**CS171: Introduction to Artificial Intelligence**

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**Sudoku Project Report**

1. A. Generate a set of 5 boards with P = 3, Q = 3, M = 15.

B. Run your Sudoku solver on the generated boards and fill in the following table:

|  |  |  |
| --- | --- | --- |
|  | Backtracks | Trail Pushes |
| FC | 179 | 4971 |
| FC MRV | 114 | 4321 |
| FC LCV | 829 | 12753 |
| FC MRV LCV | 1115 | 12665 |
| NOR | 70 | 3677 |
| NOR MRV LCV | 66 | 3666 |
| NOR DEG LCV | 516 | 10379 |
| NOR MAD LCV | 22 | 2430 |

C. Which set of heuristics produced the best results? Explain.

NOR MAD LCV had best results because it does the most constraint propagation, chooses the best possible variable, and the best possible value.

D. Describe any anomalies or patterns. Explain in detail.

Adding more heuristics resulted in better results but using NOR DEG LCV had the worst results. Choosing the variable with the most unassigned neighbors doesn’t help very much, compared to choosing the variable with the smallest domain. Some boards also run really poorly for certain heuristics: Board4 – FC LCV, Board5 – FC MRV LCV

1. A. Generate a set of 5 boards with P = 4, Q = 3, M = 25.

B. Run your Sudoku solver on the generated boards and fill in the following table:

|  |  |  |
| --- | --- | --- |
|  | Backtracks | Trail Pushes |
| FC | 6190 | 82172 |
| FC MRV | 233 | 9413 |
| FC LCV | 6336 + null | 74715 + null |
| FC MRV LCV | 48 | 6871 |
| NOR | 355 | 10268 |
| NOR MRV LCV | 126 | 7272 |
| NOR DEG LCV | 1603 + null + null | 33288 + null + null |
| NOR MAD LCV | 646 | 13759 |

C. Which set of heuristics produced the best results? Explain.

FC MRV LCV had the best results. Constraint propagation, choosing the variable with the smallest domain, and choosing the least constraining value worked the best. For a bigger board, it seems like it works better than using NOR and MAD.

D. Describe any anomalies or patterns. Explain in detail.

Using NOR and MAD resulted in worse results than when using FC or MRV. Using DEG still gave the worst results. It seems like bigger boards work better with FC and MRV. The tiebreaker in MAD and assignment in NOR don’t affect the results positively. Also, LCV doesn’t seem to be very useful without MRV.

1. A. Generate a set of 3 boards with P = 4, Q = 4, M = 45.

B. Run your Sudoku solver on the generated boards and fill in the following table:

|  |  |  |
| --- | --- | --- |
|  | Backtracks | Trail Pushes |
| FC | 242 + null + null | 6444 + null + null |
| FC MRV | 860 | 20633 |
| FC LCV | 1037 + null | 18499 |
| FC MRV LCV | 7 | 9168 |
| NOR | 19 + null + null | 3144 + null + null |
| NOR MRV LCV | 93 | 10683 |
| NOR DEG LCV | Null, null, null | Null, null, null |
| NOR MAD LCV | 61 | 9306 |

C. Which set of heuristics produced the best results? Explain.

FC MRV LCV had the best results. Constraint propagation, choosing the variable with the smallest domain, and choosing the least constraining value worked the best. For a bigger board, it seems like it works better than using NOR and MAD.

D. Describe any anomalies or patterns. Explain in detail.

Using DEG resulted in runtimes that were too long. Using only NOR or only FC also resulted in super long runtimes. NOR and MAD resulted in worse results than when using FC or MRV. Also, LCV doesn’t seem to be very useful without MRV. Having 3 heuristics yielded better results than only 1 or 2 heuristics.

1. Did the same set of heuristics produce the best results for (1), (2), and (3)? If not, explain why this might have happened.

No. For boards bigger than p=3, q=3, it seemed like FC MRV LCV was better. However, for p=3, q=3 boards, NOR MAD LCV had the best results. The degree tiebreaker in MAD and value assignment in NOR don’t seem to have a positive effect on the runtime.

1. Did you implement the Extra Credit heuristics? If so, which heuristics did you implement? Why did you choose these heuristics? How did they compare to the results in questions (1), (2), and (3)?

N/A

1. Did you encounter any problem when doing the project? How did you resolve these problems?

Yes. Sometimes we were confused about whether or not our code was correct or if our runtimes were accurate. We resolved these issues by going on Piazza and consulting with our classmates.

1. (Optional) Do you have any suggestions to improve the shells?