Intelligent Agents for Games and Computer Go

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***Abstract*—In order to stimulate the development and research in computer Go, several Taiwanese Go players were invited to play against some famous computer Go programs. Those competitions revealed that the ontology model for Go game might resolve problems happened in the competitions. Therefore, this tutorial will present a Go game record ontology and Go board ontology schemes. An ontology-based fuzzy inference system is also developed to provide the regional alarm level for a Go beginner or a computer Go program in order to place the stone at the much more appropriate position. Experimental results indicate that the proposed approach is feasible for computer Go application. Hopefully, advances in the intelligent agent and the fuzzy ontology model can provide a significant amount of knowledge to make a progress in computer Go program and achieve as much as computer *chess* or *Chinese chess* in the future.**

Keywords: Fuzzy Ontology; Fuzzy Markup Language; Computer Go; Intelligent Agent; Knowledge Management

INTRODUCTION

The game of Go originated from China. Around the 7th century, the game was imported to Japan. In the late 16th century, the first Westerner came into contact with Go. There are millions of people that regularly play Go in many countries around the world. Played by two players, Black and White, the stones of their color are placed consecutively on an empty intersection of a square grid. Normally, the weaker player plays Black and starts the game. In the end, the player who controls the most intersections of the board wins the game. Go is a board game that is much more complex than chess. Indeed, the number of possible moves in the game of Go is more important and the size of the tree of possibilities is greater than the number of atoms in the universe. However, despite several decades of artificial intelligence or computational intelligence, there are still no computer Go programs that can challenge a strong professional player in 19×19 games without handicap. This is because Go is a problem with high uncertainty, especially for big board games, like the 19×19 board. Each Go player has his own way of thinking to play with his opponent, and each top professional Go player will take different strategies even though they face the same situation. Thus, in 1997, the IBM's Deep Blue Supercomputer beat the World Chess Champion, Garry Kasparov, while the game of Go is still one of the last board games where the strongest humans are still able to easily win against computers in big board games.

Since 2008, National University of Tainan (NUTN) in Taiwan and other academic organizations have hosted or organized several human vs. computer Go-related events, including the 2008 Computational Intelligence Forum & World 9x9 Computer Go Championship, and 2009 Invited Games for MoGo vs. Taiwan Professional Go Players. Besides, the FUZZ-IEEE 2009: Panel, Invited Sessions, and Human vs. Computer Go Competition was held at the 2009 International Conference on Fuzzy Systems (FUZZ-IEEE 2009) in Aug. 2009. This event was the first human vs. computer Go competition hosted by the IEEE Computational Intelligence Society (CIS) at the IEEE CIS flag conference, and Dr. David Fogel also presented a certificate to the invited Go players to recognize their continued commitment and service to the research and development for computer Go at the banquet. MoGoTW was developed based on MoGo 4.86 Sessions and the Taiwan (TW) modifications. This was developed jointly with the Taiwanese colleagues for a National Science Council (NSC)-National Research Agency (ANR) research project between Taiwan and France. The 2010 Invited Game for MoGoTW vs. Human Go Player was held at the NUTN, Taiwan, on Mar. 21, 2010 and MoGoTW was qualified to award three certificates with 1st Dan (1D), 2D, and 3D level on Apr. 2, 2010.

The human vs. computer Go competition, organized by the IEEE CIS, 2010 IEEE World Congress on Computational Intelligence (WCCI 2010), IEEE CIS Emergent Technologies Technical Committee (ETTC), and NUTN, was held in Barcelona, Spain on July 20, 2010. Several Taiwanese Go players, including Chun-Hsun Chou (9th Dan Pro, 9P), Ping-Chiang Chou (4P), Shang-Rong Tsai (6th Dan Amateur, 6D), and Shi-Jim Yen (6D), were invited by NUTN to play against the top four computer Go programs at the human vs. computer Go competition, on July 20, 2010. This included MoGo/MoGoTW (France/Taiwan), Fuego (Canada), Zen (Japan), and Many Faces of Go (USA). A main novelty is the initial stage of 13x13 games. There are not so many games against strong humans and computers in 13x13, and the computer Go programs even won against human (6D) in 13x13 Go with handicap two (H2) [6]. From the games results at the competition, we know that the computer Go programs won 9 out of the total 22 games. The average performance of the computer Go programs is fast approaching to the professional level.

On the other hand, knowledge refers to relevant and actionable information that is based on an individual's experience. Although all knowledge workers share certain characteristic activities, annotated data is obtained within a framework or ontology. As a highly effective means of sharing knowledge and representing information and its semantics, ontology is a conceptualization of a real world domain in a human understandable, machine-readable format that consists

of entities, attributes, relationships, and axioms. Moreover, fuzzy ontology mediation allows us to combine knowledge from the ontologies. The use of fuzzy ontologies to provide interoperability among heterogeneous data sources has been applied in many domains, including medical information systems, news summarization, software engineering, food recommendation, recruitment, architectures, and etc.

In addition to ontology, the technologies of agent are also an important topic in this tutorial. Agent-based systems embedded into the ontology are increasing being applied in a wide range of areas. Over the past decade, there has been a growing interest in utilizing intelligent agents in computer games and virtual environment. There are differenent definitions of agents such as: 1) An agent physically distributes required knowledge to several locations; 2) An agent can model autonomous entities; 3) Agent-based systems can employ security mechanisms; 4) Agent technology has the ability to communicate and coordinate; 5) Agents can automatically discover and compose e-services; 6) Intelligent agents have deliberate, reactive, and flexible behaviors and can learn; 7) An agent's autonomous, reactive, and flexible characteristics make agents ideal for implementing ambient intelligence applications. Hopefully, advances in the intelligent agent and the fuzzy ontology model can provide a significant amount of knowledge to make a progress in computer Go program and achieve as much as computer chess or Chinese chess in the future.

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