Global Constraints

Peter Stuckey

Global Constraints

- Technically any constraint which can take an unbounded number of variables as input
  - so linear constraints are “global”

- Global constraints are
  - constraints that arise in many problems

- Global constraints make
  - models smaller
  - solving easier (since solvers can use the information of the structure)

alldifferent

- The alldifferent constraint
  - `alldifferent([x1,x2, …, xn])`
  - enforces that xi ≠ xj, for each i ≠ j

- Probably the most common global constraint

- alldifferent([7,3,2,5,1,6]) holds
- alldifferent([5,3,2,7,4,3]) does not hold

lex_less

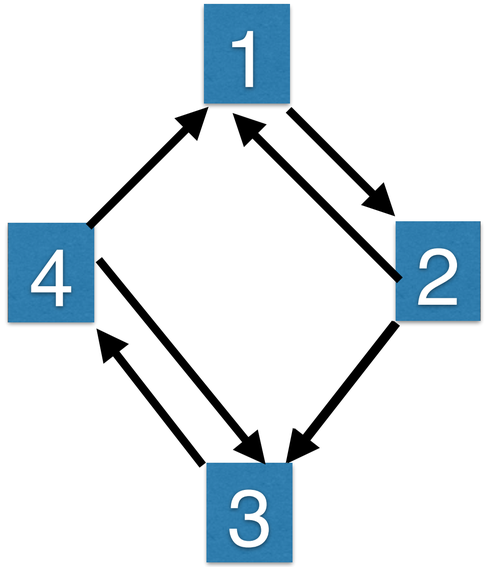
- The lexicographic less than constraint
  - `lex_less([x1, x2, …, xn], [y1, y2, … yn])`
  - requires that the [x1, x2, …, xn] is lexicographically smaller than [y1, y2, …, yn]
  - that is
    - x1 < y1 or (
    - x1 = y1 and (x2 < y2 or
    - x2 = y2 and (x3 < y3 or
    - ….
    - xn < yn) …)))
- Useful for symmetry breaking
- lex_less([7,3,5,4,2], [7,3,5,7,2]) holds

table

- The table constraint encodes arbitrary relations
  - `table([x1, x2, …, xn], T)`
  - requires that [x1,..,xn] take value from one row in the 2d array T
- table([x1,x2,x3], [| 3, 4, 5 | 5, 12, 13 | 6, 8, 10 |])
  - holds when [x1,x2,x3] = [5,12,13]
  - doesnt hold when x1 = 4

circuit

- The circuit constraint encodes Hamiltonian circuits, a single loop that visits each node in a graph exactly once
  - `circuit([x1, …, xn])`
  - xi = j means visit node j after node i
- For example
  - circuit([2,3,4,1]) holds
  - circuit([2,1,4,3]) doesn't hold
  - circuit([2,3,4,3]) doesn't hold

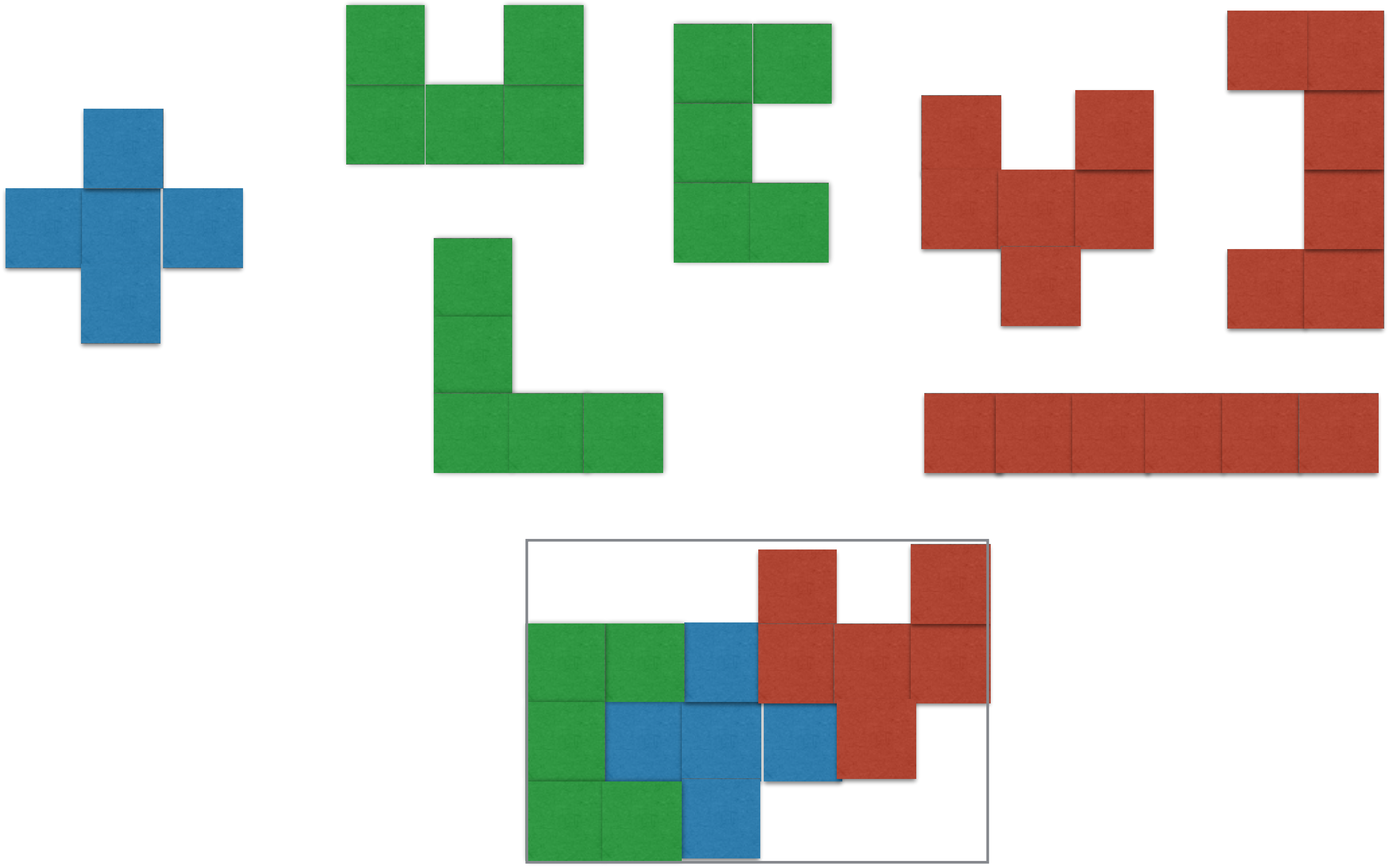


regular

- The regular constraint encodes that a sequence of values is part of a regular language
  - `regular([x1,…,xn], Q,S,d,q0,F)`
  - the sequence x1 x2 … xn is a member of the regular language defined by DFA (Q,S,d,q0,F)
- Useful for encoding complex state transitions, e.g. DFA for 1*((01)+1)*
  - regular([1,0,1,1,0,1,0,1,1], …) holds
  - regular([1,1,1,1,0,1,1], …) holds
  - regular([1,1,1,0,1,1,1], …) doesn't hold

geost

- Pack k dimensional objects with possibly different configurations so they dont overlap



Global Constraint Library

- MiniZinc includes a library of global constraints
  - Alldifferent and related constraints
  - Lexicographic constraints
  - Sorting constraints
  - Channeling constraints
  - Counting constraints
  - Scheduling constraints
  - Packing constraints
  - Extensional constraints (table, regular etc.)

Overview

- Global constraints are
  - important for making concise efficient models
- We will introduce more global constraints as their need arrives
- There are many global constraints
  - 100+ in MiniZinc
  - 300+ in the Global Constraint Catalog

EOF