ST. LAWRENCE UNIVERSITY

Design weighted Regression Adjusted Plus – Minus (D-WRAP-M) for Evaluation of Player Impact

Seongwon Im Michael Schuckers Brian MacDonald Jesse McNulty

Introduction / Abstract

Background

- Evaluating players usually relies on game statistics. For instance, a better player score and assist more and make a number of intercepts.
- However, misleading method in interactive sports where every member of a team moves simultaneously and interact frequently.
- Generally, resolved by Plus-Minus: assign +1/0/-1 to represent players during each play.

Goal

- Extend the idea of Plus – Minus by assigning different values for two-way THoR design matrix according to the location of the events and the positions of the players.
- Allow forward players more impact in offensive zone as well as allowing defence players more impact in defensive zone.
- Take THoR(NP20) and Fenwick(1/-1) as responses
- Use ridge regression and alter lambda values to increase the accuracy and estimate model parameters.
- Consider the performance via mean squared error($\hat{\sigma}_\varepsilon$), Predicted Root Squared Error($\tilde{\sigma}_\varepsilon$), and the correlation between players' coefficients.

Plus – Minus (RAPM)

- Plus – Minus constructs a model according to player's presence.
- RAPM was first publicly introduced by Rosenbaum for basketball though he suggests that Sagarin and Winston had already developed a similar system. Rosenbaum used a formulation where a single parameter is used to assess the impact of a player.

$$x_{ij} = \begin{cases} -1, & \text{if player } j \text{ is on the ice for the Away team for event } i \\ 0, & \text{if player j is not on the ice for event } i, \text{and} \\ +1, & \text{if player } j \text{ is on the ice for the Home team for event } i \end{cases}$$

$$Response = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_K x_K + x_{i1} + \dots + x_{iK} + e$$

where b_k indicates the impact of player k $\in \{1, \dots K\}$ and X_k indicates the presence of player k.

Method to Assess the Model

1. **Root Mean Squared Error:** $\hat{\sigma}_e$
   - Construct D-WRAP-M model.
   - With the model, assess prediction accuracy of the response within sample.
2. **Predicted Root Mean Squared Error:** $\tilde{\sigma}_e$
   - Split the season into half: The first and second half.
   - Construct D-WRAP-M model with the first half.
   - Apply the model to the second half to predict the response out-of-sample.
3. **Correlation of players' coefficients throughout Seasons**.
   - Construct D-WRAP-M model and compute the players' coefficients
   - Check the correlation of players' evaluation between Year T and Year $T+1$ to see if the model is consistent throughout the seasons. ($T = \{2013, 2014, 2015, 2016, 2017\}$

Design weighted Regression Adjusted Plus – Minus (D-WRAP-M)

Extending the idea for Plus – Minus, we manipulate what is assigned to players according to their positions and the location of the events. As given below, we change -1/0/+1 to signed measure of distance from an event. We assess the model with different combinations of a and b to find the best fitting model.

$$g_{ij} = \begin{cases} \gamma_{ij} = a, & \text{if player } i \text{ of } T_i = Off \text{ is on the home team, on the ice for event } j \text{ and } S_j = T_i \\ \gamma_{ij} = (5 - 2b)/3, & \text{if player } i \text{ of } T_i = Off \text{ is on the home team, on the ice for event } j \text{ and } S_j \neq T_i \\ 0, & \text{if player } i \text{ is not on the ice for event } j \\ \gamma_{ij} = b, & \text{if player } i \text{ of } T_i = Def \text{ is on the home team, on the ice for event } j \text{ and } S_j = T_i \\ \gamma_{ij} = (5 - 3a)/2, & \text{if player } i \text{ of } T_i = Def \text{ is on the home team, on the ice for event } j \text{ and } S_j \neq T_i \end{cases}$$

$$Response = b_0 + b_1 g_1 + b_2 g_2 + \dots + b_K g_K + g_{i1} + \dots + g_{iK} + e$$

where b_k indicates the effect of player k and g_k indicates the presence as well as the weighted performance of player k. T_i indicates the position of a player i and S_j indicates the location of an event j. Small weighted value of g indicates greater impact.

Model Building Factors (Other / Covariates)

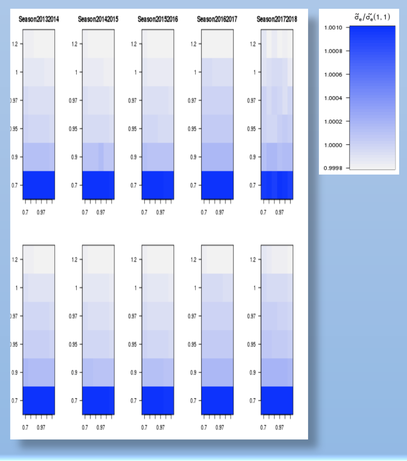
- The model also includes Home ice effect, rink, goalies, where a shift starts, score differential, score differential in the 3rd period
- Players are not weighted when the event is in neutral zone
- Responses considered: Indicator of Unblocked Shot Attempted (Fenwick), Net Goal Probability (THoR)
- Values considered: a, b ∈ {0.7, 0.9, 0.95, 0.97, 1, 1.2}
- Seasons: 2013-2014 to 2017-2018
  (1230+ games each season, 200,000 plays at even strength, 1000 players)
- Shrinkage Lambda Value considered: λ – 400, 600

Assessments

Root Mean Squared Error

THoR

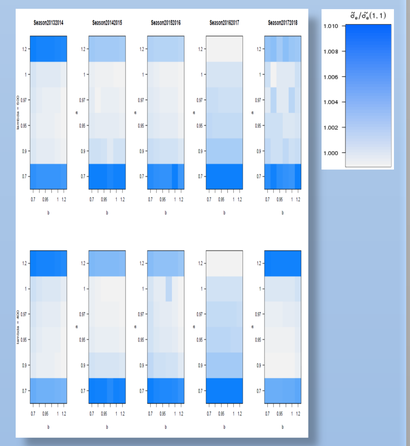
Fenwick



Predicted Root Mean Squared Error

THoR

Fenwick



Correlation between Players

- As for THoR, the correlations between players vary from 0.1 to 0.4.
- The difference of correlation between the original RAPM and D-WRAP-M is less than 0.1.
- As for Fenwick, the correlations between players vary from 0.4 to 0.6.
- The difference of correlation between the original RAPM and D-WRAP-M is less than 0.05
- Assigning a and b values did not have much impact on the correlation.

Conclusion

- Assigning a and b did not show any improvement in outcome compared to original Plus – Minus.
  - The ratio of Root Mean Squared Error between original RAPM and D-WRAP-M is extremely close to 1, which indicates that there is no significant difference.
  - Similarly, the ratio of Predicted Root Mean Squared Error is close to 1, again showing not much improvement.
  - Lastly, the slight shift of correlation between players shows the same result.
- The original plus – minus performs as well as D-WRAP-M.
- Worth considering applying to other sports such as soccer and football.
- Tracking data may allow for better value of g_{ik} and yield better performance.

References

Engelman, J. (2015). Estimating a player's influence on his teammates' boxscore statistics using a modified rapm framework.https://www.youtube.com/watch?v=OuC0YZTADcE. Accessed April 18, 2018.

Engelman, J. (2017). Possession-based player performance analysis in basketball (adjusted +/- and related concepts). In Albert, J., Glickman, M. E., Swartz, T. B., and Koning, R. H., editors, Handbook of Statistical Methods and Analyses in Sports. Chapman and Hall/CRC.

Ilardi, S. (2007). Adjusted plus-minus: An idea whose time has come. http://www.82games.com/ilardi1.htm. Accessed April 18, 2018.

Ilardi, S. and Barzilai, A. (2007). Adjusted plus-minus ratings: New and improved for 2007-2008. http: //www.82games.com/ilardi2.htm. Accessed April 18, 2018.

Kasan, S. (2008). Off-ice officials are a fourth team at every game. http://www.nhl.com/ice/news.htm?id= 388400. Accessed September 24,2013.

Macdonald, B. (2011). A regression-based adjusted plus-minus statistic for nhl players. Journal of Quantitative Analysis in Sports, 7.

Macdonald, B., Lennon, C., and Sturdivant, R. (2012). Evaluating nhl goalies, skaters, and teams using weighted shots. http://arxiv.org/abs/1205.1746. Accessed October 24, 2015.

Rosenbaum, D. T. (2004). Measuring how nba players help their teams win. http://www.82games.com/ comm30.htm. Accessed April 18, 2018.

Schuckers, M. and Curro, J. (2013). Total Hockey Rating (THoR): A comprehensive statistical rating of National Hockey League forwards and defensemen based upon all on-ice events. Proceedings of the 2013 MIT Sloan Sports Analytics Conference http://www.statsportsconsulting.com/thor.

Sill, J. (2010). Improved nba adjusted +/- using regularization and out-of- sample testing. 2010 MIT Sloan Sports Analytics Conference.