

Optimal Hockey Play

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Business Problem

Stakeholders

- Hockey teams
 - Professionals + youth leagues

Market Size

- 1.64 million people
- \$4.37 billion in annual revenue (NHL)
- Additional revenue (North American college + youth teams)



Business Problem

Challenges

- Data is from junior hockey league
- Evolving strategies

Opportunities

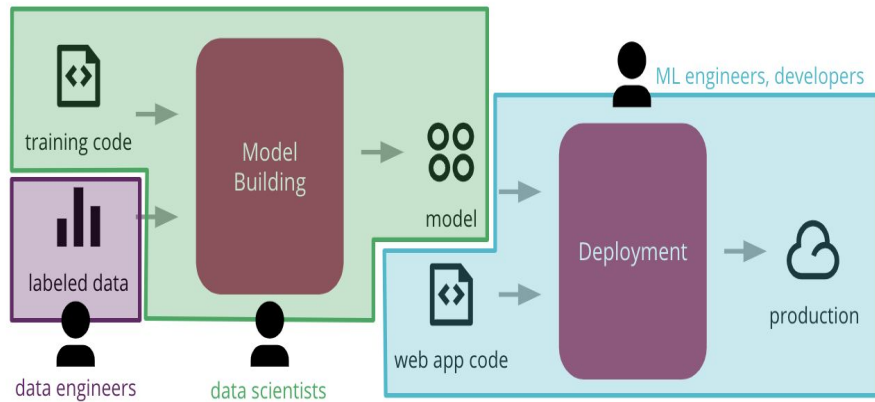
- Improve offensive strategies
- Increase probability of scoring
- Better performance results



Data Mining Problem

-Supervised, Predictive & Causal

-Deployment Process



Data Description



STATHLETES

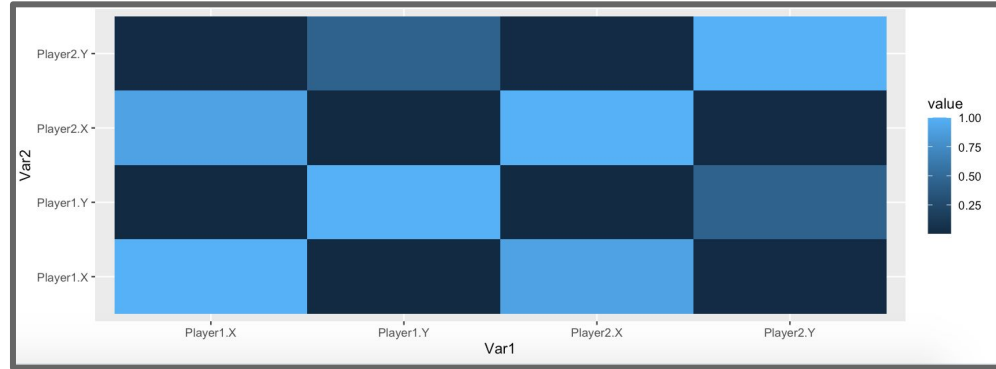
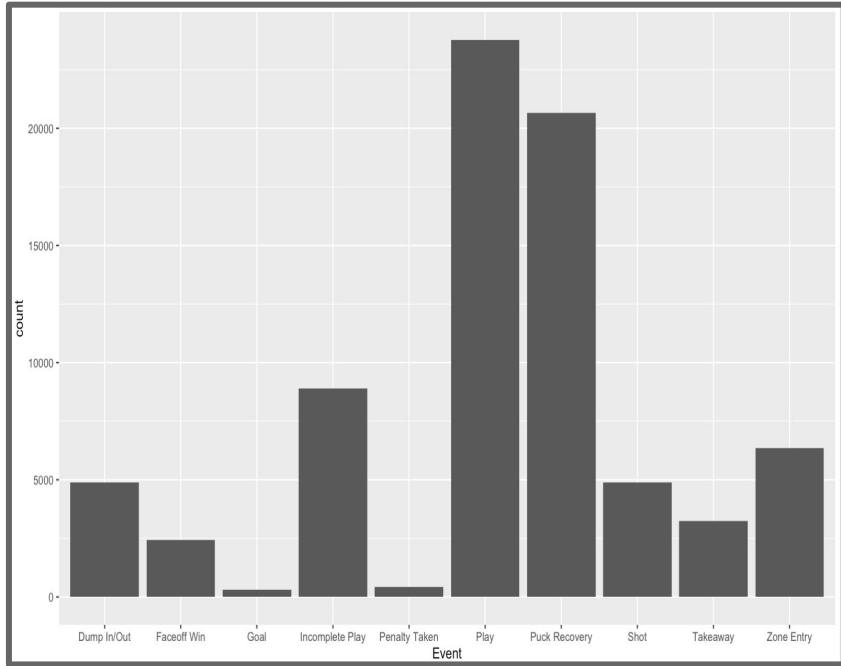
Dataset

game_date	Home Team	Away Team	Period	Clock	Home Team Skaters	Away Team Skaters	Home Team Goals	Away Team Goals	Team	Player	Event	X Coordinate	Y Coordinate	Detail.1	Detail.2	Detail.3	Det
1 2019-09-20	Erie Otters	Sudbury Wolves	1	20:00	S	S	0	0	Sudbury Wolves	Blake Murray	Faceoff Win	100	43	Forehand			
2 2019-09-20	Erie Otters	Sudbury Wolves	1	19:58	S	S	0	0	Sudbury Wolves	Emmett Serensits	Puck Recovery	67	77				
3 2019-09-20	Erie Otters	Sudbury Wolves	1	19:53	S	S	0	0	Sudbury Wolves	Emmett Serensits	Incomplete Play	45	49	Direct			
4 2019-09-20	Erie Otters	Sudbury Wolves	1	19:52	S	S	0	0	Erie Otters	Hayden Fowler	Puck Recovery	89	36				
5 2019-09-20	Erie Otters	Sudbury Wolves	1	19:51	S	S	0	0	Erie Otters	Hayden Fowler	Incomplete Play	82	49	Direct			
6 2019-09-20	Erie Otters	Sudbury Wolves	1	19:48	S	S	0	0	Sudbury Wolves	Emmett Serensits	Puck Recovery	64	75				
7 2019-09-20	Erie Otters	Sudbury Wolves	1	19:45	S	S	0	0	Sudbury Wolves	Emmett Serensits	Play	6	60	Indirect			
8 2019-09-20	Erie Otters	Sudbury Wolves	1	19:39	S	S	0	0	Sudbury Wolves	Blake Murray	Puck Recovery	59	19				
9 2019-09-20	Erie Otters	Sudbury Wolves	1	19:38	S	S	0	0	Sudbury Wolves	Blake Murray	Play	82	50	Indirect			
10 2019-09-20	Erie Otters	Sudbury Wolves	1	19:36	S	S	0	0	Sudbury Wolves	Owen Gihula	Dump in /Out	102	71	Lost			
11 2019-09-20	Erie Otters	Sudbury Wolves	1	19:36	S	S	0	0	Sudbury Wolves	Owen Gihula	Zone Entry	102	71	Dumped			
12 2019-09-20	Erie Otters	Sudbury Wolves	1	19:32	S	S	0	0	Erie Otters	Jamie Drysdale	Puck Recovery	9	74				
13 2019-09-20	Erie Otters	Sudbury Wolves	1	19:32	S	S	0	0	Erie Otters	Jamie Drysdale	Play	9	74	Indirect			
14 2019-09-20	Erie Otters	Sudbury Wolves	1	19:30	S	S	0	0	Erie Otters	Kurtis Henry	Play	4	29	Indirect			
15 2019-09-20	Erie Otters	Sudbury Wolves	1	19:27	S	S	0	0	Erie Otters	Hayden Fowler	Incomplete Play	24	2	Direct			
16 2019-09-20	Erie Otters	Sudbury Wolves	1	19:27	S	S	0	0	Sudbury Wolves	Shane Bulitka	Puck Recovery	162	54				
17 2019-09-20	Erie Otters	Sudbury Wolves	1	19:26	S	S	0	0	Sudbury Wolves	Shane Bulitka	Shot	177	57	Snapshot	On Net	f	f
18 2019-09-20	Erie Otters	Sudbury Wolves	1	19:24	S	S	0	0	Sudbury Wolves	Blake Murray	Puck Recovery	197	63				
19 2019-09-20	Erie Otters	Sudbury Wolves	1	19:22	S	S	0	0	Sudbury Wolves	Blake Murray	Play	187	77	Direct			
20 2019-09-20	Erie Otters	Sudbury Wolves	1	19:21	S	S	0	0	Sudbury Wolves	Emmett Serensits	Shot	134	79	Wristshot	Missed	f	f
21 2019-09-20	Erie Otters	Sudbury Wolves	1	19:21	S	S	0	0	Sudbury Wolves	Landon McCallum	Shot	165	56	Deflection	Missed	f	f
22 2019-09-20	Erie Otters	Sudbury Wolves	1	19:20	S	S	0	0	Erie Otters	Jamie Drysdale	Puck Recovery	23	44				
23 2019-09-20	Erie Otters	Sudbury Wolves	1	19:20	S	S	0	0	Erie Otters	Jamie Drysdale	Play	23	44	Direct			
24 2019-09-20	Erie Otters	Sudbury Wolves	1	19:18	S	S	0	0	Erie Otters	Brendan Sellan	Play	51	75	Direct			
25 2019-09-20	Erie Otters	Sudbury Wolves	1	19:16	S	S	0	0	Erie Otters	Hayden Fowler	Play	104	81	Direct			
26 2019-09-20	Erie Otters	Sudbury Wolves	1	19:15	S	S	0	0	Erie Otters	Connor Lockhart	Zone Entry	125	55	Carried			
27 2019-09-20	Erie Otters	Sudbury Wolves	1	19:12	S	S	0	0	Erie Otters	Jamie Drysdale	Puck Recovery	139	4				
28 2019-09-20	Erie Otters	Sudbury Wolves	1	19:12	S	S	0	0	Erie Otters	Jamie Drysdale	Incomplete Play	139	4	Direct			
29 2019-09-20	Erie Otters	Sudbury Wolves	1	19:12	S	S	0	0	Sudbury Wolves	Emmett Serensits	Takeaway	36	79				
30 2019-09-20	Erie Otters	Sudbury Wolves	1	19:10	S	S	0	0	Sudbury Wolves	Emmett Serensits	Play	44	80	Indirect			
31 2019-09-20	Erie Otters	Sudbury Wolves	1	19:09	S	S	0	0	Sudbury Wolves	Shane Bulitka	Dump in /Out	70	78	Lost			
32 2019-09-20	Erie Otters	Sudbury Wolves	1	19:06	S	S	0	0	Erie Otters	Jamie Drysdale	Puck Recovery	81	12				
33 2019-09-20	Erie Otters	Sudbury Wolves	1	19:04	S	S	0	0	Erie Otters	Jamie Drysdale	Play	87	24	Direct			
34 2019-09-20	Erie Otters	Sudbury Wolves	1	19:03	S	S	0	0	Erie Otters	Daniel Singer	Zone Entry	124	81	Carried			
35 2019-09-20	Erie Otters	Sudbury Wolves	1	19:01	S	S	0	0	Erie Otters	Daniel Singer	Play	124	81	Carried	On Net	f	f

Showing 1 to 35 of 75,673 entries, 21 total columns

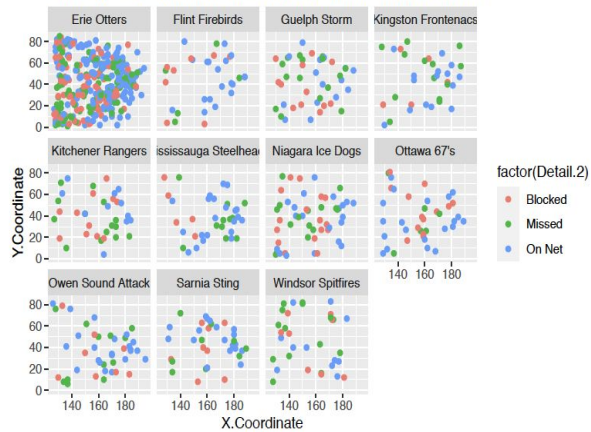
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EDA Pt.1

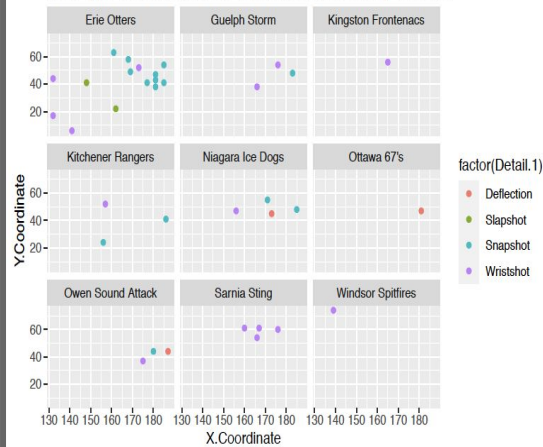


EDA Pt.2

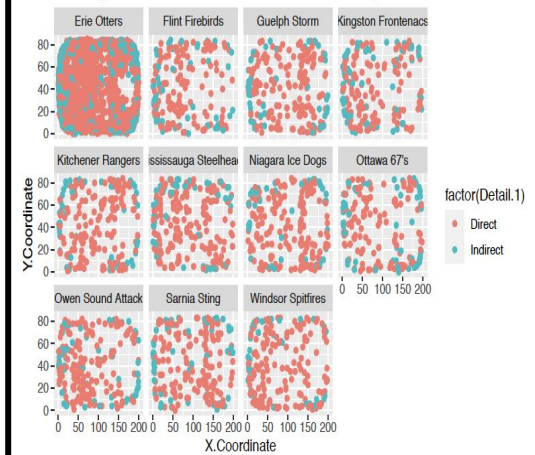
Shot Type Visualizations for Different Teams during Period 1



Goal Type Visualizations for Different Teams during Period 1



Pass Type Visualizations for Different Teams during Period 1



Dataset after Preprocessing

	Home.Team	Away.Team	Period	Home.Team.Skaters	Away.Team.Skaters	Team	Event	X.Coordinate	Y.Coordinate	Home.Team_Barrie Colts	Home.Team_Erie Otters	Home.Team_Flint Firebirds	Home.Team_Guelph Storm	Home.Team_Hamilton Bulldogs	Home.Team_Kingston Frontenacs
1	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	6	60	0	1	0	0	0	0
2	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	82	50	0	1	0	0	0	0
3	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	9	74	0	1	0	0	0	0
4	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	4	29	0	1	0	0	0	0
5	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	1	177	57	0	1	0	0	0	0
6	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	187	77	0	1	0	0	0	0
7	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	1	134	70	0	1	0	0	0	0
8	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	1	165	56	0	1	0	0	0	0
9	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	23	44	0	1	0	0	0	0
10	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	51	75	0	1	0	0	0	0
11	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	104	81	0	1	0	0	0	0
12	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	44	80	0	1	0	0	0	0
13	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	87	24	0	1	0	0	0	0
14	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	1	172	71	0	1	0	0	0	0
15	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	4	41	0	1	0	0	0	0
16	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	98	32	0	1	0	0	0	0
17	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	76	1	0	1	0	0	0	0
18	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	56	59	0	1	0	0	0	0
19	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	196	60	0	1	0	0	0	0
20	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	182	82	0	1	0	0	0	0
21	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	162	4	0	1	0	0	0	0
22	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	199	43	0	1	0	0	0	0
23	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	81	17	0	1	0	0	0	0
24	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	54	46	0	1	0	0	0	0
25	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	61	79	0	1	0	0	0	0
26	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	0	8	18	0	1	0	0	0	0
27	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	141	82	0	1	0	0	0	0
28	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	141	82	0	1	0	0	0	0
29	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	174	82	0	1	0	0	0	0
30	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	184	18	0	1	0	0	0	0
31	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	1	131	6	0	1	0	0	0	0
32	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	1	171	24	0	1	0	0	0	0
33	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	193	57	0	1	0	0	0	0
34	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	12	77	0	1	0	0	0	0
35	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	4	68	0	1	0	0	0	0
36	Erie Otters	Sudbury Wolves	1	5	5	Erie Otters	0	39	78	0	1	0	0	0	0
37	Erie Otters	Sudbury Wolves	1	5	5	Sudbury Wolves	1	147	53	0	1	0	0	0	0

Showing 1 to 41 of 28,958 entries, 62 total columns

Business Model Cost

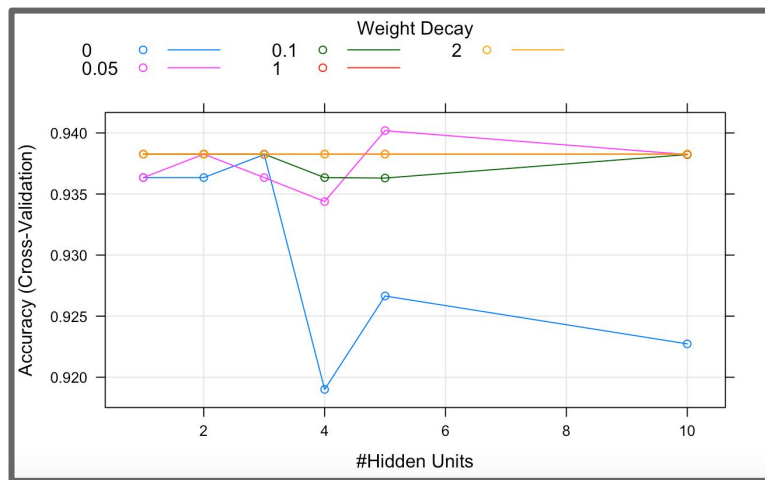


Fixed cost: Sensors



Variable Cost:
Data cleaner

Method 1: Neural Network



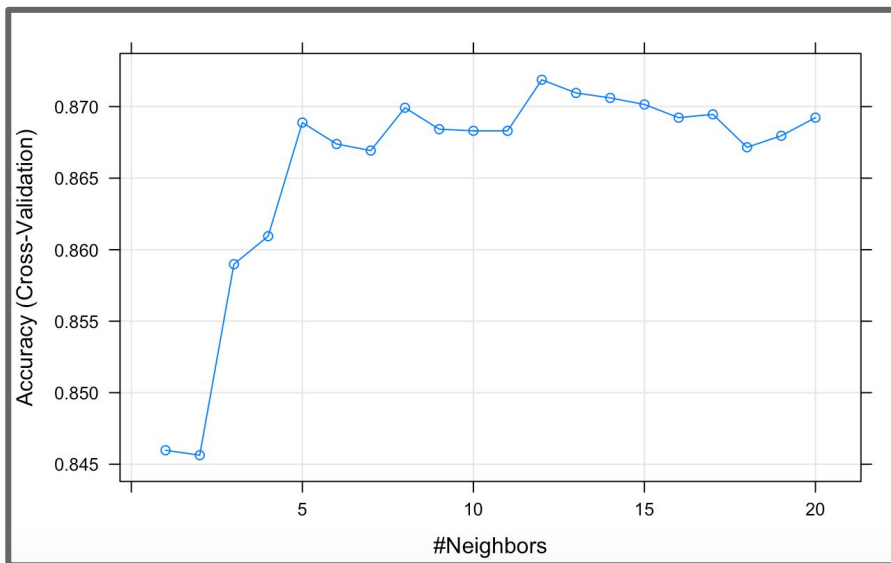
Confusion Matrix and Statistics

Reference		
Prediction	Goal	Shot
Goal	4	26
Shot	257	4375

Accuracy : 0.9393
95% CI : (0.9321, 0.946)
No Information Rate : 0.944
P-Value [Acc > NIR] : 0.9228

- Lower test accuracy (.9393) than training accuracy (.9479)
- Used decay value of 0.05
- Data slightly skewed by number of “shot” instances- could be biased toward predicting more shots
- Findings can be used for offensive or defensive strategy
 - Predict whether a player will score given a set of circumstances
- Model was trained with the x coordinate, y coordinate, # of players, and period

Method 2: K Nearest Neighbor



Confusion Matrix and Statistics

Reference			
Prediction	Goal	Play	Shot
Goal	1	3	5
Play	34	15647	1428
Shot	173	1008	1972

Overall Statistics

Accuracy : 0.8692
95% CI : (0.8645, 0.8738)
No Information Rate : 0.8218
P-Value [Acc > NIR] : < 2.2e-16

- K value of 12 provided the highest accuracy
- Model was trained with the x coordinate, y coordinate, # of players, and period
- Lower accuracy than neural network model

Non-R Evaluation



- **Offensive**
 - Goals scored
 - Individual Scoring
 - Shot percentage
- **Defensive**
 - Goals allowed
 - Shots blocked
 - Location of goals allowed

Difficulties

- SVM
- Decision Tree
- Data Shortcomings
 - No information on defenders or locations
 - Lots of superfluous information

Recommendations



Maintain Data

- Data should be kept up to date to the best of their ability
 - Must use current data to evaluate effectiveness of changes

Expand Data

- Add more sensors to keep track of defenders location for shots
- Apply methodology to opponents teams to improve defense
 - See potential holes in defense

Thank
You