R refresheR

January 24, 2022

R versus other languages

- Weird assignment operator <-
- cAsE sENsiTiVe
- Indexing starts at 1 instead of 0 (first element in a vector is element 1)

- Always more than one way to do things (sometimes many more)

- The R Inferno
  - https://www.burns-stat.com/pages/Tutor/R_inferno.pdf

Basics

- Assignment `x <- 5`
- Arithmetic operations `3 + 5, x + 3`
- Vectors `y <- c(1, 4, 5, 9)`
- Lists `z <- list(1, "wrong", c(3, 5, 7))`
- data types - "double", integer, logical, character, complex
- data structures – vector, list, matrix, data frame, factors, tables, "tibbles", ...
- `my_data_frame$variable1[1:4]` yuck
- functions!

Functions

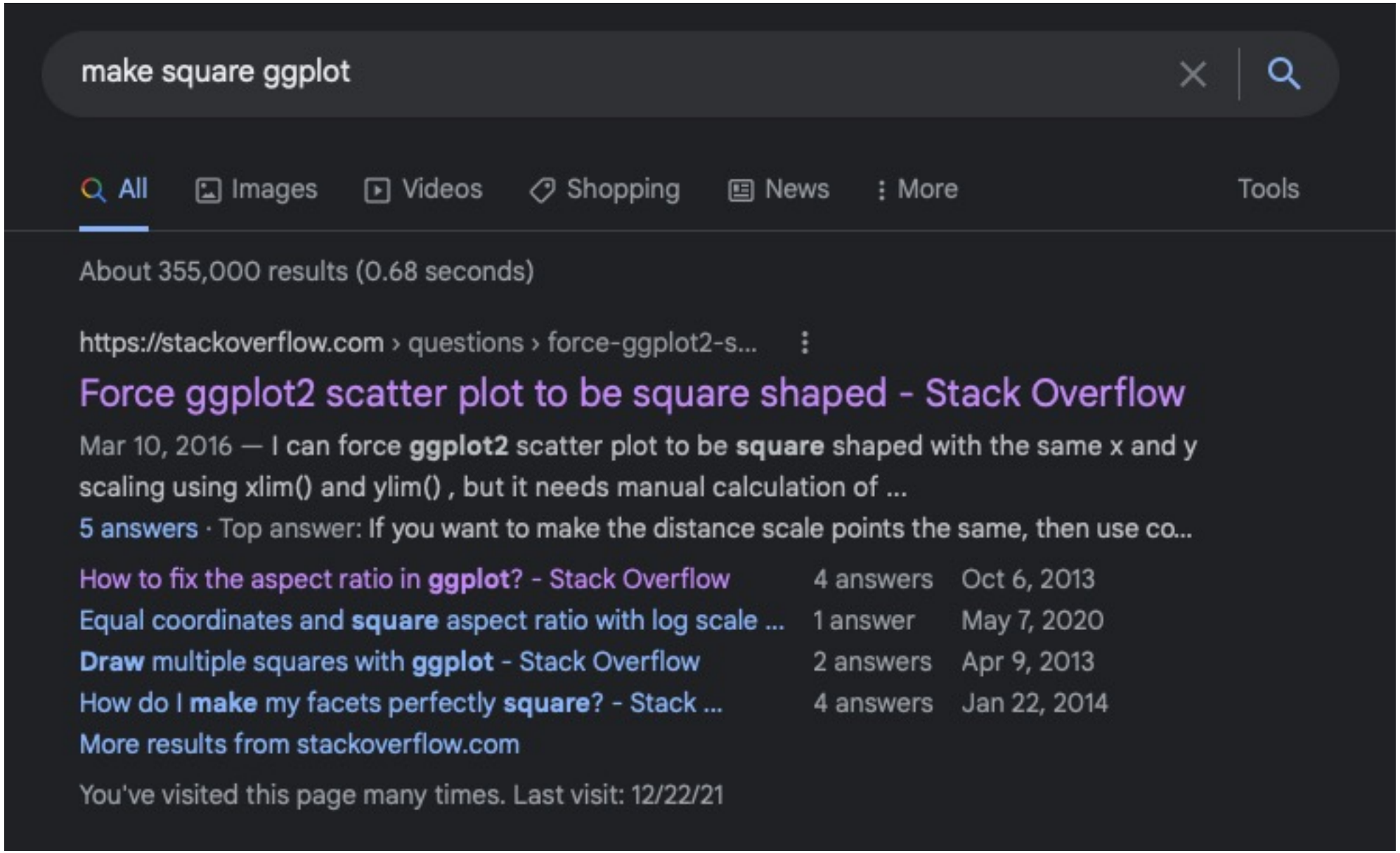
```
add_five <- function(x) {x + 5}
```

```
> add_five(30)
[1] 35
```

- Powerful and flexible
- "Functional programming"
- Work out how to do something once then wrap in a function

Figuring things out

- R help files are often not very helpful
- There is an enormous amount of helpful material online – if you have a problem, someone else has probably had that problem and figured out the answer
- Sometimes it is hard to determine whether you just can't do something or whether you haven't found the right answer yet
- Google is your friend "make square ggplot"


make square ggplot
All
Images
Videos
Shopping
News
More
Tools
About 355,000 results (0.68 seconds)
https://stackoverflow.com › questions › force-ggplot2-s...
Force ggplot2 scatter plot to be square shaped - Stack Overflow
Mar 10, 2016 — I can force ggplot2 scatter plot to be square shaped with the same x and y scaling using xlim() and ylim() , but it needs manual calculation of ...
5 answers · Top answer: If you want to make the distance scale points the same, then use co...
How to fix the aspect ratio in ggplot? - Stack Overflow 4 answers Oct 6, 2013
Equal coordinates and square aspect ratio with log scale ... 1 answer May 7, 2020
Draw multiple squares with ggplot - Stack Overflow 2 answers Apr 9, 2013
How do I make my facets perfectly square? - Stack ... 4 answers Jan 22, 2014
More results from stackoverflow.com
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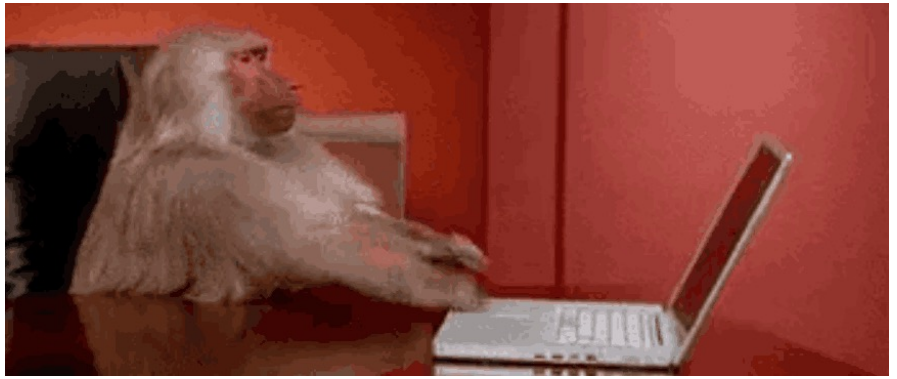
Figuring things out

- You often just have to keep flailing at the keyboard to figure out how to do something or how to get something to work

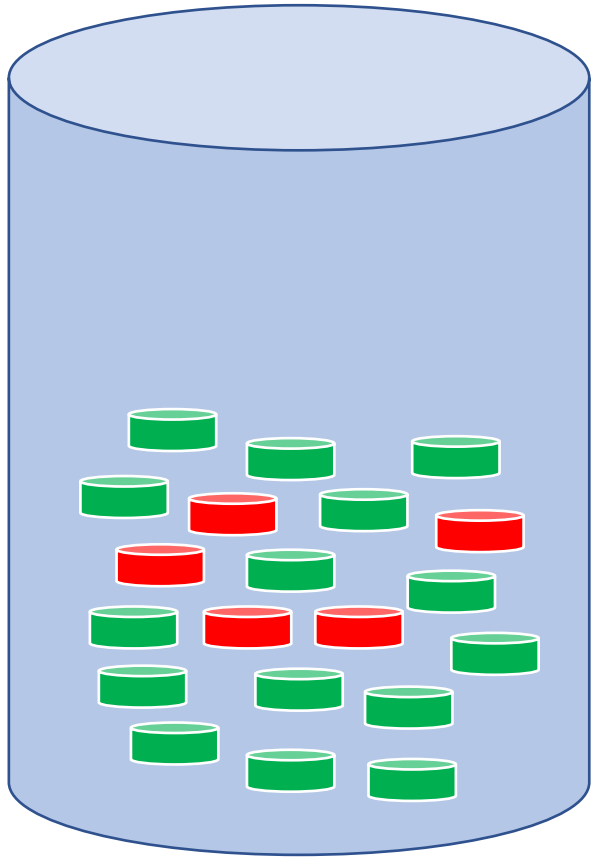
- Walk away, come back, do something else for a little while

- Ask a friend if Google fails you



- You will make mistakes. This is inevitable. What you want to avoid is realizing you've made a mistake after the paper gets published.

Questions and discussion on "pre-test"



* probabilities sum to 1

draw 1 chip: $P(\text{red}) = \frac{\text{number of red chips}}{\text{total chips}} = 0.25$

$P(\text{green}) = \frac{\text{number of green chips}}{\text{total chips}} = 0.75$

* sample with/without replacement

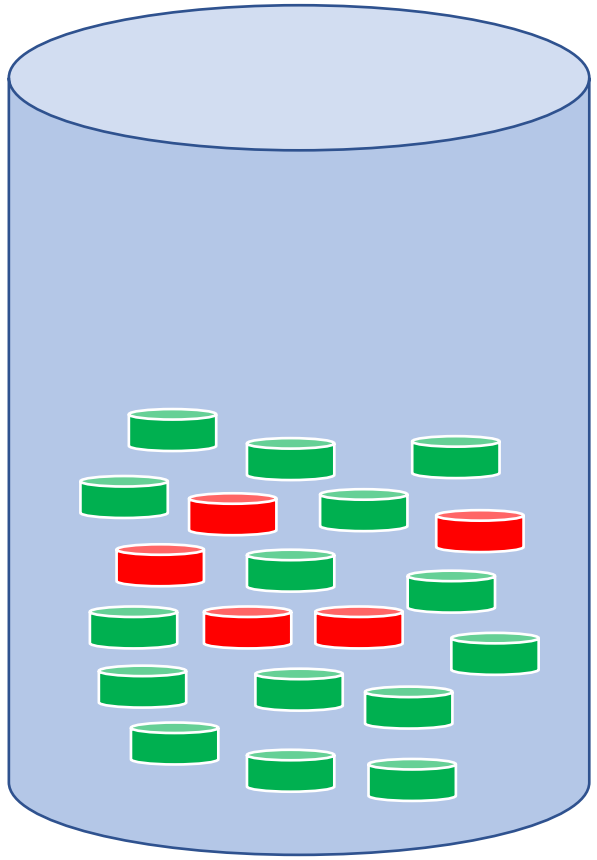
* P(all green) + P(at least 1 red) = 1

because one or the other must happen

P(at least 1 red) = 1 - P(all green)

HW0_answers.R

Questions and discussion on "pre-test"



* P(2 green) =

P(green, green, red) +

P(green, red, green) +

P(red, green, green) =

3 * (15/20) * (15/20) * (5/20)

* probabilities multiply
* independent events add
* order matters "combinatorics"

$$\binom{n}{r} = \frac{n!}{r!(n-r)!}$$

HW0_answers.R

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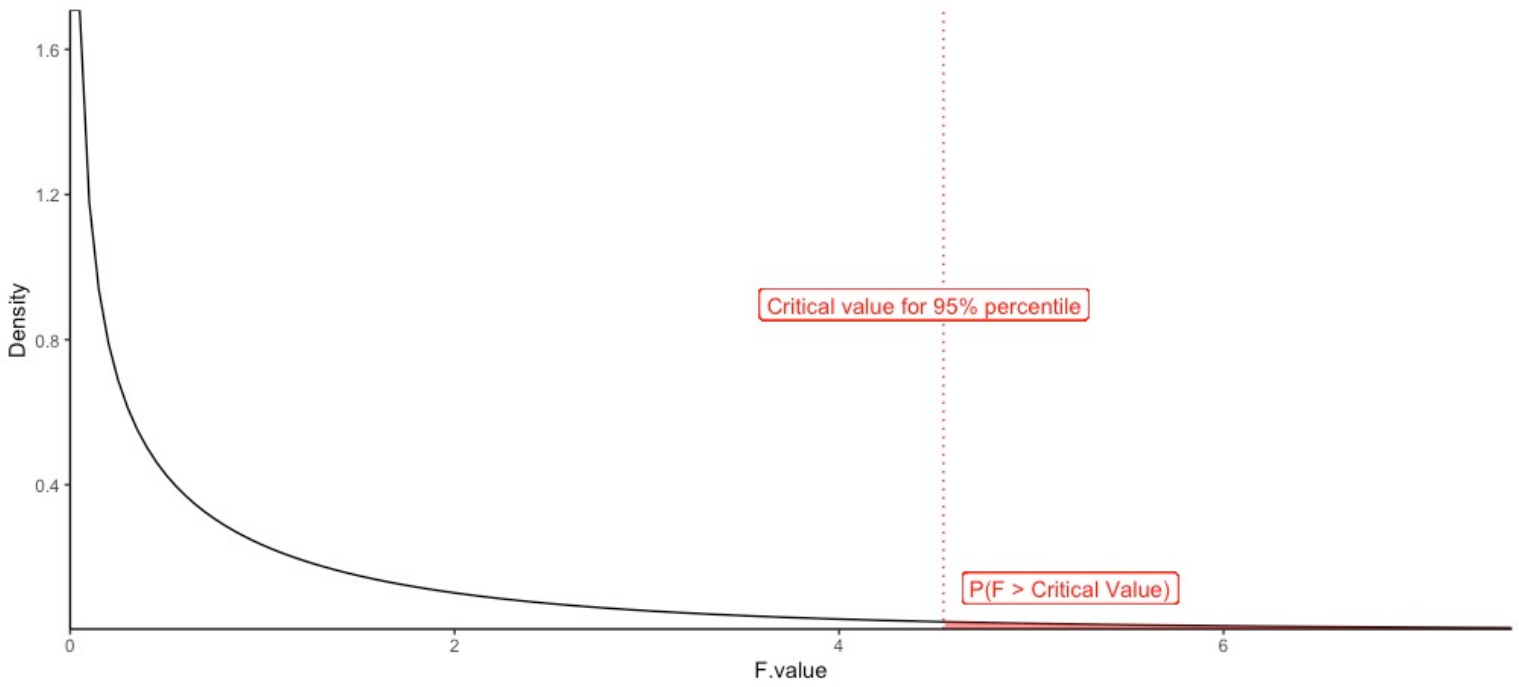


Idea of "critical value"

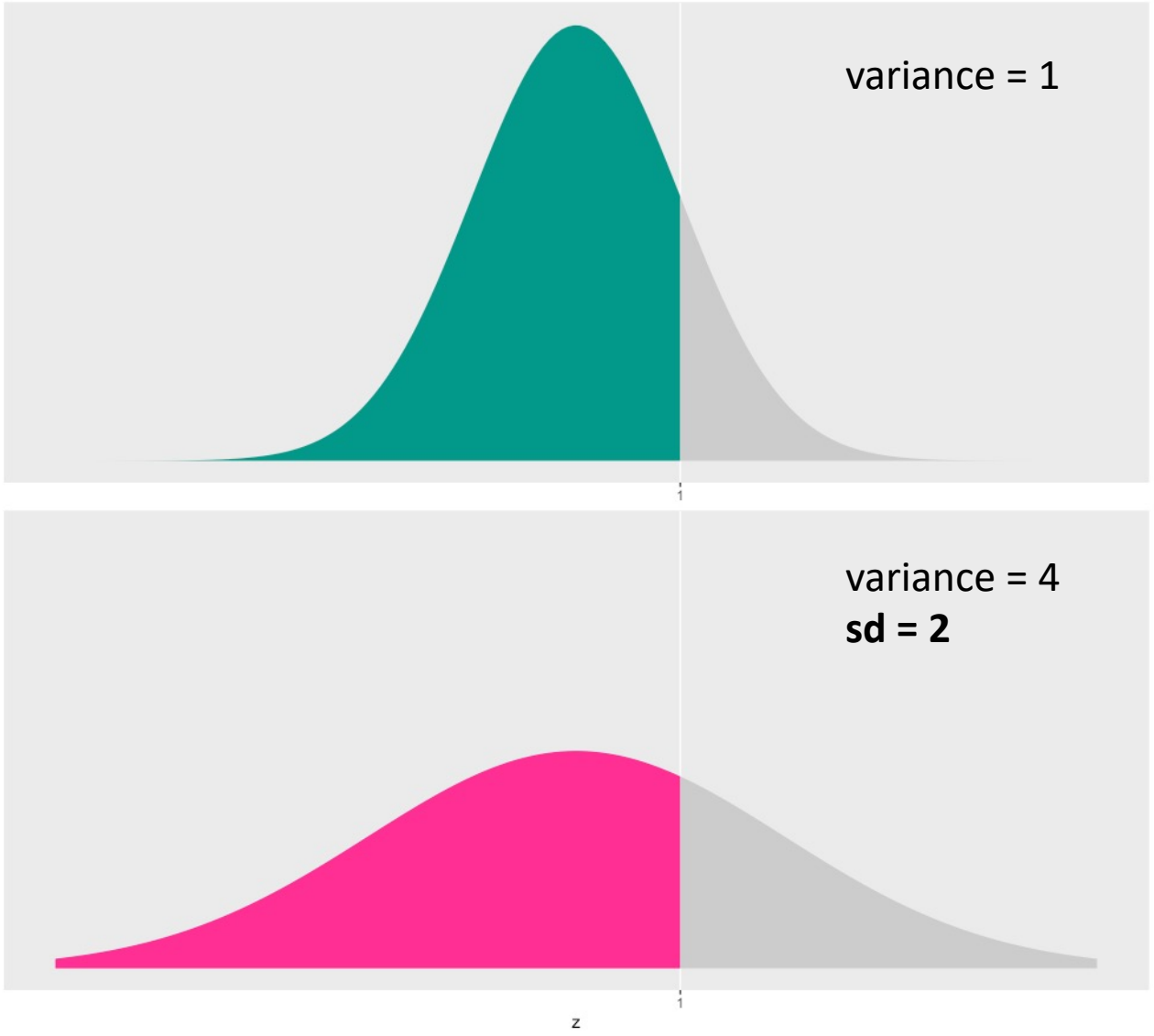
Getting areas from distribution (pf) versus getting value from curve (qf, df)

pnorm, qnorm, dnorm

Graphical representation – different graphics modules in R

HW0_answers.R

Questions and discussion on "pre-test"




```
> pnorm(1, mean = 0, sd = 1, lower.tail = TRUE)
[1] 0.8413447
> pnorm(1, mean = 0, sd = 2)
[1] 0.6914625
```

Questions and discussion on "pre-test"

```r
# imagine that these are test score data of 2 groups of participants, 10 in each group

group1 ← c(56, 46, 45, 42, 60, 45, 52, 59, 43, 55)
group2 ← c(85, 61, 57, 53, 64, 58, 67, 54, 76, 63)

# run a t-test comparing group1 and group2, ** assuming equal variances of the 2 groups **

t.test(group1, group2, var.equal = TRUE)

# What is the type 1 error associated with the t-test? (either copy from output or use an R command to display)

0.002518
t.test(group1, group2, var.equal = TRUE)$p.value  # look at output of str(t.test(group1, group2, var.equal = TRUE))
```

- default for t.test is that variances are not equal
- attributes of object can be revealed by `str` ("structure") and accessed directly

HW0_answers.R

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R: Student's t-Test | Find in Topic

t.test {stats} R Documentation

Student's t-Test

Description

Performs one and two sample t-tests on vectors of data.

Usage

```
t.test(x, ...)

## Default S3 method:
t.test(x, y = NULL,
       alternative = c("two.sided", "less", "greater"),
       mu = 0, paired = FALSE, var.equal = FALSE,
       conf.level = 0.95, ...)

## S3 method for class 'formula'
t.test(formula, data, subset, na.action, ...)
```

Arguments

`x`	a (non-empty) numeric vector of data values.
`y`	an optional (non-empty) numeric vector of data values.
`alternative`	a character string specifying the alternative hypothesis, must be one of `"two.sided"` (default), `"greater"` or `"less"`. You can specify just the initial letter.
`mu`	a number indicating the true value of the mean (or difference in means if you are performing a two sample test).
`paired`	a logical indicating whether you want a paired t-test.
`var.equal`	a logical variable indicating whether to treat the two variances as being equal. If `TRUE` then the pooled variance is used to estimate the variance otherwise the Welch (or Satterthwaite) approximation to the degrees of freedom is used.
`conf.level`	confidence level of the interval.
`formula`	a formula of the form `lhs ~ rhs` where `lhs` is a numeric variable giving the data values and `rhs` either `1` for a one-sample or paired test or a factor with two levels giving the corresponding groups. If `lhs` is of class `"Pair"` and `rhs` is `1`, a paired test is done
`data`	an optional matrix or data frame (or similar: see `model.frame`) containing the variables in the formula `formula`. By default the variables are taken from `environment(formula)`.
`subset`	an optional vector specifying a subset of observations to be used.
`na.action`	a function which indicates what should happen when the data contain `NA`s. Defaults to `getOption("na.action")`.
`...`	further arguments to be passed to or from methods.

Details

`alternative = "greater"` is the alternative that `x` has a larger mean than `y`. For the one-sample case: that the mean is positive.

If `paired` is `TRUE` then both `x` and `y` must be specified and they must be the same length. Missing values are silently removed (in pairs if `paired` is `TRUE`). If `var.equal` is `TRUE` then the pooled estimate of the variance is used. By default, if `var.equal` is `FALSE` then the variance is estimated separately for both groups and the Welch modification to the degrees of freedom is used.

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describes default behavior or how it behaves if you give it a "formula" object

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```

lists arguments the function expects. If there is an equals sign, it has a default value that will be used if it is not specified.

```
> t.test(group1)

        One Sample t-test

data:  group1
t = 23.172, df = 9, p-value = 2.47e-09
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 45.38939 55.21061
sample estimates:
mean of x
     50.3

> t.test(group1, group2)

        Welch Two Sample t-test

data:  group1 and group2
t = -3.5069, df = 15.894, p-value = 0.002946
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -21.665073  -5.334927
sample estimates:
mean of x mean of y
     50.3      63.8

> t.test()
Error in t.test.default() : argument "x" is missing, with no default
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lists arguments the function expects. If there is an equals sign, it has a default value that will be used if it is not specified.

You have to give it at least one vector of values ("`x`")

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You have to give it at least one vector of values ("x")

If you give it only x and nothing else, you get a one-sample test of the null hypothesis that the population mean of x (mu) is 0 and a two-sided alternative

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lists arguments the function expects. If there is an equals sign, it has a default value that will be used if it is not specified.

Default for `t.test` is for `var.equal` to be `FALSE` i.e. unequal variances, so if you give it 2 vectors of values and nothing else, it gives you a t-test with a correction factor for estimating separate variances in each group

```
> t.test(group1, group2, var.equal = TRUE)

        Two Sample t-test

data:  group1 and group2
t = -3.5069, df = 18, p-value = 0.002518
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -21.587565  -5.412435
sample estimates:
mean of x mean of y
     50.3      63.8

> t.test(group1, group2)

        Welch Two Sample t-test

data:  group1 and group2
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t.test(formula, data, subset, na.action, ...)
```

lists arguments the function expects. If there is an equals sign, it has a default value that will be used if it is not specified.

If you set `var.equal` to `TRUE` then you get the more typical behavior of a t-test based on a pooled variance estimate (assume population variances of the two groups are the same)

```
> my_data ← data.frame(group = c(rep("group1",10), rep("group2", 10)), values = c(group1, group2))
> my_data
    group values
1  group1     56
2  group1     46
3  group1     45
4  group1     42
5  group1     60
6  group1     45
7  group1     52
8  group1     59
9  group1     43
10 group1     55
11 group2     85
12 group2     61
13 group2     57
14 group2     53
15 group2     64
16 group2     58
17 group2     67
18 group2     54
19 group2     76
20 group2     63
> t.test(values ~ group, data = my_data, var.equal = TRUE)

        Two Sample t-test

data:  values by group
t = -3.5069, df = 18, p-value = 0.002518
alternative hypothesis: true difference in means between group group1 and group group2 is not equal to 0
95 percent confidence interval:
 -21.587565  -5.412435
sample estimates:
mean in group group1 mean in group group2
                50.3                 63.8
```

prompt

Usage

```
t.test(x, ...)

## Default S3 method:
t.test(x, y = NULL,
       alternative = c("two.sided", "less", "greater"),
       mu = 0, paired = FALSE, var.equal = FALSE,
       conf.level = 0.95, ...)

## S3 method for class 'formula'
t.test(formula, data, subset, na.action, ...)
```

`parameter`	the degrees of freedom for the t-statistic.
`p.value`	the p-value for the test.

formula syntax: `y ~ x`
"y explained by x"

if you have data with group in one column and the value in the other, you can use `t.test` with "formula" syntax – gives same answer

Questions and discussion on "pre-test"

- confidence interval more informative than binary "significant" / "not significant" conclusion based on arbitrary cutoff
- interpretation can be nuanced – inference is based on a population parameter that is a fixed quantity, so probability is on the behavior of the confidence interval
- in practice, thinking of confidence interval as putting a probability on the population value is usually not too far off (but is wrong)

HW0_answers.R; O'Brien and Yi (2016) *Transfusion*

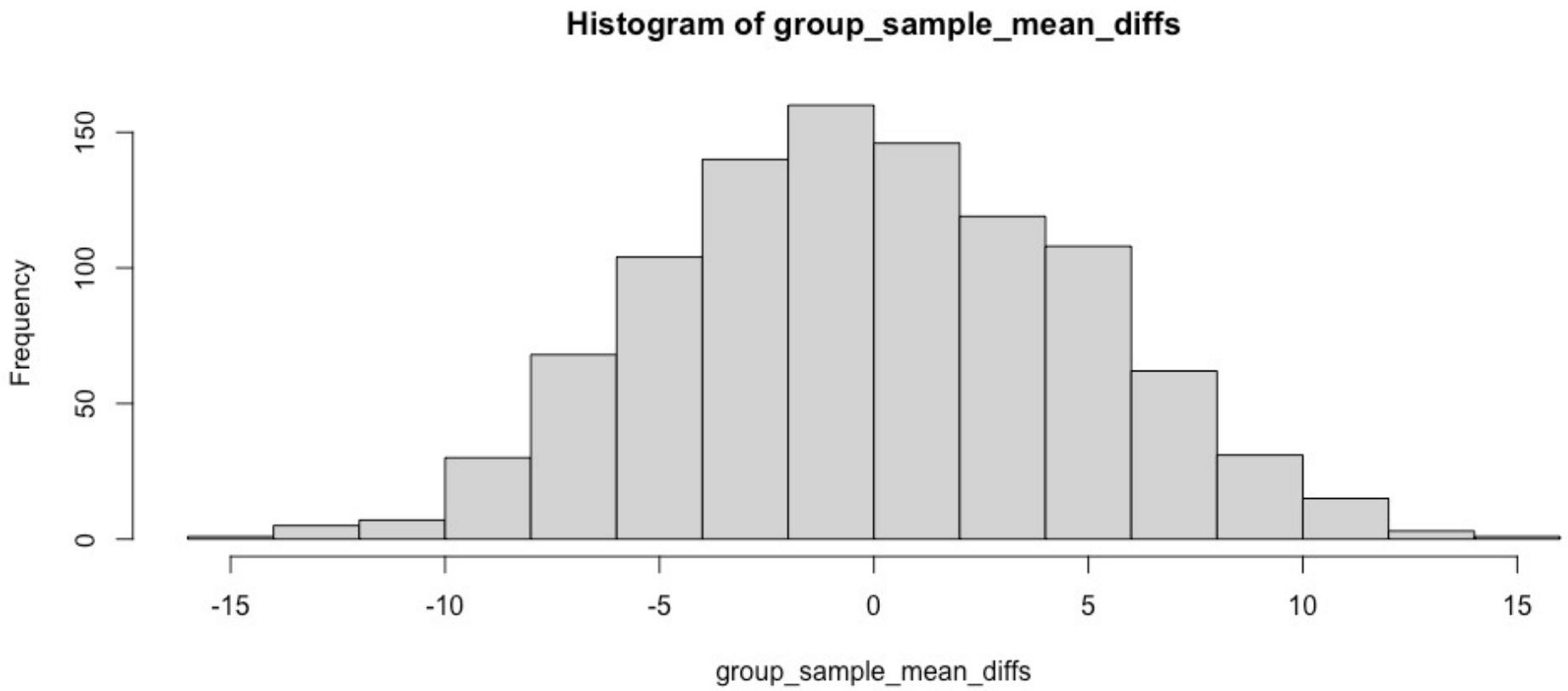
Questions and discussion on "pre-test"

```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -21.587565  -5.412435
sample estimates:
mean of x mean of y
     50.3      63.8
```

- in this case, the confidence interval is on the mean of group1 (`x`) minus the mean of group2 (`y`)
- the 95% CI doesn't contain 0, so we conclude the means of the 2 groups are "significantly" different at the .05 level
- the difference could be between 5.4 and 21.5

HW0_answers.R

Permutation tests in R



20220124_permutation.R