

# Data communication and visualization

Jae Yeon Kim

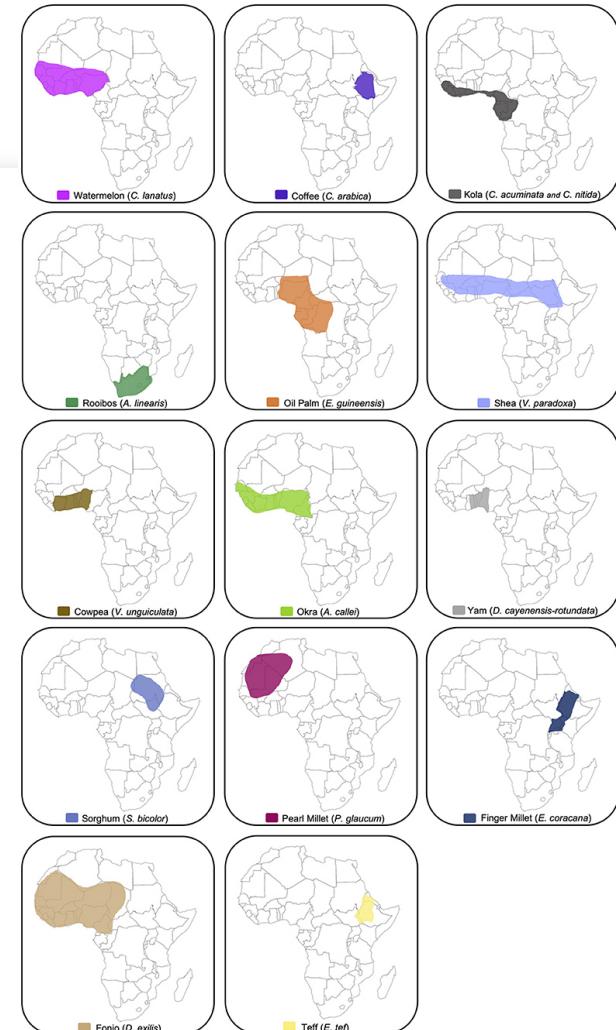


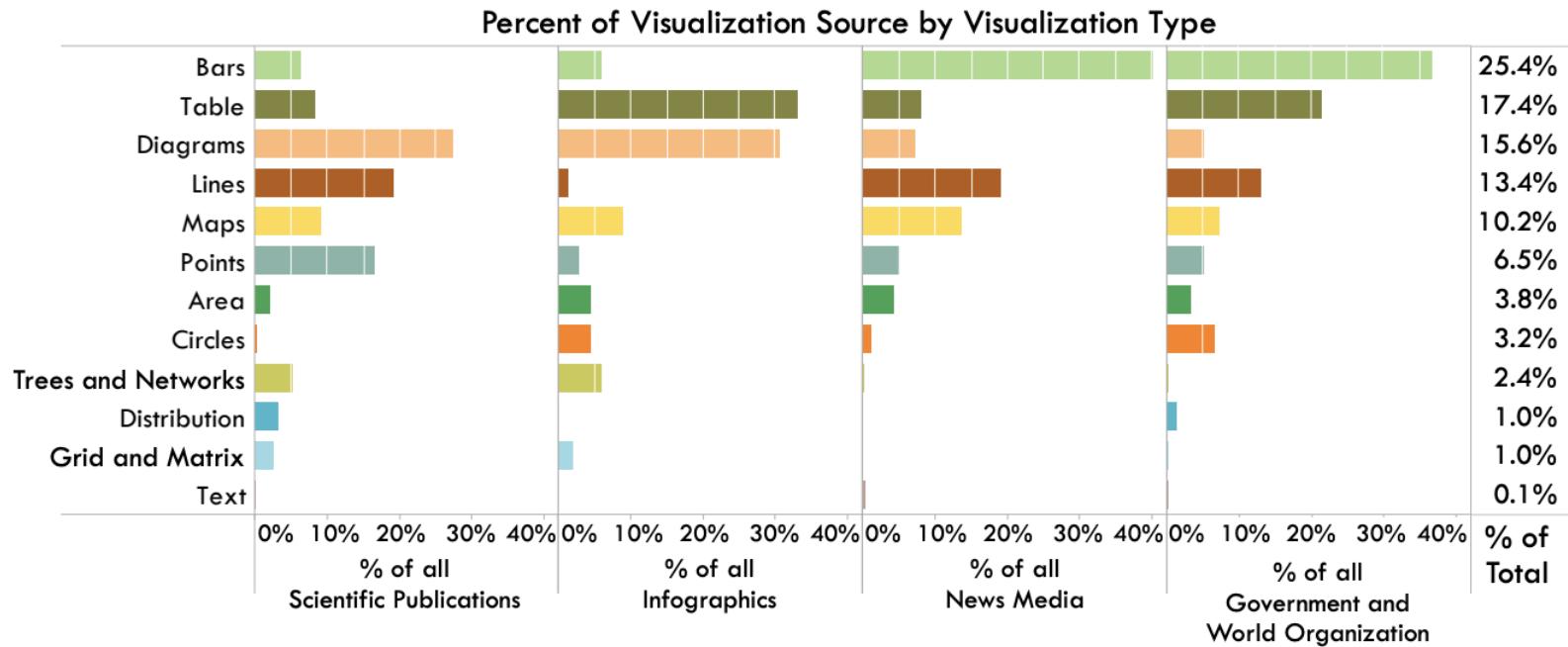
# Contributions of African Crops to American Culture and Beyond: The Slave Trade and Other Journeys of Resilient Peoples and Crops

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<sup>2</sup>Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada





Data visualization =  
turing (i.e.,  
statistical)  
information into  
visual contexts (e.g.,  
plots)

Data visualization =  
means not ends (=  
data  
communication)

# Objectives:

(1) Learn (lectures; frameworks)

and

(2) practice (workshops; workflows)

communicating data via writing (#1)

and programming (#2)

Cognitive science +  
R programming +  
data writing =  
this course

# Why not tables?

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# The Science of Visual Data Communication: What Works

**Steven L. Franconeri<sup>1</sup>, Lace M. Padilla<sup>2</sup>, Priti Shah<sup>3</sup>,  
Jeffrey M. Zacks<sup>4</sup>, and Jessica Hullman<sup>5</sup>**

<sup>1</sup>Department of Psychology, Northwestern University; <sup>2</sup>Department of Cognitive and Information Sciences, University of California, Merced; <sup>3</sup>Department of Psychology, University of Michigan; <sup>4</sup>Department of Psychological & Brain Sciences, Washington University in St. Louis; and <sup>5</sup>Department of Computer Science, Northwestern University

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# Graphs in Statistical Analysis\*

F. J. ANSCOMBE\*\*

Graphs are essential to good statistical analysis. Ordinary scatterplots and “triple” scatterplots are discussed in relation to regression analysis.

## 1. *Usefulness of graphs*

Most textbooks on statistical methods, and most statistical computer programs, pay too little attention to graphs. Few of us escape being indoctrinated with these notions:

- (1) numerical calculations are exact, but graphs are rough;
- (2) for any particular kind of statistical data there is just one set of calculations constituting a correct statistical analysis;
- (3) performing intricate calculations is virtuous, whereas actually looking at the data is cheating.

A computer should make *both* calculations *and* graphs. Both sorts of output should be studied; each will contribute to understanding.

through the computer. The analysis should be sensitive both to peculiar features in the given numbers and also to whatever background information is available about the variables. The latter is particularly helpful in suggesting alternative ways of setting up the analysis.

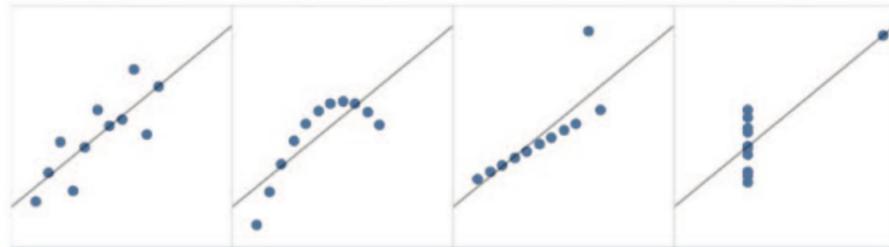
Thought and ingenuity devoted to devising good graphs are likely to pay off. Many ideas can be gleaned from the literature, of which a sampling is listed at the end of this paper. In particular, Tukey [7, 8] has much to say on the topics presented here.

A few simple types of statistical analysis are now considered.

## 2. *Regression analysis—the simplest case*

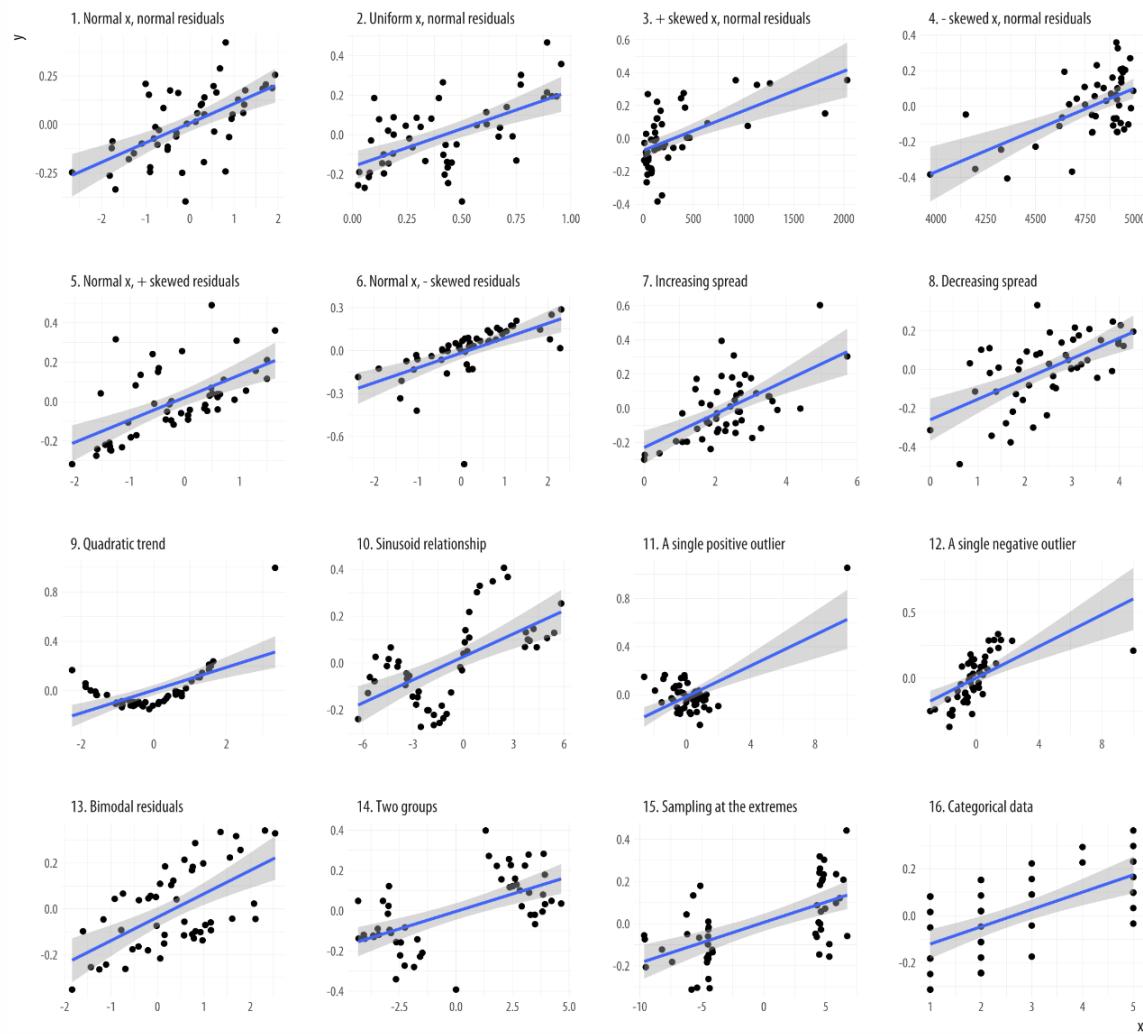
Suppose we have values for one “dependent” variable  $y$  and one “independent” (exogenous, predictor)

<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	
10	8.04	10	9.14	10	7.46	8	6.58	
8	6.95	8	8.14	8	6.77	8	5.76	
13	7.58	13	8.74	13	12.74	8	7.71	
9	8.81	9	8.77	9	7.11	8	8.84	
11	8.33	11	9.26	11	7.81	8	8.47	
14	9.96	14	8.10	14	8.84	8	7.04	
6	7.24	6	6.13	6	6.08	8	5.25	
4	4.26	4	3.10	4	5.39	19	12.50	
12	10.84	12	9.13	12	8.15	8	5.56	
7	4.82	7	7.26	7	6.42	8	7.91	
5	5.68	5	4.74	5	5.73	8	6.89	
<b>Mean</b>	9.00	7.50	9.00	7.50	9.00	7.50	9.00	7.50
<b>Stdev</b>	3.32	2.03	3.32	2.03	3.32	2.03	3.32	2.03
<b>R</b>	0.82	0.82	0.82	0.82	0.82	0.82	0.82	



X Mean : 54.26  
Y Mean : 47.83  
X SD : 16.76  
Y SD : 26.93  
Corr. : -0.06





A picture is worth a  
thousand words???

**It DEPENDS**

THE NEW YORK TIMES BESTSELLER

THINKING,  
FAST AND SLOW



DANIEL  
KAHNEMAN

WINNER OF THE NOBEL PRIZE IN ECONOMICS

"[A] masterpiece . . . This is one of the greatest and most engaging collections of insights into the human mind I have read." —WILLIAM EASTERLY, *Financial Times*

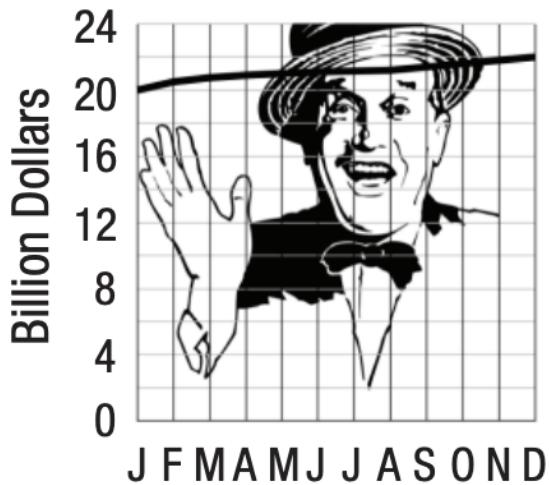
#1 *New York Times* Best-selling Author

MICHAEL  
LEWIS

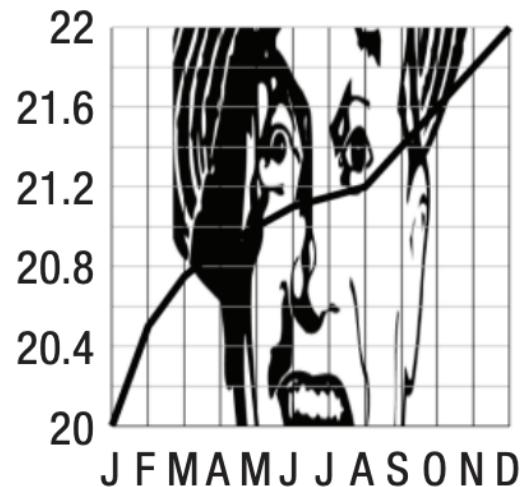


THE  
UNDOING  
PROJECT

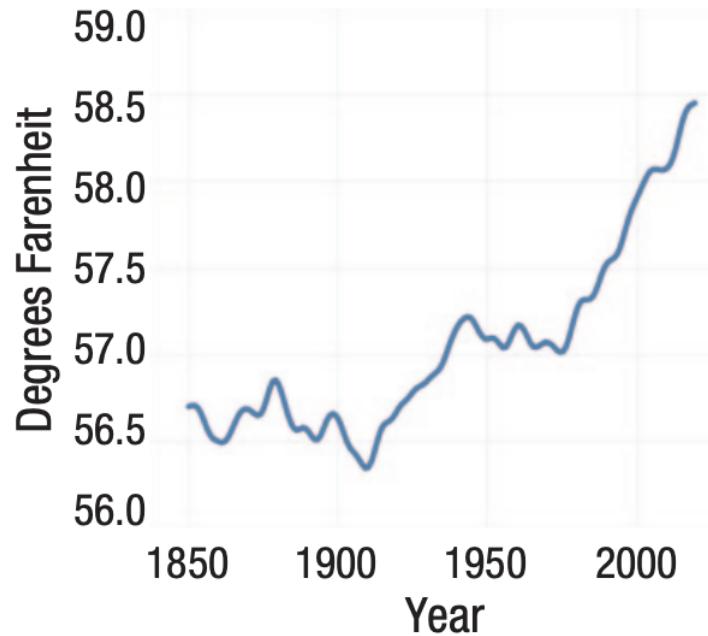
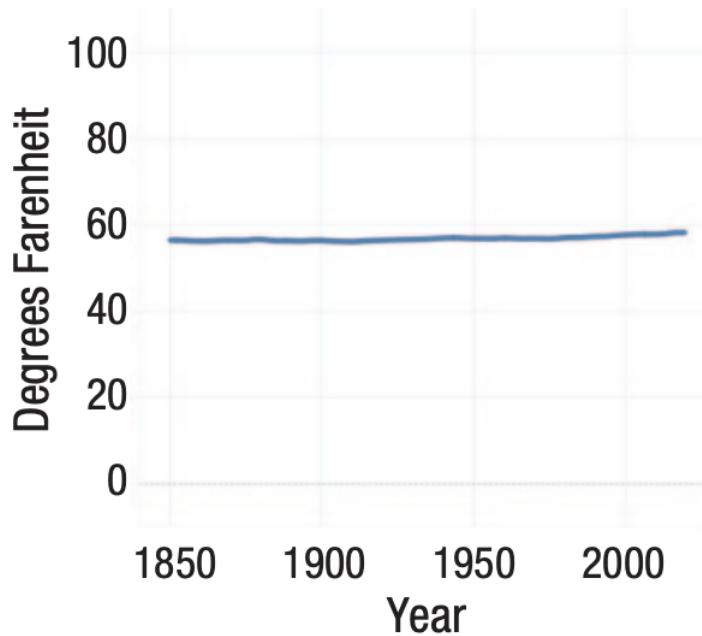
A Friendship That Changed Our Minds



J F M A M J J A S O N D



Stretching the *y*-axis scale of the left graph drastically increases the slope of the perceived trend at right, which feels dishonest.



Here, taking a small visual increase (left) and stretching it (right) is the “honest” way to show climate-change data.

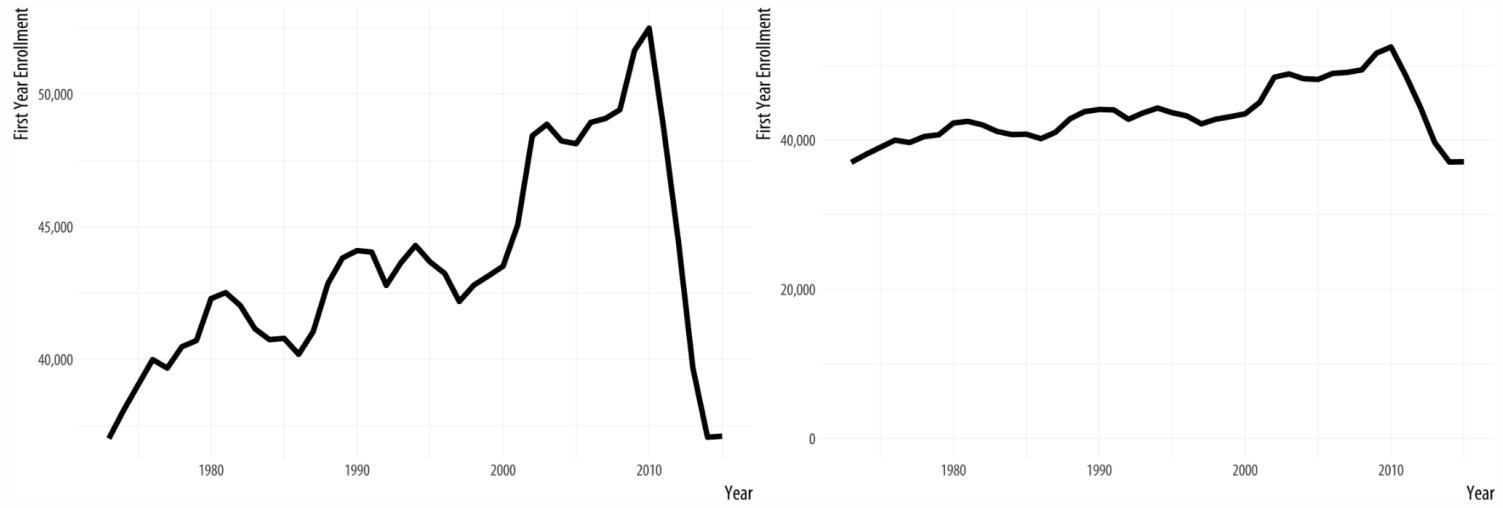
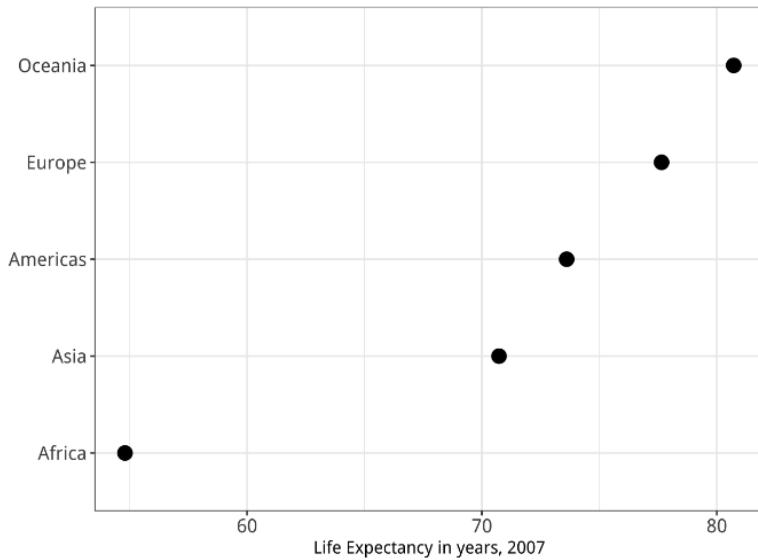
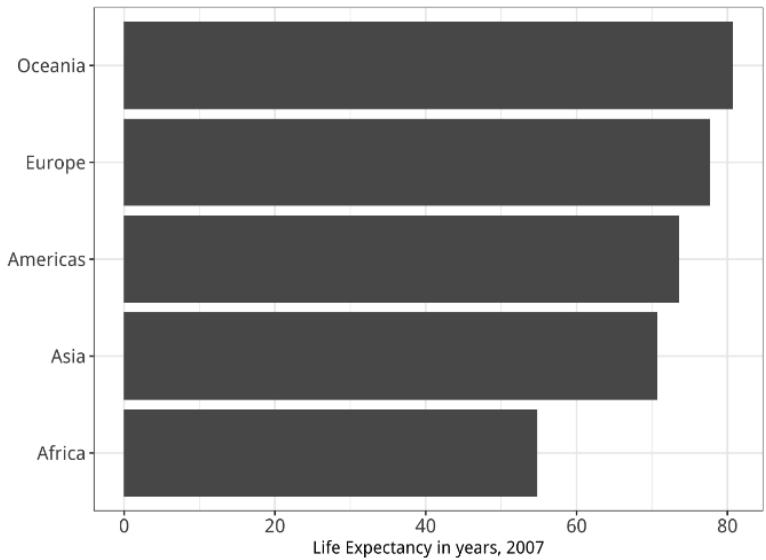


Figure 1.27: Two views of the rapid decline in law school enrollments in the mid-2010s.



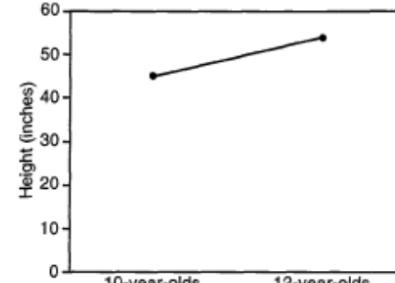
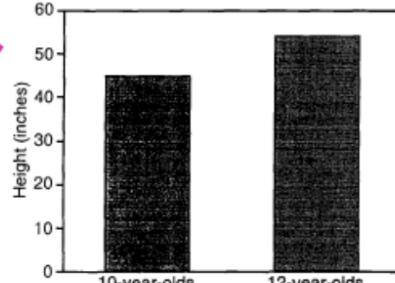
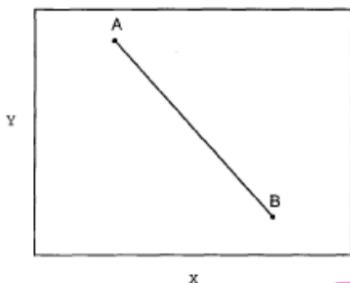
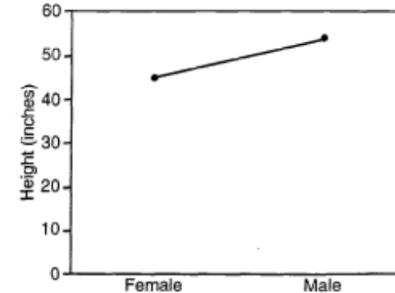
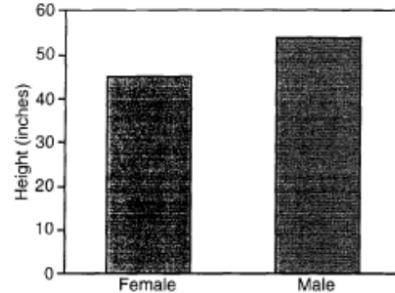
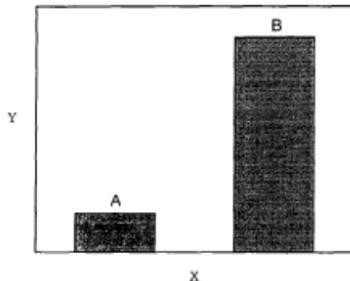
*Memory & Cognition*  
1999, 27 (6), 1073-1079

# Bars and lines: A study of graphic communication

JEFF ZACKS and BARBARA TVERSKY  
*Stanford University, Stanford, California*

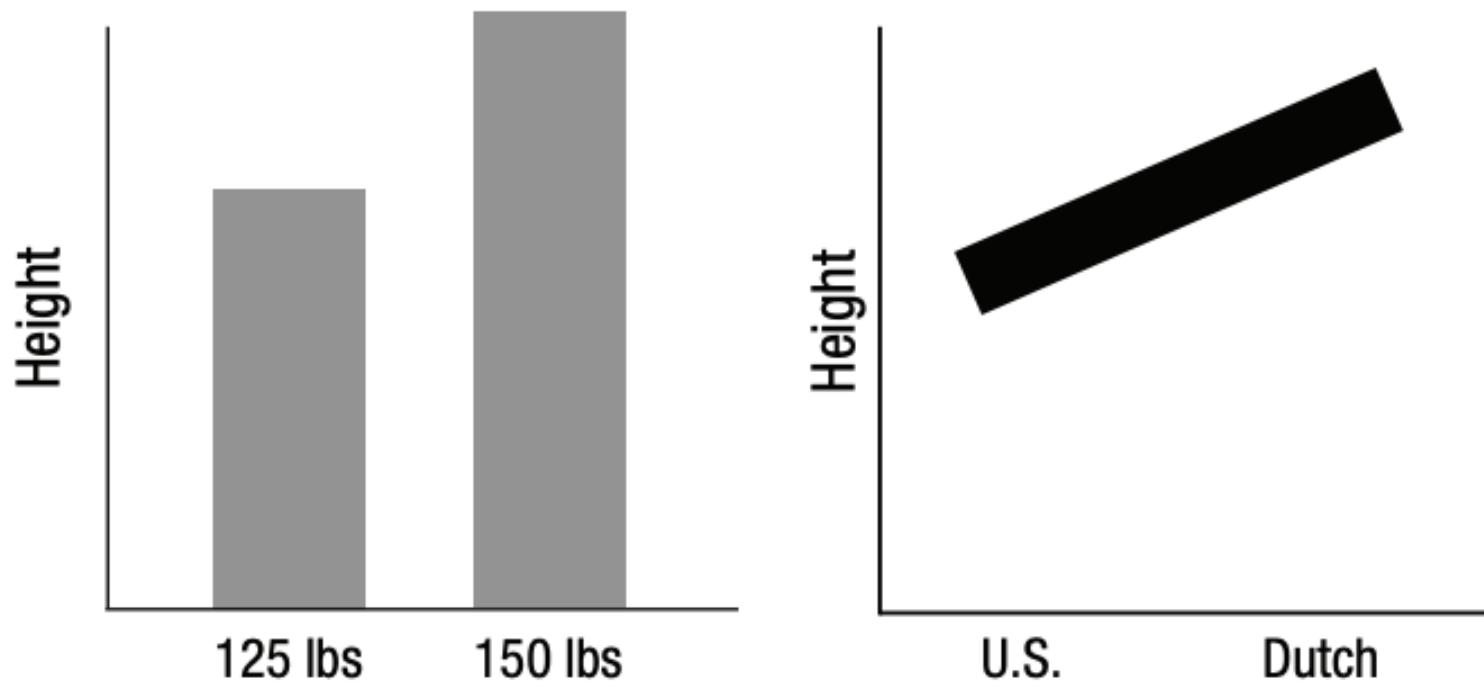
Interpretations of graphs seem to be rooted in principles of cognitive naturalness and information processing rather than arbitrary correspondences. These predict that people should more readily associate bars with discrete comparisons between data points because bars are discrete entities and facilitate point estimates. They should more readily associate lines with trends because lines connect discrete entities and directly represent slope. The predictions were supported in three experiments—two examining comprehension and one production. The correspondence does not seem to depend on explicit knowledge of rules. Instead, it may reflect the influence of the communicative situation as well as the perceptual properties of graphs.

discrete values



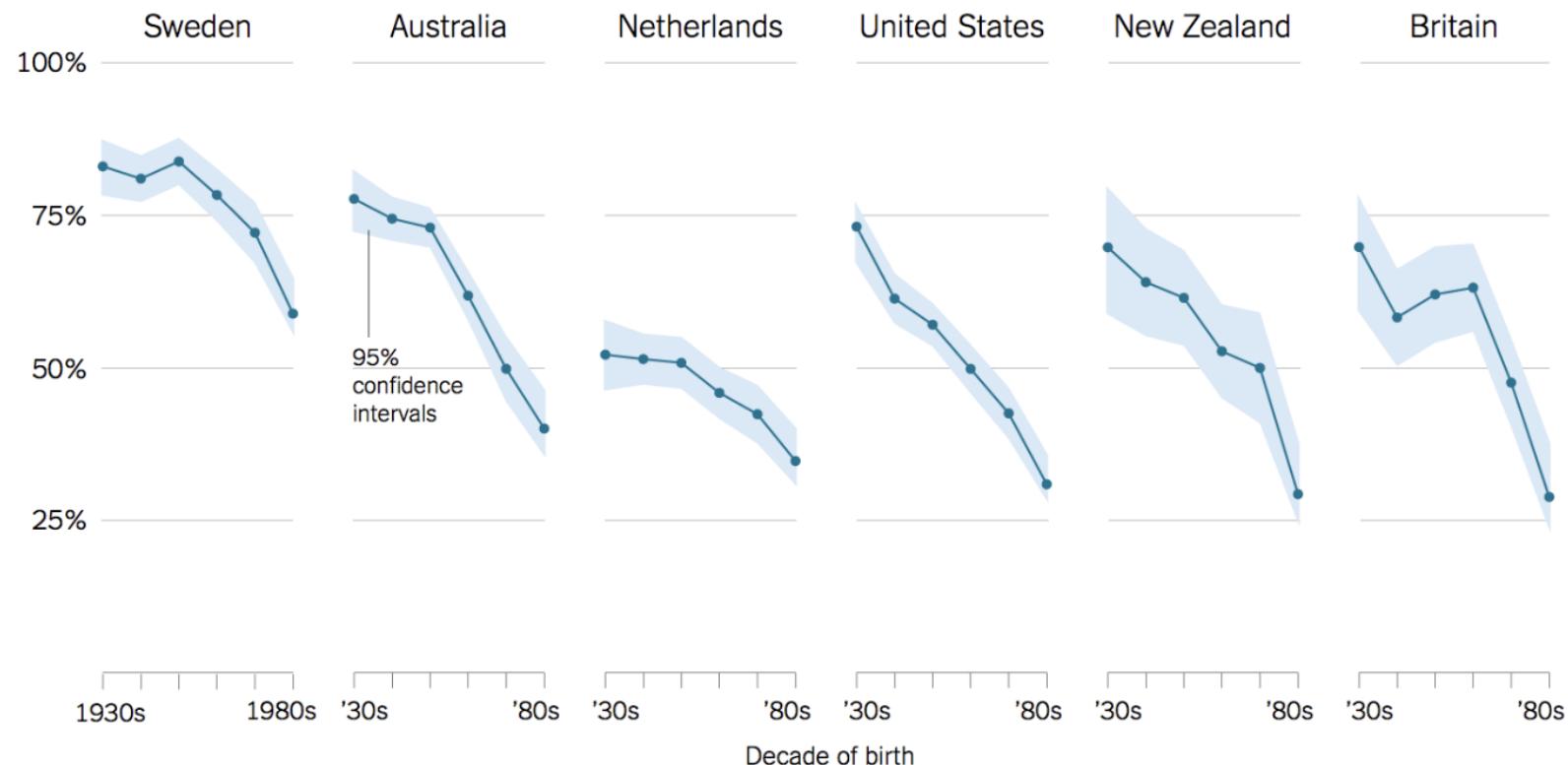
trends

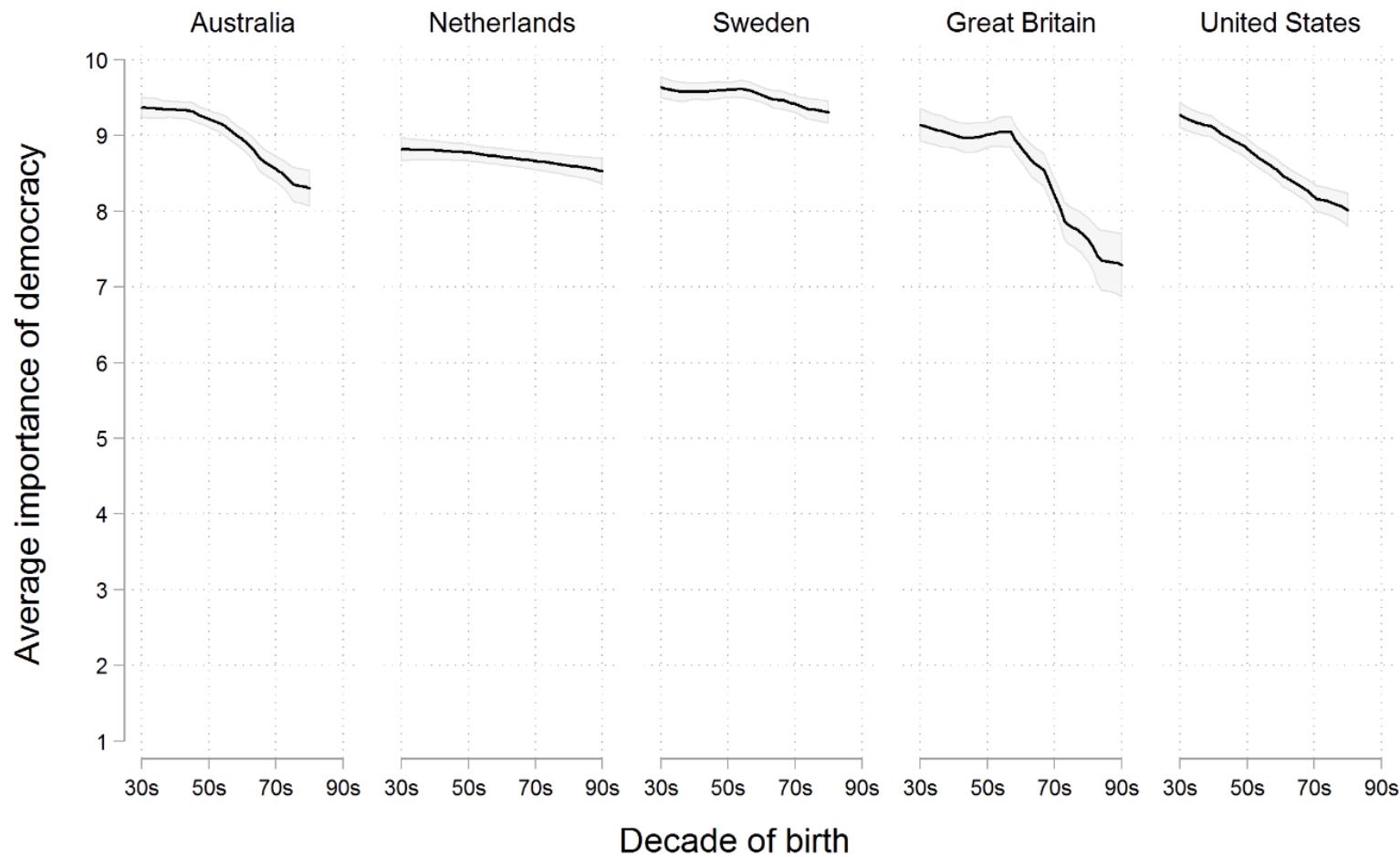
Zacks and Tversky found that participants described contrasts between the x-axis variables more when presented with bar charts, and relationships between the x-axis variables more with line charts.



The choice of graph can substantially influence conclusions made from the same data

## Percentage of people who say it is “essential” to live in a democracy





Graph by Erik Voeten, based on WVS 5

## point cloud size

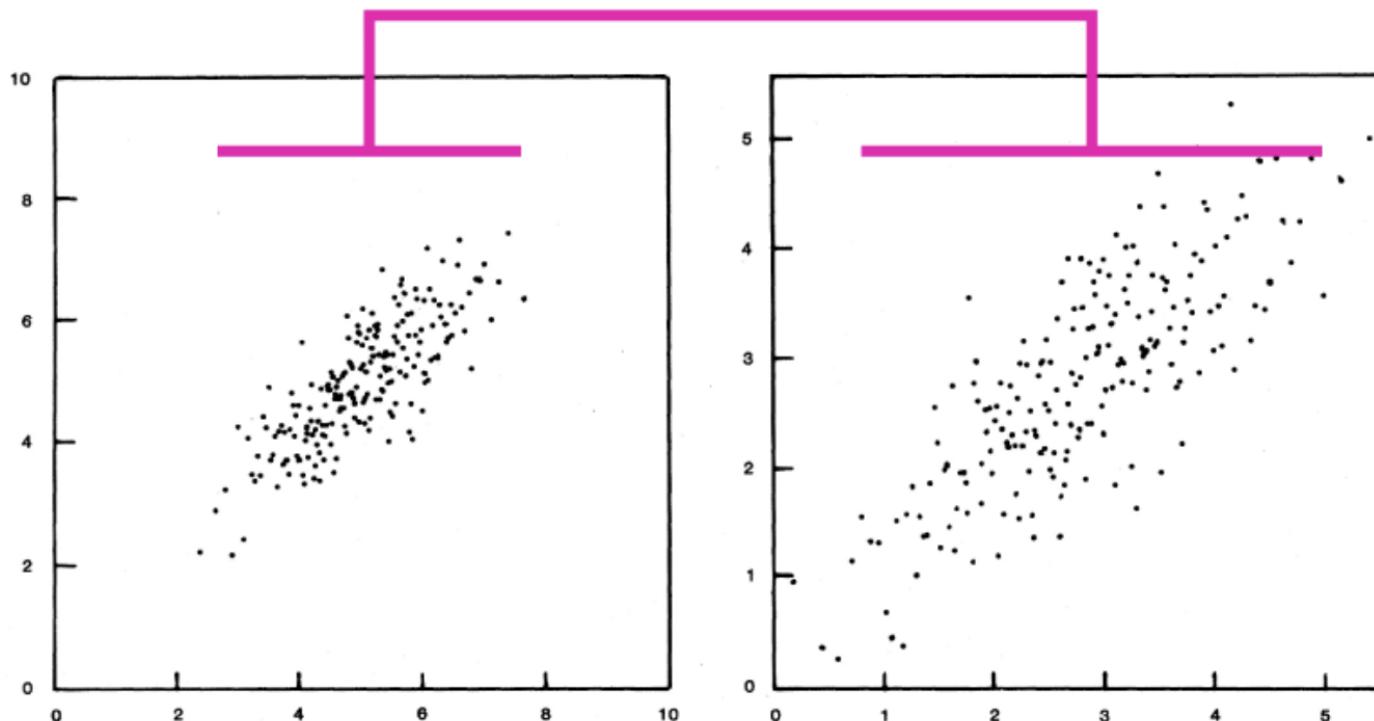
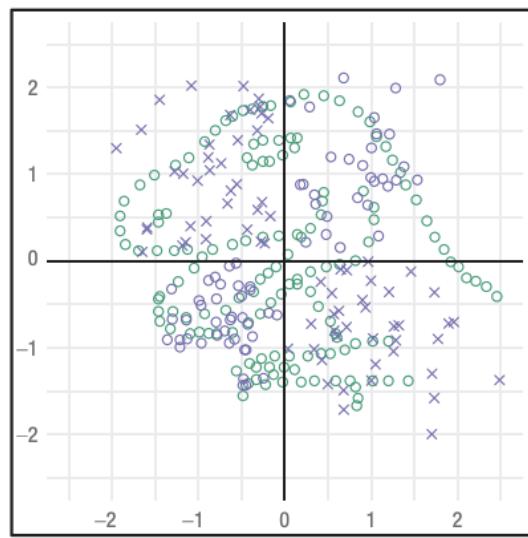
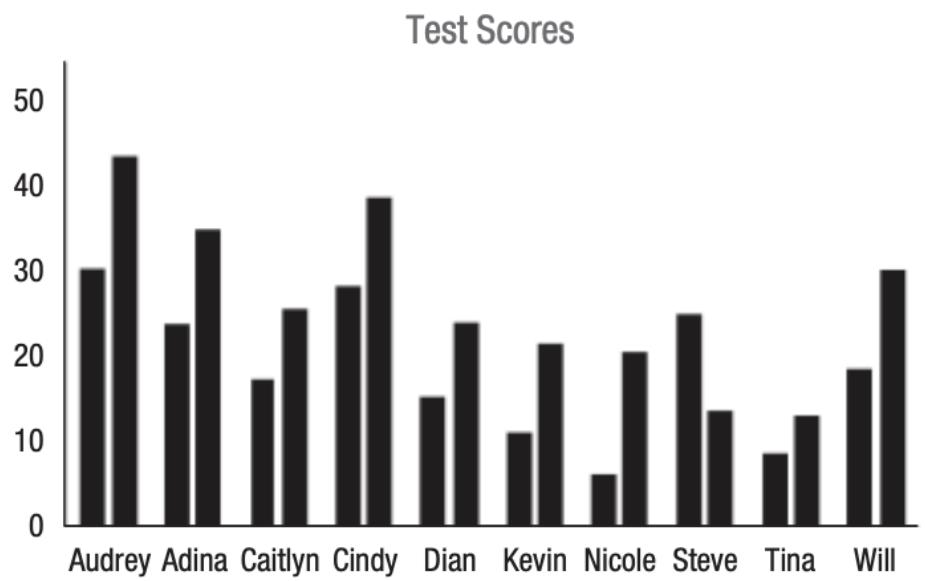


Fig. 1. Reductions of two scatterplots used in the three types of experiments. The left panel is point-cloud size 2 and the right panel is point-cloud size 4. In both panels  $w(r) = .4$  and  $r = .8$ .

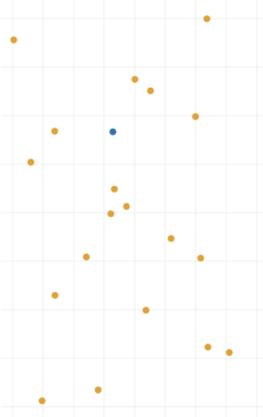
Cleveland and coauthors found that altering point cloud size alone could lead to inaccuracies in evaluating correlation in scatterplots.

# In-class discussion

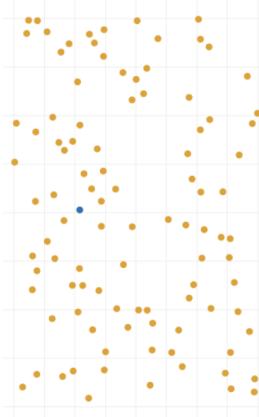
1. Form a group of 4-5.
2. Discuss when tables are more effective and when figures are more effective in communicating data.



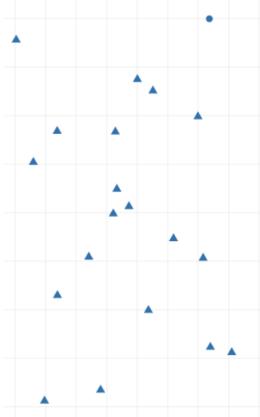
Color Only, N=20



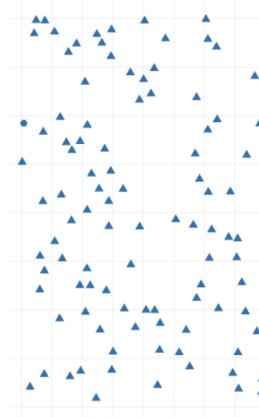
Color Only, N=100



Shape Only, N=20



Shape Only, N=100



Color & Shape, N=100

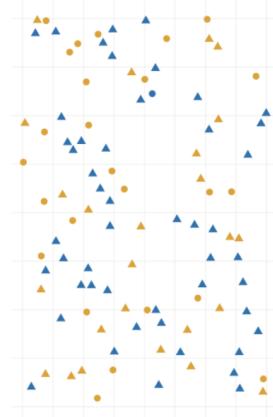
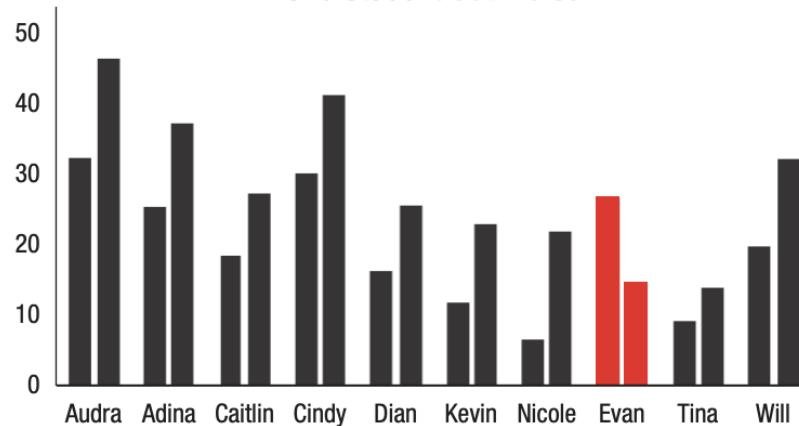


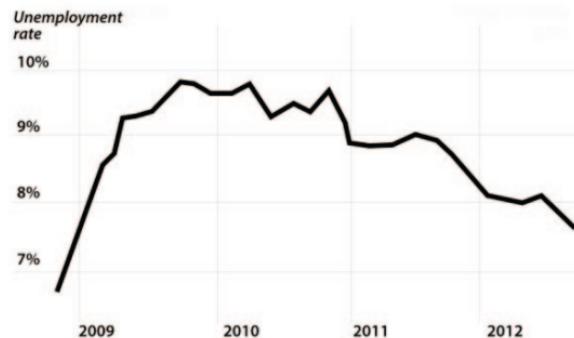
Figure 1.18: Searching for the blue circle becomes progressively harder.

## One Student Got Worse



## Unemployment is higher than stated goals

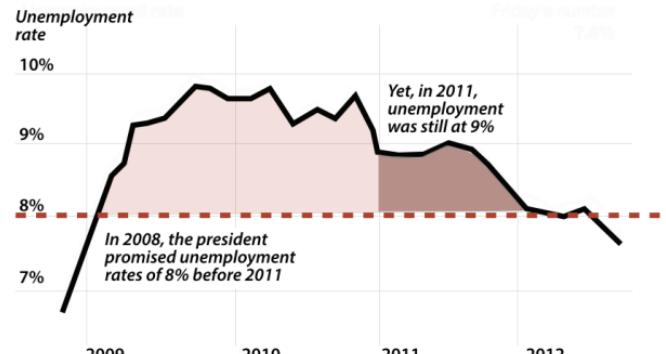
*In 2008, the president promised unemployment rates under 8% before 2011. Yet, in 2011, unemployment was still at 9%.*



Inspired by:

<http://www.nytimes.com/interactive/2012/10/05/business/economy/one-report-diverging-perspectives.html>

## Unemployment is higher than stated goals



Inspired by:

<http://www.nytimes.com/interactive/2012/10/05/business/economy/one-report-diverging-perspectives.html>



# In-class practice

1. Randomly form a group of 4-5 people
2. In Table 1, M is male, F is female. The cells indicate their incomes.
3. (1) Calculate some statistics, (2) draw a plot based on the statistical information, and (3) explain whether the plot helps make a good decision about whether there's a gender gap in this population.

ID	M	F
1	5000	100000
2	4000	100
3	6000	300
4	4000	100
5	1140	200

Table 1

# Syllabus review

# KSS survey (every Weds)

K: Keep

S: Start

S: Stop