Online Motion Planning MA-INF 1314

Example questions

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Some precise examples

1. Exploration: Smart DFS
2. Exploration: CFS Algorithm
3. Exploration: STC-Algorithm
4. Navigation: BUG Algorithms
5. Searching: Street polygons
6. Searching/Exploration: Online search path approximation
7. Other alternative cost measures
8. Escape path construction

General: For any configuration

1. Precise model
2. Motivation
3. Strategy/Algorithm
4. Correctness
5. Lower Bound
6. Upper Bound
7. Structural properties, proofs
8. Main statements
9. Extensions, Applications, Remarks

General: Lemmata/Theorems

1. Top/Down
2. Main statements
3. How did we achieve them?
4. Lemmata
5. Structural properties

General: Oral exam

1. Example is given
2. Apply the corresponding strategy
3. Do/sketch the analysis
4. Show the structural properties
5. Explain the design
6. Lower bounds: Give the examples
7. Competitive analysis: choose own example, options, lower bound, upper bound, no competitive strategy
8. Cross-references: Exploration/Searching, Escape path/Certificate

1. Definition: Grid-environment, online, vertices, simple, neighboring cells
2. Theorem: Number of steps C $+1/2$ E -3
3. Strategy Idea: SmartDFS, split-cell, recursion, quadrant Q by layer,
4. L-Offset-Lemma: 8l edges less!
5. Shortest-Path-Lemma: $1/2E-2$
6. Edge-Lemma for Q: $E(P_1)+E(P_2)=E(P)+E(Q)$
7. Excess-Lemma: $excess(P) \leq excess(P_1) + excess(K_2 \cup \{c\})$
8. Proof Theorem: Induction! Apply Lemmata!
9. Competitive ratio: In the same way!
10. Lower bound construction for comp. ratio!

2. Exploration: CFS Algorithm

1. Precise model: Constrained graph exploration, edges and vertices, Tether variant vs. Accumulator variant, depth restriction variant
2. Strategy/Algorithm: CFS, example application
3. Correctness: By construction
4. Lower Bound: $E + V$
5. Upper Bound:: $(4 + 8/\alpha)E$ (more precisely: $\Theta(E + V/\alpha)$)
6. Structural properties and poofs: Proof of the invariants, analysis of the cost
7. Main statements: Competitive online exploration, UB, depth restricted, lookahead
8. Extensions, Applications, Remarks: Search ratio approximation, adjustments for unknown depth, simulate accu-variant by thether-variant, lookahead is necessary (accu)

2. Exploration STC Algorithms

1. Precise model: Exploration, 2D cell, visit all cells by the tool, scan the 4 neighbourship of 2D cells. Return variant!
2. Strategy/Algorithm: Spanning Tree construction online (DFS), Tool left hand side
3. Correctness: Visit all 2D cells that can be entered
4. Lower Bound: Visit all cells C (Hamiltonian path!)
5. Upper Bound: C + K (Boundary cells), analysis
6. Structural properties, proofs: Example execution and analysis! Inner/Intra double visits
7. Main statements: C + K, 2-competitive, optimal in pure 2D scenes, Tightness for corridors
8. Extensions, Applications, Remarks: Scan-STC, avoid spanning tree edges of a special kind, simple heuristic/analysis: H_{opt} + Column-Divergence +1

4. Online Navigation: BUG

1. Precise model: Touch sensor, coordinates of the goal, two different movements
2. Strategy/Algorithm: BUG variants, example executions, intention
3. Correctness: Closer to the goal, leave condition, enclosed?
4. Lower Bound: Distance to the goal, plus circumference of the the obstacles
5. Upper Bound: Depending on the variant
6. Structural properties and proofs: BUG2, intersections, tight bounds, estimating the movement in the free space, LB construction circumference
7. Main statements: Correctness, robust strategies, performance
8. Extensions, Applications, Remarks: Change1, Change2, Visibility

5. Online Searching: Streets

1. Precise model: Polygons, vision, special start and goal, idea: not competitive in general polygons
2. Definition of a street, motivation
3. Lower Bound: $\sqrt{2}$ example
4. Structural properties and proofs: Suffices to consider funnels, rightmost left, leftmost right reflex vertices
5. Strategy design: Opening angles ϕ_0 to ϕ_1, general lower bound K_ϕ. Condition for the path w. Backward analysis
6. Property: Change of the vertices is not a problem
7. Main statements: Lower bound matches upper bound.
8. Extensions, Applications, Remarks: Difference small and large opening angles

6. Searching/Exploration: Search Path Approximation

1. Precise model: Problem, no competitive strategy, searching in polygons, star-shaped polygons, but optimal path exists for fixed polygon
2. Examples where this path is known
3. General approximation of this path
4. Idea: Use competitive online exploration strategy with increasing depth $d = 2^i$.
5. Results: No vision $4C$ approximation, proof idea, local worst case, formula represents connection of search ratio and exploration path, do the analysis, vision 8C
6. Give examples: SWR, graph exploration, online/offline difference, ratios, analysis
7. Where does this end? Non-approximation results: Vision, No-Vision (graphs/polygonal scene), argumentation

7. Other alternative cost measures

1. Precise model: List searching, partially uninformed agent, distibution is given, extension to polygon
2. Lists: Extreme cases and best path
3. Lists: Optimal *offline* strategy, analysis
4. Lists: Optimal *online* strategy, dovetailing, analysis
5. Extension to polygons
6. Definition: Certificate path, extreme cases, radial distance function
7. Online approximation: Logarithmic spiral, analysis of the ratio
8. Strategy design: Balance extreme cases, ratio

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8. Escape path scenario

1. Precise model: Polygon given, position unknown, escape by deterministic path
2. Some examples: Circle, semi-circle, rhombus
3. Diagonal is a candidate
4. Analysis: Proof idea for these simple cases
5. Equilateral triangle: Not the diagonal, design of the Zig-Zag path, result
6. Connection: Certificate and Escape path
7. Motivation for different cost measure

Other topics, no claim of completeness

1. Searching, Exploration, Navigation, Escape
2. Discrete and continuous models
3. Shannon, Marker Alg, searching for rays, Window-Shopper, SWR, L1, L2, offline/online, looking around a corner, Pledge algorithm, Pledge with errors, Theorem of Gal, application, ...