TDT4136 - Assignment 4

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Running the code

The code can be run by running the `Assignment.py` file. This will solve all the boards (as well as a modified map-coloring example) and print the solutions.

Sudoku solutions

The following is the direct output of the code (with some weird LaTeXformatting) for each sudoku. The number of times the backtrack-function is called for each board is also shown.

```
Solving sudoku easy.txt
7 8 4 | 9 3 2 | 1 5 6
6 1 9 | 4 8 5 | 3 2 7
2 3 5 | 1 7 6 | 4 8 9
- - - + - - - + - - -
5 7 8 | 2 6 1 | 9 3 4
3 4 1 | 8 9 7 | 5 6 2
9 2 6 | 5 4 3 | 8 7 1
- - - + - - - + - - -
4 5 3 | 7 2 9 | 6 1 8
8 6 2 | 3 1 4 | 7 9 5
1 9 7 | 6 5 8 | 2 4 3
Backtrack called 1 times, failed 0 times.
```

```
Solving sudoku medium.txt
8 7 5 | 9 3 6 | 1 4 2
1 6 9 | 7 2 4 | 3 8 5
2 4 3 | 8 5 1 | 6 7 9
- - - + - - - + - - -
4 5 2 | 6 9 7 | 8 3 1
9 8 6 | 4 1 3 | 2 5 7
7 3 1 | 5 8 2 | 9 6 4
- - - + - - - + - - -
5 1 7 | 3 6 9 | 4 2 8
6 2 8 | 1 4 5 | 7 9 3
3 9 4 | 2 7 8 | 5 1 6
Backtrack called 3 times, failed 1 times.
```

```
Solving sudoku hard.txt
1 5 2 | 3 4 6 | 8 9 7
4 3 7 | 1 8 9 | 6 5 2
6 8 9 | 5 7 2 | 3 1 4
- - - + - - - + - - -
8 2 1 | 6 3 7 | 9 4 5
5 4 3 | 8 9 1 | 7 2 6
9 7 6 | 4 2 5 | 1 8 3
- - - + - - - + - - -
7 9 8 | 2 5 3 | 4 6 1
3 6 5 | 9 1 4 | 2 7 8
2 1 4 | 7 6 8 | 5 3 9
Backtrack called 13 times, failed 8 times.
```

```
   Solving sudoku veryhard.txt
4 3 1 | 8 6 7 | 9 2 5
6 5 2 | 4 9 1 | 3 8 7
8 9 7 | 5 3 2 | 1 6 4
- - - + - - - + - - -
3 8 4 | 9 7 6 | 5 1 2
5 1 9 | 2 8 4 | 7 3 6
2 7 6 | 3 1 5 | 8 4 9
- - - + - - - + - - -
9 4 3 | 7 2 8 | 6 5 1
7 6 5 | 1 4 3 | 2 9 8
1 2 8 | 6 5 9 | 4 7 3
Backtrack called 22 times, failed 9
times.
```

About the number of backtrack-calls and -fails

The number of calls to the backtrack-function reflects how many times the algorithm has to "guess" rather than infer (with AC-3) which number is in a particular spot. When it guesses something that does not lead to a possible solution, the backtracking fails and it has to guess again.

Intuitively, for the more difficult boards, the number of times the algorithm guesses (ie. the number of times "Backtrack" is called minus one) increases. Furthermore, when the number of guesses increases, the number of failed guesses also increase. The total number of correct guesses is then (#(called backtrack) - 1 - #(failed backtrack)), which is 13 for the most difficult board.

Seeing as even for the most difficult board only 12 of the 56(=81-25) variables in the correct solution were "guessed" with backtracking, the AC-3 inference was able to fill in the remaining 44 variables not given in the unsolved input, significantly reducing the branching of the backtracking algorithm.