

# **Feasibility for Implementing Artificial Intelligence in Penn State Men's Football.**

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The purpose of this report is to determine whether it is feasible for the Penn State Men's Football program to implement artificial intelligence systems to decrease injuries. Criteria evaluated include whether artificial intelligence systems are adaptable, effectiveness of artificial intelligence systems at improving the safety of players.

## Table of Contents

List of Visuals.....	iii
Executive Summary .....	iv
I. Introduction .....	1
Purpose .....	2
Scope .....	2
Methodology.....	2
Organization.....	2
II. Solution Overview .....	3
III. Solution Criteria.....	3
Adaptability of Artificial Intelligence Systems.....	3
Artificial Intelligence’s Impact of Player Safety .....	3
IV. Evaluation of Criteria .....	4
Adaptability of Artificial Intelligence Systems.....	4
Artificial Intelligence’s Impact of Player Safety .....	4
V. Conclusion.....	5
VI. Recommendation .....	6
VII. References .....	7

## List of Visuals

**Figure 1.** Percentage breakdown of student progression to next play level ..... 1

(NCAA, Probability of Competing Beyond High School, 2020)

**Figure 2.** Number of concussions per NFL preseason and regular season since 2015 ..... 5

(NFL, Concussions: Preseason and Regular Season, Injury Data Since 2015, 2023)

## Executive Summary

American football has cemented itself as the most watched and played sport in the United States of America. It is a sport played as early as grade school to the professional leagues after college. It is known for its fast-paced and intricate play designs through various offensive and defensive strategies. American football is considered a high-impact sport where pads, helmets, and mouth guards are worn to help prevent injuries to the players. However, one of the key issues that impacts many players is the prevalence of short- and long-term injuries.

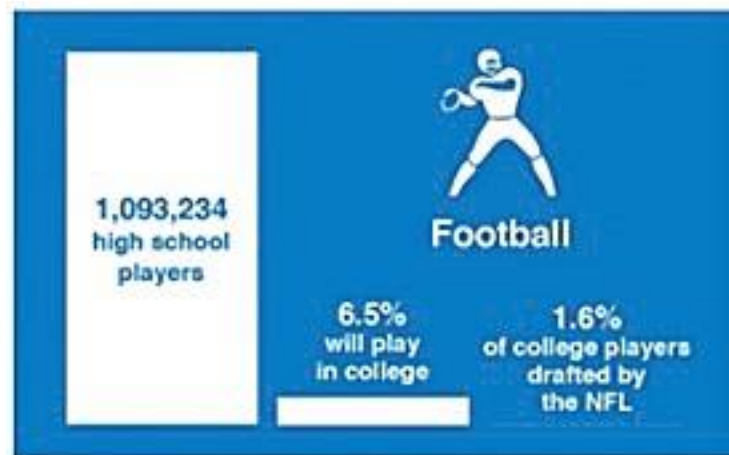
The heavy use of tackles and other collisions that are present in American football is one of the main causes of injuries. Recent improvements to the safety equipment and injury protocols have helped decrease the number of injuries when compared to the early years of gridiron football. Yet it is still considered a dangerous sport in terms of long-term injuries in which many players and parents have had to step away from football or bar their children from participating. Except for combat sports, the sport with the highest risk of concussions for adult men is American football [8]. Penn State has had its fair share of injuries in the past.

An important role of an athlete is to engage in sufficient conditioning and practice safe techniques when playing. However, it is also important to continue implementing and advancing preventative measures to help decrease injuries that the players may face. The purpose of this report is to implement artificial intelligence to decrease injuries in the Penn State football program. While there are many types of preventative measures that may help decrease injuries, the scope of this report will only focus on the measures that involve AI (Artificial Intelligence) implementations such as detection models that review game footage and data from sensors. To determine if implementing artificial intelligence into American football is feasible, we will delve into two varying criteria. The first criterion will evaluate whether artificial intelligence can be adaptable when dealing with the intricacies of American football. Even when the scope involves the reduction of injuries in American football, the National Football League is consistently adapting AI detection models so that they are more accurate in detecting players and injuries through in-game footage [4]. Similar systems can be adapted for Penn State to use as well. The second criterion evaluates the effectiveness of AI in improving the safety of players. This report has found that AI models have helped improve the detection of injuries in real-time and develop unique recovery regimen for players [6]. The real-time detection of injuries allows coaches to pull out players so that they do not incur worse injuries.

Artificial intelligence systems have been shown to meet these criteria, making it feasible to implement into the Penn State Football program. Recommendations to implement AI systems into the Penn State football program include working with data scientists to create tailored learning models to predict injuries and risks, adapting an existing learning model to the specifications that are needed by the program, investing in more data collection on the cause of different types of football injuries, working with the NFL to develop preventative measures using AI, adding AI systems on protective equipment such as the use of sensors on player helmet.

## I. Introduction

American football is the most popular sport in the United States, known for its high intensity and physicality. Its influence plays a role throughout many stages of development in the citizens of the United States or America. Bright-eyed students starting from as early as elementary school, train for years in hopes of getting drafted or playing for a professional league. The National Football League (NFL) is the highest professional level for competition in American Football. It is currently the most valuable sports league in the world at a market capitalization of about 145 billion dollars. Of the 1.1 million high school football players, 6.5% will advance to college football (Figure 1). And of the college player pool, only about 1.6% will get drafted that year (Figure 1). Talent coupled with hard work and luck is needed to make it to the various levels. Yet a single play can disable a player from ever playing football again.



**Figure 1.** Percentage breakdown of student progression to next play level.

While the game is thrilling to watch, it comes with a significant risk of injury. With players running at high speeds, colliding with one another, and engaging in tackles, the potential for injuries is always present. Injuries in American football can range from minor bruises and sprains to severe, life-altering injuries. In this context, it is important to understand the players are human and are prone to injuries when considering the physicality that is expected in their profession. The players that play in the Penn State Football program are perfect examples of this. For example, in the past season, Penn State's offensive line was riddled with injuries. Several starters and reserve players on the offensive line were out for weeks during the season [7]. With several season-ending and career ending injuries in Penn State's history, it is time to focus on improving the safety for the players [7].

## Purpose

The purpose of this report is to determine whether it is feasible for the Penn State football program to implement artificial intelligence systems to minimize injuries. Criteria evaluated include whether artificial intelligence systems are adaptable, effectiveness of artificial intelligence systems at improving the safety of players.

When assessing the feasibility of implementing artificial intelligence, we should evaluate the benefits that have been researched. Adaptability through the creation of new models or the improvement of existing models is important to consider. As equipment, tactics, techniques, etc. change over the years, the models that are being proposed must keep up. Another criterion that must be explored is the impact that the proposed system will have on the safety of the players. Positive results such as fewer injuries or improved rehab are ways that can showcase the benefits of implementing artificial intelligence over traditional methods. Player safety is a top concern for any executive in charge of a football program.

## Scope

This report is solely concerned with the feasibility of implementing artificial intelligence into the Penn State football program to reduce injuries. It will not address whether the use of specific protective equipment has proven benefits unless directly associated with artificial intelligence. Additionally, this report will only talk about artificial intelligence systems in other fields if it involves the system compatibility for American football. Lastly, this report will not go in depth into the varying costs for different programs that are present in American football.

## Methodology

The approach to creating this report involved collecting data from a diverse range of sources such as scientific journals, reports from universities, and news articles. All sources were found online through various databases.

## Organization

This report is broken into five main sections. Section I serves as an introduction to American football and provides the purpose, scope, and methodology of the report. Section II provides the solution overview by discussing artificial intelligence systems. Section III lists and defines each criterion that will be evaluated, and Section IV evaluates each criterion to evaluate feasibility. Section V is the conclusion which summarizes the findings in the report. Section VI provides a list of recommendations.

## II. Solution Overview

American football players face many risks due to the high intensity and physicality of their profession. Even though improvements to many aspects of American football have reduced injuries over the years, there are still many players getting injured. Players and their adrenaline sometimes do not realize the severity of their injuries. Their adrenaline allows them to play down their injuries and continue playing even though it is hurting them further. Coaches need to trust their players and usually will let them play while they are injured. Researchers have found that short-term injuries are worsening because neither the player nor the coach has a grasp of the extent of their injury. If implementing artificial intelligence is feasible, it would help the Penn State football team reduce unwanted injuries.

Implementing artificial intelligence models and sensors on helmets can distinguish whether a tackle or collision had an impact on the player's brain and wellbeing. Another example that is being used by the NFL, the implementation of learning models that review game footage and can help distinguish players can give coaches a better understanding of the wellbeing of their players. Implementing these types of solutions at Penn State will help reduce injuries that are currently plaguing the team.

## III. Solution Criteria

### Adaptability of Artificial Intelligence Systems

This criterion evaluates whether the proposed artificial intelligence systems are adaptable as the game of football changes. As new equipment, tactics, techniques, etc. are introduced, injuries may fluctuate. Directors or coaches will look for a solution that is adaptable so injuries can be reduced even as varying factors are changing. Specifically learning models will be evaluated to see if there are improvements being made to them. It will pass the criterion if language models show improvements through the years and the extent of the attempts to reach a greater accuracy of player detection. It will then allow us to see if injuries have conclusively reduced using this solution.

### Artificial Intelligence's Impact of Player Safety

This criterion evaluates the impact that artificial intelligence has on the safety of a player. A director or a coach is looking for this solution to improve the safety of a player by reducing the injuries that occur. Seeing the injury differentials between seasons with artificial intelligence and no artificial intelligence. Another way is to see if using artificial intelligence can help with rehab. Unique recovery plans created by artificial intelligence would need to be an improvement from current ones. Ways to measure this would be a decreased timetable for recovery and/or better recovery of post-mobility.

## IV. Evaluation of Criteria

### Adaptability of Artificial Intelligence Systems

We must first evaluate how the adaptability of artificial intelligence systems work. The defining characteristic of artificial intelligence is its ability to be ever-changing. Specifically learning models, when given data points can give a more efficient prediction than when completed manually. The AI systems that need to be implemented need to be ready to adapt to the changing factors of football such as equipment, tactics, techniques, etc.

The National Football League is taking charge in implementing and advancing these learning models into the game. In 2021, they held a challenge with a cash prize of \$100,000 to find learning models that could accurately identify players when given game footage. Partnering with Amazon Web Services (AWS) to identify players and understand the risk of injury they may face. A similar challenge was held the previous year, where they asked for learning models that can identify head impacts. The NFL has shown that adaptability is occurring through yearly competitions. The learning model that won the previous year is then used and adapted to fit more criteria for the following year's challenge [5]. Also, the use of data scientists that are not employed by the NFL explains that anyone can help adapt the learning models. Through this challenge, the NFL was able to reach a wider audience of specialists and be able to award the work of the best models. Of the 7,800 models received in 2021, they were able to find the couple optimal models [4].

Like the 2020 artificial intelligence challenge held by the NFL, another study was conducted research a learning model's accuracy in identifying head impacts from data given by sensors on the player's helmet. Adaptability is shown to have occurred as there are learning models that can be implemented through various modes [2].

The NFL is considered the next stage after college football. Penn State sends numerous athletes to the NFL every year. There are slight changes to the rules between the NFL and division 1 college football. If minor changes are made depending on the rule changes, these AI systems can be adapted to work for Penn State football. The learning models are capable of distinguishing players from differing teams with the use of game footage [5].

### Artificial Intelligence's Impact of Player Safety

Penn State football players have faced several serious injuries in the past few years. Even last season, Penn State had two players that received season-ending injuries [7]. The year prior, a Penn State junior wide receiver retired due to the concussions he got. Injuries of all types are prevalent in American football and the implementation of AI may be a way to reduce them. 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.



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. It was tested against several machine learning models and a control group of real-time human reviewers. A machine learning model called ‘Adaboost’ had the highest level of precision at about 98%. This surpassed all the other models and even the group of independent reviewers by a noticeable margin [2]. Concussions on a regular basis or on a worsening degree can cause dementia and other degenerative diseases of the brain. The average number of concussions in a season in the NFL has decreased since 2015, however the number has increased in the past 2 years (Figure 2).

### Concussions: Preseason and Regular Season

2015-2022

Year	Preseason			Regular Season			Preseason + Regular Season		
	Game	Practice	Total	Game	Practice	Total	Game	Practice	Total
2015	54	29	83	183	9	192	237	38	275
2016	45	26	71	166	6	172	211	32	243
2017	46	45	91	179	11	190	225	56	281
2018	34	45	79	127	8	135	161	53	214
2019	49	30	79	136	9	145	185	39	224
2020*	N/A	30	30	129	13	142	129	43	172
2021**	22	30	52	126	9	135	148	39	187
2022**	27	25	52	149	12	161	176	37	213

\*2020 was markedly different from other seasons due to the COVID-19 pandemic. There were no preseason games in 2020.  
 \*\*The NFL season structure changed in 2021 and 2022 to include 3 preseason games and 17 regular season games. Prior to 2021, the NFL season included 4 preseason games and 16 regular season games.  
 Data as of 17 January 2023. Injuries reported during conditioning, weight lifting, run sessions, or individual training, as well as chronic injuries or those with insidious or unknown onset are not included.

**Figure 2.** Number of concussions per NFL preseason and regular season since 2015

Better accuracy at spotting these head impacts is one way that safety can be improved. Coaches can pull out a player who received an injury due to a head impact. Coaches and players could decrease the number of concussions by knowing when the player’s limit is up. Rest and renewal can allow a player to return much faster than if they worsen an injury.

The learning models created by the NFL and AWS challenges help identify players with real-time footage. Recent models can detect head impacts with just game footage. Both the Adaboost and the learning models from the NFL have consistently beat reviewers on the sidelines. Future models will give a more detailed recovery plan unique to each player when dealing with injuries [6].

## V. Conclusion

This report evaluated the feasibility of implementing artificial intelligence into the Penn State football program in hopes to reduce injuries. The first criterion evaluated was whether the learning models could be adapted to fit the needs of a changing game and specifications. The use of several different types of learning models for the goal of identifying players and head injuries shows that it is feasible to be able to adapt learning models for the Penn State football program. The second criteria expected a positive impact on the safety of players. Many of the learning

models were found to be more accurate than human identifiers. A quicker and more accurate identification process for head impacts can prevent the worsening of concussions in players. Both criteria have been met and show that it is feasible for the Penn State football program to implement AI to reduce injuries.

## VI. Recommendation

The results of this report suggest several recommendations for the Penn State football program:

- Work with data scientists to create tailored learning models to predict injuries and risks
- Adapt an existing learning model to the specifications that are needed by the program
- Invest in more data collection on the cause of different types of football injuries
- Work with the NFL to develop preventative measures using AI
- Add AI systems on protective equipment such as the use of sensors on player helmets

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