Optimization of Angry Birds AI Controllers with Distributed Computing

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***Abstract*— The one of important issues in artificial intelligence (AI) research is the development of AI for games because of its difficulty. To promote the research on video games AI, there have been several game AI competitions. However, some games with physics engine (geometry friends or Angry Birds) have no support on the prediction of future events using simulation. It makes much difficult to build AI for the games with physics. As a result, AI creator should spend much time to optimize the parameters of their program by trial and errors. In this paper, we report our approach to build AI for Angry Birds (Plan A+, 3rd rank in 2014 Angry Birds AI competition and the first entry achieved 1 million points in benchmarking test). In our controller, we adopt multiple strategies to increase generalization ability and hybrid optimization techniques (greedy search from human's manually tuned parameters) with parallel machines.**

Keywords—Angry Birds; Artificial Intelligence; AI competition; Distributed Computing; Optimization

I. INTRODUCTION

Recently, there have been some international game AI competitions based on physics engines. For example, they're Angry Birds AI competitions [1] and Geometry Friends AI competitions. In the competition, the game outcomes are produced following the rules of physics (gravity, friction, uncertainty and so on). It makes hard to build AI for the kinds of games because it's not easy to predict the future outcome of the current behavior. As a result, search techniques (Monte-Carlo Tree Search), very successful to other game AI competitions, are not powerful in those types of games. Usually, rule-based approach can be adopted to design AI for the physics-based games. However, the hand-tuning of parameters of controllers is not a trivial task and some works introduced the use of optimization techniques [2].

In the Angry Birds AI competitions, there are several challenges to create successful entries. At first, the game states are not directly accessed but indirectly delivered from continuous loop of screen capture and image processing. It means that the vision module detects the position of the birds/pigs/objects from the screen shot captured (figure 1) [3]. As a result there are some uncertainties raised from the vision misinterpretation and delay of game state delivery. Secondly, there is no way to accelerate the speed of Angry Birds game for parameter tunings. Usually, the game requires 1 min ~ 3 min to clear one level. Because small vibration of objects can produce different results after some seconds, it is necessary to wait to be stable after the player's shot. It makes hard to use modern AI optimization techniques based on thousands of simulations of different combinations of parameters. Finally, to win the competition, it is better to be generalized well on unseen levels instead of over-fitted to some levels. It increases the times to evaluate the "estimated" goodness of candidate parameters because it's not possible to guess based on the score at one or two levels.

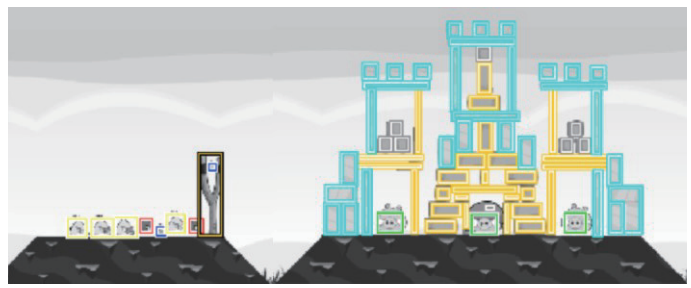

Figure 1. The screenshot based visualized game image from real game.

In this paper, we report our experience on designing AI controller for team "Plan A+." (The development of Plan A+ has been started since 2013 Fall as a course project for "intensive programming design" offered for the Junior level students. For several years, the competitions have been used in the education of programming and artificial intelligence to motivate talented students [4].) The controller is consisted of two different rule-based sub controllers. Because they have different playing styles, they can complement each other by supporting another when it fails to clear stage. Their parameters have been tuned manually from trial and errors. Although they're working well, it needs to be finely tuned using optimization techniques. Because of the long simulation time to get scores of each parameter set, we introduced the use of multiple machines (more than 20) to distribute the "evaluation tasks" in the optimization.

II. ANGRY BIRDS AI CONTROLLER OPTIMIZATION

Our AI controller has two independent modules that determine the target of the shot[1]. These two strategy modules are mutual supplementation. Among objects in the game, only pigs and TNT object are considered as a target. In the API by organizers, they provide two different ways (low or high angles) to shoot the birds. If there are three pigs in the level, there are six possible trajectories to be considered (two angle types x three pigs). The module selects the best target to attack from the candidates.

[1] The source code of Plan A+ is available from http://cilab.sejong.ac.kr

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In this work, we consider five birds and four object types (including ground) and there are 25 parameters (5+4 x 5) to be tuned by expert. The values are ranged from 1 to 5 (only integer values are considered). And we optimized some of parameters in the main strategy. Among 25 parameters, the most important nine parameters are considered for the optimization (Table 1). It defines the resistance (hardness) of each object against the specific bird type. If the value is high, it means that the bird will suffer to break the object. The parameter value is set from {1, 2, 3, 4, and 5}. In total, size of the search space is 5^9 (about two millions).

At first, the designers of Plan A+ tried to find good parameters from trial and errors. After then, a simple greedy-style search algorithm was used to tune the parameters found by humans. For each parameter, there are two possible changes (add or minus one). In total, there are 18 (9 x 2) cases. The greedy algorithm finds/updates the best "single parameter" change to the current best solution and continues until there is no progress (improvement).

Table 1. The parameters to be optimized

		Object type		
		Ice	Wood	Stone
Bird type	Red	p_1	p_2	p_3
	Blue	p_4	p_5	p_6
	Yellow	p_7	p_8	p_9

III. Experimental Results

In this paper, we set the one server and 20 clients with windows 7 environment. It's not necessarily to use very strong client machines because Angry Birds game does not require much computational cost. However, there is no way to reduce the time required for the simulation (game playing). We used AI Birds software 1.31 versions with Chrome web browser 31.0.1650.63 version in the experiment.

In the experiments, the server distributes one parameter set to all machines and waits until they complete five runs on the levels assigned. The optimization took about 55 hours (2 days and 7 hours). In average, the system can evaluate two parameter sets per hour. It means that it waits about 30 minutes to get response of five runs from the machines. Each game playing takes about 6 minutes. Because we wait until the last client responses to the server, the client with the most difficulty levels controls the total times. Although we adopt the parallelization, it still requires 9 hours to determine the best single parameter change. For the two and half days, the system updates the parameters six times.

As expected, the parameters are similar to the original one by human experts. Only two of them are different (the parameters for the red birds are changed). Although there were six updates, some of them returns the changed parameters into original one because of the randomness of the simulation. Although the change is small, the outcome shows increase of the scores on the twenty levels used in the optimization about 16%.

The Plan A+ with the optimized parameters were submitted to the 2014 Angry Birds AI competition held at European Conference on Artificial Intelligence. In this year, there were 11 submissions. In the qualification day, our agent finished the test with 2nd rank. In the semi-final, Plan A+ finished as 3rd rank with very small performance gap with 2nd ranker (60 points). After the conference, the organizers ran all the entries on the widely used benchmarking levels (poached egg episode 21 levels) and reported the scores. As noted, our agent was optimized using ten levels from the episode but other ten levels are coming from different sources. The results show that our agent recorded the highest score (1,002,380 points) in the benchmark test. It's the first time that the entry recorded million scores on the benchmarking test. From our test, the original version tuned by human recorded 966,310 scores on the benchmarking and it is revealed that the optimization improves about 3.7%.

IV. Conclusions and Future Works

In this study, we tried to apply simple optimization approach to finely tune the parameters by human experts for the Angry Birds game. Because the physics-based games require much time to get the final scores, it makes much difficult to optimize AI's parameters on the games. To solve the problem, we used well designed rule-based controllers with preconfigured parameters as a starting point of optimization. In addition, the evaluation includes multiple runs on the same levels and tests on the diverse levels to get accurate scores. The exponential growth of computational time has been handled using distributed computing (parallelization).

As future works, we will try to generate new levels (to increase the generalization ability of our controller by testing on new levels) using evolutionary algorithms. Also, we plan to use advanced optimization techniques (particle swarm optimization) to improve the performance.

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