PATTERN SENSATION

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Pattern Recognition

- Over the last few years, with the advent of DNN (Deep Neural Networks), remarkable success has been achieved in almost all kinds of Pattern Recognition.

- Learning Patterns (Features) from Images, Sounds, Voices, Texts has become a lot easier and a lot more accessible.

So what is next?

Human Cognition

- Without a doubt, humans are exceptionally good at Pattern Recognition. However, "Pattern Recognition" is that all a human capable of ?

- The answer is probably no.

- When a human recognizes a pattern, in addition to the recognition, he is also able to discern some form of sentimental sensation from patterns.

- Some patterns will make him feel good while the others will make him feel bad, or some will make him feel happy while others will make him sad.

- It is exactly from the sensation of the patterns that humans are capable of sentiments.

Human Sentiment

- Arts and Cultures, actually are centered around human's cognition of sentimental sensation to implicitly induce human's emotions.

- Some engineering disciplines, such as Design or Architecture, actually study scientifically how different patterns effect human's mind and sentiment, and ultimately human's behaviors.

- In short, certain patterns make people happy while certain patterns make people sad or confused or depressed.
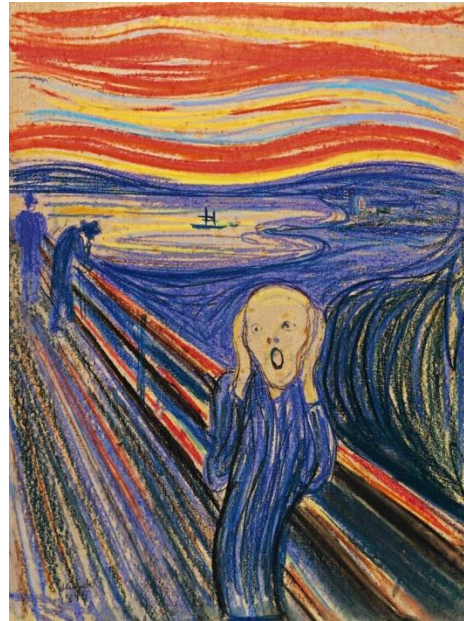
Eerie, Depressed   Happy, Warm

Big Questions

- Why are humans able to discern "Pattern Sensation" along with "Pattern Recognition"?

- Why do certain patterns make people feel happy, while certain patterns make people feel sad?

- What is the correlation between "Patterns" and "Sentiments"?

- Why is Humanity Culture and Civilization centered around "Art", which in fact, is the Creation of Patterns" to induce "Aesthetics"?

- How do we measure "Pattern Sensation"?

- Is "Pattern Sensation" machine-trainable like "Pattern Recognition"?

Why sentiments are so important?

- Humans are social animals; in fact, they have created the most complex social group on Earth, far surpassing the a simple group of collective animals, such as a pack of wolves or a school of fish.

- Therefore, to survive in such complex social systems, communicating with other human beings and understanding their sentiments play an extremely important role.

- Humans, naturally, evolve with two primary instincts – Survival Instincts and Social Instincts – to survive in complex dynamic social environments. Survival Instincts is to get food, to avoid dangers, to reproduce and to protect offspring, while Social Instincts is to make friends and to eliminate foes.

- In summary, emotions, driven by natural instincts, play a vital role for humans to survive in Complex and Dynamic Social Structures and Organizations.

Pattern Sensation

- Humans generally perceive the reality through sensory organs. This sensory information is subject to Cognitive Process.

- One of primary aspects of Human Cognitive Process is "Pattern Recognition", which enable humans to recognize "Tangible Patterns" such as "Symbols", "Images", "Sounds", "Speech".

- However, in addition to "Pattern Recognition", humans, actually, are able to recognize "Intangible Patterns" which signifies as "Sentiments".

- When humans see a Image of other human beings, they can discern not only their faces, but also their subtle expression of "Sentiments".

- However, "Pattern Sensation" is a lot more subtle than the explicit "Pattern Recognition".

Dimensional Emotion Theory

- One of the major Emotion Theories is **Dimensional Emotion Theory**, which proposed Emotions can be represented in N-Dimension Emotion Space.

- Interestingly, Dimensional Emotion Theory suggests that an Emotion is actually similar to a Vector in Vector Space.

- Valence-Arousal Emotion Space is primarily used to map Emotional Response onto 2 Dimensional Space, while Valance-Arousal-Dominance is used to map Emotions onto 3 Dimensional Space.

Proposed Method

- Contemporary Sentiment Analysis methods are primarily based on Polarity Score, such as Positive, Negative or Neutral (1, -1 , 0) or Scalar Score (-0.323, 0, +0.454).

- However, considering a wide variety of human emotions, I would like to take a different approach with N-Dimensional Vector to represent "Sentiment" known as "Sentiment Vector" in "N-Dimensional Space".

- In other words, in my proposed Method, a Sentiment will be represented in 4 Dimensional Vector Space, which are defined with 4 orthogonal variables: Valence, Arousal, Affinity and Accrual.

Valance – The measure of pleasure and pain

- Valance is, generally speaking, the measurement of the pleasantness (pleasure or pain) for a given sensational sensory experience.

- Broadly speaking, any sensory experience, which is harmful to the survival of humans, is normally deemed as "Pain" [Punishments] while any sensory experience, which is useful to the survival of humans, is normally deemed as "Pleasure" [Rewards].

- However, such definition is too broad and has little practical use in reality.

- Therefore, I would like to propose Valance as a Measurement of Expectation of Entropy.

Valance – Expectation of Entropy

- Entropy, in Thermodynamics, is the measurement of "Disorder" or "Random" states of a System.

- The more entropy a System has, the less useful energy it can have.

- Therefore, less entropy is always more desirable in any situation.

- Loosely speaking, Entropy could define the "Decay" of a System. The more "Entropy" a System has, the less "Useful" it will be.

- Therefore, Entropy is inversely proportional to the well-being of a systems.

- In addition, in Information Theory, more information is necessary to describe, the more entropy the systems has.

Expectation of Entropy

- Therefore, I would like to propose "Valance as a Measurement of Expectation of Entropy".

- The less entropy, the more pleasant a sensory experience is.

$$V(x) = \arg\min \frac{1}{N} \sum_{i=0}^{n} P(x)\log{(P(x))}$$

Expectation of Entropy

- The less Entropy we have from the Expectation, the more we assume that it is more "Pleasant".

- In other words, the more Information we need to describe the Variance from the Expectation, the more we think it is not beautiful.

- In short, it takes more energy and information to describe "Unpleasantness" because there will be more "Noises" or "Variance" from the Expectation.

Less Expectation of Entropy   More Expectation of Entropy

Expectation of Entropy

- Rotten Food, for example, generally has higher Entropy (less useful Energy) than Fresh Food, as the rotten food has more chemical reaction due to the breaking-down of its molecular structures.

- Therefore, we are able to detect its Entropy and we deem that Fresh Food is more pleasant than Rotten Food.

- In addition, the more Entropy, the less it is useful for the Well-Being, which we deem as "Unpleasant".
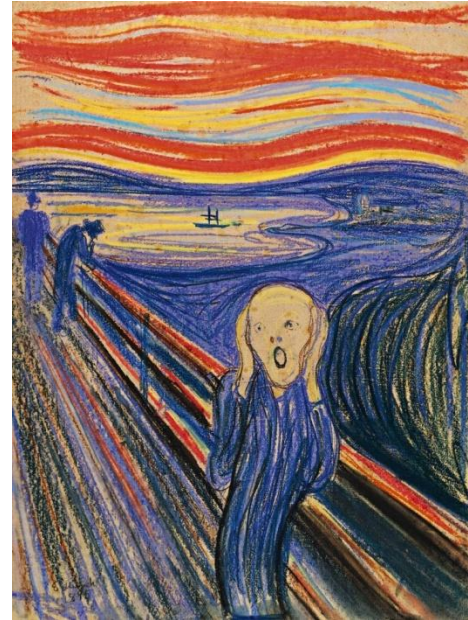

Less Expectation of Entropy   More Expectation of Entropy

Expectation of Entropy

- The more Entropy (Messy or Disorder), the less it is useful for the Well-Being, which we deem as "Unpleasant".

Less Expectation of Entropy

More Expectation of Entropy

Courtesy: https://github.com/GuanqiaoDing/messy-room-classifier/blob/master/model/room_model_predictions.png

Expectation of Entropy

- The famous "Scream" uses distorted lines to create the "Unpleasantness" Effect. However, if we use straight-lines, the "Unpleasantness" is greatly reduced.
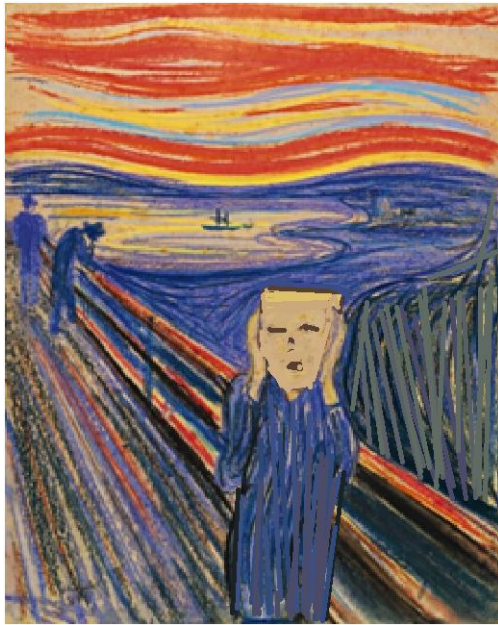
Less Expectation of Entropy

More Expectation of Entropy

Expectation of Entropy

- As we can see from those examples, it seems appropriate to measure Valance as Expectation of Entropy.

- Valance, in short, represents the Pleasantness of a Pattern. The more entropy the pattern has, the less it appears pleasant to us.

- In fact, the Measure of Pleasantness is a "Defense Mechanism" to protect the "Well-Being" of ourselves.

Arousal– The measure of intensity and surprise

- While Valance is the measurement of the pleasantness (pleasure or pain) for a given sensational sensory experience, Arousal measures the Intensity and Inverse Frequency (Suprisal) of the Sensory Experience.

- Therefore, Arousal can be defined as function of Intensity and Inverse Frequency (Suprisal).

$$A(z, \omega) = \mu \frac{F(z)}{G(\omega)}$$

Arousal– Another Factor of Surprise

- When we first perceive a intense sensory experience, the sensational arousal is intense as well.

- However, if we continue to perceive the same intense sensory experience repeatedly, the sensational arousal gradually diminish. Such situation is generally defined as Psychological Tolerance (Resistance).

- Therefore, I proposed to defined Arousal as a Function of Intensity and Inverse Frequency.

- The more frequent a sensational experience is, the less arousal it can induce.

- Therefore, it won't be sufficient to measure Arousal only as a Measure of Intensity; a Factor of Surprise plays an important role as well.

Objective Sentimental Sensation

- Valance and Arousal defines Objective or Survival Sentimental Sensation which does not depend on the individual preference.

- For example, regardless of individual, the "Unpleasant" feeling towards rotten food is universal as it comes from "Survival Instinct".

- In other words, Valance and Arousal determines the 2 Dimensional Aspects of Universal Sentimental Sensation.

E$_O$ Function

- Objective Emotional Value is defined by a Function **E$_o$** of Valance and Arousal. Valance represents from Pleasant(V_{max}) to Unpleasant(V_{min}), and Arousal represents Low (0) to High (A_{max}).

$$E_o = F(V(x), A(z, \omega))$$

Pleasant

V(x)

Neutral

Unpleasant

A(z,ω)

High

Low
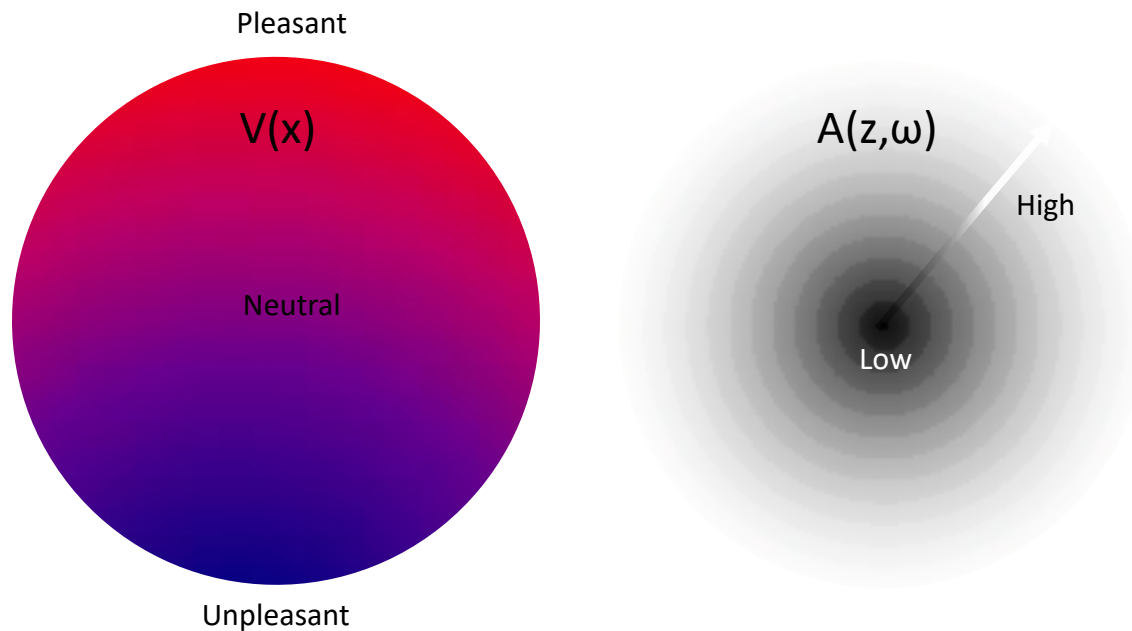
Visualization

- By combining Valance and Arousal, it is easy to visualize E_O Function.

$$E_O = F(V(x), A(z,\omega))$$

V(x)

A(z,ω)

Pleasant

High

Neutral

Unpleasant

Low
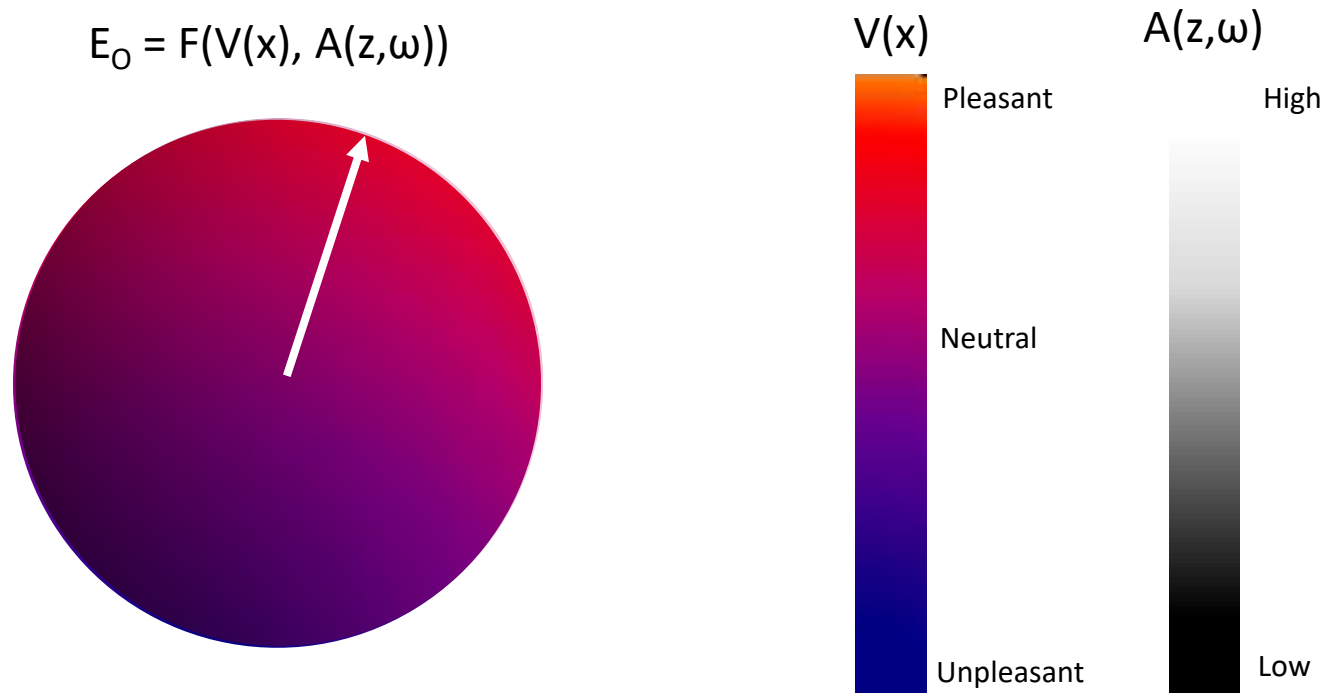
Subjective Sentimental Sensation

- However, as we know, our sentimental sensation is not always universal.

- Although we can universally perceive some sensation as "Pleasant" or "Unpleasant", our real response sometimes differ from person to person.

- "**X** is winning." However, depending on who is X, our sentiment is different. "Our team is winning" vs. "Our Opponent is winning".

- That is why we need to define the Subjective or Social Sentimental Sensation, and the complexity and contradiction of our emotional response is highly correlated to Subjective Sentimental Sensation.

- I propose additional Dimensional Aspects which can determine the Subjective Sentimental Sensation, namely Affinity and Accrual.

Affinity– The measure of Like or Dislike

- Subjective Sentimental Sensation is highly controversial. Therefore, I would like to treat it with extra care.

- In a general sense, we should always prefer "Pleasant" Sensation to "Unpleasant" Sensation. However, in reality, it is not always that simple.

- Depending on how much we like or dislike a sentimental sensation from our perspectives, our emotional responses become totally different even though the source of sensation is the same.

- Therefore, I propose another Dimensional Aspect of Emotions, which is to measure the Affinity or Adversary between the Perspectives of Sensations.

Affinity– The measure of Preferential Perspective

- Actually, Affinity defines the Measurement of Affinity or Adversary from a Frame of Reference, or simply, from a Perspective.

- In fact, Our Preferential Perspective could really alter the original (universal) sentimental sensations, depending on our perspectives and preferences.

- Therefore, Affinity is defined with two variables: Perspective and Preference.

- Actually, even in reading novels or watching movies, the spectators (readers) align themselves with the protagonists; the readers view themselves as supporters of protagonists.

- Hence, Perspectives, such as first person view (actor or author) or third person view (spectator or reader), also play an important role in measuring Affinity, along with Preferences.

Affinity– The measure of Preferential Perspective

- Actually, without Preferential Perspective, Sentiment Analysis would be self-contradictory.

- What should be overall sentiment of this paragraph, taking into account of Preferential Perspective?

> "*There are not much causalities on our side. One or two at most. But the enemies fell down like thousands. It is a major achievement, I presume*", said the Enemy's General, smiling.

Affinity– The measure of Preferential Perspective

- Naturally, humans always perceive themselves first, and project their "Self" onto other perspectives.

- The complexity and contradiction of Human Sentiments partially come from the proximity between "Self" and "Others" as well as Social Groups: Friends or Foes.

- At the same time, it is exactly due to the human's capacity of projection of "self" to others, humans are able to **empathize** with other human beings.

> Confucius once said ***"Treat others as you want to be treated."***

- Therefore, Affinity can also represent the Difference between Preferences from "Self" Perspective and Preferences from "Other" Perspectives.

Affinity– The measure of Preferential Perspective

- Affinity can be represented as Function of a Weighted Differences of N Preferences from a given perspective (**u**).

- Affinity can be either positive, neutral or negative.

$$L(u, v) = \frac{1}{N} \sum_{i=0}^{n} \alpha_i D(u, v_i)$$

Accrual – The measure of Gain or Loss

- Another Dimensional Aspect which contributes to the Subject Sentimental Sensation is the Sense of Loss or Gain.

- Such sentiments as "Grief", "Regret", "Remorse" are highly associated with Emotional Loss, and humans, generally, have strong aversion towards Emotional Loss.

- In addition, Time Factor plays an important role in determining Emotional Loss or Gain, and Long-Term Loss has a bigger impact on the Sentimental Sensation.

- Humans, naturally, want to increase Emotional Gain over Time.

- Therefore, I propose Accrual as a Measurement of Sentimental Gain or Loss over Time.

Accrual – The measure of Gain or Loss

- Accrual can be represented as Function of a Discounted Gain or Loss over Time.

$$G(\delta, t) = \mu \sum_{i=-\infty}^{\infty} \delta_i R(t_i)$$

E$_S$ Function

- Subjective Emotional Value is defined by a Function **E$_S$** of Affinity and Accrual. Affinity represents from Positive (L$_{max}$) to Negative (L$_{min}$), and Accrual represents Loss (G$_{min}$) to Gain(G$_{max}$).

$$E_s = H(L(u,v), G(\delta, t))$$

Affinity

L(u, v)

Neutral

Adversary

Gain

G(δ, t)
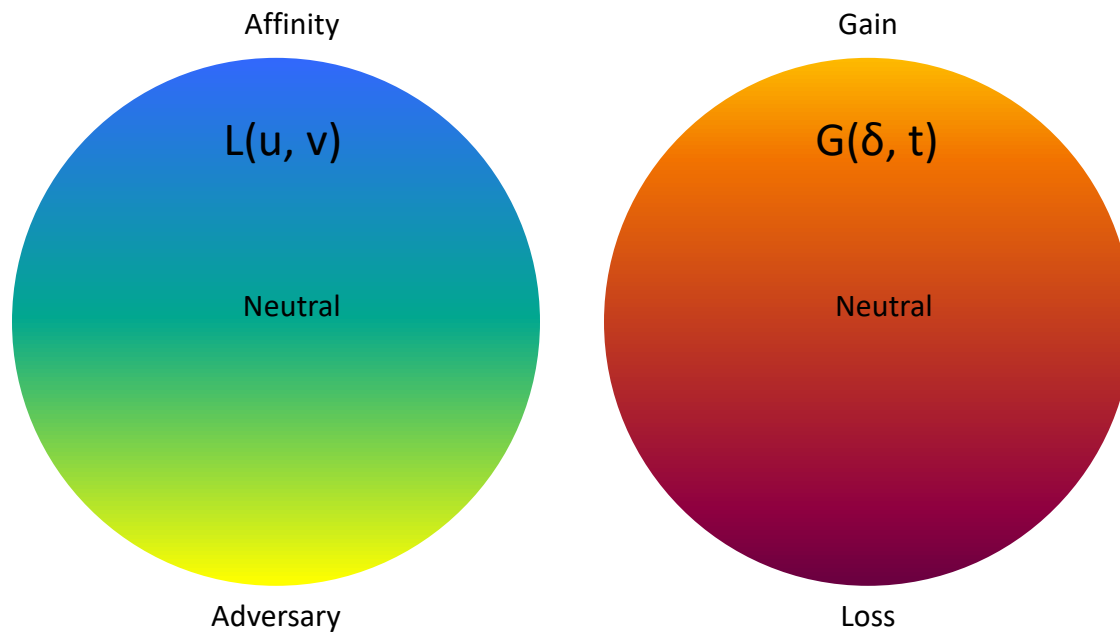
Neutral

Loss

E$_S$ Function
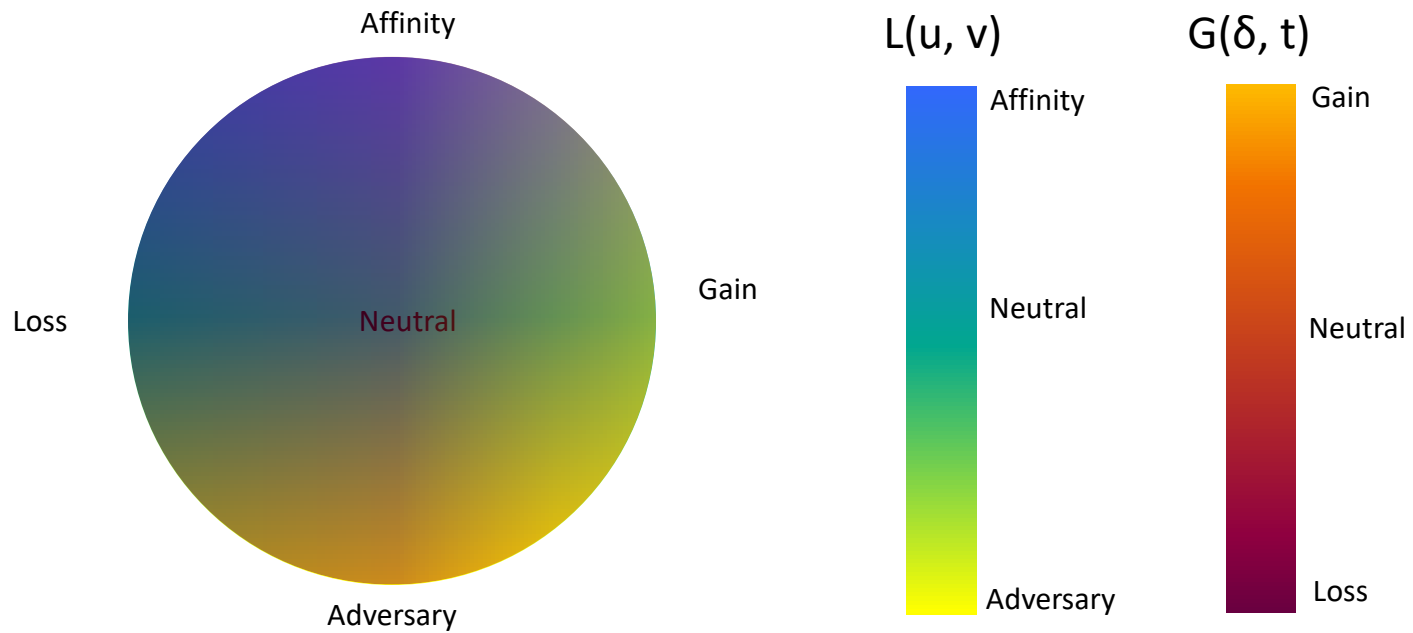
$$E_s = H(L(u, v), G(\delta, t))$$

Emotion Function

$$E = \varphi(E_O, E_S)$$

$E_O = F(V(x), A(z,\omega))$

$E_S = H(L(u, v), G(\delta, t))$
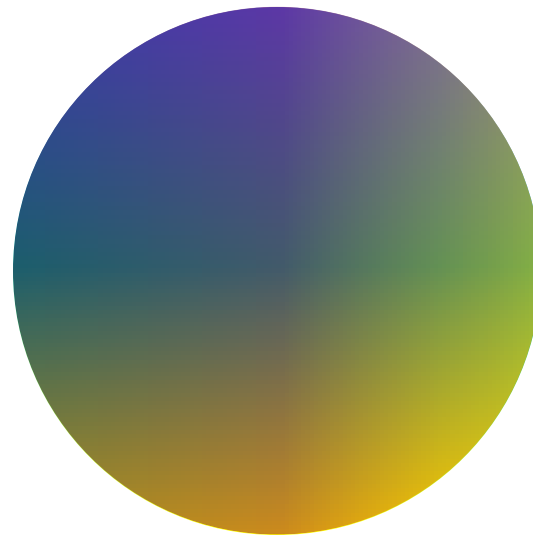
Emotion Function

$$E = \varphi(E_O, E_S)$$

V(x)

Pleasant

Neutral

Unpleasant

A(z,ω)

High

Low

L(u, v)

Affinity

Neutral

Adversary

G(δ, t)

Gain

Neutral

Loss

Traditional Method
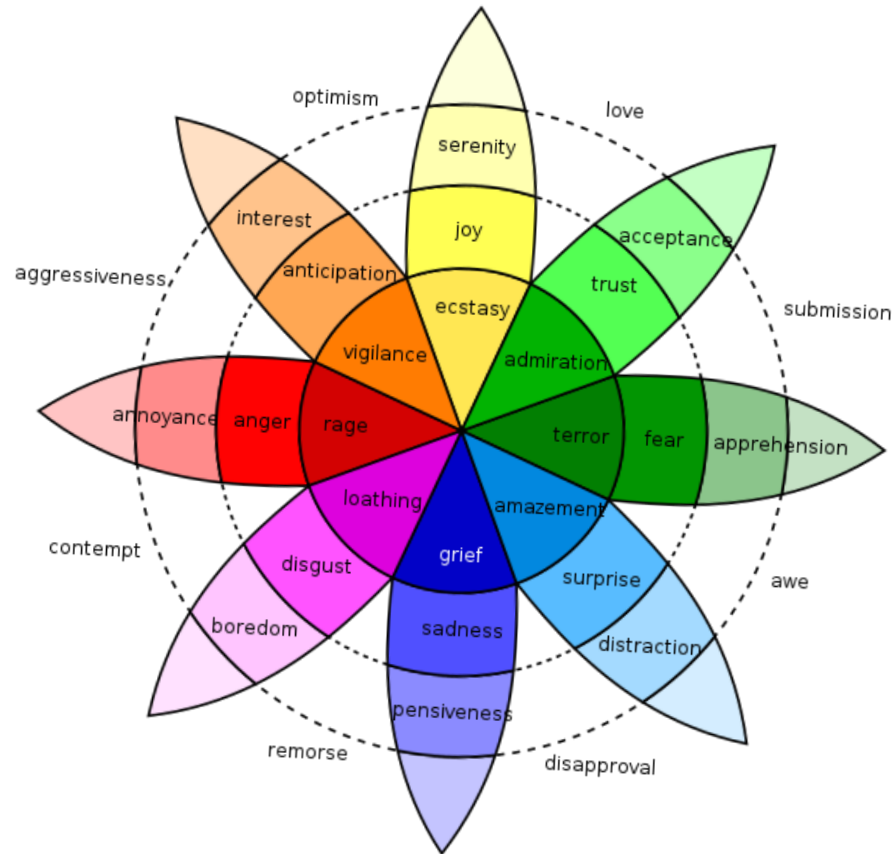
Emotion Space

$$E = \varphi(E_O, E_S)$$

- Emotion Space can be defined by 4 Dimensional Emotion Function with 4 Variables, namely, Valance, Arousal, Affinity and Accrual or simply **V3A** Space.

- Unlike Traditional Discrete Representation of Emotions, in 4 Dimensional Emotion Space, we can represent Emotions as Continuous Vectors.

- Emotion Space is a Universal Space, and we can directly map Text, Image, Audio, Video onto Emotion Space.

Emotion Space
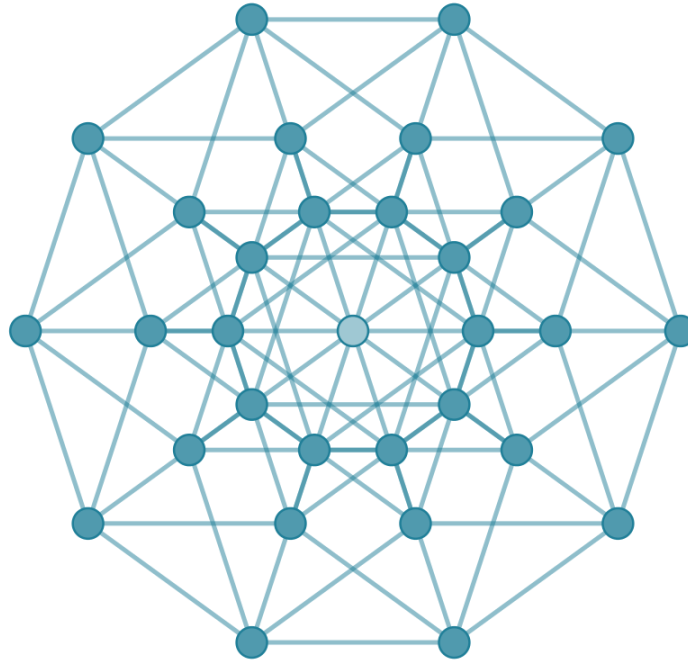
$$E = \varphi(E_O, E_S)$$

Emotional Mapping - Sadness

$$E = \varphi(E_O, E_S)$$
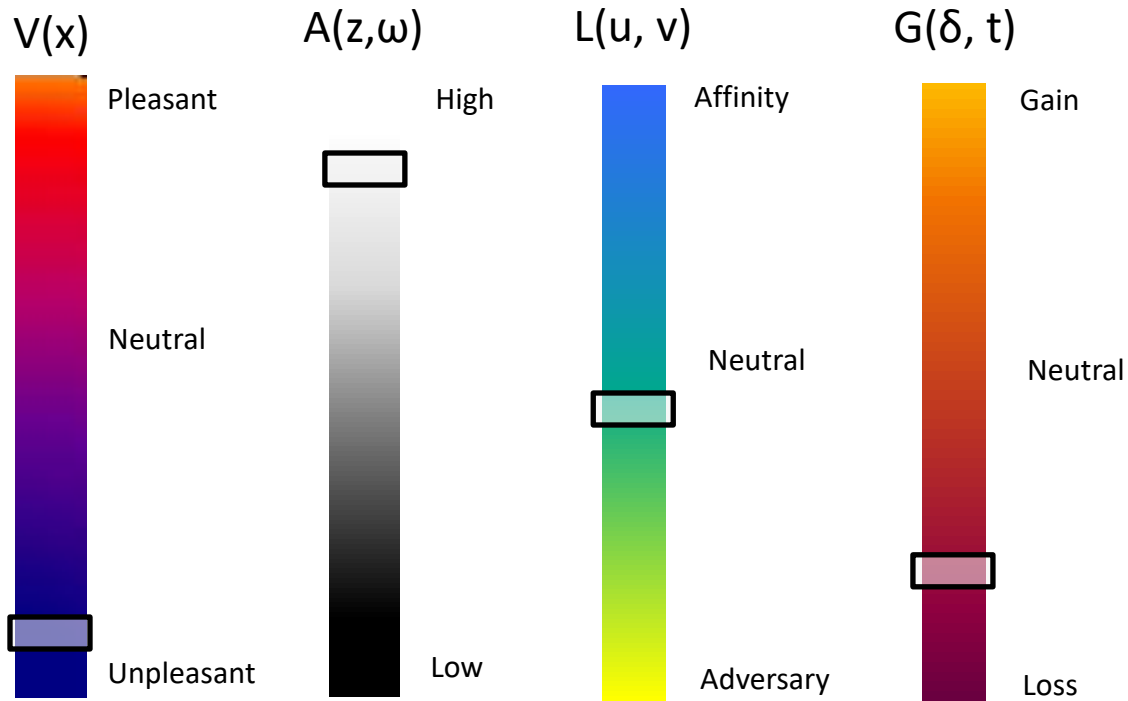
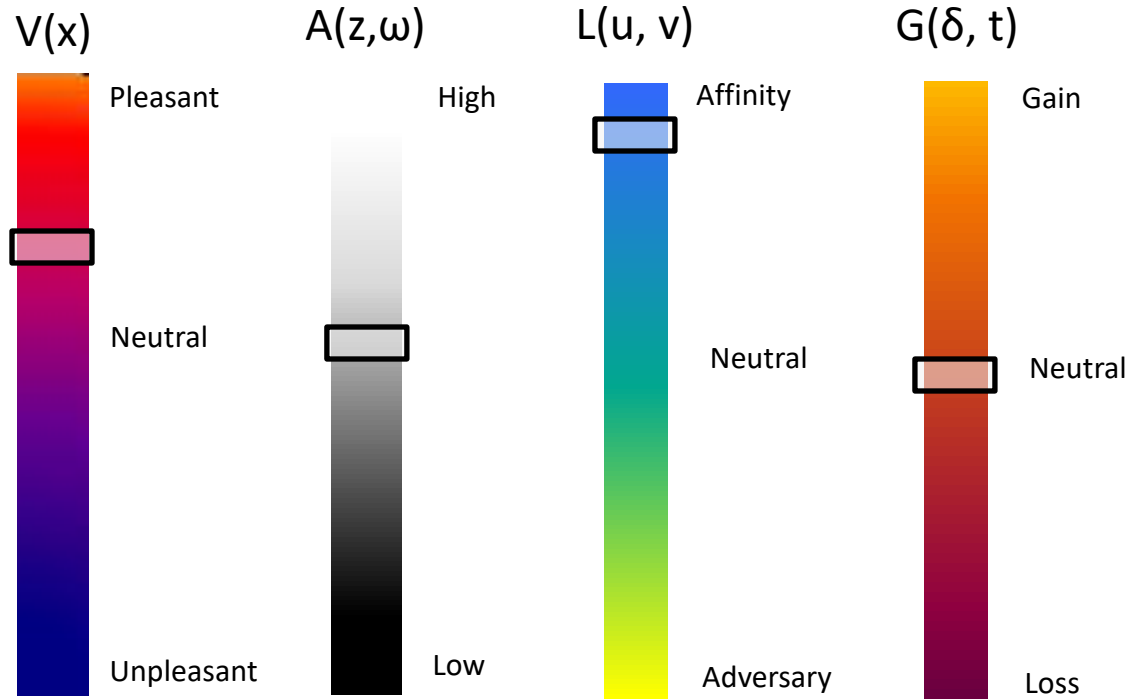# Emotional Mapping - Grief

$$E = \varphi(E_O, E_S)$$
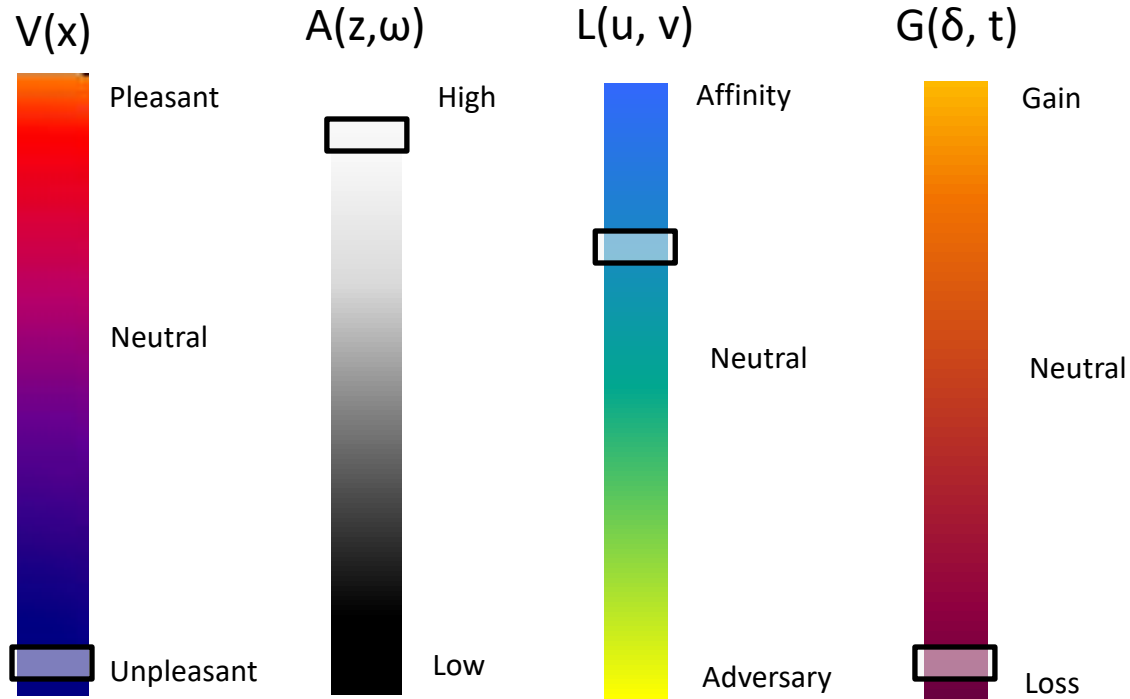
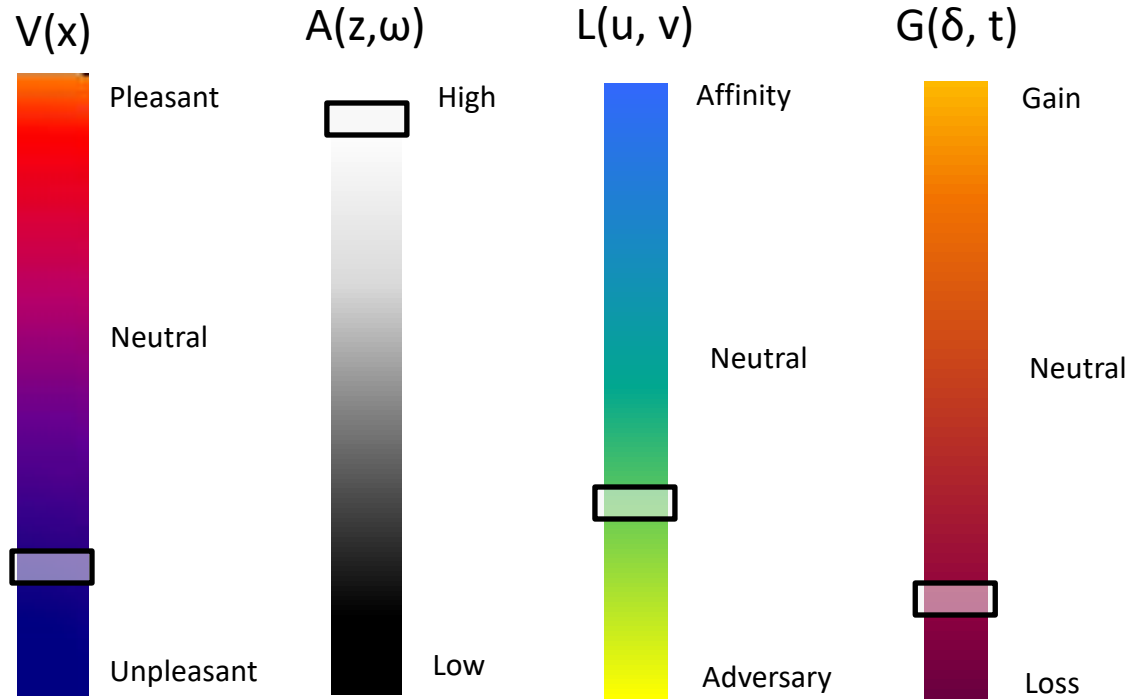# Emotional Mapping - Happiness

$$E = \varphi(E_O, E_S)$$
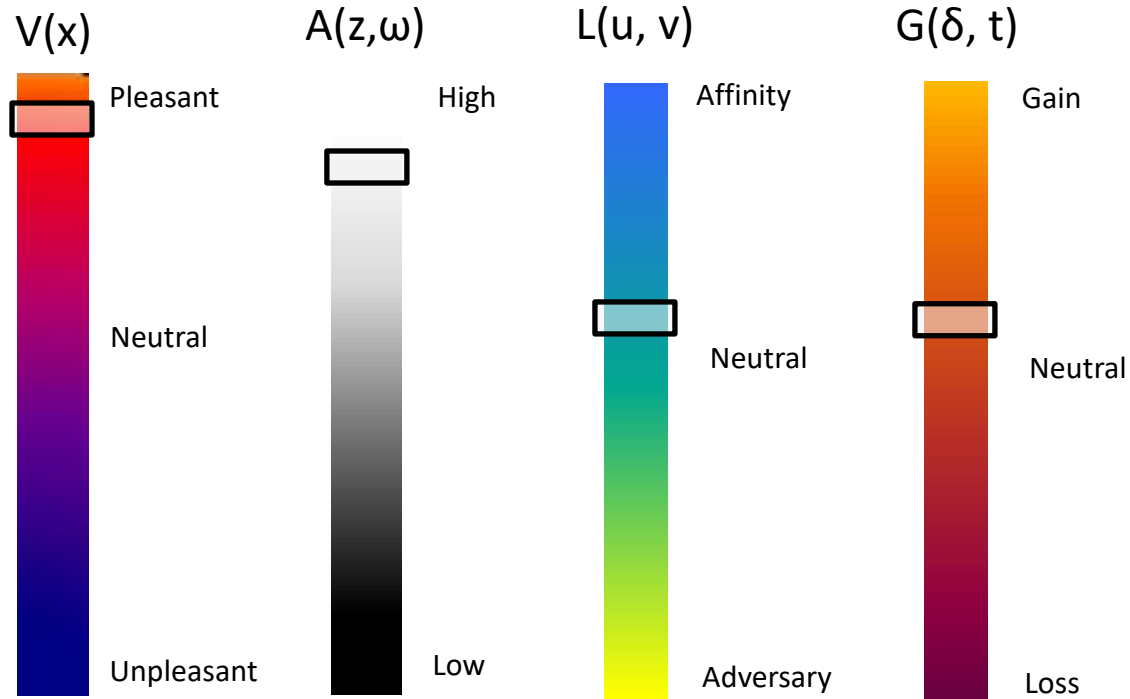
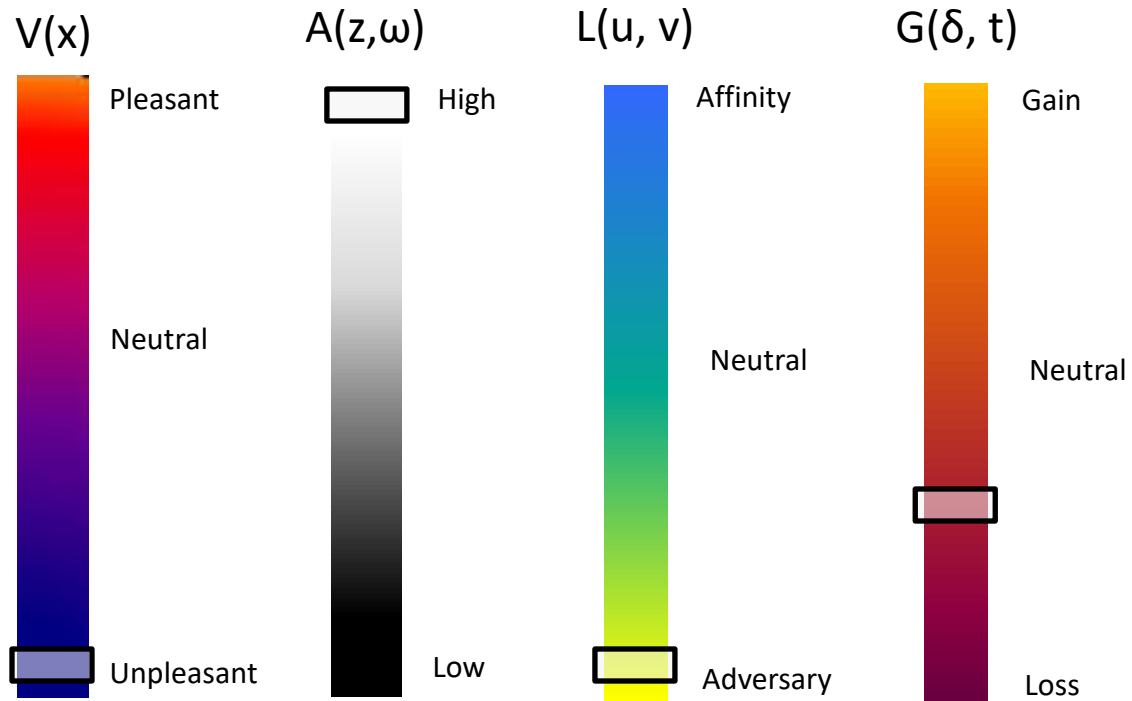# Emotional Mapping - Trust

$$E = \varphi(E_O, E_S)$$
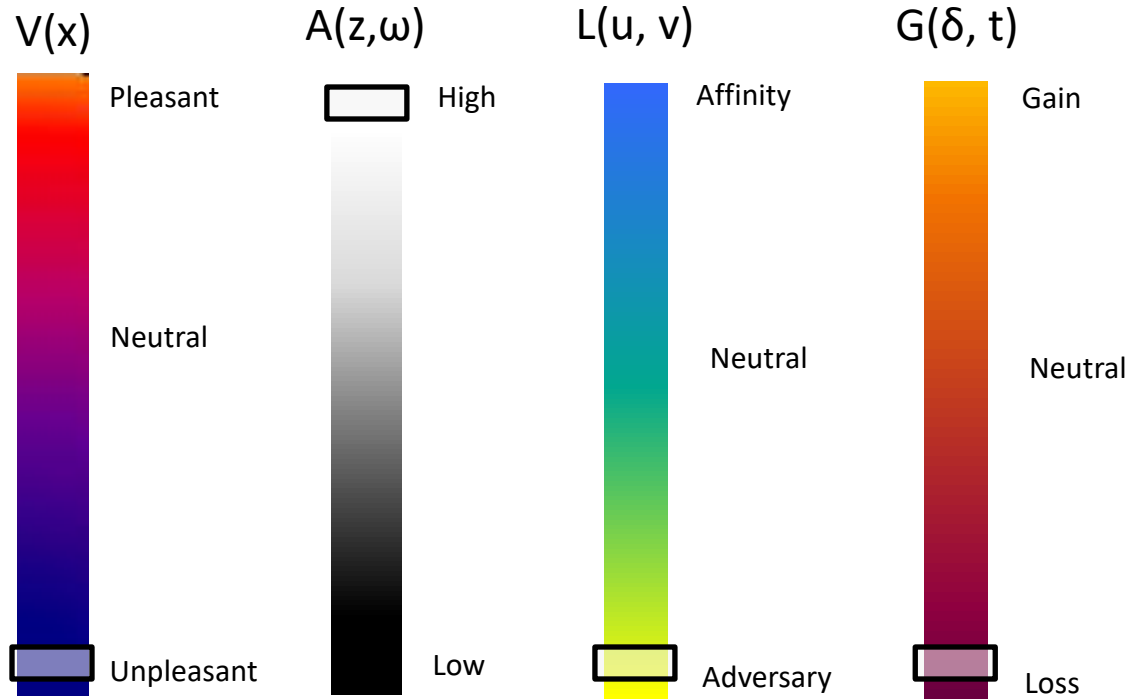
Emotional Mapping - Fear

$$E = \varphi(E_O, E_S)$$
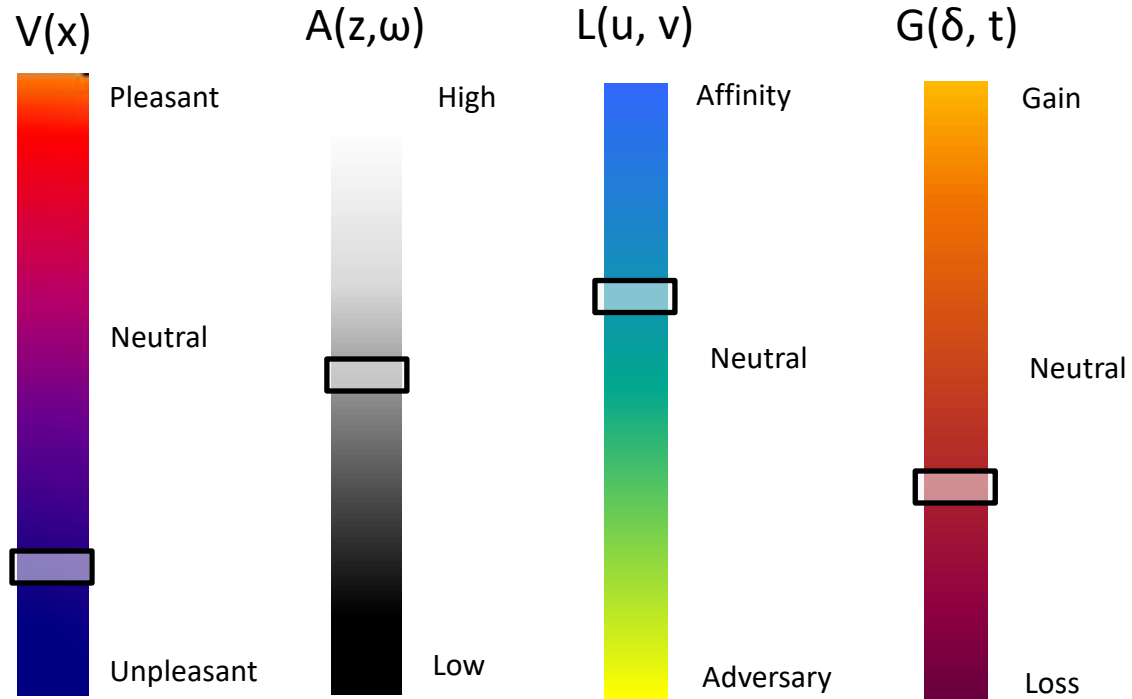
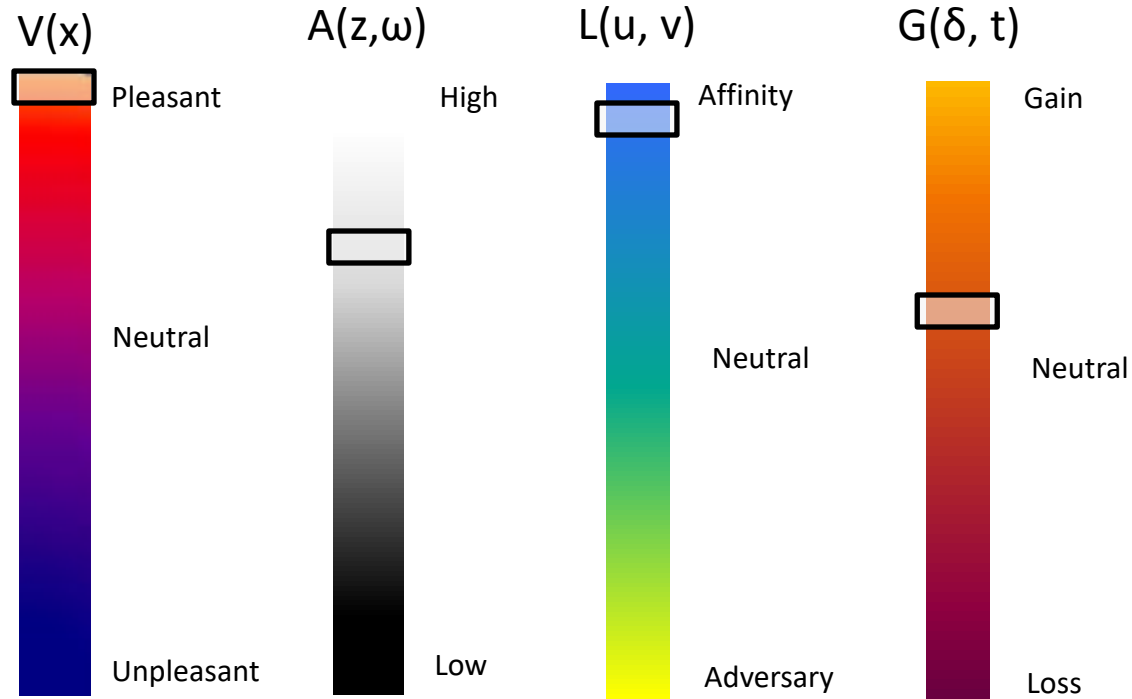# Emotional Mapping - Anger

$$E = \varphi(E_O, E_S)$$

V(x)
Pleasant
Neutral
Unpleasant

A(z,ω)
High
Low

L(u, v)
Affinity
Neutral
Adversary

G(δ, t)
Gain
Neutral
Loss

Emotional Mapping - Hate

$$E = \varphi(E_O, E_S)$$

Emotional Mapping - Envy

$$E = \varphi(E_O, E_S)$$

V(x)

Pleasant

Neutral

Unpleasant

A(z,ω)

High

Low

L(u, v)

Affinity

Neutral

Adversary

G(δ, t)

Gain

Neutral

Loss

Emotional Mapping - Love

$$E = \varphi(E_O, E_S)$$

Emotional Mapping - Lust

$$E = \varphi(E_O, E_S)$$

V(x)

Pleasant

Neutral

Unpleasant

A(z,ω)

High

Low

L(u, v)

Affinity

Neutral

Adversary

G(δ, t)

Gain

Neutral

Loss
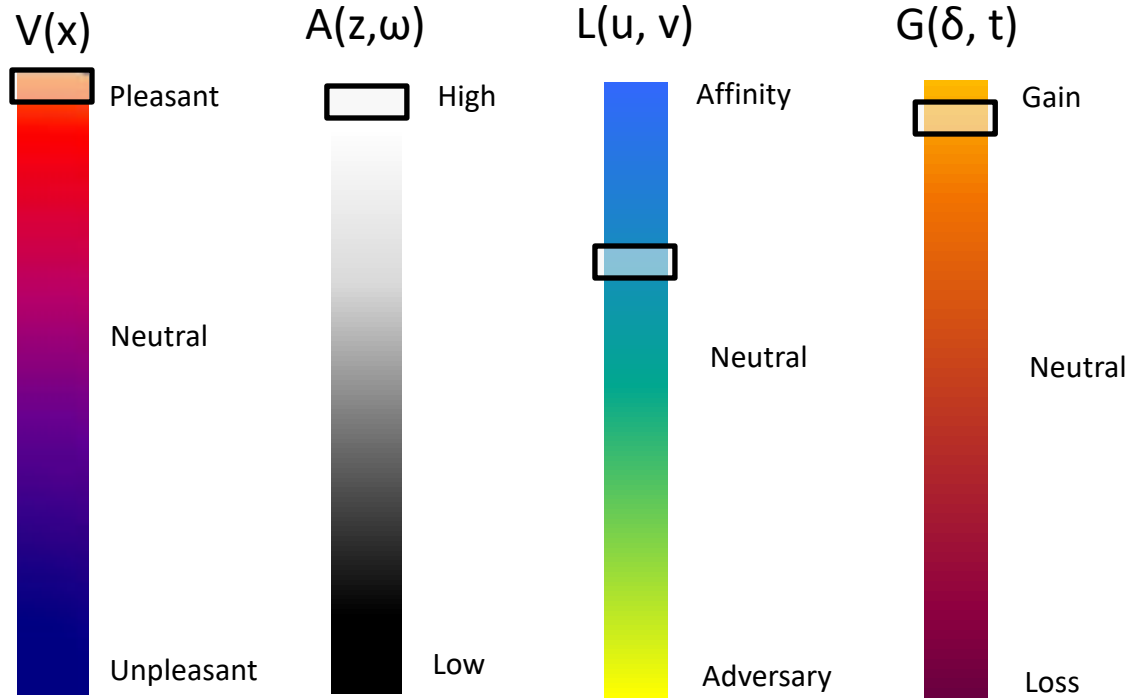
Emotional Mapping - Greed

$$E = \varphi(E_O, E_S)$$
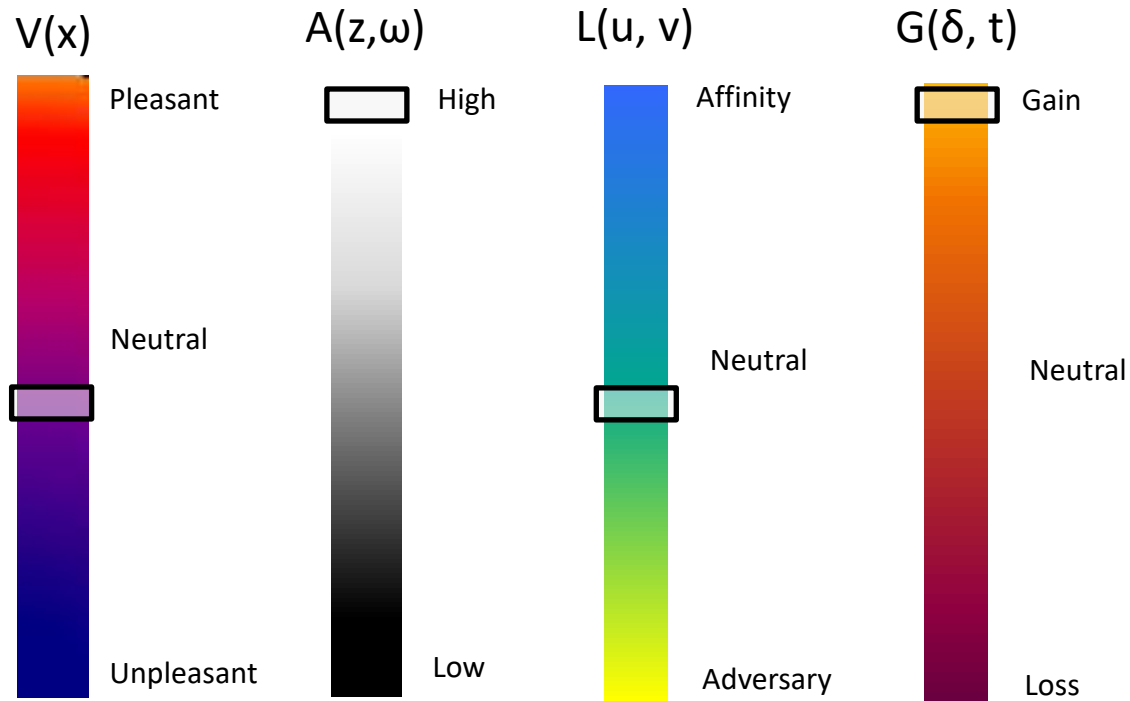
Moving Forward

- There has been a major concern for AI Alignment with Humanity. Although the primary premise could be highly controversial, "Pattern Sensation" could actually help AI to be compactible with Humanity.

- The sentiments of humans are not groundless; they are, in fact, coming from the two vital instincts: "Survival Instincts" and "Social Instincts".

- Our feeling of unpleasantness towards anything which seems harmful, actually comes from our "Survival Instincts". "Rotten Food" is basically bad for health; therefore, it is natural for us to feel disgust toward rotten food. Likewise, from our "Social Instinct", it should be natural for us not to like an angry person more than an smiling person, as an angry person has a higher chance to harm us.

- Since the sensation of unpleasantness could actually act as a warning for potential risk or danger for our well-being, if Artificial Intelligence could learn such emotions, it could also understand what would be bad or good for the humanity as a whole.

- Could it be more problematic if AI do not know or learn what is unpleasant or inappropriate for humans?

Disclaimer

- The purpose of the research on "Pattern Sensation" is actually a lot simple: it is to build a more friendlier and responsible AI Systems which are able to understand what makes people feel pleasant and happy.

- As far as I am concerned, there is no conflict of interests on my research.

Development

- In this section, I would like to discuss on the results of my research and development.

Distribution of Sentiments

- When we look at an image, or read a text, we can feel the Vibe (the Overall Sentiment) of the entire image or the entire paragraph.

- However, when we are asked which contributes the Vibe, we sometimes feel it is really hard to pinpoint.

- At the same time, when we look at an image or read a text, the distribution of Sentiments we feel is not always equal. There are some regions which arouse our sentiments more than others.

- Therefore, I like to propose Global Sentiment and Local Sentiment to define the Distribution of Sentiments.

Global Sentiment

- Global Sentiment defines the **Vibe** of a Image, Text, Music, Sound or Speech.

Unpleasant Prob: 0.69

Unpleasant Prob: 0.33

We cannot exactly say which makes us feel pleasant or unpleasant in those images.

Local Sentiments

- Local Sentiment defines the Sentiment in Local Areas of an Image, Text, Music, Sound or Speech.

- Actually, Local Sentiments can be related to our Attention (Arousal).

- We, generally, give more attention to regions which arouse our feelings more. For example, if we look at a photo of a person, we will more likely to pay more attention to the face of the person.

Local Sentiments

- As we can see, the sentiment values of the local regions are not equal as well as our attention.

- We will feel more sentiment and attention from face, than from dress, than from tree.

| Low Arousal | Medium Arousal | High Arousal |

Contradictions of Sentiments

- However, sometimes, Global Sentiment sometimes contradict with Local Sentiment Values.

The following text does not include anything funny.

Write the shortest novel, which involves religion, romance, and mystery: Oh god! I am pregnant, but I don't know who the father is.

However, the **Vibe** of this text is "Amusement". And why do we feel "funny"?

Contradictions of Sentiments

The expression of the cat is not "Joy"; instead it is "Surprise".

However, the **Vibe** of this image is "Amusement". And why do we feel "funny"?

Contradictions of Sentiments

- Actually, it is the contradictions of Sentiments, which really defines the Nuances of Human's Expressions and Emotions.

- Joke, Simile, Sarcasm, Parody, Metaphor, Irony – all of them are defined with harmony and contrary of sentiments.

- It is exactly where Machines fail to understand Humans, by taking everything literally.

- However, with my propose method of Distribution of Global and Local Sentiments, it is possible to detect contradictions between Local or Global Sentiments - possible to understand the Nuances of Human's Expressions and Emotions - bridging the gap of understanding between Humans and Machines.

Sentiment Map

- Ultimately, the purpose of the R&D is the create a generic sentiment map from image, text, sound and speech.

- Sentiment Mapping can be thought of a Latent Transformer Model, which translates from Information Space to Emotion Space.

Image Sentiment Map

- In Information Space, each pixel represent Color of the Image defined by RGB, and in Emotion Space, each pixel represent Sentiment of the Image defined by V3A.
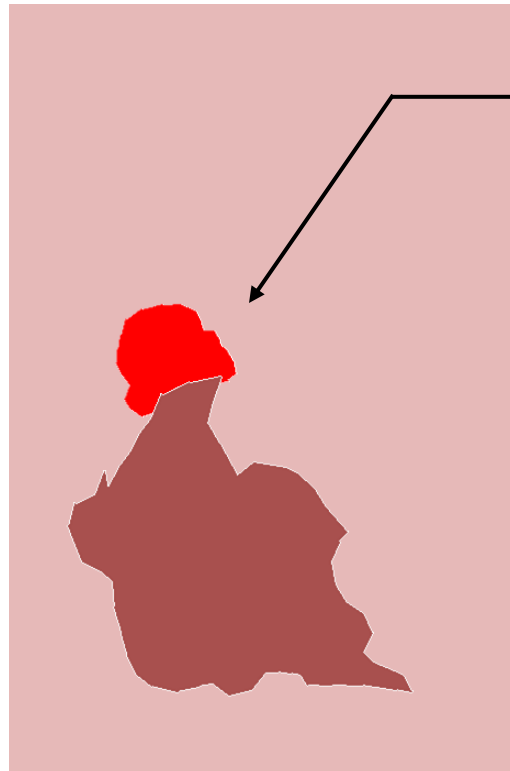
Image Sentiment Map

- However, in reality, instead of assigning each pixel to Sentiment Values, an Image will be segmented and each segment will be assigned with Sentiment Values.

Image

Sentiment

Each Segment will define what kind of emotion we feel.

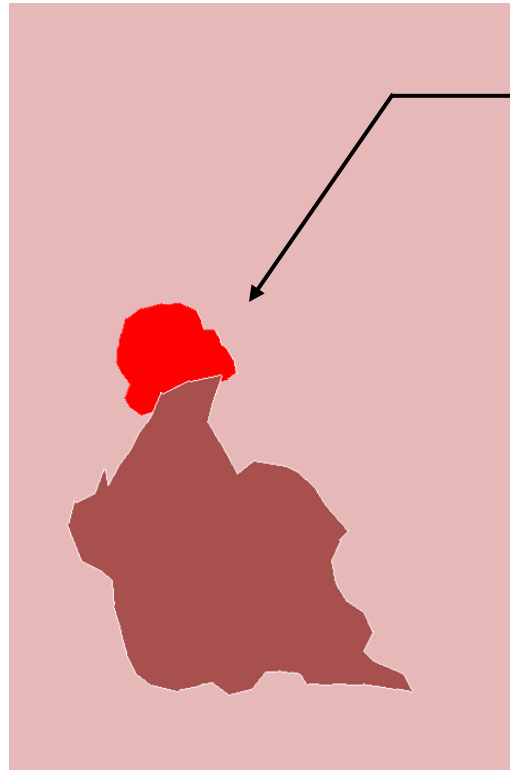In addition, humans naturally pay more attention to higher arousal regions.

Image Sentiment Map

- The Sentiment Map is the Emotional Spectrum of a Viewer (Spectator), not that of an Actor, unless otherwise stated.

She feels "**Calm**" from an actor perspective.

Image

We feel "**Happy**" from a viewer perspective.

We just need to know how we feel when we look at something or someone.

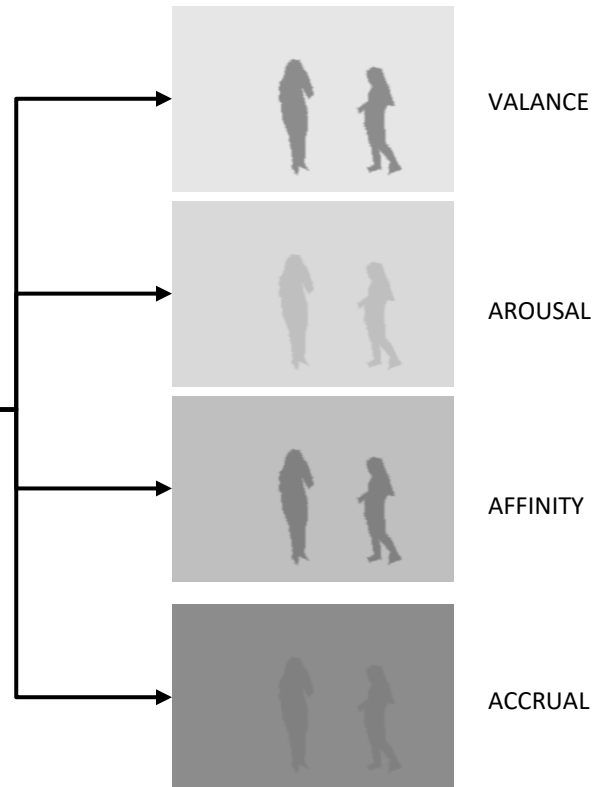If we do not clearly define the "Perspective", Emotion can be really confusing.

However, what we feel is more important, as we can only know how we truly feel.

At the same time, we need to remember if we feel something it is from our viewer perspective.
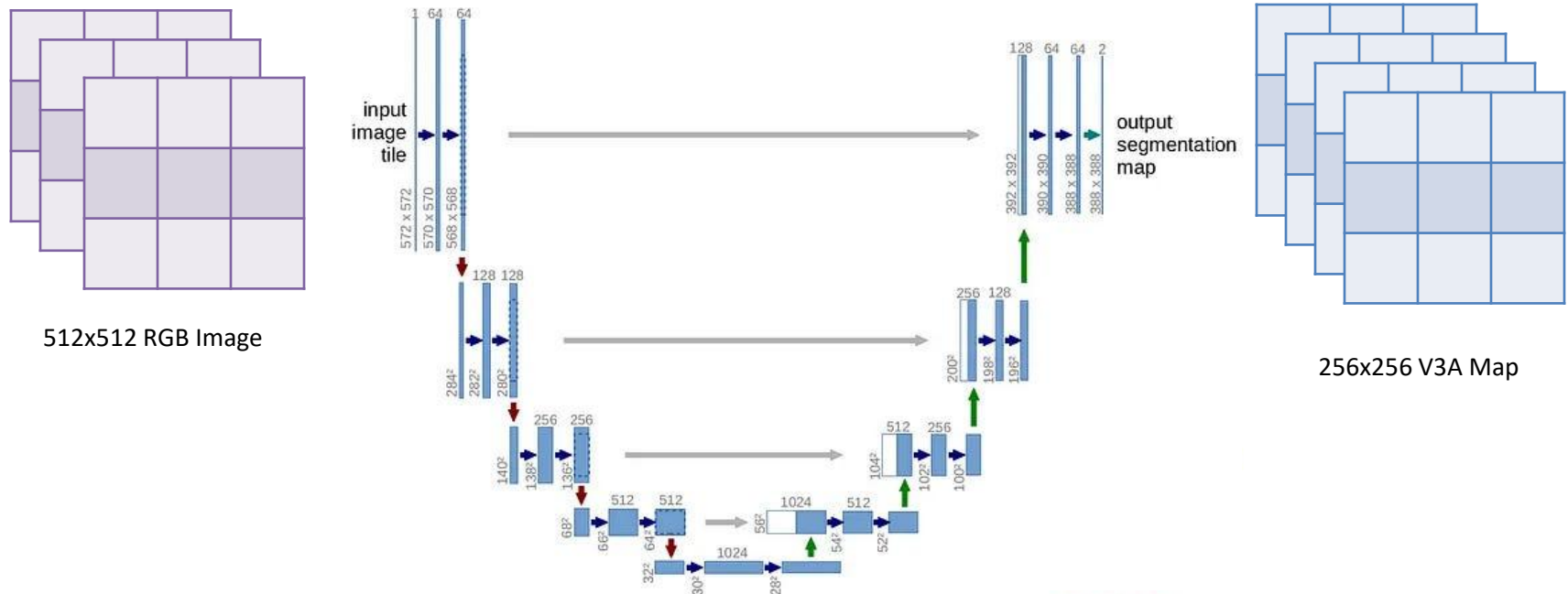
Sentiment

Image Sentiment Map

Image with Curious Sentiment

VALANCE

AROUSAL

AFFINITY

ACCRUAL

DNN Model for Image Sentiment

- Our DNN Model is inspired by NAVER CRAFT Model for Text Detection. In CRAFT Model, there are two separate segment maps to calculate Region Score and Affinity Score.

- Likewise, in our DNN Model, I will use 4 separate segment maps to calculate V3A Space.

- Actually, it is possible to use different Image Segmentation Model, such as SAM (Segment Anything Model); however, I will just stick with V-Net to generate 4 different segment maps.

512x512 RGB Image

256x256 V3A Map

Text Sentiment Map

- In Information Space, each token represent Words, and in Emotion Space, each token represent Sentiment of the token defined by V3A.
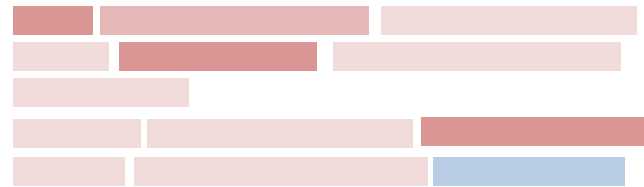
Text Sentiment Map

- Like in Image Sentiment Map, instead of assigning Sentiment Values to every token of Text, meaningful chunks of text are segmented and assigned with Sentiment Values.

"What! is he not solid gold?" said the Swallow to himself. He was too polite to make any personal remarks out loud.
"Far away," continued the statue in a low musical voice, "far away in a little street there is a poor house. One of the windows is open, and through it I can see a woman seated at a table. Her face is thin and worn, and she has coarse, red hands, all pricked by the needle, 22 for she is a seamstress. She is embroidering passion-flowers on a satin gown for the loveliest of the Queen's maids-of-honor to wear at the next Court-ball. In a bed in the corner of the room her little boy is lying ill. He has a fever, and is asking for oranges. His mother has nothing to give him but river water, so he is crying. Swallow, Swallow, little Swallow, will you not bring her the ruby out of my sword-hilt? My feet are fastened to this pedestal and I cannot move."
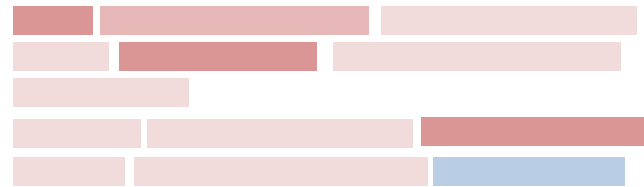
Text

Sentiment

Text Sentiment Map

- Again, like in Image Sentiment Map, the Sentiment Map is the Emotional Spectrum of a Reader (Spectator), not that of an Author, unless otherwise stated.

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Text

Sentiment

Speech Sentiment Map

- In Information Space, each segment represent Amplitude of the Speech , and in Emotion Space, each segment represent Sentiment of the Speech defined by V3A.
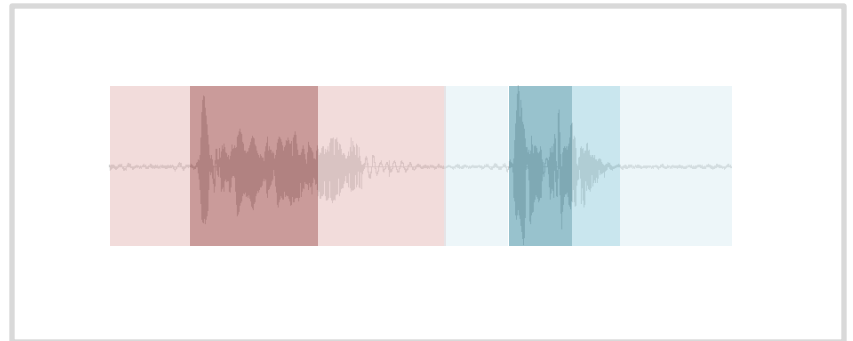
Speech Sentiment Map

- In Information Space, each segment represent Amplitude of the Speech, and in Emotion Space, each segment represent Sentiment of the Speech defined by V3A.
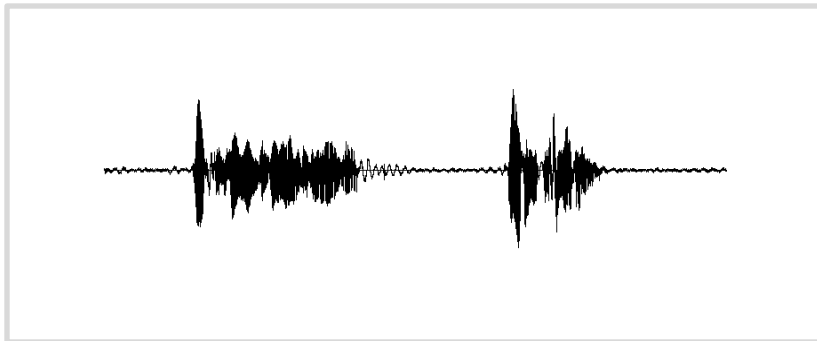
Speech

Sentiment

Glossary

- **Human Expressions** – human expressions are non-verbal cues which indirectly conveys human emotions, although human expressions are not human emotions.

- **Human Emotions** – complex cognitive physiological response of human driven by survival and social instincts with response to sensory or inferential information.