3) Solving Discrete Constraint Satisfaction Problems peer-reviewed Mahin

Write a program which finds solution to the following 3 hierarchically organized[[1]](#footnote-1) constraint satisfaction problems, involving 15 variables {A,B,C,…,N,O} which can take integer values in {1,…,50}.

1. Problem A: Find a solution to the constraint satisfaction problem involving the six variables A, B, C, D, E and F and constraints C1,…,C4:
   * (C1) A=B+C+E+F
   * (C2) D=E+F+21
   * (C3) D\*\*2=E\*E\*A + 417
   * (C4) E+F<A
2. Problem B: Find a solution to the constraint satisfaction problem involving ten variables A,…,J which satisfy constrains C1,…,C9:
   * (C5) H\*J+E\*12=(G+**I**)\*\*2
   * (C6) A+D=(F-G)\*\*21
   * (C7) 4\*J=G\*\*2+39
   * (C8) (**I**-G)\*\***9**=(F-H)\*\*3
   * (C9) (G-C)\*\*2= F\*C\*C 1
3. Problem C: Find a solution to the constraint satisfaction problem involving 15 variables A,…,O which satisfy constrains C1,..,C15:
   * (C10) 2\*M=K\*\*2 6
   * (C11) (N-**O**)\*\*3 + 7= (F-**I**)\*N
   * (C12) N\*\*2=M\*\*2 + 291
   * (C13) **O**\*\*2=G\*H\***I**\*B + 133
   * (C14) M+**O**=K\*\*2 10
   * (C15) L\*\*3 + **I**=(L+B)\*K

Remark: In the above equations the letters ‘I’ and ‘O’ where put into bold face to avoid to be mistaken as numbers 0 or 1. Moreover, the letter ‘J’ looks somewhat similar than the letter ‘I’ but to better distinguish the two letter ‘J’ is never in bold face.

Your program should contain a counter **nva** (“number of variable assignments) that counts the number of times an initial integer value is assigned to a variable or the the assigned integer to the particular variable is changed; in addition to outputting the solution to the CSV also report the value of this variable at the end of the run, and an interface to call your program for CSP Problems A, B, or C. Your program should return the solution or “no solution exists” and the value of nva after the program terminates. Moreover, terminate the search as soon as you found a solution—do not search for additional solutions.

Remark: To guarantee the anonymity of the peer reviewing, the source code and report you submit should not contain your names or other information that could be used to identify your identity. Moreover, this task will need to be submitted via Kritik and not Blackboard.

Submit a report which

* Gives a brief description of the strategy you used to solve the CSP
* Provides Pseudo Code of your CSP solver
* Explains the Pseudo Code in a paragraph
* Describes strategies (if you employed any) you employed to reduce the runtime of your program, measured by the final value of the variable nva.
* If you conducted a mathematical pre-analysis to eliminate variables, to obtain additional ‘<’ constraints to reduce search complexity or came up with other problem complexity reduction strategies based on such a pre-analysis, describe the results of the pre-analysis you conducted, and how the results of this pre-analysis were used for reducing the search complexity.
* If your program takes advantage of the hierarchical structure of the three CSP problems also explain how this was done.
* If the program you developed is generic in the sense that its code could be reused to solve constraint satisfactions which have a similar structure but different constraints, include a paragraph presenting evidence why your program has this property and what you did to make your program ‘generic’…

Moreover, submit the Source Code for the implementation in a separate file and instructions on how to run your code in a Readme File. Attach the Readme file as an appendix to your report.

Notes on grading:

* Sophisticated approaches that lead to lower complexities in solving the respective CSPs—measured by the final value of the variable nva—will get 10-15% higher scores compared to programs that use brute force approaches.
* Serious penalties will be assessed if the value of the variable nva is not properly computed.

1. A solution of the higher numbered problem also represents a solution of the lower numbered problem! [↑](#footnote-ref-1)