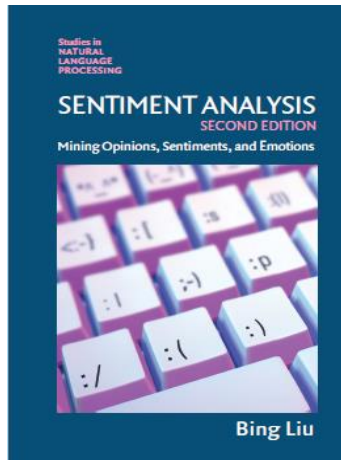


Some Reflections on Sentiment Analysis and Affective Computing

2nd edition



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Introduction

(Liu, 2020)

■ Sentiment analysis (SA)

- ❑ computational study of opinion, sentiment, affect/emotion and mood expressed in text, video, and audio.
 - Affective computing focuses on recognizing emotions in speech, facial expressions, gestures, postures, etc.

■ Why is it important?

- ❑ Opinions are key influencers of our behaviors
 - Whenever making a decision, we often seek out the opinions of others.
- ❑ Humans are affective or emotional beings
 - Emotions and feelings are an integral part of human intelligence

Introduction

- **Sentiment and emotion analysis** (SA) has been actively researched for **over 20 years**.
 - The community has made remarkable progress.
 - Applications have also flourished.
- However, **in recent years, the progress has been slow**.
 - Many papers are still published each year, but little tangible contribution is made.
- Many social science and management science researchers have tried to use SA in their research.
 - But they found that our systems are not accurate enough.
- **What should we do about it?**

Outline

- Sentiment Analysis (SA)
- Emotion Analysis (EA)
- Solving the SA and EA Problems
- Emotional Chatting
- Need a Cognitive Model of Emotions
- Summary

Sentiment/opinion analysis: problem statement

(Liu, 2020)

■ It consists of two core abstractions

(1) Opinion definition

- Give a structured definition
 - If we cannot structure a problem, we do not understand the problem.

(2) Opinion summarization

- Opinions are subjective. An opinion from a single person (unless a VIP) is often not sufficient for action.
 - We need opinions from many people, and thus opinion summary.
- Opinion summary must be quantitative, e.g., % of positive and negative
 - Different from traditional text summary

Two main types of opinions

(Jindal and Liu 2006; Liu, 2020)

- **Regular opinions:** Sentiment/opinion expressions on some target entities
 - **Direct opinions:**
 - “The **touch screen** is really cool.”
 - **Indirect opinions:**
 - “After taking the drug, my pain has gone.”
- **Comparative opinions:** Comparisons of more than one entity.
 - E.g., “iPhone is better than Blackberry.”

(1). Core Sentiment Analysis (SA) problem

(Hu and Liu 2004; Liu, 2010, 2012)

- Id: John on 5-1-2008 -- “I bought an iPhone yesterday. It is such a nice phone. The touch screen is really cool. The voice quality is great too. It is much better than my old Blackberry. ...”
- **Definition:** An *opinion* is a quadruple,
(*target*, *sentiment*, *holder*, *time*)
- A more practical definition:
(*entity*, *aspect*, *sentiment*, *holder*, *time*)
 - E.g., (iPhone, touch_screen, +, John, 5-1-2008)
- **SA goal:** Given an opinion doc, mine all quintuples

M. Hu and B. Liu. "Mining and summarizing customer reviews" KDD-2004.

B. Liu. "Sentiment Analysis and Opinion Mining." Morgan and Claypool Publishers, May 2012.

SA is a Rich Problem

■ (*entity*, *aspect*, *sentiment*, *holder*, *time*)

- target *entity*: Entity extraction & resolution
- *aspect* of *entity*: Aspect extraction & resolution
- *sentiment*: Aspect sentiment classification
- *opinion holder*: *Information/data extraction*
- *time*: *Information/data extraction*

■ About all NLP problems

- Synonym grouping (voice = sound quality)
- Lexical semantics
- Coreference resolution
-

(2) Opinion Summary and Applications

Aspect/feature-based summary
of opinions about iPhone:

Aspect: Touch screen

Positive: 212

- The *touch screen* was really cool.
- The *touch screen* was so easy to use and can do amazing things.

...

Negative: 6

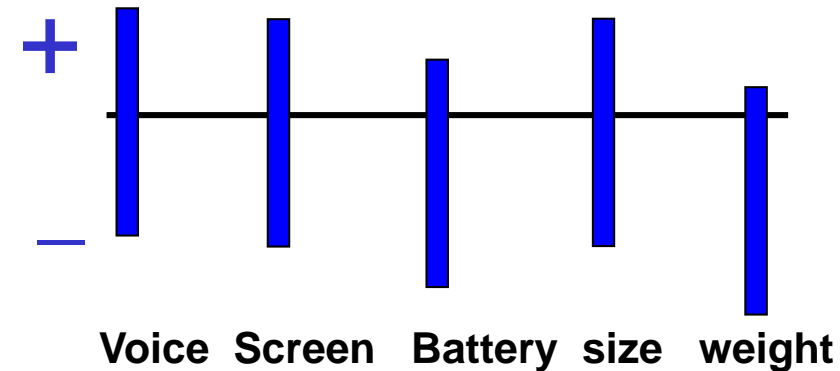
- The *screen* is easily scratched.
- I have a lot of difficulty in removing finger marks from the *touch screen*.

...

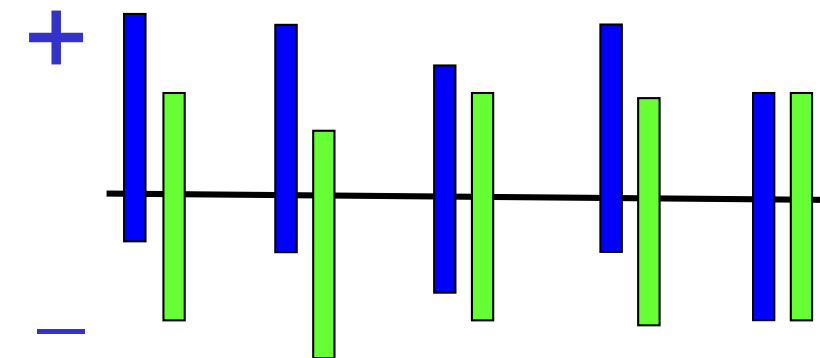
Aspect: voice quality

...

■ Opinion Summary of 1 phone



■ Opinion comparison of 2 phones



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Affect, emotion, and mood (not agreed by all)

(Liu, 2020)

- **Affect**: a neurophysiological state consciously accessible as the simplest raw feeling evident in moods and emotions (Russell, 2003) – first automatic body reaction
- **Emotion** is the displayed feeling of affect after cognitive processing, toward a specific object: a person, an event, or a topic. It is intense and focused and lasts a short time.
- **Mood**, like emotion, is a feeling or affective state, but it typically lasts longer than emotion and tends to be more unfocused and diffused.

Primary, Secondary and Tertiary emotions

(Parrott, 2001)

Primary emotion	Secondary emotion	Tertiary emotion
Anger	Disgust	Contempt, Loathing, Revulsion
	Envy	Jealousy
	Exasperation	Frustration
	Irritability	Aggravation, Agitation, Annoyance, Crosspatch, Grouchy, Grumpy
	Rage	Anger, Bitter, Dislike, Ferocity, Fury, Hatred, Hostility, Outrage, Resentment, Scorn, Spite, Vengefulness, Wrath
	Torment	Torment
Fear	Horror	Alarm, Fear, Fright, Horror, Hysteria, Mortification, Panic, Shock, Terror
	Nervousness	Anxiety, Apprehension (Fear), Distress, Dread, Suspense, Uneasiness, Worry

Emotion definition

(Liu 2015, 2020)

■ Emotion: (e, a, m, f, c, t) , - target (e, a)

where

- e is the target entity,
- a is the target aspect of e that is responsible for the emotion,
- m is the emotion type or a pair representing an emotion type and an intensity level,
- f is the feeler of the emotion,
- c is the cause of the emotion, and
- t is the time when the emotion is felt or expressed.

Mood

(Liu, 2020)

- A mood is a feeling that lasts a relatively long time, and may not have a clear cause or target object
 - hard to recognize unless declared – e.g., “*I feel sad today.*”
 - Need to monitor a person over a period of time.
- Applications
 - Discover people with prolonged mental or other medical conditions (e.g., chronic depression) and
 - tendency to commit suicides or crimes – social media analysis
 - Discover the mood of the general population,
 - the mood of US - China relations

Other feelings

(Liu, 2020)

- Sentiment analysis – sentiment, opinions, emotion, and mood.
- There are other human feelings, useful in some applications
 - *Physiological or bodily states*: hungry, warm, forgetful, and dizzy
 - *Attraction and repulsion*: attraction, e.g., love, attracted, hooked or repulsion (e.g., dislike, disgusted).
 - *Attention*: focus, attention, or interest, e.g., interested, curious.
 - *Social*: the way a person interacts with others, accepting, ungrateful
 - *Actions & prospects*: goals/tasks/actions: purpose, inspired, ambitious
 - *Hedonics*: pleasurable and painful sensations: comfortable, painful

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Stagnation in SA/EA research

- **SA/EA has been beating to death:** researched extensively for about 20 long years.
 - But the accuracy is still an issue
 - Many social science researchers told me that the accuracy is still not great. Many build their own sentiment analysis systems.
- Although a large number of papers are published each year, few make any tangible contribution.
 - If every paper actually makes the amount of improvement it claims, I am sure now the SOTA accuracy is >100%.

Using too few datasets

- So many papers are still using the two SemEval datasets
 - Restaurant and laptop.
- Using only two datasets is far from sufficient.
 - Sentiment analysis domains (products and services) are highly diverse. There are many other available datasets.
- Limited work has been done on unsupervised methods or partially supervised methods.
 - In real life applications, labeling at the aspect/target level is very time consuming.

Can we solve the SA/EA problem?

- There are so many pretrained models, BERT, RoBERTa, GPT-2, GPT-3, etc.
 - Mainly self-supervised or unsupervised.
- Can the community make an effort to build a **specific pre-trained SA/EA model** to improve SA/EA significantly?
 - Plenty of available sentiment data
 - With the pretrained model, can zero/few shot SA/EA be done accurately?
- Learning in a unsupervised and continuously manner.

Sentiment analysis is indeed hard!

- “This past Saturday, I bought an *iPhone* and my boyfriend bought a *Xiaomi* phone. We called each other when we got home. *The voice on my phone was not clear, worse than my previous Samsung phone. The battery life was short too. My boyfriend was quite happy with his phone. I wanted a phone with good sound quality. So my purchase was a real disappointment. I returned the phone yesterday.*”

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Chatting with Emotions

(Zhou et al., 2018, Liu, 2020)

- Humans are affective or emotional beings
 - feelings and emotions are an integral part of us.
- Emotion intelligence: a vital aspect of human intelligence,
 - the ability to perceive, understand, integrate, and regulate emotions
- Goal:
 - **to create chatbots that can recognize and express emotions** and learn continually during conversations.
 - Sentiments or emotions in user utterances as feedback.

Speaker emotion

- **Speaker emotion** is conveyed through paralinguistic mechanisms such as
 - intonations,
 - facial expressions,
 - body movements,
 - biophysical signals or changes,
 - gestures, and posture
- + choice of grammatical and lexical expressions

Writer emotion

- In writing, we express emotions using
 - punctuation (e.g., repeated exclamation marks, !!!!),
 - capitalization of all letters of a word,
 - emoticons,
 - lengthening of words (e.g., *sloooooow*), etc.
- + choice of grammatical and lexical expressions

Linguistic expressions of emotion

- **Emotion words/phrases:** *love, disgusting, angry, and upset*
- **Intensifiers:** *very, so, extremely, dreadfully, really, awfully (e.g., awfully bad), on earth (e.g., “What on earth are you doing?”), the hell (e.g., “What the hell are you doing?”), etc.*
- **Emotion-related behaviors:** *“He cried after he saw his mother”*
- **Superlatives:** *“This car is simply the best.”* **pejorative**, *“He is a fascist.”*, **laudatory**, *“He is a saint”*, and **sarcastic**, *“What a great car, it broke the second day”*.
- **Swearing, cursing, insulting, blaming, accusing, etc**

Studies in human-computer interaction (HCI)

- Psychology argues that humans are affective beings
 - who want their emotional and social needs to be addressed (Myers, 1989).
- Prendinger et al. (2005) showed that emotion in dialogue systems can enhance user satisfaction
 - A life-like character verbally and non-verbally expressing empathy may significantly decrease user frustration and stress.
 - A life-like character with affective behavior may have a positive effect on the users' perception of task difficulty.
- Bots must detect & express emotions in chatting

Emotions → fewer breakdowns in dialogues

- Martinovski & Traum (2003) showed while bots are error-prone, this is not necessarily a major problem, since human dialogue also contains errors.
 - **Main issue:** big deviation from the user's conversational expectations.
 - Detecting emotions and responding empathically can inspire the human users to desire to cooperate rather than force them to adapt to the “stupid machine.”
- **Conclusion:** Detecting emotions and responding appropriately in dialogue systems lead to fewer breakdowns.

Multiple possible responses

- Given a user utterance, there can be multiple possible responses with different emotions.
 - User: Worst day ever. I arrived late because of the traffic.
 - Bot (no emotion): You are late.
 - Bot (happy): I am glad that you are like me.
 - Bot (sad): This is depressing.
 - Bot (disgust): This traffic is getting worse and worse.
 - Bot (sympathetic): I am sorry to know that you were caught in traffic.
 - ...

Cognitive gap

- **Cognitive gap**: people's true psychological states of mind and the **language** used to express such states or **facial expressions**
 - may not fully match
 - recognizing true emotions can be challenging
 - Context and multi-modal data may be needed - reasoning
- **Many reasons** (e.g., *being polite*, and *do not want others to know one's true feeling*)
 - For example, when one says "*I am super-excited that you come*," one may not have any emotion, although the emotional word *super-excited* is used.
 - Using only surface information is not reliable.

Building an emotional chatbot: challenges

(Zhou et al 2018)

- Hard to obtain large scale emotion labeled data.
 - Highly subjective in annotation
 - Different emotions overlaps and associated with each other.
 - Classification of emotions is inaccurate.
- Hard to balance emotions, grammaticality, and content in response generation.
- There is no model of emotions.
 - Current chatbots have no ‘soul’.

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Natural language understanding

- **Question:** can a bot “understand” NL without “feelings”?
 - I am not sure, but I think probably not.
- Can a bot be a **philosophical zombie**?
 - indistinguishable from a normal human being except in that it lacks conscious experience and feelings
- **The hard problem of consciousness**
 - *How physical processes in the brain give rise to the subjective experiences of the mind and of the world?*
- How do these issues affect our design of dialogue systems?

Feelings: our internal evaluation system (IES)?

- Feelings serve as our internal reward or evaluation system.
 - They score everything we perceive
 - They guide and evaluate our actions
- Or, feelings are manifestations of our internal reward or evaluation system.
 - Provide implicit feedback to our actions – a supervisory info.
- We cannot learn without an evaluation/reward system
 - Reinforcement learning, self-motivation, self-supervision, curiosity
- Can a bot be autonomous without an IES (= ? “feelings”)?

Multi-modality analysis: an integrated approach

- To understand people's emotions, it is important to analyze facial expressions, behavior (gesture and postures), speech, and text they utter.
- This is critical for robot-human interactions because in many cases, human emotions may only be expressed with
 - ❑ intonations,
 - ❑ facial expressions,
 - ❑ body movements,
 - ❑ gestures, and postures

Can we build a cognitive model of emotions?

- It is still not possible to generate real feelings
- But to enable an AI agent to display emotions naturally. We need to build a cognitive model of emotions
 - To generate emotions in response to events and to human emotions/moods.
 - Using different parameters to produce different personality traits and to generate individualized emotions and responses.
 - To condition text and dialogue generation.
 - To make inference about emotions and feelings.
 - To make humans feel that the AI agent is like a human.

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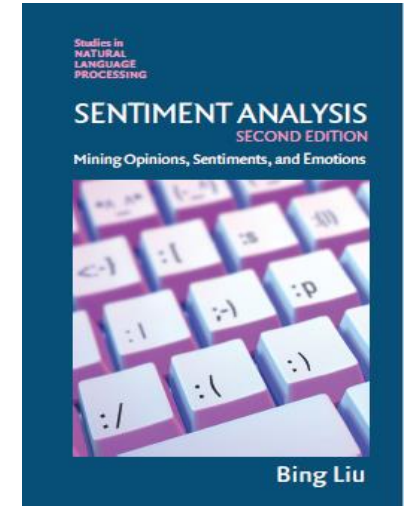
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Summary

- Sentiment (SA) and emotion analysis (EA) are **challenging**.
 - Despite challenges, **applications have flourished!**
- The general NL understanding is too hard, but
 - can we solve the SA/EA problem by using a huge amount of available sentiment data?
- The community should actively collaborate with researchers in robotics to build human-like robots.
 - Emotional dialogue systems; emotional human-robot interactions.
 - Building a cognitive model of emotions, moods and feelings.
 - Sentiment, emotion and feeling will become increasingly important for AI.

Thank You

Q&A



- B. Liu. *Sentiment Analysis: Mining Opinions, Sentiments, and Emotions*. Cambridge University Press, 2020 (second edition).