UNIVERSITÀ DI PARMA

DEPARTMENT OF ENGINEERING AND ARCHITECTURE

Application of Lovheim Model for Emotion Detection in English Tweets

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20TH WORKSHOP "FROM OBJECTS TO AGENTS"

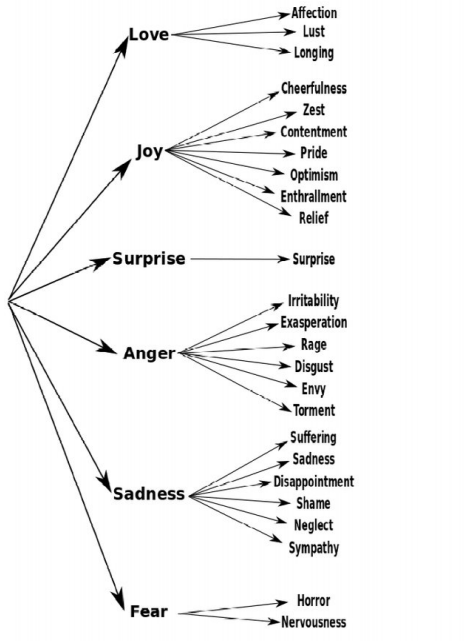
Parma, June 26th-28th, 2019

Emotion Detection

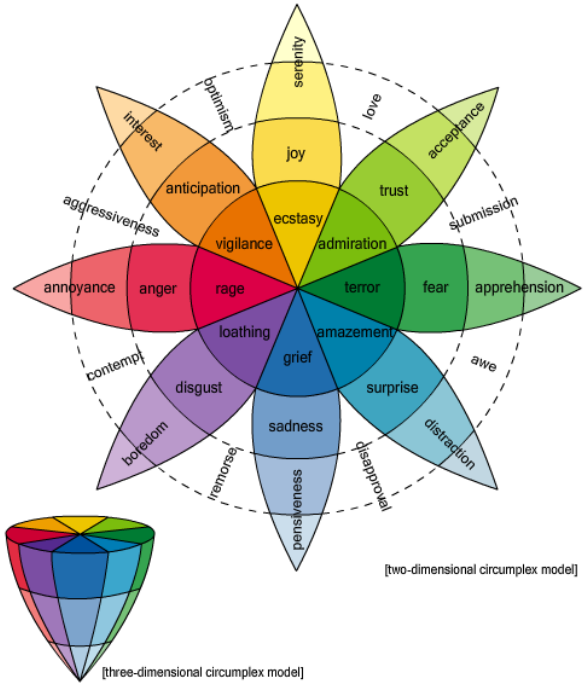
"**Emotion detection** is the process of identifying human emotion, most typically from facial expressions as well as **from text**. This is both something that humans do automatically but computational methodologies have also been developed."

[Pang, Bo, and Lillian Lee. "Opinion mining and sentiment analysis." Foundations and trends in information retrieval 2.1-2 (2008): 1-135]

Emotion Detection – Models



First two layers of Parrot's emotion classification



Plutchick's Wheel of Emotions

Ekman's Emotion Classification

Emotion Detection

Applications:

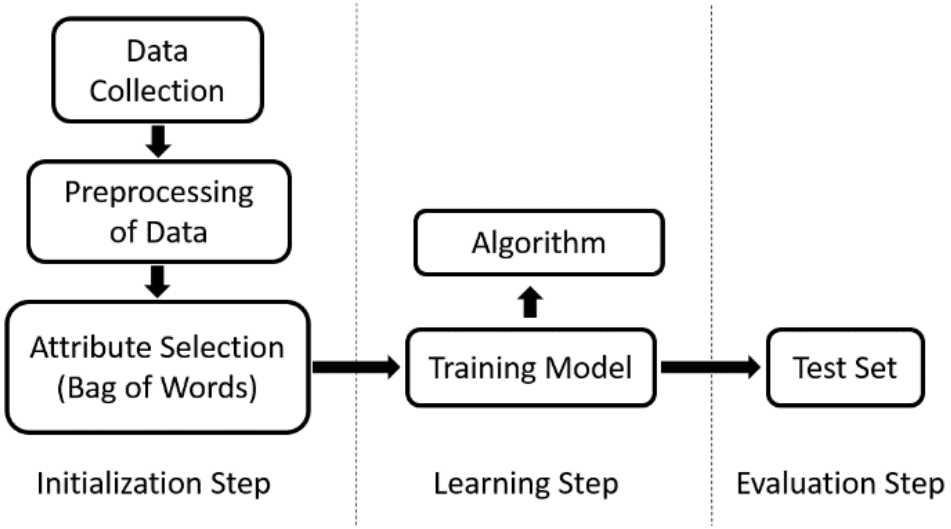
- Forecast market movement based on News, Blogs and Social media
- Computing customer satisfaction metrics
- Social media Monitoring
- Business Analytics

[Pang, Bo, and Lillian Lee. "Opinion mining and sentiment analysis." Foundations and trends in information retrieval 2.1-2 (2008): 1-135]

Emotion Detection

Main Approaches:

- Lexical analysis
- **Machine learning based analysis**
- Hybrid/Combined analysis

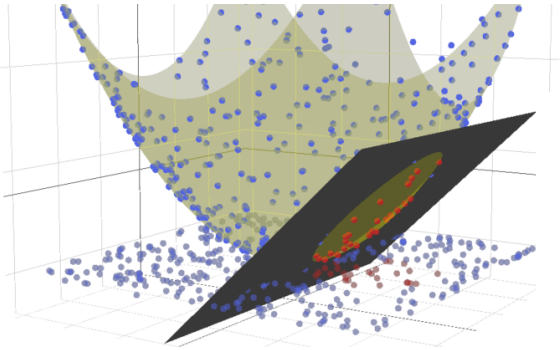


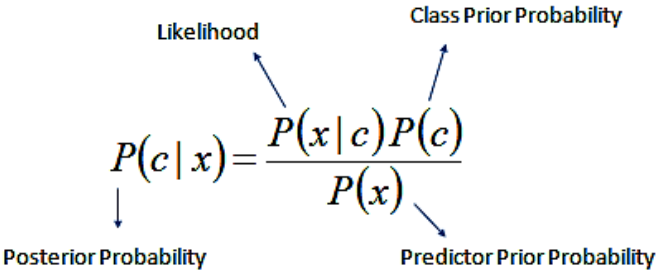
[Thakkar, Harsh, and Dhiren Patel. "Approaches for Sentiment Analysis on Twitter: A State-of-Art study." arXiv preprint arXiv:1512.01043 (2015)]

Emotion Detection with Machine Learning

List of Machine Learning Algorithms:

- **Naive Bayes Multinomial**
- Support Vector Machines
- Random Forest
- Deep Learning (Word Embedding Model)





$$P(c \mid \mathrm{X}) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

[Pradhan, Vidisha M., Jay Vala, and Prem Balani. "A survey on Sentiment Analysis Algorithms for opinion mining." International Journal of Computer Applications 133.9 (2016): 7-11]

[Thakkar, Harsh, and Dhiren Patel. "Approaches for Sentiment Analysis on Twitter: A State-of-Art study." arXiv preprint arXiv:1512.01043 (2015)]

The Bag of Words Model

Bag Of Words model assumes position doesn't matter

Example:

(1) John likes to watch movies.
(2) John also likes to watch football games.

BOW with Binary Value

	John	likes	to	watch	movies	also	football	games	Mary	too
(1)	1	1	1	1	1	0	0	0	0	0
(2)	1	1	1	1	0	1	1	1	0	0

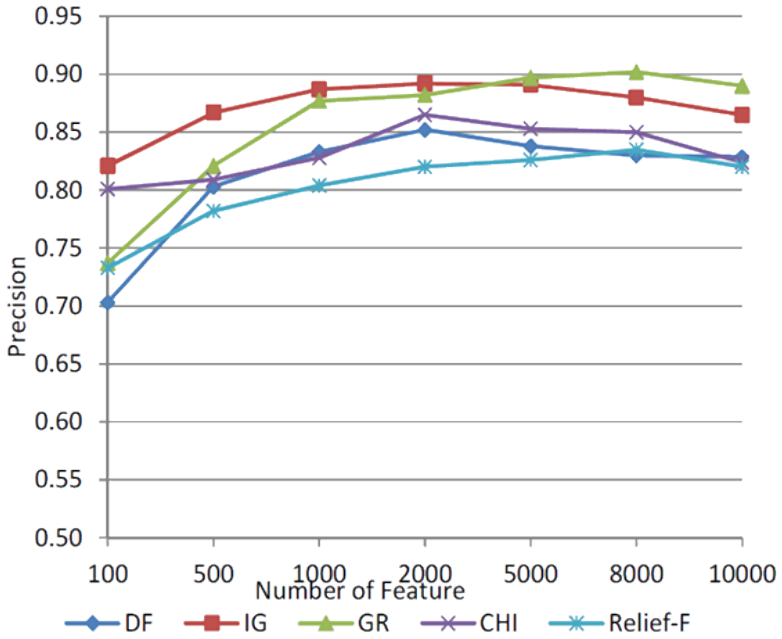
BOW with Tf-Idf Value

	John	likes	to	watch	movies	also	football	games	Mary	too
(1)	0	0	0	0	0.48	0	0	0	0	0
(2)	0	0	0	0	0	0.48	0.48	0.48	0	0

Tf-Idf Value

- x → word
- y → document
- $Tf_{x,y} = (N_{x,y} / N_{*,y})$
- $Idf_x = \log (D / D_x)$
- $Tf\text{-}Idf_{x,y} = Tf_{x,y} * Idf_x$

Feature Selection



- **Simplification** of models
- **Shorter training times**
- **Enhanced generalization** by reducing overfitting

Entropy of the Dataset

$$H(Y) = -\sum_{y \in Y} p(y) \log_2 (p(y))$$

Expected new entropy

$$H(Y/X) = -\sum_{x \in X} p(x) \sum_{y \in Y} p(y/x) \log_2 (p(y/x))$$

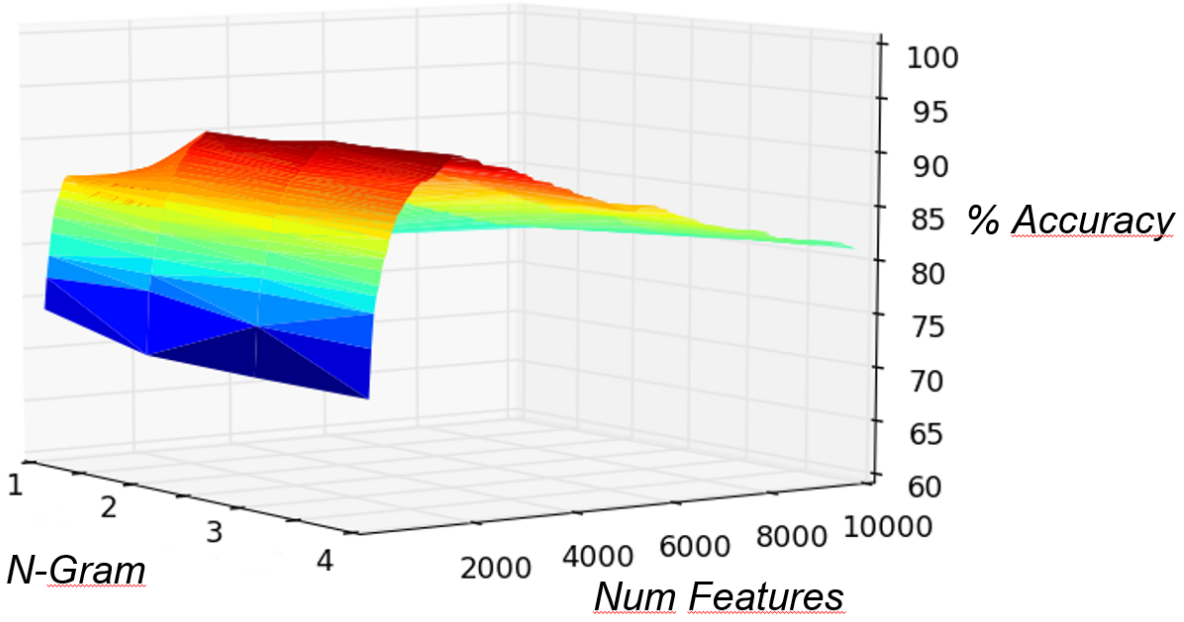
IG Information Gain

$$IG = H(Y) - H(Y/X)$$

[Anuj Sharma, Shubhamoy Dey, Performance Investigation of Feature Selection Methods, Journal of Computer Applications (0975 – 8887) on Advanced Computing and Communication Technologies for HPC Applications - ACCTHPCA, June 2012]

Hyperparameter optimization

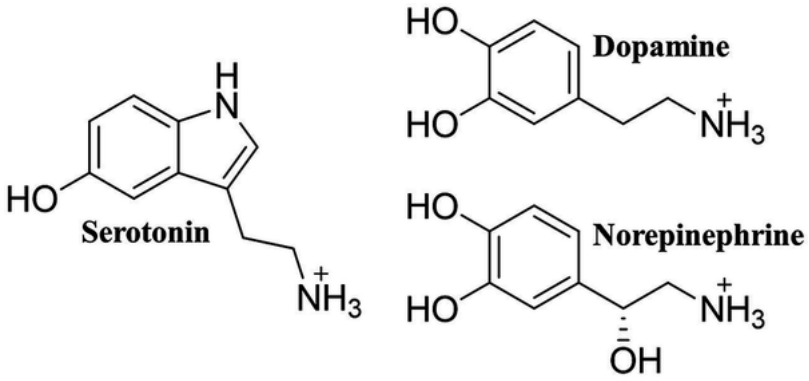
- **Naive Bayes Multinomial** algorithm
- **Grid Search** Optimization with *Cross Validation*



[G. Angiani, L. Ferrari, T. Fontanini, P. Fornacciari, E. Iotti, F. Magliani, S. Manicardi, A Comparison between Preprocessing Techniques for Sentiment Analysis in Twitter, Knowledge Discovery on the WEB (KDWEB2016)]

Serotonin, Dopamine and Noradrenaline

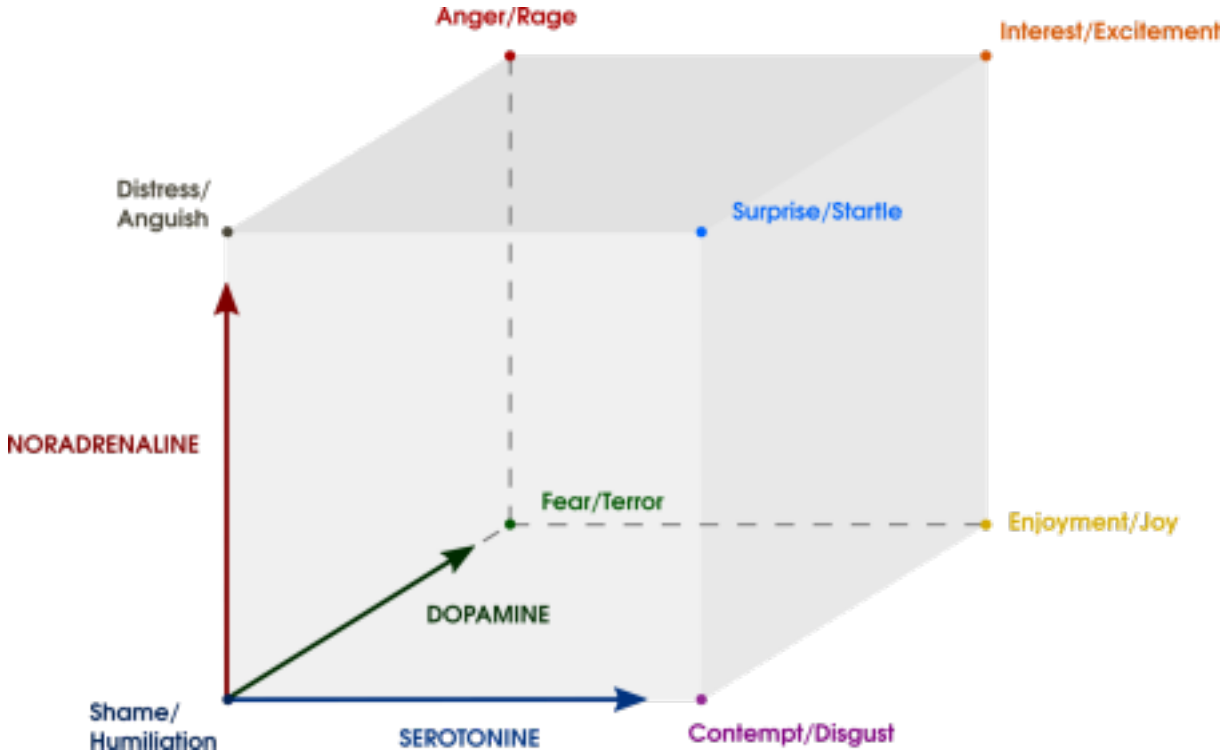
- The monoamines **serotonin**, **dopamine** and **noradrenaline** (norepinephrine) have a great impact on mood, emotion and behavior.



[Couppis MH, Kennedy CH. The rewarding effect of aggression is reduced by nucleus accumbens dopamine receptor antagonism in mice. Psychopharmacology (Berl) 2008;197:449–56.]

Lövheim cube of emotion

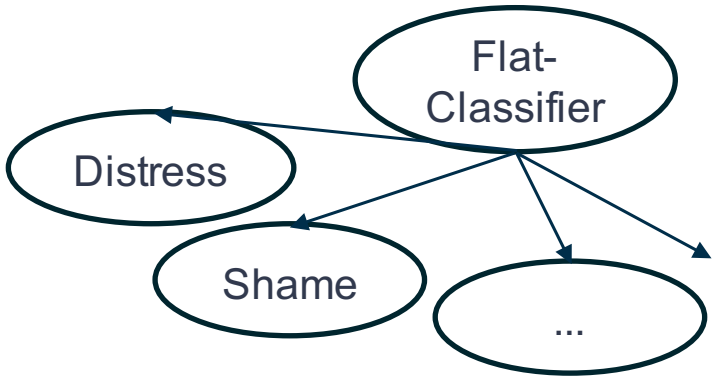
- Theoretical model that focuses on the interactions of neurotransmitters and the emotions we feel.
- In the model, the monoamine systems are represented as orthogonal axes and the eight basic emotions.
- "...further empirical studies are needed to establish its validity..."



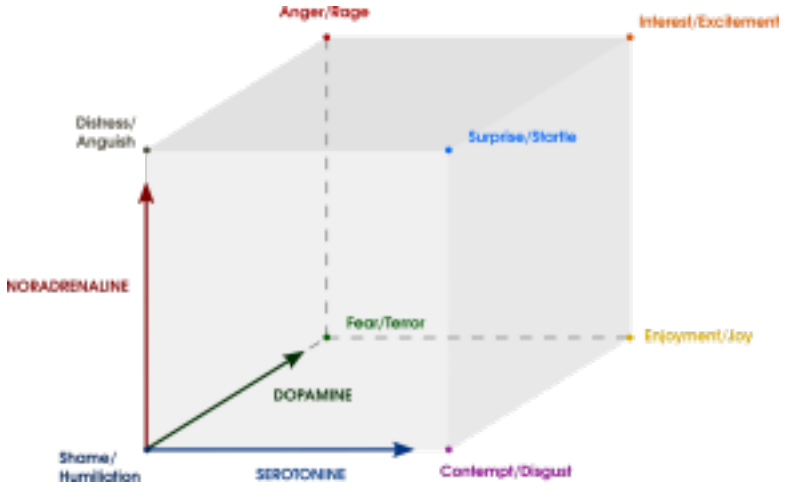
[Lövheim, Hugo. "A new three-dimensional model for emotions and monoamine neurotransmitters." Medical hypotheses 78.2 (2012): 341-348.]

The Goal

- Explore an Emotion Detection classification system, based on the Lövheim cube.
- In the best case there is an increment of the accuracy of 11,8%, with respect to a classical flat multiclass classifier

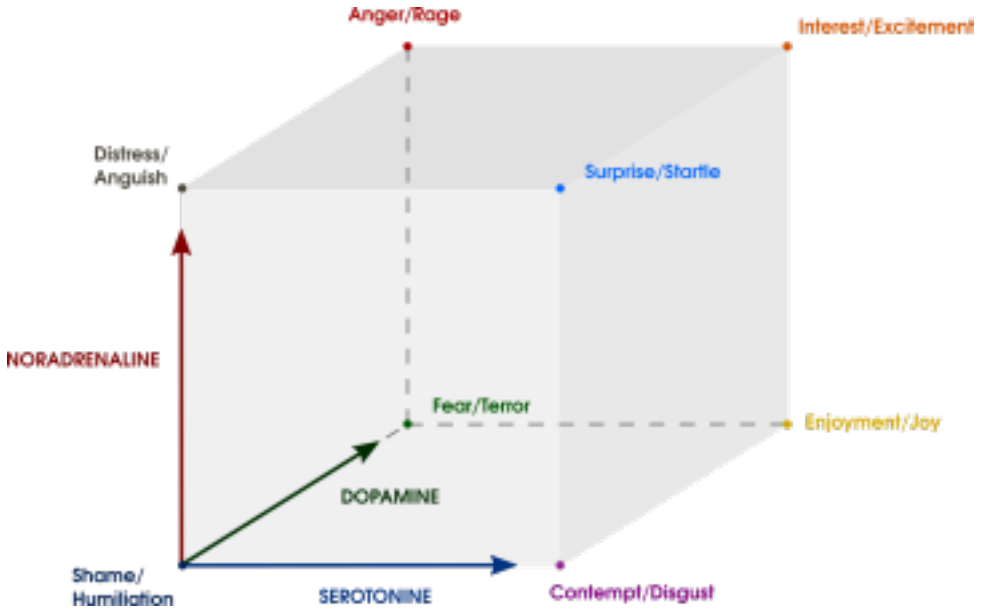


Classical 8-output classifier



New approach based on the Lövheim cube

Lövheim cube of emotion

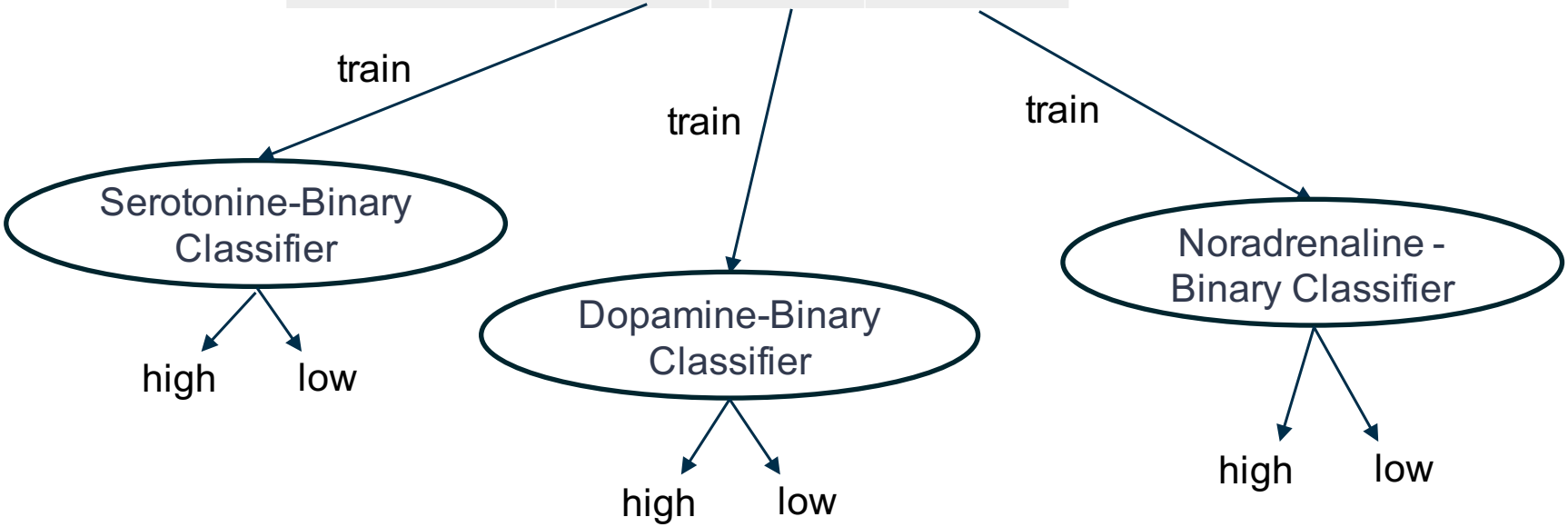


LOVHEIM'S EMOTIONS			
EMOTION	SEROTONINE	DOPAMINE	NORADRENALINE
Shame/Humiliation	Low	Low	Low
Distress/Anguish	Low	Low	High
Fear/Terror	Low	High	Low
Anger/Rage	Low	High	High
Contempt/Disgust	High	Low	Low
Surprise/Startle	High	Low	High
Enjoyment/Joy	High	High	Low
Interest/Excitement	High	High	High

[Lövheim, Hugo. "A new three-dimensional model for emotions and monoamine neurotransmitters." Medical hypotheses 78.2 (2012): 341-348.]

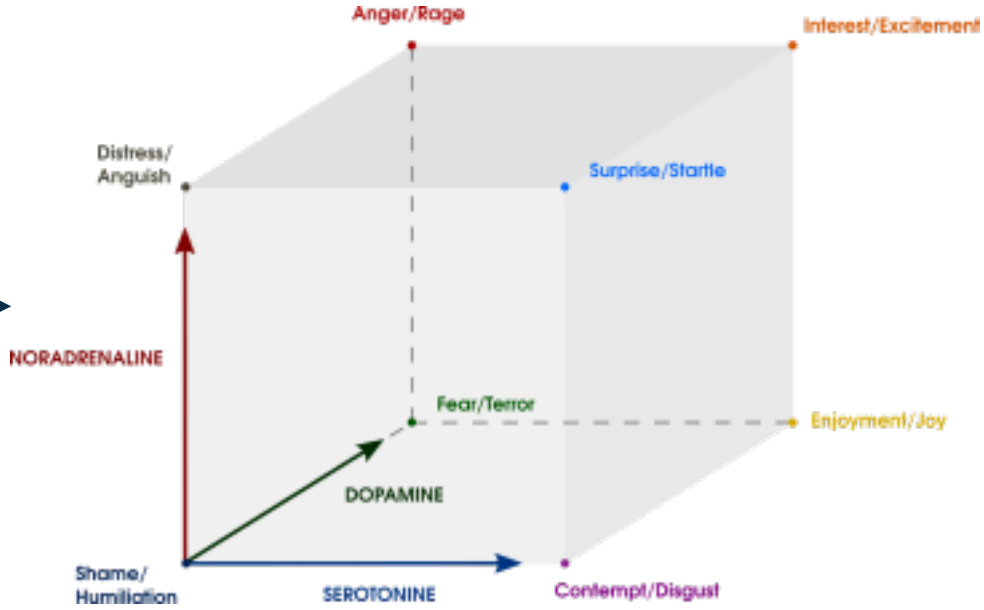
Lövheim cube of emotion – 3-binary classifier

EMOTION	SEROTONINE	DOPAMINE	NORADRENALINE
Shame/Humiliation	Low	Low	Low



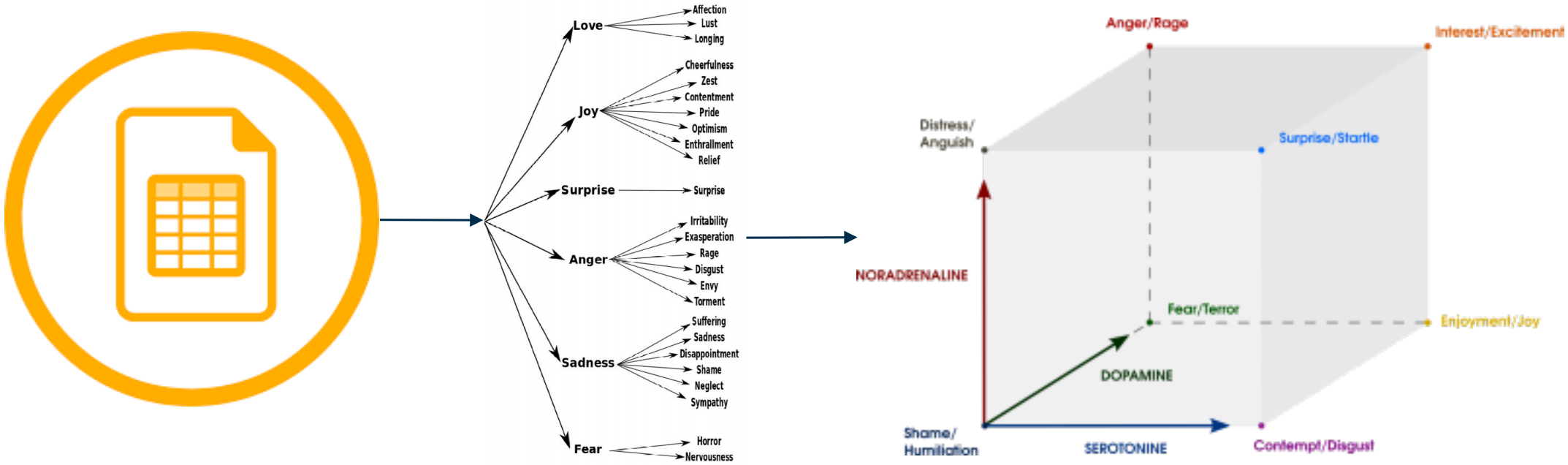
[Lövheim, Hugo. "A new three-dimensional model for emotions and monoamine neurotransmitters." Medical hypotheses 78.2 (2012): 341-348.]

Lövheim cube of emotion – Mapping Emotions with our cube



- 22901 tweet
- 7 emotions (7 classes) → https://www.kaggle.com/c/sa-emotions/data

Lövheim cube of emotion – Mapping Emotions with the cube



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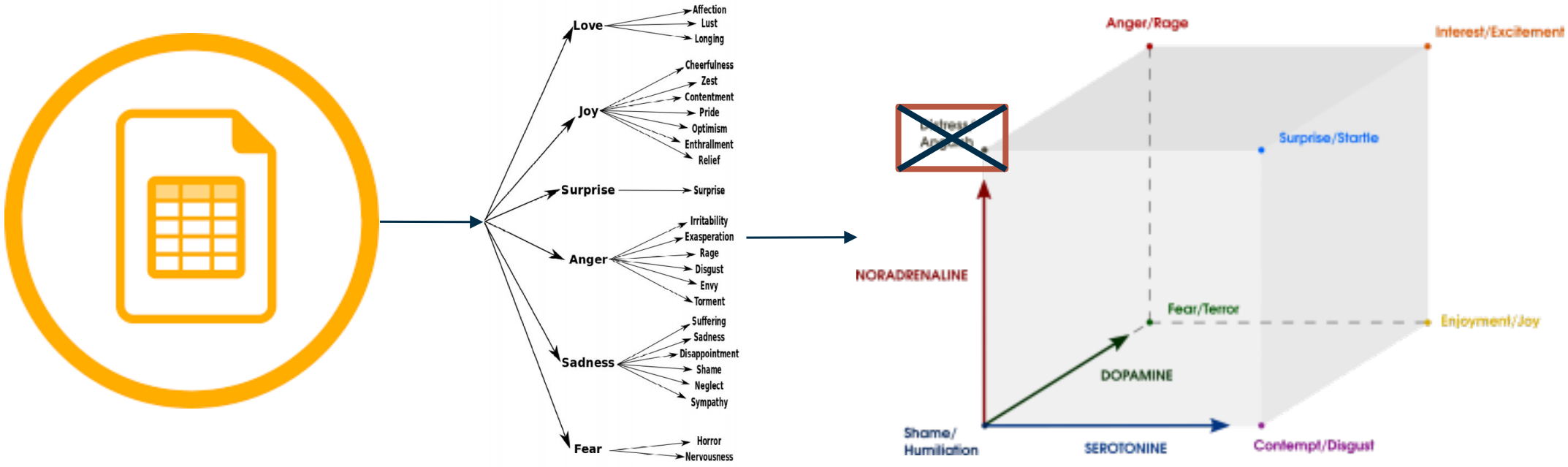
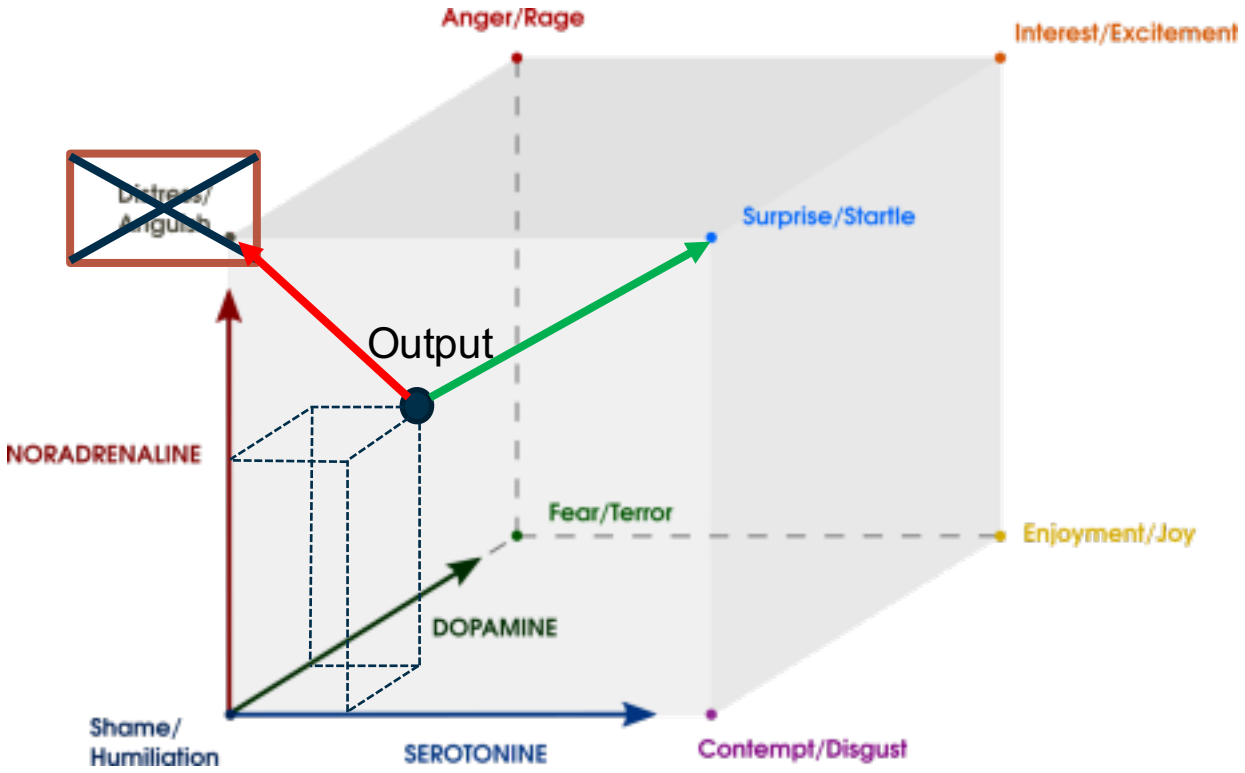


- 22901 tweet
- 7 emotions (7 classes)

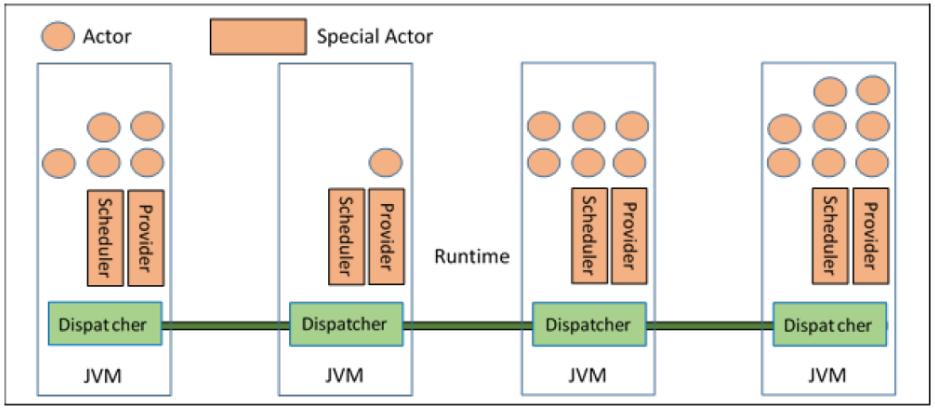
Lövheim cube of emotion – Avoid missing output

- It is common for **classification** models to predict a **continuous** value as the probability of a given example belonging to each **output** class.
- It is possible to avoid a “missing class” by considering the **continuous** output value.



Actodes

- ActoDES is a software framework which adopts the actor model for simplifying the development of complex distributed systems.
- Each simple classifier and each processing step can instantiated as an actor, allowing the whole architecture to be defined at a high level of abstraction.



Results

	Flat Results			Neurotransmitters Results			Neurotransmitters Results (assumption)		
EMOTION	Precision	Recall	f-Measure	Precision	Recall	f-Measure	Precision	Recall	f-Measure
Shame/Humiliation	44.8%	23.4%	30.7%	61.9%	57.1%	59.4%	59.3%	52.6%	55.7%
Interest/Excitement	51.1%	22.2%	31%	47.8%	49.8%	48.8%	47.8%	48.5%	48.1%
Fear/Terror	40.6%	73.3%	52.3%	67.7%	49.2%	57%	67.7%	48.8%	56.7%
Surprise/Startle	35.5%	4.8%	8.4%	46.1%	54.8%	50.1%	37.5%	49.4%	42.7%
Enjoyment/Joy	47.4%	46.8%	47.1%	61.9%	50.5%	55.6%	61.9%	50.3%	55.5%
Anger/Rage	46.6%	22.2%	30.1%	27%	56.7%	36.6%	24.8%	50.3%	33.2%
Contempt/Disgust	14.3%	1.9%	3.4%	4%	53.1%	7.4%	4%	49.7%	7.3%
Weighted Average	**44%**	**43.1%**	**39.6%**	**58.9%**	**49.3%**	**53.1%**	**57.6%**	**50%**	**52.7%**
Accuracy		**43.1%**			**49.3%**			**50%**	

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