Machine Learning Approach to Game Performance vs Training Routine Analysis

By Reid Campolong, Maggie Lehman, and Andrew Thompson

Introduction - Various athletes face the same issue when it comes to training and game performance: what type of training sessions increases their game performance the most. These Rugby athletes partake in various types of training to prepare themselves for a game including mobility, skills, speed, condition, strength and combat. While all of these play an important part in the training process, an athlete is never quite sure what combination of these yield the highest performance boost. We decided to tackle this problem from a statistical standpoint using machine learning. By analysis the data provided with our neural network, we are able to predict which combination of workouts lead to the highest performance increase per ability per player. Whether a player wants to focus on defense, offense, speed, etc. our prediction model can calculate the statistically optimal workout regimen for the player.

Prediction Model - With the provided GPS coordinate data for the players with the games (gps.csv) in addition to the workout data for the players (rpe.csv), we created a data model for each player that related their workouts leading up to each game to their performance in that game. Through this model we are able to predict per player which workout combination yields the highest performance boost dependent upon which trait they desire. For example, one player may need to run longer and require a higher average velocity during the game, whereas another player may need to sprint in bursts across the field and therefore be looking to increase their acceleration potential. We needed each player to have their own data model since players' bodies train differently in addition to responding uniquely to different types of training.

Method - To obtain the data for our predictive model, we used the given GPS data as a players 'stats' (1) during the game. We then use player's workout data to measure how long of each exercise they are doing in regards to total workout time, what type of variety of exercise they are doing, and assign a value to the workout. When a player then plays a game since the previous workout, for our neural network we used the workouts as 5 inputs, with their game stats as the outputs to determine what how the combination of these 5 workouts affects their performance for each game. From this, we then build our model by passing our inputs through 10 hidden layers and are able to predict which workouts would maximize a player's performance to either maximize one ability or find an average performance for both abilities.

Results - Our model allows us to predict which combination of workouts will either

1. **Rapidly** maximize a player's single ability by focusing on select workout combinations
2. **Gradually** maximize all of the player's abilities by focusing on select workouts combinations

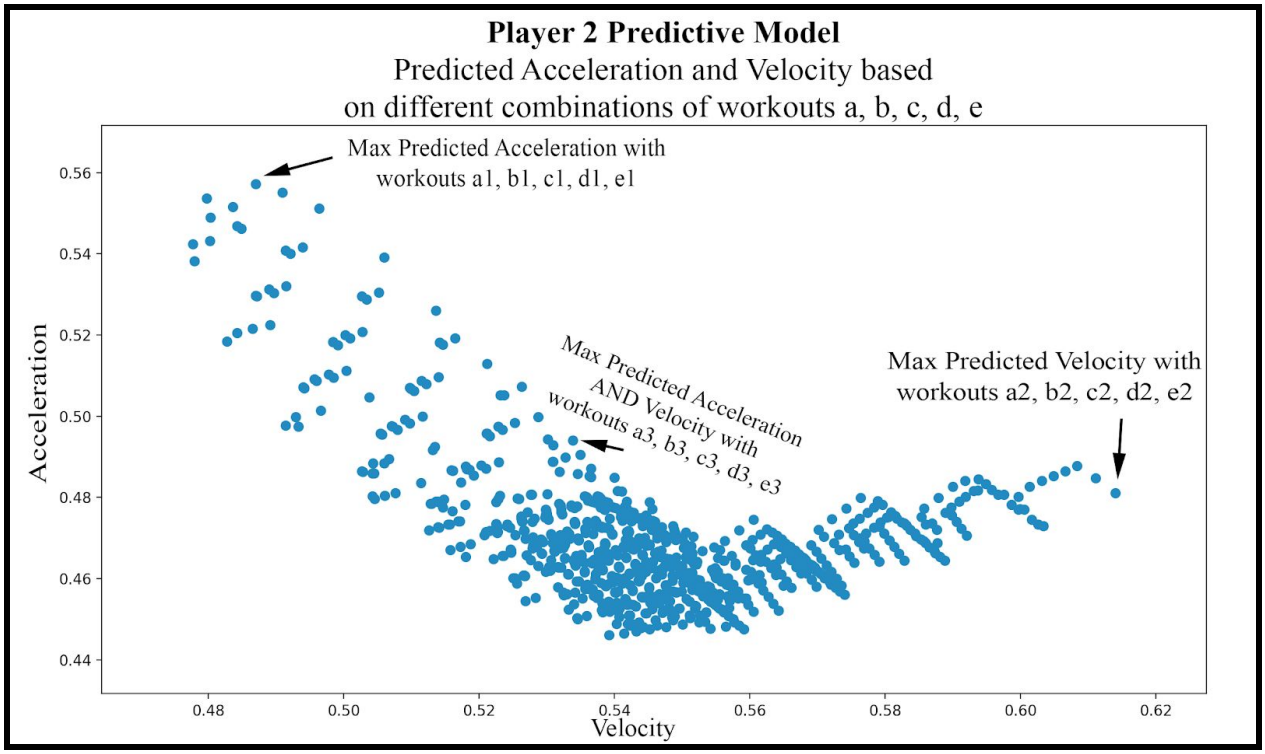
Our data model shows us what **percentage** of workouts labeled a-e where

- A = % time strength training
- B = % time speed training
- C = % time conditioning training
- D = % time skills training
- E = % time mobility/recovery training

Each label is a decimal value representing the percentage of total training time that should be spent on the workout to maximize results. Through rigorous testing of over **4.5 million** data points of positional data compiled with **8.8 thousand** data points of workout routine data, we found a strong, unique trend for each player on the team in addition to an overall trend amongst players (see figures below).

Figures -

(1.1)

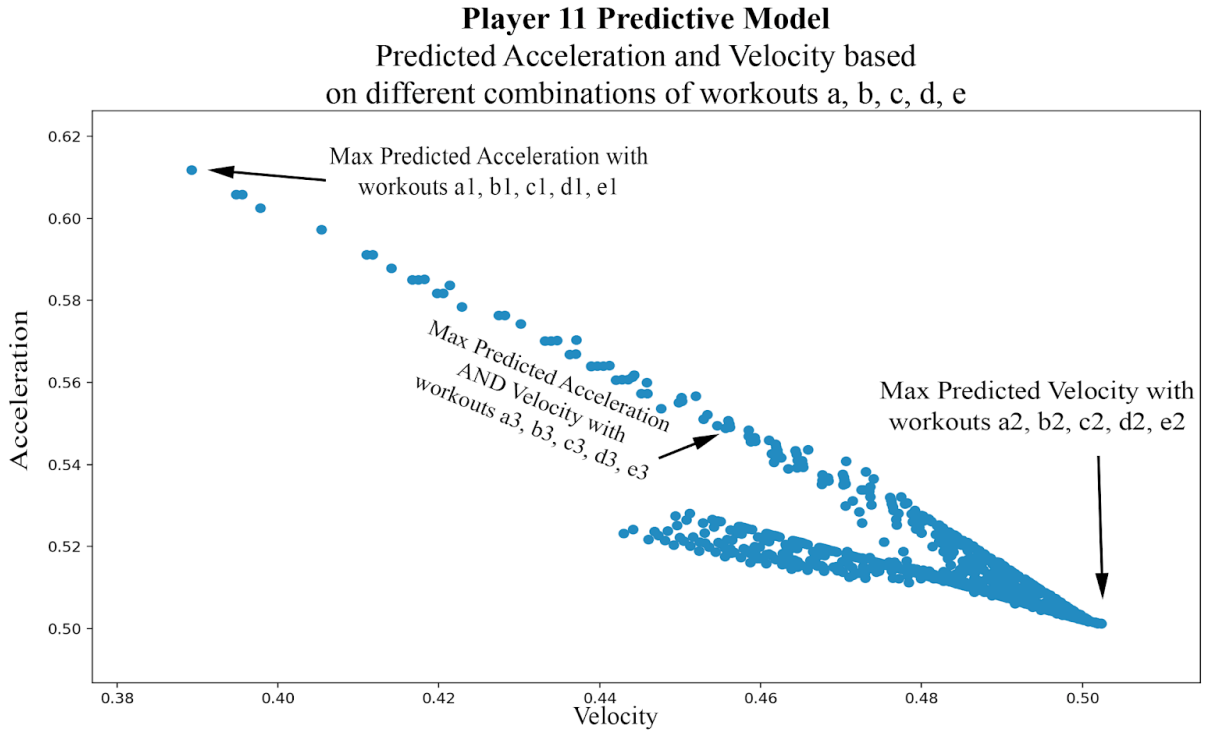


As visible in this figure, Player 2 is likely to get results of **general** improvement if training is not specialized, visible by workout combination a3-e3.

- To achieve the **greatest** improvement in **acceleration**, player 2 would follow workouts a1 - e1 where A = 0.9, B = 0.0, C = 0.1, D = 0.0, E = 0.0. By following this plan, player 2 can increase their max acceleration up to a predicted 0.55721116.

- To achieve the **greatest** improvement in **velocity**, player 2 would follow workouts a2 - e2 where A = 0.0, B = 0.0, C = 0.0, D = 0.9, E = 0.1. By following this plan, player 2 can increase their max velocity up to a predicted 0.6140104.

(1.2)

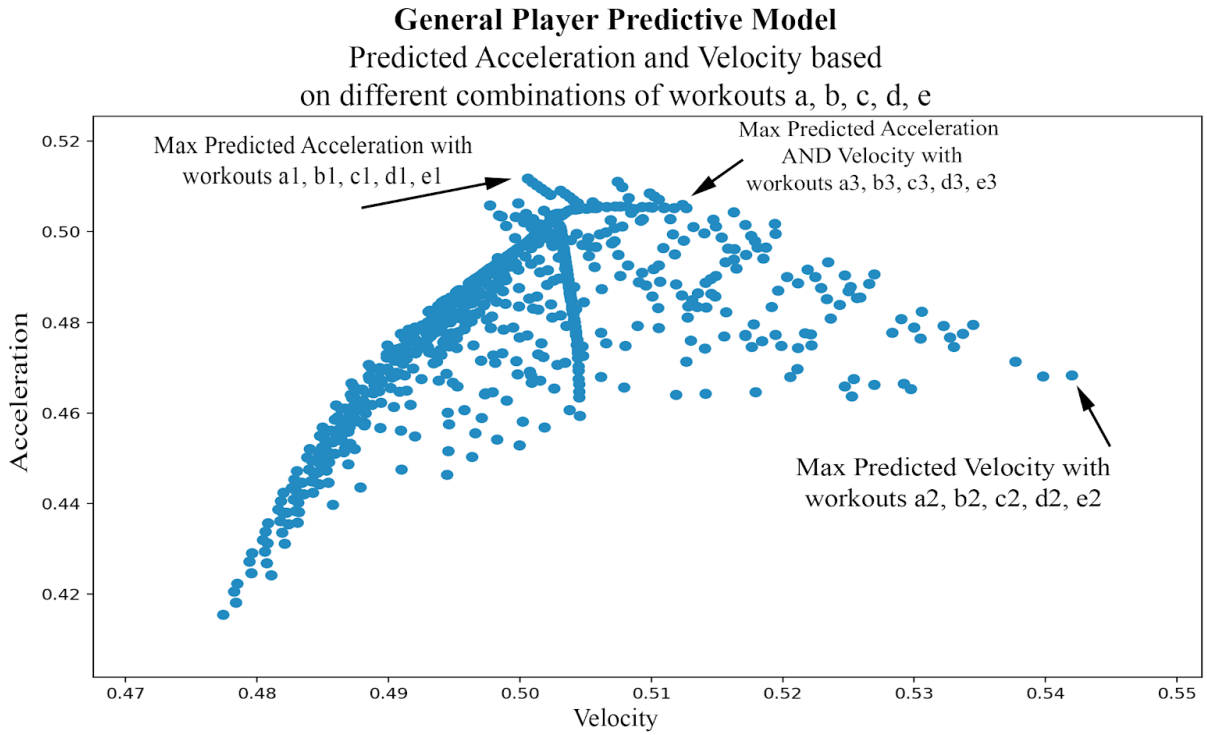


As visible in this figure, Player 11 is likely to get results of **general** improvement leaning heavily towards **velocity** if training is not specialized, visible by workout combination a3-e3.

- To achieve the **greatest** improvement in **acceleration**, player 11 would follow workouts a1 - e1 where A = 0.0, B = 0.9, C = 0.0, D = 0.0, E = 0.1. By following this plan, player 11 can increase their max acceleration up to a predicted 0.61182004.

- To achieve the **greatest** improvement in **velocity**, player 11 would follow workouts a2 - e2 where A = 0.4, B = 0.0, C = 0.5, D = 0.0, E = 0.1. By following this plan, player 11 can increase their max velocity up to a predicted 0.5023656.

(2.1)



As visible in this figure, a player is likely to get results of **general** improvement leaning towards **acceleration** if training is not specialized, visible by workout combination a3-e3.

- To achieve the **greatest** improvement in **acceleration**, a general player would follow workouts a1 - e1 where A = 0.5, B = 0.5, C = 0.0, D = 0.0, E = 0.0. By following this plan, player 11 can increase their max acceleration up to a predicted 0.5117349.

- To achieve the **greatest** improvement in **velocity**, a general player would follow workouts a2 - e2 where A = 0.8, B = 0.0, C = 0.2, D = 0.0, E = 0.0. By following this plan, player 11 can increase their max velocity up to a predicted 0.54200554.

Analysis - As visible by figures 1.1 and 1.2, players do not train the same way. To achieve maximum performance training, each player responds better to different types of workouts based on body time, game role, etc. When analysing the overall trained player model, it appears that general workouts (figure 2.1) are leaning towards an even acceleration and velocity increase, with a slight preference to velocity. In conclusion, each player should be working out based on either an attribute or following the general well-rounded model using their own classified data. If a player is new to the team, the overall model can be a good starting place until data is collected for the player. Not only can our model streamline the training process, but save time and money by showing players exactly what and how to spend their time training to maximize performance.