Greedy Agents and Interfering Humans

An artwork making humans meddle with a life in the machine

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New Media Arts with A-Life

- The arts by autonomous machines
- Cellular Automaton, L-System, Evolutionary Algorithms
- BOIDs, Ant Colony, Art by Robots
- Interactive Art (Human — A-Life interaction)
- Affecting the generative mechanism from visitors (vice versa)
- Interaction with Reinforcement Learner
- cf. Creation process with A-Life, ex. Interactive Evolutionary Computing
Reinforcement Learning

- Learning by delayed reward (and punishment)
- Fundamental model of human/animal learning
  - Thorndike, E. L. (1898), Skinner, B. F. (1953)
- Classic framework (late 1980s —)
- TD, Actor-Critic, Q-Learning
- Q-Learning by a lookup table ← Dynamic Programming
Learning Environment

- 11 x 6 Grid World (approx. 16 : 9)
- Agent behaviour: Start Cell → Goal Cell
- Sensation: Cell's ID it is located
- Action: Up, Down, Left, and Right
- Reward: given only when it reaches the Goal.
- Forced to return back to Start.
- Reset when a specified steps / goals passed.
Learning Mechanism

- Classic Q-Learning by loop-up table

\[ \Delta Q(s, a) = \alpha \cdot \left( r + \gamma \max_{b \in A(s')} Q(s', b) - Q(s, a) \right) \]

\[ P(a \mid s) = \frac{\exp(Q(s, a)/T)}{\sum_{b \in A(s)} \exp(Q(s, b)/T)} \]

- Dyna-Q: Rehearses past experiences randomly.

- accelerates the propagation of Q-values.
Interaction

- Detecting the visitors hands on the table.
  - by Kinect Azure on the ceiling.
- Placing obstacles
- An obstacle is growing when a hand stays for a while.
- Interfering the agent’s move.
- Affecting the Q-Values
- Hands motion in a range of speed modifies the vectors.
Installation (1)

- Custom built table.
- Kinect Azure above the table.
- Ultra short focus projector.
- 1920 × 1080 pixels
- Three stereo headphones
- attached to table edges, Left, Front, Right
**Installation (2)**

- Windows box computer.
  - for Kinect Azure and image processing.
- Mac mini M2
  - for learning and visualisation.
- Mac mini M2
  - for sound generation and output.
  - with multi-cannel analog audio output.
Visualisation

- Distribution of Q-values in the grid world
- Four vectors for each action in each cell.
- Vector field by interpolating those vectors.
- Particle flow following the vector field
- Colouring by speed.
- 320K particles, 60 FPS.
- M1 macMini (up to 1 million particles on M2 Ultra)
Sonification

- Providing sounds for each visitor through a headphone.
- Generating sounds of neighbouring area his/her hands placed.
- Mixing the sounds generated using data of particle flow + agent movement.
- Up to three visitors can enjoy it simultaneously.
Human lives together with A-Lives


- Collective behaviour, but fixed rules.

- Society of learners / teachers (mutual learning)

- Oscillation would happen among eager learners.

- How to regulate the diversity (mixture of lazy and eager individuals) by evolution?

- Evolutionary adaptation needs much experience by a population.

- Hard to realise it as an interactive art?
Outlook

- Grid World → Continuous Coordinate System
- Look-up table → Artificial Neural Network, k-NN, etc.
- Continuous distribution of vector field.
- Multi-agent learning
- Social interaction among agents and humans. → complex relations of cooperation and conflicts.