Carnegie Mellon University Africa
Certificate Program in AI and Machine Learning in Africa

Course AIML01: Artificial Intelligence – Past, Present, and Future

Module 3: Example Applications
Lecture 4: AI Applications in Sports

Welcome to Lecture 4 of Module 3, the last of four lectures that look at the applications of artificial intelligence. This lecture focusses on applications in sports.

In this lecture, we provide an overview of the spectrum of AI applications in sports. We look more closely at one application, umpiring games, and explore ball tracking, in particular. We explore the different ways in which AI and machine learning applications analyze the performance of sportswomen and sportsmen. We explain the potential of AI to discover of innovative strategies that help improve player performance and win games

We have three learning objectives, so that, after studying the material covered in this lecture, you should be able to do the following.

1. Identify several uses of AI and machine learning in a variety of sports.

2. Explain why some measure of confidence in the decisions made by an AI system is often needed.

3. Outline the approaches that some machine learning systems use to discover innovative strategies in games.

Slide 1   Welcome to Lecture 4 of Module 3, the last of four lectures that look at the applications of artificial intelligence.   This lecture focusses on applications in sports.

Slide 2   While the use of statistical analysis is well-established in sport, AI is taking it to a new level.

Applications range across the entire spectrum of activities.

From media and fan experience to management and operations.

From talent identification and selection, through pre-game preparation and in-game activity, to post-game analysis.

These applications all focus on machine learning and extracting useful information in data gathered from a variety of sources and sensors.

Slide 3   There are at least eleven applications across seventeen sports which are being or will be impacted by AI.

For example

Determining of optimal game strategies.

Together with wearable sensors, AI can also assist with training by providing advice on

optimal nutrition,
enhancement of physical skills,
and recovery management,

much as recommender systems do for online marketing and decision support in business.

Slide 4   AI can be used for automated generation of video highlights

Integrated vision and natural language technology (NLP) can be used for automated generation of written articles for publication in print and online

Chatbots are used to enhance the experience of fans and also support interaction with the media

Drone cameras are used to provide game footage and enhance security

AI can also be used to optimize of policies for stadium entry and for smart ticketing.

Slide 5   AI technologies such as computer vision are used routinely to assist with umpiring games, especially using automated ball tracking and line calling applications.

Slide 6   For example, the Hawk-Eye system uses six or more high-speed cameras to visually track the trajectory of the ball

Slide 7   The images are used to triangulate the ball's position over time

Slide 8   and a virtual reality trajectory of its statistically most likely path is then displayed.

Slide 9   While the system is widely used in many sports and is accurate to within 3.6 mm,

there is also some debate about whether the system's decisions should be accompanied by a confidence value.

Systems such as Hawk-Eye illustrate the difference between the models of the world that AI uses to make decisions

and the uncertain reality of the world they model (Collins and Evans, 2008).

Slide 10   Such systems are also used to provide statistical information on the performance of players when training and on competitors when preparing for matches.

Slide 11 The All England Lawn Tennis Club hosts the annual tennis championship at Wimbledon.

It uses IBM's Watson technology to provide a variety of services.

We discussed Watson in Lecture AIML01-01-03.

Slide 12 One of these is an app called "Ask Fred",

a voice-activated cognitive assistant named after the late champion Fred Perry,

to help spectators find their way around the grounds and locate facilities simply by asking questions such as 'where can I buy strawberries', or 'where are the closest toilets' (Shaw, 2017).

Slide 13 Another is "What Makes Great" to determine what attributes make a great champion.

IBM Watson analyzed tennis champions across six broad categories including

passion,
performance under pressure,
serve effectiveness,
stamina,
how well the player either adapted their normal playing style to an opponent or was able to force an opponent to conform to their tactics,
and the ability to return serves.

To do this, it analyzed over 53 million tennis data points, Wimbledon annuals, social media commentary and interviews (over 11 million words), and over six thousand newspaper articles.

Slide 14 Strategy plays a major role in sports, as it does in games.

Let's look at the game of Go to see how AI can discover innovative strategies.

"With more board configurations than there are atoms in the universe, the ancient Chinese game of Go has long been considered a grand challenge for artificial intelligence."

Slide 15   To identify successful game strategies, an AI system can play against itself,

as the DeepMind AlphaGo system did, before beating Lee Sedol, the winner of 18 world titles, in 2016.

Slide 16   and going on to achieve 60 straight wins in time-control games against top international players in 2017.

Slide 17   The original version of AlphaGo used two neural networks

a policy network that produces moves and

a value network that evaluates board positions.

The policy network was trained by supervised learning based on human expert moves and subsequently refined by reinforcement learning by playing against itself.

Slide 18   Subsequently, in AlphaGo Zero, even better performance was achieved based purely on reinforcement learning without any prior supervised training.

Apart from its formidable performance, what is significant about AlphaGo is that it uncovered several innovative strategies that greatly surprised expert players, demonstrating the potential for AI to augment human abilities and exceed human performance.

Let's listen to a five-minute video describing the development of the several incarnations of AlphaGo.

Slide 19   [Play Video]

To summarize:

1. AI and machine learning algorithms appear in many sports applications.

2. They provide ways to improve player performance, enhance the spectator experience, identify effective game strategies, and support umpiring decisions.

3. AI builds models of the world to support its inferences – its decision, conclusions, and suggestions – but there is always an element of uncertainty associated with these models and, therefore, the inferences.

Recommended Reading
Here is some recommended reading. Both are comprehensive surveys. You don't have to understand all the details to benefit from reading them and you will see how much of the material we have already covered in the course is mentioned.

Barlow, A. and Sriskandarajah, S. (2019) Artificial Intelligence – application to the sports industry.
https://www.pwc.com.au/industry/sports/artificial-intelligence-application-to-the-sports-industry.pdf

References
Here are the references cited to support the main points in what we covered today.

AlphaGo (2021)
https://www.deepmind.com/research/highlighted-research/alphago

AlphaGo - The Movie (2022)
https://www.youtube.com/watch?v=WXuK6gekU1Y

Clark J (2017) Watson serves up AI at Wimbledon 2017
https://www.ibm.com/blogs/internet-of-things/watson-serves-ai-wimbledon-2017

Collins H, Evans R (2008) You cannot be serious! Public understanding of technology with special reference to "Hawk-Eye". Public Understanding of Science 17(3):283–308.
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