Using R as a Research Tool.

NERC E4 DTP Training

Dr Susan Johnston, Institute of Evolutionary Biology

Demonstrator: Gergana Daskalova

What is  ?

- Environment for statistical computing and graphics.
- Interpreted & interactive programming language.
- Powerful research tool.
- 15,045 packages on CRAN
- **Free and open source** multi-platform software.

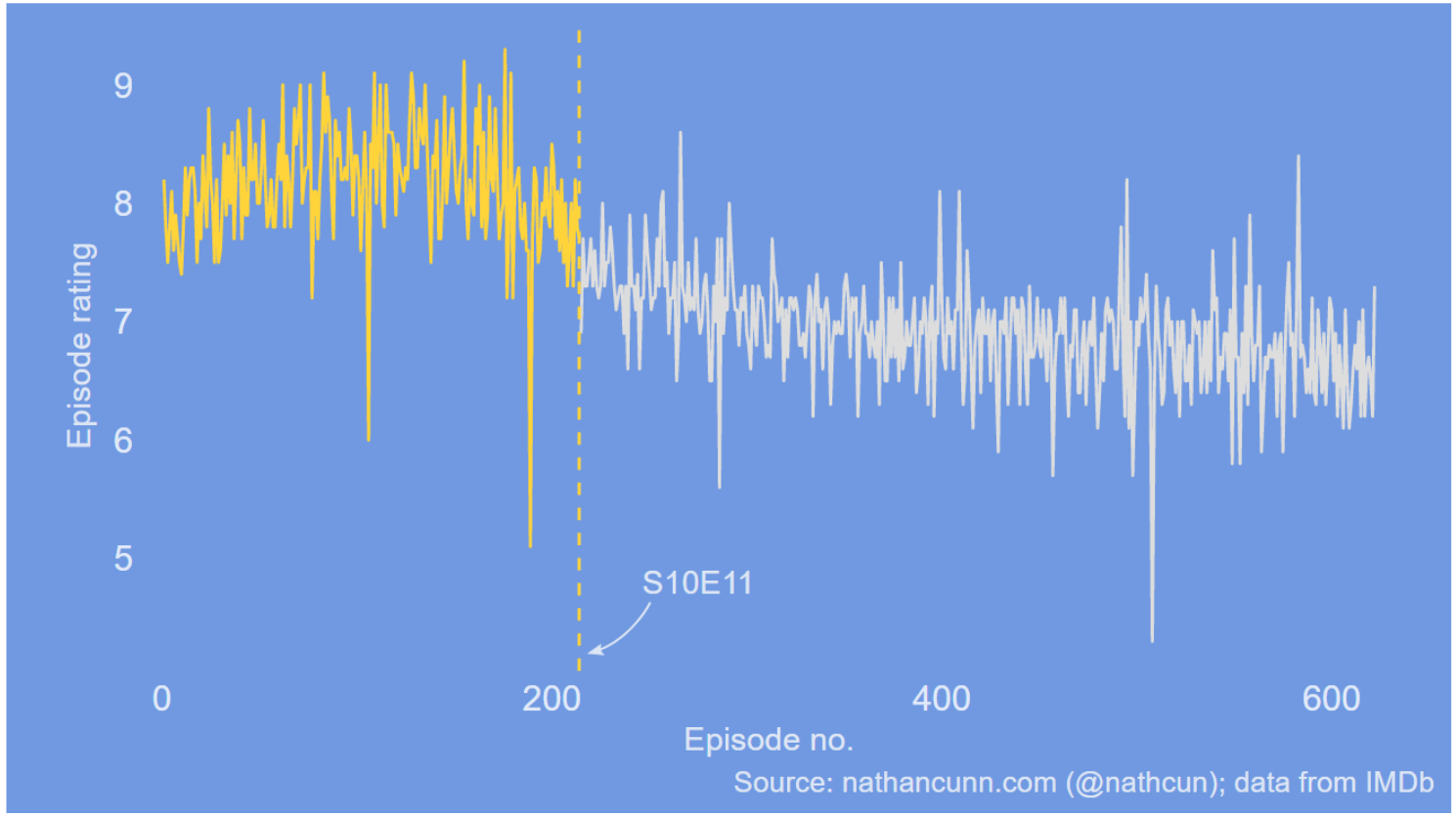
Why use  ?

> “This is R. There is no if. Only how.”
> -- Simon `Yoda' Blomberg, R-help (April 2005)

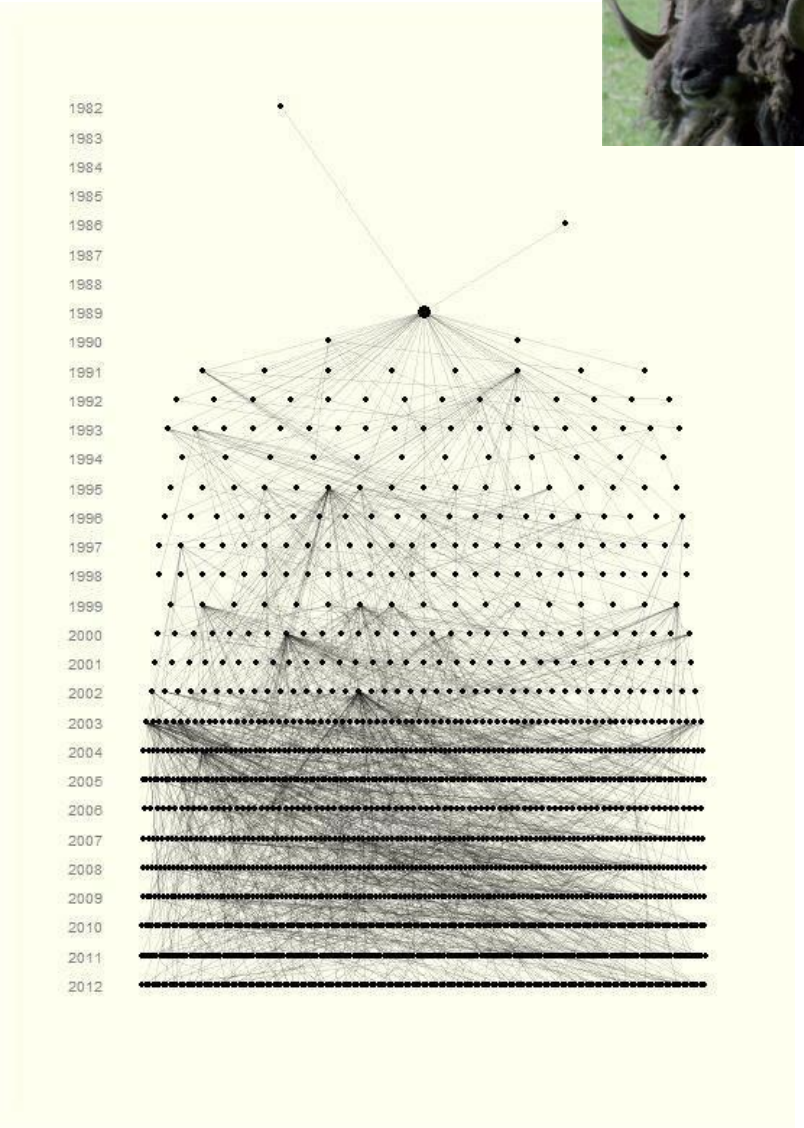
- Statistics.
- Processing and tidying data.
- Data visualisation.
- Reports and presentations.
- Interactive web applications.
- Portable projects.

Data visualisation

e.g. http://www.r-graph-gallery.com/portfolio/ggplot2-package/



When did the golden age of The Simpsons end?



Ancestors and descendants of a single Soay sheep called Snowball.

Report writing

Using R as a Research Tool.

Dr Susan Johnston: Susan.Johnston@ed.ac.uk

Demonstrators: Gergana Dalaskova, John Godlee.
Hat-Tips to Kyle Dexter, The Coding Club and R4all.

November 6, 2017

1 Introduction

1.1 What is R?

R began its life in New Zealand in 1993 as a language and environment for statistical computing and graphics. It is an interpreted programming language, meaning that rather than pointing and clicking, the user types in commands. It is **free** and works across all platforms.

1.2 Why use R?

LaTeX and R Sweave

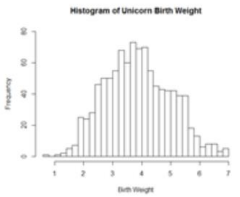
R Base Graphics: An Idiot's Guide

Comments (–) Share Hide Toolbars

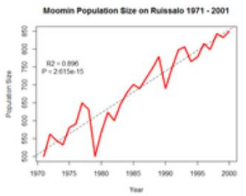
One of the most powerful functions of R is it's ability to produce a wide range of graphics to quickly and easily visualise data. Plots can be replicated, modified and even publishable with just a handful of commands.

Making the leap from chiefly graphical programmes, such as Excel and Sigmaplot. may seem tricky. However, with a basic knowledge of R, just investing a few hours could completely revolutionise your data visualisation and workflow. Trust me - it's worth it.

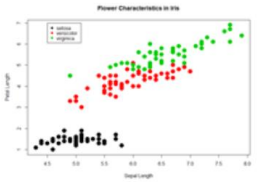
Last year, I presented an informal course on the basics of R Graphics University of Turku. In this blog post, I am providing some of the slides and the full code from that practical, which shows how to build different plot types using the basic (i.e. pre-installed) graphics in R, including:



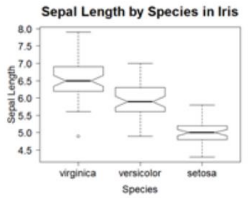
1. Basic Histogram



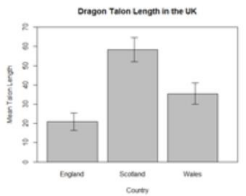
2. Line Graph with Regression



3. Scatterplot with Legend



4. Boxplot with reordered/ formatted axes

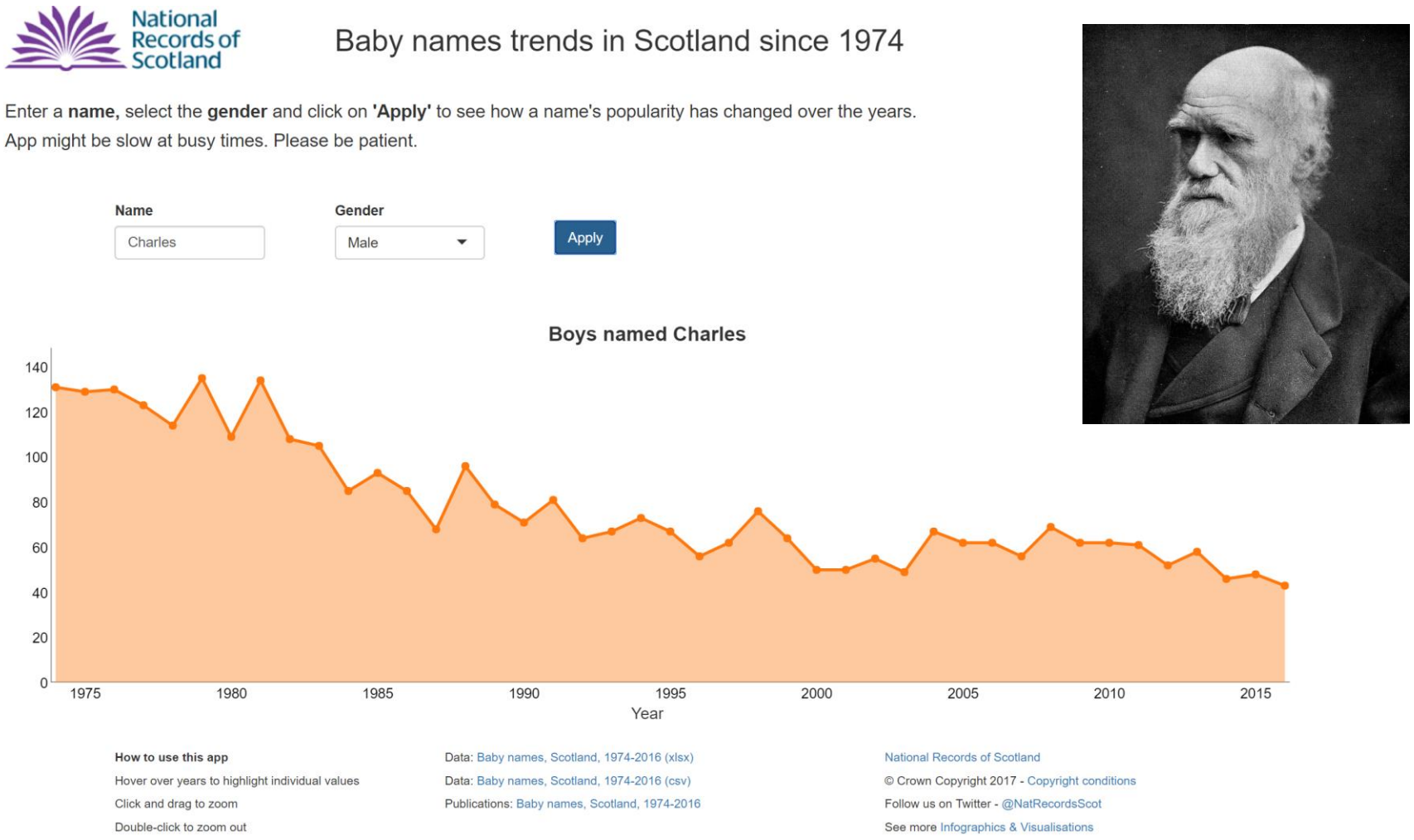


5. Boxplot with Error Bars

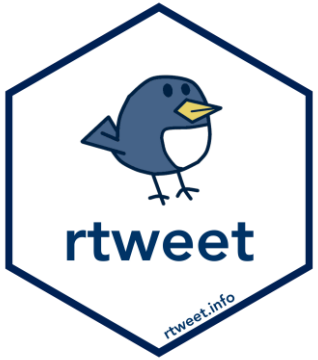
`knitr` to HTML

https://scotland.shinyapps.io/babynames/

Interactive applications (shiny)



Analytics e.g.

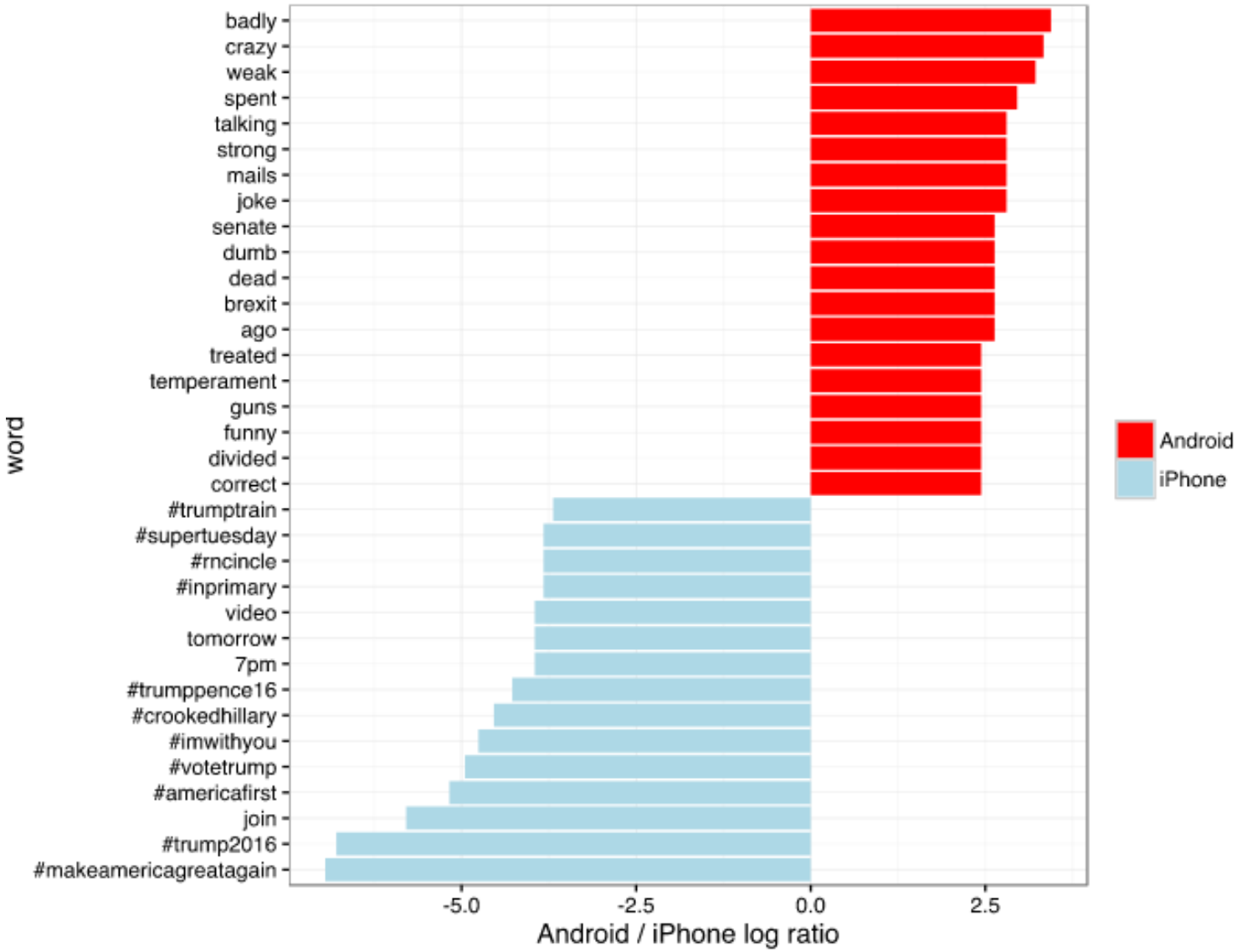


Todd Vaziri ✓
@tvaziri

Every non-hyperbolic tweet is from iPhone (his staff).

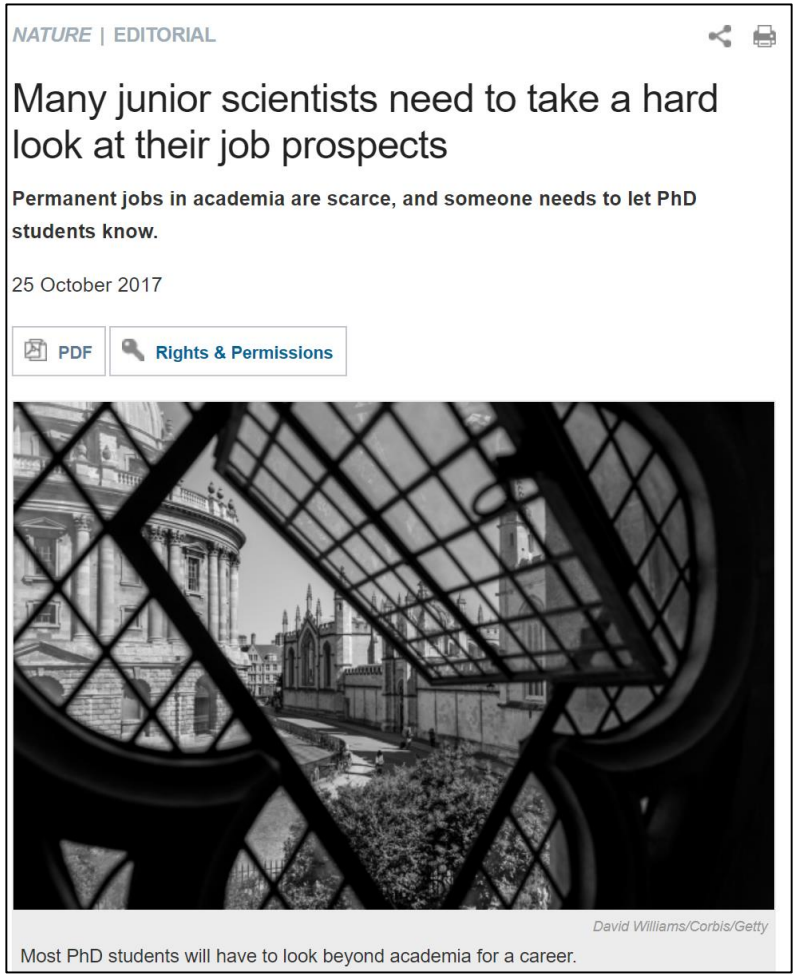
Every hyperbolic tweet is from Android (from him).

http://varianceexplained.org/r/trump-tweets/



Programmers are in demand.

- Massively transferable skill!
- Makes you competitive for postdocs and academic positions.
- Similar to Python and easy path to other languages.
- Research companies, Facebook, Google, Twitter, AirBnB.
- R jobs in Edinburgh at the Scottish Government, RBS, Tesco & Sainsburys Bank, Rockstar North, University of Edinburgh, Energy Companies.



NATURE | EDITORIAL

Many junior scientists need to take a hard look at their job prospects

Permanent jobs in academia are scarce, and someone needs to let PhD students know.

25 October 2017

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David Williams/Corbis/Getty

Most PhD students will have to look beyond academia for a career.

Anyone can code.

Ada Lovelace, 1840

FEATURE

The Secret History of Women in Coding

Computer programming once had much better gender balance than it does today. What went wrong?

https://www.nytimes.com/2019/02/13/magazine/women-coding-computer-programming.html

Mary Jackson at NASA, 1977

Rear Admiral Grace Hopper, 1960

facilitates reproducible research.

"Reproducibility is the ability of an entire experiment or study to be reproduced, either by the researcher or by someone else working independently, [and] is one of the main principles of the scientific method."

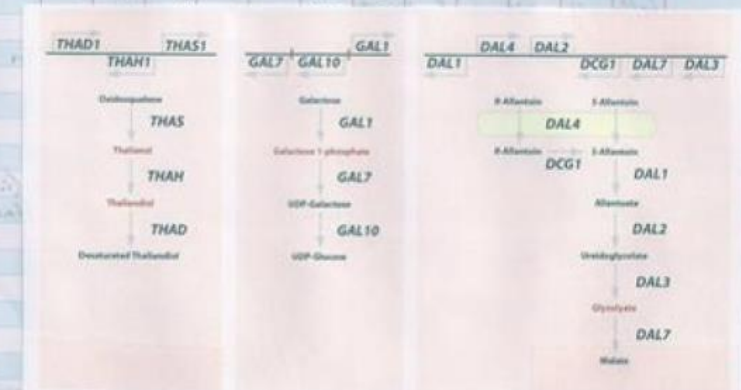
-Wikipedia

In the lab:

8/27/08

OPERON-LIKE ORGANIZATION OF THE GAL GENES

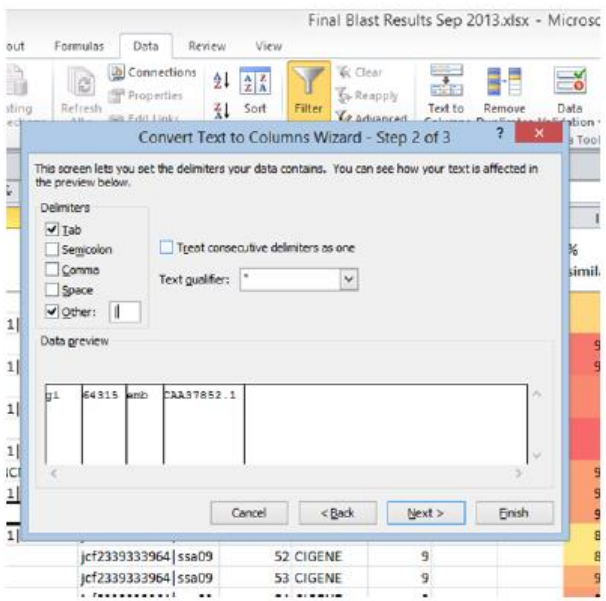
Although eukaryotes lack true operons, there are examples of operon-like gene clusters. Three examples are the galactose utilization genes in S. cerevisiae (GAL1, GAL10, GAL7), the allantoin degradation genes in S.c. (DAL1, DAL2, DAL3, DAL4, DAL7, DCG1), and the thalianditol synthesis genes in Arabadopsis (THAS, THAH, THAD):

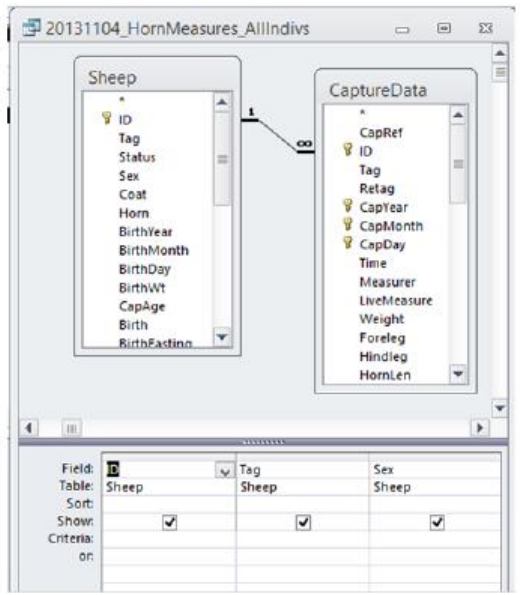


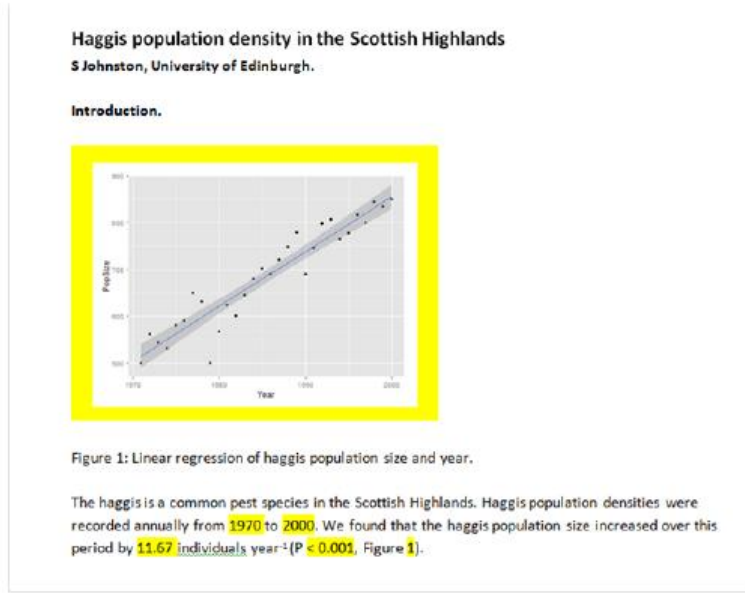
Two explanations have been given to account for this organization: genetic ~~clustering~~ linkage and metabolic channeling.

The genetic linkage hypothesis seems to be favored in the literature. It is interesting to note, however, that all three pathways above have intermediates that are toxic to the organism (in red). Here I want to test the hypothesis that the operon-like organization allows for better co-regulation of the genes and helps ~~channel~~ maintain flux through the pathway thus prevent the accumulation of the toxic intermediate ⟹

Many of us are clicking, copying and pasting...







Haggis population density in the Scottish Highlands

S Johnston, University of Edinburgh.

Introduction.

Figure 1: Linear regression of haggis population size and year.

The haggis is a common pest species in the Scottish Highlands. Haggis population densities were recorded annually from 1970 to 2000. We found that the haggis population size increased over this period by 11.67 individuals year^{-1} ($P < 0.001$, Figure 1).

- Can you repeat all of this again...
- ...and would you get the same results every time?

Worst Case Scenario

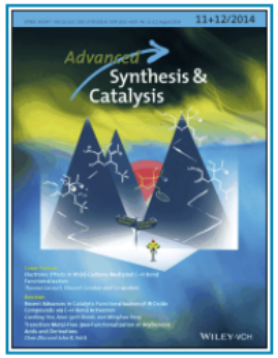
Retraction Watch

Tracking retractions as a window into the scientific process

Archive for the 'not reproducible' Category

Molecular mixup burns chemistry paper

without comments



Chemists at Lanzhou University in China did the right thing last month, retracting a paper in *Advanced Synthesis & Catalysis* because of issues with a reactant that could only be corrected by changing "all the text and quantities."

When the scientists were adding what was labeled Reactant 1 to the mix, they believed it was α-ethoxycarbonyl-α-azido-*N*-phenylacetamides. Unfortunately, what they were actually using was a decomposed version of the molecule, which threw everything off.

Here's the notice for "*tert*-Butyl Hydroperoxide and Tetrabutylammonium Iodide- Promoted Free Radical Cyclization of α-Azido-*N*-arylamides": Read the rest of this entry »

Share this:

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Written by Cat Ferguson
April 14th, 2015 at 11:30 am

Posted in Advanced Synthesis and Catalysis, chemistry retractions, china retractions, doing the right thing, freely available, not reproducible, wiley

Two more retractions bring lab break-in biochemist up to eleven

without comments

Karel Bezouška, the Czech biochemist who was caught on hidden camera breaking into a lab fridge to fake results, has turned it up to eleven with two new retractions.

Both retractions appeared in *Biochemical and Biophysical Research Communications*, one in October 2014 and one in January 2015. His story began two decades ago in 1994, when he published a paper in *Nature* that couldn't be reproduced, and was eventually retracted in 2013.

The best part of the story, of course, is that when his university was attempting to recreate his experiments, Bezouška broke into a lab fridge to tamper with the experiments. Unbeknownst to him, he was caught on hidden camera. Read the rest of this entry »

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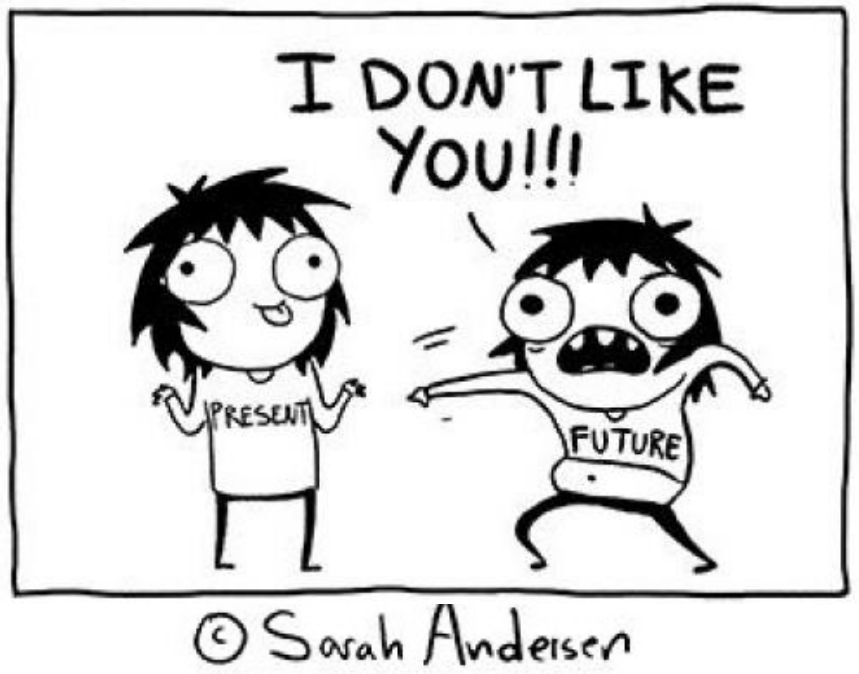
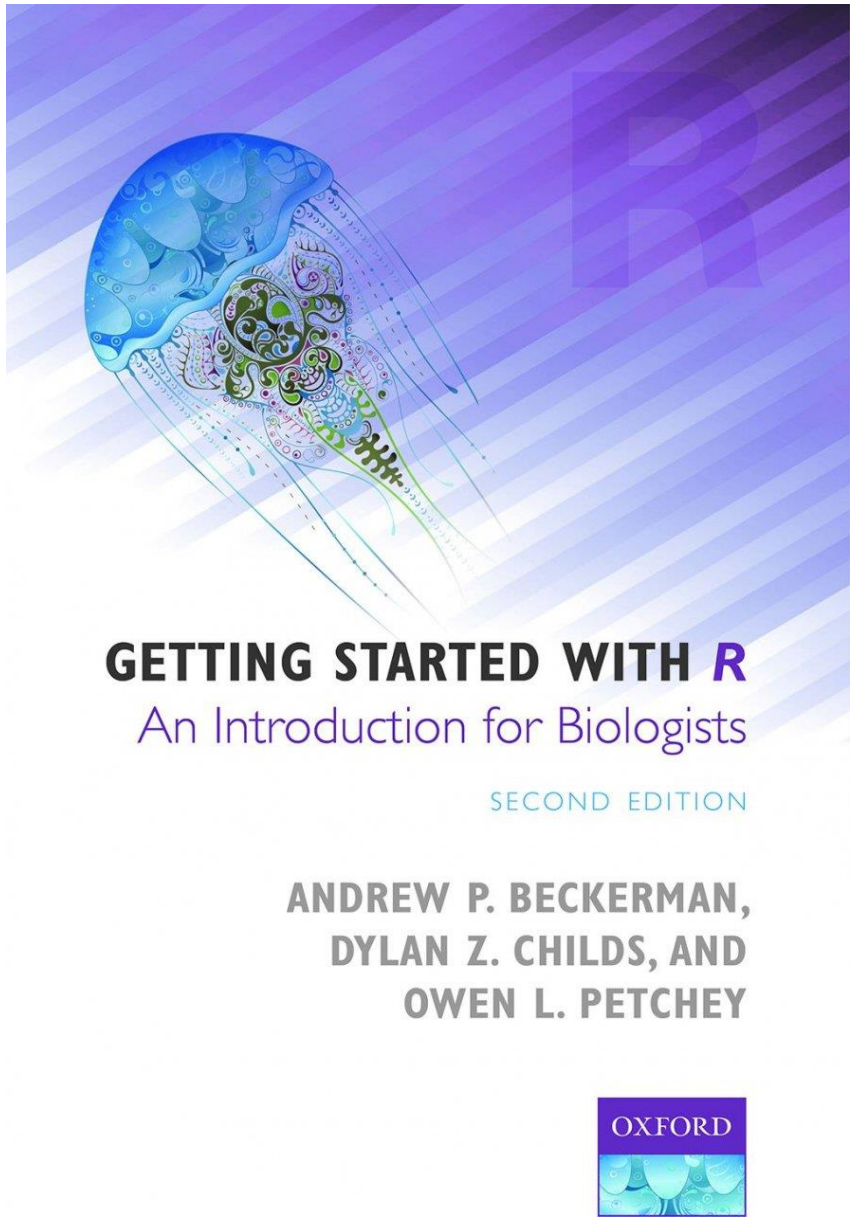
Scenarios that benefit from reproducibility



- The first researcher who will need to reproduce results is likely to be **YOU.**
- New data becomes available.
- You return to a project after a period of time.
- You give the project to a new student/collaborator.
- A reviewer wants you to change a model parameter.
- When you find an error, but not sure where you went wrong.

Using R as a Research Tool: Overview

- Getting Started: R and the Rstudio Environment.
- Loading data into R.
- Data Management in R with `dplyr`.
- Data visualisation with `ggplot2`.

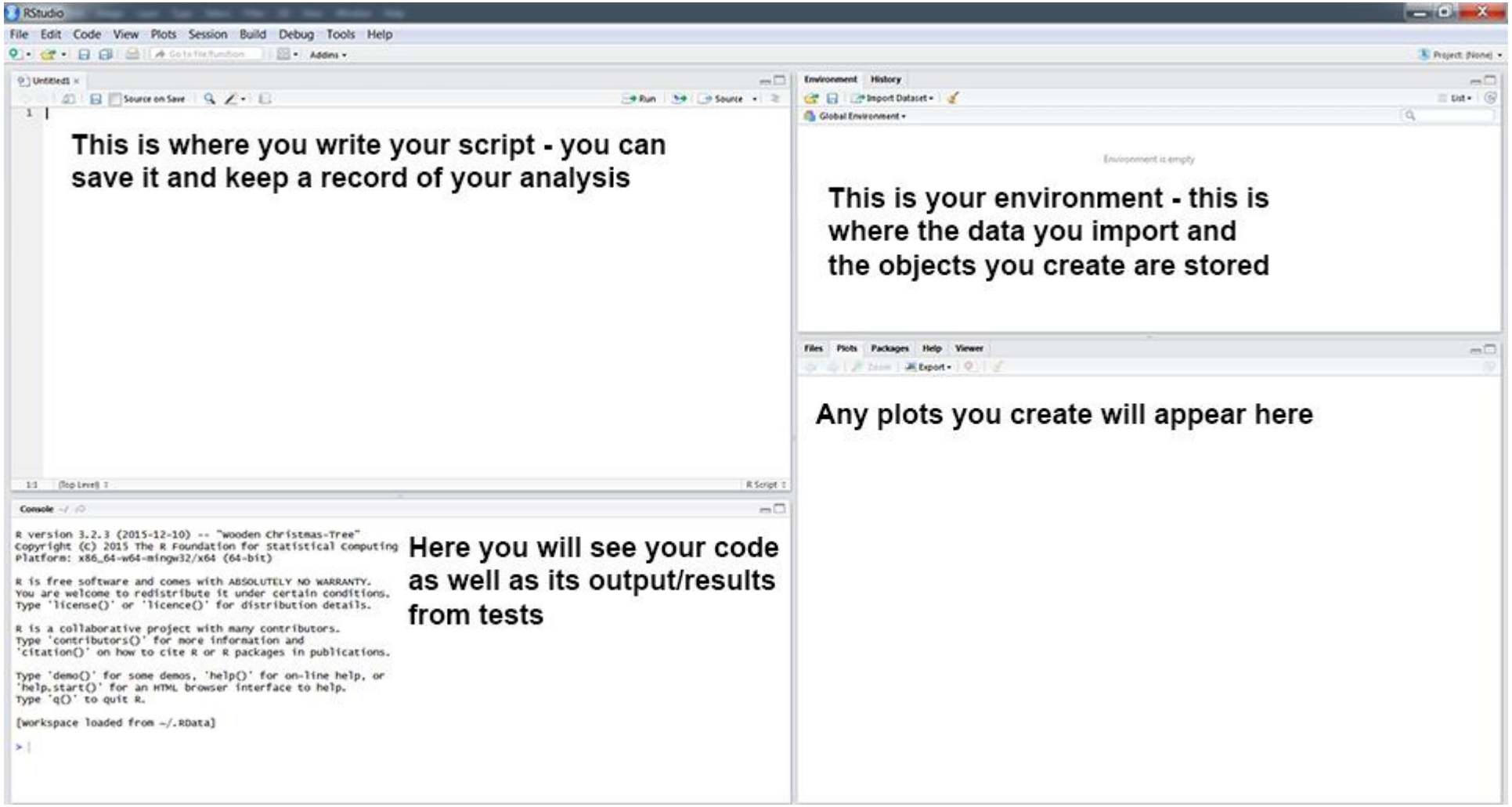


1

Getting and Getting Acquainted with R

Mhairi's Base R cheatsheet…
http://github.com/rstudio/cheatsheets/raw/master/base-r.pdf

R and the Rstudio Environment



Finding help.

- In R…
  - ? searches for a specific function.
  - ?? searches for a specific string.
  - Help tab in RStudio
- Online…
  - ourcodingclub.github.io
  - Stack Overflow
  - R Cheatsheets

Loading data into R

Data management in R with base R & `dplyr`

- Summarise data with `summary()`
- Sort data with `arrange()`
- Select columns with `select()`
- Adding columns with `$`
- Select rows with `filter()`

filter()

Operator	Function
<	less than
>	greater than
=<	less than or equal to
=>	greater than or equal to
==	equals
! =	does not equal
%in%	matches

Data visualisation with ggplot2

http://ggplot2.tidyverse.org/reference/

Base graphics…
http://rpubs.com/SusanEJohnston/7953

`ggplot2` uses three components to construct a graph.

- Layers: `ggplot()`
  - Data with aesthetic properties (`aes()`)

- Geoms: `geom_...()`
  - Type of plot (line, scatter, box-plot, etc).

- Stats: `stat_...()`
  - Statistical transformations
  - NB. Most geoms have a default stat, so this is not always need.

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