Cincinnati Reds Hackathon 2024 Submission

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Major League pitchers encounter various scenarios when thrown into a game, each with varying success. For example, one pitcher may perform best in a “closing” scenario (short-length, high risk), while another pitcher can be best in a “starting” role (long-length, low risk). Our analysis primarily focuses on the idea that pitchers can be thrown into a range of scenarios from low to high leverage at any moment of the game, and they have a certain amount of value in a given role based on how they perform in those moments.

Rather than defining pitchers by traditional roles like closer, set-up man, or swingman we decided to take the approach that a pitcher’s role should be defined as how long (or how many pitches/batters) a pitcher faces and the success in opportunities of varying leverage.

Fangraphs provides multiple leverage indexes, however none of them encapsulate a greater multitude of factors that we consider valuable to a leverage index given the availability of more data. When determining the leverage of a scenario we came up with three main factors that should be considered when creating a leverage index.

1. Game Situation
2. Team Standing
3. Atmosphere

Specifically, aspects of the game situation would include inning, outs, runners on base, score differential, batter strength, opportunities remaining and even pitch count. Team standing would factor in the status of the team relative to the season as a whole. For example, a team fighting for a playoff spot in late September would have a higher leverage index than a team who just sold away their core players at the deadline, sitting at the bottom of their division. Lastly, and most self-explanatory is the atmosphere of the game. An environment where a stadium is filled, yelling at the top of their lungs for their favorite closer to shut out their biggest rivals would obviously add pressure to the situation, so data such as noise levels or whether or not a game is on primetime should be incorporated.

Just as Einstein had many theories which were proven to be true decades later, so do we have a theory!

Pitchers should be valued based on their ability to enter a game given the **leverage of the game at that moment** and **how the pitcher succeeded in said moment**. A manager/coach can then use the given leverage scenario in a game to determine which pitchers should warm up and be put into the game.

Also, just like Einstein, we were unable to compute our theory successfully given our access to equations, data, and current statistical analysis abilities.

Our process would be first defining short relief and long relief pitchers (this can also be split into more than just two buckets). The two buckets are defined as having faced less than 4.5 batters and having faced greater than 4.5 batters in an appearance (roughly 4.5 batters were faced

per relief pitcher appearance 2021-2023). Then, defining high leverage from low leverage instances can be determined given the calculated leverage index (which we were unable to do given our statistical background and limited time).

A key source we evaluated was Tom M. Tango's *Leverage Index* concept, outlined in his sabermetrics writings. Tango in fact provided a chart (Table A) detailing his calculated leverage index for every possible situation in a 9-inning game. Initially thinking this was our perfect solution after reading up on his research, we tried reverse-engineering and condensing code down from 4,700+ lines to implement the values in our dataset. However, in the end we were unable to do so. Additionally, we have our qualms with the missing variables other than inning, outs, and run differential, and runners on base in his quantification. We would want to incorporate the variables listed above when computing a leverage index.

Table A

Top of Inning 9										
1 2 3	Outs	-4	-3	-2	-1	00	+1	+2	+3	+4
_ _ _	0	0.1	0.2	0.3	0.7	2.4	2.9	1.6	0.8	0.4
1 _ _	0	0.1	0.2	0.5	1.1	3.4	4.6	2.9	1.6	0.8
_ 2 _	0	0.1	0.2	0.4	0.8	2.6	3.7	2.7	1.5	0.8
_ _ 3	0	0.1	0.2	0.3	0.7	2.3	3.1	2.9	1.6	0.8
1 2 _	0	0.1	0.3	0.6	1.2	3.6	5.3	4.4	2.9	1.6
1 _ 3	0	0.1	0.2	0.4	0.8	2.3	4.2	4.6	3.0	1.7
_ 2 3	0	0.1	0.2	0.4	0.8	2.4	4.0	4.0	2.9	1.6
1 2 3	0	0.1	0.2	0.5	1.0	2.9	5.2	5.7	4.6	3.1
_ _ _	1	0.1	0.1	0.3	0.6	1.9	2.2	1.0	0.5	0.2
1 _ _	1	0.1	0.2	0.5	1.0	3.1	3.9	2.2	1.0	0.4
_ 2 _	1	0.1	0.2	0.5	1.0	3.3	4.0	2.2	1.0	0.5
_ _ 3	1	0.1	0.3	0.6	1.2	4.3	4.4	2.3	1.1	0.5
1 2 _	1	0.1	0.3	0.7	1.4	4.6	6.1	4.0	2.3	1.1
1 _ 3	1	0.1	0.3	0.7	1.5	5.0	5.7	4.0	2.3	1.1
_ 2 3	1	0.1	0.3	0.6	1.2	3.9	4.6	3.9	2.3	1.1
1 2 3	1	0.2	0.4	0.8	1.8	5.7	7.3	6.2	4.2	2.4

Data

MLB pitch by pitch data including the leverage index variable.

- Leverage Index: Theoretically a form of linear weights that weights given variables/scenarios with respect to the importance of the game and possibly the current WPA or RE given the scenario in the game.

Next Steps

1. To identify **characteristics** of pitchers that lead to their success in specific roles,
    a. Run an OLS model
        i. Independent Variable: Change in leverage index from beginning of pitching appearance to end of appearance
        ii. Dependent Variables: Game situation variables like those listed above; variables can/should also be figured out while in the OLS modeling phase

Run this model to find which characteristics best predict

Ex: short relief-high leverage success

Ex: short relief-low leverage success

Given the bucket (short vs long appearance and high vs low leverage) of the dataset being used.

2. To identify which **MLB pitchers** who could be better off in a different role
    a. Model which pitchers best fit the characteristics of success from the previous OLS model in a certain pitching role (**Still learning which type of model to perform this type of test)**
    b. Given the bucket of the dataset, find the pitchers who most successfully minimized negative leverage from the start of the appearance to the end of the appearance. (Pitchers who decreased the leverage of the game in favor of their team had a successful appearance).

Additionally, WPA can be looked at in the realm that we mention above with leverage, as a pitcher who increases their teams WPA from the beginning of their pitching appearance to the end of their pitching appearance have pitched successfully.

Overall, we believe that while unrefined, our project has the potential to be a legitimate indicator of where a pitcher could be used. Comparing pitchers group to group, as opposed to every pitcher in one giant pool, combined with the Leverage Index concept, is the key to solving this tough question, and it is more than doable. Quantifying information that is generally qualitative, such as success in leverage situations is no easy task, but we believe our theory is worthwhile. We have full intentions of finishing what we started, Hackathon or not.

Index

Tango, Tom M. “Crucial Situations Leverage Index”. Date Accessed February 5, 2024. http://www.insidethebook.com/li.shtml