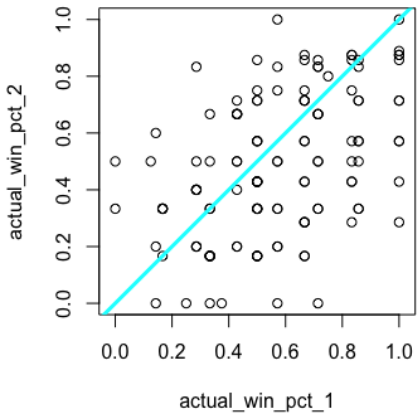
How can we best evaluate team strengths with limited data? Across all sports, ranking and evaluating teams is always a point of contention. Nowhere is this more apparent than in college football, where the entire postseason format is decided subjectively by the CFP committee. Every year, the Playoff selections spark heated debate amongst fans who believe their team is deserving of a spot. One modern method available to compare teams is the Pythagorean Formula.

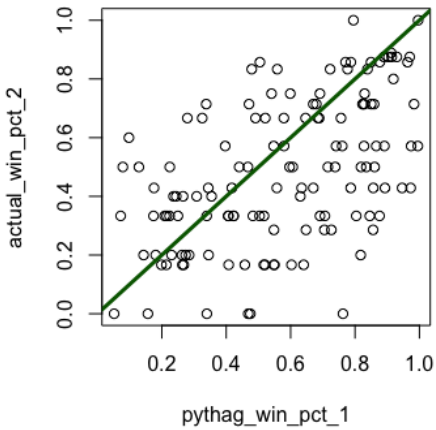
As opposed to simply looking at raw win-loss record, the Pythagorean Formula estimates team performance by the calculation: ((Points Scored^alpha) / (Points Scored^alpha + Points Allowed^alpha)), where alpha varies from sport to sport and even league to league. For the purposes of this assignment, I chose to calculate the "best" value of alpha for college football in the 2023-24 season. The dataset I used, taken from sports-reference (https://www.sports-reference.com/cfb/years/2023-schedule.html) contained every game throughout the season for all FBS teams.

In order to choose the best value of alpha, I "plugged in" all values from 0 to 10 (counting by 0.1), and chose the one which minimized the mean squared error between actual win percentage and my computed pythagorean win percentage. The value I found that minimized this error and thus optimized my Pythagorean estimate was **3.1.**

Once I had the best Pythagorean coefficient for the data, I explored the relationship between Pythagorean expectation and actual win percentages. To do this, I separated the data into two halves, at the week 8 mark of the college football season. I filtered out FCS teams from the data as some of them had no games in the second half in my data, or vice versa. I first examined the relationship between first and second half actual win percentages, to see if most teams stayed consistent throughout the season or if their performance changed over time. I found the correlation between first and second half win percentage to be around **0.456,** a moderate positive correlation suggesting, on average, teams' win percentage in the second half increases as their first half win percentage increases. The relationship is plotted to the left, with the line y=x as reference. The graph shows that this is not a perfect relationship, as many teams still over or under-perform their win percentage from one half to the next.

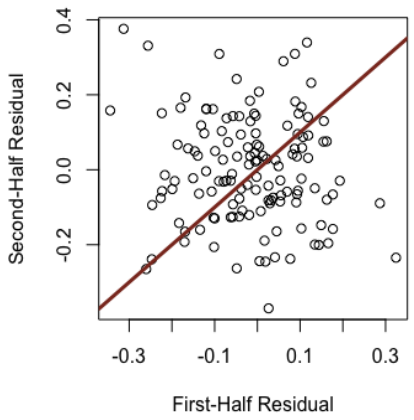


To see whether the Pythagorean estimates were more effective in predicting future success, I calculated the correlation between first-half Pythagorean estimates and second-half actual win percentage and found it to be around **0.522,** a slight improvement over the previous correlation between actual win percentages for both. As



can be seen in the plot to the right (again with the line y=x as reference), the Pythagorean estimate seems to predict second-half win percentage slightly better, although more teams seem to underperform their first-half Pythagorean in the second half than vice-versa.

But is out-performing your Pythagorean expectation a team skill in itself? Oftentimes in sports, there is this notion of "clutchness," or that certain players/teams elevate themselves in big moments, therefore being more likely to win in close games down the stretch. In order to examine whether this theory held true for college football, I took a look at residuals, or the difference between actual win percentage and Pythagorean estimate. Teams with positive residuals outperformed what was "expected" of them, and vice versa. I then measured the correlation between first-half residuals and second-half residuals to see if a pattern emerged. I found the correlation to be about **-0.105**, indicating a very weak negative relationship between the two. This suggests that over-or-underperforming your Pythagorean expectation contains a lot of noise, and you cannot reasonably expect a team to outperform it for an entire season. The plot to the left shows the extreme variance in the residuals from team to team and half to half (again, with y=x for reference).



How can we best interpret these numbers? Predicting second-half performance in college football is always difficult, as teams mostly play out-of-conference games in the first half, whereas the second half schedule is packed with conference foes that are normally higher in talent-level. When compared to the NFL example in class, the predictive power of the Pythagorean Formula isn't as much of an improvement over actual win percentage, perhaps because there are so many lopsided matchups in the first half of the CFB season. However, the Pythagorean estimate remains an improvement and should be used as a (relatively) unbiased estimate of a given team's true strength. The Playoff Committee would do well to consider point differential more strongly when selecting the top 4 teams at the end of the season, as the theory of the "clutch" team may just be a myth. Fans should also make note that point differential is important, and a team who wins by a landslide over an inferior opponent may not just be "running up the score," but truly elite. However, like any attempt at modeling reality, the Pythagorean estimate has its flaws and should not be taken as a be-all end-all. While it did outperform the raw win percentage in predictive power, it was only a slight difference and could be subject to noise from season to season. For example, the formula has no way to account for injuries and potential "sleeping giants" who have a key player go out for a stretch in the first half could very easily outperform the estimate drastically in the second. College football is an incredibly dynamic sport, and part of the reason the committee gets paid the big bucks is to sort through all of these metrics and pick the true 4 best teams.