



MOMENTUM OF THE ATHLETE

Using momentum to predict the direction of a game



1.What is an athlete's momentum?

In sports, many athletes feel that they have momentum, a magical fluctuation, and that the situation may proceed with this fluctuation during the course of the game. In physics, momentum is a physical quantity that describes the state of motion of an object and is related to both the mass and speed of the object. ¹In fact, in many match events, "momentum" is implicitly determining the direction of the match. Momentum is also used in a number of sports. ²Therefore, our team investigated a comprehensive G1-Entropy-Independence evaluation method to quantify the momentum of athletes by studying and analysing a large amount of data.



Figure 1

2.Does momentum exist?

A tennis coach once questioned the existence of "momentum" in a player, arguing that a player's performance fluctuations and scoring streak were random. In response, we developed DTW's Momentum-Performance Matching System and found that the fluctuation curve of a player's performance is highly correlated with the momentum curve, which shows that momentum can be a rough measure of a player's performance. For example, if a certain player scores consecutive points, the corresponding momentum curve also shows higher values. The table below shows the correlation between the player's volatility curve and the momentum curve for seven tennis matches, and it is found that the similarity between the two curves is above 0.9 for almost every match.

Table 1

Match	Player1	Player2
1	0.912	0.924
2	0.879	0.906
3	0.941	0.927
4	0.938	0.913
5	0.886	0.912

3.How to predict?

Our team first used the arima model to predict the momentum in the match, but found that the actual momentum may not match well with the momentum obtained from the prediction, which may be related to the fact that the ARIMA model is better at predicting the linear part. Therefore, our team went on to try the lstm model and found that it worked better with an accuracy of 76%. Then we defined the winning percentage of the match with the help of momentum. As shown below, the intersection of the winning percentage of two athletes is the turning point of the race.

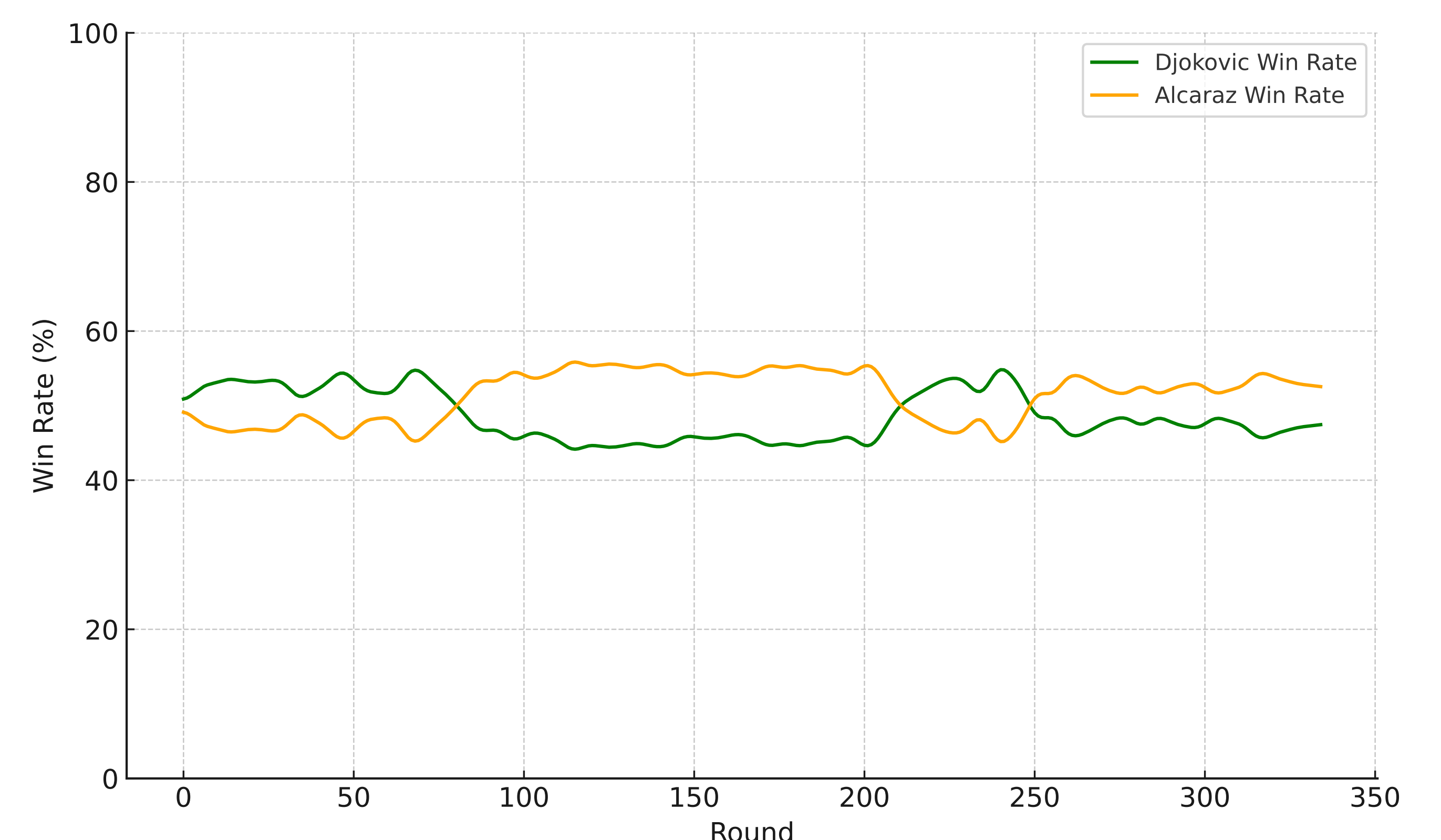
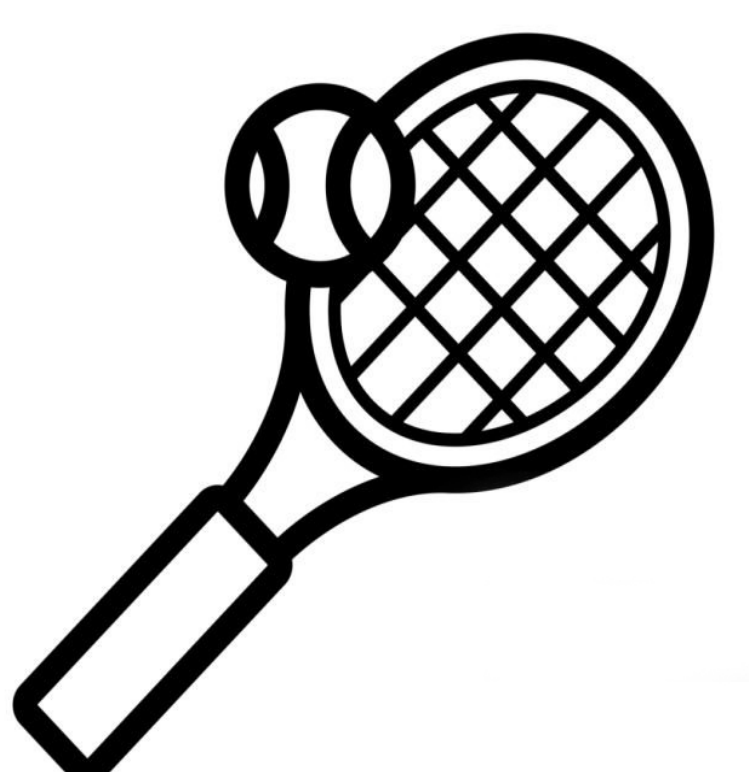


Figure 2

4.What it says about athletes?

After we have quantified momentum, we can firstly analyse all aspects of ourselves and our opponents. Players can fully analyse their opponents before the match to formulate a strategy, analysing the situations in which their opponents excel versus their weaknesses in catching and multi-hitting. In this process, we use game theory to find ways to maximise the player's gains. In addition, the amount of momentum is also related to the psychological state of the players, good psychological quality and strong mental strength can bring high momentum for the players, which helps them to win the game. At the same time, this momentum also gives the athletes a message: adjust the mentality without nervousness, and use their advantages to take the game.



¹Fitts, P. M., & Widrick, J. J. (1996). Force-velocity and impulse-momentum relationships: Implications for resistance training. *Journal of Sports Sciences*, 14(3), 265-275.
²<https://www.merriam-webster.com/dictionary/momentum>