Pursuing an Evasive Target in Games with Partial Observability
Eric Raboin, Dana Nau, Ugur Kuter, S. K. Gupta and Petr Svec - University of Maryland, College Park

Pursuit-Evasion Games
A team of tracker robots pursue an evasive target through an environment where visibility is obstructed by obstacles and sensor range is limited.

![Evasive Target](image1)

![Visibility Region](image2)

Fig 1. (left) An evasive target moves behind obstacles to break line-of-sight. (right) Example of a visibility region.

The trackers' goal is to minimize uncertainty about the target's actual location. Since the target can hide behind obstacles, the tracker team must plan appropriately to recover from any visibility loss.

Imperfect Information
When the tracker team loses sight of the target, the target's exact location is no longer known. Instead, its location is bounded inside a region:

![Region Bound](image3)

Fig 2. The tracker team corners a target that is not visible. The shaded region represents set of locations where the target might be.

This region can be computed given the target's last known location, a maximum velocity for the target, and the set of observations made by the tracker team since visibility was lost.

Even if the tracker team does not observe the target directly, it can minimize its uncertainty by identifying where the target is not located.

Relaxed Lookahead
To help plan the movement of the tracker team, we developed the *relaxed lookahead* heuristic, which predicts when visibility loss will occur in the future. The heuristic is based on differences in travel time:

![Travel Times](image4)

Fig 3. a) State of the world in an example game. b) Shortest-path distance from target's location. c) Minimum travel time before the tracker team can observe each location.

The *relaxed lookahead* heuristic identifies when the target can break line-of-sight with the tracker team. Areas that are dark red allow the target to remain hidden the longest, even if the tracker team correctly guesses where the target is going.

This heuristic offers a good estimate of the quality of a game state; if there are many locations where the target can hide for a long time, then the state is probably bad for the tracker team. The heuristic can be computed efficiently and combined with a short game-tree search to plan the trackers' movements.

Cooperative Team Behavior
The tracker team must effectively work together to achieve its goals. Cooperative behavior emerges naturally from our approach.

![Cooperative Behavior](image5)

Fig 5. Trajectories generated using the *relaxed lookahead* heuristic for two tracker robots and an evasive target.

When using the *relaxed lookahead* heuristic, the tracker team will attempt to surround the target, cornering it in areas where it's not able to escape without being detected.

Experimental Results
To evaluate our approach, we compared the *relaxed lookahead* heuristic against several other heuristics in a set of randomly generated domains:

![Heuristic Performance](image6)

(Left) Teams using *relaxed lookahead* (RLA) were twice as likely to maintain visibility on the target by the end of the game, (right) the RLA heuristic is most effective when evaluating the near future and is less effective past a certain point.