ML Engineers

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***Abstract*—In ML Engineers Group first we decided what will be our topic for presentation. Every member came up with a couple of topics for the presentation and in the end, we decided to continue with "Artificial Intelligence in Sports". After that, every member specialized his paper research in different subtopics. Batuhan Sal decided to go with data usage for strategy development, Ömer Erdağ choose to inspect ethical issues about AI usage in sports and Taekwondo sport case analysis and lastly, Serdar Biçici decided on explaining biomechanics analysis with AI and sports medicine. Subsequently, every member had approximately a week to read their papers and find essential materials for the presentation. At the end of the week, Serdar Biçici made a presentation draft with basic examples of citations and titles. Later on, all three members met in a group call and do the presentation by using online and local tools simultaneously. After being done with the presentation in a couple of hours, the ML Engineers group made some rehearsals for the real-life presentation in class. In that rehearsals, ML Engineers tried to keep up with the time limit given as "10 minutes" and found each other's mistakes while giving speeches. Before the presentation day, all members agreed upon a dress code in order to give more seriousness and a defining team look.**

I. Huge Impacts of AI On Sports

In this article, the subfields of AI are mentioned and as seen its applications in the sports industry. This text discusses the potential applications of artificial intelligence (AI) in the sports industry. It mentions the use of AI in fitness applications and wearable technology to provide personalized recommendations based on input from healthcare professionals and track users' exercise goals. The text also discusses the use of AI to improve athlete performance through the analysis of performance metrics and the development of personalized training programs. Additionally, the text mentions the potential for AI to assist coaches in analyzing player performance and tactics, as well as to enhance the viewing experience of sports fans through the use of statistics and personalized engagement. The text also mentions the potential for AI to augment the decision-making of referees and automate media coverage of sports events. Overall, the text suggests that AI has the potential to significantly impact various aspects of the sports industry.[1]

II. For non-data Scientists

In this article, it is observed that the implementation of AI in sports has gained more diversity. Some machine learning algorithms are mentioned in this paper. For example, unsupervised learning in fan segmentation is given. I think it is a very good introduction to this algorithm. We also learn the difference between supervised learning and unsupervised learning by looking at the examples. According to Chmait and Westerbeek, we also feed our supervised algorithm with our collected data results despite just saying our inputs to an unsupervised algorithm to split them into categories(2021,p.5). Thus, there are also other sports fields mentioned in the article, not just football. Formula 1, Tennis, Gymnastics and board games are examples of that. For instance, AI algorithms are being used in Formula 1 (F1) to improve racing tactics by analysing data coming from many sensors. In the last parts of the article, the topic of the future of AI in sports is discussed. I consider we will see the effects widely in the next ten years. Sports clubs have to use these cutting-edge skills to adapt to this new environment. There are a huge amount of data waiting to be analysed in the databases.[2]

III. Case Study

First of all, the author starts to talk about some basic knowledge of AI. It is stated that many fields are used in sports to interpret some messages. Liverpool Football Club has noticed this and started to cooperate with a German-based company called neuro11 in 2020. It can look like a sophisticated subject but the author summarizes it concisely. The neuro11 team has developed a highly innovative and fact-based mental strength training method that can be seamlessly integrated into their existing. This company uses scientific data collected from players and processes it by using some models. The clearest effect of this program was seen at Carabao Cup Final 2022 when the match between Liverpool and Chelsea went to the penalty shootout. The total score in penalties was 10-11 and Liverpool won. The interesting part of these penalties is related to Virgil Van Dijk's penalty. He scored a goal by kicking the ball to the region the goalkeeper was stranded. I think this shows that the neuro11 program has improved footballers' confidence levels a lot at some crucial moments. On the other hand, the 2021-2022 Premier League season is at the top about goals from set pieces for Liverpool FC.

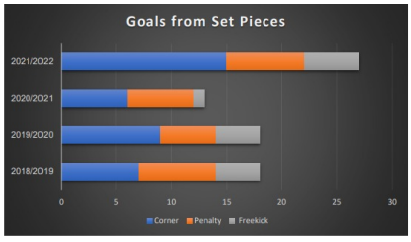

Fig 1. Liverpool Goal Stats [3]

IV. The case of AI in sport: Some ethical concerns at play

AI has played a significant role in recent sporting events, including the UEFA 2020, Copa America, the Tokyo Olympics, and the 108th edition of the Tour de France. These events have featured AI-powered technology such as social networking platforms, facial recognition, 3D athlete tracking, digital twins of race courses, and live tracking data. This paper aims to analyze the different uses and applications of AI in sports and to distinguish acceptable from unacceptable uses from an ethical perspective. The paper also discusses the ethical concerns raised by AI in sports and proposes a framework for trustworthy uses of AI in the field. Artificial intelligence is being used in various ways in the sports industry, including for training, coaching, data storage, doping monitoring, injury prevention, and assisted refereeing. In training, AI systems are used to collect data on athletes' movements and performance, and machine learning methods are used to analyze and classify this data. In coaching, AI systems are used to develop strategies and analyze player skills and endurance. They can also be used to make real-time decisions during games, such as changing strategies or substituting players. AI is also being used to improve performance by analyzing data on factors such as atmospheric conditions and analyzing how they may affect an athlete's performance. Major sporting events are also using AI to test the results of these systems. The World Anti-Doping Agency (WADA) is funding research projects on AI to improve the detection of performance-enhancing drugs such as EPO and steroids. AI is also being used to predict and prevent injuries in athletes, with some companies collecting data through technology during training and using machine learning algorithms to analyze an athlete's risk of injury and make recommendations to coaches and doctors. Video Assistant Referee (VAR) is being used in sports such as football, and FIFA is considering replacing human linesmen with robots, cameras, and computers in the future. AI is also being used in sports media for broadcast coverage, fan engagement, and personalized experiences, and for betting through predictive platforms like Quarter4, which uses machine learning algorithms to analyze athletes' and teams' performance data and provide betting guidance. AI refers to systems that can analyze their environment and take actions to achieve specific goals with some degree of autonomy. It includes machine learning, which refers to the development of computer systems that can imitate human intelligence, and autonomous systems, which are able to perform tasks independently. There is a risk that the more autonomy and independent ability that AI systems have, the fewer control humans have over them. However, the future may involve closer interaction between humans and machines, such as digital twins (digital replicas of physical entities) and cyborgs (integration of smart machines within the human body). The interaction between humans and AI may perform better than either alone, but the question of who has ultimate control over it remains. Artificial intelligence (AI) in sports has many positive applications, such as assisting with training, coaching, and doping monitoring, but it also has potential negative impacts, such as compromising privacy and leading to biased decisions. It is important to use AI ethically and in a way that promotes equality and human and planetary well-being. There are also ethical challenges, including the risk to individual privacy, the impact on decision-making processes, and the potential for AI to become unmanageable. The European Union (EU) has classified AI uses according to their risk level, with those involving unacceptable risk being strictly prohibited, those with high risk subject to strict requirements, and those with low or minimal risk following basic guidelines. It is important to create a responsible environment for AI in sports that align with the principles of good governance and respects human rights. Artificial intelligence (AI) has a wide range of applications in sports however, AI also poses ethical challenges, including risks to privacy, biased decision-making, and the potential for misuses such as cheating and manipulating competitions. To address these challenges, it is important to have a clear classification and organization of AI uses in sports, based on a risk approach that distinguishes between unacceptable risk, high risk, and low or minimal risk. In addition, AI in sports should respect human rights, including human dignity, autonomy and protection of the self, equality, and solidarity. It is important for sports governing bodies (SGBs) to have ethical frameworks and guidelines in place to ensure the responsible use of AI in sports. Artificial intelligence (AI) has been evolving since the late 20th century and includes a wide range of elements and technology. It is important to distinguish between AI in the form of machine learning and AI as autonomous systems. Machine learning is used in sports to perform tasks more efficiently and quickly, but autonomous systems can be out of human control. The use of AI in sports can improve performance, but it also raises ethical challenges such as risks to privacy and biased decision-making. It is important for the governance of AI in sports to classify its uses according to their risk level and to ensure that it is used in a fair and ethical manner that respects human rights and promotes distributive equality and human and planetary well-being. Basic ethical principles, including respect for human autonomy, nonmaleficence, beneficence, fairness, transparency, and accountability, should be followed to ensure a responsible and trustworthy application of AI in sports.[4]

V. Research on the Application of Artificial Intelligence in Taekwondo Sport

The overall quality of training for taekwondo in China needs to be improved in order to produce high-performing athletes. There are weaknesses in the mental adjustment and psychological quality of Chinese taekwondo athletes, which affects their ability to succeed in the competition. This is reflected in their technical ability and use of leg techniques and high-difficulty movements in comparison to other countries. There is a need to focus on improving training and teaching methods to improve the performance of taekwondo athletes in China.[5] Emerging sports and competition in the sports market have reduced

the attractiveness and influence of taekwondo competitions. Traditional methods of broadcasting taekwondo events have resulted in a lack of audience experience and the sport is difficult to fully appreciate through video media. The high speed and fast pace of taekwondo, as well as the importance of the referee's judgment, also make it difficult to ensure fairness in competitions. The World Taekwondo Federation has been working on the development and promotion of electronic protective gear to assist the work of referees and improve fairness, but the system is not yet mature and there are still issues with sensitivity and coverage. There are several ways that artificial intelligence technology can be integrated into taekwondo training and events:

- Creating an artificial intelligence-assisted training system that provides coaches and athletes with statistical analysis and feedback on technical movements, offensive and defensive performance, and physical data. This can help optimize the training There are several ways that artificial intelligence technology can be integrated into taekwondo training and events.
- Creating an artificial intelligence-assisted training system that provides coaches and athletes with statistical analysis and feedback on technical movements, offensive and defensive performance and physical data. This can help optimize the training process and contents.
- Using virtual reality technology to improve the psychological quality of athletes by allowing them to compete in a virtual environment that creates a sense of immersion.
- Improving the accuracy of taekwondo electronic protective gear through the optimization of artificial intelligence algorithms.
- Using artificial intelligence technology, such as intelligent 3D cameras, to intervene in critical and controversial judgments during taekwondo competitions, similar to the Hawk-Eye VAR system in soccer. This can help avoid miscues and misjudgments.

VI. Exploring the Application of Artificial Intelligence in Sports Training: A Case Study Approach

This paper is focused on certain artificial intelligence-based developments in sports training. First, it explains what is "Wearable AI Devices" and gives a specific example of "MySwing" technology. Wearable AI devices refer to devices that use artificial intelligence and are designed to be worn on the body. These devices can take many forms, such as smartwatches, fitness trackers, augmented reality glasses, and more. Wearable AI technology can be used for a variety of purposes however in this particular case, it mainly focuses on getting live data from the user in order to process sports and movement-related information. MySwing is a product developed for both professional and amateur golf players. It records your movements like motion capture technology and outputs a breakdown of your style of swinging the golf club, your hit angle, your body movements, how fast you moved the club, etc. Then you can do a much deeper analysis of your technique and improvements.

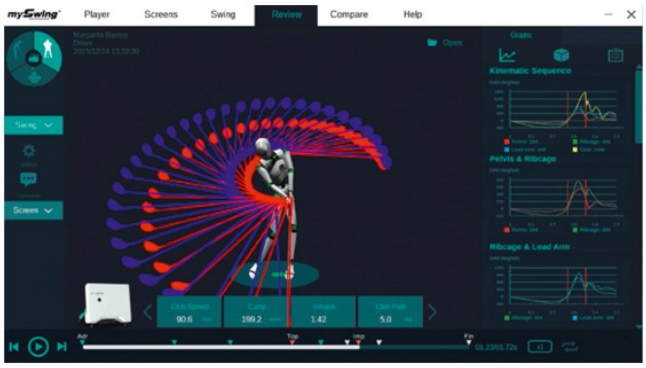

Fig 2. MySwing interface [6]

Secondly, the paper goes into the detail of "Visual Target Tracking System Based on AI". A Visual Target Tracking System Based on AI is a system that uses artificial intelligence (AI) to track and follow a specific target or object in real-time. This type of system is typically used in applications where it is necessary to continuously monitor and track a moving object, in our case, it deals with basketball players.

Fig 3. SportVU System [7]

In the NBA arenas, there are six high-definition cameras above the sealings. Before each game, an operator identifies the players to the computer system then when the match begins computer starts to record every movement of the players and gives live output and statistics including pass count, total distance covered, current player locations and much more. This helps teams' coach staff to analyse games faster and make better tactical decisions in the long run.

The third case study is Virtual Reality Sports Simulation System. A Virtual Reality Sports Simulation System is a type of technology that uses virtual reality to create a simulated sports experience for users. This can be done through the use of VR headsets or other devices that provide a sense of immersion in a virtual environment, as well as haptic feedback devices that allow users to interact with the environment in a realistic way. This artificial environment can be easily used as a training center for most sports. For each sport, some

example scenarios can be developed and put into use by the athletes. These scenarios will be dependent on live data from the athletes and can easily alter themselves. In the NFL, quarterbacks train in this way to enhance their field-seeing skills and reaction time.

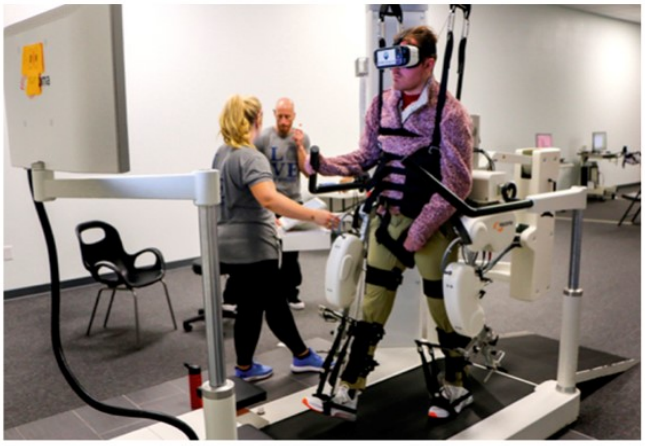

Fig 4. Virtual Reality System [8]

To sum up, using Artificial Intelligence powered devices helps us in many ways in the field of sports training. However, with great personal physical data gathering it comes great vulnerability for the athletes that have unrecoverable injuries and this situation may end their career before expected.

VII. Sports Medicine and Artificial Intelligence: A Primer

Nowadays sports are not just physical activities, they are industries that create billions of dollars every year. To keep up with the expectations athletes have to play more minutes like never seen before and not be injured. This paper explains how national leagues use Deep Learning algorithms to predict athlete injuries and use Natural Language Processeing to monitor patients' recovery online because of COVID-19 restrictions.

A. Injury Prediction

The Cleveland Clinic's Department of Orthopaedic Surgery established the Machine Learning Arthroplasty Laboratory in 2018 with the goal of exploring the practical implementation of AI techniques in the field of orthopaedics, specifically in arthroplasty and sports medicine. The laboratory has recently used machine learning techniques to predict the risk of injury for National Hockey League and Major League Baseball players. For hockey players, an ML algorithm called XGBoost was able to predict the risk of injury with an accuracy of 94.6% (SD = 0.5%), outperforming logistic regression. For baseball players, an algorithm called Top Three Ensemble was able to predict the risk of injury with an accuracy of 70% (SD = 2%) when tested on data that included player age, performance, and injury history.

B. Gait Analysis

Machine learning can also be used to detect knee injuries from gait analysis. Margarita Kotti and her team developed a random forest computer system that takes input body kinetics and produces an output estimate of the likelihood of knee osteoarthritis. The system also identifies the specific parameters and rules that led to the diagnosis, providing an "interpretation" of the diagnosis and increasing its value. The system was tested using locomotion data from 47 participants with osteoarthritis and 47 healthy participants who walked on plates with piezoelectric force sensors, and analyzed parameters such as vertical, anteroposterior, and mediolateral ground reaction forces and mean value, push-off time, and slope. This process could potentially be used to assess gait before and after arthroscopic and mini-open procedures to create objective tools for evaluating patient outcomes.

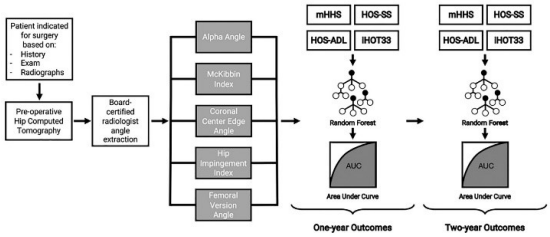

Fig 5. Random Forest HOS [9]

C. Patient Monitoring

In another study published in 2019, natural language processing was applied to the records of 186 patients who had undergone primary total shoulder arthroplasty at a single institution. The analysis revealed common themes in negative reviews, such as room condition (27%), time management (17%), communication (13%), and compassion (12%). This type of sentiment analysis has been used extensively in marketing and advertising to assess consumer perception of brands and can be a useful tool for physicians to improve the patient experience by providing feedback on the perioperative environment. In the era of the COVID-19 pandemic, the patient experience has become increasingly tied to access via remote patient monitoring and telemedicine. One system called FocusMotion uses AI to remotely monitor patients through the use of Bluetooth-enabled braces that communicate objective and subjective data to a mobile application, which are subsequently transmitted to an ML algorithm. These data are instantly interpreted to highlight warning signs and display mobility, range of motion, patient-reported outcome measures, opioid consumption, and home exercise plan compliance in a central dashboard shared with the patient and care team, which has been found to increase patient engagement and motivation to rehabilitate after knee surgery.

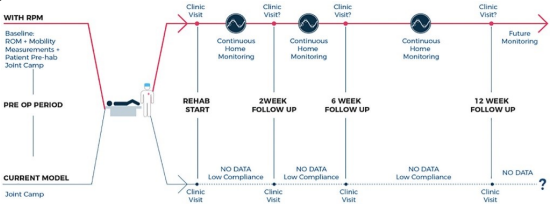

Fig 6. Random Forest HOS [10]

To conclude, Deep Learning and Natural Language Processing

help healthcare specialists to identify injuries and start treatment in a shorter time. Nonetheless, constant monitoring of patients' parameters may be unfavourable in certain kinds of situations when data gathered from the patients got leaked.

VIII. Artificial Intelligence in Sports Biomechanics: New Dawn or False Hope?

This article focuses on analysing sports techniques by using Artificial Intelligence. The article gives us examples from artificial neural networks that have been used in the field of sports biomechanics to analyze various techniques in sports such as javelin and discus throwing, shot putting, and football kicking. Evolutionary computation, another type of machine learning, has also been used to optimize movement in soccer throw-ins, predicting an optimal technique that is similar to that described in coaching literature.

A. Experts Systems

Expert systems are computer programs that use a database and a knowledge base, along with "reasoning" capabilities and a user interface, to provide expert-level advice or support on a particular topic or "domain." The knowledge base of an expert system contains specific knowledge or facts about the domain, as well as logic operations and probability theory that can be used to make recommendations or decisions. For example, an expert system for analyzing fast bowling in cricket might include a rule stating that if "shoulder-axis counter-rotation" is high, then the technique is mixed. Expert systems can be used to provide guidance and support in a variety of fields and can be especially useful when expert-level knowledge or expertise is not readily available.

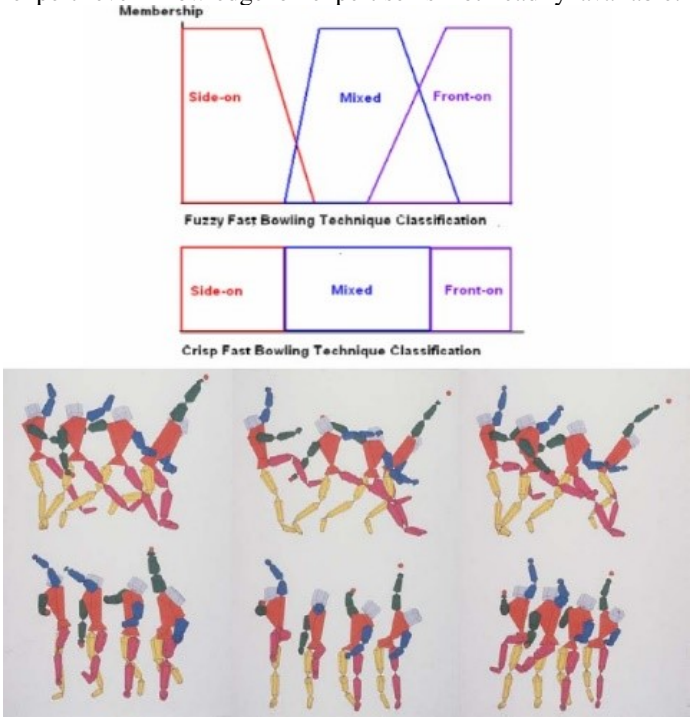

Fig 7. Classification of cricket fast bowling techniques [11]

B. Artificial Neural Networks

Artificial neural networks have been widely used in sports biomechanics for classification, clustering, and prediction. They have also been used in notational analysis and other areas of sports and exercise science. Artificial neural networks are often used to transform high-dimensional vectors of biomechanical time series into a low-dimensional output map, making it easier to analyze and understand complex data. One example of the use of artificial neural networks in sports biomechanics is the analysis of discus throws using Kohonen self-organizing maps.

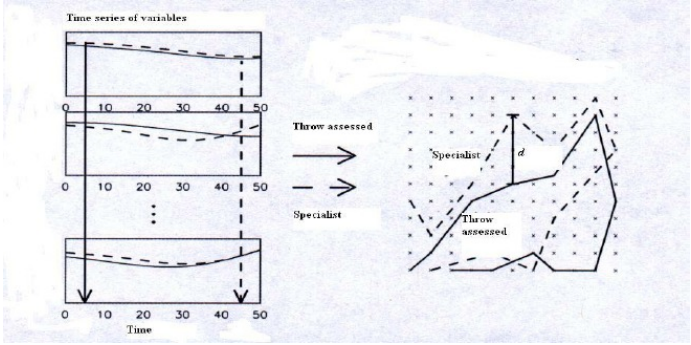

Fig 8. Kohonen self-organizing maps[12]

In the study, 53 throws (45 of a decathlete and 8 of a specialist) were recorded using semi-automated marker tracking over a one-year training period. Each throw had 34 kinematic time series for 51 normalized times, which were mapped onto a simple 11x11 neuron output space. The sequences were then expressed as the mean deviation from a reference throw by the specialist thrower. Artificial neural networks have proven to be useful in a variety of sports-related applications, and their use is likely to continue to grow in the field of sports biomechanics.

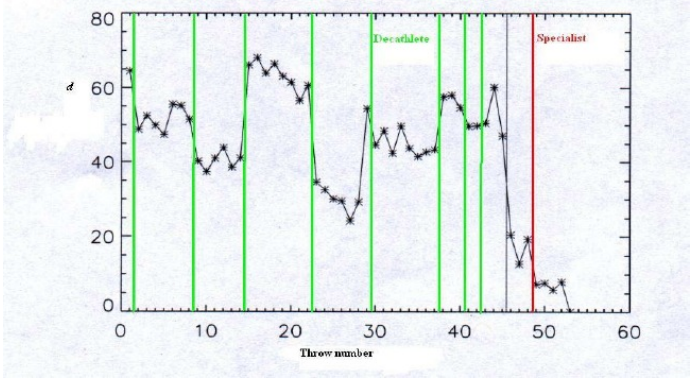

Fig 9. Grouping of throws within sessions [13]

C. Evolutionary Computation

Evolutionary computation is a type of machine learning that includes genetic algorithms, genetic programs, and evolutionary strategies. It uses artificial, numerical "chromosomes" to simulate evolution. In the field of sports biomechanics, evolutionary computation has been used to optimize various techniques, such as the joint torques in a soccer throw-in (Bächle, 2003) and the trajectory of a skier (Seifriz and Mester,

2002). In the study on soccer throw-ins, an evolutionary strategy was used to optimize the joint torques at the hip, shoulder, and elbow to maximize the distance thrown. The predicted optimal throwing technique was similar to that described in the coaching literature, with the hip initially accelerating the trunk forwards and the elbow keeping the forearm back, followed by deceleration of the trunk by a negative hip torque and acceleration of the forearm forwards by a positive elbow torque. In the study on skiing, genetic algorithms were used to calculate the optimal trajectory, but only an abstract was published. Overall, evolutionary computation has shown promise in improving sports performance and is an active area of research.

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[13] Bartlett, R. (2006). Artificial intelligence in sports biomechanics: New dawn or false hope?. Journal of sports science medicine, 5(4), 474. Figure 3