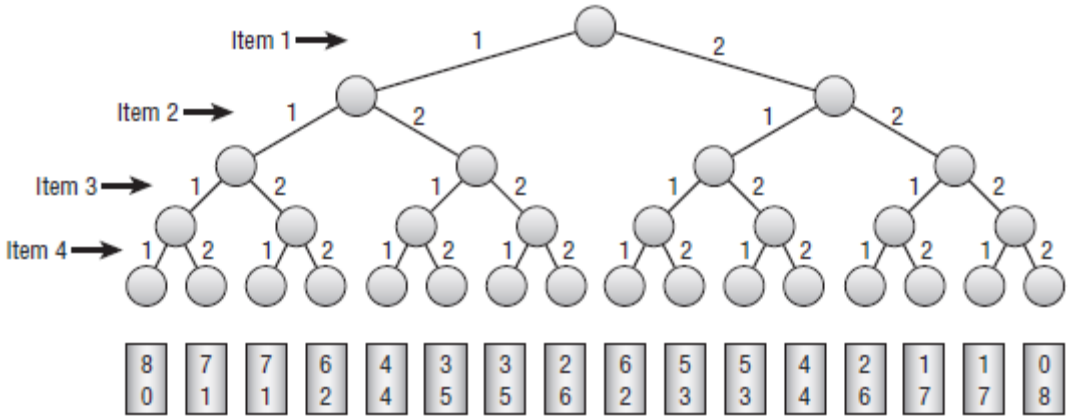
Decision Tree Heuristics



Agenda

- Decision Tree Heuristics
  - Random Search
  - Simulated Annealing
  - Hill Climbing
- Other Decision Tree Problems
- Swarm Intelligence
- Summary
- Exercises

Decision Tree Heuristics

- Decision trees are just too big for exhaustive search or even branch and bound

Random Search

- Follow random paths through the tree

```
RandomSearch()
    <Initialize best solution so it is replaced by the first
     test solution>
    For i = 1 To num_trials
        For index = 0 To max_index
            <Randomly assign item number index to group 0 or 1>
        Next index

        // See if this solution is an improvement.
        <If the test solution is better than the best solution,
         save it>
    Next i
End RandomSearch
```

Random With Improvements

- Start with a random path
- Try random changes
  - For partition problem, randomly move items to the other set
- Sometimes you need to swap multiple items
  - Example: 5, 5, 6 = 16 4, 4, 4 = 12

Simulated Annealing

- Start with a random solution
- Initially make large random changes
- Keep “bad” changes with a decreasing probability
- Over time, allow only smaller changes

Hill Climbing

- Move towards the best solution

Sorted Hill Climbing

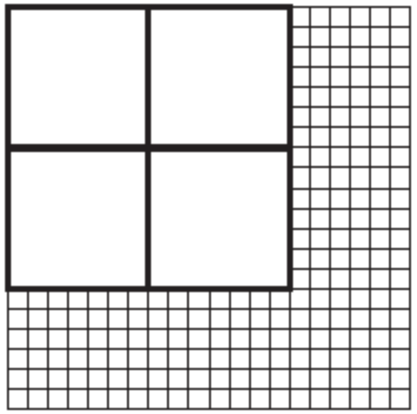
- Start with large decisions
- Fine-tune with smaller decisions

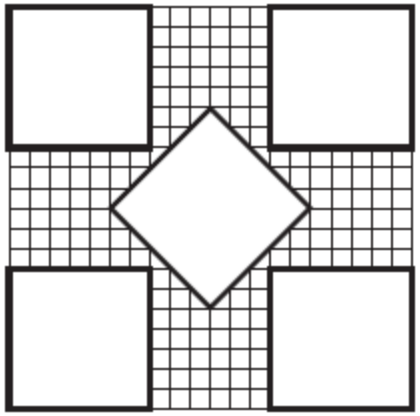
Other Heuristics

- Other heuristics may apply to different problems

Other Decision Tree Problems

- Generalized partition problem
- Subset sum
- Bin packing
- Cutting stock
- Knapsack
- TSP
- SAT and 3SAT





Swarm Intelligence

- Ant Colony Optimization
- Bees Algorithm
- Swarm Simulation

Ant Colony Optimization

- General Optimization
- Traveling Salesman

Bees Algorithm

- Scouts
- Foragers

Swarm Simulation

- Boids
- Pseudoclassical Mechanics
- Goals
- Obstacles

Summary

- Decision Tree Heuristics
  - Random Search
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  - Hill Climbing
- Other Decision Tree Problems
- Swarm Intelligence
  - Ant Colony Optimization
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  - Swarm Simulation

Exercises

- Chapter 12 Exercises 7 – 13.
- Bonus: One or more of Chapter 12 Exercises 14 – 18.
- Read *Essential Algorithms, 2e* Chapter 13 pages 381 – 402. (Stop before the section "Strongly Connected Components.")