A Modern Love Story:

Machine Learning Engines & The Global Sports Betting Industry

Lloyd Danzig





SHARP ALPHA ADVISORS





State of the Sports Betting Industry

ALIKS INS EFS



Green	Live, Legal Sports Betting (13 States)
Light Green	Legal Sports Betting, Not Yet Operational (6 States + DC)
Blue	Active 2019 Sports Betting Legislation (5 States)
Light Blue	Dead Sports Betting Legislation in 2019 (19 States)
Gray	No Sports Betting Bills in 2019 (8 States)

Source: AGA As of: November 7, 2019



Future Trends Betting on Esports

- Fans are projected to wager \$30 billion on Esports in 2020
- Sportsbook operators would generate over \$2 billion in GGR
- Challenges: lack of reliable data, pricing difficulties, and cheating

10:37 -

Vitality

OpTic Gaming

ex-Space Soldier

ENCE eSports

Jan 16, 10:05 AM

at LTE

2.12 1.72

1.75

2.07

1.76

2.06

1.97 1.84

6 500.0

Esportsbook betting volume by game

📕 League of Legends 🛛 CS:GO 📕 Dota 2 📕 Starcraft 2 📄 Other



Source: Narus Advisors / Eilers & Krejcik Garning

Future Trends Sports Betting Bots

- Sophisticated forecasting models
- Convert event probabilities into prices
- Look for differences in model price and market price
- Seek out arbitrage opportunities



Future Trends Blockchain Sportsbooks

- "Provably Fair" gaming
- Guaranteed, instantaneous payouts via smart contracts
- Streamlined, real-time financial auditing



Revenue Models

20

2,000

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NG-02

Monthly Budger. Dela

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	Customers view odds set by sportsbook	NEW YORK KNICKS	+ 190 +5.5 (-110)	
1		DETROIT PISTONS	-225 -5.5 (-110)	
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)
3a)
3b				ſ







3a

3b

Alice thinks New York has a 33% chance of winning, represented in fair odds as +203.

Exchanges offer a number of dramatic advantages over sportsbooks, most notably in the form of drastically improved odds.

Sportsbook Odds:

+190

-225

NEW YORK KNICKS

DETROIT PISTONS

+5.5 (-110)

2

3a

3b

Alice thinks New York has a 33% chance of winning, represented in fair odds as +203.

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+5.5 (-110)

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3b

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New York wins. Bob pays Alice \$203, a small percentage of which goes to the exchange. **Operator Profit = \$10.15**

3a

3b



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3a

3b



New York loses. Alice pays Bob \$100, a small percentage of which goes to the exchange. **Operator Profit = \$5.00**



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Sportsbook Odds:

+190

-225

NEW YORK KNICKS

DETROIT PISTONS

+5.5

(-110)

-5.5

(-110)

Results of Winning \$100 Wager	Sportsbook	Exchange
Alice	\$190.00	
Bob	\$44.44	

Results of Winning \$100 Wager	Sportsbook	Exchange
Alice	\$190.00	\$193.00
Bob	\$44.44	

Results of Winning \$100 Wager	Sportsbook	Exchange
Alice	\$190.00	\$193.00
Bob	\$44.44	\$46.80

Results of Winning \$100 Wager	Sportsbook	Exchange
Alice	\$190.00	\$193.00
Bob	\$44.44	\$46.80

Amount Risked to win \$100	Sportsbook	Exchange
Alice	\$52.63	
Bob	\$225.00	

Results of Winning \$100 Wager	Sportsbook	Exchange
Alice	\$190.00	\$193.00
Bob	\$44.44	\$46.80
Amount		

Risked to win \$100	Sportsbook	Exchange
Alice	\$52.63	\$51.85
Bob	\$225.00	

Results of Winning \$100 Wager	Sportsbook	Exchange
Alice	\$190.00	\$193.00
Bob	\$44.44	\$46.80

Amount Risked to win \$100	Sportsbook	Exchange
Alice	\$52.63	\$51.85
Bob	\$225.00	\$213.68

OBy Bx {yn} df Jn nen, $\sqrt[n]{4^{n} + \cos 2n} / \frac{n^{2} + n - 1}{n}$ $h^+y_n^{C_y}$ x) $\mathcal{E}[0,1]: \forall x, x \in \mathcal{X}$ Predictiv **/e** $\geq n_0: (x_n - g) < \varepsilon$ $x_n: N \to R$ | \lim_{min} | \lim n r+1 n- $\{x_n\} = \{y_n\}_{df} = \{x_n + y_n\}; 13$ $x_n \leq y_n \leq z_n$ noo n→∞ $\{x_n\}, \{y_n\} = \{x_n, y_n\}$ n -> or q a

Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of nondeterministic (i.e. random) numbers as inputs.

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Die	# of Outcomes
	16648
	16521
<mark>°。)</mark>	16910
	16539
	16843
000	16540

Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of nondeterministic (i.e. random) numbers as inputs.

Die	# of Outcomes	% of Outcomes
•	16648	16.65%
°	16521	16.52%
<mark>°。</mark>	16910	16.91%
<mark>0 0</mark> 0 0	16539	16.54%
<mark>。。</mark>	16843	16.84%
	16540	16.54%

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E.g. "What is the probability of rolling a 1 during a single throw of a six-sided die?"

=RANDBETWEEN(1,6)

=random.randint(1,6)

Die	# of Outcomes	% of Outcomes
	16648	16.65%
0	16521	16.52%
	16910	16.91%
	16539	16.54%
	16843	16.84%
	16540	16.54%

Team New York Yankees Boston Red Sox

Team	Avg. Runs Scored	
New York Yankees	5.588	
Boston Red Sox	5.390	

Team	Avg. Runs Scored	Avg. Runs Against	
New York Yankees	5.588	4.375	
Boston Red Sox	5.390	4.732	

 $=\sqrt{5.588 * 4.732}$

Team	Avg. Runs Scored	Avg. Runs Against	Adj. Runs Scored
New York Yankees	5.588	4.375	5.142
Boston Red Sox	5.390	4.732	4.856

Team	Avg. Runs Scored	Avg. Runs Against	Adj. Runs Scored	StDev (Runs Scored)
New York Yankees	5.588	4.375	5.142	3.001
Boston Red Sox	5.390	4.732	4.856	3.358

Industry Standard = NORM.INV(RAND(), μ_{Yankees}, σ_{Yankees}) Monte Carlo Simulation

Team	Avg. Runs Scored	Avg. Runs Against	Adj. Runs Scored	StDev (Runs Scored)	Norm.Inv_Runs
New York Yankees	5.588	4.375	5.142	3.001	10.147
Boston Red Sox	5.390	4.732	4.856	3.358	7.945
Industry Standard Monte Carlo Simulation

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Boston Red Sox	5.390	4.732	4.856	3.358	7.945

Simulation #	New York Yankees	Boston Red Sox	Winner	
1	10.147	7.945	New York Yankees	

Industry Standard Monte Carlo Simulation

Team	Avg. Runs Scored	Avg. Runs Against	Adj. Runs Scored	StDev (Runs Scored)	Norm.Inv_Runs
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Boston Red Sox	5.390	4.732	4.856	3.358	7.945

Simulation #	New York Yankees	Boston Red Sox	Winner
1	10.147	7.945	New York Yankees
2	0.643	5.715	Boston Red Sox
3	3.123	5.009	Boston Red Sox
4	9.203	4.555	New York Yankees
5	4.150	7.523	Boston Red Sox
6	1.737	4.017	Boston Red Sox
7	2.147	3.671	Boston Red Sox
•		•	
		•	
•			
9997	4.040	3.188	New York Yankees
9998	4.667	5.493	Boston Red Sox
9999	7.927	4.856	New York Yankees
10000	4.934	0.000	New York Yankees

Industry Standard Monte Carlo Simulation

Team	Avg. Runs Scored	Avg. Runs Against	Adj. Runs Scored	StDev (Runs Scored)	Norm.Inv_Runs
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Next Gen Statistics

10 98 KM/H

Computer Vision

Explanatory Augmented Reality

Competitor Overlays

Viewpoint Synthesis

Performance Analysis

Computer Vision



IN CS, IT CAN BE HARD TO EXPLAIN THE DIFFERENCE BETWEEN THE EASY AND THE VIRTUALLY IMPOSSIBLE.









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Wearables



Fgr Sports Betting Use Cases

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Use Case Summary





Risk Management



Bet Recommendations



Responsible Gaming



Fraud Detection

Causes for Concern



Backdoor Functionality





Flash Crash Potential

Black Box Problem



Odds Manipulation



Fraud Masking

Causes for Concern



The high demand for Al products combined with their complex nature has led many companies to falsely advertise solutions that are far less sophisticated than they purport to be.

Machine Learning offers dramatic improvements over industry standards in setting pre-match odds.



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With vast increases in computational speed and the availability of robust data sets, architectures best equipped to handle large amounts of information will become industry standards.



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Beyond their inherent performance advantages, Machine Learning algorithms are able to continuously and iteratively improve themselves.



Machine Learning offers dramatic improvements over industry standards in setting pre-match odds.



Transfer Learning is a method by which a model developed for a given task is repurposed for an unrelated one.

Source Tasks



Pre-trained models combined with maximally efficient algorithms allow can be leveraged into competitive advantages.



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Pre-trained models and cutting-edge algorithms provide superior speed and accuracy in real time odds generation.



Pre-trained models combined with maximally efficient algorithms allow can be leveraged into competitive advantages.



Ideal models will transition seamlessly from pre-match to in-play, minimizing the likelihood of exploitable inconsistencies in odds.

TECH FOOTBALL CO TECH -13	S OKLAHOMA
TURODAY OCTOBER 3 OUL GREEN	TEXAS -6
100 HISS 100 OHIO ST# -34	5 PENN ST -2.5
107 TH SA -6 107 KENT ST# -24.	5 MINNESOTA
TOA TOUST	INT MICH ST
UEDNESDAY OCTOBER 4 139 RALL ST -5.5	102 MICHIGAN -17
INT C FLORIDA	IG2 LINLU
IC IN MARSHALL -3.5 ISI ARKANSAS	164 COL ST -15-5
EN -16	N MEX ST PICK
20 THURSDAY OCTOBER 0 133 DUKER	LOG TORHO
105 FLA ST -11 134 ALABAMA# -29	INTROINIA
106 NC ST	COPOLNA -6.5
107 TCU	168 E CHROLIN
108 UTAH 137 TEXAS A&M -1.5	ISS ANOTHOTI -B
I A KANSAS	170 CINCINNII
FRIDAY OCTOBER &	171 S CHR -615
109 LOUISVILE -33 -27	172 KENTUCKY
TO ND TN ST#	173 BAYLOR
IN NICE	174 COLORADO -5
SATURDAY OCTOBER 7 142 TULINE	175 NEBRASKA -6.5
I N'HESTERN	TOUR ST
2 WISCONSN -20.5 144 RIR FURCE -3	177 MEMOUIS
PURDUE 145 STANFORD	
1008 -11 146 NTRE DAME -32	178 HLH-BIRN -6
PITTSBURG -6-5 147 W VIRGINI -28	179 MISSOURI
AND ALLER MISS ST	180 TEX TECH -3.5
THE LONG -2	INI WEST MICH -3
	182 0410
ILLINUIS -/ ISU FLORIDH	
CLEMSON -16 151 WHSH ST -4	183 VHNDT -183
IK FOREST 152 OREGON ST	184 OLE MISS
CAR 153 ARIZONA	CENT MICH

Pre-trained models combined with maximally efficient algorithms allow can be leveraged into competitive advantages.



Pre-trained models combined with maximally efficient algorithms allow can be leveraged into competitive advantages.



The ability to predict betting trends and update models in real-time allows for streamlined, automated, optimal risk management

 $\frac{\partial \theta}{\partial \theta} \mathbf{M} T(\xi) = \frac{\partial}{\partial \theta} \int_{R_n}^{T(x)} f(x, \theta) dx = \int_{R_n}^{\frac{\partial}{\partial \theta}} \int_{R_n}^{T(x)} \int_{R_n}^{\frac{\partial}{\partial \theta}} \int_{R_n}^{\frac{\partial}{\partial \theta}} \int_{R_n}^{\frac{\partial}{\partial \theta}} \int_{R_n}^{T(x)} \int_{R_n}^{\frac{\partial}{\partial \theta}} \int_{R_n}^$

Risk Management



Real-Time Book Balancing





Increased Turnover Capacity

*Turnover: Total dollar amount of wagers accepted



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POPULAR	CASINO New Players Only	9 0
	betfair Blackjack, Roulette, Slots & more!	
	Play \$100 risk-free. T&Cs apply	•
	And the second s	< (>
Odds Boost		
Promotion Type Preference		

	e Live Promotions (Casino	AI	\$13.00 DD FUNDS
POPULAR	CASINO New P	layers Only		à <u>à</u> <u>a</u>
	Blackja	ack, Roulette, Slot	:s & more!	o o o
₩ №ВА	Play \$100 risk-1	free. T&Cs apply		
	w's Pick			
	<u>y 57 /ck.</u>	NHL Playoffs Insurance Get up to \$50 Back on Your Bet Site Credit Refund	Cash Back If Bet Doesn't Hit Playoffs	e < (>
Odds Boost				
Promotion Type	Unbalanced			
Preference	Exposure			



Responsible Gaming



	Avg. Wager	\$10.01	
	Wager StDev	\$0.41	
SZ	Bets/Week	4.3 (85% Baseball)	
	% Player Props	17%	
User_01093	Max. Bet	\$35.00	

	Avg. Wager	\$210.87	
	Wager StDev	\$94.36	
	Bets/Week	29.0 (88% ATS)	
	% Player Props	0%	
User_26571	Max. Bet	\$1100.00	

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$\left(\begin{array}{c} \\ \end{array} \right)$	% Player Props	17%
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Enhanced pattern recognition will revolutionize an operator's ability to detect deviations from responsible gaming

\$210.87

\$94.36

29.0 (88% ATS)

0%

\$1100.00

Max. Bet


Sustainable Gaming

Enhanced pattern recognition will revolutionize an operator's ability to detect deviations from responsible gaming



Fraud Detection



Bonus Exploitation







Use Case Summary





Risk Management



Bet Recommendations



Responsible Gaming



Fraud Detection

Questions?

Thank You

Office Hours: 1:15pm - 2:00pm

Lloyd Danzig





SHARP ALPHA
ADVISORS

Appendix



NAS

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Bookmaking Economics

896554 6555



NEW YORK KNICKS Customers view odds set by sportsbook DETROIT PISTONS





\$100

2



Custo	mers view	odds set by	/ sportsbo	NEWY	ORK KNICKS	+190	+5.5 (-110)	
54500			,		DETRO	DIT PISTONS	-225	-5.5 (-110)
Team	Odds	Impl. Prob.	Fair Prob.	Sportsbook Profit	Expected Profit]		
NYK	+190	34.48%	33.25%	\$35.00	\$11.64	= 0.332	5 * \$35.0	0 = \$11.64
DET	-225	69.23%	66.75%	\$0.00	\$0.00			
		103.71%			\$11.64			



Customers view odds set by sportsbook

NEW YORK KNICKS	+190	+ 5.5 (-110)
DETROIT PISTONS	-225	-5.5 (-110)

Team	Odds	Impl. Prob.	Fair Prob.	Sportsbook Profit	Expected Profit
NYK	+190	34.48%	33.25%	\$35.00	\$11.64
DET	-225	69.23%	66.75%	\$0.00	\$0.00
2		103.71%			\$11.64

Overround:

2

103.71% - 100.00% = 3.71%Bookmaker will pay out \$100.00 for every \$103.71

it collects



+5.5

(-110)

-5.5

(-110)

NEW YORK KNICKS +190 Customers view odds set by sportsbook DETROIT PISTONS -225 Odds Impl. Prob. Fair Prob. Sportsbook Profit Expected Profit Team NYK +190 34.48% 33.25% \$35.00 \$11.64 DET -225 69.23% 66.75% \$0.00 \$0.00 103.71% \$11.64

Profit Margin:

Overround:
103.71% - 100.00% = 3.71%
Bookmaker will pay out
\$100.00 for every \$103.71
it collects

2

\$3.71	- 2 E 00/
\$103.71	- 3.30%

2



\$100

$\frac{103.71\% - 100.00\% = 3.71\%}{\text{Bookmaker will pay out} \\ \$100.00 \text{ for every }\$103.71 \\ \text{it collects}} \qquad \frac{\$3.71}{\$103.71} = 3.58\% \qquad \frac{\$11.64}{\$325.00} = 3.58\%$	Overround:	Profit Margin:	Expected Profit:
	103.71% - 100.00% = 3.71% Bookmaker will pay out \$100.00 for every \$103.71 it collects	$\frac{\$3.71}{\$103.71} = 3.58\%$	$\frac{\$11.64}{\$325.00} = 3.58\%$

2

3



\$100

Alice thinks New York has a 33% chance of winning, represented in fair odds as +203. The best sportsbook is offering New York +190, so Alice will prefer odds of +203.

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She offers ("lays") to accept a wager from anyone interested in Detroit -203. The best sportsbook is offering Detroit -225, so Bob accepts the other side of Alice's wager.

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She offers ("lays") to accept a wager from anyone interested in Detroit -203. The best sportsbook is offering Detroit -225, so Bob accepts the other side of Alice's wager.

Team	Fair Prob.	Winnings	Commission	Sportsbook Profit	Expected Profit
NYK	33.25%	\$203	5.00%	\$10.15	\$3.37
DET	66.75%	\$100	5.00%	\$5.00	\$3.34
					\$6.71

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She offers ("lays") to accept a wager from anyone interested in Detroit -203. The best sportsbook is offering Detroit -225, so Bob accepts the other side of Alice's wager.

Team	Fair Prob.	Winnings	Commission	Sportsbook Profit	Expected Profit
NYK	33.25%	\$2 <mark>0</mark> 3	5.00%	\$10.15	\$3.37
DET	66.75%	\$100	5.00%	\$5.00	\$3.34
					\$6.71

Simulation:							
	=RAND()		=RAND()	Book Profit	\sum^{η}	l Prof	Sit.
	0.82812	IF(Value < 0.3325)	0.29134	\$10.15	Average profits Δi	110j	
Generate large set of	0.73180	Sportsbook Wins \$10.15	0.73180	\$5.00	across all		— ≈ \$ 6 . / I
random numbers		ELSE		•	estimate of	n	
between 0 and 1		Sportsbook Wins \$5.00	•		Expected Profit		$\sigma \sim (c_2) / 2$
	0.19361		•	•	Expected Front		0 ≈ \$2.45
			0.19361	\$10.15			

	Sportsbook	Betting Exchange
Favorable Odds		
Operator Risk		
Potential Market Variety		
Reward/Bonus Programs		
Bet to Lose		
Bet Matching		
Predictive Capacity		
Max Profit (Operator)		

Exchanges offer the benefit of being riskless to operate, since payouts to winners come from deposits by losers.

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Favorable Odds		\checkmark
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Bet to Lose		
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