



NFL Injury Prediction

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DATASCI 207 Final Project

Objective

Build a classification model that can help predict injuries to NFL players based on a suite of factors present during a typical NFL game





Injury Data

Injury Data File

Field	Format	Description
PlayerKey	XXXX	Uniquely identifies a player with a five-digit numerical key
GameID	PlayerKey-X	Uniquely identifies a player's games (not strictly in temporal order)
PlayKey	PlayerKey-GameID-X	Uniquely identifies a player's plays within a game (in sequential order)
BodyPart	character string	Identifies the injured body part (Knee, Ankle, Foot, etc.)
Surface	character string	Identifies the playing surface at time of injury (Natural or Synthetic)
DM_M1	1 or 0	One-Hot Encoding indicating 1 or more days missed due to injury
DM_M7	1 or 0	One-Hot Encoding indicating 7 or more days missed due to injury
DM_M28	1 or 0	One-Hot Encoding indicating 28 or more days missed due to injury
DM_M42	1 or 0	One-Hot Encoding indicating 42 or more days missed due to injury

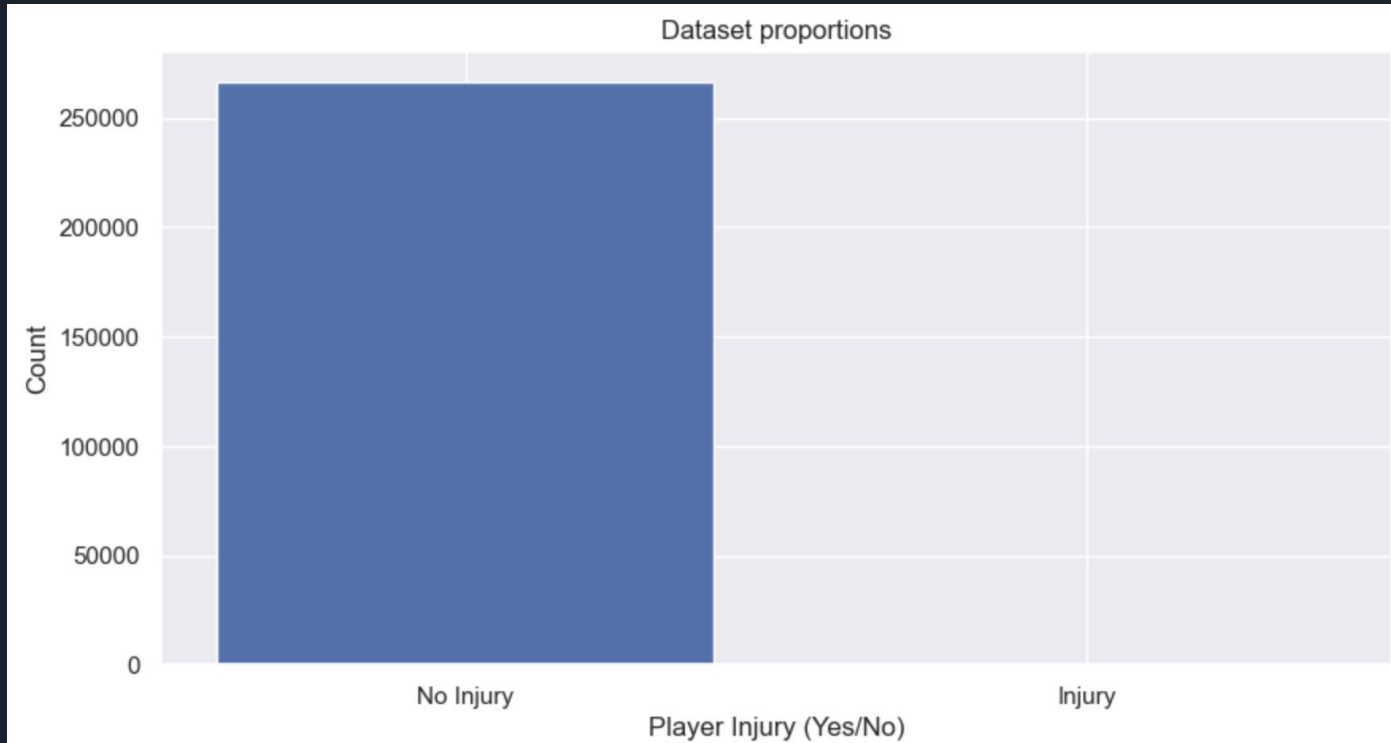
Play Level Data

Field	Format	Description
PlayerKey	XXXX	uniquely identifies a player with a five-digit numerical key
*GameID	PlayerKey-X	uniquely identifies a player-game (this index is not strictly in temporal order) – see note below
PlayKey	PlayerKey-GameID-X	uniquely identifies a player's plays within a game (in sequential order within a game)
RosterPosition	character string	provides the player's roster position (i.e. Running Back)
*PlayerDay	integer	an integer sequence that reflects the timeline of a player's participation in games; use this field to sequence player participation
*PlayerGame	integer	uniquely identifies a player's games; matches the last integer of the GameID (not strictly in temporal order of game occurrence)
StadiumType	character string	a free text description of the type of stadium (open, closed dome, etc.)
FieldType	character string	a categorical description of the field type (Natural or Synthetic)
Temperature	float	on-field temperature at the start of the game (not always available - for closed dome/indoor stadiums this field may not be relevant as the temperature and weather are controlled)
Weather	character string	a free text description of the weather at the stadium (for closed dome/indoor stadiums this field may not be relevant as the temperature and weather are controlled)
PlayType	character string	categorical description of play type (pass, run, kickoff, etc.)
PlayerGamePlay		an ordered index (integer) denoting the running count of plays the player has participated in during the game
Position	character string	a categorical variable denoting the player's position for the play (RB, QB, DE, etc.) – may not be the same as the roster position.
PositionGroup	character string	a categorical variable denoting the player's position group for the position held during the play

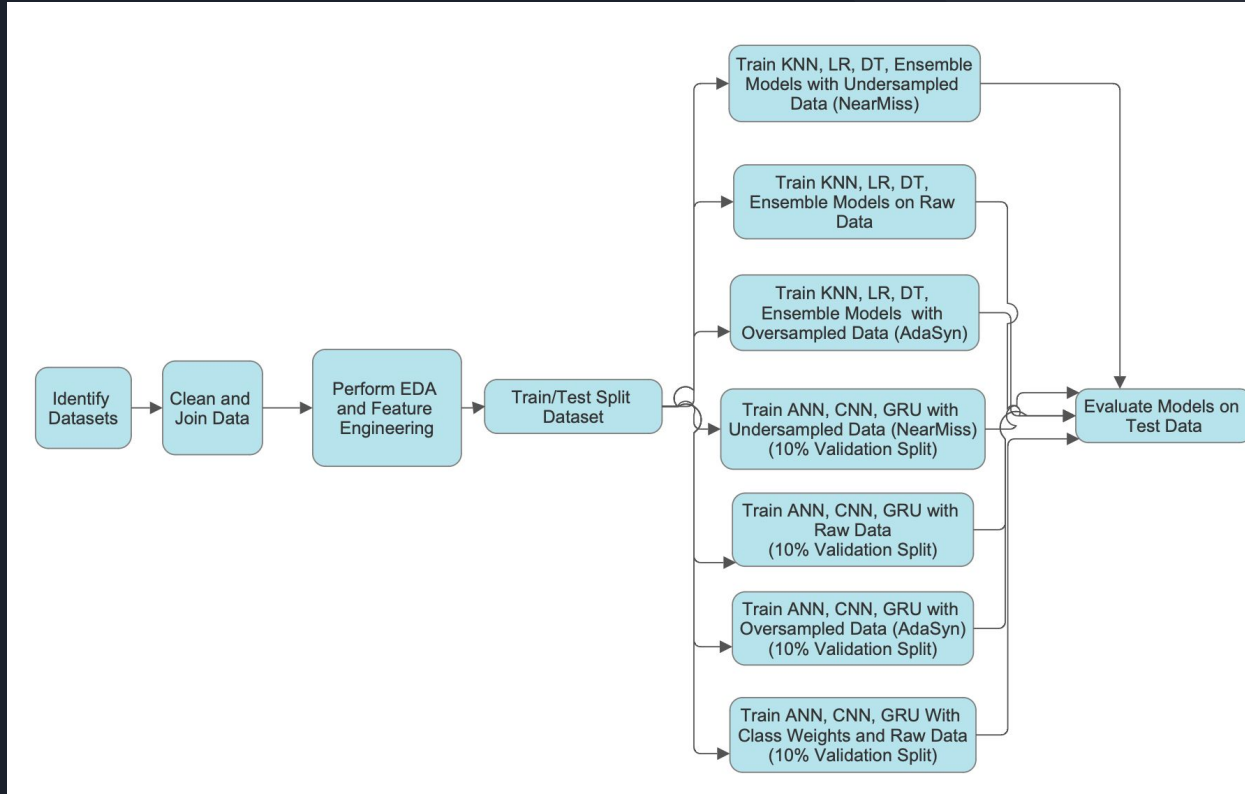
Player Tracking Data

Field	Format	Description	Additional Details
PlayKey	character string		
time	float	time in seconds (float) since the start of the NGS track for the play	this is the time index for the player track
event	character string	play details (character string) as a function of time during the play (huddle break, snap, etc.)	
x	numeric list	player position (float) along the long axis of the field (yards) over time index	0 - 120 yards
y	numeric list	player position (float) along the short axis of the field (yards) over the time index	0 - 53.3 yards
dis	numeric list	distance traveled (float) from prior time point over the time index	Distance (yards)
s	numeric list	estimated speed (float) at that particular point in time over the time index	yards per second
o	numeric	Orientation (float) - angle that the player is facing (deg)	0 - 360 degrees
dir	numeric	Direction (float) - angle of player motion (deg)	0 - 360 degrees

Imbalanced Data

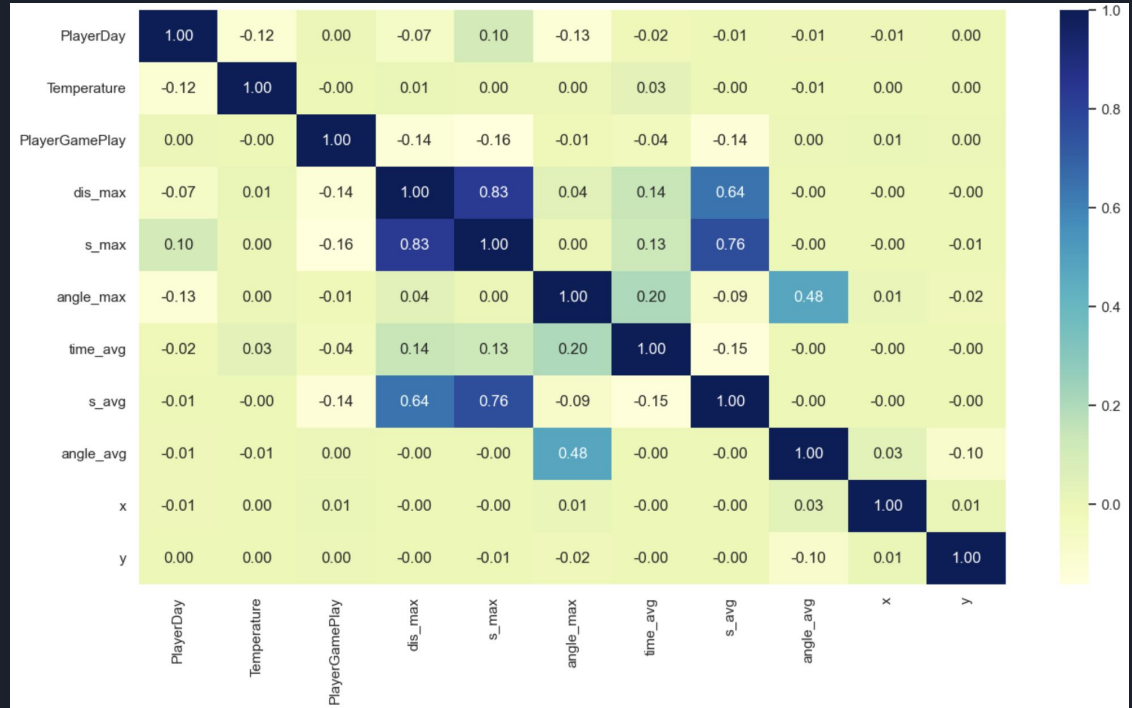


Approach and Methodology



Feature Engineering


- Fill missing values
- Compute average and max speed, distance, etc
- Drop highly correlated features
- Merge three datasets together to create input for models





Success/Failure Criteria

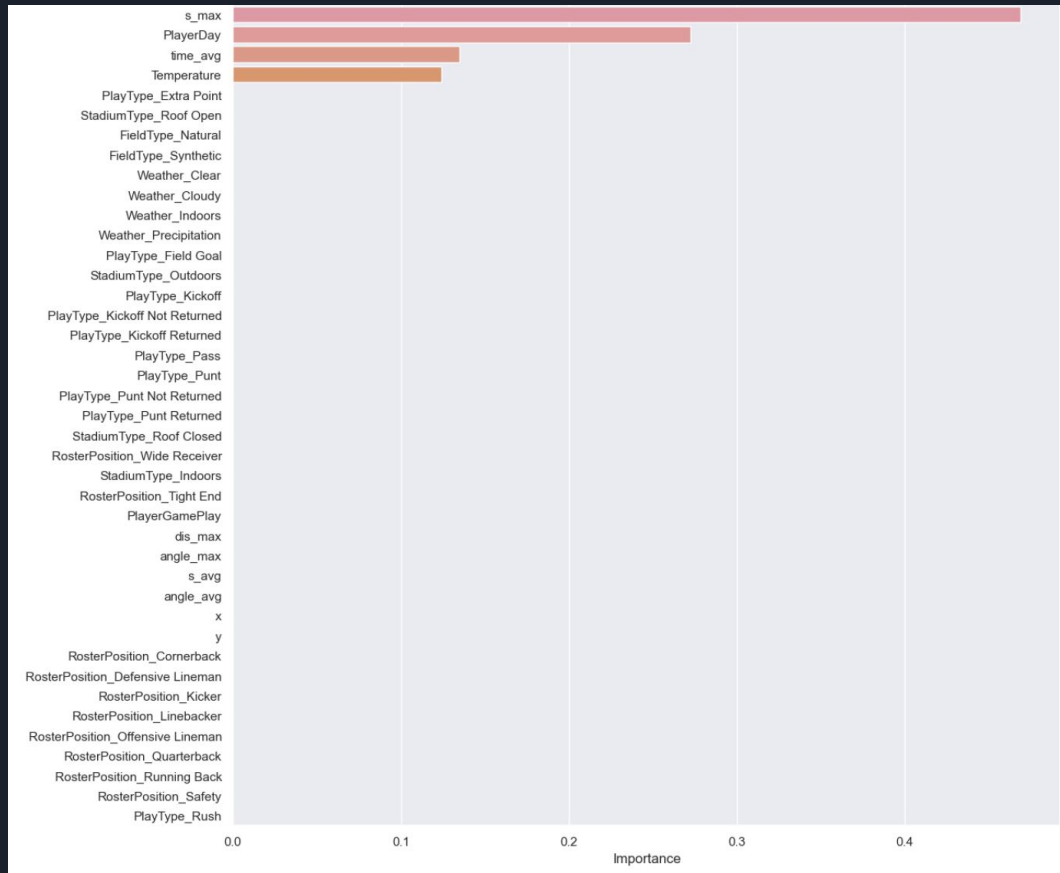
- General Rule: >70% Model Recall
- Secondary Metrics
 - Accuracy
 - F1 Score
 - Precision
 - ROC_AUC Score

A decorative graphic on the left side of the slide. It consists of a blue parallelogram and a light green parallelogram, both tilted at an angle. The blue shape is in the foreground, and the green shape is partially behind it. They are set against a dark blue background with faint, lighter blue diagonal stripes.

Model Results (Non-Neural Networks)

Models Using Raw Data (With Class Weights)

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
0	KNN	0.999606	1.000000	0.000000	0.000000	0.000000	0.500000
1	Logistic Regression	0.704708	0.619048	0.380952	0.000508	0.001015	0.542894
2	Decision Tree	0.999306	1.000000	0.000000	0.000000	0.000000	0.499850
3	Decision Tree Tuned	0.463974	0.285714	0.714286	0.000524	0.001048	0.589081
4	Random Forest	0.999606	1.000000	0.000000	0.000000	0.000000	0.500000
5	Random Forest Tuned	0.999606	1.000000	0.000000	0.000000	0.000000	0.500000
6	XGBoost	0.999569	1.000000	0.000000	0.000000	0.000000	0.499981
7	AdaBoost	0.806513	0.857143	0.142857	0.000291	0.000581	0.474816



Tuned Decision Tree

Models Using Undersampled Data

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
0	KNN	0.858260	0.904762	0.095238	0.000265	0.000529	0.476899
1	Logistic Regression	0.417740	0.285714	0.714286	0.000483	0.000965	0.565954
2	Decision Tree	0.087688	0.285714	0.714286	0.000308	0.000616	0.400863
3	Decision Tree Tuned	0.060127	0.047619	0.952381	0.000399	0.000797	0.506078
4	Random Forest	0.074264	0.047619	0.952381	0.000405	0.000809	0.513149
5	Random Forest Tuned	0.048522	0.095238	0.904762	0.000374	0.000748	0.476473
6	XGBoost	0.075557	0.095238	0.904762	0.000385	0.000770	0.489996
7	AdaBoost	0.091850	0.047619	0.952381	0.000413	0.000825	0.521946



Models Using Oversampled Data

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
0	KNN	0.999531	1.0	0.0	0.000000	0.000000	0.499962
1	Logistic Regression	0.006018	0.0	1.0	0.000396	0.000792	0.502813
2	Decision Tree	0.998913	1.0	0.0	0.000000	0.000000	0.499653
3	Random Forest	0.999606	1.0	0.0	0.000000	0.000000	0.500000
4	XGBoost	0.999588	1.0	0.0	0.000000	0.000000	0.499991
5	AdaBoost	0.994094	1.0	0.0	0.000000	0.000000	0.497243

A decorative graphic on the left side of the slide consisting of two overlapping parallelograms. The front parallelogram is blue and the back one is a light green color. Both are oriented diagonally from the top-left towards the bottom-right.

Model Results (Neural Networks)



ANN Results

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
0	Basic Neural Network	0.999606	1.000000	0.000000	0.000000	0.000000	0.500000
1	Weighted Neural Network	0.407203	0.190476	0.809524	0.000537	0.001074	0.608284
2	Undersampled Neural Network	0.554306	0.380952	0.619048	0.000547	0.001093	0.586664
3	Oversampled Neural Network	0.998800	1.000000	0.000000	0.000000	0.000000	0.499597



CNN Results

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
0	Convolutional Neural Network	0.999606	1.000000	0.000000	0.000000	0.000000	0.500000
1	Weighted Convolutional Neural Network	0.869190	0.809524	0.190476	0.000574	0.001145	0.529967
2	Undersampled Convolutional Neural Network	0.330971	0.238095	0.761905	0.000448	0.000896	0.546353
3	Oversampled Convolutional Neural Network	0.999119	1.000000	0.000000	0.000000	0.000000	0.499756



GRU Results

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
0	GRU RNN	0.999606	1.000000	0.000000	0.000000	0.000000	0.500000
1	Undersampled GRU RNN	0.817256	0.619048	0.380952	0.000821	0.001639	0.599190
2	Oversampled GRU RNN	0.999156	1.000000	0.000000	0.000000	0.000000	0.499775
3	Weighted GRU RNN	0.628738	0.761905	0.238095	0.000253	0.000505	0.433494



Discussion

- Weighted Neural Network gave overall best performance
 - Recall (0.80), F1(0.0011), Accuracy (0.41)
 - Was not trained with augmented data
- Heavy Imbalance in data still a big issue
 - Undersampling helped results slightly
 - Oversampling mainly just led to overfitting
- Overall Precision and F1 scores very low

	Model	Accuracy	FalseNegRate	Recall	Precision	F1 Score	ROC_AUC
1	Weighted Neural Network	0.407203	0.190476	0.809524	0.000537	0.001074	0.608284



Limitations and Future Work

- Time and resource constraints



- Investigate individual neural network architecture and other techniques further

- Limited to Kaggle data and provided feature list



- Collect more player data
 - Increase feature list
 - Expand scope of injuries
 - More seasons, more players

Thank You!

Backup

Layer (type)	Output Shape	Param #
dense_5 (Dense)	(None, 16)	672
batch_normalization_1 (Batch Normalization)	(None, 16)	64
dense_6 (Dense)	(None, 24)	408
dense_7 (Dense)	(None, 24)	600
dropout_1 (Dropout)	(None, 24)	0
dense_8 (Dense)	(None, 24)	600
dense_9 (Dense)	(None, 1)	25
Total params: 2,369		
Trainable params: 2,337		
Non-trainable params: 32		

Layer (type)	Output Shape	Param #
conv1d (Conv1D)	(None, 39, 64)	256
batch_normalization_2 (Batch Normalization)	(None, 39, 64)	256
max_pooling1d (MaxPooling1D)	(None, 19, 64)	0
conv1d_1 (Conv1D)	(None, 17, 64)	12352
max_pooling1d_1 (MaxPooling1D)	(None, 8, 64)	0
flatten (Flatten)	(None, 512)	0
dense_10 (Dense)	(None, 64)	32832
dense_11 (Dense)	(None, 1)	65
Total params: 45,761		
Trainable params: 45,633		
Non-trainable params: 128		

Layer (type)	Output Shape	Param #
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gru (GRU)	(None, 64)	12864
batch_normalization_3 (Batch Normalization)	(None, 64)	256
dense_12 (Dense)	(None, 64)	4160
dense_13 (Dense)	(None, 1)	65
=====		
Total params: 17,345		
Trainable params: 17,217		
Non-trainable params: 128		