Modelling and Solving Exercises in MiniZinc - 2

Before Starting

- Use a separate folder for each problem.
- Create a project file (.mzp) for the problem when there are multiple model or data files.
  - Add the model files (*.mzn)
  - Add the data files (*.dzn)
- Configure the solver to obtain the solution statistics, to search for one or all solutions, and to set a time limit when needed.

A Sequence Problem

- Find the code of my safe composed of 10 digits, where the first digit gives the number of 0s in the code, the second the number of 1s, the third the number of 2s, and so on with the 10th digit giving the number of 9s in the code.

- Solve a more general problem: find a sequence of n integers $X_0,\ldots,X_{n-1}$ that contains values between 0 and $n-1$, in a way that any value i appears X_i times in the sequence.

A Sequence Problem

- E.g., with n = 5, a solution is [2, 1, 2, 0, 0]:
  - X_0 = 2 $\rightarrow$ 0 appears 2 times in the sequence
  - X_1 = 1 $\rightarrow$ 1 appears once in the sequence
  - X_2 = 2 $\rightarrow$ 2 appears 2 times in the sequence
  - X_3 = 0 $\rightarrow$ 3 appears 0 times in the sequence
  - X_4 = 0 $\rightarrow$ 4 appears 0 times in the sequence

A Sequence Problem

- Base model
  - Variables and Domains
    - $X_0, \ldots, X_{n-1} \in \{0, \ldots, n-1\}$ where each X_i has dual role
  - Constraints
    - for all i, $X_i = \sum_j (X_j = i)$
- Base model + implied constraints
  - $\sum_i X_i = n$ (total number occurrences)
  - $\sum_i X_i * i = n$ (sum of the values via the number of value occurrences)

A Sequence Problem

- Global model
  - Constraints
    - ~~for all i, $X_i = \sum_j (X_j = i)$~~ which global constraint on X_i variables?
- Global model + implied constraints
    - $\sum_i X_i = n$
    - $\sum_i X_i * i = n$

A Sequence Problem

- Implement the models.
- Search for **one solution** for N = 500 and N =1000, using **the default search** of Gecode.
- Compare the failures and the total time.
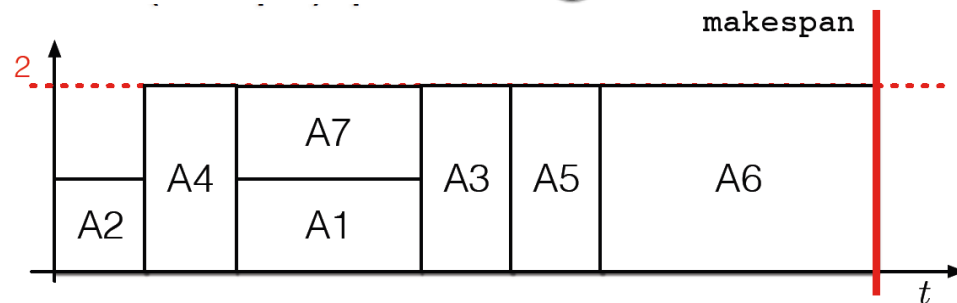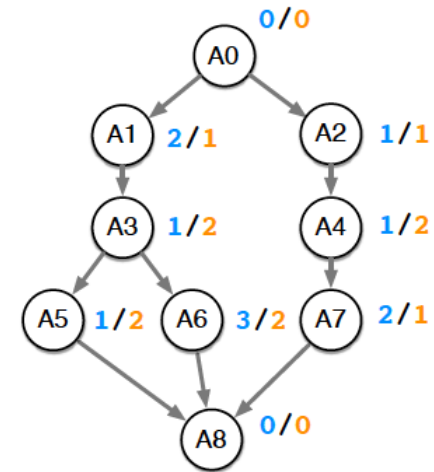- Check if any implied constraint has now become redundant.

A Scheduling Problem

- Given:
  - a set of parallel resources,
  - a set of tasks with durations and resource requirements,
  - precedence constraints between some tasks,

decide:
  - when to execute each task so as to minimize the makespan, subject to precedence and resource constraints.

■ duration
■ req for r_0 ($c_0 = 2$)

A Scheduling Problem

- Variables and Domains
  - Start time S_i for each task with domain?
- Objective variable
  - Makespan as the maximum ending time.
- Constraints
  - Precedence constraints for each given i $\rightarrow$ j
  - Resource constraints for each resource.
- Objective
  - Minimize makespan.

A Scheduling Problem

- Implement the model using a suitable global constraint.

- Can you add any implied constraints to the model?

- Search for the optimal solution to the provided instances using the default search of Gecode, with a time limit of 5 mins (300 secs).

- For the difficult instances, experiment with Chuffed and OR Tools CP-SAT solvers using default search.

- Compare the objective value and the total time.