
Gather Stars

Taipei City, Taiwan
www.gatherstars.com

Natural Language Processing, Sentiment, and Tone

28th January, 2022

ABSTRACT

Gather Stars AI enhanced communications relies on a massive graph database, and the recognition of sentiment and tone, powered by Natural Language Processing to analyze communication, create summaries, predict outcomes, and recommend courses of action.

DEFINITIONS

Natural Language Processing (NLP):

NLP is a multi-disciplinary technique built upon linguistics, data science and computer science that enables a computer to “understand” human language. It takes unstructured data, in our case voice, email, and IM conversations, and converts it into structured data that can be analyzed, during this process the data is cleaned using a variety of techniques including entity recognition and lemmatization.

NLP can be broken down into [Natural Language Understanding](#) and [Natural Language Generation](#). These subsets enable GSAI features such as summarization, [sentiment](#) analysis, and content recommendations.

Natural Language Understanding (NLU):

NLU looks at the grammatical structure and intended meaning of a piece of text, specifying the relationships between words and phrases. This can be illustrated using the following example:

1. She took the bus to the fair.
2. It was a fair price to get in.

In the first sentence, fair is a noun, whereas in the second it is an adjective and describes the price of entry. This is an important part of GSAI, as not only does this allow us to understand the meaning of the two sentences, it also allows us to infer the sentiment of the second sentence -

fair implies a mildly positive viewpoint - and the tone - fair implies that the individual is expressing mild happiness.

Natural Language Generation (NLG):

NLG is the process of producing a natural language text response based on clean, structured data. If we think of [NLU](#) as how a computer can read or listen, then NLG can be thought of as how the computer writes or speaks. As with NLU, NLG needs to consider language rules such as syntax and semantics to make choices on how to phrase answers correctly.

NLG is responsible for our text summarization capabilities and content recommendations.

Sentiment:

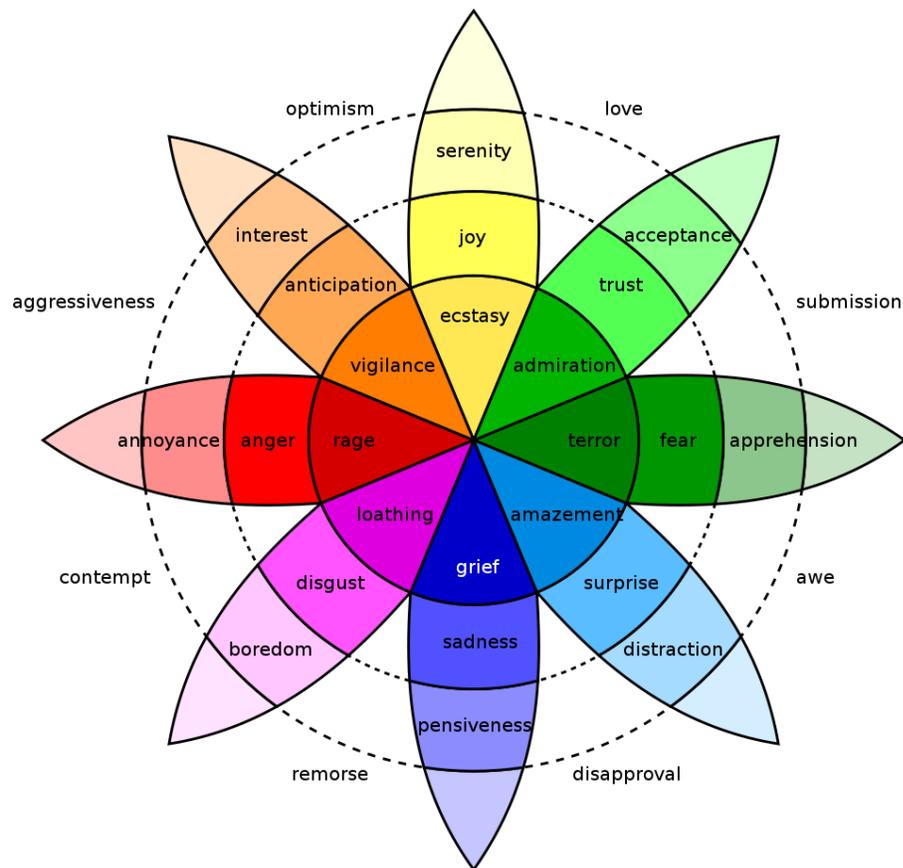
Merriam-Webster defines sentiment as:

1. An attitude, thought, or judgment prompted by feeling
2. A specific view or notion
3. An idea colored by emotion
4. The emotional significance of a passage or expression as distinguished from its verbal context

Based upon this definition of sentiment, the terms "emotion" and "sentiment" do not appear to significantly differ from each other as a sentiment seems to be an underlying emotion. The difference for us is, emotions are states of an individual, whereas sentiments are assigned properties of a word, phrase, or statement.

Psychologist Robert Plutchik distinguished eight basic emotions, with more complex emotions being made up of a combination of them. These emotions can be represented using his Wheel of Emotions:

Diagram 1: Plutchik's Wheel of Emotions¹



This is important for us, as according to Rosalind Picard², Professor of Media Arts and Sciences at MIT, “for affective computing, the recognition and modeling problems are simplified by the assumption of a small set of discrete emotions.”

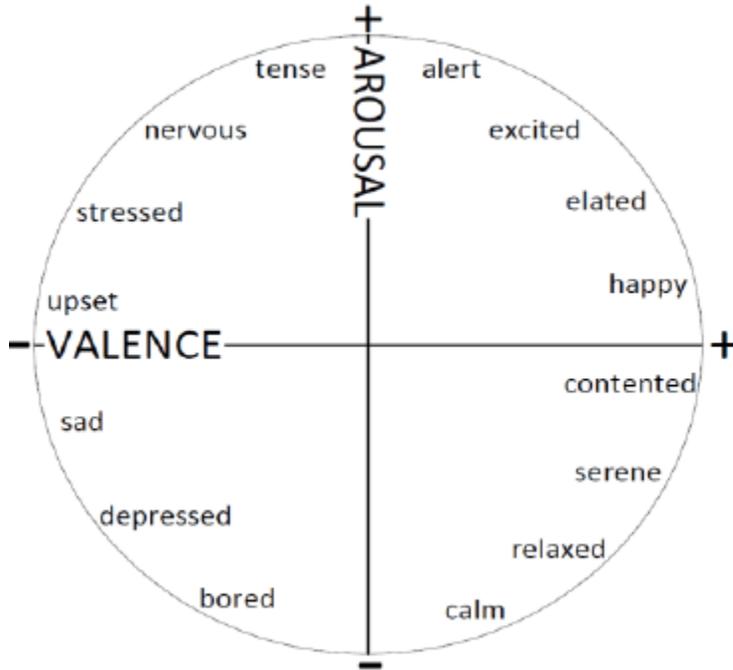
To understand sentiment further, we need to look to Russell's Circumplex Model of Affect³:

¹ Plutchik, Robert. "A general psychoevolutionary theory of emotion." Theories of emotion. Academic press, 1980. <https://commons.wikimedia.org/wiki/File:Plutchik-wheel.svg>

² Picard, Rosalind Wright, Affective Computing, 1995.

³ Russell, James A., "A circumplex model of affect." Journal of personality and social psychology, 1980

Diagram 2: Russell’s Circumplex Model of Affect



In this two-dimensional space, the horizontal is the valence dimension and the vertical is the arousal dimension. Liu⁴ defines sentiment as “the underlying positive or negative ”feeling, attitude, evaluation, or emotion associated with an opinion”, meaning that when we talk about sentiment, we are only concerned with the valence (positive or negative, pleasant or unpleasant) dimension. With this in mind, we can assign sentiment a value in the range [-1, 1], the ”sentiment score.” The farther away the value is from 0, the more positive or negative is the sentiment. The value 0 represents a neutral sentiment. In the following example, we see how different words and emotions correlate with different sentiments in written communications.

Table 1: Sentiments of Sample Words

Sentiment	Sample Words
Positive	Great, Exciting
Neutral	Unpredictable, French
Negative	Sad, Afraid

By understanding the underlying sentiment of a communication, GSAI is able to make a variety of recommendations including content and follow-up actions.

⁴ Bing Liu. Sentiment analysis: Mining opinions, sentiments, and emotions. Cambridge University Press, 2015.

Tone:

According to Merriam-Webster's dictionary⁵ tone is the “style or manner of expression in speaking or writing”. As with sentiment, the dimensions of tone are also negative and positive, but tone is also often associated with a distinct emotion, such as joy or sadness; leading to phrases such as “the restaurant has a happy tone.” It is this assignment of specific emotions to a tone which makes the concept of tone more comprehensive than the concept of sentiment. In essence, GSAI treats tones as emotions expressed through words.

Tone analysis in written language aims to identify affect expressed or implied in natural language text using computational methods, however it is difficult due to the varying emotional charge of words and phrases. Some words and phrases used in conversations “carry a clear emotional charge”, whereas others carry “emotionality on a higher level” resulting from “socially learned semantic schemata” used by human beings.⁶

Using a combination of keyword spotting, lexical affinity analysis, and statistical [NLP](#), combined with emotional labeled training data based on deep learning methods, GSAI is able to recognize and assign affinities to a range of tones including anger, fear, joy, sadness, politeness, frustration and excitement.

⁵ <https://www.merriam-webster.com/dictionary/tone>

⁶ N. Fragopanagos and J. G. Taylor. Emotion recognition in human–computer interaction. *Neural Networks*, 18(4):389 – 405, 2005.