MPP-E1180 Lecture 1: Introduction to the Course

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

Objectives for the topic

- Introduce course motivation, goals, plan, and expectations/assessment
- Introduce collaborative & reproducible data analysis
- Setup computational research environment

Objectives for the course

Collaboratively and **reproducibly**:

1. Gather and 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 computational 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 to 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: NGO

NGO's are becoming increasingly data-oriented and need people with **skills** to **handle and analyse** this data.

Ex. Former MPP-E1180 student Arndt Leininger recently co-founded CorrelAid to assist NGOs with data analysis.

Motivation: Business

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

AVERAGE SALARY FOR High Paying Skills and Experience

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%

Source: Revolution Analytics (2014)

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.

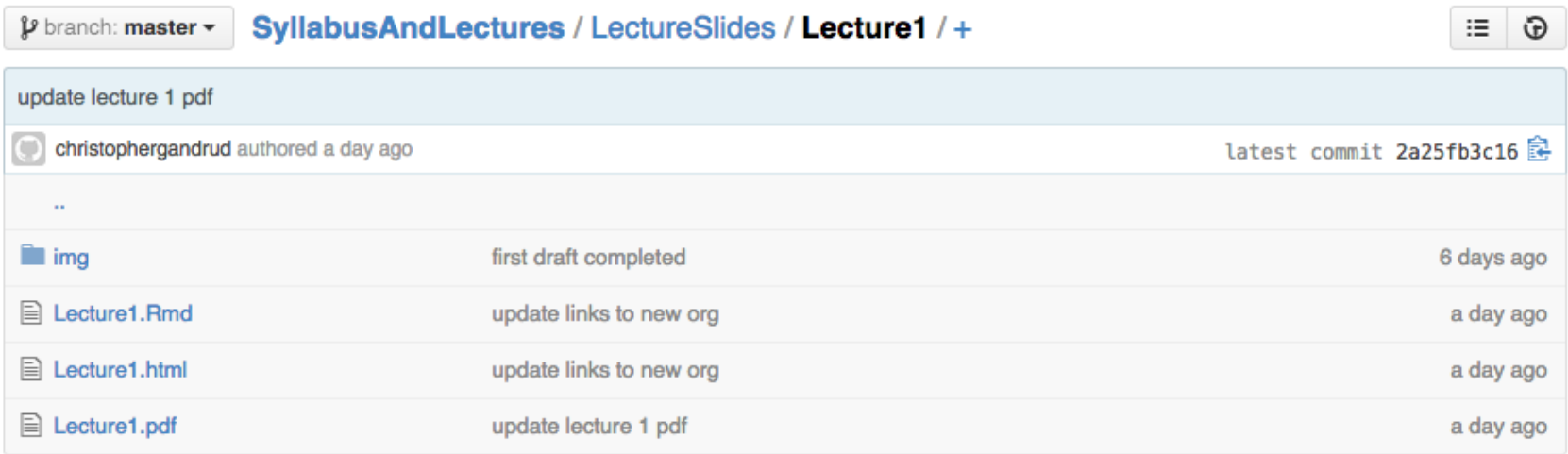
Why reproducibility?

- **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 (Truncated) Workflow

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



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, Trasformations, 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 Topic Plan

- $\sim$ 1 hour lecture
- $\sim$ 1 hour seminar
  - **Apply** what we learned in the lecture/readings to complete tasks with **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`

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.
- Find course materials and open lecture slides.
- 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`.
- 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:

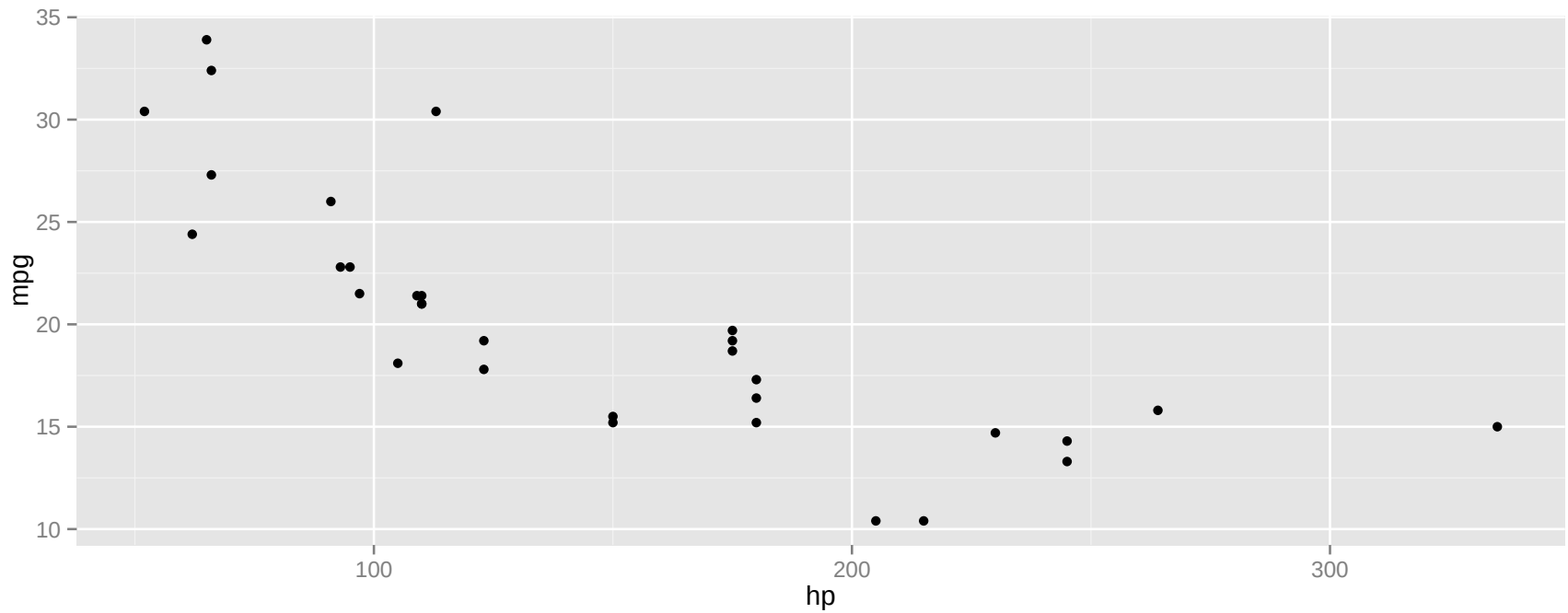
```
# Install the ggplot2 package
install.packages('ggplot2')

# 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)