AOA_202_Project_Formulation

February 16, 2023

1 "Project LUDO"

1.1 Dice

Let D_i denote the outcome of the dice rolling an outcome of i.
Let $Prob(D_i)$ denote the probability of an occurence D_i.
We are assuming a fair dice: $Prob(D_i) = 1/6 \ \forall \ i \in \{1, 2, 3, 4, 5, 6\}$

1.2 State of the board

- Let C denote the current player, a value between 1-4.
- Let P_i indicate the positions of pawn i.
  - P_i is an integer between 0 and 52 denoting all the possible locations of a pawn relative to the current player's starting position, where 0 is a special value indicating a position not reachable by enemy pawns.
- Let S_i denote the supplemental position, used only when P_i is 0. There are 7 such positions on the board: The start base (1), The home pathway (2-6), and the Home (7) itself.

The state of the board can be defined by a collection of factors, mathematically: (C, (P_pawn, S_pawn) pawns)

1.3 Risk

We consider an element "risk" at a given position to represent the danger to a pawn of getting struck at that position, given the state of the board.

Let R(S, i) denote risk to pawn i at state S.
R(S, i) can be calculated as:
$Safe(S, i) * \Sigma Prob(RiskFactors)$
where Safe(S, i) returns a 0 if the pawn is on a safe spot, else 1 and the risk factors may include pawns in the vicinity or others yet to be determined.

For example, the risk due to a pawn in the vicinity may be modelled as: $Prob(Strike|coveringDist(P_{striker}, P_{current}))$, where coveringDist will return the dice probability of a striker reaching current position.

1.4 Potential

We consider an element "Potential" at a given position to represent the potential reward to a pawn given the dice roll and the state of the board.

Let Pot(S, i) denote the reward to pawn i at state S
Pot(S, i) can be calculated as:
$\Sigma Prob(RewardFactors)$
The reward farctors may include the progress towards home, killing an enemy's pawn, Likelihood to kill an enemy's pawn in the future.

1.5 Status

We consider an element "Status" at a given position to represent some function of the reward and the risk at that postion given the state of the board.

We also add a term incentivizing the pawn to leave the start base. Overall the status can be modelled as
$Status(S', i) = F(Pot(S', i), Risk(S', i)) + isHome(S')$
Where S' represents a candidate altered state of the board, F is a arbitrary function to handle potential and risk at that position, isHome returns some positive constant if the pawn has left the start base else 0.

1.6 Aggregate

This is the objective we want to maximize.

$Aggregate(S, S', C) = max(\Delta(Status(S', pawn_1), Status(S, pawn_1)), \Delta(Status(S', pawn_2), Status(S, pawn_2)))$
where C is the current player, and $pawn_1$ and $pawn_2$ being its pawns

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