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Computer Graphics I
Literature Review 2
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As with the previous literature review, for this assignment, we were instructed to read two academic articles, and then create a summary of these two papers. The primary paper that we had to pick, had to be from a proper source as outlined by the assignment, and the second paper had to be from the those cited in the bibliography of the primary paper. The review of these two papers must have attention paid to how these two papers related to each other. Unlike the last literature assignment, I had made sure that I could find a pair of articles that were both on the provided library sources.

The assignment states that it is best to describe the secondary paper first, as it will be easier to fit it into the primary paper once that is done. The secondary paper that was chosen for this assignment was 'A Survey of Colormaps in Visualization' written by Liang Zhou and Charles D. Hansen. This article as well as the primary article is about the subject of colormaps. To start with, at their basic functionality, colormaps are three column matrix's of numbers, where each row of the matrix is a red, green, and blue number value that defines one color that is associated with that color map. The purpose of this article is to provide readers with a comprehensive review of colormap generation techniques and does this by surveying these techniques by grouping them into four classes: procedural methods, user-study based methods, rule-based methods, and data-driven methods. The purpose of this paper is to act as a possible reference for readers to make a choice of which colormap technique to use when faced with a certain task that requires one.

The paper starts off by explaining what a colormap is, and what it's possible applications are; as well as stating the various aspects of computer science that it can be used in. Mainly colormaps are used for their role in visualization as they are able to improve the efficiency and effectiveness of data perception and therefore allow more insights into the data being observed. A good colormap can provide the user with a better understanding of features in any given data. The most important part of the secondary article, is the review of major colormap design techniques, which are divided into four categories: colormap generation techniques specifically focused on addressing data perception problems, namely procedural methods, user-study-based methods, rule-based methods, and data-driven methods. The different categories that are mentioned here are what is going to be discussed, as the actual techniques mentioned are far too numerous for all of them to be the focus of this article summary.

The first of these methods is procedural colormap generation. The techniques that have been developed for this method can be described as being proposed simply to attempt to aid our understanding of most data sets. The many methods mentioned are simply just different standards being applied to how a default colormap should go about being made, so that data can be better understood.

The second method class that many colormap creation techniques fall into when being reviewed in this paper is user study based colormap generation. This is basically the category where every method that utilize user studies to evaluate the effectiveness of proposed colormaps are sorted into. Some of these techniques were created from user studies being conducted directly and have had the technique learn different colormaps from users.

The third of these methods that colormap techniques are categorized into is rule based colormap selection. This means that many techniques for colormaps were formed by many accepted rules of human perception of colors, and this relates to the field of psychology. Unlike the previous two methods, this method raises conflicting goals for the generation of colormaps. Due to this researchers conclude that an attempt to find a default colormap that would work for all data sets may be impossible. However, researchers utilize technique generated rules to propose rule based methods to generate colormaps for different data and tasks where these rules may be applicable enough to warrant use.

The fourth and final method for categorizing colormap techniques is data driven colormap generation and optimization. This method is critical of the others in how the techniques that are sorted into it are considered to have more sensible ways of generating colormaps. Most of the techniques mentioned in the article regarding the other methods discuss the generation of colormaps regardless of underlying data, although some works mention the importance of designing colormaps for specific data and others provide interactive tools for this purpose. The general rules that techniques that fall into the other categories are problematic in many cases as interesting features are given inappropriate color ranges, and this makes them hard to perceive and may interfere with the first impression of the data, making further exploration of the data difficult. Instead this final method proposes that the only thing that should be used when constructing colormaps is the underlying data being surveyed.

These four methods can be simply referred to as procedural, user-study based, rules based, and data driven. This classification shows that with a deeper understanding of colors and data as well as the advent of more powerful computation resources, methods for colormap generation have evolved from procedural designing a default colormap for all data to applying rules based on the nature of data and tasks, and then to more intelligent data-driven approaches as the state of the art. The tasks associated with the techniques cited in this paper can then be used by a reader to decide which method, and maybe which specific technique is right for whatever data set needs to be analyzed by the reader. A taxonomy for the colormap generation papers as a decision tree is proposed by this article to aide in this task.

The primary paper that I was supposed to summarize that the previously talked about secondary paper is a source of is 'ColorMoves: Real-time Interactive Colormap Construction for Scientific Visualization' written by Francesca Samsel, Sebastian Klaassen, and David H. Rogers. This article is all about presenting ColorMoves; which is an interactive tool that promotes the exploration of scientific data through artist-driven color methods in a unique and transformative way. Due to colormaps full potential for communication and discovery remaining untapped, this new tool, ColorMoves, is presented to handle the rising need for colormaps to be used on data. The explanation of the ColorMoves tool, the power of contrast in scientific visualization, and the tool's application in science domains is discussed.

What ColorMoves is, is an online tool offering artist constructed color scales and palettes in a real time interactive tool, to provide the scientific community with an easy to use method of exploring the impacts of changing color encoding on their data. Using the tool, a scientist can highlight detail and focus attention on specific regions of interest within their data, and construct exportable colormaps that can be used in most any visualization tool.

Colormaps reveal data through contrast, and there are multiple types and levels of contrasts. The degree of contrast is what gives a person the ability to focus attention and discriminate detail, not by specific hues of the colormap. This is why contrast is so important in relation to the ColorMoves tool. In fact the focus of ColorMoves is on the allocation of contrast rather than on specific hues of a given colormap. Through application of multiple spans of luminance, ColorMoves can deliver higher degrees of discriminatory power that respond to specific data distributions.

The tool has applications in three main science domains as stated by examples in the paper. The first is in climate science. Colormoves has been used by multiple climate scientists and modelers for the investigation of mixing properties using the opacity function on a time-varying sequence of baroclinic data from MPAS-Ocean (Model for Prediction Across Scales – Ocean). The series of baroclinic time steps provide a picture of mixing patterns in the oceans. The ability to see multiple time steps within a single window allowed the scientist to see the progression and characteristics of the baroclinic mixing over time, from different locations and different variables. Colormoves helps facilitate greater control over the emphasis of specific locations.

The second science domain the ColorMoves has been used in is neutron spectroscopy. Neutron spectroscopy data has features of interest across many orders of magnitude of intensity. ColorMoves has been used in an experiment stated in the paper to bring out details within neutron scattering data. While the data analysis in this case is mostly empirical, visualization played a key role in directing the analysis and communicating the results. Using ColorMoves, the scientists were able to distinguish and thus compare the distributions of regions of intensity. The ease of applying and adjusting color enabled the scientists involved in the experiment to see relationships between the areas of interest that had otherwise not been apparent.

The final science domain mentioned that ColorMoves is relevant to is related to asteroid ocean impacts. There are scientists that study asteroid ocean impacts to assist in understanding potential societal and planetary threats. Due to the subject having a variety of facets, it is beneficial to render multiple variables in each window when using the ColorMoves tool. An example given shows that scientists were able to test a range of combinations over an ensemble of simulations for many time steps until a means to render three variables clearly throughout the duration of the simulation was found.

The ColorMoves tool, provides a service of applying artistic color expertise via an interactive, exploratory interface for scientific visualization–an approach that combines the expertise of scientists, artists and computer scientists. An important aspect of this tool is how it shows the importance of someone analyzing data with the use of color created by ColorMoves colormaps. And this is how the two articles relate to each other. Using constructed colormaps created by using ColorMoves through a process of deciding the correct color contrast to use, which is reminiscent of a few of the techniques mentioned in the secondary paper, it is easier than ever to use color as a potent tool in scientific data visualization. Which in turn will make the subject of overseeing data a less laborious task.

Sources Cited

Primary Source


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@ARTICLE{8309996,
author={F. Samsel and S. Klaassen and D. H. Rogers},
journal={IEEE Computer Graphics and Applications},
title={ColorMoves: Real-time Interactive Colormap Construction for Scientific Visualization},
year={2018},
volume={38},
number={1},
pages={20-29},
keywords={Atmospheric modeling;Data visualization;Encoding;Image color analysis;Real-time systems;Task analysis;applications;color;colormoves;computer graphics;scientific data;visualization},
doi={10.1109/MCG.2018.011461525},
ISSN={0272-1716},
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Secondary Source


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@ARTICLE{7305807,
author={L. Zhou and C. D. Hansen},
journal={IEEE Transactions on Visualization and Computer Graphics},
title={A Survey of Colormaps in Visualization},
year={2016},
volume={22},
number={8},
pages={2051-2069},
keywords={data visualisation;image classification;image colour analysis;color appearance models;color spaces;colormap generation techniques;colormapping technique classification;data-driven methods;procedural methods;rule-based methods;user-study based methods;visualization;Color;Data models;Data visualization;Face;Image color analysis;Measurement;Taxonomy;Color;colormap;perception;survey;visualization},
doi={10.1109/TVCG.2015.2489649},
ISSN={1077-2626},
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