

## APPENDIX A

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### *Tables*

The following tables were taken from the results of the Monopoly Information & Data Analysis System (MIDAS) program, run by the authors at Cornell University in Ithaca, N.Y., on an IBM 370/168 computer, using a PL/C compiler. The initial landing probabilities were computed from a modification of a Markov process, using a 43-state transition matrix. All probabilities given in the tables were rounded to three significant digits, and all dollar amounts and numbers of turns were rounded to the nearest integer.

Both tables show the probabilities of landing on each square on the Monopoly board on any given roll of the dice. Table 1 is organized by color group for easy reference. Table 2 is arranged in order of frequency of landing, from the most frequently visited square (Jail) to the least frequently visited (Mediterranean Avenue).

To interpret the numbers in the tables, ignore the decimal point and you will obtain the average number of times the square in question will be landed on in 10,000 rolls of the dice. In most cases, you will be interested only in the first two significant digits of the probability. These will give you the average number of times the square will be landed on in 1000 rolls. For instance, the line "Atlantic Avenue . . . .0296" means that Atlantic Avenue will be visited an average of 30 times out of every 1000 rolls, or about once in every 34 rolls.

TABLE 1  
LANDING PROBABILITIES AND RANKINGS

GROUP	INDIV. PROB.	TOTAL PROB.	RANK*
Purples		.0473	8
Mediterranean Avenue	.0235		
Baltic Avenue	.0238		
Light Blues		.0758	6
Oriental Avenue	.0249		
Vermont Avenue	.0255		
Connecticut Avenue	.0253		
Maroons		.0835	5
St. Charles Place	.0299		
States Avenue	.0254		
Virginia Avenue	.0283		
Oranges		.0969	1
St. James Place	.0312		
Tennessee Avenue	.0329		
New York Avenue	.0328		
Reds		.0953	2
Kentucky Avenue	.0305		
Indiana Avenue	.0299		
Illinois Avenue	.0349		
Yellows		.0874	3
Atlantic Avenue	.0296		
Ventnor Avenue	.0294		
Marvin Gardens	.0284		
Greens		.0858	4
Pacific Avenue	.0294		
No. Carolina Avenue	.0289		
Pennsylvania Avenue	.0275		

\* Rank indicates the order of total landing probabilities for color groups

GROUP	INDIV. PROB.	TOTAL PROB.	RANK*
Dark Blues		.0531	7
Park Place	.0241		
Boardwalk	.0290		
Railroads		.1239	
Reading Railroad	.0327		
Pennsylvania Railroad	.0307		
B & O Railroad	.0337		
Short Line Railroad	.0267		
Utilities		.0614	
Electric Company	.0305		
Water Works	.0309		
Chance		.0833	
Square 7	.0254		
Square 22	.0325		
Square 36	.0254		
Community Chest		.0840	
Square 2	.0237		
Square 17	.0306		
Square 33	.0297		
Miscellaneous			
Go	.0340		
Income Tax	.0256		
Just Visiting	.0250		
Jail			
Sent to Jail	.0432		
Spent 1 turn	.0360		
Spent 2 turns	.0300		
Free Parking	.0329		
Go to Jail Square	.0290		
Luxury Tax	.0240		

TABLE 2  
LANDING PROBABILITIES BY RANK

RANK	SQUARES	INDIV. PROB.
1	Jail—Sent	.0432
	Spent 1 turn	.0360
	Spent 2 turns	.0300
2	Illinois Avenue	.0349
3	Go	.0340
4	B & O Railroad	.0337
5	Free Parking	.0329
6	Tennessee Avenue	.0329
7	New York Avenue	.0328
8	Reading Railroad	.0327
9	Chance (22)	.0325
10	St. James Place	.0312
11	Water Works	.0309
12	Pennsylvania Railroad	.0307
13	Community Chest (17)	.0306
14	Electric Company	.0305
15	Kentucky Avenue	.0305
16	Indiana Avenue	.0299
17	St. Charles Place	.0299
18	Community Chest (33)	.0297
19	Atlantic Avenue	.0296
20	Pacific Avenue	.0294
21	Ventnor Avenue	.0294
22	Boardwalk	.0290
23	Go to Jail Square	.0290
24	No. Carolina Avenue	.0289
25	Marvin Gardens	.0284
26	Virginia Avenue	.0283
27	Pennsylvania Avenue	.0275
28	Short Line Railroad	.0267
29	Income Tax	.0256
30	Vermont Avenue	.0255

RANK	SQUARES	INDIV. PROB.
31	Chance (36)	.0254
32	Chance (7)	.0254
33	States Avenue	.0254
34	Connecticut Avenue	.0253
35	Just Visiting	.0250
36	Oriental Avenue	.0249
37	Park Place	.0241
38	Luxury Tax	.0240
39	Baltic Avenue	.0238
40	Community Chest (2)	.0237
41	Mediterranean Avenue	.0235





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<i>Invest- ment</i>	<i>Purple</i>	<i>Lt- Blue</i>	<i>Ma- roon</i>	<i>Orange</i>	<i>Red</i>	<i>Yel- low</i>	<i>Green</i>	<i>Dk- Blue</i>
2800							33	
2900							33	
3000							34	

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NOTE: cost of buying properties is only included when figuring the number of turns with zero investment.

TABLE 4  
 EXPECTED CASH OUTPUT PER ROLL  
 (IN DOLLARS)

<i>Invest- ment</i>	<i>Purple</i>	<i>Lt- Blue</i>	<i>Ma- roon</i>	<i>Orange</i>	<i>Red</i>	<i>Yel- low</i>	<i>Green</i>	<i>Dk- Blue</i>
100	1	2	2	3	—	—	—	—
200	2	3	3	4	4	4	4	7
300	4	6	4	6	6	6	4	7
400	9	8	7	10	6	6	7	9
500	13	13	9	13	7	8	7	9
600		23	11	16	12	14	10	17
700		31	18	26	12	14	10	17
800		34	25	35	17	19	17	24
900			32	44	21	24	17	24
1000			36	49	21	24	23	42
1100			40	54	32	36	23	42
1200			44	59	42	47	29	55
1300			49	64	42	47	29	55
1400			51	69	55	58	41	61
1500			54	74	59	62	41	61
1600					59	62	53	65
1700					63	66	53	65
1800					68	70	64	72
1900					68	70	64	72
2000					72	74	69	76
2100					77	78	69	
2200					77	78	73	
2300					81	82	73	
2400							78	
2500							78	
2600							82	
2700							82	
2800							87	
2900							87	
3000							90	

The effect of Go is to add \$33/turn after taxes.



## NOTES ON TABLES 3 AND 4

Tables 3 and 4 are analysis charts. Table 3 measures each color group's efficiency at 30 different levels of investment (\$100 increments). The numbers represent how many rolls of the dice it will take you to get your invested money returned at each level of investment. The faster your money is returned, the more *efficient* the color group is at turning your investment into profits. If you have \$900 to invest, the chart shows that you can get your money back fastest if you invest it in the Oranges (21 turns). If you scan the chart, you will see that the Oranges are, in general, the most efficient color group. If you have \$900 to invest and you don't own the Oranges, the second fastest way to get your money back would be to invest \$750 in the Light Blues. (The Light Blues do not have a value on the chart for \$900, since the maximum investment you can make in buildings is \$750. At \$750, it will take you about 23 turns to get your money back.) The formula which was used to compute Table 3 is:

$$\text{Number of rolls} = \frac{\text{u.c.} \times B}{\sum_{i=1}^N P_i R_i}$$

- where u.c. = unit development cost (per house)  
 B = number of houses to be built  
 N = number of properties in the color group  
 $P_i$  = probability of landing on property "i"  
 $R_i$  = rent on property "i"

Note: when it is possible to arrange houses in more than one way on a color group, the number given in the table is computed assuming the *most efficient* arrangement.

Table 4 (which is used comprehensively in the cash flow section of the Appendix) is a much more useful gauge of a color group's value. Whereas Table 3 tells how efficient a color group is, Table 4 translates that efficiency into the number of dollars you can expect to receive each time the dice are rolled by an opponent who is not immune on your color group. The highest number in each row is enclosed in a box to show which color group returns the most money per turn at each level of investment. If you are investing \$900, this table clearly shows that the Oranges are your best investment. On the average, this color group will return you \$44 per turn. Why are the Oranges so valuable at this level of investment? Because \$900 will develop the Oranges to the critical level, and the critical level is highly profitable.

## APPENDIX B

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### *Your Horoscope*

**CAPRICORN (The Goat).** Dec. 22–Jan. 20.

This is the sign of the cautious Monopoly player. You make trades only when they “feel right,” being careful not to be fooled. You are often the underdog, but this does not make you uncomfortable, since you are confident that patience and planning will bring you victory.

Your best token: the shoe. Your best day to play Monopoly: Saturday.

**AQUARIUS (The Water Carrier).** Jan. 21–Feb. 18.

Your fair mind and cool head make you a respected player in any Monopoly game. To you, the rules are flexible, and you have the ability to display your inventiveness in imaginative trades. You are not afraid to take risks, although you do not play foolishly. Every now and then you make little mistakes that hurt your play.

Your best token: the thimble. Your best day to play Monopoly: Monday.

**PISCES (The Fish).** Feb. 19–Mar. 20.

Your ability to perceive your opponent's true desires makes you a good player. Your ability to sway people gives you a strong influence over the game, even though at times you prefer to remain silent. Guard against your lack of confidence and use your game-winning abilities. Boardwalk and Park Place seem especially strong for you.

Your best token: the flat iron. Your best day to play Monopoly: Friday.

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**ARIES (The Ram).** Mar. 21–Apr. 20.

You are the give-'em-hell type and take a back seat to nobody during a Monopoly game. Your imagination and energy will sometimes make you quick-tempered and impatient and will make you appear scornful of other players' advice at times. You spend more time in Jail and roll more doubles than does the average player. Watch out for the Red group.

Your best token: one of your own. Your best day to play Monopoly: Saturday.

**TAURUS (The Bull).** Apr. 21–May 21.

You are very practical, conservative, and persistent. When you desire a property, you are usually stubborn enough to end up getting it. Those lucky breaks which seem to come your way so often are not all by accident. You like to develop properties slowly, and this can be a strategic error. Chance cards are especially unlucky. Do your best to avoid Pennsylvania Avenue.

Your best token: the dog. Your best day to play Monopoly: Saturday.

**GEMINI (The Twins).** May 22–June 21.

You are difficult to bankrupt, since your friends always want to give you another chance. You have an excellent wit and should not be afraid to use that wit over the Monopoly board. You get off to slow starts, but come on strong in a long game. Never buy utilities.

Your best token: a \$20 double eagle. Best day to play Monopoly: Sunday.

**CANCER (The Crab).** June 22–July 22.

You derive special joy from bankrupting close friends and relatives, although you try to hide this pride. You are a shrewd investor and don't play hunches. Fight your tendency toward procrastination, which can cause you to pass up golden opportunities. Never forget to roll again on doubles. Beware of Greeks bearing properties.

Your best token: the horseman. Your best Monopoly position: sit on the side of the cheap streets.



**LEO (The Lion).** July 23–Aug. 23.

This is an excellent sign for a Monopoly player. You are filled with spirit and determination. You will often be impulsive, but not without cause. Watch out for Park Place, as it can knock you out fast. Use your skills to compensate for your frequent streaks of bad luck. Don't fall in love with the player that uses the dog token.

Your best token: the wheelbarrow. Best day to play Monopoly: Thursday.

**VIRGO (The Virgin).** Aug. 24–Sept. 23.

This is the sign of the analytical mind. Your obsession with details will sometimes get in the way of your trading. Try to relax more during Monopoly games, and your play will improve. Your dislike for screamers is well founded. Do not make partnerships with Leos, as this can upset the stars.

Your best token: the racecar. Your best starting position: second roller.

**LIBRA (The Balance).** Sept. 24–Oct. 23.

As your symbol implies, you are very good at playing your opponents off against one another. Hotels are very unlucky for you—stick with four houses on each property. Shake the dice well and avoid Luxury Tax. Always cut the Chance cards at the start of the game. Do not become overly concerned if you fall behind early, just don't fall too far behind.

Your best token: the steamboat. Your best day to play Monopoly: Monday.

**SCORPIO (The Scorpion).** Oct. 24–Nov. 22.

This is the sign of some of the world's best and worst Monopoly players. Be watchful of the housing supply and try not to triple-outguess your opponents. Beware of the trend of almost achieving victory and blowing it at the last moment. Avoid the Income Tax square, as this kind of tax can be the worst.

Your best token: a miniature razor. Your best day to play Monopoly: any day but Saturday.



**SAGITTARIUS (The Archer). Nov. 23–Dec. 21.**

Your optimistic approach means that you start every game with high hopes. Don't let bad luck discourage you. Don't forget to collect rents, but be careful not to collect rents on Baltic Avenue if it has no houses. Success is yours if you keep your mind from wandering during the game. The Light Blues are a favorable color group.

Your best token: the hat. Your best days to play Monopoly: Wednesdays and holidays.

## APPENDIX C

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### *Tips for Games with Other Than Four Players*

#### *Two Players*

Monopoly games involve a lot more luck and a lot less skill when only two people play. Devices such as partnerships and revenue sharing have no application whatsoever, and giving immunity is equivalent to throwing the properties away. The winner in a two-player game is usually the player who is the first to develop a color group to the critical level. Options are still used in two-player games, and they have the effect of guaranteeing that the player who receives the option will eventually get the optioned property. After all, either he gets it or his opponent does. The only real question is when. Housing shortages are a lot less frequent in two-player games because the players rarely manage to accumulate enough money to buy 32 houses. With four players there is a lot more money at the beginning of the game, and there are more people passing Go and collecting \$200. If at all possible, try to get a free land on your opponent's color group. Then, using the free land as a margin of safety, invest all of your available cash, and any other money you can raise, in houses or hotels on your color group. Your hope is to quickly bankrupt your single opponent and win the game. Remember, with only two players in the game, if one gets in trouble there is nobody else around to help bail him out. Go after bankruptcy as quickly as possible, since one unlucky break can undo a lot of skillful playing when only two players are involved.

### *Three Players*

Strategies in a three-player game are altered somewhat from those in a four-player game. Immunities and partnerships can be used, but their use is extremely limited. In this type of game, it is important to prevent your opponents from trading with one another. The best strategy is to join with another player and gang up on a third player, making sure that you are the one who will do the actual bankrupting and receive the properties. In a three-player game, it is also important to try and bankrupt earlier than in a four-player game, since it is much more difficult to recoup after a bad start. There is still some room to appeal to the third player if you get yourself in rent trouble, but not much. Once again, the dice play a much more important role (or is it roll?) in a three-player game than in a four-player game. In other words, play as skillfully as possible, and be doubly careful to avoid making mistakes. You have much less chance to recover.

### *Five Players*

A Monopoly game gets rather awkward with more than four players (for one thing, there are only four sides to the board), but every now and then you'll find yourself in a five-player game. In a five-player game, the importance of going first or second is increased. Going last in a five-player game can be deadly, so do all you can to buy the right to go first or second if luck doesn't go your way. Owning property, any property, is important in a five-player game. There will always be a lot of trading, so the more properties that you own at the start, the better your chances. If the game lasts awhile and a lot of color groups are developed, be prepared for an early housing shortage. For this reason, the more expensive color groups are a very big risk if it is uncertain that there will be enough time to adequately develop them. Immunities and partnerships can be great in a five-player game. Options, of course, are a lot less valuable, since there are more players to land on an optioned property.

## APPENDIX D

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### *Drawn Games*

Although it happens very rarely, it is possible to have a tie game. Assuming that all players have enough cash on hand to survive a run of bad luck, any of the following three positions is a drawn game:

1. All remaining players own color groups which give approximately equal average returns per roll of the dice, and there are no more ways to build houses, which would change those values.

2. One player is receiving more money than the remaining players, but the inflation from the Go salary is enough to give all players positive cash flows. In other words, one player may be getting rich faster than the other players, but no player is getting poorer.

3. There are two players remaining in the game, and each is immune on the other's complete color groups.

But after all, the object of the game isn't to win, it's to have fun!