Abstract:

We look to find out what common traits fun games have in relation to their game trees and create a metric in order to quantify the “fun-ness” of a game. To find these quantities, we run experiments, take surveys, and find a quantity to measure in the game tree that we predict will have a direct correlation with “Fun.” In our experiments, we predict that in the analysis of games that are considered fun, after several iterations of the game, we will see a consistency in the strategy of each player with the exception of instances of the game where a lose is apparent. With respect to games that are not considered to be fun, we predict the opposite. Strategies will tend to be random at each iteration as the players will be less engaged and will be less willing to invest in a strategy for the game.

Fun, or the engagement of players in a particular game, we predict will be directly correlated to the number of possible strategies in a game, likely because players are interested in seeing the strength of strategies against one another. However, this measurement will be quantified by counting the ratio of draw positions to total positions. A higher ratio of draws will be less fun because of a stalemate and a likelihood of repetitive play where no progress will be made in the game. Hence, we chose to study games known to have high draw ratios (Pong Hau Ki) in comparison to those with significantly lower draw ratios (Othello) to make this observation.

Heat, the state at which the player has an opportunity to get ahead by a large amount, we believe is directly correlated to the Fun of a game and best measured through the number of a special win available throughout the games. Specifically, games where there are wins that point only to loses is a special kind of a win → it means that you can’t screw up and you can get ahead by a lot. Quantified by positions in the game tree only pointing to loses.

<u>Known Game Analysis:</u>

Othello

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	0	0
12	0	1	0	0	1
11	4	0	0	0	4
10	8	16	0	0	24
9	58	8	0	0	66
8	44	172	0	0	216
7	646	88	12	0	746
6	292	1520	92	0	1904
5	3224	658	232	0	4114
4	1522	6422	412	0	8356
3	9266	2380	914	0	12560
2	3626	10148	1222	0	14996
1	9846	2418	1370	0	13634
0	1620	3793	755	0	6168
Totals	30156	27624	5009	0	62789

Total Positions Visited: 62789

Win Ratio: 30156 / 62789 → 48.027521% win rate
Draw Ratio: 0 / 62789 → 0% draw rate

Pong Hau Ki

```
Remoteness          Win         Lose          Tie         Draw        Total
-------------------------------------------------------------------------------
       Inf            0            0            0           44           44
         1            8            0            0            0            8
         0            0            4            0            0            4
-------------------------------------------------------------------------------
Totals                8            4            0           44           56
Draws = 44

Fringe1 Nodes = 4
Average Win/Draw Child Ratio = 2.000000
Avg No. Winning Children = 2.000000
```

Win Ratio: 8 / 56 → 14.285714 % win rate
Draw Ratio: 44 / 56 → 78.571429% draw rate

Shift Tac Toe

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	2344	2344
20	0	4	0	0	4
19	36	0	0	0	36
18	0	64	0	0	64
17	120	0	0	0	120
16	0	132	0	0	132
15	190	0	0	0	190
14	0	250	0	0	250
13	338	0	0	0	338
12	0	526	0	0	526
11	606	8	0	0	614
10	16	1022	0	0	1038
9	1400	12	0	0	1412
8	32	1766	0	0	1798
7	1962	32	0	0	1994
6	32	2684	0	0	2716
5	2450	32	0	0	2482
4	24	3538	0	0	3562
3	3440	36	0	0	3476
2	12	7414	0	0	7426
1	34976	36	0	0	35012
0	11914	31338	0	0	43252
Totals	57548	48894	0	2344	108786

Draws = 2344

Fringe1 Nodes = 2344
Average Win/Draw Child Ratio = 41.835270
Avg No. Winning Children = 55.256824

Win Ratio: 57548 / 108786 → 52.900189% win rate
Draw Ratio: 2344 / 108786 → 2.154689% draw rate

Quick Chess

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	19564	19564
20	0	16	0	0	16
19	68	0	0	0	68
18	0	88	0	0	88
17	580	0	0	0	580
16	0	1084	0	0	1084
15	4034	0	40	0	4074
14	0	4705	176	0	4881
13	17960	0	246	0	18206
12	0	13128	224	0	13352
11	25964	0	256	0	26220
10	0	13366	1837	0	15203
9	25091	0	4065	0	29156
8	0	13957	10771	0	24728
7	44223	0	20258	0	64481
6	0	20056	32608	0	52664
5	55076	0	42775	0	97851
4	0	26875	47004	0	73879
3	139347	0	32776	0	172123
2	0	42404	21057	0	63461
1	396094	0	6315	0	402409
0	0	172364	1696	0	174060
Totals	708437	308043	222104	19564	1258148

Draws = 19564

Fringe1 Nodes = 0
Average Win/Draw Child Ratio = nan
Avg No. Winning Children = nan

Win Ratio: 708437 / 1258148 → 56.307922% win rate
Draw Ratio: 19564 / 1258148 → 1.554984% draw rate

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Process/Documentation/Notes:
In order to run tests and allow people to play the games we selected for this experiment, we used the gamebase and information already present in GamesmanClassic. One of the largest hurdles we faced was getting this software to run and load onto our computers, and although we were able to get it running on the Mac interface, we have yet to figure out how to install it on a PC.

How to install GamesmanClassic: (Seth helped guide)

1. Install brew if you don't have it already (https://brew.sh/)
    a. Or just use the command

```
/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
```

2. Clone GamesmanClassic from the github using the terminal command
    a. git clone https://github.com/GamesCrafters/GamesmanClassic.git
3. Download the following
    a. tcl version 8.5.18.0 (note this is not the most recent version) (https://www.activestate.com/products/activetcl/downloads/)
    b. xquartz (https://www.xquartz.org)
        i. `ln -s /opt/X11/include/X11 /usr/local/include/X11`
4. Type the following commands in the terminal
    a. brew install autoconf
    b. brew install zlib
    c. cd (to wherever GamesmanClassic was installed onto your laptop)
    d. Autoconf
    e. ./configure --with-aqua
    f. ./build.sh
5. GamesmanClassic should now be working!

To get the data acquired regarding the win/draw ratios for individual games:

1. cd (to wherever GamesmanClassic was installed on your laptop)
2. cd bin
3. ./m(whatever game you are trying to analyze)
4. Go through the prompted fields generated, to start and analyze the game, once it has been analyzed, these values will be outputted onto the terminal.

Questions:

1. How fun was this game on a scale of 1-5?
2. Why would you say this game was fun/not fun?
3. How difficult would you rate this game on a scale of 1-5?
4. At any point in the game, did you have any predictions on who would win?

5. Did you have a strategy in playing this game? If so, briefly describe it:
6. If this is not your first time playing this game, how fun would you say it was compared to the first time you have played it?

Experiments/Interpretations:

//FIXME

Heat / Draw Code:

Link:
https://docs.google.com/document/d/1W7qbhdNzs5aszct0322XB1S4l6t7PBw6mi8U0vinLCo/edit

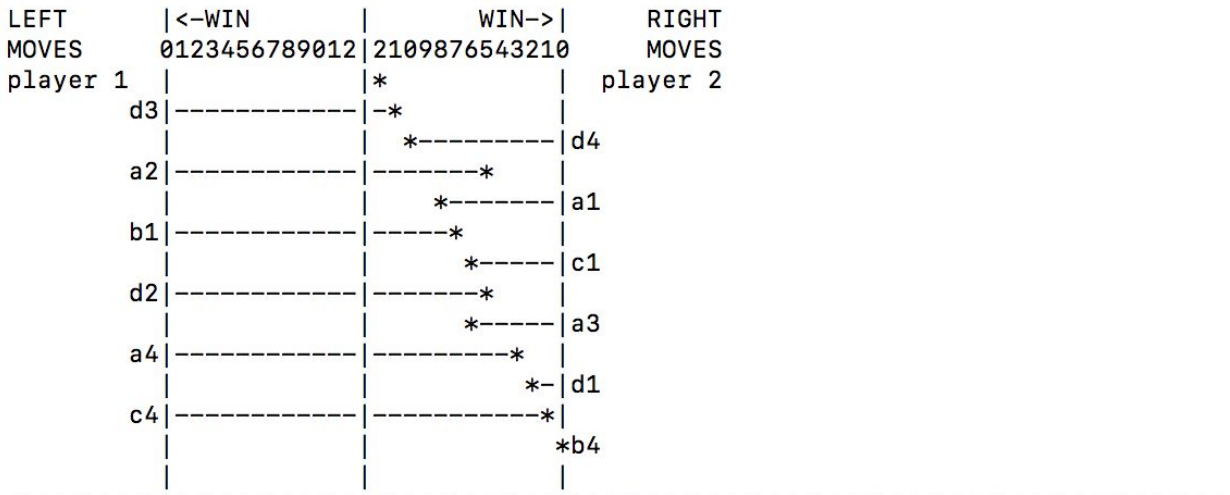
Conclusion:

Shift-Tac-Toe was ranked the most fun game, with an average fun score of 4.5 out of 5. In contrast, the lowest ranked was Pong Hau Ki, with an average score of 2 out of 5.

Interestingly, neither of these games were ranked as the most difficult. Othello took the title there, with a ranking of 3.8 out of 5, compared to Pong Hau Ki's 2.5 out of 5 and Shift-Tac-Toes' 3.1. Othello also won in the player's ability to see strategy. Five out of Six of the players stated that they had a prediction on who would win far before the last two moves, with one player saying they knew who would win with 5 moves still left.

Players were asked to verbally describe what they found fun about the games. Shift-Tac-Toe was most frequently described with words like "new", "unpredictable", "requires thought." In contrast, Pong Hau Ki was most commonly described as "boring", "repetitive," and that it had "few options." Othello was verbally described as "difficult", with "many options."

The ranking of Shift-Tac-Toe as the most fun goes against our original hypothesis. We predicted that a higher number of draws would lead to less fun and greater dissatisfaction in the players. Shift-Tac-Toe, at an approximately 2.15% draw rate, has higher chance of draws than Othello, with 0% of draws. However, Pong Hau Ki's ranking as the least fun concurs with our hypothesis.

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```
        ----- Postgame Menu for Othello -----

        u)      (U)ndo the last move
        v)      Print (V)isual Value History
        w)      Print Visual Value History (W)ith All Possible Moves
        m)      Script of (M)ove History
        b)      (B)ack to the Play Menu
        q)      (Q)uit
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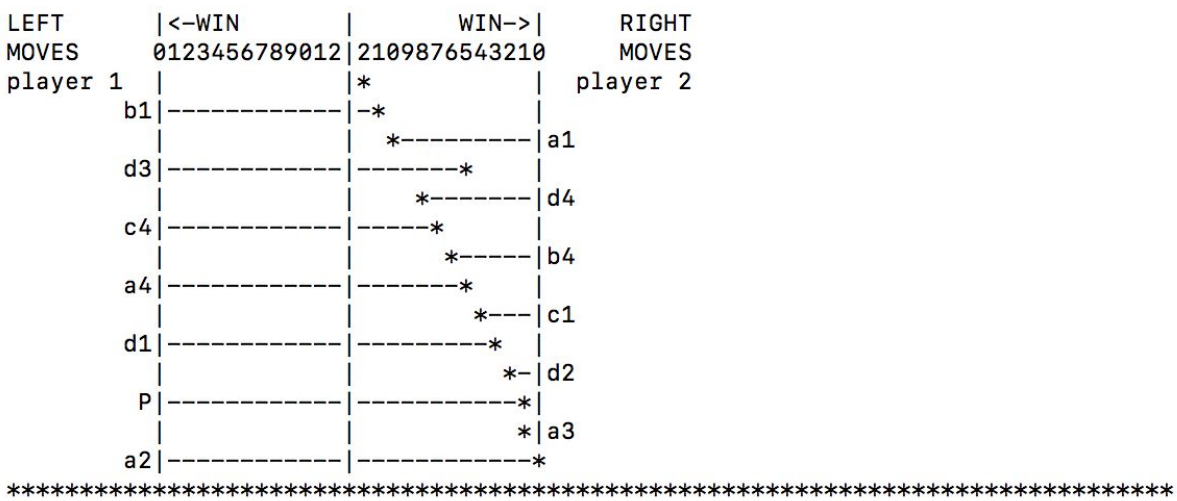


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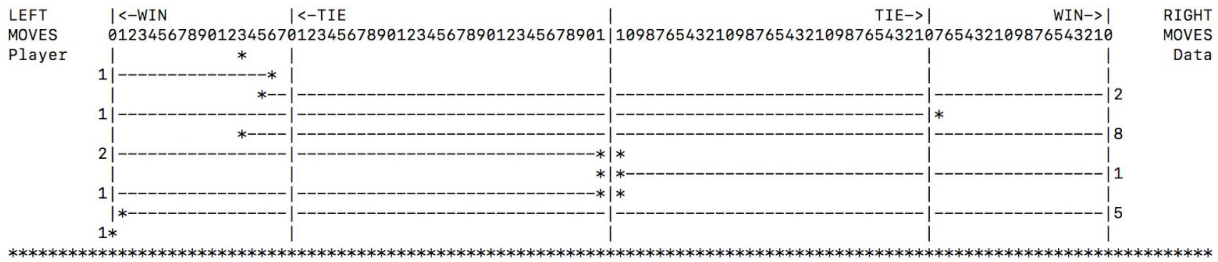

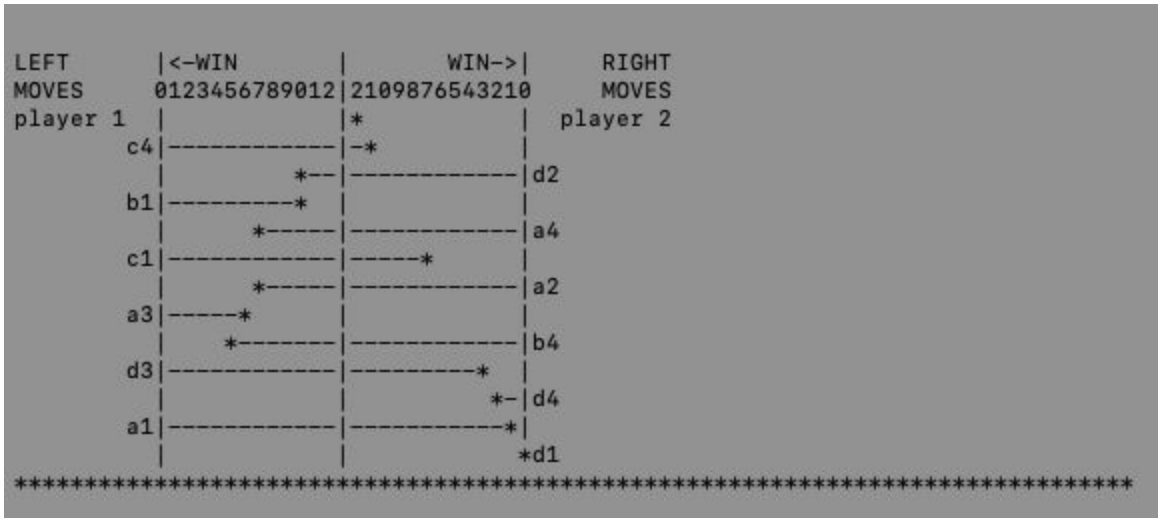


```
**********************************************************************************
Pong Hau K'i Visual Value History (aka "who messed up when?!)
**********************************************************************************

    3 -- 4    X -- O
    | \ /     | \ /
    |  0      |
    | / \     | / \
    2 -- 1    O -- X

It is player 1's turn (X).


LEFT      |<-WIN   |   WIN->|     RIGHT
MOVES     012345678|876543210     MOVES
player 1  |        |  *     |  player 2
Segmentation fault: 11
```

```
LEFT      |<-WIN           |           WIN->|     RIGHT
MOVES     01234567890123456|6543210987654321     MOVES
player 1  |            *   |                |  player 2
         3|---------------*|                |
          |              *-|----------------|2
         2|-------------*  |                |
          |      *---------|----------------|8
         2|-----*          |                |
          |    *-----------|----------------|2
         1|---*            |                |
          |  *-------------|----------------|9
         1|-*              |                |
          |*---------------|----------------|5
         1*                |                |
********************************************************************************

        ----- Postgame Menu for Shift-Tac-Toe -----

        u)      (U)ndo the last move
        v)      Print (V)isual Value History
        w)      Print Visual Value History (W)ith All Possible Moves
        m)      Script of (M)ove History
        b)      (B)ack to the Play Menu
        q)      (Q)uit
```

```
LEFT      |<-WIN DR|AW WIN->|     RIGHT
MOVES     012345678D876543210     MOVES
player 1  |        *        |  player 2
         1,0|--------*        |
          |        *--------|2,1
         3,2|--------*        |
          |        *--------|4,3
         0,4|--------*        |
          |        *--------|3,0
         2,3|--------|-------*|
          |        |        *1,2
********************************************************************************

        ----- Postgame Menu for Pong Hau K'i -----

        u)      (U)ndo the last move
        v)      Print (V)isual Value History
        w)      Print Visual Value History (W)ith All Possible Moves
        m)      Script of (M)ove History
        b)      (B)ack to the Play Menu
        q)      (Q)uit
```

```
*******************************************************************************
Pong Hau K'i Visual Value History (aka "who messed up when?!)
*******************************************************************************

    3 -- 4    X -- O
    | \ /     | \ /
    |  0      |
    | / \     | / \
    2 -- 1    O -- X

It is player 1's turn (X).


LEFT      |<-WIN    |   WIN->|     RIGHT
MOVES     012345678|876543210     MOVES
player 1  |        |  *     |  player 2
Segmentation fault: 11


LEFT      |<-WIN        |<-TIE    |   TIE->|        WIN->|     RIGHT
MOVES     012345678901230123456 78|765432103210987654321 0     MOVES
player 1  |            *|         |         |              |  player 2
         2|----------* |         |         |              |
          |          *--|--------|--------|-------------|1
         1|----------* |         |         |              |
          |          *--|--------|--------|-------------|1
         2|---------*   |         |         |              |
          |        *----|--------|--------|-------------|2
         7|-------*     |         |         |              |
          |      *------|--------|--------|-------------|2
         4|-----*       |         |         |              |
          |    *--------|--------|--------|-------------|8
         2|-------------|--------|--------|-----------*|
          |             |         |         |            *1
*******************************************************************************

        ----- Postgame Menu for Shift-Tac-Toe -----

        u)      (U)ndo the last move
        v)      Print (V)isual Value History
        w)      Print Visual Value History (W)ith All Possible Moves
        m)      Script of (M)ove History
        b)      (B)ack to the Play Menu
        q)      (Q)uit
```

```
Select an option:  v

********************************************************************************
Othello Visual Value History (aka "who messed up when?!)
********************************************************************************
        +---------------------------------+
        | GAMESMAN Othello                |
        +-----------------+---------------+
        |                 |               |
        |     a b c d     |               |
        |    ---------    |               |
        |  4 | | | | | 4  |               |
        |    ---------    |               |
        |  3 | |B|W| | 3  |               |
        |    ---------    |               |
        |  2 | |W|B| | 2  |   Black: 02   |
        |    ---------    |               |
        |  1 | | | | | 1  |   White: 02   |
        |    ---------    |               |
        |     a b c d     |               |
        |                 |               |
        +-----------------+---------------+
        | It is player1's turn.           |
        | player1 is playing Black        |
        +---------------------------------+


LEFT      |<-WIN       |       WIN->|     RIGHT
MOVES     0123456789012|2109876543210     MOVES
player1   |             |*           |   player2
        c4|-------------|-*          |
          |       *-----|------------|b4
        a3|-------------|---*        |
          |         *---|------------|d2
        b1|-------------|-----*      |
          |       *-----|------------|a1
        a4|-----*       |            |
          |     *-------|------------|c1
        d3|---*         |            |
          |   *---------|------------|d4
        d1|-*           |            |
          |*------------|------------|P
        a2*             |            |
********************************************************************************

        ----- Postgame Menu for Othello -----

        u)      (U)ndo the last move
        v)      Print (V)isual Value History
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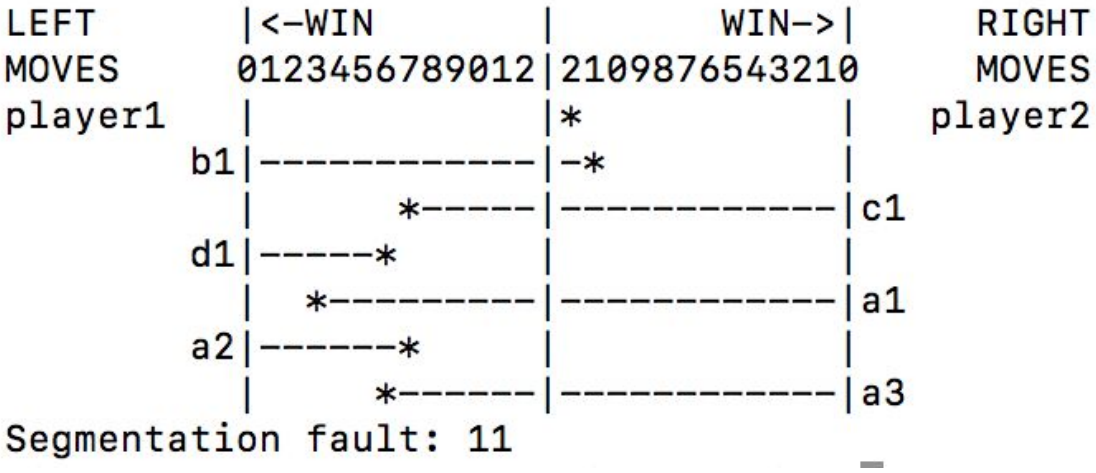

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