

STAT 6560
Graphical Methods

Spring Semester 2009

Project Work

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Introduction of Visual Perception

Overview: *Introduction of Visual Perception.*

We need obtain the knowledge about visual perception so that we won't be fooled by counterintuitive graphs. Visual perception is the ability to interpret information from visible light reaching the eye. The resulting perception is also known as eyesight, sight or vision (derived from http://en.wikipedia.org/wiki/Visual_perception). From the statistical point of view, visual perception is more like a psychological process rather than a physiological function. Researchers actually conduct visual perception experiments to reveal and solve psychological problems. Generally speaking, there are two ways in obtaining information from graphs.

- One is from a quick glance at a graph, it is more like the first impression of the graph. We only get the most standing-out information. This is referred by (Rensink (2006)) as rapid vision and rapid detection. We normally don't need to pay too much conscious effort to derive the information.

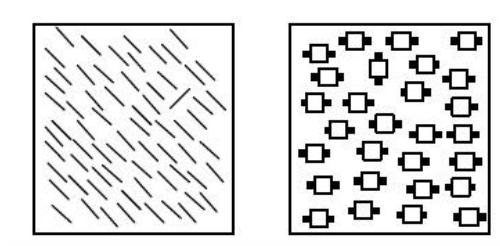


Figure 1: rapid detection. *Source:* Figures taken from Rensink (2006).

- One is from "a more extended process where we consciously think about particular aspects of the graph" (Ihaka, notes derived from <http://www.stat.auckland.ac.nz/~ihaka/courses/120/notes.html>). This is referred by (Rensink (2006)) as visual attention. It means that close attention is needed to obtain meaningful information from graphs. Change blindness and detection, which is the main topic of this presentation is focused on this procedure of visual perception.

Cleveland Lists provides us ten elementary visual perception tasks. (from Ihaka's lecture notes derived from <http://www.stat.auckland.ac.nz/~ihaka/courses/120/notes.html>)

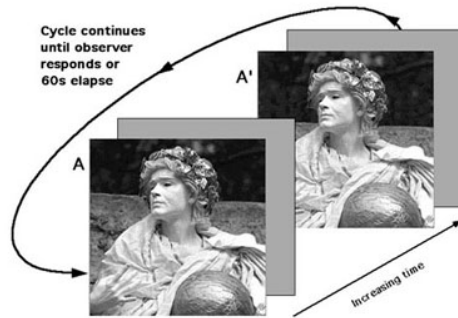


Figure 2: change detection. *Source:* Figures taken from Rensink (2006).

- Angle
- Area
- Colour hue
- colour saturation
- Density (amount of black)
- Length (distance)
- Position along a common scale
- Position along identical, nonaligned scales
- Slope
- Volume

The Area Judgement example is used here to illustrate the impact of visual perception on graphs.

The two figures in Figure 3 have the same area, and the area of Florida is actually smaller than Georgia. Some assumptions we made by rapid vision or even attentional vision are intuitive. The knowledge of visual perception helps us to make correct and counterintuitive judgement.

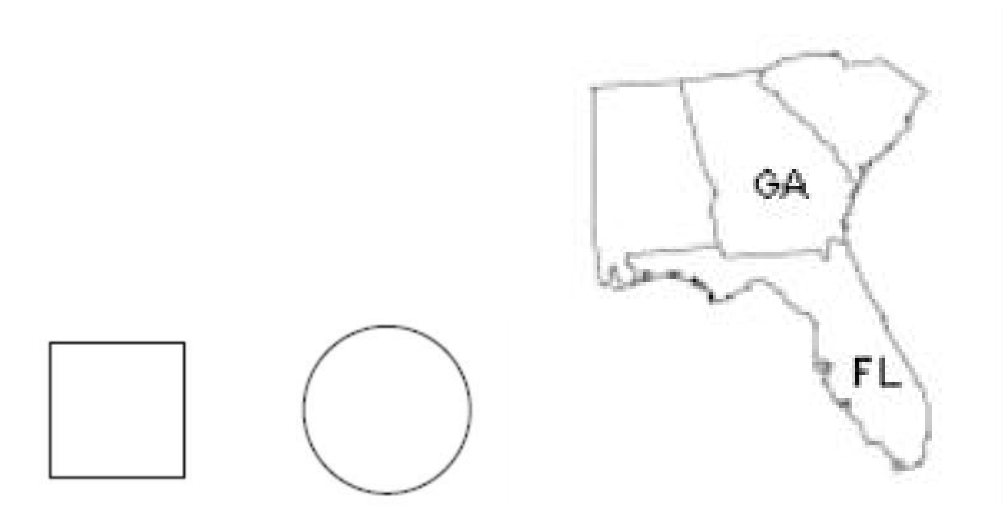


Figure 3: Which figure/area has the larger area? *Source:* Figures taken from <http://www.stat.auckland.ac.nz/~ihaka/courses/120/notes.html>.

Change blindness and change detection

Before the formal explanation of change blindness, the video demonstrations from the Change Detection Database will give us a more straightforward flavor of what it is.

Change Detection Database:<http://viscog.beckman.uiuc.edu/change/>.

”The term ‘change blindness’ refers to the surprising difficulty observers have in noticing large changes to visual scenes” (Rensink & Simons (2005)).

Causes of change blindness:

- The impaired localization of the motion signals accompanies the change, which means the motion signals failed to draw attention. (i.e. eye blinks, brief occlusions, or changes made gradually)
- Changes are not expected. (inattention blindness)
- The limit size for visual short-term memory. Normally, attention can only be distributed to 4-5 items at a time. Graphs containing large information would cause the failure of change detection.

Some benefits from research in change blindness and change detection:

- Due to the dynamic property of visual attention, attention management is required. For example, earlier attention is needed for the change property of interest. Based on the different attention management, important insights into individuals and groups differences are revealed. (i.e. American football experts are better able to spot meaningful changes to football scenes than are novices.
- Change blindness help determine the mechanisms and strategies used by patients with various visual deficits.

Implications for designs of efficient graphs:

The following are guidelines and principles to avoid change blindness and to create efficient graphs.

- Principle of simple structure. For rapid detection, the structures of graphs should be simple. If a graph contains multiple structures, the attention is focused more on the group difference rather than on elements.
- Principle of limited information. Not to exceed the attentional capacity (4-5 items at a time).
- Principle of maximal static representation. Motion signals are easy to lost.
- Principle of minimal motion. If motion is necessary, use motions as less as possible.
- Principle of single dynamic source.

Transformation from png to pnm files:

There is a software named "pngtopnm" in Linux operating system, which is used to transform png files pnm files. The software needs two arguments to work, the first one is the path of the png file, the other one is the target path of the transformed pnm file which is composed of the target saving directory and the name of the transformed pnm file. Actually, the only thing we need to do is that type a command string like this "pngtopnm /SOURCE DIRECTORY/source.png /TARGTE DIRECTOR/transformed.pnm, and then press "enter" on the keyboard in your linux shell. We have to note that this is a Linux software which may not be available in Windows system.

Links to Data file and R-code:

- http://www.math.usu.edu/~symanzik/teaching/2009_stat6560/RDataAndScripts/jin_ying_project1_plane.R
- http://www.math.usu.edu/~symanzik/teaching/2009_stat6560/RDataAndScripts/jin_ying_project1_money.R
- http://www.math.usu.edu/~symanzik/teaching/2009_stat6560/RDataAndScripts/jin_ying_project1_statistics.R
- http://www.math.usu.edu/~symanzik/teaching/2009_stat6560/RDataAndScripts/jin_ying_project1_parallel.R
- <http://www.math.usu.edu/~adele/s5600/data/airpol.dat>

Acknowledgement:

I would like to thank my friend Long Zhang in China who helped me on the transformation from png to pnm files. Because of his help, I can successfully obtain the pnm files transformed from png files derived from Rensink's movies.

References

- Rensink, R. A. (2006), Attention, Consciousness, and Data Display, *in* '2006 JSM Proceedings', American Statistical Association, Alexandria, VA, pp. 2412–2421. (CD).
- Rensink, R. A. & Simons, D. J. (2005), 'Change Blindness: Past, Present, and Future', *Trends in Cognitive Sciences* **9**, 16–20.