

OPPONENT RECORD

Thesis compiled by

Anders Broström, Simon Johansson

Title of thesis:

Sudoku Solvers: Man versus Machine

Opponent:

Badar Mian

Was it easy to understand the underlying purpose of the project? Comments.

Yes the purpose was clear to implement a Sudoku solver and compare it to different type of Sudoku solvers. The problem statement and the purpose went hand in hand and were very well written. For further development one could have written the problem statement on point list to make it easier for the reader to find it and read it through if one forgets it. The problem statement for the thesis can be written in bullet points like with the purpose.

Do you consider that the report title justly reflects the contents of the report?

The title is very good but somewhat misleading as one would believe they have tested humans against machine but they have actually implemented human Sudoku solving psychology into a program and test that against other Sudoku solvers. Of course it wouldn't be fair to compare a computer, which can make calculations very fast, with humans but the title felt like that is what the thesis was about. Another example could be to change the man versus machine to human solving algorithm versus brute-force algorithm.

How did the author describe the project background? Was there an introduction and general survey of this area?

The project is introduced with a simple explanation of how Sudoku works and later on a whole chapter is given to the background research. One thing missing is a small outlining (what the chapter is about, like a small introduction) of respective chapter in the beginning of that chapter. The authors have instead put a subchapter in the introduction called outline which goes through the whole thesis and summarizes what each chapter includes. The introduction is a bit short while the background is a lot larger. One suggestion would be to move the Sudoku subchapter from background to introduction as it only explains how Sudoku works and where it came from. It has very little information that is useful to know when it comes to different types of Sudoku solvers.

To what degree did the author justify his/her choice of method of tackling the problem?

The authors have not clearly written which method they will use to tackle the problem but have mentioned different ways to approach their problem and have chosen one of them. An improvement would be to have a subchapter in the "Approach" chapter which is named "method used" and mentions what specific methods they will use and continues into how they will use them. There is some jumping between "are" (present tense) and "were" (past tense) in the whole thesis. For example

in subchapter “Implementation” first line the authors say “the two solvers are both written in java” and later say “we wrote both solvers in the same programming language”.

Did the author discuss the extent to which the prerequisites for the application of such a method are fulfilled?

Yes this is fully discussed in the “Background” and “Approach” chapters. They also mention what choices they will make for development of their Sudoku solver. The discussion could have been more extensive to make the reader more aware of the thoughts behind the authors’ choices.

Is the method adequately described?

Yes they have written very well what kind of thoughts they had about the algorithm for the Sudoku solver and also why they choose it. They go into good details when they describe how they run the tests and how they compiled the results from the tests they did.

Has the author set out his/her results clearly and concisely?

The results are presented very well with graphs and short text under each explaining what the graph is showing. Some part of the result is actually written in the conclusion. In subchapter “2 Number of misses ...” the authors mention another way of interoperating the results by adding a number to the already miss count in one of the solvers results. This should have been shown in graphs and mentioned in the results as what the authors mention as reason for doing this is valid and very interesting for the thesis’ results.

Do you consider the author’s conclusions to be credible?

The conclusions are relevant and credible from the results. I even marked the same Sudoku IDs in the results as the authors talked about in the conclusions. This shows that the results are easy to read and the conclusions come naturally to the reader. The authors also repeat things they have mentioned before in the thesis which is very good because it makes it easier for the reader to follow from the problem to the method to the results and what ground they got from all of this to use in the conclusion.

What is your opinion of the bibliography? What types of literature are included? Do you feel they are relevant?

The bibliography needs to be worked on. They only have one reference to an article from a journal and two references have the same name. As they use numbers to differentiate the references it is alright but in the text they mention the reference by name as well and this could confuse the reader.

Which sections of the report were difficult to understand?

The background chapter has a subchapter “techniques” which is a bit hard to understand and follow. If the authors add some figures with examples and arrows I think it will be easier for the reader to follow and understand what methods for solving Sudoku’s they want to implement.

Other comments on the report and its structure.

There were some spelling errors in the report which I have written and marked in the report I will hand to the authors at the opposition. Also the authors have used different layout sometime. They have sometimes forgotten to have a break line when a new paragraph starts (marked in the printed copy that

will be handed to the authors). The chapters are missing number which would have made it much easier for the reader to find the chapter the authors sometimes refer to in the thesis.

What are the stronger features of the work/report?

I believe most of them have been mentioned above. A strong feature might also be that the Sudoku puzzles have become more and more interesting in the 21th century. I myself use to solve them a lot when I was younger and have seen a lot of people solving them on the public transport in different newspapers. The description of the testing approach is very good and it makes it very easy for other people to run the same tests to further research the subject.

What are the weaker features of the work/report?

One weak aspect might be the fact that they had to manually feed the Sudoku puzzles into files that their program could read. If they would have found a database filled with puzzles, they could have increased the empirical study and gotten a much larger result base for their conclusions. They use a lot of “we” in the thesis which can sometimes give the feeling that it is not a research paper but more a paper on what the authors think.

What is your estimation of the news value of the work?

I don't believe this is a relevant question as this thesis is only on 6 HP (högskolepoäng) and does not give a lot of time to research. They have done a good job with the time they had to work.

Summarize the work in a few lines.

The thesis is a comparison of how well a Human behaviour algorithm works against a brute-force algorithm when solving Sudoku puzzles. The authors start with mentioning how Sudoku works and its background. Here they make a hypothesis for their work. Then they describe how they implemented the human solver and what changes they made to their brute-force algorithm to make it faster. They also mention what commands they used and how they exported the data to Excel to make it easier to export different graphs from the statistical data. In the results they show some graphs showing how well the different Sudoku puzzles (categorized by difficulty). They measured both how fast the algorithms where in the sense of time and also how many misses the algorithm made before it got to a solution (misses meaning how many times the algorithm had to back trace incorrect guesses). From this the authors write down the conclusions which also match the hypothesis they made, that the human behaviour algorithm is faster and has less misses then the brute-force algorithm but that it unfortunately cannot solve very hard puzzles (at championship level, too hard for a common human being).

Questions to author:

1. Did you find a pattern in the Sudoku's that the brute-force algorithm solved faster than the human solver? (e.g. did it have more cells in the beginning with clues so the first few cells it solved made the rest of the puzzle much easier to solve)
2. Did you find any articles in journals about this type of research?
3. How did you find the most common algorithms used to solve Sudoku's?
4. Did you find any ready-made human solvers?