Modelling Scotland Yard

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1   Introduction

We concentrate on a popular search game called Scotland Yard involving one player, 'Mr X' and 1-5 'Detective' players. The game is played on a ???Multigraph??? with vertices representing locations in London and 3 edge types representing taxi, bus and underground travel. The players take it in turns to move to an adjacent vertex. The aim of the Detectives is to 'capture' Mr X by landing on the same vertex as him or not allowing him to move and the aim of Mr X to stop this from happening. If Mr X is captured the detectives win, whereas if Mr X can last 24 turns without being captured they win.

The game is begun by all players choosing at random a starting tile. The detectives locations are at all times common knowledge however the location of Mr X is only revealed after his 3rd, 8th, 13th, 18th and 24th turns. Each detective receives 4 underground tickets, 8 bus tickets and 11 taxi tickets.

On each turn Mr X moves to an adjacent vertex and records it covering it up with the ticket used to get there (taxi, bus, undergraound). If this is not possible due to surrounding detectives the game is over and the detectives win. The detectives then move in the same way on either a taxi, bus or underground edge spending a respective ticket in the process.

Furthermore, Mr X receives 5 blank tickets, which allow Mr X to hide his mode of transport on a turn, and 2 double move tokens ,which allow him to take 2 turns before the detective get a chance to move.

There are always at least 4 searchers in the game. When there are less than 4 detective players then up to 2 of the 4 players are 'Policemen' and do not have the ticket restriction that detectives have. These players are controlled jointly by the searcher players.

2   Model of the game

We will model a simplified version of the game in order to improve the performance of the player algorithms. We will set the searchers to 4 remove of rules involving travel tickets for the detectives, essentially making all

detectives policemen (we will continue to refer to all searchers as detectives throughout). In balance, we will further simplify the game by removing all double move tokens and blank tokens.

We make an undirected graph with vertex set $V = [1 : 200]$ and 3 edge sets E_t, E_b and E_u to represent the board and taxi, bus and underground edges respectively.

3   Initial Strategies

As an initial strategy we will select the move of every player by choosing a vertex uniformly at random from the set of unoccupied vertices adjacent to his current vertex location.
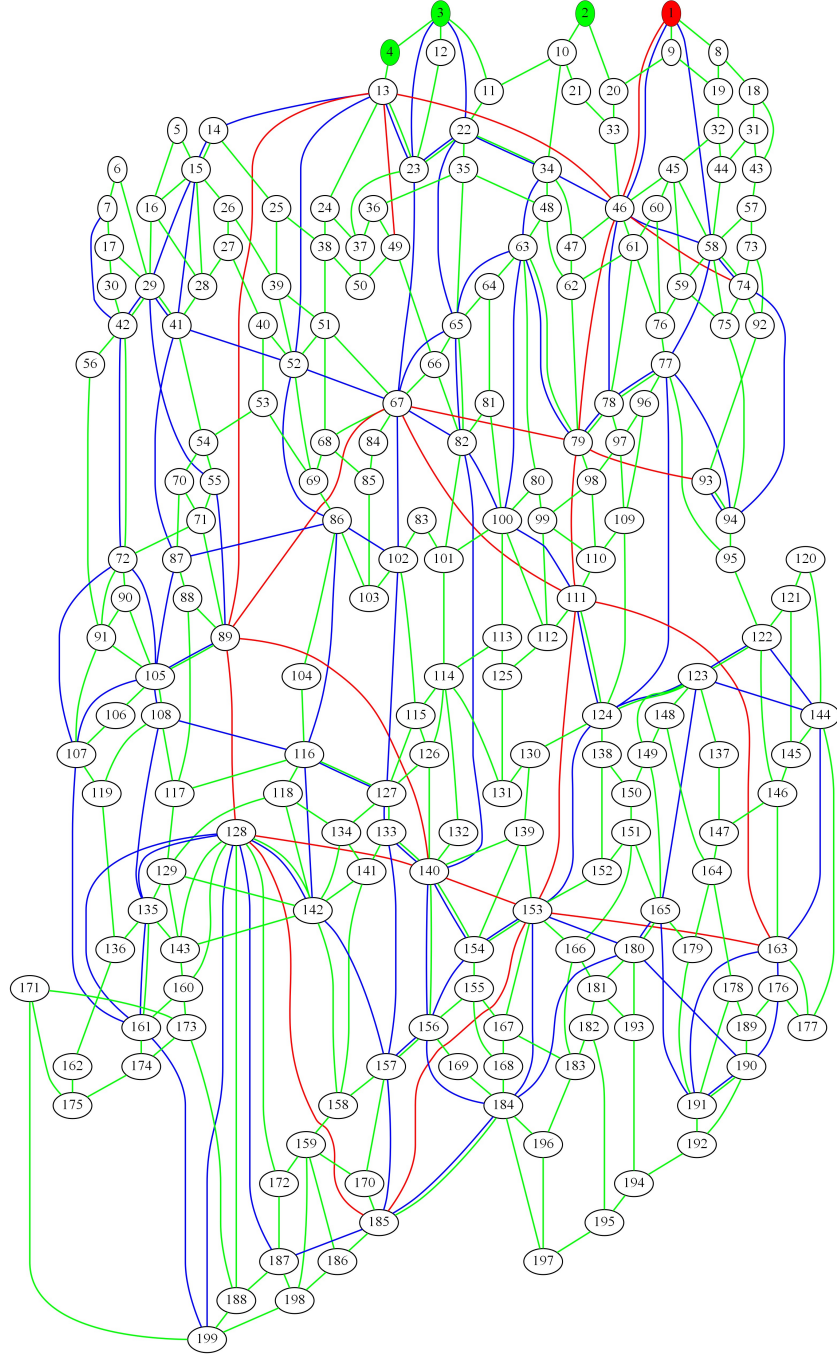
4   Updated Strategy for Detectives

Figure 1: The graph $G(V, E_t, E_b, E_u)$ with edges of E_t, E_b and E_u represented in yellow, blue and red respectively