Al Experimental Course

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August 28, 2020





Overview

- Search
 - Uninformed Search
 - Informed (Heuristic) Search
 - Adversarial Search
 - Constraint Satisfaction Problems (CSPs)
 - Typical Problems
- 2 Prolog
 - Typical Problems
- FF Planning System
 - Typical Problems
- Machine Learning
 - Typical Algorithms



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Uninformed Search

- DFS
- BFS
- Uniform-cost search
- Depth-limited search
- Iterative-Deepening search

```
function ITERATIVE-DEEPENING-SEARCH(problem) returns a solution, or failure for depth = 0 to \infty do result \leftarrow \mathsf{DEPTH\text{-}LIMITED\text{-}SEARCH}(problem, depth) if result \neq \mathsf{cutoff} then return result
```

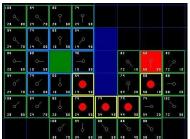
Bidirectional search

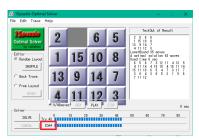


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Informed (Heuristic) Search

- Greedy best-first search
- A* (https://www.redblobgames.com/pathfinding/ a-star/introduction.html)
 - \Box f(n) = g(n) + h(n)
 - \Box f(n) is the estimated cost of the cheapest solution through n
 - \Box g(n) is the path cost from the start node to node n
 - h(n) is the estimated cost of the cheapest path from n to the goal
- Iterative-deepening A* (IDA*)









Adversarial Search

- The minimax algorithm
- $\alpha \beta$ pruning

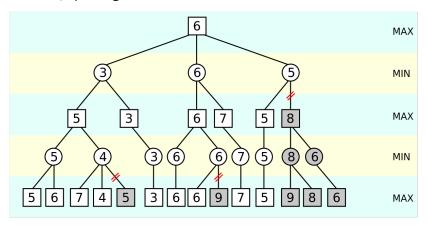


Figure 1: $\alpha - \beta$ pruning



Constraint Satisfaction Problems (CSPs)

- Backtracking Search for CSPs
- Forward Checking (FC)
- Generalized Arc Consistency (GAC)



Typical Problems

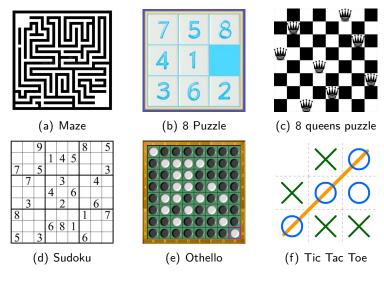


Figure 2: Typical Problems

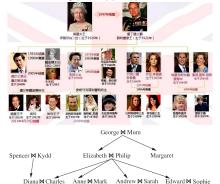


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Typical Problems

- Search Problems
- KR (e.g. Family Problem)
- Queries on KB (Similar to SQL)
- CSPs
 - Sudoku Problem
 - Eight Queens Problem
 - Other Games





Examples

Example 1 (Family Problem)

```
\begin{split} & grandChild(A,B):\text{-child}(A,C),\text{child}(C,B).\\ & aunt(A,B):\text{-child}(B,C),\text{sister}(A,C).\\ & \dots\\ & male('George').\\ & child('Elizabeth','George').\\ & \dots\\ & \dots\\ \end{split}
```

Example 2 (Tower of Hanoi)

```
\begin{split} &\mathsf{hanoi}(\mathsf{N})\text{:-move}(\mathsf{N},\mathsf{a},\mathsf{b},\mathsf{c}).\\ &\mathsf{move}(\mathsf{1},\mathsf{A},\_,\mathsf{C})\text{:-inform}(\mathsf{A},\mathsf{C}).\\ &\mathsf{move}(\mathsf{N},\mathsf{A},\mathsf{B},\mathsf{C})\text{:-N1 is}\\ &\mathsf{N-1},\mathsf{move}(\mathsf{N}\mathsf{1},\mathsf{A},\mathsf{C},\mathsf{B}),\mathsf{inform}(\mathsf{A},\mathsf{C}),\mathsf{move}(\mathsf{N}\mathsf{1},\mathsf{B},\mathsf{A},\mathsf{C}).\\ &\mathsf{inform}(\mathsf{Loc1},\mathsf{Loc2})\text{:-nl},\mathsf{write}(\mathsf{'from '}),\mathsf{write}(\mathsf{Loc1}),\mathsf{write}(\mathsf{' to '}),\mathsf{write}(\mathsf{Loc2}). \end{split}
```



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Typical Problems

- Blocks Problem
- Logistic Problem
- 8-puzzle Problem
- Freecell Game
- Boxman Game



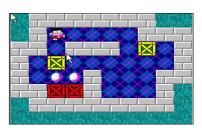


Figure 3: Freecell Game and Boxman Game





Examples

Spare Tire (domain)

```
(:action Remove
:parameters (?x - physob ?y - location)
:precondition (At ?x ?y)
:effect (and (not (At ?x ?y)) (At ?x Ground)))
(:action PutOn
:parameters (?x - physob)
:precondition (and (Tire ?x) (At ?x Ground)
(not (At Flat Axle)))
:effect (and (not (At ?x Ground)) (At ?x Axle)))
```

Spare Tire (data)

```
(define (problem prob)
(:init (Tire Flat)(Tire Spare)(At Flat Axle)(At Spare Trunk))
(:goal (At Spare Axle))
```

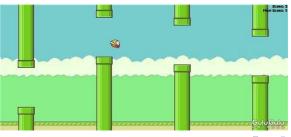


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Typical Algorithms

- Probabilistic Reasoning (Bayesian Network)
- Decision Tree (ID3 and C4.5)
- Naive Bayes
- EM Clustering
- BP-Neural Network
- Deep Learning
- Reinforcement Learning (Q learning and Sarsa)





The End



