



## Cops and robbers

### Motivation and Informal Description

The game of Cops and Robbers is a vertex-to-vertex pursuit game played on a graph. The game starts by the cop putting a pawn on a vertex of the graph followed by the robber doing the same thing. After this, the players successively move the pawns along the edges of the graph (one at a time) starting with the cop.

The goal for the cop is to catch the robber, i.e. move to the vertex occupied by the robber. For the robber, the goal is to avoid being captured. The first question that arises is, given a graph, whether or not the cop can catch the robber. For example, the robber has obvious winning strategies in graphs that are not connected and in cycles of length greater than 3. Typical examples of cop-win graphs are trees.

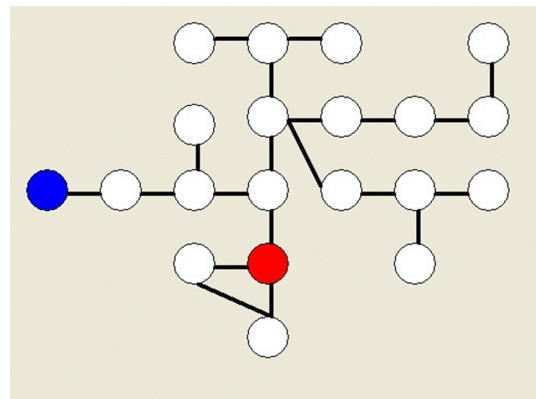
A natural extension of the game is to add more cops, which leads into the question of the minimum number of cops needed to catch the robber. A trivial upper bound is the number of vertices as putting cops on all vertices ends the game immediately. Computing the exact number of required cops proves to be difficult at times and therefore finding upper and lower bounds for the number of cops in different families of graphs is of interest. The game is often considered in random graphs.

Limiting the players' vision is another natural way to make the problem more difficult. There are also lots of less obvious extension to the game such as giving the cops ability to shoot the robber, to place alarms on the map or to use a helicopter.

Current research on the topic seems to be concentrated on the random graphs and impaired vision. What about adding a lack of communication capabilities to the players, i.e. making each pawn an individual unit that does not know the local information on (all?) other pawns?

An example of a pursuit game from practice is the Scotland Yard game that won the German "Game of the Year" Award in 1983 [http://en.wikipedia.org/wiki/Scotland\\_Yard\\_\(board\\_game\)](http://en.wikipedia.org/wiki/Scotland_Yard_(board_game)).

If you are interested and/or have nice ideas on the topic, come by my office for a chat.



### Contact

- Jara Uitto: [juitto@tik.ee.ethz.ch](mailto:juitto@tik.ee.ethz.ch), ETZ G64.1
- Roger Wattenhofer: [wattenhofer@tik.ee.ethz.ch](mailto:wattenhofer@tik.ee.ethz.ch), ETZ G63