

PROJ 201 PROJECT PROPOSAL REPORT

AI4PUZZLES

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March 4, 2020

ABSTRACT

In this project, it is aimed to write ASP statements based on the rules of the puzzle and solve those puzzles with an Artificial Intelligence tool called Clingo. This tool uses the ASP problem-solving method that expresses natural languages as statements, and it outputs the possible solutions/answer sets according to inputs given by the user. The program should assist user to find the correct solutions for every input. So, this project should generate a general formula for Akari puzzles which means that the formula is satisfied for every input. To generate a general formula; all rules, conditions, inputs and exceptional situations should be considered. In the project, it is supervised that ASP solver Clingo was requested to learn the approaches to those puzzles as artificial intelligent contributor. In sum, this program basically assists to find out all possible solutions to given puzzles with its restrictions by a general formula. This project is necessary in order to show that human beings are not able to comprehend and develop such solutions as rapidly as AI machines. During this project, the Clingo solver will be learnt by all group members through examples and after all, the project group will be able to present a complete solution for the Akari puzzle.

INTRODUCTION

Artificial Intelligence is a machine's capability of imitating intelligent human behavior (Artificial Intelligence, n.d.). Implementation of AI in solving complex puzzles provides much more accurate and effective solutions in a short amount of time which is beyond the capacity of the human brain. *Answer Set Programming* (ASP) is a method for declarative modeling and solving computational/complex problems (Holtz, 2014). The concept behind ASP is to structure a problem as a “program” whose answer sets are equivalent to the solutions of the problem. The answer sets

of the programs computed by answer set solvers which were special software systems, such as Potassco. N-queens and graph coloring are famous examples of ASP programs. The usage of ASP methods in solving various problems can be considered as *machine learning* for AI systems. Erdem et al highlight that due to the continuous developments and innovations in ASP, it can be used in various domains in AI. In the fields AI, ASP used for planning, probabilistic reasoning, integrating data, processing natural language, understanding and machine learning (2016, pg.2). Bioinformatics, software engineering, robotics, and automatic music composition are the other areas that use applications of ASP. AI and ASP have great advantages for humanity in the sense of increasing the pace of development and innovation by providing fast, consistent solutions. Due to this reason, AI4PUZZLES is a significant project in the sense of providing a tangible example of the application of AI and demonstrating the compatibility difference between human problem-solving skills and AI's ASP.

This project aims to solve the Akari Puzzle by using the ASP and Clingo which is the solver of the ASP program. Akari is a puzzle about placing “lightbulbs” in some grid squares (Nikoli, n.d.). Each lightbulb brightens the square it placed in four compass directions up until a black cell is hit. Every grid square must be brightened, but two lightbulbs should not illuminate each other. A black cell with a number indicates how many light bulbs are in the four surroundings of the cells vertically and horizontally. The program that was constructed at the end of the project will be an example of a system that determines the optimal solution due to inputs (constraints) coming from users and learns how to place light bulbs according to the constraints. This ability of the program is a demonstration of machine learning.

PURPOSE

Our approach in this project is to translate the rules and constraints of the Akari puzzle which was written in natural language into statements in Answer Set Programming (ASP) by using artificial intelligence operations. In the project AI4PUZZLES, ASP solvers such as Clingo used to solve the puzzle.

DESCRIPTION OF SPECIFIC STEPS

Learning Clingo which is a tool of ASP was the first step in the project. In order to comprehend the basics of programming with Clingo, N Queens and Graph Coloring examples were introduced and solved for a better approach. After successfully completing of those examples, the main project puzzle , Akari is introduced to members and their first task is to find the restrictions of the puzzle for an in-depth understanding of the rules which will be expressed as statements in the Clingo tool.is After completing this step, members will be modeling the puzzle and then expressing the statements.

DESCRIPTION OF RESPONSIBILITIES OF INDIVIDUAL MEMBERS

In this project work division had done equally among group members. Everyone followed the same steps with other members. Everybody got the same training about ASP, focused on the same puzzle at the same time which were Graph Coloring, N-Queens and Akari puzzles, and developing solutions to each puzzle by using Clingo in sub-groups consisting of 2 members.

GANTT CHART

						Week														
Tasks	Description	Duration (week)	Start	Finish	Person Responsible	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Getting started – Determining the basis of ASP	1	1	2	All member															
2	Learning ASP solver Clingo with a Graph Coloring example	2	1	3	All member															
3	Solving N-Queen puzzle	3	2	4	All members															
4	Finding alternative solutions for the previous puzzles	1	2	3	All member															
5	Continue to improve ASP skills	1	2	3	All member															
6	Looking for the Akari puzzle rules and restrictions	2	3	5	All member															
7	Using problem solving skills to determine a strategy for solving Akari	1	5	6	All member															
8	Framing pseudo code for the related puzzle	3	6	9	All member															
9	Algorithm development of the pseudo code	1	8	9	All member															
10	Converting pseudo code into ASP	1	9	10	All member															
11	Making the last optimizations on the solution	1	10	11	All member															
12	Finalizing the ASP solution of the Akari	1	10	11	All member															
13	Poster preparing	1	11	12	All member															
14	Poster printing and getting ready for the presentation	2	12	14	All member															
15	Presentation	2	13	15	All member															

Color Coding:
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