PSYC 579
8.2 – Depictions of Time and Movement — Word Count: 577
Implications for Perceptual Mechanisms — Author: *Romulan*

This essay discusses three perceptual mechanisms in relation to depictions of time and movement. In particular, it will focus on **event segmentation**, **visual attention**, and the Gestalt principle of **connectedness**.

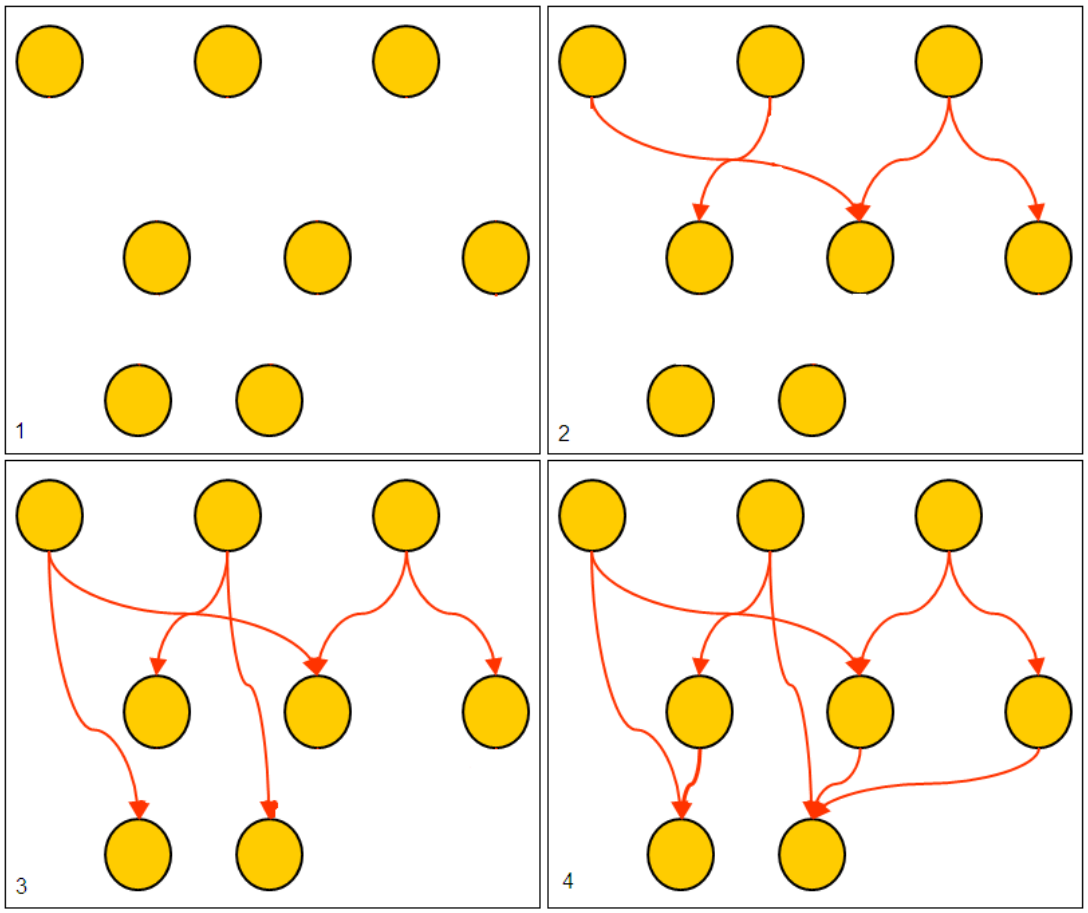

Figure 1: **Breakpoints** during propagated connectivity in a node-link graph; event segmentation, visual attention, and grouping by connectedness in a dynamic display (assume smooth animation of lines between breakpoints).

Event segmentation

Just as we characterize events in everyday life, the same process occurs for events in dynamic depictions of time and movement.

Events are characterized **partonomically** at temporal boundaries corresponding to moments of maximal perceptual change, based on the number of changing physical fea-

tures [8]. This bottom-up **segmentation** tends to have high reliability between observers. These **breakpoints** often correspond with top-down conceptual knowledge or expectations that are meaningful to individual observers. Consider the example of propagated connectivity in an animated node-link graph (Figure 1); depending on the observer's conceptual knowledge of the domain, top-down and bottom-up event perception may culminate in a variety of segmented interpretations. Making an appropriate segmentation of an event improves how the event is understood and remembered [7]. Thus improving the saliency of breakpoints in a dynamic display may improve learning and memory for the concepts being depicted.

Visual attention

Our understanding of **visual attention** can explain why some motion is perceived while other motion goes unseen in dynamic depictions of time and movement [1].

Motion that is either too slow or too abrupt can be difficult to perceive [4]. In the latter case, motion may not be smooth because the frame rate is insufficiently low, producing a flickering effect. As a result, the observer may not be aware of any change in motion. This is described as the phenomenon of **change blindness** [3], in which elements that abruptly appear, disappear, or change position go unseen. Increasing the frame rate and thus smoothing the depicted motion will likely improve the observer's awareness of movement in a display.

Connectedness

Gestalt grouping principles are omnipresent when observing depictions of time and movement. Many contain elements grouped perceptually based on the principle of **connectedness**.

Connectedness is a more powerful grouping principle than colour, size, or shape, and smooth curves are more effective than lines that change direction for connecting elements [6]. This likely contributes to the ease in which an observer can perceive connections in the transit timetable shown in Figure 2-a [5], a repetition of connected departure and arrival nodes. Similarly, the use of smoothly interpolated curves in Havre *et al.*'s *ThemeRiver* climate visualization (Figure 2-b) is likely more effective than a non-interpolated representation [1]. In both examples, non-interpolated lines that change direction could mislead the observer into perceiving discontinuities or event nodes that do not accurately reflect the data.

[1] Appropriate temporal scaling is assumed [2].

As static depictions of time and movement are used to understand trajectories or trends occurring over time, an observer relies on the smooth connectedness of elements to complete a narrative from one point in time to another.

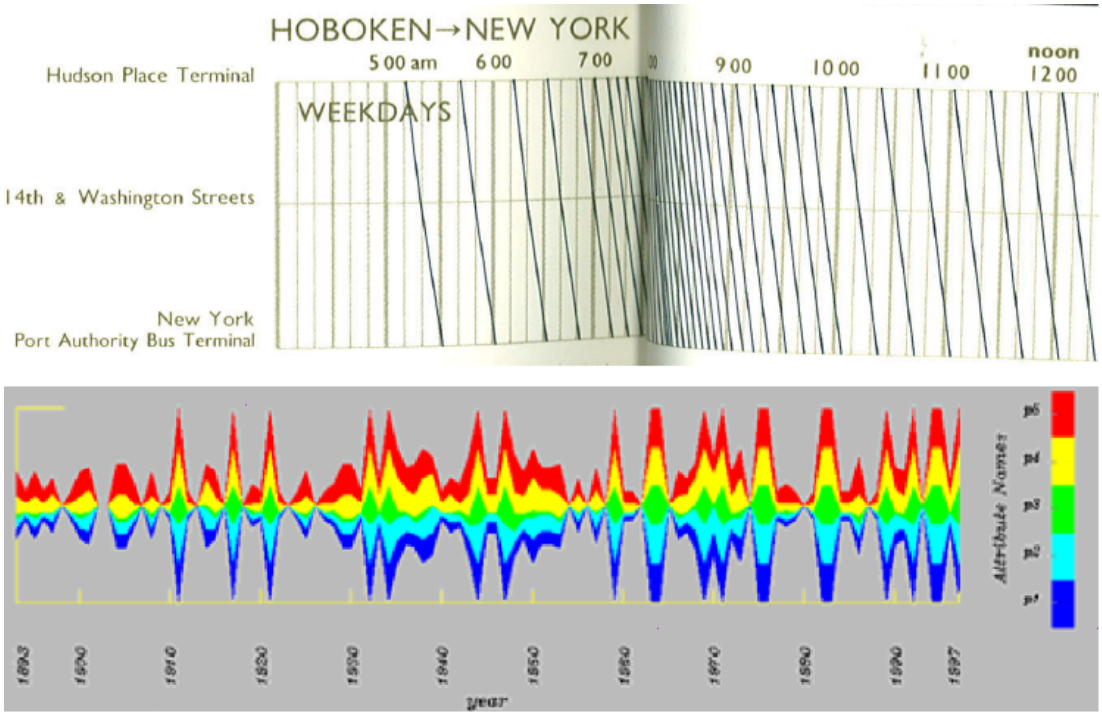

Figure 2: Smooth curves connecting nodes (a – *top*): in a transit timetable; (b – *bottom*): in *ThemeRiver*.

Conclusion

This discussion of perceptual mechanisms has focused on how depictions of time and movement are interpreted. Consider again the dynamic node-link graph in which continuous curves are smoothly animated to join nodes, one generation at a time, from root node to leaf node (Figure 1). In this example and in other similar displays, **event segmentation**, **visual attention**, and the principle of **connectedness** each play important and complimentary roles in the process of gaining insight about a concept.

References

[1] S. Havre, B. Hetzler, and L. Nowell. ThemeRiver: Visualizing Theme Changes over Time. In *IEEE Symposium on Information Visualization*, pages 115–123, 2000.

[2] W. Müller and H. Schumann. Visualization Methods for Time-Dependent Data - An Overview. In S. Chick, P. J. Sanchez, D. Ferrin, and D. J. Morrice, editors, *2003 Winter Simualtion Conference*, pages 737–745, 2003.

[3] R. A. Rensink, J. K. O'Regan, and J. J. Clark. To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science*, 8:368–373, 1997.

[4] R. Sekuler, S. N. J. Watamaniuk, and R. Blake. *Motion Perception*, chapter 4, pages 121–176. 1988.

[5] E. R Tufte. *Envisioning Information*, chapter 6, pages 108–109. Graphics Press, Cheshire, CT, USA, 1990.

[6] C. Ware. *Information Visualization: Perception for Design*, chapter 6, pages 191–193. Morgan Kaufmann, San Fransisco, CA, USA, 2nd edition, 2004.

[7] J. M. Zacks and K. M. Swallow. Event Segmentation. *Current Directions in Psychological Science*, 16(2):80–84, April 2007.

[8] J. M. Zacks and B. Tversky. Event Structure in Perception and Conception. *Psychological Bulletin*, 127(1):3–21, 2001.