Fast Two-Robot Disk Evacuation

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Distributed Search Aspects

- Mobile agents: robots, software pieces, etc.
- Environment: discrete (graph) or continuous (Euclidean)
- Tasks: exploration, rendezvous, evacuation, patrolling
- Communication: wireless (global), face-to-face (local), pebbles
- Capabilities: speed, energy, environment dynamicity

Our Problem: Fast Evacuation

- Two robots: Fast and Slow
- Unit disk environment
- Robots initially at center, move within disk
- Unknown exit on boundary; identified only when on it
- Instantaneous communication: once exit found, beeline
- Fast with speed $s \geq 1$, Slow with speed 1

A First Strategy: Both-to-the-Same Point [1]

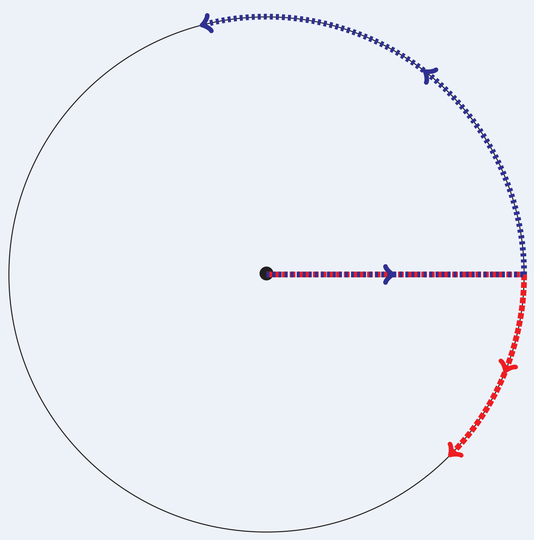

Figure 1: The ***BSP*** Strategy

- Fast and Slow trajectories
- Both-Explore Strategy
- Both to the same boundary point; explore in opposite directions
- Optimal for case $s = 1$

A Better Strategy: Half-Chord

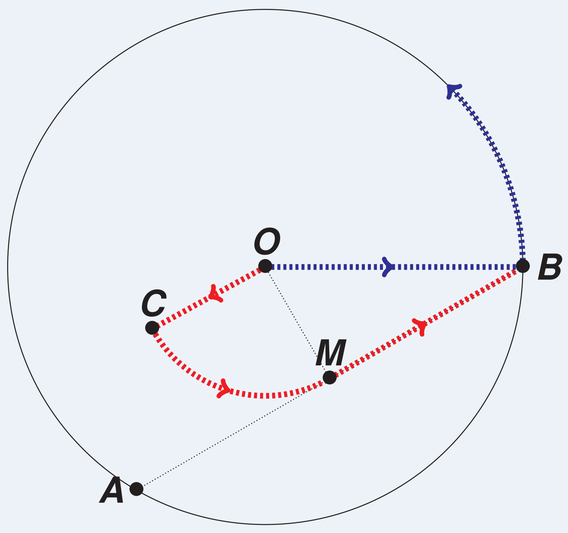

Figure 2: The Half-Chord Strategy (Example for $s = 4$)

The Strategy

- Fast explores counterclockwise
- Slow takes a $\frac{2}{s}$ radius to C, then $\overset{\frown}{CM}$, then *half-chord* MB
- Slow on M exactly when Fast on A
- Finally on B at the same time

Lemma

HC outperforms BSP for $s \geq 1.86$

An Extra Improvement: Fast-Chord

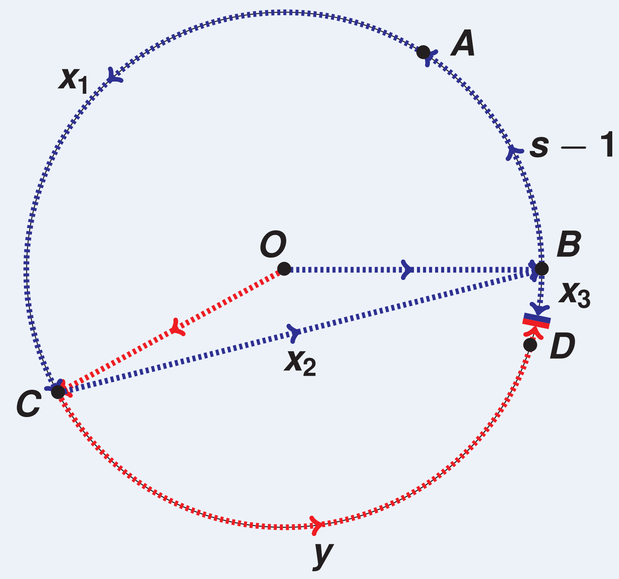

Figure 3: The Fast-Chord Family of Strategies

The Strategy

- HC near $s = 2$ forces some double exploration
- Fast follows CB; only Slow explores $\overset{\frown}{CD}$
- Fast on B exactly when Slow on D
- Experiment with $|\overset{\frown}{DB}|$

Lemma

FC outperforms HC for $1.71 \leq s \leq 2.07$

Lower Bounds

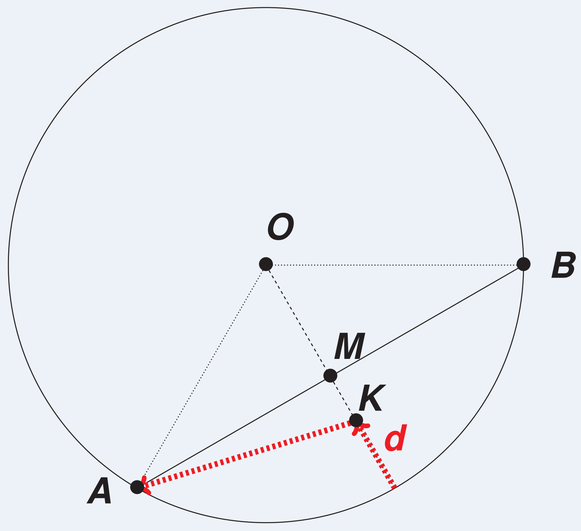

Figure 4: A Lower Bound Depiction

The idea

- Long chord with unexplored endpoints
- When one explored, adversary places exit on the other
- Slow may be d away from boundary; covers at least $|AK|$

Theorem

HC optimal for $s \geq 2.75$; ratio ≤ 1.22 for $s < 2.75$

Further Work

- Optimality for $s < 2.75$
- More than two robots
- Face-to-face communication

References

[1] J. Czyzowicz et al. Evacuating robots from an unknown exit located on the boundary of a disk, *DISC 2014*, LNCS 8784, pp. 122-136, Springer, 2014.