A Primitive emotion and its cooperative function simulated in neural networks:towards a theory of emotions as cognitive functions

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A Primitive Emotion and Its Cooperative Function Simulated in Neural Networks

Towards a Theory of Emotions as Cognitive Functions **S. Nagataki, M. Shibata, et al.**

nagataki@lets.chukyo-u.ac.jp mshibata@kenroku.kanazawa-u.ac.jp

Purpose

 Clarifying what <u>functional-causal</u> roles emotions play and how they relate to other cognitive mechanisms

- 1 Focusing on a primitive emotion performing a cooperative function
- 2 Simulating that function as acquired in the evolutional process

Working Hypotheses

1 Multi-dimensionality of emotions

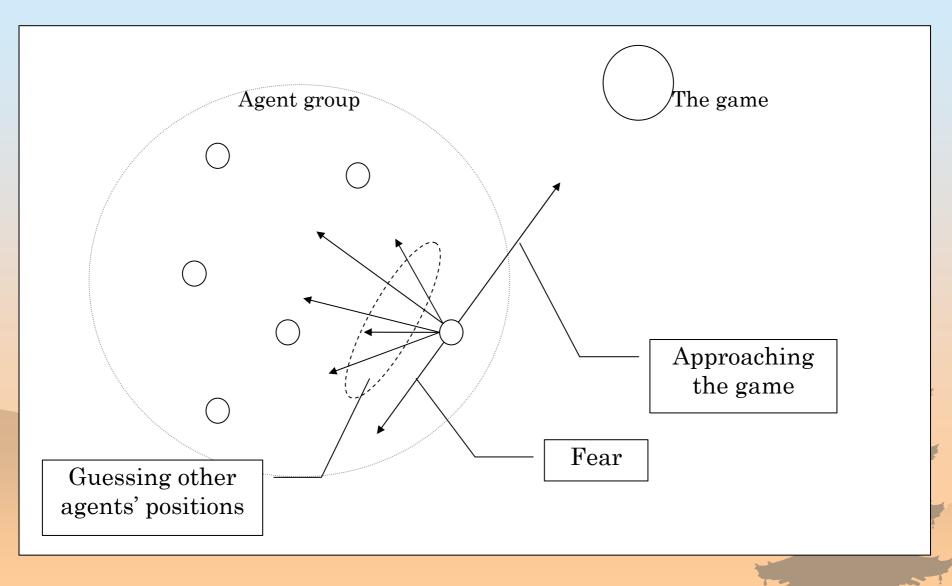
Emotions evolutionarily have got multiple layers operating differently in a variety of cognitive tasks.

2 Computational intractability Emotions have mechanisms that attain rationality not by means of computation but bio-chemical causation.

Evolution

- Humans acquire emotions through evolution.
 - For example, hunting required us to get cooperative behaviors against the most primitive disposition of fleeing from dangerous animals.
- These cooperative behaviors were enabled by having emotions.

Outline of the model



Model

Neural networks (NN): learning + Genetic algorithms (GA) : evolution

Each NN represents an agent (organism)

By BP, each agent learns to hunt the big game, while guessing other agents' positions and overcoming his/her fear.

BP Learning

Goal: hunting together the game guessing every other agent's position

Conditions

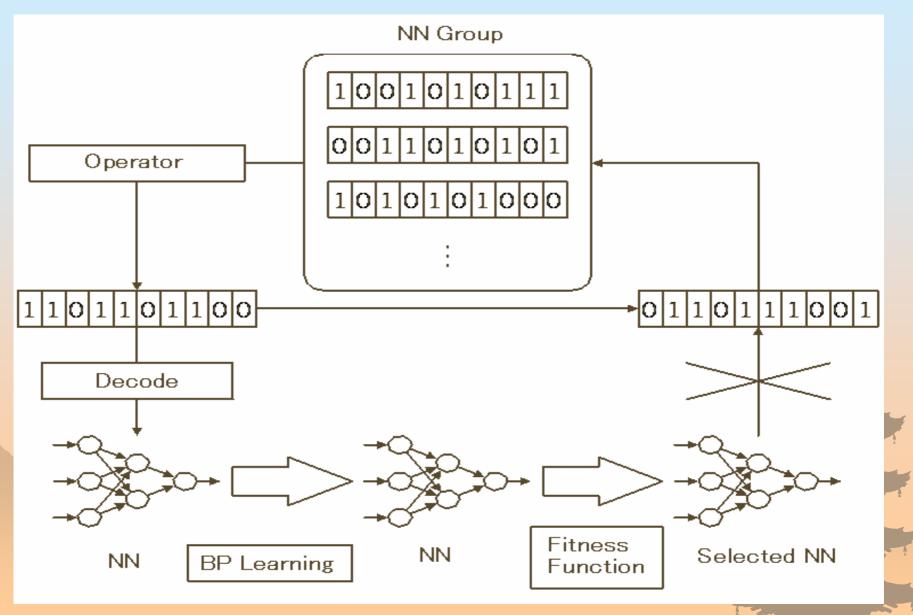
- 1. The game can be hunted only by multiple agents \rightarrow It requires cooperativeness.
- 2. Agents' learning consists in overcoming fear.



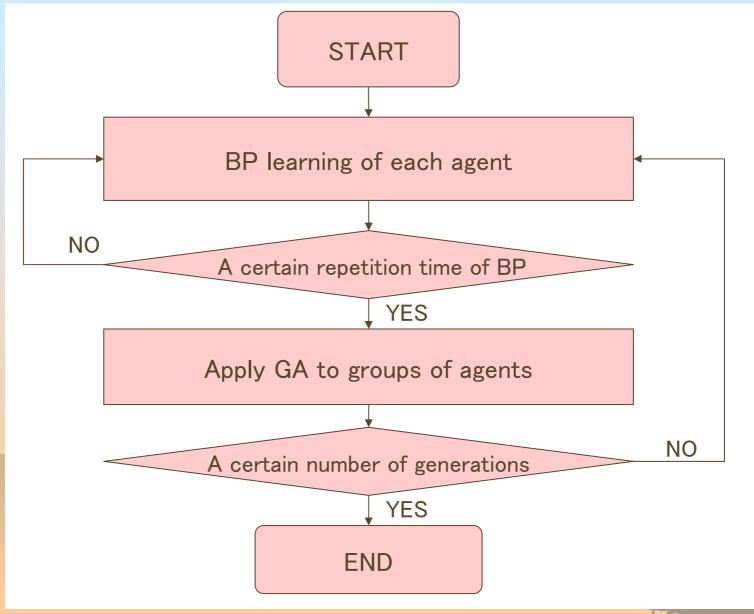
GA operators

- Three operations:
 - Selection, Crossover, Mutation
- Searching for adaptive agents by applying these GA operations.

Mechanism of GA



Flow chart of simulation model



Picture of simulation

EvoGameGUI		
141	Rambdal Max :	0.8959097657
	Rambda1 Min :	0. 1083431065
	Rambdal Ave :	0. 4957034264
•	Rambda1 Dec :	5.361932751e-002
° ° °		
· · ·	Rambda2 Max :	0.8889338911
°°°°°°	Rambda2 Min :	0. 1230595809
° ° ° ° °	Rambda2 Ave :	0.5218323827
· · · · ·	Rambda2 Dec :	5.29951739e-002
3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		
° ° ° °	Eta Max :	0.8986082289
°°° °°° °	Eta Min :	0. 1065956637
0.0	Eta Ave :	0. 4951101789
• • • • •	C Eta Dec :	6.359519112e-002
	<u>`</u>	
	Sigmoid Max :	0.8831988115
	Sigmoid Min :	0. 1550868381
	Sigmoid Ave :	0.5211745209
	Sigmoid Dec :	4.66404926e-002
GENERATION : 0 TARGET INFO.	2 201)	
STEPS : 14 COORD. : (0.995, (J.261) Fitness Max :	0.
GAMES : 0 RANGE : 0.111 INJURED : 0 CAPT. THRES. : 4	Fitness Min :	0.
INJURED : 0 CAPT. THRES. : 4	¥ Fitness Ave :	0.
RESULT	Fitness Dec :	0.

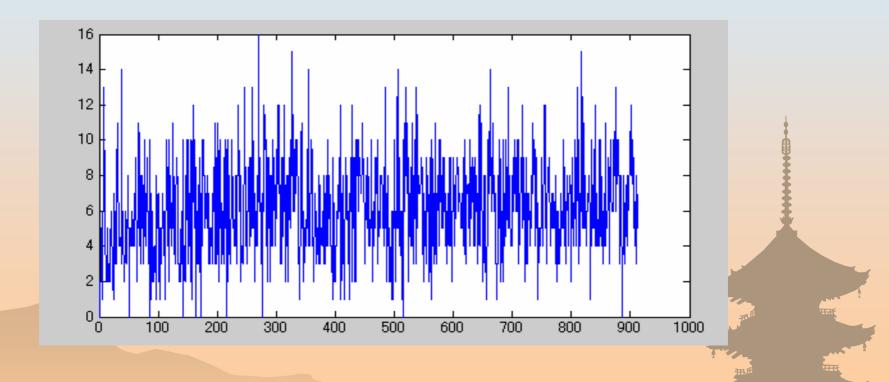
Details of Simulation

GENERATION

- STEP: repetition time of BP
- GAME: number of BP learning
- INJURED: number of injured agents
- RESULT: applying GA on each session
 O: success ×: failure

Result

Numbers of getting the game



Verification: Prisoner's Dilemma

Prisoner's Dilemma

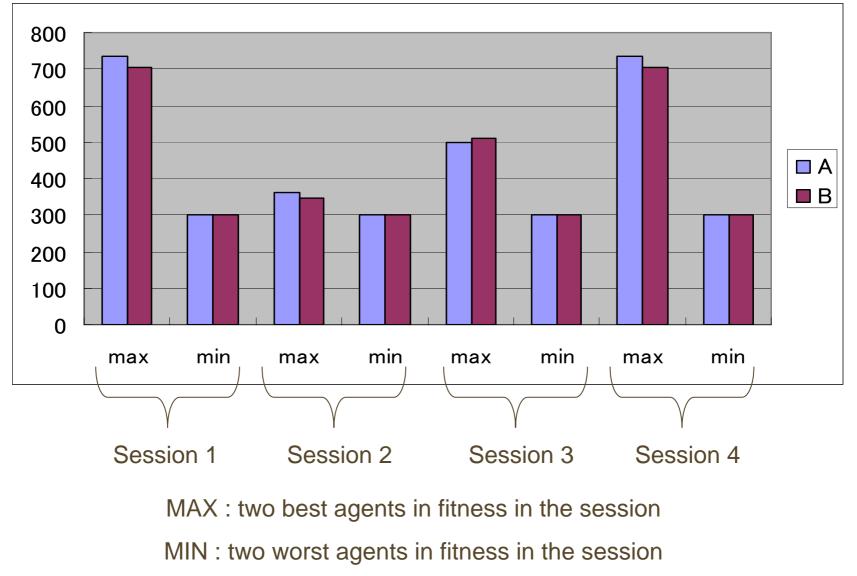
	B: Cooperates	B: Betrays
A: Cooperates	Both serve 6 months	A serves 10 years B goes free
A: Betrays	A goes free B serves 10 years	Both serve 2 years



Verification task

	B: Enters	B: Not enter
A : Enters	Both get 10 points	A gets 1 point B gets 15 points
A : Not enter	A gets 15 points B gets 1 point	Both get 3 points

Result of Verification



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