

# Toward Comprehensive Understanding of a Sentiment Based on Human Motives

Naoki Otani and Eduard Hovy Language Technologies Institute, Carnegie Mellon University, USA.

## What is the reason for a sentiment value?

Many studies have focused on the aspect & valence of a sentiment

Everything is always cooked to perfection. 😊 (FoodQuality, P)  
The waiter was rude at times. 😞 (Service, N)

but have paid little attention to *the reasons* for holding a sentiment.

Aspects are typically limited to properties of entities

and do not show *why* and *how* such aspects cause sentiments.

→ *Clues* to better respond to the sentiments.

We assume that a sentiment is triggered by whether the holder's *motive* is satisfied. (Li&Hovy,17)

## → Human motive detection as the first step.

Everything is always cooked to perfection. 😊

Feeling satisfied Self-fulfilment

The waiter was rude at times. 😞

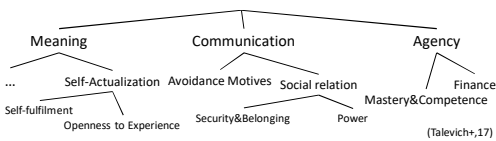
Being treated well Social Relation

## Highlights

- Define six basic motives covering a wide range of topics in reviews.
- Annotate 1,600 restaurant & laptop reviews by crowdsourcing.
- Empirically show that underlying motives are universal across domains.

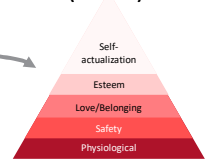
## Representation of Human Motives

We use the hierarchical taxonomy defined by Talevich et al. (2017)



Why?

- Comprehensive (161 motives)
- Links to well-known theories like Maslow's hierarchy (Maslow, 43)
- Easy to adjust the granularity based on the hierarchical structure



Maslow's hierarchy is used in several NLP studies (Ding&Riloff,18; Rashkin+,18)

## Annotation by Crowdsourcing

Based on preliminary annotations, we choose seven motive categories.

Self-Fulfilment	Finding meaning in life or feeling satisfied with one's life.	"The quality of the food was perfect."
Embrace & Explore Life (merged into self-fulfilment)	Being entertained and exploring a new thing	"The wine list is extensive."
Appreciating Beauty	Enjoying fine visual design/arts/natural beauty or being creative.	"A beautifully designed dreamy restaurant."
Social Relation	Being treated well by others or belonging to a social group.	"Everyone was cheerfully cooperative."
Health	Being physically healthy/good.	"The fish was not fresh, and the rice tasted old."
Ambition & Ability	Being competent/knowledgeable, keeping things in order, or being efficient.	"I've waited over one hour for food."
Finance	Saving money or getting things worth the financial cost.	"The prices are high, but I felt it was worth it."

**Data:** SemEval 2016 Aspect-based Sentiment Analysis (Pontiki+,16)

Restaurant and Laptop reviews, 800 sentences w/≤ 25 tokens from each domain.

**Label distribution:**

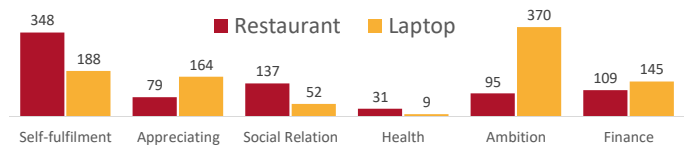
Use MACE (Hovy+,13) to obtain gold standard labels.

**Quality Control:** worker qualification + redundancy (3 workers/text)



- Labels on the first 200 texts\* are corrected by the first author.
- We qualify workers whose F1 score is higher than 0.5.

Annotation agreement (Krippendorff's  $\alpha$ ): 0.51 (restaurant), 0.61 (laptop)



## Human Motive Detection

Given a sentence, predict relevant motives. (Multi-label classification)

**Predictive Models:** Linear SVM

SVM only uses surface word forms.

- Bag of  $n$ -gram vectors ( $n=1,2,3$ )
- Scale  $n$ -gram counts by TFIDF

**Multi-layer Perceptron (MLP)**

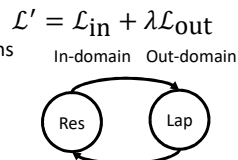


Encoding a series of word embeddings into a sentence embedding

- SWEM (Shen+,18) average and max-pooling
- CNN (Kim,14) with window size 3,4, and 5
- BiLSTM: Two-layers Bidirectional LSTM

**Training:** Transfer learning across domains

Human motives will be universal across domains although distributions can be different.



**Weighted loss function (MLP)**

for handling highly skewed class distributions.

$$\mathcal{L} = - \sum_{(x,y) \in \mathcal{D}} \sum_{c \in \mathcal{C}} [w_c y_c \log \text{MLP}_c(x) + (1 - y_c) \log(1 - \text{MLP}_c(x))]$$

$\mathcal{D}$ : training data  $\mathcal{C}$ : classes (motives)  $w_c$ : class weight (Morik+,99) =  $\frac{\#(y \neq c)}{\#(y = c)} = \frac{\sum_{(x,y) \in \mathcal{D}} (1 - y_c)}{\sum_{(x,y) \in \mathcal{D}} y_c}$  ( $c \in \mathcal{C}$ )

## Experiments

**Settings:**

Primary measure: macro-F1

3-fold CV: in each fold

- Train/valid/test = 1:1:1
- Tune hyperparameters using the train and valid sets.
- Train a model on the train+valid set and evaluate on the test set.

100D GloVe embeddings (Pennington+,14)

Trained on 6B tokens from Wikipedia and En Gigaword.  
Embedding layers are fixed during training.



**Results:** Out-of-domain training data helps.

↑ The precision of MLP classifiers.

This indicates the universality of underlying motives across domains.

SVM performs poorly in terms of recall.

Surface-level features are insufficient.

Large gap between the classifiers and human.



**Error Analysis:** Errors concentrate on *ambiguous* examples.

Text	Gold	Prediction
I had to ask her three times before she finally came back with the dish I've requested. [restaurant service]	Ambition & Ability (Being efficient)	Self-fulfilment, Social Relation
English must have been his third or fourth language. [laptop customer service]	Social Relation	Ambition & Ability