Section 4

CSP'S AND LOCAL SEARCH

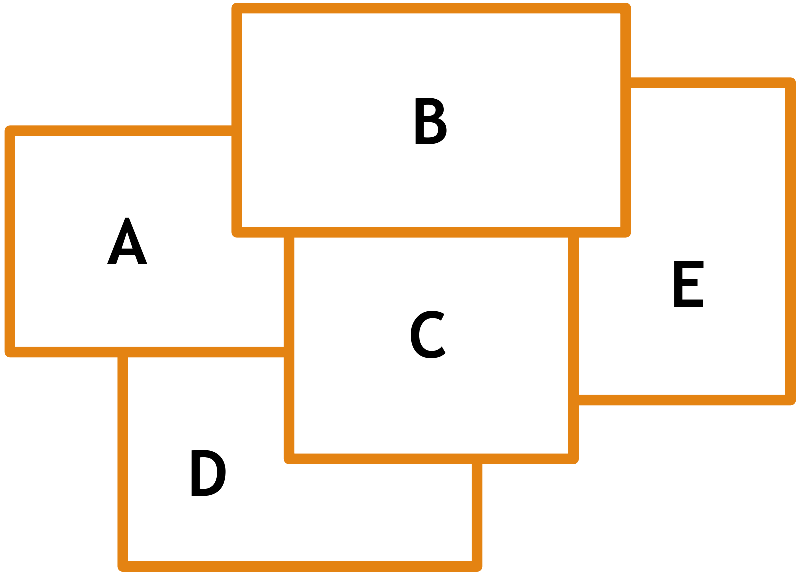
CSPs and Local Search

Last week in CSPs:
- variables, domains, constraints
- backtracking

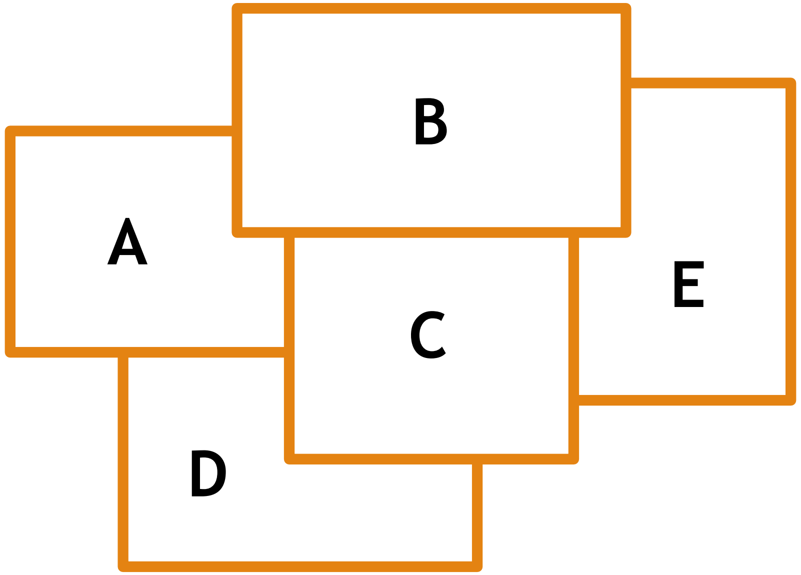
This week in CSPs:
- ordering
- forward checking
- arc consistency

Also, in local search:
- optimization and convexity
- hill climbing
- beam search
- simulated annealing
- gradient descent
- genetic algorithms

Constraint Satisfaction Problems



Constraint Satisfaction Problems



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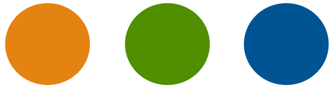

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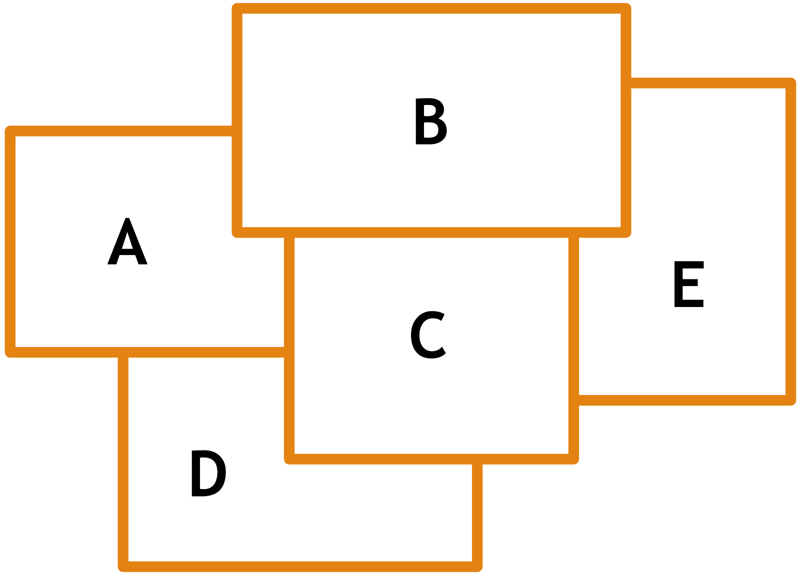
Constraint Satisfaction Problems



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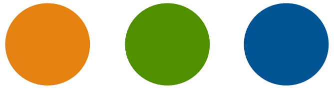

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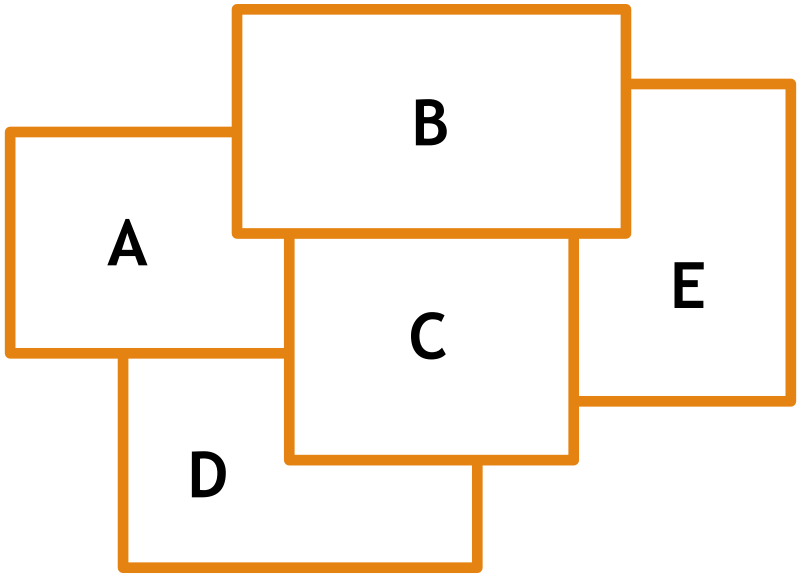
Constraint Satisfaction Problems

Most naive search tree:
branching factor of 15

Fixed ordering search tree:
branching factor of 3

What is a better way to order?



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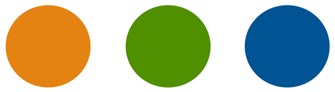
Values: 

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Constraint Satisfaction Problems

Most naive search tree:
branching factor of 15

Fixed ordering search tree:
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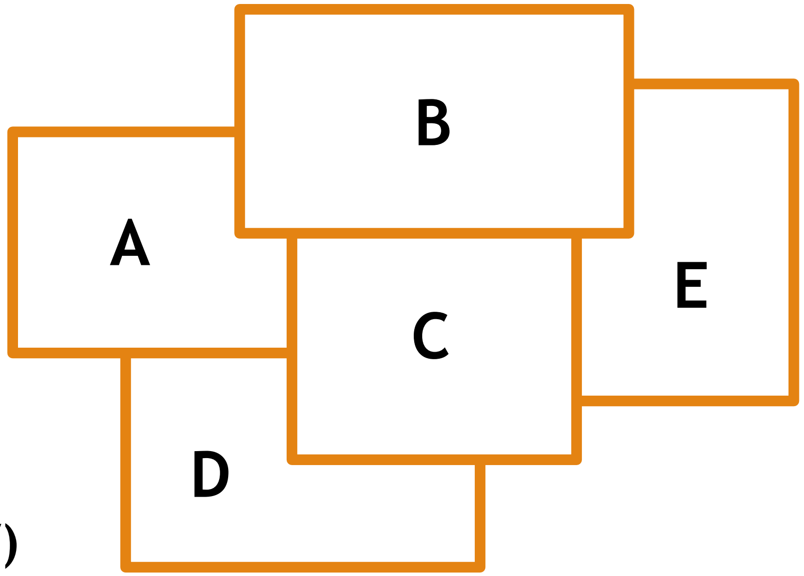
What is a better way to order?

Heuristics:
- **Minimum remaining values (MRV)**
- **Fewest constraints (degree)**
- **Least constraining value**



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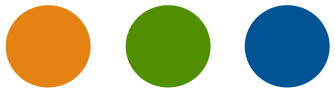
Values: 

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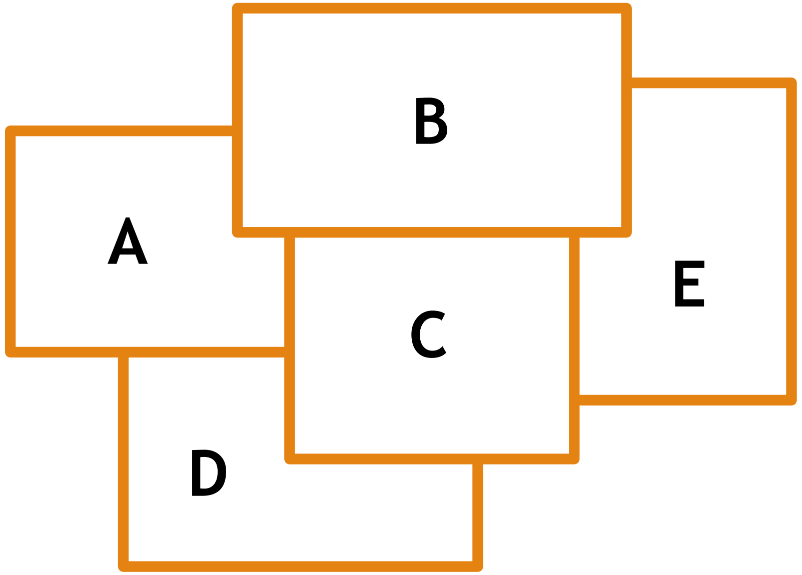

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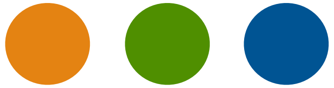
Values: 

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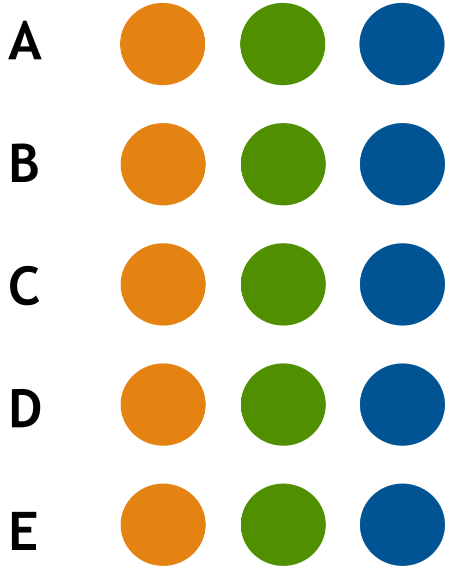

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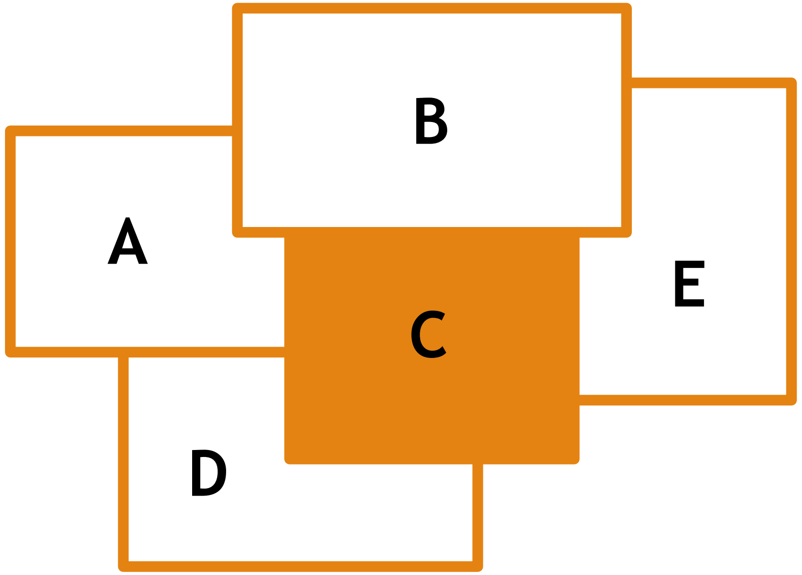

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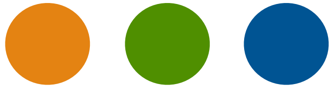
<u>Values:</u> 

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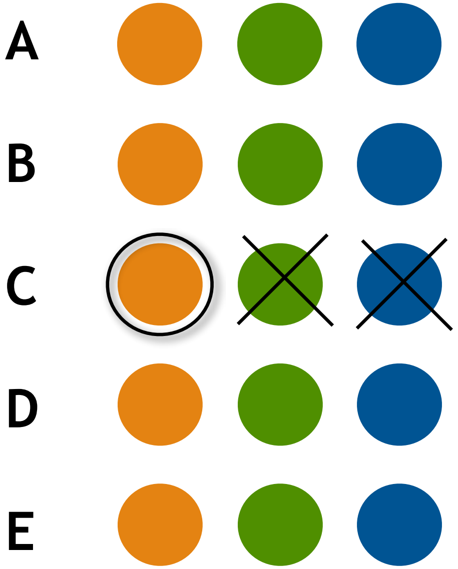

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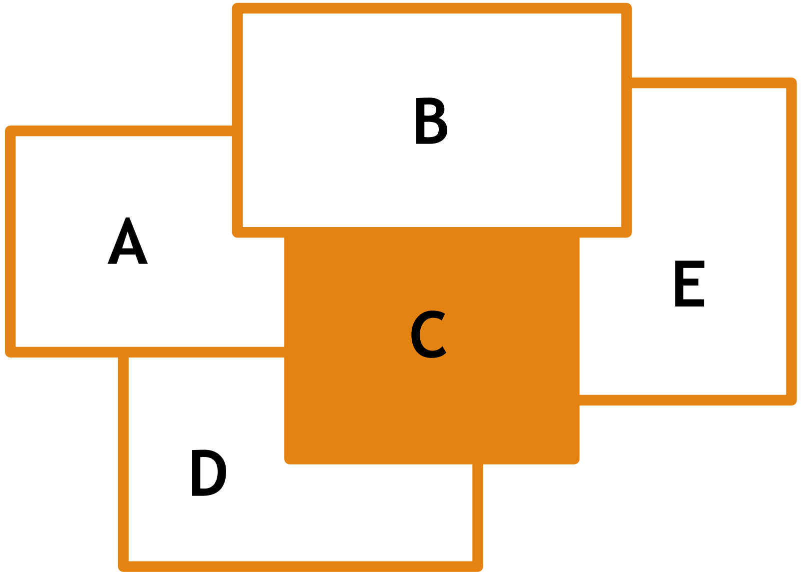

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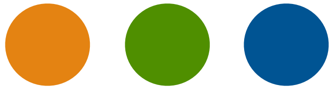

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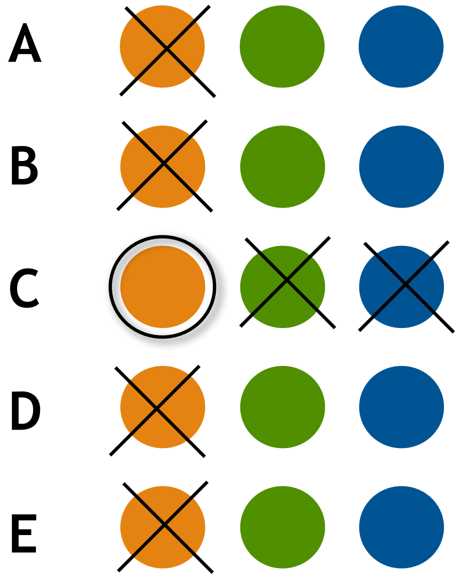

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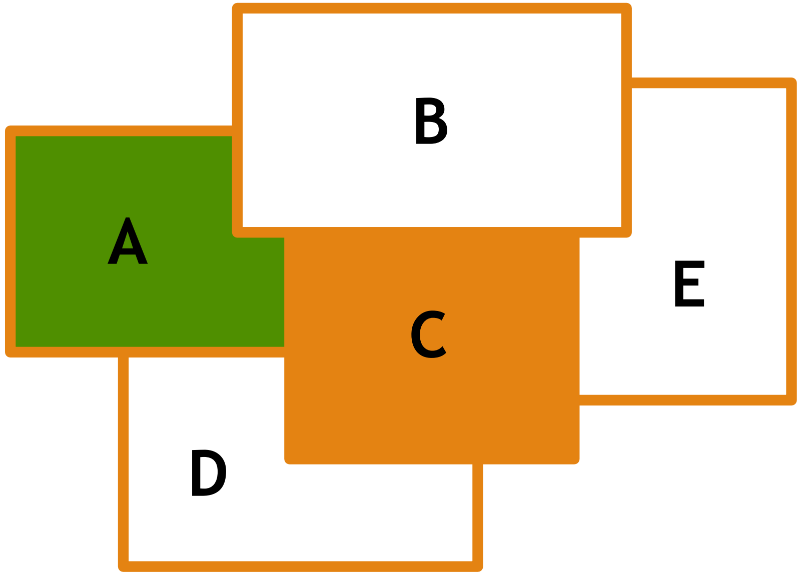

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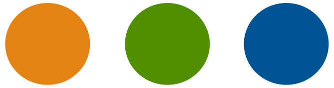
Values: 

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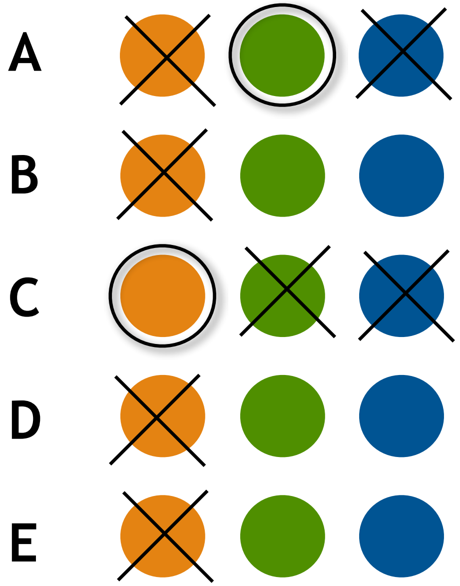

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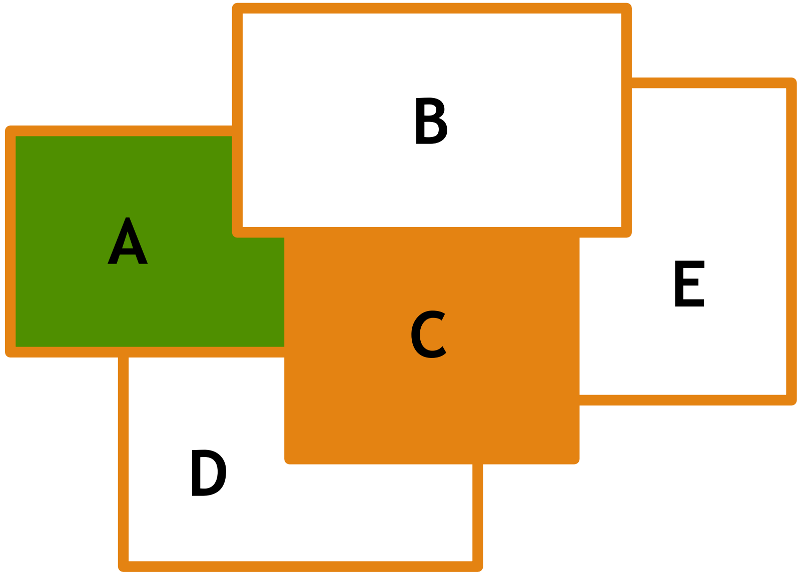

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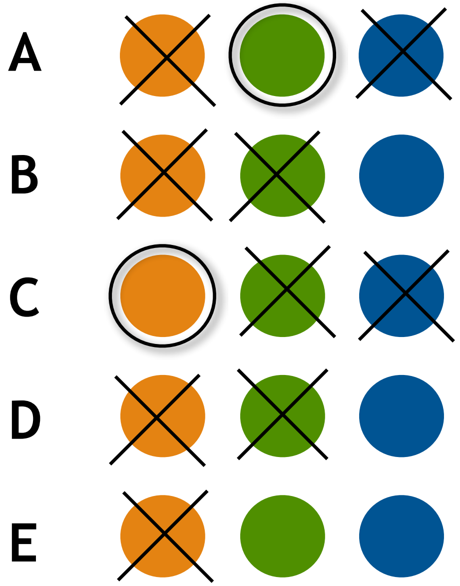

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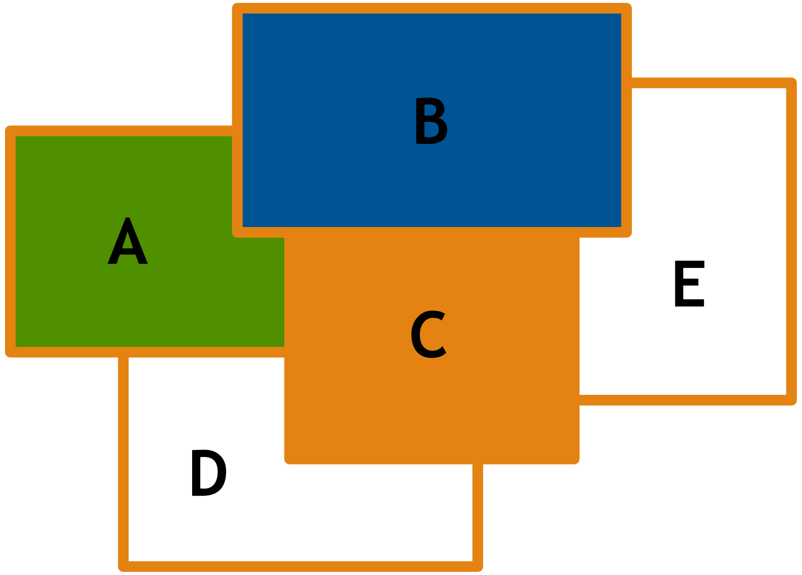

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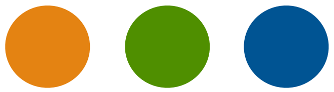

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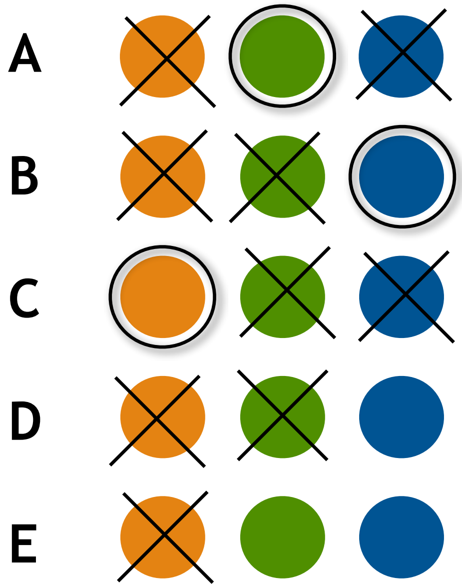

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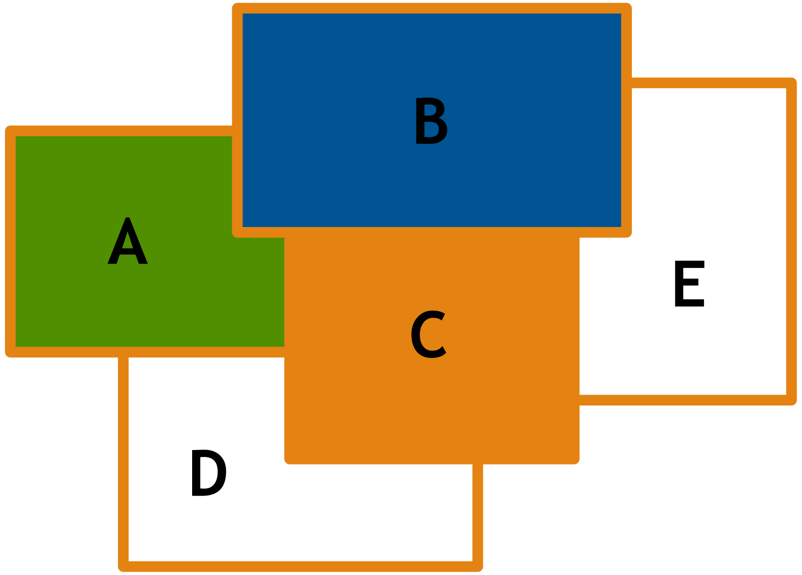

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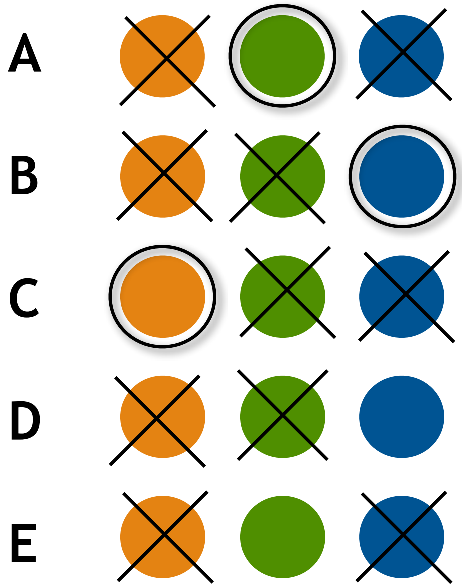

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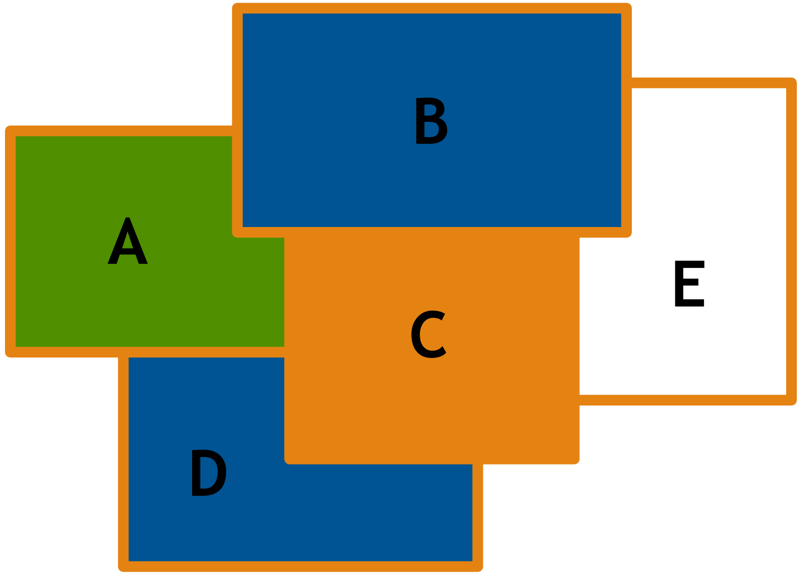

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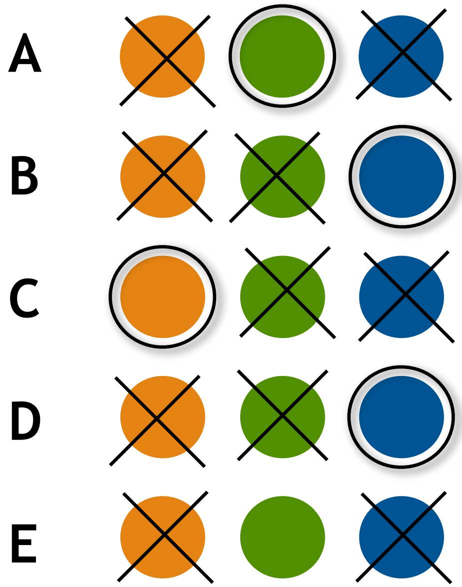

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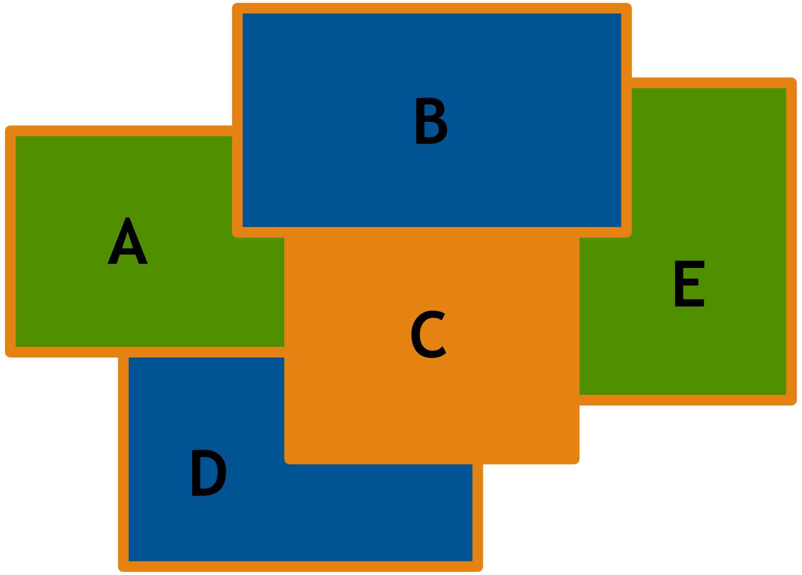

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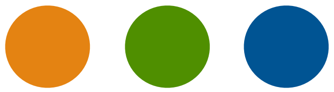

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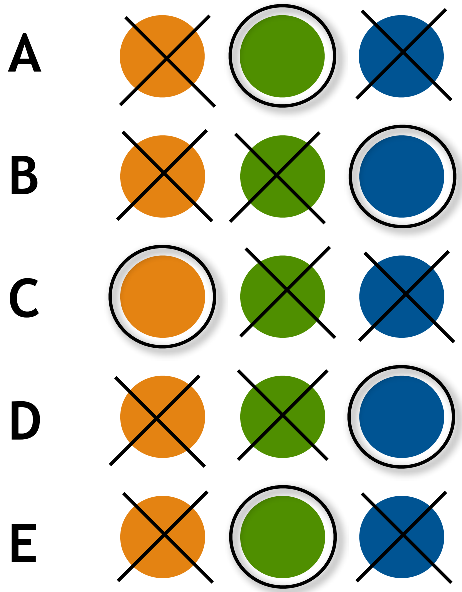

Optimization

Hill climbing

Beam search

Simulated annealing

Genetic algorithms

Gradient descent

Optimization

Hill climbing
Given a state, generate all successors and choose the best one. If none are better, return current state.

Beam search

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Given a state, generate all successors and choose the best one. If none are better, return current state.

Beam search
Choose *k* initial states. For all states, expand all successors. Among the generated states, choose the best k and continue until convergence.

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Gradient descent

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At each iteration, choose a random successor. Accept the successor with a “temperature”-dependent probability, which decreases over time.

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At each iteration, choose a random successor. Accept the successor with a “temperature”-dependent probability, which decreases over time.

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At each iteration, generate (and mutate) successors from the “best” sample in the previous iteration.

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Given a state, generate all successors and choose the best one. If none are better, return current state.

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Choose *k* initial states. For all states, expand all successors. Among the generated states, choose the best k and continue until convergence.

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Gradient descent
Calculate and repeatedly step down the gradient (for continuous functions).