TIC TAC TOE PROBLEM

```
In[1]:= generaltictactoe[simulate_,
   numiter_, size_] := Module[{},
   (* simulate = 1 if simulating,
   if 0 brute force *)
   (* numiter is the number of
    times we go through *)
   (* doing it on size by size for the board *)
   If[simulate > 1,
    Print["Bad choice of simulate."]];
   wins[1] = 0; wins[2] = 0;
   (* keeps track of wins *)
   list = {};
   For[i = 1, i ≤ size, i++,
    For[j = 1, j ≤ size, j++,
     list = AppendTo[list, {i, j}]
    ]]; (* creates the board for the game *)
   If[simulate == 0,
    biglist = Permutations[list]];
   (* if brute force, store ALL games *)
   If[simulate == 1, numdo = numiter,
    numdo = (size*size)!];
   (* this sets how many times we do *)
   For[n = 1, n ≤ numdo, n++,
{
 If[Mod[n, numdo / 10] == 0, Print[
   "We have done ", 100.0 n / numdo, "%."]];
 (* prints out status every 10% *)
 If[simulate == 1, game =
   RandomSample[list], game = biglist[[n]]];
 (* randomly choose a game,
 or take the next brute force game *)
 (* reset game board;
 we have list of moves now *)
 For[i = 1, i ≤ size, i++,
  For[j = 1, j ≤ size, j++,
   board[i, j] = 0; ]]; (* initialize all
  board squares to 0; no one took *)
 gameover = 0; (* make this 1
  as soon as game done *)
 nummoves = 0; (* keeps track
  of what move we are on *)

 While[
  nummoves < size * size && gameover < 1,
  {
   (* play till run
    out of moves or someone wins *)
   nummoves = nummoves + 1;
```

```
(* making a move! *)
currentmove = game[[nummoves]];
(* loads move *)
x = currentmove[[1]];
y = currentmove[[2]];
If[Mod[nummoves, 2] == 1,
 board[x, y] = 1, board[x, y] = -1];
(* adds move to board *)

(* check to see if someone has won *)
win = 0;
For[i = 1, i ≤ size, i++,
 If[Abs[Sum[board[i, j], {j, 1, size}]] ==
    size, win = 1];
]; (* ends i for loop;
checks columns *)
For[j = 1, j ≤ size, j++,
 If[Abs[Sum[board[i, j], {i, 1, size}]] ==
    size, win = 1];
]; (* ends i for loop; checks rows *)
If[Abs[Sum[board[i, i], {i, 1, size}]] ==
  size, win = 1];
If[Abs[Sum[board[size + 1 - i, i],
    {i, 1, size}]] == size, win = 1];
    If[win > 0,
     {
      gameover = 1;
      (* someone won!  record *)
      If[Mod[nummoves, 2] == 1, wins[1] =
        wins[1] + 1, wins[2] = wins[2] + 1];
     }]; (* end if statement on win *)

   }]; (* end of While loop *)

 }]; (* end of n for loop *)

If[simulate == 1,
 Print["We are simulating and doing ",
  numiter, " trials."],
 Print["We are brute force enumerating
    all possibilities."]];

Print["Percentage of time player 1 won: ",
 100. wins[1] / numdo, "(actual = ",
 wins[1] / numdo, ")"];
Print["Percentage of time player 2 won: ",
 100. wins[2] / numdo, "(actual = ",
 wins[2] / numdo, ")"];
Print["Percentage of time of tied game: ",
    100. - 100. (wins[1] + wins[2]) / numdo,
    "(actual = ",
    (numdo - wins[1] - wins[2]) / numdo, ")"];
  ] (* end of module *)
```

```
In[]:= Timing[generaltictactoe[1, 1000, 20]]
       We have done 10.%.
       We have done 20.%.
       We have done 30.%.
       We have done 40.%.
       We have done 50.%.
       We have done 60.%.
       We have done 70.%.
       We have done 80.%.
       We have done 90.%.
       We have done 100.%.
       We are simulating and doing 1000 trials.
       Percentage of time player 1 won: 0.(actual = 0)
       Percentage of time player 2 won: 0.(actual = 0)
       Percentage of time of tied game: 100.(actual = 1)
Out[]= {216.327, Null}
```

```
In[12]:= Timing[generaltictactoe[0, 1000, 2]]
         We have done 50.%.
         We have done 100.%.
         We are brute force enumerating all possibilities.
         Percentage of time player 1 won: 100.(actual = 1)
         Percentage of time player 2 won: 0.(actual = 0)
         Percentage of time of tied game: 0.(actual = 0)
Out[12]= {0., Null}
```

```
In[]:= Timing[generaltictactoe[0, 1000, 3]]
```

```
We have done 10.%.

We have done 20.%.

We have done 30.%.

We have done 40.%.

We have done 50.%.

We have done 60.%.

We have done 70.%.

We have done 80.%.

We have done 90.%.

We have done 100.%.

We are brute force enumerating all possibilities.

Percentage of time player 1 won: 58.4921(actual = 737/1260)

Percentage of time player 2 won: 28.8095(actual = 121/420)

Percentage of time of tied game: 12.6984(actual = 8/63)

Out[∘]= {122.664, Null}
```

```
In[3]:= Timing[generaltictactoe[1, 1000, 20]]
```

```
We have done 10.%.

We have done 20.%.

We have done 30.%.

We have done 40.%.

We have done 50.%.

We have done 60.%.

We have done 70.%.

We have done 80.%.

We have done 90.%.

We have done 100.%.

We are simulating and doing 1000 trials.

Percentage of time player 1 won: 0.(actual = 0)

Percentage of time player 2 won: 0.(actual = 0)

Percentage of time of tied game: 100.(actual = 1)

Out[3]= {238.853, Null}
```

```
In[27]:= fastgeneraltictactoe[simulate_, numiter_, size_] := Module[{},
           (* simulate = 1 if simulating, if 0 brute force *)
           (* numiter is the number of times we go through *)
(* doing it on size by size for the board *)
If[simulate > 1, Print["Bad choice of simulate."]];
wins[1] = 0; wins[2] = 0; (* keeps track of wins *)
list = {};
For[i = 1, i ≤ size, i++,
 For[j = 1, j ≤ size, j++,
  list = AppendTo[list, {i, j}]
 ]]; (* creates the board for the game *)
If[simulate == 0, biglist = Permutations[list]];
(* if brute force, store ALL games *)
If[simulate == 1, numdo = numiter, numdo = (size * size) !];
(* this sets how many times we do *)
For[n = 1, n ≤ numdo, n++,
 {
  If[Mod[n, numdo / 10] == 0, Print["We have done ", 100.0 n / numdo, "%."]];
  (* prints out status every 10% *)
  If[simulate == 1, game = RandomSample[list], game = biglist[[n]]];
  (* randomly choose a game, or take the next brute force game *)

  gameover = 0; (* make this 1 as soon as game done *)
  nummoves = 0; (* keeps track of what move we are on *)
  (* initialize all sums to 0 *)
  For[k = 1, k ≤ size, k++,
   {
    rowsum[k] = 0;
    columnsum[k] = 0;
   }];
  maindiagsum = 0; oppdiagsum = 0;

  While[nummoves < size * size && gameover < 1,
   {
    (* play till run out of moves or someone wins *)
    nummoves = nummoves + 1; (* making a move! *)
    currentmove = game[[nummoves]]; (* loads move *)
    x = currentmove[[1]];
    y = currentmove[[2]];
    If[Mod[nummoves, 2] == 1, player = 1, player = -1];

    rowsum[x] = rowsum[x] + player;
    columnsum[y] = columnsum[y] + player;
    If[x == y, maindiagsum = maindiagsum + player];
```

```
        If[x + y == size + 1, oppdiagsum = oppdiagsum + player];

        (* check to see if someone has won *)
        win = 0;
        (* only check where add new mark! *)
        If[Abs[rowsum[x]] == size, win = 1,
         If[Abs[columnsum[y]] == size, win = 1,
          If[x == y && Abs[maindiagsum] == size, win = 1,
           If[x + y == size + 1 && Abs[oppdiagsum] == size, win = 1]]]];

        If[win > 0,
         {
          gameover = 1; (* someone won!  record *)
          If[Mod[nummoves, 2] == 1, wins[1] = wins[1] + 1, wins[2] = wins[2] + 1];

         }]; (* end if statement on win *)

       }]; (* end of While loop *)

     }]; (* end of n for loop *)

    If[simulate == 1, Print["We are simulating and doing ", numiter, " trials."],
     Print["We are brute force enumerating all possibilities."]];

    Print["Percentage of time player 1 won: ",
     100. wins[1] / numdo, "(actual = ", wins[1] / numdo, ")"];
    Print["Percentage of time player 2 won: ", 100. wins[2] / numdo,
     "(actual = ", wins[2] / numdo, ")"];
    Print["Percentage of time of tied game: ",
     100. - 100. (wins[1] + wins[2]) / numdo,
     "(actual = ", (numdo - wins[1] - wins[2]) / numdo, ")"];
   ] (* end of module *)
```

```
In[29]:= Timing[fastgeneraltictactoe[0, 1000, 3]]
```

```
We have done 10.%.

We have done 20.%.

We have done 30.%.

We have done 40.%.

We have done 50.%.

We have done 60.%.

We have done 70.%.

We have done 80.%.

We have done 90.%.

We have done 100.%.

We are brute force enumerating all possibilities.

                                                  737
Percentage of time player 1 won: 58.4921(actual = ────)
                                                  1260

                                                  121
Percentage of time player 2 won: 28.8095(actual = ───)
                                                  420

                                                  8
Percentage of time of tied game: 12.6984(actual = ──)
                                                  63
```

```
In[30]:= Timing[generaltictactoe[1, 1000, 20]]
```

```
We have done 10.%.

We have done 20.%.

We have done 30.%.

We have done 40.%.

We have done 50.%.

We have done 60.%.

We have done 70.%.

We have done 80.%.

We have done 90.%.

We have done 100.%.

We are simulating and doing 1000 trials.

Percentage of time player 1 won: 0.(actual = 0)

Percentage of time player 2 won: 0.(actual = 0)

Percentage of time of tied game: 100.(actual = 1)
```

```
Out[30]= {228.573, Null}
```

```
In[34]:= Timing[fastgeneraltictactoe[1, 1000, 20]]
```

```
         We have done 10.%.
         We have done 20.%.
         We have done 30.%.
         We have done 40.%.
         We have done 50.%.
         We have done 60.%.
         We have done 70.%.
         We have done 80.%.
         We have done 90.%.
         We have done 100.%.
         We are simulating and doing 1000 trials.
         Percentage of time player 1 won: 0.(actual = 0)
         Percentage of time player 2 won: 0.(actual = 0)
         Percentage of time of tied game: 100.(actual = 1)
Out[34]= {5.25723, Null}

In[33]:= Timing[fastgeneraltictactoe[1, 1000, 200]]
         We have done 10.%.
         We have done 20.%.
         We have done 30.%.
         We have done 40.%.
         We have done 50.%.
         We have done 60.%.
         We have done 70.%.
         We have done 80.%.
         We have done 90.%.
         We have done 100.%.
         We are simulating and doing 1000 trials.
         Percentage of time player 1 won: 0.(actual = 0)
         Percentage of time player 2 won: 0.(actual = 0)
         Percentage of time of tied game: 100.(actual = 1)
Out[33]= {536.082, Null}

In[35]:= Timing[generaltictactoe[1, 1, 200]]
         We have done 100.%.
Out[35]= $Aborted

In[37]:= Timing[generaltictactoe[1, 1, 100]]
```

```
         We have done 100.%.

         We are simulating and doing 1 trials.

         Percentage of time player 1 won: 0.(actual = 0)

         Percentage of time player 2 won: 0.(actual = 0)

         Percentage of time of tied game: 100.(actual = 1)

Out[37]= {126.517, Null}

In[40]:= Timing[fastgeneraltictactoe[1, 1000, 100]]

         We have done 10.%.

         We have done 20.%.

         We have done 30.%.

         We have done 40.%.

         We have done 50.%.

         We have done 60.%.

         We have done 70.%.

         We have done 80.%.

         We have done 90.%.

         We have done 100.%.

         We are simulating and doing 1000 trials.

         Percentage of time player 1 won: 0.(actual = 0)

         Percentage of time player 2 won: 0.(actual = 0)

         Percentage of time of tied game: 100.(actual = 1)

Out[40]= {132.211, Null}
```