TEAM
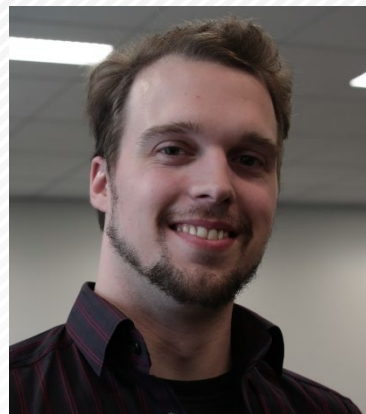
Gautier Boeda

Yuta Mizuno
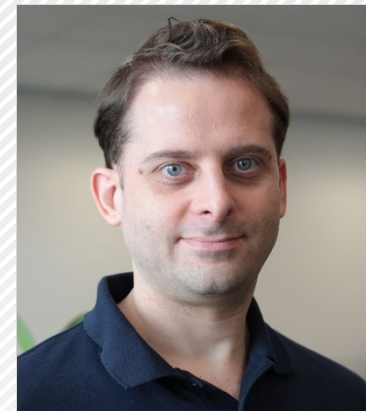
Remi Driancourt

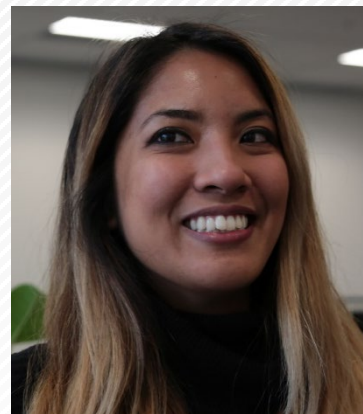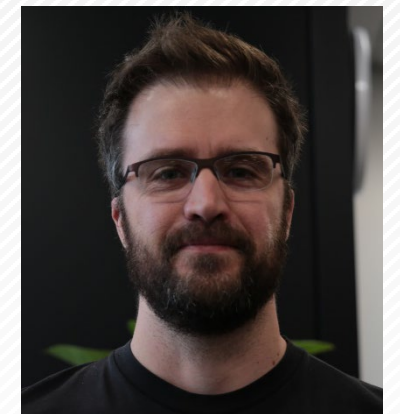Brian Wanamaker

Perry Leijten

Stephanie Timmins

Adelle Bueno

Eduardo Mosena

Louis-Philippe Sanschagrin

MOTIVATION
WHAT ARE WE TRYING TO IMPROVE?

- Non-playable characters in virtual reality feel really close!
  - Enhance immersion
- Interacting with them felt sloppy, breaking the immersion
  - Limited to buttons or other classic mechanism
  - No reaction, as if the player was a ghost

MOTIVATION

- Mission
  - Bring more natural interactions:
    - Voice interaction
    - Body interaction
  - Create more aware, expressive and lively agents
    - Interact with the player appropriately (Actions, Emotions, Reactions, …)
    - Answer their own needs

DEMO
FIRST GLANCE AT KOBUN
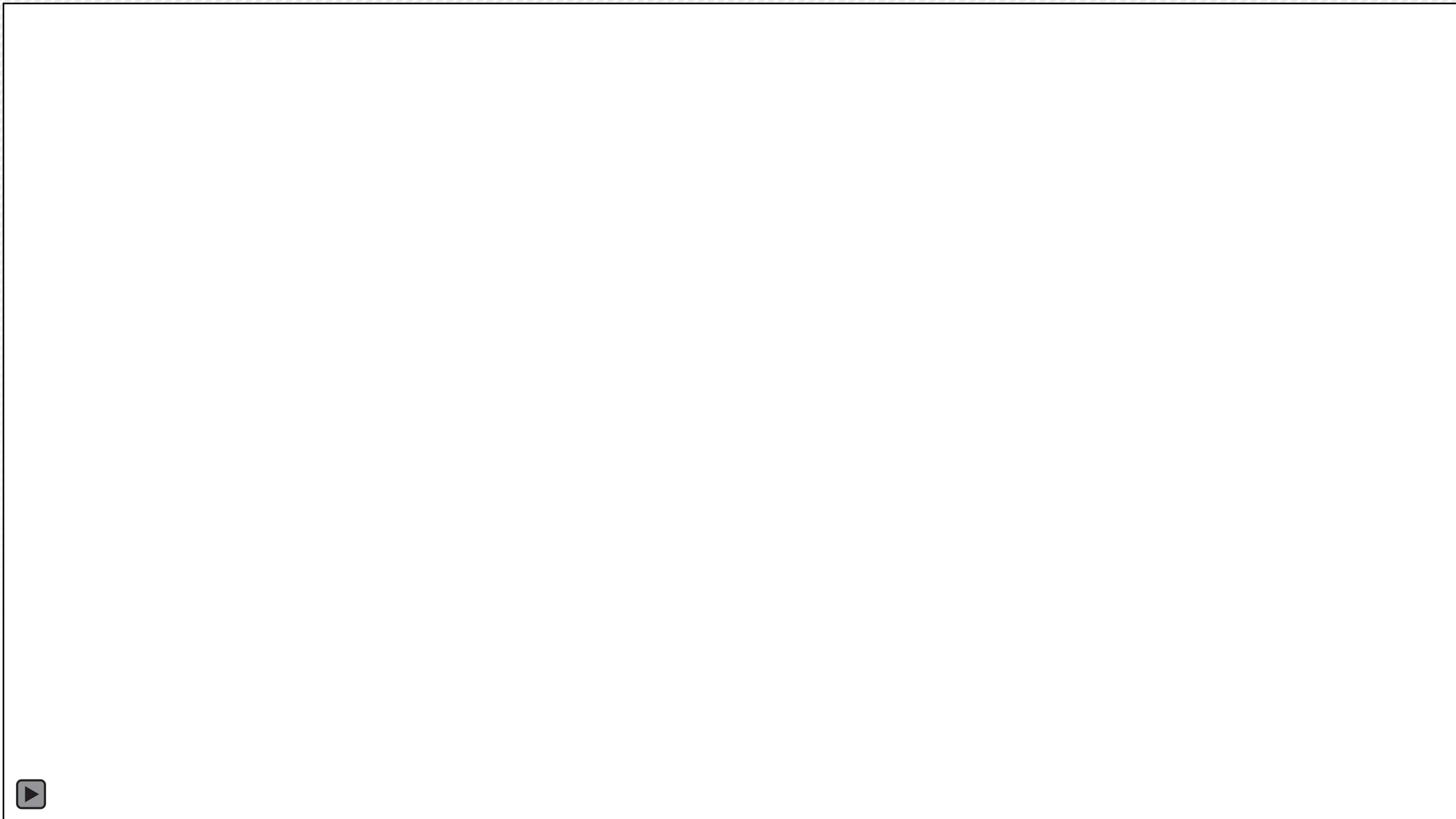
WHAT'S ON THE MENU TODAY?

- Speech recognition pipeline
- Decision Making
- Emotional Component
- Factual statement

SPEECH RECOGNITION PIPELINE
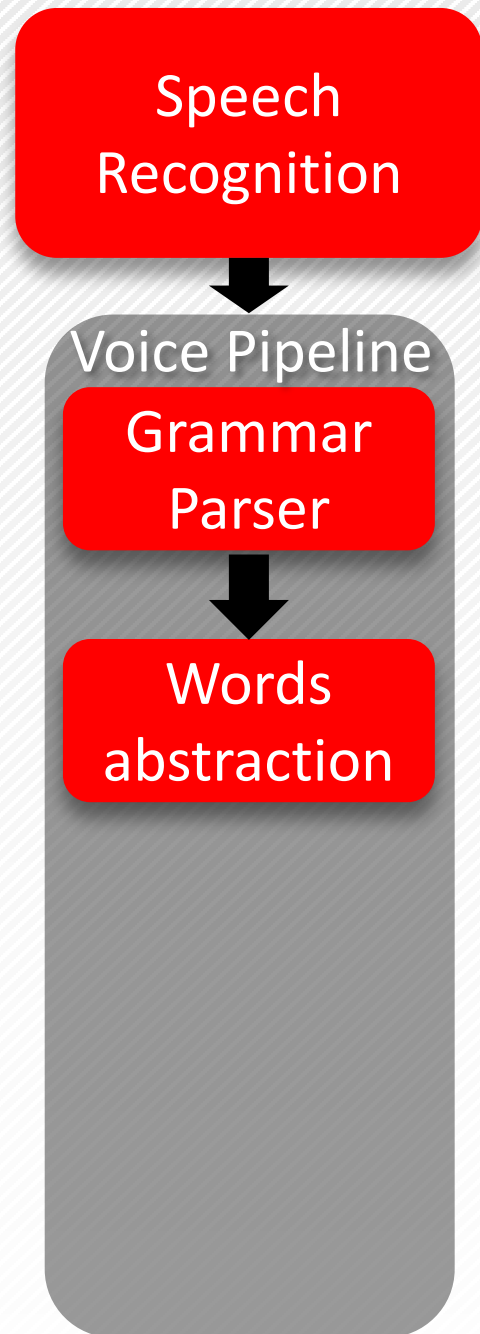
PIPELINE SUMMARY

Speech Recognition

↓

Voice Pipeline

Grammar Parser

↓

Words abstraction

Pick up an enormous apple
[Verb: Pick] [Preposition: up] [Determiner: an] [Adjective: enormous] [Noun: apple]

[Verb: Pick up] [Predicate: enormous] [Object: apple]

[Verb: ▨] [Predicate: ▨] [Object: ▨]

SQUARE ENIX

ADVANCED TECHNOLOGY DIVISION

SPEECH RECOGNITION PIPELINE
WORDS ABSTRACTION

Speech Recognition

Voice Pipeline

Grammar Parser

Words abstraction

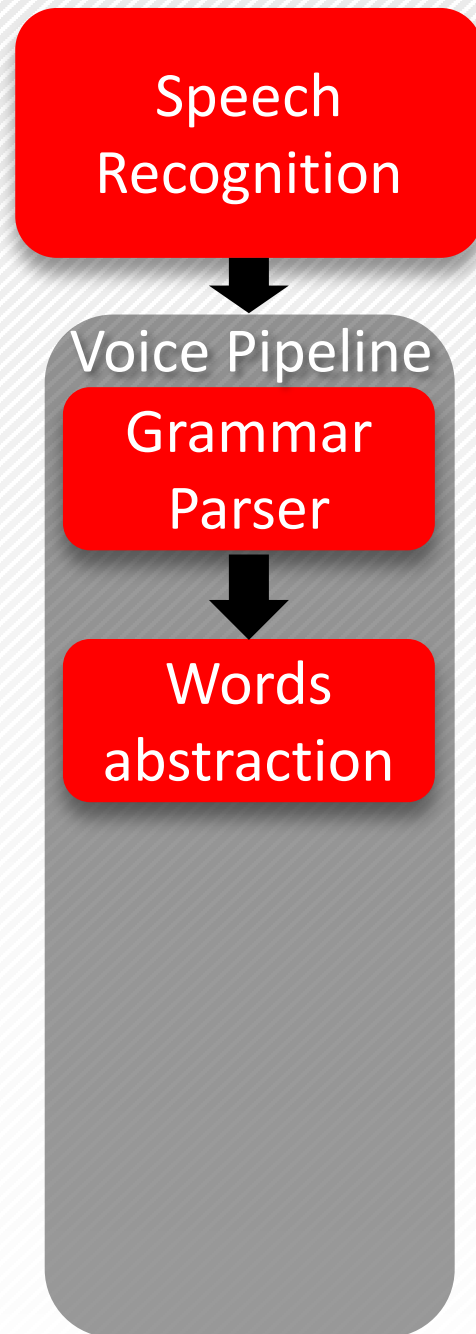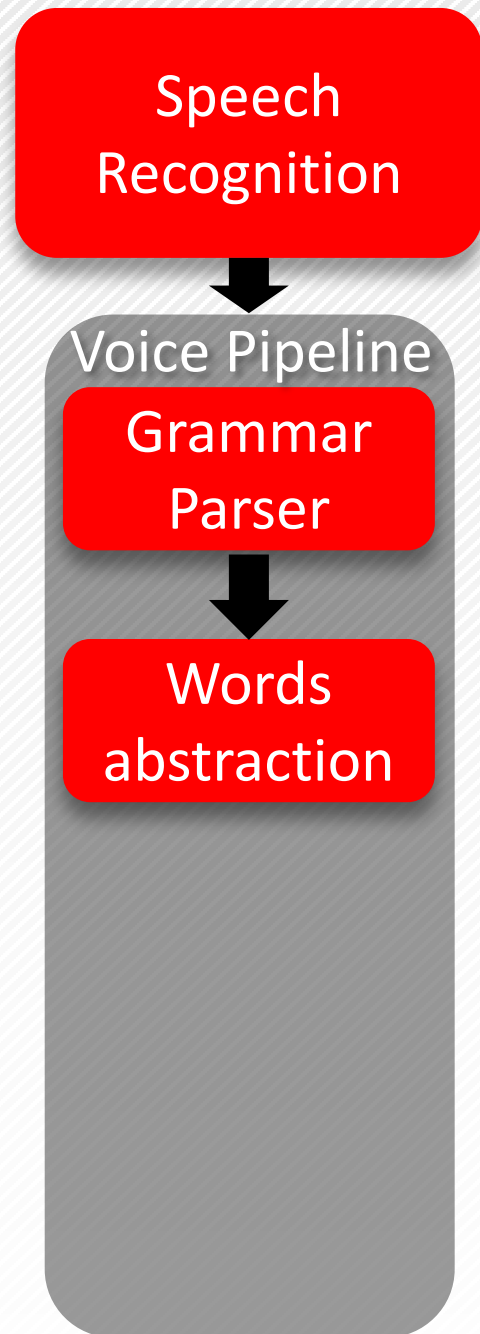- Problem to solve:
  - Support multiple languages without limiting the player's set of vocabulary

- Cause of the Problem:
  - Words are language-based. They don't have bindings between languages.

    We need to abstract them.

- Idea:
 - Can we create the DNA of a word? What could be the genes?

SQUARE ENIX   ADVANCED TECHNOLOGY DIVISION

SPEECH RECOGNITION PIPELINE
WORDS ABSTRACTION

Speech Recognition

Voice Pipeline
- **Grammar Parser**
- **Words abstraction**

Take an **apple**

Get into one's hands, take physically

Take a **break**

Make, undertake, or perform (an action or task).

List of meanings
=
DNA

Take

Get into one's hands, take physically

Make, undertake, or perform (an action or task)

Meaning = Gene
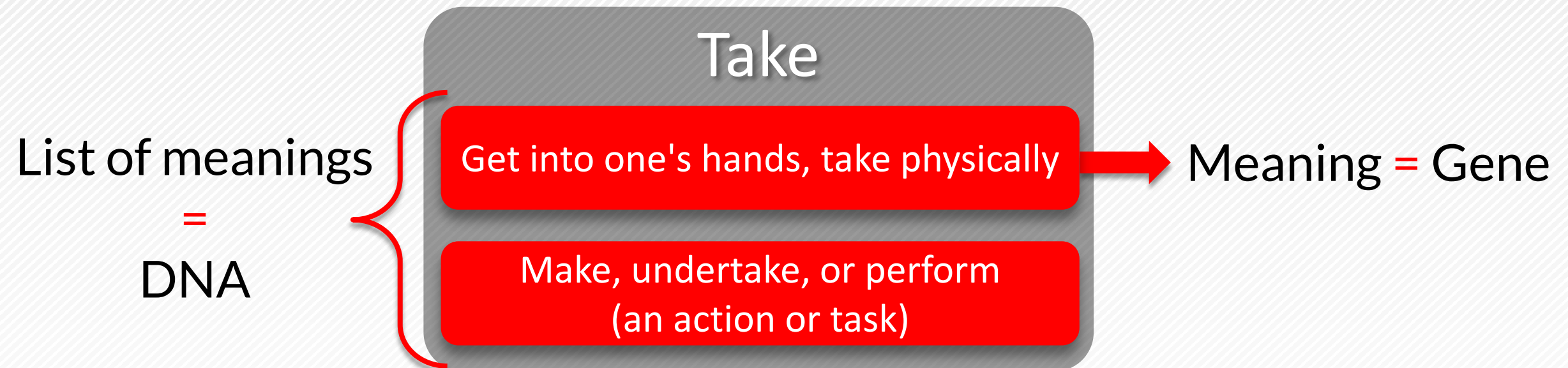
How? → **WordNet**
- Database of "sets of cognitive synonyms (synset), each expressing a distinct concept" wordnet.princeton.edu/
- Support multiple languages

SPEECH RECOGNITION PIPELINE
WORDS ABSTRACTION

Speech Recognition

Voice Pipeline

Grammar Parser

Words abstraction

- Example:
  - We need a concept of "Big" in our experience, as in "A big apple"

00225892-r		big	on a grand scale
01890752-a	(1)	boastful, big, braggart, bragging, braggy, cock-a-hoop, crowing, self-aggrandizing, self-aggrandising	exhibiting self-importance
01488616-a	(5)	full-grown, grown, adult, big, fully grown, grownup	(of animals) fully developed
01191780-a		big	marked by intense physical force
00225672-r	(2)	boastfully, big, vauntingly, large	in a boastful manner
00226054-r	(1)	big	extremely well
01382086-a	(246)	large, big	above average in size or number or quantity or magnitude or extent
00225805-r		big	in a major way
01890187-a	(1)	swelled, big, vainglorious	feeling self-importance
00173391-a	(2)	gravid, big, enceinte, expectant, great, large, heavy, with child	in an advanced stage of pregnancy
01276872-a	(7)	big	significant
01114658-a		big, large, magnanimous	generous and understanding and tolerant
01111418-a	(6)	handsome, liberal, big, bountiful, bighearted, bounteous, freehanded, giving, openhanded	given or giving freely
02402439-a		big, heavy	prodigious
01510444-a	(5)	bad, big	very intense
00579622-a	(11)	prominent, big, large	conspicuous in position or importance
01453084-a	(2)	big	loud and firm

SPEECH RECOGNITION PIPELINE

WORDS ABSTRACTION

Speech Recognition

Voice Pipeline

Grammar Parser

Words abstraction

Which "big" meaning are we interested in?

1) Keep adjectives
   r = adverb
   a = adjective

2) Select concepts

01890752-a	(1)	boastful, big, braggart, bragging, braggy, cock-a-hoop, crowing, self-aggrandizing, self-aggrandising	✖ exhibiting self-importance
01488616-a	(5)	full-grown, grown, adult, big, fully grown, grownup	✖ (of animals) fully developed
01191780-a		big	✖ marked by intense physical force
01382086-a	(246)	large, big	above average in size or number or quantity or magnitude or extent
01890187-a	(1)	swelled, big, vainglorious	✖ feeling self-importance
00173391-a	(2)	gravid, big, enceinte, expectant, great, large, heavy, with child	✖ in an advanced stage of pregnancy
01276872-a	(7)	big	significant
01114658-a		big, large, magnanimous	✖ generous and understanding and tolerant
01111418-a	(6)	handsome, liberal, big, bountiful, bighearted, bounteous, freehanded, giving, openhanded	✖ given or giving freely
02402439-a		big, heavy	✖ prodigious
01510444-a	(5)	bad, big	✖ very intense
00579622-a	(11)	prominent, big, large	✖ conspicuous in position or importance
01453084-a	(2)	big	✖ loud and firm

SQUARE ENIX

ADVANCED TECHNOLOGY DIVISION

SPEECH RECOGNITION PIPELINE
WORDS ABSTRACTION

Speech Recognition

Voice Pipeline

Grammar Parser

Words abstraction

- Our "Big" predicate DNA will be composed of:

  [01382086-a] above average in size or number or quantity or magnitude or extent

  [01276872-a] Significant

  Big

- Check our synsets:
  - Multi languages!

01382086-a ✛ 'above average in size or number or quantity or magnitude or extent' ;

Language	Translation
Albanian	i madh , i gjerë
Arabic	كبير
Bulgarian	голям
Catalan	gran
Chinese (simplified)	大+的 , 巨大+的 , 大 , 巨大
Danish	stor
Greek	μεγάλος
English	large$_{139}$ (⊵ ⊵ ⊕) , big$_{107}$ (⊵ ⊕)
Finnish	iso , suuri
French	grand , gros , large , nombreux
Hebrew	גדול
Croatian	krupan , obiman , velik
Indonesian	gedang , terbesar , banyak , besar , bidang , luas , gadang , gede , ramai
Icelandic	stór , stæðilegur , fastur fyrir , þéttur fyrir
Italian	grosso , vasto , grande
Japanese	でっかい , 太い , でかい , 大き , 偉い , 大 , おっきい , 大きい , 広い
Lithuanian	didelis
Bokmål	stor
Polish	niemały , duży
Portuguese	grande
Chinese (traditional)	碩 , 大量 , 豪
Romanian	mare
Slovak	veľký , počet ný , obrovský
Slovene	velik
Spanish	gran , grande
Swedish	stor
Thai	ใหญ่
Malaysian	gedang , terbesar , banyak , besar , bidang , luas , gadang , gede , ramai

Search WN | English
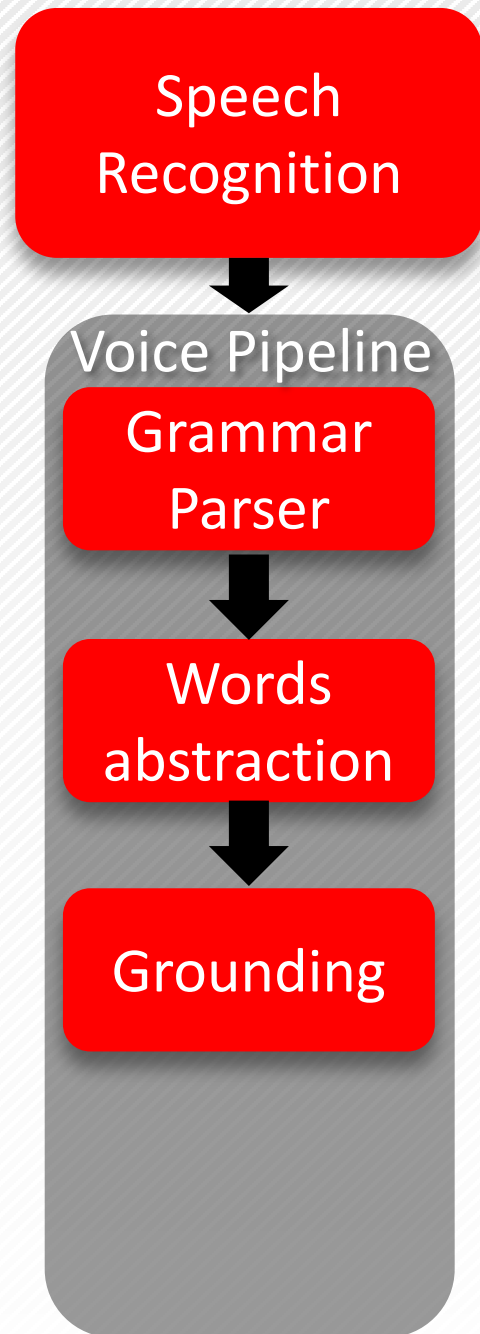
Japanese
サイズ、数、量、大きさまたは範囲において平均以上の — 大都市; 世界の広範囲; 大都市に出発してください; 多額; 大きい (または大きい) 納屋; 大家族

English
above average in size or number or quantity or magnitude or extent — a large city; large areas of the world; set out for the big city; a large sum; a big (or large) barn; a large family

Italian
Superiore a misura ordinaria per dimensioni, quantità, durata e simili

SPEECH RECOGNITION PIPELINE

PIPELINE SUMMARY

Speech Recognition

Voice Pipeline

Grammar Parser

Words abstraction

Grounding

Pick up an enormous apple
[Verb: Pick] [Preposition: up] [Determiner: an] [Adjective: enormous] [Noun: apple]

[Verb: Pick up] [Predicate: enormous] [Object: apple]

[Verb: ▮] [Predicate: ▮] [Object: ▮]
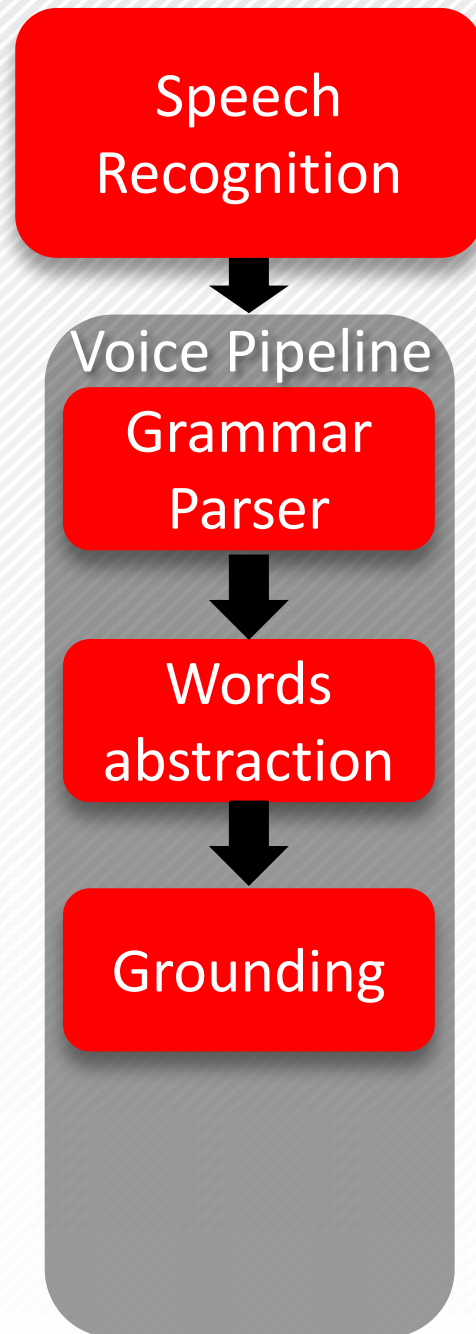
[Take] [big] [Object: ▮]

SQUARE ENIX

ADVANCED TECHNOLOGY DIVISION

SPEECH RECOGNITION PIPELINE

GROUND THE WORDS INTO THE CONCEPTS OF OUR WORLD

Speech Recognition

Voice Pipeline
- Grammar Parser
- Words abstraction
- Grounding

Ground the abstracted words to our concepts:
- Locations (above, behind, left, etc)
- Predicates (color, size, etc)
- Verbs
- ...

Using a utility-based scoring method.

Example:
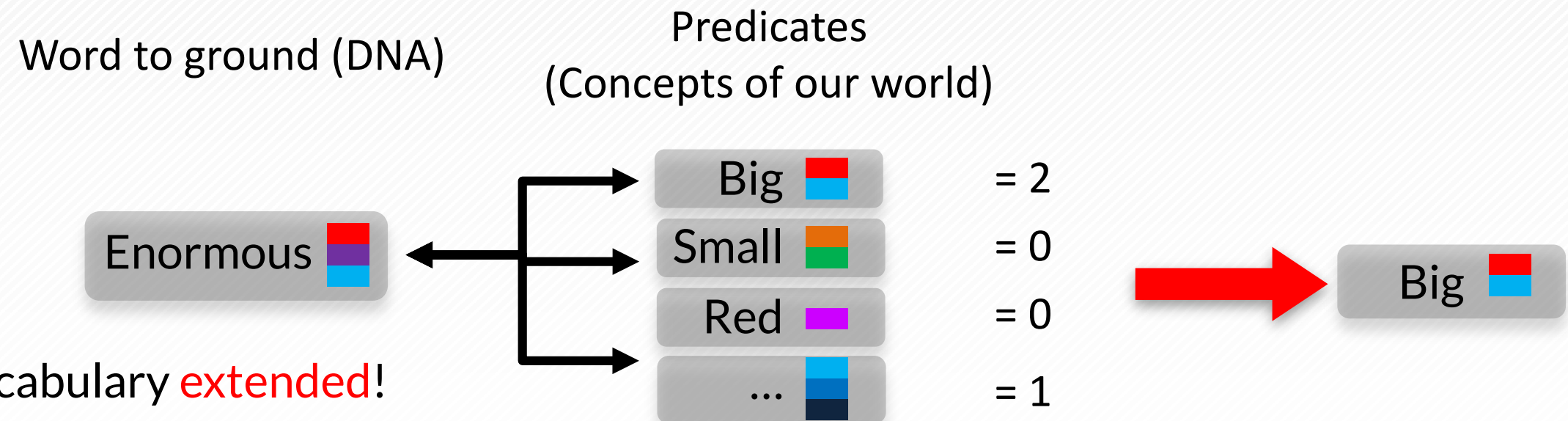
Word to ground (DNA)

Predicates (Concepts of our world)

Enormous

Big = 2
Small = 0
Red = 0
... = 1

Big

Player's set of vocabulary extended!

SQUARE ENIX

ADVANCED TECHNOLOGY DIVISION

SPEECH RECOGNITION PIPELINE

GROUND THE WORDS INTO THE CONCEPTS OF OUR WORLD

Speech Recognition

Voice Pipeline

Grammar Parser

Words abstraction

Grounding
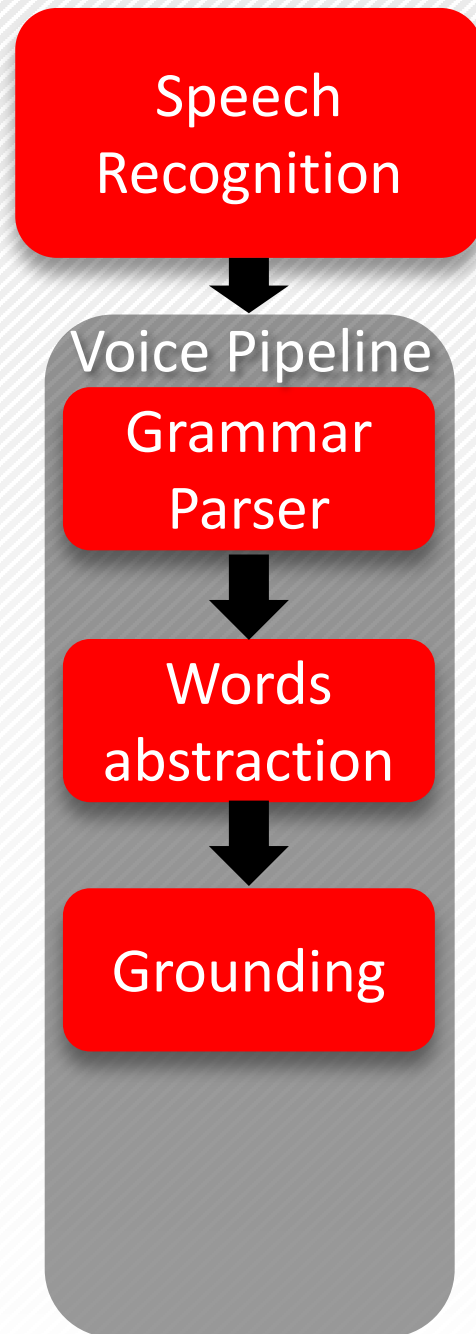
Everything cannot be grounded!

→ Objects relies on the knowledge of each agent.

Agent A Known Items

Ball | Banana

Table

Agent B Known Items

Apple | Banana

Fridge
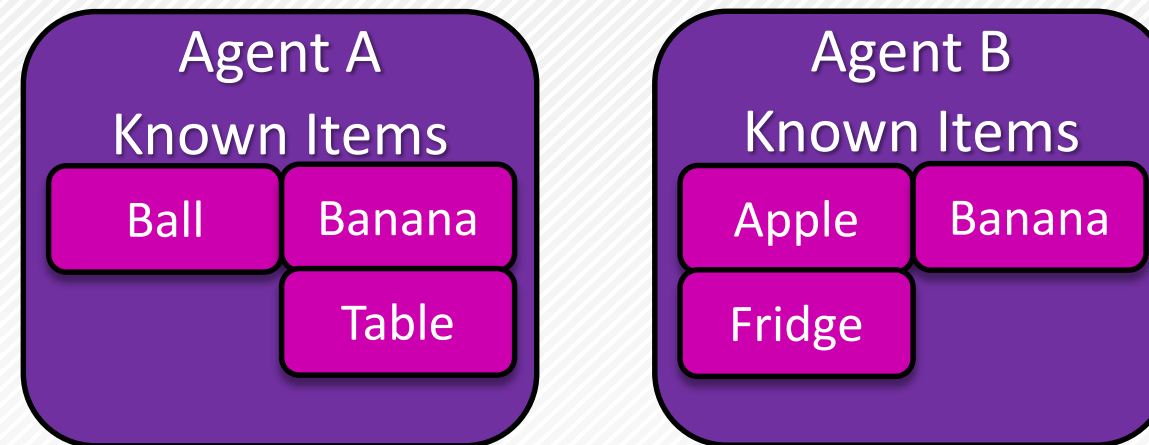
We need to ground them on a per-agent basis.

We will do this at a later stage

SPEECH RECOGNITION PIPELINE
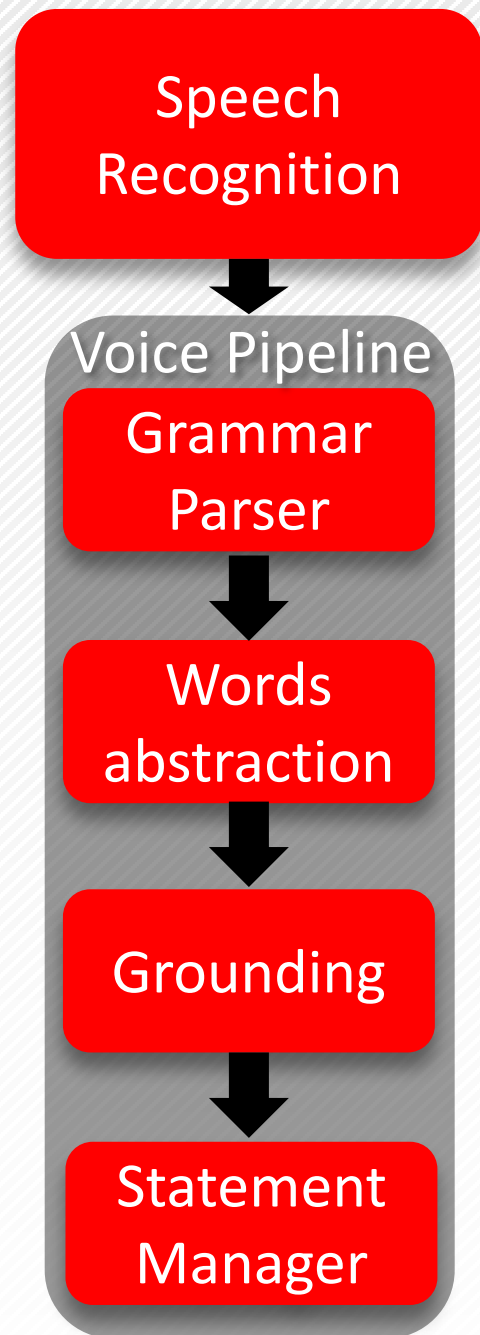
PIPELINE SUMMARY

Speech Recognition

Voice Pipeline
- **Grammar Parser**
- **Words abstraction**
- **Grounding**
- **Statement Manager**

Pick up an enormous apple
[Verb: Pick] [Preposition: up] [Determiner: an] [Adjective: enormous] [Noun: apple]

[Verb: Pick up] [Predicate: enormous] [Object: apple]

[Verb:] [Predicate:] [Object:]

[Take] [big] [Object:]

Store the statement in memory.   [Take] [big] [Object:]

DECISION MAKING
GOAL MANAGER

SQUARE ENIX   ADVANCED TECHNOLOGY DIVISION   INTRODUCTION   SPEECH RECOGNITION   DECISION MAKING   EMOTIONAL COMPONENT   FACTUAL STATEMENT   CONCLUSION

© 2019 SQUARE ENIX CO., LTD. All Rights Reserved.

DECISION MAKING

GOAL MANAGER

Voice Pipeline

Grammar Parser → Words abstraction → Grounding → Statement Manager

[Take] [big] [Object:]

AI Pipeline

Decision Making

Goal Manager
Utility-based

Listen to Player	X
Execute Order	0.9
Eat	0.35
Flee away	0.1
...	...

Planner

Execute Order

Put

Go

Look for

Take | ...

Execution

1 Look for <item>
2 Go near <item>
3 Take <item>

Memory

[Take] [big] [Object:]

GROUNDING OBJECTS
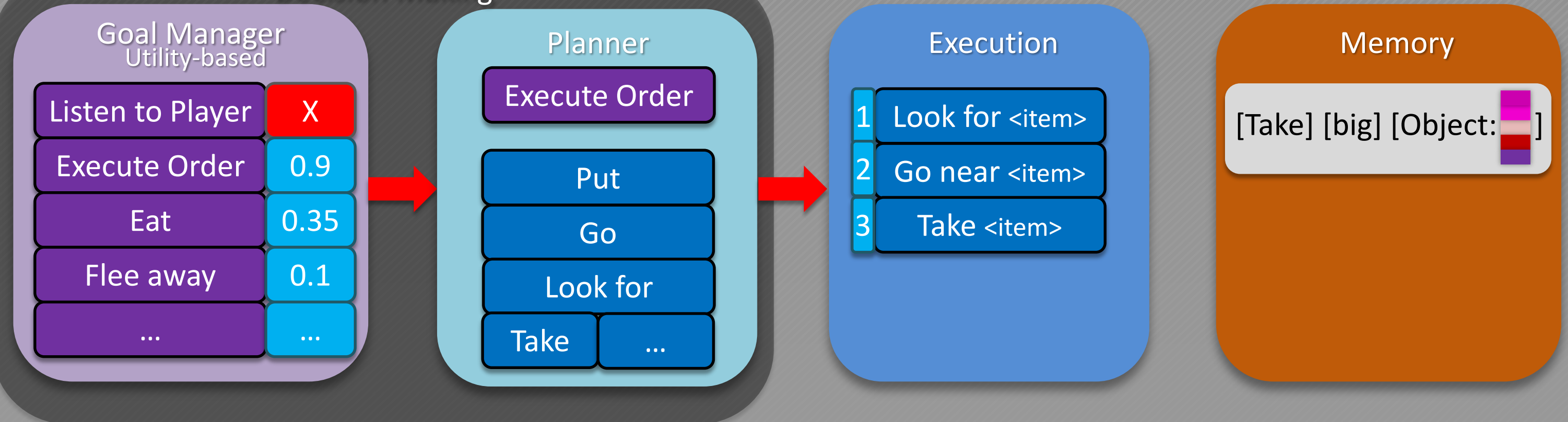
LOOK FOR "BIG APPLE"

Execution

1. Look for <item>
2. Go near <item>
3. Take <item>

(Pick up an enormous apple)

Look for [Object:]

How to find a suitable object in our knowledge?

→ Using again an utility-based system
(Infinite Axis Utility System)

Memory

[Take] [big] [Object:]

Known Items

Apple A	Banana
Apple B	Table
Apple C	...

Look for [Object:]

Goals	Targets	
Attack	Target A	0.7
Attack	Target B	0.5
Eat	Meat	0.1
Eat	Apple	0.8

Goals	Targets
Find suitable object	Item A
Find suitable object	Item B
Find suitable object	Item C
Find suitable object	Item D

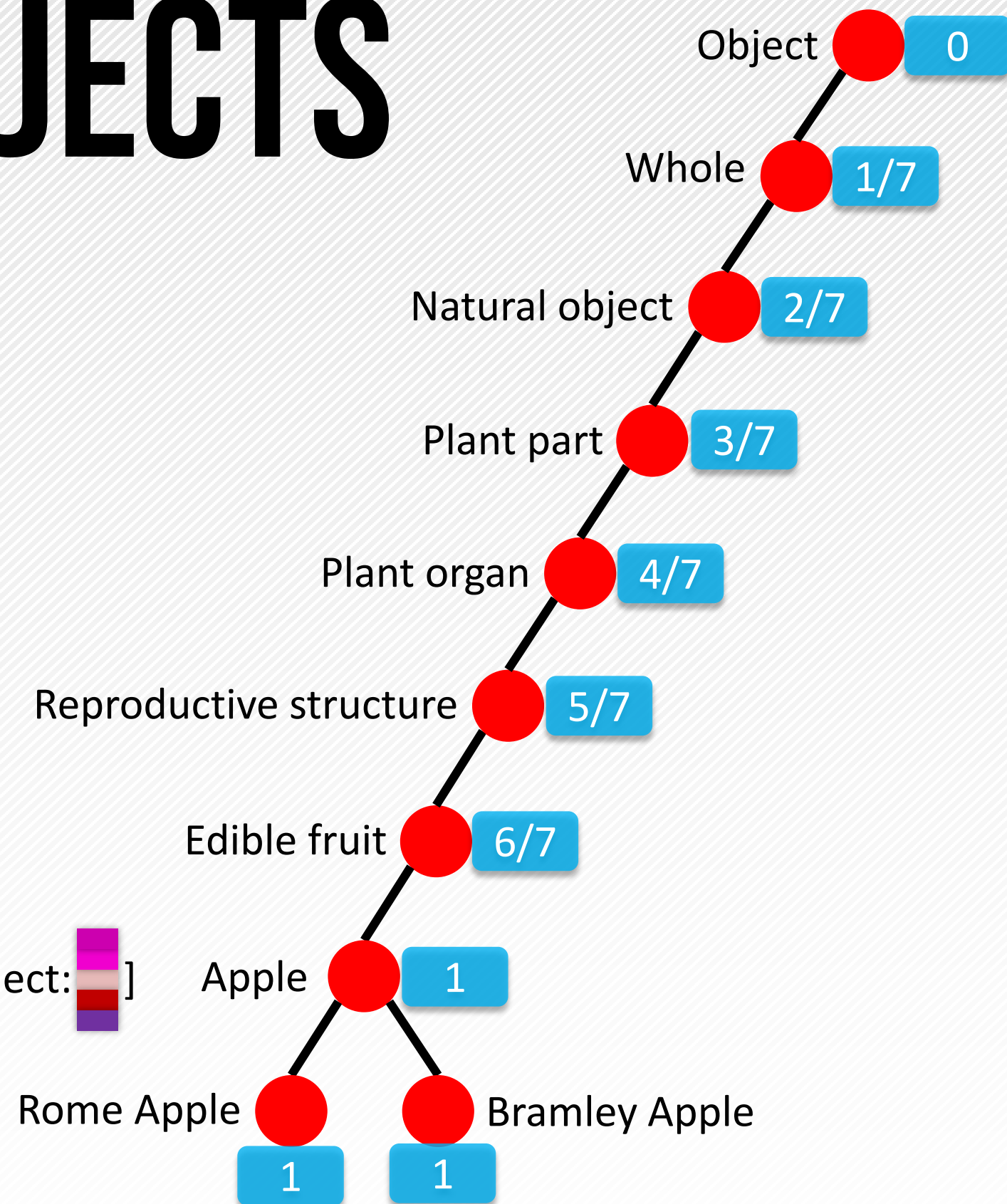# GROUNDING OBJECTS
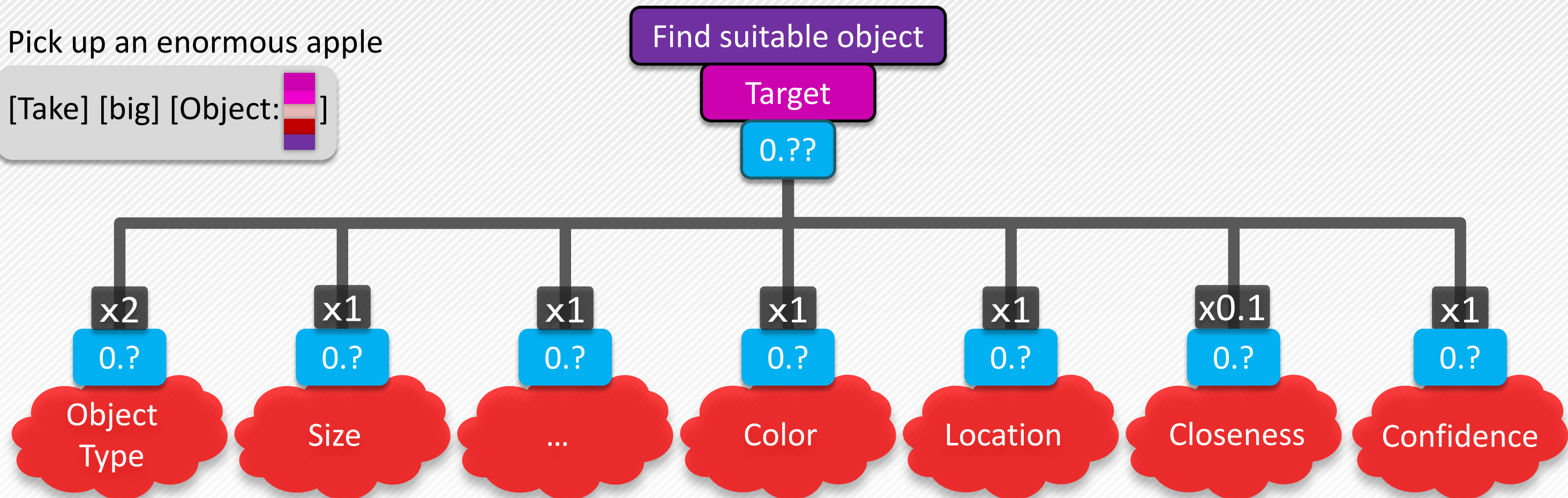
LOOK FOR "BIG APPLE"

Pick up an enormous apple

[Take] [big] [Object:]

Find suitable object

Target

0.??

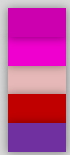| x2	x1	x1	x1	x1	x0.1	x1
0.?	0.?	0.?	0.?	0.?	0.?	0.?
Object Type	Size	...	Color	Location	Closeness	Confidence

GROUNDING OBJECTS

LOOK FOR "BIG APPLE"

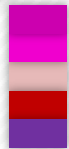Pick up an enormous apple

[Take] [big] [Object: █]

Find suitable object
Apple
x2
1
Object Type

[Object: █][█ :Apple A]

Find suitable object
Banana
x2
0
Object Type

[Object: █][█ :Banana]
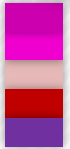
Find suitable object
Table
x2
0
Object Type

[Object: █][█ :Table]

Fruit, edible

GROUNDING OBJECTS
LOOK FOR "BIG APPLE"

Find suitable object

Target

[:Apple]

[:Banana]

[:Table]

Pick up an enormous apple
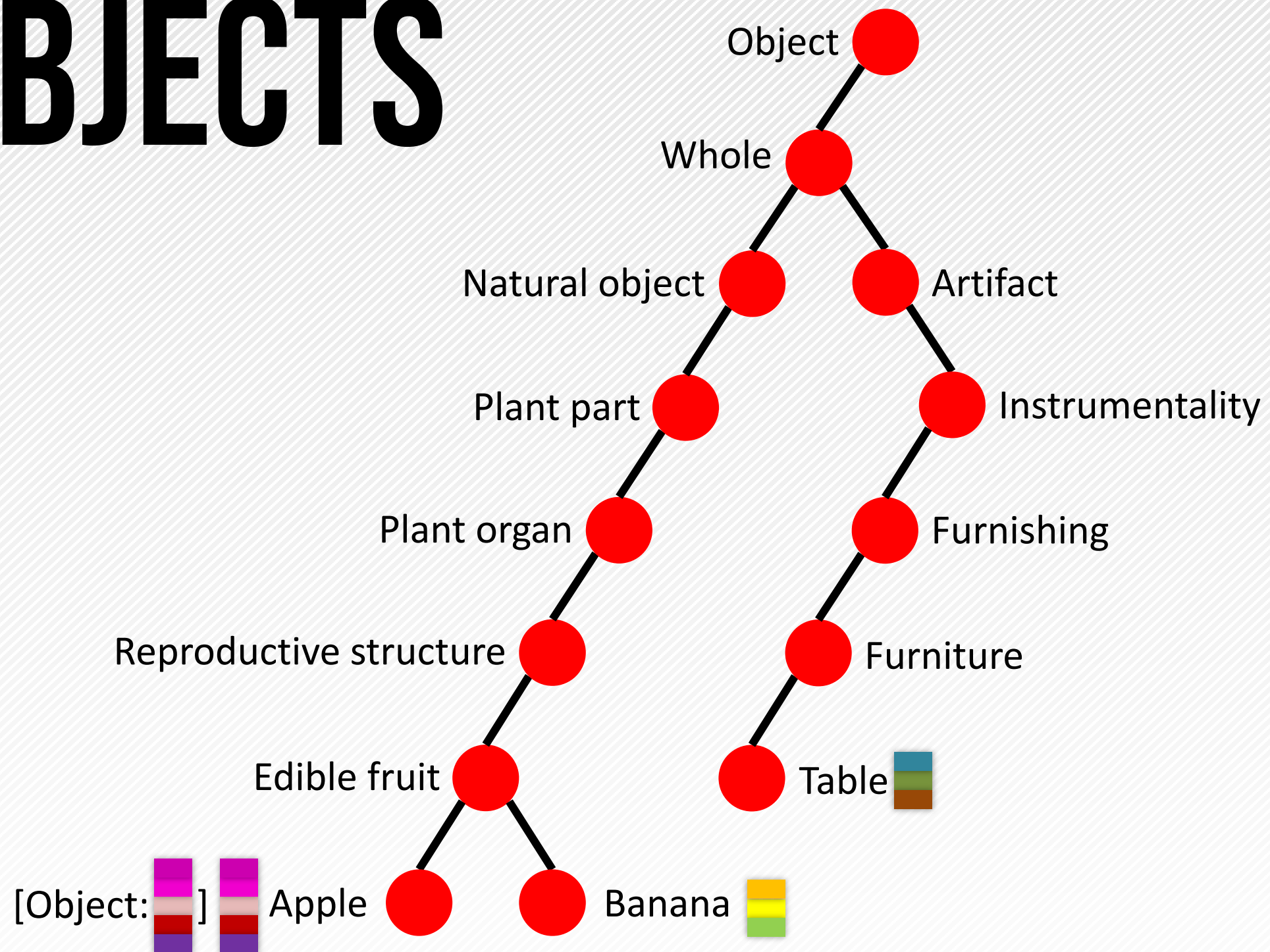
[Take] [big] [Object:]

Object

Whole

Natural object — Artifact

Plant part — Instrumentality

Plant organ — Furnishing

Reproductive structure — Furniture

Edible fruit — Table

[Object:] Apple — Banana

GROUNDING OBJECTS

LOOK FOR "BIG APPLE"

Object   0

Whole   1/7

Natural object   2/7

Plant part   3/7

Plant organ   4/7

Reproductive structure   5/7

Edible fruit   6/7

Apple   1

Rome Apple   1   Bramley Apple   1

Pick up an enormous apple

[Take] [big] [Object:]

[Object:]

SQUARE ENIX

ADVANCED TECHNOLOGY DIVISION

GROUNDING OBJECTS
LOOK FOR "BIG APPLE"

Find suitable object

Target

Pick up an enormous apple

[Take] [big] [Object:]

[:Apple] 1.0

[:Banana] 0.86

[:Table] 0.14

Object

Whole 1/7 ≈ 0.14

Natural object Artifact

Plant part Instrumentality

Plant organ Furnishing

Reproductive structure Furniture

Edible fruit 6/7 ≈ 0.86 Table

[Object:] Apple 1.0 Banana

GROUNDING OBJECTS

LOOK FOR "BIG APPLE"

Pick up an enormous apple

[Take] [big] [Object: ▮]

Find suitable object

Apple

x2

1

Object Type

[Object: ▮][▮ :Apple A]

Find suitable object

Banana

x2

0.86

Object Type

[Object: ▮][▮ :Banana]

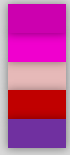**Find suitable object**

Table

x2

0.14

Object Type

[Object: ▮][▮ :Table]

GROUNDING OBJECTS

LOOK FOR "BIG APPLE"
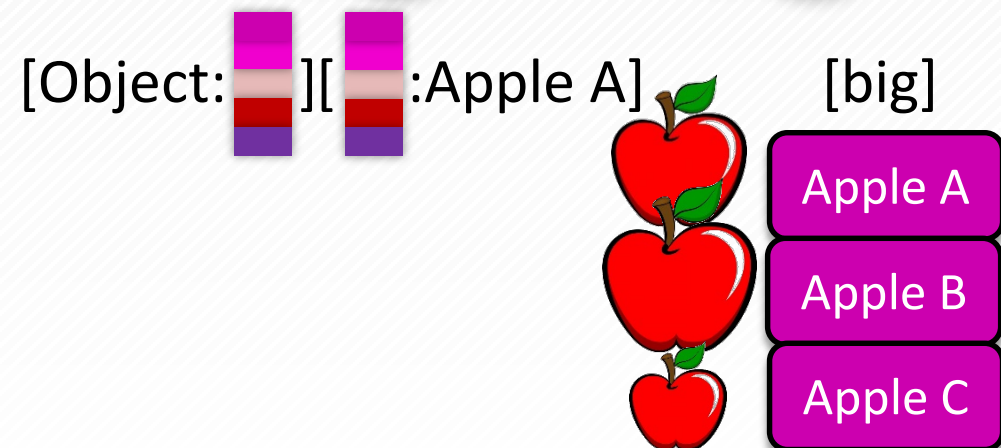
Pick up an enormous apple

[Take] [big] [Object: ▮]

Find suitable object

Apple A

0.91

Known Items

Apple A	Banana
Apple B	Table
Apple C	...
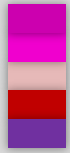
Apple A	0.91
Banana	
Table	
Apple B	
Apple C	
...	
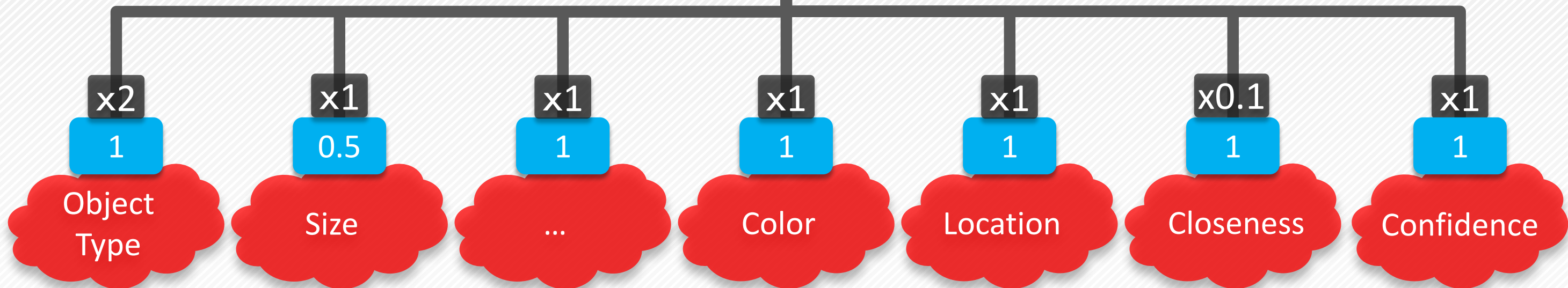
x2 — 1 — Object Type

x1 — 0.5 — Size

x1 — 1 — ...

x1 — 1 — Color

x1 — 1 — Location

x0.1 — 1 — Closeness

x1 — 1 — Confidence

[Object: ▮][▮ :Apple A]   [big]

Apple A
Apple B
Apple C

GROUNDING OBJECTS

LOOK FOR "BIG APPLE"

Pick up an enormous apple

[Take] [big] [Object: ▮]

Apple A	0.91
Banana	0.89
Table	0.47
Apple B	0.97
Apple C	0.86
...	0.35

Find suitable object

Known Items

Apple A	Banana
Apple B	Table
Apple C	...

x2	x1	x1	x1	x1	x0.1	x1
Object Type	Size	...	Color	Location	Closeness	Confidence
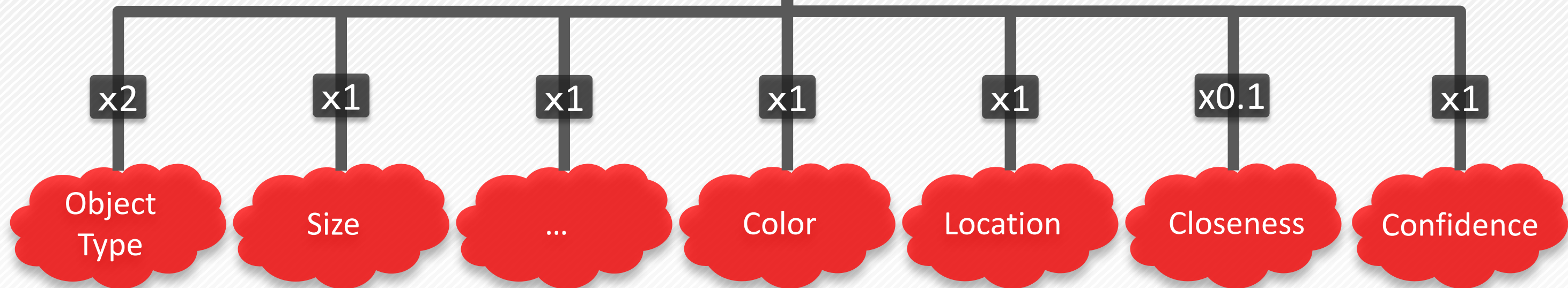
Look for <big apple>

Apple B	0.97

GROUNDING OBJECTS
LOOK FOR "BIG APPLE"

Execution

1. Look for <item> — Apple B
2. Go near <item>
3. Take <item>

EMOTIONAL COMPONENT
PIPELINE OVERVIEW

Emotional Component

Personality

Emotion ⟷ Mood

Defines the agent
No evolution 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, …
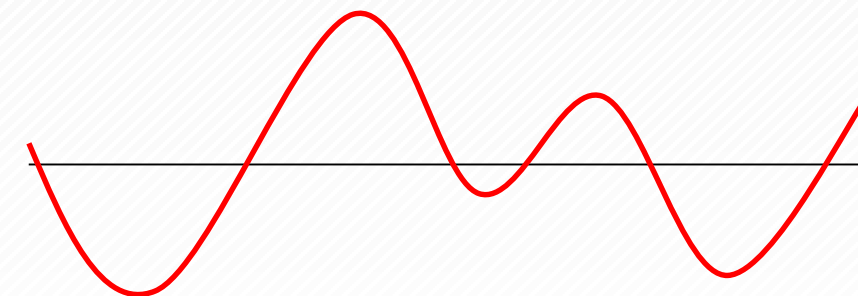
EMOTIONAL COMPONENT
EMOTION – INSPIRED OCC MODEL

Valenced Reaction
Event

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

RELATED
CONSEQUENCE

RELATED
CONSEQUENCE

Gratification
Remorse

Gratitude
Anger

EMOTIONAL COMPONENT
EXAMPLE

Agent has been shocked by a cable, activated by the player
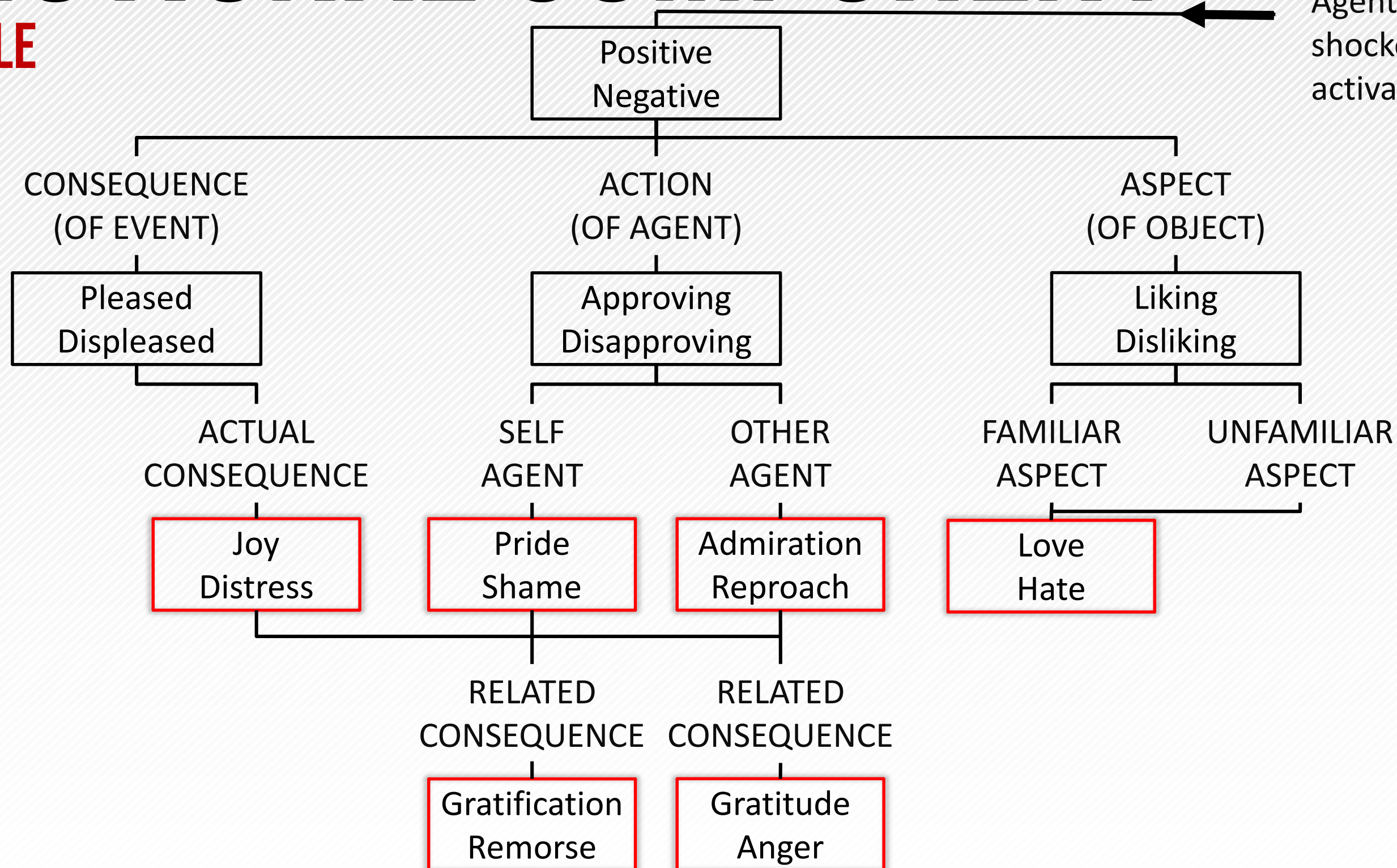
Positive
Negative

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

RELATED CONSEQUENCE

RELATED CONSEQUENCE

Gratification
Remorse

Gratitude
Anger

EMOTIONAL COMPONENT
DEVELOP A LIKING OR DISLIKING TOWARD WHAT THE AGENT EXPERIENCES IN THE WORLD

CONSEQUENCE
(OF EVENT)

Pleased
Displeased

ACTUAL
CONSEQUENCE

Joy
Distress

Agent has been shocked by a cable, activated by the player

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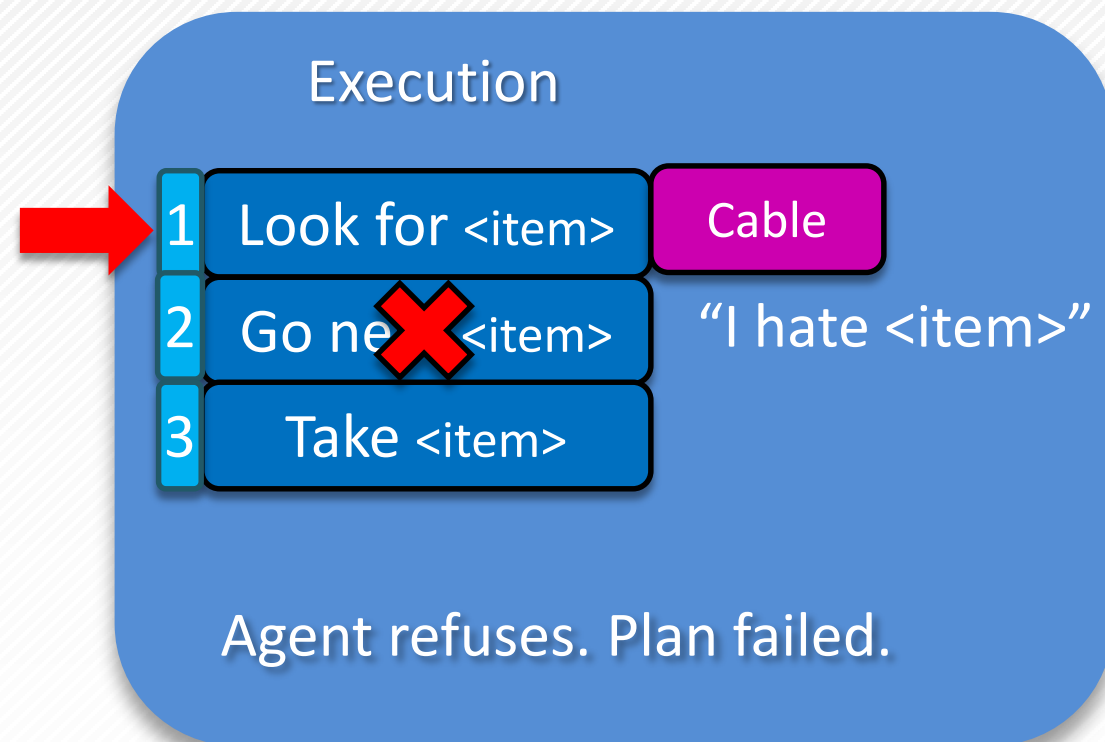   - "electrified" predicate

An affect has:
- intensity
- memorable duration

EMOTIONAL COMPONENT

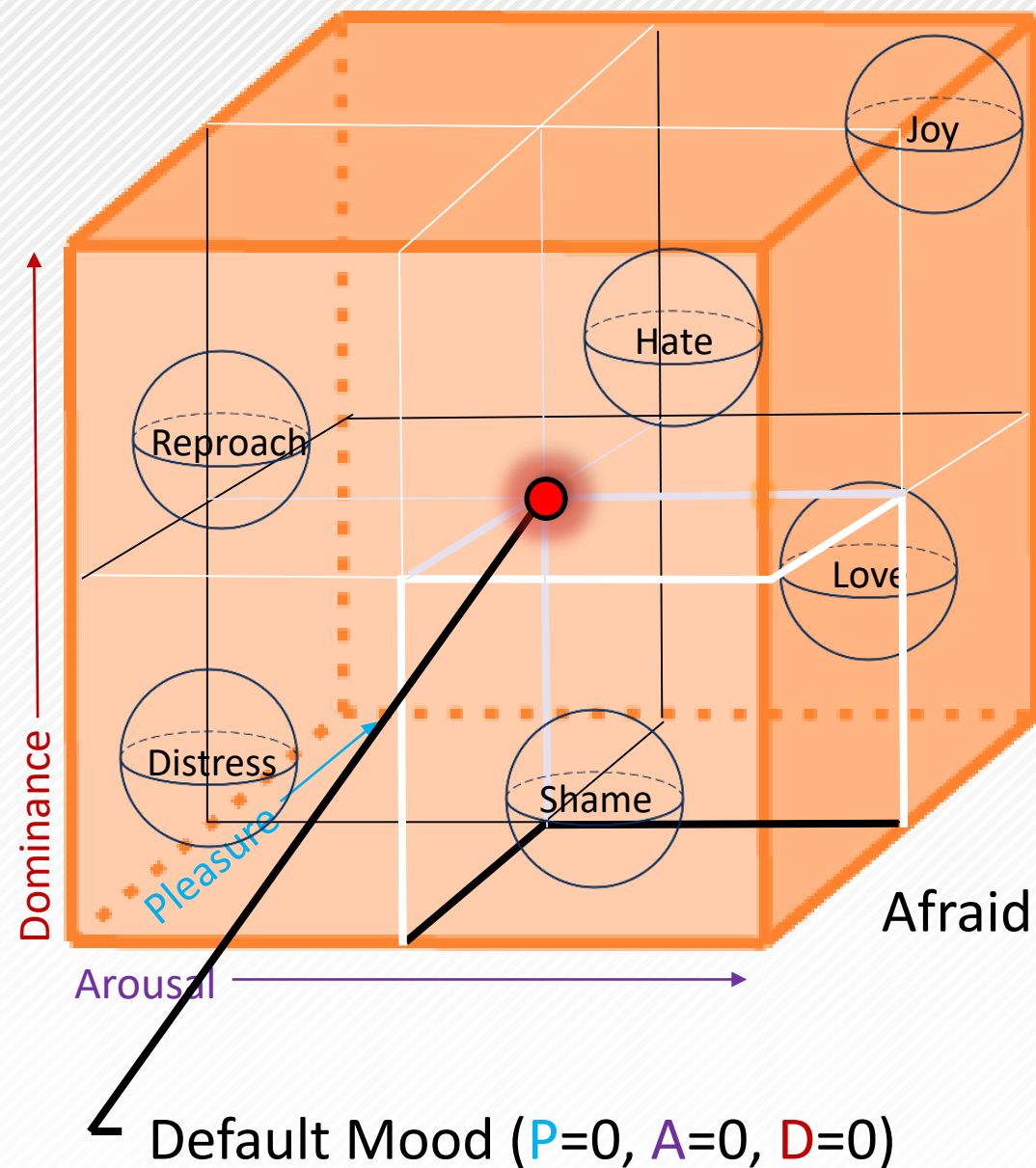## DEVELOP A LIKING OR DISLIKING TOWARD WHAT THE AGENT EXPERIENCES IN THE WORLD

- Great! The agent does not like the "electrified cable" anymore.

- What if we tell him to take it again?

EMOTIONAL COMPONENT

MOOD – PAD MODEL (PLEASURE AROUSAL DOMINANCE)

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

P   Pleasure Displeasure

A   Arousal Nonarousal

D   Dominance Submissiveness

How **pleasant** is an emotion.
Joy ⟷ Fear

How **intense** is an emotion.
Rage ⟷ Boredom

How much **control** and **influence** the agent has over situations
Anger ⟷ Distress

MOOD OCTANT	P	A	D	EMOTION
Exuberant	+	+	+	Joy
Dependent	+	+	-	Admiration
Relaxed	+	-	+	
Docile	+	-	-	
Afraid	-	+	-	Shame
Hostile	-	+	+	Hate
Disdainful	-	-	+	Reproach
Depressed	-	-	-	Distress

EMOTIONAL COMPONENT

MOOD – PLEASURE AROUSAL DOMINANCE MODEL
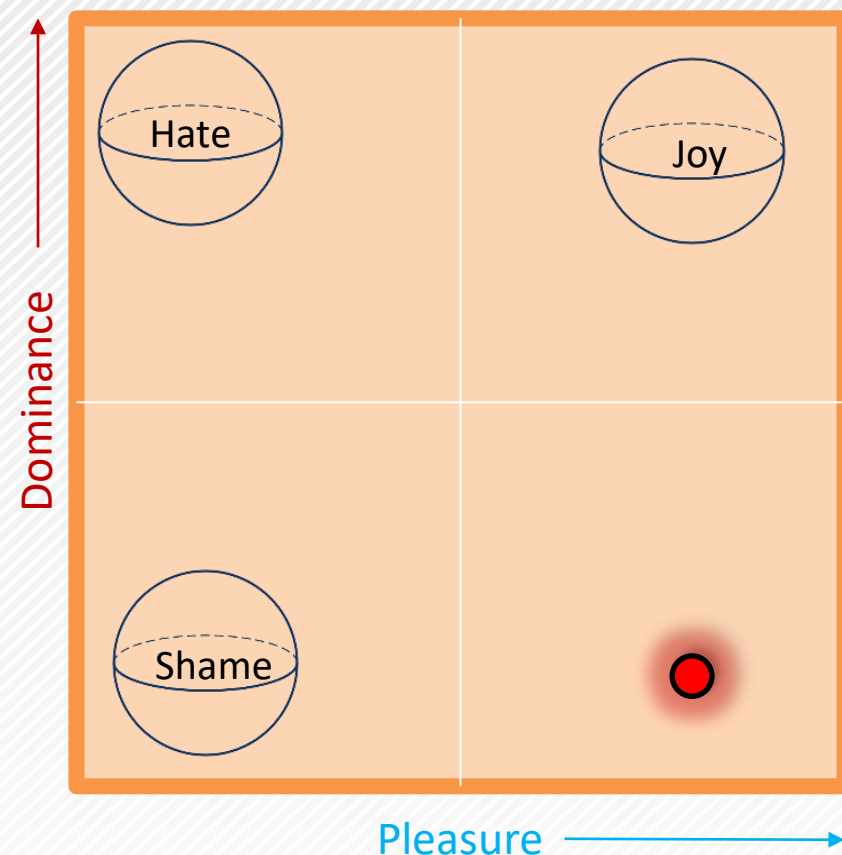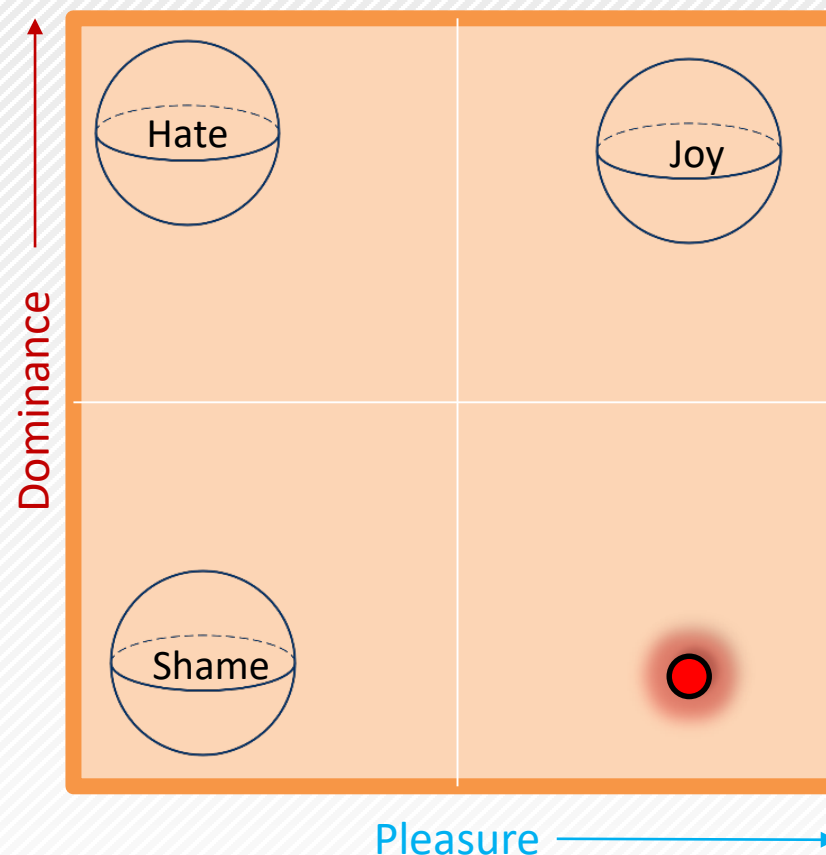
EMOTIONAL COMPONENT
MOOD – PAD MODEL (PLEASURE AROUSAL DOMINANCE)

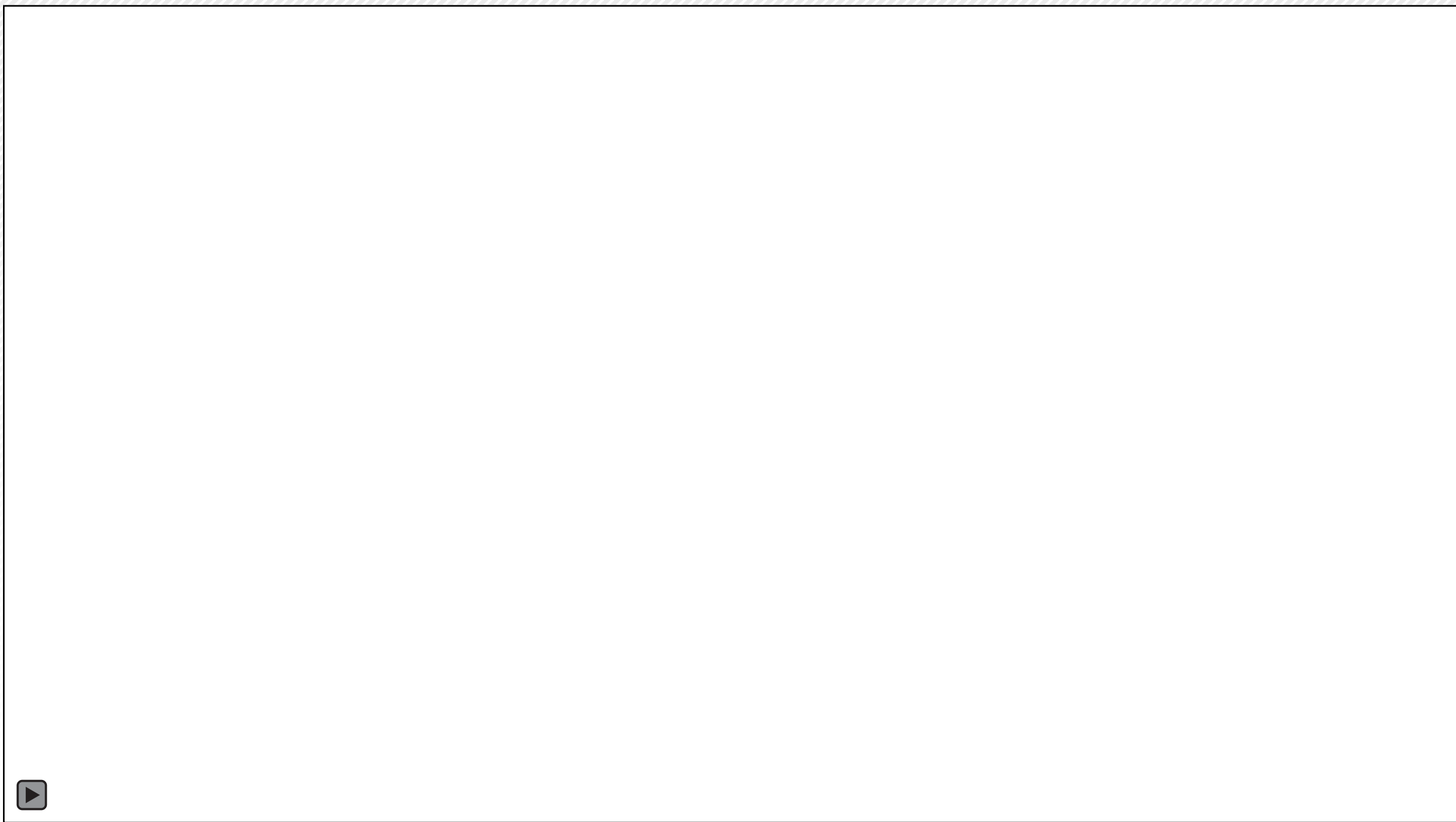| Emotions	Intensity
Joy	1.0
Hate	0.5
Shame	0.75
Hate	1.0
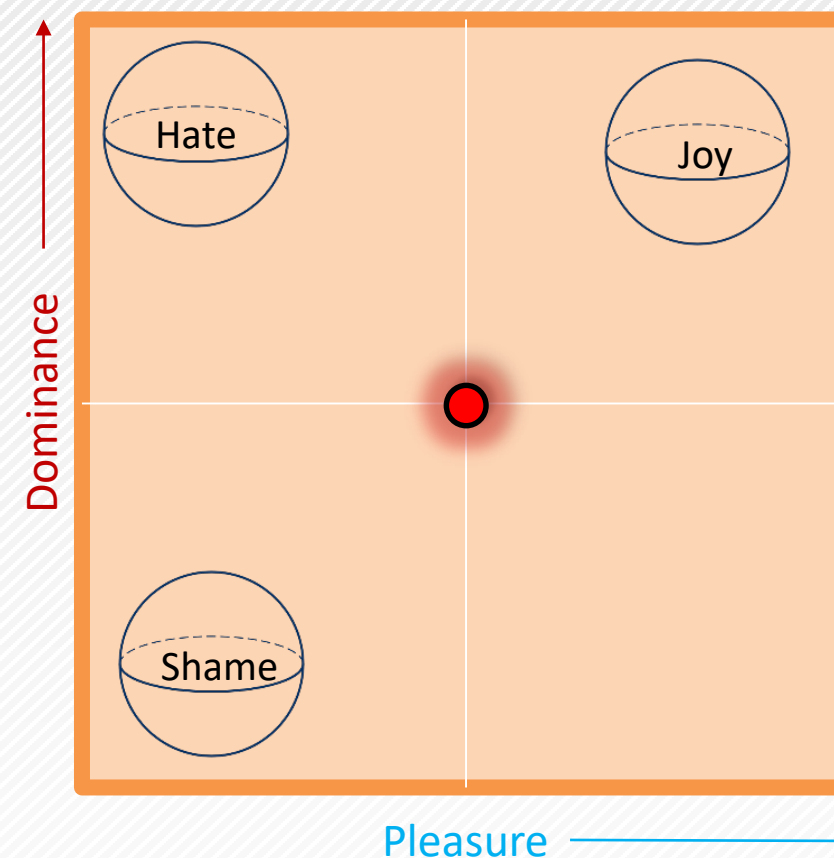
Current Mood

Afraid
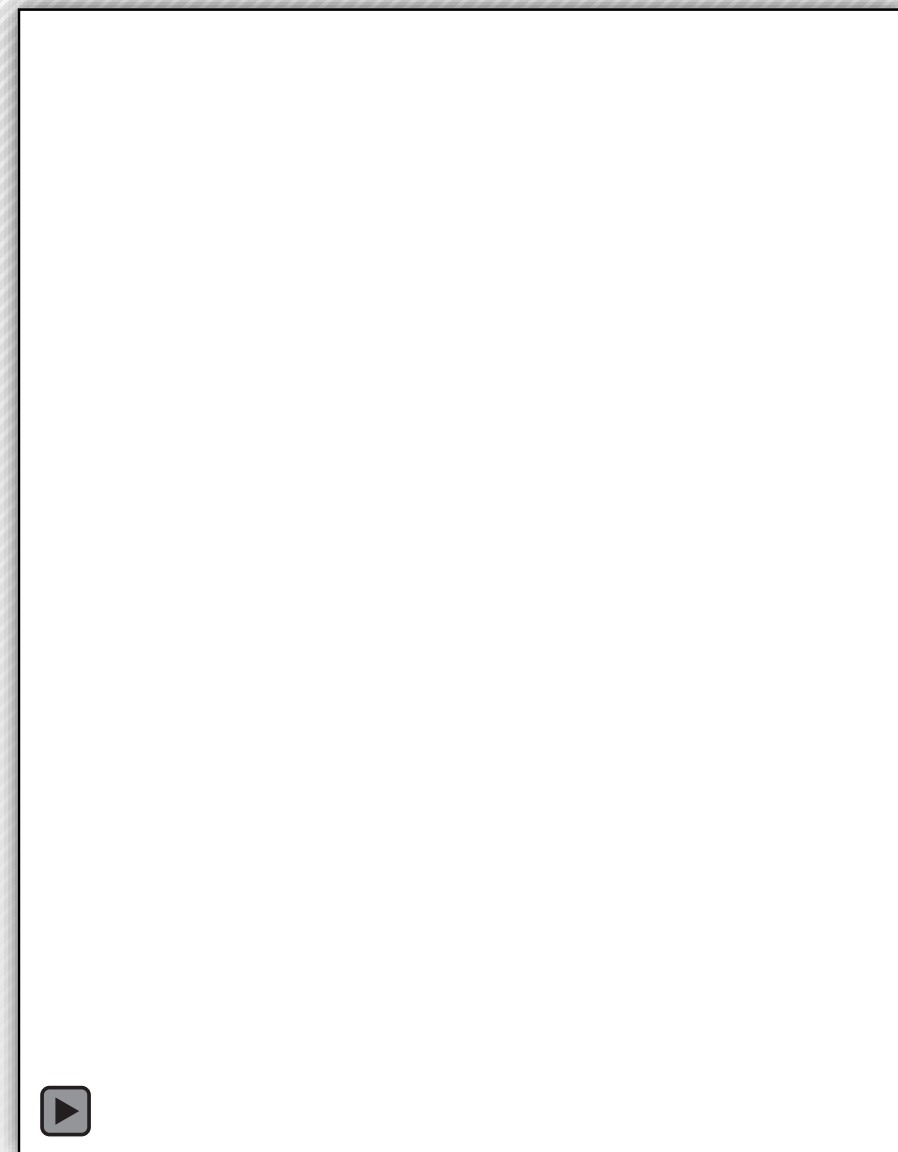
EMOTIONAL COMPONENT

PERSONALITY

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

SQUARE ENIX

ADVANCED
TECHNOLOGY
DIVISION

EMOTIONAL COMPONENT
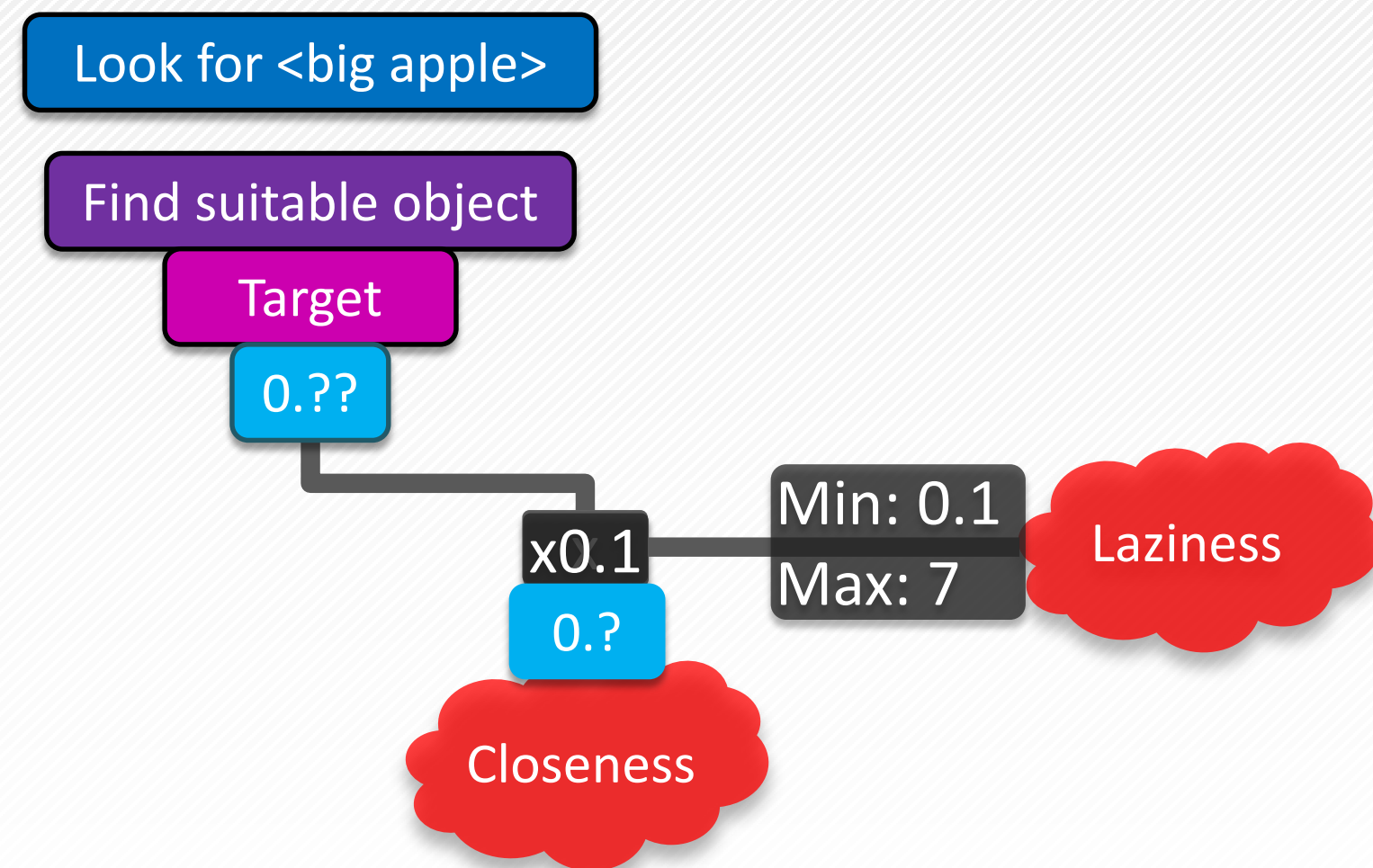
PERSONALITY

EMOTIONAL COMPONENT

PERSONALITY: LAZINESS

- Affect "Look For" action
  - Will favor closer object over farther object

How can it be done?

The lazier the agent,
The more important the Closeness axis should be

The weight should depend on the Laziness

Look for <big apple>

Find suitable object

Target

0.??

x0.1

Min: 0.1
Max: 7

Laziness

0.?

Closeness

EMOTIONAL COMPONENT
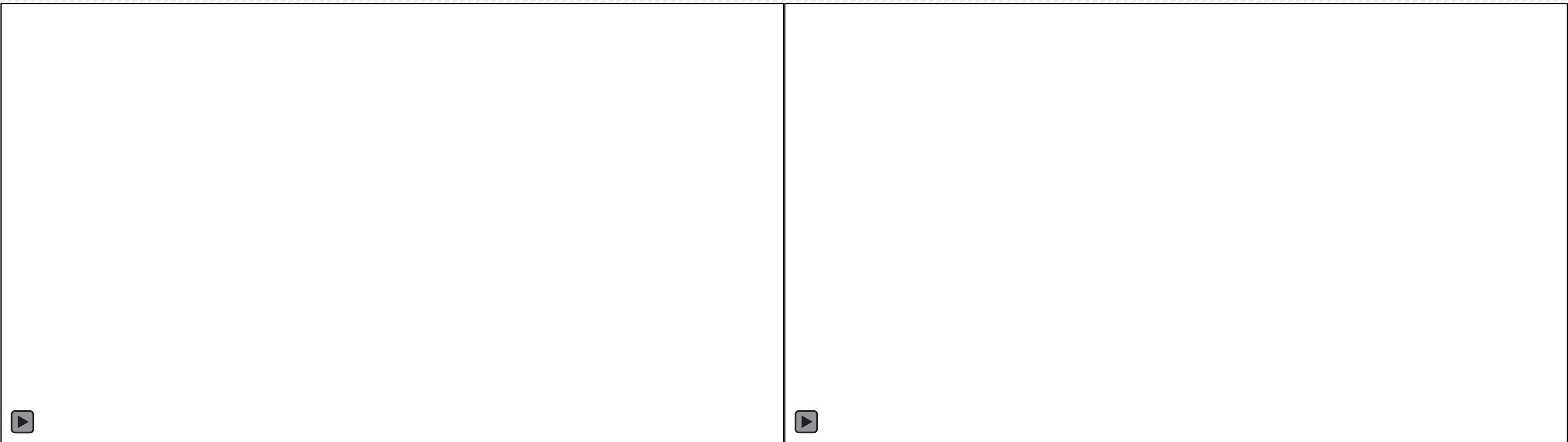
PERSONALITY

- Affect the Decision Making and the Expression
  - Goal Manager:
    - Goal score
  - Planner:
    - Action cost, changing the plan
    - Different set of actions
  - Action
    - Tolerance on Liking/Disliking (objects, etc)
    - Execution
  - Emotion:
    - Change the emotions expression (shyness)
    - Reacts to specific events (curiosity)
  - Mood:
    - default mood

Great variation of play

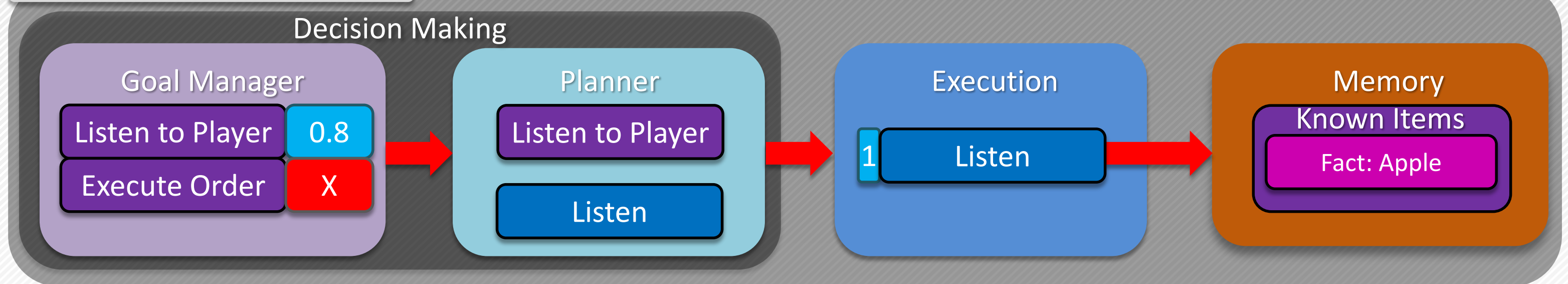- NPCs will feel different to each other

FACTUAL STATEMENTS

FACTUAL STATEMENTS
GROUNDING A FACT – CASE OF A TRUTH

[There is] [Apple] [On] [Table]

Decision Making

Goal Manager
| Ground Fact | 1.5 |
| Execute Order | 0.9 |

Planner
Ground Fact
Search | Go

Execution
1 Go <on Table>
2 Search

Memory
Known Items
Apple

[Take] [Apple]

Decision Making

Goal Manager
| Ground Fact | X |
| Execute Order | 0.9 |

Planner
Execute Order
Take | Go

Execution
Look For | Apple
2 Go
3 Take

FACTUAL STATEMENTS
GROUNDING A FACT – CASE OF A LIE

[There is] [Apple] [On] [Table]

Decision Making

Goal Manager
| Ground Fact | 1.5 |
| Execute Order | 0.9 |

Planner
Ground Fact

| Search | Go |

Execution
1 Go <on Table>
2 Search

Memory
Known Items
Fact: Apple

[Take] [Apple]

Decision Making

Goal Manager
| Ground Fact | X |
| Execute Order | 0.9 |

Planner
Execute Order

| Take | Go |
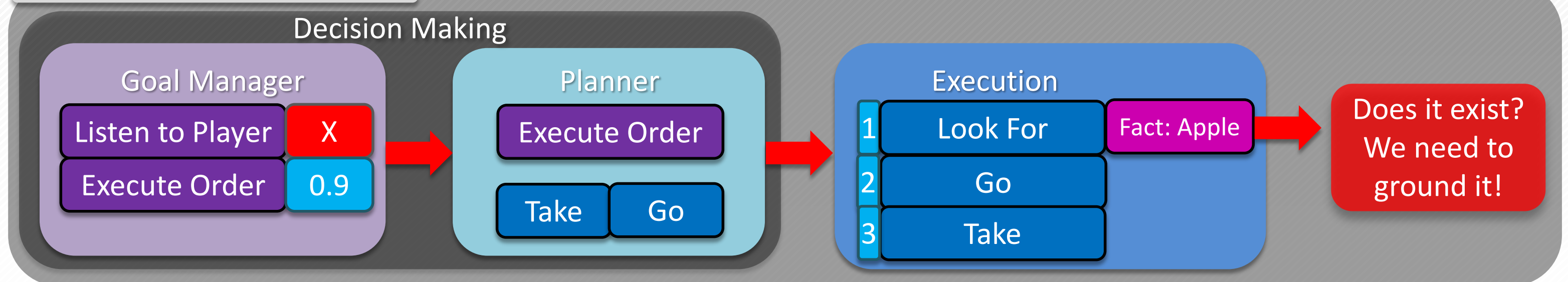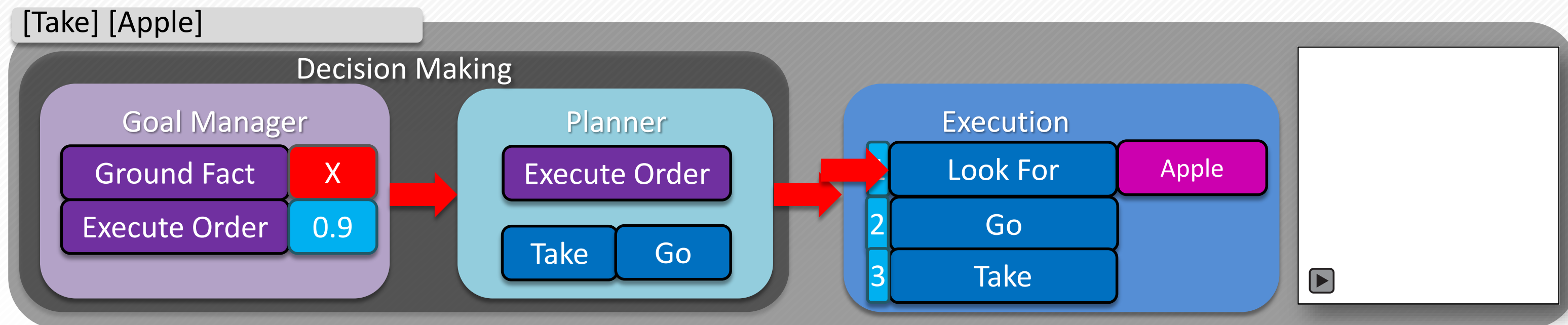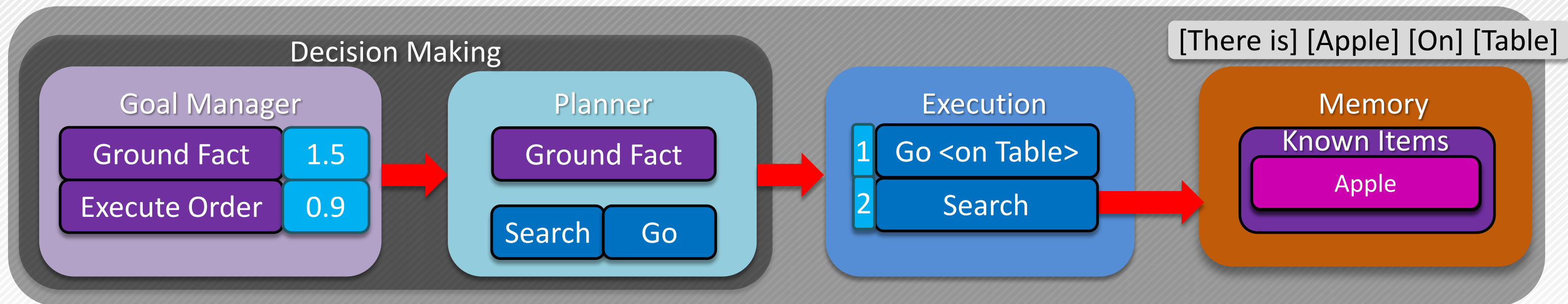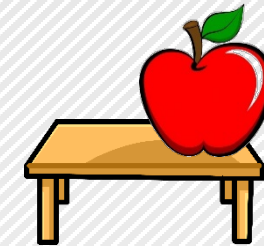
Execution
Look For ❌
2 Go
3 Take
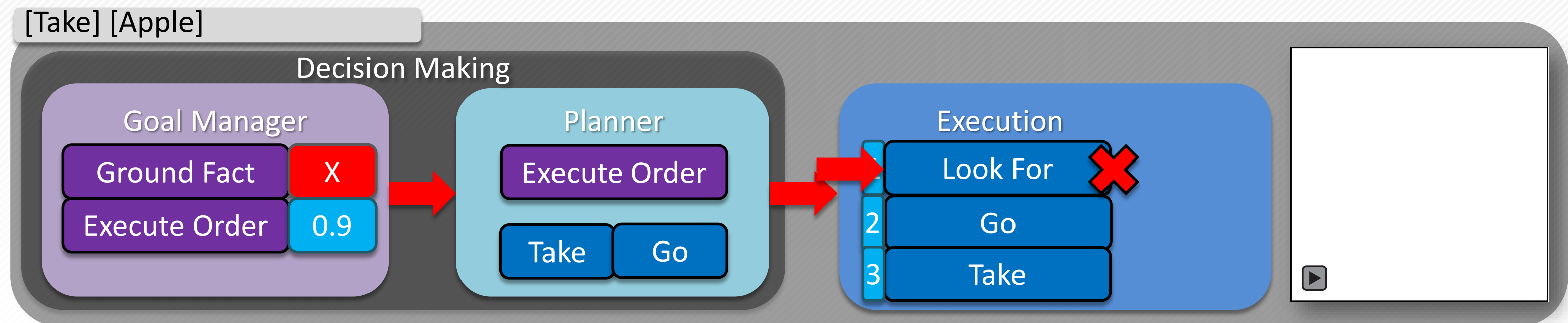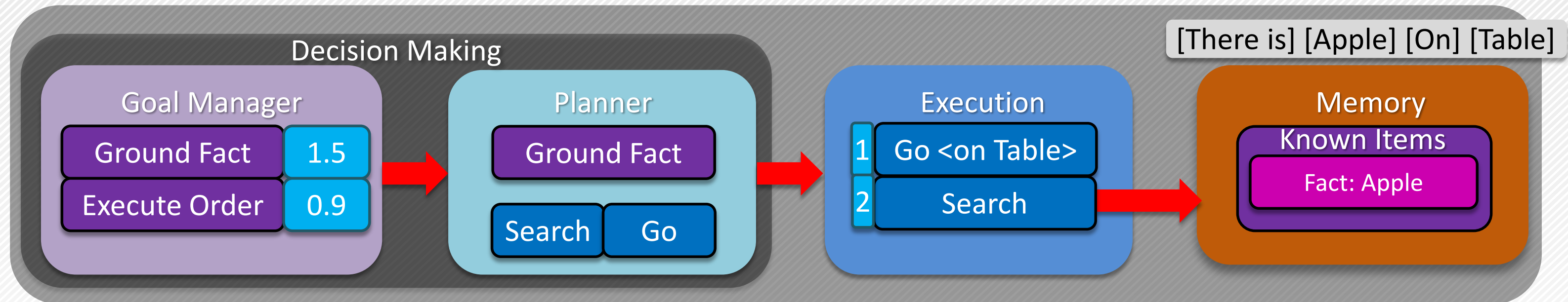
WHAT DID WE ACHIEVED SO FAR

- Bring more natural interactions:
  - Voice interaction (Speech recognition pipeline)
- Create more aware, expressive and lively agents
  - Emotional reactions (Emotion, Mood)
  - Have great variations (Personality)
  - Environment awareness
    - Can like/dislike, and react appropriately
      - Refuse to do an action involving something it hates
    - NPCs can reacts to truths and lies

WHAT CAN WE DO FROM HERE?

- Relationship development
- Multi-agents
- More diverse feedback from the AI-agent
  - I did not understand your speech
  - I did not find what you were talking about
  - I understand but I don't have the ability to execute your order
  - I don't like you, therefore I won't listen to you
  - I don't like the object, therefore I won't execute your order.
  - ...