AI and ML

Hello and welcome to Module 8. Today, we will be looking at some of the integrated disciplines, their scope, and importance in human movement science. The topic for today is Artificial Intelligence. Some of the learning outcomes for these modules are, we will be looking at what AI is or what artificial intelligence is, how we can use AI in human movement science, its scope, collaboration potential, sharing of ideas. So we will also be looking at some of the popular AI techniques that are currently being used in human movement science research. Last one again, we will also be looking at opportunities for collaboration within AI.

So integration of AI in human movement science, so the field of data science is rapidly growing, evolving and it is gaining popularity. This is happening due to the technological advances and improved data science techniques as we have watched in the previous video. All this is allowing us to collect big data. So with these recent advancements in technology, data science and the growing commonalities between the fields of movement science and data analytics, there is an opportunity for us to share ideas, theories, methods, and approach across these two fields for problem solving.

So what is AI? So AI is the development of computer systems that can perform tasks typically requiring human intelligence such as problem solving, decision making and understanding patterns in data. They have demonstrated the potential to improve our quality of life, increase productivity and also push the current state of understanding within human movement science. Popular AI techniques applicable in human movement science include machine learning, you have deep learning, computer vision, robotics and human activity recognition. Now let's look at some of these in detail in the coming few slides. Let's look at machine learning.

So what is machine learning? So machine learning is a part of AI, so machine learning is a part of AI studying how computer science can improve perception, knowledge, thinking and actions based on experience or data. So it draws from different fields of computer science, statistics, psychology, neuroscience, economics, and control theory, even game theory to name a few. Let's look at an example where machine learning can be used. As an example in identification of normal and abnormal gait patterns, so we've looked at gait analysis, we've studied it in some of the previous modules, so identification of such patterns for informed patient intervention is one area where machine learning algorithms can be used. Another popular AI technique is computer vision.

So computer vision basically involves allowing the computer to interpret and understand visual information, for example feeding it image and video data. So where can we use this? So let's look at an example. An example would be to estimate the pose or the technique of an athlete using real-time training videos. Now what would this be used for? Imagine you

have all of the training videos of an athlete and you can use this to give real-time feedback and make informed coaching session planning. Another popular AI technique in human movement science is deep learning.

So deep learning is a subfield of machine learning that uses neural networks with many layers. So these neural networks resemble the human brain networks to process and understand complex data. So deep learning over machine learning is gaining popularity to understand complex data sets. An example of that in human movement science would be pattern recognition for gait, for example stroke rehabilitation. So for us to inform rehabilitation programs for different individuals, deep learning can be used to understand the underlying injury patterns that help us and guide us understand patient recovery, the rate of recovery, and what kind of programs we need to individually design.

So what does this mean for human movement science? So we, as human movement scientists, clinical biomechanists, and performance analysts, generally collect large sets of data. We collect this data using motion capture technology, so the 3D technology, force plates, variable technologies of various sensors or insoles, and or computer simulation modeling, for example. So once we collect this data, just do it on this slide, we collate it. So we manually need to collate this data using different resources and then what we do, we select the parameters and the variables that we want to study. So all of this manual process then helps us reduce the entire data that we have collected into few or certain number of variables that we can study using the statistical techniques.

So in case of traditional statistics, we are often limited to the number of variables we can study. This is due to the reason that statistical techniques require simplified data sets. So what does that result in? It results in large amount of data being lost. So hence the data and understanding is quite limited. It limits our data understanding, hence some variables that have multiple interactions or have complex relationships with the outcome variable, we might fail to understand or capture the entire knowledge.

So this also, it, let's do it again. So it also restricts scalability of research or scalability of your analysis to large population. So for example, today you are researching on a cohort of 15 athletes and you want to be able to generalize the results on a group of 100. So traditional statistics in that scenario are limited and restrictive in their ability to do so. All of the process is again manually collated and you need to reduce the number of variables that you are working on.

So what does that result in? Manual integration of results results in lot of time taken to achieve the same task and also may have risk of error or bias that may lead to limited efficiency. Let's look at the significance of human movement science. So the fast growing and huge amounts of data that we collect using the different resources we've looked at in the previous slide and store has far exceeded the human ability to collate, articulate and

comprehend. That's where we can use AI or machine learning algorithms. So there is a need hence for a systematic development of data mining tools or data analysis tools primarily needed for the transformation of this raw data that's collected into golden nuggets of knowledge.

So, the aim of data mining is twofold to understand the data and second to make necessary predictions using the data accordingly. AI modeling using machine learning, deep learning and computer vision. So let's look at some of the additional significance. The addition of applied data science techniques involving AI as we looked at in the previous slide. They adopt statistical and computational techniques for big data handling that increases precision and accuracy of analysis.

They also aid in understanding complex patterns in the data so that might reveal meaningful relationships between the variables. So it also helps us scale analysis to a larger population so research findings can be extrapolated. It enhances the scope of automated solutions so it reduces the need for manual time-intensive tasks. It can also help us or guide us in personalized tailor-made assessments. What would that be useful for? So we can use it to optimize individual technique for example.

And it might also help us track or monitor an athlete for long period of time categorized under continuous learning. So in continuous learning it can aid informed long-term interventional planning. Another key benefit is real-time analysis. So using machine learning algorithms we can also have real-time monitoring of the athlete for feedback. So let's look at these in detail and look look at some of the examples of where they can be used.

So handling big data and pattern recognition for example. So let's take an example of 3D motion capture data. So if you've collected biomechanical data full body kinematics and kinetics to look at complex movements in sport we can use it to identify fine-tuning parameters for technique that are related between the biomechanical parameters that are studied and the skill outcome. So, for example, in fast bowling, you can look at the technique parameters that are associated with high ball release speed. Another example that we can look at is identification of injury patterns.

So like we spoke about earlier in terms of stroke rehabilitation you can also look at unique gait patterns in patients. So, for example, neurological disorder gait or movement gait that can help us identify early diagnosis and can guide treatment and planning. So scalability and automated solutions how can we use this technique? So movement and biomechanical analysis often require automated solutions to be extrapolated to large populations for better understanding of the behavior of the cohort. So in healthcare industry for example automating large-scale physical activity data analysis using for example variables to track population level trends. So you can have these variables for example your activity tracker

watches to track population level trends in order to understand exercise habits that inform public health initiatives or that may inform public health initiatives.

In exercise in sport you can also use it for performing analysis of a large cohort of athletes that might also inform equipment design. So if we need any changes in equipment design or we need to understand how equipment design is progressing with related to the athlete we can also use scalability and automated solutions for the same. For movement analysis solutions can also provide physical activity monitoring that might aid in informed intervention programs. So personalized assessments and continuous learning so repeated personalized assessments of movement by tracking clear activity for continuous learning can help in long-term intervention planning. It can also help us in evaluating the technical skills change over time.

So in healthcare for example clinical biomechanics can monitor unique biomechanical characteristics of individual patients and design custom orthotics or prosthetics that help in improved comfort and functionality. Also developing AI driven systems that continuously adapt to individuals changing movement patterns can help us design better rehabilitation programs for them. Another good feature is a real-time analysis so by providing real-time insights so by providing real-time insights coaches can also access to giving feedbacks to the athletes within the moment. Let's look at real-time analysis real-time analysis helps in providing real-time insights that aids in feedback that can in turn help in informed intervention planning. So for example in sport real-time athlete load monitoring in team sport for example like soccer and rugby we can see the use of variable sensors that measure player load acceleration and fatigue levels in real time.

So this information can be used by the coaches to make informed decisions like substitutions, managed player workloads, and also optimize tactical decisions. So, another example would be technique analysis in rowing. So inertial sensors can be attached on the board or the oar that can provide insights into oar angle for example stroke rate and power output. So what can this help the coaches in the coaches can then guide the rowers during the training sessions to maintain optimal or proper technique. To summarize with recent developments in technology including data science, and the growing commonalities between the fields of human movement science and data analytics there's an there's an opportunity for collaboration, such as sharing ideas, methods, and theories that can be used to our advantage.

So we also looked at the definition of AI, which is the development of computer systems that can perform tasks that typically require human intelligence, like problem-solving, decision making, and understanding patterns. We then looked at the popular techniques, for example, machine learning, deep learning, computer vision, robotics, and human activity recognition, and how they can be used for the various tasks to analyze and how they can be used for movement analysis. We also looked at some of the application of AI

techniques that aid in handling big data pattern recognition, increase research scalability, real-time analysis also aid in continuous learning, providing personalized assessments, and providing automated solutions to name a few. Thank you.