CITS3001: Algorithms, Agents & Artificial Intelligence

Project Name: Love Letter

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**Literature Review**

Love Letter is a game of risk, deduction, and luck for 2–4 players. A player’s goal is to get their love letter to the Princess. Two ways through which the letter can be delivered are: giving the letter to an intemediary or directly to the princess. From a deck of sixteen cards, each player starts with only one card in hand; with each card representing an intermediary. Each intermediary corresponds to an action that can affect all players in the game in different ways. Actions consists of swapping cards with another player to eliminating a player completely from the round. The game comprises of 13 rounds and each player draws a card on their turn leading to make a choice between two cards depending on what action increases their chance of winning the round and essentially the game. Powerful cards lead to early gains, but make you a target. A player can rely on weaker cards, however, their letter may be tossed in the fire!(intext reference) (mention something about incomplete information..)

Monte Carlo Tree Search (MTCS by itself is not able to deal with imperfect information game)

<http://teaching.csse.uwa.edu.au/units/CITS3001/project/2017/paper1.pdf>

Examples:

1. They integrated the MCTS algorithm with a Bayesian classifier, which is used to model the behavior of the opponents. The Bayesian classifier is able to predict both the cards and the actions of the other players. (Texas Hold’em Poker)
2. MCTS was integrated with Location Categorization, a technique which provides a good prediction on the position of the hiding player. (Scotland Yard)
3. MCTS is integrated with determinization methods (Section 2.5.1). With this technique, during the construction of the tree, hidden or imperfect information is considered to be known by all players (Magic: The Gathering)
4. Information Set Monte Carlo Tree Search (Section 2.5.2), a modified version of MCTS in which the nodes of the tree represents information sets (Section 2.5). (Spades)

The MCTS algorithm relies on two fundamental concepts: • The expected reward of an action can be estimated doing many random simulations. • These rewards can be used to adjust the search toward a best-first strategy.

(Read pages 40&41)

UCT: The idea is to exploit the advantages of the two approaches and build up a tree in an incremental and asymmetric manner by doing many random simulated games. For each iterations of the algorithm, a tree policy is used to find the most urgent node of the current tree, it seeks to balance the exploration, look at areas which are not yet sufficiently visited, and the exploitation, look at areas which can returns a high reward. Once the node has been selected, it is expanded by taking an available move and a child node is added to it. A simulation is then run from the child node and the result is backpropagated in the tree. The moves during the simulation step are done according to a default policy, the simplest way is to use a uniform random sampling of the moves available at each intermediate state. The algorithm terminates when a limit of iterations, time or memory is reached, for this reason MCTS is an anytime algorithm, i.e. it can be stopped at any moment in time returning the current best move. A Great benefit of MCTS is that the intermediate states do not need to be evaluated, as for Minimax with alpha-beta pruning, therefore it does not require a great amount of domain knowledge, usually only the game’s rules are enough.

1. Determinization UCT (PIMC)

* One approach to designing AI for games with stochasticity and/or imperfect information is determinization. A determinization is a conversion of a stochastic game with imperfect information to a deterministic game with perfect information, in which the hidden information and the outcomes of all future chance events are fixed and known. In other words, a determinization is a sampled state in the current information set of the game.

1. Single Observer-Information Set MCTS

 (Read pages 59-65)

<https://pdfs.semanticscholar.org/d10e/31ed85cc6ea79d3d961730da2b07c32aa984.pdf>

1. 3.3.4 Counterfactual Regret Minimization (p33) (other than MCTS)
2. PIMC (p53)
3. ISMCTS (p67)

**Selected Technique(s)**

**Implementation(s)**

**Validation(s)**