The Design Space of Typeface

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Abstract

Type attributes, e.g. bold, italics, case and spacing can be used to encode data in visualizations. A survey across domains and an analysis of the relations to visual channels itemizes the attributes.

Keywords: Typeface attributes, font attributes, visual attributes.

1 Background

Type-specific attributes, such as bold and italic, are not commonly used to encode data in information visualization. A review of visual attribute lists by researchers, such as Bertin, Cleveland, MacKinlay, Wilkinson, Ware, Mazza and Munzner shows that type is either not included on these lists or relegated to a single entry as *text* or *label*.

Exploring the design space of typographic attributes is important. Identification of type-specific visual attributes broadens the design-time range of potential visualizations and potentially leads to novel visualization techniques. The organization and summary of type attributes is a unique contribution to infovis.

The approach is to 1) identify attributes of type via a broad survey across multiple domains and 2) relate type attributes to well-known, well-studied traditional visual channels (e.g. size, angle color) to characterize the attribute and potentially identify effectiveness relative to the other type attributes.

2 Type Use Across Domains

Of 144 information visualizations on scimaps.org, more than 80% use text. Out of these 63% vary type using traditional visualization attributes of size, hue or brightness in visualizations such as treemaps, tag clouds and labelled node-link graphs. Only 28% use variation in type, such as bold or italics. Out of this small subset, type-specific attributes are used as follows:

- Infographic-style visualizations often use bold, serif/sans-serif, uppercase and/or italics to differentiate compositional elements (e.g. title, subtitle, labels, axes, tooltips, and explanatory text) but do not use type attributes to encode data values.
- Some designers use one or two type attributes such as bold, italics or uppercase to differentiate among different classes of data in a visualization, e.g. B. Paley.
- Some designs are maps or borrow representational techniques from cartography, making use of typographic attributes such as spacing, italics and size to indicate different types or ranges of information, e.g. A. Skupin.

Beyond the survey, Baecker and Marcus [1] used a wide variety of typographic attributes in the 1980's to enhance readability of computer code - many of these attributes are now used in modern code editors. FatFonts [2] is a novel technique that varies weight of numeric glyphs such that the ink varies in proportion to the numerical value represented. Typographic Maps [3] uses text only to define geographic features. Stem and leaf plots, point and figure charts and market profile charts use stacks of alphanumeric symbols.

Other domains provide examples of typographic attributes to differentiate data in displays.

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Typography has a 1000+ year history. Centuries old documents use typographic techniques to differentiate data e.g. Cyclopaedia from 1728 (fig. 1) uses italics, small caps and roman text:

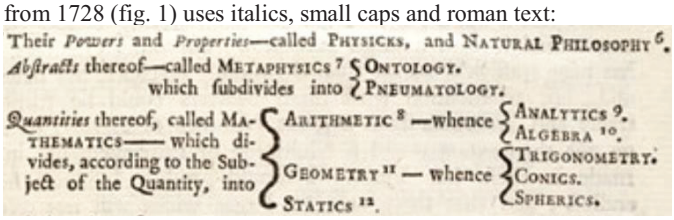

Fig. 1. Text tree using italics for broad topics, small caps for specific fields, roman text and superscripts for section numbers.

More broadly, typographic techniques for creating emphasis and hierarchy in text are detailed with various notes on usage in type design references (e.g. R. Binghurst, K. Cheng, J. Felici, E. Lupton, G. Rookledge, V. Squire). Type-specific attributes include: **weight**, *italics/obliques*, CASE (upper/lower/mixed), Small Caps, letter spacing (i.e. tracking, leading), typeface (i.e. font family), underline and condensed/expanded font variants. There are a wide variety of guidelines, e.g. ALL CAPS considered harder to read than lower case, underlines not recommended (considered distracting), proper condensed fonts preferred instead of scaled fonts (as done here), etc.

Similarly, UX guidelines provide recommendations regarding the use of type in user interface design and web design. These guidelines have changed as technology has improved, e.g. increased pixel densities, improved font rendering (e.g. ClearType, Quartz) and wider availability of fonts, makes use of italics, more weights and small caps now feasible. Guidelines may recommend use of type attributes to create an information hierarchy, differentiate among types of interactions, or specific recommendations (e.g. underlines are a specific convention for indicating hyperlinks).

Cartography also has a long history of using type attributes. There are some map conventions, e.g. increased spacing on labels to indicate the extents of the feature (e.g. mountain ranges). A survey by [4] compares usage of serif/sans-serif, case and italics by feature type (e.g. water, peaks, cities) with findings such as italics are used by all publishers for water features. Cartographic texts provide guidelines e.g. font sizes (e.g. fonts as small as 3 or 4 points are the lower bound for print), label positions, etc but do not provide guidance for encoding additional data via visual attributes, other than the use of ordinal encoding by varying type size, although other orderings are sometimes identified, e.g. ALL CAPS, *ITALIC CAPS*, lower roman, *lower italic*. The breadth of visual attributes discussed in references includes traditional visual attributes (e.g. size, color, transparency, lightness) and type-specific attributes (e.g. bold, italics, case, font-family, condenses/expanded, spacing, etc).

Notation systems use type attributes to structure information:

Chemical formulas, e.g. $[As@Ni_{12}As_{20}]^{3-}$, utilize case, super/subscript, symbols (e.g. @) and paired delimeters (e.g. []) to indicate different properties within a string of text.

Mathematical formulas use super/subscript (and other baseline shifts), mixed cases, characters from multiple languages (e.g. α, β, Σ), symbols (e.g. ∞,∩,√), paired delimiters and different font families (e.g. script (ℛ), blackletter (ℜ) and mathematical bold (ℝ)) to express relationships.

Markup notation, such as used in computer programming (e.g.) use mixed cases, symbols and paired delimiters to indicate containment (e.g. <>,(),"").

3 RELATION OF TYPE TO VISUAL CHANNELS

In an evaluation of infovis heuristics, Forsell and Johansson [3] identify Information Coding as the most frequent heuristic for explaining usability problems, i.e. a problem in the mapping of data elements to visual objects, such as an inappropriate encoding. Relating type attributes to visual channels enables visual channel heuristics to be applied when considering type attribute encodings during the visualization design stage.

Font weight leverages the channels of intensity and size. In print, bold fonts use more ink, changing intensity at a macro-level reading from surrounding type (referred to as *color* by typographers). Font weight can also be considered an attribute of line width (i.e. size channel): at a micro-level of individual glyphs, weight varies glyph line thickness. Size typically ranks highly in rankings of visual attributes - font weight is likely to be effective. Weight can be used to represent ordered data or a few levels of quantitative data.

Obliques use the channel of angle - vertical stems are sheared to a uniform slope. *True italics* also vary the shape of the glyph for further differentiation from roman (non-italic) counterparts. Reverse-sloped italics and vertical italics exist but are uncommon.

UPPERCASE and lowercase utilize channels of size and shape: uppercase letters are typically larger than their lowercase counterpart. Note that upper/lower case does not exist for numeric glyphs nor in some languages.

SMALL CAPS ARE DIFFERENT THAN UPPERCASE. By using a lower height for non-capitalized letters that match the x-height of lowercase letters the effect of size is removed. The only differentiation is shape, and therefore uppercase is more likely to be visually distinct from lowercase than small caps.

Different typefaces may vary in weight, glyph width and x-height confounding the use of other attributes. Given two typefaces with similar weight, width and x-heights, then the remaining differences will be shape. The difference between serif and sans serif can be limited to tiny details at the ends of stems and may risk the viewer not noticing the change in typeface; whereas the difference between a *script font* and serif will be the numerous curves and angle of orientation. Some to indicate the extents of the feature maps label historic sites in blackletter, an uncommon typeface with sharp angles.

S p a c i n g , (called tracking between letters and leading between lines) varies density of ink. It requires a sequence of characters to be salient. Some effectiveness may be assumed based on the long history of tracking on maps. Tracking varies the length of a string, potentially usable for encoding quantitative values (i.e. the length that the letters are stretched across). Typographers may recommend condensed/expanded fonts in preference to tracking.

Condensed and expanded fonts vary the width of a glyph, i.e. a size attribute. Condensed and expanded fonts are considered superior to scaling fonts by typographers, but condensed and expanded fonts are unavailable for most fonts or in only 2 or 3 width variants.

Underlining directly utilizes the strong visual channel of length. Underlining can *interfere* with letterforms. Some typographers recommend against underlines or suggest subtle variants e.g. dashed.

Superscript and subscript encode via relative position (i.e. a shift from the baseline) and relative size to adjacent text.

Alphabetic and numeric glyphs (A,B,C,1,2,3) use the visual channel of shape. A well designed font will not have weight variation across a sequence of characters. Two unique properties of alphanumeric glyphs compared to other glyphs are a) orderability, although this ordering will not be pre-attentive; and b) linear sequences of alphanumeric glyphs can be combined to create words which may be perceived quickly although not pre-attentively (e.g. www.microsoft.com/typography/ctfonts/wordrecognition.aspx). Glyphs in foreign languages (e.g. diacritical marks, additional glyphs) can encode additional information, but possibly have slower cognitive performance than glyphs native to a viewers' first language.

Symbols and punctuation (e.g.@#4&.,!?) specifically designed for use with other typeface glyphs can also be used with together with other type attributes, but are not orderable.

"Paired delimiters" evoke enclosure (or containment) though shape and pairing of {mirrored} or the - same - shapes. The pair of glyphs do not actually complete visual enclosure, presumably the gestalt principle of closure and/or similarity completes the pairing.

	Text Attribute	# Unique Values Typical typographic/cartographic convention applies to: Character, Word, Line, Paragraph				Primary Visual Channels
		Sample	Categoric	Ordered	Quantitative	
Type Glyphs	Basic Alphanumeric glyphs	A B C 1 2	26+10+words ltd pop-out C, W, L, P	Alpha order no pop-out	No	Shape
	More alphanumeric glyphs (diacritics, languages, etc)	À Ã Ä Ă Æ α ℵ ア 诶	1000's ltd pop-out C, W, L, P	Sometimes alpha order no pop-out	No	Shape (+added mark)
	Symbols & Punctuation	;!?#@€∞	1000's C	No	No	Shape
	Paired delimiters	{} () "" **	2-100's W, L	No	No	Shape + Containment
Type Formatting	**Weight**	G G **G G**	No	2-9 W, L	2-9 W, L	Size (line width) + Intensity
	UPPER / lower Proper / SMALLCAPS	G g	2 C 4 W, L, P	No	No	Size + Shape
	Oblique / Italic	G *G* g *g*	2-3 W	No	No	Angle
	Underline	G G G G g g g g	2-5 C, W, L	No	No	Position + Length
	Condensed Expanded	g g	No	2-3 L	?	Length + Intensity
	Font Family	g g g g *g*	2-1000's L,P	No	No	Shape*
	S p a c i n g Tracking/Leading	ggg g g g	No	No	2-5 W, L	Length + Intensity
	Super/Subscript	g_a g^a	2 C	No	No	Position + Size

Table 1. Type attributes with samples; applicability to categoric, ordered and quantitative encodings; and visual channels. Other visual attributes that apply to all glyphs are not shown (e.g. size, hue, angle).

Table 1 summarizes the type attributes grouped into two categories: 1) *type glyphs* indicate basic letterforms which can be assembled into words, etc, and 2) *type format* indicates type variations typically considered formatting. Within the cells of the encoding columns, the numeric values indicate the number of unique values with the lower bound indicating conventional use and the upper bound indicating an upper limit, e.g. font weight 2-9 indicates 2 levels are typical (e.g. bold/non-bold) with 9 being the upper level of unique weights (e.g. Univers typeface). Letters in the cells indicate conventions of application, i.e. C indicates typically applied to character, W word, L line, and P paragraph.

4 CONCLUSION

There are many type attributes. Using visual channel heuristics, some attributes (e.g. weight) will outrank others (e.g. small caps).

Future work requires identifying potential applications where use of type attributes may provide benefit (e.g. knowledge mapping and information retrieval [6]) and evaluating effectiveness.

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