DH4003 – Final Year Project Report

By Ultan Cunningham – 120499244

How is Artificial Intelligence influencing refereeing and scouting practices in professional football?

An in-depth analysis.

Table of Contents

- Research Question
- Similar Projects
- Literature Reviews
- Understanding AI
- AI Advancements in Refereeing
- Video Assistant Referee (VAR)
- Semi-Automated Offside Technology
- Goal Line Technology
- AI Advancements in Scouting
- Case study: Brighton & Hove Albion and Brentford FC
- My Digital Artefact
- Conclusion
- Bibliography

Research Question: How is artificial intelligence influencing refereeing and scouting practices in professional football?

My project aims to investigate the relationship between modern day professional football and the rise of artificial intelligence. Technological advancements have played a major part in reshaping refereeing, player performance analysis and coaching practices. I believe it is important to acknowledge the presence of artificial intelligence in today's game, allowing us to understand its role and how we can use it to positively progress the sport of football. There is widespread confusion, among both fans and professionals, about how exactly the use of AI benefits the sport so, I hope that, within this project, I can deliver some clarity and demonstrate whether the world of football is profiting from these technological advancements or if it is just adding an unnecessary layer of confusion to the sport.

Why did I choose this research question? Throughout the past ten years, I have noticed a massive change in the sport of football. Every year, it seems as though there is a new state of the art technology being introduced to finally solve a previously relatively small problem. I have felt, at times, that it has an effect on my love for the sport of football. It seems to me that many of the things being introduced are unnecessary, over complex and generally not needed. The general consensus amongst fans, at least from my point of view, is that they are all in agreement that these new technologies are just not needed. It gets to a point that judging a game pixel by pixel or waiting minutes for a decision to be made just sucks the enjoyment completely out of the game and kills the atmosphere within a stadium. Within this project, I aim to investigate a number of things. I aim to discover just how accurate and effective the artificial technologies within refereeing are, whether they truly do help refs make the right decision or whether they are just an unnecessary addition. I hope to uncover the effects of the use of artificial intelligence driven technologies within the scouting systems of clubs and see just how vital they are for getting results and finding hidden gems by using artificial intelligence driven tactical assistance and data driven analytics.

Similar Projects

To prepare for this project, I researched a number of different projects that currently utilise the assistance of artificial intelligence within football. These gave me an opportunity to try to understand how artificial intelligence can be used to benefit clubs and help them get an edge over their opponents, helping them to push ahead and get to that next level. The practices include TacticAI, VAR and artificial intelligence based scouting recruitment. I tried to ideally seek out three different uses of artificial intelligence that covered my research question just to get a base level of understanding on each topic before I did some deeper research.

Project 1 - TacticAI: an AI assistant for football tactics TacticAI is an AI powered tool that provides football coaches and teams, most notably English Premier League team Liverpool FC, with tactical insights with the help of artificial intelligence, through predictive and generative AI. This tool is used to generate analysis on set pieces such as corner kicks, helping teams get the edge over their opponents in these scenarios. TacticAI analyses a number of datasets in order to provide coaches with tactical suggestions. The tool aims to provide deeper, more thorough analysis and to move away from traditional statistics by providing scenario driven insights in the hopes of evolving football coaching to an even more detailed level. TacticAI is an example of how artificial intelligence is being used by certain clubs to gain a tactical advantage over their opponents. Traditionally, coaches will sit and watch hours upon hours of footage from both their own previous matches and their opponents in an attempt to understand circumstances where they may have made mistakes or to try pinpoint weaknesses their opponents have to develop new tactics. This tool saves time for players and coaches and allows them to use that time on the training pitch, perfecting the new tactics while preparing for the upcoming matches. TacticAI is exactly the kind of tool many teams around the globe would massively benefit from within their match preparation. I was incredibly impressed by the depth of analysis this tool provides, and the report laid out by the development team was hugely insightful.
https://deepmind.google/discover/blog/tacticai-ai-assistant-for-football-tactics/

Project 2 - Does video assistant referee technology change the magnitude and direction of home advantages and referee bias? A proof-of-concept study This study was conducted to determine whether home teams would see less of a bias in officiating after the introduction of video assistant referees (VAR). There is a common consensus within the world of football that home teams tend to see more lenient refereeing decisions than away teams, therefore the main intention of VAR is to execute fair, unbiased refereeing decisions. The researchers analysed over 1,800 matches in the Turkish Super League before and after the implementation of VAR. They focused on things such as fouls called, yellow and red cards given, penalties awarded and match outcomes while trying to identify any changes in trends or refereeing biases pre and post VAR. The interesting thing is that they actually discovered a decrease in fouls after the implementation of VAR. This could be due to players being more aware that they are being watched in greater detail and are less likely to get away with overly aggressive play or it could be as a result of referees being aware that due to the fact they can now rely on the assistance of VAR to let them know if there was a foul they missed, they are less likely to blow the whistle so they can let the

game flow and continue. This study concluded that despite the fact that away teams still on average receive more cards and commit more fouls, this is not down to the implementation of VAR. However, it does help to reduce extreme cases of bias, resulting in fairer officiating.

https://bmcsportsscimedrehabil.biomedcentral.com/articles/10.1186/s13102-024-00813-9

Project 3 - How AI-powered recruiting helps Spain's leading soccer team score Earlier this year, one of Spain's biggest football clubs, Sevilla FC, partnered with IBM to develop an AI driven scouting tool. The aim was to evolve and improve the club's player recruitment system and give them the edge over their rivals when it comes to securing promising young talent for the future from across the globe. The tool, ScoutAdvisor, analyses over 200,000 scouting reports based on a number of different factors such as height, weight, age, goals scored, xG (expected goals), nationality among many others. The aim is to create a system that the club's scouts can easily navigate and find certain potential players by using simple prompts to express what it is they are seeking. The benefit of this system is that it allows Sevilla FC to gain an advantage in an ever competitive transfer market. We have seen how other clubs have used AI driven scouting to their advantage, for example, Brighton Hove & Albion in the English Premier League are one of the great success stories of AI driven scouting. Their use of AI has allowed them to maintain a net spend a fraction of their rivals by buying players for cheap and selling them for a large profit. All of this is as a result of AI systems helping find undiscovered players, allowing Brighton to capitalise and buy for a fraction of their true value.

https://www.ibm.com/blog/watsonx-scout-advisor-fc-sevilla/

Literature Reviews

I also conducted a number of literature reviews throughout the year on my chosen topic. Below are some of the reviews which I completed and that I considered to be some of the more important pieces that furthered my knowledge of artificial intelligence in football. Undergoing these reviews helped me to fully grasp the idea and level of importance many people within the game of football consider artificial intelligence to have. The reviews below are short and concise, allowing me to understand the content while not flooding the reviews with unnecessary text.

Game Plan: What AI can do for Football, and What Football can do for AI

This research paper delves into the relationship between AI and football and how technological advancements are constantly changing the game. It talks about how this can be a mutually beneficial relationship, how AI can help football positively evolve while changes in football can do the same for AI. The fact that AI can essentially use real world scenarios to test and refine its models can only prove beneficial for the improvement of said models. This paper also discusses some of the applications of AI in match preparation, such as analysis of penalty kicks and set pieces. It also speculates on what the future may hold for both of these fields. This paper helps inform my project as it gives me a deeper understanding of how football matches can be used as a sort of testing ground for AI models and systems. It also covers a vast scope, diving into player performance, match analytics and team strategy. I believe that I need to understand the relationship between artificial intelligence and football on a deeper level, how they can both build upon each other, to allow me to produce a more detailed report.

Slicker systems don't help – treat offside like rugby's forward pass

This article by James Gheerbrant from The Times discusses the argument that perhaps too much artificial intelligence involvement with the sport of football is a bad thing. Gheerbrant explains how the offside rule was introduced as a way to prevent players from getting an unfair advantage by running ahead of the defence before the ball was played. However, due to the implementation of automated offsides, we have gotten to the point where if you are even a half of an inch ahead of the last defender, you will be judged as offside. The hyper-precise measurements that the automated offside systems use means that now the attacker has to be inch perfect in their movements when trying to get past a defender. Not only does this make things much more difficult for the players, but it also makes it frustrating as a viewer watching the referees go through the footage frame by frame to decide whether a player is offside or not. This article helps inform my project as it asks the question of whether we should be so over reliant on the use of technology in football and whether we need to be so exact and precise in instances like this.
https://www.thetimes.com/sport/football/article/semi-automated-offside-not-in-spirit-of-rulexxdhzm2vg?t=ie

The English Premier League Will Ditch Its Hated VAR Offside Tech for a Fleet of iPhones (B.Dowsett 2024)

This article discusses a new offside technology being implemented in the English Premier League later this season. The new technology, known as Dragon, created by Genius Sport is set to be used to try and enhance the accuracy of AI offside detection. Due to video assistant referee offside technology leaving a lot to be desired, the Premier League have decided to try something new. One of the main reasons for trying this new system is due to the lengthy time it takes to come to a decision with the current VAR setup. They will be utilising iPhone technology by strategically placing over 20 iPhone 14 devices around the pitch to capture high frame rate video from multiple different angles. "Dragon tracks between 7,000 and 10,000 data points on each player, including body contours and skeletal frames. This detailed tracking allows for precise 3D modeling of player positions relative to the offside line." This article helps influence my project as it shows the ever changing, ever evolving nature of artificial intelligence within the world of football refereeing. It shows how despite relative success with VAR over the past 10 years, there is still an effort to strive for perfection by testing out new AI systems.
https://www.wired.com/story/the-english-premier-league-has-a-new-iphone-powered-offsidedetection-system/

Prediction of Football Players' Performance using Machine Learning and Deep Learning Algorithms

This research paper investigates the use of artificial intelligence in studying player performance in football. It discusses the use of machine learning, the analysis of data compiled from multiple previous seasons and the utilisation of position specific AI models. The models are built to be able to recognise different player's positions based on certain key stats, for example, a goalkeeper and saves made, a striker and shots on target etc. These models are used in a variety of circumstances, most notably in player scouting and team management. They are used in scouting for selecting certain players based on their performance in certain stats e.g a player with a low shot on target rate to low goal conversion rate would be a sub optimal choice to pursue. It also details the challenges that using data from players creates due to unforeseen issues such as player injuries, inconsistencies and low team cohesion. These aspects can affect the quality of data produced by the model. This paper benefits my project as it details real life applications and consequences of AI in football management and there is a heavy focus on player performance which is an avenue I am looking to go down.

https://ieeexplore.ieee.org/document/9456424

Applications of Artificial Intelligence in the Game of Football: The Global Perspective

This research paper investigates the implementation of artificial intelligence in football, discussing several of its applications and weighing up the positives and negatives of its use in

today's game while also speculating what it could mean for the future of the sport. This study is aimed at stakeholders of football clubs, and how they can benefit from the use of AI within their teams while also being made aware of its limitations. The study finds that AI has improved the sport in a number of different ways, most notably in terms of player performance and fan experience. The use of AI in coaching practices benefits players as the new models help tailor training plans and drills specifically to the strengths of certain players which in turn heightens their decision making and focus in game. The study also acknowledges that due to the use of AI in football still being in the relatively early ages, it still has some drawbacks and limitations as we are unable to harness the full potential of artificial intelligence. This study is influential to my project as it discusses multiple different AI applications and their benefits and limitations in several areas of football ranging from the fan's view to the coaches and players.
https://www.researchgate.net/publication/344266622_Applications_of_Artificial_Intelligence_in_the_Game_of_Football_The_Global_Perspective

Understanding AI

To gain a deeper understanding of artificial intelligence on an intellectual level, I began researching the history of a number of types of AI and where (or if) they fit into football. I felt

that to truly understand the importance and level of reliability it holds within the world of football, I needed to acknowledge the beginnings of artificial intelligence.

Generative AI

Generative AI is a type of artificial intelligence that creates new content, such as text, images, audio, and video, based on what it has learned from existing data.

Generative AI is a type of artificial intelligence system that is used to create types of content such as images, videos and music among many other things. The use of generative AI has grown over the years as different industries have discovered ways in which it can be beneficial to them. Companies such as Adobe have implemented Gen AI within some of their products such as Adobe Photoshop, with tools that allow users to create and edit images automatically. While the emergence of artificial intelligence itself can be dated back to the mid-1950s, generative AI is much more of a recent revelation. In 1950 Alan Turing, a British mathematician and computer scientist, published a seminar paper entitled "Computer Machinery and Intelligence". In this paper, he questioned if machines could think for themselves and to try answer this question, he created a test based on a game called The Imitation Game which is commonly known as The Turing Test nowadays. The aim of this test is to see if a machine can answer questions intelligently and exhibit behaviour that is almost identical to a human being. It is based on a game where there are three participants, Player A, Player B & Player C (the judge). Player A & B's genders can be interchangeable, and they are unknown to the judge. Player A must attempt to convince the judge that they are the opposite gender while Player B must try to help the judge make the right decision. This is all done through notes or any other way that doesn't give away the genders. The Turing Test replicates this where one of the players is a computer. The two players must convince the judge that they are human. This is done through a terminal and if the judge cannot tell which is which, the computer wins the game. The Turing Test was the first attempt at assessing a computer's ability to display human-like intelligence. This test has been critiqued by some experts around rhe world as they feel that it is more of a test of a computer's ability to imitate rather than prove intelligence. The concept of AI was first introduced by computer scientist John McCarthy during a conference in 1956 where he coined the term "artificial intelligence". This is where the evolution of AI really began. It wasn't until around 2014 that the concept of the generative adversarial network (GAN) was introduced which is where generative AI evolved into how we know it today, being able to create realistic, life-like images and videos. Chat-GPT is one of the most used and well-known gen AI systems. AI chatbots have been around for many years with the first one created by Joseph Weizenbaum. The chatbot was named ELIZA and was coded to make it reply with the role of a psychiatrist. Weizenbaum wanted to clarify that despite creating this chatbot, he didn't believe that computers were capable of mimicking human emotional intelligence. However, he noticed that people were ending up confiding their deepest secrets within this bot. "What I had not realized is that extremely short exposures to a relatively simple computer program could induce powerful delusional thinking in quite normal people." (J. Weizenbaum 1966).

Uses of generative AI within football: TacticAI, PassAI, Eyeball (used for scouting purposes), Stats Perform (AI driven stats), media puropses such as “Beyond Stats" in La Liga etc.

Predictive AI

Predictive artificial intelligence (AI) is a computer program's ability to use statistical analysis to identify patterns, anticipate behaviors, and forecast future events.

Much like the history of generative AI, predictive AI also dates back much further than one might expect. The roots of predictive AI within football goes all the way back to the mid 1950’s where a man named Charles Reep codified, detailed and analysed football matches. Charles Reep was an accountant in the RAF who, as a massive football fan, analysed well over two thousand football matches from 1950 to 1990, sometimes spending up to 80 hours on a single match. Another pioneer in this field was a man by the name of Valeriy Lobanovskyi. Lobanovskyi was the coach of Dynamo Kyiv and the USSR from 1970 to 2002. He saw the potential computers had to change the sport of football all while computer processors were still enormous in size. ***Known for his fastidious match preparations and scientific scouting, he said: "A team that commits errors in no more than 15% to 18% of its actions is unbeatable."***

With the advancement in technology regarding computers, football clubs and their analyststs began systematically collecting and organising match data. The late twentieth century ushered in basic digital records and by the early to mid 2000s, methods inspired by *Moneyball* started influencing football, leading to the exploration of advanced metrics such as looking past just goals and assists when it comes to scouting players. Regression, probability models and structured historical analysis became a vital part of player scouting.

In the mid 200s, the introduction of GPS tracking, video analysis and wearable sensor technology gave analysts a deeper understanding and insight into player movement, fitness and positioning within games. Companies such as Opta and Prozone became incredibly popular and important as they both offered detailed event based datasets. Opta, which was founded in 1996, is still the most popular data analytics company in sports today, covering over 30 sports in 70 countries. They are the primary data analytics used by the Premier League today.

As the years progressed, these types of predictive analytics became vital for clubs around the world in forecasting game outcomes, injury risks, and talent evaluation. Models like the World Football Elo Ratings**,** derived from the chess Elo system, demonstrated superior predictive power over traditional FIFA ranking systems. Since around 2015, firms like Stats Perform (formerly Opta + Perform) have heavily invested in AI, eventually deploying hundreds of AI models and generative tools to analyse roughly half a million matches annually.

A landmark development emerged with TacticAI, a collaboration between Google DeepMind and Liverpool FC. Using geometric deep learning on spatiotemporal tracking data from over 7,000 Premier League corners, TacticAI predicts receiver likelihoods and shot probability, and

proposes tactical setups that experts preferred 90% of the time over human-devised variants. Models such as TacticAI have been incredibly influential in paving the way for more of these artificial intelligence driven models to emerge. It could also be noted how since the start of using TacticAI in conjunction with their training, Liverpool FC have become noticeably stronger in set piece areas and have successfully won the 2024/2025 English Premier League.

Computer Vision AI

Computer vision tasks include methods for acquiring, processing, analyzing, and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the form of decisions.

The modern era of computer vision in soccer began in the mid-1990s, when Ramm Mylvaganam created Prozone by investing in camera-based machine vision technology that could deliver real-time, centimeter-level positional data of players and the ball, significantly more precise than earlier GPS or sensor systems. This allowed coaches to tailor their training sessions and strategies with previously unattainable levels of accuracy and precision. By the mid 2000s, Prozone had evolved to the point where they had multiple cameras within stadiums that logged thousands of player's touches and movements per game, with the help of 2d bird's eye animation, capturing players movements every 0.1 seconds. Over time, companies such as Wyscout (founded in 2004) and InStat (launched in 2007) further developed platforms that linked event data with video playback, enriching scouting, match analysis, and performance review workflows. In the early 2010s, the introduction of Goal Line Technology marked a major landmark in refereeing with the help of computer vision AI. In July 2012, just before the start of the 2012/13 football season, the IFAB approved the addition of goal line technology to the laws of the game and it was instantly deployed at FIFA events, the 2012 FIFA Club World Cup being one of the first to include goal line technology. Systems such as GoalControl and Hawkeye were used. HawkEye, a camera based detection system, became massively popular and widespread across major leagues worldwide as it allowed for precise goal line detection and reliability within refereeing. Another ground breaking advancement in computer vision AI within football was the creation and implementation of VAR (Video Assistant Referee). This was developed by Hawk Eye Innovations and was officially adopted by FIFA and added to the laws of the game in 2018. Since then, VAR has been used in all top tier leagues throughout the world such as the UEFA champions league and the English Premier League. One of the more recent innovations in this field is the introduction of semi automated offside technology. This technology made it's debut in the 2022 FIFA World Cup and was relatively successful. However, it is still a work in progress and has a number of flaws which I will talk about later on. Computer vision AI technology has also evolved to interpret player movements and biomechanics. A group of analysts and engineers at Loughborough University used AI to detect body poses, limb movements and actions such as detecting which foot a player uses when passing, whether they are jumping or running. This type of technology is used as a non intrusive way of tracking a certain player's performance, picking up on potential injury risks and rehabilitation monitoring. It allows the coaches and medical staff to have a more detailed understanding and view of their

squad's fitness levels. Other academic contributions throughout the years have continued to shape the field. The SoccerNet v2 dataset, which was released in 2020, includes a plethora of data ranging from over 300,000 annotated broadcast video segments, with tasks such as action spotting, camera shot segmentation and replay grounding all of which facilitate strides towards full video understanding in a footballing context.

Descriptive AI

Descriptive AI is an AI model that has been pre-trained and fine-tuned to generate metadata from unstructured input data like business documents. Typically, Descriptive AI can extract complex metadata with high accuracy and classify documents into multiple dimensions as needed.

Again, much like both generative and predictive artificial intelligence within football, descriptive AI dates back to the mid 1960s where an accountant from Swindon Town named John Mercer introduced performance indicators like pass accuracy, tackles, and goals scored, laying groundwork for quantifying what was traditionally judgment based. This was improved and built upon by the previously spoken about Charles Reep and Valeriy Lobanovskyi from the 1970s throughout to the early 2000s. In the early 21st century, platforms such as Wyscout, founded in 2004, provided tools and video linked data for scouting, match analysis, and transfers, coupling event data with visual context. InStat, founded in 2007, initially organized raw match statistics, later incorporating AI driven aggregation and video integration to produce analytical reports via InStat Scout from around 2012 onward. On the fan engagement side of things, applications like Sofascore, which was launched in 2010 and is still one of the most popular sports analytics apps today, introduced real-time performance ratings accessible to mobile users worldwide. As big data became central, descriptive AI matured with advanced metrics. By the 2010s, expected goals (xG), expected assists (xA), heat maps, zone maps and making nuanced tactical assessments became commonplace. These metrics offered contextually rich insights, for example shot quality or chance creation, that standard stats couldn't provide. A notable figure in this field is Sarah Rudd. Sarah Rudd is one of the earlier pioneers of sports analytics relating to football. In 2011, she introduced a Markov chain based framework intended to evaluate player performance, especially in offensive sequences. Her work has influenced both academic and professional club level analysis and has led to practical adoption by Arsenal FC's analytics team. Other advanced frameworks, such as the Skellam regression framework for evaluating positional value and the PlayeRank system have helped to expand the reach of descriptive AI. The use of descriptive AI has proven to drive strategic breakthroughs. An example of this, which I will discuss in greater detail further on, is Leicester City FC's historic 2015/16 Premier League triumph. The club utilised data driven insights to structure counter attacking tactics, manage player fitness and target undervalued and unidentified talents like Riyad Mahrez and N'Golo Kante. Liverpool FC are known for utilising similar descriptive models to develop on pitch tactics and gain an upper hand in the transfer market. Within the world of football, descriptive AI has evolved from early manual metrics to AI enhanced systems capable of capturing thousands upon thousands of data points, generating deep and detailed insights and enabling vivid analytics. From notational

pioneers to modern event driven platforms and standardised data languages, the tools evolved and transformed every level of the sport from top clubs perfecting their transfer strategies and on pitch tactics to fans consuming data rich media. Descriptive AI continues to grow and evolve and undergird decision making, engagement and strategy in football.

Reinforcement Learning and Simulation

Reinforcement learning (RL) is a machine learning technique that enables robots to make intelligent decisions by learning from experience. By receiving programmatic rewards or penalties, the AI models that power robots improve through a process of trial and error.

The foundation for reinforcement learning and simulation in football traces back to something known as the RoboCup Simulation League, which began in the mid 1990s.

The RoboCup Simulation League is a league within the larger RoboCup competition focused on the development of artificial intelligence and team strategies through simulated soccer matches. It uses virtual soccer fields where autonomous software agents (players) compete, allowing researchers to explore multi-agent systems, AI, and machine learning without the need for physical robots. The league has two main sub-leagues: 2D and 3D, which differ in the dimensionality of the simulated environment.

(https://www.robocup.org/leagues/23#:~:text=RoboCupSoccer%20%2D%20Simulation,list%20(Both%202D%20and%203D)

These leagues provided the world with rich testbeds for developing multi agent coordination, strategy and control, well before reinforcement learning gained mainstream traction. For robot football, reinforcement learning has been rather instrumental in learning certain behaviours like kicking the ball and scoring goals. However, like all potential advancements in technology, it comes with some difficulties. The act of transferring simulation learned policies to real robots has proven a challenge due to the sim to real 'reality gap' for developers. Platforms like the FC Portugal 3D team have included RL into their frameworks, using the simulation environments to help refine low level, mundane skills such as kicking and running. In recent years, researchers have scaled RL to full team environments. ***Innovations in custom football sims have allowed for the creation of teams sized from anywhere between 1 vs. 1 to 11 vs. 11 by utilising efficient Python based wrappers and fast parallel simulation alongside reward shaping to train agents effectively.*** These environments are key to helping study learning dynamics, multi agent coordination and strategy emergence. They act as the perfect testing bed for researchers and potential developers. The theory of RL in simulation is now transitioning into real world application for the first time ever. In June of this year, 2025, Beijing plans to host the first ever 3 on 3 humanoid football match in a RoBoLeague match. Robots that are completely controlled by deep reinforcement learning and the use of optical camera inputs for vision will be taking the pitch and playing the game of football, having learned object recognition, positioning, passing and shooting all through reinforcement learning. From the early days of RoboCup's 2D sims to modern, highly advanced technological environments like Google Research Football,

reinforcement learning has broken boundaries that many developers and researchers could only dream of. The recent massive strides of end to end learned perception to action policies and real world robot competitions only further demonstrate how reinforcement learning and simulation are hurtling towards physical and strategic proficiency in football. The continued upward trajectory shows the massive advancement of AI not only in the sport of football but in the greater world in general. This has been a massive success in the world of AI, with great implications on robotics and engineering.

Natural Language Processing

Natural Language Processing (NLP) is a field of artificial intelligence that focuses on enabling computers to understand, interpret, and generate human language. It combines computer science, linguistics, and artificial intelligence to allow machines to process and make sense of text and speech data in a way that is similar to how humans do.

The use of natural language processing in the sport of football has surprisingly not been around for all that long. It is still an incredibly young and new aspect of the use of AI in football. One of the earliest applications of NLP in football happened around major tournaments such as the 214 FIFA World Cup. Companies such as Luminoso analysed nearly 900,000 social media posts in an attempt to track fan reaction and sentiment in real time. For example, tracking and gauging reactions during Germany vs. Brazil. The goal of this was to help teams, broadcasters and sponsors understand audience sentiment on a much larger scale. Over the years, the technology matured, and NLP had begun powering automated match summaries and the generation of real time commentary. Platforms such as Stats Perform (which was formerly known as Opta) developed a system to convert structured event data into narrative text. This created instant post match reports and dynamic play by play descriptions. The aim of these systems was to make a more inclusive space for visually impaired fans by transforming and translating the game events into vivid, descriptive language. The role of NLP in fan engagement and marketing grew incredibly quickly and significantly. Teams and sports apps began using sentiment analysis on social media to tailor their content, regionally customise messaging and engage fans with personalised highlights and experiences. Gone were the days of default messages and greetings, the same highlights regardless of location or preferences, NLP had helped introduce a world of personalised, targeted experiences for football fans. Simultaneously, NLP driven chatbots were introduced in an attempt to enhance user experiences, answering fan queries and delivering updates, making fan interactions feel satisfying and immersive. As recently as 2024, voice driven NLP applications have entered the footballing scene. Most notably StatMuse, an AI powered sports stats service that allows users to ask detailed football related questions in natural language and receive spoken or visual responses. For example, one could ask “How many minutes per game did Mo Salah play last season when coming off the bench?” and they would be answered with a detailed response with the answer and the breakdown. StatMuse has been around for quite some time within the basketball world, so it will take some time for it to be fully fool proof when it comes to football stats and data. Currently it focuses mainly on the English Premier League with an aim to expand to other leagues across the globe. The trajectory of NLP in football

illustrates a shift in traditional fan experiences to a reshaping of media workflows to enable deep analytic insight and seamless multimodal access. As transformer models and multimodal integration continue to evolve, one would hope for data richer, more conversational and context aware applications that will shape the future of how fans, clubs and analysts interact with the sport of football and beyond.

AI Advancements in Refereeing

Throughout the years, one of the few things within the sport of football that stayed somewhat consistent was refereeing. Football is governed by The Laws of the Game, a universal framework put in place to ensure the game is played correctly and consistently throughout all levels, from grassroots football all the way up along the ladder to FIFA World Cup level. They are adopted and maintained by the International Football Association Board (IFAB). The laws of the game were set in stone, rarely changed and were generally well understood by players and referees alike. The first laws of the game were written in 1863 in England and have been tweaked and

changed slightly throughout the years as they evolved with the sport. As of today, there are 17 laws in total. They are as follows;

- Law 1: The Field of Play
- Law 2: The Ball
- Law 3: The Players
- Law 4: The Players' Equipment
- Law 5: The Referee
- Law 6: The Other Match Officials
- Law 7: The Duration of the Match
- Law 8: The Start and Restart of Play
- (Covers the kick-off and dropped-ball; other methods of restarting play are covered in other laws.)
- Law 9: The Ball In and Out of Play
- Law 10: Determining the Outcome of a Match
- Law 11: Offside
- Law 12: Fouls and Misconduct
- Law 13: Free Kicks
- Law 14: The Penalty Kick
- Law 15: The Throw-in
- Law 16: The Goal Kick
- Law 17: The Corner Kick

These laws define the field of play (dimensions, markings, goals), the ball's specifications and the number of players required (a maximum of 11, a minimum of 7). The Laws also set out player equipment standards, such as mandatory shin guards and outline the responsibilities of referees and assistant referees.

Within the last 15 years there have been some massive additions to the sport of football to assist referees in confidently making correct decisions and maintaining the fluidity and essence of the game. The three main additions that I will be focusing on are Video Assistant Referee, Semi Automated Offside and Goal Line Technology. While investigating and researching them I aim to answer the following questions.

- Has there been a noticeable increase in red cards awarded since the inception of Video Assistant Referee?
- Has the introduction of Video Assistant Referee hurt or helped the fluidity of the game?
- Has there been a noticeable increase in the number of penalties awarded since the inception of Video Assistant Referee?
- How frequent are offsides called in games nowadays compared to before the introduction of semi automated offside?

- Is the introduction of semi automated offside hurting or helping the game?
- Has the average number of goals scored per game/season risen since the introduction of goal line technology?
- What is the general consensus amongst fans, players and managers on these three additions?
- How often do referees make incorrect decisions despite the addition of these aids?
- What is **my opinion** on these additions to the sport as a lifelong fan?
- How can these additions be improved? Do they even need to be improved?

Video Assistant Referee (VAR)

Video Assistant Referee (VAR) was formally introduced and included in The Laws of the Game prior to the 2018/19 football season; however, trials had begun prior to this at the 2018 FIFA World Cup. The end goal of introducing VAR was to help referees make consistent, correct decisions on a regular basis. For years, there had been outrage amongst fans and coaches who believed referees were not capable of making decisions in the heat of the moment on the pitch and that they needed assistance from an impartial aid who was not going to be influenced by the atmosphere in the stadium or the players around them. Something akin to this had already been used undeniably successfully in the sport of rugby. In rugby, if a referee is unsure of an on pitch decision and feels that they need some clarification, they will contact the television match official (TMO) who is in a booth where they have access to multiple screens with replays played at different angles so they can happily and confidently make the correct decisions on foul play or try decisions. The success of the TMO was definitely an indication that VAR, if handled correctly and by competent referees, would be a roaring success in football.

"The use of VARs during a match involves the following practical arrangements:

- ***The VAR watches the match in the video operation room (VOR) assisted by one or more assistant VARs (AVARs)***
- ***Depending on the number of camera angles and other considerations, there may be more than one AVAR and one or more replay operators (ROs)***
- ***Only authorised persons are allowed to enter the VOR or communicate with the VAR/AVAR/RO during the match***
- ***The VAR has independent access to, and replay control of, TV broadcast footage***
- ***The VAR is connected to the communication system being used by the match officials and can hear everything they say; the VAR can only speak to the referee by pushing a button (to avoid the referee being distracted by conversations in the VOR)***
- ***If the VAR is busy with a 'check' or a 'review', the AVAR may speak to the referee especially if the game needs to be stopped or to ensure play does not restart***

- ***If the referee decides to view the replay footage, the VAR will select the best angle/replay speed; the referee can request other/additional angles/speeds"***

Has there been a noticeable increase in red cards awarded since the inception of Video Assistant Referee?

Interestingly enough, there has actually been a decrease in red cards by 21.4% since 2009/10. Whether this is entirely due to the introduction of VAR is unclear, but it is definitely a possibility. While the introduction of VAR allows for referees to have a second chance at reviewing fouls and awarding red cards, it means that players are aware of this also. Therefore, the players on the pitch tend to play cleaner and are less likely to throw themselves into dangerous tackles as they know they have another set of eyes watching them at all times and that play can be pulled back if VAR feels it to be appropriate.

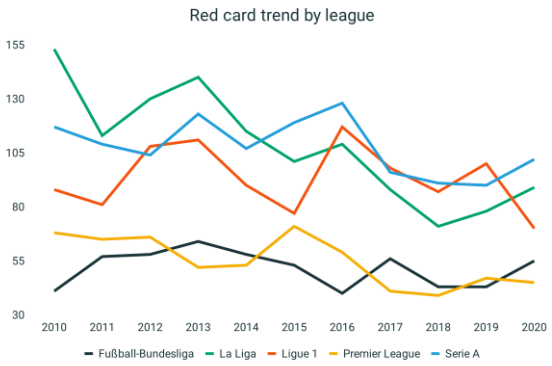
After VAR, red cards have gone up in the English Premier League & La Liga and down in Bundesliga & Ligue 1. The number in Serie A has not fluctuated much at all.

Average red cards per season before and after the introduction of VAR

Competition	Avg. Prior to VAR**	Avg. after VAR	% Change
Serie A	96.00	94.33	-1.74%
La Liga	79.50	83.50	+5.03%
Bundesliga	56.00	47.00	-16.07%
Premier League	42.33	45.00	+6.30%
Ligue 1	92.50	85.00	-8.11%
All Leagues	69.22	73.27	+5.85%

*The first season of VAR for each league was: Serie A - 17/18, La Liga - 18/19, Bundesliga - 17/18, Premier League - 19/20, Ligue 1 - 18/19.

**Avg. prior to var is calculated based on red card totals per league after the implementation of double jeopardy and prior to the implementation of VAR in order to reflect the most complete and accurate data.



"This data has been collected from 19,985 games in Europe's top 5 leagues between seasons 2009/10 and 2019/20.

It contains:

- ***German Bundesliga: 3,366 games***
- ***Spanish La Liga: 4,180 games***
- ***French Ligue 1: 4,079 games (due to Covid shortened 2019/20)***
- ***English Premier League: 4,180 games***
- ***Italian Serie A: 4,180 games"***

Historically, the home team tends to receive bias relating to refereeing decisions, this no longer seems to be the case. In the Premier League, the ratio of away-team to home-team red cards fell from **1.8 (pre-2001)** to **1.04 post-VAR (2019 onward),** indicating improved fairness.

In the 2018 FIFA World Cup, only 4 red cards were awarded, the fewest in 40 years.

(https://www.thetimes.com/sport/football/article/bowens-crossbar-hat-trick-and-did-var-vanquish-home-team-bias-t6qpzl5qp)

(https://runrepeat.com/red-card-frequency)

Has there been a noticeable increase in the number of penalties awarded since the inception of Video Assistant Referee?

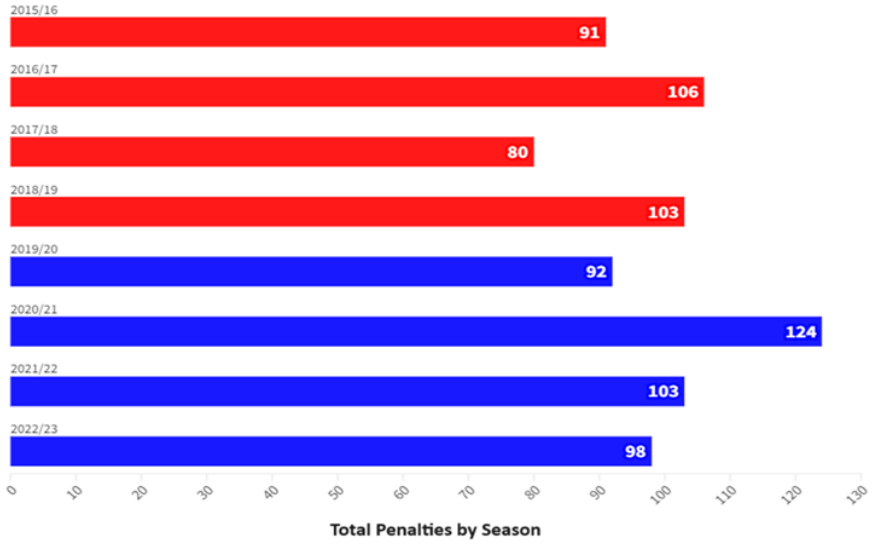
Yes, there has generally been a pretty noticeable increase in penalties awarded since the introduction of VAR, especially in leagues like La Liga and at global tournaments like the World Cup.

At the 2018 FIFA World Cup, a record 29 penalties were awarded. This was also the first major tournament in which VAR was used. The following World Cup saw 23 penalties awarded, still 5 more than the previous record of 18 at the 1998 World Cup. It is fair to say that VAR was a deciding factor in these numbers.

From 2019/20 to 2023/24, the number of penalties per season in the English Premier League increased from 95 to 104.26, a near 10% increase.

- **2019–20**: **22** VAR penalties out of **92** total (**~24%**)
- **2020–21**: **29** of **125** (**~23%**)
- **2021–22**: **38** of **103** (**~37%**)

Handball tends to be the most common reason for VAR to award a penalty, 60% of VAR awarded penalties are given for handball.



Total penalties per season EPL, pre and post VAR.

Has the introduction of Video Assistant Referee hurt or helped the fluidity of the game?

While VAR was introduced to try and help the fluidity of the game, there have been both positive and negative impacts in this regard.

Pros:

- Fewer player and manager protests - if a decision is being taken into account by the VAR officials, players and coaches are unable to protest towards them as they are off location reviewing the footage.
- Players are typically less likely to lunge into tackles, try sneakily throw a punch or kick into another player as they are aware they are being monitored by VAR at all times.

- In some cases, VAR can be used to quickly make a decision. For example, in cases of mistaken identity or a clear red card foul, penalty incident.

Cons:

- Reviews often halt play for 1-3 minutes, disrupting rhythm. Studies of the Bundesliga and Serie A found an average of 6-7 VAR interventions per match week, adding significant stoppage time. It has been noticed that the average stoppage time in football matches has increased by quite a bit since the introduction of VAR. It is not uncommon for there to be 7 or more minutes of stoppage time, whereas pre VAR, this would have been an anomaly.
- The introduction of VAR has led to uncertainty amongst fans and players in the stadium when decisions are being made. While it can be interesting for those watching at home as the broadcast tends to include the decision making process, for those at the stadium all it does is cause confusion and dismay. Fans and players are more reluctant to celebrate due to the thought that the goal may be called back for a foul that happened in the build up or offside.
- The introduction of VAR has made 'grey area fouls' much harder to detect. While this may sound unusual, the reason behind it is that due to the VAR officials having all the replays and angles of the footage, it allows them to almost over analyse it to an extent. A tackle can look career threatening when you watch it frame by frame compared to if you watch it in real time. It happens more often than not that a player is sent off for a tackle because the VAR team have slowed everything down, go through it frame by frame and decide it is a bad tackle due to a split second reduced to a frame. The problem here is the inconsistency and inexperience shown by the officials.

How often do referees make incorrect decisions despite the addition of these aids?

The Professional Game Match Officials Limited (PGMOL) issued 13 apologies due to errors in VAR decision making from the start of the 2022/23 season to October 3, 2023. When the technology is so advanced, this should not be an issue.

<u>Semi-Automated Offside Technology</u>

"After first being trialled in 2021 during the FIFA Club World Cup, before being properly rolled out at the 2022 FIFA World Cup, semi-automated offside technology is a tool designed to automates key elements of the offside decision-making process for the match officials."

Semi-automated offside technology is another recent addition to the game's long list of AI aids. It was formally introduced to the game at the 2022 FIFA World Cup after successful trials in lesser competitions. The goal of semi-automated offside was to support the referees and VAR officials in making faster, consistent, correct decisions in relation to offside. The offside rule has been and will continue to be a bone of contention amongst everyone involved in football no matter what is done to accurately identify and rule offside decisions. The hope is that semi-automated offside technology would lessen the controversy surrounding this rule.

Semi-Automated Offside Technology utilises "***specialised tracking technology and artificial intelligence. A sensor inside the match ball communicates with a network of cameras around the stadium, tracking both the ball and players' limb positions in real time. This data is then processed by AI, which alerts the VAR team instantly when a potential offside has occurred. The referee is still the final decision-maker, but the system provides a highly reliable and impartial layer of assistance, reducing the need for lengthy video checks.".***

How frequently are offsides called in games nowadays compared to before the introduction of semi automated offside technology?

A detailed 10-season study by Yangqing Zhao analysed the top five European leagues (English Premier League, La Liga, Serie A, Bundesliga, Ligue 1) and found a consistent decline in offsides per match over that period.

Notably:

Offside calls in 2018/19 were significantly fewer than in prior seasons—especially in Ligue 1 (2018/19 vs. earlier seasons) and Serie A; La Liga also dropped but was comparable to 2017/18 levels.

Overall decreases from 2009/10 to 2018/19:

- Premier League: ~11% decrease
- Bundesliga: ~36%
- Serie A: ~40%
- La Liga: ~23%
- Ligue 1: ~27%

As the semi automated offside technology is so young, and has only been used in a number of leagues for the better part of 2 years, there is not enough data to suggest that there has been a noticeable increase or decrease in the number of offside calls per game/season/league. Over the course of the next few years, it should become clearer whether semi automated offside technology is causing a fluctuation in the number of offside calls. There just isn't enough data to give an outright answer as of today.

Before this technology, we were already on a downward trajectory. This could well be due to tactical changes around the world of football. Each era of football comes with a fairly consistent play style among teams. In today's game, FC Barcelona are one of the few teams who take advantage of the introduction of this technology by playing a high line with an offside trap. This resulted in a staggering 201 offsides suffered by their opponents in 36 matches as of February 2025, proving that play styles can be revolved around these technologies.

Has the introduction of semi automated offside hurt or helped the game?

Again, like VAR, the introduction of this technology has resulted in both positive and negative impacts.

Pros:

- Traditionally, VAR would take an average of 3 minutes to make an offside decision. This was due to the officials having to manually draw lines and manipulate the footage to give them the correct angle to make the decision. With this new technology, the decision typically takes around 30 seconds. This massive time decrease helps remove any concern and restlessness among fans, players and coaches.
- Much greater consistency due to the use of 12-15 cameras that track 29 body points of the player, with a sensor in the ball also. This helps remove the risk of human error that came with manual drawing within VAR.
- It removes the confusion among fans as the offside technology shows an animation detailing exactly where and how the player is offside within the stadium on the big screen.

Cons:

- The main problem with this technology is that it judges a player offside no matter how fractionally offside they may appear to be. For example, if the tip of a player's boot is offside, and we are talking about millimeters of millimeters here, the player will be judged offside. This obscurity only causes and creates more problems and controversy.
- Despite the risk of human error, the loss of human engagement in the offside decision making process will always be an issue. Traditionally linesmen would have called

someone offside by raising their flag. Some fans feel the game is becoming far too sterile and has too much technological involvement.

- Inconsistency among the leagues. The English Premier League has a 5cm buffer zone where a player can technically be 5cm offside and still be judged to be onside to avoid extremely tight and controversial calls whereas FIFA tournaments and the majority of leagues around the world do not follow this rule.

Goal Line Technology

The oldest of these three AI additions is Goal Line Technology. Goal Line Technology was first introduced to the sport of football at the 2014 FIFA World Cup in Brazil and was subsequently rolled out in major leagues around the world (La Liga still have not implemented the use of goal line technology despite availing of other technologies like VAR and semi automated offside). Calls for goal line technology had been intensifying for years prior to it's induction due to many famous cases of clear goals not being given because the referee and linesemen were not sure if

the ball had crossed the line fully, most notably Frank Lampard's volley vs. Germany in 2010 which was not given as a goal despite crossing the line by some distance. In the laws of the game, the entire ball must cross the line for it to be awarded as a goal. This therefore in rare occasions caused some controversy when it wasn't clear to the human eye whether the ball had crossed the line fully or not.

The two main systems used are HawkEye and GoalRef & Cairos. HawkEye is also used in a number of other sports such as hurling and Gaelic football. Once the ball crosses the line, a notification is sent to the referee's watch to let them know they can award the goal. The introduction of this technology has resulted in several iconic moments where games and even league titles have been won due to the ball being cleared off the line with mere millimetres of it having not crossed the line, most notably in Manchester City vs. Liverpool in 2019 where the ball was 11 millimetres from crossing the line before John Stones cleared it and subsequently won the match and league title for Manchester City.

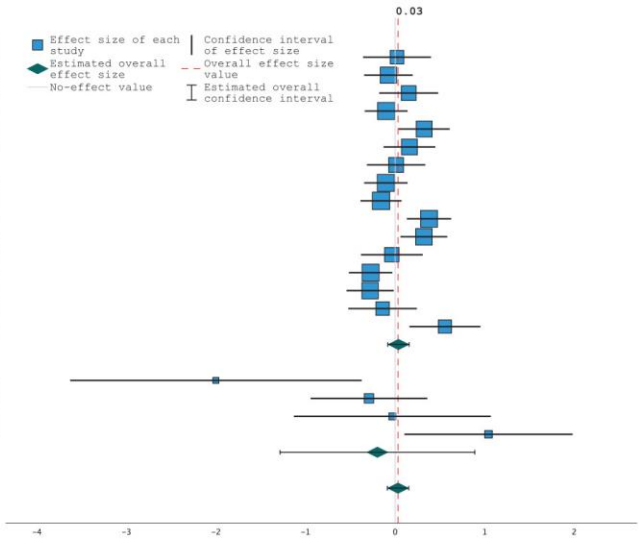
Has the average number of goals scored per game/season risen since the introduction of goal line technology?

A recent meta analysis study by ***Mike Rogerson, School of Sport, Rehabilitation and Exercise Sciences, University of Essex*** looked at the average goals scored per match across a number of competitions before and after the introduction of VAR (GLT included) and found little to no statistically significant difference.

- **Pre-VAR:** 2.9 goals per match (± 0.5)
- **Post-VAR:** 2.9 goals per match (± 0.3)
- **Mean difference:** just 0.03 goals per match (not significant, $p = 0.60$)

The study's conclusion stated the following; ***"The current meta-analysis concludes that overall, across football's geographical, club and international landscape, the respective initial implementations of VAR did not influence the number of goals scored to a statistically nor meaningful significant extent. This finding was also true when examining each of the home and away goals scored in isolation. Lastly, inter-competition heterogeneity was found to be small."***

Competition Type	Study	Mean difference	Lower	Upper	p-value	Weight	Weight (%)
Club	A-League (Australia)	0.02	-0.36	0.40	0.92	12.94	4.76
	Bundesliga 1 (Germany)	-0.08	-0.35	0.20	0.58	16.95	6.24
	Chinese Super League	0.15	-0.18	0.48	0.37	14.68	5.41
	English Premier League	-0.10	-0.34	0.14	0.41	18.27	6.73
	Eredevisie (Netherlands)	0.32	0.04	0.61	0.03	16.39	6.03
	Juliper Pro League (Be...	0.16	-0.13	0.45	0.28	16.25	5.98
	K League 1 (South Korea)	0.01	-0.32	0.34	0.95	14.82	5.45
	La Liga (Spain)	-0.10	-0.35	0.14	0.40	18.12	6.67
	Ligue 1 (France)	-0.16	-0.39	0.07	0.18	18.69	6.88
	Major League Soccer (USA)	0.38	0.13	0.63	0.00	17.91	6.59
	Primera Liga (Portugal)	0.32	0.06	0.58	0.02	17.34	6.38
	Saudi Pro League	-0.04	-0.38	0.31	0.83	14.12	5.20
	Serie A (Italy)	-0.28	-0.52	-0.03	0.03	18.12	6.67
	Süper Lig (Turkey)	-0.28	-0.54	-0.02	0.04	17.28	6.36
	Swiss Super League	-0.14	-0.52	0.24	0.47	12.81	4.72
	UAE Pro League	0.56	0.16	0.95	0.01	12.38	4.56
	Subgroup Overall	0.04	-0.08	0.16	0.55		
Nations	FIFA Confederations Cup	-2.00	-3.63	-0.38	0.02	1.37	0.50
	FIFA Men's World Cup	-0.29	-0.94	0.36	0.38	6.66	2.45
	FIFA Women's World Cup	-0.03	-1.13	1.07	0.95	2.82	1.04
	UEFA Women's European ...	1.04	0.10	1.98	0.03	3.71	1.37
	Subgroup Overall	-0.20	-1.29	0.89	0.72		
Overall		0.03	-0.09	0.15	0.60		



Model: Random-effects model
Heterogeneity: Tau-squared = 0.04, H-squared = 2.55, I-squared = 0.61
Homogeneity: Q = 53.54, df = 19, p-value = 0.00
Test of overall effect size: z = 0.52, p-value = 0.60
Test of between-subgroup homogeneity: Q = 0.18, df = 1, p-value = 0.67

Forest plot of unstandardised overall and subgroup effects for total number of goals scored, by competition type.

AI Advancements in Scouting

Scouting is one of football's oldest practices, a man named Herbert Chapman is often recognised as the figurative father of football scouts. ***"In the early 20th century, Herbert Chapman was a name synonymous with innovation. As the manager of Arsenal from 1925 to 1934, he revolutionized the scouting system. Chapman believed in meticulous preparation and was one of the first to deploy scouts to watch opponents extensively before matches, a practice now commonplace in modern football. Chapman's approach to scouting set the standard for systematic player analysis and helped Arsenal become one of the dominant forces in English football."*** During a time where scouting wasn't fully understood, Chapman believed that sending scouts to watch opponents would give his side the upper hand due to their understanding of their opponent's play style. Another scout known for his scouting prowess was Jock Stein, a man responsible for unearthing some of Celtic's most legendary of gems. ***"Jock Stein, a Scottish football icon, managed Celtic during the 1960s and 1970s. Stein's scouting prowess led him to discover talents like Kenny Dalglish and Danny McGrain. His keen eye for talent transformed Celtic into a European powerhouse. Stein's legacy lives on through the many players he brought to Celtic and his impact on Scottish football as a whole."***

What is scouting? Football scouting is the process of identifying, analysing and recruiting players through extensive research typically done by watching them play for a number of weeks and analysing not only their goals and assists but also, more importantly, their underlying statistics. Scouts compile detailed reports for their club to help find players who fit the needs of a club and can help enhance the team and take them to the next level. These reports include a number of traits including technical skills, tactical awareness, physical attributes and personality traits to name a few.

How is AI involved? Traditionally, scouting would consist of a club sending a scout to monitor and report on a certain player or a club would send a scout to a certain location, give the scout specific parameters and hope they could find a player who ticks all the boxes. This, however, can make way for a plethora of limitations. To have and maintain a diverse, detailed scouting system is largely unaffordable for most clubs in the world. It becomes unrealistic and relatively impossible to cover a large number of countries or locations and due to this, clubs will find it rather difficult to find the figurative diamonds in the rough when it comes to promising footballers.

In the 2000s - 2010s, data analytics platforms like Opta and Wyscout revolutionised scouting by providing statistics (passes completed, sprints, pressing actions).

AI took this a step further by enabling:

- **Pattern recognition:** identifying players whose metrics resemble current stars.
- **Predictive modelling:** forecasting how a player might perform in different leagues or systems.

- **Automated video analysis:** computer vision tracking movements and decision-making from match footage.

Case study: Brighton & Hove Albion and Brentford FC

Brighton & Hove Albion

In 2009, Brighton & Hove Albion had just finished 16th in League One, the third division of English football. They had not been in the top flight since the mid 1980s and it looked as though this would long continue. However, exciting times for the club were afoot as 39 year old professional gambler and entrepreneur, Tony Bloom, had just purchased the club with a 75% share, and £93 million raised to build a new stadium. Over the years, through improvements to the stadium, training facilities and coaching staff, Brighton & Hove Albion gained promotion back to the top flight of English football for the first time in 34 years ahead of the 2016/17 season.

Tony Bloom is the owner of Starlizard, a betting consultancy that uses advanced analytics and machine learning to predict football outcomes. Brighton's recruitment algorithm and strategy is an offshoot of this data culture. Bloom partnered with Jamestown Analytics, a boutique data firm, to build proprietary algorithms to help identify undervalued talent. Brighton's scouting strategy is to buy low and sell high. By utilising AI in assisting with these algorithms, they are able to identify talent that has sneaked under the radar of bigger clubs. Brighton replaced the intuition-first scouting model with a data-first system. Brighton's recruitment runs on algorithms that generate a "scoring system" for players worldwide. The algorithm evaluates thousands of metrics such as:

- Technical actions (passes, shots, dribbles, pressures).
- Physical data (sprints, distance, stamina).
- Psychological cues (composure under pressure, decision-making).
- Contextual stats (performance relative to league difficulty, team style).

Brighton's algorithm goes well beyond physical stats, using AI to analyse player's psychology. Their systems can track body language, decision-making under stress and consistency across matches.

Some of the metrics include:

- Leadership behaviors (gesturing, directing teammates).
- Emotional control (responses to fouls or missed chances).
- Risk-taking vs. safe play (decision analysis from video footage).

Access is highly restricted, so much so that even senior Brighton staff are not aware of the full formula. This is done so to ensure nothing leaks and Brighton maintains a competitive advantage over their opposition.

During the 2024/25 season, Brighton made headlines by releasing a number of scouts in favour of implementing more AI systems to generate targets. This shift shows Brighton's belief that objective, repeatable analytics outperform subjective human judgments in talent identification. Traditional scouts still play a role in identifying initial targets which are then run through the algorithm to see if they are a good fit for Brighton's philosophy. While big clubs like Manchester United and Chelsea have vast scouting systems that stretch across the globe, Brighton maintains that less people and more data is the key to a successful scouting system. The results definitely help Brighton's case.

Below are just a few cases of where shrewd spending, backed by Brighton's AI driven scouting system, allowed them to buy low and sell high, or in some cases, see massive rising value.

Player	**Bought For**	**Sold For/Value**	**ROI**
Moises Caicedo	£4.5m	£115m (to Chelsea)	25x
Marc Cucurella	£15m	£60m (to Chelsea)	4x
Alexis MacAllister	£7m	£35m (to Liverpool)	5x
Karou Mitoma	£2.5m	£50-70m valuation	20x
Robert Sanchez	£0 (Academy)	£25m (to Chelsea)	Pure Profit
Leandro Trossard	£15m	£27m (to Arsenal)	~2x
Carlos Baleba	£20m	£115m valuation	~6x

Why does it work?

- Tony Bloom's gambling/data background drives top to bottom commitment.
- Unlike other clubs using somewhat archaic tools (but still reliable) like Wyscout and Hudl, Brighton's algorithms are professionally tailored and suited to their wants and needs.
- The model emphasises value creation, not superstar spending.
- While data leads, Brighton hasn't *fully* abandoned humans, character checks are essential.
- Recruitment aligns with Brighton's tactical philosophy (possession-based, versatile players, high resale value).

Criticisms/Negatives

- Releasing traditional scouts drew criticism, AI might miss intangible qualities. It was seen as a massive insult to the footballing community that Brighton valued machines over human beings.
- Rivals are now copying data-led approaches (Liverpool, Brentford, Midtjylland). Brighton's edge could shrink.
- Success leads to bigger clubs poaching both players and staff (e.g., Graham Potter to Chelsea, Alexis MacAllister to Liverpool).
- Models are only as good as the data, there's risk of undervaluing unconventional talents. While the algorithms are great, there's always something the human eye can pick up that the data cannot.

AI driven scouting systems have been a massive success for Brighton & Hove Albion. The implementation of these systems has led to their first promotion to the Premier League in 34 years, shrewd business which helped them secure incredible signings that brought the team to qualify for European competitions and most importantly, helped them accumulate over £320 million worth of profit in transfer sales over the past few years. An almost unheard of number.

Brentford FC

Much like Brighton, Brentford FC also value AI driven scouting. However, they have implemented a 'Moneyball' type approach when it comes to identifying players of value. In 2012, Brentford FC found themselves finishing 9th in League One, the third tier of English football. In this same year they were taken over by Matthew Benham, an Oxford physics graduate and former derivatives trader. He applied his expertise from sports betting and predictive modeling, via his company SmartOdds, to fundamentally change how the club makes decisions, both on and off the pitch. His primary goal was to prioritise objectivity over intuition, operating the club almost like a hedge fund, seeking big upside from a small risk.

The club thoroughly evaluates over 85,000 players globally. Brentford have a seven stage recruitment process, operated by Technical Director Lee Dykes, which goes as follows:

- **Data Filtering:** SmartOdds narrows down vast pools to manageable targets.
- **Role-Based Profiling:** The club defines 16 specialised roles (e.g., differentiating types of wingers or forwards).
- **Priority Identification:** Decide which positions to reinforce each window.
- **Target Shortlisting:** Narrow to top 2 - 3 candidates per role, blending data with video scouting (e.g., >50 video reports for Bryan Mbeumo).
- **Staff Validation:** Coaches and analysts assess tactical fit and development potential.
- **Final Decision:** Dykes, Frank, and Benham jointly select based on metrics, value, and fit for the club and squad.

- **Strategic Negotiation:** Deals are discreet and value driven (e.g., Said Benrahma for £1.5 M sold for £25 M)

Below are a number of players who were bought utilising Brentford's detailed AI driven data scouting systems, and sold for a big profit.

Player	Bought For	Sold For
Ollie Watkins	£6.5m	£30.6m
Neal Maupay	£1.8m	£20m
Said Benrahma	£1.5m	£25m
Ezri Konsa	£2.5m	£12m
David Raya	£3m	£35m
Ivan Toney	£5m	£40m
Bryan Mbeumo	£5.8m	£71m
Christian Nørgaard	£2m	£10m

Why it works

- Benham's commitment anchors decisions, from recruitment to sports science.
- SmartOdds gives Brentford a unique edge over teams using other systems.
- Repeated, high margin player sales fund infrastructure and stability.
- Science-backed methods enhance injury prevention, fitness, and tactical planning.
- Data drives ideas and scouting, humans verify execution and cultural fit. A match made in heaven.

Challenges

- Rival clubs are adopting similar data-led recruitment strategies, potentially diluting Brentford's edge.
- Constant selling necessitates regular rebuilding, posing challenges to team cohesion. It's hard to always get it right, even perfect data can lie.
- As with any analytics system, intangible aspects like dressing-room dynamics remain hard to quantify. Again, data can lie and not tell the full truth about a player who seems perfect on paper.

Brentford FC are another success story in the world of AI in football. A club that hadn't been in the top flight for 60+ years, now a Premier League mainstay and another club with a knack for unearthing gems in the transfer market. It won't be long before other clubs copy what they are doing and reap the benefits for themselves.

My Digital Artefact

For my digital artefact, I chose to develop a webpage that displayed my findings through interactive graphs and charts, as well as information about my project. I coded this website using the TypeScript coding language, one of which I learned through my years studying Digital Humanities. I chose to develop a website as I found this to be one of the more enjoyable aspects throughout my years of study. Prior to beginning the creation of my website, I weighed up a couple of options of what was best to make a smooth, fully functional website. I began creating the site on Drupal, however I ran into a few problems when it came to laying out things exactly as I intended. After a while of trial and failure, I decided to code the website myself using the TypeScript coding language, with CSS for styling as I felt this would give me the best chance at properly creating what I visualised the site would look like.

My site consists of 6 different pages, Home, About, Applications, Research Data, Analysis and Sources.

- **Home:** Main landing page, basic info about the project.
- **About:** More detail about my project, what I researched, goal.
- **Applications:** Lets user explore the specific AI technologies that I researched for this project.
- **Research:** Project overview and research focus areas with some of my key findings,
- **Data Analysis:** Contains graphs and charts related to my findings.
- **Sources:** Lists my sources with Harvard referencing style.

Conclusion

Artificial Intelligence implementation is and always will be a controversial topic within the world of football, I don't think that's ever going to change. However, after learning more and more about both the benefits and the challenges of AI in football while undertaking this project, I believe that over the next few years, fans will slowly learn to accept it's place in football and appreciate the good that it does for the sport. While it can make mistakes, that's also what kind of humanises it to an extent. I truly believe that AI has, and will continue to help the sport grow, evolve and improve for years to come.

Without the use of AI, I believe that the sport would be even more negative than it already is. We have seen in the past how referees were targeted and abused over small mistakes that were incredibly easy to make without technological assistance. Whether fans like it or not, the data proves that the implementation of these AI systems has drastically improved the fairness of the sport. Players are less likely to receive unworthy red cards than before, offsides are spotted within seconds, goals are given when they are meant to be given, and referees are able to take

some time to reevaluate their decisions by watching all the replays and angles of the moment in question.

On the scouting side of things, it is without question that AI is beneficial and yields incredibly positive results. Without it, we wouldn't see the success stories of clubs like Brighton & Hove Albion and Brentford FC. These smaller clubs utilising the presence of AI has allowed a break from the norm, where the 'Big 6' would constantly take up European spots. It means that now money doesn't equal success, shrewd analysis and smart spending does. I believe AI implementation within scouting practices is fantastic and has gifted the sport of football with a plethora of undervalued gems that previously would have gone unknown.

To conclude, I believe my research has met the brief and answered the research question I set out to answer. I am happy to conclude that while it is still young and evolving, AI has changed the sport of football as we know it in a positive way, promoting fairness and levelling the playing field so to speak. While there will be some challenges and criticisms of AI, I believe that if used morally and intelligently, it can only benefit the sport of football even more so than it has already.

Bibliography

- *Akdağ, E., Işın, A., Lorenzo Calvo, A., Alonso Pérez Chao, E. & Jiménez Sáiz, S. L. (2025). 'Evaluating the Impact of Video Assistant Referee Implementation in Football: A Four-Season Analysis of Match Performance Trends', Applied Sciences, 15(9), 4789. Available at: https://www.mdpi.com/2076-3417/15/9/4789*
- *Bunker, R., Yeung, C. & Fujii, K. (2024). 'Machine Learning for Soccer Match Result Prediction', arXiv preprint arXiv:2403.07669. Available at: https://dl.acm.org/doi/pdf/10.1145/3477314.3507257*
- *Cortez, A., Trigo, A. & Loureiro, N. (2021). 'Who Will Score? A Machine Learning Approach to Supporting Football Team Management', Entropy, 23(1), 90. Available at: https://www.mdpi.com/1099-4300/23/1/90*
- *de la Torre, R., Calvet, L. O. & López-López, D. (2022). 'Business Analytics in Sport Talent Acquisition: Methods, Experiences, and Open Research Opportunities', International Journal of Business Analytics, 9(1), pp. 1-20. Available at: https://www.researchgate.net/publication/357490127_Business_Analytics_in_Sport_Talent_Acquisition_Methods_Experiences_and_Open_Research_Opportunities*
- *Decroos, T., Bransen, L., Van Haaren, J. & Davis, J. (2019). 'Actions Speak Louder than Goals: Valuing Player Actions in Soccer', Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, pp. 1851-1861. Available at: https://www.janvanhaaren.be/assets/papers/kdd-2019-vaep.pdf*
- *Deliège, A., Cioppa, A., Giancola, S., Seikavandi, M. J., Dueholm, J. V., Nasrollahi, K., Ghanem, B., Moeslund, T. B. & Van Droogenbroeck, M. (2021). 'SoccerNet-v2: A Dataset and Benchmarks for Holistic Understanding of Broadcast Soccer Videos', Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 4508-4519. Available at: https://openaccess.thecvf.com/content/CVPR2021W/CVSports/papers/Deliege_SoccerNet-v2_A_Dataset_and_Benchmarks_for_Holistic_Understanding_of_Broadcast_CVPRW_2021_paper.pdf*
- *Desai, S. (2025). 'Real Time Offside Detection using a Single Camera in Soccer', arXiv preprint arXiv:2502.16030. Available at: https://arxiv.org/abs/2502.16030*
- *D'Urso, D. J., Petri, C., Bisciotti, G. N., Guenoun, D., Coudeyre, E., Gremeaux, V. & Edouard, P. (2023). 'Machine learning for understanding and predicting injuries in football', Sports Medicine - Open, 9(1), 73. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC10443261/*
- *Dowling, E. (2023). How has VAR affected the Premier League? Sports Gazette. Available at: https://sportsgazette.co.uk/how-has-var-affected-the-premier-league/*
- *Frost, W., Groom, R. & Nicholls, S. B. (2025). 'The use of performance analysis and data driven approaches within senior men's football recruitment', International Journal of*

Sports Science & Coaching, pp. 1-13. Available at: https://repository.derby.ac.uk/item/qvxz1/the-use-of-performance-analysis-and-data-driven-approaches-within-senior-men-s-football-recruitment

- *Guardian, The (2025). "It's a new world": the analysts using AI to psychologically profile elite players', The Guardian, 19 April. Available at: https://www.theguardian.com/football/2025/apr/19/analysts-artificial-intelligence-psychologically-profile-elite-players*
- *Guardian, The (2025). 'Brighton's transfer push backed by 'physicality' and cutting-edge data', The Guardian, 22 June. Available at: https://www.theguardian.com/football/2025/jun/22/brightons-transfer-push-backed-by-physicality-and-cutting-edge-data*
- *IFAB (2025). Video Assistant Referee (VAR) protocol. Available at: https://www.theifab.com/laws/latest/video-assistant-referee-var-protocol/#reviewable-match-changing-decisions-incidents*
- *360 Scouting (2023). 'Brentford's Scouting Success: A Comprehensive Guide to Their Recruitment Strategy', 360 Scouting. Available at: https://360scouting.com/brentford-scouting-success*
- *Beesotted (2024). 'What's the process of signing a player? A breakdown of Brentford's scouting system', Beesotted. Available at: https://beesotted.com/whats-the-process-of-signing-a-player-a-breakdown-of-brentfords-scouting-system*
- *Johnson, D. (2022). 'How VAR has changed the Premier League, from penalties to offside and handball', ESPN, 6 June. Available at: https://www.espn.co.uk/football/story/_/id/37628835*
- *Kolbinger, O., Linke, D., Link, D. & Lames, M. (2015). 'Do We Need Goal Line Technology in Soccer or Could Video Proof Be a More Suitable Choice: A Cost-Benefit-Analysis of Goal Line Technology in Soccer and Thoughts About an Introduction of Video Proof', in J. Cabri, J. Barreiros & P. Pezarat Correia (eds.), Sports Science Research and Technology Support, Springer International Publishing, pp. 107-118. Available at: https://link.springer.com/chapter/10.1007/978-3-319-25249-0_8*
- *Lacan, S. (2024). 'Stacking-based deep neural network for player scouting in football', arXiv preprint arXiv:2403.08835. Available at: https://arxiv.org/abs/2403.08835*
- *Leveridge, S. (2024). 'Why La Liga Doesn't Have Goal-Line Technology', Forbes, 22 April. Available at: https://www.forbes.com/sites/samleveridge/2024/04/22/why-doesnt-la-liga-have-goal-line-technology/*
- *McLoughlin, D. (2023). 'Red Card Frequency', RunRepeat, 2 November. Available at: https://runrepeat.com/red-card-frequency*
- *Memmert, D., Lemmink, K. A. P. M. & Sampaio, J. (2025). 'Contextualization of soccer analysis with tactical periodization and performance analysis', Data Mining and Knowledge Discovery, 39(1), pp. 1-25. Available at: https://link.springer.com/article/10.1007/s10618-025-01092-9*

- *OG Pitch (2024). 'Eye-opening ,Why Brentford FC Proved Moneyball Works in Football: Inside the Premier League's Data Revolution', OG Pitch. Available at: https://ogpitch.com/eye-opening-why-brentford-fc-proved-moneyball-works-in-football-inside-the-premier-leagues-data-revolution-18*
- *Muthuraman, K., Joshi, P. & Raman, S. K. (2018). 'Vision Based Dynamic Offside Line Marker for Soccer Games', arXiv preprint arXiv:1804.06438. Available at: https://arxiv.org/abs/1804.06438*
- *Nlandu, T. (2012). 'The Fallacies of the Assumptions Behind the Arguments for Goal-Line Technology in Soccer', Sport Ethics and Philosophy, 6(4), pp. 451-466. Available at: https://www.researchgate.net/publication/271757092_The_Fallacies_of_the_Assumptions_Behind_the_Arguments_for_Goal-Line_Technology_in_Soccer*
- *Pantuso, G. & Hvattum, L. M. (2020). 'Maximizing performance with an eye on the finances: a chance-constrained model for football transfer market decisions', arXiv preprint arXiv:1911.04689. Available at: https://arxiv.org/abs/1911.04689*
- *Pappalardo, L., Cintia, P., Ferragina, P., Massucco, E., Pedreschi, D. & Giannotti, F. (2019). 'PlayeRank: Data-driven Performance Evaluation and Player Ranking in Soccer via a Machine Learning Approach', ACM Transactions on Intelligent Systems and Technology, 10(5), Article 59. Available at: https://dl.acm.org/doi/10.1145/3343172*
- *Plakias, S., Moustakidis, S., Kokkotis, C., Papalexi, M., Tsatalas, T., Giakas, G. & Tsaopoulos, D. (2023). 'Identifying Soccer Players' Playing Styles: A Systematic Review', Journal of Functional Morphology and Kinesiology, 8(3), 104. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC10443261/*
- *Pinnacle (2018). 'Analysing VAR - Could VAR affect home advantage?', Sports Trading Network. Available at: https://www.sportstradingnetwork.com/article/analysing-var-could-var-affect-home-advantage/*
- *Reynoso-Sánchez, L. F. (2023). 'Tech-Driven Talent Identification in Sports: Advancements and Implications', Health Nexus, 1(3), pp. 80-85. Available at: https://www.researchgate.net/publication/377912388_Tech-Driven_Talent_Identification_in_Sports_Advancements_and_Implications*
- *Rogerson, M., Knight, D. & Hope, E. (2024). 'The impact of video assistant referee (VAR) on the number of goals scored in football: A meta-analytic approach', Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology. Available at: https://journals.sagepub.com/doi/full/10.1177/17543371241242914*
- *Sports Odds History (2024). 'Sports Analytics History: Cases and Methods'. Available at: https://www.sportsoddshistory.com/sports-analytics-history-cases-and-methods/*
- *Spencer, P. (2025). 'Premier League semi-automated offside: How it works', TalkSPORT, 11 April. Available at: https://talksport.com/football/3074533/premier-league-semi-automated-offside-how-it-works*

- *Times, The (2024). 'Bowen's crossbar hat-trick and did VAR vanquish home team bias?', The Times. Available at: https://www.thetimes.com/sport/football/article/bowens-crossbar-hat-trick-and-did-var-vanquish-home-team-bias-t6qpzl5qp*
- *Times, The (2025). 'Jamestown Analytics: The data revolution in football transfers', The Times. Available at: https://www.thetimes.com/sport/football/article/jamestown-analytics-data-football-moises-caicedo-gxztr67hk*
- *Times, The (2024). 'How Brentford's data geeks turned them into top flight mainstay', The Times. Available at: https://www.thetimes.com/sport/football/article/how-brentfords-data-geeks-turned-them-into-top-flight-mainstay-z8sptt96t*
- *Vidal-Codina, F., Evans, N., El Fakir, B. & Billingham, J. (2022). 'Automatic event detection in football using tracking data', arXiv preprint arXiv:2202.00804. Available at: https://arxiv.org/abs/2202.00804*
- *Yunus, M., Aditya, R. S., Wahyudi, N. T. & Alrazeeni, D. M. (2024). 'Talent scouting and standardizing fitness data in football club: systematic review', Retos, 61, pp. 1588-1595. Available at: https://www.researchgate.net/publication/386281256_Talent_scouting_and_standardizing_fitness_data_in_football_club_systematic_review*
- *Zaalberg, A., Ramos, J. & Van Haaren, J. (2024). 'Beyond Playing Positions: Categorizing Soccer Players Based on Match-Specific Running Performance Using Unsupervised Machine Learning', Journal of Sports Science and Medicine, 23(1), pp. 565-574. Available at: https://www.jssm.org/jssm-24-565.xml-Fulltext*
- *Zhao, Y. (2021). 'Downtrends in Offside Offenses Among "The Big Five" European Football Leagues', Frontiers in Psychology, 12. Available at: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2021.719270/full*
- *Zone14 (2024). 'Brighton & Hove Albion: The modern age of football', Zone14, 2 May. Available at: https://zone14.ai/en/blog/brighton-the-modern-age-of-football*

Resources Used

- https://www.w3schools.com/css/
- https://www.w3schools.com/typescript/index.php
- https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html
- https://medium.com/@dimi_2011/setting-up-css-modules-in-typescript-project-52596526d19
- https://www.typescriptlang.org/play/