更高，更快，更强——更团结！一直以来，无数运动员和体育学者借助科学分析的手段，将世界纪录不断推进至人类极限，向世界传递了体育的精神与价值。本文重点从功率曲线的角度，结合环境因素，预测骑手在公路自行车比赛中的表现，分析影响个人计时赛和团体赛成绩的多种因素，帮助体育健儿不断超越自我。

Higher, faster, stronger - United! For a long time, countless athletes and sports researchers resort to the methods of scientific analysis to constantly break world records, thus breaking through the limits of human beings and demonstrating the spirit and value of sports to the whole world. In this paper, we predict the performance of riders in road cycling competitions and analyze various factors that affect the results of individual time trials and team competitions, from the perspective of power curves, together with environmental factors, so as to help athletes strive for further improvement.

我们建立了基于COGGAN模型的功率曲线模型和骑手的力学模型。我们设计了疲劳度的定量概念，推导出类Logistic的微分方程系统，建立了我们的功率曲线模型，该模型描述了在骑手身体条件确定的情况下，骑手的输出功率与时间的关系。STRAVA的数据为我们完善功率曲线模型提供了重要的帮助。骑手的力学模型借助了牛顿力学基础，充分考虑了风速，风向，坡度与地面摩擦等环境因素的作用。

We build up a power curve model based on the COGGAN model and a mechanics model for cyclists. We define a quantitative concept of fatigue, derive a Logistic-like differential equation system, and establish our power curve model, which describes the relationship between the rider’s power output and time under the condition that the rider’s physical condition is determined. The data from STRAVA offers important help for us to perfect the power curve model. The mechanical model for cyclists is based on Newtonian mechanics. The effects of environmental factors such as wind speed, wind direction, slope and ground friction, are fully considered.

首先，我们按照功率曲线模型将骑手根据最大摄氧量，乳酸阀值和肌纤维型被分为Time Trail Specialist，Climber，Sprinter三种类型。最终我们对男女分别分析，得到了对应的功率曲线。与COGGAN等人基于统计的研究结果大致相当，因此具有很高的合理性。

Firstly, according to the power curve model, the riders are divided into three types according to the maximum oxygen uptake, lactate threshold and muscle fiber type, namely Time Trail Specialist, Climber, and Sprinter. Then we discuss male and female separately and obtain the corresponding power curve. Curves are roughly similar to the statistics-based curves of COGGAN et al., thus this model has a high plausibility.

然后，我们结合骑手的力学模型，构建了预测骑手表现的数值计算算法，并应用于Tokyo Olympics和UCI的个人计时赛项目中，其预测结果与冠军成绩的误差不超过15%。兼顾多种因素，我们设计了一条赛道并进行了模拟。我们结合了定性分析的不同类型选手的擅长特性，对三场比赛中不同类型选手的表现进行了分析。

Secondly, by referring to the rider’s mechanical model, we set up a numerical calculation algorithm for predicting rider performance, and apply it to the Tokyo Olympics and UCI’s individual time trial events. Taking various factors into account, we design a race track. We conduct a qualitative analysis of the characteristics of different types of players, then analyze the performance of different types of players in the three games.

第三，我们使用控制变量法，探究天气，特别是风速和风向，对比赛结果的影响。结果表明，较小的风速可能对结果有正向作用，较大的风速阻碍了运动员的前进，随着风速的增加，运动员的比赛时间先减小后增大，顺逆风也对比赛产生了一定的影响。

Thirdly, we make use of the method of controlled variable to explore the effect of weather, especially wind speed and direction, on the outcomes of the race. The results indicate that the smaller wind speed may exert positive effect on the results, and the larger wind hinders the athletes' moving. Wind direction also played a role in the outcome of the race.

第四，我们借助超车动作的概念，探究了骑手部分时段超越功率曲线做功行为对结果的影响，其成严格地线性负面相关关系，因为骑手会进入一段时间的“疲劳期”。我们明确了比赛结果对于这种行为较为敏感，为提高比赛成绩提供了理论帮助。

Fourthly, with the concept of overtaking action, we explore the effect of the rider's behavior over the power curve on the results, which is a strictly linear negative correlation, because the rider will experience a "fatigue period". We have also clarified that the game results are sensitive to this behavior, which provides theoretical help for improving performance.

最后，我们在团体赛中，借助Kyle规律深入挖掘了drafting策略。并且我们合理分配了队伍分工，结果表明，科学地借助drafting策略对于提升团体赛具有重要作用。

Fifthly, we delve into drafting strategies with the help of Kyle's Law in team competitions. We rationally arrange everyone's role. The results show that scientifical usage of drafting strategies has an important impact on improving the team competition.

建模之后，我们还对模型进行了敏感性分析，总结了我们的优势和劣势。并借助模型分析，为在Tokyo Olympics中表现不佳的选手提供了建议。

To conclude, we further perform a sensitivity analysis of the model, and evaluate our model’s strengths and weaknesses. And by use of our model, we provide recommendations for players who are underperforming in the Tokyo Olympics.

关键词：公路自行车赛，功率曲线，力学模型，Logistic模型

Key words: road cycling, power curve, mechanical model, logistic model.