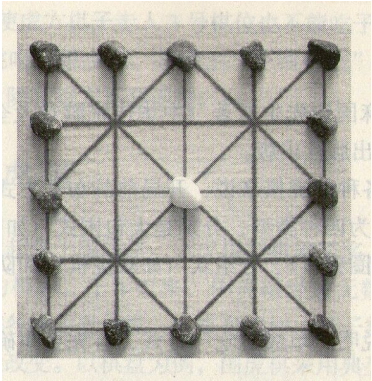
Option A: Tiger vs. Dogs in GDL

The aim of this assignment is to develop your ability of formalising abstract concepts and enhance your understanding of logical reasoning in General Game Playing.

Game Description

Here is a very ancient game originated from China: Tiger vs. Dogs.



In the above 5×5 board, there are one tiger (represented by a white stone in the center) and 16 dogs (represented by black stones in the perimeter).

The tiger is controlled by the tiger player and the dogs are controlled by the dog player. The tiger player goes first and then they take turns. Each player can go one step along the line to an adjacent position that is not occupied.

When the tiger enters a position such that the following condition hold "two dogs are adjacent to this position such that they three are in the same line, and also these two dogs have no adjacent dogs in the same line", then these two dogs are killed by the tiger. If 6 dogs are killed, then the tiger player wins and the dog player loses.

When the dogs surrounded the tiger such that there is no unoccupied adjacent position for the tiger to move, then the tiger player loses and the dog player wins.

Task 1 (20 Marks)

Describe this game mathematically (Refer to lecture slides). Here are some key points:

(a) The set of game states S. Give your estimation of the number of different states. (4 marks)

Hint: take the Tic-Tac-Toe for example, a state can be described using,

- 9 variables of Cell(1,1), Cell(1,2), Cell(1,3), Cell(2,1), Cell(2,2), Cell(2,3), Cell(3,1), Cell(3,2), Cell(3,3), with possible values x, o, b to represent if cell is marked by xplayer, oplayer or is blank.
- 1 variable of control, with possible values xplayer and oplayer, to represent which player is in control

e.g., for the initial state, s_0, it can be described as $\langle$ Cell(1,1)=b, Cell(1,2)=b, ... , Cell(3,3)=b, control=xplayer $\rangle$

A very rough estimation of the number of states for Tic-Tac-Toe is: $3^9 \times 2$, because for each of 9 cells, it has 3 possible values, and the control variable has 2 possible values. But you could be more precise by removing some impossible states (the states are not reachable from the initial state), e.g.,

$\langle$ Cell(1,1)=x, Cell(1,2)=x, Cell(1,3)=x, Cell(2,1)=o, Cell(2,2)=o, Cell(2,3)=o, Cell(3,1)=b, Cell(3,2)=b, Cell(3,3)=b, control=xplayer $\rangle$

In the above state both xplayer and oplayer have formed 1 line of their own markings, but this is not possible as once one player manages to get 1 line of its own marking, then the game is over.

(b) Players $P = \{1, 2\}$. You may use 1 to represent the tiger player and 2 the dog player. Feel free to use your own version. (0 marks)

(c) Actions A. You may use abstraction to get as few types of actions as possible. (4 marks)

Hint: use A_1 for the tiger player, and A_2 for the dog player. $A = A_1 \times A_2$.

Just list all possible actions for each player, e.g., you can use left as one action for tiger player. Note that for a particular state, it is not necessary all actions are possible.

(d) Transition function $S \times A \to S$. This function is huge. What we ask you to present is not the entire function but the effects of actions you described in (c) on different games states, in a general way, e.g., you may just select a few representative ones to describe. This serves the foundation of Task 2.

(6 marks)

Hint: You can just use the following format:

give a state s, and players's joint action (a_1, a_2), then give the resulting state s'.

(e) Terminal states and utilities.

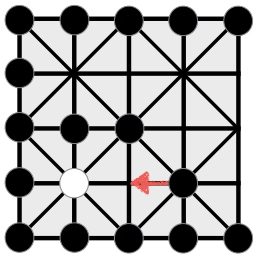
Hint: When a game terminates, it is either because the tiger is captured or 6 dogs are killed. So describe the conditions on a terminal state using the state representation you give in (a).

You may use a few representative ones to illustrate.

(6 marks)

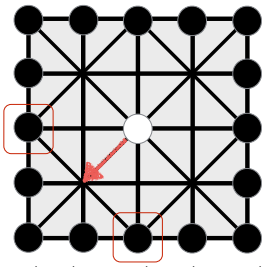
To help you to understand this game, here are a few examples:

Example:



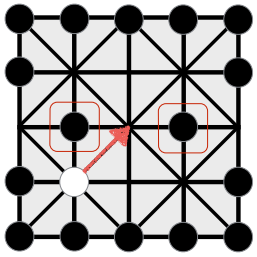
When the dog makes the move by red arrow, the tiger is surrounded.

Example:



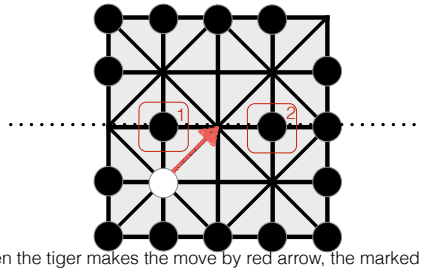
When the tiger makes the move by red arrow, the marked two dogs are killed.

Example:



When the tiger makes the move by red arrow, the marked two dogs are killed.

Example:



When the tiger makes the move by red arrow, the marked two dogs are not killed because there is a dog in the same line that is next to dog 2 (as marked).

Task 2 (80 Marks)

(a) Write a game description in GDL (KIF form) for this game. Note that this involves in making the concepts developed in Task 1 into GDL. The transition function in Task 1 is now succinctly represented as a set of logical rules. Your GDL should be annotated for better readability, especially the new predicates that you've created. Have a clear separation of the following sections: (60 Marks)

- Roles and the initial states;
- Legal moves;
- State transitions (next rules);
- Terminal conditions;
- Utilities (goal).

(b) Test and debug your game description using the game controller (refer to tutorials) to ensure that it runs correctly. (20 Marks)

`http://sourceforge.net/projects/ggpserver/files/gamecontroller/`

In your submission, you need to include at least two execution traces generated by the game controller with both players using the random type.

Extra marks (up to 10) will be given if you are able to do something extra, e.g., classifying and visualising the transition function in 1(d) and the traces in 2(b). These extra marks can make up your loss in other parts of this assignment. The total mark is capped at 100.

Submission

You can team up with a classmate to work on this assignment. One submission per team.

You are required to provide

(1) Your solution to Task 1,

(2) Your GDL file for Task 2(a), and

(3) Your test results for Task 2 (b).

We prefer that (1) and (3) are included in a single PDF file. Your submission should including everything in a zip file with the following format: AI2021A2A-XY.zip, where XY is your student ID(s). The submission is via Blackboard.

(Note that you might be able to find some online discussions on this problem, but you have to write your own GDL code.)