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#### **Title**

A Computational Model of Connotation-Based Revision

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#### **Journal**

Proceedings of the Annual Meeting of the Cognitive Science Society, 13(0)

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#### **Publication Date**

1991

Peer reviewed

# A Computational Model of Connotation-Based Revision

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## Abstract

Previous studies on text generation and revision seldom consider emotions and social relations as motivations for linguistic variations such as word choice and syntactic structure arrangement. This paper proposes a computational model that uses four attributes *affect*, *activity*, *power*, and *emphasis* to revise texts. These attributes express ideological beliefs, the connotations of lexical items, and connotation propagation properties of sentence structures. With these formal tools, an algorithm of backward chaining revises sentences with sensible choices of word and sentence structures. The model provides a basis for future research that can lead to a fully automated text revision system.

**Topic areas:** Text generation and revision, ideology, lexical and sentential connotations.

## Introduction

In the early 1970's, research on linguistic variations during text generation started with the works on paraphrase generation from semantic nets ([Simmons and Slocum, 1972], [Goldman, 1975]). But this approach did not address the problem of how to determine the fitness of paraphrase in a text nor did it consider social context for the text.

Artificial intelligence research on ideology modeling was done in [Abelson, 1973] and [Carbonell, 1978]. This approach focused on the planning of actions with given ideologies but did not consider the ideological effects on linguistic variations when describing the actors and their behavior.

Computational issues on text generation based on pragmatic and social factors are addressed in [Hovy, 1988]. His system PAULINE makes use of conversation setting such as: time availability and formality, the expertise of speaker and hearer, their social relationship, and speaker's goals in affecting hearer's

emotions towards speaker. These parameters influence linguistic decisions like topic collection and organization, sentence grammatical arrangement, and word choice. These parameters characterize the relationship between the writer and the reader and say little about the connotations on the topics in the text (with the exception of the parameter of affect). This paper proposes a text revision model that focuses on the connotations imposed on the textual topics. Hence, our model extends the logic of PAULINE to make better writing decisions.

Underlying PAULINE is an important message that many computational linguistic studies have neglected — there is significant relationship between language and society. This is in sharp contrast to the more commonly recognized relationship between language and thought. This paper takes a social perspective of language, as urged by Whorf ([Carroll, 1956]), Fowler, Kress, Hodge and Drew, ([Fowler *et al.*, 1979], [Kress and Hodge, 1979]), etc. From this perspective, language plays a major role in the social construction of reality, manipulates as well as informs, and distorts reality to serve class and individual interests. The sociological linguistic studies cited above provide plenty of empirical texts where people use language to achieve their social objectives and to communicate their "social reality" with systematic choices of words, syntactic and case relations, and information.

Our strategy is to identify a small number of social attributes to express the ideological beliefs of a text, the connotations of individual words and phrases, and the connotations assigned to topics in a sentence structure. The major attributes of interest are **affect**, **activity**, **power** and **emphasis**. Based on the author's understanding of lexical connotations from sources such as [Hayakawa, 1968] and the Webster's New World Dictionary, these attributes are defined in the following way. Affect refers to people's general feeling towards events, people, institutions, or ideals, e.g., happiness is positive affect (+aff), tragedy negative (-aff). Activity refers to people's activeness in performing an action, e.g., fighting an enemy is active (+act) and resting is inactive (0act). Power refers to

\*This work was partially sponsored by the Army Research Office under contract DAAG29-84-K-0060 for the AI Lab.

any physical, emotional, social or spiritual force, e.g., riot is more forceful than disorder, which is more forceful than trouble. We define riot to have emphasized power (+pow, +emp), disorder non-emphasized power (+pow, 0emp), and trouble no power (0power). Emphasis refers to the degree of connotation, e.g., the adverb 'very' and 'extremely' connote positive emphasis, while 'merely' and 'just' connote de-emphasis(-emp). The subtle distinctions between the above synonyms and hyponyms are undoubtedly relative and dependent on cultural framework and communication situation. So the values of 'positive' or 'plus' (+), 'negative' or 'minus' (-), and 'neutral' (0) assigned to words and concepts are arbitrary to certain degree. Future research must sharpen these distinctions with a refined scale or more attribute types. For the purpose of this paper, we assume a convention on the attribute values of words and concepts exists for our particular communication situation.

### Language and Ideology

Briefly speaking, an ideology is a body of related beliefs about social agents, institutions, and relationships from a specific social perspective. Almost every real-life text is produced with some ideological beliefs and reflects the beliefs. As an illustration, let us examine the news reports from two newspapers, the *Sun* and the *Morning Star* (hereafter referred to as the *Star*) about the disorder at the Notting Hill Carnival in London in 1977 ([Drew, 1979]). Because of ideological differences, two contrasting pictures about the carnival resulted:

#### 1. *Sun* August 30, 1977:

**INTO BATTLE! RIOT SHIELDS OUT AS THE POLICE STORM CARNIVAL MOB.**

*Two hundred police carrying riot shields and truncheons last night charged a rioting mob of black youths at London's Notting Hill Carnival. More than 70 policemen were injured, one stabbed, before the Special Patrol Group officers cleared the trouble spot at Acklam Road — flash-point of last year's riot in which 600 were injured.*

*The 10-minute riot began when youths charged a police cordon. Hurling bottles and bricks they burst through the thin blue line....*

#### 2. *Star* August 30, 1977:

**FIGHTING MARS END OF CARNIVAL AFTER A DAY OF PEACE.**

*Police observers hovering in a helicopter above the huge crowds at London's Notting Hill Carnival yesterday estimated between 200,000 and 250,000 people were taking part.*

*For most of the time and for the majority of the people it was a happy, peaceful occasion.*

*But by 9p.m. some streets in Notting Hill had become a battlefield, with the police mounting a massive operation to clear them.*

*The trouble started about 8p.m. at the top of the Portobello Road, near Westway. A scuffle erupted into the police cordon....*

Clearly, the two reports asserted two very different set of connotations about the Carnival, police, and people who fought with the police. Each set reflects a certain network of ideological beliefs about the government, people and other social elements. These beliefs affect many of the linguistic and information choices of the reports.

### Input Text and Writing Decisions

A text generation system usually takes some conceptual structures as inputs, e.g., relational data base ([McKeown, 1985]), conceptual dependency ([Hovy, 1988]), and frames ([Paris, 1988]). These conceptual structures generally contain concrete, denotative meanings such as physical motions and attributes but not connotative meanings such as emotions and social relationships. The text generated from these structures is like a first draft, which is to be revised with considerations on connotative meanings given as additional input. This level of revision is what our model focuses on.

The model accepts input text that is pre-analyzed and represented in terms of syntactic relations and sorted case relations. A major task of the model is to consider word choices to satisfy the given ideological beliefs. If no word choices can satisfy the desired connotations, an alternative sentence structure is tried until success is achieved. If no structures can satisfy the wanted connotations, deletion of the sentence from the text is suggested.

All input sentences from the initial draft are represented with a conjunction of grammatical relations (e.g., subject, object and preposition) and case relations (e.g., agent, affected entity, location, attributeOf). Each object is sorted as some general class (e.g., action, occasion, attribute, entity). For instance, a sentence in the draft *A mob rioted at the end of the Carnival* is represented as:

• **v:act:v1 -subj:agt → n:entity:a1**

The general subject:agent relation signifies an action undertaken by an entity, which can be people, organization, non-human objects, etc. The particular relation, for the clause 'mob rioted', specifies a mob a1 who performed the action v1 of rioting.

• **v:act:v1 -p:orient:p1 → n:occ:e2**

The general preposition:orientation relation signifies a relation between the action and the occasion from a particular perspective such as 'action at occasion' or 'action after occasion'. The particular relation, for the phrase 'rioted at the end', specifies a rioting action at the end of the Carnival occasion.

• **n:att:e2 -p:attOf:p2 → n:occ:e1**

The general preposition:attributeOf signifies that

something is an attribute of an occasion. The particular relation, for the phrase 'the end of the Carnival', focuses on the end e2 of the Carnival occasion e1.

During revision, the synonyms and hyponyms of the words in this sentence are considered. For examples, the noun 'mob' has a generalization 'people', the verb 'riot' has a less forceful synonym 'disorder' and an even less forceful synonym 'make trouble.' Also, the phrase 'the end of' is grammatically optional. But pragmatically, the phrase increases the distance between the riot and the Carnival, thus de-emphasizing the negative affect associated with the Carnival due to the riot. Moreover, an alternative structure is 'there-be' construction with nominalization of the action verb with agent deletion. A combination of all the above alternatives generates 18 near-paraphrases, one of which is to be selected during revision. These candidate sentences assign connotations to the agents or occasion mentioned in the sentence in very different ways. A good target sentence must satisfy the given ideological beliefs. We summarize the 18 sentences as below, with the abbreviation notation "{A | B | C}" meaning one of A, B, or C can be selected when revising the sentence:

- {A mob | People} {rioted | caused disorder | made trouble} at the end of the Carnival. (6 choices)
- {A mob | People} {rioted | caused disorder | made trouble} at the Carnival. (6 choices)
- There was {a riot | a disorder | trouble} at the end of the Carnival. (3 choices)
- There was {a riot | a disorder | trouble} at the Carnival. (3 choices)

### Representation of Ideological Beliefs

Our revision model expresses ideological beliefs with the attributes of affect (aff), activity (act), power (pow), and emphasis (emp). The two news reports about the Notting Hill Carnival quoted earlier reflect the following ideological beliefs:

1. The *Sun* hated (-aff) the dangerous rioting (-aff, +act, +pow, +emp) mob, who thus carried the attribute values {-aff, +act, +pow, +emp}. The *Star* de-emphasized the affect, activity, and power of the people (-aff, +act, +pow) involved in the disorder. They did not have any common characteristics such as "black" or "youth" and they were not (-emp) even identified as causing agents of violent actions (+act, +pow). So for the *Star*, these people carried {-aff, +act, +pow, -emp}.
2. The *Sun* disliked (-aff) the Carnival because it gave the mob a chance to riot (-aff, +act, +pow). So the Carnival carried the social values {-aff, +act, +pow, 0emp}. The *Star* increased the distance between the riot (+act, +pow) and the Carnival (0act,

0pow), and de-emphasized (-emp) the negative affect (-aff) of the Carnival, which thus carried {-aff, 0act, 0pow, -emp}.

3. The *Sun* liked (+aff) the police, who were well equipped (+pow) to protect (+act) the people from the violence of the mob. The *Star* disliked (-aff) the armed (+pow) police who attacked (+act) people. So for the *Sun*, the police carried the attribute values {+aff, +act, +pow, 0emp} and for the *Star*, the police carried {-aff, +act, +pow, 0emp}.

From the perspective of text understanding, these ideological beliefs are abstractions of the two newspaper reports. Some time after reading such reports, the reader is likely to forget about the details but still feel these abstracted connotations associated with the Carnival, the police and the people involved in the disorder. It is through numerous exposures to reports with similar ideological beliefs (such as that of a single newspaper or magazine) that the reader is indoctrinated. The ideological manipulation of language is very powerful indeed ([Fowler *et al.*, 1979], [Kress and Hodge, 1979]).

### Word Dictionary of Connotations

Given the ideological beliefs on the topics of a text, the text must be composed in a way to assert these beliefs. The connotations the text carries must finally depend on specific words in the text. Most words have synonyms and hyponyms, which stress different attributes or different values of the attributes. A writer's ability to differentiate these stresses, which are often quite subtle, is a major component of the writer's competence. If a computer is to write, as people do, about people and for people, it must possess knowledge about the social connotations of words.

Our model represents words, especially those carrying heavy connotations and have synonyms, with the social attributes of affect, activity, power, and emphasis. These attributes are undoubtedly not sufficient to distinguish many words. For instance, one other common attribute is formality ([Hovy, 1988]), which has more to do with the writer-reader relationship and communication setting than with the subject matter itself. But the four attributes do exhibit some generality in differentiating many words. In particular, the three attributes of affect, activity, and power follow the *semantic differential* model of [Osgood *et al.*, 1957], which found in psychological experiments people differentiated words with different values of evaluation, activity, and potency.

Our revision model uses a dictionary that specifies the social connotations of words. The dictionary is expedient for the purpose of this paper but not universal, as discussed in the introduction section. For the following sample lexical entries, the absence of an attribute implies that the value of the attribute is neutral, and "?" means a variable which can match any sign (+,

-, or 0) during connotation propagation in a sentence (see a later section):

- charge (verb): +act +pow (0aff 0emp)
- disorder (noun): -aff, +pow
- end (noun): ?aff, ?act, ?pow, -emp
- erupt (verb): +act +pow
- fight (verb): +act
- make (verb): +act
- mob (noun): -aff +pow
- people (noun): all neutral
- protect (verb): +aff +act
- riot (verb): -aff +act +pow +emp
- riot (noun): -aff +act +pow +emp
- scuffle (verb): +aff +act
- scuffle (noun): -aff +act
- trouble (noun): -aff
- very (adverb): ?aff, ?act, ?pow, +emp

### Connotation Propagation Properties of Sentence Structure

Consider the eighteen near-paraphrases given in an earlier section. Each candidate sentence assigns different values of social attributes to the Carnival and the people who took part in the disorder. Each particular sentence structure, with its syntactic and sorted case relations, assigns connotations to the sentential topics in its own way. The properties of these sentence structures can be expressed as rules. The precondition of a rule specifies the syntactic relation and the sorted case relations between two constituents of a sentence. The action of a rule specifies how the connotations of one constituent propagates to another. We show four sample rules below.

#### V:Action-to-Subj:Agent Rule

If  $v:act -subj:agt \rightarrow n:entity$ ,  
then  $n:entity := v:act \oplus n:entity:lex$

The above assignment statement (“:=”) means to assign to the agent ( $n:entity$ ) the vector addition  $\oplus$  of the connotations of the action ( $v:act$ ) and the connotations of the actual words used for the subject ( $n:entity:lex$ ). A vector addition between two n-tuples is defined to be a n-tuple whose sign elements result from the addition of the corresponding sign elements of the original two tuples. A table for addition of two signs is given in Table 1, with the notation ‘?’ referring to a variable that can match any sign during connotation propagation.

This rule applies to clauses like ‘mob rioted’ and ‘police charged.’ In the first case, the verb ‘rioted’ connotes  $\{-aff, +act, +pow, +emp\}$  and the noun ‘mob’ connotes  $\{-aff, 0act, +pow, 0emp\}$ . According to the rule, the mob is assigned the connotations of  $\{-aff, +act, +pow, +emp\}$ , the result of  $(\{-aff, +act, +pow, +emp\} \oplus \{-aff, 0act, +pow, 0emp\})$ .

Sign1	Sign2	Sign1 + Sign2
+	+	+
+	0 or ?	+
+	-	0
0 or ?	+	+
0	0	0
0	?	0
?	0	0
?	?	?
0 or ?		
-	+	0
	0 or ?	

Table 1: Sign Addition

#### V:Action-to-Pp:Occasion Rule

If  $v:act -p:orient \rightarrow n:occ$  and  
 $p = \text{‘at’, ‘in’, ‘during’, or ‘under’}$ ,  
then  $n:occ := v:act \oplus n:occ:lex$

This rule applies to phrases like ‘made trouble at the end’ and ‘danced in the Carnival.’ In the first case, the verb phrase ‘made trouble’ connotes  $\{-aff, +act, 0pow, 0emp\}$  and the noun ‘end’ connotes  $\{?aff, ?act, ?pow, -emp\}$ . The propagation rule states that the ‘end’ occasion is assigned  $\{-aff, +act, 0pow, -emp\}$ .

#### N:Attribute-to-Pp:Occasion Rule

If  $n:att -p:attOf \rightarrow n:occ$   
then  $n:occ := n:att \oplus n:occ:lex$

This rule applies to phrases like ‘end of the Carnival’ and ‘shattering music of the concert.’ In the first case, the noun ‘end’ connotes  $\{?aff, ?act, ?pow, -emp\}$  and the referring expression ‘the Carnival’ is neutral ( $\{0aff, 0act, 0pow, 0emp\}$ ). Thus, the Carnival occasion is assigned the connotation of  $\{0aff, 0act, 0pow, -emp\}$ .

#### Adj:Act-to-N:entity Rule

If  $adj:act -preModOf \rightarrow n:entity$ ,  
then  $n:entity := adj:act \oplus n:entity:lex$

This rule applies to phrase like ‘rioting mob.’ Since ‘rioting’ connotes  $\{-aff, +act, +pow, +emp\}$ , and ‘mob’ connotes  $\{-aff, 0act, +pow, 0emp\}$ , then the mob is assigned the connotations  $\{-aff, +act, +pow, +emp\}$ .

#### Multiple Connotation Propagations

Understanding the connotations assigned to topics by a sentence usually involves a series of connotation propagations. For example, consider the sentence ‘The mob rioted at the end of the Carnival.’ The connotation assignment of the occasion Carnival (e1) involves two steps. First, the condition  $v:act -p:orient \rightarrow n:occ$  matches the verb phrase ‘rioted (v1) at end (e2)’. So the V:Action-to-Pp:Occasion Rule applies. The propagation resulted from the rule involves the following derivation, with

each step accompanied with a reason at the end of the line:

$$\begin{aligned}
 e2 &:= v1:lex \oplus e2:lex && [\text{Rule}] \\
 &= \{-aff, 0act, 0pow, +emp\} && [\text{'rioted'}] \\
 &\oplus \{?aff, ?act, ?pow, -emp\} && [\text{'end'}] \\
 &= \{-aff, 0act, 0pow, 0emp\} && [\oplus]
 \end{aligned}$$

Second, the condition  $n:att:e1 -p:attOf \rightarrow n:occ:e2$  matches the noun phrase 'end (e2) of the Carnival (e1)'. Thus,

$$\begin{aligned}
 e1 &:= e2 \oplus e1:lex && [\text{Rule}] \\
 &= \{-aff, 0act, 0pow, 0emp\} && [\text{'end'}] \\
 &\quad \{0aff, 0act, 0pow, 0emp\} && [\text{'the Carnival'}] \\
 &= \{-aff, 0act, 0pow, 0emp\} && [\oplus]
 \end{aligned}$$

### Selection of Word and Sentence Structure

The above connotation rules can be used for both understanding and generating sentences. Since this paper focuses on revision, it remains to show how words and sentence structures are selected with the given ideological beliefs. From a psychological perspective, such selection can be done actively or subconsciously. A manipulative writer does the selection actively to affect the reader. A casual writer does the selection subconsciously because ideological beliefs limit the way the writer understands and perceives events, people and institutions.

The basic idea of the algorithm for word choices and syntactic structure arrangement is backward chaining with backtracking. This is best illustrated by an example. Consider again the sample draft sentence of **A mob rioted at the end of the Carnival** and the ideological beliefs of the newspapers Sun and Star. The sentence has the following relations:

- $v:act:v1 -subj:agt \rightarrow n:entity:a1$   
(‘mob (a1) rioted (v1)’)
- $v:act:v1 -p:orient:p1 \rightarrow n:occ:e2$   
(‘rioted (v1) at (p1) end (e2)’)
- $n:att:e2 -p:attOf:p2 \rightarrow n:occ:e1$   
(‘end (e2) of (p2) Carnival (e1)’)

### Star’s Ideological Linguistic Choices

When revising this sentence based on the Star’s ideological beliefs, two conditions are relevant:

**Condition 1** The affect, activity, and power of the people (a1) involved in the riot have de-emphasis. That is, a1 must connote  $\{-aff, +act, +pow, -emp\}$ .

**Condition 2** The Carnival (e1) has de-emphasized negative affect. That is, e1 must connote  $\{-aff, 0act, 0pow, -emp\}$ .

The first condition will eliminate any sentence structure containing the relation  $v:act:v1 -subj:agt \rightarrow n:entity:a1$ , which asserts the existence of a specific group of people actively causing disorder and fails to satisfy the required negative emphasis of the attributes for the people a1 (Condition 1).

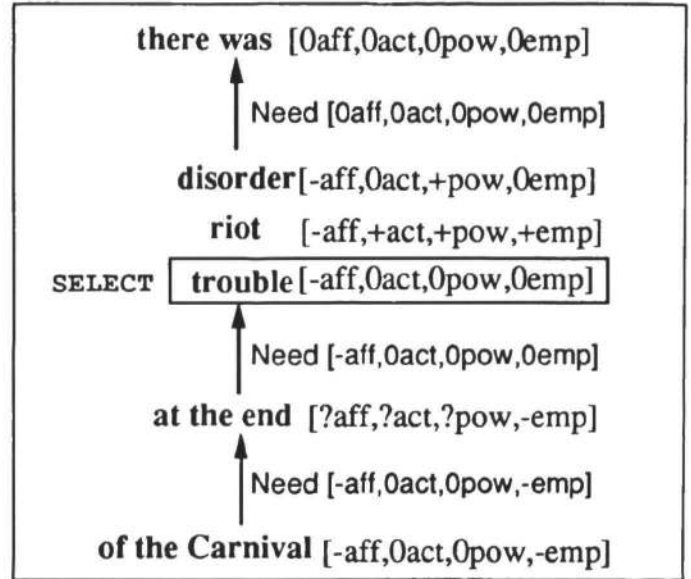


Figure 1: Backward Propagation to select ‘trouble’

An alternative structure which satisfies Condition 1 is the “there-be” construction with verb nominalization and agent deletion. One such sentence is ‘**There was a riot at the Carnival**’ where the noun ‘riot’, now normalized to an occasion (occ), can be replaced by synonyms ‘disorder’ or ‘trouble’.

The candidate structure contains the noun phrase ‘riot at the Carnival’, represented as  $n:occ:v1 -p:orient:p1 \rightarrow n:occ:e1$  whose propagation rule is  $e1 := v1 \oplus e1:lex$ . Below is the derivation of the connotation back-propagation with the rule.

- A e1 =  $\{-aff, 0act, 0pow, -emp\}$  [Cond. 2]
- B e1:lex = ‘the Carnival’
- =  $\{0aff, 0act, 0pow, 0emp\}$  [Neutral]
- C v1 =  $\{-aff, 0act, 0pow, -emp\}$  [A, B]

Now, the structure ‘there was’ is neutral, and consider the word choices:  
 $v1:lex = \text{'riot'} = \{-aff, +act, +pow, +emp\}$   
 $v1:lex = \text{'disorder'} = \{-aff, 0act, +pow, 0emp\}$   
 $v1:lex = \text{'trouble'} = \{-aff, 0act, 0pow, 0emp\}$

No word choice can satisfy the back-propagated Condition C. Hence this sentence structure fails to satisfy the top-level ideological beliefs.

Then another structure with the addition of ‘the end of’ is tried with the same procedure as above — ‘**There was a riot at the end of the Carnival**’, again with ‘trouble’ and ‘disorder’ as alternatives to ‘riot’ (Figure 1). This sentence involves the phrase ‘the end of the Carnival’ represented as  $n:att:e2 -p:attOf:p2 \rightarrow n:occ:e1$ , whose propagation rule  $e1 := e2 \oplus e1:lex$  applies. Thus the back-propagation continues:

- D e1 =  $\{-aff, 0act, 0pow, -emp\}$  [Cond. 2]
- E e1:lex = ‘the Carnival’
- =  $\{0aff, 0act, 0pow, 0emp\}$  [Neutral]
- F e2 =  $\{-aff, 0act, 0pow, -emp\}$  [D, E]

Now, the sentence also involves the noun phrase 'a riot at the end' represented as  $n:occ:v1 -p:orient:p1 \rightarrow n:occ:e2$ , the propagation rule  $e2 := v1 \oplus e2:lex$  applies. The back-propagation continues:

G  $e2:lex =$  'end'  
 $= \{?aff, ?act, ?pow, -emp\}$  [Lex]  
 H  $v1 = \{-aff, 0act, 0pow, 0emp\}$  or  
 $\{-aff, 0act, 0pow, -emp\}$  [F, G]

Only the noun 'trouble', but not 'riot' or 'disorder', has connotations that satisfy the back-propagated Condition H. So the "there-is" structure with the inclusion of the structure 'the end of' and the word choice of 'trouble' can satisfy the top-level ideological Conditions (1) and (2). The sentence selected is 'There was trouble at the end of the Carnival.'

Similar procedure revises 'A mob started a disorder at 8pm' as 'Trouble started at 8pm' and 'A mob scuffled and erupted into the police cordon' as 'A scuffle erupted into the police cordon.'

### Sun's Ideological Linguistic Choices

For the Sun, the mob carried negative affect, plus activity, plus power, and plus emphasis while the Carnival carried the same social values with no emphasis. The same backward chaining procedure mentioned above does not change the draft sentence 'A mob rioted at the end of the Carnival' during revision, but revises the sentence 'A mob started a disorder at 8pm' as 'A mob started to riot at 8pm.'

### Summary

This paper has demonstrated the use of four attributes affect, activity, power, and emphasis in influencing writing decisions of word choices and syntactic structure arrangement using given ideological beliefs, a lexicon of connotations, and rules of connotation propagation. Since the model is still at the exploratory stage, we expect modifications as the model develops further. Nevertheless, the current model has demonstrated a significant insight that most of the previous works of computational linguistics have ignored — an inherent and often the most interesting part of the meanings of language is its connotations. Our model is a further step in understanding more about the way people communicate linguistic connotations. In addition, the model provides a basis for future research to automate text revision with social intelligence.

### Acknowledgment

I thank the following people for helpful discussions with the model described in this paper: Robert Simmons, Ron Mabbit, James Lester, Wood-Wai Lee, Gregory Kelly, Hwee-Tou Ng, Joycelyn Liu.

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