

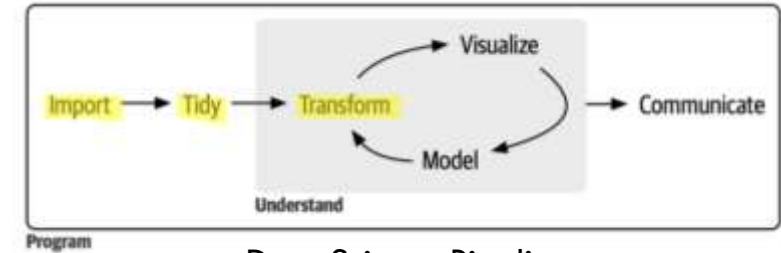
SESSION 3: STATISTICS

DR. SOFIA GIL-CLAVEL

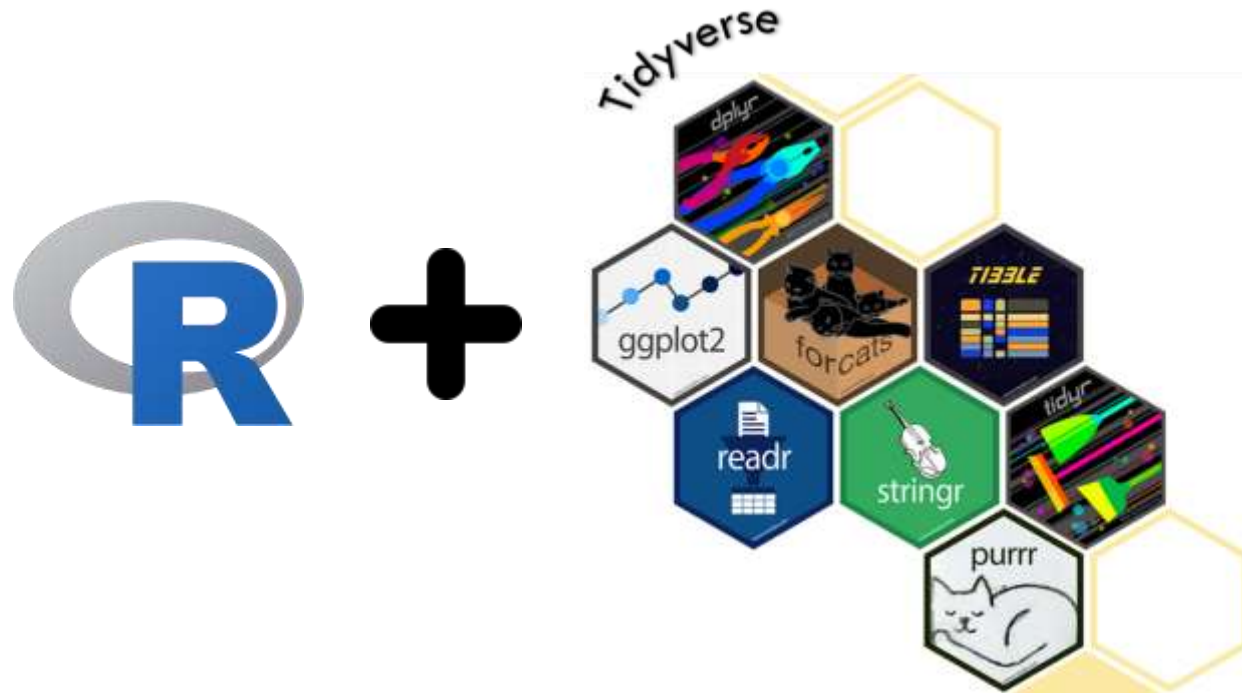
- ❖ Recap
- ❖ Fundamentals of modeling in R: Example applied to linear models
- ❖ Other models?

1. SESSION 1-2: RECAP

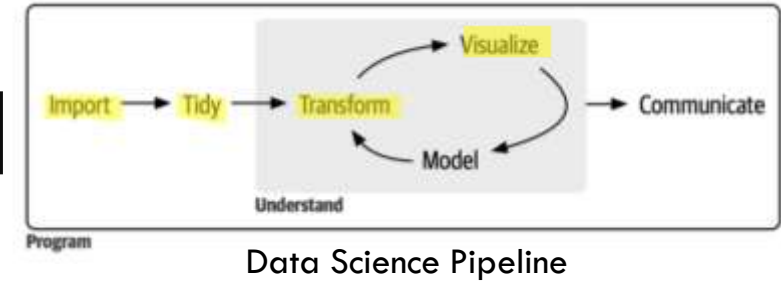
SESSION 1: DATA MANAGEMENT



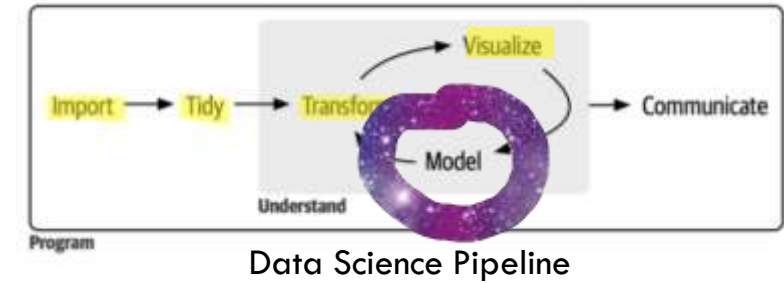
Data Science Pipeline



SESSION 2: DATA VISUALIZATION



SESSION 3: STATISTICS



stats-package {stats}

R Documentation

The R Stats Package

Description

R statistical functions

Details

This package contains functions for statistical calculations and random number generation.

For a complete list of functions, use `library(help = "stats")`.

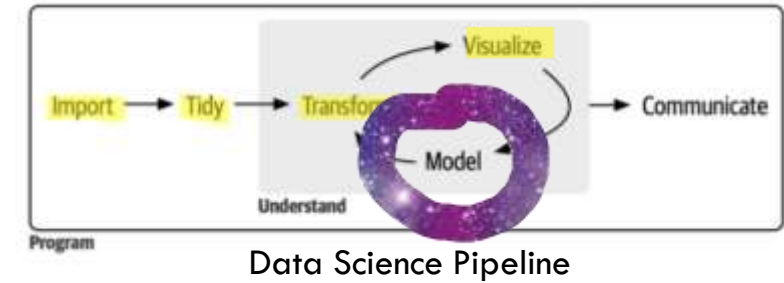
Author(s)

R Core Team and contributors worldwide

Maintainer: R Core Team R-core@r-project.org



SESSION 3: STATISTICS



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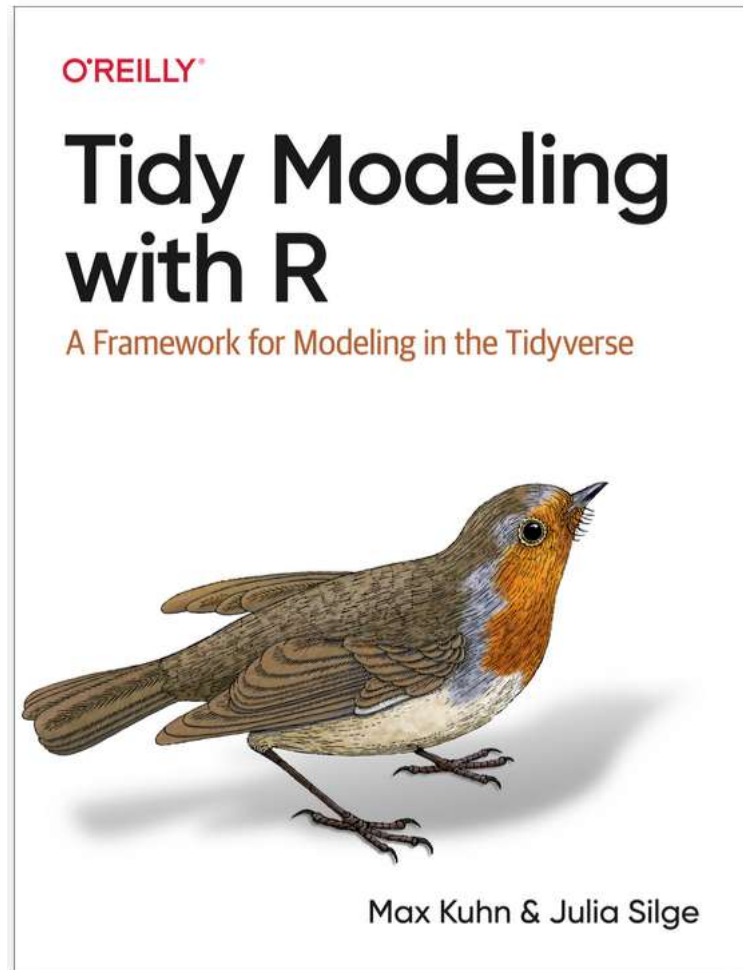
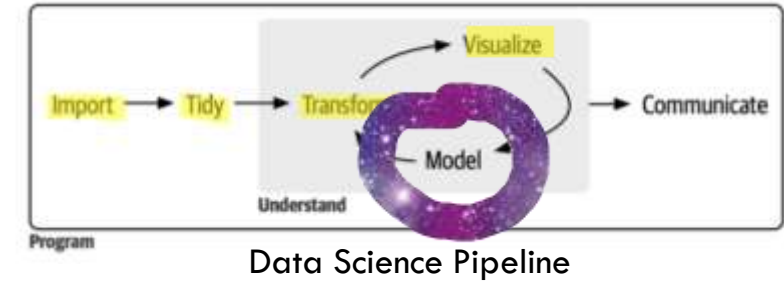
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SESSION 3: STATISTICS



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Check for free here: <https://www.tmwr.org/>

3. FUNDAMENTALS OF R-MODELING

TYPES OF VARIABLES

➤ **Dependent:** The variable (also known as outcome) we are analyzing and that we believe its behavior “depends” on other variables.

$Y \sim$

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Symbolic
Language

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Symbolic
Language

$$Y \sim X1 + X2 + X3$$

 was built to
understand symbolic
language!

BUT FIRST, LET'S OPEN SOME DATA

For this section, we will use the database “**ChickWeight**” from the basic R package.

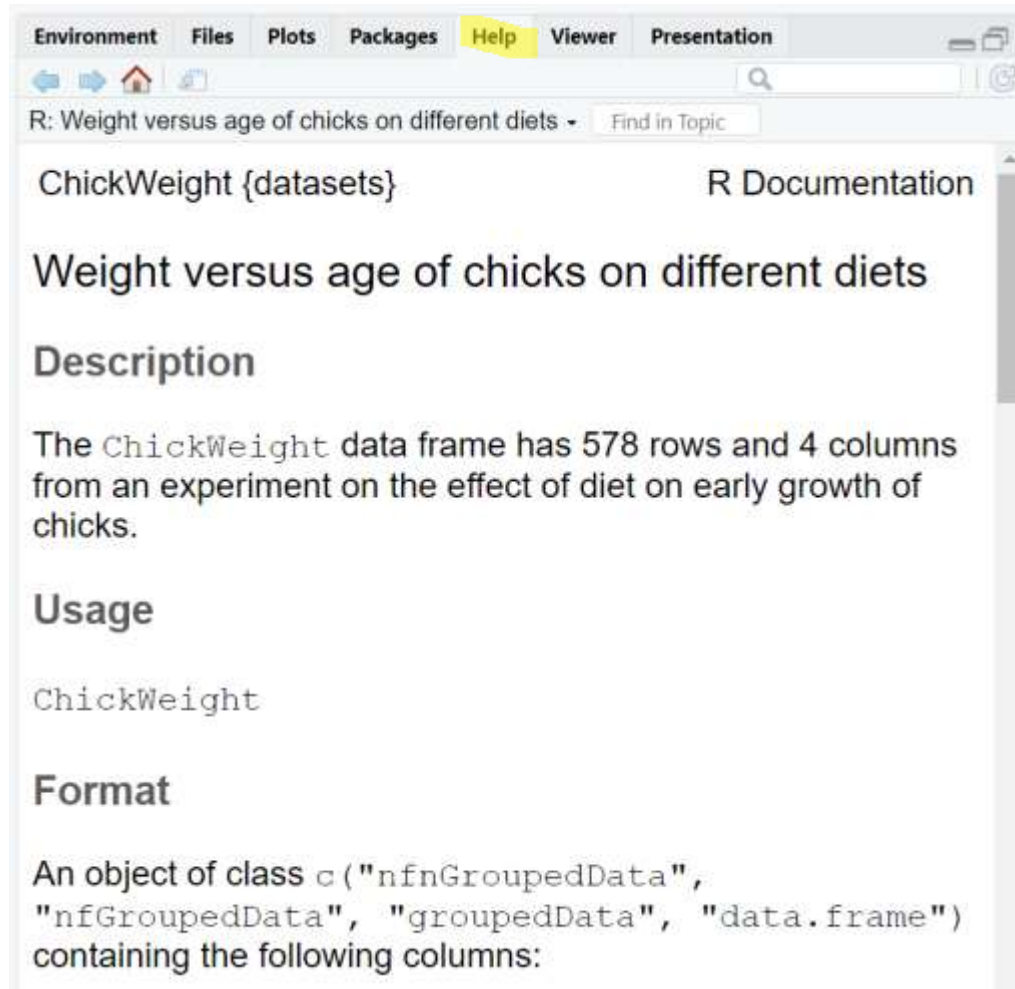
To open it, you just need to write down the name in the console:

```
ChickWeight
```

To see in an independent window, you can use:

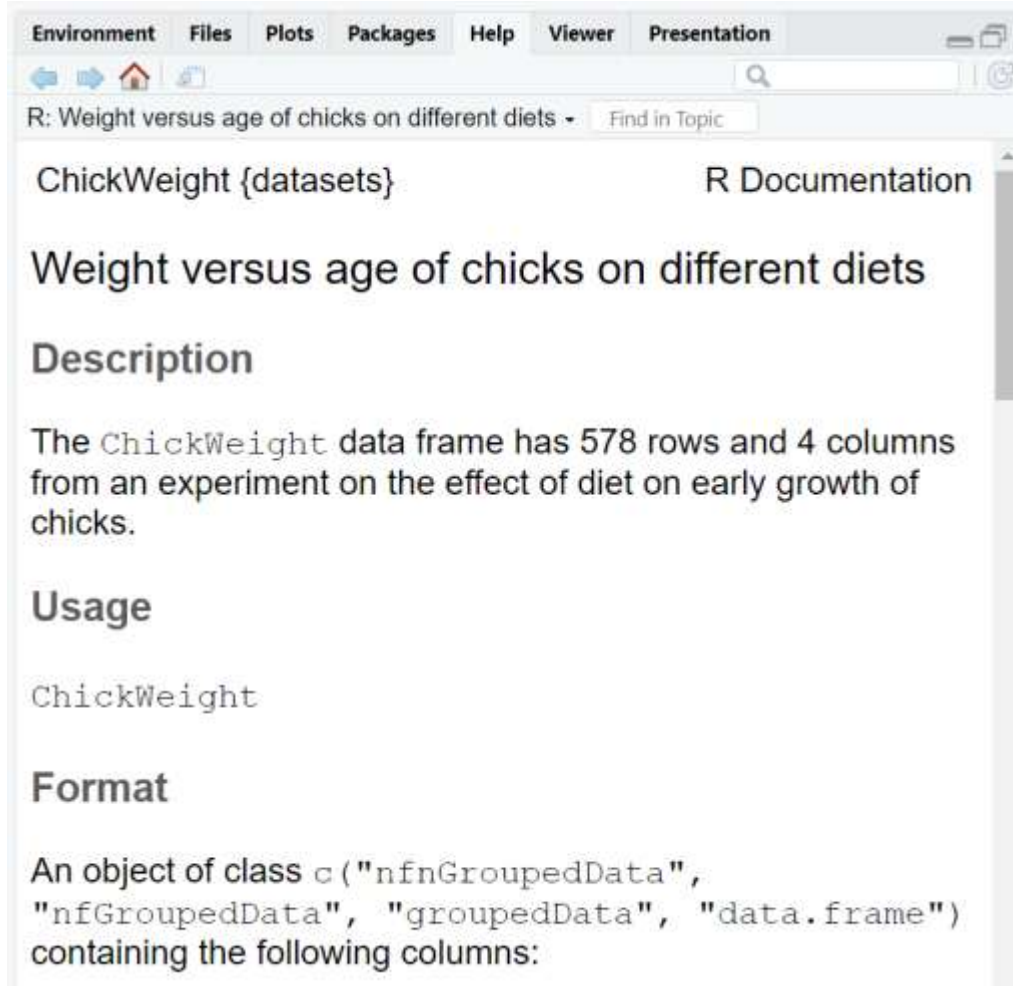
```
view(ChickWeight)
```

BUT FIRST, LET'S OPEN SOME DATA



To learn what each variable represents, you can check its documentation in the “help” window.

BUT FIRST, LET'S OPEN SOME DATA



Environment Files Plots Packages Help Viewer Presentation

R: Weight versus age of chicks on different diets - Find in Topic

ChickWeight {datasets} R Documentation

Weight versus age of chicks on different diets

Description

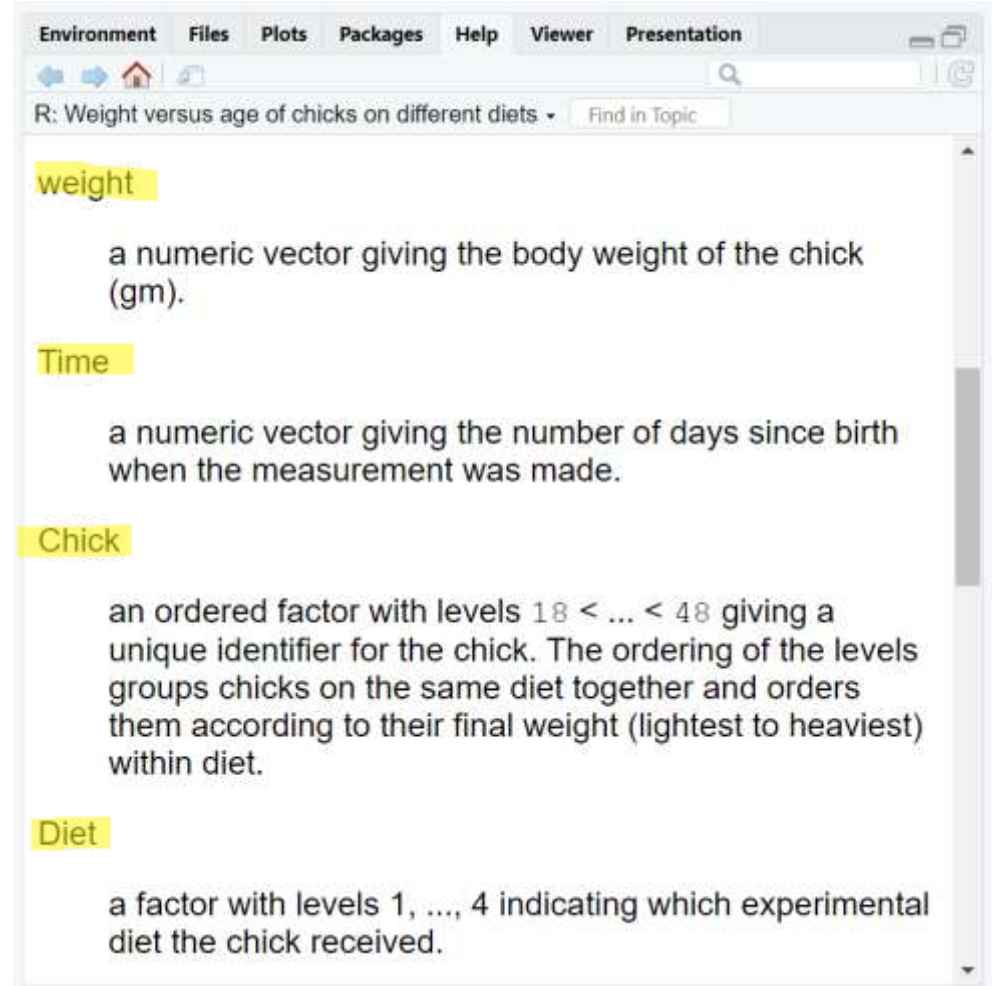
The `ChickWeight` data frame has 578 rows and 4 columns from an experiment on the effect of diet on early growth of chicks.

Usage

```
ChickWeight
```

Format

An object of class `c("nfGroupedData", "nfGroupedData", "groupedData", "data.frame")` containing the following columns:



Environment Files Plots Packages Help Viewer Presentation

R: Weight versus age of chicks on different diets - Find in Topic

weight

a numeric vector giving the body weight of the chick (gm).

Time

a numeric vector giving the number of days since birth when the measurement was made.

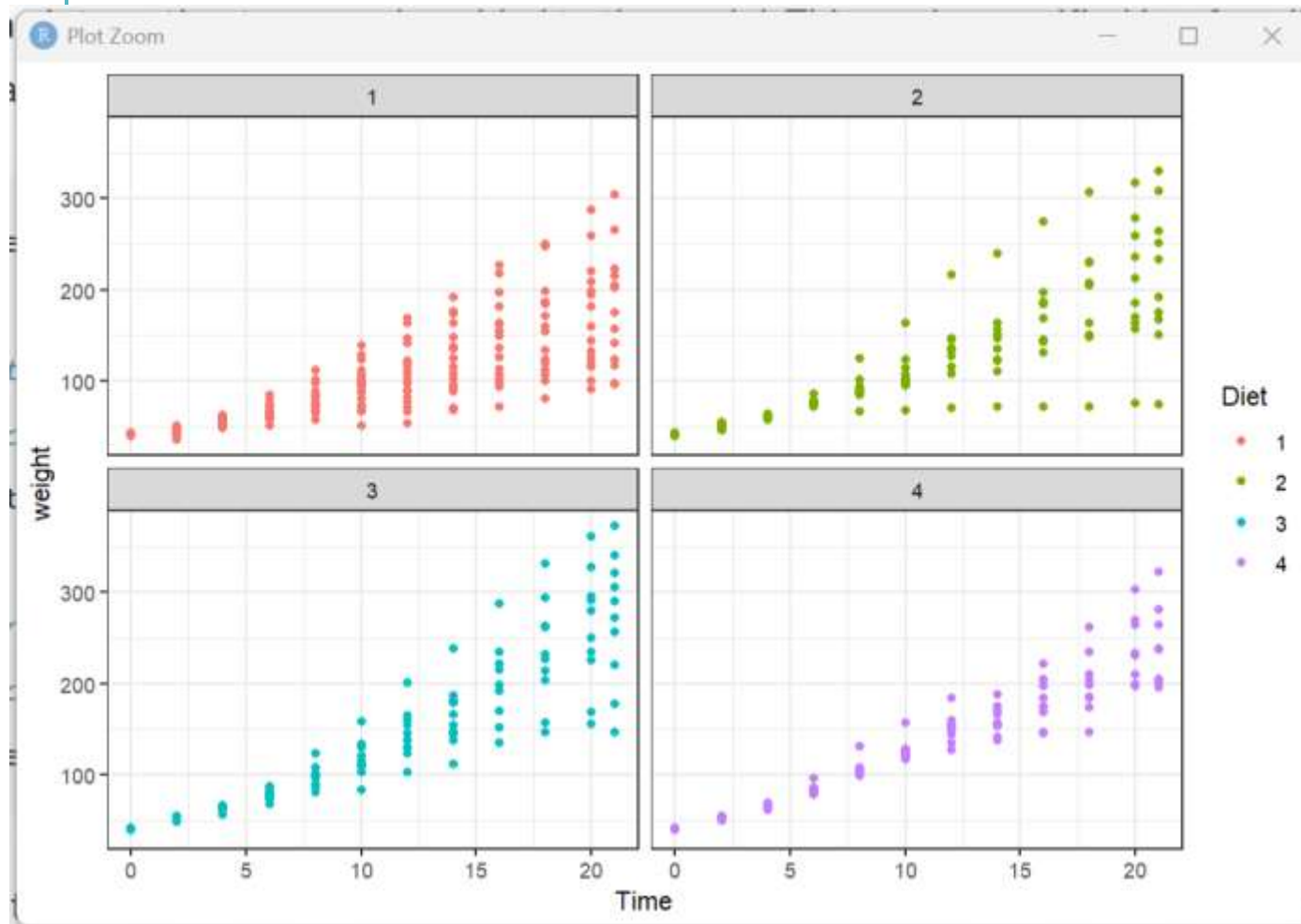
Chick

an ordered factor with levels `18 < ... < 48` giving a unique identifier for the chick. The ordering of the levels groups chicks on the same diet together and orders them according to their final weight (lightest to heaviest) within diet.

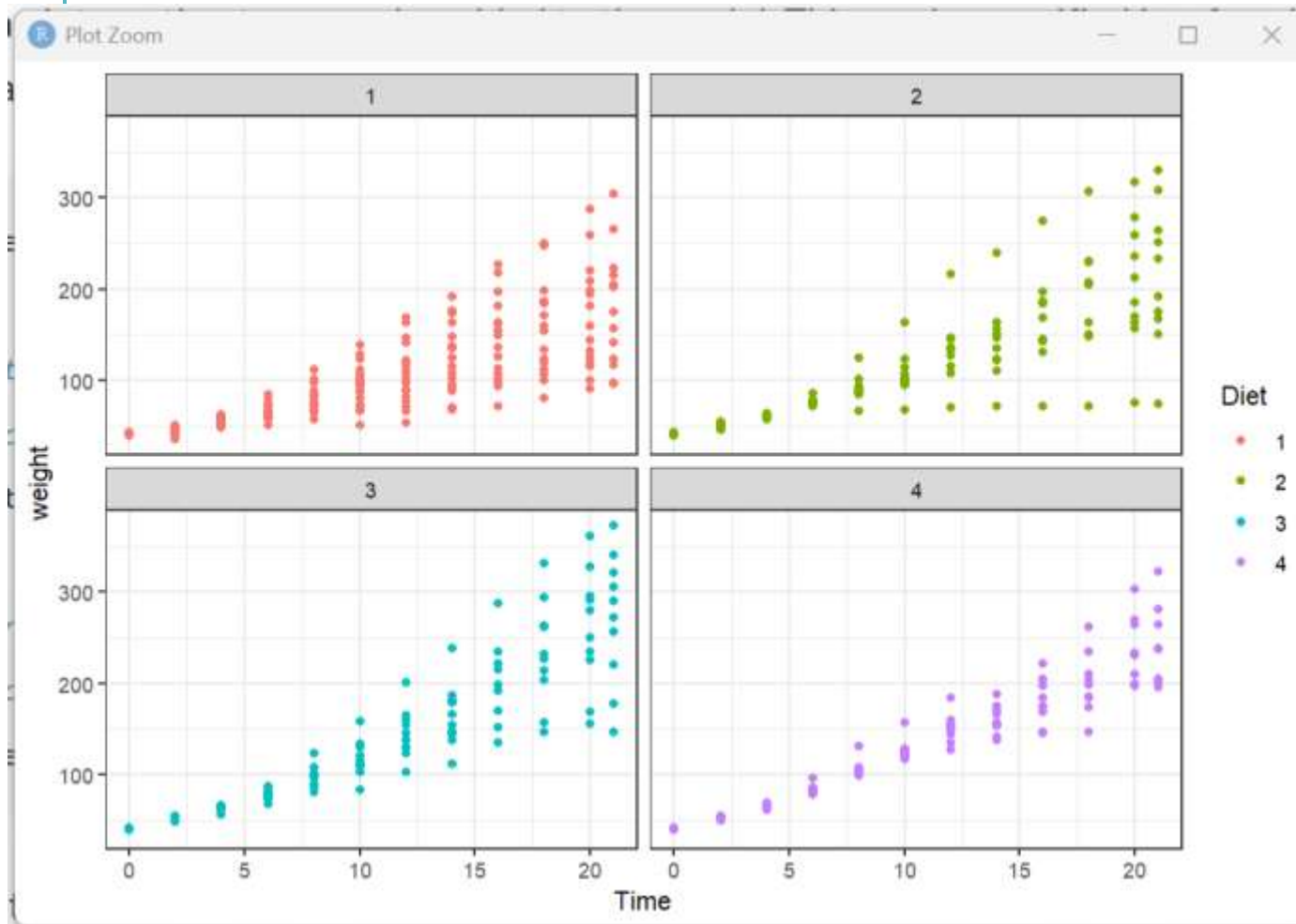
Diet

a factor with levels `1, ..., 4` indicating which experimental diet the chick received.

LET'S CHECK HOW THE DATA LOOKS

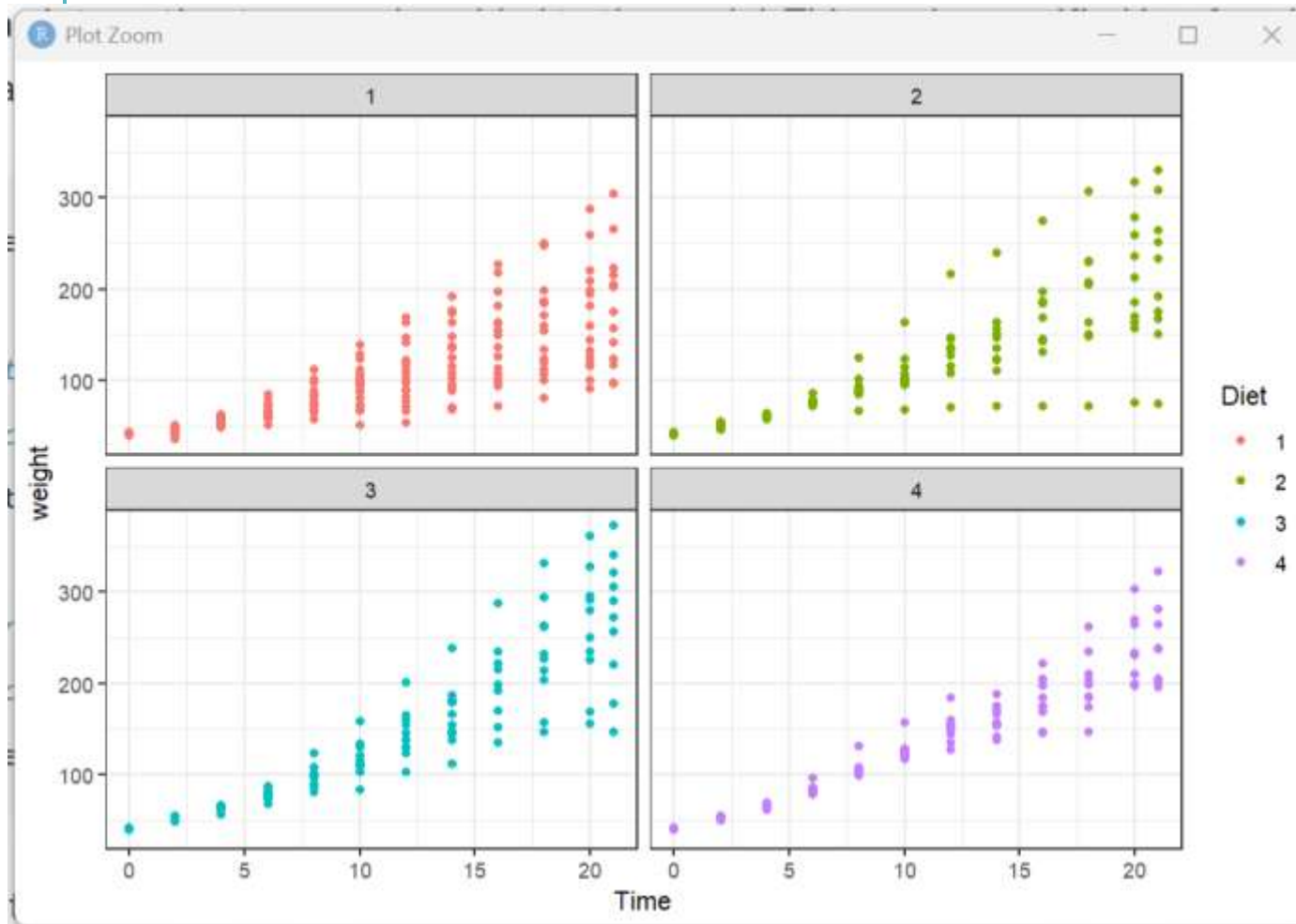


LET'S CHECK HOW THE DATA LOOKS



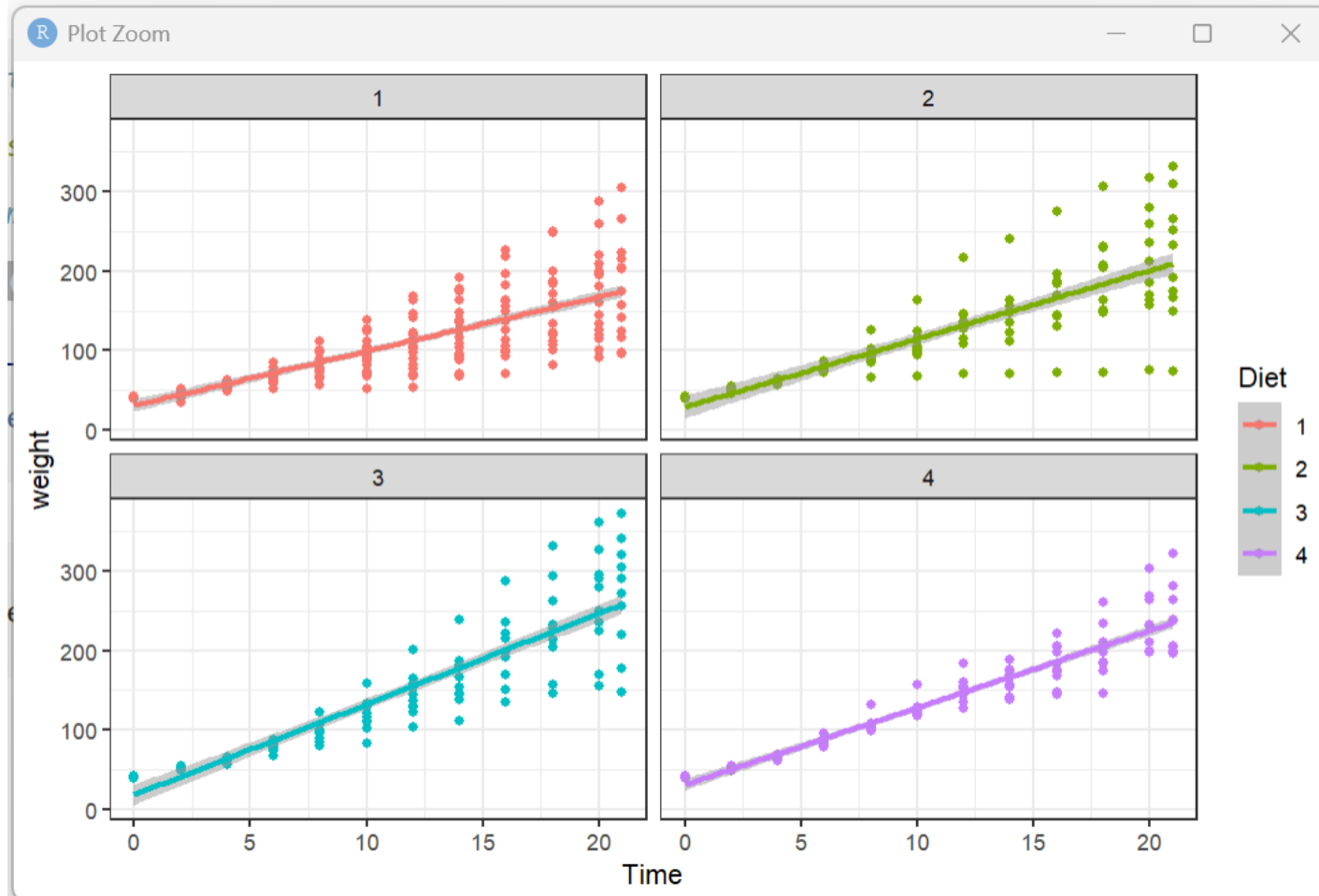
What are some interesting statistical questions?

LET'S CHECK HOW THE DATA LOOKS



What are some interesting statistical questions? That is up to you!

LET'S CHECK HOW THE DATA LOOKS

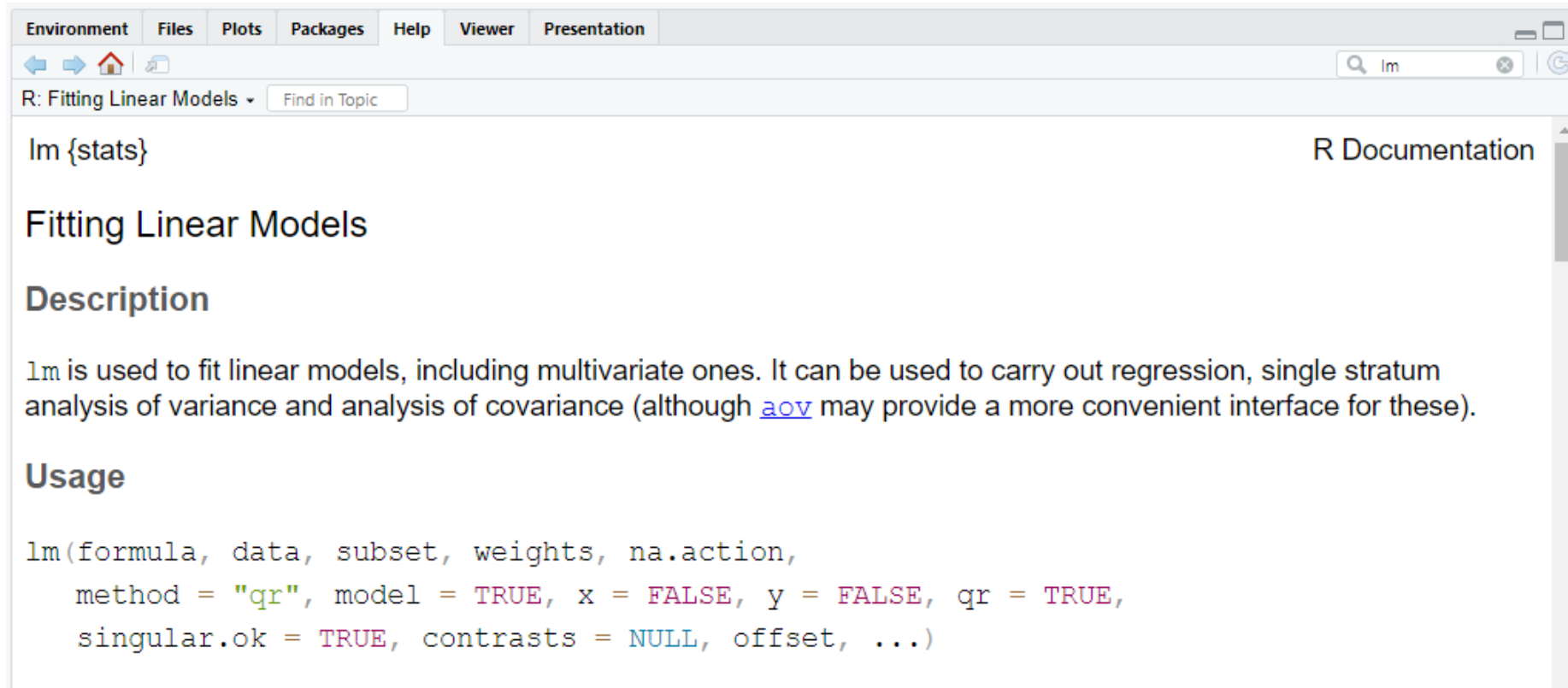


What are some interesting statistical questions? That is up to you!

Now we will learn about:

- Linear regression models

FITTING LINEAR MODELS

A screenshot of the R Documentation window for the 'lm' function. The window has a menu bar with 'Environment', 'Files', 'Plots', 'Packages', 'Help', 'Viewer', and 'Presentation'. Below the menu bar is a search bar containing 'lm' and a 'Find in Topic' button. The main content area shows the title 'lm {stats}', the subtitle 'Fitting Linear Models', and a 'Description' section. The description states that 'lm' is used to fit linear models, including multivariate ones, and can be used for regression, single stratum analysis of variance, and analysis of covariance. It also mentions that 'aov' may provide a more convenient interface for these. Below the description is a 'Usage' section showing the function signature: 'lm(formula, data, subset, weights, na.action, method = "qr", model = TRUE, x = FALSE, y = FALSE, qr = TRUE, singular.ok = TRUE, contrasts = NULL, offset, ...)'.

Environment Files Plots Packages Help Viewer Presentation

R: Fitting Linear Models Find in Topic

lm {stats}

R Documentation

Fitting Linear Models

Description

`lm` is used to fit linear models, including multivariate ones. It can be used to carry out regression, single stratum analysis of variance and analysis of covariance (although [aov](#) may provide a more convenient interface for these).

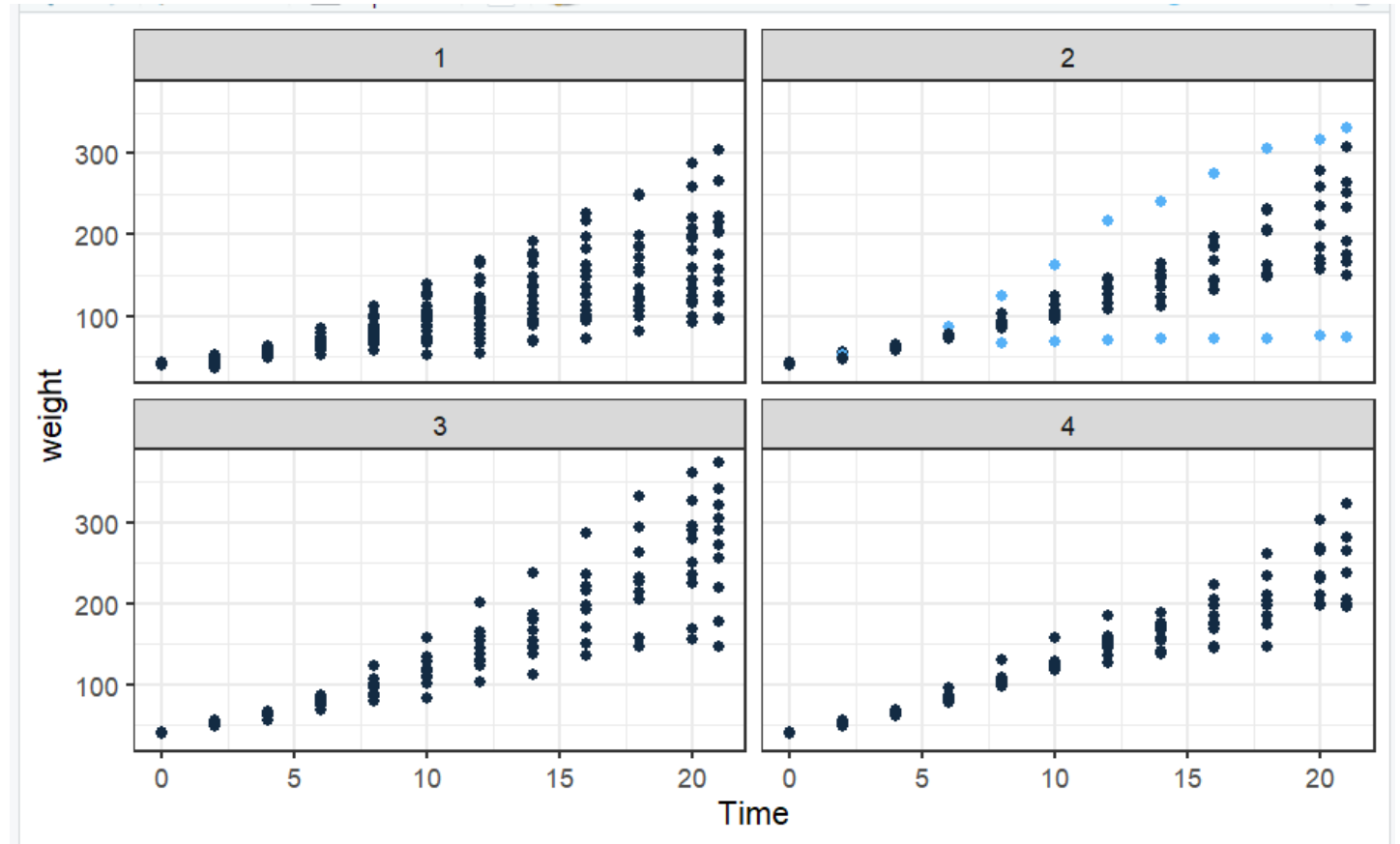
Usage

```
lm(formula, data, subset, weights, na.action,  
   method = "qr", model = TRUE, x = FALSE, y = FALSE, qr = TRUE,  
   singular.ok = TRUE, contrasts = NULL, offset, ...)
```


HANDLING OUTLIERS

An outlier can be higher or lower than expected or **displaced more to the right or left than expected.**

Outliers can affect regression lines, **making the regression lines less accurate** in predicting other data.



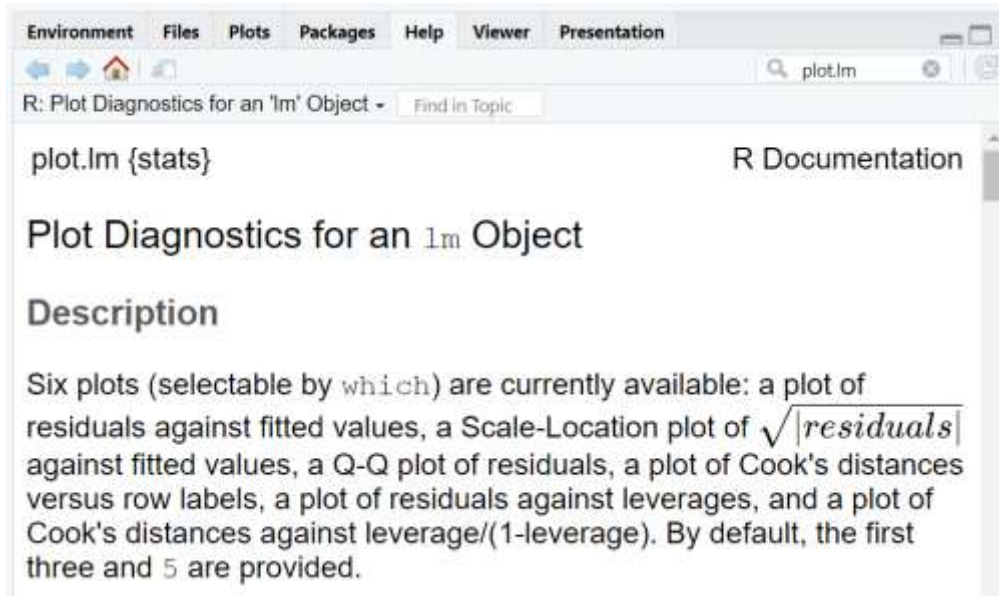
CHECKING THE ASSUMPTIONS

There are five key assumptions of linear regression:

1.  **Linearity**
2.  **independence**
3.  **homoscedasticity**
4.  **normality**
5.  **no multicollinearity**

Ensuring these assumptions are met is critical to creating an accurate and reliable model for predicting and drawing insights from data.

CHECKING THE ASSUMPTIONS



CHECKING THE ASSUMPTIONS

Environment Files Plots Packages Help Viewer Presentation

R: Plot Diagnostics for an 'lm' Object - Find in Topic

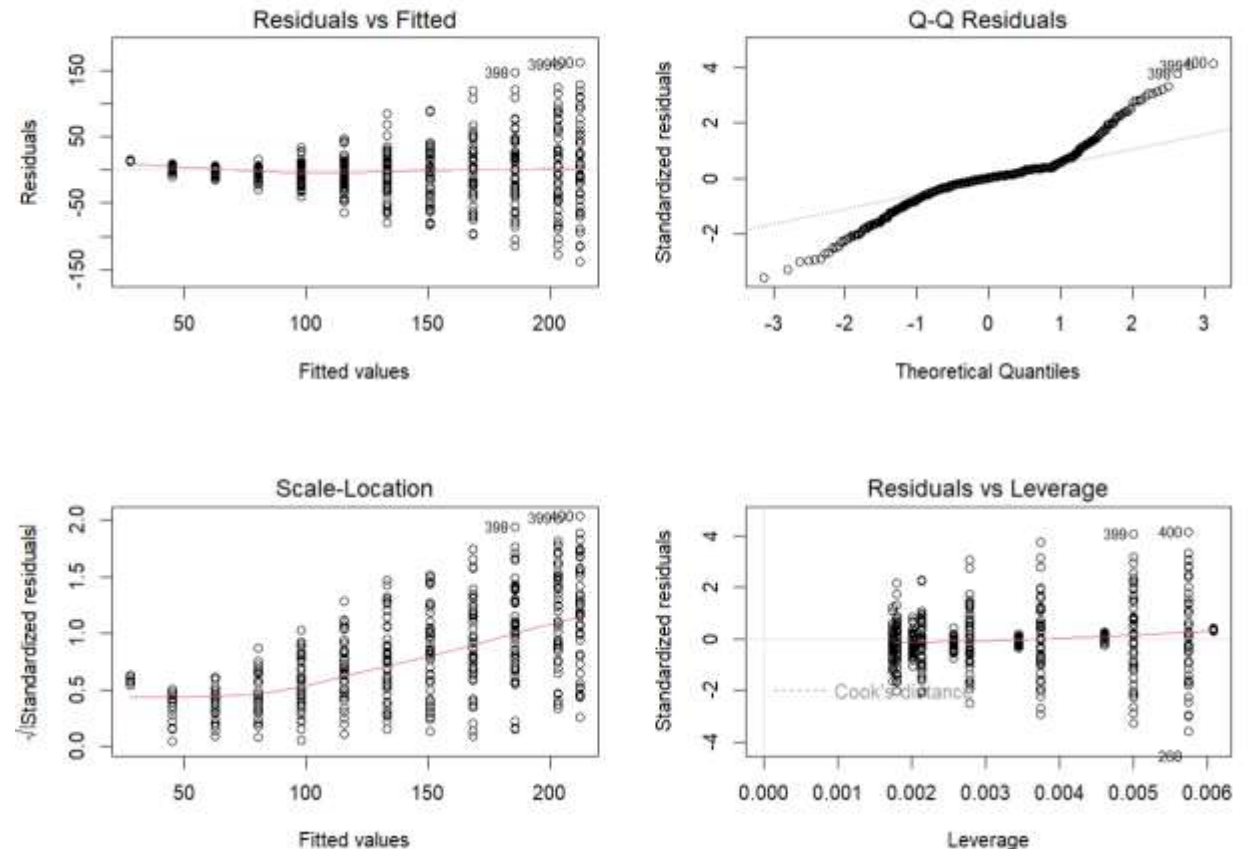
plot.lm {stats} R Documentation

Plot Diagnostics for an `lm` Object

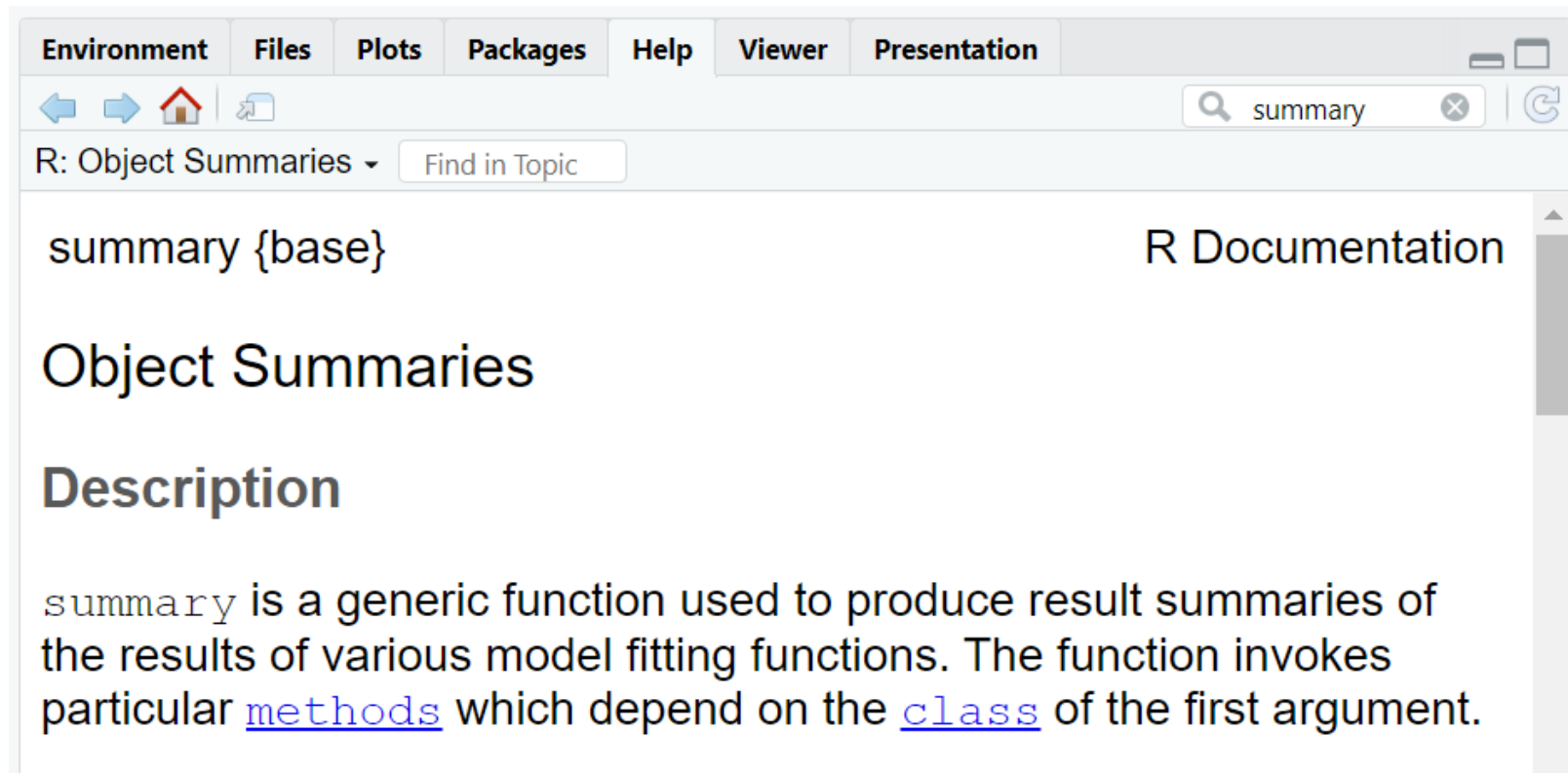
Description

Six plots (selectable by `which`) are currently available: a plot of residuals against fitted values, a Scale-Location plot of $\sqrt{|residuals|}$ against fitted values, a Q-Q plot of residuals, a plot of Cook's distances versus row labels, a plot of residuals against leverages, and a plot of Cook's distances against leverage/(1-leverage). By default, the first three and 5 are provided.

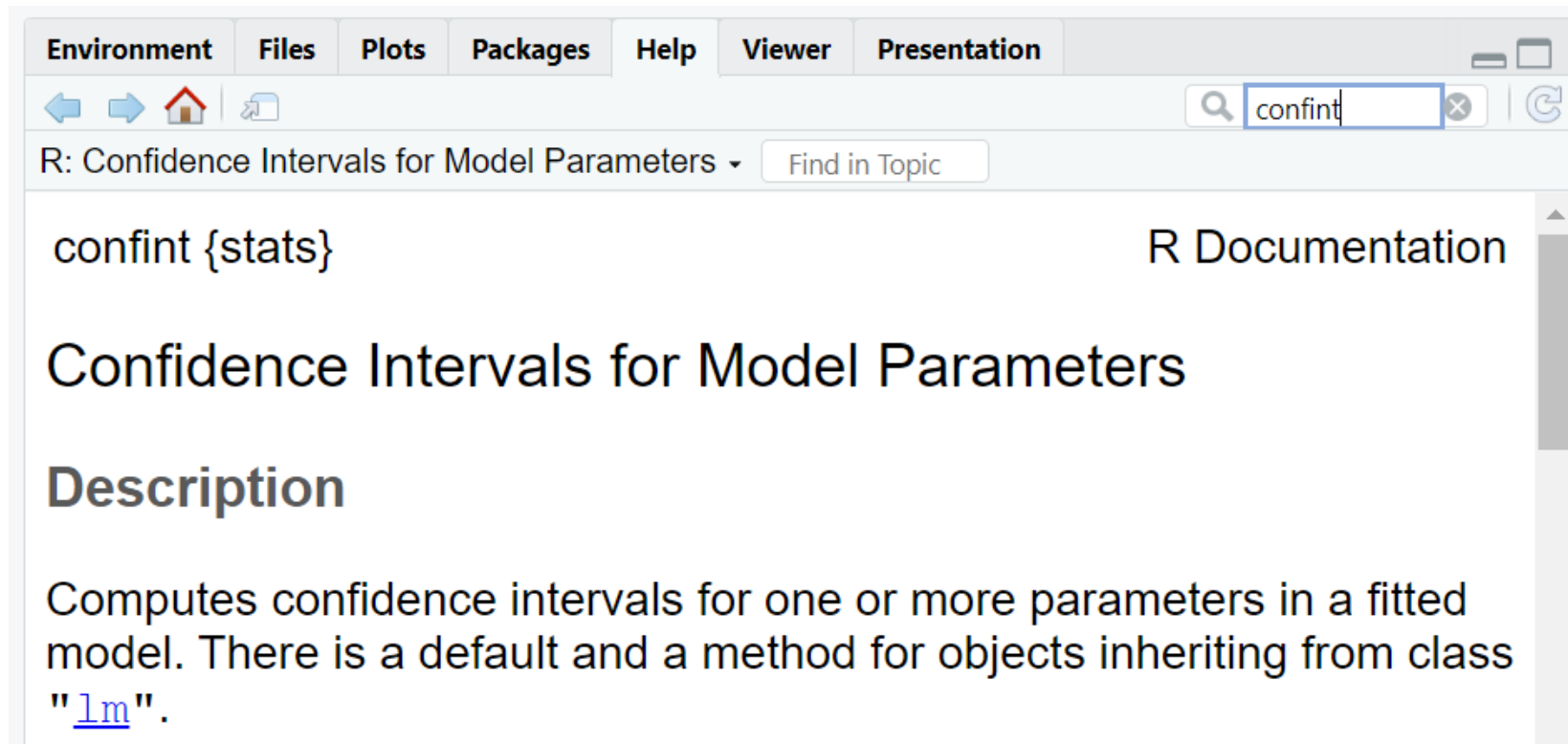
lm(weight ~ Time)



CHECK THE COEFFICIENTS AND OTHER STATS



CONFIDENCE INTERVALS



INTERACTION TERMS

Statistical **interaction** means **the effect of one independent variable(s) on the dependent variable depends on the value of another independent variable(s).**

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So, in our data, we could think that **the effect that time has on the chickens' weight depends on the diet:**

$$\textit{weight} \sim \textit{Time} \times \textit{Diet}$$

INTERACTION TERMS

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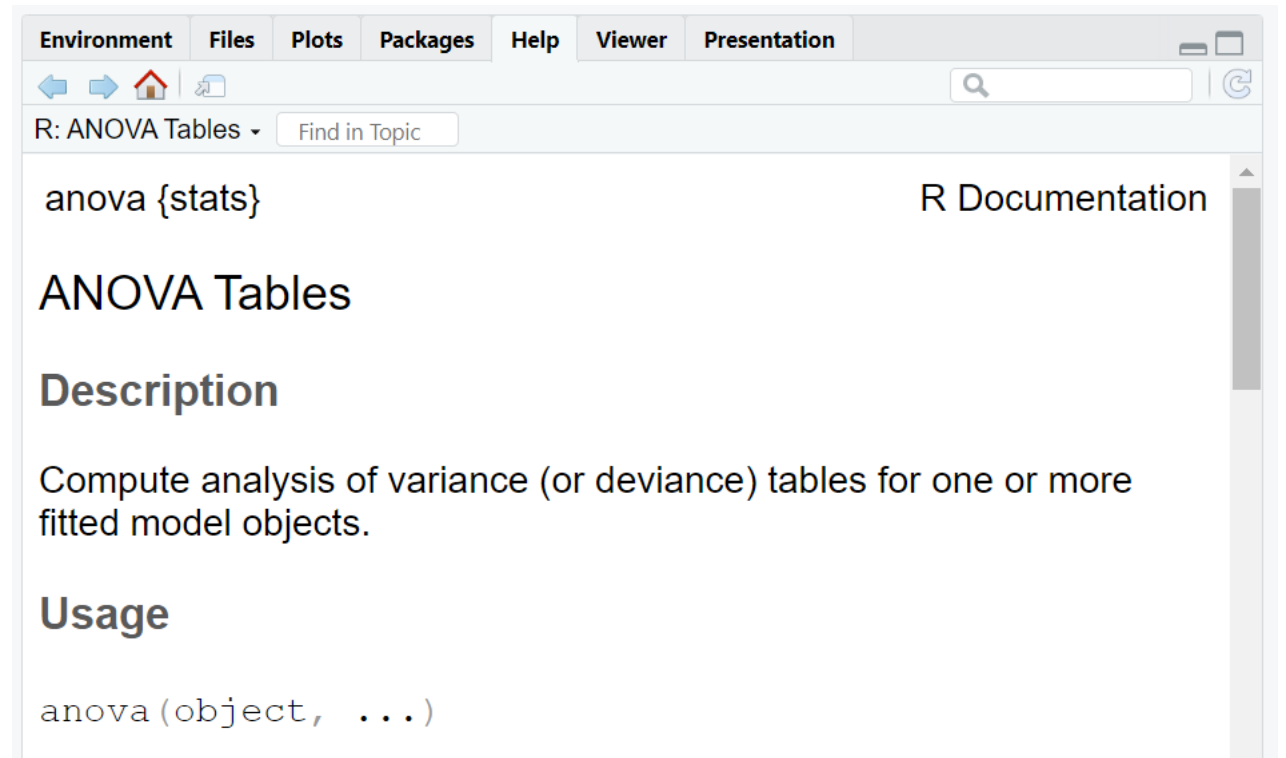
So, in our data, we could think that **the effect that time has on the chickens' weight depends on the diet:**

$$\textit{weight} \sim \textit{Time} \times \textit{Diet}$$

Remember, this is
**Symbolic
Language**

ANOVA: ANALYSIS OF VARIANCE

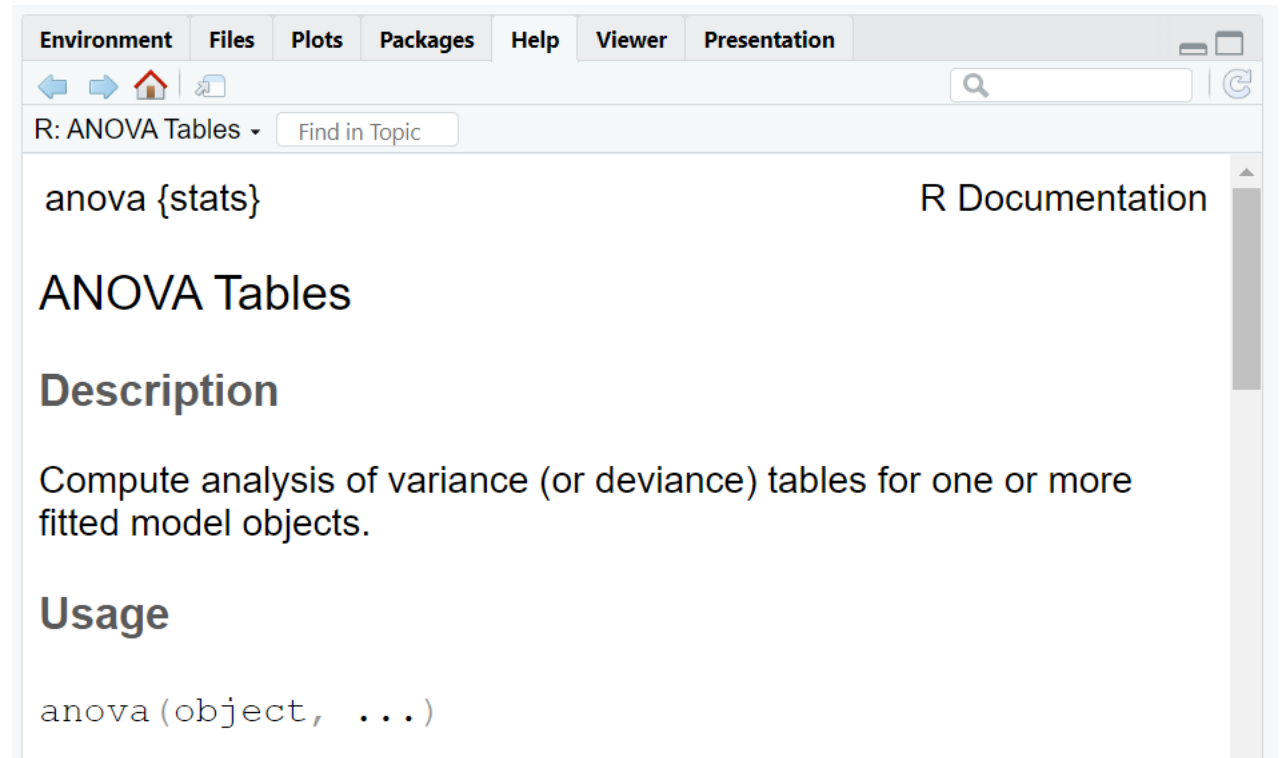
The ANOVA test is very useful when we want to compare two models to see which one fits the data better.



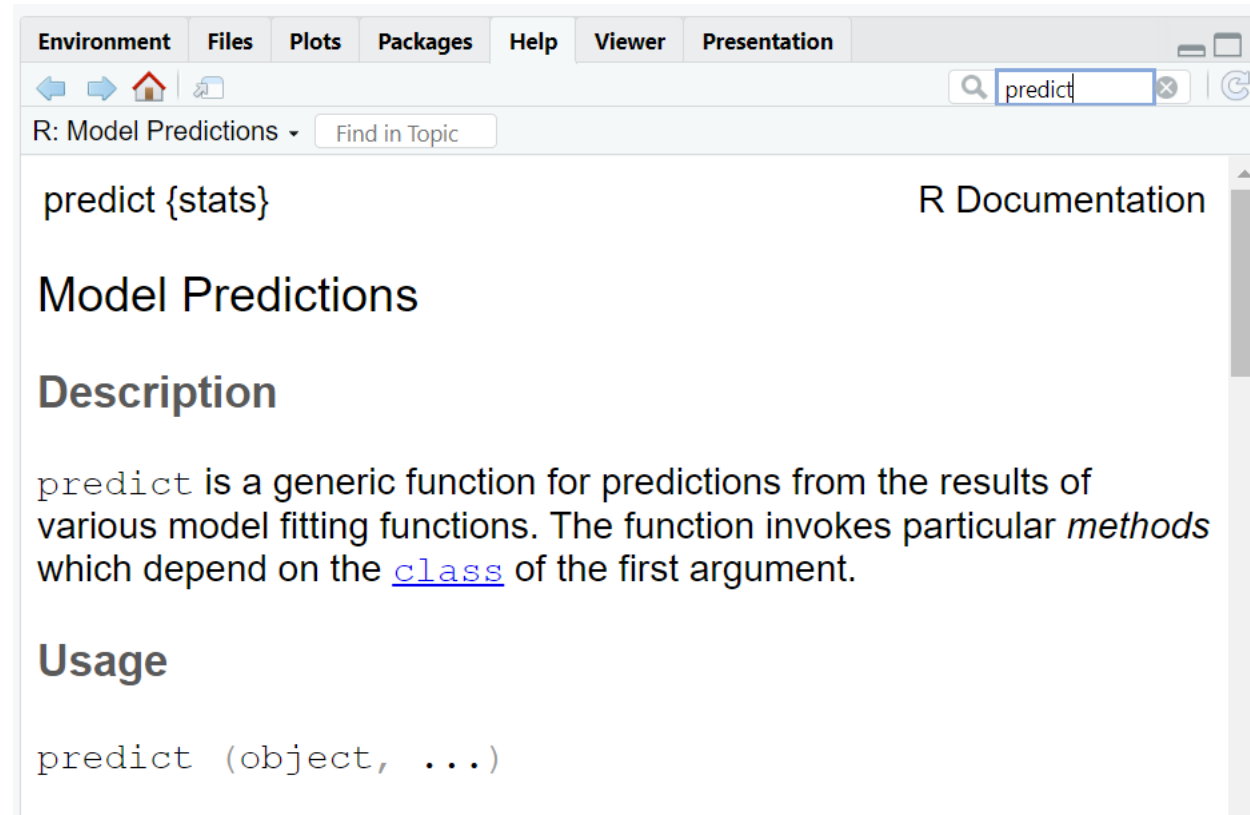
ANOVA: ANALYSIS OF VARIANCE

The ANOVA test is very useful when we want to compare two models to see which one fits the data better.

So, which model is better, with or without interaction term?



PREDICTING



3. OTHER MODELS?

TYPES OF STATISTICAL ANALYSES AND MODELS

Based on the research question, we can perform:

- Descriptive
- Inferential
- Predictive
- Causal
- Etc....


Depending on the type of **Dependent** variable are the models we can use:

- Linear Model: Continuous
- Logit Model: Dichotomous
- Probit Model: Ordinal data
- Multinomial Model: Categorical Data
- Poisson/Binomial: Counting data

The relation between the **Dependent** and the **Independent** dictates the model structure:

- Nested model
- Bayesian

TYPES OF STATISTICAL ANALYSES AND MODELS

 has them all!

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question, v

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TYPES OF STATISTICAL ANALYSES AND MODELS

Based on the question, we

- Descriptive
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- Etc....

 has them all!

They all work with the functions that we learned today. Sometimes, it is just a matter of adjusting some parameters.

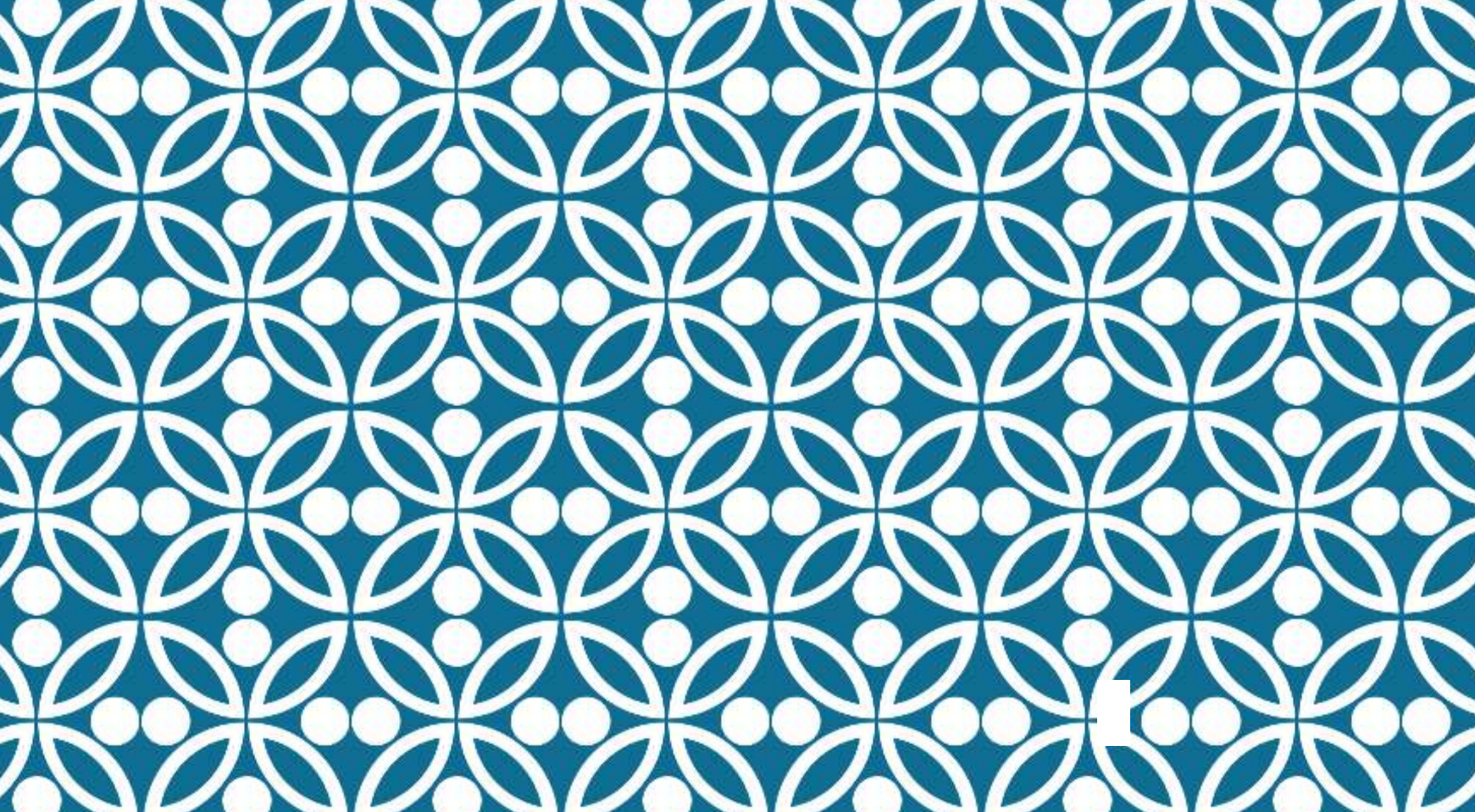
➤ Multinomial model:

Categorical Data

➤ Poisson/Binomial: Counting data

Using all you new knowledge, try to statistically analyze the Titanic data in R.

EXERCISE 5.1: ANALYZING THE TITANIC DATA



<https://sofiag11.github.io/>

THANKS!

Dr. Sofia Gil-Clavel