Acknowledgments

Firstly to Edward O. Thorp and Julian Braun for their initial contributions on the game. To Lance Humble and Carl Cooper for the book *The World's Greatest Blackjack Book*. This was the first useful book I came across at a city bookshop. To Stanford Wong for his assistance via the Internet and for providing the excellent resources, in particular *Professional Blackjack* and the *Blackjack Count Analyzer*.

Dedication

Peter Griffin sadly passed away in 1999 with cancer. The news hit Australia through the Internet, coinciding with some research on the game of Blackjack. His works, namely *The Theory of Blackjack* is an invaluable book for both the player and mathematician, and he will truly be missed.

Preface

There is one thing that casinos don't tell you and that is they can be beaten. Not once, not twice, but consistently over a long period of time.

How is this possible?

Cards have memory. Blackjack is the only casino game that has this property. When an excess number of tens and/or aces are remaining in the shoe, this is favourable to the player and more money is wagered. This is more commonly known as card counting.

Traditionally, Blackjack was played using one deck of cards including the dealer's hole card. Even though this may still exist in America today, this is definitely not the case in Australia. For this reason, this book is intended for Blackjack in Australia and emphasis will be placed on practical methods on how to beat the house, without going into the specifics of the mathematical theory behind the method. This allows you to start playing in the shortest possible time, while still using mathematical proven ways to keep the winning edge.

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Section I
Introduction

Why this book?

Having a main interest in games involving strategies and studying mathematics and statistics throughout my tertiary years, I have been looking forward to putting these interests into real life applications, i.e. making money.

Casino games just happen to fit the scene, and with no doubt it was Blackjack that stood out as being the most reliable and effective game for the player.

The amount of material available on Blackjack is extremely comprehensive, ranging from Basic Strategy charts for the recreational player to someone who makes a very wealthy living playing the game. However, the problem with Blackjack today is the rules and playing conditions have changed so much over the years in different places, that an excellent understanding of how to play the game is required for that location. This allows the player to avoid confusion and to start playing in the shortest possible time. This is my main intention for writing this book.

In my research and playing days I did not find a book which focused on Blackjack in Australia with the main objective being to maximize money, while still minimizing risk and detection to casino personnel.

Section I will introduce the game through the Evolution of Blackjack Systems to the rules used in Australia today. Section II will cover the strategies for Traditional Blackjack and Section III will modify these strategies for Blackjack in Australia. Lastly Section IV will cover advanced techniques, including the psychology of gambling and an overall game plan.

I hope this book will achieve two things. Firstly to extend the research of all the other excellent works that have been written and to help change your way of thinking towards gambling so you will be in complete control and hopefully bring out your ultimate dream - making a lot of money.

When speaking to other people about Blackjack, the most common reactions are:*"It's still comes down luck", "You must have a good memory", "Only a mathematician can achieve this".*

Throughout this book I will prove all these statements to be completely false. All you need is patience and persistence.

Why Play Blackjack?

First of all gambling in Australia is tax-free. Secondly and most importantly, Blackjack will earn you a lot more money than the average job.

Exactly how much more?

Starting with a $15,000 dollar bankroll, I have proven mathematically that you can become a millionaire in two years. Also it is the least risky of all moneymaking schemes. For example if you were offered even money on a biased coin that came up heads 50.3% of the time, would you play? The answer should be yes. With excellent bankroll management you would make a lot of money over time by betting continually on heads. This is essentially the edge we have in Blackjack. If the casinos know they can be beaten then why do they still offer Blackjack? Or why don't they change the rules to make this impossible? To answer these questions we need to look at the history of the game.

Evolution of Blackjack Systems

The origin of Blackjack is unknown and the casinos knew little about the percentages of the game. In 1930, Joe Treybal published a book titled *Handbook on Percentages*. It stated "The principle percentage in favour of the dealer arises from the fact that all busts must pay the dealer irrespective of his own hand. Therefore, we have no definite figures as to the percentage, but guarantee it will get the money whenever you get any players to draw cards".

How wrong could he have been?

In 1963 Professor Edward Thorp wrote a book called *Beat the Dealer*, which explains basic strategy and the systems used to win at Blackjack. The casinos were worried they would lose money and started changing some of the rules, such as increasing deck size and payoffs. This had the effect of losing customers and they were forced to go back to the old rules. But the casinos really had nothing to worry about. Not only were they gaining more customers, but also they were making a lot more money because most people did not spend the time to master the difficult Ten-Count system available.

More powerful systems developed with increasing technology of computers. Players were winning greater amounts than ever before with the Hi-Lo (presented in this book) and the Hi-Opt 1 counting systems. This forced the casinos to introduce multideck games, change deck penetration and increase surveillance to detect counters.

What about Blackjack in Australia?

Initially when casinos came to Australia, they strongly objected to cheating. This is why the shoe games and the no dealer hole card are used. Eventually,

like America, the card counters caught up with them and Star City in Sydney for example uses a deck penetration (more about this later), which wipes out almost all of the player's advantage. Why the other casinos do not do this is because of supply and demand, and the laws underlying certain playing conditions. Casinos have implemented a computer-operated device known as Protec 21. This machine has the ability to detect increase in wagering, a common strategy used by many card counters. The only way to be a successful counter in Australia these days is to make money and have the casinos welcome you back. This is exactly the system I have developed; being able to play in a way that goes undetected to the Protec 21 device.

Is card counting legal?

Certain cards are favourable to the player and certain cards are favourable to the dealer. By assigning a number to each card we keep a running count as the cards are being dealt out and estimate our expectation on the next hand. In other words we are doing calculations like $1+1=2$. This is definitely not illegal and you cannot get into any trouble for it. Of course the casinos don't like it, or any consistent winner.

Cheating

Edward Thorp stated that in a shoe game with a no dealer hole card, then cheating is almost impossible for the dealer or the player. This is essentially the ingredients for Blackjack in Australia.

Rules

The player receives two cards face up while the dealer starts with one card face up from a device called a shoe. Picture cards count as 10, aces count as 1 or 11, whichever is to your advantage and the other cards count as their face value. The idea is to get as close as possible to 21 without going over, known as busting. If you bust, you lose. If the dealer busts and you have a total 21 or less, you win. If you both have a total 21 or less, the higher total wins. If you and the dealer both have the same total, this is known as a StandOff in which case no one wins. If your first two cards add to 21, you have a Blackjack and you are paid at odds of 3-2, providing the dealer does not have a total of 21 on the first two cards, in which case a Stand-off. If your first two cards are not a Blackjack you may Hit (receive more cards one at a time) or Stand. You must hit if the total of your cards is 11 or less. The dealer must Hit with 16 or less

and stand with 17 or above. Besides Hit and Stand there are a variety of player options.

Doubling

This is where you can double your original bet on your first two cards. Some casinos allow you to double on any, whereas others restrict doubling to 9,10,11. You only receive one additional card for a double.

Splitting

This is where you can split your first two cards if they have the same point value. At least one card will be dealt to each hand. The number of splits allowed on each hand depends on the casino but most allow 1 or 2 splits. If you split Aces, only one card is dealt to each ace. A resplit of Aces may or may not be allowed and if a ten-point value card is dealt to either Ace, it is treated as 21, not Blackjack. Doubling is allowed after pair splitting.

Insurance

If the first card dealt to the dealer is an Ace, the player has the option of wagering an additional bet, an amount not more than half your original bet, that the dealer gets a Blackjack. A winning insurance bet is paid at odds of 2-1, otherwise the insurance bet is lost and the game continues with usual playing rules.

Blackjack

If the dealer receives a Blackjack and you have placed additional bets on Split hands and/or Doubling, then some casinos only take your original bet. This condition is known as Original Bets Only (OBO). Another condition used in some casinos, known as Original and Busted Bets Only (OBBO), is where the original bet is lost along with any busted hands from Pair Splitting.

Section II
Traditional Blackjack

Basic Strategy

When playing at Star City I entered halfway through a shoe with $100 dollar chips. On the first hand I drew a pair of eight's against a dealer's ten. I split these and the couple sitting next to me just laughed as if to say, *"What on earth are you doing"*. Next I was dealt a three and doubled for a total of 21, On the other hand I was dealt an eight and split again. I then drew totals of 18 and 20 and at this stage had $400 dollars on this one hand. The dealer then turned over a 4 and proceeded to bust. The couple blurted out, textit"You were lucky mate".

Luck had nothing to do with it, nor whether I won this hand or not. I was simply following what Blackjack players call Basic Strategy.

Basic Strategy is about decision making. Knowing exactly what option to take depending on the cards you are dealt, in relation to the dealer's up-card. This is the first step towards being a successful Blackjack player and requires some very simple memory work. The charts are presented below, look at them but do not learn them yet. For Blackjack in Australia these charts will be modified due to the playing techniques that follow. The following playing conditions are used: 6 Decks, Double after Split, Double 9,10,11, Double A-8 and A-9 but these are treated as hard 9 and 10 respectively, Resplit to make three hands, no resplit aces, OBO.

Stanford Wong's Blackjack Count Analyzer, Version 2, produced the results.

HIT(H) / STAND(S)

	2	3	4	5	6	7	8	9	X	A
20	S	S	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	S	S
18	S	S	S	S	S	S	S	S	S	S
17	S	S	S	S	S	S	S	S	S	S
16	S	S	S	S	S	H	H	H	H	H
15	S	S	S	S	S	H	H	H	H	H
14	S	S	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
12	H	H	S	S	S	H	H	H	H	H
A9	S	S	S	S	S	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S
A7	S	S	S	S	S	S	S	H	H	H
A6	H	H	H	H	H	H	H	H	H	H

DOUBLE(D)

	2	3	4	5	6	7	8	9	X	A
11	D	D	D	D	D	D	D	D	D	H
10	D	D	D	D	D	D	D	D	H	H
9	H	D	D	D	D	H	H	H	H	H
A9	S	S	S	S	S	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S

SPLIT(SP)

	2	3	4	5	6	7	8	9	X	A
A,A	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
X,X	S	S	S	S	S	S	S	S	S	S
9,9	SP	SP	SP	SP	SP	S	SP	SP	S	S
8,8	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
7,7	SP	SP	SP	SP	SP	SP	H	H	H	H
6,6	SP	SP	SP	SP	SP	H	H	H	H	H
5,5	D	D	D	D	D	D	D	D	X	X
4,4	H	H	H	SP	SP	H	H	H	H	H
3,3	SP	SP	SP	SP	SP	SP	H	H	H	H
2,2	SP	SP	SP	SP	SP	SP	H	H	H	H

Calculating the house advantage from Basic Strategy

Let's take a look at exactly what percent house margin means.
Given by a mathematical formula:

$$\%HM = \frac{expected\ loss\ by\ gambler}{total\ outlay * 100}$$

Effects of Rules Variation

The table below comes from a combination of *Professional Blackjack* by Stanford Wong, *The World's Greatest Blackjack Book* by Lance Humble/Carl Cooper and *Blackjack Conditions in Australia* by Mike Van Emmerik. The table assumes a single-deck game with dealer standing on any 17, doubling on hard or soft hands, no double after split, and no surrender. This situation gives 0% HM (an even game).

Variations	**Player Advantage %**
Drawing any number of cards to split aces	+ 0.14
Doubling allowed after pair splitting	+ 0.14
Resplit aces	+ 0.08
Eight decks	- 0.55
Six decks	- 0.52
No doubling on 9	- 0.17
No resplit of aces	- 0.05
No soft doubling	- 0.08
No original bets only	- 0.13
Original and busted bets only	- 0.01

Now lets have a look at the percent HM for Star City.

Variations	**Player Advantage %**
Doubling allowed after pair splitting	+ 0.14
Resplit aces	+ 0.08
Eight decks	- 0.55
No soft doubling	- 0.08
	- 0.41

This means that in the long run you will lose 0.41% of the money you have outlaid. This is not much, and with about 100 hands being played per hour at $10 per hand this only corresponds to an expected loss of $4.10 per hour.

When compared to other games this is by far the best game for the recreational player who just likes the excitement of gambling and receiving free comps of food and drinks.

Generally the casinos in Australia use the playing rules of:

Variations	**Player Advantage %**
Doubling allowed after pair splitting	+ 0.14
Six decks	- 0.52
No resplit of aces	- 0.05
No soft doubling	- 0.08
Original bets only	- 0.13
Resplit to make three hands	

This corresponds to a percent House Margin of 0.46% and these playing rules will be used as a starting point for the results in the rest of the book. This figure will only vary to a maximum of 0.6 and a minimum of 0.41. With playing rules often changing in casinos I cannot be sure of the exact rules for each casino, but I suggest referring to *Blackjack Conditions in Australia* by Mike Van Emmerik at website http://www.bjrnet.com/Australia/bjtable.htm or http://www.whiteknightblackjack.com/casinos/ and phoning the particular

casino with the contact numbers also listed through these websites or at the Appendix of this book.

At this stage do not become too discouraged by the terminology and the different playing rules. They are not the main issues when it comes to making money. The most important feature of any Blackjack game that I haven't mentioned is deck penetration. This is how far the dealer deals into the shoe, and will more than compensate the small changes in playing rules.

Just for your interest the %HM for various casino games are:

Baccarat	1.2%
Craps	1.4%
Roulette	2.7%
Poker Machines	8-15%
Keno	25%

Card counting Systems

Lets start by assigning a number to each card. We will give a 1, every time we see a 2,3,4,5,6. We will give a -1, every time we see a 10,Jack, Queen, King, Ace. The other cards are given a zero and so are considered neutral.

NOW PRACTICE WITH A DECK OF CARDS, KEEPING A RUNNING COUNT AS YOU ARE GOING.

This will be very difficult at first, but with daily practice your speed will be rapidly increasing. When you can count down a deck one card at a time in less than 20 secs, you're well on your way. By cancellation you should always end up with a count of 0.

What does all this mean?

Let's take a look at a very concrete example. Say you were playing in a two-deck game and you knew there were only 8's remaining in the deck. How much would you bet on the next hand? The answer is simple. Everything you've got. You stand on a hard 16 and the dealer is forced to bust. You can see that cards have memory by forming dependent trials.

How about something a bit more realistic? Say there were only cards to the value of ten and one ace remaining in the deck. Who has the advantage on the next hand? Well you might first think that it's 50/50 because the Blackjacks even out. This is indeed true but remember that Blackjacks pay 3-2, so the player clearly has the edge. Lets now take this a step further and add one 9 and one 2. Who now has the edge? Well again things even out, but remember that basic strategy tells us to double down on 11 versus a dealer 10 and with an excess number of tens in the deck this is very advantageous!!

The whole point is that when there are an excess number of tens and/or aces remaining in the deck this is favourable to the player.

1)The player gets more blackjacks
2)Doubling down and pair splitting becomes more powerful
3)The dealer tends to bust more often

How do we know when there are an excess number of tens and/or aces in the deck? By no coincidence this comes directly from our counting system and refers to a positive count.

How do we know how much advantage we have per hand?

Before we answer this question, we need to define what true-count means. The formula is:

$$True\ count = \frac{running\ count}{number\ of\ decks\ remaining}$$

In other words the true count is a relative count when comparing different deck games. The higher the true count, the more advantage the player has. This advantage is approximately given by the Griffin formula:

$$Player\ Advantage\ (in\ per\ cent) = basic\ strategy\ expectation + 0.515 * true\ count$$

For example if the true count is +2 at Star City then the player advantage = 0.62%

Modified basic strategy

Say for example the true count is +4 and we drew a 9 against a dealer 2. Basic strategy would tell us to hit. But it turns out that with an excess number of tens you would double on a 9 against a dealer 2 if the true count were ≥ 1. I will not present the charts as yet for modified basic strategy as they will be adjusted even further to suit the playing style for Blackjack in Australia.

Section III
Modified Strategies

Wonging (Back counting)

Named after a true expert of the game, Stanford Wong, this technique involves jumping into a game while the count is favourable. Because the cards coming out of the shoe form dependent trials, when a count is favourable it tends to remain that way. This technique will form the basis for playing Blackjack in Australia.

Basic Strategy revisited

What is the minimum true count needed to enter a favourable shoe? By applying the Griffin formula in reverse this turns out to be at least +2 (+1 is roughly an even game, so we will round up to +2). Therefore our basic strategy charts presented below will include the playing options for true counts of 0, +1, and +2.

HIT(H) / STAND(S)

	2	3	4	5	6	7	8	9	X	A
20	S	S	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	S	S
18	S	S	S	S	S	S	S	S	S	S
17	S	S	S	S	S	S	S	S	S	S
16	S	S	S	S	S	H	H	H	S	H
15	S	S	S	S	S	H	H	H	H	H
14	S	S	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
12	H	S	S	S	S	H	H	H	H	H
A9	S	S	S	S	S	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S
A7	S	S	S	S	S	S	S	H	H	S
A6	H	H	H	H	H	H	H	H	H	H

DOUBLE(D)

	2	3	4	5	6	7	8	9	X	A
11	D	D	D	D	D	D	D	D	D	D
10	D	D	D	D	D	D	D	D	H	H
9	D	D	D	D	D	H	H	H	H	H
A9	S	S	S	S	S	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S

SPLIT(SP)

	2	3	4	5	6	7	8	9	X	A
A,A	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
X,X	S	S	S	S	S	S	S	S	S	S
9,9	SP	SP	SP	SP	SP	S	SP	SP	S	S
8,8	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
7,7	SP	SP	SP	SP	SP	SP	H	H	H	H
6,6	SP	SP	SP	SP	SP	H	H	H	H	H
5,5	D	D	D	D	D	D	D	D	X	X
4,4	H	H	H	SP	SP	H	H	H	H	H
3,3	SP	SP	SP	SP	SP	SP	H	H	H	H
2,2	SP	SP	SP	SP	SP	SP	H	H	H	H

AT THIS STAGE, IT IS ADVISED TO PRACTICE USING THESE CHARTS WITH A BLACKJACK COMPUTER PROGRAM.

The one I used is Ultimate Blackjack and the shareware version can be obtained off the Internet: www.accidental.com. Make sure the rules are adjusted for Blackjack in Australia.

Card Counting systems

Now lets review some of the recognized card counting systems and compare the difficulty of these systems versus performance (refer below). The betting correlation (BC) refers to how frequent the point values of the counting system refer to favourable situations of the next hand. The playing efficiency (PE) refers to how effective the point values of the counting system are for varying playing strategies. Ease of use is the most important factor and for this reason we will only consider level 1 systems. Out of these systems the Braun +- (also known as the Hi-Lo) has a BC of 0.97 and a PE of 0.51. The Hi-Opt 1 has a BC of 0.88 and a PE of 0.615 but it has only 5 values compared to the Braun +- of 7.

Card Count Systems *(The World's Greatest Blackjack Book, p207)*

	2	3	4	5	6	7	8	9	X	A
Hi-Opt 1	0	1	1	1	1	0	0	0	-1	0
Gordon	1	1	1	1	0	0	0	0	-1	0
Braun +-	1	1	1	1	1	0	0	0	-1	-1
Revere Adv.	1	1	1	1	1	0	0	-1	-1	0
Ita	1	1	1	1	1	1	0	-1	-1	-1
Hi-Opt II	1	1	2	2	1	1	0	0	-2	0
Revere Pt.Ct.	1	2	2	2	2	1	0	0	-2	-2
Revere APC (73)	2	2	3	4	2	1	0	-2	-3	0
Revere APC (71)	2	3	3	4	3	2	0	-1	-3	-4
10 Count	4	4	4	4	4	4	4	4	-9	4
Thorp Ultimate	5	6	8	11	6	4	0	-3	-7	-9

Difficulty of Systems versus Performance *(The World's Greatest Blackjack Book, p209)*

System	Level	No. of Values	BC	PE
Hi-Opt 1	1	5	0.88	0.615
Gordon	1	5	0.86	0.574
Braun +-	1	7	0.97	0.510
Revere Adv.	1	7	0.89	0.592
Ita	1	9	0.96	0.532
Hi-Opt II	2	7	0.91	0.671
Revere Pt.Ct.	2	8	0.98	0.527
Revere APC (73)	4	8	0.92	0.657
Revere APC (71)	4	9	0.995	0.523
10 Count	n/a	10	0.72	0.621
Thorp Ultimate	11	9	0.996	0.525

Which card counting system is optimal ?

The Hi-Opt 1 and Braun +- have advantages and disadvantages. What I have concluded through extensive research is that for hand-held games the Hi-Opt I is preferable, having the advantage of adopting the ace-side count for increasing both the BC and the PE. For shoe games including Blackjack in Australia use the Braun +- (the system covered earlier) as the BC is more important than the PE and more than compensates for the extra two number values.

AT THIS STAGE PRACTICE ON A COMPUTER PROGRAM USING BASIC STRATEGY AND KEEP A RUNNING COUNT USING THE BRAUN +-.

Modified Basic Strategy Revisited

You are well aware by now that we are only interested in true counts ≥ 2. So below is the complete set of charts including index numbers from +3 to +6. Learn the precise playing options from these tables. For ease of use the charts are again presented at the Appendix of this book.

HIT(H) / STAND(S)

Stand if true count $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
20	S	S	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	S	S
18	S	S	S	S	S	S	S	S	S	S
17	S	S	S	S	S	S	S	S	S	S
16	S	S	S	S	S	H	H	5	S	H
15	S	S	S	S	S	H	H	H	**4**	H
14	S	S	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
12	**3**	S	S	S	S	H	H	H	H	H
A9	S	S	S	S	S	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S
A7	S	S	S	S	S	S	S	H	H	S
A6	H	H	H	H	H	H	H	H	H	H

DOUBLE(D)

Double if true count is $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
11	D	D	D	D	D	D	D	D	D	D
10	D	D	D	D	D	D	D	D	**4**	**4**
9	D	D	D	D	D	**3**	H	H	H	H
A9	S	S	**6**	**5**	**4**	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S

SPLIT(SP)
Split if true count is ≥ table number

	2	3	4	5	6	7	8	9	X	A
A,A	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
X,X	S	S	**6**	**5**	**4**	S	S	S	S	S
9,9	SP	SP	SP	SP	SP	**3**	SP	SP	S	**3**
8,8	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
7,7	SP	SP	SP	SP	SP	SP	H	H	H	H
6,6	SP	SP	SP	SP	SP	H	H	H	H	H
5,5	D	D	D	D	D	D	D	D	**4**	**4**
4,4	H	H	**3**	SP	SP	H	H	H	H	H
3,3	SP	SP	SP	SP	SP	SP	H	H	H	H
2,2	SP	SP	SP	SP	SP	SP	**5**	H	H	H

Take insurance≥ 3

<u>Modifications for rule variations</u>

1)Doubling allowed on any hand

DOUBLE(D)
Double if true count is ≥ table number

	2	3	4	5	6	7	8	9	X	A
8	H	H	**6**	**3**	**D**	H	H	H	H	H
A8	S	**6**	**3**	**D**	**D**	S	S	S	S	S
A7	**D**	**D**	**D**	**D**	**D**	S	S	H	H	S
A6	**D**	**D**	**D**	**D**	**D**	H	H	H	H	H
A5	H	**4**	**D**	**D**	**D**	H	H	H	H	H
A4	H	H	**D**	**D**	**D**	S	S	S	S	S
A3	H	H	**D**	**D**	**D**	S	S	S	S	S
A2	H	H	**4**	**D**	**D**	S	S	S	S	S

2)Only lose original bet to a dealer blackjack except on busted hands

SPLIT(SP)
Split if true count ≥ table number

	2	3	4	5	6	7	8	9	X	A
9,9	SP	SP	SP	SP	SP	3	SP	SP	S	S
8,8	SP	SP	SP	SP	SP	SP	SP	SP	**S**	**H**

3)Lose all to a dealer's blackjack

DOUBLE(D)
Double if true count is $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
11	D	D	D	D	D	D	D	D	**3**	**H**
10	D	D	D	D	D	D	D	D	**H**	**H**

SPLIT(SP)
Split if true count $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
A,A	SP	SP	SP	SP	SP	3	SP	SP	SP	**H**
9,9	SP	SP	SP	SP	SP	3	SP	SP	S	**S**
8,8	SP	SP	SP	SP	SP	SP	SP	SP	**S**	**H**

AGAIN PRACTICE USING THESE CHARTS VIA A COMPUTER PROGRAM.

Estimating the True Count

Calculating the true count in theory sounds simple; you divide the running count by the number of decks remaining. This should not be too much of a problem with a one or two deck game. However in Australia with 6 or 8 decks, this can be rather difficult and confusing, so the technique I have developed, is easier and suits my playing style. Lets now start to develop this technique.

The average number of cards dealt per hand is 2.7. Therefore if there were 8 people at the table including the dealer it would take about 1 round to go through half a deck of cards by the simple calculation 2.7*8*1 = 21.6. So working backwards we would need a running count of at least +15 to enter into a favourable situation for an eight-deck game. This is calculated by 15/7.5 = 2. Therefore we can estimate when to enter a favourable situation by the number of players at the table. Three tables are listed below. The first table lists the number of players with relation to the number of rounds to be counted. The second and third tables are for the mathematically inclined but no need to memorize all these figures in practice. They show the accuracy of this strategy, when determining a favourable shoe. The exact number of cards remaining is compared to the observed number of cards remaining for the different number of players and deck size. We will take 7 players to mean a full table, not including the dealer.

Players	Rounds
7	1
6	1 to 2
5	1 to 2
4	2
3	2 to 3
2	3 to 4
1	5

6 decks

Run. Count	EX	7P	6P	5P	4P	3P	2P	1P
11	285	289	283	287	284	284	283	284
10	259	268	254	262	257	257	254	257
9	233	246	226	238	230	230	226	230
8	207	225	198	214	203	203	198	203
7	181	203	169	190	176	176	169	176
6	155	181	141	165	149	149	141	149
5	129	160	113	141	122	122	113	122
4	103	138	84	117	95	95	84	95
3	77	117	56	92	68	68	56	68
2	51		28		41	41	28	41

8 decks

Run. Count	EX	7P	6P	5P	4P	3P	2P	1P
15	389	393	387	391	388	388	387	388
14	363	372	358	366	361	361	358	361
13	337	350	330	342	334	334	330	334
12	311	329	302	318	307	307	302	307
11	285	307	273	294	280	280	273	280
10	259	285	245	269	253	253	245	253
9	233	264	217	245	226	226	217	226
8	207	242	188	221	199	199	188	199
7	181	221	160	196	172	172	160	172
6	155	199	132	172	145	145	132	145
5	129	177	103	148	118	118	103	118
4	103	156	75	123	91	91	75	91
3	77	134	46	99	64	64	46	64
2	51		18		37	37	18	37

Notice how the results are most accurate for 1 to 4 players at the table. In particular, 3 or 4 players is what the computer simulations (later on) are based in terms of win rate/hour.

How does this work in practice?

Assume there are 3 people at the table at an 8-deck game. This means that alternating between two and three rounds, we need a count ≥ 15 after one round has been dealt out. By standing behind the table, we keep count of the first two rounds using our fingers. After another three rounds have been dealt out we enter the table only if the count is ≥ 14. We gradually keep working our way down until we can enter a favourable situation. Now suppose that one player decides to leave and we now have only 2 people at the table. Not a problem, as we now need three/four rounds to go down into the count. In effect you are really keeping three counts. The usual running count, the count involving your decision on entering the table and the count involving the number of rounds. After we have entered a favourable situation we will generally only keep the running count and develop an intuition for modifying basic strategy. Notice that we have not mentioned anything about the true count explicitly.

Playing Style

Since the rounds in Blackjack form dependent trials, when a shoe enters a favourable situation it tends to remain favourable. This is why the technique of back counting is so powerful. It allows you to enter a favourable situation and to keep betting the same amount. You will not be ranging your bets and should not be detected as a counter. It's interesting to note that a surveillance system known as Protec 21 has been designed to keep track of the cards and detect increases in bets. What the casino personnel fail to realise is the concept about dependent trials and hence the technique of back counting!

Let's suppose you will enter a favourable shoe with $100 chips. Firstly have only a single $100 chip in your hand, keep about 7 $100 chips in your pocket and at least $500 in your wallet for doubling and splitting purposes only if you are down to your last chip. When the count becomes favourable take a seat at the table with your first chip.

Rules about playing

1)Always keep playing if you won the preceding hand on the same shoe
2)Never pocket your winning chips while at the table
3)Only ever draw one chip at a time from your pocket
4)Always play while sitting at the table
5)Always keep playing if the running count remains positive
6)Only leave the table if the running count is 0 or negative
7)Once left the table never reenter on the same shoe, go to another table
8)It does not matter where you enter a favourable situation. i.e. being first player is just as effective as last player
9)Play at tables with fewer players i.e. 2 to 3 is ideal
10)Play when it's least crowded i.e. avoid weekend nights
11)Never drink alcohol while playing

Why this method

Well firstly it does not involve playing every hand which will save you a lot of time and effort, and an increase in the expected hourly win rate as a result. As mentioned before it does not require a dramatic increase in bet spread and hence adopts a disguise undetectable by the surveillance cameras or the casino personnel. If you prefer the traditional method of estimating the true count, then use it. The trouble with this method I found was the uncertainty in deck levels led to not knowing whether a favourable situation arose. The method I developed also will have slight errors, but is methodical in the process of entering a favourable shoe.

AT THIS STAGE, PRACTICE ON COMPUTER SOFTWARE THIS METHOD BY PUTTING THE PROGRAM ON SIMULATION MODE.

Section IV
Advanced Strategies

Psychology of gambling

When playing at Star City and entered into a favourable shoe, there was only one person already playing and just as I entered, this man stopped playing. He refused to put down any chips and just sat there watching. So I thought I would have a bit of fun and see what he would do if I didn't play. And as expected he continued to bet, until I started putting my chips down again. Eventually he just stomped off and said, *"It's the height of rudeness"*.

Whether I played or not did not affect his result. He was always going to lose money because he could not control his emotions.

Blackjack should be a mechanical operation where the dealer just feeds the cards from the shoe and the player wagers the money according to the count. Unfortunately this is not the case. Too many players get emotionally involved in the game and start doing the worst possible thing, "chasing their losses". This is where you over bet or double your money to recoup your losses.

DO NOT LET THIS HAPPEN TO YOU

As you we see later on, you will encounter large fluctuations and so you need to be in full control of your wagering. Don't be anxious to enter a favourable situation. In fact Peter Griffin calculated that you are only on an overall high 1.6 of the time and 98.4% of the time you seem as if you are getting nowhere, but the tendency is to keep going up.

On the other hand, do not be afraid of laying out bets when you are losing. If the count allows you to keep playing then do so.

How much Advantage

Again, the simulations were run using Stanford Wong's *Blackjack Count Analyzer*. About 3 to 4 million hands were used when comparing the paybacks against the number of decks and deck penetration using our standard rule variations. \$100 bets were used on a true count > 0. A reshuffle was used when the running count got to -7. The reason being that you would go to another table if the running count were -5 or less. Due to the completion of the shoes and crowded tables you will not immediately be able to start counting at a new shoe, so an extra 2 digits were used in the simulation for -7.

6 decks / 1 deck cut		
Win Rate	SE	SD
100.542	0.079	
\$32.30 / 100 hands	\$4.71	\$874
\$9.66 / shoe	\$1.41	\$477.88

6 decks / 1.25 deck cut		
Win Rate	SE	SD
100.478	0.077	
\$28.25 / 100 hands	\$4.54	\$869.96
\$8.15 / shoe	\$1.31	\$467.44

6 decks / 1.5 deck cut		
Win Rate	SE	SD
100.419	0.073	
\$24.73 / 100 hands	\$4.28	\$868.96
\$6.90 / shoe	\$1.19	\$459.08

6 decks / 2 deck cut		
Win Rate	SE	SD
100.31	0.081	
\$18.14 / 100 hands	\$4.69	\$861.96
\$4.68 / shoe	\$1.21	\$437.81

8 decks / 1 deck cut		
Win Rate	SE	SD
100.611	0.074	
\$38.95 / 100 hands	\$4.72	\$903.73
\$14.08 / shoe	\$1.71	\$543.45

8 decks / 1.5 deck cut		
Win Rate	SE	SD
100.488	0.069	
\$31.00 / 100 hands	\$4.40	\$901.35
\$10.78 / shoe	\$1.53	\$531.45

8 decks / 2 deck cut		
Win Rate	SE	SD
100.254	0.074	
\$15.99 / 100 hands	\$4.68	\$897.33
\$5.29 / shoe	\$1.55	\$516.29

Approximately 100 hands are dealt per hour with 3 to 4 players at the table in 6 and 8 deck games. This is given as a win rate in the above tables along with the overall payback and the amount won per shoe. Standard Error (SE) refers

to how much fluctuation there is about the win rates. About 95% of the time, the sample estimate will lie within two SE of the true win rate. As an example of 6 decks / 1.25 deck cut our values simulated at $28.25 / 100 hands may in reality be as high as $37.33 or as low as $19.17. To decrease SE, you would need to increase sample size, which becomes rather time consuming. Through observation and intuition, I ran the simulations until the results were relative to each other when considering number of decks and deck penetration.

You might have noticed the difference in win rates is mostly due to deck penetration and this rule will be the most important factor when deciding which table or casinos to play at. Most casinos in Australia use a deck penetration between 1-1.5, with the main exception being Star City in Sydney using a deck penetration of 2.5 - 3. My advice is for a 6-deck game use a DP no more than 1.25 and for 8 decks no more than 1.5. For the calculations to following I will use 6 decks with a DP giving 0.3units / hour.

Game Plan

Let's assume we have a starting bankroll of $15,000.

Then bet $100 for each hand until you are in profit by $20,000. Then bet $200 for each hand until you are ahead by $30,000. Then bet $300 for each hand until you are ahead by $40,000. If at $30,000 you drop back to $20,000 then bet $200 each hand until you get back to $30,000. If at $20,000 you drop back to $10,000 then bet the original $100. The idea behind this system is to slowly increase our bets to make more money, while still allowing to decrease our bets, due to the fluctuations. The full chart is shown below.

Starting bankroll
$15,000 - Bet $100

Bet ($)	Profit ($)
200	20,000
300	30,000
400	40,000
500	50,000
600	60,000
700	70,000
800	80,000
900	90,000
1000	100,000
1500	150,000
2000	200,000
2500	250,000
3000	300,000

You might be thinking if we have the edge and the tendency is to keep going up, then why decrease our bets after we have dropped down to a certain level? Well, this way the Gambler's Ruin is almost unaffected (explained next) and we will never be over betting. You always have to be confident about increasing profit, but still allow for the fluctuations that do occur.

Gambler's Ruin and Fluctuations

How reliable is our game plan? What is the probability of losing our entire bankroll? What we are referring to here is more commonly known as "Gambler's Ruin". In order to have any success in blackjack, one needs to be familiar with the fluctuations that do occur in the game.

Given by a mathematical formula (p140 Blackjack Attack)

$$RUIN = (\frac{1-\omega/\sigma}{1+\omega/\sigma})^{\frac{bank}{\sigma}}$$

ω = hourly win rate (in units)
σ = hourly standard deviation (in units)
bank = players bankroll (in units)

For our system $\omega = 0.3$, $\sigma = 8.7$

Let's work backwards and calculate the bankrolls required for the levels of ruin given by 10%, 20%, 30%. I will omit the calculations and give the results.

For 10%, Bankroll = 290units
For 20%, Bankroll = 203units
For 30%, Bankroll = 151units

What does all this mean?

If we start betting \$100 per hand there is a 10% chance that we will lose an entire bankroll of \$29000, a 20% chance we will lose \$20300 and a 30% chance we will lose \$15100. To reduce risk you could either increase your bankroll or start betting less. If we start betting with say \$75 / hand then we would only be making \$75 * 0.3 = \$22.50 per hour. Perhaps a little low. Is there a better way? Yes there is, by betting multiple hands. By betting two hands of \$50 say, than betting one hand of \$100, we end up with about the same win rate but reduce standard deviation. By reducing σ, we reduce Gambler's Ruin. The simulations presented below were run through 35 million rounds for improved accuracy. The first table is for 1 hand of \$100 and the second table is 2 hands of \$50.

6 decks / 1.25 deck cut		
Win Rate	SE	SD
100.513	0.026	
$30.40 / 100 hands	$1.51	$871.41
$8.78 / shoe	$0.44	$468.31

6 decks / 1.25 deck cut		
Win Rate	SE	SD
100.512	0.022	
$26.40 / 100 hands	$1.14	$673.72
$6.01 / shoe	$0.26	$321.60

Something worth noting here is that the win rate per 100 rnds is slightly less when playing multiple hands, but is more than compensated with the decrease in standard deviation.

Now calculating Gambler's Ruin with 0.3, 6.7. Again I'll omit the calculations and give the results

For 10%, Bankroll = 173 units
For 20%, Bankroll = 119 units
For 30%, Bankroll = 90 units

Therefore starting with a bankroll of $15 000 and betting 2 hands of $50 we can reduce Gambler's Ruin to about 15%

As you are aware by now, my style of playing is to maximize profits without being detected. For this reason the game plan constructed reflects this approach. Lets now how have a look at the fluctuations that may occur over a 6-hour day or a 36-hour week.

Fluctuations (standard deviation)

The expected value has been defined as our win rate per hour. This is what we expect to make per hour in the long run. But there is no guarantee that this is what we'll make in a 3-hour session for example. In fact, far from it. What we are referring to is standard deviation. Exactly how much fluctuation we expect in fixed "n" trials. Now 95% of the time our 6-hour playing session will lie within two standard deviations of the expected value. For 2 * $50 bets

Hourly σ = $673, 6-hour $\sigma = \sqrt{6} * 673$ = $1649, ω = $30 / hour, 6-hour ω = 30 * 6 = $180

Therefore the 95% confidence interval is (-$3118, $3478). Meaning, 95% of the time our 6 hour playing day will be in between -$3118 and $3478. For a 36 hour week, 95% of the time we will be in between -$6996 and $9156. This means that 2.5% of the time we will lose more than $6996 in a 36-hour week. If this happens the first 2 weeks in succession, this could be the end of our bankroll and hence Gambler's Ruin, but this would be extremely unlikely.

Becoming a Millionaire

Let's assume you play 6 hours a day, 6 days a week, for a total of 36 hours/week. Firstly we will be betting $100 until we reach a $20,000 profit. Expected profit is $1080/ week. Let's say it would take 19 weeks to gain $20,000. Now we can bet $200/week until we get to $30,000.

Bet ($)	Weeks	Gain ($)
100	19	20,000
200	5	10,000
300	4	10,000
400	3	10,000
500	2	10,000
600	2	10,000
700	2	10,000
800	2	10,000
900	1	10,000
1000	5	50,000
1500	4	50,000
2000	3	50,000
2500	2	50,000
3000	22	700,000
	76	1,000,000

What about fluctuations that will force us to bet less than the previous hands? That's where the extra 28 weeks comes in to make up the 2 years.

Will you become a millionaire after two years? Of course not? This is what is expected to occur, and could occur before or well after. But one thing is clear, that this is definitely the best way at making approximately this much in this time. Play multiple hands where possible to reduce σ and you might want to extend bets beyond $3000 if adequately capitalized.

Also working with a partner is very advantageous and will almost double your expected win rate.

In fact working in a team is so advantageous that below is a possible scenario.

Number in team: 4
Initial Bets: 2 * $200 each person
Hours played per week: 36 hours per person

Therefore 36 * 4 = 144 hours a week is spent per person
ω = $100 * 0.3 * 144 * 3/4 = $3240 per person

N.B. The 3/4 is due to the lack of tables that might occur in practice.

Before we were making only $1080 per week playing alone. With a team we now have increased the weekly win rate to $3240 per person and still have the same Gambler's Ruin.

Therefore we can expect to make about $500,000 per person in about 1 year. Of course trust and honesty needs to be heavily enforced to have any success.

Playing records

You will also need to keep a record of your playing session. A sample chart is listed below:

Date	Time	Bet	Won/Lost	Comment
10/5	10am-4pm	$100	+250	Busy at 3pm
10/5	10am-4pm	$100	-50	85% deck penetration with Carina
10/5	10am-4pm	$100	+600	Nice run with Carina again

Summary

1) Learn the rules
2) By using the counting system described in this book, practice the running count with a deck of cards.
3) Practice the Basic Strategy charts for Blackjack in Australia with a Blackjack computer program.
4) Now practice Basic Strategy while keeping a running count using the Braun+- on the computer program.
5) Learn and practice Modified Basic Strategy for Blackjack in Australia using the Braun +- on the computer program
6) Learn and practice entering a favourable situation by putting the computer program on simulation mode.

7) Once you have mastered all of the above PERFECTLY, then start to play for money in a casino.

Conclusion

Is this the most powerful money making system on earth?

For its low starting capital and calculated risk, I feel that this is reliable and effective.

What does it require?

Just like any other job, several months training to become an efficient counter and then 30 - 36 hours a week playing the game at a casino.

When should you stop playing?

This is purely personal choice. Obviously to make large sums of money you need to bet big and be well capitalized to allow for fluctuations. This is the hardest decision to make, as this money cannot be spent. The one million mark sounds like a great figure, but this might not be your choice. As long as you strictly follow the game plan outlined in this book, you should eventually reach your target.

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Appendix

Glossary

Back counting. A playing technique used to count cards as a spectator before entering a favourable situation.

Basic Strategy. The set of playing conditions you should use by having no information of what cards are remaining in the shoe.

Blackjack. If your first two cards are an Ace and a ten value you have a Blackjack and is paid at odds of 3-2, unless the dealer has a Blackjack, in which case a Stand-Off

Bust. Draw enough cards to exceed the total of 21.

Double Down. This is where you double your original bet on your first two cards. You only receive one additional card.

First Base. The seat farthest to the right facing the dealer, which is dealt first and must play first.

Flat Bet. Betting the same amount from hand to hand.

Hard Total. A hand in which no ace is counted as 11.

High-Low Count. A counting system where 2,3,4,5,6 count as -1, 7,8,9 count as 0 and 10,J, Q, K, A count as -1.

Hit. Asking for another card by the dealer.

Hole Card. The dealer card that remains face down until the players hands have been resolved. There is no Hole Card for Blackjack in Australia.

Insurance. This is a side bet that the dealer has a Blackjack. You may buy insurance only when the dealer's upcard is an ace.

Modified Basic Strategy. This is varying Basic Strategy by the true count.

Original and Busted Bets only. If the dealer has a Blackjack, the only additional bets lost are from busted hands from Pair Splitting.

Original Bet Only (OBO). If the dealer has a Blackjack, no additional bets are lost.

Penetration. This describes how far down into the shoe the dealer goes before a reshuffle.

Resplit. This occurs when you split a pair and receive another card of the same value. This means you would put out a third bet and play the cards as three hands.

Round. This is where everyone at the table including the dealer have played their hands and the correct payoffs have been made.

Running Count. This is the total points your counting system assigns to all the cards you have seen since the last shuffle.

Shoe. This is a device used for holding and dealing the cards.

Soft Total. A hand in which the ace is counted as 11.

Split. This is where you have two cards of the same value, you can separate buy putting out an additional bet and play the cards as two hands.

Stand. Receive no more cards from the dealer.

StandOff. This is a tie and no money changes hands. This occurs when both you and the dealer have unbusted hands with the same total points.

Stiff. Hand values from 12 to 16.

True Count. This is the running count divided by the number of decks remaining in the shoe.

Upcard. This is the card in the dealer's hand that is face up for all the players to see before they play their hands.

Winrate. This is how fast you are expected to win.

Casinos in Australia

City	Casino	Phone
Adelaide	Adelaide	(08) 82122811
Alice Springs	Lasseters	(08) 89525066
Brisbane	Conrad Treasury	(07) 33068888
Cairns	Reef	(07) 40308888
Canberra	Canberra	(06) 62577074
Darwin	MGM Grand	(08) 89438888
Gold Coast	Conrad Jupiters	(07) 55921133
Hobart	Wrest Point	(002) 250112
Launceston	Launceston	(03) 63448855
Melbourne	Crown	(03) 96854200
Perth	Burswood	(08) 93627777
Sydney	Star City	(02) 96578393
Townsville	Sheraton Breakwater	(07) 47222333

Blackjack Charts for Australia

HIT(H) / STAND(S)

Stand if true count $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
20	S	S	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	S	S
18	S	S	S	S	S	S	S	S	S	S
17	S	S	S	S	S	S	S	S	S	S
16	S	S	S	S	S	H	H	5	S	H
15	S	S	S	S	S	H	H	H	**4**	H
14	S	S	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
12	**3**	S	S	S	S	H	H	H	H	H
A9	S	S	S	S	S	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S
A7	S	S	S	S	S	S	S	H	H	S
A6	H	H	H	H	H	H	H	H	H	H

DOUBLE(D)

Double if true count is $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
11	D	D	D	D	D	D	D	D	D	D
10	D	D	D	D	D	D	D	D	**4**	**4**
9	D	D	D	D	D	**3**	H	H	H	H
A9	S	S	**6**	**5**	**4**	S	S	S	S	S
A8	S	S	S	S	S	S	S	S	S	S

SPLIT(SP)
Split if true count is $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
A,A	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
X,X	S	S	**6**	**5**	**4**	S	S	S	S	S
9,9	SP	SP	SP	SP	SP	**3**	SP	SP	S	**3**
8,8	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
7,7	SP	SP	SP	SP	SP	SP	H	H	H	H
6,6	SP	SP	SP	SP	SP	H	H	H	H	H
5,5	D	D	D	D	D	D	D	D	**4**	**4**
4,4	H	H	**3**	SP	SP	H	H	H	H	H
3,3	SP	SP	SP	SP	SP	SP	H	H	H	H
2,2	SP	SP	SP	SP	SP	SP	**5**	H	H	H

Take insurance$\geq$ 3

<u>Modifications for rule variations</u>

1)Doubling allowed on any hand

DOUBLE(D)
Double if true count is $\geq$ table number

	2	3	4	5	6	7	8	9	X	A
8	H	H	**6**	**3**	**D**	H	H	H	H	H
A8	S	**6**	**3**	**D**	**D**	S	S	S	S	S
A7	**D**	**D**	**D**	**D**	**D**	S	S	H	H	S
A6	**D**	**D**	**D**	**D**	**D**	H	H	H	H	H
A5	H	**4**	**D**	**D**	**D**	H	H	H	H	H
A4	H	H	**D**	**D**	**D**	S	S	S	S	S
A3	H	H	**D**	**D**	**D**	S	S	S	S	S
A2	H	H	**4**	**D**	**D**	S	S	S	S	S

2)Only lose original bet to a dealer blackjack except on busted hands

SPLIT(SP)

Split if true count ≥ table number

	2	3	4	5	6	7	8	9	X	A
9,9	SP	SP	SP	SP	SP	3	SP	SP	S	S
8,8	SP	SP	SP	SP	SP	SP	SP	SP	**S**	**H**

3)Lose all to a dealer's blackjack

DOUBLE(D)

Double if true count is ≥ table number

	2	3	4	5	6	7	8	9	X	A
11	D	D	D	D	D	D	D	D	**3**	**H**
10	D	D	D	D	D	D	D	D	**H**	**H**

SPLIT(SP)

Split if true count ≥ table number

	2	3	4	5	6	7	8	9	X	A
A,A	SP	SP	SP	SP	SP	3	SP	SP	SP	**H**
9,9	SP	SP	SP	SP	SP	3	SP	SP	S	**S**
8,8	SP	SP	SP	SP	SP	SP	SP	SP	**S**	**H**

Players	Rounds
7	1
6	1 to 2
5	1 to 2
4	2
3	2 to 3
2	3 to 4
1	5