CP Fifth Assignment

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Optimal N-Queens

Looking for the different solution we find we can clearly see how the object of the function (the total distance between the all Queens and the diagonal of the matrix) change between the four different method we implement. Let's see the four different search methods:

- **Default search:** in the default search we can clearly see how the obj has the highest value respect the three different method. Also the fails has a number quite high but not the highest possible.

- **dWd - rand:** the highest number of fail is coming from the domWdeg - random where the obj value is much better respect the default search. The high number of fail depends on the nature of the method because the random can give us more randomness in particular when we assign the variable to a random value in the domain. But this is not enough to avoid the number of backtrack and fail the domWdeg heuristics find during all the exploration of the problem. Using dom, we choose the next variable with minimum domain size. Choosing variables with the minimum domain size allow us to create the minimum search tree after propagation and its effect became more powerful. With weighted degree heuristic, instead, we combine min domain size and the weighted degree. In this model, we give more weight to the constraints that are more difficult to satisfy, and we calculate the degree of the variable's according. The highest number of fail on domWdeg is because the method follow the fail-first principle, so it trying where the failures is most likely to occur. To reduce the size of the search tree, the solver will therefore first fail a number of branches.

- **dWd - rand + restart:** the situation became much better adding a Luby restart to the previous method. The number of failures is halved and the total distance of all the queens to the diagonal is also lower. That happen because the Luby after a certain number of fails or conflicts restart in a complete different part of the search space to try to avoid the situation where we are stuck in a local minima. This method applied more diversification respect the intensification in fact with the Luby restart can explore a complete different search space respect the one already explored andd where we have found a local minima.

- **dWd - rand + restart + LNS:** the better situation we can find in the domWdeg - rand + restart + Large Neighbourhoods Search where with this method we can find the best obj with the lowest number of failures respect the other three method used before. This method is an integration of Local Search based method and Complete method like Cp (approximate+complete method). The main idea is to view the exploration of a neighbourhood as the solution of a sub-problem and we use a tree search to explore it in a pretty quickly way and in an exhaustively way. The number of fail is greatly reduced because the LNS take a solution already found and fixed some value (fragment) and relax the remaining values. Now we don't have to analyze all the problem but only a sub problem and the used of a fixed variables reduces the domain size and the propagation works much better respect work in the entire domain.

Search	failures	obj
def	23.346.589	810
dWd - rand	27.333.373	726
dWd - rand + restart	11.573.394	672
dWd - rand + restart + lns	1.707.973	650

Table 1: Optimal N-Queens Statistics