Analysis of Data Patterns by Local Adaptive Color Mapping

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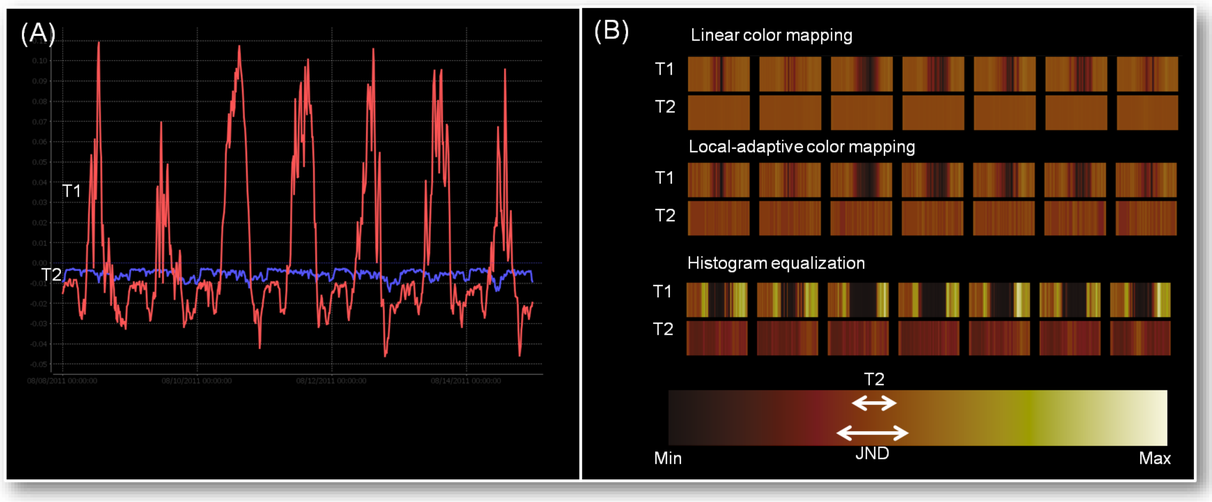
Introduction

Color, after position, is among the most effective visual variables to encode information. It is pre-attentively processed by the visual system, and if used appropriately, supports detection and correlation of patterns. In pixel-oriented visualization the choice of color mapping should ideally allow to read and compare data values on an absolute scale, allow to compare data values across the global and across the local scale. Since there are many ways to map values to color, this is a critical point in the technique.

Research Problem

- Static schemes may map data of small local variation to small color differences below the just noticeable difference (JND)
- Existing techniques require either user interaction [2], are based on specific assumptions about the data and/or introduce global distortion [1].
- There is no guaranty that important data points are visible due to their surrounding



Contribution

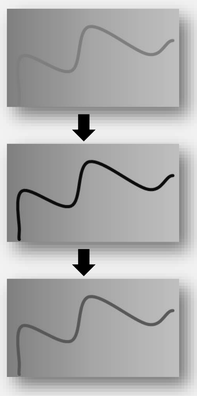
- A color boosting algorithm [3] that ***locally adapts the color mapping*** for important data structures and ***guarantees the visibility*** of important data points, based on just noticeable differences.
- It ***preserves global metric quantities*** of the data and provide an informative overview without interaction.
- And thereby ***introduces contrast effects*** [4] in order to enhance the visibility of structures.

Problem

Change color for “not visible” structures, so that

color difference to surrounding is maximized…

… but keep distortion at a minimum.



Make it “just” visible!

Global Issues

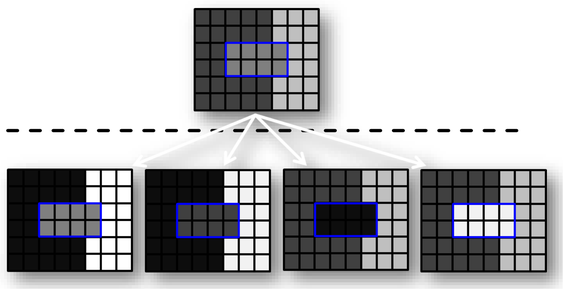
Original

Adapted

Equal values → different colors

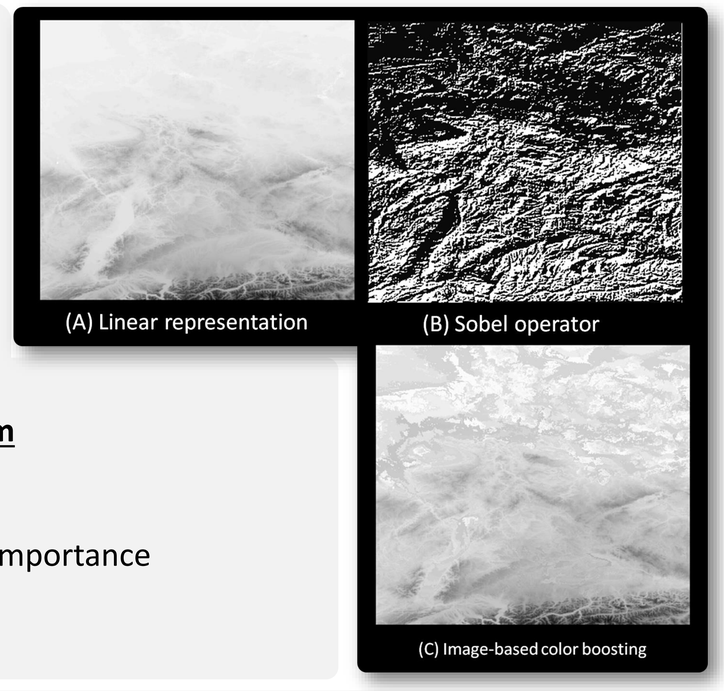
Different values → equal colors

Many solutions



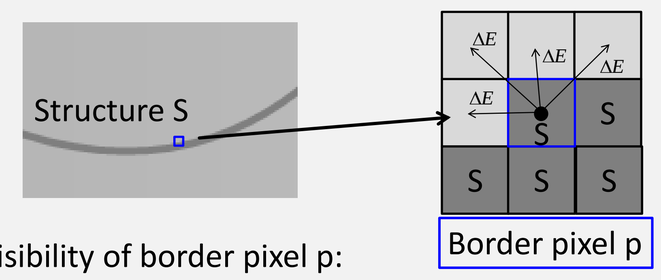
Color boosting

1. **Structure detection:**
   Local structures of interest are detected by a generic image-based analysis method, or an application dependent detector.



2. **Solve optimization problem**
   - Brute force
   - Genetic algorithm
   - Greedy: Sorting according importance (application dependent)

3. **Color boosting:**
   The color value of these structures is scaled in both directions of the color map until they become just noticeable from their spatially surrounding area.



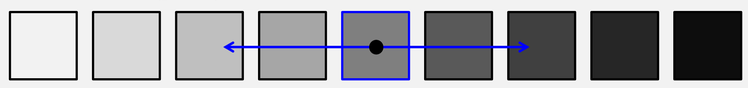
Visibility of border pixel p:

$\min_N(\Delta E(p,n)) > JND \rightarrow visible(p)$

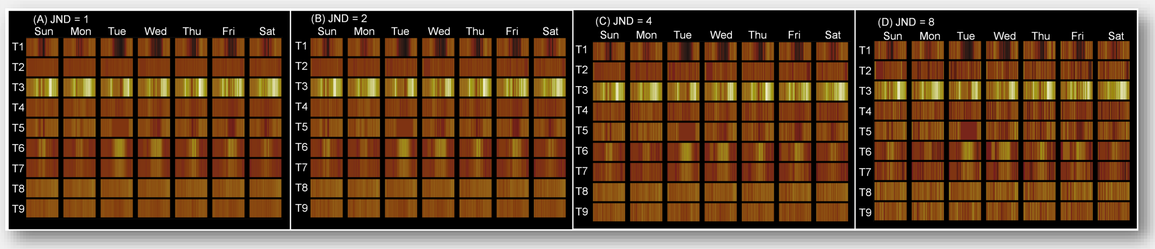
Visibility of structure S:

$\forall p \in borderPixels(S) | visible(p) \rightarrow visible(S)$

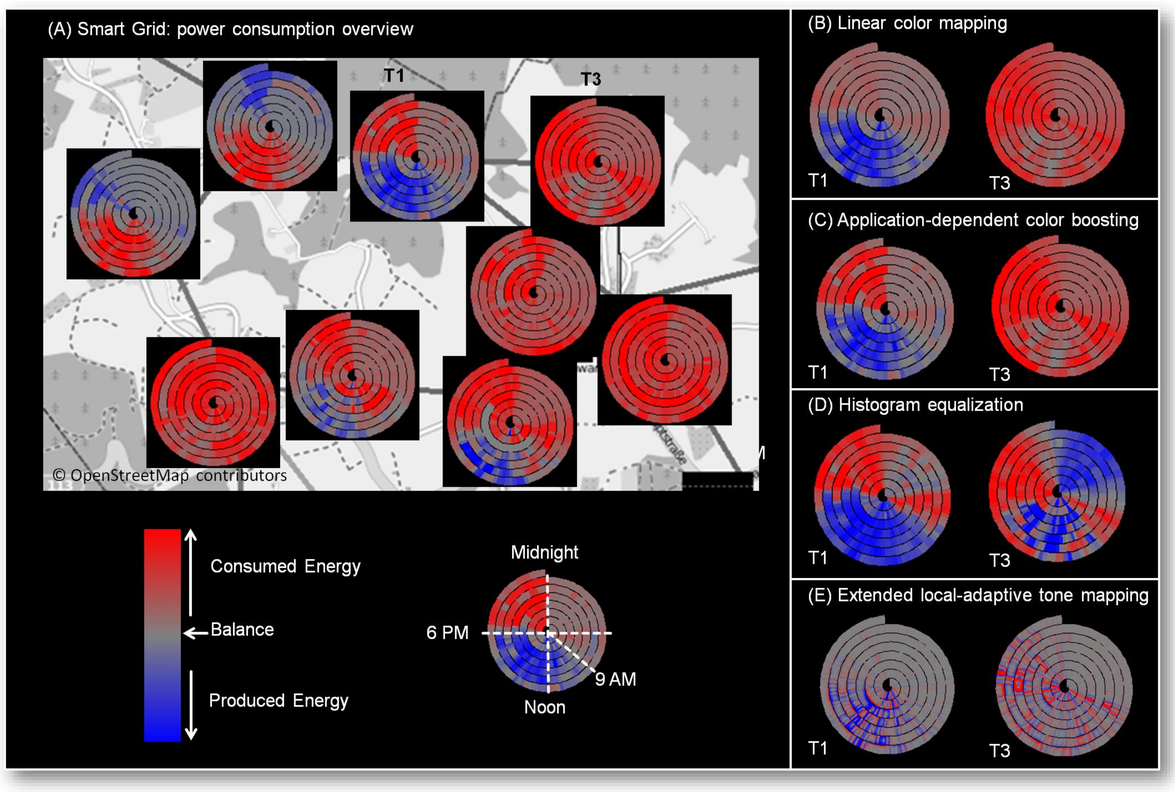
Distort color in both directions, stop as soon as $\min_N(\Delta E(p,n)) > JND$



Parameter : *JND* (just noticeable difference)



Application



References

[1] E. Bertini, A. Girolamo, and G. Santucci. See what you know: Analyzing data distribution to improve density map visualization. IEEE Symposium on Visualization (Eurographics 2007), 2007.

[2] N. Elmqvist, P. Dragicevic, and J. Fekete. Color lens: Adaptive color scale optimization for visual exploration. IEEE Transactions on Visualization and Computer Graphics, 17(6), 2011.

[3] D. Oelke, H. Janetzko, S. Simon, K. Neuhaus, and D. Keim. Visual boosting in pixel-based visualizations. IEEE Symposium on Visualization 2011 (EuroVis), 30(3), 2011.

[4] S. Mittelstädt, A. Stoffel, and D. Keim. Methods for compensating contrast effects in information visualization. Computer Graphics Forum, 33(3), 2014.

IEEE VIS 2014
Paris, France
09. - 14. November, 2014

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