Dimensions of Style in Computer Mediated Text

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Abstract: This note explores ways that style manifests in computer mediated texts, in a broad sense including cinema, video games, and even living. Much of our analysis relies on blending, enriched from cognitive linguistics with structure building operations to get structural blending, which we show encompasses metaphor, syntax, and narrative. Initial results concern poetry, but the approach generalizes to other media. One result is that optimality principles very different from those of common sense blending are needed for creative poetic blends.

1 Introduction

James Meehan's 1976 TALE-SPIN [13] was perhaps the first computer story generation system. It explored the creative potential of viewing narrative generation as a planning problem, in which agents select appropriate actions, solve problems in the simulated world, and output logs of their actions, using syntactic templates. Here is a sample:

> Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned.

The logic is impeccable: Gravity is pulling Henry into the river, and it has no friends, arms, or legs that can save it from the river; therefore Gravity drowns. But humans know Gravity is not subject to drowning; there is a startling type check error here. Subsequent systems were better, but still mainly used templates and logic, following the lines of "good old fashioned AI," which assumed that human cognition is computation over logic-based data structures, and which largely ignored (or even denied) the embodied and socially situated nature of being human. They lacked elegance and style. But how can we do better? And what is style anyway?

The deconstructionists tell us there is no good answer to such questions, and perhaps they are right. But it seems easier to generate texts that "have a consistent style" than than to define what "style" is, and this paper only aims to distinguish certain useful dimentions of style, for the special case of computer mediated texts (see 4.4). In particular, it considers real-time generated poetry (see Section 4.2), unconventional blends (Section 4.3), and by way of future work, computer games that generate new plots (see Section 5). Some foundations are briefly reviewed in Section 2.

2 Foundations

This section briefly reviews some topics that are foundational for the work reported in this paper.

2.1 Narrative

Narrative provides the basis for a deeper and more satisfying involvement for most entertainment, and for many games and art works. Temporal and causal succession are essential for narrative, but values also play a key role, by connecting events in the story to the social worlds and personal experiences of users. These two aspects of narrative provide the sense that a work is "going somewhere" and that it "means something," respectively. Sociolinguist William Labov and others have studied oral narratives of personal experience, which are told orally to a group of peers under natural conditions. The following briefly summarizes their structure:

1. There is an optional **orientation section**, giving information about the time, place, characters, etc. in what will follow.
2. The main body of the narrative consists of a sequence of **narrative clauses** describing the events of the story; by a default convention, called the **narrative presupposition**, these are taken to occur in the same order that they appear in the story. The narrative clauses are usually in the past tense.

3. Narrative clauses are interwoven with **evaluative material** relating events to the narrator's value system, which is presumed shared with the audience.
4. There is an optional **closing section**, summarizing the story, or perhaps giving a moral.

The interpretation of narrative also employs the **causal presupposition**, which says that, other things being equal, given clauses in the order A, B we may assume that A causes B.

These claims are thoroughly grounded in empirical research and linguistic theory. Although strictly speaking, they only apply to oral narratives of personal experience, they still yield insight into other forms, such as novels and human computer dialogues, because oral narratives of personal experience are foundational. It may be surprising that values are an integral part of the internal structure of stories, rather than being confined to a "moral" at the end, but they occur often and in many different ways, including explicit justifications for the narrator's choice of what to tell, or a character's choice of what to do, and implicitly via emphatic words, such as "very" or "extremely." The default narrative presupposition can be overridden by explicit markers of other temporal relations, such as flashbacks and flashforwards. Moreover, narratives may involve multiple times, places or narrators, but still be composed of subsequences that conform to the above structure.

The structural aspects of this theory can be formalized as a grammar, the instances of which correspond to the legal structures for narratives. The following uses so called extended BNF notation,

```
<Narr> ::= <Open> (<Cls> <Eval>*)* [<Coda>]
<Open> ::= ((<Abs> + <Ornt>) <Eval>*)*
```

where `[...]` indicates either zero or one instance of whatever is enclosed `*` indicates one or more instances, `+` indicates exclusive or, and juxtaposition of subexpressions indicates concatenation. Here `<Narr>` is for narratives, `<Cls>` is for narrative clauses, takeen to potentially include evaluation, `<Eval>` is for stand-alone evaluative clauses, `<Open>` is for the opening section, which may include an orientation and/or abstract, and `<Coda>` is for the closing section.

2.2 Metaphor and Blending

Fauconnier and Turner have developed a theory known as **conceptual blending**, or **conceptual integration** [2]. **Conceptual spaces** are a basic notion of this theory, building on Fauconnier's earlier notion of mental spaces. Conceptual spaces are relatively small, transient collections of concepts, selected from larger domains for some purpose at hand, such as understanding a particular sentence. Conceptual spaces are sets of "elements" and relation instances among them. George Lakoff, Mark Johnson, and others [11, 10] have studied metaphor as a mapping from one conceptual space to another, and shown that metaphors come in families, called **image schemas**, having a common theme. One example is MORE IS UP, as in "His salary is higher than mine," or "That stock rose quite suddenly." The source UP is grounded in our experience of gravity, and the schema itself is grounded in everyday experiences, such as that when there is more beer in a glass, or more peanuts in a pile, the level goes up. Many image schemas, including this one, are grounded in the human body, and are called **basic image schemas**; they tend to yield the most persuasive metaphors, and can be useful, for example, in user interface design [4].

Fauconnier and Turner study the **blending** of conceptual spaces, to obtain new spaces that combine parts of the input spaces [2]. Blending is common in natural language, for example, in words like "houseboat" and "roadkill," and in phrases like "artificial life" and "computer virus." blending is claimed to be a basic human cognitive operation, invisible and effortless, but pervasive and fundamental, for example in grammar and reasoning. It also gives a new way to understand metaphor. For example, in "the sun is a king," we blend conceptual spaces for "sun" and "king," resulting in a new, blended space, together with **conceptual mappings** to it from the "king" and "sun" spaces. Although there is no direct mapping between the two original spaces, there are "cross space" identifications, certainly including the identification of the "sun" and "king" elements, so that they are the same element in the blended space. **Metaphoric blends** are asymmetric, in that the **target** of the metaphor is understood using only certain salient concepts from the other "source" space [8]. For example, aspects of "king" are "**blocked**" from mapping to the blend space – usually the sun does not wear a crown or charge taxes. Additional information needed to understand a blend may be recruited from other spaces, as well as from **frames**, which encode highly conventionalized information. **Conceptual integration networks** are networks of conceptual spaces and

conceptual mappings, used in blending the component spaces for situations that are more complex than a single metaphor.

2.3 Optimality Principles

Here are six of the principles that Fauconnier and Turner [2] give to characterize optimal blends:

1. *Integration:* The scenario in the blend space should be a well-integrated scene.
2. *Web:* Tight Connections between the blend and the inputs should be maintained, so that an event in one of the input spaces, for instance, is construed as implying a corresponding event in the blend.
3. *Unpacking:* It should be easy to reconstruct the inputs and the network of connections, given the blend.
4. *Topology:* Elements in the blend should participate in the same kinds of relation as their counterparts in the inputs.
5. *Good Reason:* If an element appears in the blend, it should have meaning.

All these require human judgement, and cannot be implemented in any obvious way. However the Topology Principle, in the special case where the relations involved are identities does not involve meaning, and so can be implemented; indeed, it is part of our blending algorithm.

3 Algebraic Semiotics and Structural Blending

It may help to first clarify our philosophical orientation, since mathematical formalisms are often given a status beyond what they deserve. For example, Euclid wrote, "The laws of nature are but the mathematical thoughts of God." However, our viewpoint is that formalisms are constructed by researchers in the course of particular investigations, having the heuristic purpose of facilitating consideration of certain issues in that investigation; theories are situated social entities, mathematical theories no less than others.

Whereas conceptual spaces are good for studying concepts, but are inadequate for structure, e.g., to describe how a particular meter combines with a specific rhyme scheme in a fixed poetic form; music raises similar issues, which again require an ability to handle structure. Thus, to use blending as a basis for stylistic analysis, we must generalize conceptual spaces to take account of structure, which requires constructors and axioms; it also helps to have a hierarchical type system. Hence we distinguish conceptual blending from **structural blending**, which we may also call **structural integration**, where the former is blending of conceptual spaces and the latter is blending that in general involves non-trivial constructors.

Algebraic semiotics uses algebraic semantics to describe the structure of complex signs (e.g., a music video with subtitles), and to study the blending of such structures. Algebraic semantics has its origin in the mathematical foundations of abstract data type theory [7]. The basic notion is that of a **theory**, consisting of sort and operation declarations, possibly with some subsort declarations.

A **semiotic system** (also called a **semiotic theory** or **sign system**) [4] consists of a algebraic theory, plus a **level ordering** on sorts (having a maximum element called the **top sort**) and a **priority ordering** on the constituents at each level. Sorts classify the parts of signs, while data sorts classify the values of attributes of signs (e.g., color and size). **Signs** of a certain sort are represented by terms of that sort, including but not limited to constants. Among the operations, some are **constructors**, which build new signs from given sign parts as inputs. **Levels** express the whole-part hierarchy of complex signs, whereas **priorities** express the relative importance of constructors and their arguments; social issues play an important role in determining these orderings. Conceptual spaces are the special case with only constants and relations, and one sort. Many details omitted here appear in [4, 5].

Books provide a simple example of a semiotic theory. `Book` is the top sort, `Chapter` is the secondary sort, `Head` and `Content` are tertiary sorts, and `Title` and `PageNo` are fourth level sorts. One constructor build chapters from their head and content, and another builds heads from a title and page number. Among the constituents of `Head`, `Title` has priority over `PageNo`, and among those for `Chapter`, `Head` has priority over `Content`. The grammar for narratives can also be described as a semiotic system. The top level sort is of course `<Narr>`; the second level sorts are `<Cls>`, `<Eval>`, `<Open>`, and `<Coda>`, while `<Ornt>` and `<Abs>` are third level sorts.

The structures described by semiotic spaces, like those of conceptual spaces, are static. Fauconnier and Turner do not attempt to capture the behavior of dynamic entities, with changeable state, in their theory. However (given the necessary mathematics), it is not very difficult to extend semiotic spaces to include dynamic structures; in fact, such an extension is needed for applications to user interface design, and is carried out in detail, with examples, in [5]. The conceptual blending theory of Fauconnier and Turner also does not assign types to elements of conceptual spaces; this makes sense, due to the very flexible way that blends treat types, but it also represents a significant loss of information, which in fact can be exploited in some interesting ways, such as being able to characterize some metaphors as "personifications," and being able to generate more striking and unusual blends by identifying sorts that are far apart. Another difference from cognitive linguistics is that we do not first construct a minimal image in the blend space, and then "project" it back to the target space, but instead, we build the entire result in the blend space.

Mappings between sign systems in semiotics are uniform representations for signs in a source space by signs in a target space, and user interface design is an important application area for such mappings [4]. Since we formalize sign systems as algebraic theories with additional structure, we should formalize semiotic morphisms as theory morphisms; however, these must be partial, because in general, not all of the sorts, constructors, etc. are preserved in the intended applications. For example, the semiotic morphism from the conceptual space for "king" into the blended space for the metaphor "The sun is a king" discussed above (most likely) blocks the throne, court jester, queen, and castle. In addition to the formal structure of algebraic theories, semiotic morphisms should also (partially) preserve the priorities and levels of the source space. The extent to which a morphism preserves the features of semiotic theories helps to determine its quality [4, 6, 5].

The simplest form[1] of blend is shown in Figure 1, where I_1 and I_2 are called **input spaces**, and G is called a **base space**. We call I_1, I_2, G together with the morphisms $I_1 \to G$ and $I_2 \to G$ an **input diagram**. Given an input diagram, we use the term **blendoid** for a space B together with morphisms $I_1 \to B$, $I_2 \to B$, and $G \to B$, called **injections**, such that the diagram of Figure 1 **commutes**, in the sense that both compositions $G \to I_1 \to B$ and $G \to I_2 \to B$ are "weakly equal" to the morphism $G \to B$, in the sense that each element in G gets mapped to the same element in B under them, provided that both morphisms are defined on it. In general, all four spaces may be semiotic spaces; the special case where they are all conceptual spaces gives conceptual blends. We call the composition of the two morphisms on the left of Figure 1 as its **left morphism**, the composition of the two morphism on its right as its **right morphism**, to the middle upward morphism as its **center morphism**, to the triangle on its left as its **left triangle**, and the triangle on its right as its **right triangle**. A more precise, but mathematically difficult definition is given in Appendix B of [7]. Since there are often very many blendoids, some way is needed to distinguish those that are desirable. This is what optimality principles are for, and a **blend** is then defined to be a blendoid that satisfies some given optimality principles to a significant degree. Section 4.1 gives optimality principles based only on the structure of blends, rather than their meaning, such as the degrees of commutativity and of type casting.

$$\begin{tikzcd}
 & B & \\
I_1 \arrow[ur] & & I_2 \arrow[ul] \\
 & G \arrow[ul] \arrow[ur] \arrow[uu] &
\end{tikzcd}$$

Figure 1: Blending Diagram

We can illustrate conceptual blending with the concepts "boat" and "house," as shown on the left of Figure 2. For this blend, the two triangles commute for all three sorts in the base space; similarly, the two base constants `object` and `person` are preserved. Thus we have commutativity for this blend, so that corresponding elements of the input spaces are identified in the blend; e.g., `house` and `boat` are identified in `HOUSEBOAT`, and the merged element is named `house/boat`. Similarly, the two relations in the base space map to the same relation in the blend via the three paths, so that the relations `live-in` and `ride` are

[1] This diagram is "upside down" from that used by Fauconnier and Turner, in that our arrows go up, with the generic G on the bottom, and the blend B on the top; this is consistent with the basic image schema MORE IS UP, as well as with conventions for such diagrams in mathematics. Also, Fauconnier and Turner do not include the map $G \to B$.

identified. Finally, for each pair of elements in the base space for which a relation holds, the corresponding elements in the blend space satisfy the corresponding relation, which means that all three paths preserve the axiom in the same way.

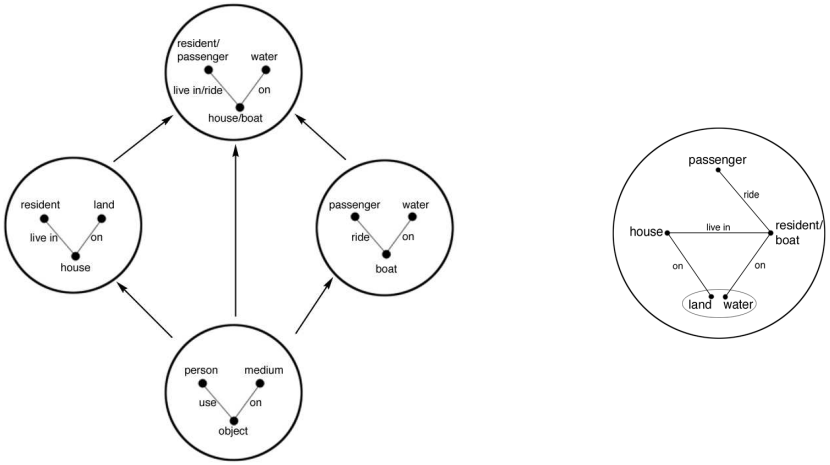

Figure 2: Houseboat Blend Diagram & Boathouse Blend Space

The right part of Figure 2 shows a second blend of the same two concepts, which in English is called a "boathouse." In it, the boat ends up in the house. Notice that mapping `resident` to `boat` would not type check, where it does if we "cast" `boat` to be of type `person`. Without this, the boat could not live in the boathouse; it is a kind of metaphor, called **personification** in literary theory, in which an object is considered a person. For this blend, neither triangle commutes, because the base element `object` is mapped to `boat` in the blend by the right morphism, and to `house` by the left morphism, but is not mapped to `boat/house` in the blend. Similarly, the central morphism cannot preserve the base element `person`, and the some goes for the base `use` operation. On the other hand, the base relation `on` goes to the same place under all three maps. There is a third blend which is similar to (in fact, symmetrical with) the above `BOATHOUSE` blend, in which a `house/passenger` ends up riding in the boat. (There are real examples of this, e.g., where a boat is used to transport prefabricated houses across a bay for a housing development on a nearby island.)

There is a fourth blend, the meaning of which is less familiar than the first three, but the preservation and commutativity properties of which are very good, so that it is a very pure blend of its input, even though its physical existence is doubtful. This is an amphibious RV (recreational vehicle), a vehicle that you can live in, and that you can ride in on land and on water. In addition, there is a fifth blend, the meaning of which is even less familiar: a livable boat for transporting livable boats. Perhaps only a blending algorithm could have discovered it, since it seems rather counter-intuitive for humans. Finally, a sixth blend gives a boat used on land for a house; it arises omitting the axioms that require a house/boat to be on water and a passenger to ride a house/boat.

It is encouraging that our intuitive sense of the relative purity of these blends, and the degree to which they seem "boat-like" and "house-like," corresponds to principles such as degree of commutativity, and preservation of axioms in input spaces. This suggests that measuring the quality of blends by preservation is reasonable.

Narrative construction provides a nice example of structural blending. We first define a "narrative space" for the rules in Section 2.1, seen as constructors by reversing their direction and expanding the $*$s; in this context, such constructors are conventionally called "templates." The narrative space also needs additional rules to supply clauses to instantiate the arguments of the Labov constructors. Some arguments would be blended with elements from other spaces to provide particular persons (e.g., a protagonist), places, objects, etc.; this cross-space sharing is indicated by shared generic constants from a generic space. All these spaces vary from one narrative to another; it is a major task of the artist to choose them appropriately.

4 Computational Stylistics

Espen Aarseth's extended analysis [1] of text generation systems considers relationships among programmer, system, and reader, as a basis for critical analysis. This focus is useful, because readers' authorial models affect their interpretation of works, causing the approaches of traditional literary criticism to fail. Although there are differences in the theoretical foundations for the templates and rules, the generalizability and soundness of those foundations, and the success of the experience generated, all these systems ultimately amount to some set of precomposed textual templates plus rules for combining and instantiating them, inspired by work like that of Vladimir Propp, in the tradition of Russian formalism. In contrast, cognitive linguistics does not consider meaning to reside in the language forms themselves, but to be generated by operations involving metaphor, mental spaces, prototypes, blending, etc.

4.1 Algorithmic Blending

The blending algorithm is programmed in LISP, and given an input diagram, either computes one good blend, or else all blendoids over that diagram. It is a depth first traversal over the binary trees describing the ways to identify relations and the the ways to identify constants. The algorithm currently uses degree of commutativity as its only optimality principle, but we are considering other optimality principles that are easy to implement, such as the amount of type casting for constants, because the more of these a blendoid has, the more constants get unnatural sorts. Another is axiom preservation. A running program is valuable, because even for relatively simple inputs, the number of blendoids is so large that it is difficult for a human to discover them all. In the houseboat example, the algorithm computes 48 primary blendoids (in which every possible axiom is preserved), and 736 if it also computes those that fail to preserve some axioms. An important conclusion is that efficient techniques for computing high quality blends are necessary for the theory to be useful for content generation and analysis.

4.2 Active Poetry

This section describes an experiment with improvisational poetry. Such experiments are not intended to produce comprehensive models of the human mind. Instead, the motivation is to improve the algorithm, the theory, and our understanding of blending. Fox Harrell used the blending algorithm in a system called "The Girl with Skin of Haints and Seraphs" [9]. The LISP program draws on a set of theme domains such as skin, angels, demons, Europe, and Africa, given as sets of axioms. It constructs input spaces by extracting axioms from two different domains, and then infers relations, sorts, and constants from these axioms. A base space is generated by instantiating shared structure between the spaces. Morphisms from the base space to the input spaces are generated, and the input spaces, base space, and morphisms are passed to the blending algorithm. The generated blends are then placed in poetic phrase templates, and larger grain templates for Labov narrative structure. Only blends with the highest possible commutativity are given as output. A sample poem generated by the system is given below, edited lightly for grammar and format:

> her tale began when she was infected with smugnessloveitis.
> she began her days looking in the mirror
> at her own itchy entitled face.
> her failure was ignoring her tormented angel nature.
> life was an astounding miracle.
> nordic-beauty death-figure vapor steamed from her pores
> when she rode her bicycle. that was nothing lovely.
> when 21 she was a homely woman. she decided to persevere;
> in the rain, she fears only epidermis imperialists.
> she believes that evil pride devours and alternates with pride of hope.
> it was no laughing matter.
> she snuggles in angel skin sheets and sleeps.
> inside she was resolved to never find
> a smug or paranoid love.

This poem is a commentary on racial politics and the limitations of simplistic binary views of social identity. The dynamic nature of social identity is a central theme of this poetic system, as reflected in the way the program dynamically generates many poems based upon fixed theme domains. The program can be run any number of times, and will produce different poems with different novel metaphors, though reading large numbers of these could become tiresome.

4.3 Unconventional Blends

The poem "Walking around" by Pablo Neruda has narrative form. Its first stanza serves as an orientation, introducing the protagonist, the place, and the time (the latter two in a condensed poetic form); the location is perhaps a small city in Chile. Each subsequent stanza explores aspects of some area within that city, using metaphors that are often quite striking. The general theme of the poem is weariness induced by consumerism. Here are its first two stanzas (out of ten, from [3]):

> It so happens that I am tired of being a man.
> It so happens, going into tailorshops and movies,
> I am withered, impervious, like a swan of felt
> navigating a water of beginning and ashes.
>
> The smell of barbershops makes me weep aloud.
> All I want is a rest from stones or wool,
> all I want is to see no establishments or gardens,
> no merchandise or goggles or elevators.

Neruda draws on rich domains of imagery, allusion, multi-sensory experience, objects, and cultural context, which can be represented as a set of domains. For example, a `Town-location` is a place such as a tailorshop, movie theater, or barbershop, and would contain `town-objects`, such as goggles, elevators, wool, and stones, where attributes of wool might be heavy and impervious. Neruda's metaphors often blend concepts in unusual, creative ways (such as "swan of felt" and "water of beginning and ashes"). This requires optimality principles very different from those that produce conventional blends, for example, type casts to very different sorts may be preferred. To blend knowledge domains with theme domains requires selecting appropriate conceptual spaces from these domains. Selecting by priority of sorts and relations gives one approach. Knowledge domains provide background context.

4.4 Twelve Dimensions of Style

We have proposed using blending at three different levels[2]: large grain narrative (or other) structure (e.g., Labov), where structural blending combines clausal units, which in turn result from structural blending of phrasal elements, which the.selves result from conceptual blending. Different choices of constructors at the top two levels can produce very different styles, for example, a linear narrative vs. a random "post-modern" exposition vs. deeply embedded narrative structure (as in *A Thousand and One Nights*); constructors at these levels can also be used to control transitions among such styles. Other stylistic parameters at the second level include syntactic complexity, and tense and mood of verbs. Domains can also play a role, with different choices are activated at different times. The phrasal level has noun clusters, verb phrases, etc., again potentially from different domains at different times. At each level, different optimality principles will be appropriate, and these too can change with time. Thus there are at least 12 dimensions of style in this approach, 4 at each level: choice of domain, content of domain, optimality principles for blending, and controls for changing domains. Note that the content of a domain may include not just constructors and elements, but also relations and axioms; if these are counted as dimensions, the we get 20 altogether. All of this would need to be finely tuned to achieve reasonable approximations to existing styles, but we expect it would still be far from the genius of a great poet like Neruda.

[2]Howeover, the division into levels is somewhat arbitrary, and more or less could be used if there were any good reason to do so.

5 Conclusions and Future Work

One surprising result of our research is that a combination of conceptual and structural blending can produce interesting poetry, which some critics have even considered superior to prior computer generated efforts. Another is that both large grain structure and syntax can be handled by blending in ways that are close to, but somewhat extend, what has been done in prior text generation programs; this use of blending also gives rise to a somewhat novel view of grammar as emergent from processes of blending, rather than fixed. A third result is that it is easy to extend the approach to interaction, to media other than text, and to forms other than narrative. The result that was most surprising to us is that the optimization principles proposed by Fauconnier and Turner [2], though good for common sense blends like "house boat," do not work well for creative poetry, where it seems that some kind of *dis*optimization principles are more appropriate, at least for language like that in the Neruda poem.

Future work will extend ideas discussed in this paper to interactive systems, for example, an interactive version of the Neruda poem, which produces different output depending on user navigation through a map of the small Chilean town, or a computer game that produces different story lines depending on the prior history of interaction. We also wish to refine our ideas on the relation of blending and stylistics.

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