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UFC SCORE PREDICTIONS

LINEAR REGRESSION

INTRODUCTION

- Project Goal
  - Create a multivariate linear regression model to determine the winner of a UFC fight using fight metrics (striking statistics, grappling statistics, control time, etc).
- Ultimate Fighting Championship UFC Judging
  - There are 3 to 5 rounds per fight.
  - For each round, each judge gives 10 points to the winner. The loser receives 9 points, or in some cases, 8 points. Both fighters get 10 points in the event of a tie.
  - Judges score fights based on a hierarchy of criteria: 1) effective striking and grappling, 2) effective aggression, and 3) control of the fight area.

MODEL DATA

Dataset

2,258 fights and 4,516 records. Each record represents a fighter_id/ fight_id combination

Features

Individual statistics were converted to disparity between fighter_1 and fighter_2

Train Test Split

60% training, 20% validation, and 20% testing data using a time-based split.

Significant Strikes Landed, Significant Strikes Attempted, Takedowns Landed, Takedowns Attempted, Control Time, Leg Strikes, Body Strikes, Head Strikes, Submission Attempts, Total Strikes Landed, Total Strikes Attempted

DATA SOURCES AND TOOLS

Data Sources:

Web Scraping:

Data Cleaning:

Data Storage:

Regression Model:

Database Interactions:

Visualization:

WEB SCRAPING – UFCSTATS.COM

1

Events & Fights

Enter Event Name...

Completed | Upcoming

NAME/DATE	LOCATION
NEXT UFC Fight Night: Rozenstruik vs. Sakai June 05, 2021	Las Vegas, Nevada, USA
UFC Fight Night: Font vs. Garbrandt May 22, 2021	Las Vegas, Nevada, USA
UFC 262: Oliveira vs. Chandler May 15, 2021	Houston, Texas, USA
UFC Fight Night: Rodriguez vs. Waterson May 08, 2021	Las Vegas, Nevada, USA

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UFC Fight Night: Font vs. Garbrandt

DATE: May 22, 2021 **LOCATION:** Las Vegas, Nevada, USA

Click on a row below to see in-depth event stats. Fight, Perf, Sub, and KO of the Night Bonuses: •FIGHT •PERF •SUB •KO

W/L	FIGHTER	KD	STR	TD	SUB	WEIGHT CLASS	METHOD	ROUND	TIME
WIN	Rob Font Cody Garbrandt	0 0	176 63	2 3	0 0	Bantamweight	U-DEC	5	5:00
WIN	Carla Esparza Yan Xiaonan	0 0	27 5	3 0	0 0	Women's Strawweight •PERF	KO/TKO Punches	2	2:58
WIN	Jared Vanderaa Justin Tafa	0 0	121 74	0 0	0 0	Heavyweight •FIGHT	U-DEC	3	5:00
WIN	Norma Dumont Felicia Spencer	0 0	68 47	1 0	0 0	Women's Featherweight	S-DEC	3	5:00

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UFC Fight Night: Font vs. Garbrandt

L Felicia Spencer "FEENOM"

W Norma Dumont "THE IMMORTAL"

WOMEN'S FEATHERWEIGHT BOUT

METHOD: Decision - Split **ROUND:** 3 **TIME:** 5:00 **TIME FORMAT:** 3 Rnd (5-5-5) **REFEREE:** Chris Tognoni

DETAILS: Sal D'amato 27 - 30. Brian Miner 29 - 28. Junichiro Kamijo 28 - 29.

SIGNIFICANT STRIKES

FIGHTER	SIG. STR	SIG. STR. %	HEAD	BODY	LEG	DISTANCE	CLINCH	GROUND
Felicia Spencer	47 of 114	41%	27 of 76	14 of 27	6 of 11	38 of 102	9 of 12	0 of 0
Norma Dumont	68 of 135	50%	40 of 100	14 of 20	14 of 15	59 of 123	9 of 12	0 of 0
PER ROUND								
ROUND 1								
Felicia Spencer	11 of 37	29%	7 of 25	2 of 8	2 of 4	8 of 34	3 of 3	0 of 0
Norma Dumont	21 of 46	45%	11 of 35	3 of 3	7 of 8	18 of 43	3 of 3	0 of 0
ROUND 2								
Felicia Spencer	20 of 51	39%	12 of 35	5 of 10	3 of 6	19 of 49	1 of 2	0 of 0
Norma Dumont	35 of 60	58%	23 of 45	6 of 9	6 of 6	33 of 57	2 of 3	0 of 0
ROUND 3								
Felicia Spencer	16 of 26	61%	8 of 16	7 of 9	1 of 1	11 of 19	5 of 7	0 of 0
Norma Dumont	12 of 29	41%	6 of 20	5 of 8	1 of 1	8 of 23	4 of 6	0 of 0

WEB SCRAPING – MMADECISIONS.COM

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EVENTS

2021 | 2020 | 2019 | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008
2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994

Date	Event	#
May 22, 2021	UFC on ESPN+ 46: Font vs. Garbrandt	8
May 21, 2021	Bellator 259: Cyborg vs. Smith 2	6
May 21, 2021	Invicta FC: Rodriguez vs. Torquato	4
May 15, 2021	UFC 262: Oliveira vs. Chandler	5
May 08, 2021	UFC on ESPN 24: Rodriguez vs. Waterson	6
May 07, 2021	Bellator 258: Archuleta vs. Pettis	5
May 01, 2021	UFC on ESPN 23: Reyes vs. Prochazka	8
Apr 24, 2021	KSW 60: De Fries vs. Narkun 2	3
Apr 24, 2021	UFC 261: Usman vs. Masvidal 2	4
Apr 17, 2021	UFC on ESPN 22: Whittaker vs. Gastelum	8

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UFC on ESPN+ 46: Font vs. Garbrandt
UFC Apex
Las Vegas, Nevada, USA
May 22, 2021

Fight	Scores		
Font def. Garbrandt *Unanimous*	CLEARY 48 - 47	D'AMATO 50 - 45	KAMIJO 50 - 45
Vanderaa def. Tafa *Unanimous*	BELL 30 - 27	COLÓN 29 - 28	WEEKS 30 - 27
Dumont def. Spencer *Split*	D'AMATO 30 - 27	KAMIJO 29 - 28	MINER 28 - 29
Ramos def. Algeo *Unanimous*	BELL 30 - 27	CLEARY 29 - 28	COLÓN 30 - 27
Hermansson def. Shahbazyan *Unanimous*	BYRD 29 - 27	D'AMATO 29 - 27	KAMIJO 29 - 27
McGee def. Silva *Unanimous*	BELL 29 - 27	BYRD 30 - 26	CLEARY 30 - 26
Culibao def. Nuerdanbieke *Unanimous*	CLEARY 29 - 28	HAGEN 29 - 28	MINER 29 - 28
Ismagulov def. Alves *Unanimous*	BELL 29 - 28	HAGEN 29 - 28	KAMIJO 29 - 28

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Norma Dumont
defeats
Felicia Spencer

SPLIT DECISION

UFC on ESPN+ 46: Font vs. Garbrandt
May 22, 2021
Las Vegas, Nevada, USA
REFEREE: Unknown

TALE OF THE TAPE

Spencer		Dumont
Quebec, Canada	BORN	Minas Gerais, Brazil
30	AGE	30
5'6"	HEIGHT	5'7"
145 lbs.	WEIGHT	146 lbs.
68"	REACH	67"
Orlando, FL	FIGHTING OUT OF	Belo Horizonte, Minas Gerais, Brazil
Feenom		*The Immortal*

Sal D'Amato

ROUND	Dumont	Spencer
1	10	9
2	10	9
3	10	9
TOTAL	30	27

Junichiro Kamijo

ROUND	Dumont	Spencer
1	-	-
2	-	-
3	-	-
TOTAL	29	28

Bryan Miner

ROUND	Dumont	Spencer
1	-	-
2	-	-
3	-	-
TOTAL	28	29

MEDIA SCORES

Dayne Fox *BloodyElbow.com*	29-28	Dumont
Matthew Wells *TheBodyLockMMA.com*	29-28	Dumont
Ryan Frederick *WrestlingObserver.com*	29-28	Dumont
Drake Riggs *TheBodyLockMMA.com*	29-28	Dumont
Rob Tatum *CombatPress.com*	29-28	Dumont
Marcel Dorff *mmadna.nl*	29-28	Dumont
Shawn Bitter *Cageside Press*	29-28	Dumont
MMAJunkie.com	29-28	Dumont
MMAMania.com	29-28	Dumont
Jay Pettry *Sherdog.com*	28-29	Spencer
Ben Duffy *Sherdog.com*	28-29	Spencer
Tyler Treese *Sherdog.com*	28-29	Spencer

YOUR SCORECARD

ROUND	Dumont	Spencer
1	-	-
2	-	-
3	-	-
TOTAL	-	-

Submit Scorecard

Show Results

CROSS VALIDATION – R-SQUARED

	Linear Regression	LASSO Regression	Ridge Regression	SGD Regression	Random Forest
Unaltered Data	0.6832	0.6832	0.6832	N/A	0.6955
MinMaxScaler (Normalized)	0.6832	0.6831	0.6832	0.6661	0.6954
StandardScaler (Standardized)	0.6832	0.6832	0.6832	0.6832	**0.6958**

- The best R-Squared in the models tested was approximately **0.6958**.
- Random Forest had the highest R-Squared, but also had the largest generalization error from training to validation. Hyperparameter tuning only partially fixed overfitting.
- Normalizing with MinMaxScaler and standardizing with StandardizedScaler had minimal impact on performance.
- SGDRegressor performed differently each iteration. Unaltered data produced nonsensical results.

CROSS VALIDATION – RMSE

	Linear Regression	LASSO Regression	Ridge Regression	SGD Regression	Random Forest
Unaltered Data	0.2025	0.2025	0.2025	N/A	**0.1984**
MinMaxScaler (Normalized)	0.2025	0.2025	0.2025	0.2075	0.1987
StandardScaler (Standardized)	0.2025	0.2025	0.2025	0.2026	0.1986

- The minimum RSME in the models tested was approximately **0.1984**.
- The reasonable actual per round score range is 8.0 - 10.0. The RMSE results range from 9.4% - 10.4% of this range.
- Normalizing with MinMaxScaler and standardizing with StandardizedScaler had minimal impact on performance.
- SGDRegressor performed differently each iteration. Unaltered data produced nonsensical results.

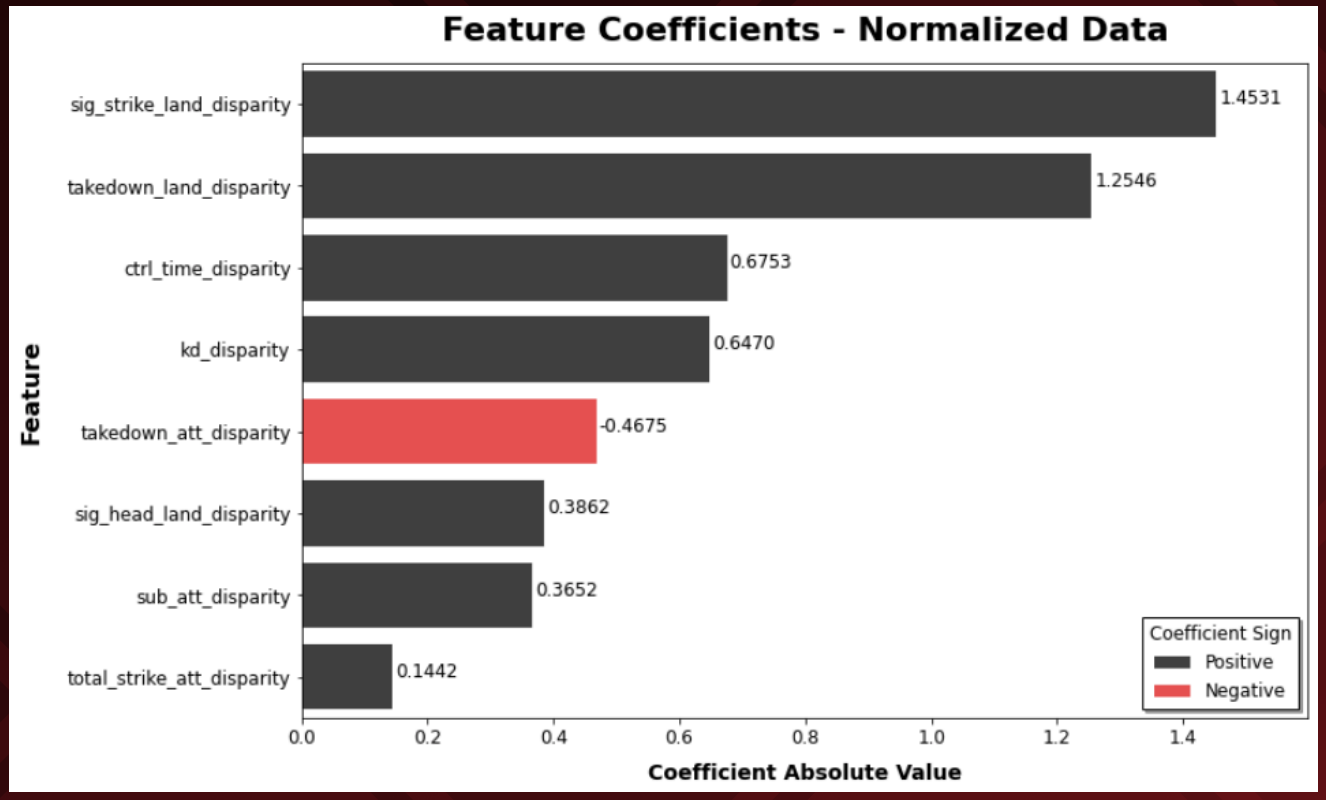
TEST RESULTS – TOP 3 MODELS

	Linear Regression Normalized	SGD Regression Normalized	Random Forest Regression Standardized
R-Squared	0.7070	0.7085	**0.7152**
RMSE	0.2078	0.2072	**0.2053**
Prediction Accuracy	85.5%	**86.4%**	84.4%

- My preferred regression model is Linear Regression with Normalized Data
- Linear Regression is easily interpretable and normalized features allow for a more natural comparison of feature coefficients
- All models performed very similarly in cross validation, simple validation, and in testing
- Random Forest Regression had strong cross validation results, but even with hyperparameter tuning, the model was overfit to the training data.

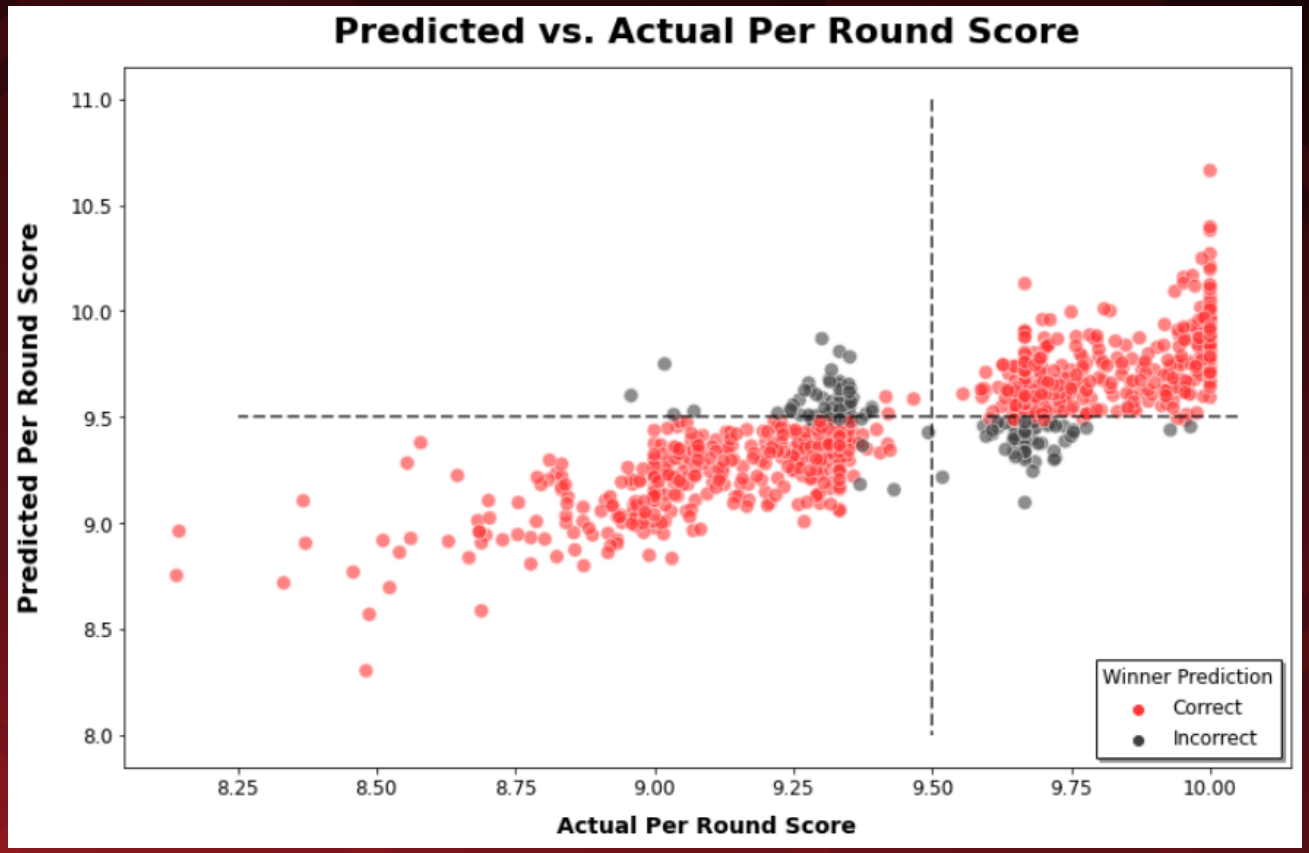
FEATURE IMPORTANCE – LINEAR REGRESSION, NORMALIZED DATA

$$\text{Per Round Score} = 1.4531X_1 + 1.2546X_2 + 0.6753X_3 + 0.6470X_4 - 0.4675X_5 + 0.3865X_6 + 0.3652X_7 + 0.1442X_8 + 7.2543$$



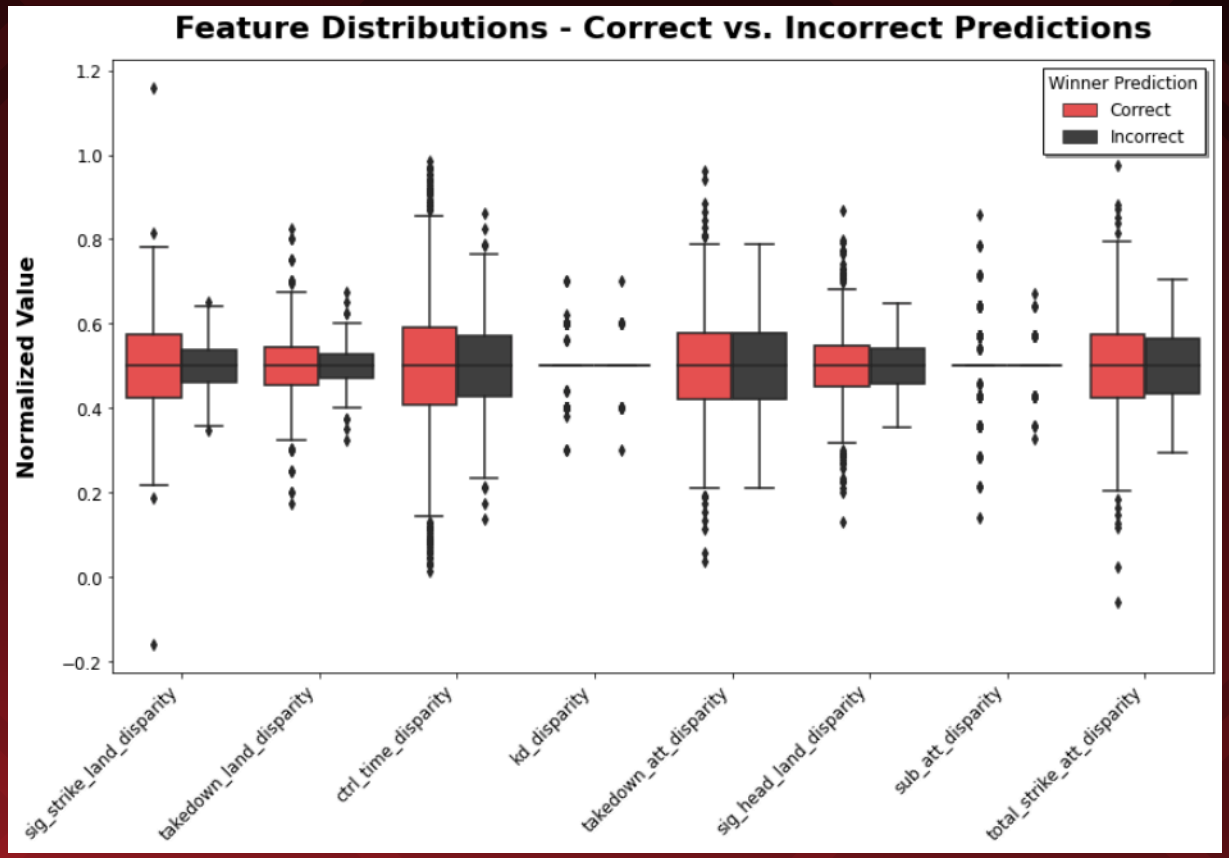
- The metrics with the greatest impact on predictions are in line with intended UFC judging criteria:
  - 1) effective striking and grappling
  - 2) aggression
  - 3) fight area control
- The error term for this model is **7.2543** points per round.
- Takedown attempts have a negative impact on projected score. For every takedown attempt, the fighter is penalized. For each successful takedown, the reward exceeds the penalty.

WINNER PREDICTION – LINEAR REGRESSION, NORMALIZED DATA



- Winner Prediction Accuracy: **85.5%**
- Typically, the model is correct when both predicted and actual per round score fall on the same side of 9.5 points per round.
- The model predicts the winner more accurately the further the actual score gets from 9.5 points per round.

WHERE STATISTICS FALL SHORT



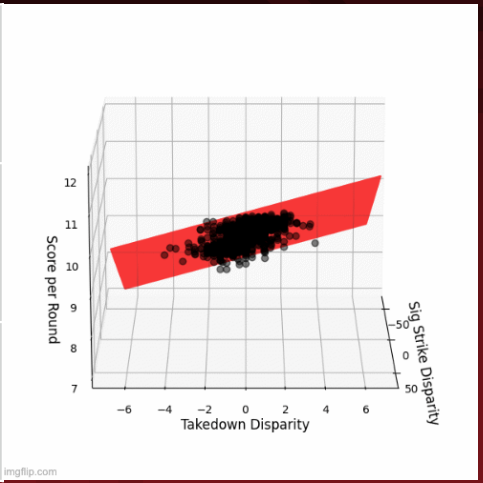
- Fight metric distributions were narrower in fights where the model made the wrong prediction. Closer fights are harder to judge.
- Statistics struggle to capture aggression and damage inflicted by fighters, both key factors in judging close fights.
- Knockdowns are much more rare than, for example, significant strikes. Any knockdown disparity is rewarded heavily, as even the 3rd quartile for knockdown disparity per round is zero. Knockdown disparity has the 4th largest coefficient in the regression model.

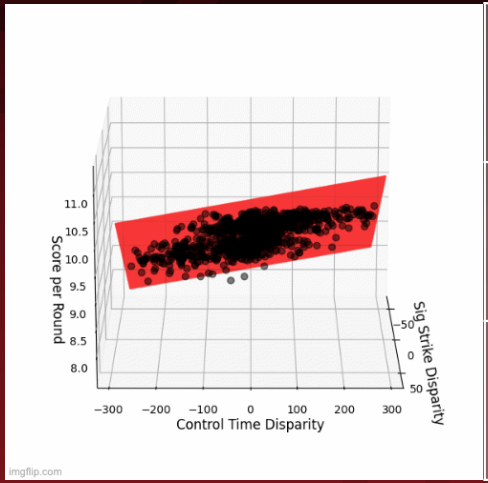
FUTURE WORK

- Model Enhancements
  - Logistic Regression on a per round basis
- Analysis of Fighter Styles
  - Which styles match up most effectively with other styles?
- Judging the Judges
  - Which judges historically deviate furthest from the regression model?

THANK YOU!

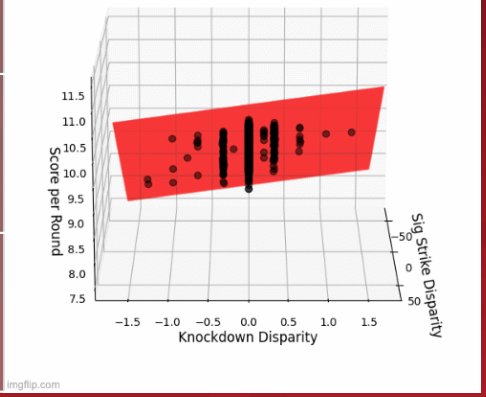
Feature 1	Sig Strike Disparity
Feature 2	Takedown Disparity
R-Squared	0.6190

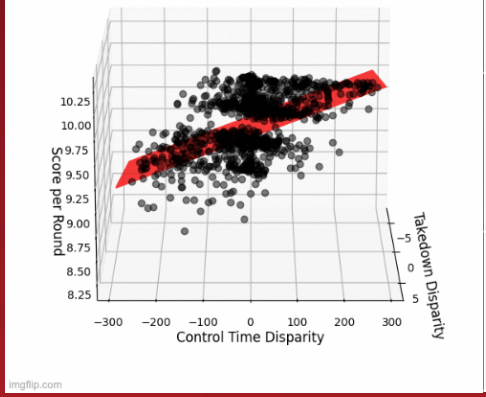




Sig Strike Disparity	Feature 1
Control Time Disparity	Feature 2
0.6624	R-Squared

Feature 1	Sig Strike Disparity
Feature 2	Knockdown Disparity
R-Squared	0.5071





Takedown Disparity	Feature 1
Control Time Disparity	Feature 2
0.3283	R-Squared

APPENDICES

FEATURE IMPORTANCE COMPARISON

Linear Regression		
Rank	Feature	Coefficient
1	sig_strike_land_disparity	1.4531
2	takedown_land_disparity	1.2546
3	ctrl_time_disparity	0.6753
4	kd_disparity	0.6470
5	takedown_att_disparity	-0.4675
6	sig_head_land_disparity	0.3862
7	sub_att_disparity	3652
8	total_strike_att_disparity	0.1442

Random Forest		
Rank	Feature	Importance
1	sig_strike_land_disparity	0.6165
2	ctrl_time_disparity	0.2280
3	takedown_land_disparity	0.0515
4	sig_head_land_disparity	0.0410
5	total_strike_att_disparity	0.0264
6	takedown_att_disparity	0.0180
7	kd_disparity	0.0094
8	sub_att_disparity	0.0094

MOST CONTROVERSIAL FIGHTS OF 2020

Fighter 1	Fighter 2	Judges	Media	Judges + Media	Model
Jon Jones	Dominick Reyes	Jones 9.67	Jones 9.60	Jones 9.61	Reyes 9.53
Paul Felder	Dan Hooker	Hooker 9.53	Hooker 9.60	Hooker 9.59	Hooker 9.54
Stipe Miocic	Daniel Cormier	Miocic 9.73	Miocic 9.64	Miocic 9.65	Miocic 9.58
Pedro Munhoz	Frankie Edgar	Munhoz 9.53	Edgar 9.67	Edgar 9.65	Munhoz 9.57
Israel Adesanya	Yoel Romero	Adesanya 9.67	Adesanya 9.60	Adesanya 9.61	Adesanya 9.52
Alexander Volkanovski	Max Holloway	Volkanovski 9.53	Volkanovski 9.60	Volkanovski 9.59	Volkanovski 9.64
Robert Whittaker	Darren Till	Whittaker 9.60	Whittaker 9.63	Whittaker 9.63	Whittaker 9.62
Dan Ige	Edson Barboza	Ige 9.56	Ige 9.67	Ige 9.65	Barboza 9.53
Song Yadong	Marlon Vera	Yadong 9.67	Yadong 9.68	Yadong 9.68	Yadong 9.49
Max Holloway	Alexander Volkanovski	Volkanovski 9.73	Volkanovski 9.74	Volkanovski 9.74	Volkanovski 9.53

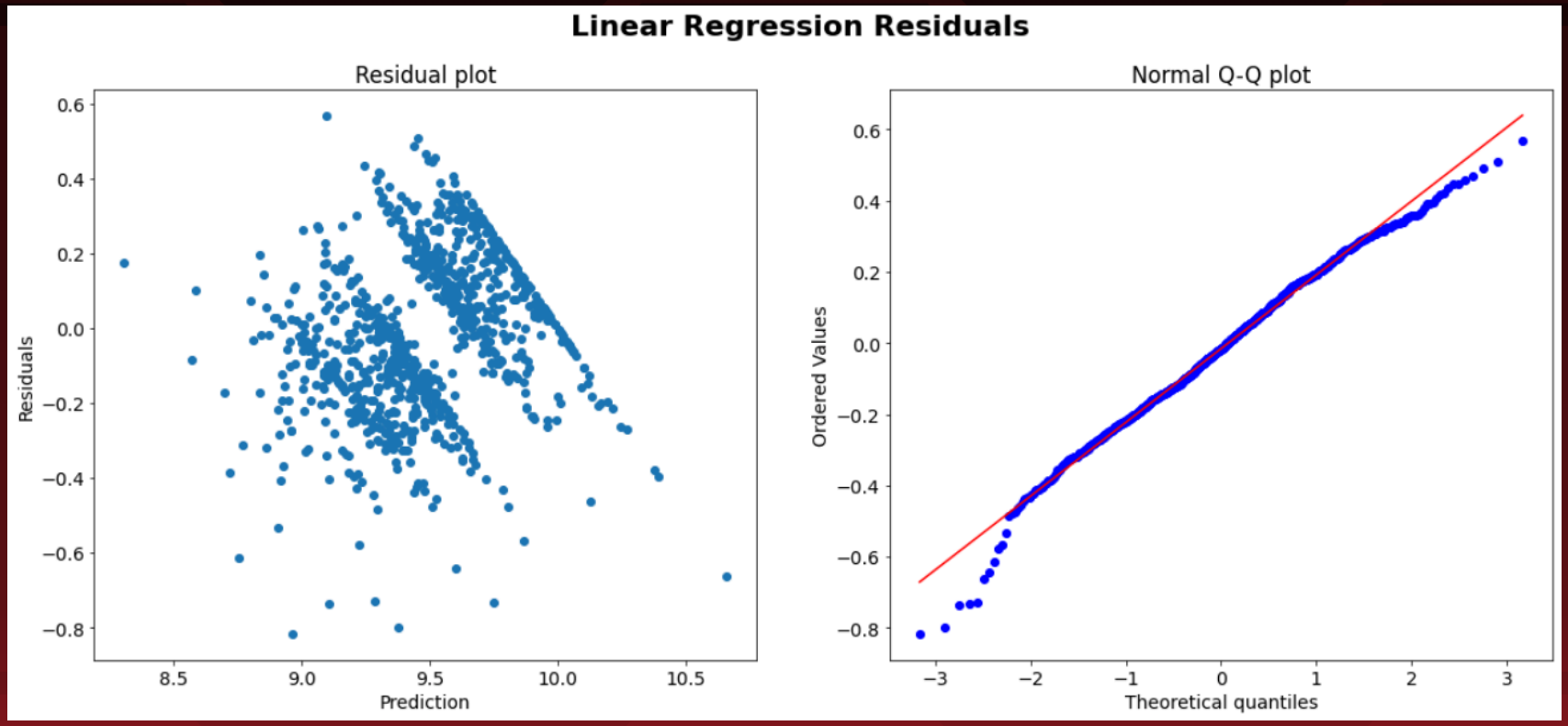
Source: MMAOddsBreaker.com

MUNHOZ V. EDGAR – 2020

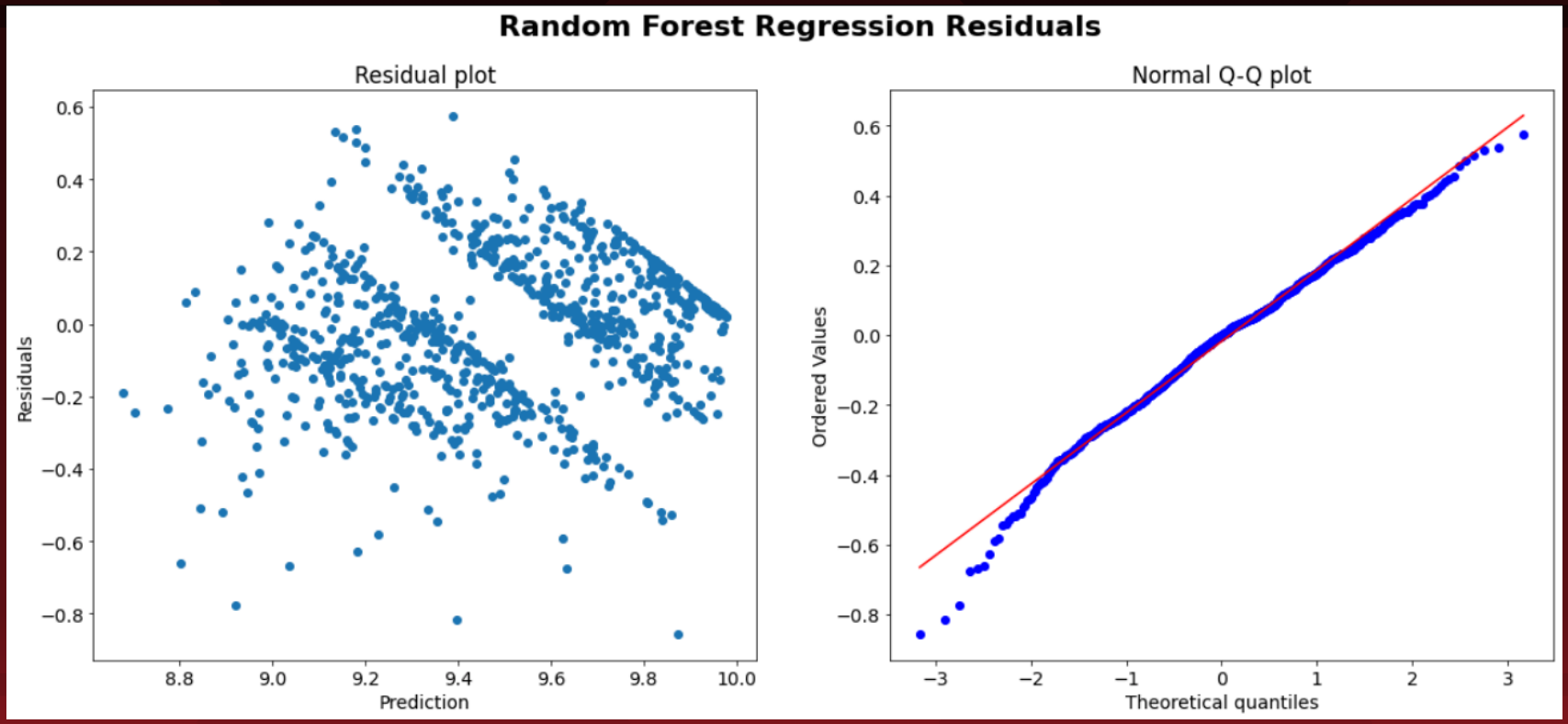
Fighter 2	Munhoz	Edgar
Significant Strikes Landed Disparity	4.6	-4.6
Takedowns Landed Disparity	0.0	0.0
Control Time Disparity (Seconds)	8.6	-8.6
Knockdown Disparity	0.0	0.0
Takedowns Attempted Disparity	0.8	-0.8
Significant Head Strikes Landed Disparity	-3.6	3.6
Submissions Attempted Disparity	0.0	0.0
Total Strikes Attempted Disparity	-0.2	0.2

- Judges
  - Edgar wins by split decision
  - Total points per round in favor of Munhoz with 9.53 points per round
- Media
  - Edgar wins with 9.67 points per round
- Judges & Media Combined
  - Edgar wins with 9.65 points per round
- Regression Model
  - Munhoz wins with 9.57 points per round

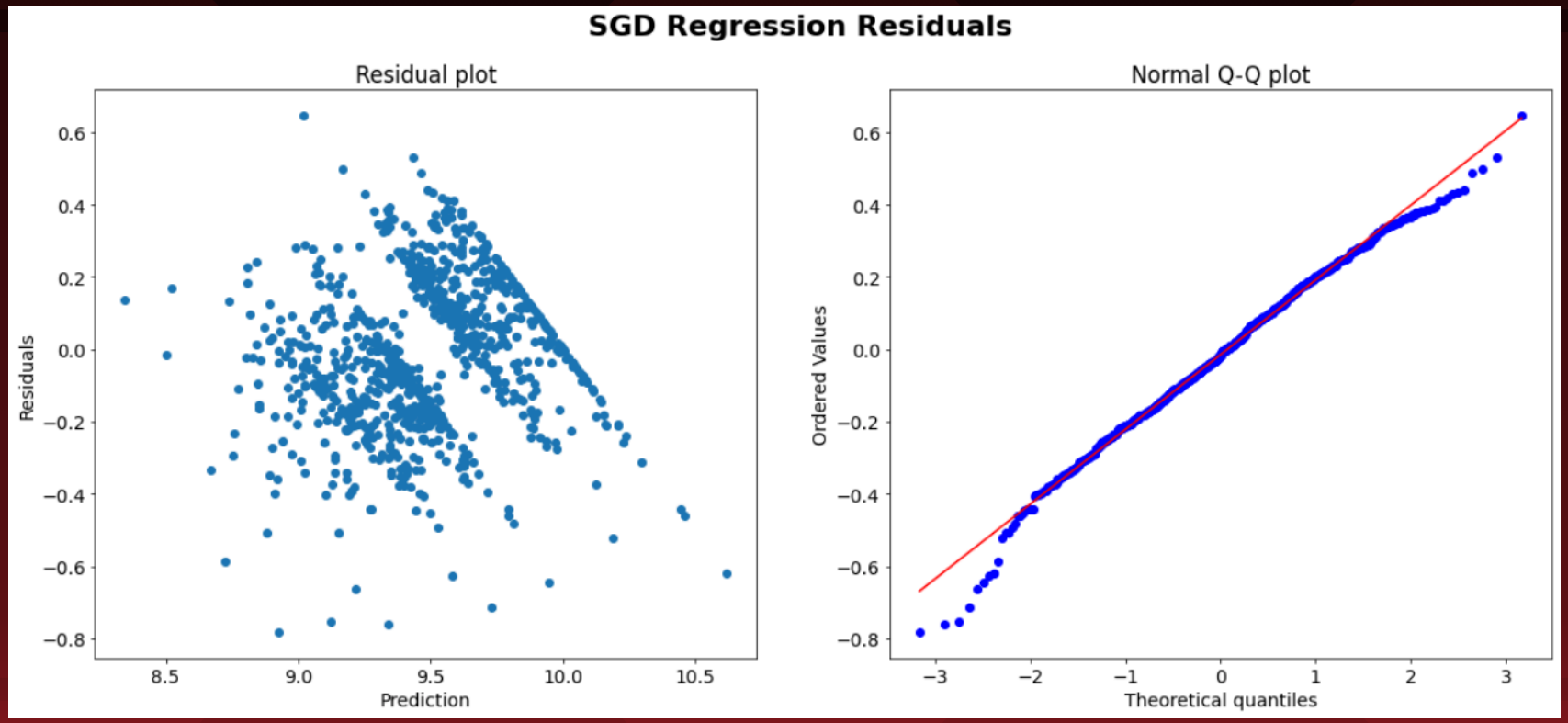
RESIDUAL PLOTS – LINEAR REGRESSION



RESIDUAL PLOTS – RANDOM FOREST



RESIDUAL PLOTS – STOCHASTIC GRADIENT DESCENT



SIMPLE VALIDATION – WINNER PREDICTION

	Linear Regression	LASSO Regression	Ridge Regression	SGD Regression	Random Forest
Unaltered Data	85.2%	85.2%	85.2%	47.2%	84.4%
MinMaxScaler (Normalized)	85.2%	85.8%	85.2%	**86.6%**	84.0%
StandardScaler (Standardized)	85.2%	85.2%	85.2%	85.1%	84.4%

- The best winner prediction accuracy in the models tested was approximately **86.6%.**
- SGDRegressor was worse than 50/50 using unaltered data. When data was normalized, it produced the best results of all models tested in simple validation.
- Normalizing with MinMaxScaler and standardizing with StandardizedScaler had minimal impact on prediction accuracy.
- Random Forest Regression had the lowest predictive ability, which makes intuitive sense given the established hierarchy of judging criteria.

VALIDATION MODEL COMPARISON – R-SQUARED

Model	Data	Training R2	Simple Val R2	Simple Val Diff	Cross Val R2	Cross Val Diff
Linear Regression	Unaltered	0.699158	0.716776	0.017618	0.683173	-0.015985
Linear Regression	Normalized	0.699158	0.716776	0.017618	0.683173	-0.015985
Linear Regression	Standardized	0.699158	0.716776	0.017618	0.683173	-0.015985
LASSO Regression	Unaltered	0.699130	0.716628	0.017498	0.683170	-0.015960
LASSO Regression	Normalized	0.698653	0.715392	0.016738	0.683096	-0.015558
LASSO Regression	Standardized	0.699119	0.716667	0.017549	0.683171	-0.015948
Ridge Regression	Unaltered	0.699158	0.716775	0.017618	0.683173	-0.015985
Ridge Regression	Normalized	0.699158	0.716775	0.017618	0.683173	-0.015985
Ridge Regression	Standardized	0.699158	0.716776	0.017618	0.683173	-0.015985
SGD Regression	Normalized	0.687999	0.720987	0.032988	0.668185	-0.019814
SGD Regression	Standardized	0.698567	0.716564	0.017997	0.682459	-0.016109
Random Forest Regression	Unaltered	0.801955	0.715137	-0.086818	0.690881	-0.111074
Random Forest Regression	Normalized	0.802300	0.715964	-0.086336	0.691025	-0.111275
Random Forest Regression	Standardized	0.801614	0.715161	-0.086452	0.691330	-0.110284

VALIDATION MODEL COMPARISON – RMSE

Model	Data	Training RMSE	Simple Val RMSE	Simple Val Diff	Cross Val RMSE	Cross Val Diff
Linear Regression	Unaltered	0.197553	0.204277	0.006723	0.202475	0.004922
Linear Regression	Normalized	0.197553	0.204277	0.006723	0.202475	0.004922
Linear Regression	Standardized	0.197553	0.204277	0.006723	0.202475	0.004922
LASSO Regression	Unaltered	0.197562	0.204330	0.006768	0.202476	0.004914
LASSO Regression	Normalized	0.197719	0.204775	0.007056	0.202504	0.004785
LASSO Regression	Standardized	0.197566	0.204316	0.006750	0.202476	0.004910
Ridge Regression	Unaltered	0.197553	0.204277	0.006723	0.202475	0.004922
Ridge Regression	Normalized	0.197553	0.204277	0.006723	0.202475	0.004922
Ridge Regression	Standardized	0.197553	0.204277	0.006723	0.202475	0.004922
SGD Regression	Normalized	0.200283	0.202763	0.002480	0.207538	0.007255
SGD Regression	Standardized	0.198540	0.206520	0.007979	0.202568	0.004027
Random Forest Regression	Unaltered	0.160121	0.204813	0.044692	0.198378	0.038257
Random Forest Regression	Normalized	0.160120	0.204869	0.044749	0.198724	0.038604
Random Forest Regression	Standardized	0.160181	0.205574	0.045393	0.198638	0.038456