

Evolutionary Fuzzy Rule Acquisition for Playing Ms.PacMan

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Abstract—This short description is written for the Ms.PacMan competition in CEC2007, held in Singapore. First, instructions, i.e., how to run our implementation, are described. Next, our method is briefly mentioned: the proposed method employs fuzzy logic and the evolution of their fuzzy rule parameters. That is, basic structure of fuzzy rule is given in advance. Then, the rule parameter is evolved by using (1+1)ES.

I. INSTRUCTIONS

A. Software Versions

The version of software we examined is enumerated as follows:

- OS: Windows XP
- java: Verstion 1.5.0-12
- Browser: Internet Explorer Ver 6.02

One of Emulator, Cottage.jar, is used in our approach. We believe it is identically same as in Web Pacman: <http://www.webpacman.com/> .

B. Extracting the ZIP file

The ZIP file (src.zip) can be extracted by a standard way, i.e., by clicking right button of mouse, and selecting extracting zip file..., in GUI on Windows XP. After extracting, such sub-directories and files will be shown.

```
games/ pacman/ roms/ utilities/ 1st.csv
2nd.csv Cottage.jar data1_output.csv
data2_output.csv MsPac.html mspacman.htm
```

As you can see, we used the sample toolkit provided by competition organizers. Therefore, some sub-directories are same as the sample toolkit.

C. How to run it

First of all, we need to run Game Environment. Just open “MsPac.html” by using “Internet Explorer,” and click “click here”. Then, a new small window whose size and location are configured is opened. In the case of another browser, such as firefox and mozilla, it does not work well so that we need to adjust window location.

Next, as the same as the sample toolkit, java program must be launched as follows:

```
java pacman.MsPacInterface
```

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II. EVOLUTIONARY FUZZY RULE ACQUISITION FOR PLAYING MS.PACMAN

A. Preprocessing the captured image

The image process for captured image is carried out for every cycle. As a consequence of the image process, we obtained the following information:

- Distance to each ghost,
- Distance to each edible ghost,
- Position of the closest uneaten pill, and
- Distance to the nearest intersection from PacMan/Ghost,

where the metric for calculating distance, including the “closest” pill, does not indicate Euclid one while the distance used in the proposed method is calculated by taking account into the structure of the maze.

Moreover, the preprocessing can detect if the game play is end. Hence, this detection allow us to use Evolutionary Approach since auto-replay can be done by `java.awt.robot` if such game play termination is detected.

B. Fuzzy Rules

Fuzzy logic is used to decide the action of PacMan at each time step. The structure of such fuzzy rules is predefined: Avoid, Chase, Eat, and Go-Through.

Avoid The rule description of “Avoid” is:

IF a ghost IS close THEN PacMan go to avoiding directions.

This Fuzzy rule is examined for each ghost. Fig. 1 illustrates how this rule works: Suppose that PacMan is now at a intersection, and Blinky and Pinky are approaching to PacMan from upper side and lower side, respectively. For Blinky, the Fuzzy rule

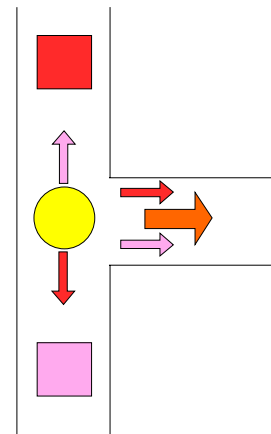


Fig. 1. A depiction of avoidance action

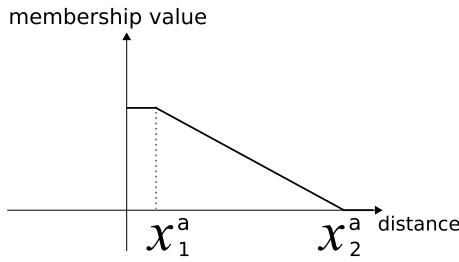


Fig. 2. The membership function of fuzzy rule “Avoid”

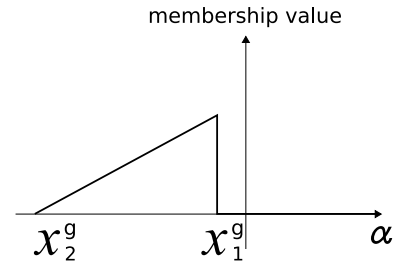


Fig. 4. The membership function of fuzzy rule “Go-Through”

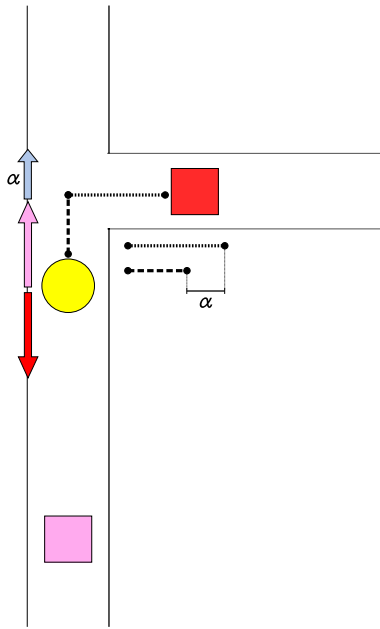


Fig. 3. A depiction of Go-Through action

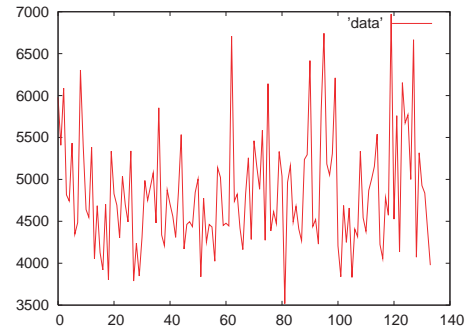


Fig. 5. The changes of fitness functions

“Avoid” infers that PacMan should go down or right. The Fuzzy rule “Avoid” is also applied for Pinky so that it recommends that PacMan should go up or right.

The membership function for this rule can be illustrated as shown in Fig. 5. The x axis denotes the distance from a ghost to PacMan. The y axis is corresponding membership value. The parameters x_1^a and x_2^a are defined by using Evolutionary Computation.

Chase The rule description of “Chase” is:

IF an edible ghost IS close THEN PacMan go to the ghost.

The mechanism of this fuzzy rule is similar to the one of “Avoid.” However, this rule is only applied to edible ghosts. In addition, this fuzzy rule recommends PacMan to go to the direction where near edible ghosts exist.

Eat Strictly speaking, this may not be a fuzzy rule. This rule is always activated while the membership value of this rule is quite small. This rule acts as default behavior if no other fuzzy rule is activated.

Go-Through Because of the fuzzy rule “Avoid,” PacMan tends not to pass through intersection if ghost is around there. Therefore, a fuzzy rule “Go-Through” is defined as follows:

IF the distance of PacMan to the nearest intersection on the direction of movement is smaller than the distance of a ghost to the intersection THEN PacMan go through the intersection.

This rule might be complicated one. The Fig. 3 explains certain situations such that this fuzzy rule works: Now, Pinky is supposed to chase PacMan from the behind of her. Moreover, Blinky is approaching another direction. Suppose that the distances from PacMan is not so different. In this case, PacMan will be not able to go to a specific direction because the fuzzy rule “Avoid” suggest contradict directions for these ghosts. As described in the figure, however, since Blinky is at opposite side of the intersection, PacMan may be able to go through the intersection. Therefore, the membership function for the fuzzy rule “Go-Through” can be defined as the Fig. 4.

C. Evolutionary Fuzzy Rule Acquisition by (1 + 1)ES

Parameters x_1^a , x_2^a , x_1^c , x_2^c , x_1^{gt} and x_2^{gt} are tuned by using (1 + 1)ES. The fitness for tuning these parameter is defined as the average steps of game play. This average is calculated over 5 game plays since it takes much time for a single evaluation. Initial parameters hand-coded values. Although we don’t have enough time to evolve the parameters, some improved solutions are acquired.