

# Money puck

## Linear Programming and Hockey

Daniel Gemara

April 19, 2017

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# Motivation

- Evaluate individual performance in a team sport.
- See the different factors that go into hockey.

# Factors

*Not everything that can be counted counts, and not everything that counts can be counted.*

*-Albert Einstein*

*"People in both [baseball and the stock market] operate with beliefs and biases. To the extent you can eliminate both and replace them with data, you gain a clear advantage"*

*-Michael Lewis, Moneyball*

# Toronto Maple Leafs Lineup

Forwards		
Left Wingers	Centers	Right Wingers
Zach Hyman	Auston Matthews	William Nylander
Leo Komarov	Nazem Kadri	Connor Brown
James van Riemsdyk	Tyler Bozak	Mitchell Marner
Matt Martin	Brian Boyle	Kasperi Kapanen

Defensemen	
Right Defensemen	Left Defensemen
Morgan Rielly	Matt Hunwick
Jake Gardiner	Roman Polak
Martin Marincin	Connor Carrick

Goalies
Frederik Andersen
Curtis McElhinney

# Example

Video

# Traditional Metrics

Depends on position and style:

- Defensive center
- Offensive defenseman
- Shutdown defenseman
- What should we consider? How do we compare against each other?

## Traditional Metrics

Confusing, often relying on goals and assists for offensive forwards, face-off wins/losses and points for 2-way centers,  $+/-$  for defensemen, which is why we need an encompassing metric to tell a better story.

# New Age Metrics

## Game Score

*Game Score* = *Offense* + *Defense* + *Other*

*Game Score* =

$$0.75G + 0.7A1 + 0.55A2 + 0.075SOG + 0.05BLK + 0.05(CF - CA) + 0.15(GF - GA) - 0.75GA + 0.1SV + 0.15(PD - PT) + 0.01(FOW - FOL)$$

and then converted into “wins added above replacement” depending on position.

## Other Methods

Point shares, WAR, etc.



# What we can do



(a) 2017 All Star Game



(b) Las Vegas  
Golden Knights

# All Star Model

$$\text{Max } z = \sum_{i=1}^n y_i x_i \quad (1)$$

$$x_F = 6 \quad (2)$$

$$x_D = 3 \quad (3)$$

$$x_G = 2 \quad (4)$$

$$\text{Team}(x_i) \geq 1 \quad (5)$$

$$x_i = \text{binary} \quad (6)$$

# R Code

Find the optimal All Star teams using R .

# All Star Teams

Atlantic	Metropolitan	Pacific	Central
<b>Brad Marchand</b>	<u><b>Sidney Crosby</b></u>	<u><b>Connor McDavid</b></u>	<b>Patrick Kane</b>
<b>Nikita Kucherov</b>	<b>Alex Ovechkin</b>	<b>Jeff Carter</b>	Artemi Panarin
David Pastrnak	<b>John Tavares</b>	<b>Joe Pavelski</b>	<b>Vladimir Tarasenko</b>
<b>Auston Matthews</b>	Jeff Skinner	Tanner Pearson	<b>Tyler Seguin</b>
Henrik Zetterberg	<b>Taylor Hall</b>	<b>Ryan Kesler</b>	Blake Wheeler
<b>Vincent Trochek</b>	Mats Zuccarello	Mickael Backlund	<b>Nathan MacKinnon</b>
<b>Victor Hedman</b>	Zach Werenski	<b>Brent Burns</b>	<u>PK Subban</u>
Torey Krug	Kevin Shattenkirk	Dougie Hamilton	<b>Duncan Keith</b>
<b>Erik Karlsson</b>	Shayne Gostisbehere	<b>Drew Doughty</b>	Dustin Byfuglien
<u>Carey Price</u>	<b>Braden Holtby</b>	<b>Mike Smith</b>	<b>Corey Crawford</b>
Robin Lehner	<b>Sergei Bobrovsky</b>	Ryan Miller	<b>Devan Dubnyk</b>

# CapFriendly



# Expansion Draft

$$\text{Max } z = \sum_{i=1}^n y_i x_i$$

Constraints:

$$x_C \geq 4$$

$$\sum x_i = 30$$

$$x_{RW} \geq 4$$

$$\sum x_i c_i \geq 43,800,000$$

$$x_{LW} \geq 4$$

$$\sum x_i c_i \leq 73,000,000$$

$$x_D \geq 9$$

$$\text{Team}(x_i) = 1$$

$$x_G \geq 3$$

$$x_i = \text{binary}$$

# R Code

Find the optimal team under constraints using R.

# Las Vegas Golden Knights Roster

Forwards		
Left Wingers	Centers	Right Wingers
Dustin Brown (LAK)	Sam Gagner (CBJ)	Jakob Silfverberg (ANA)
Jason Zucker (MIN)	Colin Wilson (NSH)	Michael Grabner (NYR)
Adam Lowry (WPG)	Brian Boyle (TOR)	Lee Stemniak (CAR)
Justin Abdelkader (DET)	Lars Eller (WSH)	Matt Read (PHI)

Defensemen	
David Schlemko (SJS)	Trevor Van Riemsdyk (CHI)
Adam McQuaid (BOS)	Cody Franson (BUF)
Jordie Benn (MTL)	Calvin de Haan (NYI)

Goalies
Matt Murray (PIT)
Mike Condon (OTT)



# Results

How is this team projected to do?

# Sensitivity Analysis

**Shadow Price** for a constraint is the amount by which the optimal  $z$ -value is improved if the right-hand side of the constraint is increased by 1.

# Limitations

- Is this what Las Vegas should do?
- Is this realistic?
  - QoC, QoT
- Different objective function

# Conclusion

Thank you very much for listening.

Any questions?