Course Summary
&
Revision Guide

week 1

Intro … crystal maze

Getting started with miniZinc

Modelling & solving problems

Intro … crystal maze

week 1

Modelling and solving:

a decision problem

an optimisation problem

knapsack problem

Production planning: decision and optimisation problems

Guard Rota … all guards are equal (a symmetry break!)

Symmetries and how they might be broken
Search annotations
Useful lower bounds when proving optimality

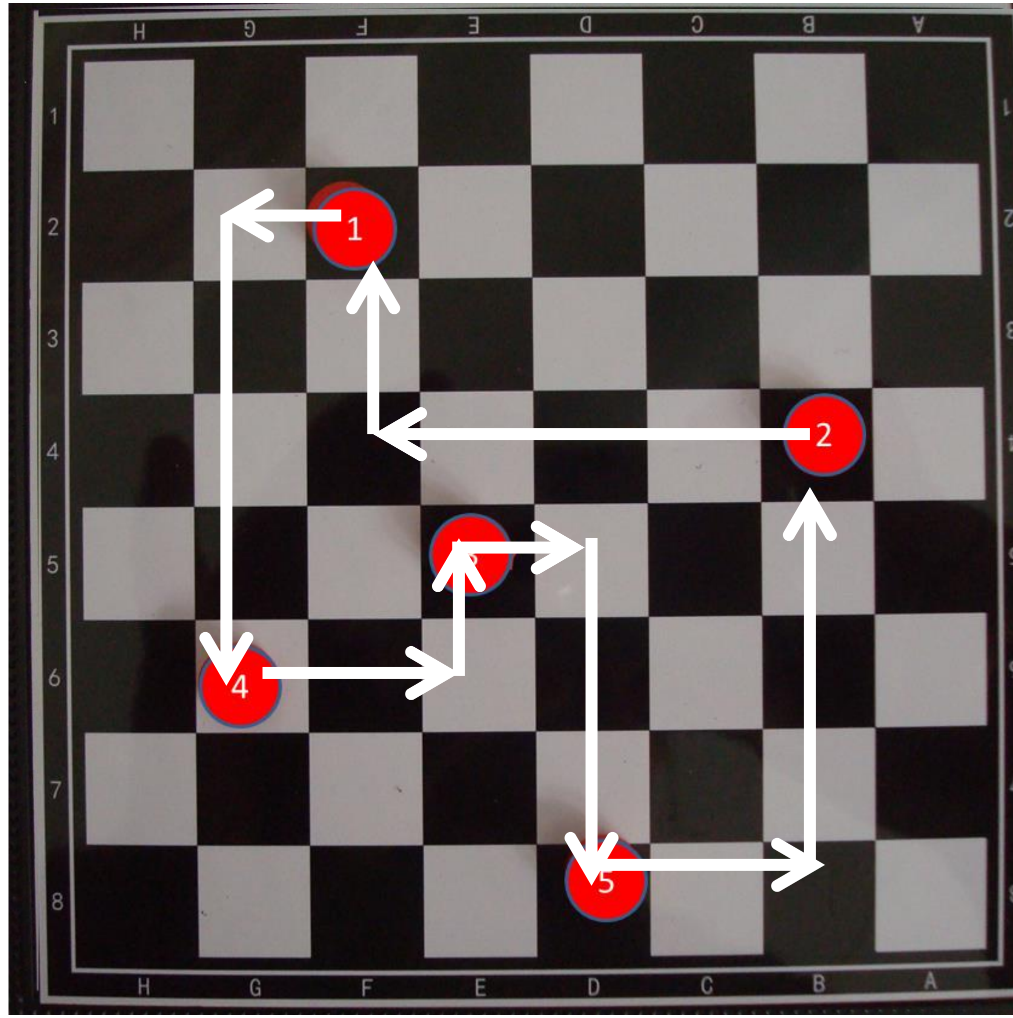
Clique and Graph Colouring:

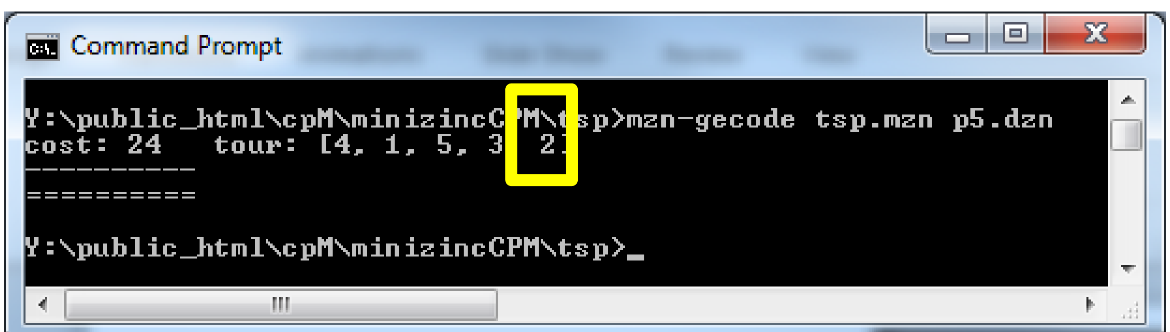
- What have the two in common?
- An example of branch-and-bound (BnB)

TSP: a demonstration of elegance (not efficiency)

week 2

5 goes to 2




Command Prompt

```
Y:\public_html\cpM\minizincCPM\tsp>mzn-gecode tsp.mzn p5.dzn
cost: 24   tour: [4, 1, 5, 3, 2]
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==========

Y:\public_html\cpM\minizincCPM\tsp>_
```

Exercise 1

week 2

The Team Building Problem

At least 3 models, symmetry breaking, search annotations,
channeling between models, use of global constraints …

week 3

Backtracking search

- BT checking backwards
- CBJ jumping backwards
- FC checking forwards

Backtracking search

- BT checking backwards
- CBJ jumping backwards
- FC checking forwards

Thrashing!

More on modelling: GCol with set variables (colour classes)

More on modelling: GCol with set variables (colour classes)

SIP

(subgraph isomorphism problem):

a thought experiment

Think like a Constraint Programmer

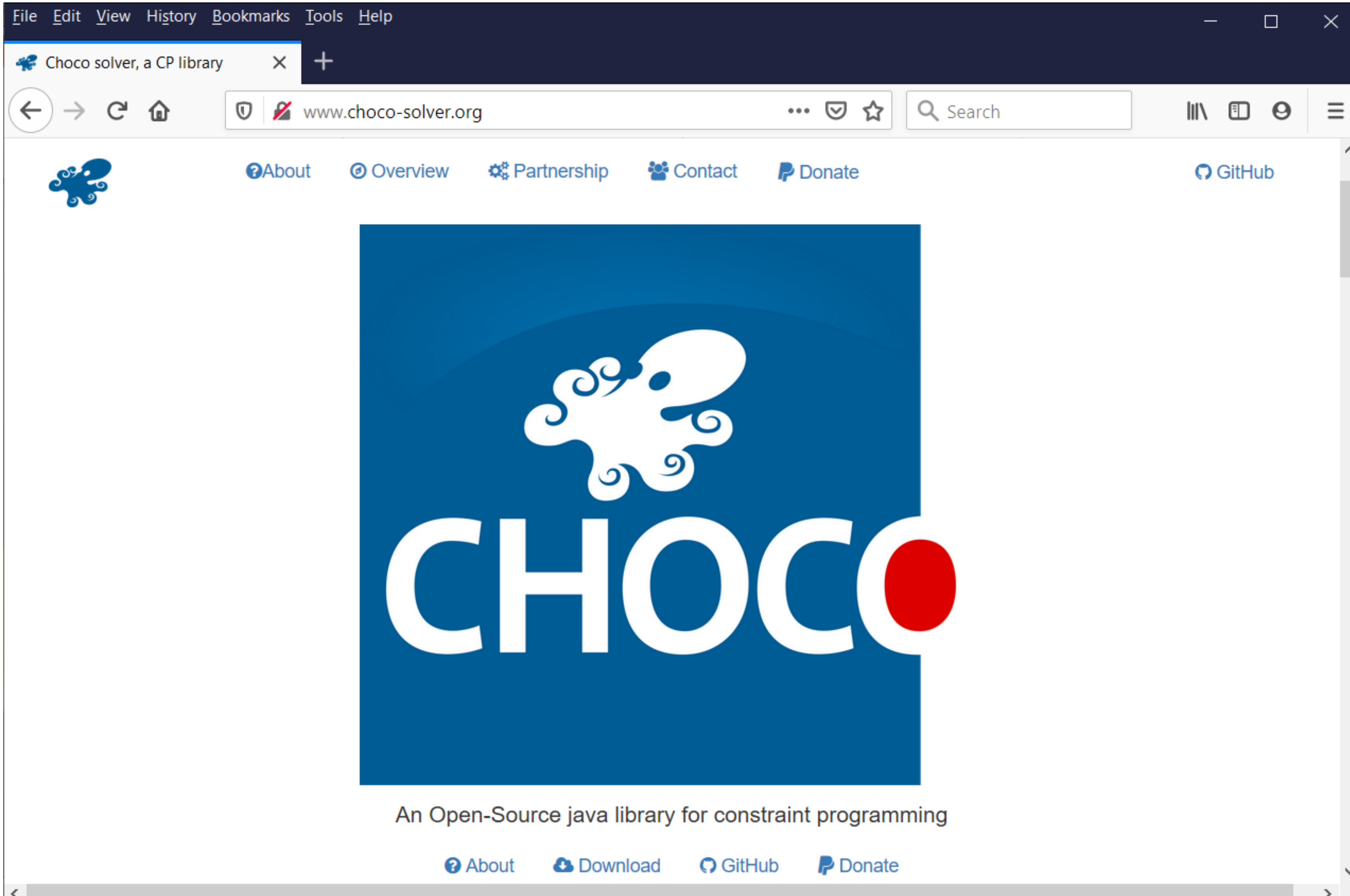
Arc-consistency (AC), node consistency, path consistency

AC3 (coarse grained),
AC4 (fine grained),
AC5 (exploiting semantics)

Bound consistency and domain consistency

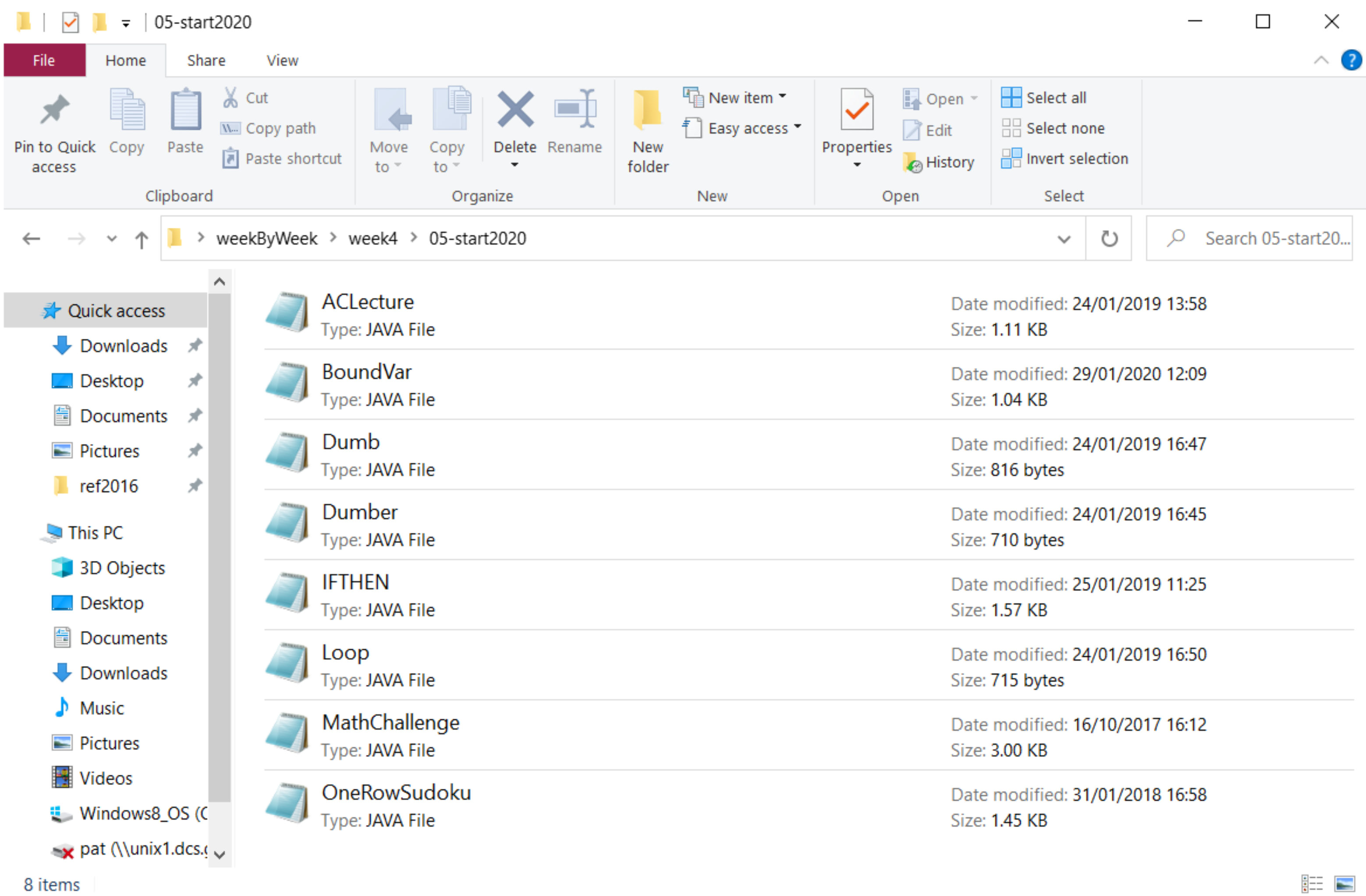
Introduction to Choco

week 4

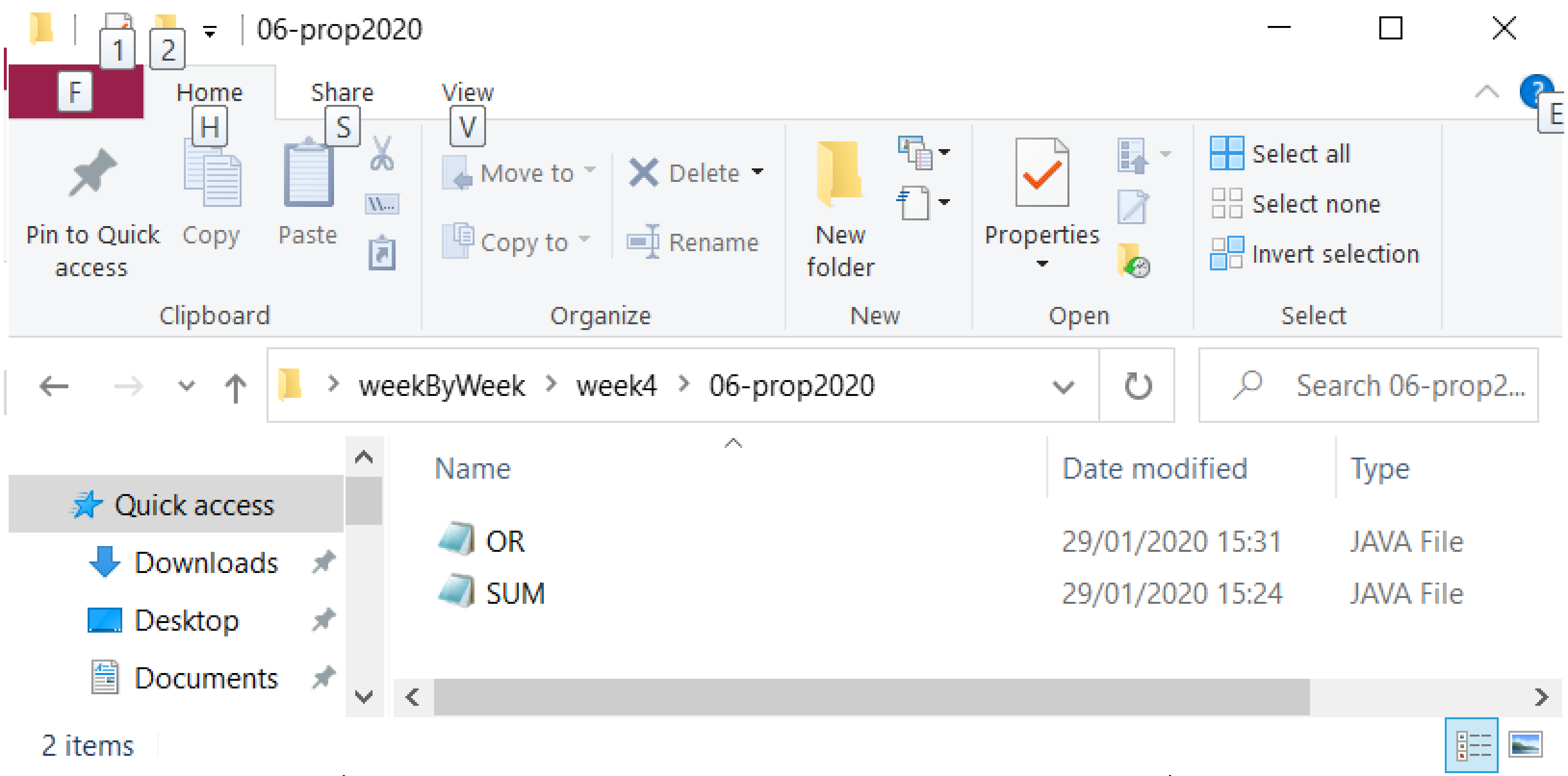


- Crystal maze in choco
- How many dominoes?
- Knapsack problem … decision and optimisation, specialised constraint!
- Propagate …

Propagate … consistency in choco (part 1)



Propagate … consistency in choco (part 2)



- Disjunction, constructive disjunction …
- The sum constraint …

Exercise 2 handed out

week 4

BACP: balanced academic curriculum problem

Variable and Value ordering heuristics

- Static variable ordering (SVO)
- Dynamic variable ordering (DVO)
- Domain specific heuristics
- Value ordering … promise

First example: NQueens

WIKIPEDIA
The Free Encyclopedia

navigation
- Main page
- Contents
- Featured content
- Current events
- Random article

search
Go Search

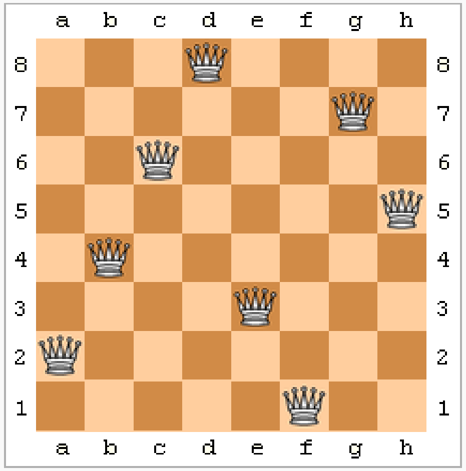
interaction
- About Wikipedia
- Community portal
- Recent changes
- Contact Wikipedia
- Donate to Wikipedia
- Help

toolbox
- What links here
- Related changes
- Upload file
- Special pages
- Printable version
- Permanent link
- Cite this page

Eight queens puzzle

From Wikipedia, the free encyclopedia

The **eight queens puzzle** is the problem of putting eight chess queens on an 8×8 chessboard such that none of them is able to capture any other using the standard chess queen's moves. The queens must be placed in such a way that no two queens would be able to attack each other. Thus, a solution requires that no two queens share the same row, column, or diagonal. The eight queens puzzle is an example of the more general ***n* queens puzzle** of placing *n* queens on an *n*×*n* chessboard, where solutions exist only for *n* = 1 or *n* ≥ 4.



One solution.

Contents [hide]

History [edit]

The puzzle was originally proposed in 1848 by the chess player Max Bezzel, and over the years, many mathematicians, including Gauss and Georg Cantor, have worked on this puzzle and its generalized n-queens problem. The first solutions were provided by Franz Nauck in 1850. Nauck also extended the puzzle to n-queens problem (on an n×n board—a chessboard of arbitrary size). In 1874, S. Gunther proposed a method of finding solutions by using determinants, and J.W.L. Glaisher refined this approach.

Some modelling decisions (allDifferent constraint)

DVOs in choco … effect on search

Nqueens, NASA and the min-conflicts heuristic/approach

Ian Gent’s nqueens completion

Second example: teams with budgets

Teams with Budgets

- Various models, some using 0/1 variables
- Effect of value ordering: 1 (take) before 0 (don’t take)
- Symmetry breaks (all teams are equal)
- Using the specialised BinPack constraint (yes, it’s bin packing)

Ex01 in choco

Team building: done in choco

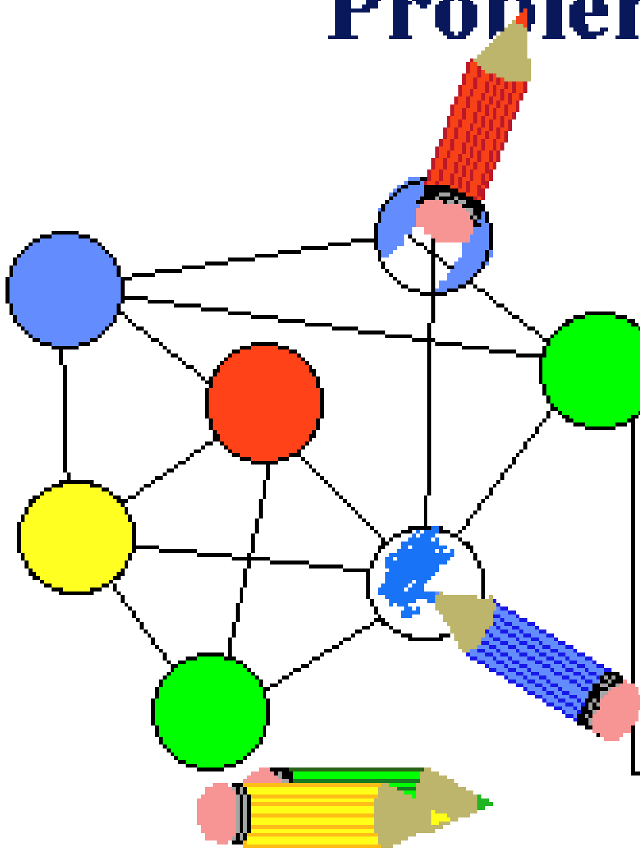
- Compare with miniZinc models
- Assist for ex02

Phase transition phenomena

We have seen this in most every decision problem we have studied

Ames Research Center
Artificial Intelligence Branch

Where the *Really* Hard Problems Are



Peter Cheeseman
RIACS
Bob Kanefsky
Sterling Software
William Taylor
Sterling Software

Where are the hard problems?

A history, examples, theory

Empirical examples: number partitioning

Recent examples: Subgraph Isomorphism, Nqueens Completion …

Rejected papers (don’t give up the day-job) weeSeepy: how to implement a CP toolkit (an example)

Hands on with CP … modelling and solving in practice

- Magic Square
- Mutually Orthogonal Squares
- The 15 puzzle

Discrepancies …

Limited Discrepancy Search (LDS) and its justification

Parallel Search …

Combined with LDS hypothesis

Critique …

LDS: taking discrepancies early or late, does it matter

Local Search

Local Search

Hill climbing and escaping from local minima …

Models from nature

Local Search

- Restarts
- Simulated Annealing (SA)
- Tabu Search (TS)
- GLS (Guided Local Search)
- GA (Genetic Algorithms)
- Other techniques

Local Search

- Restarts
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Applications
- TSP
- CSP (with min-conflicts)
- Drone Delivery

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