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# Plentiful Possibilities for Pen, Pencil, and Paper Play

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# Plentiful Possibilities for Pen, Pencil, and Paper Play

## **Abstract**

Neller presented games such as Dots and Boxes, Sprouts, Jotto, Chomp, and Pentominoes in order to illustrate the diversity of existing pencil and paper games. Additionally, he presented his own pencil and paper game design, Paper Penguins, and discussed the game design process.

## **Keywords**

games, pencil and paper games, Dots and Boxes, Sprouts, Jotto, Chomp, Pentominoes

## **Disciplines**

Computer Sciences | Game Design

## **Comments**

This presentation was given for the Gettysburg College Games Club on March 2nd, 2018 at Gettysburg College.

# Plentiful Possibilities for Pen, Pencil, and Paper Play

Todd W. Neller

# Motivation

- My recommended first purchases to play the best, most diverse games for the least money:
  - Playing Cards
  - Dice
  - Chess Set
  - Poker Chips (+ Chess Set = Chess-and-chip games)
  - **Paper and Pencil**

# Sampling of Common Games

- [Tic-Tac-Toe](#) (try [Connect6!](#))
- [Hangman](#)
- [Salvo](#) (marketed as Battleship)
- Picture Charades (marketed as [Pictionary](#))
- [The Dictionary Game](#) (a.k.a. [Fictionary](#), marketed as [Balderdash](#))
- [Guggenheim](#) (marketed as [Scattergories](#))

# Materials

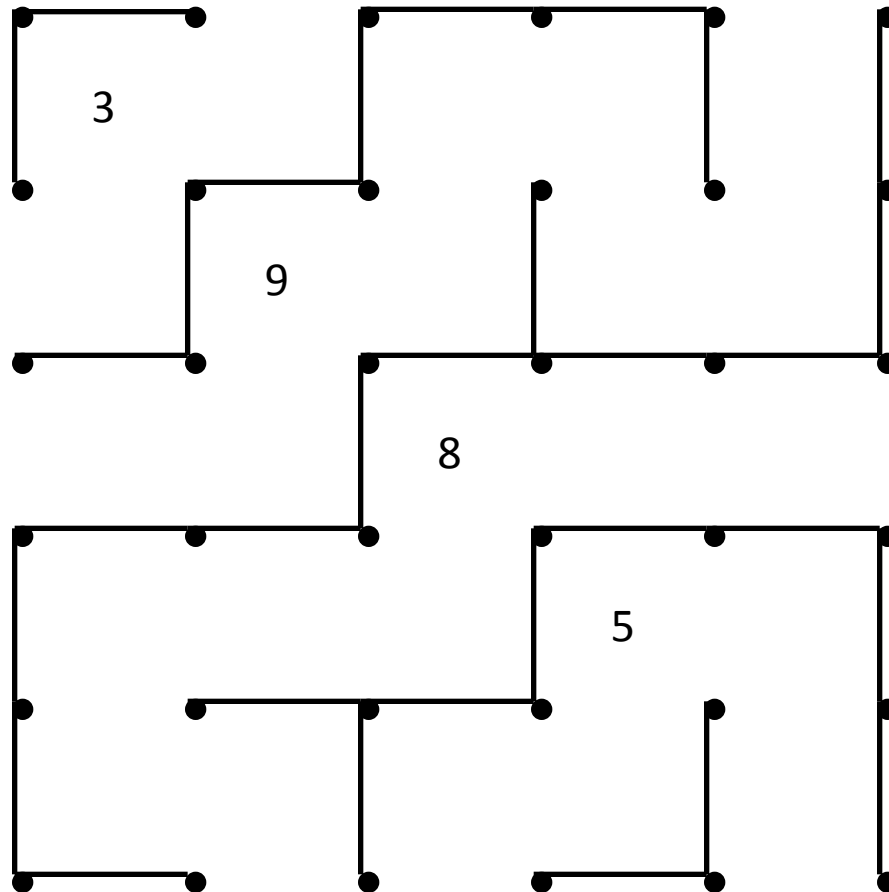
- For many games (e.g. [Connect6](#), [Salvo](#), [Pentominoes](#), [Paper Penguins](#)), graph paper is very handy
- Prefer pencil to pen to fix game rule mistakes
- Some games benefit from two colors of pencil/pen

# Dots and Boxes

- Board: An arbitrary number of dots in a rectangular grid layout. (On graph paper, dots are at intersections.)
- Move: Mark a horizontal or vertical line between adjacent dots. If this forms complete square(s), mark the square(s) with a unique player initial, and make another move.
- When all squares are claimed the player marking the most squares wins.

# Dots and Boxes: Example

- Your move:





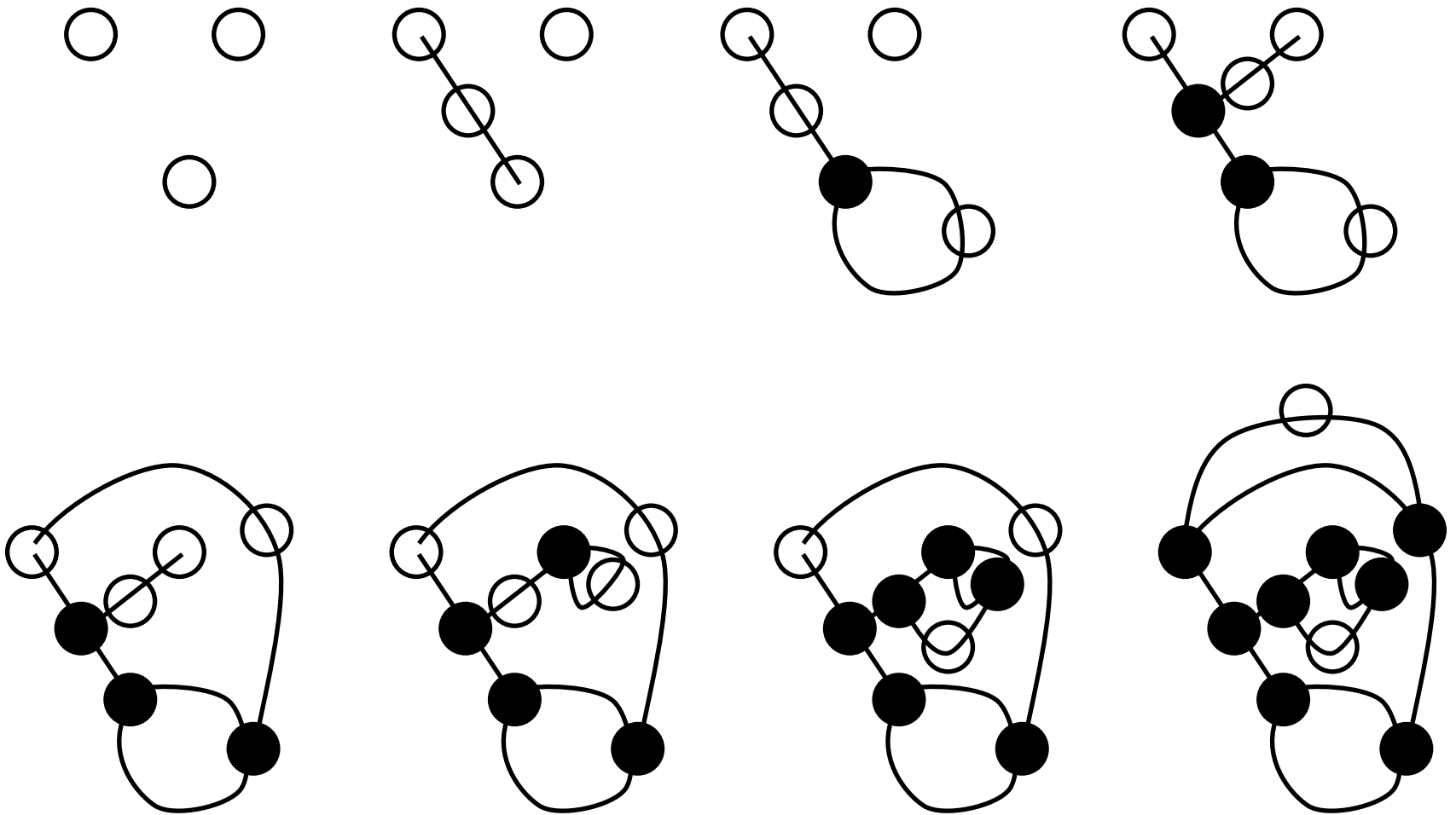
# Dots and Boxes: Basic Strategy

- Avoid creating third sides of squares.
- Consider the common end-game scenario where there are a number of disjoint chains of varying length.
  - Players typically take turns claiming one chain and giving away the next.
  - No brainer: Give away shortest chain to other player.
  - However, control in the endgame is key, so...
  - Leave the last two squares of all but last chain for the other player!
- Advanced strategy: Berlekamp, Elwin R. *The Dots and Boxes Game: sophisticated child's play*, 2000.

# Sprouts

- Rules:
  - Draw a number (e.g. 3) of unfilled small circles
  - On each turn, draw a (possibly curving) line between circles (or from a circle to itself), and draw a new circle splitting the new line. However:
    - Lines cannot touch or cross.
    - At most three lines may exit a circle.
    - (Fill in a three-line circle to aid visual reasoning.)
  - The first player unable to make a legal move loses.

# Sprouts: Example



# Sprouts: Variations

- Brussels Sprouts:
  - Instead of a circle, make a cross (plus); cross each new line.
  - Lines must be drawn from the ends of crosses.
  - Uninteresting game: Total moves, winner predetermined based on initial number of crosses. ( $5n-2$  moves; player 1/2 win with odd/even crosses)
- Weeds and Brambles
  - Respectively, Sprouts and Brussels Sprouts with *optional* circle/cross on new line
  - Makes Brussels Sprouts interesting
  - Complicates analysis of Sprouts
- More info: [http://en.wikipedia.org/wiki/Sprouts\\_\(game\)](http://en.wikipedia.org/wiki/Sprouts_(game))

# Jotto

- Deductive word game akin to Mastermind, Bulls and Cows, etc.
- Two players each choose a secret 5-letter word (not proper noun)
  - Others disallow repeated letters.
- Players seek to guess the opponent's word first.
- On each turn a player guesses a word, and the opponent responds with "Jotto!" if the guess is correct, or the number of "jots" otherwise.
  - A jot is the number of letters in the guess that may be used in the construction of the secret word.

# Jotto Examples

- Guess “piece” has 3 jots for secret word “crisp”.
- “Games” has 2 jots for secret word “soggy”.
- “Lulls” has 4 jots for secret word “gulls”.
- “Steak” has 5 jots (but no “Jotto!”) for secret word “stake”.

# Jotto Strategy

- Ideas for secret word choice:
  - Obscure words with many anagrams (e.g. “tares”)
  - Words with uncommon letters (e.g. “jazzy”)
  - Words with multiple letters (e.g. “lulls”)
- Ideas for guessing strategy:
  - Write down a list of letters, crossing out those that cannot occur in the secret word. (0 jots is good!)
  - Write down each guess and the number of jots.
  - In each guess, circle each confirmed secret letter, and cross out each confirmed non-secret letter.
  - Guess initial sequences of words with high letter coverage, e.g. blown-fixed-gravy-jumps-ketch.
  - Choose guesses to strategically aid in deductive process

# Chomp

- Based on a game by Fred Schuh (1952), given current form by David Gale and named by Martin Gardner.
- Draw an  $m$ -by- $n$  chocolate bar grid, and mark the lower-left corner square  $(0,0)$  as “poisoned”.
- Each turn, a player must take a “bite”, choosing an uneaten square and removing all squares above and/or to the right.
- The player that bites the poisoned square loses.



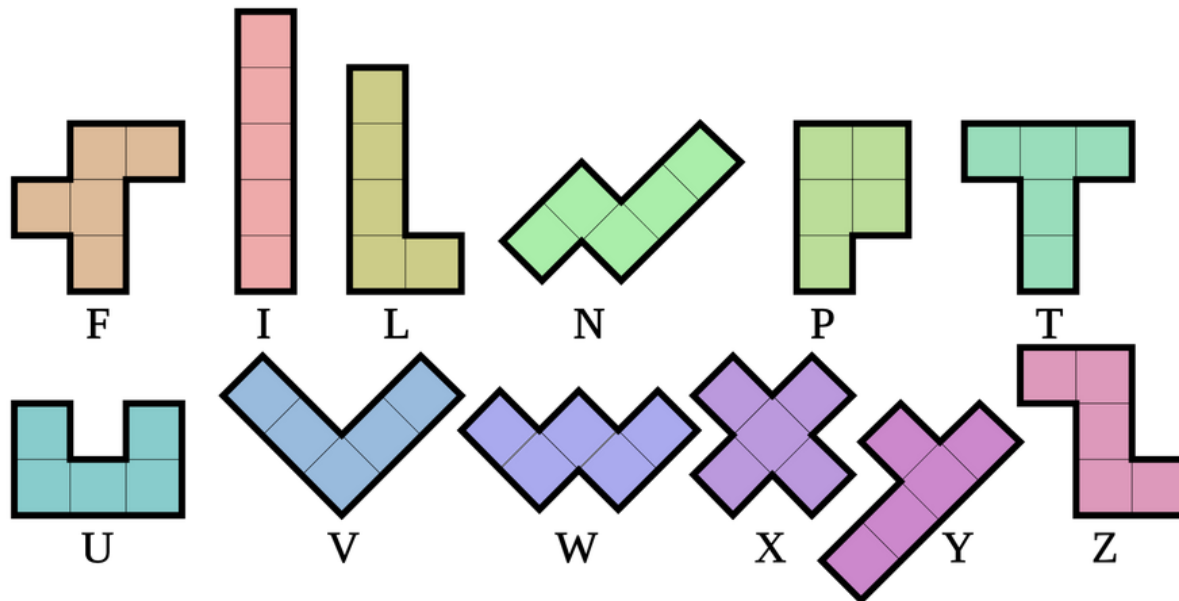


# Chomp Strategy

- Avoid allowing opponent to make symmetric “v” of squares in row 0 and column 0.
  - opponent can mirror your subsequent moves until you are forced to take the last square
  - don’t play on n-by-n boards (winning 1<sup>st</sup> play at (1,1))
- Except for 1-by-1 board, the first player can always win. Strategy stealing argument:
  - Suppose the first player takes (m-1, n-1) and the second player can guarantee a win playing at (p, q).
  - Then the first player could have guaranteed a win by playing at (p, q). (See previous example game.)

# Pentominoes

- Pentominoes (and “Polyominoes”) defined by Solomon Golomb in 1956.
  - Polyomino = figure formed by joining identical squares edge-to-edge
  - Pentomino = 5-square polyominoes
  - A way to remember the pentominos: FLIP N TUVWXYZ

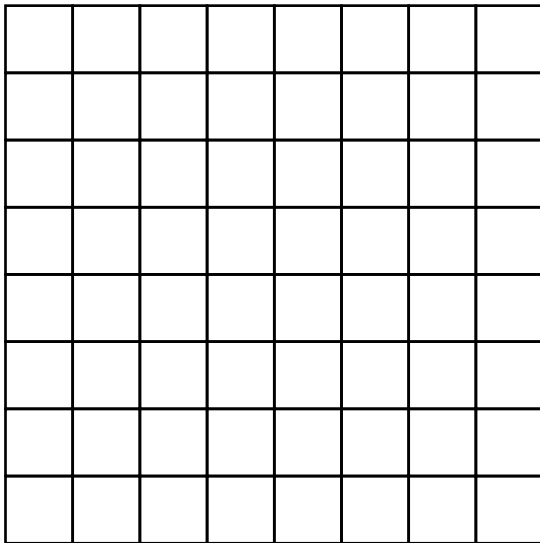


# Pentominoes Game

- On graph paper, create an 8-by-8 box, and write the letters of the 12 pentominoes to the side: FLIP N TUVWXYZ. (Each may be played once, and we'll cross each off as it is played.)
- Each turn, a player seeks to place (with rotation and flipping) a remaining pentomino into the grid, outlining it, filling it in, and crossing out its corresponding letter.
- The last player able to place a remaining pentomino wins.

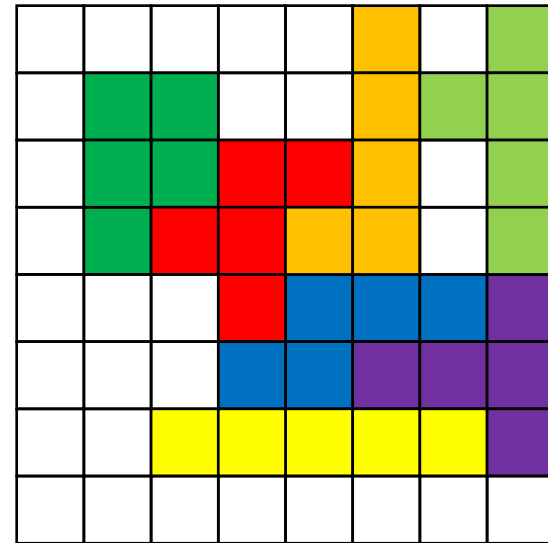
# Pentominoes Game Example

Initial Board



FLIP N TUVWXYZ

Your Move?



FLIP N TUVWXYZ

# References

- Wikipedia “paper and pencil games”:
  - category: [http://en.wikipedia.org/wiki/Category:Paper and pencil games](http://en.wikipedia.org/wiki/Category:Paper_and_pencil_games)
  - article: [http://en.wikipedia.org/wiki/Paper and pencil game](http://en.wikipedia.org/wiki/Paper_and_pencil_game)
  - Connect6: <http://en.wikipedia.org/wiki/Connect6>
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# Other Paper-and-Pencil Games

- Domineering (<http://en.wikipedia.org/wiki/Domineering>)
- Col ([http://en.wikipedia.org/wiki/Col\\_\(game\)](http://en.wikipedia.org/wiki/Col_(game)))
- Snort ([http://en.wikipedia.org/wiki/Snort\\_\(game\)#Snort](http://en.wikipedia.org/wiki/Snort_(game)#Snort))
- Hackenbush (<http://en.wikipedia.org/wiki/Hackenbush>)
- Hex ([http://en.wikipedia.org/wiki/Hex\\_game](http://en.wikipedia.org/wiki/Hex_game))
  - See also Shannon Switching Game ([http://en.wikipedia.org/wiki/Shannon\\_switching\\_game](http://en.wikipedia.org/wiki/Shannon_switching_game))
- Join Five ([http://en.wikipedia.org/wiki/Join\\_Five](http://en.wikipedia.org/wiki/Join_Five), a.k.a Morpion Solitaire)
- Lexicant (<http://en.wikipedia.org/wiki/Lexicant>)
- Racetrack ([http://en.wikipedia.org/wiki/Racetrack\\_\(game\)](http://en.wikipedia.org/wiki/Racetrack_(game)))
- Sim ([http://en.wikipedia.org/wiki/Sim\\_\(pencil\\_game\)](http://en.wikipedia.org/wiki/Sim_(pencil_game)))
- Hip (<http://delphiforfun.org/programs/HIP.htm>)
- [Word Squares](#) (see below)
- [Paper Penguins](#) (see below)

# Word Squares

a.k.a. Crosswords, Word Exchange, Stock Exchange

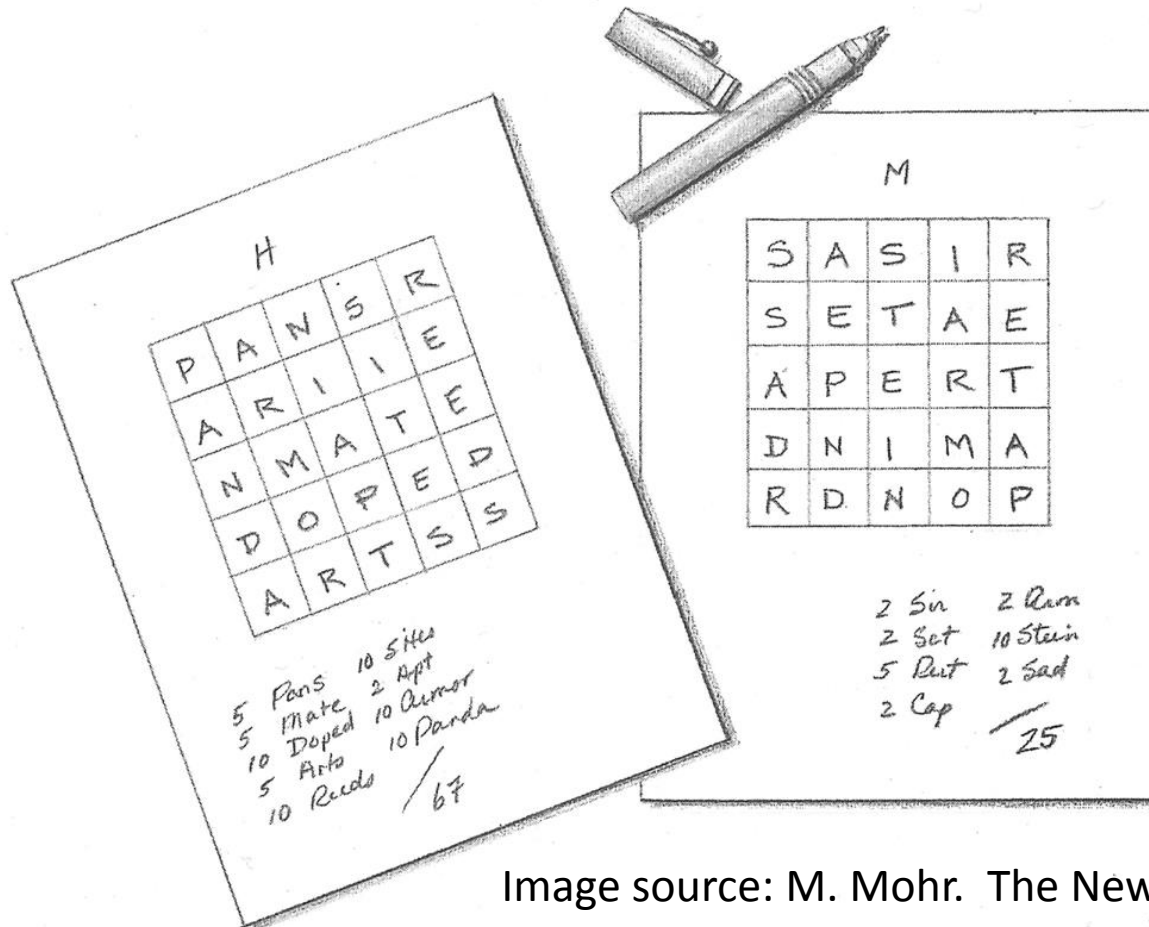


Image source: M. Mohr. The New Games Treasury



# Word Squares General Overview

- A random **letter** is announced to all.
- Each player independently places that same **letter** into a **5x5 square grid**.
- These steps are repeated until grids are full.
- The goal is to place the **letters** so as to achieve the highest scoring **words**.




# Word Squares Rules

- Each player has a pen and paper with a 5x5 grid.
- Players take turns choosing and announcing letters that each player must write into an empty grid space.
- After 25 turns, grids are scored for words formed across/down within rows/columns as follows:
  - 5 letters → 10 points; 4 letters → 5 points; 3 letters → 2 points
  - Words contained within other words do not count. E.g. one scoring TWINS cannot also score TWIN, WIN, WINS, and INS.
  - Overlapped words may score. E.g. a row/column with GAMEN would score both GAME and AMEN for  $2 \times 5 = 10$  points.
  - As in other word games, challenges are allowed, so that players should agree upon word restrictions (e.g. 3-or-more-letter Scrabble words) and a dictionary (e.g. Scrabble player's dictionary) to check challenges.

# Paper Pen-guins

- My core idea: Pen and paper “Hey! That’s My Fish!” on a square grid.
- Board: 8x8 square grid filled with random point distribution of 32 ones, 21 twos, and 11 threes. (May be generalized to other sizes with proportions 3:2:1.)
- Pen(s)/pencil(s), ideally contrasting color pencils.
- The first and second player mark square and circle pieces, respectively.

	a	b	c	d	e	f	g	h	
8	2	3	2	3	2	2	3	1	8
7	1	1	3	2	1	3	1	2	7
6	2	1	1	1	1	2	2	2	6
5	1	1	1	1	1	2	1	3	5
4	1	1	1	1	1	2	1	1	4
3	1	2	3	2	3	1	3	2	3
2	2	2	2	1	2	1	1	1	2
1	3	2	2	1	1	1	1	3	1
	a	b	c	d	e	f	g	h	

 0     0     to play

# Paper Pen-guins: Initial Placements

- Players take turns “placing” pieces by scoring point numbers and circumscribing them with player shapes, 4 per player.

	a	b	c	d	e	f	g	h	
8	2	3	2	3	2	2	3	1	8
7	1	1	3	2	1	3	1	2	7
6	2	1	1	1	1	2	2	2	6
5	1	1	1	1	1	2	1	3	5
4	1	1	1	1	1	2	1	1	4
3	1	2	3	2	3	1	3	2	3
2	2	2	2	1	2	1	1	1	2
1	3	2	2	1	1	1	1	3	1
	a	b	c	d	e	f	g	h	

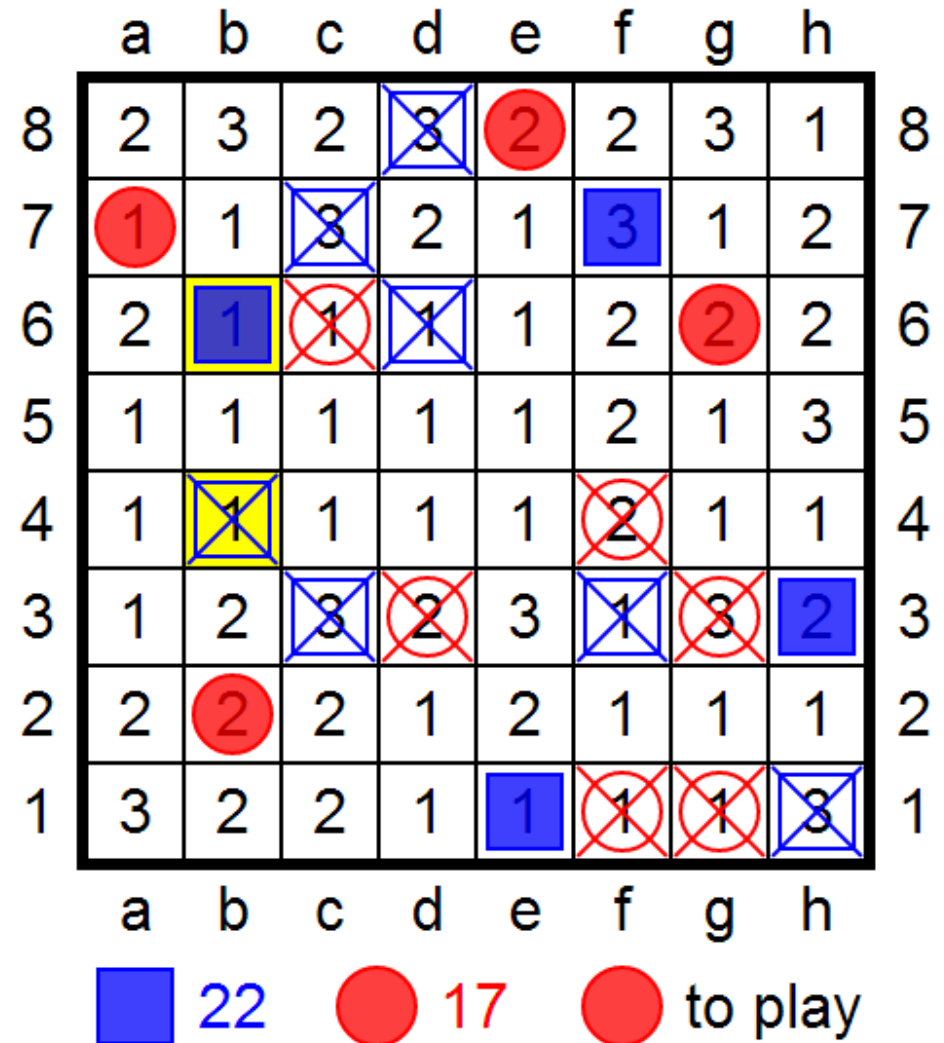
■ 10    ● 6    ● to play

	a	b	c	d	e	f	g	h	
8	2	3	2	3	2	2	3	1	8
7	1	1	3	2	1	3	1	2	7
6	2	1	1	1	1	2	2	2	6
5	1	1	1	1	1	2	1	3	5
4	1	1	1	1	1	2	1	1	4
3	1	2	3	2	3	1	3	2	3
2	2	2	2	1	2	1	1	1	2
1	3	2	2	1	1	1	1	3	1
	a	b	c	d	e	f	g	h	

■ 10    ● 7    ■ to play




# Paper Pen-guins: Move

- Following placements, players take turns making queen-like “moves”. The source position is blocked with an “X” drawn corner to corner. The destination position score number is scored and circumscribed with the player’s shape.



# Paper Pen-guins: Game End

- Play ends when neither player can move, and sometimes ends by mutual consent when end play is agreed upon.
- Players then claim remaining points as possible.
- Highest score wins.

	a	b	c	d	e	f	g	h	
8	<del>2</del>	3	2	<del>3</del>	<del>2</del>	2	3	1	8
7	<del>1</del>	<del>1</del>	<del>3</del>	<del>2</del>	1	<del>3</del>	<del>1</del>	2	7
6	<del>2</del>	1	<del>1</del>	<del>1</del>	<del>1</del>	2	<del>2</del>	<del>2</del>	6
5	<del>1</del>	1	1	1	<del>1</del>	<del>2</del>	1	<del>3</del>	5
4	1	<del>1</del>	<del>1</del>	1	<del>1</del>	<del>2</del>	1	1	4
3	<del>1</del>	<del>2</del>	<del>3</del>	<del>2</del>	<del>3</del>	<del>1</del>	<del>3</del>	<del>2</del>	3
2	2	<del>2</del>	<del>2</del>	<del>1</del>	<del>2</del>	1	1	1	2
1	<del>3</del>	2	<del>2</del>	<del>1</del>	<del>1</del>	<del>1</del>	<del>1</del>	<del>3</del>	1
	a	b	c	d	e	f	g	h	
		45		44		to play			