A new combination of Qualitative Spatial Representation and Utility Function for the FEI2 agent in the Angry Birds Domain

C. Pavanelli[2], M. Maresch[2], T. Calcagniti[2], F. Martino[2], D. R. Meneghetti[2], L. A. Ferreira[1,2] and P. E. Santos[2]
[1]Universidade Metodista de São Paulo [2]Centro Universitário da FEI
São Bernardo do Campo - São Paulo - Brazil
caiopava@gmail.com, marcos.maresch@uol.com.br, tiako_@hotmail.com,
felipemartino@hotmail.com, douglasrizzom@gmail.com, leonardo.ferreira@metodista.br, psantos@fei.edu.br

Abstract

The usage of Qualitative Spatial Representation and Utility Function for the 2012 competition provided a good overall performance during the development of the agent. For this year competition, the main change was the simplification in the Utility Function used for the targets and the usage of Region Connection Calculus instead of the Directional Calculus used last year.

Overall, the agent presented a good overall performance in the Poached Eggs levels used for testing, even only using pigs as possible targets.

1 Introduction

In 2012, the Australia National University (ANU) provided a framework for the development of Angry Birds autonomous playing agents. For that first competition, the FEI2 agent used a combination of Utility Function, Qualitative Spatial Representation (QSR) and Decision Making Under Uncertainty to choose the best object to be used as target.

Given that the agent had a good overall performance during development, this year's agent tries to improve the combination of Utility Function and QSR. Furthermore, since the possible error in the trajectory was not perceived using the new framework, no need to use Decision Making Under Uncertainty when choosing the target was found.

This paper is organized as follows: Section 2 presents a brief description of Qualitative Spatial Representation, followed by an introduction of Utility Function in Section 3. In Section 4, the agent developed for the 2013 Angry Birds AI Competition is presented and Section 5 concludes the paper.

2 Qualitative Spatial Representation

Qualitative Spatial Reasoning can be used to symbolically represent objects and provide a inference system for them [Santos, 2010]. Without the usage of quantitative methods, the main challenge of Qualitative Spatial Reasoning is to provide the calculi that allows for this representation and reasoning over the objects [Cohn and Renz, 2008].

There is a large number of methods that can be used to work with Qualitative Spatial Reasoning [Ligozat, 2011]. However, to develop the agent for the Angry Birds competition, we used the Region Connection Calculus [Randell *et al.*, 1992].

This technique was used to discover the relation of a given point in a possible trajectory and the objects in the level that the agent is currently playing.

3 Utility Function

Utility Function can be defined as a method that allows for the description of an agents preferences regarding to states, by mapping states to real numbers [Russell and Norvig, 2004]. A notation that can be used to describe is an agents preferences regarding its options is:

- $A \succ B$: A is preferred than B;
- $A \sim B$: the agent is indifferent between both options;
- $A \succeq B$: the agent prefers A than B or is indifferent between them;

[Russell and Norvig, 2004] define a set of six axioms that constrain the utility function, so that the agent can only behave rationally and by using those axiom we can define Utility as a function that map a set of states $\mathcal{S}$ to real values $\mathcal{U}$, which allows the agent to prefer one state $s \in \mathcal{S}$ than others.

Finally, considering that each state $s_i \in \mathcal{S}$ has a probability p_i of occurring, we can define the principle of Maximum Expected Utility (MEU) as:

$$U([p_1, s_1; p_2, s_2; \ldots; p_n, s_n]) = \sum_{i=1}^{n} p_i \times U(S_i) \quad (1)$$

and once we can calculate the utility of each state, the agent can use this calculi to decide which action is preferable to take in order to solve a given problem.

4 The agent for the 2013 competition

Considering the agent used in the previous competition, this year's agent main change is in the usage of the trajectory calculated by the provided framework.

In last year's framework, we perceived that there was possibility of an error in the trajectory when using the environment we had for development and thus we used the trajectory as a probability to hit a given target. However, since there was not possibility of a trajectory error in this year's framework, the

calculated trajectories were used to choose the best pig to be used as primary target and also which was the best trajectory to use.

As shown in table 4, each combination of bird type and obstacle in the trajectory received an utility value. Using only pigs as targets, trajectories were calculated to hit each pig and it was verified which obstacles contained points of the trajectory.

	Woods	Ice	Stone	Hills
Red	1	6	2	100
Blue	3	1	6	100
Yellow	1	6	3	100

Table 1: Weights used when calculating the pig's utility for the 2013 competition.

Thus, the utility of a pig is the function of how easy it is for it to be hit given a trajectory and obstacles in it. Consequently, the pig chosen as target is the one with the lowest utility, which is the one easier to be hit.

5 Conclusion

This year's agent was simpler to implement since we did not need to make use of decision making under uncertainty, as we did with the last year's agent. Furthermore, the simplification in the utility function used to find the target provided us with an easier method to integrate new objects – such as TNT boxes – in the agent's reasoning process. Finally, the change from Directional Calculus to Region Connection Calculus provided a new method to calculate the utility for a target.

Even though this year's agent has a good overall performance in the Poached Eggs levels, the usage of objects other than pigs as possible targets can be useful in more complex levels and help achieving a greater performance. Thus, future work includes the usage of other useful obstacles as possible targets.

Acknowledgments

Leonardo Anjoletto Ferreira acknowledges support from CAPES. Paulo E. Santos acknowledges support from FAPESP grant 2012/04089-3 and CNPq, grant PQ2 - 303331/2011-9.

References

[Cohn and Renz, 2008] A. G. Cohn and J. Renz. Qualitative spatial representation and reasoning. *Foundations of Artificial Intelligence*, 3:551–596, 2008.

[Ligozat, 2011] G. Ligozat. *Qualitative Spatial and Temporal Reasoning*. Wiley-ISTE, 2011.

[Randell *et al.*, 1992] David A Randell, Zhan Cui, and Anthony G Cohn. A spatial logic based on regions and connection. *KR*, 92:165–176, 1992.

[Russell and Norvig, 2004] S. J. Russell and P. Norvig. *Artificial Intelligence*. Pearson Education India, NJ, USA, 2 edition, 2004.

[Santos, 2010] P. E. Santos. Spatial reasoning and perception: a logic-based approach. *Tutoriais do XVIII Congresso Brasileiro de Automática*, 2010.