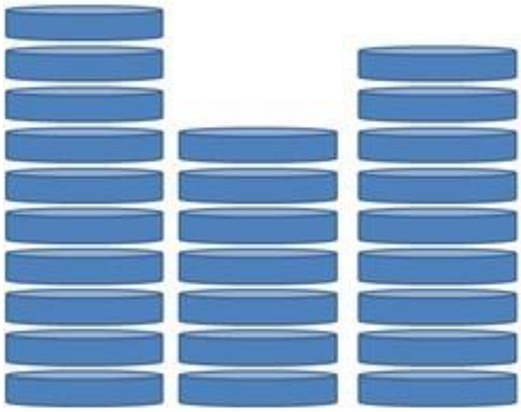
B. *Read about the game of Nim (a player left with no move losing the game). For the initial configuration of the game with three piles of objects as shown in Figure, show that regardlessof the strategy of player-1, player-2 will always win. Try to explain the reason with the MINIMAX value backup argumenton the game tree.*



In order to win the game player-2 will have to leave a Nim Sum of zero for player-1 every turn.

Nim Sum : Pile 1 - 10 discs = 8+0+2+0 Pile 2 - 7 discs = 0+4+2+1 Pile 3 - 9 discs = 8+0+0+1

The Nim Sum here is not zero, there are 4 extra discs inpile 2.

The number of discs in each pile have to be representedas a sum of powers of 2. If all of those numbers have a pair among themselves then it is said to be Nim Sum.

So, in the initial configuration the Nim Sum != 0. Player-1 goes first and randomly picks up any number of discs from any pile.

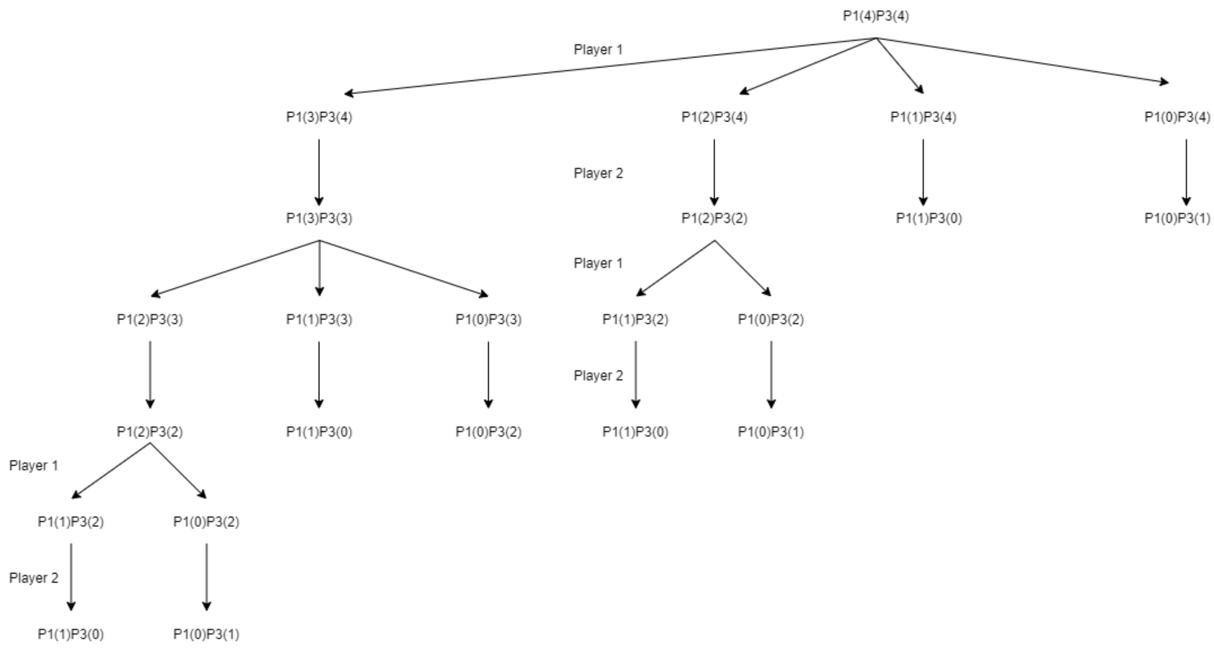
If player-1 picks n(1-3) discs from Pile 2, player 2 goes andpicks 4-n discs leaving the pairs (1,1) (2,2) (8,8).

If player-1 makes any other choice, then player-2 needs to remove 4 discs from pile 2.

From the next turn any move player-1 makes, player-2 needsto check Nim sum of the piles again and balance out by makingthe sum 0 again.

For player-2 to win, player-1 has to pick the last disc. Takingthe above method into consideration let's assume there is a lastpair left of 4 discs each in pile 1 and pile 3(this is possible because number of discs in a group of 2, 4, or 8 can be split to balance and make the Nim Sum 0) The next turn would be of player-1.

Let us look at the game tree from this state : Each node denotes the number of discs left in both the piles



All the terminal cases are the cases where player-2 wins despite any moves made by player-1.

This case of making player 2 win every time can fail if player 1 is also following the same strategy.

Taking the case where player 1 follows the rule of keeping Nim Sum = 0 for player 2, the first move he will make is remove 4 discs from pile 2 leaving the Nim Sum = 0. If player1 keeps following the strategy from here, then player 2 cannot win.