

CRAFT: A Tool for Customizing Color and Font Selections Guided by Perceptual Rules

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Abstract

This paper describes an interactive approach to customizing the selection of colors and fonts for workstation applications. In CRAFT (Color Rule and Font Tool), the interactive selection of colors and fonts is guided by rules based on principles of text legibility, human color perception and aesthetics.

Introduction

As workstation and personal computers become more powerful, more MIPS have become available to the user interface. This has lead directly to the development of richer, more interactive interfaces to computer systems and applications. Furthermore, the designer has enough flexibility and power that display limitations are no longer the major constraint in interface design. The designer now has the luxury to ask how best to design the interface to make the computer more comprehensible, intuitive and fun for the user.

In the area of workstation color selection, many commercially available products allow the user to interactively select colors from a palette and apply them to various fields and attributes of the workplace environment. Several experimental systems have gone even farther in this direction by developing very sophisticated systems for displaying colors and by representing the colors in terms of their positions in calibrated color spaces (Robertson, 1988; Hedin and Derefeldt, 1990; Bauersfeld, 1990; Bardon, 1992).

The system we are developing builds on this base, but enhances the functionality in two important ways. First, we provide a mechanism which guides the user in his/her interactive selection of colors. These perceptual rules assist the user in selecting color combinations which provide good legibility and color harmony. Second, we provide a mechanism for integrating color and font selection, taking advantage of our knowledge of spatial/color interactions in the perception of spatial patterns. This system is called CRAFT — Color Rule And Font Tool).

Perceptual Rules

Many researchers have developed rules for the presentation, legibility and aesthetics of color information in computer applications, including, for example, Robertson, 1980; Murch and Taylor, 1986; Thorell and Smith, 1990; Feldman, et. al., 1993. These rules, however, are presented in the form of guidelines which can be consulted by the application developer or by the indi-

vidual customizing his/her workstation. These rules are not incorporated into the system.

Meier (1988) has implemented a system which does incorporate perceptual rules into the user interface design process. This expert system, however, does not allow the user to interact in the selection of colors. Initial conditions are set, the rules operate, and a configuration is selected.

In CRAFT, we implement perceptual guidance as a set of rules which constrain the set of colors a user can select for the screen background, individual windows, window text, title bars, title bar text, etc. The rules constrain the set of choices, but the human is an integral part of the system, actively making selections based on personal preference. The rules guarantee that the user interface will be legible and that the colors will blend in a harmonious palette across all windows. CRAFT, however, is not an arbiter of taste, and the user has freedom to exercise personal preference. CRAFT is an interactive assistant, not an expert system.

The idea of combining a direct manipulation methodology with data-driven rules was first introduced by Rogowitz and Treinish (1993) in the context of scientific visualization. In their system, the user controls the application of operations, which are applied iteratively, but these operations are constrained by perceptual rules. Likewise, in CRAFT, the user controls the selection of colors and fonts, but the system guides these choices through a system of perceptual rules. This approach can be described as a direct manipulation methodology supplemented with rules, or as an interactive expert system.

Color/Font Integration

In current workstation systems, the facility which provides for the selection of colors is independent of the facility for the selection of fonts. This means that the user can select text and background colors using an initial font selection and be surprised to find that these same colors are illegible when a smaller or finer font is selected. Since the two systems are separate, the process of discovering which color combinations are legible for which fonts can be a difficult and tedious iterative process. In CRAFT, color and font selection are linked, so that the user can see text in different fonts, in context, in different color combinations, in a manner which supports rapid iteration. Furthermore, principles of human spatial vision guide the user in selecting good font/color combinations. For example, the color selections CRAFT offers the user depends on the spatial frequency (or weight) of the font. If the font is fine or small, CRAFT only offers the user color combinations which provide adequate luminance contrast for good legibility.

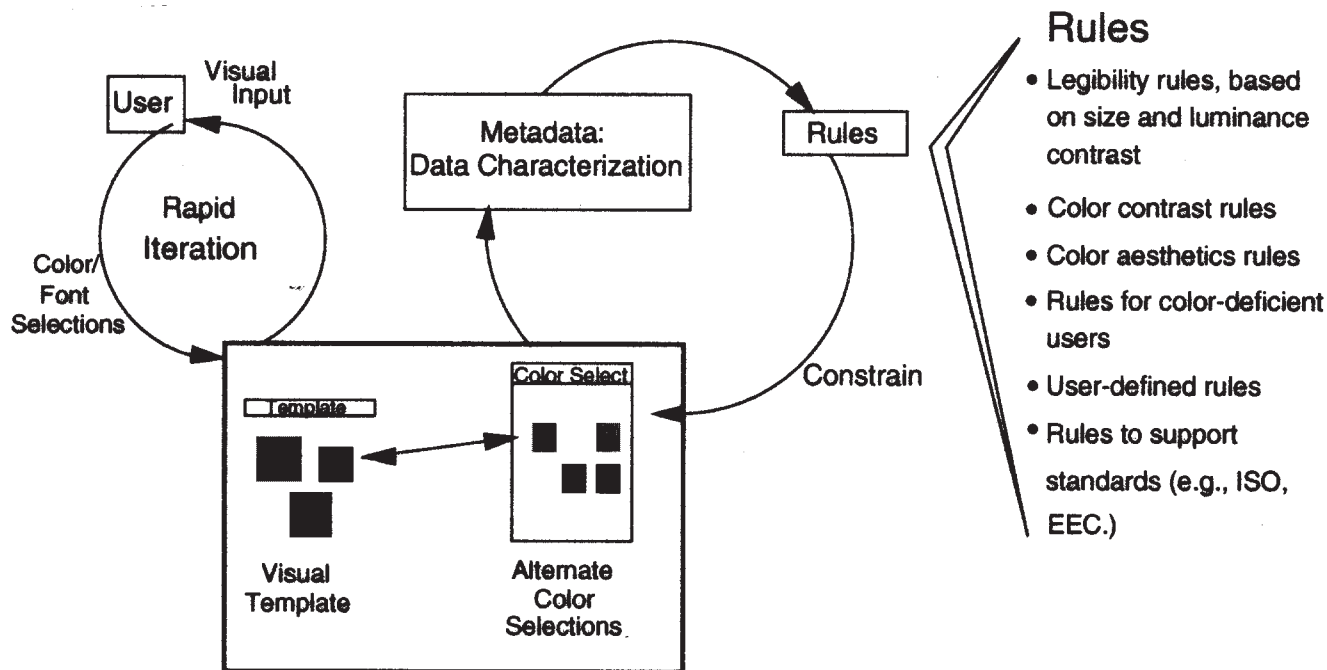


Figure 1. Interactive Rule-Based Selection of Colors in CRAFT

Designing User Interfaces with CRAFT

In CRAFT, the user interacts with a template window and with multiple color and color/font selection windows. Figure 1 shows a sketch of the template window and a color selection window. The template consists of several windows so that the user can select colors and fonts for all his/her applications at a time and see all the window components in visual context. The selection windows show color or color/font selections, which the user can select interactively.

The cyclical process in the left of this figure shows that selecting colors and fonts is iterative, and that the user is directly involved. Through the template, the user interacts directly with all the components of the interface in context. Changing colors and fonts is accomplished by directly interacting with the selections displayed in the color and font-selection windows. Once a color or color/font combination is selected, it is shown immediately in appropriate window in the template.

The process to the right shows that these color and font selections are guided by rules. Whenever the user selects a color or a font, information about these choices is sent to a set of rules. Based on this information, the rules constrain the set of colors and/or fonts available for next selection.

These rules incorporate principles of text legibility, human color perception, and graphic design. Thus, every time a color or font is selected, every remaining choice is constrained by perceptual or aesthetic considerations. The user always makes selections from a set of choices, but the elements of the set depend on the choices already made, and the rules. In this system, the user must override the rules to select illegible combinations, such as yellow text on a white background, or visually fatiguing

combinations, such as bright red letters on a bright blue background.

Templates

In CRAFT, **templates** provide a representation of the workstation front-of screen. Each template represents what the user's screen would look like if a window were open showing each of his/her applications. A typical family of windows shown in a template might include focus and non-focus windows for *aixterm*, *emacs*, etc. Each window in the template has a title bar with title text, a window region with window text, and a border.

CRAFT provides a library of templates which express different aesthetic design points, but which all obey basic rules of legibility and color harmony. The user can begin the customization task by examining the library of templates. The user is free to use one of the existing templates, modify an existing template, or create his/her own template.

If the user selects one of the templates from the library, he/she simply labels each template window according to the application receiving each window's color and font selections (e.g., *emacs*, *aixterm*).

Before modifying one of the library templates or creating a new color scheme, the user may want to use the simulated window manager provided with each template to add, delete, resize and move windows around in the template in order to configure the template so that it resembles an actual session, and then label the windows to indicate which application should be assigned the colors and fonts selected. Once the template is configured and each window is labeled, the user can begin the interactive color and font selection process. At any time in the process, he/she can use the maximize button to see how this combination of colors and fonts will look at full

size, and can type any text into the windows to get a more representative view of how these selections will look.

The Spectrum Window

To select a color for one of the window attributes (e.g., titlebar, titlebar text), the user uses the mouse to click on the target region, which brings up a **spectrum window**. The spectrum is a 3-d representation of a metric color space, which can be rotated, zoomed and clipped. The color for that region is selected by a mouse click over the desired color “chip” for that region. This instantaneously updates the color in the selected region, and a border of that color is shown in the spectrum window to remind the user which color has been selected. Any number of spectrum windows can be brought up simultaneously. This allows the user to see how color selections in one region affect the set of allowable colors in another.

This mechanism can be used to select the background screen color, and the color of all the attributes of every window in the template (e.g., titlebar color, titlebar text color, window background color, window text color, window border color, focused window titlebar color).

In our current implementation, several different color spaces can be selected, including uncalibrated {R,G,B}, uncalibrated {R,G,B} transformed algorithmically to {H,S,I}, and calibrated CIE-1931. We hope the industry is moving toward the use of calibrated color spaces, especially the use of perceptually uniform metric color spaces. In this light, we also plan to provide a calibrated Munsell space and CIE LUV.

The Font Window

Font selection is accomplished by clicking on any area in the template where text appears. This brings up the **font window** which shows rows of text written in various typefaces, in the colors selected. If no color has been selected, they appear as black text on a white background, since the greatest number of fonts satisfy the legibility criteria at high contrast, and thus offer the user the greatest number of selectable fonts. If colors have already been selected, the font window will show the user only those typefaces which will provide good legibility in those colors. Changing colors interactively changes the set of typefaces from which the user can choose, still guaranteeing good legibility.

Rules

Rules in CRAFT are implemented as a lightweight set of constraints which compute a weight for each of the color chips and fonts in the set, and allow the system to display only those color chips or fonts which reach a criterion index value. Each time the user makes a selection, all the rules affected by this choice are recomputed, and the new set of colors and fonts which reach criterion are displayed. The basic set of rules puts constraints on color and font selections in a way which guarantees good text legibility and basic color harmony. One rule, thus, specifies a relationship between text and background luminance. Another specifies a hue and intensity relationship between the screen background and the background color of each window.

Since one of the color harmony rules links background color to window color, selecting a blue-green background color puts constraints on what colors can be selected for the individual windows. Selecting a window background color, in turn, constrains the luminance of the text which can be selected for that window, etc..

In our constraint language, we specify rules in terms of the color characteristics of each of the window attributes. There are three color dimensions for each color space. For example, `titletext.x` refers to the CIE x value for the color of the text in the titlebar. The rule:

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1: titletext.x == titlebar.x
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states that the titlebar and that titlebar's text should have very similar values of x, and that this rule is weighted with great importance (1:).

This system can easily be extended to accommodate color and font selection rules for other user-configurable features (e.g., buttons and widgets), and rules could be easily added to constrain relationships between other user-interface features (e.g., spatial layout).

Future Directions

The mechanism for developing and integrating rules into the system is being designed in a very open manner. Currently, we support legibility rules and rules which provide for color harmony within an individual window and across the family of windows. Additional constraints can be added to accommodate additional requirements. Some constraint sets might include rules for users with low vision, color deficient users, users whose displays must conform to guidelines set by standards' organizations, users who prefer vibrant or subtle color selections, etc. In addition, users will be able to include rules to suit their own particular needs (e.g., different aesthetic rules for different cultures). The development of these additional rules is an area of continuing research.

In addition to enriching the rule set, we are enhancing the lightweight language we are designing for rule-expression, implementing more sophisticated color models to support more sophisticated rules, and exploring mechanisms for making these tools available to higher-level applications (e.g., architectural).

Conclusion

CRAFT is a system which guides the user in crafting his or her user interface. It is designed to be useful for individuals who want to customize their electronic desktops as well as for application developers building user interfaces.

In CRAFT, the user is a key component of the design system. Selecting colors and fonts is an interactive, iterative process for the user, who experiments with various combinations of colors and fonts whose effects can be seen in context in the template window. This process allows for personal taste, judgment and preference, constrained by basic rules about legibility and color harmony. The rules constrain the set of colors and fonts the user can select, but the user makes all the selections.

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