

Chapter 6

Conclusion

I now return to the real world to see what, if anything, the analysis of the previous chapters has to say about it.

6.1 Pessimism vs. Realism

If I had given you a winning strategy for tetris, you could have used it to make a real game of TETRIS last as long as you wished, provided the game didn't get too fast for you. You would have been able to beat TETRIS no matter how cleverly it was programmed to defeat you. In fact, I've shown that you don't have a winning strategy for tetris, because if it were programmed to do so, the machine could send you a sequence of kinks which would quickly end your game. But what does this say about TETRIS?

I have no evidence to contradict the hypothesis that the TETRIS machine simply flips a seven-faced coin to decide which piece it will hand you — TETRIS doesn't appear programmed to act as an opponent. In a typical game, the random sequence of pieces you receive will probably allow you to play for much longer than you could if the pieces were carefully chosen. If I call this the **average case** scenario, then my concept of strategy assumes a **worst case** scenario: the machine tries its best to defeat you, turning the game into a contest between two players. (You can actually play tetris against a human opponent using a pencil and a piece of paper; delete rows by folding them out of existence. If the player sending the pieces has read this thesis, the game won't last long!)

I suspect it would be more difficult to come up with any exact results in the average

case scenario. However, I'd still like some indication of how my worst-case results relate to reality. One question I find interesting is whether the seven pieces can be ranked according to how difficult, on average, they are to play. Instead of analyzing the average case mathematically, I've decided to bring in some expert opinion.

6.2 The player survey

For two weeks in February, 1992, I conducted a passive survey of TETRIS players. I put a total of 100 survey forms (see Figure 6.31) into envelopes stuck to three TETRIS machines on the UBC campus (one in each of Gage and Vanier residences, and one in the SUB video arcade). Players were informed about the survey by the instruction sheet shown in Figure 6.32. Twenty-four forms were returned, and I have summarized the results in Table 6.4.

Table 6.3: The average rank of TETRIS pieces, where smaller means harder. The sample size is 24, and the standard error equals the standard deviation divided by $\sqrt{24}$.

	Right Kink	Left Kink	Right Elbow	Left Elbow	Tee	Square	Bar
Avg. Rank	0.75	0.96	2.13	2.54	3.92	3.96	4.67
Std. Dev.	1.01	1.40	1.13	1.22	2.02	1.65	1.95
Std. Err.	0.21	0.29	0.23	0.25	0.41	0.34	0.40

In Table 6.3, I've listed the "average" rank for each piece. Each player was asked to rank the pieces, with 1 for the hardest, higher numbers for easier pieces, and with equally difficult pieces getting the same rank. I counted, for each piece and player, how many pieces that player ranked as being less difficult to play than that piece. The averages and standard deviations in the table are for this transformed rank. For example, the average rank of 2.54 for left elbows indicates that, on average, players ranked 2.54 other pieces as being more difficult to play than left elbows.

The fact that the two kinks had the lowest average rank indicates they were generally perceived to be the hardest pieces to play. This is reminiscent of the results in Chapter 5. The square was ranked easier than all other pieces except the bar. This might remind you of the two-piece strategies in Chapter 3: if one of the pieces you are playing with is a square, then your winning strategy (if you have one) doesn't require lookahead. Elbows received an intermediate rank. This might reflect the fact that winning strategies for sets of pieces with an elbow require lookahead, unless the other piece is a square. I know of no strategy for the two elbows which doesn't use lookahead. That makes elbows "more difficult" to play than the square, but "less difficult" than the kinks. These comparisons are vague, but I find them interesting nonetheless.

I posed questions 8 and 9 of the survey to see what factors players found most important in ending their games. One of the assumptions I made in formulating tetris was that you could take as long as you wanted to play the pieces. This affects the relevance of tetris to TETRIS: the more important are time factors, the less relevant is this thesis. For the game just played, 14 out of 24 players chose a time-related factor (i.e. "b", "c", or "h") as most important in ending their game, while only 6 chose a piece-related factor (i.e. "a" or "g"). (Other responses deal with factors incidental to the game.) As for what usually ended their games, 18 of 24 players indicated a time-dependent factor, while only 6 chose a piece-related factor. It probably doesn't surprise you that speed and timing play a major role in influencing the length of a game of TETRIS, and thus the score obtained therein.

The answers to the lookahead questions indicate that most players make use of this information at least often (19 of 24 players), with a slight trend towards greater usage among players with higher scores. Of the 19 frequent lookahead users, 5 thought two piece lookahead would not be helpful, 8 thought it would be somewhat helpful, and 5 thought it would be very helpful. In Chapter 3, I gave you winning strategies for some

pairs of pieces in which you had to use lookahead, but not very often. I know of no set of pieces for which there is a winning strategy with two- (or more) piece lookahead, but none for one-piece lookahead.

The most common piece of advice selected was "Try not to leave any holes" (8 of 24 players). Players' own advice included "Stay calm", "Leave a space by the wall for a tetris [i.e. a simultaneous clearing of four rows]", "Don't wait for that perfect piece", and "Pretend you are having sex" (the latter proffered by player 3, who, judging by his/her score, is adept at following this advice).

Unfortunately, when I posed question 10, I was thinking in terms of tetris. In TETRIS, the best way to play a piece seems usually to depend on how many rows you have left to clear in the current round. I didn't indicate this number in the six situations, and so it's not clear that I can conclude anything from the responses. Moreover, I had intended each situation to pose a simple tradeoff (clearing a row vs. not leaving a hole, for example), but, for example, players indicated five different plays in the first situation, and six in the second.








6.3 Personal Conclusion

Even with knowledge of the results in this thesis, I can't get a TETRIS score higher than about 100000. However, 6 of the 24 people in the survey can obtain much higher scores, and the typical high score on TETRIS machines at UBC is roughly 900000. Therefore, I have no choice but to conclude that, at least for TETRIS,

We do not learn from inference and deduction and the application of mathematics, but by direct intercourse and sympathy. [2]

Tetris Player Survey (to be completed right after a game)















1. What was your score (roughly)? _____ 2. At what level did you begin *this* game? Easy Medium Hard
3. At what level do you *usually* begin? Easy Medium Hard
4. Rank the Tetris pieces according to how difficult you *usually* find it to play them. Use 1 to indicate the hardest piece(s) to play, and use 2, 3, and so on to indicate easier pieces. If you find two or more pieces roughly equally difficult to play, give them the same number. Please assign a number to every piece.

Piece:       

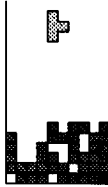
Your ranking:
(1=hardest) _____ _____ _____ _____ _____ _____

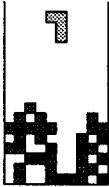
5. While you are playing a piece, Tetris shows you the next piece you'll have to play. How often do you use this information?
a) Never b) Seldom c) Often d) Usually
6. At low game speeds, how helpful would it be to see the next two pieces, rather than just the next one?
a) Not helpful b) Somewhat helpful c) Very helpful
7. If you wanted to help a beginning Tetris player, and could give only one simple piece of advice to that player, what would it be? (If you have advice you prefer to the ones listed, please circle f and write it in the space provided.)
a) Play pieces as low as possible. b) Try not to leave any holes. c) If you can clear a row, do it.
d) Watch to see which piece will come next. e) Play pieces of the same type close to one another.
f) (your own): _____


For questions 8 and 9, choose the factor that you feel contributed most to ending *this* game of Tetris, and the one which *usually* does so when you play. If you think a factor not listed here was more important, please circle i and write it in the space provided.

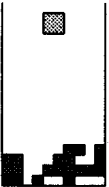
<ol style="list-style-type: none"> 8. This game: <ol style="list-style-type: none"> a) _____ b) _____ c) _____ d) _____ e) _____ f) _____ g) _____ h) _____ i) _____ 	<ol style="list-style-type: none"> 9. Usually: (Please circle only one letter in each column.) <ol style="list-style-type: none"> a) I was waiting for a certain piece, and the machine didn't send it. please circle which one:        b) I was trying to play a piece in a certain spot, but it was dropping so fast I didn't have time to move it across to that spot. c) I accidentally played a piece where I didn't mean to. d) The joystick or rotate button malfunctioned. e) I got distracted by something outside of the game. f) I didn't feel like playing any longer. g) The machine was sending too many of a certain type of piece. please circle which one:        h) The game got so fast I couldn't keep track of what was happening. i) (your own): _____
---	---

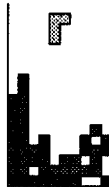
10. Here are 6 situations you might face. Please draw the piece where you would play it. (The next piece is shown in small.)














Thanks for your help. If you have comments/questions about Tetris or this survey, please put them on the back of this sheet.

Figure 6.31: The TETRIS player survey form.

The Tetris Player Survey: Why and How?

Why:

The purpose of this survey is to discover commonly held beliefs about Tetris. In particular, I'm interested in strategies people are using and in how different aspects of the game affect their scores.

This data is being collected as part of the research for my Master's thesis. (I'm a graduate student in the Institute of Applied Mathematics, here at UBC.) Survey results will appear in copies of the thesis at both Main and Math libraries.

The aim of the thesis is to investigate, mathematically, common knowledge about Tetris. The survey data will tell me both what beliefs (if any) people hold about the game, and what aspects of the game are essential and must be included in reasonable mathematical models of it. Such models will be used to explore questions about strategy like those on the other sign.

How

- * Play a game of Tetris
- * Fill out a survey form:
 - give the answers **you feel are best**
 - don't peek at other people's forms
 - if you're really unsure about what a question is asking for, leave it blank.
 - write any comments or questions you have about this survey, or Tetris, on the back of the page
- * Leave the completed form in the envelope provided.
- * Feel good about yourself for contributing to interesting research and for helping another student to graduate.

Thank-you for your help!

Figure 6.32: Instructions for TETRIS player survey participants.

Table 6.4: Results of the TETRIS player survey. Each row corresponds to answers provided by one player, in the same order as questions appear on the survey. Levels: easy, medium, hard. Ranks: Tee, Right Elbow, Left Kink, Square, Bar, Left Elbow, Right Kink. Lookahead: 1 is use of current lookahead, 2 is potential use of 2-piece lookahead. Reasons why game ends: Now is this game, Most is usually. The letters correspond to the choices on the survey form.

Player No.	Score	Levels	Ranks	Look		Advice	Game End	
				1	2		Now	Most
9		e,e	3,2,1,4,5,2,1	c	a	a	d	b
14		m,e	3,2,1,5,4,2,1	c	b	b	b	a
10		e,e	6,3,1,5,7,4,2	d	c	d	a	f
7		e,e	1,2,2,3,3,2,2	d	c	f	ah	ach
6			7,3,5,6,1,2,4	b	b	f		ac
2	16000	e,e	3,4,2,6,7,5,1	b	a	b	c	c
12	20000	e,e	3,1,2,4,5,1,2	d	b	b	b	b
22	20000	e,e	4,3,1,2,5,3,1	d	a	a	c	b
16	30171	e,e	6,4,1,3,7,5,2	b	b	c	eg	abcdfh
8	50000	e,e	7,5,2,6,3,4,1	c	b	c	bc	bcdh
4	59289	e,e	2,3,1,4,5,3,1	d	b	b	c	b
21	60000		6,2,1,4,5,3,2	cd	b	cf	c	c
18	75000	e,m	6,3,1,5,7,4,2	c	c	b	a	b
11	80978	e,e	5,2,1,3,4,2,1	c	a	d	b	b
13	93000	h,h	7,5,1,3,4,6,2	b	b	b	a	f
17	103979	h,h	4,3,2,1,5,3,2	d	b	c	c	cg
20	110000	e,e	7,2,5,6,3,4,1	b	c	a	h	h
24	122246	m,m	5,3,1,6,7,4,2	d	c	f	h	f
23	235000	e,e	3,4,2,6,7,5,1	d	a	b	c	c
1	287635	e,e	6,4,2,5,3,4,1	c	b	c	e	d
19	350000	e,e	1,1,1,1,1,1,1	d	c	f	d	h
5	400000	h,h	3,3,2,4,4,3,1	d	a	f	c	c
3	847088	e,e	1,3,2,4,5,3,2	d	b	f	a	gi
15	987000		4,1,6,3,7,2,5	c	b	b	e	c