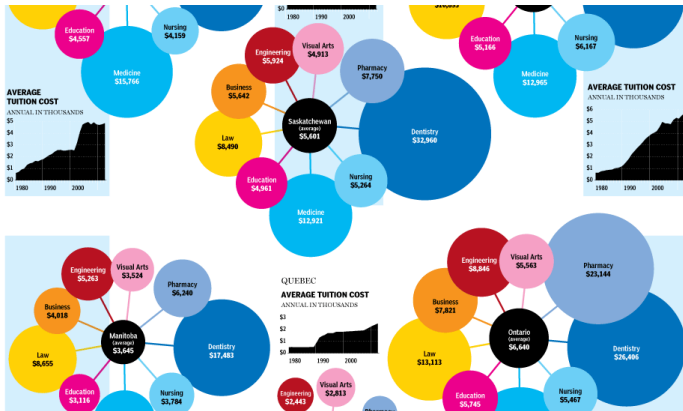


## 2 - Advanced Graphics

### 05 - Perception

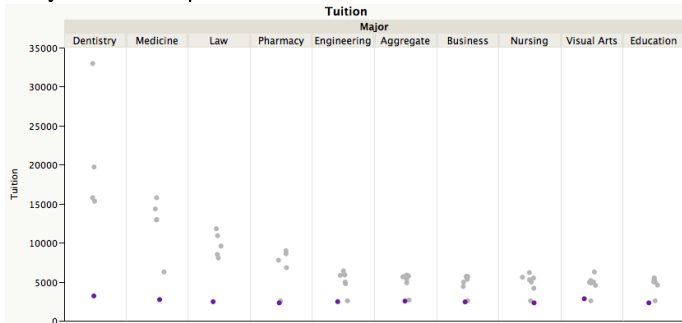
Iowa State University

# Cost of an Education



# Motivation

- Why are some plots easier to read?



- [http://junkcharts.typepad.com/junk\\_charts/2012/05/spring-flowers-and-striking-hours.html](http://junkcharts.typepad.com/junk_charts/2012/05/spring-flowers-and-striking-hours.html)

# Good Graphics

Graphics consist of

- ▶ Structure (boxplot, scatterplot, etc.)
- ▶ Aesthetics: features such as color, shape, and size that map other characteristics to structural features

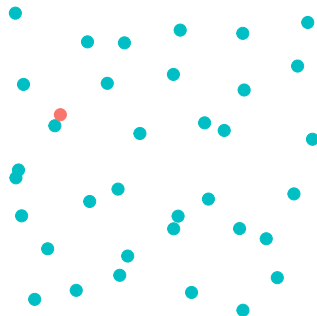
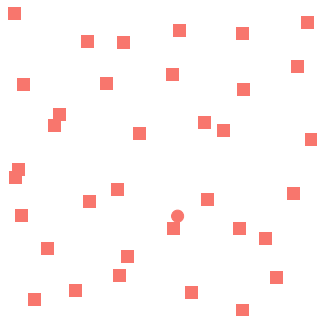
Both the structure and aesthetics should help viewers interpret the information.

# Outline

- ▶ Cognitive aspects of perception and aesthetic choices
- ▶ Visual ordering mechanisms and color choices
- ▶ Faceting graphs to show additional variables

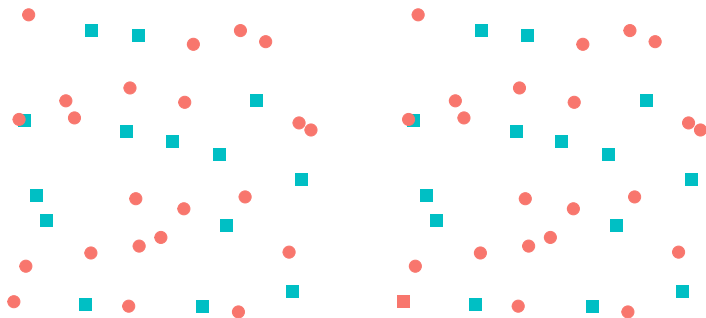
# Pre-Attentive Features

- ▶ Things that “jump out” in less than 250 ms
- ▶ Color, form, movement, spatial localization



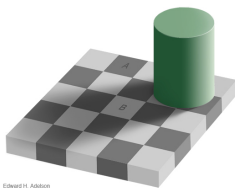
# Hierarchy of Features

- ▶ Color is stronger than shape
- ▶ Combinations of pre-attentive features are usually not pre-attentive due to *interference*



# Color

- ▶ Hue: shade of color (red, orange, yellow...)
- ▶ Intensity: amount of color
- ▶ Both color and hue are pre-attentive. Bigger contrast corresponds to faster detection.



















Color is context-sensitive: the exact same hue and intensity in one situation may appear to be a different color in a different context. A and B are the same intensity and hue, but appear to be different.



# Aesthetics in ggplot2

## Scales

Scales control the mapping between data and aesthetics. [Read more](#)

	<b>scale_alpha</b> Alpha scale for continuous variable		<b>scale_brewer</b> Sequential, diverging and qualitative colour scales from colorbrewer.org
	<b>scale_continuous</b> Continuous position scale		<b>scale_date</b> Position scale, date
	<b>scale_datetime</b> Position scale, date time		<b>scale_discrete</b> Discrete position scale
	<b>scale_gradient</b> Smooth gradient between two colours		<b>scale_gradient2</b> Smooth gradient between three colours (high, low and midpoints)
	<b>scale_gradientn</b> Smooth gradient between n colours		<b>scale_grey</b> Sequential grey colour scale
	<b>scale_hue</b> Qualitative colour scale with evenly spaced hues		<b>scale_identity</b> Use values without scaling
	<b>scale_linetype</b> Scale for line patterns		<b>scale_manual</b> Create your own discrete scale
	<b>scale_shape</b> Scale for shapes, aka glyphs		<b>scale_size</b> Size scale for continuous variable

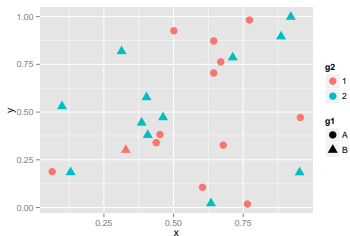
Main parameters: alpha, shape, color, size

# Your Turn

Find ways to improve the following graphic:

```
frame <- data.frame(x=runif(25), y=runif(25),  
  g1=rep(c("A","B"), c(12,13)),  
  g2=rep(c("1", "2"), c(13,12)))  
qplot(x,y, shape=g1, colour=g2, data=frame, size=I(4))
```

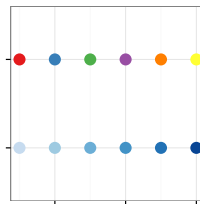
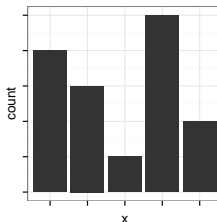
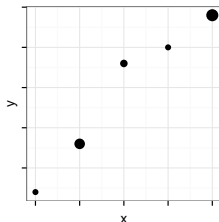
- ▶ Make sure the “oddball” stands out while keeping the information on the groups
- ▶ Hint: `interaction` combines factor variables



# Ordering Variables

Which is bigger?

- ▶ Position: higher is bigger (y), items to the right are bigger (x)
- ▶ Size, Area
- ▶ Color: not always ordered. More contrast = bigger.
- ▶ Shape: Unordered.



# Using Color

- ▶ Qualitative schemes: no more than 7 colors

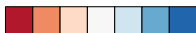


- ▶ Quantitative schemes:

- ▶ use color gradient with only one hue for positive values



- ▶ use color gradient with two hues for positive and negative values. Gradient should go through a light, neutral color (white)

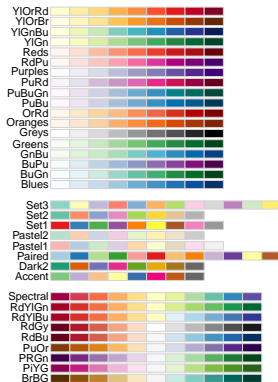


- ▶ Small objects or thin lines need more contrast than larger areas

# RColorBrewer

R package based on Cynthia Brewer's color schemes  
([ColorBrewer2.org](http://ColorBrewer2.org))

```
install.packages("RColorBrewer")  
library(RColorBrewer)  
help(package=RColorBrewer)  
display.brewer.all()
```



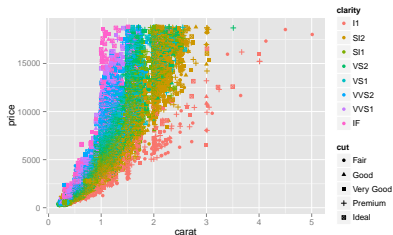
## Color in ggplot2

- ▶ factor variable:  
  `scale_colour_discrete`  
  `scale_colour_brewer(palette=...)`
- ▶ continuous variable:  
  `scale_colour_gradient` (define low, high values)  
  `scale_colour_gradient2` (define low, mid, and high values)
- ▶ equivalents for fill: `scale_fill_...`

# Your Turn

- ▶ In the diamonds data, clarity and cut are ordinal, while price and carat are continuous
- ▶ Find a graphic that gives an overview of these four variables while respecting their types
- ▶ Hint: Start with

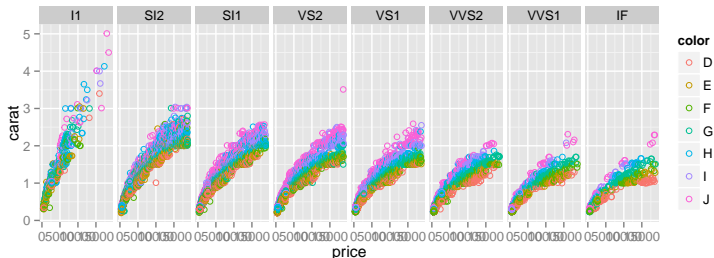
```
data(diamonds)
qplot(carat, price, shape=cut, colour=clarity,
      data=diamonds)
```



# Facetting

- ▶ A way to extract subsets of data and place them side-by-side in graphics
- ▶ Syntax: `facets = row ~ col` Use `.` if there is no variable for either row or column (i.e. `facets = . ~ col`)

```
qplot(price, carat, data=diamonds, color=color,  
       facets = . ~ clarity)
```





## Your Turn

- ▶ The `movies` dataset contains information from IMDB.com including ratings, genre, length in minutes, and year of release.
- ▶ Explore the differences in length, rating, etc. in movie genres over time
- ▶ Hint: use facetting!