

MPP-E1180 Lecture 9: Automatic Tables and Static Visualisation

Christopher Gandrud

30 October 2015

Objectives for the week

- ▶ Assignment 2 general feedback
- ▶ Assignment 3/Final Project
- ▶ Review
- ▶ Static results presentation
 - ▶ Automatic table creation
 - ▶ Plotting best practices
 - ▶ ggplot2 for general graphing
 - ▶ Zelig simulations for showing results

Assignment 2 General Feedback (1)

- ▶ Please see me in my office hours to help refine operationalisation, research question, etc.
- ▶ Proofread your work!
 - ▶ Finish your sentences!
 - ▶ Check output document to see if it has rendered correctly.
- ▶ A catchy and descriptive title is good to have!
- ▶ If you use HTML make sure you provide a link to a hosted and rendered version, e.g. on rawgit.

Assignment 2 Feedback (2)

- ▶ Numbered section headings, in YAML header:

```
number_sections: true
```

Assignment 2 Feedback (3)

Figure captions, in YAML header include:

```
fig_caption: true
```

Then, in knitr head include option:

```
fig.cap = "A Caption Example"
```

or in imported images:

```
![A Caption Example \label{LaTeXref}](some_image.png)
```

Can reference in knitr LaTeX with `\ref{LaTeXRef}`.

Assignment 3

Purpose: Gather, clean, and analyse data

Deadline: 13 November 2015

You will submit a GitHub repo that:

- ▶ Gathers web-based data from at least **two sources**. Cleans and merges the data so that it is ready for statistical analyses.
- ▶ Conducts basic descriptive and inferential statistics with the data to address a relevant research question.
- ▶ Briefly describes the results including with dynamically generated tables and figures.
- ▶ Has a write up of 1,500 words maximum that describes the data gathering and analysis and uses literate programming.

Collaborative Research Project (1)

Purposes: Pose an interesting research question and try to answer it using data analysis and standard academic practices. Effectively communicate your results to a **variety of audiences** in a **variety of formats**.

Deadline:

- ▶ Presentation: In-class Thursday 4 December
- ▶ Website/Paper: 11 December

Collaborative Research Project (2)

The project can be thought of as a 'dry run' for your thesis with multiple presentation outputs.

Presentation: 10 minutes **maximum**. **Engagingly** present your research question and key findings to a general academic audience (fellow students).

Paper: 6,000 words maximum. **Standard academic paper**, properly cited laying out your research question, literature review, data, methods, and findings.

Website: An engaging website designed to convey your research to a **general audience**.

Collaborative Research Project (3)

As always, you should **submit one GitHub repository** with all of the materials needed to **completely reproduce** your data gathering, analysis, and presentation documents.

Note: Because you've had two assignments already to work on parts of the project, I expect **high quality work**.

Collaborative Research Project (3)

Find one other group to be a **discussant** for your presentation.

The discussants will provide a quick (max 2 minute) critique of your presentation—ideas for things you can improve on your paper.

Office hours

I will have normal office hours (Friday 15:00-17:00, room 1.64) every week for the rest of the term, **except** 13 November.

Please take advantages of this opportunity to **improve your final project**.

Review

- ▶ What is the basic R syntax for a regression model?
- ▶ What is a model function? What two parts do GLM model functions have?
- ▶ How do you find a 95% confidence interval for a parameter point estimate (both mathematically and in R)?
- ▶ What is one good way to interpret and present results from a logistic regression to both a statistical and general audience?

Motivation

Today we will learn how to **communicate your research findings** with automatically generated tables and static plots.

Why automatically generate?

- ▶ **Saves time:** don't have to re-enter numbers by hand into a table or restyle a graph each time you change the data/analysis.
- ▶ Easier to **find and correct errors:** all source code that created all tables and figures is linked and output updated when corrections are made.
- ▶ **More reproducible:** everything is clearly linked together.

General process

In general include the functions to create the tables/figures in a code chunk.

Include in the **code chunk head** `echo=FALSE`, `warning=FALSE`, `error=FALSE`, `message=FALSE`.

You may need to also include `results='asis'` for some table functions.

See previous weeks 4 and 5 for figure code chunk options.

Automatic table generation

There are a number of tools for automatically generating tables in R/R Markdown.

- ▶ `kable` in the `knitr` package
- ▶ `xtable` package
- ▶ `texreg` package
- ▶ `stargazer` package

Today

We will focus on `kable` and `stargazer`.

- ▶ `kable` is a good, **simple** tool for creating tables from **data frames** (or matrices).
- ▶ `stargazer` is useful for creating more complex tables of **regression model output**.

Example Docs:

[HertieDataScience/Examples/PaperWithRegressionTables](#)

kable example: predicted probabilities

Set up from Lecture 8:

```
# Load data
URL <- 'http://www.ats.ucla.edu/stat/data/binary.csv'
Admission <- read.csv(URL)

# Estimate model
Logit1 <- glm(admit ~ gre + gpa + as.factor(rank),
              data = Admission, family = 'binomial')

# Create fitted data
fitted <- with(Admission,
               data.frame(gre = mean(gre),
                           gpa = mean(gpa),
                           rank = factor(1:4)))
```

kable example: predicted probabilities

```
library(knitr)
fitted$predicted <- predict(Logit1, newdata = fitted,
                             type = 'response')
kable(fitted)
```

gre	gpa	rank	predicted
587.7	3.3899	1	0.5166016
587.7	3.3899	2	0.3522846
587.7	3.3899	3	0.2186120
587.7	3.3899	4	0.1846684

kable example: predicted probabilities

You can stylise the table.

```
kable(fitted, align = 'c', digits = 2,  
      caption = 'Predicted Probabilities for Fitted Values
```

Table 2: Predicted Probabilities for Fitted Values

gre	gpa	rank	predicted
587.7	3.39	1	0.52
587.7	3.39	2	0.35
587.7	3.39	3	0.22
587.7	3.39	4	0.18

Note

Don't showing more digits to the right of the decimal than are statistically and substantively meaningful.

A rule of thumb: more than one or two digits are rarely meaningful.

See also: <http://andrewgelman.com/2012/07/02/moving-beyond-hopeless-graphics/>

Show regression output with stargazer

`kable` is limited if we want to create regression output tables, especially for multiple models.

`stargazer` is good for this.

stargazer example

Estimate models

```
L1 <- glm(admit ~ gre,  
          data = Admission, family = 'binomial')  
  
L2 <- glm(admit ~ gre + gpa,  
          data = Admission, family = 'binomial')  
  
L3 <- glm(admit ~ gre + gpa + as.factor(rank),  
          data = Admission, family = 'binomial')
```

stargazer example HTML

When you are creating a table for an HTML doc with stargazer use:

► `type = 'html'`

```
# Create cleaner covariate labels
```

```
labels <- c('(Intercept)', 'GRE Score', 'GPA Score',  
            '2nd Ranked School', '3rd Ranked School',  
            '4th Ranked School')
```

```
stargazer::stargazer(L1, L2, L3, covariate.labels = labels,  
                      title = 'Logistic Regression Estimates of Grad School A  
                      digits = 2, type = 'html')
```

stargazer example HTML

stargazer example PDF

When you are creating a PDF use the arguments:

- ▶ `type = 'latex'`
- ▶ `header = FALSE`

```
# Create cleaner covariate labels
```

```
labels <- c('(Intercept)', 'GRE Score', 'GPA Score',  
            '2nd Ranked School', '3rd Ranked School',  
            '4th Ranked School')
```

```
stargazer::stargazer(L1, L2, L3, covariate.labels = labels,  
                      title = 'Logistic Regression Estimates of Grad School A  
                      digits = 2, type = 'latex', header = FALSE)
```

stargazer output in PDF

Showing Results with Figures

Tables **are important** to include so that readers can **explore details**, but are **usually not the best way** to show your results.

Figures are often more effective.

General principles

(A Selection of) Tufte's Principles for Excellent Statistical Graphics (2001, 13):

- ▶ Show the data
- ▶ Encourage the eye to compare **differences** in the data
- ▶ Serve a clear purpose
- ▶ Avoid distorting the data
- ▶ Be closely integrated with the text

Show the data

Show the data, not other things like silly graphics or unnecessary words.

Have a high **data ink** ratio:

$$\text{Data Ink Ratio} = \frac{\text{data} - \text{ink}}{\text{total ink}}$$

Encourage the eye to compare differences

How did the budgets change? (Orange is 2013, Blue is 2012)

A little better

Even better

Avoid distorting the data: special case circles

In general: Avoid using the **size** of a circle to mean something!

So, avoid:

- ▶ bubble charts
- ▶ pie charts

Why avoid circles?

Circles can distort data.

- ▶ It is difficult to compare their size.
- ▶ The Ebbinghause Illusion!

Order the circles from smallest to largest.

The circles are on a scale of 0-100, so what are their values?

Ebbinghause Illusion

Which circle is bigger?

Colours and Data Distortions

Which square is darkest?

Colour Principles

Only give graphical features (e.g. bars in a bar chart) different colours if it **means something** in the data.

Colour Principles

Colours should be used to:

- ▶ highlight particular data,
- ▶ group items,
- ▶ encode quantitative values
 - ▶ Values of continuous variables should be represented using **increasing hues of the same colour**.
 - ▶ Categorical variables should be represented with **different colours**. (rule of thumb: avoid using more than about 7 colours in a plot)

Bad

Good

Colours and accessibility

Color Blindness

People who are colour blind can have difficulty distinguishing between **red-green** and **blue-yellow**.

About 5-8% of men are colour blind.

We need to choose colour schemes for our graphics that are **colour blind friendly**.

For more information see <http://www.usability.gov/get-involved/blog/2010/02/color-blindness.html>.

Selecting colors

Color Brewer is a great resource for selecting colours:
<http://colorbrewer2.org/>.

A more systematic introduction to ggplot2

“gg” means “Grammar of Graphics”.

“2” just means that it is the second one.

ggplot2 syntax

Each plot is made of **layers**. Layers include the coordinate system (x-y), points, labels, etc.

Each layer has **aesthetics** (aes) including the x & y, size, shape, and colour.

The **main layer types** are called **geometrics** (geom). These include lines, points, density plots, bars, and text.

ggplot2 examples setup

```
library(devtools)
library(ggplot2)

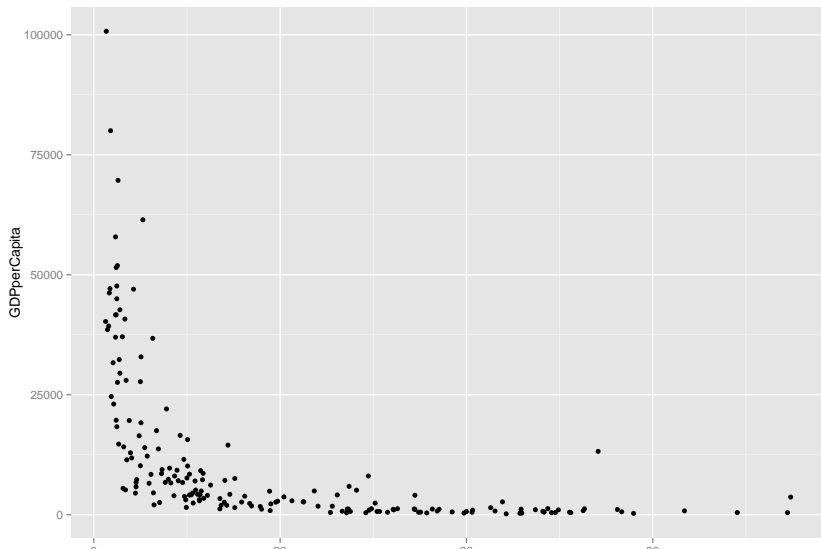
source_url("http://bit.ly/OTWEGS")

# Create data with no missing values of infant mortality
InfantNoMiss <- subset(MortalityGDP,
                       !is.na(InfantMortality))

# Create High/Low Income Variable
InfantNoMiss$DumMort[InfantNoMiss$InfantMortality
                     >= 15] <- "high"
InfantNoMiss$DumMort[InfantNoMiss$InfantMortality
                     < 15] <- "low"
```

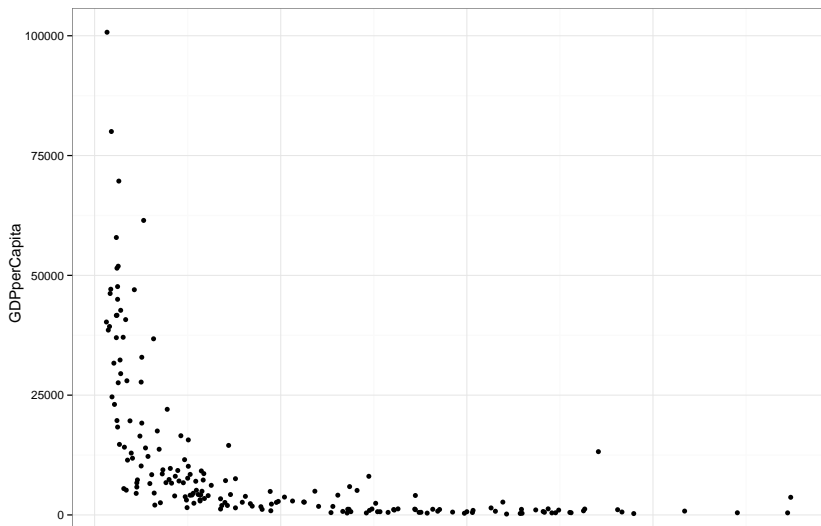
Simple example

```
ggplot(data = MortalityGDP, aes(x = InfantMortality,  
  y = GDPperCapita)) + geom_point()
```



Simple example with BW theme

```
ggplot(data = MortalityGDP, aes(x = InfantMortality,  
  y = GDPperCapita)) + geom_point() + theme_bw(base_s
```

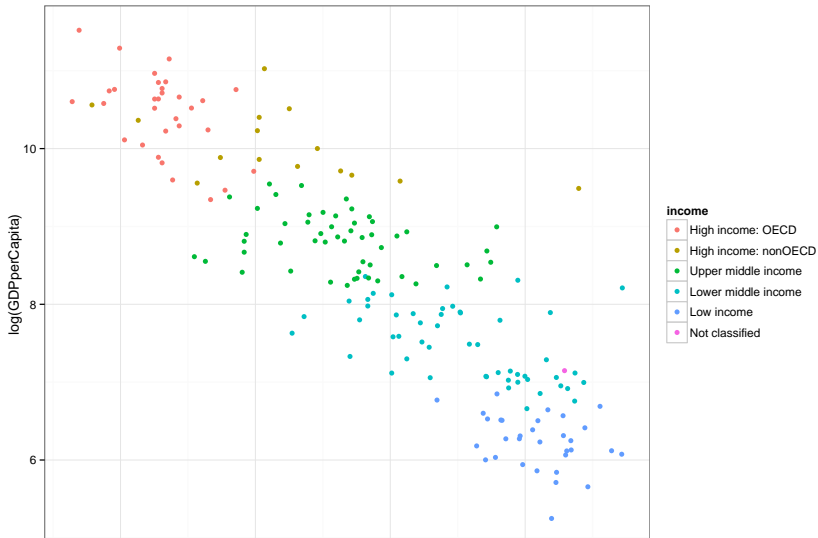


Colours

There are a number of ways to specify colours in `ggplot2`.

The simplest way is to let `ggplot` choose the colours for you.

```
ggplot(data = InfantNoMiss, aes(log(InfantMortality),  
                                log(GDPperCapita))) +  
  geom_point(aes(colour = income)) +  
  theme_bw()
```



Selecting colours

There are many ways to pick specific colors.

In this class we will mainly use **hexadecimal** colours.

This is probably the most commonly used system for choosing colours on the web.

Every colour is given six digits.

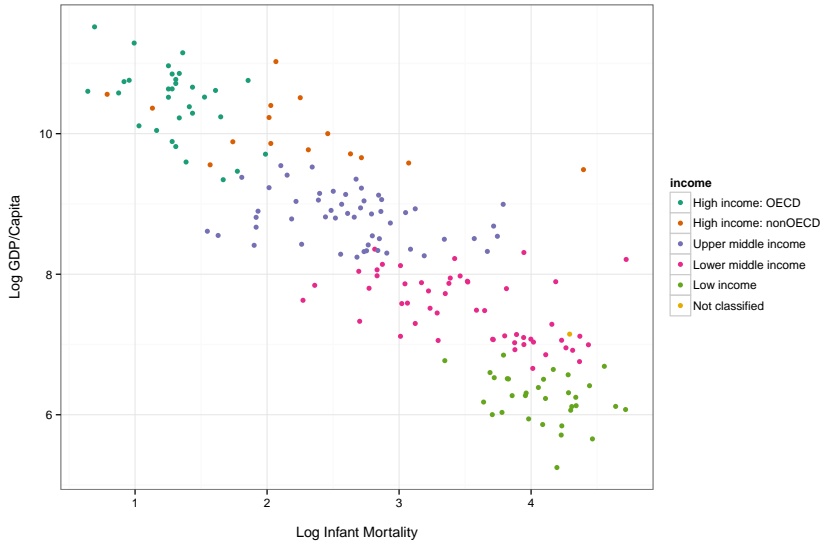
A good website for getting hexadecimal colour schemes is:

<http://colorbrewer2.org/>.

```
# Create colour vector
Colours <- c("#1B9E77", "#D95F02", "#7570B3",
             "#E7298A", "#66A61E", "#E6AB02")

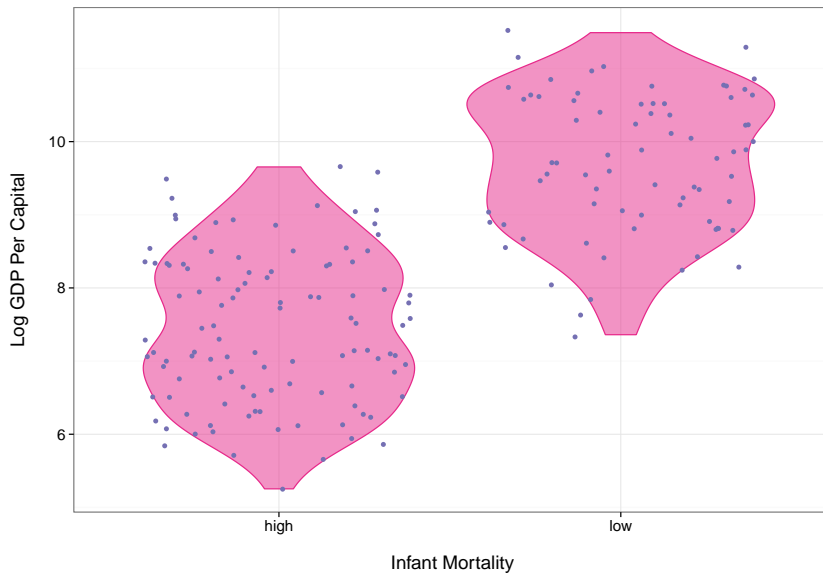
# Create graph
ggplot(data = InfantNoMiss,
        aes(log(InfantMortality),
             log(GDPperCapita))) +
  geom_point(aes(colour = income)) +
  scale_color_manual(values = Colours) +
  xlab("\nLog Infant Mortality") +
  ylab("Log GDP/Capita\n") +
  ggtitle("Log Transformed Data\n") +
  theme_bw()
```

Log Transformed Data



ggplot2 is very flexible

```
# Create a violin Plot  
ggplot(InfantNoMiss, aes(factor(DumMort),  
                           log(GDPperCapita))) +  
  geom_violin(fill = "#E7298A",  
              colour = "#E7298A",  
              alpha = I(0.5)) +  
  geom_jitter(color = "#7570B3") +  
  xlab("\n Infant Mortality") +  
  ylab("Log GDP Per Capital\n") +  
  theme_bw(base_size = 16)
```



Showing results from regression models

King, Tomz, and Wittenberg (2001) argue that **post estimation simulations** can be used to effectively communicate **results from regression models**.

Steps

1. Estimate our parameters' point estimates for $\hat{\beta}_{1...k}$.
2. Draw n values of the point estimates from multivariate normal distributions with means $\bar{\beta}_{1...k}$ and variances specified by the parameters' estimated co-variance.
3. Use the simulated values to calculate quantities of interest (e.g. predicted probabilities).
4. Plot the simulated distribution using **visual weighting**.

Notes

Post-estimation simulations allow us to effectively communicate our estimates and the **uncertainty around them**.

This method is broadly similar to a fully Bayesian approach with Markov-Chain Monte Carlo or bootstrapping. Just differ on **how the parameters are drawn**.

Implementation

It is relatively easy to find the coefficient estimates from an estimated model with `coef`.

You can find the co-variance matrix with `vcov`.

Then draw the values from the multivariate normal distribution with `mvrnorm`.

Finally, calculate the quantity of interest with the draws + fitted values using and plot the results.

Easier Implementation

The Zelig package streamlines this process.

Zelig (1)

First estimate your regression model using zelig.

```
library(Zelig)

# Have to explicitly declare rank as factor
Admission$rank <- as.factor(Admission$rank)

Z1 <- zelig(admit ~ gre + gpa + rank, cite = FALSE,
            data = Admission, model = 'logit')
```

Zelig (2)

Then set the fitted values with `setx`.

```
setZ1 <- setx(Z1, gre = 220:800)
```

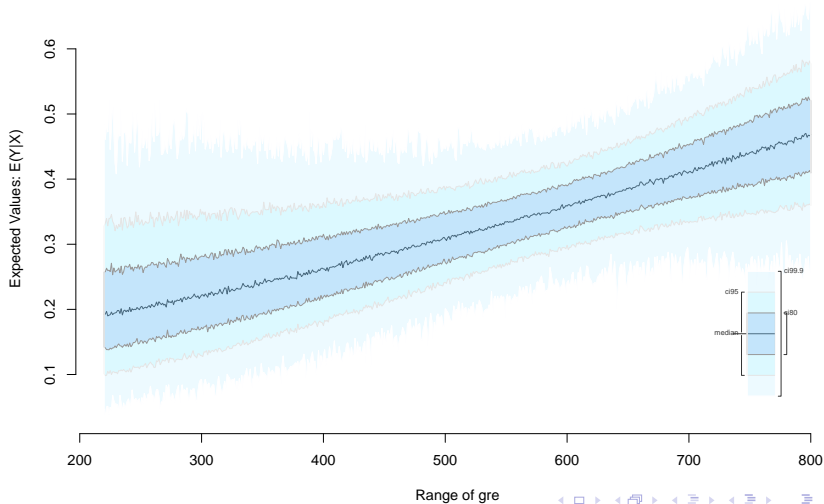
And run the simulations (1,000 by default) with `sim`.

```
simZ1 <- sim(Z1, x = setZ1)
```

Zelig (3)

Plot:

```
plot(simZ1)
```



Seminar

Create **tables** and **visualisations** of **descriptive** and **inferential** for your Assignment 3 using the techniques covered in class today.

If you don't have your data set fully cleaned yet, use one of the built-in R data sets for practice.

References

King, Gary, Micheal Tomz, and Jason Wittenberg. 2001. "Making the Most of Statistical Analyses: Improving Interpretation and Presentation." *American Journal of Political Science* 22 (4): 341–255.

Tufte, Edward R. 2001. *The Visual Display of Quantitative Information*. 2nd ed. Cheshire, CT: Graphics Press.