

1 **How to apply preattentive visual properties in information visualization**

2 Preattentive processing of visual information is processed automatically on the entire
3 visual field, and it is performed before any conscious attention arrives to the display (Ware,
4 1999). A typical reaction time (RT) in preattentive processing is less than 10 milliseconds (ms)
5 per item versus a typical RT of 40 ms or more in non-preattentive processing (Treisman and
6 Gormican, 1988). Hence, it is quick and effortless to make inference without loading any
7 capacity on working memory. Preattentive processing is at the low level visual system, but its
8 properties can guide viewers' attention to salient items in a display and perform high-level
9 analysis tasks. This is a good new for Information visualization designers, as they can utilize
10 preattentive visual properties to help users effectively extracting information in complex data.
11 This article will discuss applications of few preattentive features in information visualization.

12 Preattentive feature is the unique feature that would "popout" in the visual field. Not
13 every preattentive features have equivalent "popout" effect. But color is undoubtedly one of the
14 strongest attributes to guide attention to area of potential interests (Wolfe and Horowitz, 2017).
15 A key application of color is in medical images, which are conventionally displayed in grayscale,
16 since individual regions of similar density can be easily located. However, color images provide
17 preattentive features (i.e., tumor shows in red patch) that direct users' attention to the abnormal
18 areas which might not be immediately apparent in a grayscale, due to weak contrast.

19 Within each preattentive feature, the degrees of "popout" effect is also different (Ware,
20 1999). The preattentiveness of color depends on the degree of difference to the surroundings.
21 The larger difference, the more likely a color will pop out (Callaghan, 1989). One method of
22 maximizing perceived color difference is linear separation technique: the target colors should be
23 linearly separable from its distractor colors on a color space (D'Zumura, 1991; Figure 1). The
24 technique can be particularly useful we need to highlight certain points from large scatterplots.
25 We should select color green or purple, rather orange and purple as the distractors if the targets
26 are in red.

27 Unlike color, luminance onset (flicker) is a "probable" preattentive feature (Wolfe and
28 Horowitz, 2017), because it does not have a certain definition. Generally, flicker refers to a
29 repeating on-off pattern applied to an image or an object. Coherent flicker is easier to be detected
30 than non-coherent flicker (Huber and Healey, 2005). For example, a on-off pattern flicker at
31 same onsets $t = 0\text{ms}, 60\text{ms}, 120\text{ms}, 180\text{ms}, \dots$ is more likely attract attention than a pattern at
32 different onsets $t = 0\text{ms}, 60\text{ms}, 80\text{ms}, 120\text{ms}, \dots$ (Huber and Healey, 2005). Huber et al. (2005)
33 explains that is because the visual system cannot group different onsets together. Flicker could
34 be annoying in static visualization, but it is an effective guidance of dynamic information. For
35 example, when users are analyzing real-time stock trading information, flicker will make new and
36 important price changes stand out.

37 Preattentive features can be processed quickly and effortless by visual system, and they
38 will immediately pop out in the visual field. The information visualization designers should
39 apply these attributes to help users prioritize their attention towards the areas of interests.
40 Preattentive features have different degrees of "popout" effect. Color is undoubtedly one of the
41 top preattentive feature, but careful selection is required to maximize the effect. We should use
42 strong preattentive features (i.e., color) before weak ones (i.e., flicker) where ease of search is
43 important.

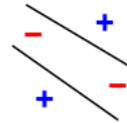
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Figure 1.



Points are linearly separable



Points are not linearly separable

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Reference

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