Driving Emotionally Expressive NPC Animations and Behaviors with a Designer-friendly Pipeline

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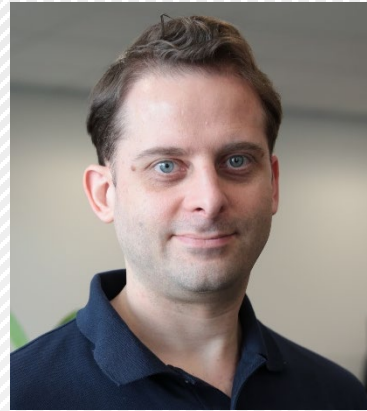GAME DEVELOPERS CONFERENCE | July 19-23, 2021
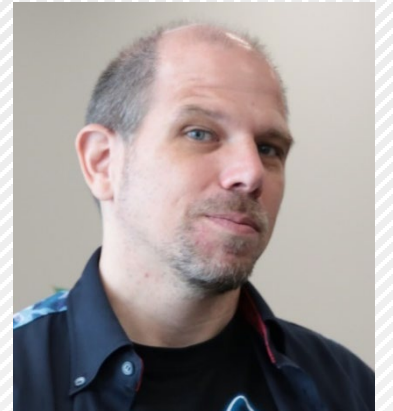
team

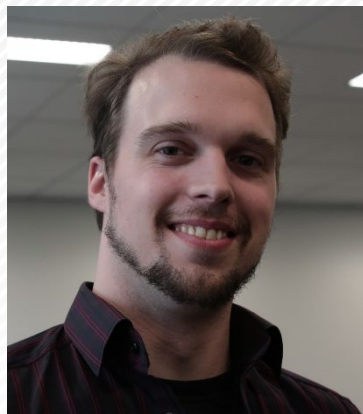Gautier Boeda

Shinpei Sakata

Remi Driancourt

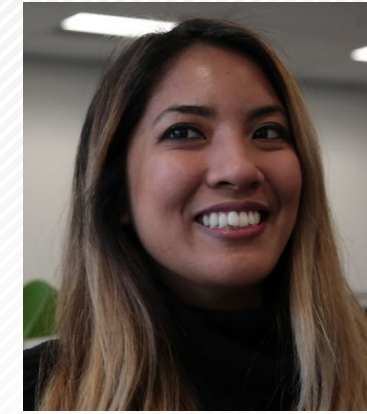Youichiro Miyake

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Xintong Lyu

Sietske Wielsma

Justin (Wai Keat) Wong

Adelle Bueno

Eduardo Mosena

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history

history

Style Transfer
Deep Learning

Photograph
Genetic Algorithm

Drawing
Neural Network

Learning
Operant Conditioning

Pathfinding
Navigation Mesh

Perception
Smart Object

Inheritance Action
Affordance Comparison

Animation Blending
Finite State Machine

Buddy Communication
Multi Agent Language

Memory
Associative Tagging

Personality & Emotion
Emotional Component

Decision Making
Utility System

Problem Resolution
GOAP

AI Technologies
G D C 2 0 2 1

"Gods do not play dice."

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What?

What are emotions, moods, personalities?

Emotion mood persona
explanation

Personality

Emotion ⟷ Mood

Defines the agent
Fixed or evolve very slowly over time
Curiosity, Shyness, Laziness, ...

Long term feeling
Evolve slowly over time
Exuberant, Depressed, Afraid, ...

Short term feeling
Evolve quickly over time
Joy, Distress, Fear, ...

Why?

Why would you want them in ?Owhdorthebring?

Why?
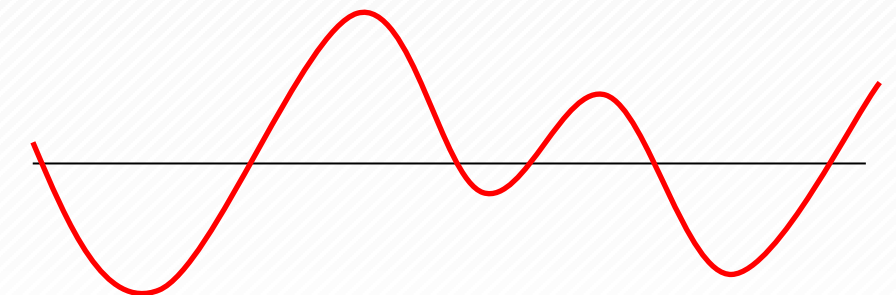
Why would you want them in your game? What do they bring?

without Emotional Component

with Emotional Component

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Emotional PIPEL

Emotion, mood, personality

Emotional PIPELINE

Emotion + OCC MODEL

Game Event

Positive
Negative

CONSEQUENCE (OF EVENT)

Pleased
Displeased

PROSPECTIVE CONSEQUENCE

Hope
Fear

ACTUAL CONSEQUENCE

Joy
Distress

ACTION (OF AGENT)

Approving
Disapproving

SELF AGENT

Pride
Shame

OTHER AGENT

Admiration
Reproach

RELATED CONSEQUENCE

Pride
Shame

RELATED CONSEQUENCE

Admiration
Reproach

ASPECT (OF OBJECT)

Liking
Disliking

FAMILIAR ASPECT

Love
Hate

UNFAMILIAR ASPECT

Interest
Disgust

CONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE

Satisfaction

CONFIRM PROSPECTIVE UNDESIRABLE CONSEQUENCE

Fears-confirmed

DISCONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE

Relief

DISCONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE

Disappointment

CONFIRM PROSPECTIVE DESIRABLE FOR OTHER

Happy-for
Resentment

CONFIRM PROSPECTIVE UNDESIRABLE FOR OTHER

Gloating
Pity

Emotional PIPELINE

Emotion-inspired OCC model ← Holder example

Game Event

↓

Positive
Negative

```
CONSEQUENCE              ACTION                  ASPECT
(OF EVENT)               (OF AGENT)              (OF OBJECT)

Pleased                  Approving               Liking
Displeased               Disapproving            Disliking

PROSPECTIVE   ACTUAL     SELF        OTHER
CONSEQUENCE   CONSEQUENCE AGENT      AGENT

Hope          Joy        Pride       Admiration   Love
Fear          Distress   Shame       Reproach     Hate
```

Emotional PIPELINE

Emotion-inspired OCC model — Holder example

Player hit the ball with the bat

Positive
Negative

CONSEQUENCE
(OF EVENT)

ACTION
(OF AGENT)

ASPECT
(OF OBJECT)

Pleased
Displeased

Approving
Disapproving

Liking
Disliking

PROSPECTIVE
CONSEQUENCE

ACTUAL
CONSEQUENCE

SELF
AGENT

OTHER
AGENT

Hope
Fear

Joy
Distress

Pride
Shame

Admiration
Reproach

Love
Hate
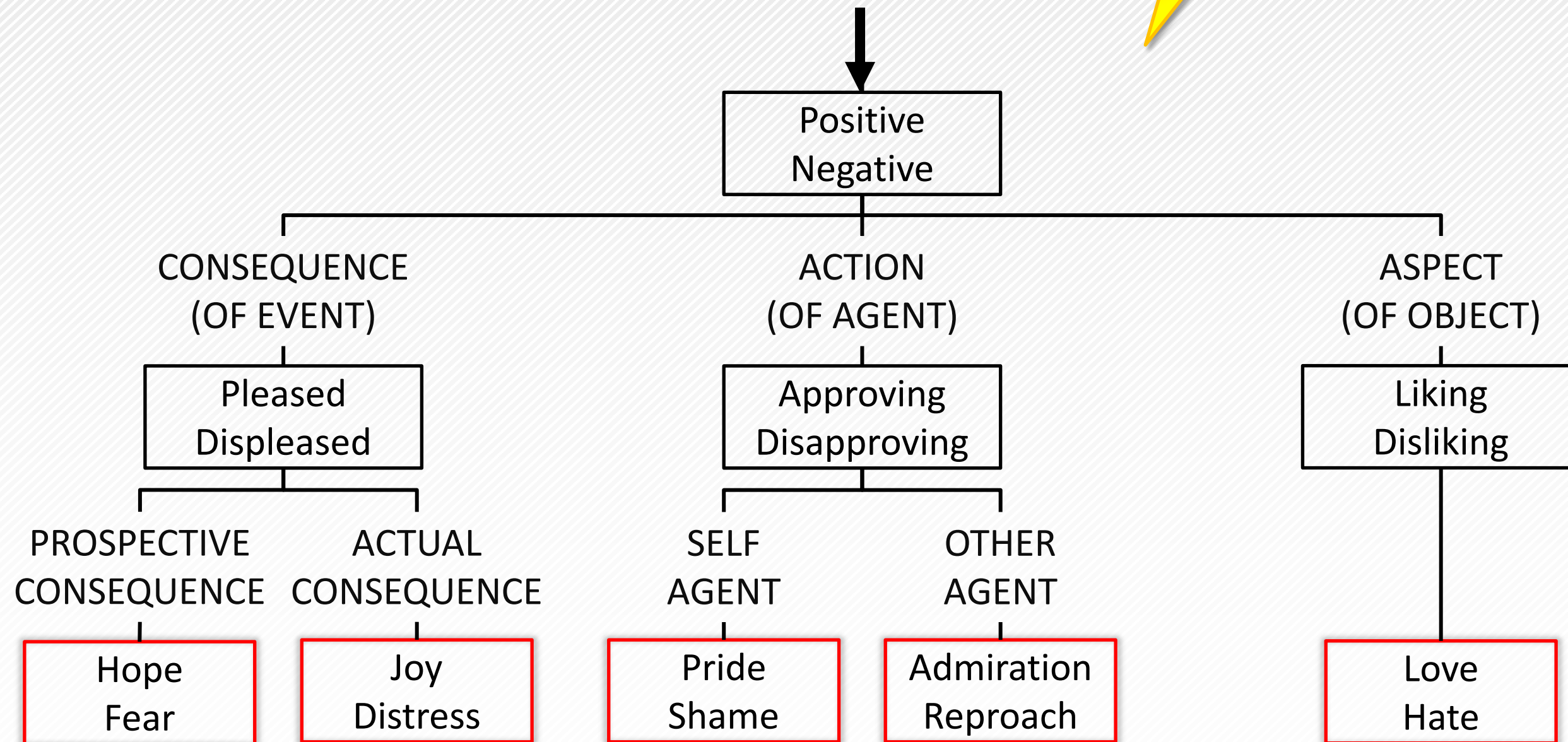
Emotional PIPELINE

Emotion-inspired OCC model — Wilder example

Window broke due to the ball
(hit by the player earlier)

```
                          Positive
                          Negative
```

CONSEQUENCE   ACTION   ASPECT
(OF EVENT)   (OF AGENT)   (OF OBJECT)

```
    Pleased                   Approving                      Liking
    Displeased                Disapproving                   Disliking
```

PROSPECTIVE   ACTUAL   SELF   OTHER
CONSEQUENCE   CONSEQUENCE   AGENT   AGENT

| Hope | Joy | Pride | Admiration | Love |
| Fear | Distress | Shame | Reproach | Hate |

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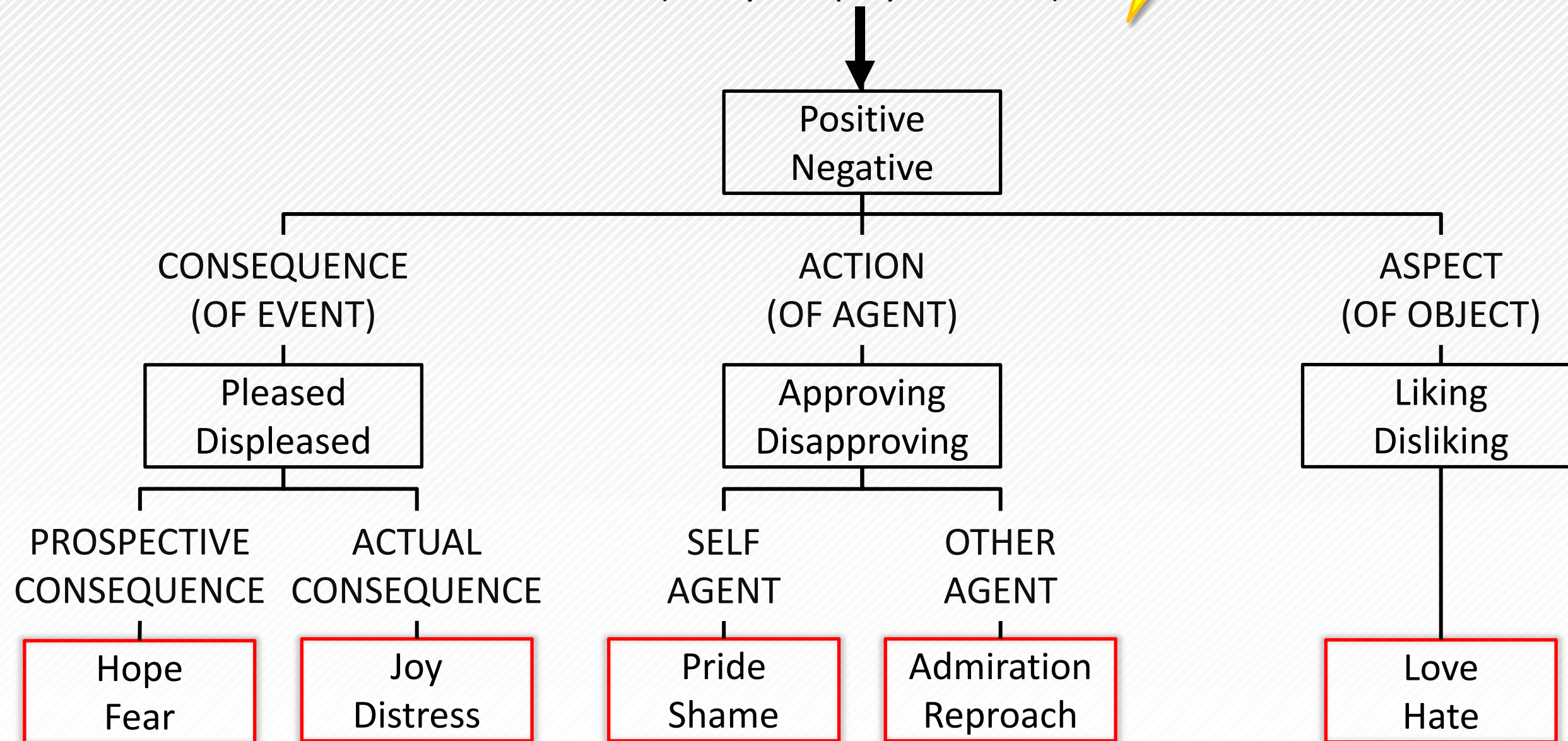
Emotional PIPELINE

Emotion—explanation

Game Event

↓

| Positive |
| Negative |

CONSEQUENCE (OF EVENT)

| Pleased |
| Displeased |

ACTION (OF AGENT)

| Approving |
| Disapproving |

ASPECT (OF OBJECT)

| Liking |
| Disliking |

PROSPECTIVE CONSEQUENCE

| Hope |
| Fear |

ACTUAL CONSEQUENCE

| Joy |
| Distress |

SELF AGENT

| Pride |
| Shame |

OTHER AGENT

| Admiration |
| Reproach |

FAMILIAR ASPECT

| Love |
| Hate |

UNFAMILIAR ASPECT

| Interest |
| Disgust |

RELATED CONSEQUENCE

| Pride |
| Shame |

RELATED CONSEQUENCE

| Admiration |
| Reproach |

CONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE

Satisfaction

CONFIRM PROSPECTIVE UNDESIRABLE CONSEQUENCE

| --- |
| Fears-confirmed |

DISCONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE

Relief

DISCONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE

| --- |
| Disappointment |

CONFIRM PROSPECTIVE DESIRABLE FOR OTHER

| Happy-for |
| Resentment |

CONFIRM PROSPECTIVE UNDESIRABLE FOR OTHER

| Gloating |
| Pity |

Emotional PIPELINE

Emotions expression

- Voice sound

- Facial blend

- Specialanimations

- Specific speech

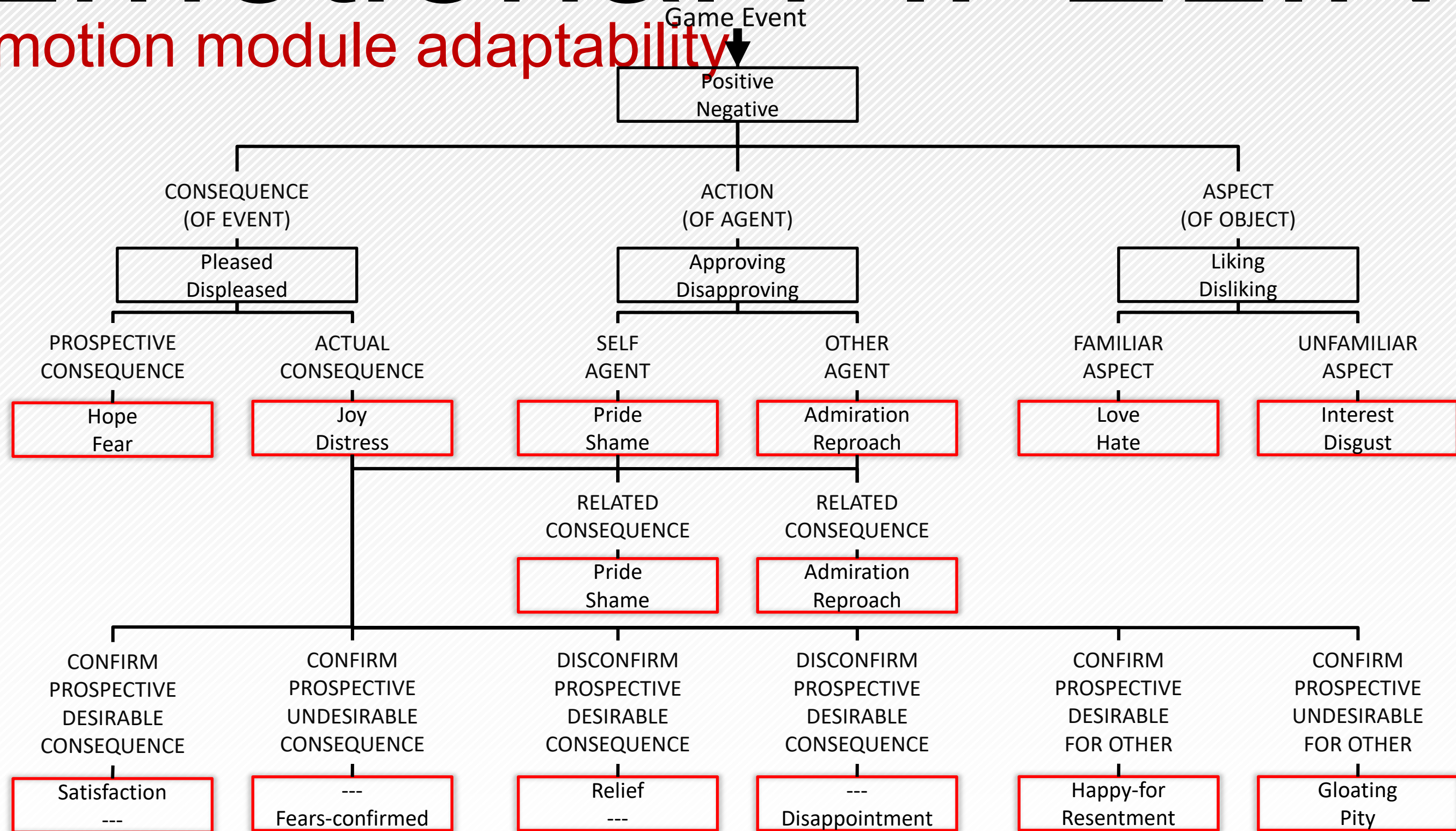Blended on top of personality and mood animations.

Fear	Hope
Distress	**Joy**
Shame	Pride
Anger	Admiration
Hate	Love
None	

Emotional PIPELINE

Emotion module adaptability

Game Event

Positive
Negative

| CONSEQUENCE (OF EVENT) | ACTION (OF AGENT) | ASPECT (OF OBJECT) |

Pleased
Displeased

Approving
Disapproving

Liking
Disliking

| PROSPECTIVE CONSEQUENCE | ACTUAL CONSEQUENCE | SELF AGENT | OTHER AGENT | FAMILIAR ASPECT | UNFAMILIAR ASPECT |

Hope
Fear

Joy
Distress

Pride
Shame

Admiration
Reproach

Love
Hate

Interest
Disgust

RELATED CONSEQUENCE

RELATED CONSEQUENCE

Pride
Shame

Admiration
Reproach

| CONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE | CONFIRM PROSPECTIVE UNDESIRABLE CONSEQUENCE | DISCONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE | DISCONFIRM PROSPECTIVE DESIRABLE CONSEQUENCE | CONFIRM PROSPECTIVE DESIRABLE FOR OTHER | CONFIRM PROSPECTIVE UNDESIRABLE FOR OTHER |

Satisfaction

Fears-confirmed

Relief

Disappointment

Happy-for
Resentment

Gloating
Pity

Emotional PIPELINE

Emotion module adaptability

Emotional PIPELINE
Emotion module adaptability

Positive
Negative

CONSEQUENCE
(OF EVENT)

ACTION
(OF AGENT)

ASPECT
(OF OBJECT)

Pleased
Displeased

Approving
Disapproving

Liking
Disliking

ACTUAL
CONSEQUENCE

SELF
AGENT

OTHER
AGENT

FAMILIAR
ASPECT

UNFAMILIAR
ASPECT

Joy
Distress

Pride
Shame

Admiration
Reproach

Love
Hate

Interest
Disgust

Emotional PIPELINE

Emotion module adaptability

Emotional PIPELINE
Emotion module adaptability

Emotion
- Type
- Duration
- Intensity

Event	Category	Intensity [-1, 1]	MinDuration	MaxDuration	DurationRatio [0, 1]
EAT_FOOD	ACTION_OF_AGENT	= memory.liking(event.item)	4	4	1
HIT_BY_OBJECT	CONSEQUENCE_OF_EVENT	= - event.hit.speed * event.item.weight	4	20	= power(intensity, 2)
OBJECT_VISIBLE	ASPECT_OF_OBJECT	= memory.liking(event.item)	4	4	1

Positive/Negative evaluation is done based on the Intensity result

Emotional PIPELINE

Like dislike

CONSEQUENCE
(OF EVENT)

Pleased
Displeased

ACTUAL
CONSEQUENCE

Joy
Distress

Agent electrified by a fence.

1. Generate a Distress emotion
   - Intensity computed based on the severity of the shock
2. Add a negative affect to
   - "fence" object

An affect has:
- intensity
- memorable duration

Red Apple

Times Used — 8

Preference

Eat	60%	Lift	10%
Stomp	10%		
Throw	10%		
Kick	10%		

In Wonder, we do not have time-based affect. We only increment/decrement the liking of the item.

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Emotional PIPELINE

Mood Model – PAD

MOOD OCTANT	P	A	D
Exuberant	+	+	+
Dependent	+	+	-
Relaxed	+	-	+
Docile	+	-	-
Afraid	-	+	-
Hostile	-	+	+
Disdainful	-	-	+
Depressed	-	-	-

Default Mood (P=0, A=0, D=0)
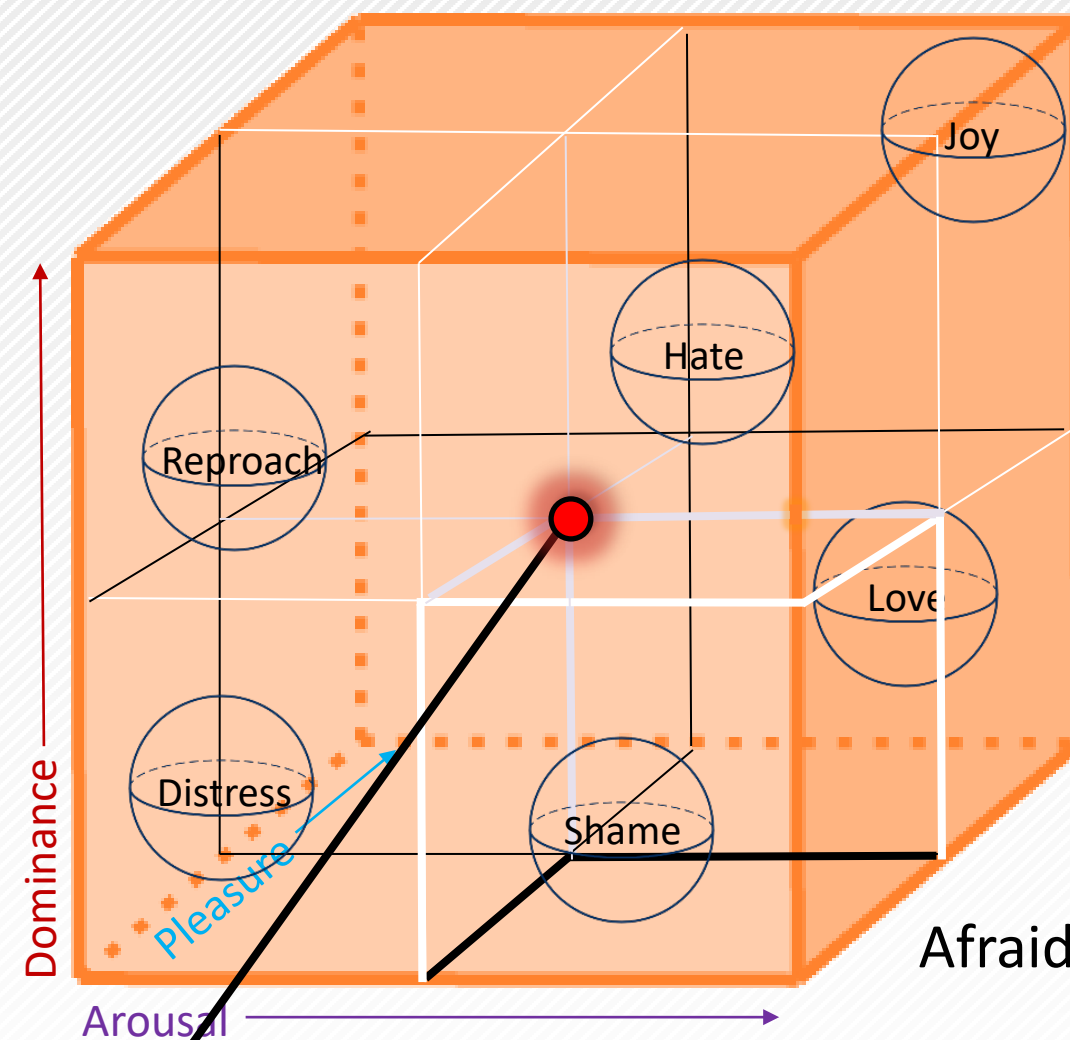
P   Pleasure Displeasure

How **pleasant** is an emotion.

Joy   ⟷   Fear

A   Arousal Nonarousal

How **intense** is an emotion.

Rage   ⟷   Boredom

D   Dominance Submissiveness

How much **control** and **influence** the agent has over situations

Anger   ⟷   Distress

Patrick Gebhard. 2005. ALMA: a layered model of affect. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems* (*AAMAS '05*).

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Emotion a PIPELINE
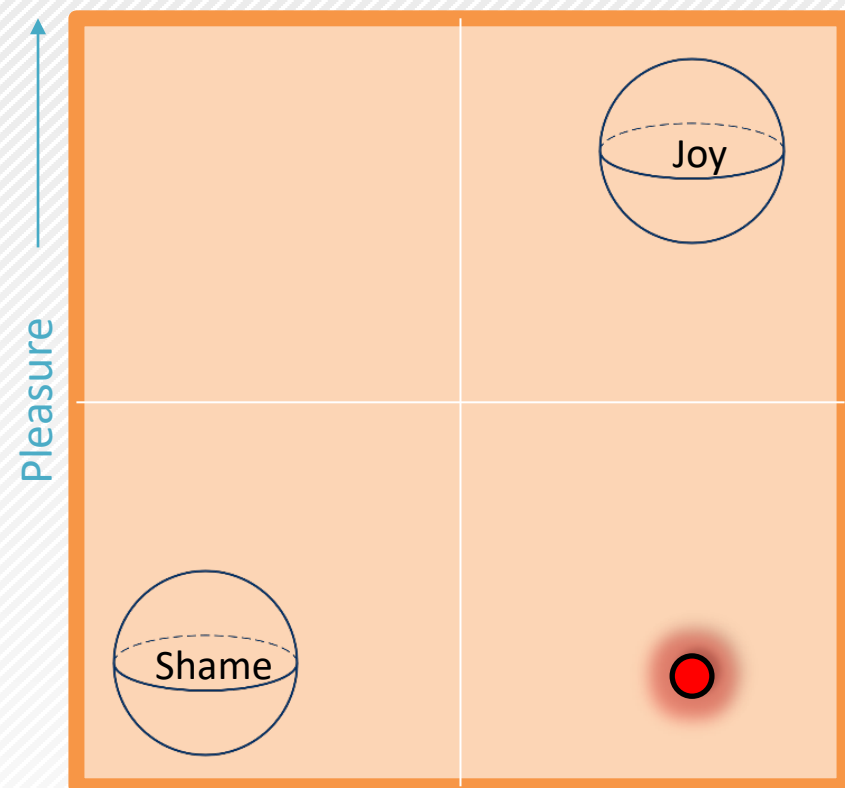
Mood Module—PAD

Emotions	Intensity	Time
Joy	0.5	5s

| Emotions	Intensity	Time
Joy	1.0	5s

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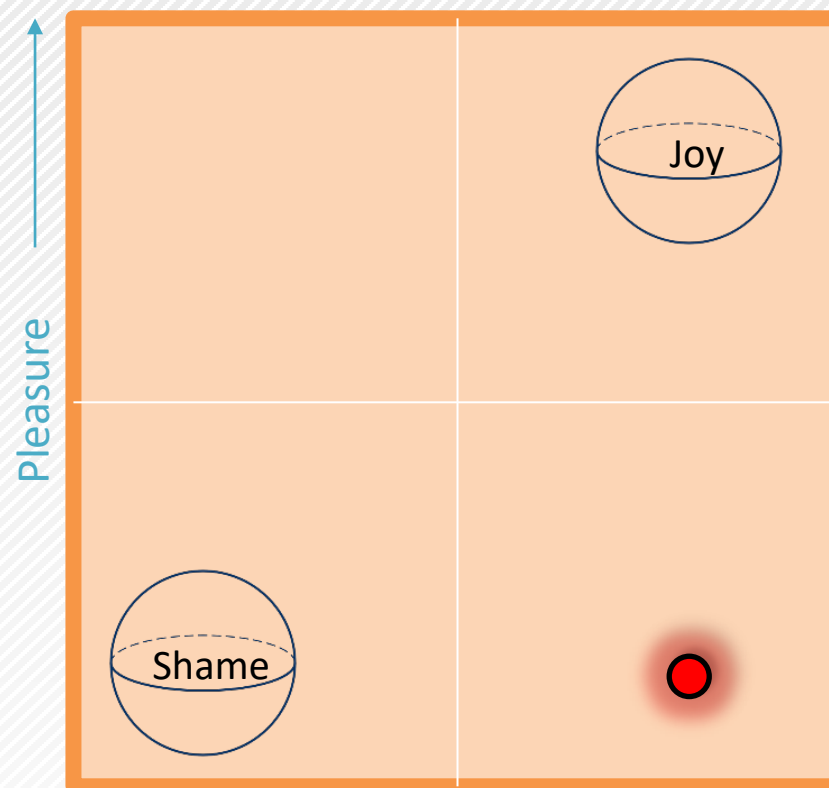
Emotional PIPELINE

Mood Module + Expression

- Decision Making (Goal selection, planning, learning etc)

- Voice tone (Wonder)

- Variation of the base body animation, and can be blended together (Not changing the way of doing the action of the base body animation) (Wonder)

Docile   Exuberant

Vigorous

Afraid   Hostile

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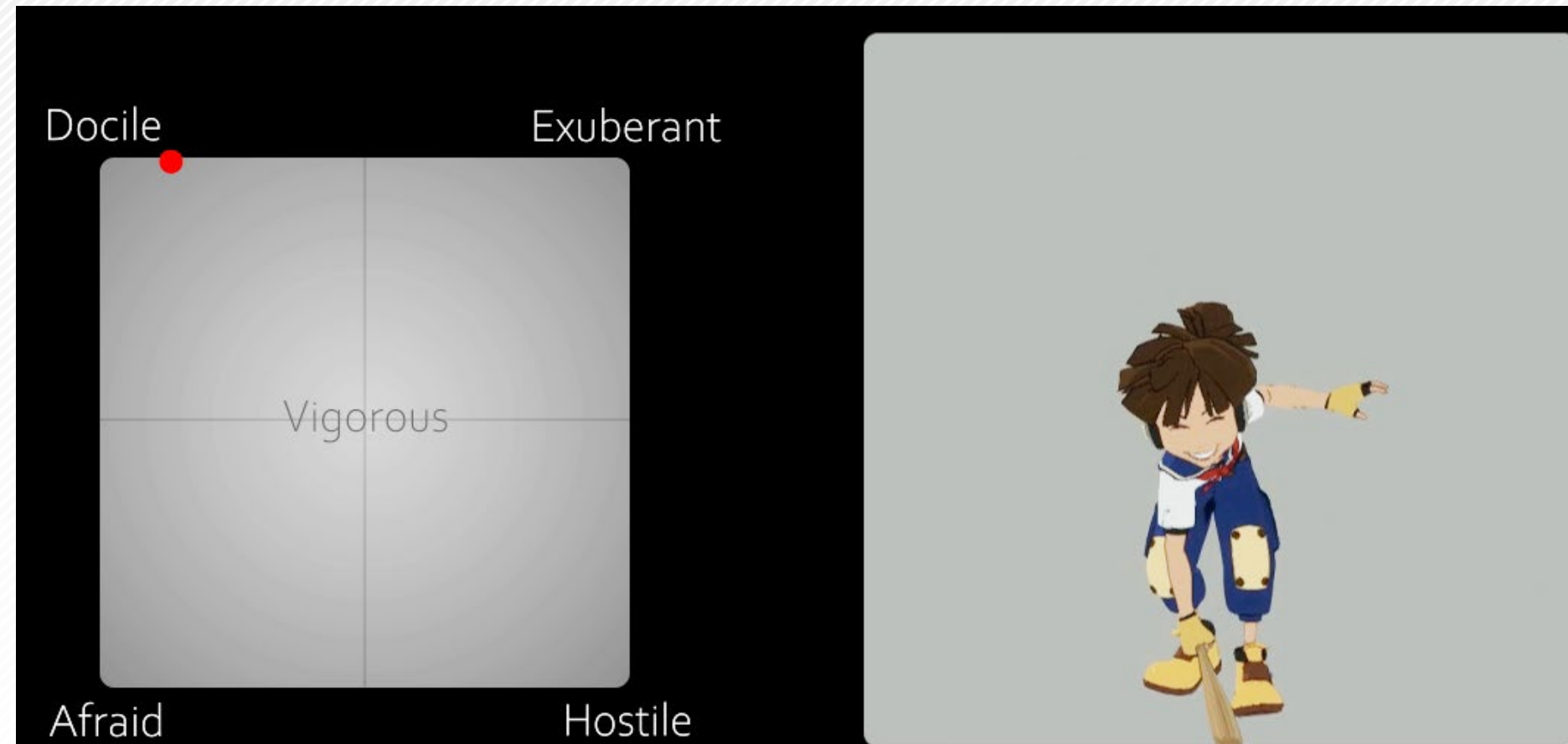
Emotional PIPELINE
PAD MODEL adaptability
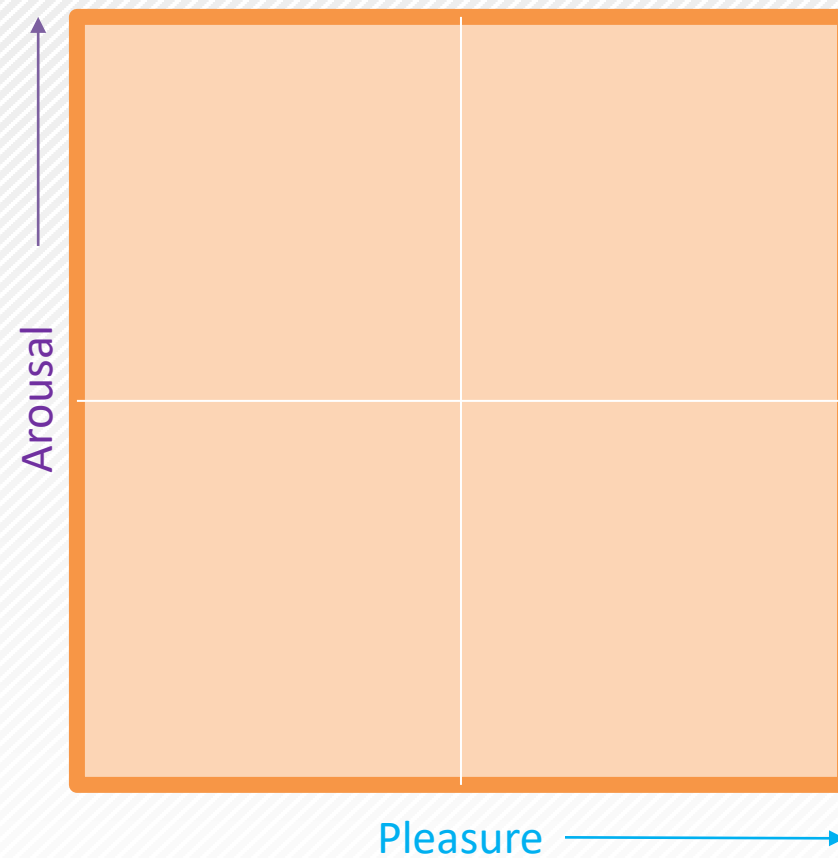
3D mood space:

Pros:
- Vast variations of expressions

Cons:
- The more dimension, the harder to debug, balance
- Depending on mood expression, assets cost can go out of hands.

Dominance

Pleasure

Arousal

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Emotional PIPELINE

PAD MODEL adaptability

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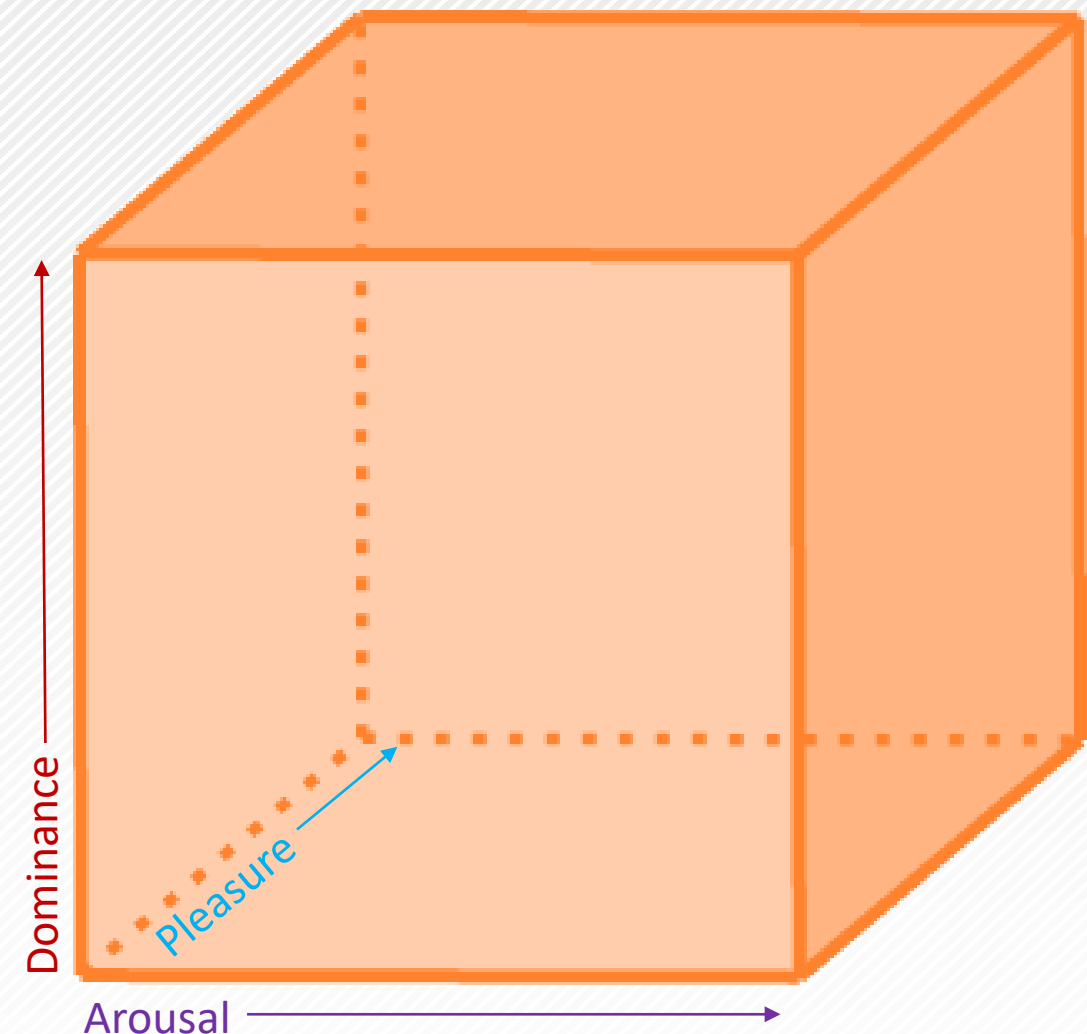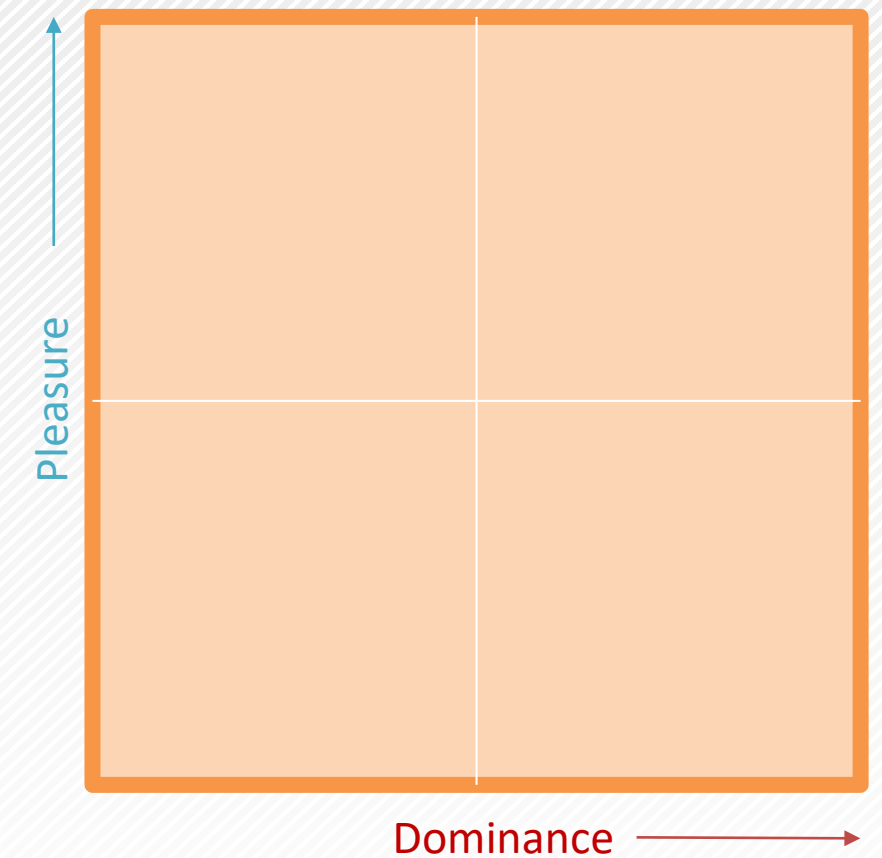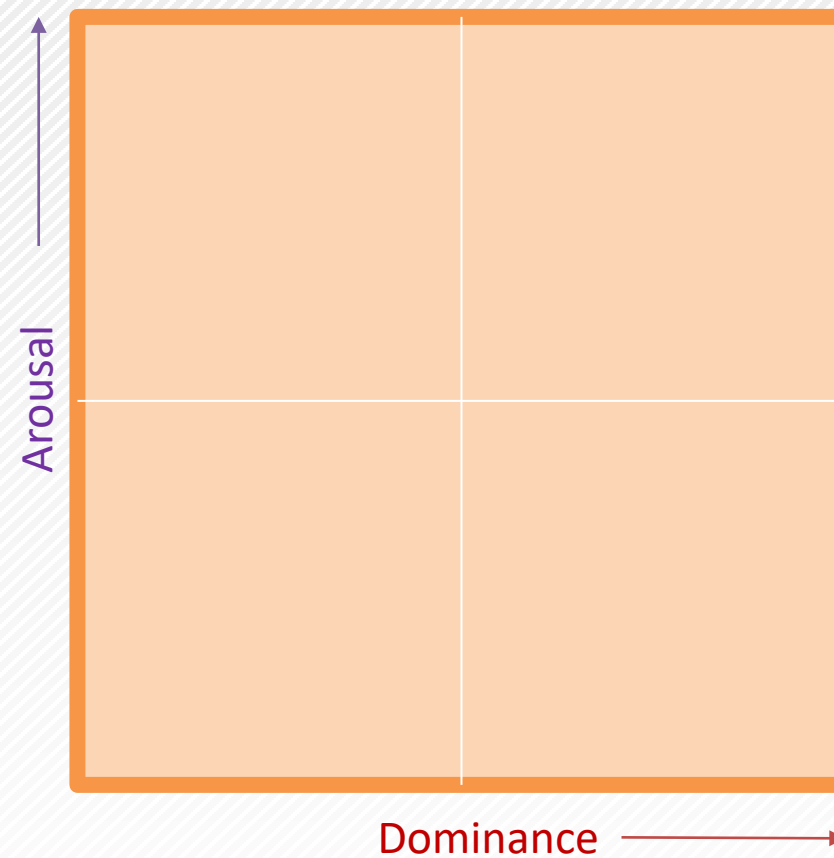
Emotional PIPELINE

PAD model adaptability

Pleasure

How **pleasant** is an emotion.

P+	P-
Exuberant	Afraid
Dependent	Hostile
Relaxed	Disdainful
Docile	Depressed

Arousal

How **intense** is an emotion.

A+	A-
Exuberant	Relaxed
Dependent	Docile
Afraid	Depressed
Hostile	Disdainful

Pleasure
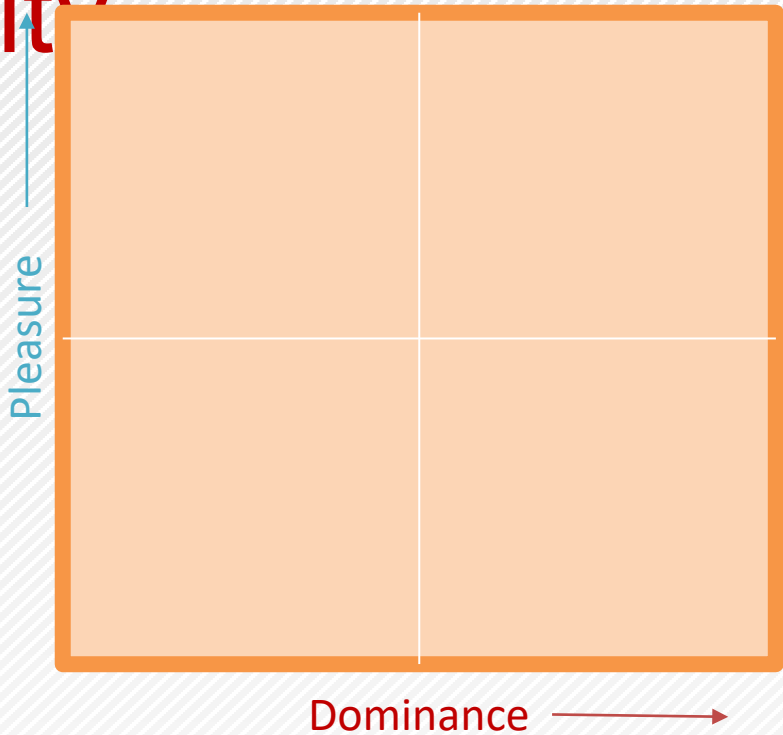
Dominance

Dominance

How much **control** and **influence** the agent has over situations

D+	D-
Exuberant	Dependent
Relaxed	Docile
Hostile	Afraid
Disdainful	Depressed

Generated Emotions

Emotion	P	A	D
Hope	+	+	-
Fear	-	+	-
Joy	+	+	+
Distress	-	-	-
Pride	+	+	+
Shame	-	+	-
Admiration	+	+	-
Reproach	-	-	+
Love	+	+	+
Hate	-	+	+

Patrick Gebhard. 2005. ALMA: a layered model of affect. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems* (AAMAS '05).

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Emotional PIPELINE

PAD MODEL adaptability

A+	A-	
Exuberant	Relaxed	Exuberant
Dependent	Docile	Docile
Afraid	Depressed	Afraid
Hostile	Disdainful	Hostile

Generated Emotions

Emotion	P	A	D
Hope	+	+	-
Fear	-	+	-
Joy	+	+	+
Distress	-	-	-
Pride	+	+	+
Shame	-	+	-
Admiration	+	+	-
Reproach	-	-	+
Love	+	+	+
Hate	-	+	+

Docile	Exuberant
Afraid	Hostile

Pleasure (vertical axis) — *Dominance* (horizontal axis)

Patrick Gebhard. 2005. ALMA: a layered model of affect. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems (AAMAS '05)*.

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Emotional PIPELINE

PAD model adaptability Emotion placements

Emotion	P	A	D	Mood Octant
Admiration	0.5	0.3	-0.2	Dependent
Anger	-0.51	0.59	0.25	Hostile
Disliking	-0.4	0.2	0.1	Hostile
Disappointment	-0.3	0.1	-0.4	Anxious
Distress	-0.4	-0.2	-0.5	Bored
Fear	-0.64	0.6	-0.43	Anxious
FearsConfirmed	-0.5	-0.3	-0.7	Bored
Gloating	0.3	-0.3	-0.1	Docile
Gratification	0.6	0.5	0.4	Exuberant
Gratitude	0.4	0.2	-0.3	Dependent
HappyFor	0.4	0.2	0.2	Exuberant
Hate	-0.6	0.6	0.3	Hostile
Hope	0.2	0.2	-0.1	Dependent
Joy	0.4	0.2	0.1	Exuberant
Liking	0.4	0.16	-0.24	Dependent
Love	0.3	0.1	0.2	Exuberant
Pity	-0.4	-0.2	-0.5	Bored
Pride	0.4	0.3	0.3	Exuberant
Relief	0.2	-0.3	0.4	Relaxed
Remorse	-0.3	0.1	-0.6	Anxious
Reproach	-0.3	-0.1	0.4	Disdainful
Resentment	-0.2	-0.3	-0.2	Bored
Satisfaction	0.3	-0.2	0.4	Relaxed
Shame	-0.3	0.1	-0.6	Anxious

	P	D
Hope	0.2	-0.1
Fear	-0.64	-0.43
Joy	0.4	0.1
Distress	-0.4	-0.5
Pride	0.4	0.3
Shame	-0.3	-0.6
Admiration	0.5	-0.2
Reproach	-0.3	0.4
Love	0.3	0.2
Hate	-0.6	0.3

	P	D
Hope	1	-1
Fear	-1	-0.33
Joy	1	0.33
Distress	-1	-1
Pride	0.33	1
Shame	-0.33	-1
Admiration	1	-0.33
Reproach	-1	1
Love	1	1
Hate	-1	0.33
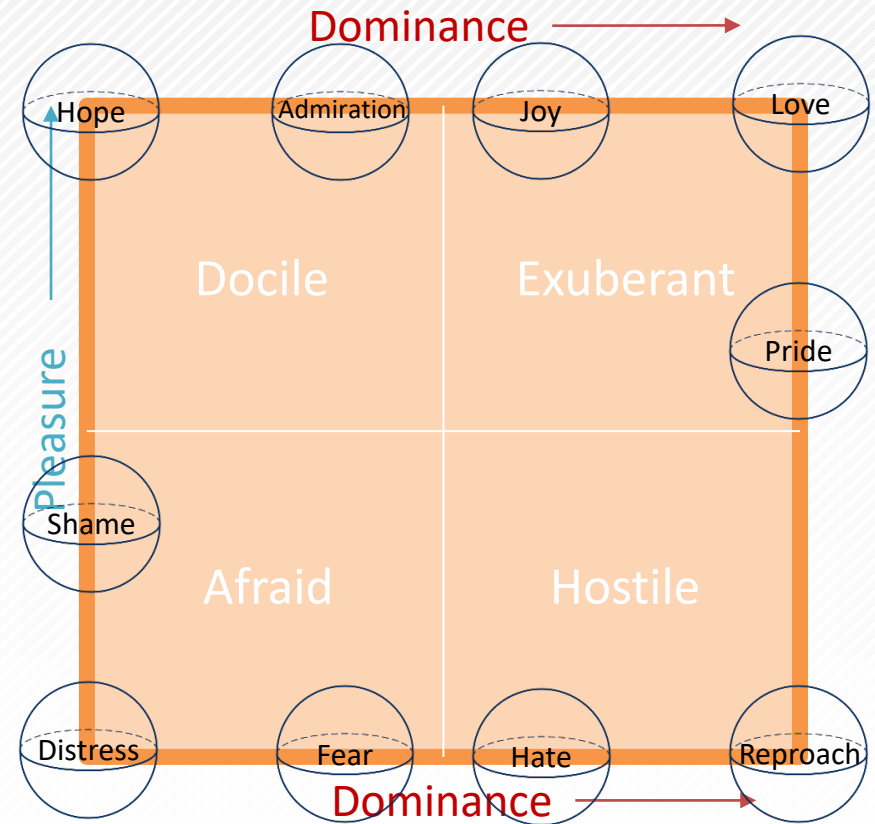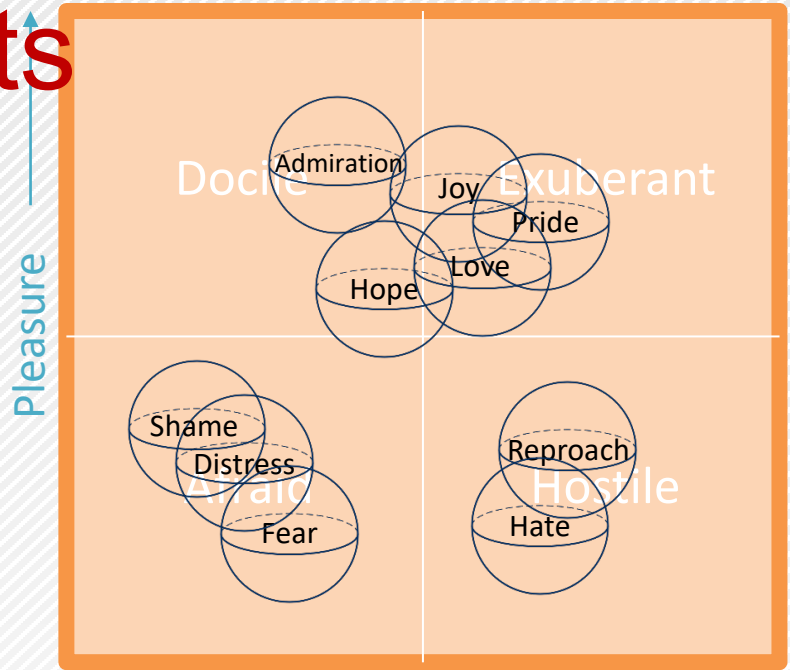
Patrick Gebhard. 2005. ALMA: a layered model of affect. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems (AAMAS '05)*.

Emotional PIPELINE

EMOTIONAPIELINE

Personality

- Simple structure (utility parameters in [0..1])
  - Laziness = 0.8
  - Curiosity = 0.3
  - Honesty = 0.1
  - Obedience = 0.9
  - …

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Personality expression

- Decision Making (Goal selection, planning, learning, etc)

- Base body animation strong variation (Way of doing the action) (Wonder)

- Way of Speaking (Wonder)

- Default mood position

Philanthropism
Rationalism
Idealism
Enthusiasm

EMOTIONAL PIPELINE

- Choose where to express them, where they have influences

  - Decision Making

    - Any number of personalities should be manageable as it has only design cost in a majority of the cases

  - Animations, Speech, assets-related applications

    - Can quickly go out of hands. (Wonder example)

EMOTIONAL PIPELINE
personality adaptability

We have 8 personalities in Wonder

- Cheerfulness
- Independence
- Passion
- Confidence
- Logic
- Integrity
- Kindness
- Cooperation

Personalities in Wonder decide:
- Base animation of walk/idle/reactions...
- Way of speaking (all speeches)

8 personalities X 4 moods + 1 base = 33 variant animations

Personalities Principles
- Idealism
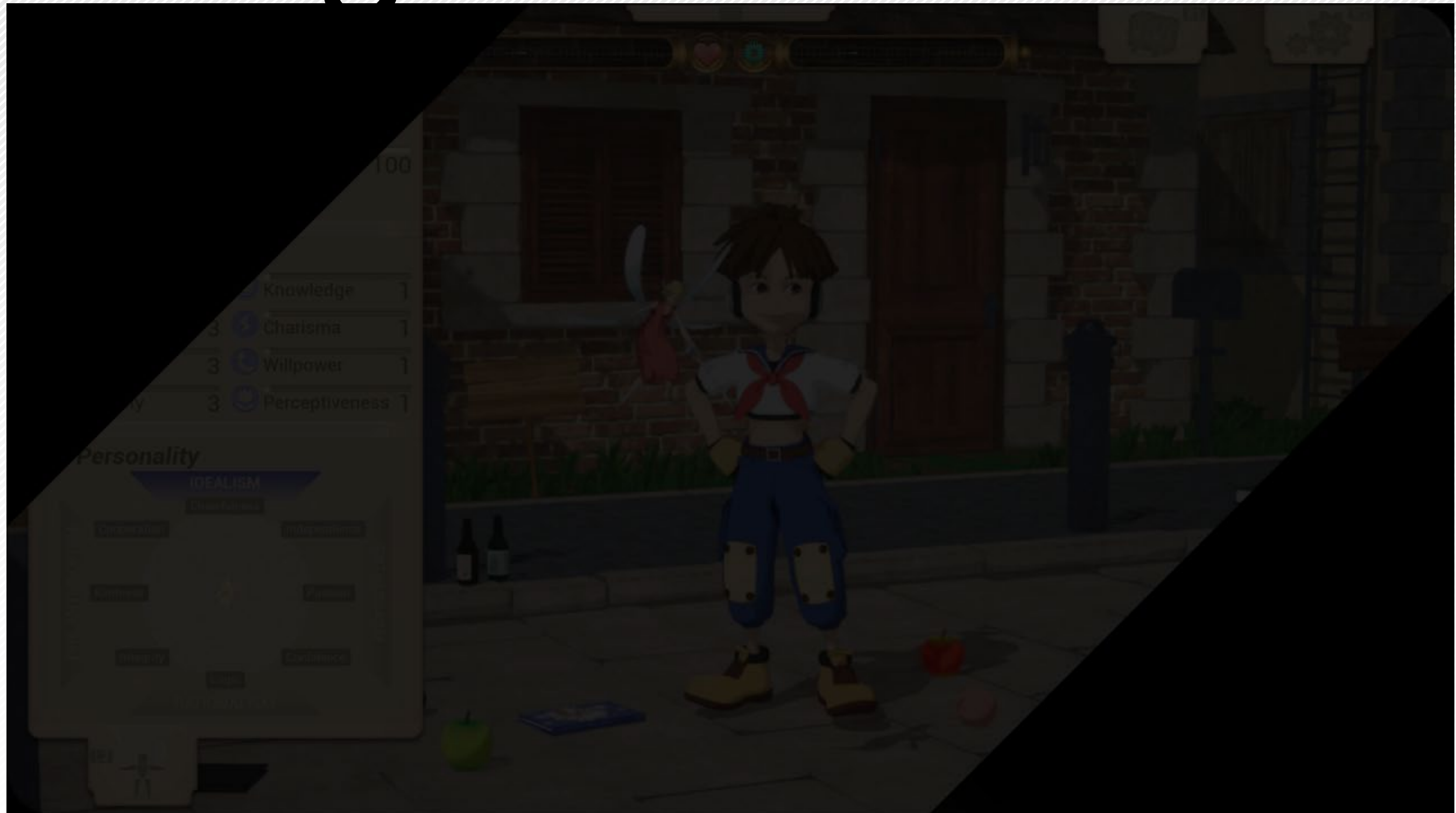- Enthusiasm
- Rationalism
- Philanthropism

4 personalities X 4 moods + 1 base = 17 variant animations
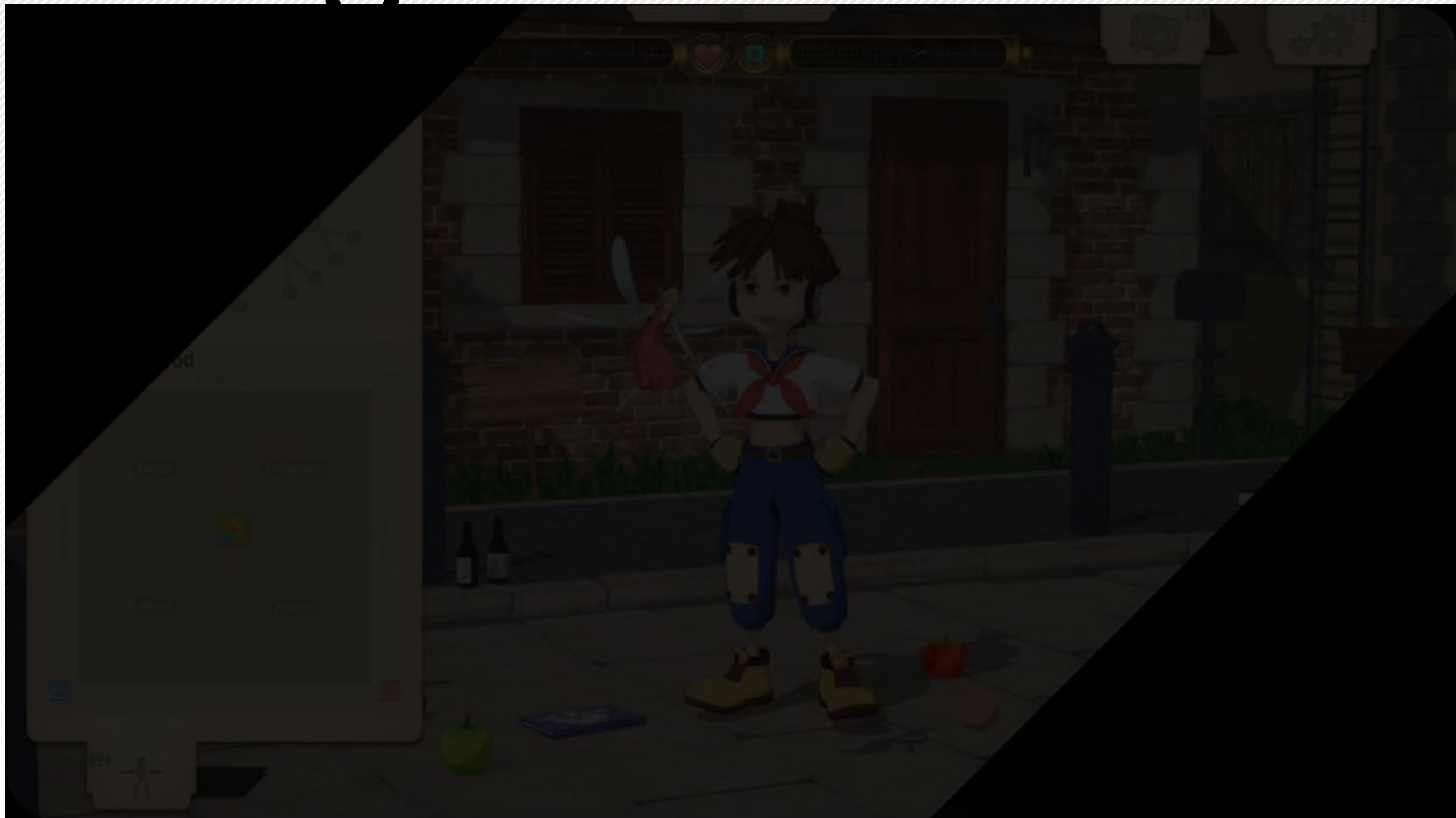
Troubleshooting

Debutgols and tweaks

Debug tools and Balan

Debug tools and Balan

Debutgols and Balance

- Mood heat map
- Personality history: evolution of each parameter with the source (action, etc)
- Emotion history: Time, source, parameters
- Emotion overall information: influence score, occurrences

	Occurences	Average Intensity	Average Duration	Influence Score
Joy	52	0.8	4	166.4
Distress	31	0.55	4	68.2
Pride	25	0.9	2.5	56.25
Shame	34	0.75	3	76.5

Influence Score = SUM(Intensity*Duration)

	Occurrences	Average Intensity	Average Duration	Influence Score
Joy	52	0.8	4	166.4
Distress	31	0.55	4	68.2
Pride	25	0.9	2.5	56.25
Shame	34	0.75	3	76.5

- Emotion / Mood balance:
  - The mood is always in this area
    - Compute influence score: per emotion: SUM(Intensity * Duration)
      - Highest influence score emotion is the culprit
    - Investigate the culprit:
      - How many times each emotion occurs relative to the other?
        » A lot more? Reduce the number of occurrences. If not possible, go next step
      - How strongly the emotion is (Intensity)
        » Always very intense? Reduce intensity/fix scoring so that 0-1 range is used. If the intensity makes sense, go next step:
      - How long it last (Duration):
        » Adjust time to influence less
          • Knowing influence score of the counter emotion, adjust duration to equilibrate. If it makes sense already, go next
      - Everything looks fine?
        » The counter emotion does not occur enough, too low intensity, or duration is too short. Investigate it in the same way.

Thank you for watching!

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