

기계 학습 기반 감정 인식 게임 개발

2016.06.03

홍익대학교 게임학부 / 조교수

강신진

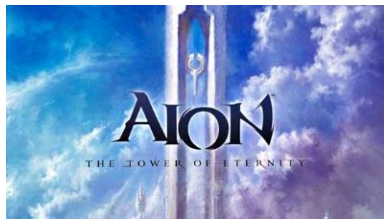
소개: 강신진

- **경력**

- 홍익대학교 게임학부, 조교수 (2008-현재)
- 엔씨소프트(NCsoft) (2006-2008)
- 소니 컴퓨터 엔터테인먼트 코리아(Sony Computer Entertainment Korea) (2003-2006)

- **상용 게임**

- 아이온 (AION), 와일드스타 (WildStar), 블레이드 앤 소울 (Blade and Soul) 외 10여 개의 PC, 모바일, 콘솔 게임 프로젝트 참여

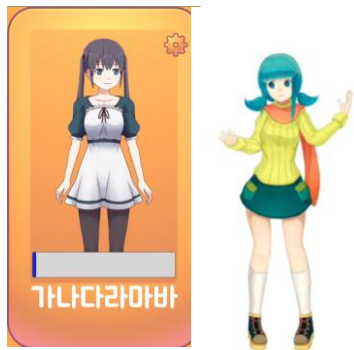


Evolutionary Game Lab



EGLAB Research

ECA Content



Embodied
Conversational Agent

Emotion Recognition



Multimodal Emotion
Recognition

Emotional Model



Rule-based Model / DQN

Index

- Machine Learning in Computer Games
- Affective Computing in Computer Games
- [ML + Affective Computing] Game Development

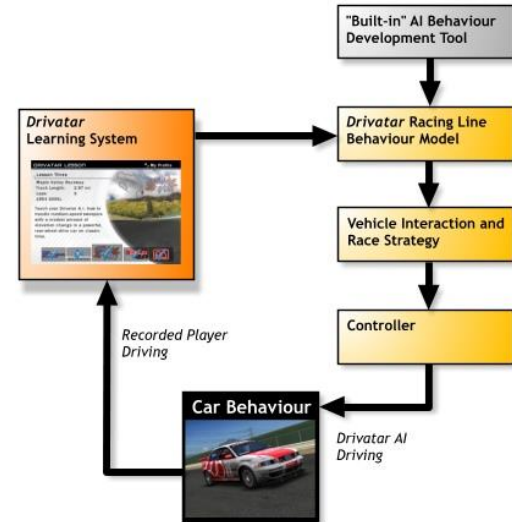
Machine Learning in Commercial Games



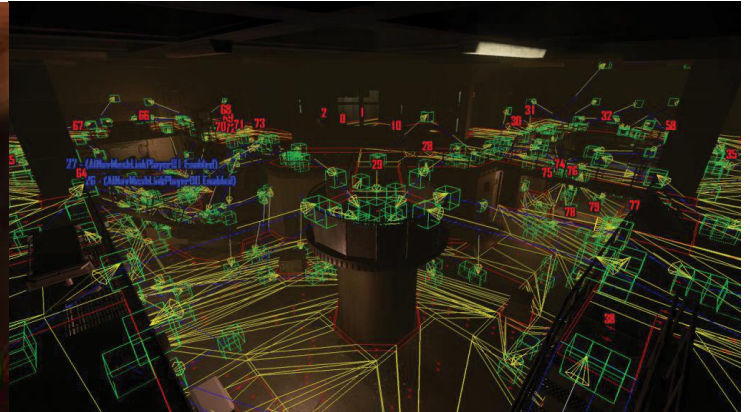
Black and White (Lionhead, 2001)



Forza Motorsport (Microsoft, 2005)



F.E.A.R. (Monolith Production, 2005)



HALO3 (Microsoft, 2007)



Virtua Fighter Ghost System (SEGA, 2015)



Tekken 5: Dark Resurrection (Namco, 2016)



Blade & Soul (NCsoft, 2016)

전략 무공

무한의 탑에서는 탑 내부에서만 사용할 수 있는 '전략 무공'을 사용할 수 있습니다. 도전자들은 전투에 돌입하기 전, 준비 시간 동안 3가지의 전략 무공 중 하나를 선택할 수 있으며, 전투 중 언제든지 [] 키를 이용하여 전략 무공을 사용할 수 있습니다. 20여 가지의 다양한 전략 무공이 준비되어 있으며, 층을 오르면 사용한 전략 무공의 자리에 새로운 전략 무공이 채워지게 됩니다. 단, 선택한 전략 무공은 해당 층에서만 사용할 수 있으며, 전투 중 사용하지 않더라도 사라지는 점 주의하시길 바랍니다.



ML in Computer Games

Strengths

- Re-playability
- Emergent Game Play

Weakness

- Limitation of CPU resources for AI
- Low Development Priority
- Absence of Evaluation Function
- ML Content is not Fun
- ML Content is Unpredictable

Index

- Machine Learning in Computer Games
- Affective Computing in Computer Games
- [ML + Affective Computing] Game Development

Affective Computing in Commercial Games



2600
7800
COMPUTER

ATARI

THE MINDLINK™ SYSTEM

FEATURES:

- Uses EMS technology to respond to each individual's level of concentration and reaction time.
- Compatible with 2600™, 5200™, and Atari home computers.
- Over 100 games available.
- Works on reduced-costline with up to 30-foot range.
- Includes laser-based tracking console.

BENEFITS:

- Increases and stabilizes the level of concentration and the capability of getting your mind ready for any situation.
- Helps you to concentrate and focus.
- A handy new way to communicate with your Master Computer System or Atari computer using your usual method of play.
- Mostly overhead or on-line, both modes and user manual included.

ADVERTISING/PROMOTION:

- Increases sales and profit in computer stores.
- Increases sales and profit in computer stores.
- Increases sales and profit in computer stores.
- Increases sales and profit in computer stores.

SYSTEM:

- Includes console, headset, control, and manual from Atari and Atari.

DESCRIPTION:

Atari Mindlink is an innovative system that enables you to control your Atari game system or computer without ever touching a joystick. The 3-way optical sensor console responds to your level of concentration, reaction time, and heart rate, and challenges to make.

REQUIREMENTS:

- Atari Mindlink is not compatible for console use or with any Atari system that uses the Atari 2600, 5200, or Atari 800.
- Atari Mindlink is not compatible with the Atari 2600, 5200, or Atari 800.
- Atari Mindlink is not compatible with the Atari 2600, 5200, or Atari 800.

AVAILABILITY:

| Order Number | MSRP | Computer |
|--------------|----------|------------|
| 2600-0101 | \$199.95 | Atari 2600 |
| 5200-0101 | \$199.95 | Atari 5200 |
| 800-0101 | \$199.95 | Atari 800 |

CompuLink
large unit



デジタル恋愛シミュレーション
素直な想い出るプリントアウト

デート企画に、恋人候補生の数え切れないほどのシミュレーションが収録された、恋の悩みを解決できるプリントアウトゲーム。恋の悩みを解決できるプリントアウトゲーム。恋の悩みを解決できるプリントアウトゲーム。

◆ダウンロード版
◆プレイバック
◆恋愛シミュレーション

◆コンテナ
◆恋愛シミュレーション
◆恋愛シミュレーション
◆恋愛シミュレーション

◆恋愛シミュレーション
◆恋愛シミュレーション
◆恋愛シミュレーション
◆恋愛シミュレーション

コナミ株式会社

KONAMI Co., Ltd.
4-1-3, Higashi-Shinjyuku, Shinjyuku-ku, Tokyo, 162-0843, Japan.



Mindlink (ATARI, 1984)

2600
7800
COMPUTER

ATARI



THE MINDLINK™ SYSTEM

FEATURES:

- Uses EMS technology to respond to each individual's level of concentration, vital muscle tension.
- Compatible with 7800™, 2600™, and Atari home computers.
- Offers two player expandability.
- Works on almost anyone with up to 30 foot range.
- Includes Heavy Breakthrough™ cartridge.

BENEFITS:

- Acting and responsive. Offers the magic of telekinesis right in the comfort of your own seat.
- Helps you to relax and feel good.
- A revolutionary new way to communicate with your Video Computer System or Atari computer using your mind instead of your hands.
- Broad market appeal to all ages, both inside and outside business office systems, your computer, non-computer users.

ADVERTISING/PROMOTION:

- Heavy business and magazine advertising.
- Large scale publicity program.
- Distributed promotional support (print with 7800).

SYSTEM:

Package includes headset, control unit and standard telex cable and scanner.

DESCRIPTION:

Uses Mindlink as an interactive system that enables you to control your Atari game system or computer without ever touching the mouse. A heavy optical sensor, designed to interact with every individual's unique EMG muscles, it transmits you to concentration and stress, and gives you your own feedback to listen.

REQUIREMENTS:

- Atari Mindlink is accompanied by a special line of all size and will not work with existing 2600 or computer systems.
- To use Mindlink with the 5000™, you will need an Atari 1000™ interface.
- The headset and controller require a 9V DC battery, which is not included in the package.

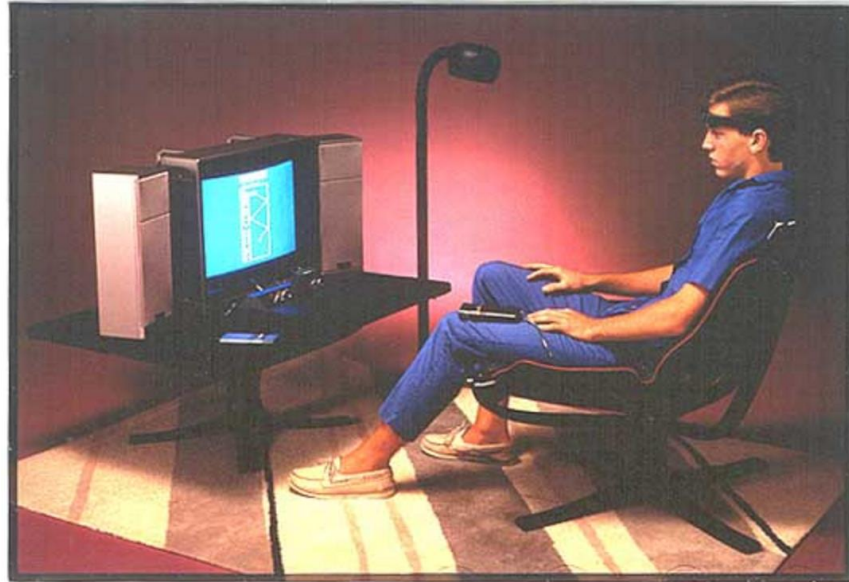
AVAILABILITY:

| Order Number | 2600/7800 | Complete |
|--------------|-------------|-------------|
| Kit Kit 504 | Kit Kit 504 | Kit Kit 504 |
| Shelf pack | Kit Kit 504 | Kit Kit 504 |
| Case pack | Kit Kit 504 | Kit Kit 504 |

For Further Information, Please
CALL (800) 521-5211 (Outside California)
(813) 475-2000 (In California)

© 1984 Atari, Inc. All Rights Reserved.

ENTERTAINMENT
HARDWARE



Tokimeki Memorial (Konami, 1997)



**ドキドキ恋愛シミュレーション
素敵な思い出をプリントアウト**

デートを重ねて、楽しい高校生活の思い出
全部お楽しみシミュレーション。従来のプレイに
追加でごきめきセンター、プレイヤー
の心の距離とヒートで、彼女たちのハート
イベントを呼び起こす。コンテスト・メ
ジカート・イベント・フリットアウト

プリントには
イメージおぼえの
全種類
集めてね

●オプションは
標準装備

先付メーター (ゲーム専用)

ライフアップ
ゲーム専用

新作カットガ
収録

ひびきかな
のミニクワ
収録!!

心拍モニター (標準装備)

♥遊び方♥

- ① コインを投入
- ② 名前を入力 (登録番号等)
- ③ 相手を選んでデートに誘おう
- ④ イベント発生!!
- ⑤ あなただけの発情形をセンサーが感知。
それが女の子に伝わります。
- ⑥ 選択した答えとセンサーの反応が
女の子の発情形に変化を与えます。
- ⑦ ゲーム終了後、2人だけの思い出
がメッセージカードとしてプリント
アウト

※本機は、専用カードの投入によりプレイが可能となります。
カードは、専用機にのみ対応した専用カードです。

◆仕様

| | |
|----------|----------------------------|
| 本体寸法 | W 750 mm |
| D 948 mm | H 1,968 mm |
| 消費電力 | AC100V±10%(50/60Hz)実消費210W |
| 消費電力 | 消費電力 約 1.30W |
| モニター | 20インチカラーモニター |

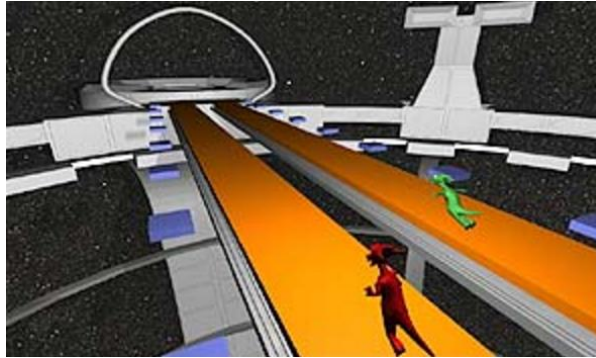
※設置上の注意事項については、必ず取扱説明書をご確認ください。
※設置されている場所の環境、利用は、今後におこないます。変更が
ございます。ご了承ください。

◆お買い合わせ先

コナミ株式会社

KONAMI Co., Ltd.
HEADQUARTERS 4-1-1 Toriyanagi, Minato-ku, Tokyo, 108, Japan

Relax to Win Game (McDarby, 2002)



PlayStation Eyetoy / Microsoft Kinect (2003)



Expression

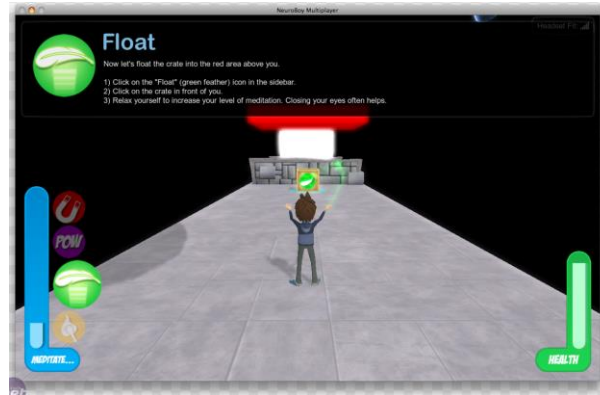
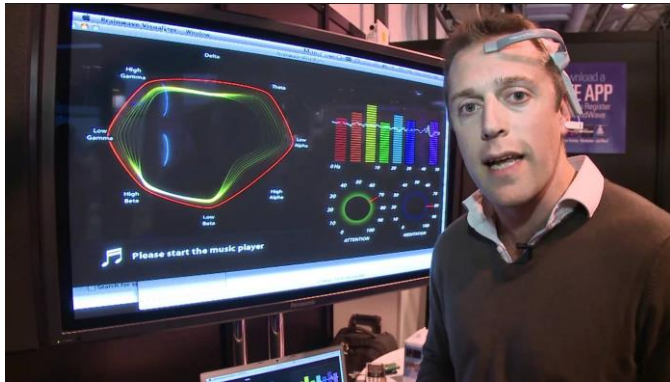
| Guest01 | Controller 1 |
|---------------------|---------------------|
| 2533275001293731 | BiometricUserid 16 |
| BiometricUserid 0 | BiometricUserid 0 |
| Expression: Neutral | Expression: Neutral |
| Engaged: Yes | Engaged: Yes |
| Looking Away: No | Looking Away: No |
| Talking: Yes | Talking: Yes |
| Mouth Moved: Yes | Mouth Moved: Yes |
| Mouth: Open | Mouth: Open |
| Glasses: No | Glasses: No |
| Left Eye: Open | Left Eye: Open |
| Right Eye: Open | Right Eye: Open |

See my video about these questions...

Skeleton Orientation Muscle+Force Heartrate Expression

60

Mindwave (Neurosky, 2012)



Affective Computing in Computer Games

Strengths

- Providing New Experience
- Market Share Expansion

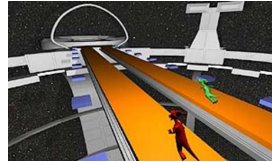
Weakness

- Intrusive Additional Hardware
- Low Recognition Rate of Player's Emotion

Index

- Machine Learning in Computer Games
- Affective Computing in Computer Games
- [ML + Affective Computing] Game Development

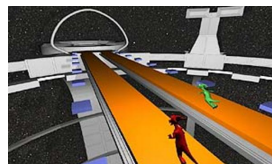
[ML + AC] in Computer Games



Commercially Successful Games



[ML + AC] in Computer Games



[ML + AC] in Computer Games

Strengths

- Re-playability
- Emergent Game Play

Strengths

- Providing New Experience
- Market Share Expansion

Weakness

- Limitation of CPU resources for AI
- Low Development Priority
- Absence of Evaluation Function
- ML Content is not Fun
- ML Content is Unpredictable

Weakness

- Intrusive Additional Hardware
- Low Recognition Rate of Player's Emotion

[ML + AC] in Computer Games

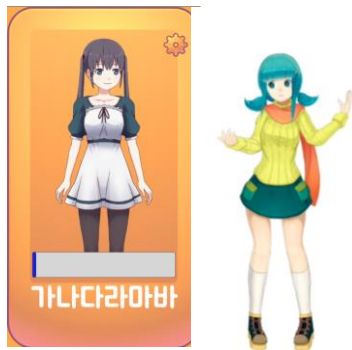
- Limitation of CPU resources for AI
- Low Development Priority
- Content is not Fun
- Content is Unpredictable
- Intrusive Additional Hardware
- Low Recognition Rate of Player's Emotion
- Absence of Evaluation Function

Solutions

- Limitation of CPU resources for AI → **AI Oriented Content**
- Low Development Priority → **Long Term Project**
- Content is not Fun → **Appropriate Genre**
- Content is Unpredictable → **Non-Competitive Game**
- Intrusive Additional Hardware → **Non-Intrusive/Default Hardware**
- Low Recognition Rate of Player's Emotion → **ML with Big Data**
- Absence of Evaluation Function → **Robust Emotional Model**

EGLAB Research

ECA Content



Embodied
Conversational Agent

Emotion Recognition



Multimodal Emotion
Recognition

Emotional Model

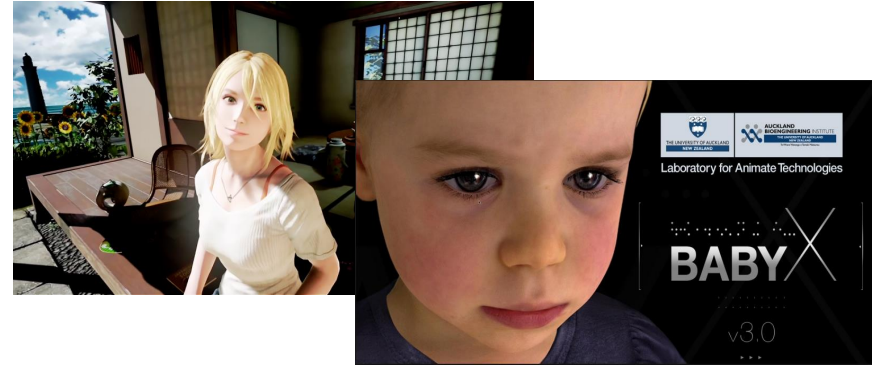


Rule-based Model / DQN

Embodied Conversational Agent (ECA)



GRETA, SEMAINE, HUMAINE (2007)



Summer Lesson, BabyX (2016)

Summer Lesson (Namco, 2015)



BabyX (Sagar, 2016)



ECA Core Technologies

Verbal
Communication

Non-Verbal
Communication



ECA Core Technologies

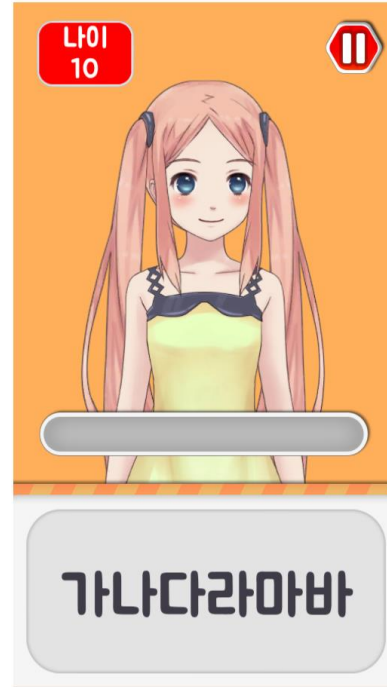
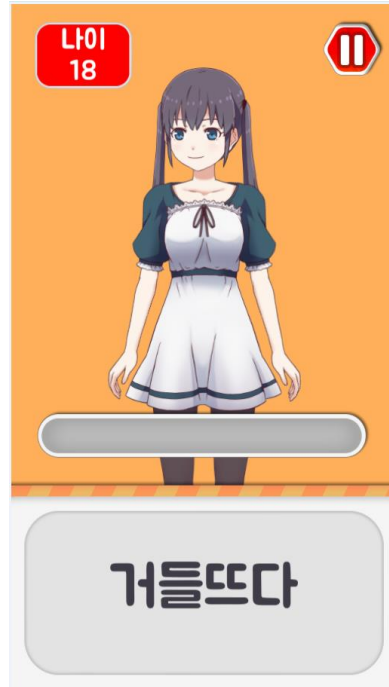


Implementation Results



“Love Senor”

Implementation Results



Solutions

- Limitation of CPU resources for AI → **AI Oriented Content**
- Low Development Priority → **Long Term Project**
- Content is not Fun → **Appropriate Genre**
- Content is Unpredictable → **Non-Competitive Game**
- Intrusive Additional Hardware → **Non-Intrusive/Default Hardware**
- Low Recognition Rate of Player's Emotion → **ML with Big Data**
- Absence of Evaluation Function → **Robust Emotional Model**

Hardware for Affective Computing

Intrusive H/W

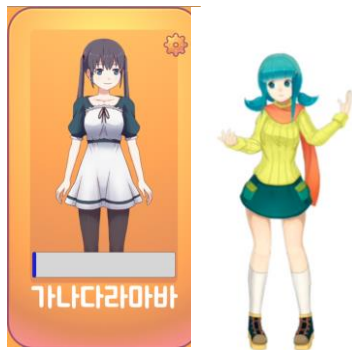
- EEG
- Heart Rate
- Depth Camera
- Brain Wave

Non-Intrusive H/W

- Multimodal Interface
- Keyboard
- Mouse
- Webcam

EGLAB Research

ECA Content



Embodied
Conversational Agent

Emotion Recognition



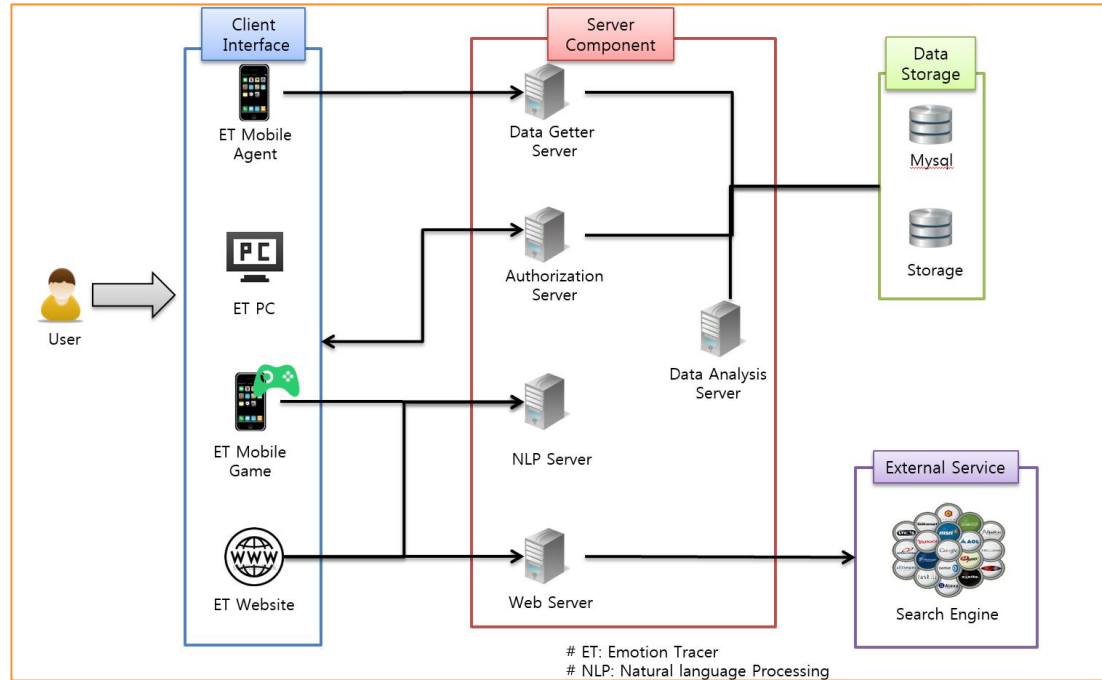
Multimodal Emotion
Recognition

Emotional Model



Rule-based Model / DQN

Implementation Result



“Emotion Recognition System with Multimodal Interface”

Implementation Result



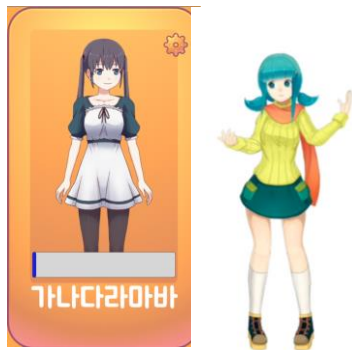
“Emotion Tracer Client”

Solutions

- Limitation of CPU resources for AI → **AI Oriented Content**
- Low Development Priority → **Long Term Project**
- Content is not Fun → **Appropriate Genre**
- Content is Unpredictable → **Non-Competitive Game**
- Intrusive Additional Hardware → **Non-Intrusive/Default Hardware**
- Low Recognition Rate of Player's Emotion → **ML with Big Data**
- Absence of Evaluation Function → **Robust Emotional Model**

EGLAB Research

ECA Content



Embodied
Conversational Agent

Emotion Recognition



Multimodal Emotion
Recognition

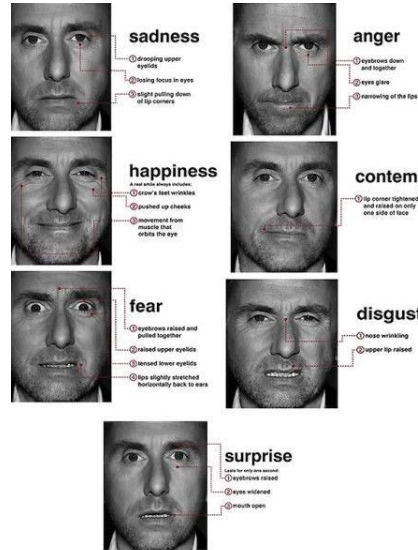
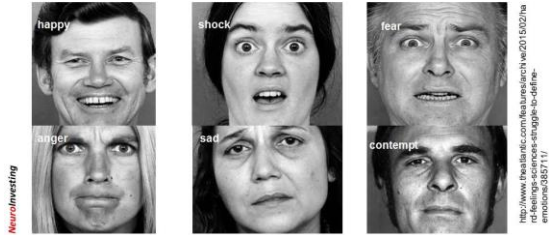
Emotional Model



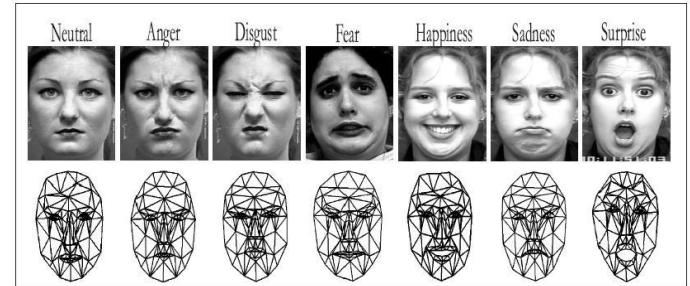
Rule-based Model / DQN

Discrete Emotion Model

6 universal emotions

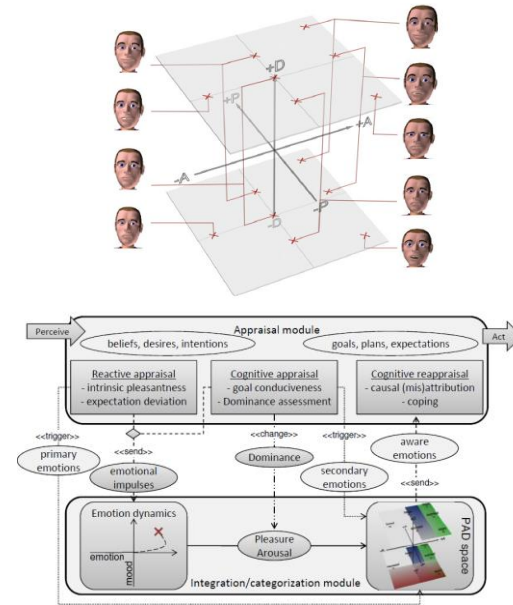
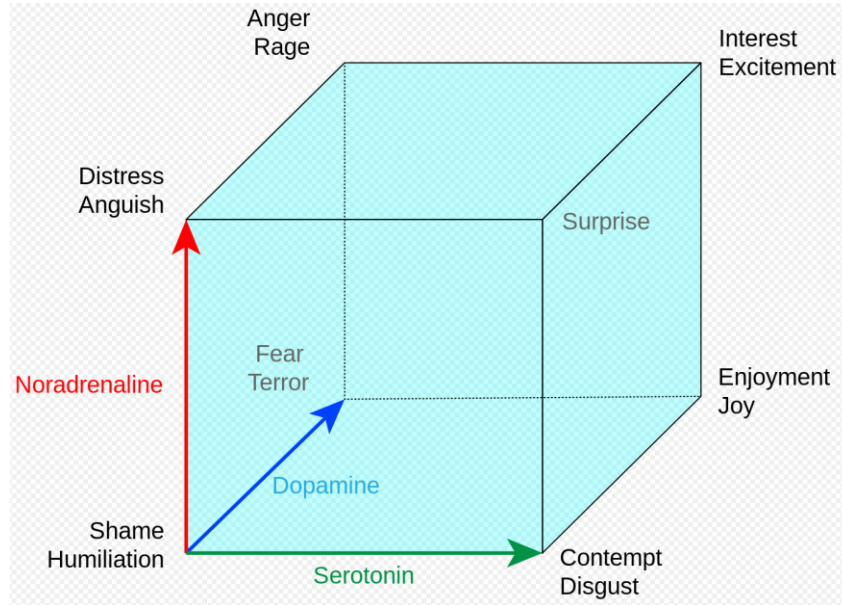


| Upper Face Action Units | | | | | |
|-------------------------|---------------------|---------------------|-------------------|---------------|---------------|
| AU 1 | AU 2 | AU 4 | AU 5 | AU 6 | AU 7 |
| Inner Brow Raiser | Outer Brow Raiser | Brow Lowerer | Upper Lid Raiser | Cheek Raiser | Lid Tightener |
| *AU 41 | *AU 42 | *AU 43 | AU 44 | AU 45 | AU 46 |
| Lid Droop | Slit | Eyes Closed | Squint | Blink | Wink |
| Lower Face Action Units | | | | | |
| AU 9 | AU 10 | AU 11 | AU 12 | AU 13 | AU 14 |
| Nose Wrinkler | Upper Lip Raiser | Naolabial Depressor | Lip Corner Puller | Cheek Puffer | Dimpler |
| AU 15 | AU 16 | AU 17 | AU 18 | AU 20 | AU 22 |
| Lip Corner Depressor | Lower Lip Depressor | Chin Raiser | Lip Puckerer | Lip Stretcher | Lip Pummeler |
| AU 23 | AU 24 | *AU 25 | *AU 26 | *AU 27 | AU 28 |
| Lip Tightener | Lip Pressor | Lips Part | Jaw Drop | Mouth Stretch | Lip Suck |



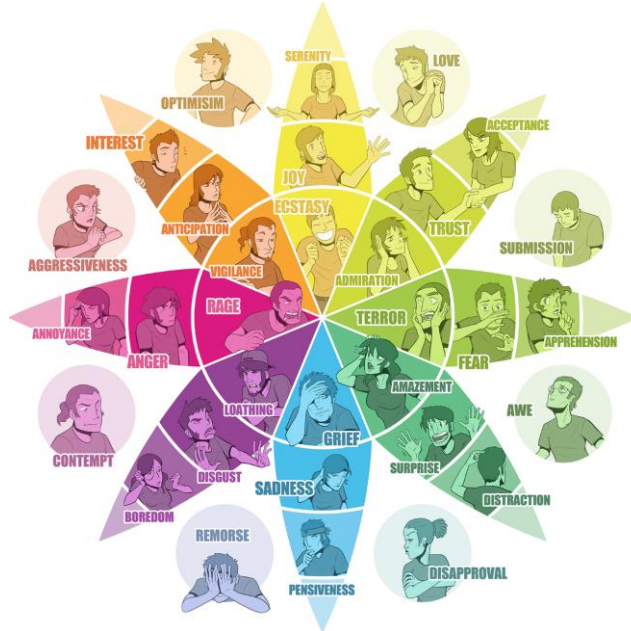
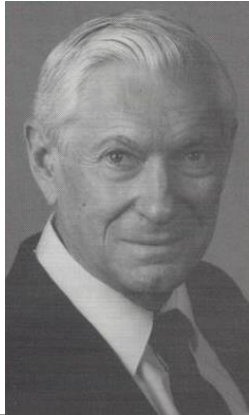
- Ekman's 6 Universal Emotions

Dimensional Theory

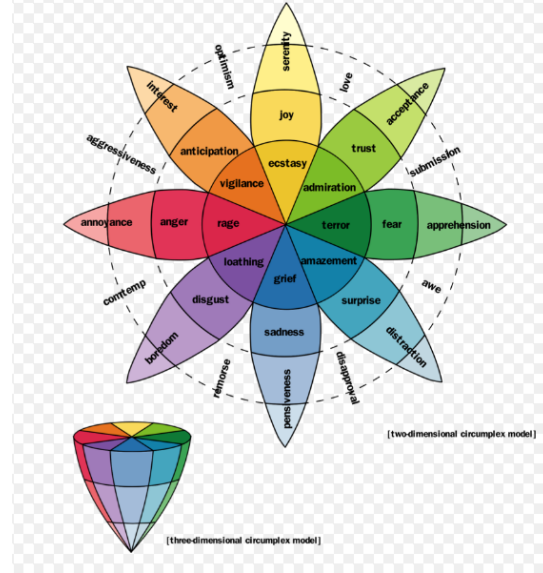


- The PAD (*Pleasure, Arousal, Dominance*) model, Albert Mehrabian and James A. Russell

Evolutionary Model

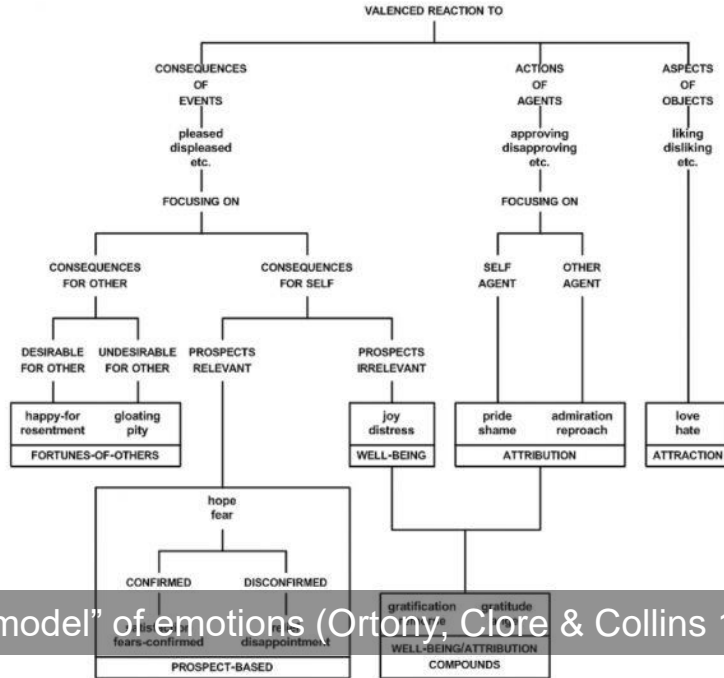


Plutchik's Wheel of Emotions



- Plutchik's wheel of emotions

OCC Model



- "OCC-model" of emotions (Ortony, Clore & Collins 1988)

A Better Narrative using OCC Emotional Model

by Rizky Winanda on 05/13/14 07:40:00 pm Featured Post

8 comments [f](#) [Share](#) [G+](#) [S](#)

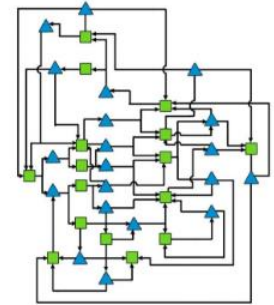
The following blog post, unless otherwise noted, was written by a member of Gamas. The thoughts and opinions expressed are those of the writer and not Gamasutra or i

Narrative is a complicated word. Some people believe that narrative could increase others say it is only a tainted game play. I won't start a fuss about it, but I narrative holds a prospect in the game. This year GDC, Ken Levine, presented narrative in a game referred as Narrative Lego. I see a big chance on it though chance where narrative not only acting as decoration, but also a core of motivation for me to do my own little research about narrative. Herewith, I will pres

In my opinion, the narrative is considered great when it triggers emotional effect happens, the character in the game must possess emotion itself and delivers could feel the character's emotion in order to create empathy towards the creating a great narrative is to know more about emotion, explore how many them. There are many concepts about emotion that we can use, but I'll use OCC how the emotion created in a structural way which makes it easier to understand into philosophy or psychology, read about emotion will push your brain off to the



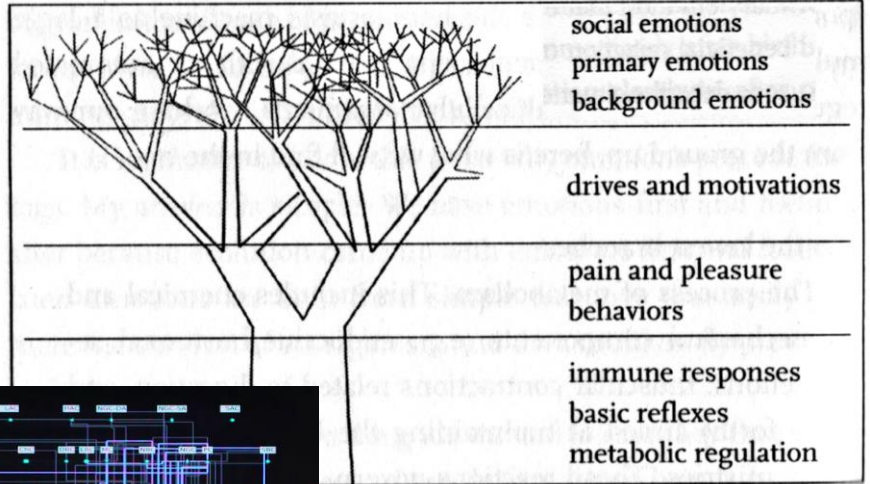
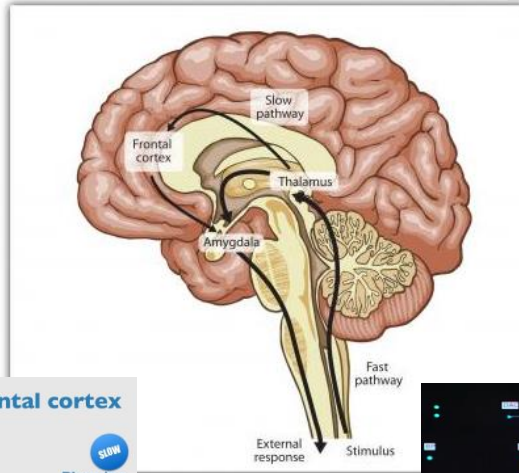
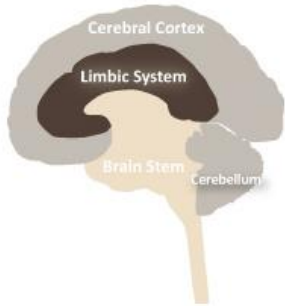
The sequence of appraisal where square represents event, triangle represents action, and circle represents object.




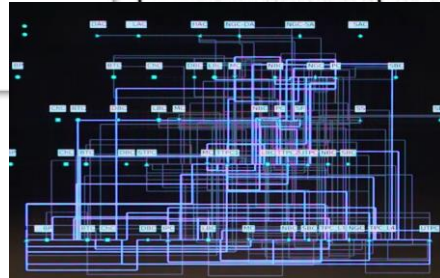
Example of chain of action-event

Circuit Model (Neural Darwinism)

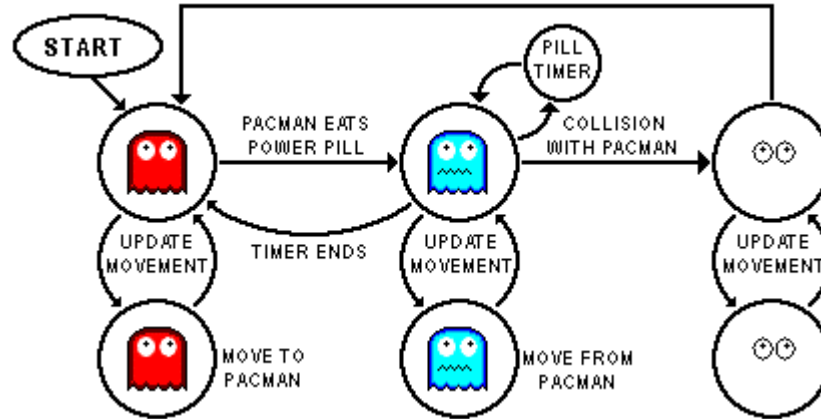
Figure 10.3. Slow and Fast Emotional Pathways



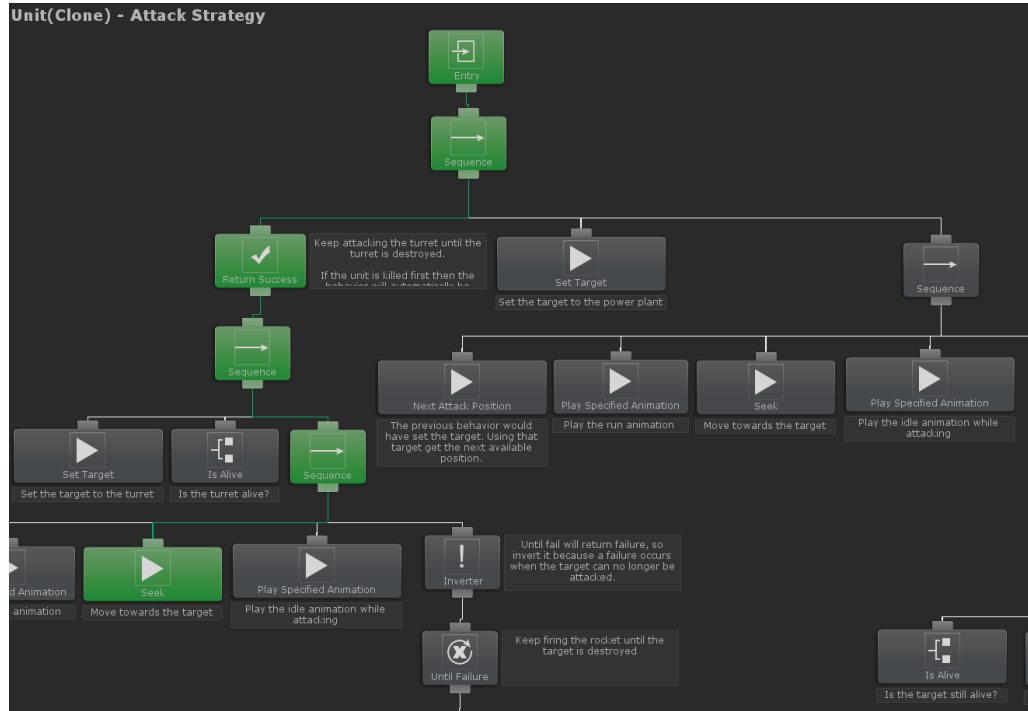
| | |
|--|---|
| <p>Limbic system</p> <p>FAST</p> <p>Pleasure Fear Reward Arousal</p> | <p>Prefrontal cortex</p> <p>SLOW</p> <p>Planning Future Abstract concepts Distant goals</p> |
|  | |
| <p>NOW is better than LATER</p> | |



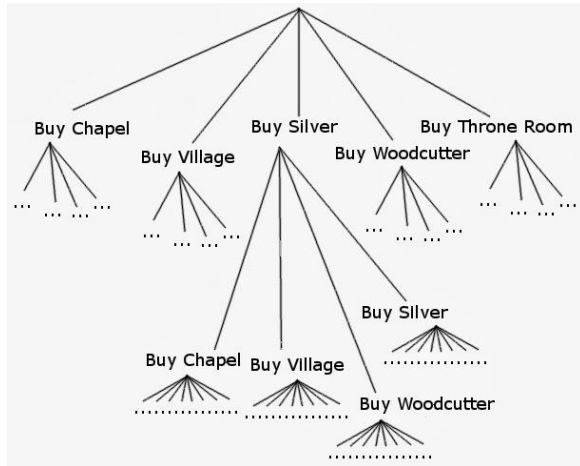
Finite State Machine (FSM)



Behavior Tree

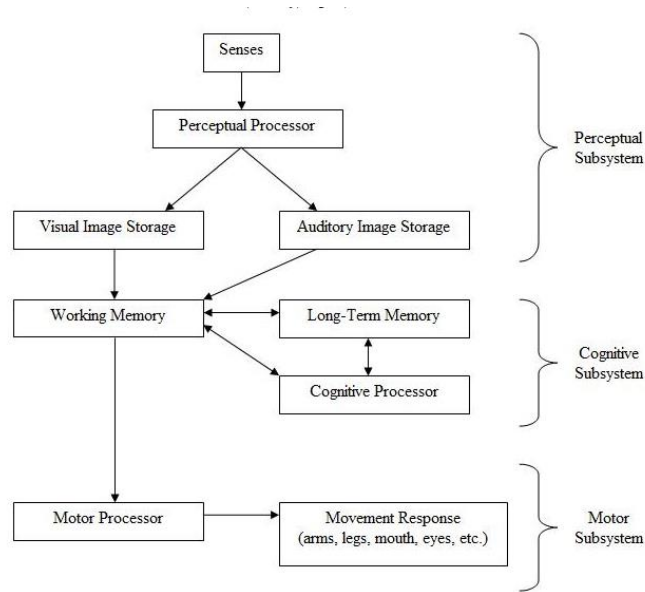
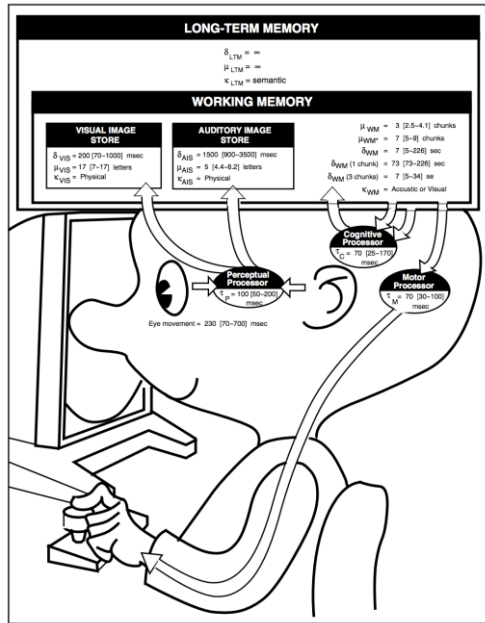


Decision Tree



MHP (Model Human Process)

Figure 1. Model Human Processor. Based on Card, Moran, and Newell (1983).



| Parameter | Mean | Range |
|--|------------|-----------------|
| Eye movement time | 230 ms | 70-700 ms |
| Decay half-life of visual image storage | 200 ms | 90-1000 ms |
| Visual Capacity | 17 letters | 7-17 letters |
| Decay half-life of auditory storage | 1500 ms | 90-3500 ms |
| Auditory Capacity | 5 letters | 4.4-6.2 letters |
| Perceptual processor cycle time | 100 ms | 50-200 ms |
| Cognitive processor cycle time | 70 ms | 25-170 ms |
| Motor processor cycle time | 70 ms | 30-100 ms |
| Effective working memory capacity | 7 chunks | 5-9 chunks |
| Pure working memory capacity | 3 chunks | 2.5-4.2 chunks |
| Decay half-life of working memory | 7 sec | 5-226 sec |
| Decay half-life of 1 chunk working memory | 73 sec | 73-226 sec |
| Decay half-life of 3 chunks working memory | 7 sec | 5-34 sec |

- Cognitive Model (Card, Moran, and Newell)

ACT-R (Adaptive Control of Thought)

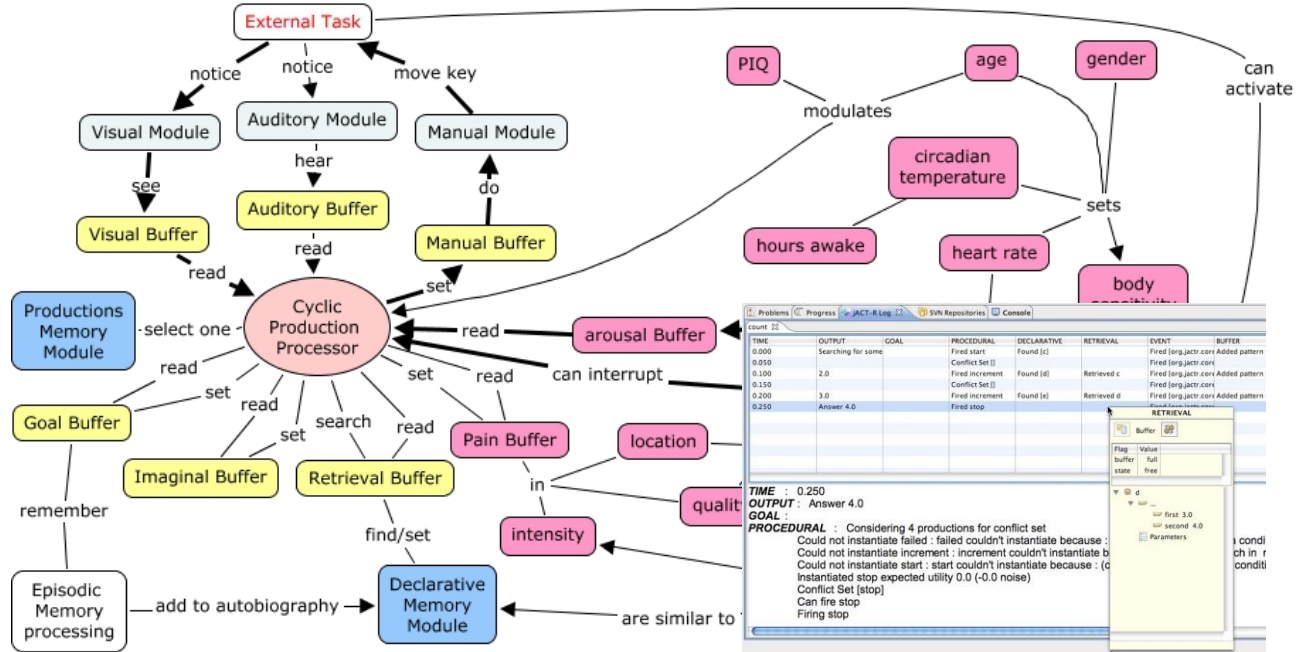
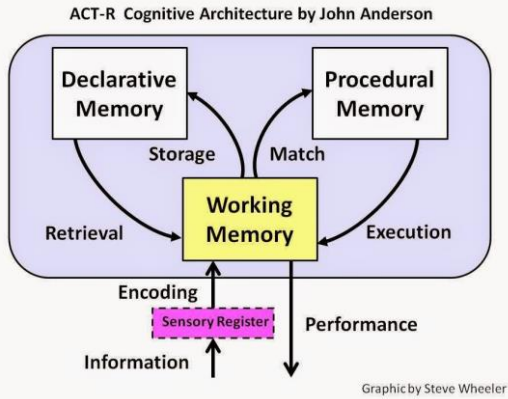
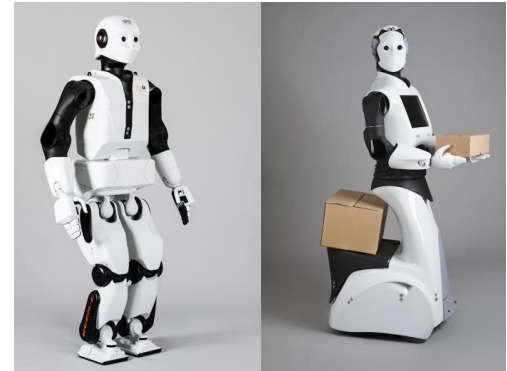
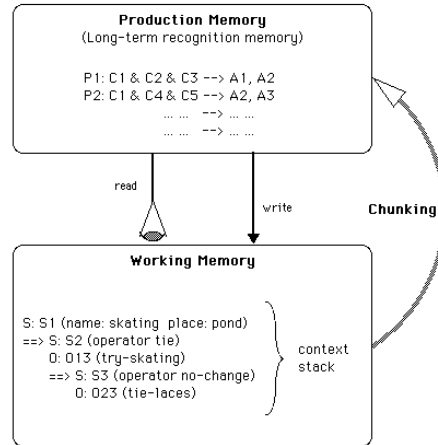
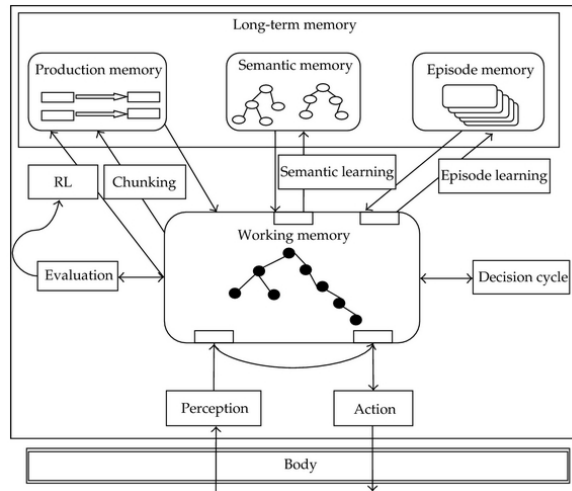


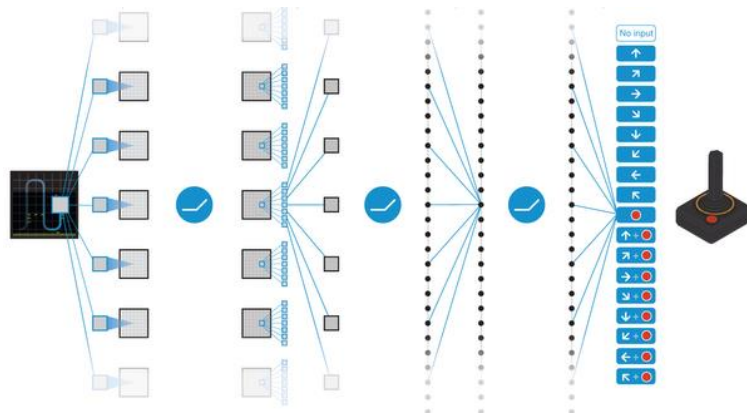
Figure 1. Sample knowledge tree where information becomes more structured as it reaches progressively higher stages of the pyramid. Cognitive Architecture (Anderson & Lebiere)

SOAR (State, Operator And Result)



- Cognitive Architecture (Laird, 2008; Laird, Newell, & Rosenbloom, 1987; Newell, 1990)

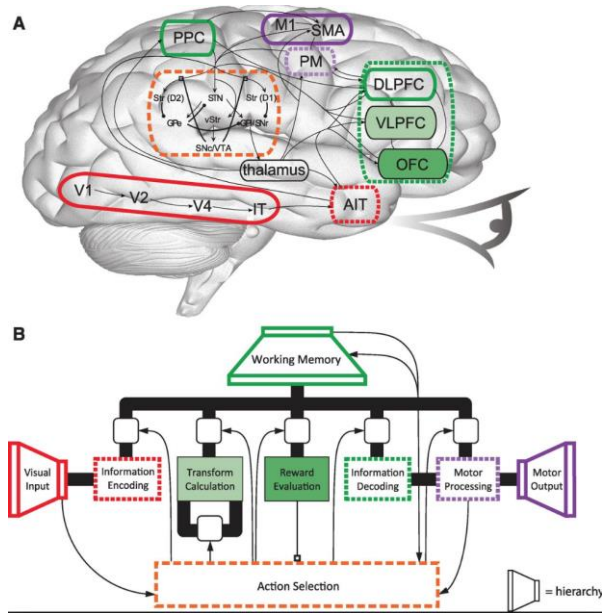
Deep Q-Learning



The screenshot shows the ALE (Arcade Learning Environment) visualization and the corresponding DQN training logs. The visualization displays a game state with a score of 8 and a level indicator of 19. The training logs show the following data:

```
GREEDY
Time Step 1073222 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.197432
GREEDY
Time Step 1073223 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.238866
RANDOM
Time Step 1073224 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.276253
RANDOM
Time Step 1073225 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.267412
GREEDY
Time Step 1073226 / ACTION 0 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.367146
GREEDY
Time Step 1073227 / ACTION 1 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.327974
RANDOM
Time Step 1073228 / ACTION 0 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.158499
GREEDY
Time Step 1073229 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.410332
GREEDY
Time Step 1073230 / ACTION 1 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.393161
RANDOM
Time Step 1073231 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.391696
GREEDY
Time Step 1073232 / ACTION 2 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.153511
GREEDY
Time Step 1073233 / ACTION 1 / REWARD 0.0 / EPSILON 0.100000 / Q_max 1.154750
DQN is Learning ...
Episode 787 2557 steps 12.0 total reward
DQN is Learning ...
Episode 788 3001 steps -2.0 total reward
DQN is Learning ...
Episode 789 2810 steps 10.0 total reward
DQN is Learning ...
```

Neural Engineering Framework



```

import nengo
model = nengo.Model("Communication Channel")

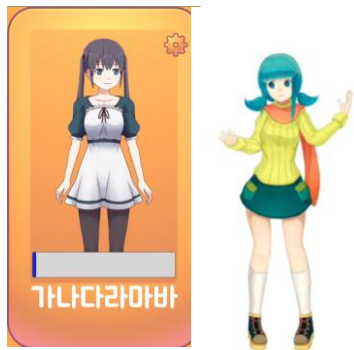
import pynn.nest as pynn
import numpy as np
pynn.setup(timestep=1)
lif_params = {'tau_refrac': 2.0, 'tau_syn_E':100, 'tau_syn_I':100}
def encoders(n_neurons, dimensions):
    samples = np.random.randn(n_neurons, dimensions)
    norm = np.sum(samples * samples, axis=1)
    return np.sqrt(norm)[:, np.newaxis]
def gain_bias(max_rates, intercepts):
    x = 1.0 / (1 - np.exp((lif_params['tau_refrac'] - (1.0 / max_rates))
        / pynn.IF_cond_exp.default_parameters['tau_m']))
    gain = (1 - x) / (intercepts - 1.0)
    bias = 1 - self.gain * intercepts
    return gain, bias
A = nengo.Ensemble(nengo.LIF(30), 1)
B = nengo.Ensemble(nengo.LIF(30), 1)
input = nengo.Node(0.5)
nengo.Connection(input, A)
nengo.Connection(A, B)
Bval = nengo.Probe(B, "decoded_output", filter=0.01)
sim = nengo.Simulator(model)
sim.run(1)
Bdata = sim.data(Bval)

A = pynn.Population(30, pynn.IF_cond_exp, lif_params)
Again, Abias = gain_bias(np.random.uniform(80, 100, 30), np.random.uniform(-1, 1, 30))
biasinputA = [pynn.DCSource(amplitude=val) for val in Abias]
for i, pulse in enumerate(biasinputA):
    pulse.inject_into(A[i+1])
Aencoders = encoders(30, 1) * Again[:, np.newaxis]
B = pynn.Population(30, pynn.IF_cond_exp, lif_params)
Bgain, Bbias = gain_bias(np.random.uniform(80, 100, 30), np.random.uniform(-1, 1, 30))
biasinputB = [pynn.DCSource(amplitude=val) for val in Bbias]
for i, pulse in enumerate(biasinputB):
    pulse.inject_into(B[i+1])
Bencoders = encoders(30, 1) * Bgain[:, np.newaxis]
inputnode = [pynn.DCSource(amplitude=val) for val in 0.5 * Aencoders]
for i, pulse in enumerate(inputnode):
    pulse.inject_into(A[i+1])
# Decoder solving too long to include; assume we have Adecoder and Bdecoder
weights = []
for i in xrange(30):
    for j in xrange(30):
        weights.append((i, j, np.dot(Adecoder[i], Bdecoder[j]), 1.0))
connection = pynn.Projection(A, B, pynn.FromListConnector(weights))
B.record('spikes')
pynn.run(1000)
Bdata = numpy.zeros(1000)
for i in xrange(1000):
    Bspikes = B[i+1].getSpikes()[1:].astype('int')
    Bdata[B.spikes] += Bdecoder[i]
decay = np.exp(-1.0 / 100)
Bdata[0, :] *= (1 - decay)
    
```

- Nengo: graphical and scripting based software package for simulating large-scale neural systems,
- SPAUN: 2.5 million simulated neurons

EGLAB Research

ECA Content



Embodied
Conversational Agent

Emotion Recognition



Multimodal Emotion
Recognition

Emotional Model

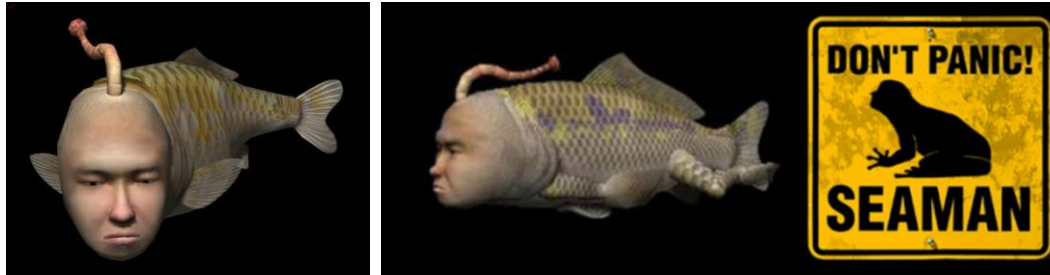


Rule-based Model / DQN

Future Works: Façade (Mateas & Stern, 2004)



Future Works: Seaman (SEGA, 1999)



QnA

경청해 주셔서 감사합니다.



<http://www.myeglab.com/>