# Game of Life Game Theory

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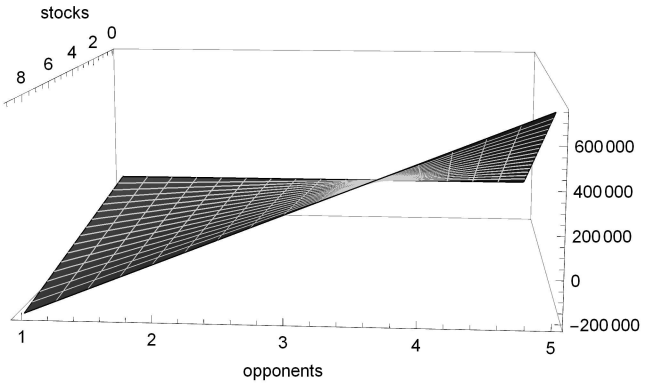
**In the Game of Life, you can buy a stock card for $50,000. As a result, each time a player spins the stock-number you bought, he has to pay you $10,000. There are 9 possible stocks to buy, and 10 numbers to spin. For part a) I assume you can buy unlimited stocks. How many should you buy? And in what circumstances? Note, all code will be done in Mathematica 11. Note: Income only includes money made from stocks.**

# a)

```
totalTurns = 26.5; (*This number was averaged from the turns my brother and I
 took to complete the game*)
chanceOfMoneyPerSpin[stocks_] := .1 * stocks; (*there are 10 numbers on the spinner,
so you have a 10% chance per stock you own of making money*)
```

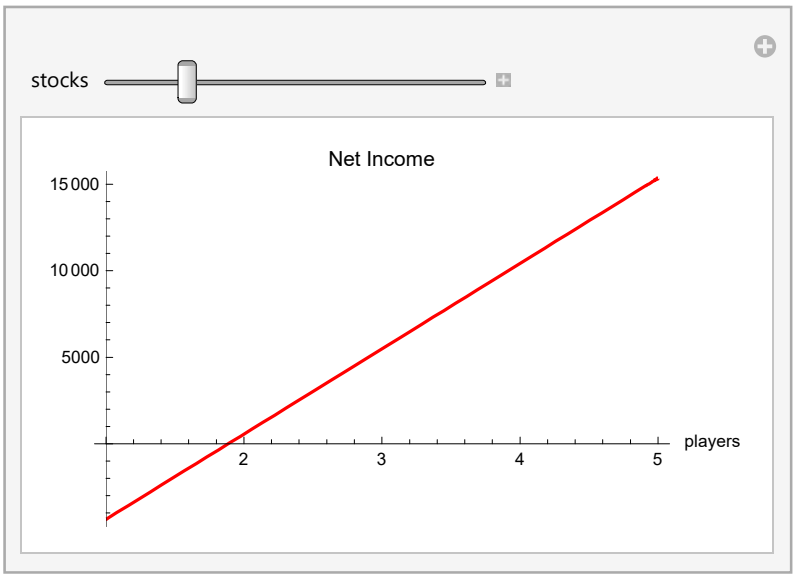
In[4]:=
```
Income[stocks_, opponents_] :=
  opponents * 10 000 * chanceOfMoneyPerSpin[stocks] * totalTurns - 50 000 * stocks;

Plot3D[Income[stocks, opponents], {stocks, 0, 9}, {opponents, 1, 5}, AxesLabel → Automatic,
 PlotTheme → "LightMesh"]
```



***From the 3-d graph, you can see that if there are enough players, you keep making more money by buying more stocks.***

***How many opponents do you need to have to justify buying stocks?***




**Conclusion: As long as there are more than 2 opponents, you are likely to make more money if you buy more stocks. So your best option would be to buy all 9 stock cards on the first term.**

# b)

**In the rulebook, it states that you can actually only purchase one stock, but you *can* hold up to two if you land on the "Stock Boom" space. What if we pick the "strategy" where your main source of income is generated from stocks? Instead of choosing the "college track" and accepting $100k of debt, we will choose a career that pays you when other players spin a certain number (Police of Artist)**

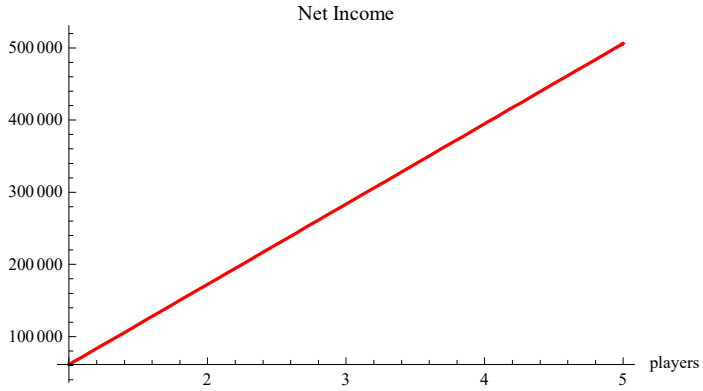
- **Recall your salary is based on which card you randomly draw from the allowed salary cards. Which career should you choose? I found the mean for Artist's $42,500 and Police's $61,666.7**

**Note: you will likely not have to go into debt to buy a stock on the first turn because there is a payday on the first square. You are also unlikely to need to go into debt even if you are an artist, because there is another payday on the 4th square.**

In[23]:=
```
(*There are 39 spaces until the stock zoom space. Note we are negleting the
  "STOP" spaces in the measure of average turns to get there*)
AverageTurnsToZoom = 39 / 4.5;
```

**Note: if you go first AND you are a police officer, you essentially own 2 stocks on the first turn, and we're enforcing that land on "Stock Boom."**

In[24]:=
```
IncomeBestCaseJob[stocks_, opponents_] :=
  opponents * 10000 * chanceOfMoneyPerSpin[2] * totalTurns +
   opponents * 10000 * chanceOfMoneyPerSpin[3] * (totalTurns - AverageTurnsToZoom) - 50000;
```




***From this graph you can see the linear relationship between your expected net worth at the end of the game and the number of opponents. The slope is the amount of money you expect to make per player.***

In[32]:=
```
moneyPerPlayer = IncomeBestCaseJob[1, 5] / 5 (*the slope*)
```

Out[32]=
```
96 500.
```

In[26]:=
```
list1 = {}; For[players = 1, players < 6, players++,
 list1 = Append[list1, IncomeBestCaseJob[1, players]]];
list1 (*how much you expect to make per player. Note because of linearity: Mean[list1]=
 $283682*)
```

Out[27]=
```
{56 500., 163 000., 269 500., 376 000., 482 500.}
```

**Note: if you DON'T get to go first, you can expect to make $6000 less!**

In[28]:=
```
IncomeBestCaseJobSecond[stocks_, opponents_] :=
  opponents * 10 000 * chanceOfMoneyPerSpin[2] (totalTurns - 1) +
   opponents * 10 000 * chanceOfMoneyPerSpin[3] * (totalTurns - AverageTurnsToZoom) - 50 000;
```

In[29]:=
```
list2 = {};
For[players = 1, players < 6, players++,
 list2 = Append[list2, IncomeBestCaseJobSecond[1, players]]];
list2 (*how much you expect to make per player. Again,
Mean[list2]=$277683 by linearity*)
```

Out[30]=
```
{54 500., 159 000., 263 500., 368 000., 472 500.}
```

In[31]:=
```
Mean[list1] - Mean[list2]
```

Out[31]=
```
6000.
```