

Learning to Play Pac-Man: An Evolutionary, Rule-based Approach

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Abstract- Pac-Man is a well-known, real-time computer game that provides an interesting platform for research. This paper describes an initial approach to developing an artificial agent that replaces the human to play a simplified version of Pac-Man. The agent is specified as a simple finite state machine and ruleset, with parameters that control the probability of movement by the agent given the constraints of the maze at some instant of time. In contrast to previous approaches, the agent represents a dynamic strategy for playing Pac-Man, rather than a pre-programmed maze-solving method. The agent adaptively “learns” through the application of population-based incremental learning (PBIL) to adjust the agents’ parameters. Experimental results are presented that give insight into some of the complexities of the game, as well as highlighting the limitations and difficulties of the representation of the agent.

1 Introduction

Pac-Man is a well-known, real-time arcade computer game originally developed by Toru Iwatani for the Namco Company in 1981. Different versions of the game have been developed subsequently for a large number of home computer, game-console, and hand-held systems.

The typical version of Pac-Man is a one-player game where the human player maneuvers the Pac-Man character around a maze, attempting to avoid four “ghost” characters while eating dots initially distributed throughout the maze. If Pac-Man collides with a ghost, he loses one of his three lives and play resumes with the ghosts reassigned to their initial starting location (the “ghost cage” in the centre of the maze). Four “power pills” are initially positioned near each corner of a maze: when Pac-Man eats a power pill he is able to turn the tables and eat the ghosts for a few seconds of time. The game ends when Pac-Man has lost all (usually 3) of his lives. Figure 1 shows a screen-shot of the starting position of the first maze in the game. Pac-Man is a real-time computer game that resembles a simplified version of many modern first-person environment computer games. That is, the game is centered around navigating the player character around a semi-structured world, accumulating points, avoiding and (when appropriate) attacking

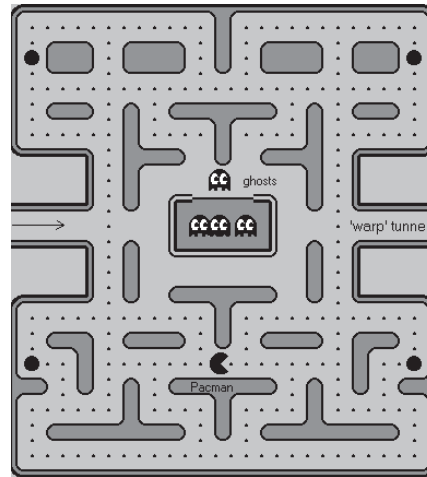


Figure 1: The starting position of the Pac-Man game, showing the maze structure, Pac-Man (lower-center), power pills (large dots), dots (small dots) and ghosts (center).

non-player game characters¹. This kind of game requires dynamic control of the game agent by the human player and involves task prioritization, planning, and risk assessment. While it is relatively easy for a human to learn a basic strategy for Pac-Man, the game has complex aspects that allow the possibility of developing more intelligent strategies (in conjunction with other skills such as hand-eye coordination). It is also a challenge for a person to describe precisely their Pac-Man-playing strategy, or to represent such a strategy formally (e.g., as a set of rules).

This paper describes an initial approach to developing an artificial agent that replaces the human playing Pac-Man. For this work, the game has been significantly simplified to having only a single ghost, dots and the Pac-Man agent present in the mazes. The agent is specified as a simple finite state machine and ruleset, with parameters that specify the state transition and the probabilities of movement according to each rule. Section 2 provides an overview of previous work relevant to Pac-Man and AI game playing,

¹Alternatively, other game characters might be controlled by other human players in a multi-player setting.