A Formal Description of the VAS Emotion Model and Its Use in Agent-Based Simulation

Chryote

Abstract

This document formalizes a Valence–Arousal–Sociality (VAS) emotion model for autonomous agents. The model incorporates perception, personality traits, attribution logic, emotion dynamics, and relationship memory. Together, these mechanisms produce coherent emotional behavior and emergent social drama in simulations such as text-based RPG worlds.

1 Overview of the VAS Dimensions

The VAS model represents emotion as a three-dimensional continuous vector [1]:

$$E = (V, A, S)$$

where:

- **Valence** V: Pleasantness of the emotion, ranging from -1 (very negative) to $+1$ (very positive).
- **Arousal** A: Activation level, ranging from 0 (calm) to 1 (high intensity).
- **Sociality** S: Directionality of social behavior, ranging from -1 (avoid/flee) to $+1$ (approach/engage).

Example reference values from the model notes [1]:

- Anger: $(-0.7,\ 1.0,\ +0.7)$
- Disgust: $(-0.5,\ 0.7,\ -0.9)$
- Love: $(+1.0,\ 0.6,\ +1.0)$

2 Perception Layer

Agents do not respond to raw events, but to their *interpretation*. We define the following perception variables:

$$SV \in [0, 1] \quad \text{(sensory intensity)}$$
$$I_{\text{raw}} \in [-1, 1] \quad \text{(perceived intent)}$$
$$u \in [0, 1] \quad \text{(uncertainty)}$$
$$A_{\text{mod}} \in [-1, 1] \quad \text{(attribution modifier)}$$

Higher uncertainty increases arousal and may reduce the clarity of valence.

3 Personality Traits

Each agent i has stable personality traits :

$$T = \{dominance,\ agreeableness,\ anxiety\_sensitivity,\ novelty\_seek,\ self\_worth\}$$

For example, an agent may have:

$$dominance = 0.70, \quad agreeableness = 0.55, \quad anxiety\_sensitivity = 0.45$$

These traits bias both interpretation and emotional responses.

4 Emotion Computation

4.1 Valence

Valence incorporates perceived intent, attribution, and relationship history:

$$V = (1 - u)(I_{\text{raw}} + A_{\text{mod}}) + \alpha R_v$$

where:

- u reduces certainty.
- R_v is the relationship valence baseline.
- α is a weighting coefficient (0.1–0.3).

4.2 Arousal

Arousal increases with sensory intensity, uncertainty, and relationship importance:

$$A = SV(1 + u) + \beta|R_v|$$

4.3 Sociality

Sociality determines whether the agent approaches or avoids the target:

$$S = \gamma V + \delta I_{\text{raw}} + \epsilon dominance + \eta R_s$$

where R_s is long-term sociality memory.

5 Emotion Dynamics

5.1 Decay

Emotions naturally fade over time:

$$E_{t+1} = E_t(1 - d)$$

with decay rate $d \in [0.01, 0.2]$.

5.2 Stacking (Accumulation)

If multiple events push emotion in the same direction:

$$E_{t+1} = E_{t+1} + kE_t$$

where k is a stacking factor (0.05–0.2). This produces escalation such as anger spirals or deepening attachment.

6 Relationship Memory

Relationships evolve using an exponential moving average:

$$R'_v = 0.9R_v + 0.1V$$
$$R'_s = 0.9R_s + 0.1S$$

Agents thus develop trust, resentment, affection, or hostility over time.

7 Case Study Simulation

We illustrate the model using a simple scenario:

Scenario

Agent A accidentally bumps into Agent B in a crowded market. Agent B must interpret the event.

Initial Conditions

$$SV = 0.3 \quad \text{(light impact)}$$
$$I_{\text{raw}} = -0.2 \quad \text{(possibly careless but not malicious)}$$
$$u = 0.4 \quad \text{(uncertainty due to crowd)}$$
$$A_{\text{mod}} = -0.1 \quad \text{(attribution: mildly negative)}$$

Relationship baselines:

$$R_v = 0.0, \quad R_s = 0.0$$

Personality:

$$\textit{dominance} = 0.7$$

7.1 Step 1: Compute Valence

$$V = (1 - 0.4)(-0.2 - 0.1) + 0 = 0.6(-0.3) = -0.18$$

7.2 Step 2: Compute Arousal

$$A = 0.3(1 + 0.4) = 0.42$$

7.3 Step 3: Compute Sociality

$$S = 0.6V + 0.3I_{\text{raw}} + 0.2dominance$$

$$S = 0.6(-0.18) + 0.3(-0.2) + 0.2(0.7)$$

$$S = -0.108 - 0.06 + 0.14 = -0.028$$

Interpretation: Weak avoidance; not enough to escalate into hostility.

7.4 Step 4: Update Relationship Memory

$$R'_v = 0.1(-0.18) = -0.018$$
$$R'_s = 0.1(-0.028) = -0.0028$$

The relationship becomes slightly negative, reflecting a mild annoyance.

7.5 Simulated Outcome

Agent B may respond with:

- slight avoidance,
- a passive-aggressive glance,
- or a minor verbal complaint.

Emotional stacking would amplify this if multiple annoyances accumulate.

8 Conclusion

The VAS model formalized here provides a continuous emotional engine supporting emergent social behavior. Its modular perception, personality influence, and dynamic relationship memory allow sophisticated social simulations suitable for narrative-driven games and autonomous agent worlds.

References

[1] Russell, James A. "A circumplex model of affect." Journal of personality and social psychology 39.6 (1980): 1161.