Regularized Estimation of Hockey Player Performance

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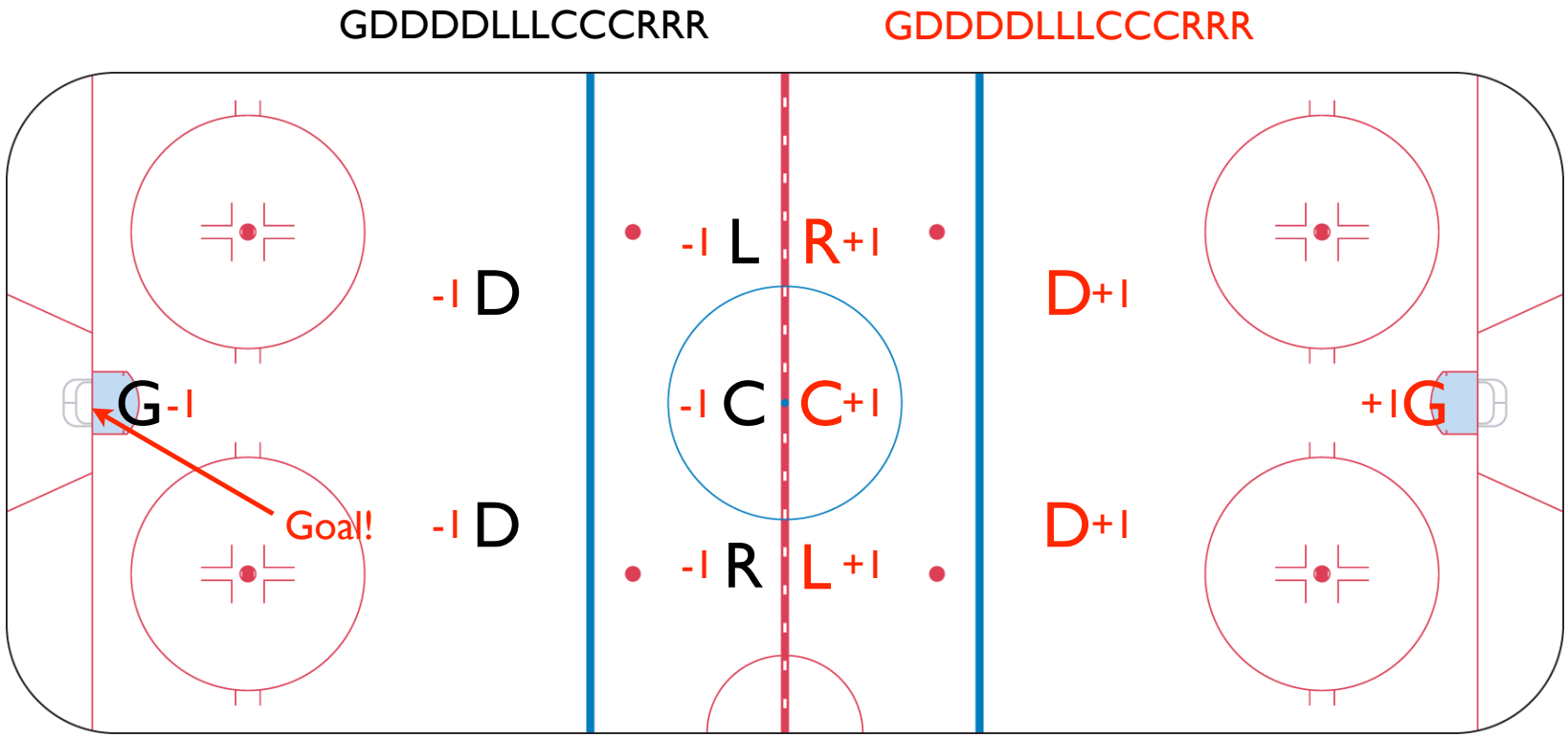
Plus-Minus

PM is a running count of, for every goal, a +1 for those on the scoring team and -1 for those on the team scored upon.



It doesn't quite measure player quality, as we haven't controlled for the effects of teammate and opponent quality (or anything else).

A Regression version of PM

Set up a 'response' variable:

$y_i = +1$ for a *home* team goal,

$y_i = -1$ for an *away* team goal.

We're interested in how individual players affect

$$q_i = \mathrm{p}(y_i = 1) = \mathrm{p}(\text{home team scored goal } i)$$

The standard model for such problems is logistic regression, say

$$\log\left[\frac{q_i}{1-q_i}\right] = \alpha + \beta_{HG} + \beta_{HD} \ldots + \beta_{HR} - \beta_{AG} - \ldots - \beta_{AR}$$

where β_{HG} is Home-Goalie and β_{AR} is Away-Right-wing, etc.

Then, for player j and given a goal was scored, e^{β_j} is the multiplier on odds that it was scored by his team if he's on the ice.

We actually use a larger regression model:

$$\log\left[\frac{q_i}{1-q_i}\right] = \alpha + \mathbf{u}_i'\gamma + \mathbf{v}_i'\varphi + \mathbf{x}_i'\beta_0 + (\mathbf{x}_i \circ \mathbf{s}_i)'(\beta_s + p_i\beta_p)$$

where

- $\mathbf{u}_i$ holds indicators for each team-season,
- $\mathbf{v}_i$ holds indicators for various special-teams scenarios,
- $\mathbf{x}_i$ contains player-presence indicator,

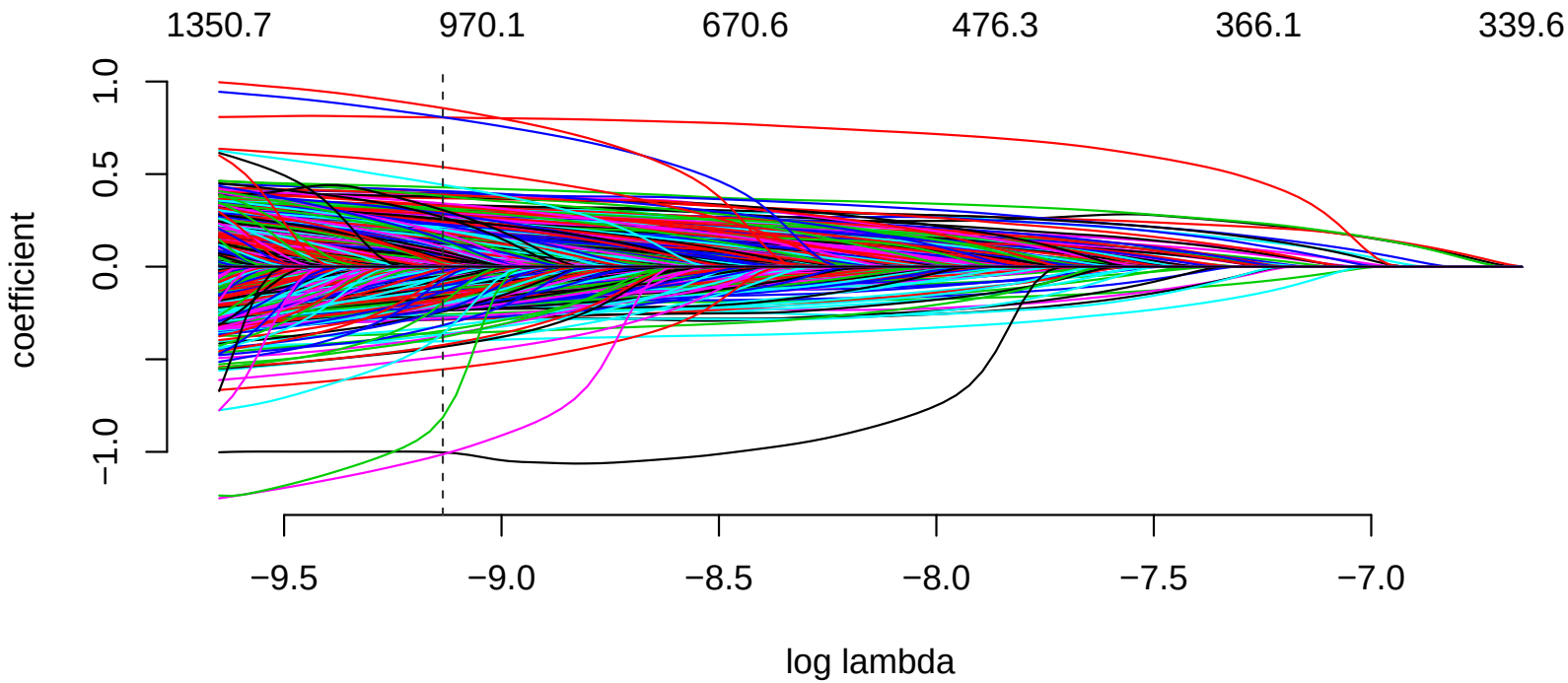
All of these indicators are $+1$ for home and -1 for away.

Then β_j measures player effect after controlling for team strength (e.g., coach or schedule) and on-ice scenarios (e.g., PP or PK).

We also allow deviations in the player effects for specific seasons (s_{it}) and in the playoffs (p_{it}), but these are seldom 'significant'.

Regularization

Instead of minimizing deviance, we minimize deviance *plus penalty* $\lambda|\beta_j|$ *on the size of each* β_j *coefficient*. This is called the LASSO.



Enumerate a 'path' of models for different λ, and use the one that predicts best out-of-sample. This is how modern statistics works.

See the `gamlr` package for R, and `help(hockey)` for this example.

Partial PM and FP

We use the estimated logistic regression model to produce 'partial' (i.e., without effect of confounders) versions of standard statistics.

- For-Probability: $PFP_j = \dfrac{e^{\beta_j}}{(1 + e^{\beta_j})}$
- Plus-Minus: $PPM_j = G_j PFP_j - G_j(1 - PFP_j)$
  where G_j is the total goals with player j on-ice.

PFP measures the player's average contribution, and PPM scales this up by # of goals (which is a rough surrogate for time-on-ice).

We also fit models for non-goal response y_i, like shots or corsi events. This gives partial versions of stats based on those metrics.

Goal-based performance analysis, ordered by PPM: Studs

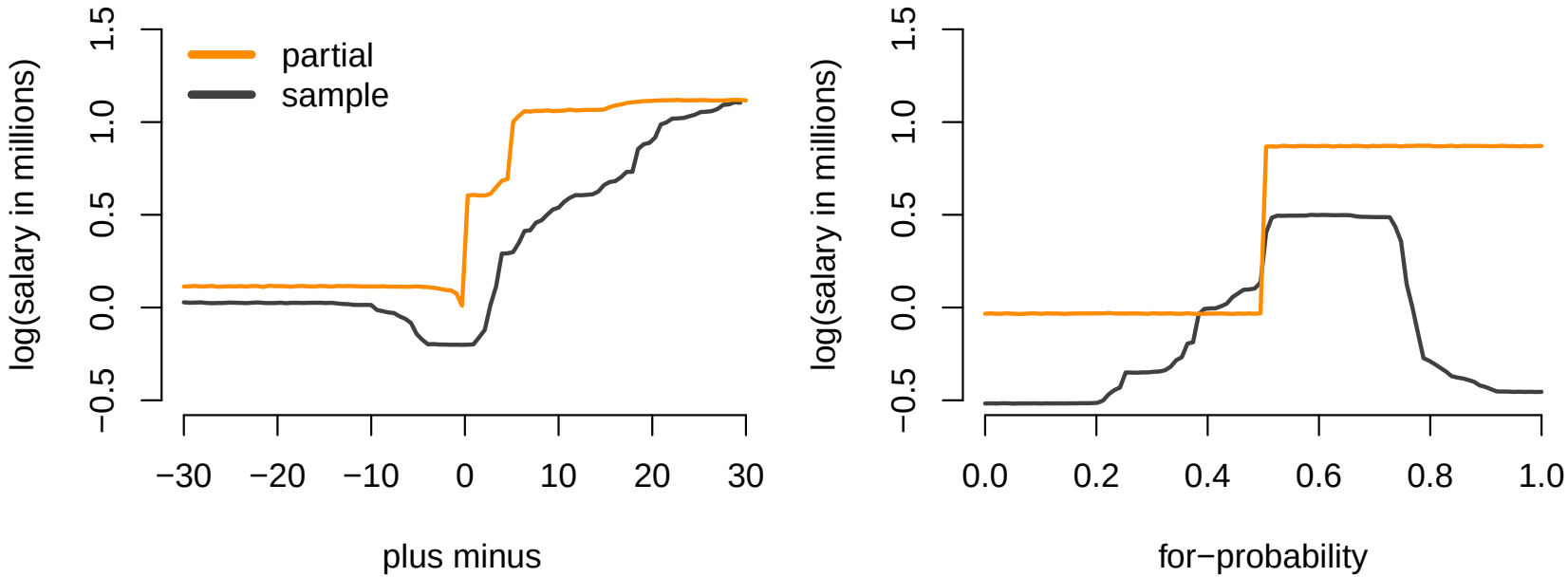
Rank	Player	Season	Team	PFP	FP	PPM	PM
1	PETER FORSBERG	2002-2003	COL	0.68	0.77	55.52	85
2	SIDNEY CROSBY	2009-2010	PIT	0.60	0.64	43.47	60
3	DOMINIK HASEK	2005-2006	OTT	0.59	0.67	42.45	80
4	SIDNEY CROSBY	2008-2009	PIT	0.60	0.61	42.26	48
5	SIDNEY CROSBY	2005-2006	PIT	0.60	0.62	41.86	52
6	PETER FORSBERG	2005-2006	PHI	0.68	0.77	40.67	61
7	PAVEL DATSYUK	2007-2008	DET	0.60	0.72	39.49	87
8	PAVEL DATSYUK	2008-2009	DET	0.60	0.67	39.49	69
9	SIDNEY CROSBY	2006-2007	PIT	0.60	0.72	35.62	79
10	MARK STREIT	2008-2009	NYI	0.59	0.56	35.08	24
11	MATT MOULSON	2011-2012	NYI	0.60	0.61	34.92	37
12	LUBOMIR VISNOVSKY	2010-2011	ANA	0.58	0.66	34.52	70
13	ALEX OVECHKIN	2008-2009	WAS	0.57	0.66	34.46	80
14	JOE THORNTON	2009-2010	SJS	0.60	0.65	33.91	52
15	JOE THORNTON	2010-2011	SJS	0.60	0.64	33.91	48
16	ONDREJ PALAT	2013-2014	TAM	0.64	0.66	32.75	37
17	PAVEL DATSYUK	2006-2007	DET	0.60	0.71	32.61	70
18	JOE THORNTON	2002-2003	BOS	0.60	0.64	32.17	47
19	JOE THORNTON	2007-2008	SJS	0.60	0.71	32.17	69
20	ANDREI MARKOV	2007-2008	MON	0.57	0.60	31.9	47

Goal-based performance analysis, ordered by PPM: Duds

Rank	Player	Season	Team	PFP	FP	PPM	PM
10184	PATRICK LALIME	2008-2009	BUF	0.43	0.44	-15.79	-15
10185	JACK JOHNSON	2007-2008	LOS	0.45	0.39	-15.82	-34
10186	BRETT CLARK	2011-2012	TAM	0.44	0.35	-16.93	-47
10187	NICLAS HAVELID	2008-2009	ATL	0.45	0.39	-16.97	-40
10188	JACK JOHNSON	2010-2011	LOS	0.45	0.53	-17.21	9
10189	JACK JOHNSON	2011-2012	LOS	0.45	0.5	-17.21	-1
10190	P. J. AXELSSON	2008-2009	BOS	0.41	0.49	-17.35	-1
10191	BRYAN ALLEN	2006-2007	FLA	0.45	0.45	-17.9	-17
10192	JACK JOHNSON	2009-2010	LOS	0.45	0.49	-19.46	-4
10193	PATRICK LALIME	2005-2006	STL	0.43	0.40	-19.77	-29
10194	ALEXANDER EDLER	2013-2014	VAN	0.37	0.27	-20.49	-35
10195	PATRICK LALIME	2007-2008	CHI	0.43	0.49	-22.29	-4
10196	TIM THOMAS	2009-2010	BOS	0.43	0.46	-24.22	-16
10197	ANDREJ MESZAROS	2006-2007	OTT	0.42	0.48	-27.32	-6
10198	BRYCE SALVADOR	2008-2009	NJD	0.35	0.37	-34.4	-31
10199	PATRICK LALIME	2002-2003	OTT	0.43	0.58	-37.81	47
10200	PATRICK LALIME	2003-2004	OTT	0.43	0.56	-37.81	37
10201	NICLAS HAVELID	2006-2007	ATL	0.34	0.44	-62.64	-22
10202	NICLAS HAVELID	2005-2006	ATL	0.33	0.40	-65.94	-41
10203	JAY BOUWMEESTER	2005-2006	FLA	0.33	0.42	-69.62	-32

For abundant detail and analysis, see our handbook chapter
Hockey Performance via Regression by Gramacy, Taddy, and Tian.

e.g., look at average player salary by standard and partial statistics



Bargains!

Top-15 undervalued players in 2013-2014

Rank	Player	Team	Goals per million
1	ONDREJ PALAT	TAM	58.27
2	RYAN NUGENT-HOPKINS	EDM	19.81
3	GABRIEL LANDESKOG	COL	16.74
4	TYLER TOFFOLI	LOS	16.72
5	GUSTAV NYQUIST	DET	9.08
6	JADEN SCHWARTZ	STL	8.43
7	ERIC FEHR	WAS	7.51
8	ANDREW MACDONALD	NYI	7.48
9	BENOIT POULIOT	NYR	6.43
10	BRAD BOYES	FLA	6.01
11	TOMAS TATAR	DET	5.83
12	AL MONTOYA	WPG	5.79
13	BRANDON SAAD	CHI	5.5
14	FRANS NIELSEN	NYI	5.5
15	JAROMIR JAGR	NJD	4.73

We also include comparison of shot and goal-based metrics:

PFP player rankings

	goal-based				Corsi-based			
Rank	Player	Season	Team	PFP	Player	Season	Team	PFP
1	PETER FORSBERG	2002-2003	COL	0.68	DAVID VAN DER GULIK	2010-2011	COL	0.64
2	PETER FORSBERG	2005-2006	PHI	0.68	DAVID BOOTH	2012-2013	VAN	0.63
3	PETER FORSBERG	2003-2004	COL	0.68	DANIEL SEDIN	2012-2013	VAN	0.62
4	PETER FORSBERG	2006-2007	PHI	0.68	ALEXANDER SEMIN	2003-2004	WAS	0.61
5	PETER FORSBERG	2007-2008	COL	0.68	DANIEL SEDIN	2010-2011	VAN	0.60
6	PETER FORSBERG	2010-2011	COL	0.68	MIKHAIL GRABOVSKI	2010-2011	TOR	0.60
7	ONDREJ PALAT	2013-2014	TAM	0.64	DANIEL SEDIN	2007-2008	VAN	0.60
8	ONDREJ PALAT	2012-2013	TAM	0.64	DANIEL SEDIN	2008-2009	VAN	0.60
9	TYLER TOFFOLI	2013-2014	LOS	0.63	DANIEL SEDIN	2011-2012	VAN	0.60
10	TYLER TOFFOLI	2012-2013	LOS	0.63	PATRIK ELIAS	2010-2011	NJD	0.60
11	VINCENT LECAVALIER	2006-2007	TAM	0.61	SIDNEY CROSBY	2013-2014	PIT	0.60
12	VINCENT LECAVALIER	2003-2004	TAM	0.61	DANIEL SEDIN	2009-2010	VAN	0.60
13	SIDNEY CROSBY	2009-2010	PIT	0.60	JUSTIN WILLIAMS	2010-2011	LOS	0.60
14	SIDNEY CROSBY	2008-2009	PIT	0.60	DANIEL SEDIN	2013-2014	VAN	0.60
15	SIDNEY CROSBY	2005-2006	PIT	0.60	PATRIC HORNQVIST	2013-2014	NSH	0.60
16	PAVEL DATSYUK	2007-2008	DET	0.60	PAVEL DATSYUK	2012-2013	DET	0.60
17	PAVEL DATSYUK	2008-2009	DET	0.60	ALEX STEEN	2011-2012	STL	0.60
18	SIDNEY CROSBY	2006-2007	PIT	0.60	BRAD RICHARDSON	2011-2012	LOS	0.60
19	MATT MOULSON	2011-2012	NYI	0.60	ERIC FEHR	2008-2009	WAS	0.60
20	JOE THORNTON	2009-2010	SJS	0.60	TYLER TOFFOLI	2013-2014	LOS	0.60

and much else.

Wrap-up

The model is very transparent and easy to estimate.

Check out `gamlr` and the `hockey` example:

```
data(hockey)
x <- cBind(config,team,player)
y <- goal$homegoal
fit <- gamlr(x, y, free=1:(ncol(config)+ncol(team)),
                   standardize=FALSE, family="binomial")
```

We take no stand about what stats lead to wins,
and don't attempt to model full game action.

But this simple regression tells you a lot about who is contributing.

Thanks!