Constraint Satisfaction

N-queens Solver
Brute-force Search
Forward Checking

What is Constraint Satisfaction?

- It is a decisions problem
- With limited choices in each decision
- Constraints on combination of choices
- It’s about solving problems efficiently
- Combinatorial explosion limits our ability to solve large problems
- Heuristics can sometimes help us to find the first solution quickly
- Useful for many practical applications

A Car-sequencing Problem

Production Requirements:
- Options (1=required, 0=not):
  - Sun-roof
  - Radio-cassette
  - Air-conditioning
  - Anti-rust paint
  - Power-brake

Number of cars required:
- Total: 120

Work Area for Sun-roof
Capacity Constraint: 2/3

Work Area for Radio-cassette
Capacity Constraint: 3/5

The 8-Queens Constraint Satisfaction Problem

Task: to put 8 queens on the board such that no queen attacks others
- No two queens appear in the same row, column and diagonal

Sample Solution

Backtracking Search In The 8-Queens Problem
- Place one queen per row
- Place one queen at a time
- Examine each column
- Backtrack at dead-ends

Forward Checking Search
- Problem reduction – a major technique
- Combined with search methods
- Reduce domain of future variables
- Detect dead-ends – To backtrack early
- Dead-end detected after Queen 4 – no legal space for row 6, backtrack…
Forward Checking Principles

- Maintain a Domain for each variable
  - Domain = list of available values remaining
- Every time a variable $x$ is assigned a value $v$
- For every unassigned variable $y$:
  - Remove from domain of $y$ all values that is inconsistent with “$x = v$”
  - Backtrack immediately if any domain is empty

Constraint Techniques Overview

- Problem Reduction
  - To reduce domain size
  - To add or tighten constraints
  - Aims:
    - To reduce the problem to an easier one
    - To detect dead-ends
- Search
  - Backtracking search
  - Lookahead search
  - Learning nogoods at dead-ends
  - Intelligent Backtracking at dead-ends
  - Stochastic methods
- (Solution Synthesis)

Simple Backtracking, Implementation

- Delete one column at a time
- Make it the column for the next row from the last
- Backtrack if necessary

Program Nqueens.plg

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