UNIVERSITI TEKNOLOGI MARA

NEUTRALISATION STATE DRIVEN SINGLE-AGENT SEARCH STRATEGY FOR SOLVING CONSTRAINT SATISFACTION PROBLEM

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Mathematics and Computer Science

December 2019

ABSTRACT

In the past seven decades, Constraint Satisfaction (CS) has been extensively studied and remarkably evolved to where the scientific community perceives it as the centre of the intelligent behaviour. Therefore, most of the recent research in the field is devoted to improving the problem solvers that utilize search strategies and techniques. Since Constraint Satisfaction Problem (CSP) is an NP-complete problem, brute-force search algorithms such as Backtracking algorithm (BT) are required as the guarantee to find a solution, when there is one. Moreover, since the establishment of the field, AI pioneers and specialists have setup instructions and guidelines on how to solve this type of problems back in the seventies of the last century and have not been changed or improved. For example, the framework of solving CSP imposes a complete permutation of assignments to all remaining variables in order to derive a valid model. The author argues in this study that the problem can be neutralised and it is not necessary to perform brute-force searching all the time if a search strategy could have guided the process to the level where the values of the remaining variables can be determined implicitly, creating what the author calls *Solo-Path* of assignments in the problem search tree. The deficiency of the commonly adopted heuristic strategy of Minimum Remaining Values (MRV) clearly appears whenever two or more frontiers get evaluated with the same heuristic value in a phenomenon called by the author Fog of Search (FoS). In such an event, selecting the most promising state is usually taken based on nothing but an arbitrary random selection to break a tie. Since the quality of states selection relies on a coherent evaluation to the available information of the revealed part of the problem search-space; this study aims to introduce a novel strategy called *Contribution Number* (CtN) that helps in accelerating the neutralisation process. In order to achieve that, basic definitions and łemmas of the novel approach will be provided to construct the concept from scratch. Thereafter, an extensive study conducted on graph topologies will be introduced to help in understanding the type of features a constraint network needs to neutralise the problem efficiently. Thenceforward, the established foundations will be used to create network structures of the testing models for all three methodologies of the research. The behaviour of the proposed strategy has been examined using the well-known Australia map case study and the result concludes that the technique was able to prune out 41% of the total size of the search-tree as it was able to identify 17,706 neutralisation nodes, only six of which were considered the most optimal solutions to the problem that lead to the longest solo-path. The research, then, presents an exhaustive proof for evaluating 8,550 distinct constraint networks that fall into 10 different levels of complexity, and the results show that CtN was consistently able to outperform MRV. Last but foremost, the proposed strategy was evaluated on a popular and well-studied CSP instance of Sudoku puzzle as the author have conducted an extensive experiment on a large set of Sudoku puzzles that includes 10,000 puzzles and falls into five different difficulty categories. The results show that CtN is 30%~50% faster in neutralising the puzzles than MRV and remarkably avoids FoS.

ACKNOWLEDGEMENT

I wish to thank God for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully. I also wish to thank all the people who helped or contributed in this work. First and foremost, I would like to thank my academic supervisor at the UiTM, Professor Hajah Azlinah Hj. Mohamed, for accepting me into this program. During my research journey, she shared many special skills and a rewarding graduate school experience by giving me intellectual freedom in my work, engaging me in intelligent thoughts of her own, and demanding a high quality of work in all my attempts to achieve the research objectives. I also would like to express my great gratitude and appreciation to a very special person, who without him, none of this would possibly have come to light; My academic supervisor from JAIST university, Professor Hiroyuki Iida, who was my infinite resource of knowledge, and inspiration. He provided me with unconditional support to attending various conferences, workshops, and activities. He enabled me to access the university's supercomputer remotely, and he introduced me to some of the most enlightened minds of my field of study. Every result described in this thesis was accomplished with a direct assistance of himself and his lab-mates/lab-students in his laboratory with whom I had privilege to work. I greatly benefited from his keen scientific insights, his knack for solving seemingly intractable practical difficulties, and his ability to put complex ideas into simple terms. I am also indebted to Professor Yap Bee Wah, and Professor Noor Laila, some of the most brilliant persons whom I have ever met. They wholeheartedly supported me during my journey with their wisdom and advice. Those were the best instruments that kept me motivated to complete this research. Dr. Nathan Nossal, who revised this thesis and inspired me with many ideas on how to improve the research. I fondly recall whiling numerous hours with my dear colleague Dr. Nossal, weighing the philosophical and pragmatic implications of the future of AI and search algorithms. I would like to acknowledge the brilliant work produced by Alan Mackworth, Edward Tsang, Peter Norvage, Zineb Habbas, Robert Haralick, Rina Dechter, and all the earliest pioneers of the field of Constraint Satisfaction. Finally, I would like to acknowledge family and friends who supported me during my time here in Malaysia. First and foremost, I would like to thank my mother who taught me to trust in God, believe in the fruit of hard work, and that anything can be achieved if I set my mind to it. Although I was far away from home for the past ten years doing my master's and PhD; I felt your presence watching over me giving me the strength to continue on my long journey. Thank you, Mama. My father, who always provided an honest living for our family and for supporting and believing in my dreams. Anything good that has come to my life has been because of your example and guidance. My brother and sisters who have stood beside me and have always encouraged me to persevere. Hiroki Chiba-San, Eito Hayashi-San, and the rest of Arche Info. team for the unconditional support they have provided me with throughout the years. I would be remiss if I did not thank Dr. Ali Asghar and his wife Dr. Anila Asghar for being the best friends I have ever met. This work is dedicated to Leonhard Euler, the pioneer of Graph theory and one of the greatest mathematicians of all time.

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