First download MiniZinc from https://www.minizinc.org/ and have a look at the handbook including a tutorial https://www.minizinc.org/doc-latest/en/index.html. You can also use MiniZinc to test whether your encodings actually work :)

**Exercise 5.1:**
Consider the following crossword puzzle, where a given list of words can be used to fill the empty spaces.

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AFT   LASER  
ALE   LEE   
EEL   LINE   
HEEL  SAILS  
HIKE  SHEET  
HOSES STEER  
KEEL  TIE    
KNOT

a) Formalize the problem as a CSP and draw the constraint graph.

b) Reduce the domains of the variables by applying the constraint propagation method *arc consistency*.

c) Use a search algorithm with forward checking and the degree heuristic to obtain all solutions of the CSP.

**Exercise 5.2 (Subsetsum problem):**
given a set (or multiset) of integers, is there a non-empty subset whose sum is zero? For example, given the set \{-7, -3, -2, 5, 8\}, the answer is yes because the subset \{-3, -2, 5\} sums to zero. Formulate the problem as CSP.

**Exercise 5.3 (Rucksack problem):**
Given a set of \(n\) items numbered \(1 \ldots n\), each with a weight \(w_i\) and a value \(v_i\), determine whether or not to include an item in a collection so that the total weight \(W\) is less than or equal to a given limit \(W_{\text{max}}\) and the total value \(V\) is as large as possible. Formulate the problem as CSP.