

# TDT4136 Assignment 3

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## Easy board

```
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
Number of backtracking calls: 1
Number of backtracking fails: 0
```

Figure 1: Easy Sudoku board

## Medium board

```
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
Number of backtracking calls: 3
Number of backtracking fails: 0
```

Figure 2: Medium Sudoku board

## Hard board

```
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
Number of backtracking calls: 12
Number of backtracking fails: 4
```

Figure 3: Hard Sudoku board

## Very hard board

```
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  
Number of backtracking calls: 68  
Number of backtracking fails: 57
```

Figure 4: Very hard Sudoku board

## 4.2c)

As we can see from the different figures, as we use the methods on supposedly harder boards, the number of times `backtrack()` gets called and returns failure increases. If we take some time to think about this, for me at least, this makes a lot of sense. A harder board would require more trial and error than a easier board that has more solutions than the harder boards.

For the easy board, `backtrack` was called 1 time. The first time we tried assigning values, the solution allowed us to update the domains of the other variables and find a solution.

When we then take a look at the medium difficulty board, we end up having to call `backtrack` 3 different times, meaning we have to try 3 values that was consistent which ended up giving the solution.

In the hard board `backtrack` returned failure 4 times, meaning that it tried 4 times different values that was consistent in the partial assignment, but ending up not giving a complete consistent assignment.

In the very hard board, there where a total of 57 times `backtrack` gave failure out of a total of 68 different consistent values. This makes sense, given that it is harder to find a consistent solution on a harder board because of the smaller set of solutions.