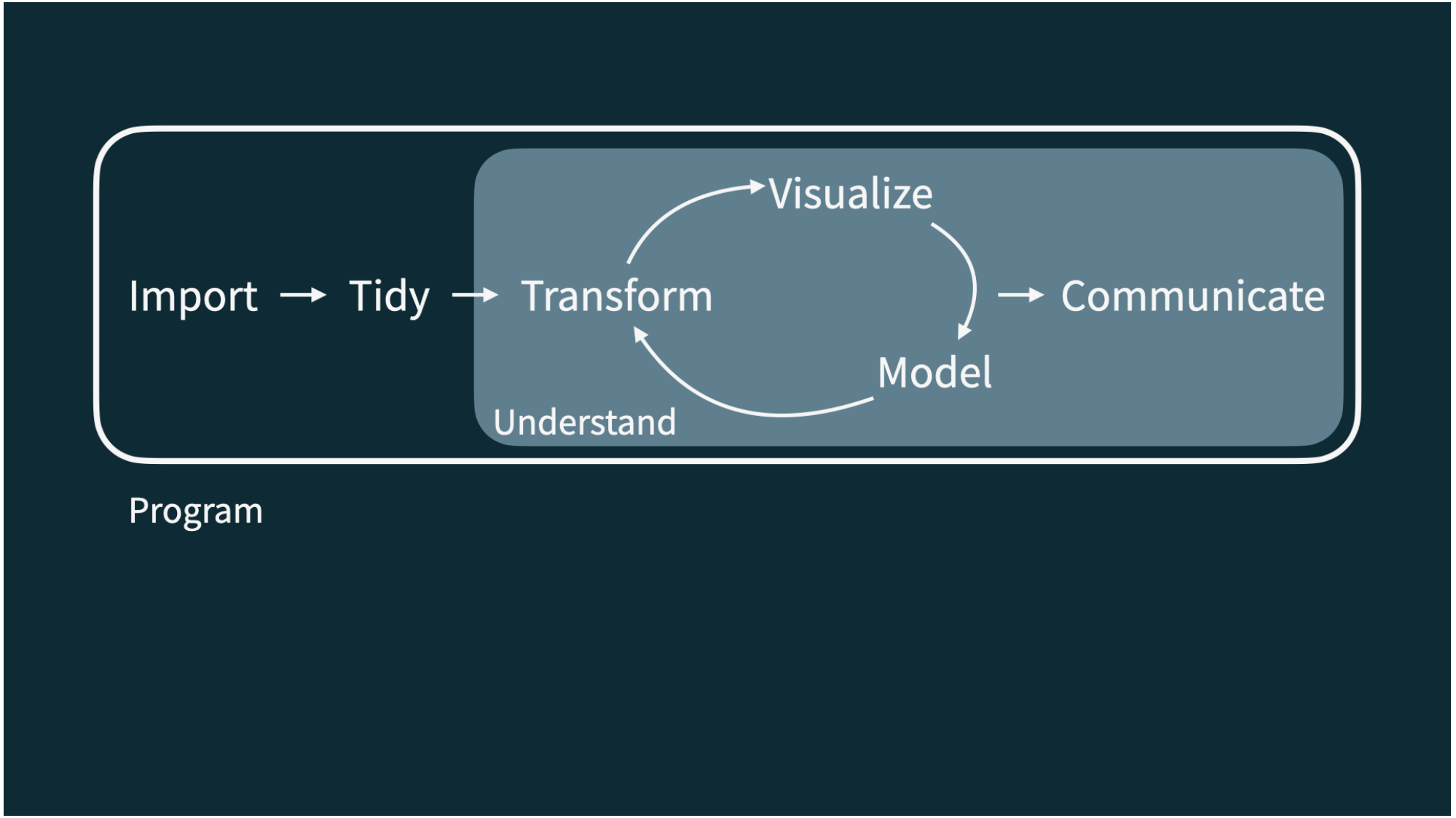
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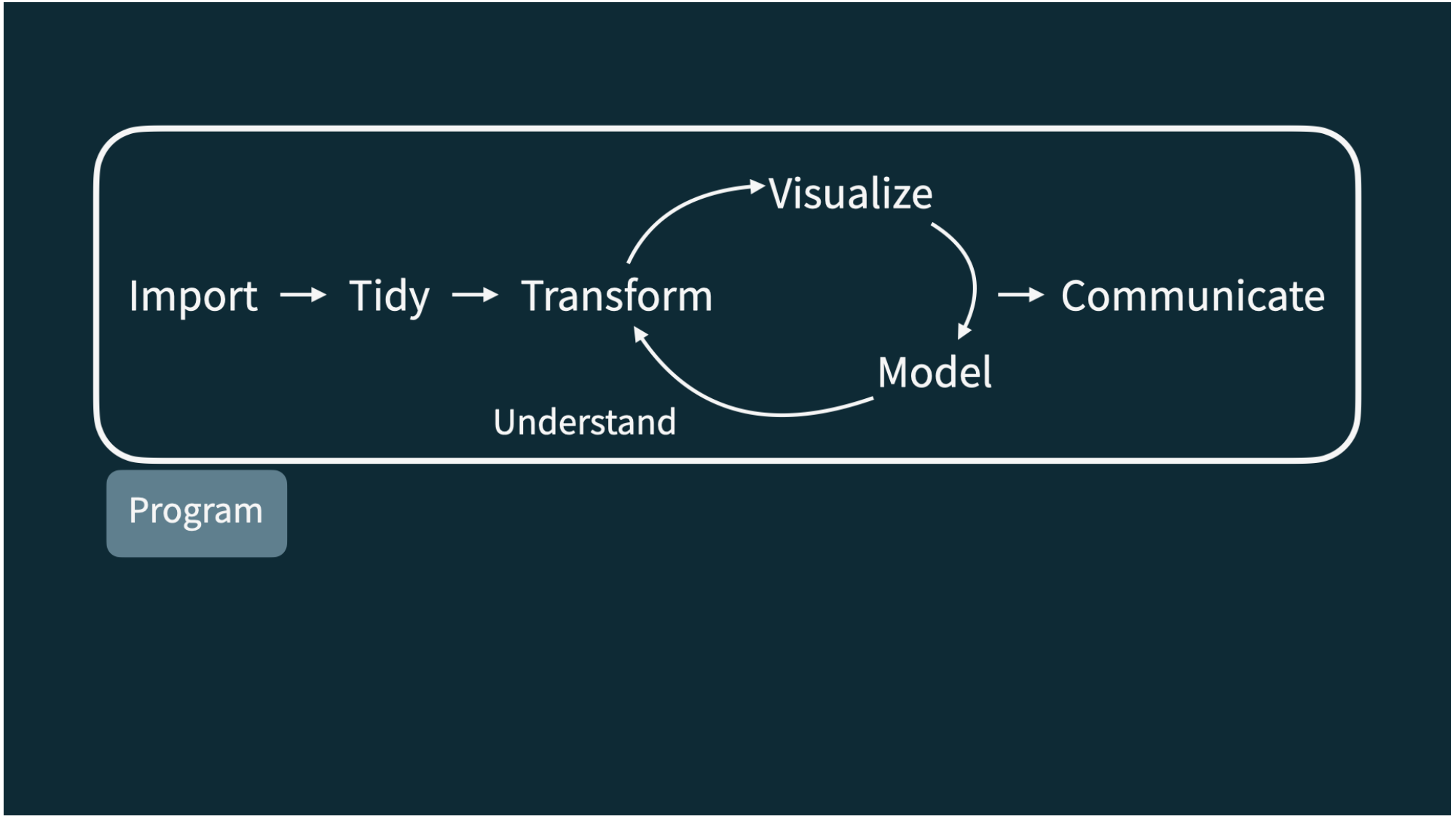
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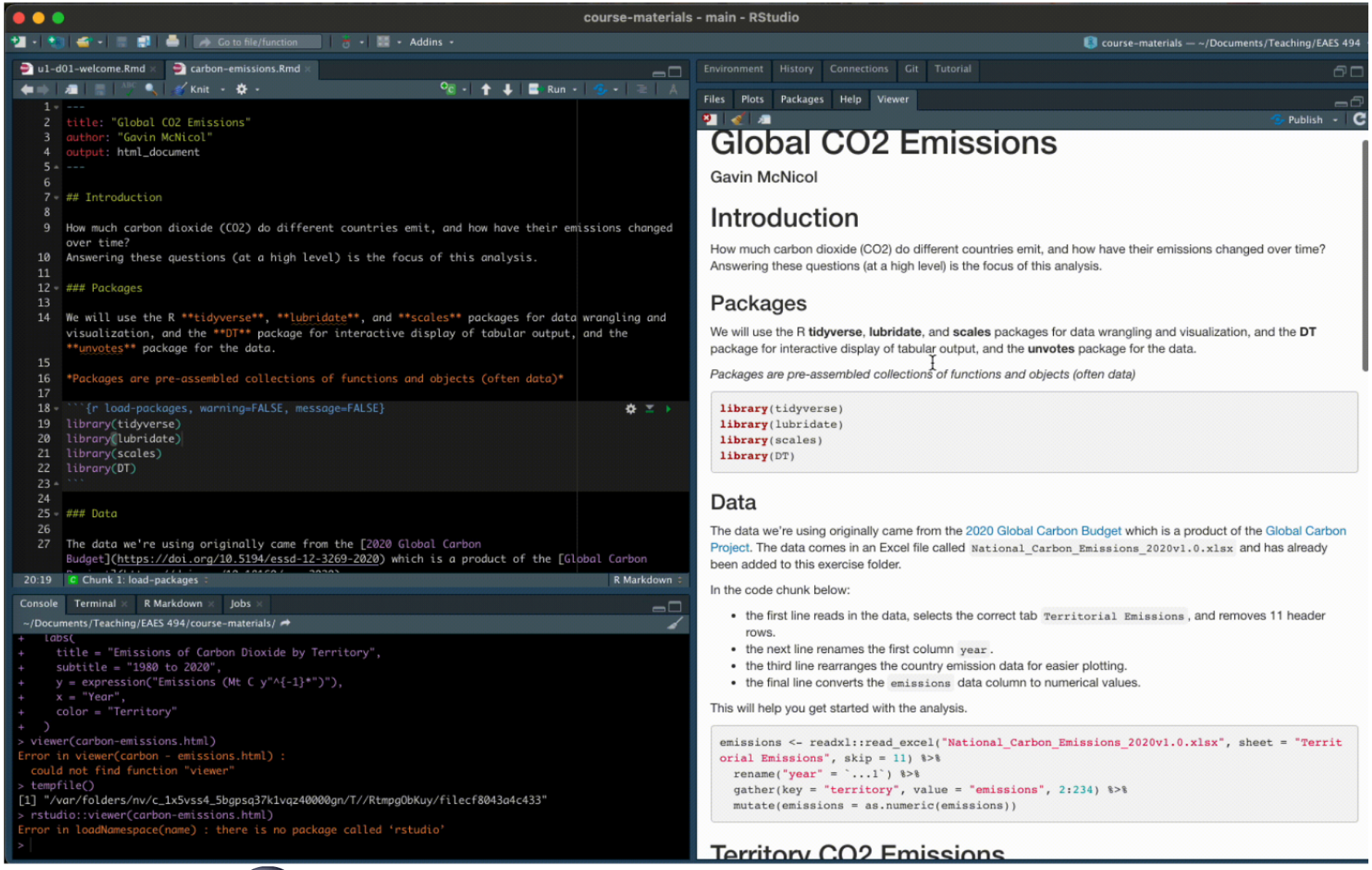
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carbon-emissions.Rmd
Knit
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2 title: "Global CO2 Emissions"
3 author: "Gavin McNicol"
4 output: html_document
5 ---
6
7 ## Introduction
8
9 How much carbon dioxide (CO2) do different countries emit, and how have their emissions changed over time?
10 Answering these questions (at a high level) is the focus of this analysis.
11
12 ### Packages
13
14 We will use the R **tidyverse**, **lubridate**, and **scales** packages for data wrangling and visualization, and the **DT** package for interactive display of tabular output, and the **unvotes** package for the data.
15
16 *Packages are pre-assembled collections of functions and objects (often data)*
17
18 ```{r load-packages, warning=FALSE, message=FALSE}
19 library(tidyverse)
20 library(lubridate)
21 library(scales)
22 library(DT)
23 ```
24
25 ### Data
26
27 The data we're using originally came from the [2020 Global Carbon Budget](https://doi.org/10.5194/essd-12-3269-2020) which is a product of the [Global Carbon
20:19
Chunk 1: load-packages
R Markdown
Console
Terminal
R Markdown
Jobs
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+ labs(
+ title = "Emissions of Carbon Dioxide by Territory",
+ subtitle = "1980 to 2020",
+ y = expression("Emissions (Mt C y"^{-1}*")"),
+ x = "Year",
+ color = "Territory"
+)
> viewer(carbon-emissions.html)
Error in viewer(carbon - emissions.html) :
could not find function "viewer"
> tempfile()
[1] "/var/folders/nv/c_1x5vss4_5bgpsq37k1vqz40000gn/T//RtmpgObKuy/filecf8043a4c433"
> rstudio::viewer(carbon-emissions.html)
Error in loadNamespace(name) : there is no package called 'rstudio'
course-materials — ~/Documents/Teaching/EAES 494
Environment
History
Connections
Git
Tutorial
Files
Plots
Packages
Help
Viewer
Publish
Global CO2 Emissions
Gavin McNicol
Introduction
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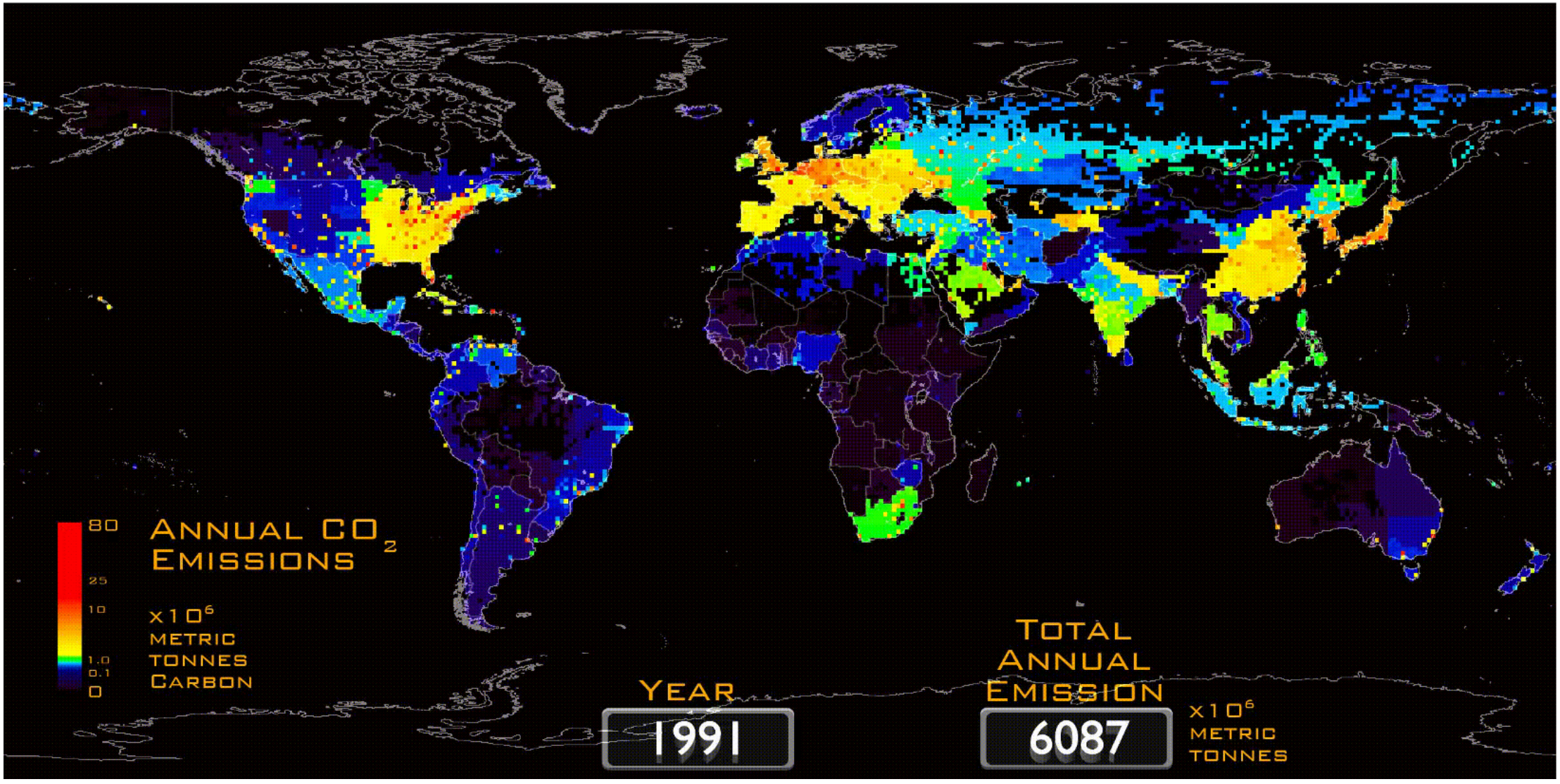
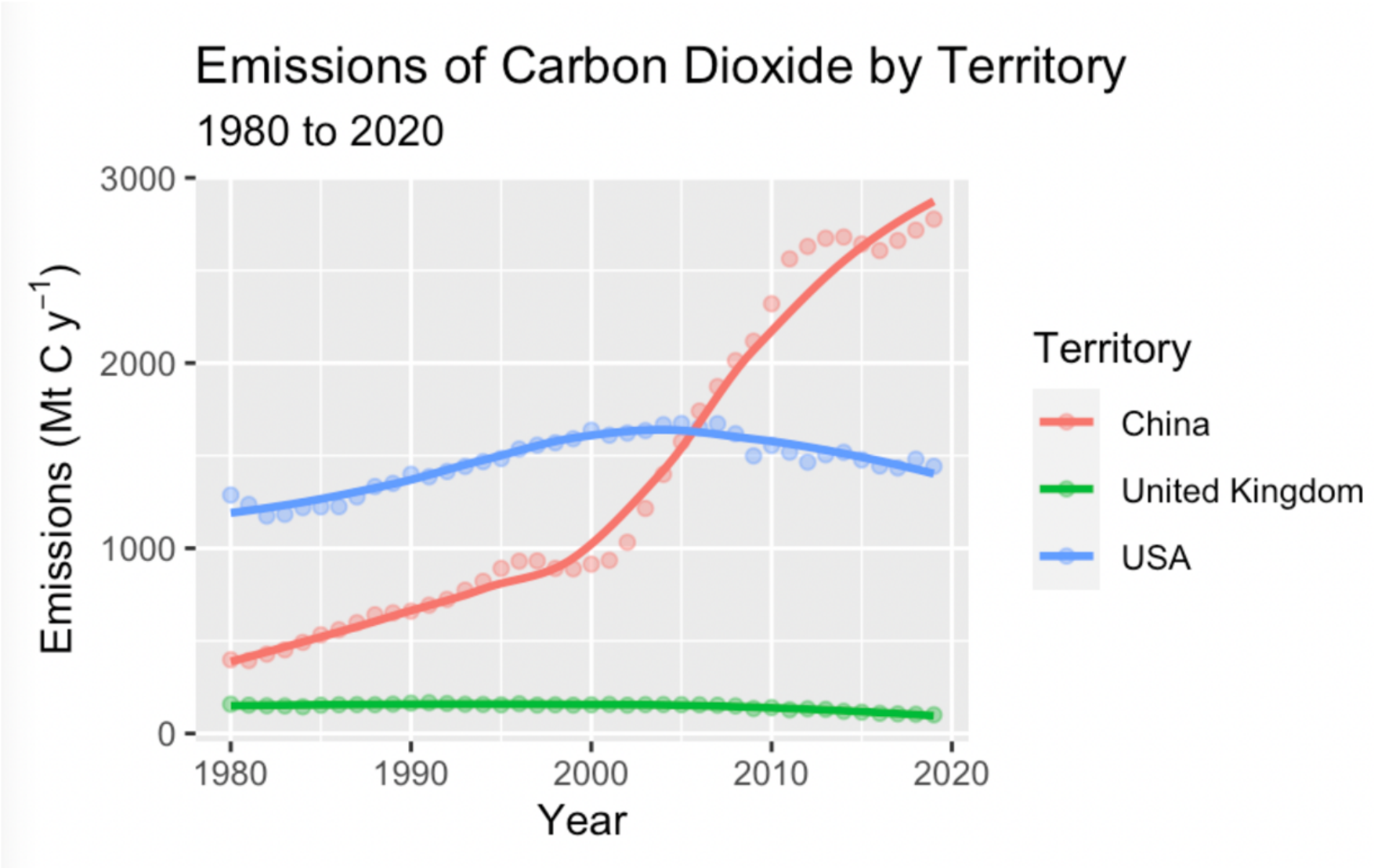
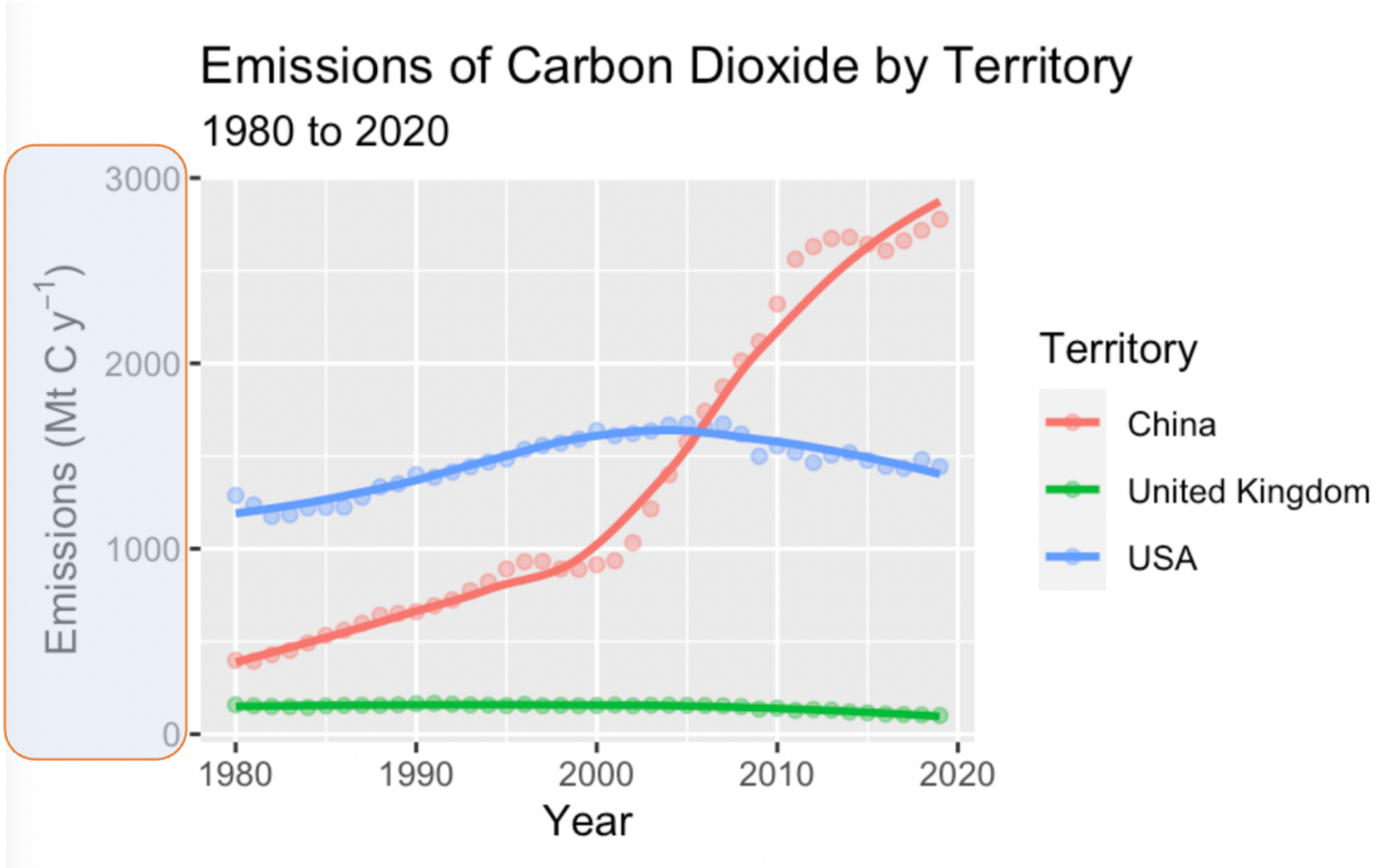
Territory CO2 Emissions

Let's dive in!


80
25
10
1.0
0.1
0
ANNUAL CO2 EMISSIONS
x10^6 METRIC TONNES CARBON
YEAR
1991
TOTAL ANNUAL EMISSION
6087
x10^6 METRIC TONNES


Emissions of Carbon Dioxide by Territory
1980 to 2020
Emissions (Mt C y^{-1})
3000
2000
1000
0
1980
1990
2000
2010
2020
Year
Territory
China
United Kingdom
USA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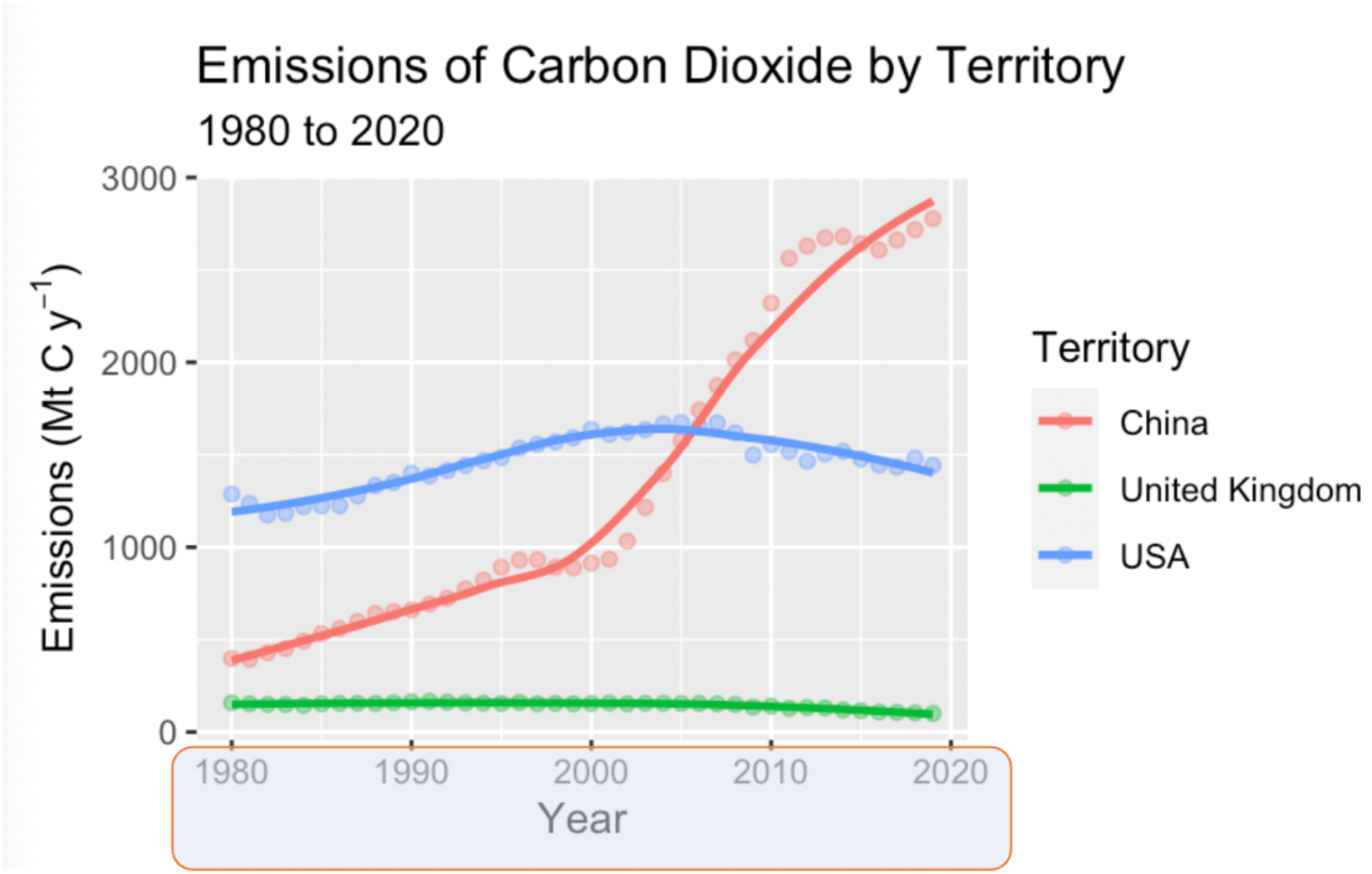
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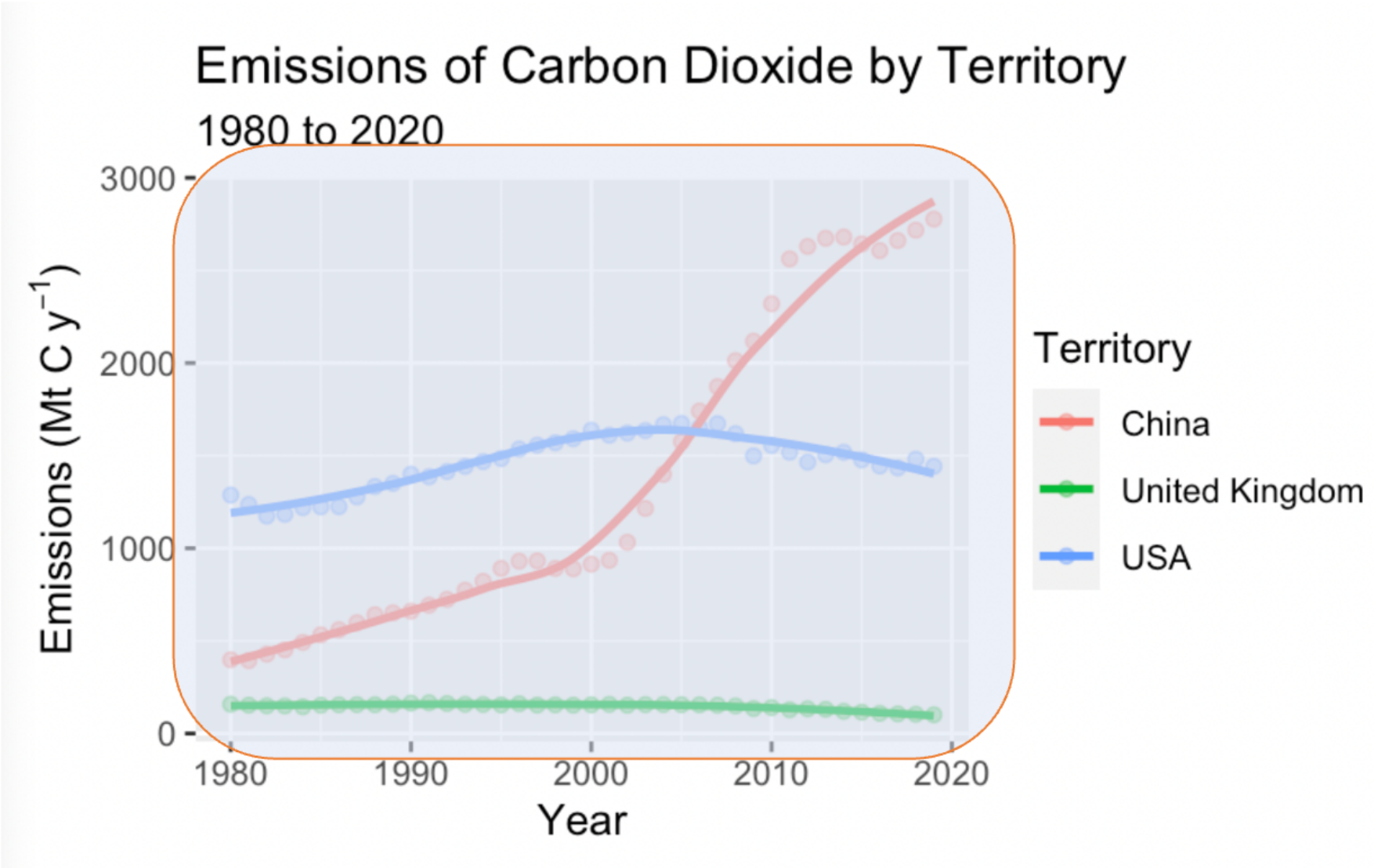
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Emissions (Mt C y^{-1})
3000
2000
1000
0
1980
1990
2000
2010
2020
Year
Territory
China
United Kingdom
USA

emissions

Filter

	year	territory	emissions
1	1959	Afghanistan	0.1049594
2	1960	Afghanistan	0.1129598
3	1961	Afghanistan	0.1339513
4	1962	Afghanistan	0.1879351
5	1963	Afghanistan	0.1928865
6	1964	Afghanistan	0.2288621
7	1965	Afghanistan	0.2748135
8	1966	Afghanistan	0.2978054
9	1967	Afghanistan	0.3498540
10	1968	Afghanistan	0.3338949
11	1969	Afghanistan	0.2568865
12	1970	Afghanistan	0.4558943
13	1971	Afghanistan	0.5168072
14	1972	Afghanistan	0.4176876
15	1973	Afghanistan	0.4463936
16	1974	Afghanistan	0.5221996
17	1975	Afghanistan	0.5790436
18	1976	Afghanistan	0.5407152
19	1977	Afghanistan	0.6507874
20	1978	Afghanistan	0.5877777
21	1979	Afghanistan	0.6094850
22	1980	Afghanistan	0.4793848
23	1981	Afghanistan	0.5400434
24	1982	Afghanistan	0.5717566
25	1983	Afghanistan	0.6877769
26	1984	Afghanistan	0.7702047

Showing 1 to 26 of 14,213 entries, 3 total columns

carbon-emissions.Rmd

Knit | Run

```
44 ```
45
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62   geom_point(alpha = 0.4) +
63   geom_smooth(method = "loess", se = FALSE) +
64   labs(
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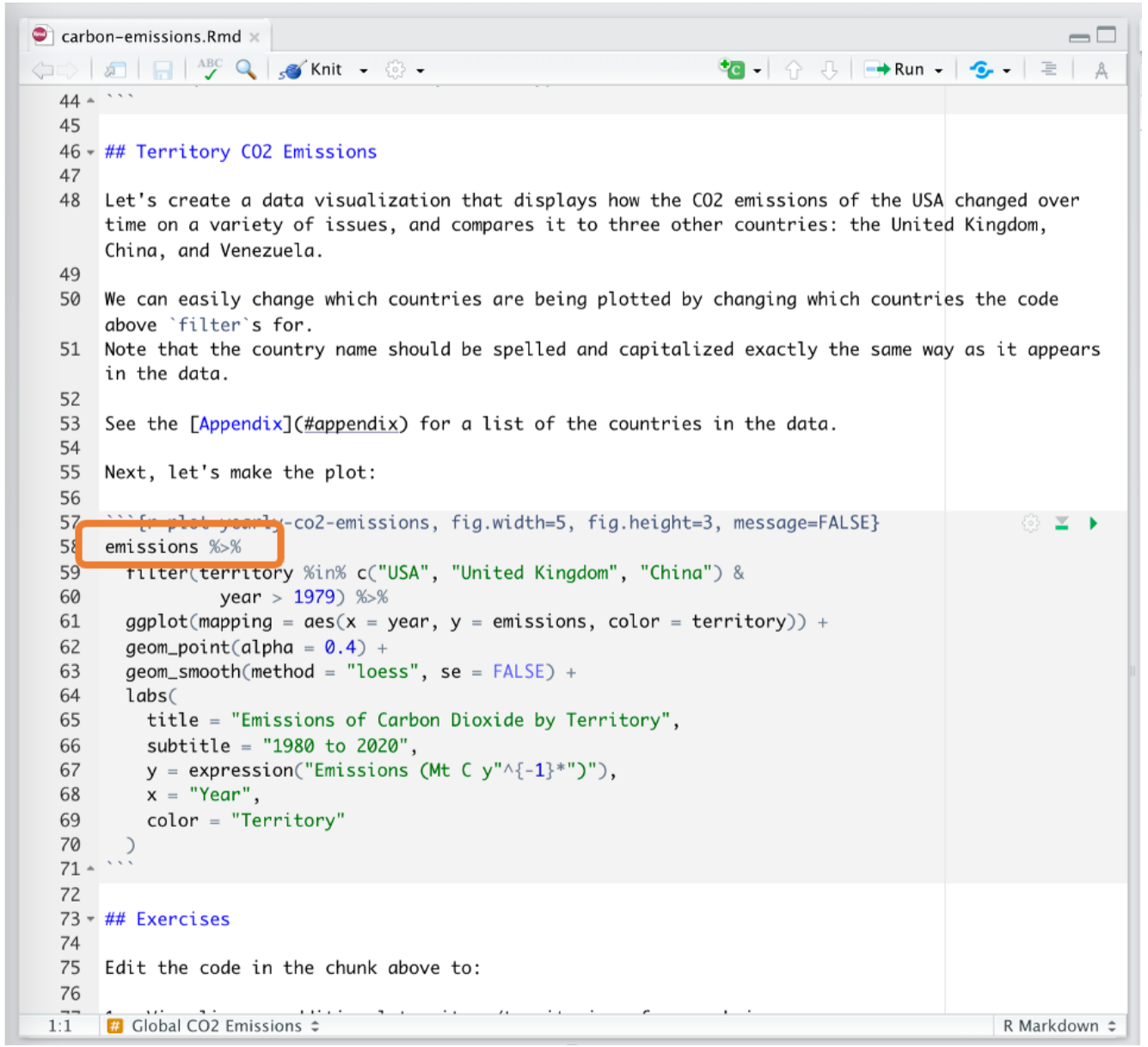
66     subtitle = "1980 to 2020",
67     y = expression("Emissions (Mt C y"^{-1}*")"),
68     x = "Year",
69     color = "Territory"
70   )
71 ```
72
73 ## Exercises
74
75 Edit the code in the chunk above to:
76
```

1:1 | Global CO2 Emissions | R Markdown


carbon-emissions.Rmd
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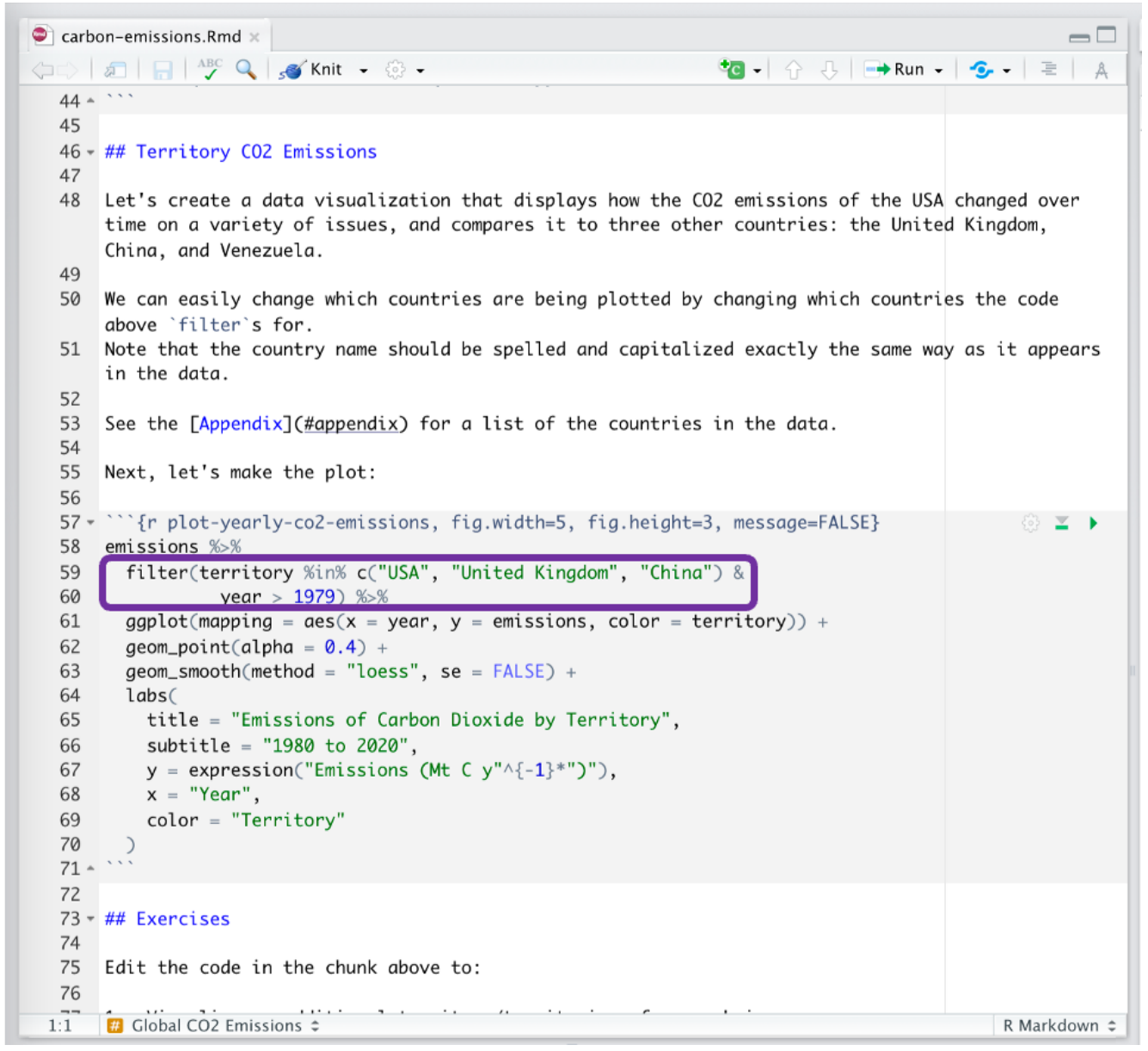
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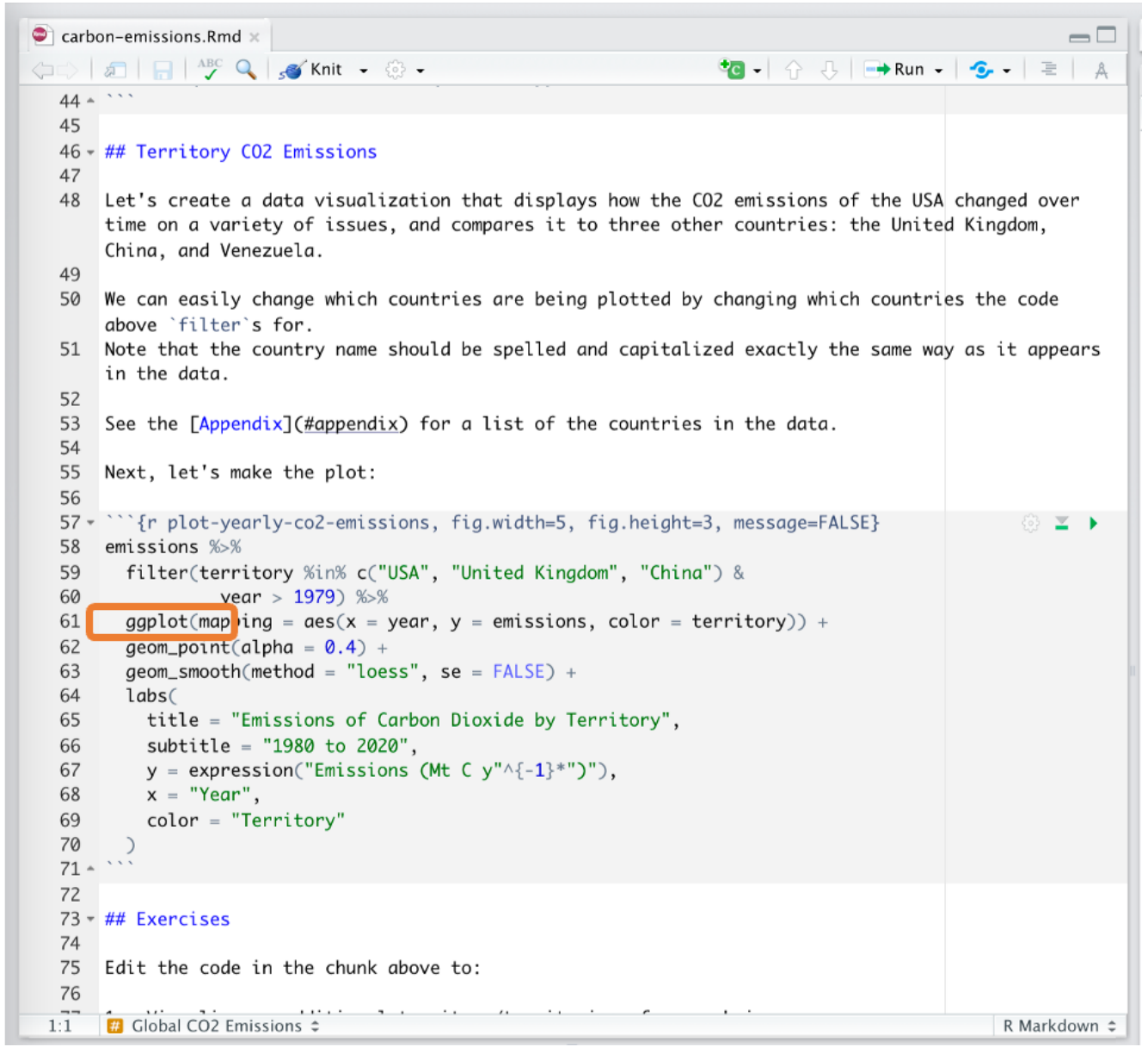
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carbon-emissions.Rmd

Knit | Run

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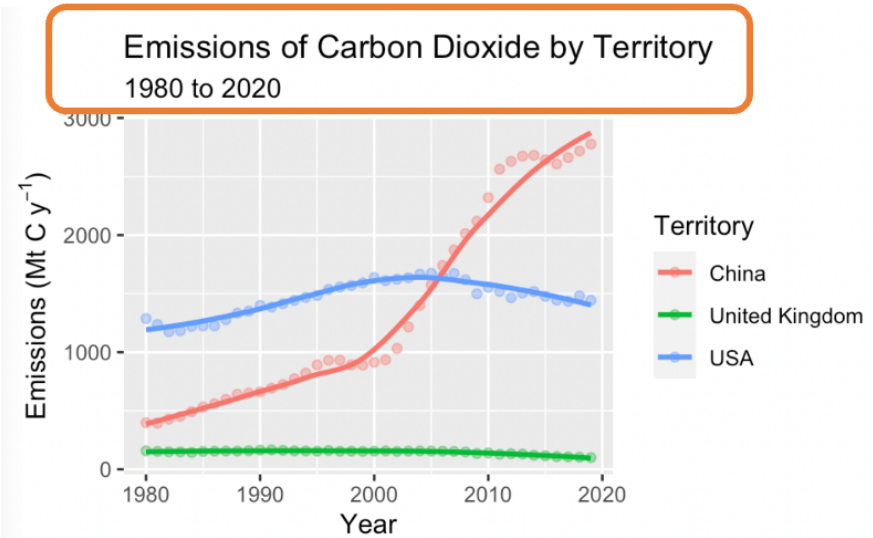

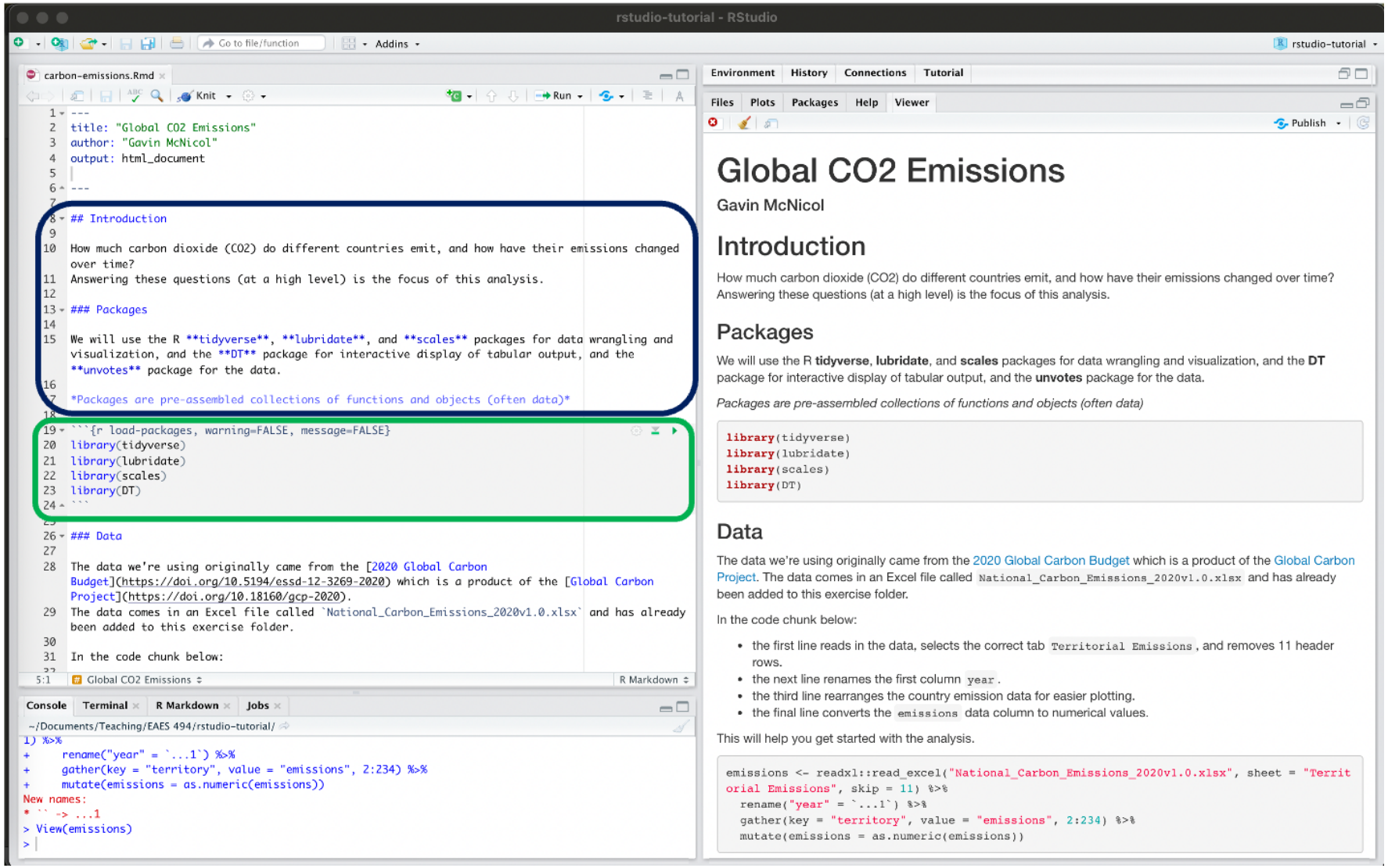
rstudio-tutorial - RStudio
carbon-emissions.Rmd
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title: "Global CO2 Emissions"
author: "Gavin McNicol"
output: html_document

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Global CO2 Emissions
R Markdown
Console
Terminal
R Markdown
Jobs
~/Documents/Teaching/EAES 494/rstudio-tutorial/
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New names:
* `` -> ...1
> View(emissions)
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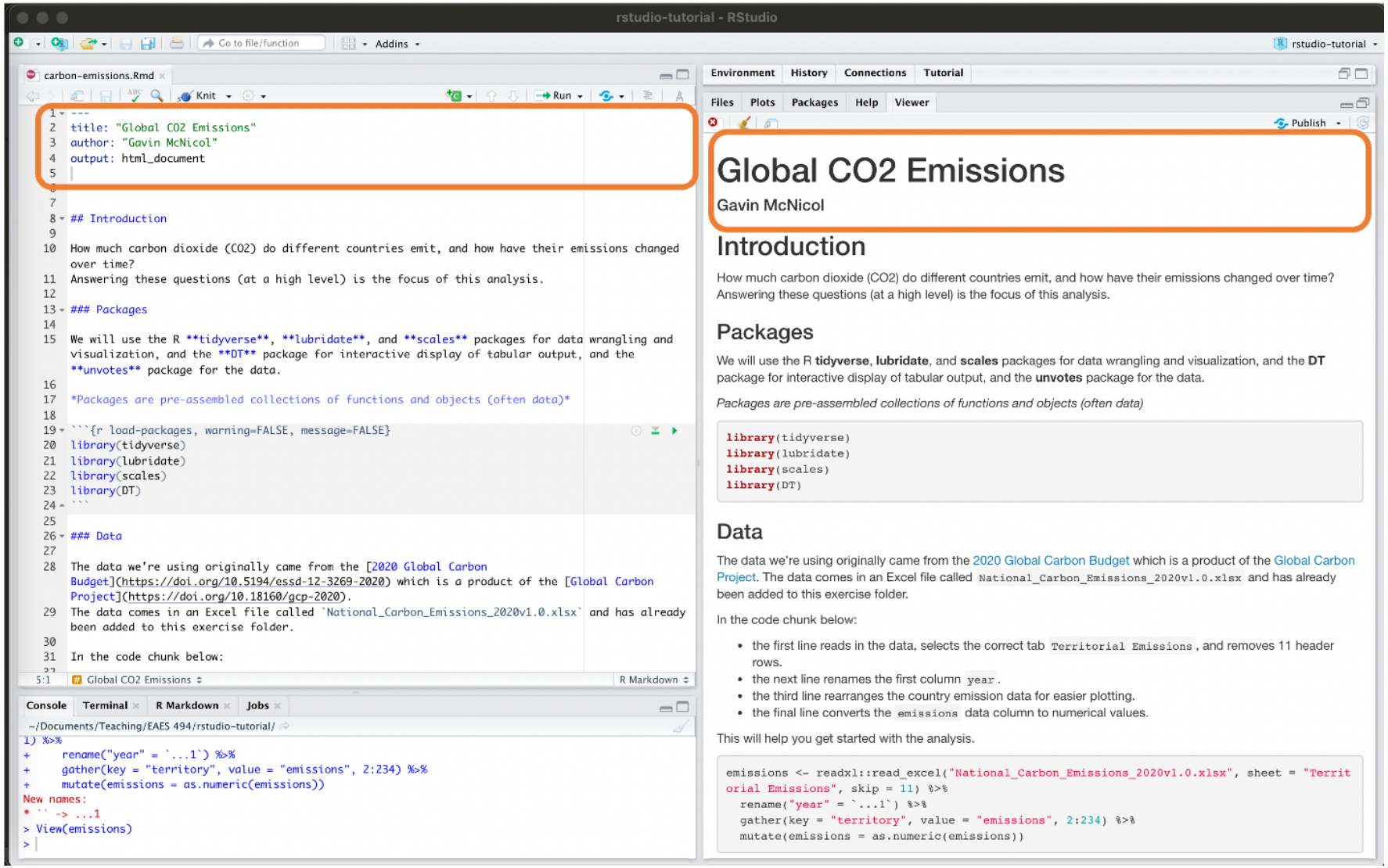
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Now, your turn!

Open the **exercise-01 carbon emissions** project in RStudio Cloud!