

# MPP-E1180 Lecture 1: Introduction to the Course

Christopher Gandrud

11 September 2015

# Christopher Gandrud

## Contact:

- ▶ Public
  - ▶ SyllabusAndLectures/issues
  - ▶ @ChrisGandrud
- ▶ Private
  - ▶ [gandrud@hertie-school.org](mailto:gandrud@hertie-school.org)

## Official Office Hours:

- ▶ Room: 1.64
- ▶ Friday: 15:00-17:00

# Objectives for the topic

- ▶ Introduce the course motivation, goals, plan, and expectations/assessment
- ▶ Introduce Collaborative & Reproducible Data Analysis
- ▶ Set up computational research environment

# Objectives for the course

## **Collaboratively** and **reproducibly**:

1. Gather/clean social data
2. Analyse it to draw informed descriptions/inferences
3. Present results (in a variety of mediums)

# Objectives for the course

Learn how to actually **do** data analysis using **best practices**

We are going to use **ugly real-world data**, not pristine training data sets.

Use **advanced computation tools** to do **data munging**.

# Motivation: Academic

- ▶ Skills needed to do **original quantitative research** for your **thesis**.
  - ▶ The final project will be a **trial version** of your thesis.
- ▶ State-of-the-art tools needed for **future high-level academic research**.
  - ▶ Take advantage of new data sources.
  - ▶ Avoid effort duplication.
  - ▶ Make your research reproducible.
  - ▶ Present your results in multiple forums.

# Motivation: Government

- ▶ Government agencies are increasingly adopting the technologies and methods of open data science.

# Motivation: Government

- ▶ Public data is increasingly **accessible**.
  - ▶ e.g. World Bank Development Indicators, GovData Germany, data.gov.uk, New York City, data.gov
- ▶ Governments rely on data analysis for evidence based decision-making.
  - ▶ Tools of open data analysis enable better use of data **within** and **between** government actors.
  - ▶ Governments can take advantage of analyses done by **third parties**.



# Motivation: Government

- ▶ They are also **sharing** and **collaboratively** developing code; **reducing development costs** and **improving applications**.
- ▶ Version control to **increase engagement with the legislative process**.
  - ▶ San Francisco laws are now forkable.

## Motivation: Business

- Data analysis and R programming skills in particular are **highly valued** in businesses such as finance and management.

AVERAGE SALARY FOR <b>High Paying Skills and Experience</b>		
SKILL	2013	YR/YR CHANGE
R	\$ 115,531	n/a
NoSQL	\$ 114,796	1.6%
MapReduce	\$ 114,396	n/a
PMBok	\$ 112,382	1.3%
Cassandra	\$ 112,382	n/a
Omnigraffle	\$ 111,039	0.3%
Pig	\$ 109,561	n/a
SOA (Service Oriented Architecture)	\$ 108,997	-0.5%
Hadoop	\$ 108,669	-5.6%
Mongo DB	\$ 107,825	-0.4%

# Why Collaborative?

- ▶ Research is collaborative (even if you don't know it).
- ▶ Need tools and shared best practices to enable effective collaboration between **explicit research partners**.
- ▶ Need tools and shared best practices to enable collaboration between researchers who are **not explicitly** working together often in **unexpected ways**.
  - ▶ **Avoids effort duplication**
  - ▶ Enables **cumulative knowledge development**
- ▶ Tools for collaboration tend to enhance **reproducibility**.

# What is reproducibility?

**Really reproducible** research (Peng 2011, 1226):

*the data and code used to make a finding are **available** and they are **sufficient** for an independent researcher to **recreate the finding**.*

- ▶ In practice reproducibility is enhanced by **literate programming** where the data, analysis, and presentation of the results are 'weaved' or 'knitted' together.
  - ▶ Make available the research, **not just the advertising** for the findings (e.g. papers, book).

# Reproducibility vs. Replication?

**Reproducibility:** an independent study makes the same findings using the **same data** and **code** as the original researchers.

**Replicability:** an independent study makes the same conclusions as the original using **other data, code, and even methods**, i.e. independent verification.

# Reproducibility vs. Replication?

**“A study can be reproducible and still be wrong”** Peng 2014.

E.g. a finding that is statistically significant in one study may remain statistically significant when reproduced using the original data/code, but **replication studies are unable to find a similar result.**

The original finding could just have been noise.

# Why reproducibility?

- ▶ **Replication** is the “**ultimate standard**” for judging scientific claims (Peng 2011).
- ▶ **Reproducibility**
  - ▶ **Enhances replication** (other researchers can understand how an analysis was actually done)
  - ▶ Is a **minimum standard** for judging scientific claims when replication is not possible.

# Why reproducibility?

Reproducibility helps **avoid effort duplication**:

- ▶ Others **don't waste time**:
  - ▶ Gathering data that has already been gathered.
  - ▶ Discovering procedures that have already been discovered.



# Why reproducibility?

- ▶ Reproducibility also makes it possible to **find and correct errors**.
- ▶ Recent examples:
  - ▶ Translation errors in the World Values Survey.
  - ▶ Data errors in research on intestinal worm treatment and school attendance.
  - ▶ L'Affaire LaCour: data *fabrication* discovered.
- ▶ Data errors can cause spurious findings that ultimately **waste researchers time**, because they try to explain 'wrong' findings.

# Why reproducibility?

- ▶ **Higher research impact**

- ▶ Reproducible research is likely to be more **useful for other researchers**. They can use your data and learn from your code and methods.
- ▶ More use more impact (e.g. citations)

- ▶ **Better work habits**

- ▶ Thinking about reproducibility from the beginning makes your files **better organised** and your work is **better documented**.
- ▶ This allows you to **build on your own work** more effectively.

# Reproducible Workflow

# Example of Truncated Workflow

This lecture is created using RMarkdown. It allows me to create both PDF and HTML slides.

branch: master ▾ SyllabusAndLectures / LectureSlides / Lecture1 / +

update lecture 1 pdf

christophergandrud authored a day ago latest commit 2a25fb3c16

..		
img	first draft completed	6 days ago
Lecture1.Rmd	update links to new org	a day ago
Lecture1.html	update links to new org	a day ago
Lecture1.pdf	update lecture 1 pdf	a day ago

# Practical Tips for Reproducible Research

- ▶ Document Everything!
- ▶ Everything is a (text) file.
- ▶ All files should be human readable.
- ▶ Explicitly tie your files together.
- ▶ Have a plan to organise, store, and make your files available.

# Course Prerequisites

- ▶ **Introductory-level statistics**

- ▶ Basic descriptive statistics (e.g. data types, ways of describing distributions)
- ▶ Basic inferential statistics: (significance testing, linear regression)
- ▶ Exposure to statistics software (e.g. SPSS, STATA)

- ▶ Knowledge of particular software or computer programming is **not expected**

- ▶ **Patience**

- ▶ Work hard so you can be lazy.

# Course Outline (1)

## Part I: Motivation and Getting Started

- ▶ Introduction to the Course
- ▶ Introduction to the R Programming Language
- ▶ Files, Files Structures, Version Control, and Collaboration

## Part II Markup Languages and Literate Programming

- ▶ Introduction to Markup Languages and Literate Programming (1)
- ▶ Introduction to Markup Languages and Literate Programming (2)

# Course Outline (2)

## **Part III: Data Gathering, Transformations, and Analysis**

- ▶ Automatic Data Gathering via Curl, API Packages + Cleaning
- ▶ Automatic Data Gathering via Web Scraping
- ▶ Statistical Modelling with R

## **Part IV: Communicating Results from Statistical Analyses**

- ▶ Automatic Table Generation and Static Visualisation
- ▶ Dynamic Visualisation

## **Part V: Collaborative Research Project**



# Typical Two Hour Class Plan

- ▶ ~ 1 hour lecture
- ▶ ~ 1 hour seminar
  - ▶ **Apply** what we learned in the lecture/readings to achieve specific goals, i.e. **no set pattern** to copy by rote.
  - ▶ **Pair programming**: work together with others to achieve these goals.
  - ▶ **Documentation**: document your work with Git/GitHub.
    - ▶ Your seminar work should be **reproducible**.
    - ▶ It should be **useful** to your **future self** and **others**.

# Three Hour Classes (1)

This year the course is broken into **8 classes** that are each **three hours long**.

Today we will do:

- ▶ 1 hour lecture on topic 1 (Course Introduction),
- ▶ 1 hour seminar on topic 1,
- ▶ 1 hour lecture on topic 2 (Intro to R).

## Three Hour Classes (2)

Next class we will do:

- ▶ 1 hour seminar on topic 2 (Intro to R),
- ▶ 1 hour lecture on topic 3 (Files, File Structures, Version Control),
- ▶ 1 hour seminar on topic 3.

# Class dates

## September

11, 19, 25

## October

9, 16, 30

## November

20

## December

4

# Assessment

- ▶ 3 Pair Assignments (2 Oct, 23 Oct, 6 Nov)
  - ▶ 10% each
- ▶ Collaborative Research Project (Presentation: 4 Dec, Website/Paper: Exam Week)
  - ▶ 50%
- ▶ Attendance & Active Participation
  - ▶ 20%
- ▶ No traditional midterm or final exam

# Assessment Details (1)

- ▶ All assignments must be developed and submitted electronically on GitHub.
- ▶ Late assignments: -10% every day that the assignment is late.
- ▶ All assignments must be completed in **pairs**.
  - ▶ Each pair member receives the same score
  - ▶ Exception: very large discrepancy in contributor statistics



## Assessment Details (2)

- ▶ All assignments must be **reproducible**.
- ▶ **Due:** Midnight on the due date.
- ▶ More details will be given on the specific pair assignments/research project in future classes.



# Assessment (attendance, participation)

- ▶ Usual Hertie Rules for attendance (examination rules §4)
- ▶ Participation:
  - ▶ **Traditional Participation**, e.g. engaging in class discussions, doing readings
  - ▶ **Non-Traditional Participation**: pair programming in seminars, document your seminar work on GitHub, pull request to the course repository (syllabus/lecture slides) and other groups' projects

# Syllabus & Lecture Slides

https:

[//github.com/HertieDataScience/SyllabusAndLectures](https://github.com/HertieDataScience/SyllabusAndLectures)

**Syllabus:** README.md

- ▶ The syllabus will be **updated**. **Check regularly**.
  - ▶ Changes to course **difficulty** is **monotonically decreasing** from the original (11 September) baseline.

**Lecture Slides:** Links in Online Syllabus or LectureSlides/

- ▶ Usually accessible as both HTML (recommended) or PDF.
- ▶ Slides will be **optimized for the web**.

# Reading

## Core Texts

- ▶ Gandrud, Christopher. 2015. *Reproducible Research with R and RStudio*. 2nd Edition. Chapman & Hall/CRC Press, Oxford. (RRRR)
  - ▶ 1st edition is also fine.
- ▶ Crawley, Michael J. 2005. *Statistics: An Introduction Using R*. John Wiley and Sons Ltd., Chichester.

Both are available in the library.

**Other readings** generally available online (see syllabus) or I will make a copy available.

# Issues

If you have general questions, please post them to the GitHub Issue Pages:

`https://github.com/HertieDataScience/  
SyllabusAndLectures/issues`

Includes answers to questions asked last year.

# Seminar to-do

- ▶ Meet each other, get idea of background.
- ▶ Setup software (all software is free).
  - ▶ **Highly recommended:** use your own laptop

# Modern Web browser

- ▶ Make sure you have a modern web browser, e.g.:
  - ▶ Chrome

# GitHub

Setup Git/GitHub for version control, collaboration, and remotely storing your files.

- ▶ Set up (free) GitHub account: <https://github.com/join>
- ▶ **Give me your GitHub username** so that I can add you to the **HertieDataScience** group (<https://github.com/HertieDataScience>).
- ▶ Install GitHub application: <https://desktop.github.com/>

# Statistics software

- ▶ **Install** software:

- ▶ R (version 3.2.2): <http://cran.rstudio.com/>
- ▶ RStudio (dev build):  
<http://www.rstudio.org/download/daily/desktop/>

- ▶ Make sure that you can install R packages:

```
# Install the ggplot2 package
```

```
install.packages('ggplot2')
```

```
# Check to see if it loads properly
```

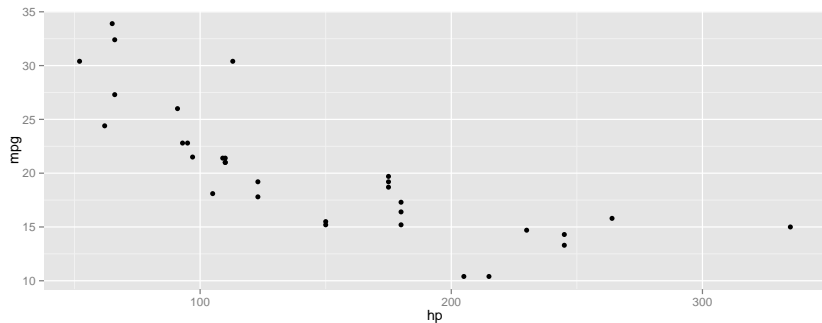
```
library(ggplot2)
```

```
ggplot(mtcars, aes(hp, mpg)) + geom_point()
```



# Expected Test Result

```
ggplot(mtcars, aes(hp, mpg)) + geom_point()
```



# LaTeX

- ▶ Install a LaTeX distribution. Creates well formatted PDF versions of your presentation documents.
  - ▶ Mac: <https://tug.org/mactex/>
  - ▶ Windows: <http://miktex.org/download>
- ▶ This is a large download, so maybe do it in your spare time.

# Post-Installation

Play around with the software (especially RStudio)