Winning at Daily Fantasy Hockey Using Analytics

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Example Entry

<table>
<thead>
<tr>
<th>POS</th>
<th>PLAYER</th>
<th>OPP</th>
<th>FPPG</th>
<th>SALARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Jussi Jokinen</td>
<td>Fla@Anh</td>
<td>3.1</td>
<td>$5,300</td>
</tr>
<tr>
<td>C</td>
<td>Brandon Sutter</td>
<td>Pit@Van</td>
<td>3.0</td>
<td>$4,400</td>
</tr>
<tr>
<td>W</td>
<td>Nikolaj Ehlers</td>
<td>Wpg@Tor</td>
<td>3.9</td>
<td>$4,800</td>
</tr>
<tr>
<td>W</td>
<td>Daniel Sedin</td>
<td>Pit@Van</td>
<td>3.8</td>
<td>$6,400</td>
</tr>
<tr>
<td>W</td>
<td>Radim Vrbata</td>
<td>Pit@Van</td>
<td>3.4</td>
<td>$5,800</td>
</tr>
<tr>
<td>D</td>
<td>Brian Campbell</td>
<td>Fla@Anh</td>
<td>2.6</td>
<td>$4,100</td>
</tr>
<tr>
<td>D</td>
<td>Morgan Rielly</td>
<td>Wpg@Tor</td>
<td>3.5</td>
<td>$4,200</td>
</tr>
<tr>
<td>G</td>
<td>Corey Crawford P</td>
<td>StL@Chi</td>
<td>6.3</td>
<td>$7,800</td>
</tr>
<tr>
<td>UTIL</td>
<td>Blake Wheeler</td>
<td>Wpg@Tor</td>
<td>4.8</td>
<td>$7,200</td>
</tr>
</tbody>
</table>
100% of the money in the top 20% lineups
26% of the money in the top 10 lineups (0.04%)
Previous Knowledge:
Analytics
Previous Knowledge:
Analytics

#KnightsOfMIP
Building a Lineup
Using this knowledge...
Were we able to do it?


200 lineups
Policy Change
Policy Change

200 lineups -> 100 lineups
Were we able to continue it?

December 12, 2015

100 lineups
Legal Disclaimer:
All profits are in the process of being donated to charity.
Integer Programming Formulation

- We will make a bunch of lineups consisting of 9 players each
- Use an integer programming approach to find these lineups

Decision variables

\[ x_{pl} = \begin{cases} 
1, & \text{if player } p \text{ in lineup } l \\
0, & \text{otherwise} 
\end{cases} \]
First Attempt...
Basic Feasibility

- 9 different players
- Salary less than $50,000

Basic constraints

$$
\sum_{p=1}^{N} c_p x_{pl} \leq 50,000, \quad \text{(budget constraint)}
$$

$$
\sum_{p=1}^{N} x_{pl} = 9, \quad \text{(lineup size constraint)}
$$

$$
x_{pl} \in \{0, 1\}, \quad 1 \leq p \leq N.
$$
Position Feasibility

• Between 2 and 3 centers
• Between 3 and 4 wingers
• Between 2 and 3 defensemen
• 1 goalie

Position constraints

\[ 2 \leq \sum_{p \in C} x_{pl} \leq 3, \quad (\text{center constraint}) \]

\[ 3 \leq \sum_{p \in W} x_{pl} \leq 4, \quad (\text{winger constraint}) \]

\[ 2 \leq \sum_{p \in D} x_{pl} \leq 3, \quad (\text{defensemen constraint}) \]

\[ \sum_{u \in G} x_{pl} = 1 \quad (\text{goalie constraint}) \]
Team Feasibility

- At least 3 different NHL teams

Team constraints

\[
\begin{align*}
t_i & \leq \sum_{p \in T_i} x_{pl}, & \forall i \in \{1, \ldots, N_T\} \\
\sum_{i=1}^{N_T} t_i & \geq 3, \\
t_i & \in \{0, 1\}, & \forall i \in \{1, \ldots, N_T\}.
\end{align*}
\]
First Attempt...

$6400  $7200  $4200  $4100  $5300  $4400  $4800  $5800  $7800

W  UTIL  D  D  C  C  W  W  G

Feasible...
But Not Good

> 3 Different Teams
First Attempt...
Second Attempt...

• Must increase our mean points...
• Solution:

USE EXPERT PREDICTIONS
Prediction Errors

Mean Absolute Error [FPPG]

- Goalie
- Center
- Winger
- Defenseman
- Skaters

Legend:
- Daily Fantasy Nerd
- Rotogrinders
Maximize Points

- Forecasted points for player $p$: $f_p$

- You get to choose what the forecasts are

Points Objective Function

$$\sum_{p=1}^{N} f_p x_{pl}$$
Second Attempt...

Maximize points

$$\max_x \sum_{p=1}^{N} f_p x_{pl}$$
Old Lineup

12 points on average

Feasible...
But Not Good

12 points on average
New Lineup

Projections: 5.4  2.5  3.4  3.0  3.2  4.2  3.5  3.4  5.7
$9500  $2700  $4600  $3800  $4600  $6400  $5200  $5100  $8000
W    UTIL    D    D    C    C    W    W    G

Better...

23 points on average
Second Attempt...
How can we do better?

- Three D’s of Finance:
So what do we do?
By doing this...
Stacking Lineups

• Stacking means putting players on a single lineup that have a positive correlation

• Either the players pop off together -> tons of points

• Or the players crap out -> few points

• We stack using “structural correlations”
Structural Correlations - Teams
Structural Correlations - Lines
Structural Correlations - Lines

• At least 1 complete line (3 players per line)
• At least 2 partial lines (at least 2 players per line)

1 complete line constraint

\[
3v_i \leq \sum_{p \in L_i} x_{pl}, \quad \forall i \in \{1, \ldots, N_L\}
\]

\[
\sum_{i=1}^{N_L} v_i \geq 1
\]

\[
v_i \in \{0, 1\}, \quad \forall i \in \{1, \ldots, N_L\}.
\]

2 partial lines constraint

\[
2w_i \leq \sum_{p \in L_i} x_{pl}, \quad \forall i \in \{1, \ldots, N_L\}
\]

\[
\sum_{i=1}^{N_L} w_i \geq 2
\]

\[
w_i \in \{0, 1\}, \quad \forall i \in \{1, \ldots, N_L\}.
\]
Structural Correlations – Goalie Against Opposing Players
Structural Correlations – Goalie Against Opposing Players

Corr. Coeff. of Goalie-Skater FPPG

Offensive Player
Defencemen

Same Team
Opposing Team
Structural Correlations – Goalie Against Skaters

- No skater against goalie

No skater against goalie constraint

\[ 6x_{pl} + \sum_{q \in \text{Opponents}_p} x_{ql} \leq 6, \quad \forall p \in G \]
Feasible Line

Team Line

Goalie Not Against
Second Attempt...
To Increase Our Chances
Lineup Diversity

• Make sure lineup \( l \) has no more than \( \gamma \) players in common with lineups 1 to \( l-1 \)

\[
\sum_{p=1}^{N} x^*_p k x_{pl} \leq \gamma, \quad k = 1, \ldots, l - 1
\]
To Review...
PERFORMANCE ON REAL CONTESTS
Performance on Real Contests

- Each point is a contest, with profit margin shown
- Used all stacking, a maximum overlap of 7, and 200 lineups
Impact of Stacking

• Used a maximum overlap of 7, and 200 lineups

More stacking is better
Impact of Number of Lineups

More lineups is better
Impact of Lineup Birth Order

- We create lineups sequentially
- Are the best lineups the “oldest” lineups?

**First lineup isn’t usually the best lineup**
Impact of Diversity

More games -> Use more diversity
How can you do it?
Lineup Construction Procedure

• Get projection data
  – Make sure you wait until the starting goalies are announced

• Solve integer program for each lineup one at a time
  – But add in the new diversity constraints for each new lineup
< 30 Minutes
How can you do it?

Download Code from Github:

https://github.com/dscotthunter/Fantasy-Hockey-IP-Code
Performance Time

<table>
<thead>
<tr>
<th>Solver</th>
<th>CBC</th>
<th>GLPK</th>
<th>Gurobi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runtime (minutes)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In the paper...

- Consider several strategies
- Different Integer Programming formulations
- Varying prediction models
- Number of lineups
