Resolving Problem Gambling: a mathematical approach

Unit Description

An extension to the current model for treating problem gambling is obtained by including strategies for optimal gambling, correct gambling and eradication. Part 1 outlines correct gambling where the analysis of casino games is derived such that a player can gamble with the aim of minimizing losses. The analysis obtains distributional characteristics of profits, the distribution of profits and the percent house margin. This analysis is applied to games of Keno, Roulette, Big Wheel, Let it Ride Poker, Casino Stud Poker, 3 Card Stud Poker, Casino War, Red Dog and Video Poker. The probabilities of obtaining outcomes in basic strategy Blackjack, Pontoon and Pai Gow Poker are combinatorically difficult to calculate. However, there are strategies in such games and these strategies are obtained. Mathematical and logical reasoning to poker machine regulations are given as suggestions for amendments to the "the Standard" with the purpose to increase consumer protection. An online casino promotion offer is analysed to determine if the offer is worthwhile and which is the best game to play. Part 2 outlines optimal gambling where the analysis of casino games in video poker and blackjack are derived such that a gambler can expect a long-term profit. The Kelly Criterion when multiple outcomes exist is derived and this is applied to both non-progressive and progressive video poker. The automation of online video poker is also covered. Blackjack card counting, blackjack modified basic strategy and blackjack team play is covered as depicted in the movie "21". Also, a model is derived in tennis such that a gambler can potentially generate a long-term profit.

Unit Outcomes
- Learn concepts in casino games analysis, Kelly Criterion, Binomial theorem, probability theory, distribution theory, generating functions, Normal distribution, Normal Power approximation, recursion formulas, exponential smoothing and Bayesian updating
- Become familiarized with Excel software by hands-on experience in building your own casino games and tennis calculators, which in turn assists in the understanding of probability and statistical concepts
- Apply operation research techniques to addressing real-world problems in gambling
- Have a greater appreciation of casino games through the well-defined mathematical formulations
- Prepare students with quantitative skills for careers in gambling

Structure of the course
The course is divided into two parts. Part 1 defines 'Correct Gambling' where the analysis of casino games is derived such that a player can gamble with the aim of minimizing losses. Part 2 defines 'Optimal Gambling' where the analysis of casino games in video poker and blackjack are derived such that a gambler can expect a long-term profit. Also, a model is derived in tennis such that a gambler can potentially generate a long-term profit.

Resources

The textbooks for the course:
Barnett T (2019). Resolving Problem Gambling: a mathematical approach. Strategic Games.
1. http://strategicgames.com.au/gambling.pdf

Vancura O and Fuchs K (1998). Knock-Out Blackjack. Huntington Press.

Calculators for the course:
Roulette calculator
1. http://strategicgames.com.au/roulette.xlsx

Big Wheel
2. http://strategicgames.com.au/bigwheel.xlsx

Poker Machine
3. http://strategicgames.com.au/pmachine.xlsx

Excel tennis calculator using simulation for the distribution of points played in a set/match
4. http://strategicgames.com.au/tennisdeucesim.xlsx

Java Tennis Calculator
5. http://strategicgames.com.au/TennisCalc.jar

Excel point-by-point predictions for the Roddick vs El Aynaoui match plated at the 2003 Australian Open
6. http://strategicgames.com.au/RoddickElAynaoui.XLS

WinPoker
7. http://www.zamzone.com/

Casino Verite Software
8. https://www.qfit.com/

Data for the course:
OnCourt: tennis software
9. http://oncourt.info/

Tennis Navigator: tennis software

10. http://www.tennisnavigator.com/

Unit Schedule

Week	Part 1: Correct Gambling	Book	Chapter	Calculator/Data
1	Problem Gambling Model, Analysis of Casino Games	1.	1./2.	
2	Blackjack Basic Strategy, Pontoon, Roulette, Big Wheel	1.	1./3.	1./2.
3	Poker machines, Poker Machine Regulations	1.	2./3.	3.
4	Casino Promotion Offer, Keno, Let It Ride Poker, Casino Stud Poker	1.	7.	
5	3 Card Stud Poker, Casino War, Pai Gow Poker, Red Dog	1.	7.	
6	Non-Progressive Video Poker	1.	5.	7.
	Part 2: Optimal Gambling			
7	Kelly Criterion, Non-Progressive Video Poker, Progressive Video Poker	1.	4./5.	7.
8	Automating Online Video Poker	1.	6.	7.
9	Tennis Markov Chain Model	1.	8.	4./5.
10	Tennis Prediction Model	1.	8.	6./9./10.
11	Blackjack Card Counting, Blackjack Modified Basic Strategy	2.		8.
12	Blackjack Team Play			8.
13	Revision			

Assessment

Item	Amount
Tutorial Exercises	20%
Mid-Semester Exam	40%
Semester Exam	40%

Part 1: Correct Gambling

Week 1 – Problem Gambling Model, Analysis of Casino Games
The current model for treating problem gambling is either control your gambling (known as Controlled Gambling) and quit Gambling (known as Abstinence). In Controlled Gambling the patient is allowed to gamble on a limited basis. In Abstinence, the patient in recovery must completely abstain from all gambling. Abstinence is the goal of Gamblers Anonymous and most, though not all, treatment professionals. A new model is devised for treating problem gambling as a generalization of the current model by including Controlled Gambling and Abstinence as treatment possibilities. The model is based on a process which is trying to maximize the return to the player whilst allowing for the entertainment factor in gambling. The analysis of casino games is covered to obtain distributional characteristics of profits, the distribution of profits and the percent house margin.

Week 2 – Blackjack Basic Strategy, Pontoon, Roulette, Big Wheel
The analysis of casino games covered in week 1 is applied to roulette and the big wheel. The probabilities of obtaining outcomes in blackjack and pontoon are combinatorically difficult to calculate. However, there are strategies in such games and these strategies are obtained.

Week 3 – Poker machines, Poker Machine Regulations
The analysis of a sample poker machines is obtained. Mathematical and logical reasoning to poker machine regulations are given as suggestions for amendments to the "the Standard" with the purpose to increase consumer protection.

Week 4 – Casino Promotion Offer, Keno, Let It Ride Poker, Casino Stud Poker
InterCasino, an online gambling web site at https://www.intercasino.com/, offered a free flight to New York as a promotional offer to new customers. From Australia, the value of the flight was about $2,000. To qualify, players had to complete their wagering requirements for one of the online games. Assuming the player was happy with the terms and conditions of the offer, two obvious questions are:
Is the offer worthwhile?
Which is the best game to play?
To answer these questions, we need probability theory, details concerning the games, and clear criteria on which to base our answers. Keno, Let is Ride Poker and Casino Stud Poker are analysed.

Week 5 – 3 Card Stud Poker, Casino War, Pai Gow Poker, Red Dog
A continuation of week 4 is obtained by analysing 3 Card Stud Poker, Casino War, Pai Gow Poker and Red Dog.

Week 6: Non-Progressive Video Poker
Video Poker machines along with the tradition slots provide entertainment to the player in a variety of computer operated machines. Entertainment value of traditional machines involves watching the reels spinning around in the hope of producing a win each time the reels come to a stop. These machines involve no strategy, and the expected return to the players is fixed at around 87%. Australia owns 21% of the world's total slot machines, and proportionally have the highest number of these machines in the world. While prize tables are displayed, other necessary information is not readily available to the player. On the other hand, it could be argued the entertainment value of Video Poker machines is greater. They require some thought process from the player in deciding which cards to hold on any hand. Optimal strategy depends on the various payouts, and while all the necessary information is available, the calculations are extremely difficult. With perfect strategy most Video Poker machines pay back 97-99%.

Part 2: Optimal Gambling

Week 7: Kelly Criterion, Non-Progressive Video Poker, Progressive Video Poker
A question that arises whenever a game is favourable to the player, is how much to wager on each event? Whilst conservative play (or minimum bet) minimizes "large" fluctuations, it lacks the potential in maximizing the long-term growth of the bank. At the other extreme, aggressive play (or maximum bet) runs the risk of losing your entire bankroll even though the

player has an advantage in each trial of the game. What is required is a mathematical formulation that informs the player of how much to bet with the objective of maximizing the long-term growth of the bank. The famous Kelly criterion achieves this objective; as developed by John L. Kelly in a 1956 publication. The Kelly criterion has been most recognised in games when there are two outcomes – win $x with probability p and lose $y with probability 1-p. When there are more than two outcomes, a generalized Kelly formula is required and this is also discussed and given by John Kelly in the original 1956 paper. This article will apply the Kelly criterion when multiple outcomes exist (more than two) through working examples in video poker. The methodology could be used to assist "advantage players" in the decision-making process of how much to bet on each trial in non-progressive and progressive video poker.

Week 8: Automating Online Video Poker
The arrival of online casinos in 1996 brought games that you would find at land-based casinos (roulette, blackjack, video poker, etc.) to the computer screens of gamblers all over the world Whilst the focus for professional players to obtain a long-term profit from video poker is generally through land-based casinos, a better approach is through online casinos - as this makes automation of systems possible across several computers. For example, if the hourly win rate using one machine is $10/hour, then the same code used to automate one machine could be used on ten machines for an hourly win rate of 10*$10/hour= $100/hour with the same amount of risk

Week 9: Tennis Markov Chain Model
The basic principles involved in modelling a tennis match are well known, and a Markov chain model with a constant probability of winning a point is available in much of the literature. While such a model is acceptable within a game, a model which allows a player a different probability of winning depending on whether they are serving or receiving is essential for tennis. Statistics of interest are usually the chance of each player winning, and the expected length of the match. Most of the previous work uses analytical methods, and treats each scoring unit independently. This results in limited tables of statistics. Thus, the chance of winning a game and the expected number of points remaining in the game is calculated at the various scores within a game. The chance of winning a set and the expected number of games remaining in the set is calculated only after a completed game and would not show for example the probability of a player's chance of winning from three games to two, 15-30. We will discuss the use of spreadsheets to repeat these applications using a set of interrelated spreadsheets. This allows any probabilities to be entered and the resultant statistics automatically calculated or tabulated. In addition, more complicated workbooks can be set up which allow the calculation of the chance of winning a match at any stage of the match given by the point, game and set score. These allow the dynamic updating of player's chances as a match progresses.

Week 10: Tennis Prediction Model
By assigning two parameters, the constant probabilities of player A and player B winning a point on serve; modelling the probability of winning the match can be determined using a

Markov Chain model as represented in week 10. This week will therefore derive the probabilities of winning on serve when two players meet on a particular surface. This is achieved by collecting, combining and updating player serving and receiving statistics.

Week 11: Blackjack Card Counting, Blackjack Modified Basic Strategy
If the cards dealt from blackjack are not shuffled after each hand, then the trails are dependent. Edward Thorp revolutionized the gambling world with 'Beat The Dealer' in 1966 by showing that when there are an excess number of 10's remaining in the deck then then game can be favourable to the player. To recognize such favourable events requires a card counting system. Different count counting systems will be explored and a modified basic strategy will be devised based on the card counting system.

Week 12: Blackjack Team Play
21 is a 2008 American heist drama film directed by Robert Luketic and starring Jim Sturgess, Kevin Spacey, Laurence Fishburne, Kate Bosworth, Liza Lapira, Jacob Pitts, Aaron Yoo, and Kieu Chinh. The film is inspired by the true story of the MIT Blackjack Team as told in Bringing Down the House, the best-selling book by Ben Mezrich. Despite its largely mixed reviews and controversy over the film's casting choices, 21 was a box office success, and was the number one film in the United States and Canada during its first and second weekends of release. The techniques used in this movie based on team play to 'bring down the house' will be explored.

Week 13: Revision

Resources

Online Content
Strategic Games (html)
The Blackjack Hall of Fame & Members (html)
Video Poker Hall of Fame (html)
The Wizard of Odds (html)
Smartgambler (html)
21 produced by Dana Brunetti, Kevin Spacey and Michael De Luca (html)
Gamblers Book Club (html)
Blackjack Masters (html)
Arnold Snyder's Blackjack Forum (html)

Publications
CHANCE (html)
Significance Magazine (html)
Gaming Law Review and Economics (html)

Books
The Mathematics of Tennis by Tristan Barnett and Alan Brown (pdf)
Winning Strategies for Video Poker by Lenny Frome (html)
Video Poker for the Winner by Martin Jensen (html)
Beyond Counting: Exploiting Casino Games from Blackjack to Video Poker by James Grosjean (html)

Million Dollar Blackjack by Ken Uston (html)

Beat the Dealer: A Winning Strategy for the Game of Twenty-One (html)

Bringing Down the House: The Inside Story of Six M.I.T. Students Who Took Vegas for Millions by Ben Mezrich (html)

The Theory of Gambling and Statistical Logic by Richard Epstein (html)

The Mathematics of Games and Gambling by Edward Packel (html)

Taking Chances: Winning with Probability by John Haigh (html)

Probability Guide to Gambling: The Mathematics of Dice, Slots, Roulette, Baccarat, Blackjack, Poker, Lottery and Sport Bets by Catalin Barboianu (html)

The Mathematics of Poker by Bill Chen and Jerrod Ankenman (html)

The Doctrine of Chances: Probabilistic Aspects of Gambling by Stewart Ethier (html)

The Theory of Blackjack by Peter Griffin (html)

Finding the Edge: Mathematical and Quantitative Analysis of Gambling edited by Olaf Vancura, William Eadington and Judy Cornelius (html)

Optimal Play edited by Stewart Ethier and William Eadington (html)

The Mathematics of Gambling by Edward Thorp (html)

Mathematics in Games, Sports, and Gambling - The Games People Play by Ronald Gould (html)

Gambling and Sport: A Statistical Approach by John Croucher (html)

Luck, Logic, and White Lies: The Mathematics of Games by Jorg Bewersdorff (html)

21: Bringing Down the House - Movie Tie-In: The Inside Story of Six M.I.T. Students Who Took Vegas for Millions by Ben Mezrich (html)

Gambling 102: The Best Strategies for All Casino Games by Michael Shackleford (html)

Basic Gambling Mathematics: The Numbers Behind The Neon by Mark Bollman by (html)

The Perfect Bet: How Science and Math Are Taking the Luck Out of Gambling by Adam Kucharski (html)

Calculated Bets: Computers, Gambling, and Mathematical Modeling to Win by Steven Skiena (html)

Understanding and Calculating the Odds: Probability Theory Basics and Calculus Guide for Beginners, with Applications in Games of Chance and Everyday Life by Catalin Barboianu (html)

The Mathematics of Slots: Configurations, Combinations, Probabilities by Catalin Barboianu (html)

What's Luck Got to Do with It?: The History, Mathematics, and Psychology of the Gambler's Illusion by Joseph Mazur (html)

Casino-ology: The Art of Managing Casino Games by Bill Zendor (html)

Roulette Odds and Profits: The Mathematics of Complex Bets by Catalin Barboianu (html)

Mathematics of Keno and Lotteries by Mark Bollman (html)

Casino Math by Robert Hannum and Anthony Cabot (pdf)

Sports Wagering in America: Policies, Economics and Regulation edited by Anthony Cabot and Keith Miller (html)

Bet Smart: The Kelly System for Gambling and Investing by Stefan Hollos and Richard Hollos (html)