

SmartRoster

Daily NFL Fantasy Football Player
Performance Projection and
Lineup Optimization

MIDS Summer 2020 Capstone Presentation

W210 Thu 4:00-5:30

Martin Jung, Paul Petit, Keith Wertsching

Today's playbook

- Project background and motivation
 - What are fantasy football and daily fantasy sports?
 - Why are we doing this project?
 - What are our objectives?
 - Who are our users?
- Product demonstration
- Product development and evaluation
 - How did we build SmartRoster?
 - How do our projections compare against DraftKings'?
 - How do our lineups perform in historic competitions?
- Learnings
 - What can we do in the short-term with SmartRoster?
 - What can we do in the long-term with SmartRoster?

Project Background & Motivation



Daily fantasy football is betting on actual player performance

We **buy** a weekend **lineup**



Projection P_1 Cost C_1



Projection P_2 Cost C_2

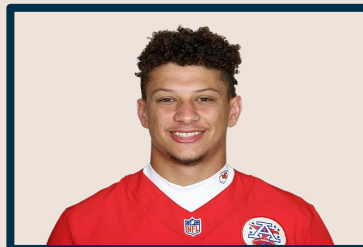


Projection P_3 Cost C_3

NFL players play **real** games



Strong performance returns **fantasy** points



Good lineups **win** money



Eg. Martin_Paul_Keith - \$80

Patrick Mahomes(QB).....\$10
Deandre Hopkins (WR).....\$15
Jamison Crowder (WR).....\$10
Mike Evans (WR).....\$15
Ezekiel Elliott (RB).....\$5
Tevin Coleman (RB).....\$10
Austin Hooper (TE).....\$5
Chris Carson (FLEX).....\$5
Denver Broncos (DST).....\$5

Eg. Patrick Mahomes

Passing Yds: 345 yds
Passing TDs: 3 TD
Rushing Yds: 27 yds

Eg. Patrick Mahomes (fantasy)

Fantasy Points: 35.6
Passing TDs: 3 TD
Rushing Yds: 27 yds

**MID\$\$\$ - \$martRo\$ter = \$
:)**

Users

Us



- Assemble optimal teams
- Put our money where our models are



DraftKings Users



- Millions of annual users
- Thousands of first-time betters
- Product: more accurate projections than DraftKings

Objectives

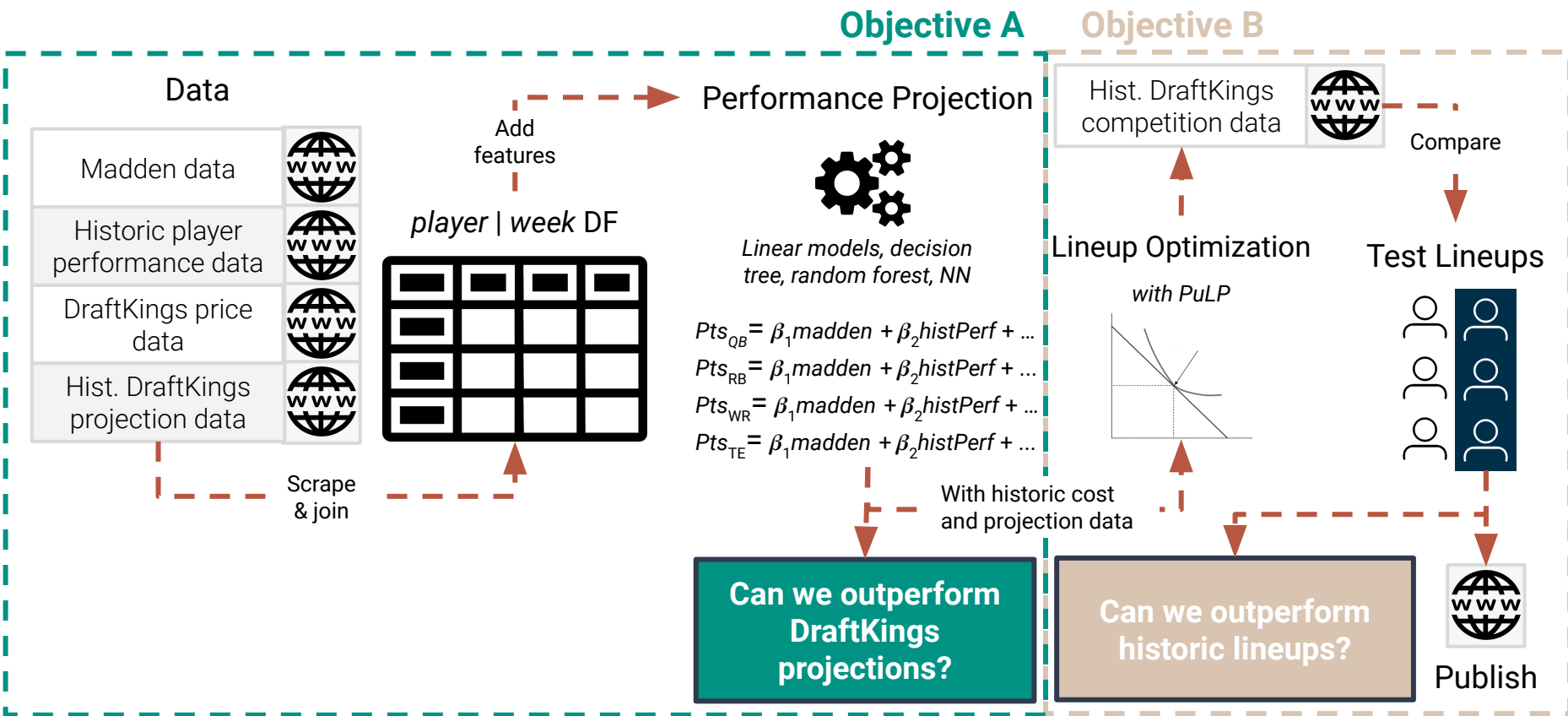
- A) **Project** weekly NFL offensive **player performance** in 2019 *more accurately than DraftKings*
- B) **Assess** optimized **weekly lineup performance** in 2019 DraftKings DFS competitions

Product Demonstration

[Link](#)

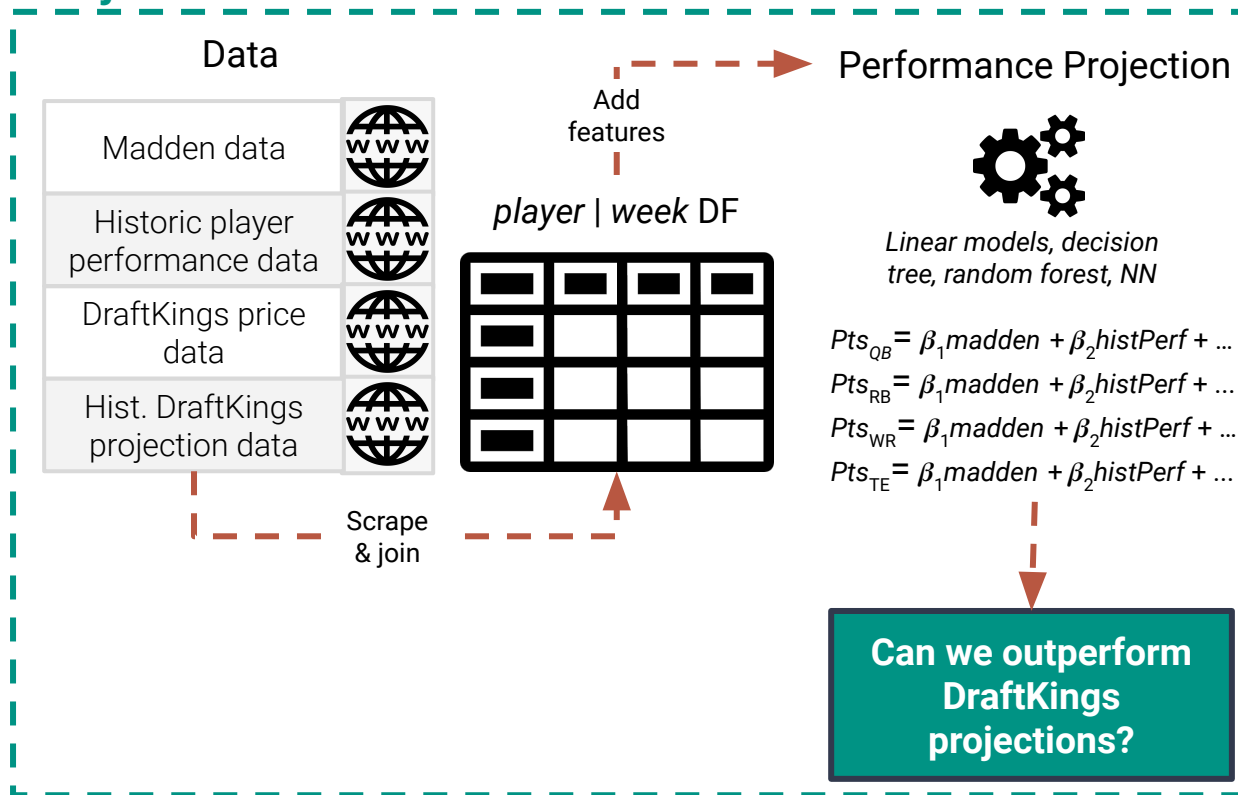


Our data pipeline, from web to projection and lineup evaluation



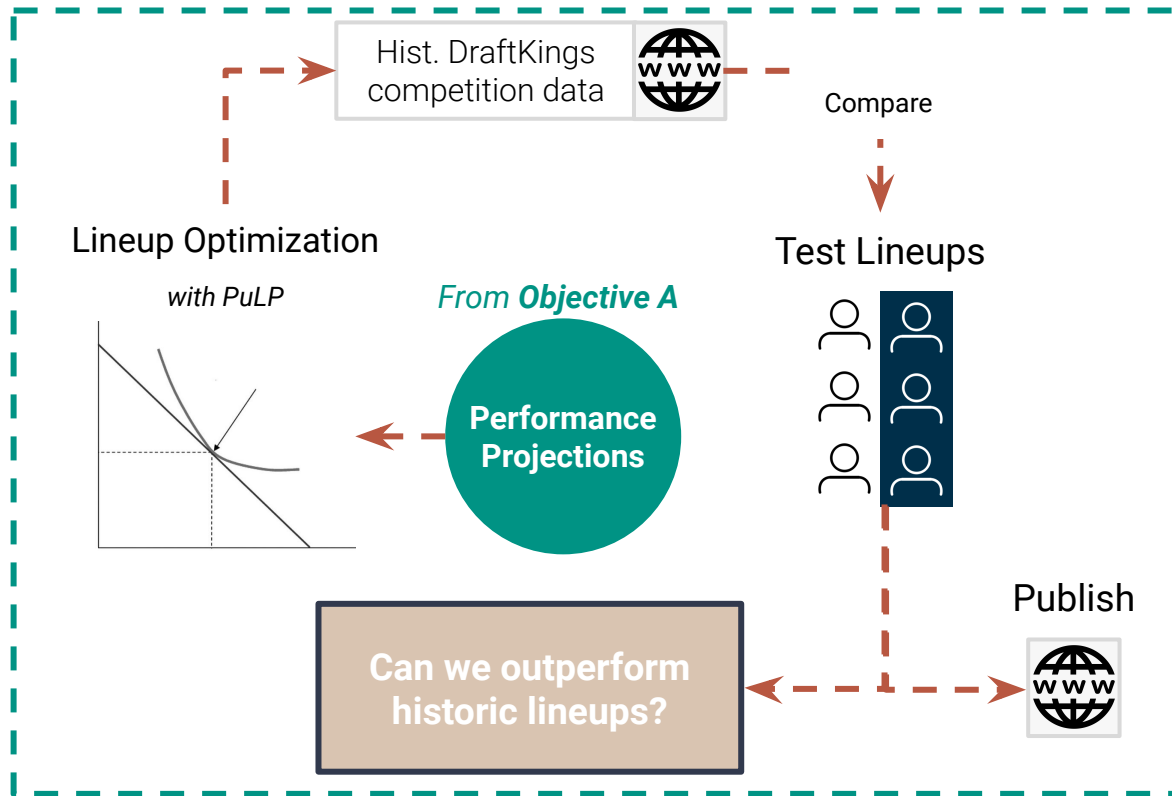
Our data pipeline, from web to projection evaluation

Objective A



From projections to lineup evaluation and publishing

Objective B



Product Performance



SmartRoster beat DraftKings projections for 3 of 4 positions

Objective A: Project weekly NFL offensive player performance in 2019 more accurately than DraftKings

<i>Position</i>	<i>Best Model</i>	<i>Optimal Feature Set</i>	<i>SmartRoster Test RMSE</i>	<i>DraftKings Test RMSE</i>
Quarterback	Decision Tree	Player Performance + Madden	7.17	7.88
Running Back	Ridge Regression	Player Performance + Madden + Opponent Performance	6.14	6.54
Tight End	Linear Regression	Player Performance + Madden + Opponent Performance	5.46	5.87
Wide Receiver	Linear Regression	Player Performance + Opponent Performance	6.91	6.68

SmartRoster lineups would have made up to \$64,184 in 2019



ODIN

- Madden
- Madden Def
- Player Avg.
- Opponent Avg.



THOR

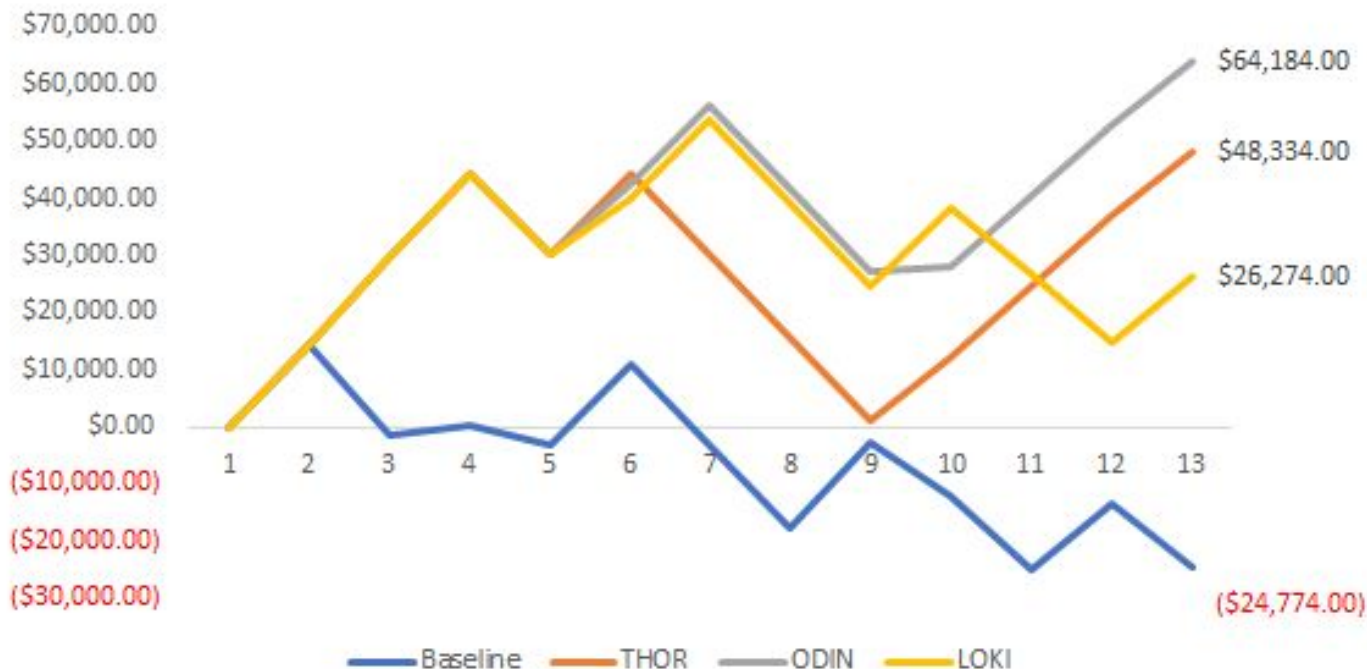
- Madden Def
- Player Avg.
- Opponent Avg.



LOKI

- Madden
- Madden Def
- Player Avg.

Weekly Cumulative Profit By Model

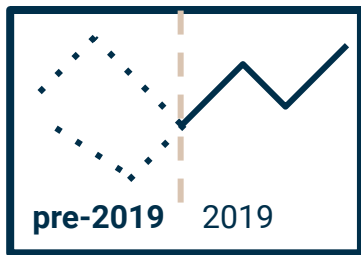


Project Learnings and Next Steps

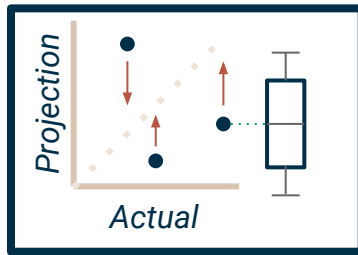


Cross-season validation, improving projections, bet hedging

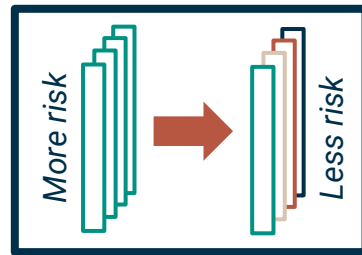
Cross-season Validation



Improving Projections



Bet Hedging



Learning

- Pre-2019 data accessibility a challenge

- Consistency important in contests
- Touchdown prediction challenges

- Submitting one lineup multiple times is a recipe for boom or bust outcomes

Value

- Showing results across multiple seasons

- Better performance, especially in double-up competitions

- Balanced lineup portfolios perform better in long-run

Launching and scaling our platform



\$4.92M per season



\$780K per season



\$7.2M per season



\$1M per season

Total Expected Prize Money:

\$14,000,000 Per Season



\$200K per season



Thank you! Questions?

Congratulations MIDS graduates!!

Contribution – Paul Petit

Category	Contribution
Admin	<ul style="list-style-type: none">• Project plan creation and tracking• Deck creation
Data	<ul style="list-style-type: none">• Interviewed subject matter expert and research• Scraped historic player performance data• EDA on historic performance data
Feature Engineering	<ul style="list-style-type: none">• Data engineering work to unify all features into key tables and assembling clean pipeline• Engineered rolling X-week average features for historic performance models
Model building and evaluation	<ul style="list-style-type: none">• Built and tuned linear, lasso, ridge regression models, decision tree and random forest models using basic historical player performance features only• Trained 2010-18; tested 2019; also trained 2019 weeks 1-9; test weeks 10-13• Evaluated projections to determine where they were failing
Translating results	<ul style="list-style-type: none">• Determining short-term next steps and how to improve our models

Contribution - Keith Wertsching

Category	Contribution	Remark
Admin	Project Management	Project Plan Updates, Weekly Deck creation weeks 2-4
Data	Madden Data	Web-Scraped data for all available madden players for all weeks
	Master Match Dataframe	Created a master matching file to be able to compare across Madden Data, Actuals Data, Performance Data, and Projection Data
Code	Master Dataframe Creation	Wrote code that integrates Madden Data, Actuals Data, Performance Data, and Projection Data
	Neural Network Design	Designed and implemented a Neural Network to predict player performance

Contribution - Martin Jung

Category	Contribution	Remark
Data	Weekly DraftKings Projection Data (All Positions)	Web-Scraped Projected DraftKings Points, Projected Each Category (Pass Yards, Rushing Yards, etc)
	Past Performance	Defense Team Draftking Points
	DraftKings Salary data	
	DraftKings Past Contest Data	- Week 1 to Week 13 (2019) - 50/50 contest only
Code	RMSE Comparison	- Our model against Actual DraftKings Points - External Projected Point against Actual DraftKings Points
	Lineup Optimizer	FLEX position, Defense Team handling
	Past Contest Comparison	- Ranking using actual DraftKings Points - Expected Earning in Past 50/50 contests
	Front End	Build End-to-End Front End

Appendix



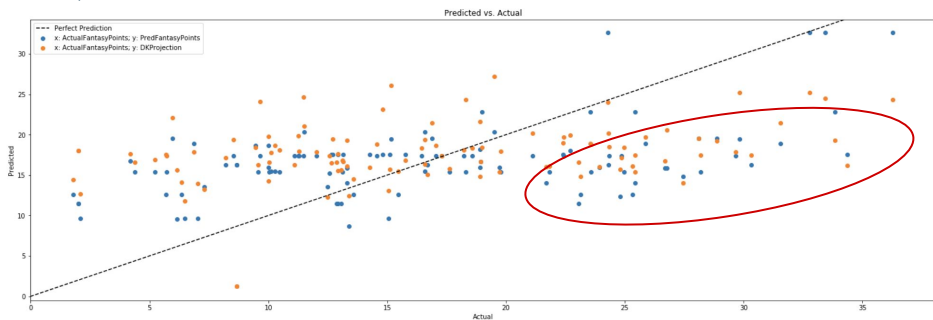
Minimize touchdowns projection inaccuracy

Portion of Error in Fantasy Points Projection by Projection Component

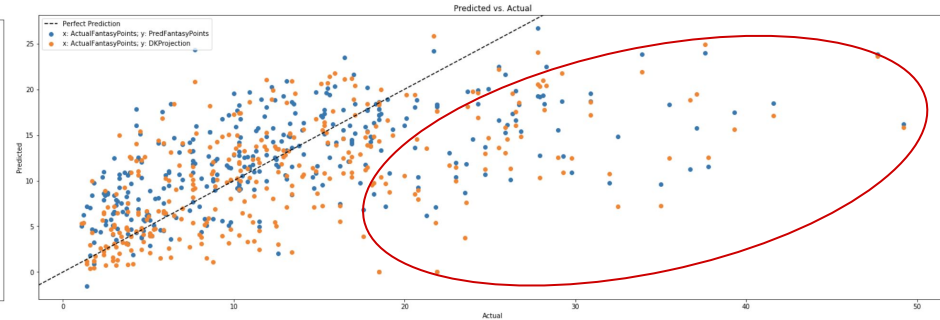
<i>Position</i>	<i>Touchdowns</i>	<i>Passing/Rushing/Receiving Yards</i>	<i>Receptions</i>	<i>Interceptions</i>
Quarterback	67%	11%		22%
Running Back	53%	36%	11%	
Wide Receiver	41%	36%	36%	
Tight End	18%	59%	24%	

Improve models' ability to project excellent performances

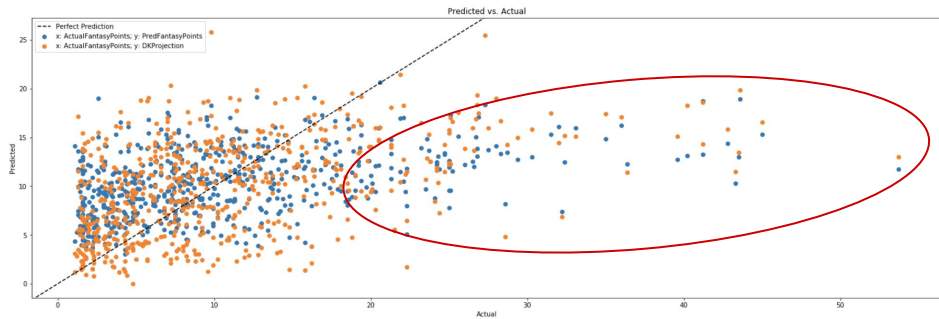
QB



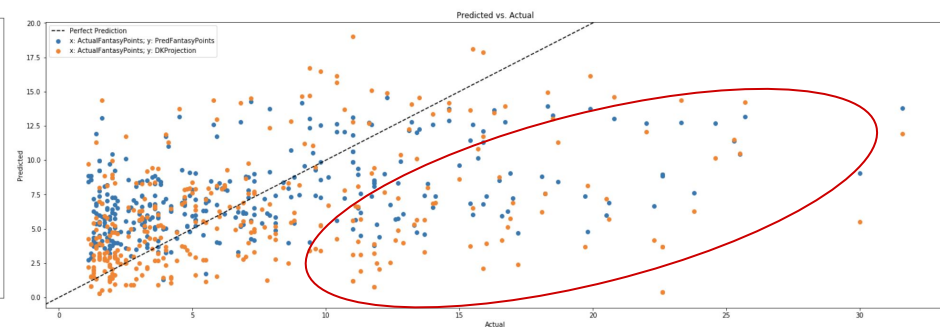
RB



WR



TE



Contest Rules Algorithm - 5050

Game Style
All

Showdown
5 Games

All Game Sets
(11)

Today 9/26
(PHI vs GB)
Featured
PHI @ GB

Sun 9/29
1:00 PM
Featured
12 Games

Today 9/26
(Thu Mon)
8:20 PM
15 Games

Search Contests

Entry Fee
Free to \$1,000+

Contest Types
All
Featured
Beginner
Casual
Tournaments
Head to Head
50/50s & Double Ups
Multipliers
Satellites & Qualifiers
Advanced Filter
Field Size

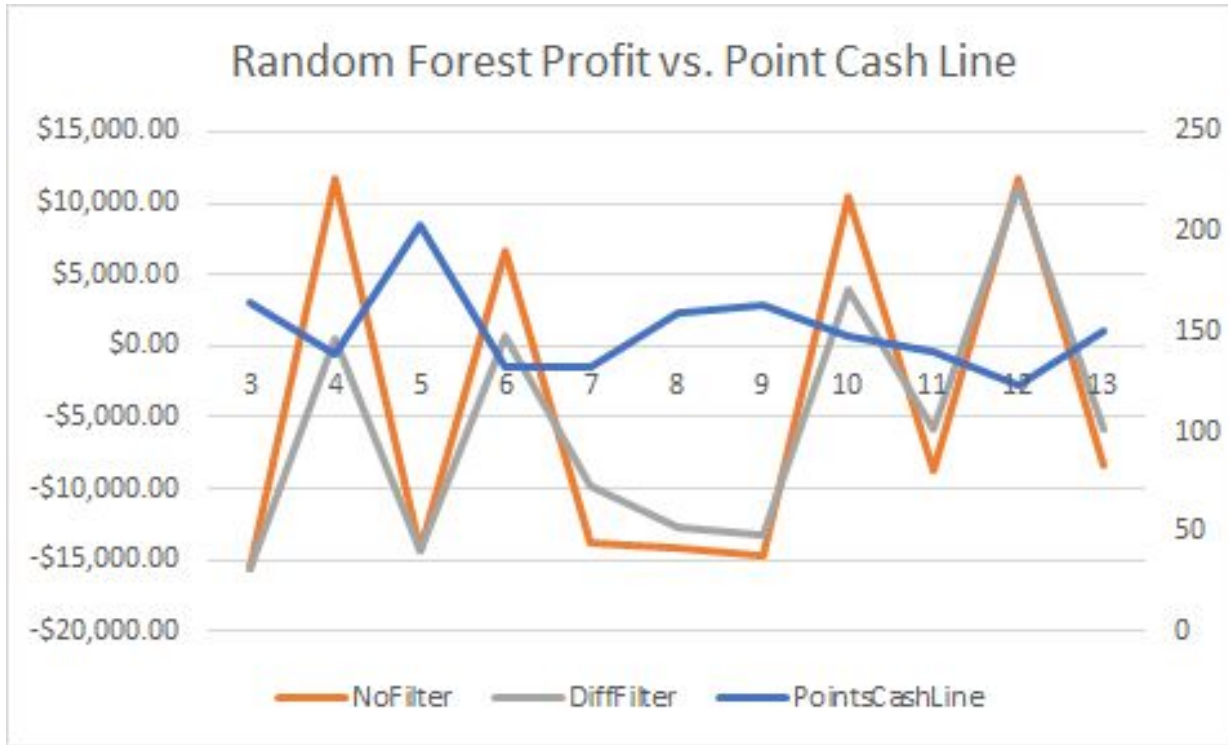
Contest	Style	Entry Fee	Total Prizes	Entries	Live	
★ NFL Showdown Single Entry \$5 Double Up (P...	Showdown...	\$5	G \$15,000	1346/3448	10:22:12	ENTER
★ NFL Showdown GIANT \$25 Double Up [Singl...	Showdown...	\$25	G \$30,000	516/1379	10:22:12	ENTER
★ NFL Showdown GIANT \$5 Double Up (PHI vs ...	Showdown...	\$5	G \$25,000	M 2291/5747	10:22:12	ENTER
★ NFL Showdown \$25 Double Up (PHI vs GB)	Showdown...	\$25	G \$10,000	M 226/459	10:22:12	ENTER
★ NFL Showdown \$250 Double Up (PHI vs GB)	Showdown...	\$250	G \$16,000	M 21/71	10:22:12	ENTER
★ NFL Showdown Single Entry \$50 Double Up (...	Showdown...	\$50	G \$15,000	134/340	10:22:12	ENTER
★ NFL Showdown Single Entry \$10 Double Up (...	Showdown...	\$10	G \$15,000	629/1724	10:22:12	ENTER
★ NFL Showdown Single Entry \$100 Double Up...	Showdown...	\$100	G \$10,000	58/111	10:22:12	ENTER
★ NFL Showdown \$2 Double Up (PHI vs GB)	Showdown...	\$2	G \$6,000	M 1212/3448	10:22:12	ENTER
★ NFL Showdown \$1,060 50-50 [Top 50% Win] (...	Showdown...	\$1,060	G \$16,000	7/16	10:22:12	ENTER
★ NFL Showdown \$100 Double Up (PHI vs GB)	Showdown...	\$100	G \$7,000	M 25/77	10:22:12	ENTER

Contest Data

A	B	C	D	E	F	G	H
Name	Prize Pool	Buy In	Top Prize	Max Entries	Entries	Cash Line	Winning Score
NFL \$2M Play-Action [\$200K to 1st]	2000000	3	200000	20	747667	164	292.22
NFL \$250K First Down [20 Entry Max]	250000	1	20000	20	297266	166.66	280.12
NFL \$5M Fantasy Football Millionaire [\$1M to 1st]	5000000	20	1000000	150	294118	169	281.36
NFL \$50K Quarter Jukebox [Just \$0.25!]	50000	0.25	2000	20	237813	165.7	294.2
NFL \$22K Micro Bargain Bin [Guaranteed Overlay, \$2K Added!]	22000	0.1	1000	20	200001	165.72	284.62
NFL \$60K mini-MAX [150 Entry Max]	60000	0.5	5000	150	142688	168.32	288.32
NFL \$500K Slant [\$50K to 1st, 2x Min Cash]	500000	9	50000	150	65360	173.06	278.6
NFL \$100K Pylon [Single Entry]	100000	3	10000	1	39636	166.7	281.36
NFL \$150K Nickel [3 Entry Max]	150000	5	20000	3	35672	167.22	281.36
NFL \$6K Quarter Jukebox [Just \$0.25!]	6000	0.25	600	20	28538	169.7	266.32
NFL \$100K Flea Flicker [\$10K to 1st]	100000	5	10000	150	23782	174.76	272
NFL MASSIVE \$5 Double Up	100000	5	10	150	22989	162.96	247.36
NFL MASSIVE \$5 Double Up	100000	5	10	150	22989	164.12	243.86
NFL GIANT \$2 Double Up	40000	2	4	20	22989	161.22	271.42
NFL \$200K Fair Catch [Single Entry]	200000	12	20000	1	19608	168.5	281.36
NFL \$15K Daily Dollar [Single Entry]	15000	1	750	1	17836	166.96	277.6
NFL \$15K First Down [20 Entry Max]	15000	1	750	20	17836	166.52	276.32

Week 8 Number of Contest: 55, Total Invest: \$14587.0, Total Prize: \$104.0, Total Profit: \$-14483.0
 Week 9 Number of Contest: 52, Total Invest: \$14817.0, Total Prize: \$21334.0, Total Profit: \$6517.0
 Week 10 Number of Contest: 47, Total Invest: \$14252.0, Total Prize: \$0, Total Profit: \$-14252.0
 Week 11 Number of Contest: 29, Total Invest: \$12747.0, Total Prize: \$25494.0, Total Profit: \$12747.0
 Week 12 Number of Contest: 36, Total Invest: \$12082.0, Total Prize: \$4460.0, Total Profit: \$-7622.0
 Week 13 Number of Contest: 47, Total Invest: \$11472.0, Total Prize: \$22944.0, Total Profit: \$11472.0

Model Profitability per Week



RMSE Deep Dive

Feature category	Model	Train RMSE	Test RMSE
PlayerPerf only	Linear Regression	7.71	6.93
PlayerPerf+OppPerf	Linear Regression	7.70	6.95
PlayerPerf+OppPerf	Ridge Regression	7.73	6.97
PlayerPerf only	Ridge Regression	7.74	6.97
PlayerPerf+Madden	Linear Regression	7.43	7.05
PlayerPerf+Madden+OppPerf	Linear Regression	7.43	7.05
PlayerPerf+Madden+OppPerf	Ridge Regression	7.43	7.07
PlayerPerf+Madden	Ridge Regression	7.43	7.08
PlayerPerf+Madden	Random Forest	3.28	7.23
PlayerPerf+Madden+OppPerf	Random Forest	3.34	7.24
Madden only	Ridge Regression	7.51	7.28
Madden only	Linear Regression	7.51	7.28

Development Journey

Week 1 - 2

Which sport?
What kind of betting?
What data sources are available?
What's our explicit objective?
Which tools do we want to use?

Week 5 - 6

Join data sources
Basic feature engineering
Build/eval basic model one pos
Scale basic model multi pos

Week 9 - 10

Evaluate model multi pos
Sophisticated lineup optimization
Basic evaluation of opt lineups
Basic front-end locally deployed

Web scraping Madden data
Web scraping historic perf data
Web scraping historic price data
Determine evaluation metric
Exploratory data analysis

Week 3 - 4

Build/evaluate model multi pos
Compare multiple basic models
Basic lineup optimization

Week 7 - 8



Front-end Mockup

week

player(s)

salary cap

Show another lineup



Player	Position	OurProjection	Draft Kings Salary	Pt. Projection / Sal
Jameis Winston	QB	23.10	6500	281.4
Brian Hill	RB	14.41	4800	333.1
Miles Sanders	RB	14.45	4100	283.7
D.J. Moore	WR	16.28	5900	362.4
DeAndre Hopkins	WR	18.98	8100	426.8
Michael Thomas	WR	26.92	9900	367.8
Deebo Samuel	FLEX	12.86	4100	318.8
Eric Ebron	TE	10.18	3600	353.6
Buffalo Bills	DST	8.22	3000	365.0
TOTAL		138.37	50000	341.1

[Link](#) to WIP Front-end

Lineup Optimization

PuLP - High-level modelling library that allows the user to create optimization leveraging linear programming

Optimized to maximize the Projected DraftKings Points

Conditions - Salary Cap (\$50,000), Number of Players in Each Position

	DK Position	Player	Position	Team	DK Salary	Model DKP	External DKP	Actual DKP
0	DST	Tennessee Titans	DST	TEN	3200.0	9.30	9.30	11.00
1	QB	Russell Wilson	QB	SEA	7200.0	15.02	23.02	15.68
2	FLEX	Leonard Fournette	RB	JAX	7800.0	11.34	19.37	20.60
3	RB	Tra Carson	RB	DET	3200.0	8.64	1.38	3.40
4	RB	Zach Zenner	RB	ARI	3000.0	7.28	3.33	2.30
5	TE	Greg Olsen	TE	CAR	3700.0	6.56	9.19	3.30
6	WR	Chris Godwin	WR	TB	7100.0	9.29	17.64	10.30
7	WR	Michael Thomas	WR	NO	8000.0	10.60	25.47	30.30
8	WR	Mike Evans	WR	TB	6600.0	9.09	15.81	45.80

Number of Players in Each Position

Quarterback (QB): 1

Running Back (RB): 2

Wide Receiver (WR): 3

Tight End (TE): 1

Defense Team (DST):1

Flex (FLEX): 1 from RB,WR,TE

Comparison to Past Contests

Past DraftKings Contests Data - 1 Contest per week from Week 1 to Week 13 of 2019

Data - Rank, DraftKings UserID, Total DraftKings Points, Lineup

Using Actual DK Point (Optimizer Validation)

Week 2 Performance = 1/672756 (Top 0.0%)
Week 3 Performance = 1/249540 (Top 0.0%)
Week 4 Performance = 1/13657 (Top 0.0%)
Week 5 Performance = 1/234832 (Top 0.0%)
Week 6 Performance = 1/26736 (Top 0.0%)
Week 7 Performance = 1/411027 (Top 0.0%)
Week 8 Performance = 1/22389 (Top 0.0%)
Week 9 Performance = 1/176077 (Top 0.0%)
Week 10 Performance = 1/43474 (Top 0.0%)
Week 11 Performance = 1/176053 (Top 0.0%)
Week 12 Performance = 1/176024 (Top 0.0%)
Week 13 Performance = 1/175996 (Top 0.0%)

Using External DK Projection (Baseline)

Week 2 Performance = 82806/672756 (Top 12.3%)
Week 3 Performance = 140568/249540 (Top 56.3%)
Week 4 Performance = 6774/13657 (Top 49.6%)
Week 5 Performance = 10201/234832 (Top 4.3%)
Week 6 Performance = 7742/26736 (Top 29.0%)
Week 7 Performance = 231509/411027 (Top 56.3%)
Week 8 Performance = 5571/22389 (Top 24.9%)
Week 9 Performance = 24036/176077 (Top 13.7%)
Week 10 Performance = 31096/43474 (Top 71.5%)
Week 11 Performance = 23990/176053 (Top 13.6%)
Week 12 Performance = 110054/176024 (Top 62.5%)
Week 13 Performance = 4643/175996 (Top 2.6%)

Base Model: Comparison to Baseline

Past DraftKings Contests Data - 1 Contest per week from Week 1 to Week 13 of 2019

Data - Rank, DraftKings UserID, Total DraftKings Points, Lineup

Our Linear Regression Model (Historical Data Only)

Week 2 Performance = 23588/672756 (Top 3.5%)
Week 3 Performance = 226996/249540 (Top 91.0%)
Week 4 Performance = 1116/13657 (Top 8.2%)
Week 5 Performance = 156119/234832 (Top 66.5%)
Week 6 Performance = 3495/26736 (Top 13.1%)
Week 7 Performance = 52006/411027 (Top 12.7%)
Week 8 Performance = 19625/22389 (Top 87.7%)
Week 9 Performance = 44235/176077 (Top 25.1%)
Week 10 Performance = 17396/43474 (Top 40.0%)
Week 11 Performance = 109071/176053 (Top 62.0%)
Week 12 Performance = 28298/176024 (Top 16.1%)
Week 13 Performance = 109402/175996 (Top 62.2%)

Using External DK Projection (Baseline)

Week 2 Performance = 82806/672756 (Top 12.3%)
Week 3 Performance = 140568/249540 (Top 56.3%)
Week 4 Performance = 6774/13657 (Top 49.6%)
Week 5 Performance = 10201/234832 (Top 4.3%)
Week 6 Performance = 7742/26736 (Top 29.0%)
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Week 12 Performance = 110054/176024 (Top 62.5%)
Week 13 Performance = 4643/175996 (Top 2.6%)

Advanced Models: Comparison to Baseline

		RMSE vs. Actual Points Scored					
Position	Baseline	Neural Network	Lasso	LinearRegression	RandomForest	DecisionTree	Ridge
QB	7.54	8.60	8.77	43.90	8.50	10.56	12.40
RB	7.06	7.97	7.39	1.13E+13	7.82	9.27	10.48
TE	5.93	6.25	5.90	27.18	6.41	8.10	7.63
WR	7.28	8.02	7.57	7.79E+12	7.78	9.75	7.61

		Predicted Lineup Performance					
Week	Baseline	Neural Network	Lasso	LinearRegression	RandomForest	DecisionTree	Ridge
8	Top 24.9%	Top 27.7%	Top 43.0%	Top 21.3%	Top 61.2%	Top 69.0%	Top 8.0%
9	Top 13.7%	Top 33.7%	Top 77.3%	Top 71.0%	Top 68.9%	Top 95.3%	Top 71.0%
10	Top 71.5%	Top 78.8%	Top 63.7%	Top 66.5%	Top 38.7%	Top 88.2%	Top 48.5%
11	Top 13.6%	Top 76.1%	Top 58.2%	Top 76.2%	Top 35.3%	Top 93.1%	Top 81.8%
12	Top 62.5%	Top 56.8%	Top 93.7%	Top 96.1%	Top 32.5%	Top 61.7%	Top 87.7%
13	Top 2.6%	Top 67.2%	Top 63.1%	Top 31.2%	Top 41.6%	Top 40.2%	Top 31.2%

Filters: PointDiff > 0

Evaluation Week	Train Records - No Filter	Train Records - Filtered
2	286 Records	143 Records
3	563 Records	280 Records
4	841 Records	415 Records
5	1103 Records	557 Records

Model	No Filter	Filter
DecisionTree	\$ (21.00)	\$ (19.00)
LinearRegression	\$ (26.00)	\$ (20.00)
RandomForest	\$ (16.00)	\$ (36.00)
Ridge	\$ (20.00)	\$ (20.00)

Filters: Weekly

Evaluation Week	Train Records - No Filter	Train Records - Filtered
2	286 Records	286 Records
3	563 Records	277 Records
4	841 Records	278 Records
5	1103 Records	262 Records

Model	No Filter	Filter
DecisionTree	\$ (21.00)	\$ (15.00)
LinearRegression	\$ (26.00)	\$ (36.00)
RandomForest	\$ (16.00)	\$ 9.00
Ridge	\$ (20.00)	\$ (31.00)

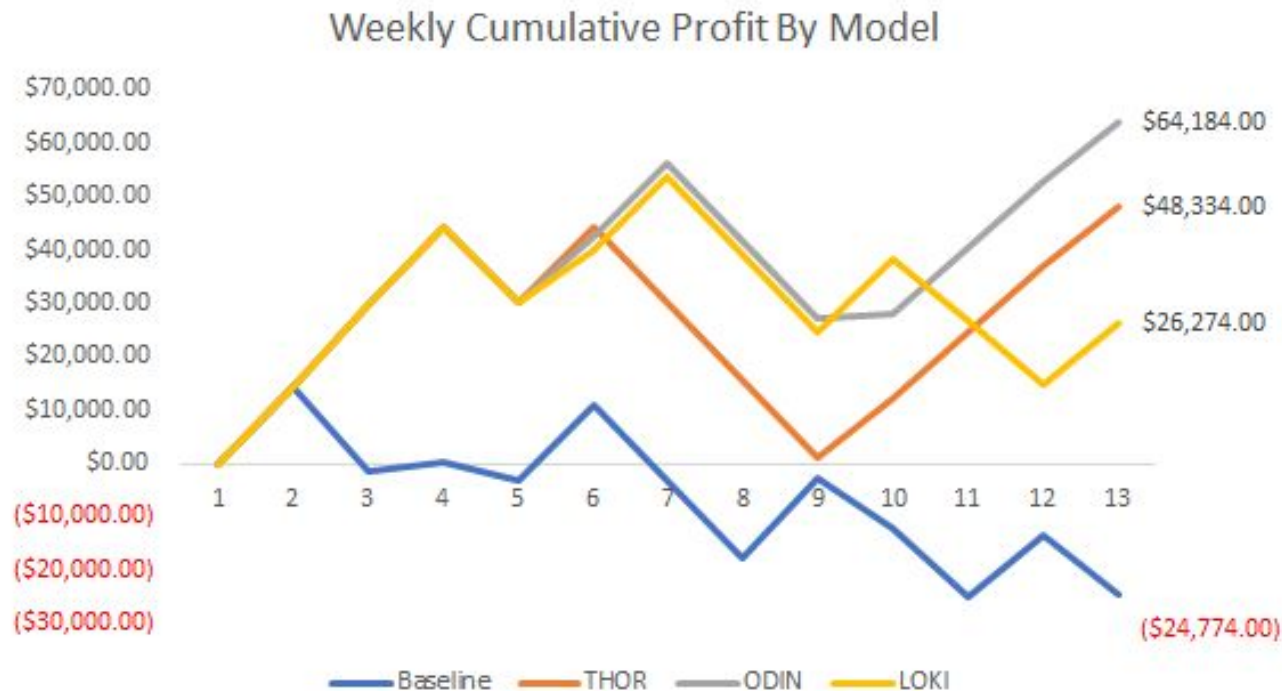
Plenty of NFL data, opportunity to perform better than market

Contest Performance Using FantasyData DraftKings Projections:

Week 2 Number of Contests: 48, Total Invest: \$14202.0, Total Prize: \$28404.0, Total Profit: \$14202.0
Week 3 Number of Contests: 49, Total Invest: \$15557.0, Total Prize: \$0, Total Profit: \$-15557.0
Week 4 Number of Contests: 44, Total Invest: \$14727.0, Total Prize: \$0, Total Profit: \$-14727.0
Week 5 Number of Contests: 42, Total Invest: \$14382.0, Total Prize: \$0, Total Profit: \$-14382.0
Week 6 Number of Contests: 36, Total Invest: \$14017.0, Total Prize: \$28034.0, Total Profit: \$14017.0
Week 7 Number of Contests: 43, Total Invest: \$13832.0, Total Prize: \$0, Total Profit: \$-13832.0
Week 8 Number of Contests: 55, Total Invest: \$14587.0, Total Prize: \$0, Total Profit: \$-14587.0
Week 9 Number of Contests: 52, Total Invest: \$14817.0, Total Prize: \$29634.0, Total Profit: \$14817.0
Week 10 Number of Contests: 47, Total Invest: \$14252.0, Total Prize: \$4810.0, Total Profit: \$-9442.0
Week 11 Number of Contests: 29, Total Invest: \$12747.0, Total Prize: \$25494.0, Total Profit: \$12747.0
Week 12 Number of Contests: 36, Total Invest: \$12082.0, Total Prize: \$0, Total Profit: \$-12082.0
Week 13 Number of Contests: 47, Total Invest: \$11472.0, Total Prize: \$0, Total Profit: \$-11472.0

Total Prize: \$ -50298.0

SmartRoster lineups would have made up to \$64,184 in 2019



ODIN

- Madden
- Madden Def
- Player Avg.
- Opponent Avg.



THOR

- Madden Def
- Player Avg.
- Opponent Avg.



LOKI

- Madden
- Madden Def
- Player Avg.

Launching and scaling our platform

Sport	Expected Prize Money	Contest Weeks Per Year	Total Prize Money
NFL 50/50	\$ 10,000.00	13	\$ 130,000.00
NFL TopPrize	\$ 50,000.00	13	\$ 650,000.00
MLB 50/50	\$ 20,000.00	60	\$ 1,200,000.00
MLB TopPrize	\$ 100,000.00	60	\$ 6,000,000.00
NBA 50/50	\$ 10,000.00	82	\$ 820,000.00
NBA TopPrize	\$ 50,000.00	82	\$ 4,100,000.00
NHL 50/50	\$ 2,000.00	82	\$ 164,000.00
NHL TopPrize	\$ 10,000.00	82	\$ 820,000.00
Golf	\$ 8,900.00	20	\$ 178,000.00
Total			\$ 14,062,000.00