

# Certificate I: Understanding AI and Machine Learning in Africa

Course AIMLO1: Artificial Intelligence – Past, Present, and Future

Module 3: Example Applications

Lecture 4: AI Applications in Sports

**Carnegie Mellon University**  
**Africa**

# Learning Objectives

1. Identify many applications of AI and machine learning in a variety of sports
2. Explain the functionality of some representative applications
3. Explain the technical difference between
  - the model of the world that an AI system builds to support its decisions and conclusions and
  - the world that is being modelledand the consequent need for some measure of confidence in these decisions

# Lecture Contents

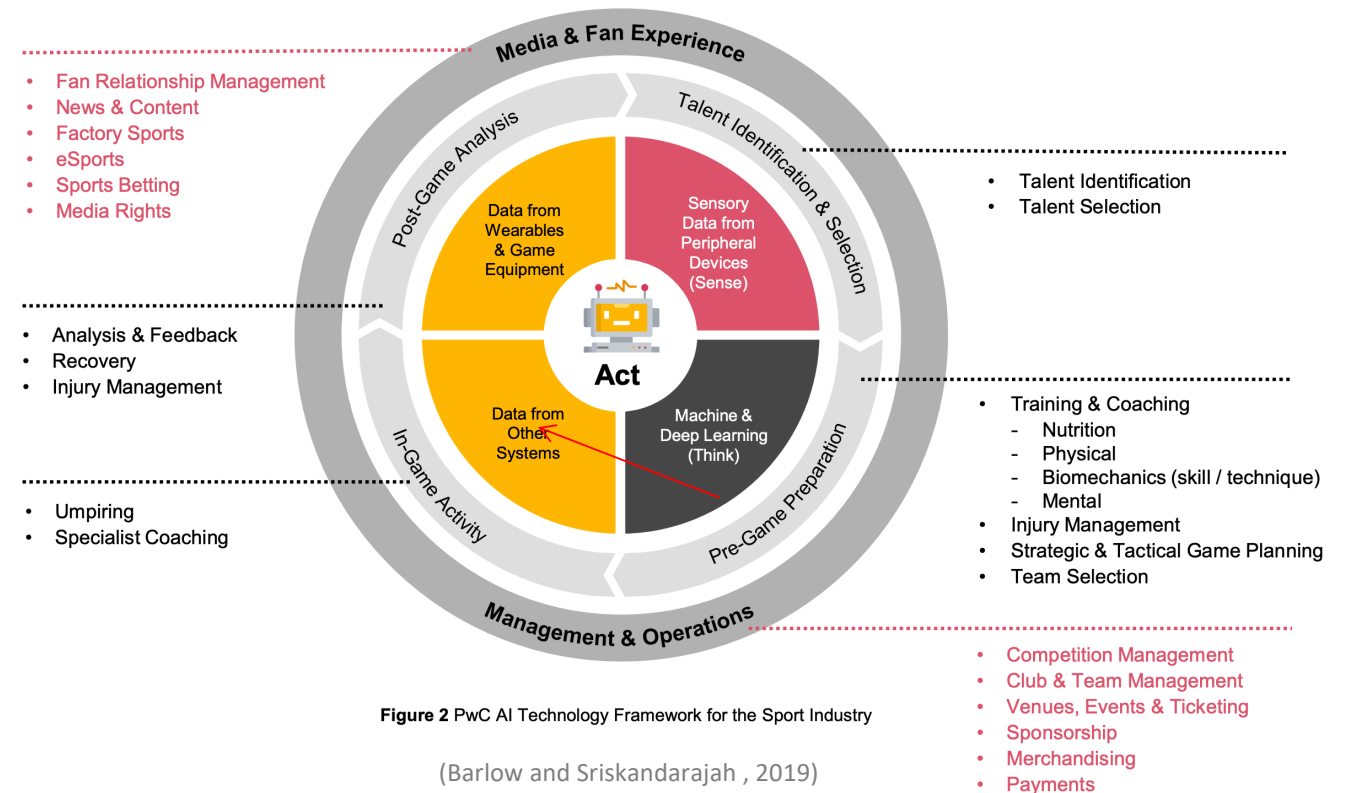
1. The spectrum of AI applications in sports
2. Umpiring
3. Performance analysis
4. Enhancing spectator experience
5. Discovery of innovative strategies
6. Lecture summary
7. Recommended reading & references

# The Spectrum of AI Applications in Sports

AI is taking statistical analysis in sport to a new level

Wide 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**
- Using **machine learning** to extract useful information in **data** gathered from a variety of sources and sensors



# The Spectrum of AI Applications in Sports

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

For example,

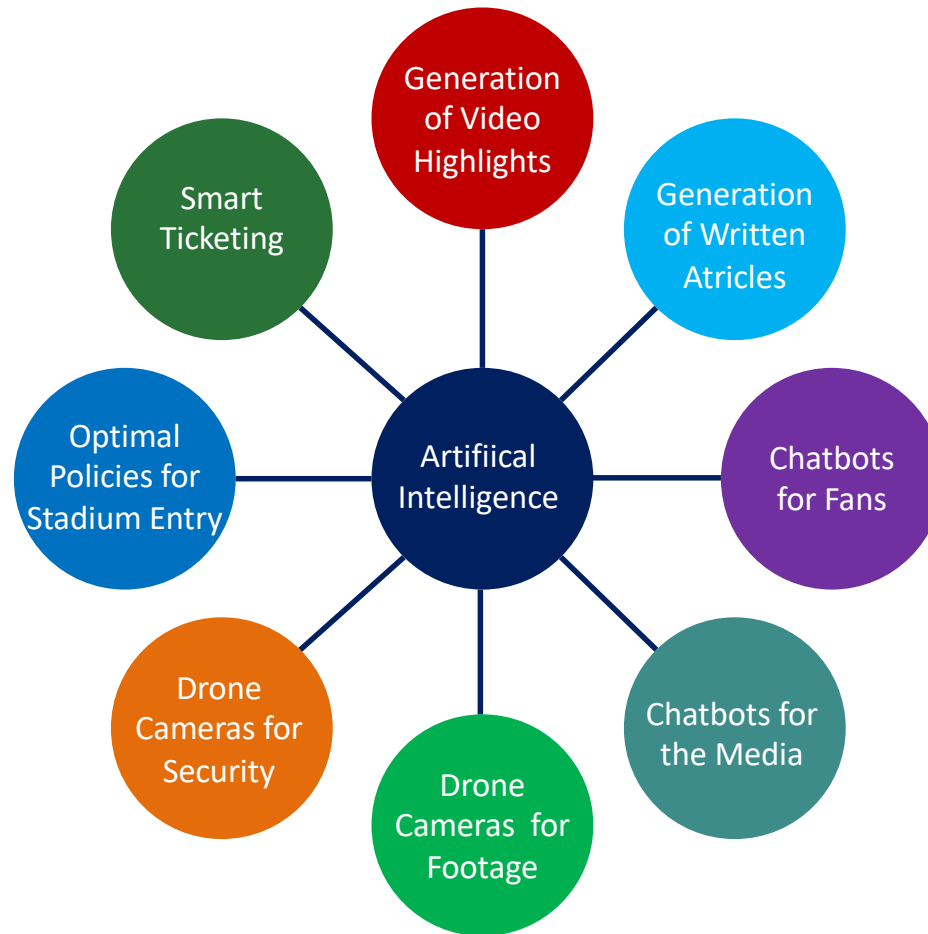
- Determining optimal **game strategies**.
- Using wearable sensors, assist with training by providing advice on
  - optimal nutrition
  - enhancement of physical skills
  - and **recovery management**,

Examples of AI Applications in Sport	Stadiums & Venues	Major Tournaments	Grassroots	American Football	Australian Football	Baseball	Basketball	Combat Sports	Car Racing	Cricket	Football (Soccer)	Golf	Ice Hockey	Rugby	Snow Sports	Tennis	Track & Field
AI Applications																	
Stadium Entry	●																
Drone Cameras (game footage and security)	●																
Smart Ticketing	●	●															
Chatbots & Smart Assistants*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Automated Video Highlights*		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Automated Journalism*			●		●	●	●			●	●	●				●	
Wearable IOT Devices* (nutrition, physical, biomechanics, recovery management)			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Virtual Umpires*			●	●	●	●		●		●	●					●	
AI Assistant Coaching (in-game)*			●	●	●	●	●	●	●	●	●	●	●	●	●		●
Computer Vision			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Talent Selection			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

● Experimentation (based on publicly available data)    ● Future Potential    \* AI Applications briefly explored in this publication

(Barlow and Sriskandarajah , 2019)

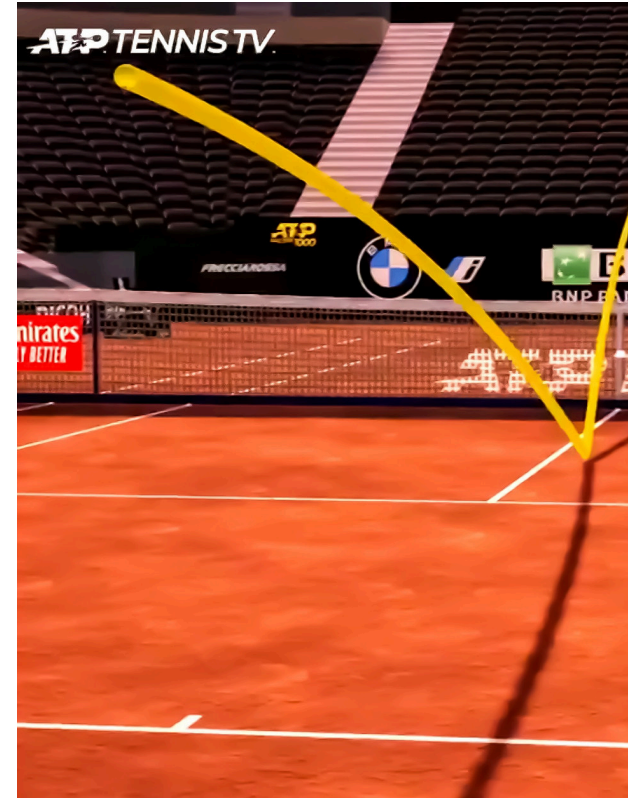
# The Spectrum of AI Applications in Sports



# Umpiring

AI technologies such as computer vision are used routinely to assist with umpiring games

Especially using automated **ball tracking** and line calling applications



<https://www.hawkeyeinnovations.com/>

# Umpiring

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



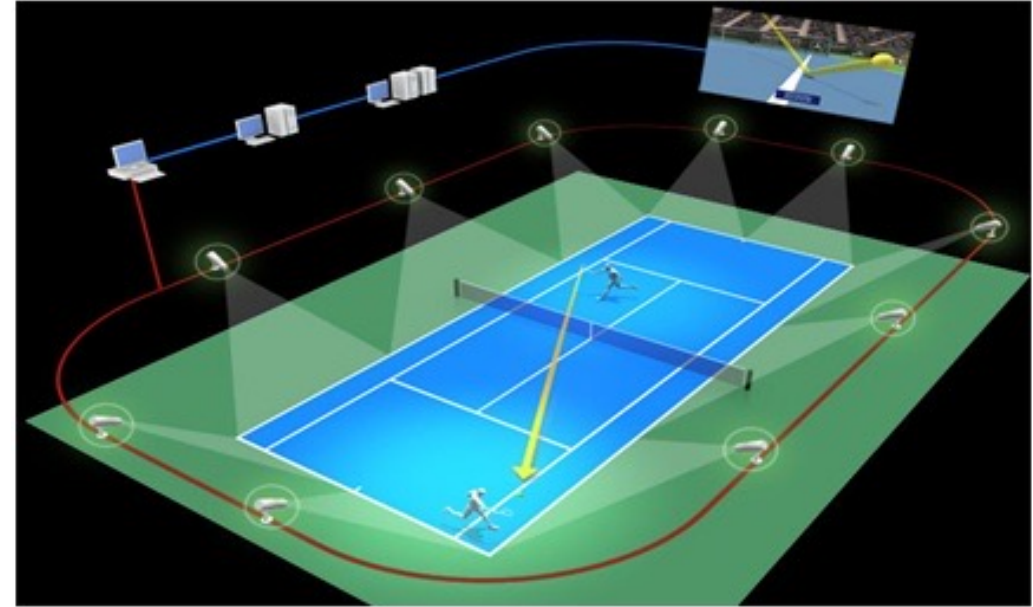
<https://www.hawkeyeinnovations.com/>



# Umpiring

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

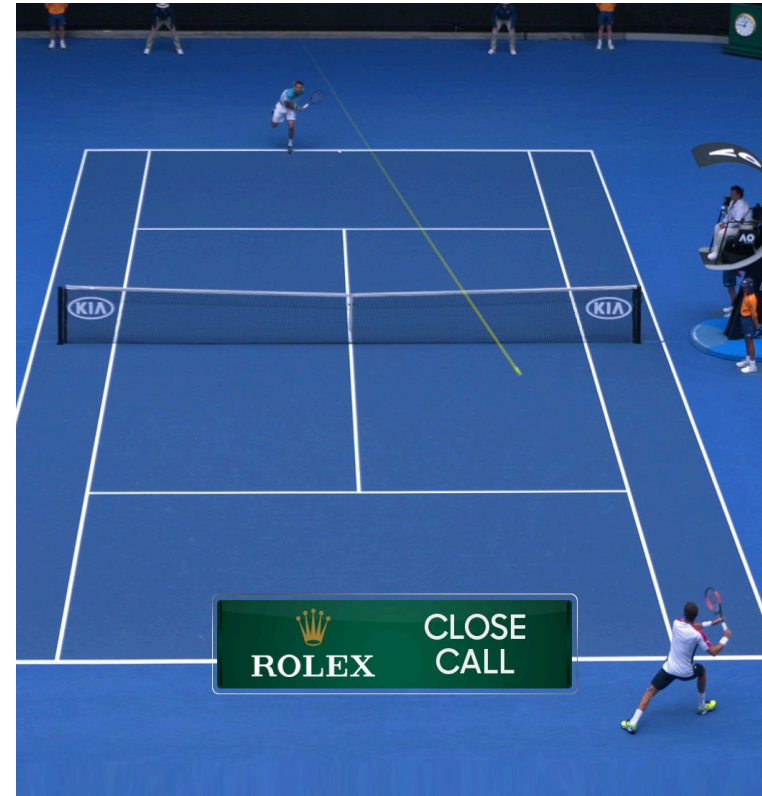
By combining positional information from multiple viewpoints



<https://trainingwithjames.wordpress.com/research-papers/the-impact-of-the-hawk-eye-system-in-tennis/>

# Umpiring

And a **virtual reality trajectory** of its **statistically most likely path** is then displayed



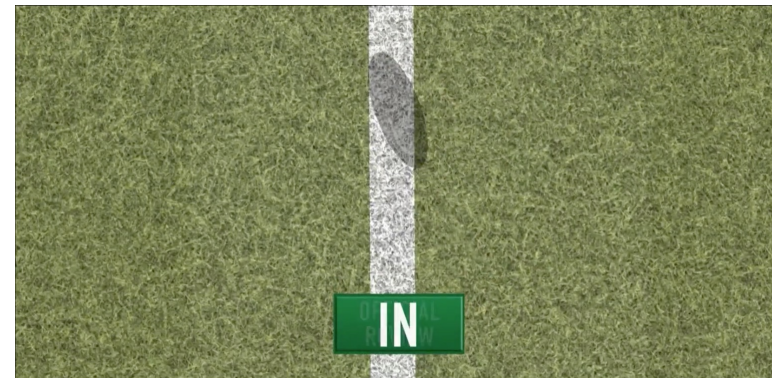
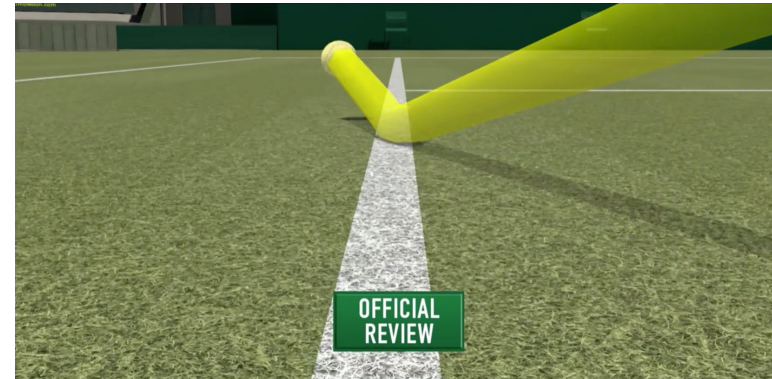
<https://www.hawkeyeinnovations.com/>

# Umpiring

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)
- A model is only an approximation of what is being modelled: the better the approximation, the higher the confidence



<https://www.hawkeyeinnovations.com/>

# Performance analysis

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



<https://www.hawkeyeinnovations.com/>



# Enhancing Spectator Experience

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



<https://twitter.com/ibmwatson/status/883332286535663616>

# Enhancing Spectator Experience

One of these is an app called **ASK FRED**,

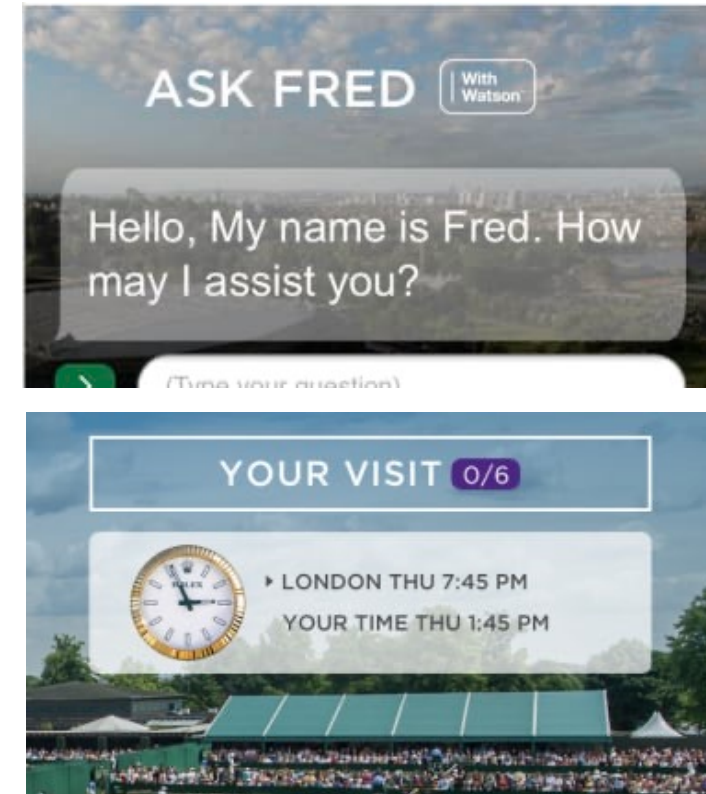
This is a voice-activated **cognitive assistant** named after the late champion **Fred Perry**

It helps spectators find their way around the grounds and locate facilities using **natural language**

‘where can I buy strawberries’

‘where are the closest toilets’

[Shaw, 2017]



<https://www.itpro.co.uk/apps/28934/wimbledon-and-ibm-create-fred-an-ai-chatbot-for-tennis>

# Enhancing Spectator Experience

## What Makes a Great Champion

- IBM Watson analyzed tennis champions across six broad categories including
  1. Passion
  2. Performance under pressure
  3. Serve effectiveness
  4. Stamina
  5. How well the player adapted their normal playing style to an opponent & how well the player was able to force an opponent to conform to their tactics
  6. Ability to return serves
- To do this it analyzed 53,713,514 tennis data points, Wimbledon annuals, social media commentary and interviews (amounting to 11,208,192 words), and 6,349 newspaper articles (Clark, 2017).

# Discovery of 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**."

[AlphaGo – The Movie, 2021].



<https://www.deepmind.com/research/highlighted-research/alphago>

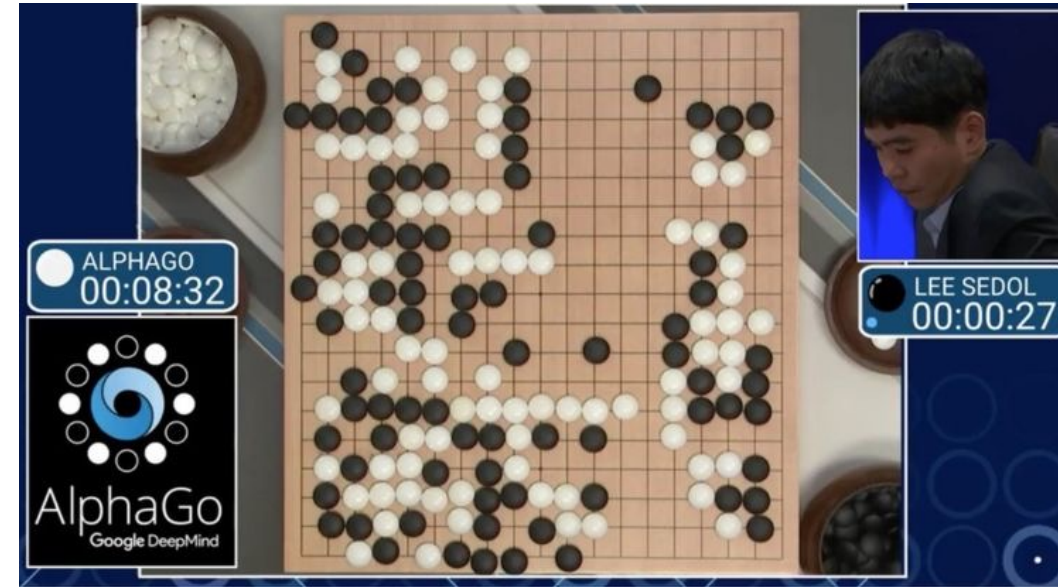


# Discovery of Innovative Strategies

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

This is what the DeepMind **AlphaGo** system did

Before beathing Lee Sedol, the winner of 18  
world titles, in 2016



<https://www.bbc.com/news/technology-35785875>

# Discovery of Innovative Strategies

It achieved 60 straight wins in time-control games against top international players in 2017 [AlphaGo, 2021].



AlphaGo - The Movie

<https://www.youtube.com/watch?v=WXuK6gekU1Y>

# Discovery of Innovative Strategies

The original version of AlphaGo used two neural networks

- a **policy network** that produces moves
- a **value network** that evaluates board positions

The policy network was trained by **supervised learning** based on human expert moves

It was subsequently refined by **reinforcement learning** by playing against itself



AlphaGo - The Movie

<https://www.youtube.com/watch?v=WXuK6gekU1Y>

# Discovery of Innovative Strategies

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

AlphaGo uncovered several **innovative strategies** that greatly surprised expert players,

Demonstrating the potential for AI to **augment human abilities** and **exceed human performance**



AlphaGo - The Movie

<https://www.youtube.com/watch?v=WXuK6gekU1Y>

# video

<https://www.youtube.com/watch?v=9xISy9FE5WtE>

NEW DEEPMIND AI  
**BEATS ALPHAGO 100-0**

Disclaimer: I was not part of this research project. I am merely providing commentary on this work.

# Lecture Summary

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 but there is always an element of uncertainty associated with these models and, therefore, the inferences

# Recommended Reading

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

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.

<https://journals.sagepub.com/doi/10.1177/0963662508093370>