

Preface

*When we see a natural style, we are astonished and delighted;
for we expected to see an author, and we find a man.*

—Blaise Pascal

What is it that distinguishes a Monet from a Picasso? A Mozart concerto from a Bach fugue? Ballet from hip-hop? Melville from Dickens? Jazz from bluegrass? Valley-speak from the Queen’s English?

Style.

Every one of us can intuitively tell when the styles of two artworks, stories, songs, or buildings are similar or different, and this perception affects how we respond to them long before any thoughtful reflection. Judging people or things by their differing styles is nearly instantaneous—conscious reasoning only comes in after the fact, if at all. We size people up at a glance based on their style; we know which styles we like and which we don’t; we connect styles of music, literature, and architecture in categories called “art deco” or “punk”; learned experts can even lecture with erudition on the evolution of various styles from historical antecedents. But what is it that underlies this ubiquitous and important yet obscure phenomenon?

By analogy to qualities such as “color” or “size,” which can be directly seen and measured, we can use the word “style” to refer to a notional quality that underlies all these feelings and thoughts. A general understanding of how style works, however, is quite elusive; though we all intuitively recognize different styles when we see or hear them, it is difficult to say anything unified that relates the many diverse aspects of style.

The Structure of Style explores this question from a computational view of the nature of style, how it is perceived, and how it is used. The computational viewpoint is one which seeks understanding specifically in terms of how information is represented, organized, and transformed in the production and perception of different styles. By doing so, we hope to point towards more general and comprehensive understandings of style and how it works, as well as to enable development of more useful intelligent computer systems.

Research in this field of *computational stylistics* is currently growing, as more scholars, researchers, and technologists realize the importance of dealing explicitly with questions of style. In text analysis, style is key to understanding the feelings and

social relationships expressed in a text; in music and art, style is a major determinant of the character of a work; in design and architecture, function and style interact in intricate ways. New mathematical and computational techniques now make it possible to model the role of style in the creation and reception of human artifacts and thus to develop software systems that can directly use style in various ways. Ultimately, machines must be aware of different styles and their effects if they are to interact intelligently with people rather than through artificially constrained user interfaces as they do now.

Current applications of computational stylistics are diverse, including authorship attribution for criminal and literary investigations, information retrieval based on document genre or emotion, plagiarism detection, composition of new music in a given composer's style, realistic improvisational musical accompaniment, rendering animation in different motion styles, analyzing architectural styles for functionality and emotional resonance, and much more. Research on style in all areas shares the problem of formalizing what style means, and of developing a modeling language to represent the characteristics of different styles.

The common theme is that style is fundamentally about the *manner* in which something is done or made, which is separate from its primary intended effect, or its *function*. The possibility of different styles thus arises from the fact that every human creation may be put together in a great many different ways while still serving the same basic function. (Style, of course, is not always entirely distinct from function, as discussed further below.) Consider, for example, the fact that the simple function of restricting unauthorized access to a space can be performed by any one of a dizzying assortment of different kinds of locks, each with its own individual character.

This essential idea behind style, that a particular general function can be effected in many different ways, is just as applicable to behaviors, such as sports or dance, as it is to physical artifacts, such as sculptures, home appliances, or books. Indeed, when we examine style generally as a quality of various human creations, we begin to see that there really is no clear line between those creations that are artifacts (i.e., "things") and those that are behaviors (i.e., "actions"). Consider a piece of music—for concreteness, say, Beethoven's Moonlight Sonata (Fig. 1). On the one hand, it can be looked at as an artifact, a kind of thing, defined (more or less) as set of overlaid sequences of notes and harmonies, with given durations as well as relative tempo, loudness, etc. This is the representation provided by the score, itself a physical artifact.

On the other hand, any particular performance of the sonata is also an instance of the same creation, each one a complex behavior giving rise to an experience of the playing and the music in time. A performance contains details that the score does not, of course, and its style may be considered a sort of collaboration between the composer and the performer, with choices of interpretation as to what to bring out and how, and yet we may examine the style of the piece both by viewing it as an artifact, looking at the score, or as a behavior, listening to the performance.

Sonate

Sonata quasi una Fantasia ('The Moonlight')

L. van Beethoven Op 27 No 2



Fig. 1 The beginning of Beethoven's Moonlight Sonata

When we examine the sonata's style, then, we might look at the physical artifact of the score, noting that although its surface texture is very classical, similar to works by Mozart or Haydn, we also see Beethoven's distinctive style in the D-flat note in the third bar which forms a Neapolitan chord, surprising us after the dormant melancholy of the opening triplets. Then, in bars five and six, the juxtaposition of 16th notes in the melody against the triplets in accompaniment creates a structural tension between the initial lullaby and a more dramatic expression (characteristic of Beethoven). Alternatively, we might understand the style of the piece by listening to a particular performance and noting how these structural relations between notes and chords express feelings unfolding over time; different performers, of course, will emphasize or downplay different possible feelings by adjusting the speed, loudness, and other qualities of the performance.

There is thus an essential unity between human behaviors and human artifacts, which may both be viewed generally as kinds of *human creations*. Any such creation is an intricate arrangement of many interlocking parts whose detailed relationships enable an overall function. In the case of a behavior, such as a musical performance, the parts are all the myriad small actions (hitting piano keys, pressing pedals, etc.) that, in a precisely timed formation, together constitute the complete performance. In the case of an artifact, such as a piano, the physical properties and organization of its parts (keys, levers, hammers, strings, soundboard, etc.) enable it to perform its function.

So, since any given function can be effectively implemented in a great many different ways, the *specific* configuration of interlocking parts that comprises a given creation is not essential to its function. Rather, each of its many components has been chosen from a large set of different, but equally functional, elements. For example, an author may choose to describe a given event using formal words and syntax, or in more casual language; an architect may design in concrete or in steel. The aggregate effect of such choices (some large, most small) on a creation constitutes its style. When such choices are conscious and based on expertise, the style may be thought of as “artistic”, but even less-consciously produced artifacts and behaviors have definable styles, to the extent that they express a consistent manner of construction.

It should not be thought, however, that style can be separated entirely from function and meaning. In fact, manner itself can convey meaning to observers. An artist paints a tree with bold strokes and bright colors because that is the way he wants viewers to see it—not simply as a tree, but rather as *his* tree. The similarities and differences between his vision of a tree and others’ visions create resonances in the viewer’s mind. As Virginia Postrel has eloquently argued [1], stylistic and aesthetic judgments are not merely optional add-ons to more essential functionality, but constitute part of the very essence of all human creations. As she notes, “the aesthetic . . . matters to people’s sense of self.” Surface appearances and sounds evoke the complex interplay of social and environmental context, and so give rise to social and personal meanings.

Yet in addition to patterns of surface characteristics and socially constructed meaning, style also includes a third dimension—it conveys feeling and emotion. For example, when the artist paints a tree with certain kinds of strokes, evoking particular meanings of “tree-ness”, he also paints to evoke feelings of tension or pleasure in his audience. The fundamental challenge of stylistics, then, is to understand these three levels of stylistic expression and their interrelationships: patterns, meanings, and feelings.

Research on style thus differs fundamentally from most other computational work dealing with complex human artifacts, such as information retrieval or computer-assisted creativity. Although there is much we *can* understand by creating formal models of basic elements of text, music or images, such descriptions cannot possibly account on their own for what the author had in mind or what the audience gets from it. We must go beyond merely finding patterns or statistics that describe observable differences between genres—rather, we must pay equal attention to the role of the reader, listener or viewer, and try to grasp the meanings and feelings that constitute the reading, listening or viewing experience.

The research collected in this volume explores these questions from a variety of computational perspectives. *The Structure of Style* is an outgrowth of the American Association for Artificial Intelligence (AAAI) Fall Symposium on Style and Meaning in Language, Art, Music, and Design [2], held October 21–24, 2004 in Washington, DC. Chapters for this book were solicited from authors of selected papers presented at the symposium, as well as from other prominent researchers in the area, and were peer-reviewed.

The book as a whole is divided into three parts, according to the roles that computation can play in stylistics. The first part, *Production*, provides a conceptual basis for stylistic research by examining computer systems that produce artifacts (musical pieces, texts, artworks) in different styles. The second part, *Perception*, describes research on methods for analyzing different styles and gleaning useful information from them as part of an author-audience communication. The third part of the book, *Interaction*, deals with the reciprocal actions of style producers and perceivers as demonstrated in several state-of-the-art research projects.

The research described herein can also be divided, as shown in Table 1, into four domains: visual art and design (Chapters 1, 2, 8, and 9), language (Chapters 4, 5, 6, and 11), music (Chapters 3, 7, and 10), and gaming (Chapter 12).

Table 1 Organization of *The Structure of Style*. Chapter 13 cuts across these categories, dealing in a unified fashion with all roles and domains

	Production	Perception	Interaction
Visual Art/Design	Chapters 1 and 2	Chapter 8	Chapter 9
Language	Chapter 4	Chapters 5 and 6	Chapter 12
Music	Chapter 3	Chapter 7	Chapter 10
Gaming			Chapter 11

The first section of the book, *Production*, has four chapters. Chapter 1, by Harold Cohen, discusses the style of painters and their paintings, arguing that style results from the interplay of the artist's beliefs and their chosen materials and technologies. Cohen derives insight into what constitutes an acceptable understanding of a style from his own experience trying to understand the coloring style of AARON, the AI program he developed that paints original artworks. Chapter 2, by George Stiny, explores the nature of shape in visual design, seeing style as complex combinations of rules that change with time. The rules can be embedded and recursive and otherwise computationally complex, such that style emerges in an environment with no clear divide between design and calculation. Chapter 3, by Roger Dannenberg, analyzes familiar musical styles, such as Baroque and Classical, showing how they are distinguished both in terms of surface characteristics like ornamentation and in deeper levels of meaning and emotion. The chapter also surveys key computational approaches to musical style classification and generation. Chapter 4, by Ehud Reiter and Sandra Williams, describes how different writing styles can be generated by an automatic text generation system. Style implies making specific choices during the text generation process, either at the level of a generic style based on a large text collection (a genre), or at the level of the individual author. There are many similarities between Reiter and Williams's analysis of text and Dannenberg's discussion of style in music; many of aspects of style discussed reflect the idiosyncrasies of an individual person or genre, taking into account expectations or preferences of a particular user or genre.

The second section, *Perception*, has four chapters. Chapter 5, by Shlomo Argamon and Moshe Koppel, suggests that meaning can be found in textual style variation by considering aspects of the *communicative act* embodied by a text—including its

author's identity, its purpose, its medium, and its intended audience. Three case studies are presented to illustrate the framework: author profiling, authorship verification, and analysis of scientific rhetoric. Chapter 6, by Jussi Karlgren, highlights the importance of measures of variation and choice informed by readership analysis and formulated in terms that agree with reader experience of text. He examines different possible feature dimensions for analysis of statistical variation in style—which he suggests can be improved by a closer look at the purposes and preferences of writers and readers, including relevance and utility. In Chapter 7, Shlomo Dubnov introduces a communication-based model of musical listening, applying information-theoretic analysis based on probabilistic models of musical structure in time. Specific components of the “information rate” are related to expectancies and are translated into human feelings such as surprise and familiarity, which combine to create more complex emotions experienced over time. Chapter 8, by Julie Jupp and John Gero, proposes new models of similarity for analysis of visual designs, using semantic feature extraction and self-organizing maps, combining machine processing with human relevance feedback. The approach is evaluated on experiments using architectural design diagrams, highlighting the cognitive compatibility of the computed classifications.

The third section, *Interaction*, has five chapters. Chapter 9, by Sheldon Brown, puts forth a notion of *Troiage Aesthetics* in visual art, which includes collage, assemblage, and montage. This aesthetic is enabled by computing as a medium, and is illustrated by examples from Brown's series of artworks called *Scalable City*. Chapter 10, by Gerard Assayag, George Bloch, Arshia Cont, and Shlomo Dubnov, presents two computational architectures by which machine agents can learn from and interact with an improvising musician, using statistical modeling of musical style. In one framework the musician controls the interaction; in the other there is *active* machine learning. Chapter 11, by Kevin Burns, deals with strategic style from economic and psychological perspectives, analyzing competitive styles in a simplified version of poker. The study shows that cognitive style can be remarkably efficient, winning as much money as the optimal (Bayesian) strategy but with orders of magnitude less effort. Results are related to practical applications in war and risk by analyzing the evolution of terror networks and the escalation of system failures. Chapter 12, by Joseph Goguen and D. Fox Harrell, explores how poetry results from “blending” concepts, focusing on the principles that underlie an author's choices and describing how the principles of narrative structure go beyond those of conceptual blending in metaphor. The authors present a computational implementation of their system, showing how it performs in interactive generation of poetry.

The book concludes with Chapter 13, by Kevin Burns and Mark Maybury, which gives a survey of the future of style in artificial intelligence applications in the domains of language, music, design, and gaming, cutting across all three functions of style (production, perception, and interaction) and all three levels of style (patterns, meanings, and feelings). Findings suggest that applications of AI have thus far been focused mainly on the levels of pattern and meaning, for the functions of production and perception—this points to future research challenges in extending this work to addressing feelings and interaction.

Ultimately, we hope that the computational study of style will serve to both humanize computation and deepen our intellectual understanding of style in all areas of life.

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