# 272SM: Introduction to Artificial Intelligence
# Homework Assignment: CSPs

Monday 27$^{\text{th}}$ March, 2023 - Thursday 25$^{\text{th}}$ May, 2023

## Instructions

Report your answers to the following exercises and submit them at any time before the exam. Submitting homework solutions is highly recommended; Correct solutions will be counted as bonus points towards the final grade.

## 1  Exercise 1: Formulating a CSP

Suppose you have a state-space search problem defined by the usual stuff:

- a set of states s;
- an initial state s0;
- a set of actions A including the NoOp action that has no effect;
- a transition model Result(s, a);
- a set of goal states G.

Unfortunately, you have no search algorithms! All you have is a CSP solver. How could you reformulate this as a CSP? You may assume that you are given the maximum number of steps, T that any plan can have. Make sure that your formulation makes it easy to see what the plan is.

## 2  Exercise 2: Algorithmic map coloring - Performance analysis

Generate random instances of map-coloring problems as follows: scatter n points on the unit square; select a point X at random, connect X by a straight line to the nearest point Y such that X is not already connected to Y and the line crosses no other line; repeat the previous step until no more connections are possible. The points represent regions on the map and the lines connect neighbors. Now try to find k-colorings of each map, for both k=3 and k=4, using min-conflicts, backtracking, backtracking with forward checking, and backtracking with arc consistency. Construct a table of average run times for each algorithm for values of n up to the largest you can manage. Comment on your results.

# 3    Exercise 3: Critical ratio

Using a CSP solver program and another program to generate random problem instances of CSPs, report on the time to solve the problem as a function of the ratio of the number of constraints to the number of variables.