Player impact measures for scoring in ice hockey

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Outline

- Motivation
- Method
- Results
- Conclusion

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Motivation

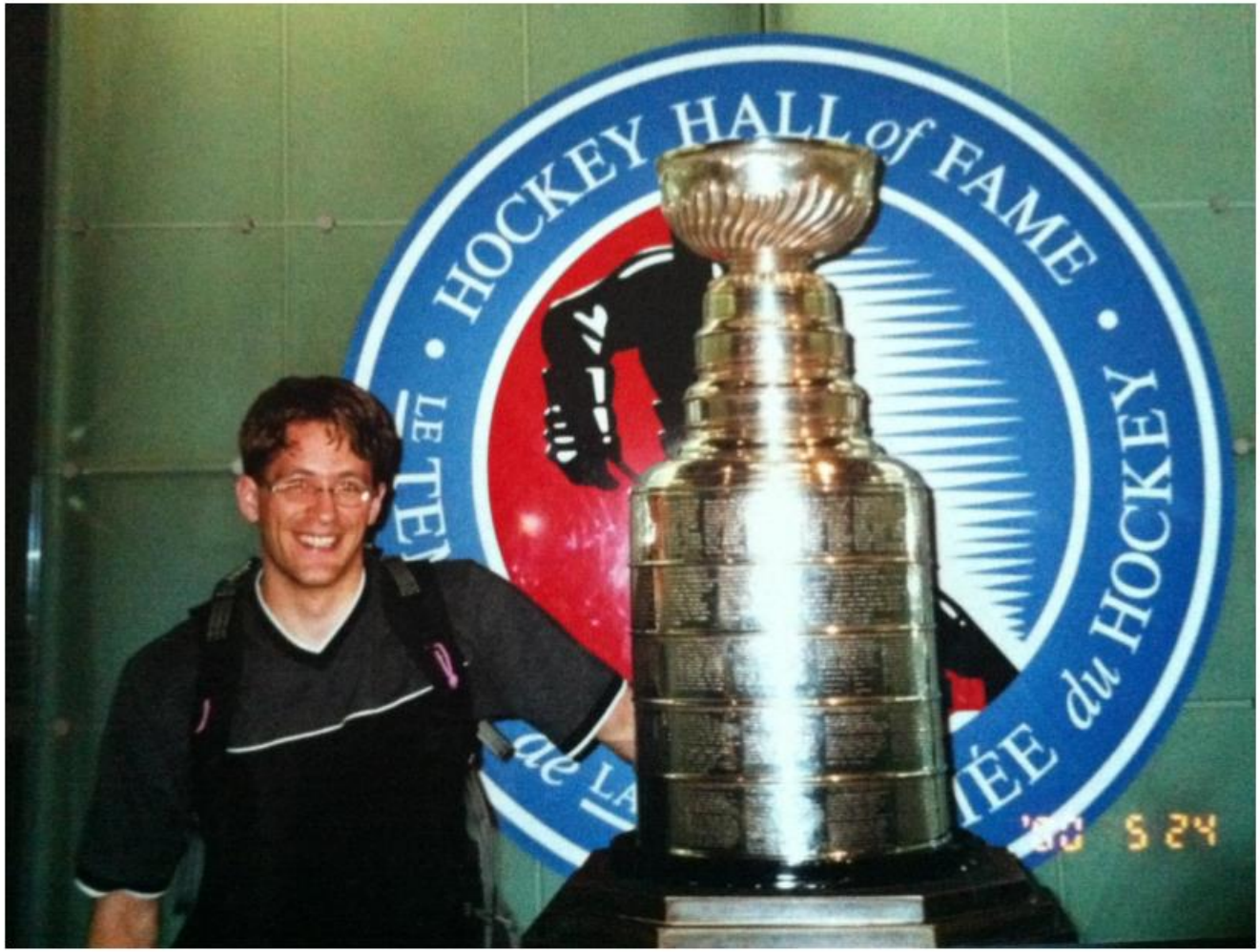
Niklas
(and many others)
dream of:

Motivation

First try

Motivation

A bit easier …



Motivation

- Player impact measure for scoring
- Measure that captures context
- Measure that allows for look-ahead

- Extend existing work: direct vs on-ice impact
- Relation to traditional performance measures

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Action Impact Model

- Based on the work by Routley and Schulte 2015
- Idea:
  - Define state $s = < c, ps >$

    where c is a context and ps is a play sequence
  - Actions are performed in states
  - Define impact of action in a state
  - Define player impact based on action impacts

Action Impact Model

Context

Notation	Name	Range
GD	Goal Differential	[-8,8]
MD	Manpower Differential	[-3,3]
P	Period	[1,7]

Action Impact Model

Events

Action Event	Start/End Event
Faceoff	Period Start
Shot	Period End
Missed Shot	Early Intermission Start
Blocked Shot	Penalty
Takeaway	Stoppage
Giveaway	Shootout Completed
Hit	Game End
Goal	Game Off
	Early Intermission End

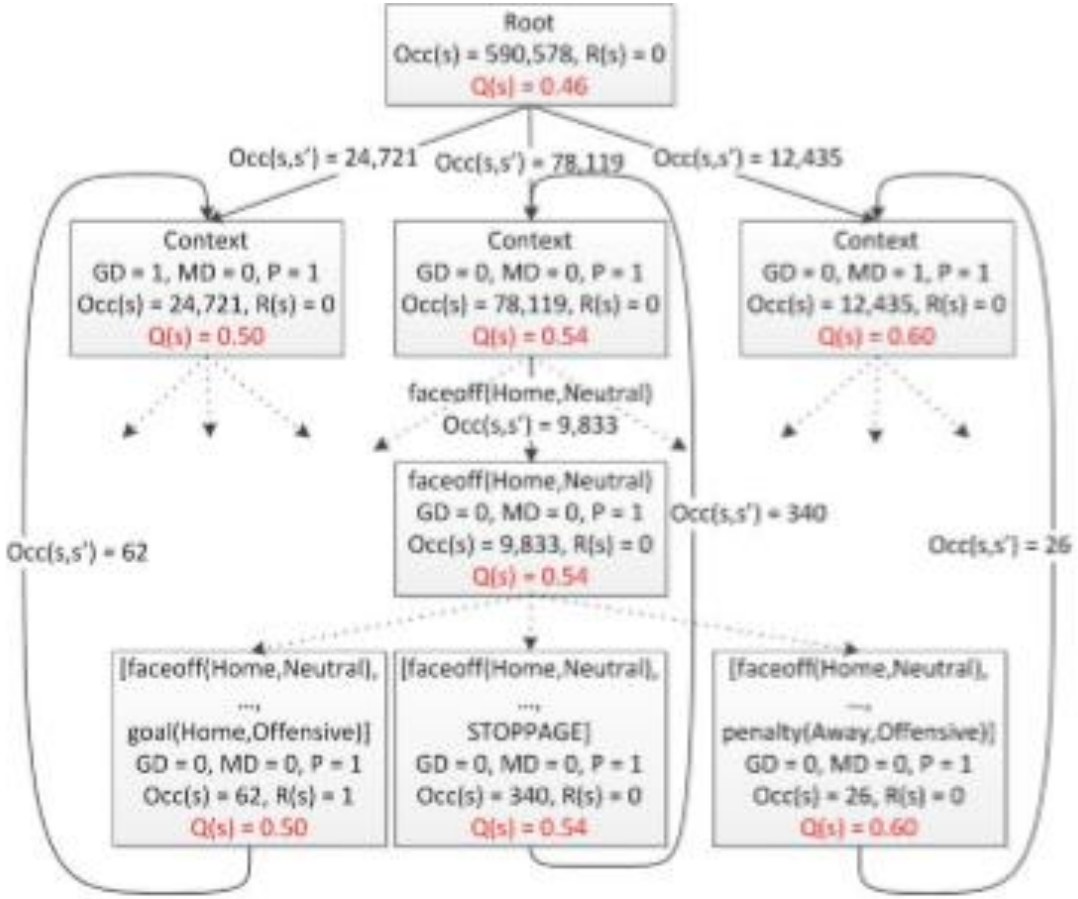
Action Impact Model

A play sequence is defined as

- the empty sequence or
- a sequence of events
  - first event: start marker
  - (possible) next events: action events
  - (possible) last event: end event

(→complete sequence)

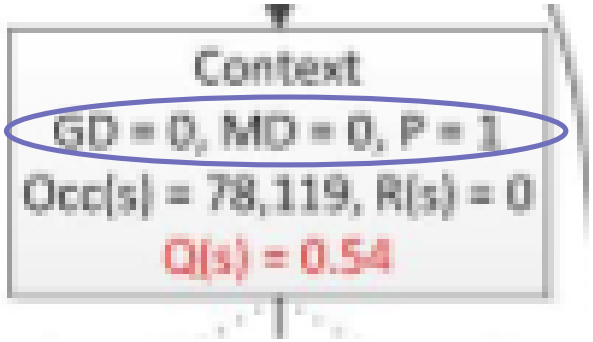
Action Impact Model

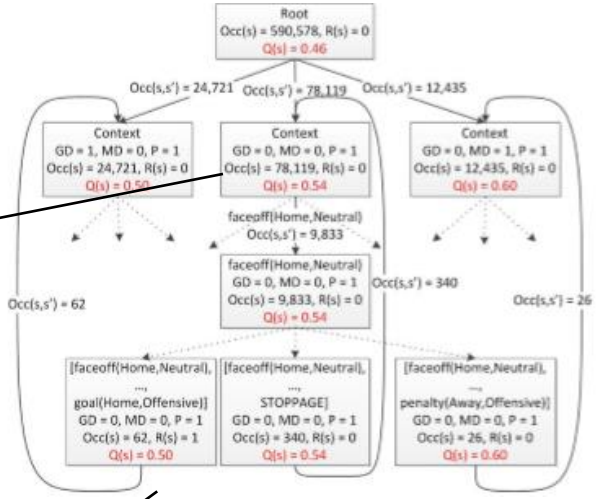


Routley and Schulte, 2015

Action Impact Model

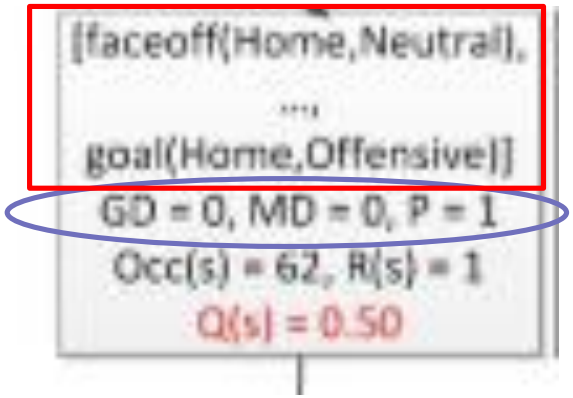
State $s = < c, ps >$





Context

Play sequence



Routley and Schulte, 2015

Action Impact Model

- Actions are performed in states

$< c, ps > * a =$

$< c, append\ (ps,a) >$ if state has no end event

(add action to play sequence, e.g., shot)

$< c', \ empty\text{-}set >$ if state has end event

(change context, e.g., after a goal)

Action Impact Model

Based on play-by-play data:

- Occurrences of state *s*: *Occ(s)*
- Occurrences of state *s* immediately followed by state *s'*: *Occ(s,s')*

- Transition probability $T(s,s') = Occ(s,s') / Occ(s)$

Action Impact Model

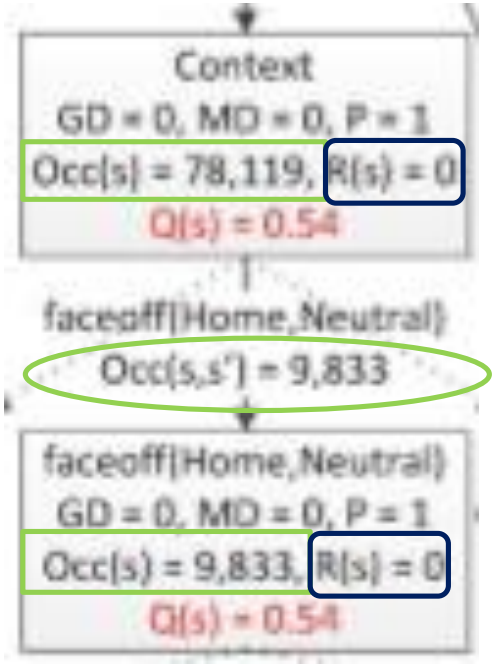
Value iteration algorithm → Q-values

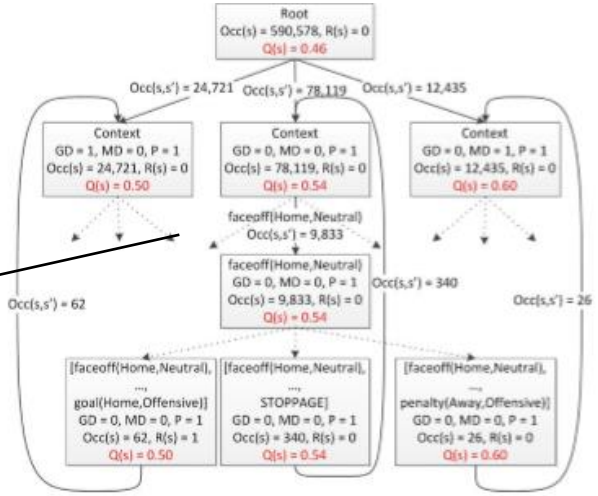
Reward function: goal states receive reward 1

$Q(i+1)(s) = R(s) + SUM\_(s,s') T(s,s') \times Q(i)(s')$

Impact of action *a* in state *s*: $Q(s*a) - Q(s)$

Action Impact Model





Occurrences

Occurrences

Reward

Routley and Schulte, 2015

Player Impact

Sum of action impacts

1. Based on all actions performed by the player (direct impact)
2. Based on actions when the player is on the ice (on-ice impact)

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Experiments

Data:

NHL play-by-play data from the 2007-2008 through 2013-2014 NHL season*

Focus on 2007-2008 and 2008-2009

* As provided by Routley and Schulte

Top 10 – direct impact

Table 3: Top 10 players for 2007-2008 and 2008-2009 for the direct impact.

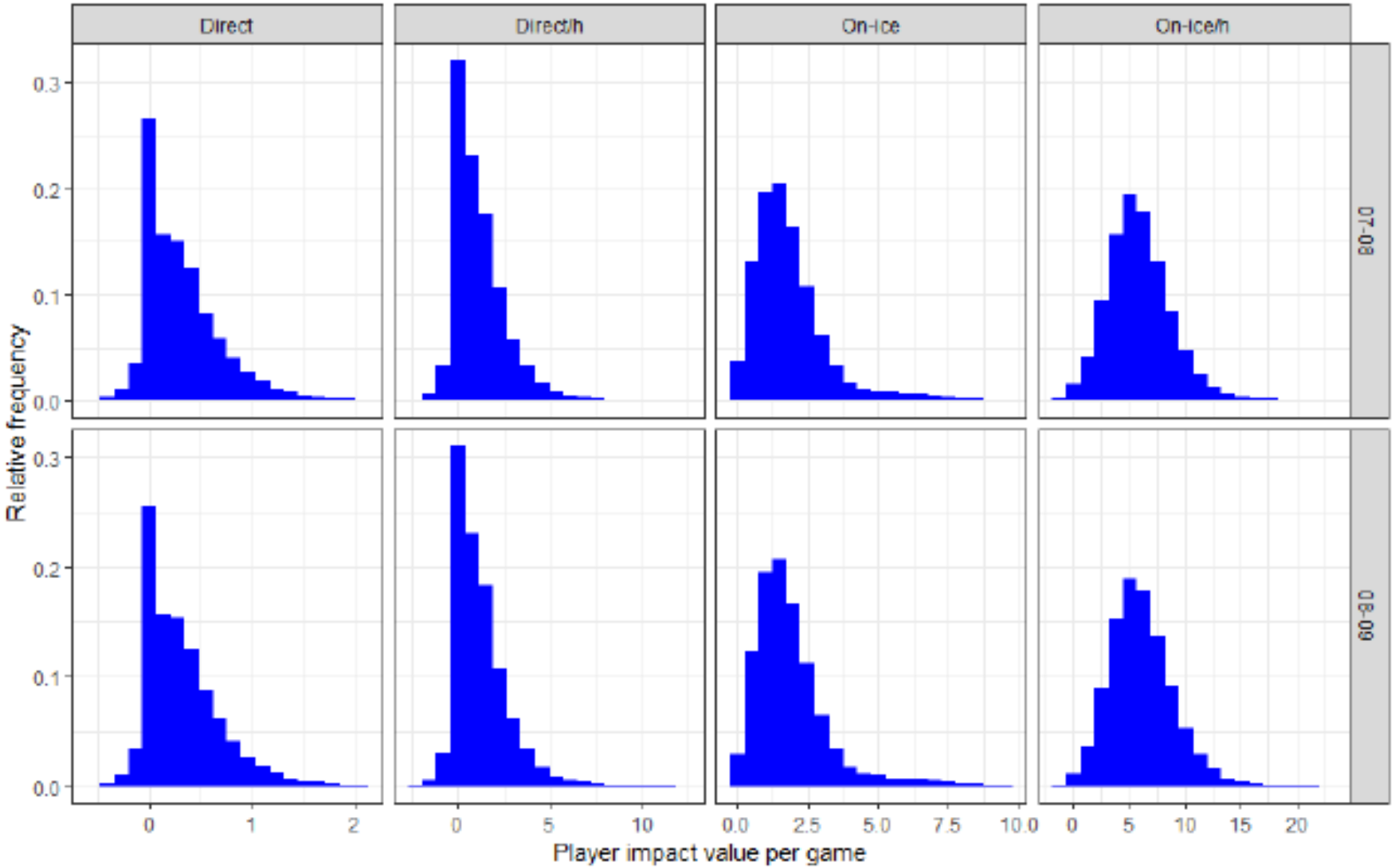
Player Name	Position	Age	Salary	GP	G	A	+/-	Points	Direct	Direct/h	On-ice	On-ice/h
2007-2008												
Alex Ovechkin	F	22	3.83	82	65	47	28	112	71.96	182.65	232.56	588.85
Dion Phaneuf	D	22	0.94	82	17	43	12	60	59.22	134.05	246.12	559.67
Rick Nash	F	23	5.50	80	38	31	3	69	59.01	181.80	158.82	485.99
Jarome Iginla	F	30	7.00	82	50	48	27	98	58.94	161.92	204.12	560.88
Dustin Brown	F	23	1.18	78	33	27	-13	60	53.78	156.41	171.40	501.48
Brenden Morrow	F	28	4.10	82	32	42	23	74	51.15	146.62	171.59	504.57
Zdeno Chara	D	30	7.50	77	17	34	14	51	50.74	117.69	203.78	468.89
Trent Hunter	F	27	1.55	82	12	29	-17	41	50.31	167.65	153.36	508.27
Mike Green	D	22	0.85	82	18	38	6	56	48.26	122.63	219.72	545.08
Pavel Datsyuk	F	29	6.70	82	31	66	41	97	48.22	134.68	198.44	559.41
2008-2009												
Alex Ovechkin	F	23	9.00	79	56	54	8	110	75.93	194.34	239.89	612.23
Dustin Brown	F	24	2.60	80	24	29	-15	53	59.76	177.60	178.34	540.84
Shea Weber	D	23	4.50	81	23	30	1	53	53.14	136.10	201.19	511.36
Evgeni Malkin	F	22	3.83	82	35	78	17	113	50.76	134.92	220.41	591.75
Dion Phaneuf	D	23	7.00	79	11	36	-11	47	50.34	122.64	240.57	532.49
Vincent Lecavalier	F	28	7.17	77	29	38	-9	67	49.46	143.99	188.17	549.37
Sheldon Souray	D	32	6.25	81	23	30	1	53	49.38	125.86	203.08	514.73
Jeff Carter	F	24	4.50	82	46	38	23	84	48.88	141.78	189.35	548.30
Rick Nash	F	24	6.50	78	40	39	11	79	48.88	145.11	171.59	498.26
Martin St. Louis	F	33	5.00	82	30	50	4	80	47.82	135.55	204.19	569.06

Top 10 – on-ice impact

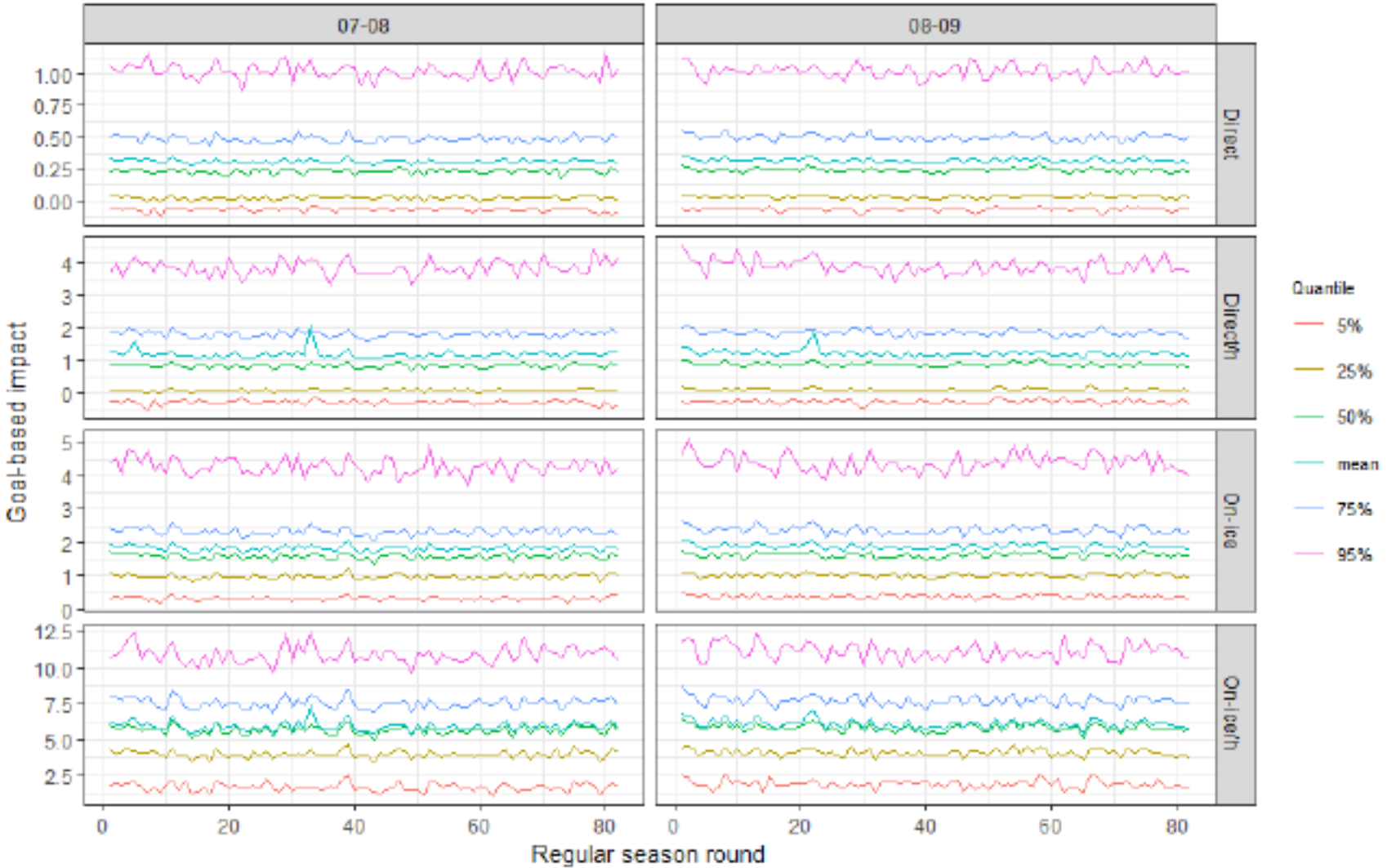
Table 4: Top 10 players for 2007-2008 and 2008-2009 for the on-ice impact (goalkeepers removed).

Player Name	Position	Age	Salary	GP	G	A	+/-	Points	Direct	Direct/h	On-ice	On-ice/h
2007												
Dion Phaneuf	D	22	0.94	82	17	43	12	60	59.22	134.05	246.12	559.67
Alex Ovechkin	F	22	3.83	82	65	47	28	112	71.96	182.65	232.56	588.85
Tomas Kaberle	D	29	4.25	82	8	45	-8	53	38.32	93.36	221.93	551.72
Mike Green	D	22	0.85	82	18	38	6	56	48.26	122.63	219.72	545.08
Andrei Markov	D	29	5.75	82	16	42	1	58	42.37	105.18	213.81	530.37
Nicklas Lidström	D	37	7.60	76	10	60	40	70	29.04	66.41	205.68	480.18
Jarome Iginla	F	30	7.00	82	50	48	27	98	58.94	161.92	204.12	560.88
Zdeno Chara	D	30	7.50	77	17	34	14	51	50.74	117.69	203.78	468.89
Lubomir Visnovsky	D	31	2.05	82	8	33	-18	41	32.64	83.52	201.34	523.00
Roman Hamrlik	D	33	5.50	77	5	21	7	26	37.79	93.89	201.29	509.39
2008												
Dion Phaneuf	D	23	7.00	79	11	36	-11	47	50.34	122.64	240.57	532.49
Alex Ovechkin	F	23	9.00	79	56	54	8	110	75.93	194.34	239.89	612.23
Evgeni Malkin	F	22	3.83	82	35	78	17	113	50.76	134.92	220.41	591.75
Dan Boyle	D	32	6.67	77	16	41	6	57	36.11	88.65	219.94	539.81
Chris Pronger	D	34	6.25	82	11	37	0	48	43.40	99.89	217.92	503.72
Mike Green	D	23	6.00	68	31	42	24	73	46.41	106.62	214.33	493.09
Nicklas Backström	F	21	2.40	82	22	66	16	88	37.12	111.83	214.19	630.43
Braydon Coburn	D	23	1.20	80	7	21	7	28	40.78	100.10	211.64	516.12
Andrei Markov	D	30	5.75	78	12	52	-2	64	38.03	96.17	209.18	527.62
Mark Streit	D	31	4.10	74	16	40	6	56	39.38	97.60	206.59	504.31

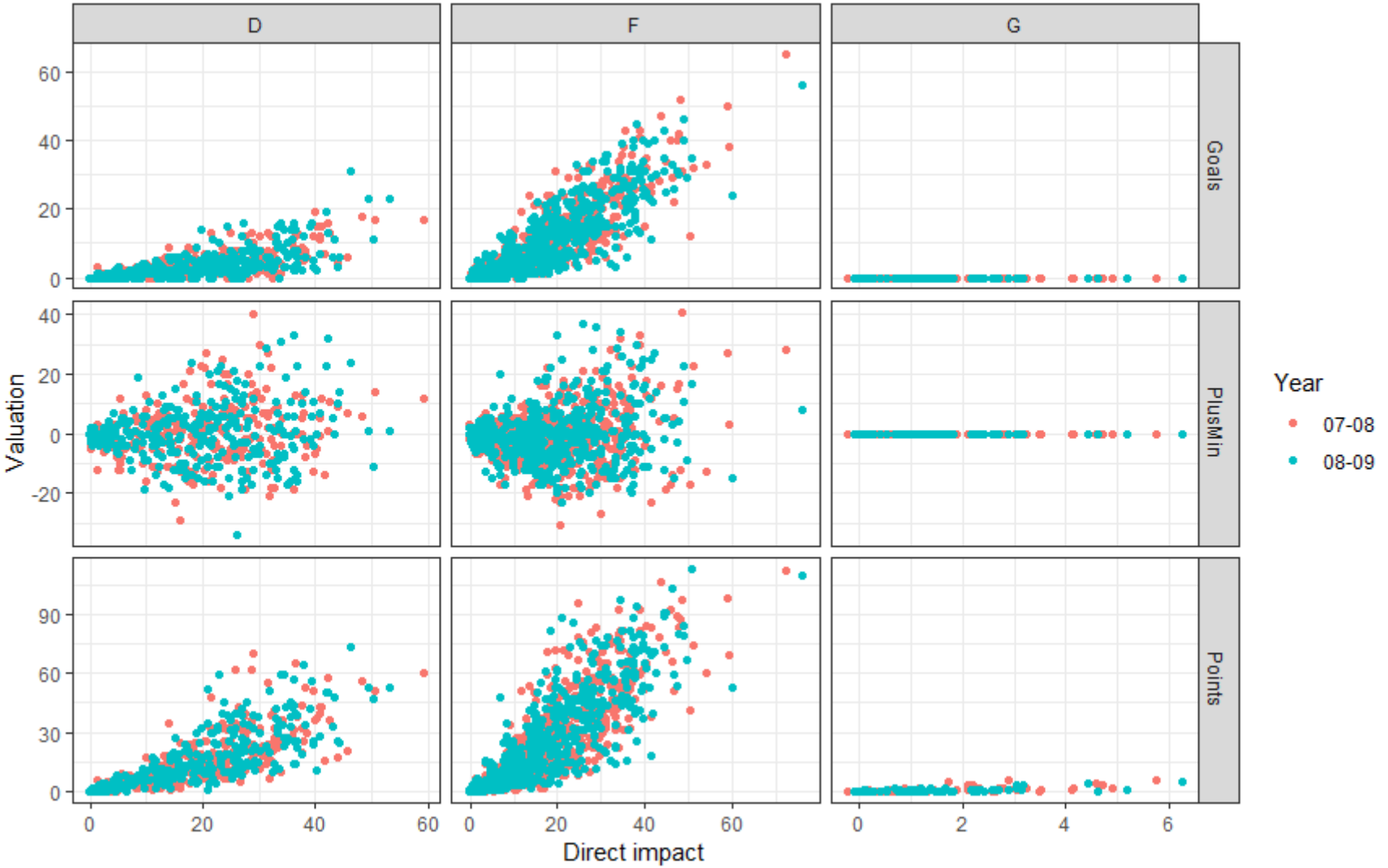
Relative frequencies



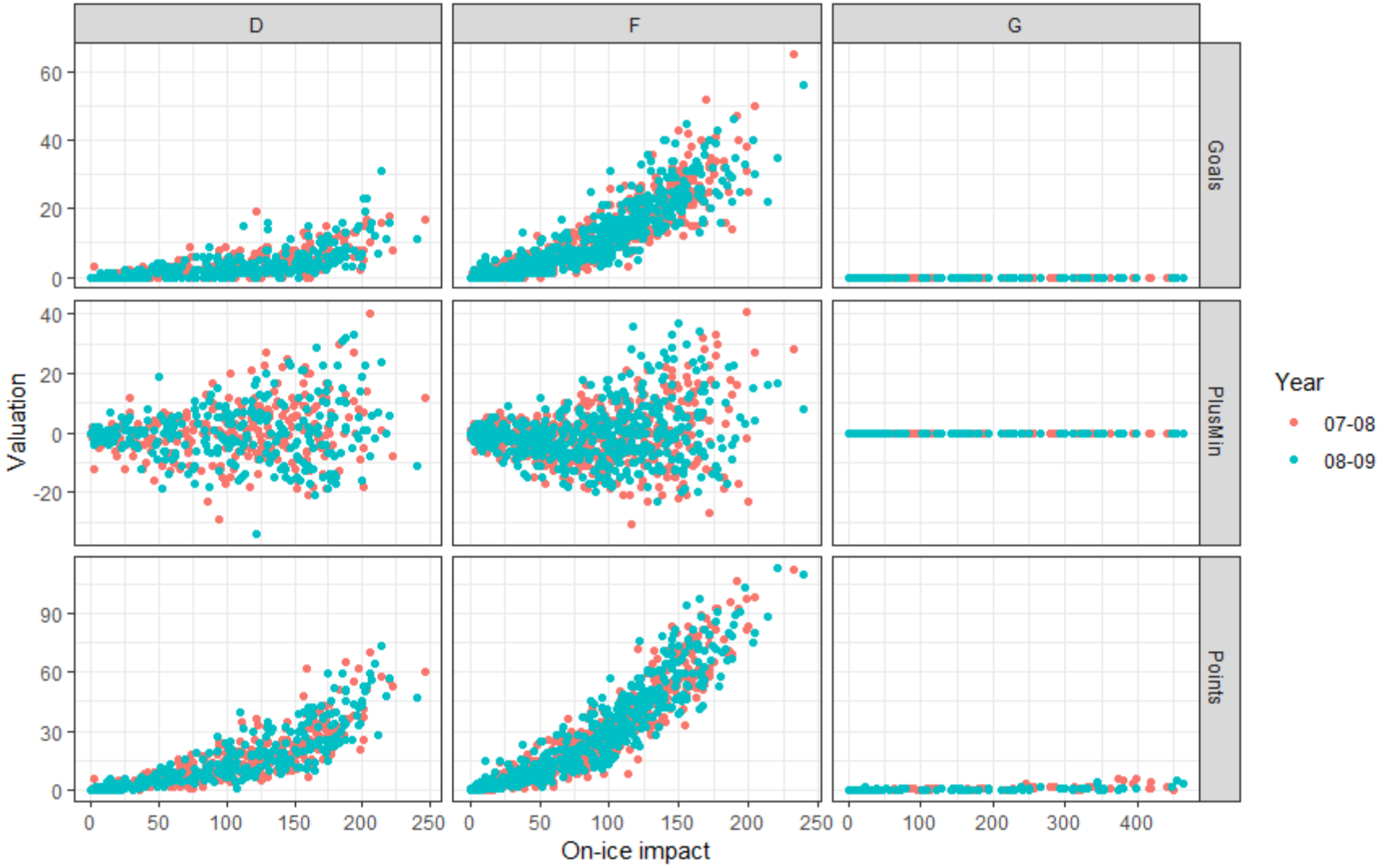
Quantiles


07-08
08-09
Direct
Direct/h
On-ice
On-ice/h
Goal-based impact
Regular season round
Quantile
5%
25%
50%
mean
75%
95%

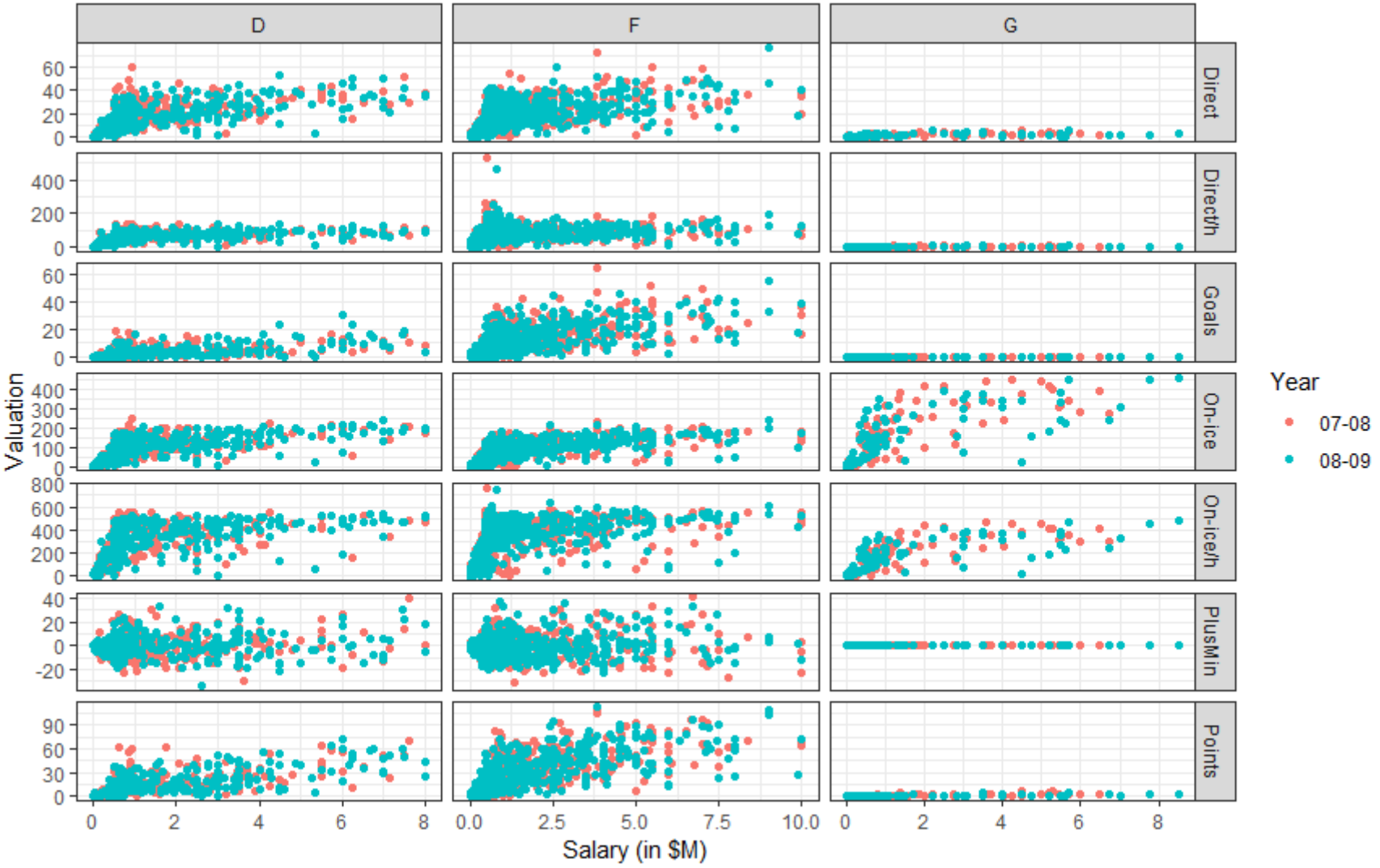
Direct vs goals, +/-, points



On-ice vs goals, +/-, points



Salary vs performance measures



Player pair valuation in ice hockey

MLSA 2018

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Motivation

- Ice hockey is a team sport
  - → important to identify players that play particularly well together (or not).
- On ice: usually two defenders, three forwards, and a goaltender

  pairs:
  - defender pairs are natural
  - more data on forward pairs than triplets
  - mixed pairs not studied

Player Pair Impact

Sum of action impacts when both players are on the ice

- On-ice impact

Experiments

Data:

NHL play-by-play data from the 2007-2008 through 2013-2014 NHL season*

Focus on last two full seasons (2011-2012 and the 2013-2014)

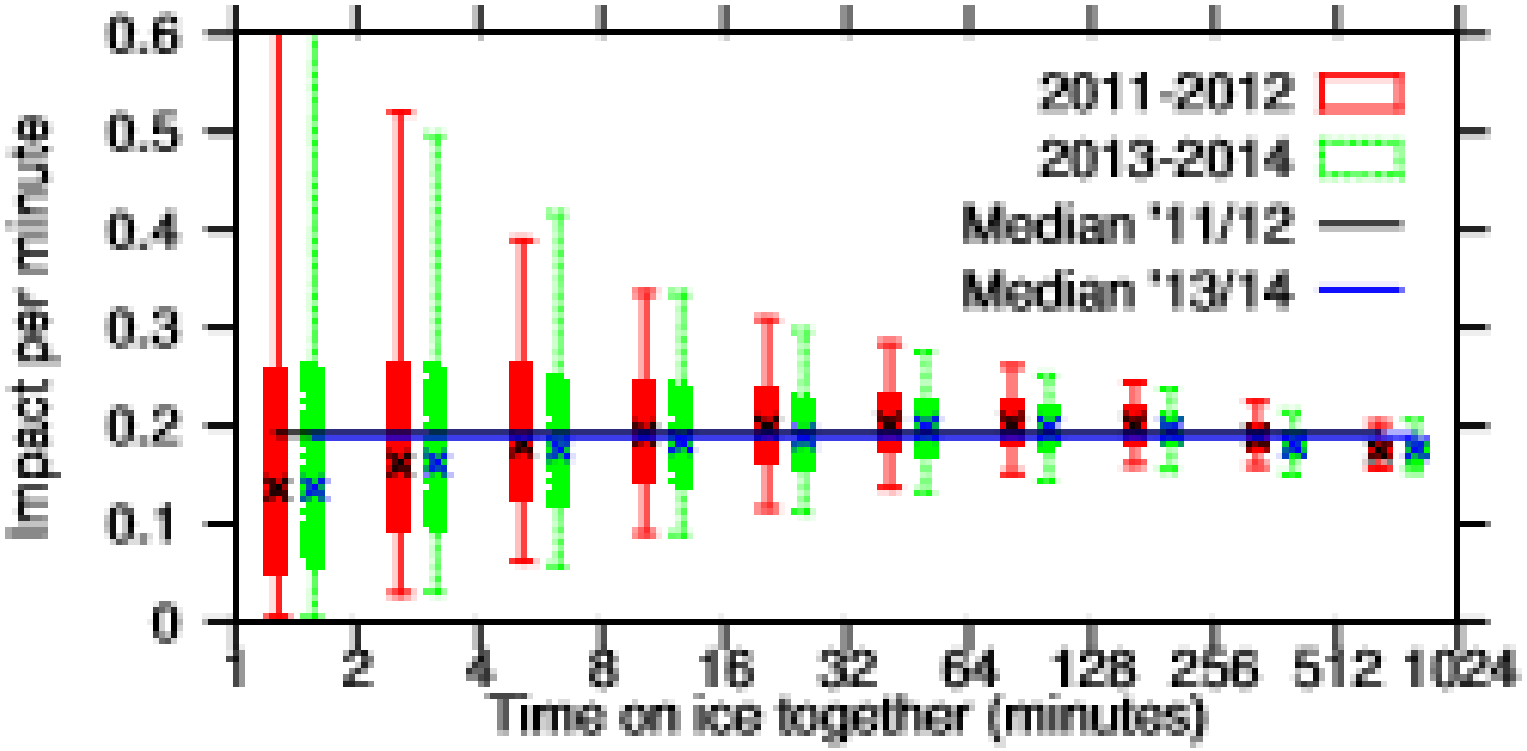
* As provided by Routley and Schulte

Top pairs 2011-2012

Table 3. Top pairs 2011-2012 according to total impact.

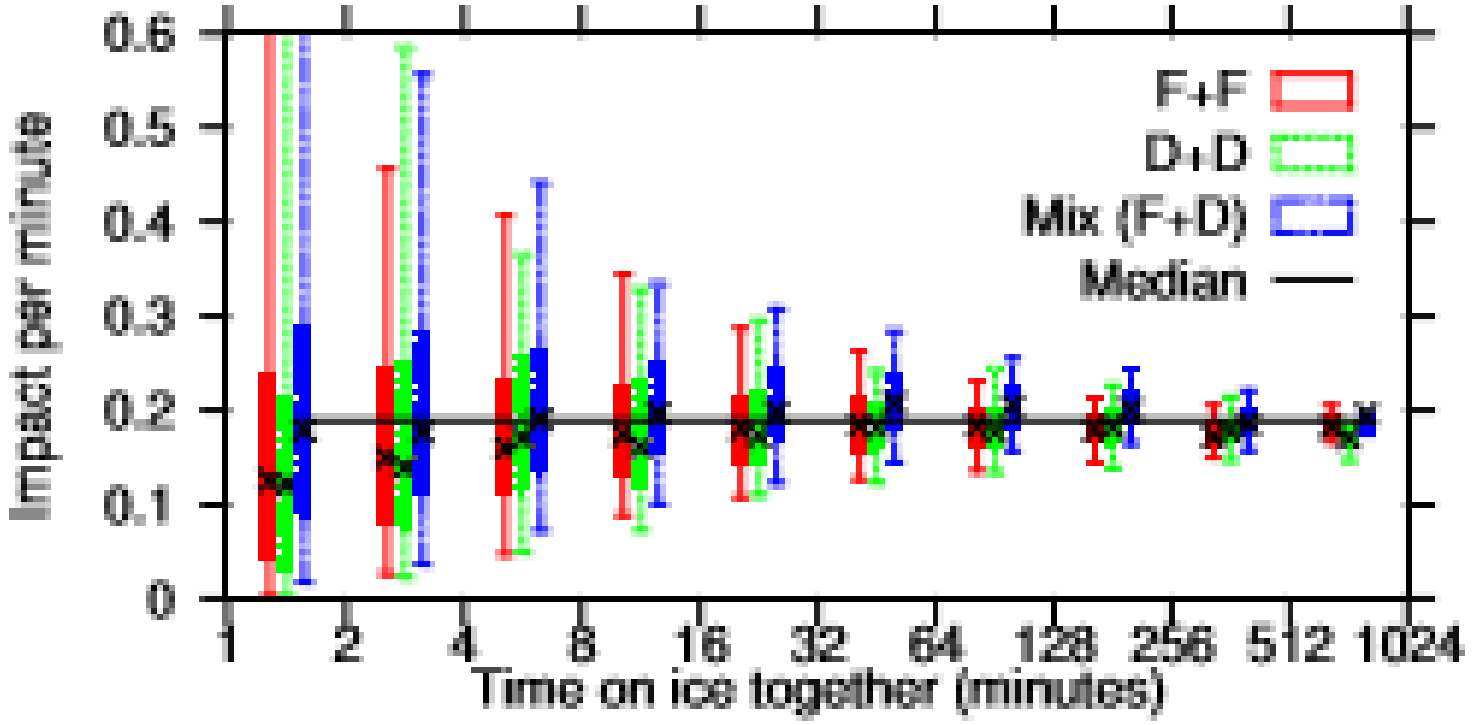
	Player 1					Player 2					Pair stats		
	Name	Pos	G	A	+/-	Name	Pos	G	A	+/-	Team	Impact	TOI
Forwards	Ilya Kovalchuk	R	37	46	-9	Zach Parise	L	31	38	-5	NJD	121.17	40,163
	Ryan O'Reilly	C	18	37	-1	Gabriel Landeskog	L	22	30	+20	COL	115.74	39,021
	Joe Pavelski	C	31	30	+18	Joe Thornton	C	18	59	+17	SJS	112.65	39,353
	Steven Stamkos	C	60	37	+7	Martin St. Louis	R	25	49	-3	TBL	111.77	35,941
	Milan Michalek	L	35	25	+4	Jason Spezza	C	34	50	+11	OTT	111.73	36,689
Defenders	Dan Girardi	D	5	24	+13	Ryan McDonagh	D	7	25	+25	NYR	155.28	55,911
	Filip Kuba	D	6	26	+26	Erik Karlsson	D	19	59	+16	OTT	134.74	47,985
	Francois Beauchemin	D	8	14	-14	Cam Fowler	D	5	24	-28	ANA	125.54	45,795
	Josh Gorges	D	2	14	+14	P.K. Subban	D	7	29	+9	MTL	125.16	44,390
	Carl Gunnarsson	D	4	15	-9	Dion Phaneuf	D	12	32	-10	TOR	123.06	36,181
Mixed	Jason Spezza	C	34	50	+11	Erik Karlsson	D	19	59	+16	OTT	110.58	35,990
	Joe Pavelski	C	31	30	+18	Dan Boyle	D	9	39	+10	SJS	106.04	35,612
	Joe Thornton	C	18	59	+17	Dan Boyle	D	9	39	+10	SJS	102.96	35,160
	Tomas Fleischmann	L	27	34	-7	Brian Campbell	D	4	49	-9	FLA	98.08	31,804
	Stephen Weiss	C	20	27	+5	Brian Campbell	D	4	49	-9	FLA	96.79	32,995

Impact per minute



Variation decreases when more joint TOI
Medians highest in 16-256 minutes joint TOI

Impact per minute



Mixed pairs may have higher impact

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Conclusion

- Investigated ways to define goal-based player impact in ice hockey – direct and on-ice
- Relation to other performance measures
- Extension to pairs of players in ice hockey

- Future work
  - Alternative impact definitions
  - Alternative reward functions
  - More refined analysis