Case Study: How Misinterpreting Probabilities Can Cost You the Game

Kurt W. Rotthoff*
Seton Hall University
Stillman School of Business

Abstract:

Using data to make future decisions can increase the odds of success in many aspects of life, however, using the data incorrectly can be worse than not using any data at all. In this study, I present a case where a collegiate football coach attempted to use data to enhance the chances of success. In fact, because of his misinterpretation the dependence (or independence) of odds across his play-calling, his play-calling was not only sub-optimal but was detrimental to his team. This case study is designed as a way to clarify this common mistake our students make when interpreting data.

* Kurt Rotthoff at: Kurt.Rotthoff@shu.edu or Rotthoff@gmail.com, Seton Hall University, JH 674, 400 South Orange Ave, South Orange, NJ 07079 (phone 973.761.9102, fax 973.761.9217). A special thanks to Rey Hernandez and Todd McFall for helpful comments. Any mistakes are my own.

I. Introduction

In statistics and econometrics, we teach our students about sequences of random variables with each event having a given probabilities of occurring. In events that are mutually exclusive, it is possible that the odds of each event occurring can be either dependent or independent. For a dependent event, one event occurs and impacts the likelihood of another event occurring. Whereas independent events are two different events in which the prior event has no impact on the probability on the second event occurring. These two expectations in probability are often misinterpreted. As an example in football: a trick play (which, once called, decreases the odds it will work again – dependent) or a slant route (which does not change the odds of it working again later in the game – independent).

The separation of dependent and independent events is often hard for our students to remember, much less apply. This case study looks at a major college football program's coach's play calling throughout a game.[1] Specifically, this team's offensive coordinator was argued to consistently misinterpret the use of dependent and independent observations. After analyzing how often a play worked in past games, for example if the screen pass worked on average eight of twelve times per game, he would then use that information in his play calling in upcoming games. Which, in general, is a good strategy: using data for play calling increases the odds that you will call good plays. However, misusing this data can be detrimental to its effectiveness, as I argue it was for this particular team.

If plays are independent, then the expectation is that this type of play will work 67% (8/12) of the time. However, if plays are dependent, the calling of this particular play directly impacts the odds of the next play working. Given that this play worked eight out of twelve times

[1] This case study is designed as a learning note for professionals and students. It is not designed to question the coach's career or his professional activities. Thus, I will not name the coach or his school to protect his anonymity.

in the past, this coach would think (incorrectly) that it would only work a max of eight times per game. Thus, if it worked during the first eight attempts, he would never call the play again (claiming the good plays have been "used up"). In the next section, I focus on independent vs. dependent probabilities. I then discuss the case in college football, followed by a conclusion.

II. Independent vs. Dependent Probabilities

The interpretation of dependent events is that when one event occurs, it has an impact on the probability of other events occurring. When you pick the queen of hearts from a deck of cards, this impacts the odds of picking it again from that deck (the odds are zero) and decreases the odds the next card is red. Likewise, when you learn from each attempt to bake brownies correctly, the odds of you cooking brownies correctly increases in subsequent attempts.

Independent events are when one event occurring has no impact the odds of any other event occurring. This can be thought of as a coin flip. When you flip the coin once, it does not impact the odds of getting heads or tails during your next flip. Rolling a die is also independent; if you roll a given number one time it has no impact on what you will roll the next time.

A misinterpretation of this independent vs. dependent events can be thought through a coin flipping example: We all know that the odds of flipping a coin yields a 50% chance of heads and a 50% chance of tales. When we flip a coin ten times, in expected terms we expect to get five heads and five tails. Misinterpreting this would come if you plan to flip the coin ten times – then when it comes up heads five of the first six flips, saying that this will then guarantee the last four flips are tails (which is clearly not possible).

III. The Case of Coaching Football

College football coaches have a strong desire to win, which comes through efficient play calling. This is driven by the fact that they make large sums of money, primarily to win games against other collegiate teams. In 2015, 71 coaches made more than one million dollars per year.[2] This case study is designed around a specific coach's play calling decisions for a power five conference school, the biggest football schools in the nation. Although the school will not be mentioned, it is rumored that the offensive coordinator at this school misused statistical analysis throughout his career – which lasted 13 years at this school and was successful, for at least a period of time, as they won many games and a conference championship. However, this coach would have been even more successful if he was not making these simple statistical mistakes.[3]

Most play calling in sports would be considered independent, with a few caveats. Calling the same play multiple times or, at the extreme, only calling one play over-and-over throughout an entire game could (would) make the play no longer independent. Also, trick plays are often not considered independent (because once a trick play is tried, it is no longer tricky; thus the other team can watch for that type of play). But an overwhelming majority of plays called throughout a game are independent. The largest factor driving the odds a play will work are things like the type of defense a team faces (i.e. zone vs. man-to-man). However, these odds of a play working are defense dependent, not previous play dependent.

This coach, after analyzing how often a play worked in past games would calculate each play's odds of working. For example, if the screen pass worked on average eight of twelve times per game, he would then use that information in his play calling in upcoming games – which is a good strategy for any professional career, assuming you are doing it correctly. Instead of

[2] See USA Today's college football coaches salary database: http://sports.usatoday.com/ncaa/salaries/.
[3] Ironically, he was an economics major.

thinking it would work 67% of the time the play is called (an independent odds condition), he thought it would only work eight times per game (a dependent odds condition). Thus, if the play worked the first eight times it was called, he would never call the play again (claiming he "used up" all the successful attempts for that game, as if he had drawn all 13 hearts out of a deck of cards).

This is a complete misunderstanding of how the observations are related. He should have thought of these plays as independent. Each play in this example is expected to work 67% of the time, independent of how many times it worked immediately before that.

On top of that, if there is some form of dependence between play calling throughout a game, that would actually mean this coach should have been doing the opposite of what he was doing. If it worked the first eight times, then the odds of that particular play working in a given game are actually higher than the baseline, not lower, and he should call it more often, not stop calling the play. When using dependence and independence correctly, this means you would continue to call the plays that are working when your team is leading after three-quarters. If you are misusing this information, you stop using the plays that are working when leading after three-quarters – increasing the odds that you lose the game in the fourth quarter.

IV. Conclusions

Throughout a career, using data to make decisions is valuable. This is why we spend a large amount of time teaching our students how to use data correctly. But this is only value enhancing if the data is used correctly. This coach was using plays that are independent odds events, not dependent odds events. When acting like events are dependent, when they are

actually not, not only causes you to make the wrong decisions but causes non-optional play calling (with the possibility of calling plays in a detrimental way).