Introduction to Sentiment Analysis

Text Analytics - Andrea Esuli
What is Sentiment Analysis?
What is Sentiment Analysis?

“What sentiment analysis and opinion mining is the field of study that analyzes people’s opinions, sentiments, evaluations, attitudes, and emotions from written language.”


SA works on the subjective/evaluative/emotive components of textual information, which have often been ignored in the objective/factual/topical analysis usually performed in traditional TA.
Topic vs Sentiment

Topic and sentiment are two main orthogonal dimensions:

- Topic/Fact/Objective information
- Sentiment/Opinion/Subjective information (affective states, emotions. . . )

Topical analysis:

- Discriminating political news from sport news.
- Extracting mention of names of persons in text.

Sentiment analysis:

- Discriminating between favorable and negative attitude toward a subject.
- Identifying the expressions of an emotion and the target of that emotion.
Objective information:

The 4.7-inch display on the iPhone 6 is arguably its best feature.

...concerns have been raised about the relatively low resolution (1334 x 750 pixels)
Subjective information:

The 4.7-inch display on the iPhone 6 is arguably its best feature.

...concerns have been raised about the relatively low resolution (1334 x 750 pixels)
Topic vs Sentiment

Classification of documents:

- with respect to the Thomson Reuters taxonomy*.

- with respect to the content being a positive, neutral, or a negative evaluation†.

{"data": [{"text": "I love Titanic.", "id":1234, "polarity": 4},
{"text": "I hate Titanic.", "id":4567, "polarity": 0}]

* Source † Source
Topic vs Sentiment

Extraction of information:

- regarding objective properties
  - The NBA player Michael Jordan is from the United States of America*
    - **Organization** Person Location
- regarding the expression of opinions.
  - soldiers with 20 years or more service are generally satisfied with termination packages being offered†
    - **Agent** Attitude **Target**
L'esame è stato eseguito con sequenza T2 STIR e con sequenze T1 3D dinamiche prima e dopo somministrazione di mdc paramagnetico, acquisite secondo piani di scansioni assiali.

Diffusi esiti cicatriziali in sede retroareolare sinistra.

Non si apprezzano potenziamenti sospetti bilateralmente.

In particolare non si è osservato un corrispettivo RM dell'immagine descritta mammograficamente a sinistra.

In sede ascellare bilateralmente si apprezzano alcune linfoadenopatie di verosimile significato reattivo.

In relazione al quadro RM, si ritiene sufficiente eseguire controllo con esame ecografico tra 6 mesi.

CODICE ACR:06.1

Annotation of radiology reports
Opinion Annotation in GATE
Facts, Sentiments and Big Data
When looking for factual information, the comparison of many sources of information allows to check for its truth, consistency and relevance.

Temporal/spatial anomalies in the use of language, e.g., spikes in the use of words like “earthquake”, “shots”, “explosion”, may allow to recognize events, and gather relevant data about them.
Event recognition from hashtag use distribution
Subjective information is varied by definition. The more sources are compared, the more the vision of the feelings on the matter is complete.

Sentiment and Big Data

I have been begging for this camera for ever so I bought it right here off amazon as I got the the box I opened it and the hole box fell apart the camera fell and the lens focus ring broke as well as the lcd screen got scratch. I wouldn't be complaining but the camera didn't come with a warranty so I wasted 500 dollars on a broken camera.
Sentiment and Big Data

Twitter Political Index: A Comparison to Gallup
with 30-day moving averages — August 1, 2010 - July 31, 2012
Why Sentiment Analysis?
(Is it of practical use?)
Why Sentiment Analysis?

When we have to take a decision we look for the opinion of the others.

The textual user-generated content that is

- shared on the Web/social networks,
- written in open-ended questions in questionnaires,
- sent to companies as feedback, . . .

contains

- voluntarily produced,
- unconstrained,
- first-hand/personal,
- fresh,

evaluative information about our topic of interest.
Why Sentiment Analysis?

Practical example: customers satisfaction questionnaires.

- Are you happy with us? yes/no
- How much are you happy on a scale from 0 to 10?
- Your vote is determined by our: □ rates □ service □ other
- Write here any other feedback: _____________________________

The first three answers can be directly automatically processed to extract statistical information.

The last answer to an open-ended question is the only potential source of unexpected information.
Report: Woman jumped from ship, boyfriend followed

Video footage from the Carnival cruise ship where a young couple went missing this week appears to show the woman jumping from the vessel and her panic-stricken boyfriend moments later, Australia’s Herald Sun is reporting.

The news outlet, citing local police, said an enhancement of security video from the ship shows Australia-based Carnival Spirit appears to say goodbye to Rossington, 30, jumping after his girlfriend, Kristin Schroder, 27, about 20 seconds after she plunged over the ship.

but no one realized they were in Sydney, Australia.

A massive air and sea search of the waters off the Australia coast begun on Thursday was called off today, and the couple is presumed dead.

RELATED: Couple missing from Carnival ship
PHOTO TOUR: Look inside a Carnival ship

The Herald Sun says detectives have spent the last day enhancing and analyzing surveillance footage from the ship to figure out what happened to the couple, who were traveling with friends and family.

In a statement sent to USA TODAY on Thursday, Carnival was vague about what the security camera footage showed but ruled out anything criminal.
Cambodian plane crashes, 20 feared dead
June 25, 2007 - 7:01PM

A chartered plane flying today between two popular tourist destinations in Cambodia has crashed, with at least 20 people on board feared killed, an aviation official said.

The plane, a Russian-made AN-24, was flying from Siem Reap – where the famous Angkor Wat temple complex is located – to Sihanoukville, a coastal city with access to beaches, said Him Sarun, Cabinet chief for the Secretariat of Civil Aviation.

An official at Siem Reap airport said 13 of the passengers were from South Korea, three were Czech, one was Russian and five were Cambodian.

He said the plane carried a crew of five Cambodians.

The plane belonged to a small Cambodian


Why Sentiment Analysis?
Why Sentiment Analysis?

AP Breaking News

Tiger Kills Teen During Senior Photo Shoot

Thursday, August 18, 2005

(08-18) 14:29 PDT Mound Valley, Kan. (AP) --

A Bengal tiger attacked and killed a teenage girl who was posing for her senior high school pictures at an animal sanctuary Thursday in southeast Kansas, authorities said.

The Labette County Sheriff's office identified the victim as Haley R. Hilderbrand, 17, of Altamont. A news release said Hilderbrand was at the Lost Creek Animal Sanctuary posing for a photo with the 7-year-old tiger, which was being restrained by its handler, when the animal attacked her.

Officers and handlers killed the animal. Emergency personnel were not able to revive Hilderbrand.
Why Sentiment Analysis?

CHP: Drunk Aptos driver crashes into "Report Drunk Drivers" sign on Highway 1

Amy Larson, KSBW. Published 9:00 am, Thursday, August 17, 2017

The driver, identified by the CHP as Stephen DeVitt, 57, of Aptos, was "quite intoxicated," one officer said.
Why Sentiment Analysis?

Q&A Here's why experts say all kids ages 6 and up should be screened for obesity

By Karen Kaplan
Contact Reporter

JUNE 26, 2019, 3:55 PM
Why Sentiment Analysis?

As obesity keeps rising, more Americans are just giving up

New research shows if you know you're overweight or obese, and you know your extra pounds are unhealthy, that you may not be making a stab at losing weight anymore.

By Melissa Healy  •  Contact Reporter

It stands to reason that if you know you're overweight or obese, and you know your extra pounds are unhealthy, that you've made a stab at losing weight. Right?
Why Sentiment Analysis?
Why Sentiment Analysis?

Health News

Study: 75 percent of Americans will be overweight by 2020

PARIS – Citizens of the world’s richest countries are getting fatter and fatter and the United States is leading the charge, an organization of leading economies said Thursday in its first ever obesity forecast.

Three out of four Americans will be overweight or obese by 2020, and disease rates and health care spending will balloon, unless governments, individuals and industry cooperate on a comprehensive strategy to combat the epidemic, the study by the Organization for Economic Cooperation and Development said.
Why Sentiment Analysis?
Why Sentiment Analysis?

Hostess fa sesso con i passeggeri: “Ho guadagnato circa 90mila euro in due anni”
Why Sentiment Analysis?

Instant divorce unconstitutional, India’s top court rules

By Shashank Bengali and Parth M.N. | August 22, 2017

A Muslim bride participates in a mass wedding in 2016 in Mumbai. India is home to nearly 200 million Muslims — the largest minority in a Hindu-majority country of 1.3 billion people.
Sentiment Analysis tasks
Sentiment Analysis tasks

Most of SA research and applications are focused on the simple positive vs negative dichotomy (or a graded scale among this two opposites).

Most common SA tasks:

- Subjectivity/polarity classification
- Regression
- Opinion extraction
- Quantification

There is also research on emotions, attitude and humor in human language.
Classification

Classification: determining the attitude of the author of a document toward the document subject matter.

By **subjectivity**: determining if the text contains or not subjective evaluations.

   “The movie is set in WW2” → Objective

   “The plot is confusing” → Subjective

By **polarity**: determining if the subjective evaluations are positive or negative with respect to its topic.

   “This movie is a masterpiece” → Positive
Regression

Regression: extending the polarity classification problem to a ordinal scale.

Typical scenario: “Star rating” of product reviews.

“This phone is not worth its price”  ➡️  ⭐⭐⭐⭐⭐

Regression can produce a global evaluation or be focused on specific aspects.

<table>
<thead>
<tr>
<th>Score breakdown</th>
<th>8.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness</td>
<td>7.9</td>
</tr>
<tr>
<td>Comfort</td>
<td>8.9</td>
</tr>
<tr>
<td>Location</td>
<td>7.7</td>
</tr>
<tr>
<td>Facilities</td>
<td>8.1</td>
</tr>
<tr>
<td>Staff</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Based on 1940 reviews
Extraction

Extraction: identifying the expressions of an opinion, its properties, and the target of that opinion.

“The phone has a great display but it is killed by the small battery”

(display: great, positive), (battery: small, negative)

Extraction is often modeled as a classification problem at the word level.

The output of extraction contribute to build a knowledge base, which can be then queried by traditional methods from Information Retrieval and Data Mining.
Example of extraction of aspect-related relevant evaluations, Google Shopping
Quantification

Quantification is an aggregate analysis problem: a set of documents is processed as single entity in order to determine some properties of the whole set.

- Determining the proportion, and its trend over time, of positive reviews about a product.

"Card has good features/benefits"

interest rate decreased
Sentiment Analysis methods

There is no one-stop solution for Sentiment Analysis.
Sentiment Analysis is not a single problem.
Sentiment Analysis is not a dataset.
Sentiment Analysis is not a lexicon.
Sentiment Analysis is not an algorithm.

Sentiment Analysis is a special scenario for text analysis problems.
A “standard” method produces 70-90% of the result.

Exploiting the characteristic that are specific of a given Sentiment Analysis problem produces that 10-30% improvement that separates an average solution from a good one.
Sentiment Analysis methods

Multidisciplinary approach:

- Natural Language Processing
- Information Retrieval
- Machine Learning

The template solution to a sentiment analysis problem is the same of a “generic” one, e.g.:

Most of sentiment-specific methods deal with **capturing how sentiment are expressed in natural language**.
The language of opinions
The language of opinions

The language we use to express our subjective evaluations is one of the most complex parts of language.

There are many components in the language of opinions:

- Global/Domain-specific lexicon.
- Valence shifters/Comparative expressions.
- Irony, sarcasm, common knowledge.
- ...

The main aim of NLP/IR/ML applied to Sentiment Analysis is to recognize sentiment expressions and to model them into semantic abstractions.
The language of opinions

Some **words** have a **globally** recognized **sentiment valence** in any context of use, e.g.: “good”, “poor”, “perfect”, “ugly”

“A good tool that works **perfectly**”

“I had an **horrible** experience”

**General purpose lexical resources** list these words associating sentiment labels to them, e.g.:

- The General Inquirer lexicon
- WordNet affect
- SentiWordNet
The language of opinions

Domain/aspect-specific expressions: words that have a sentiment valence only when used in the context of a **specific domain**, or when they are associated with a **specific aspect**.

“The phone is made of *cheap* plastic”

“The carrier offers *cheap* rates”

“We have got a *warm* welcome”

“We have got a *warm* beer”

A collection of text from the domain can be used to build a **domain lexicon**.
The language of opinions

**Negation** and **valence shifters**: they do not determine sentiment directly but have **influence** on it.

It is difficult to determine their **scope** and **combined effect**.

“This is a very good car” (increment)

“This car is not very good” (flip, decrement)

“I don’t like the design of the new Nokia but it contains some intriguing functions”

“Not only is this phone expensive but it is also heavy and difficult to use”
The language of opinions

Punctuation, emoticons, emoji:

“7AM battery 100% - 9AM 30% : (”

Irony, sarcasm:

“Light as a bulldozer”

“The most useful idea since the DVD rewinder”

Common knowledge:

“Windows Vista: the new Windows ME”

“Windows 7: the new Windows XP”
5,448 of 5,551 people found the following review helpful

⭐⭐⭐⭐⭐ Good for clensing
By Davie Blossom on August 17, 2009

Format: Paperback

My wife and I were actually quite impressed with this item. Between the two of us it took 9 days to finish and I must say I found it hard to get used to during the first few sittings, but gradually became more comfortable as time went on.

Although neither of us paid too much attention to the content, the sheer volume and quality of the paper contained within was pleasantly surprising. The paper feels crisp, heavy and tough, yet the pages separate with just the slightest tug of a thumb and forefinger.

The only real controversy this book created for my wife and I was mostly my fault. You see after I finished the last page I was too lazy to replace the book with another and I left the empty cover sitting on top of the system. Let me tell you I copped a nagging!

Overall the item was an interesting change, but we found it a bit expensive and not as suitable as the regular stuff available at the supermarket. Together my wife and I have decided just to stick with normal sorbent two-ply rolls from now on, and would suggest others do the same.
A model for Sentiment Analysis
A model for Sentiment Analysis

Referring to Bing Liu’s model, an opinion, in the context of a sentiment analysis problem, can be defined as a quintuple:

\[ \langle e_i, a_{ij}, s_{ijkl}, h_k, t_l \rangle \]

where

- \( e_i \) is the entity that is the target of the opinion
- \( a_{ij} \) is the aspect of the entity \( e_i \) that is the target of the opinion
- \( s_{ijkl} \) is the sentiment toward \( a_{ij} \) expressed by \( h_k \) at time \( t_l \)
- \( h_k \) is the holder of the opinion, i.e., who expresses the opinion
- \( t_l \) is the time the opinion has been expressed
A model for Sentiment Analysis

The entity-aspect pair identify the subject of the opinion expression, which can be refer to a main object, a sub-part, or an aspect of a sub-part.

“iPhone is great”

\(<e=\text{iPhone}, \ a=\text{GENERAL},...>\)

GENERAL indicates that the entity as a whole is the target of opinion.

“iPhone battery sucks”

\(<e=\text{iPhone}, \ a=\text{battery},...>\)
A model for Sentiment Analysis

Sub-parts/aspects can be arranged in a hierarchy.

“iPhone display has a good resolution, but colors are washed out”

\[ \langle e=\text{iPhone}, \ a=\text{display}, \ldots \rangle \]

\[ \langle e=\text{iPhone}, \ a=\text{display}, \ldots \rangle \]

\[ \langle e=\text{iPhone}, \ a=\text{display/resolution}, \ldots \rangle \]

\[ \langle e=\text{iPhone}, \ a=\text{display/color}, \ldots \rangle \]
A model for Sentiment Analysis

Sentiment can be defined as binary “positive” vs “negative” labeling, include also a “neutral” label, or use a graded scale.

“iPhone display has a good resolution, but colors are washed out”

<e=iPhone, a=display/resolution, s=positive,...>

<e=iPhone, a=display/color, s=negative,...>

“iPhone display has an amazing resolution, but colors are bit washed out”

<e=iPhone, a=display/resolution, s=5/5,...>

<e=iPhone, a=display/color, s=2/5,...>
A model for Sentiment Analysis

The opinion holder may be the **writer** of the text, or the text may **report** someone else’s opinion:

“**I love my new bicycle**”

<e=bicycle, a=GENERAL, s=positive, h=WRITER,...>

“**My friend hates my new bicycle**”

<e=bicycle, a=GENERAL, s=positive, h=EnviousFriend,...>

Tracking opinion holders is useful, e.g., in social debates analysis and recurring market research activities.
A model for Sentiment Analysis

Time is a relevant dimension whenever the analysis process is recurrent or it is focused on an evolving situation, e.g., elections, social reaction to relevant events.

In many cases time can be tracked from metadata. A dedicated analysis can improve dating accuracy.
A model for Sentiment Analysis

Liu's model is a simple model for direct, non-contextualized, and non-comparative opinions.

“*A boring story if you expect to see an action movie.*”
“*The role and the actor don’t fit together*”
“*Both X and Y are good, but X is better than Y*”

Yet, it covers most of the applications, which can be seen as more or less simplified instances of the model.

It’s an example of a framework to translate the unstructured information contained in text into a structured knowledge base, on which traditional data mining methods can be applied.
Sentiments, Emotions, Humor
Affective computing

Modern Sentiment Analysis applications are mainly data mining oriented and focused on the evaluations expressed toward the subject matter of the text.

There is also active research on the topic of affective computing, more related to psychology and cognitive sciences.

In affective computing the focus is on the human computer interaction, aiming at identifying the emotions and feelings conveyed by the text to the reader.
Affective computing

Recognizing the expression of six basic emotions: anger, disgust, fear, joy, sadness and surprise:

“He looked at his father lying drunk on the floor” (disgust)

“She was leaving and she would never see him again” (sadness)

“She turned and suddenly disappeared from their view” (surprise)

“They celebrated their achievement with an epic party” (joy)

Strapparava and Mihalcea. Learning to Identify Emotions in Text. SAC 2008
Computational humor

Generating and recognizing humor: jokes, puns, wordplay.

“Beauty is in the eye of the beholder”
“Beauty is in the eye of the beer holder”

Generation is usually based on templates, recognition is mainly based on stylistic features.

An example of application is building a language playground for people with complex communication needs.

Irony and sarcasm

Irony and sarcasm are pervasive on social media.

Both are linguistic phenomena that rely on context and common knowledge.
Irony and sarcasm

Research on computational recognition of irony is at an early stage, mainly focusing on syntactic features. Data is often collected from tweets with #ironic or #sarcasm hashtag.

Wallace, "Computational irony: A survey and new perspectives" AIR 2015
Hernández & Rosso "Ironic, Sarcasm, and Sentiment Analysis" Chapter 7 in "Sentiment Analysis in Social Networks" Liu, Messina, Fersini, Pozzi