

Artificial Intelligence in American Football

By: Akshay Nataraja

The Pennsylvania State University, University Park, PA 16801

I. Introduction

American football has cemented itself as the most watched and played sport in the United States of America. It is known for its fast-paced and intricate play designs through various offensive and defensive strategies. In addition to the numerous play calls, there are several varying positions on the team that require a player to have different physical qualities, capabilities, and responsibilities. A well-balanced team where each player fits their role is required for a team to successfully function. With these special rules and considerations, there are plenty of data points that can be harvested and used in artificial intelligence systems. Artificial intelligence systems are able to take in data and then run numerous simulations that can help quantify the possible outcomes. The purpose of this literature review is to determine if there is compelling evidence to suggest whether the use of artificial intelligence is improving the game of American football.

A. Issues

In order to measure the benefit of artificial intelligence in American football, we will look at two major areas where it is implemented. The first topic that will be addressed is AI improvements in injury and risk prevention. American football is a physical game with numerous short and long-term injuries. We would hope to see fewer injuries as AI models are implemented. The second area that this review will focus on is the use of AI models in improving training and preparation.

B. Scope

There are plans to incorporate AI into other aspects of American football. They either have not been implemented yet or not enough time has passed for conclusive data to have been collected. Therefore, any application without evidence of success or failure will not be discussed. Since the focus of this review is to measure AI's success in football, intricate details about the models and applications will not be discussed.

II. Injury and Risk Prevention

Injuries can occur due to a multitude of reasons. Targeted tackles, faulty equipment, and even in-game brawls to name a few. There are many instances in which players have a career-ending injury due to a single play. These would include injuries to the neck and severe concussions. Advancements in protective equipment have been made through the years. Artificial intelligence has played a part in improving equipment to reduce the risks of injuries. In a study led by senior engineer Lee F. Gabler et al. (2020), mouthguards with built-in sensors were tested to see if they could accurately spot head impacts. Repeated head impacts and concussions have been shown to cause chronic traumatic encephalopathy (CTE). CTE is associated with the development of other brain diseases such as dementia and Alzheimer's disease. In conjunction with the mouthguards, various machine learning (ML) algorithms were tested for their accuracy to determine whether a hit was a head impact. Collegiate players were given these mouthguards and recorded head impacts and their severity. One group of human reviewers stayed on the sidelines during the games and recorded whether they believed a hit was a head impact or not. At the end of the season, a second group of human reviewers were given time with game tapes and finalized an accurate number of head impacts. A machine learning model called Adaboost had the highest level of precision at about 98%. This surpassed all of the other models and even the group of reviewers by a noticeable margin (Lee F. Gabler et al. 2020). Misdiagnosing head injuries was a huge problem in the National Football League last year. The Miami Dolphins quarterback Tua Tagavailoa was allowed to play in a game after he had sustained a head impact in the game prior. In this game, he suffered an even greater head injury that left him unconscious on the field and needing to get carted off. The underlying cause of this was the hit he received in the prior game. Machine learning models with the capabilities of preventing these types of incidents would allow players to have longer careers and protect themselves from developing CTE in the future. This specific study shows that head injuries are identified more accurately and efficiently with this machine-learning model.

Another study focused on using artificial intelligence to predict a player's likelihood of sustaining an injury. The model that was tested used various data points including age, weight, position, previous injuries, play intensity, soreness, etc. The model was put to work during an NCAA collegiate season on a single team. They found that the model had a conclusive improvement in the precision than if random guessing was involved (Andrew Lyubovsky et al. 2022). The precision of this ML model is about 47%. This number may not seem like a success, but the factors that the model simulated do show a correlation in future injuries. Seeing that it still outperformed guessing at random, shows that it is an improvement to our ways of predicting injuries.

III. Training and Preparation

AI is used to estimate statistics for a team based on data from their prior games. A research group from BYU has implemented artificial intelligence into the pregame preparation a team must go through before each game. A team has to spend hours watching film tapes of the next team they will be facing. It will allow them to recognize plays and calls that they may see. They will then be able to formulate a specific game plan to counter the enemy team. But before they are able to watch any tapes, much more time is required to annotate enemy play designs. Professor Dah Jie-Lee from BYU has developed an automated deep-learning application to accurately annotate play designs. His application uses a subset of artificial intelligence called deep learning. It involves the use of neural networks and pattern recognition to recognize the formations and positions of players. The application boasts about 90% on player position detection and about 85% on formation detection. This application categorizes the positions of the players with the number of players of that position on the field. Formations tend to have varying numbers of specific positions. For example, many run plays have more tight ends than wide receivers. Tight ends are better blockers than wide receivers because of their larger frame. A run play needs as many people blocking for the running back. There would be more wide receivers on the field during a Hail Mary. This formation is usually a last-ditch effort to score a long score, so a team places fast and tall wide receivers and limits the number of tight ends and running backs on this play. The application is then able to select a play from the number of players in each position and the overall top view of the formation. The program also assumes that the formation follows certain rules like having 5 offensive linemen at all times (Dah Jie-Lee et al. 2023). This is a very important application that will be able to increase the amount of time that a team is able to prepare. Erasing the hours of work required to annotate enemy plays will allow coaches to be able to review a larger amount of tape. Professor Jie-Lee has expressed his opinion that there will be more positive improvements in AI that will help build on processing football analytics.

Another program focuses on using machine learning to see whether it can identify if a player catches a football or not. The goal of this experiment is to begin the process of automating training in football. It uses a camera and a microphone to pick up data and is immediately sent to a computer system that uses neural networks to classify the footage data. Participants of the study were asked to perform varying types of catches to test the program's functionality. This would include a catch over the shoulder in which the player's body would obstruct the view of the camera. The application uses a pre-trained neural network that works with a single frame of footage at a time. To test the accuracy of this application, statistical data was collected and compared against a human group that

distinguished whether a player had caught the ball or not. It reached an accuracy percentage of about 92.19% (Hollaus et al, 2023). The accuracy of this system that uses machine learning is lower than a human reviewer. This may be the case, however, the researchers also affirm that immediate analytics without the need for a human analyst will allow athletes greater opportunities. Researchers explain that this program could become the framework for the further collection of analytics with the use of automation.

IV. Conclusion

This literature review examined various research articles published on whether there is compelling evidence to suggest proven success for artificial intelligence in the area of American football. One main area that was discussed was the implementation of artificial intelligence in systems that focus on injury and risk prevention. The implementation of AI models and sensors in mouth guards had a greater accuracy to discern head impacts than sideline reviewers. Another study focused on a prediction model that takes in various factors of data and predicts future injuries for players. Results after an NCAA season showed that the model had greater accuracy than when compared to random guessing. The second main topic we discussed was the improvements in training and preparation using artificial intelligence. The use of neural networks and pattern recognition were used to accurately annotate the play designs of an enemy team. It makes the process of preparation to become more efficient and allows teams an opportunity to have more time to prepare. The last study that was discussed implemented machine learning into player training. The application had a high level of accuracy by using data collected from a camera and microphone.

Based on the evidence discussed in this literature review, there is compelling evidence to suggest that artificial intelligence has a positive impact on improving American football.

A. Future Research

Future research will implement new types of artificial intelligence into the field of American football. Current implementations will work to improve the rate of accuracy and involve more factors. More research should be conducted to check if these new implementations have a positive impact. Decreasing the risk of injury and improvements in preparation are two areas to help understand whether they have positive impacts.

References

Andrew Lyubovsky, Zhenming Liu, Amanda Watson, Scott Kuehn, Erik Korem, Gang Zhou, A pain free nociceptor: Predicting football injuries with machine learning, *Smart Health*, Volume 24, 2022, 100262, ISSN 2352-6483, <https://doi.org/10.1016/j.smhl.2021.100262>.

Gabler, L.F., Huddleston, S.H., Dau, N.Z. *et al.* On-Field Performance of an Instrumented Mouthguard for Detecting Head Impacts in American Football. *Ann Biomed Eng* 48, 2599–2612 (2020). <https://doi.org/10.1007/s10439-020-02654-2>

Hollaus, B.; Reiter, B.; Volmer, J.C. Catch Recognition in Automated American Football Training Using Machine Learning. *Sensors* **2023**, 23, 840. <https://doi.org/10.3390/s23020840>

Lee, D.-J.; Sumsion, A.; Torrie, S.; Newman, J. Automated Pre-Play Analysis of American Football Formations Using Deep Learning. *Electronics* **2023**, 12, 726. <https://doi.org/10.3390/electronics12030726>