How Do You Think Wearables Can Help People?

In this first module of our course's Gamut workbook, you will begin exploring wearable devices and how they can be used. Reflect on what you have learned about wearables in this course. Up until this point, we have mostly focused on the use of wearables within the context of sports. What ideas do you have for how wearables could be of benefit to various types of populations (e.g., patients, office workers)? In your reflection, identify a specific wearable and a specific use case to explain the benefit you think the device could bring to the user.

Wearable devices have immense potential to benefit various populations beyond sports, offering critical insights and support in daily life and health management. One notable example is the continuous glucose monitor (CGM), which is particularly beneficial for individuals with diabetes. A CGM continuously measures glucose levels, providing real-time data that helps users make informed decisions about their diet, physical activity, and medication, ultimately leading to better glucose control and reduced risk of complications

Player Load Relative to Body Mass

We have started to explore the external measures of wearable technology, measures occurring outside the body that quantify a physical load experienced by an athlete or individual. Examples of external measures include acceleration, GPS distance, and velocity. In this activity, we will begin exploring some of these measures more in-depth - starting with the possible misconceptions of the different external measures.

Many of the measures and/or metrics used by wearable technology devices, both internal and external, have names that seem pretty straightforward (e.g., “player load”, “recovery score”, “sleep score”, “stress score, etc.). However, sometimes their simplicity can be misleading and result in misinterpretation. Our topic for this module is external measures so we’ll focus on “player load” for the moment. This sounds like a very straightforward measure that would be evaluating the “load” of a player. There may be cases where you might need to strip your scientific use of the word “load” to appreciate what “Playerload” really means.

To help us work through this process, we want you to reflect on the following prompts:

- Reflect on what player load means relative to a player’s body mass:
- Is body mass incorporated in these measures?Should it be? Why or why not?

Keep your ideas from this reflection in mind as we move forward in order to appreciate the similarities and differences between your own thoughts on what “load” should mean and what it actually represents when provided as a metric by different wearable devices.

Player load, as measured by wearable technology, typically refers to the cumulative physical stress experienced by an athlete during activity. This metric can include factors like acceleration, deceleration, changes in direction, and impacts. While body mass is not always directly incorporated into these measures, it arguably should be. Body mass plays a crucial role in determining the actual physical load and strain on an athlete's body; for example, a heavier athlete may experience greater stress on their joints and muscles from the same movement compared to a lighter athlete. Including body mass in player load calculations would provide a more accurate representation of the physical demands on each individual, leading to better-informed decisions about training, recovery, and injury prevention.

Machine Learning Reflection

We have been discussing the utility of machine learning for making predictions about performance and optimal training load. Our example in the “Predicting and Preventing Injury” lecture video looked at machine learning in boxing and the accuracy of machine learning in differentiating between different striking patterns.

Reflect on what you have learned about the role of machine learning for pattern identification. Do you think it is possible for machine learning—a self-improving program utilizing algorithms—to detect and appropriately label certain skill movements within a data set?

For example, if a basketball player were to pass, shoot free throws, or take a jump shot, *would machine learning be able to detect those? And would the ability to capture and quantify that information adds value for a team and/or athlete?*

Machine learning has significant potential for identifying and labeling specific skill movements within a dataset due to its ability to recognize patterns and improve over time. In sports like basketball, ML algorithms can analyze data from wearable sensors and video footage to detect distinct movements such as passing, shooting free throws, or taking jump shots. By training on labeled datasets, these algorithms can learn to differentiate between various actions based on unique motion patterns, speed, angles, and other relevant metrics.

The ability to capture and quantify this information is immensely valuable for teams and athletes. It allows for precise performance analysis, identifying strengths and areas for improvement. For example, by analyzing shooting techniques, coaches can provide tailored feedback to enhance accuracy and consistency. Moreover, understanding movement patterns can help in designing more effective training regimens, optimizing load management to prevent injuries, and developing strategic game plans based on player tendencies and opponent weaknesses. Overall, integrating ML into sports analytics enhances decision-making and contributes to the holistic development of athletes.

Considering the Benefit of Internal Measures for Your Favorite Sport

Internal measures can be a little more difficult to perform as they typically require a more direct connection to the athlete. For example, we have seen athletes that have a layer of clothing between the electrodes of a device and the skin (e.g. surface electrodes for electromyography on the gluteus muscles). In many cases -- such interference with the measure performed at the skin will lead to useless data. External sensors tend to have a greater flexibility regarding where they are worn. However, internal sensors provide a unique perspective about the athlete that the external sensors don't provide.

Therefore, we want you to consider the inclusion of one or more internal measures for your favorite sport.

Reflection Task:

Choose your favorite sport and then explore the pros and cons of using an internal sensor for the athletes of your sport:

- First, choose a wearable that would be used for this sport and describe its main purpose
- Make a case for how a sports team would use the information produced by this particular wearable:What will it provide that makes it worthwhile? Is the benefit of the device the feedback provided in "real-time"? Or is it the post-practice or post-game summaries that provide benefit?
- Explain the possible downsides of the device being worn: Is it cumbersome or intrusive to the activity of the sport? Is the data not relevant - or is it too intrusive to the sport performance?
- Finally, present an overall argument for or against the use of the internal sensor for your sport's athletes, providing a clear rationale for why you choose this stance.

The use of internal sensors to monitor core body temperature in European football offers a valuable means of ensuring player safety and optimizing performance. These sensors, often ingested in pill form, provide continuous, accurate readings of a player's core temperature. This real-time data is crucial during high-intensity matches or training sessions, especially in hot conditions, to prevent heat-related illnesses and maintain optimal thermal conditions.

Real-time feedback from the sensor allows the coaching and medical staff to intervene before a player reaches a critical temperature threshold, thus ensuring player safety and reducing the risk of heat exhaustion or heatstroke. Additionally, post-practice or post-game analysis of the collected data helps understand how different players' bodies respond to physical exertion and heat. This information can be used to tailor individual training programs and recovery protocols, optimizing each player's performance and ensuring they remain within their optimal temperature range.

While there are some downsides to consider, such as the initial discomfort of ingesting a sensor and the inconvenience of regular replacement, these issues can be mitigated through proper education and ensuring players understand the benefits. The data generated may be overwhelming, requiring

significant effort to analyze and interpret, and there might be privacy concerns regarding continuous monitoring. However, these can be addressed by establishing clear protocols and maintaining open communication with the players.

Overall, the benefits of using internal sensors to monitor core body temperature in European football outweigh the potential downsides. By preventing heat-related illnesses and optimizing performance through personalized training and recovery plans, these sensors provide a significant advantage to teams. The overarching goal is to ensure player health and safety while maximizing their on-field performance, making the use of internal sensors both compelling and justifiable.

Interpreting the Connection Between Internal and External Measures

We have begun exploring internal and external measures together - both their relationship with one another and the benefits of combining them - to appreciate how these measures can be used together to better understand an individual's activity in various situations. In this activity, we will explore how external measures impact internal measures and the usefulness of the combined measures.

Think about what would happen to the heart rate of an athlete during training or competition with an increased or decreased accelerometry load and GPS distance. ***How would a rapidly increasing heart rate be interpreted? How about a rapidly decreasing heart rate? Could a team use this in real-time?***

Combining internal measures such as heart rate monitoring with external measures like accelerometry load and GPS distance can provide a comprehensive understanding of an athlete's activity and physical condition during training or competition. For example, an increased accelerometry load and GPS distance typically indicate higher physical exertion, which is usually accompanied by an increase in heart rate. Conversely, a decreased accelerometry load and GPS distance may correspond to lower physical exertion and a subsequent decrease in heart rate.

A rapidly increasing heart rate, especially if it occurs without a corresponding increase in accelerometry load or GPS distance, could be a sign of overexertion, dehydration, or the onset of a heat-related illness. It might also indicate a high-stress response or a possible cardiovascular issue. Conversely, a rapidly decreasing heart rate during periods of high physical activity could signal an issue such as fatigue, a sudden drop in blood pressure, or other underlying medical conditions. It might also indicate that the athlete is slowing down or stopping, either voluntarily or due to an injury.

Teams can use this data in real-time to make informed decisions about the athletes' well-being and performance. For instance, if an athlete's heart rate increases rapidly without a corresponding increase in physical activity, the coaching staff can intervene, possibly calling for a rest period, hydration, or medical evaluation. Similarly, a rapid decrease in heart rate during intense activity might prompt the coaching staff to check on the athlete's condition to prevent potential injuries or medical issues.

The combination of internal and external measures allows for a more nuanced understanding of an athlete's physiological state. It enables the detection of anomalies that might not be apparent when only one type of measure is considered. This integrated approach enhances the ability of the coaching and medical staff to monitor athletes' health, optimize performance, and ensure safety during both training and competition. By leveraging real-time data from both internal and external sensors, teams can respond quickly to any issues, providing immediate care and adjusting training regimens as needed to maintain peak performance and well-being.

Global Metrics in Your Own Life

In this lesson, we are discussing global metrics - specific metrics created from the combination of measures collected from several data sensors. Common measures utilized by global metrics include heart rate, breathing rate, and acceleration. We have introduced three global metrics so far. A summary of those metrics is provided below:

- Sleep Score: Measures how well did you sleptFor example, the Fitbit produces a sleep score based on heart rate, breathing rate, acceleration data, and sleep cycles data
- Stress Score: Measures how much stress have you accumulated throughout a day
- Body Battery: Measures how much energy your body has left before reaching exhaustion, or how ready are you for activity.

As these examples show, global metrics tend to be whole-body measures.

Reflection Prompt:

Reflect on our discussion of global metrics so far and your initial impression of them. Of the global metrics we have discussed, which would you be interested in using in your own life and why?

Reflecting on the discussion of global metrics, my initial impression is that these comprehensive measures can significantly enhance our understanding of overall health and well-being. By aggregating data from various sensors, global metrics provide valuable insights that go beyond what individual data points can offer. They offer a more holistic view of the body's status and can be used to make informed decisions about lifestyle, fitness, and health.

Of the global metrics discussed, the Sleep Score is particularly interesting to me. Good sleep is foundational to overall health, affecting everything from cognitive function and mood to physical health and recovery. The Sleep Score provides a clear and comprehensive assessment of sleep quality by considering multiple factors such as heart rate, breathing rate, acceleration data, and sleep cycles. This can help identify patterns and issues in sleep that might not be apparent through subjective self-assessment alone.

Using a Sleep Score could help me understand how different factors, such as stress, diet, exercise, and daily routines, impact my sleep quality. It can also provide actionable insights to improve sleep hygiene and make necessary adjustments to my lifestyle for better sleep. For instance, if the Sleep Score indicates poor sleep quality, I could experiment with changes like adjusting my bedtime, reducing screen time before bed, or incorporating relaxation techniques to see how they affect my sleep.