Big Data Architectures and Neural Networks focusing on Health Trackers and Athlete Injury Prevention

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*I have always considered myself quite an active person, as a young person I was often keen to try my hand at different sports and as I have gotten older, I still have that desire to seek new challenges. Unfortunately, my desire to push myself has often resulted in serious injury. In order to better understand my body and prevent these injuries I recently purchased a wearable fitness tracker, monitoring my sleep and recovery. These kinds of wearable fitness trackers have seen a rapid increase in popularity in recent years.*

*With this increase in popularity, real-time health data is more accessible than ever. In this literature review, I aim to explore how big data architectures can be used to process this kind of data and how neural networks can help predict and prevent injuries.*

# Introduction

The objective of this literature review is to explore the latest research involving big data architectures and neural networks, ideally within my domain area but I have often delved into broader domains. I also wish to demonstrate how the implementation of these proposed methods can contribute to effective health tracking and injury prevention.

My research question will be "How can the combination of big data architectures and neural networks enhance the prediction injuries amongst athletes and overall health tracking?"

Research Methodologies:

I relied heavily on google scholar for finding appropriate papers to research. I would select and search for certain keywords and if I deemed a paper was relevant to my objective and research question, I would read the abstract, introduction and conclusion in order to assess whether was relevant to include in my literature review.

I will say that I came across a number of great papers which I didn’t end of selecting for various reasons. For example, often the paper was not quite as applicable compared to others or some papers were too technical for my current level of understanding. Some papers that caught my eye were also behind a pay wall and so not directly accessible, which is unfortunate.

I did experiment with other sources like Scopus which I found difficult to use and I soon found myself reverting back to using Google Scholar.

Reviewed Papers selected for Literature Review:

1. Analysis and Design of dual-feature fusion neural network for sports injury estimation model
2. A novel deep learning method for predicting athletes’ health using wearable sensors and recurrent neural networks
3. Dockerised Big Data Architecture for Sports Analytics
4. An Introduction to Neural Networks
5. A Framework for Quantitative Data Analysis of Big Data Collected by Activity Trackers
6. A Framework for AI-Powered Low-Cost Wearable Health Tracker Targeted towards Elderly in Developing Countries
7. Big Data Architecture for Pervasive Healthcare: A Literature Review
8. Deep Neural Architectures for Prediction in Healthcare
9. Wearable IoT Enabled Real-Time Health Monitoring System

# Literature Review

## Analysis and Design of dual-feature fusion neural network for sports injury estimation model

Authors: Linsheng Meng, Endong Qiao

Institution: Shanxi University, China

Date Published: 7th July 2021

During my research, I came across a paper written by two academics in Shanxi University, Linsheng Meng and Endong Qiao. It immediately grabbed my attention as it incorporated some initial thoughts I had when considering the uses of neural networks in sports injury prevention.

In their paper, they propose the use of a novel dual-feature fusion neural network model. The “dual feature fusion” term used here refers to the incorporation of both image/picture data and physiological into the neural network. For those of us, like myself, who are unaccustomed to reading academic literature, the term novel is used here to describe something that is new or innovative. I came across this term quite a lot when reading other academic literature.

The thought process behind the proposal of this dual feature model is to directly address a number of issues that have arisen in previous investigations. Primarily, the feature loss caused by merging operations, which results in poorer classification results. More specifically, the concern here is that merging operations have led to a reduction in the quality of the features, resulting in poorer classification results. By employing a new (or novel) approach to fuse dual features, our two academics aim to overcome the limitations associated with previous merging operations.

Their approach utilizes a 1x1 convolution and a communication link to build a dual-fusion structure, improving the model's ability to distinguish and categorize effectively. The 1 x 1 convolution term here means that our model adjusts the representation of features across channels. It's a way for the neural network to learn complex relationships and representations in the data, especially in the context of deep learning architectures.

Our two academics have not simply just explored this standalone model. They have tested their model against several other commonly used models, such as SVM, 3D-CNN, DenseNet to name a few.

The dataset used to complete this research is comprised of 33 high-level sprinters from Hainan Provincial Athletics team, comprised of 17 females and 16 males. A scoring system was designed based of a number of basic athletic movements and their resultant pain levels. Injury data is also collected. Injury probability was split into 4 classes, as shown below:

**Table 1**: Risk factors and its output values

|  |  |
| --- | --- |
| Sports Injury risk warning level | Output Value |
| No Risk | 0 |
| Low Risk | 1 |
| Medium Risk | 2 |
| High Risk | 3 |

A 70/30 training/testing split was used in the modelling and multiple methods of model evaluation were incorporated into the study. These are accuracy, sensitivity, specificity, AUC, precision, recall, f1-score and MCC. In summary, the proposed DFFNN model was incredibly accurate in classifying with an impressive score of 97% and was an improvement compared every other model tested in almost every category.

## A novel deep learning method for predicting athletes’ health using wearable sensors and recurrent neural networks

Authors: Wael Y.Alghamdi

Institution: Taif University, Saudi Arabia

Date Published: 31st March 2023

As mentioned in my introduction, a primary motivator for selecting this topic was my recent acquisition of a wearable fitness tracker. The next paper that I choose places an emphasis on data collected from wearable fitness trackers or “Wearable Health Monitoring Systems (WHMS)” as they are referred to in this paper. And after reading the paper I chose to include it in my literature review as I felt it gave me some valuable insights into this domain.

Wael proposes a method whereby WHMSs will track various physiological features of an athlete’s health such as heartbeat frequency, blood pressure, and skin temperature. The athlete's medical history is fed into a recurrent neural network (RNN) for predicting the athlete’s future health. The term recurrent here refers to a type of architecture that allows the network to retain and utilise past information in the sequence. Employing an RNN here is an appropriate choice here as there is an importance to the continuous, cyclical nature of our time-series data. Wael discusses an issue he faced regarding the complexity of WHMSs. Currently, WHMS lack a unified design due to different system approaches. This is something I myself have come across when choosing a suitable WHMS to purchase, each company’s product is noticeably different and focuses on different aspects of health. Each product utilises different methods in tracking one’s health and the results are displayed in different fashions.

The paper then goes on to discuss current studies being performed regarding blood pressure prediction, convolution kernels for sporting action recognition and joint points in the human skeleton. It also compares the paper’s proposed approached to previous studies, highlighting the improved efficiency and simplicity of the proposed method, as it requires less data collection time and training settings.

In the paper’s conclusion, it is discussed how they employed a recurrent neural network to extract deep features from the collected data at each time step. In the final phase, health prediction findings were obtained. The experiments were conducted with a random sample of 100 football players and demonstrated an impressive accuracy of 81%. The paper notes that these results are an improvement over alternative methods.

## Dockerized Big Data Architecture for Sports Analytics

Authors: Yavuz Melih Özgüven, Utku Gönener

Institution: Kocaeli University, Turkey

Date Published: 31st March 2023

My next chosen paper focuses less on injury prevention but on a more general view of sport-related data analysis, with a key focus on data architectures.

The introduction of this paper discusses the rapidly evolving area of sports analytics. It discusses the primary goal of sports analytics, which is to draw conclusions from the data, inform decisions and gain a competitive edge in a competitive setting. Modern sports analytics rely heavily on mathematical models. This industry change has resulted in a surge in data volumes from smart devices and necessitates the need for improved big data analytics.

Handling this big data will involve distributed and parallel computing technologies. Distributed systems offer scalability while parallel computing mechanisms like cluster computing and cloud computing enhance performance.

Following the introduction, the paper then goes on to focus on four topics related to sports data analytics.

* Structured Sport Data Analysis
* Sport Data Streaming
* Machine Learning-Based Sports Data Analysis
* Graph-based Sports Data Analysis

Structure Sport Data Analysis

This subsection focuses on the classifying data based on velocity and variation. It highlights the analytical approach known as ELT (Extract-Load-Transform). This is where raw data is extracted, loaded, and transformed (using SQL) resulting in accessible data for users. It mentions a number of specific studies in sports like basketball and speed-skating which utilise this approach.

Sport Data Streaming

This subsection focuses on a number of key conclusions from various other academic studies surrounding the impact of wearable health/sport tracking devices. Some studies which I found particularly interesting where a study by Grun et al which developed a real-time tracking system for dynamic sports events such as football games. I should also mention the study by Haiyun and Yizhe who created a Hadoop platform for predicting match results using machine learning algorithms.

Machine Learning-Based Sports Data Analysis

This section highlights a number of studies which outline various applications of machine learning in sports analytics. An interesting one I read was written by Ehrlich and Ghimire who explored the impact of fan presence on team performance in Major League Baseball. It reminded me of a classic saying in soccer that the crowd is the “twelfth” man. If you are unfamiliar with this, it means that the crowd give such support to their team that they have as much value as an extra player.

Graph-based Sports Data Analysis

This section gives us an overview of graph-based approaches in sports analysis. It is argued that it is often the case in sports data analysis that a graph is the best tool to model relationships, interactions, or connections between different items, such as players, teams, events etc. Again, it highlights a number of other studies in this area.

In summary, this section provides insights into the challenges of acquiring suitable sports datasets and highlights GitHub as a major platform for sports analytics repositories. The importance of reproducibility, underlining the significance of sharing both data and code for transparent assessment in research is underscored.

Section 4 is where the paper really begins it discussion on the core components of the containerised big data architecture, focusing on Apache Spark and Docker. Containerisation involves putting your software (and libraries, settings, and dependencies) into a neat, self-contained box. This container is isolated from the rest of your computer system, making it easy to move around and run consistently. Containerisation is a fundamental technology in data analytics, offering agility, consistency and scalability in analytical processes.

Apache Spark:

The first subsection introduces us to Apache Spark. Apache Spark is a powerful distributed computing framework that scales out by distributing tasks across multiple different machines. Spark supports various tasks, including machine learning and structured data analysis, unifying tasks into a single framework.

Docker:

The second subsection outlines a popular containerisation platform known as Docker. Docker enables the creation of containers, which, as mentioned earlier, includes all the necessary components to run an application. Docker's methodologies for testing and deploying code contribute to reduced delays.

It moves on to discuss the experimental results and discussions based on the proposed containerised big data architecture for sports analytics. I will discuss the key points from this section below.

Firstly, the paper describes the setup for the experiments conducted. The performance tests were carried out on Microsoft Azure (a cloud computing platform) using a specific server configuration. The tests used Spark, a popular open-source data processing engine, and MaRe, an open-source programming library which enables scalable data-intensive processing. The paper then looks into four case-studies which demonstrate the practical applications of containerised big data architecture. These case studies are:

* SQL Analysis of Football Players
* Machine Learning Practices on Sports Datasets
* Anomaly Detection in eSports Data
* Football Passing Networks

Essentially, these case studies highlight the versatility of the containerised big data architecture for various analytical tasks, showcasing its effectiveness in processing, analysing, and deriving meaningful insights from a diverse array of sports-related datasets.

The final section summarises the conclusions of this research paper, I will discuss this in more detail in section 3.

## An Introduction to Neural Networks

Author: Kevin Gurney

Institution: University of Sheffield

Date Published: 1997

I wanted to expand my overall understanding of neural networks in general, so I spent some time researching the broader subject area. I felt this would really aid my overall understanding of the domain area as I progress through this course. I came across this publicly available book by Kevin Gurney which was very highly rated by a number of sources.

The thing that stood out to me about this book is its straightforward and simple language. It uses a of metaphors, and visual aids to explain complex ideas, covering topics like artificial neurons and network functions. The book concludes with glossary surrounding network architectures and algorithms, making neural networks understandable for a broad audience interested in the fundamentals of this subject area.

Whilst I did not read all 150 pages of this detailed literature, I did select a number of chapters which were of a key interest to me:

* Chapter 1: Neural networks—an overview
* Chapter 4: Training TLUs: the perceptron rule

I will discuss the key findings on these in subsequent sections.

## A Framework for Quantitative Data Analysis of Big Data Collected by Activity Trackers

Author: Matabo Mdunyelwa and Liezel Cilliers

Institution: University of Fort Hare, South Africa.

Date Published: 2021

As mentioned previously, I am keen on investigating the impact that these health tracking devices will have on the future of the health industry. As I am an actuary by trade, I was also interested on their potential in the insurance industry. My subsequent research lead me to the following paper by two academics from the University of Fort Hare, South Africa.

This paper aims to address a number of challenges associated with big data collected from tracking devices, aiming to develop a comprehensive, standardised framework for its analysis. The proposed framework incorporates six primary factors for success, these include ensuring high quality data, selecting appropriate software, meaningful data visualisations, continuous data monitoring, communicating data trends, and ensuring feedback leads to behavioural improvements.

## A Framework for AI-Powered Low Cost Wearable Health Tracker Targetted towards elderly in Developing Countries

Author: Celine Tioh, R. Dhakshyyani

Institution: Technology and Innovation (APU)

Date Published: 2022

After reading this paper I found out that the original motivation behind the paper was due to the limited healthcare access in Malaysia. The paper proposes an innovative solution leveraging mobile sensor technology. By integrating a sensor into a wearable health tracker, along with an AI-powered predictive system, the project aims to provide a more affordable alternative to existing smartwatches and fitness trackers. The system serves as an early predictor of heart diseases, as issue that is rife amongst the poor, elderly people of Malaysia. The system ultimately aims to enhance the potential for comprehensive healthcare solutions. The integration is facilitated through an innovative mobile application that displays and processes aspects of an individual’s health at a low cost.

## Big data architecture for pervasive healthcare: a literature review

Author: Tan, C., Sun, L., Liu, K.

Institution: University of Reading

Date Published: 2015

This paper focuses on pervasive healthcare, which is a relatively new concept aiming to address rising healthcare costs. If you were unaware with this terminology, as I was, pervasive healthcare is defined as healthcare to anyone, anytime, and anywhere by removing locational, time and other restraints while increasing both its coverage and quality.

The paper focuses on the 4Vs (velocity, volume, variety, and veracity) of big data and proposes a novel architecture to address certain data privacy and security challenges, which are particularly important in the healthcare industry. The architecture covers certain aspects such as data collection, governance, integration, analytics, and visualisation, aiming to improve healthcare delivery and reduce operational costs.

## Deep neural architectures for prediction in healthcare

Author: Dimitrios Kollias, Athanasios Tagaris,

Institution: Technical University Athens, Athens, Greece

Date Published: 2017

This paper investigates the limitations of deep neural networks (DNN) in the healthcare industry, specifically focusing on Parkinson's disease. The paper outlines how DNNs excel in processing tasks but their lack of decision-making transparency hurts their practicality within the personalised healthcare environment. The study introduces us to a novel DNN system tailored for Parkinson's disease.

The proposed methodology combines supervised training and unsupervised learning for network adaptation and transparency. The aim of this research is to improve healthcare predictions and includes a detailed experiments demonstrating the overall performance of the developed DNN architecture.

## Wearable IoT enabled real-time health monitoring system

Author: Jie Wan, Munassar A. A. H. Al-awlaqi

Institution: NanTong University China,

Date Published: 2018

This paper addresses the impact of changing demographics on healthcare, emphasising the need for improved ICT. It explores the integration of assisted living, accessible healthcare, and the Internet of Things (IoT) to enhance healthcare services. I came across this IoT terminology in numerous other studies. This term is used to describe a network of ‘things’ that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data over the internet.

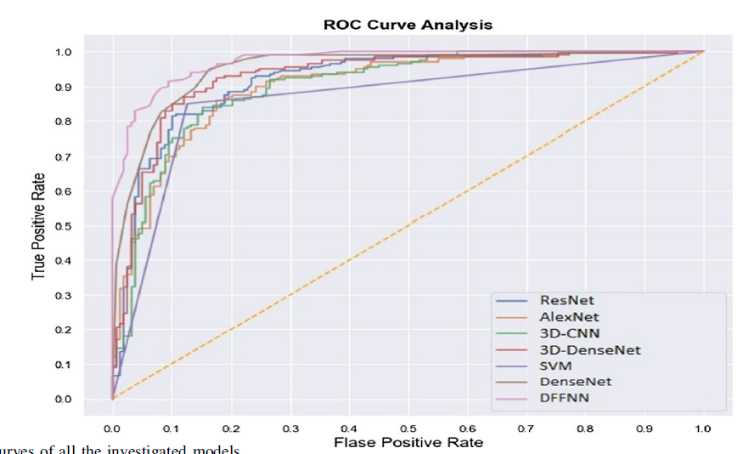
The proposed Wearable IoT-cloud-based Health Monitoring System (WISE) is introduced as a framework for smart and personalised healthcare, incorporating sensors, network communication, data processing, and intelligent applications. The paper concludes with discussions on related research, the proposed system design, and future directions for further research.

# Evalutation of key findings

I gained a huge amount of exposure and knowledge through studying the papers outlined above as well as from reading the papers I chose not to include. Below I will discuss the key findings from these papers and attempt to give my own perspective on their key findings, where relevant.

## Analysis and Design of dual-feature fusion neural network for sports injury estimatation model

Whilst I am by no means a subject matter expert, I will attempt to evaluate the key findings of this highly technical paper. The experimental results of this study using various classification models, highlight the superior performance of the proposed dual-feature fusion neural network model. Outperforming a number of competitor model on numerous key metrics. I know from my own practical demonstration how challenging this can be, particularly considering the class imbalance between injured and non-injured athletes.

The robustness of the model is demonstrated through consistent scored across multiple metrics and ROC curves.

Overall, the study feels almost like a showcase for the dual-feature fusion neural network in predicting injuries. It positions the model as a promising advancement in the subject area.

## A novel deep learning method for predicting athletes’ health using wearable sensors and recurrent neural networks

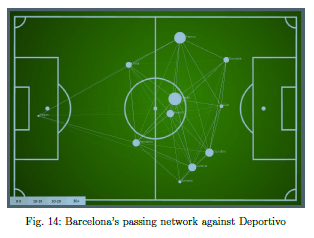
As mentioned in my literature review this paper’s conclusion, it is discussed how the experiments demonstrated an impressive accuracy rate of 81%. They mention how this result is a notable improvement over numerous alternative models.

Whilst this may be the case, the paper does not appear to include a huge amount of detail on the performing of this experiment, instead choosing to focus on certain related aspects of the overall topic like blood pressure prediction and the importance of joint analysis. It is hard to give weight to the validity of this conclusion given the lack of preceding discussion surrounding this conclusion.

## A Dockerized Big Data Architecture for Sports Analytics

I found the literature review section of this paper to be incredibly extensive, collecting a host of interesting papers and case studies. Although my experience in academic literature is limited, I would class this as a very high standard of literature review.

As mentioned earlier, this paper chooses to display it’s results through a practical demonstration of how the Dockerised big data Architecture through four case studies, covering structured analysis, streaming, machine learning, and graph-based analysis in sports analytics. I think the best approach is to look at each of these case studies individually.

SQL Analysis of Football Players

The first case study focuses on using SQL to extract insights from a dataset taken from FIFA 20 (a soccer videogame). SQL queries were written and encapsulated into a JAR file (sql.jar) and then copied into a Docker image containing Java. Subsequently, these SQL queries were executed in MaRe, a platform facilitating parallel processing, to analyse the dataset efficiently.

It is quite difficult to evaluate this case study, but it does give us a simple demonstration of a practical example of Dockerised big data architecture in action. It serves a good purpose as it leads us nicely into more complicated case studies.

Machine Learning Practices on Sports Datasets

This case study is quite similar to the first and employs Spark MLlib, a machine learning framework, to conduct regression, classification, and clustering analyses on different sports datasets. The results are informative for predicting player performance and match outcomes, but there are limitations and potential biases in the datasets must be acknowledged.

This case study is essentially the first case study with an added machine learning aspect to it.

Anomaly Detection in eSports Data

For this case study, the focus is on finding unusual patterns in data collected from players during video game tournaments, particularly in brain activity. The goal is to detect anomalies or irregularities in real-time, which could be indicators of various factors, including player well-being or unexpected behaviours (such as cheating). The study utilises advanced algorithms (IsolationForest) and streaming technology (Apache Pulsar) to perform this analysis efficiently.

The “Spark Streaming” engine, responsible for real-time data processing, is containerised and integrated with Apache Pulsar, a distributed messaging platform. This combination enables processing of different events in near-real-time.

`Evaluating this case study, ethical considerations about player privacy and data usage need to be carefully addressed. It would also be nice to understand the implications of utilising the Dockerised big data architecture. In other words, could this task be performed without Dockerisation? and if so what, can the improved time/efficiency be quantified for comparison?

Football Passing Networks

Finally, the last case study utilises Spark GraphX (a graph processing framework built on top of Apache Spark, a distributed data processing engine) to model and analyse passing systems in football, providing a graph-based representation of player interactions (or passes). The results offer a visual depiction of team dynamics which could aid player assessments for coaching and game analysis purposes. An example graph is shown below:

Similar to the last case study, it would have been nice to have a quantifiable gauge of the case study being performed with and with Dockerisation.

Lessons Learned:

The paper also offers several lessons learned, which I have repeated directly here, with my own added commentary:

* Academic Awareness: Recognised a gap in academic literature regarding the utilisation of business intelligence and analytics tools in sports.

This implies the need for further research, the paper does not delve deeply into specific reasons behind the academic neglect which could have been useful.

* Reproducible Research: Emphasized the importance of reproducibility in research by making both data and code available to peers.

I agree with this point and the paper does provide sufficient detail of this issue.

* Containerized Processing: Highlighted the advantages of Docker methodologies for quick code deployment, reducing delays between coding and production.

As mentioned previously, whilst we do look at a number of case studies where these methods are used, we do not get a sense of how these tasks would be worse if we did not incorporate Dockerisation. I believe this is a potentially area for improvement. Quantifiable statistics to support the reduction in delays would be useful and provide validity to this statement.

* Different Data Analytics: Demonstrated the versatility of the architecture across various data-intensive case studies in sports analytics.

I agree with this point.

* Big Data Techniques: Discussed the potential of big data and artificial intelligence techniques in extracting valuable insights from raw sports data.

I agree with this, and this is demonstrated on numerous occasions in the report.

Whilst it is clear that I agree with the majority of the lessons learned, there is room for further research and exploration to address certain limitations and provide a more intricate understanding of the implications of Dockerisation of sports analytics.

## A An Introduction to Neural Networks

Chapter 1: Neural networks—an overview

This chapter serves as a great introduction for anyone who is new to the subject area and even those who have experience could find benefits from reading this chapter. It elaborates on how neural networks serve as simplified models inspired by networks of neurons in animal brains. The focus is on leveraging parallel computing for effective problem solving. The fundamental artificial neuron, a threshold logic unit (TLU), mimics the integrate-and-fire mechanism of brain neurons by computing a weighted sum input and outputting this based on whether it exceeds a certain threshold.

Chapter 4: Training TLUs: the perceptron rule

The next chapter that piqued my interest was chapter 4, this chapter delves into the adaptation of nodes like threshold logic units (TLUs) using a geometric approach. It demonstrates how these nodes, learn to classify problems by adjusting weights. The learning rule is integrated into a training algorithm, and the chapter touches on addressing specific problems with a two-layer network. It also outlines a number of considerations for the implementation of neural networks is also explored.

Obviously, it is quite difficult to evaluate key findings from this highly educational literature, but it was certainty a key part of my research.

## A Framework for Quantitative Data Analysis of Big Data Collected by Activity Trackers

Data governance is a crucial aspect of data analytics, and this paper places a huge emphasis on that exact growing challenge facing numerous industries. The framework emphasises the importance of role of big data analytics will have, focusing on early health issue detection and behavioral change promotion. It hopes that the standardised framework will ultimately assist in the advancement of user-engaged health outcomes.

I think this is a high-quality paper that has extremely valuable ideas and intentions, whilst perhaps not focusing on the most glamourous of subject areas.

## A Framework for AI-Powered Low Cost Wearable Health Tracker Targetted towards elderly in Developing Countries

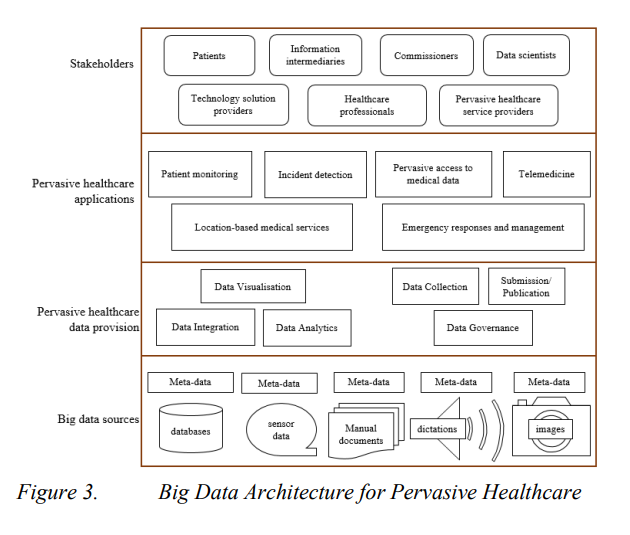
The key findings of the paper highlight the development of an innovative, cost-effective wearable health tracker targeting developing countries with certain economic constraints.

The fact that the experimental result are easily repeatable demonstrates the system’s reliability. Achieving a 100% accuracy on healthy subjects for the heart disease prediction model is highly impressive. However, challenges include instability in heart rate detection with the current sensor technology available, limitations in real-time data access and reduced accuracy in predicting heart disease for females and lower blood pressure values. The experiment also notably had a small sample size when compared to other experiments I came across.

The paper does suggest a number of potential areas for improvements based off these challenges outlined above, such as sensor enhancement, implementation of reinforcement learning for model refinement/improvements. They also suggest the implementation of new features like emergency alerts and GPS features which could have life-saving consequences.

Overall, I think the paper contributes valuable insights into the development of accessible and effective health monitoring systems for resource-limited regions. The paper was also very detailed on ESG considerations which was something often lacking in other academic literature.

## Big data architecture for pervasive healthcare: a literature review

This paper draws knowledge from a lot of previous studies and covers a broad range of findings through researching certain case studies. I will choose to focus on the proposed big data architecture suggested by the paper, outlined below:

The proposal covers four key levels:

1. The ‘stakeholders’ level outlines user roles, involving patients, healthcare professionals, government, data scientists, and technology providers.
2. The ‘Pervasive Healthcare Applications’ level focuses on services including telemedicine, monitoring, and emergency responses.
3. The ‘Pervasive Healthcare Data Provision’ level addresses data challenges through components like data collection, governance and analytics.
4. The ‘Big Data Sources’ level manages data with Hadoop, highlighting security and governance considerations.

This architecture serves as a comprehensive guide for any healthcare organisations who are seeking to integrate big data techniques for improved healthcare facilities.

## Deep neural architectures for prediction in healthcare

As mentioned earlier, this academic study introduces recent findings in healthcare diagnostics, particularly in diagnosing Parkinson's disease using deep neural architectures. Key contributions include successful design and implementation of end-to-end architectures, incorporating multiple types of neural networks. The novel unsupervised approach, improves adaptability and transparency in decision making which is great to address communication issues and reducing adverse selection. The paper outlines how there are ongoing efforts aiming to correlate clusters with medical data for explanations, aiming to enhance user trust in the system. The paper outlines potential future research extends methodologies to other degenerative diseases, showcasing scalability and broader applicability in healthcare diagnostics.

Overall, the study provides valuable insights for advancing disease diagnosis systems and gave me a lot of insights into the area. I can see how the methodologies utilised in this paper could transfer to an injury prediction/prevention scenario.

## Wearable IoT enabled real-time health monitoring system

The WISE system, involves using iconnected wearable sensors to observe an individual’s health conditions. It reads health data such as heartrate, temperature and blood pressure, and transmits this data directly to the cloud server.

The W-Cloud, as it is referred to, performs data storage, processing, visualisations and disease identification. The system allows users (patients, doctors, and family members) to access both real time and historical data through a web-based application. The system aims to monitor health conditions, identify abnormalities, and notify relevant stakeholders. Machine learning techniques are applied to disease diagnosis based on the data extracted from the health sensor. In summary, WISE facilitates personalised and remote health monitoring.

I felt that some aspects could be further elaborated, such as specific details on the machine learning techniques used and a more extensive discussion on the potential for data privacy issues.

Additionally, some user feedback would have been useful and add validity to the study. In summary, the research provides a foundation for advancing personalised health monitoring systems.

# Conclusions

After reading each paper and analysing their key findings, I was left to draw my own conclusions, which I have discussed below.

## Analysis and Design of dual-feature fusion neural network for sports injury estimatation model

Whilst I found this paper very interesting and showcased an impressive grasp of the subject area, I felt that communicating the data collection process was slightly confusing with some odd wording. I assume a lot of this could be attributed to a language barrier, so for that reason, I do not feel this warrants any real criticism.

## A novel deep learning method for predicting athletes’ health using wearable sensors and recurrent neural networks

This paper provided myself with a lot of insight into the issues regarding the use of WHMSs and how these can be used in injury prevention, but, as mentioned previously, I felt that it lacked a lot of information on the actual experiment performed on the 100 professional footballers. Perhaps this was done with good reason, as Wael did not feel that the sample size was large enough to give any real validity to the results. Alternatively, he may have felt that the data collection methods weren’t sufficiently accurate enough to provide valid results, I only mention this due to the fact that a “modest processing budget” is mentioned. I get the sense that this paper was written with the intention of gaining access to more resources to further the initial ideas discussed in this paper.

## A Dockerized Big Data Architecture for Sports Analytics

Whilst this paper didn’t give me a lot of numerical statistics to delve into, I felt that the paper was extremely well-written and increased my awareness of number aspects of the subject matter. The paper gave me a lot of further areas to study and research and followed a coherent structure.

I found this paper the easiest to comment on which is a credit to how well it is written, in comparison the other papers where slightly more challenging.

It could be argued that this paper is not particularly applicable to my research question but given the broad nature of the topic I felt that this paper could easily be applied to my domain area. The real time monitoring system utilised in the eSports case study could easily be translated to athletes in a match environment used to detect real time injuries as they happen. In this example Dockerisation would reduce any delays present otherwise.

## A An Introduction to Neural Networks

I do not feel it is appropriate to discuss the conclusions of this book in great detail as I used it as more of an extremely broad educational resource and so I feel this lack the necessary criteria to be discussed here. I will say that I gained a huge amount of value from reading through certain chapters of this book.

## A Framework for Quantitative Data Analysis of Big Data Collected by Activity Trackers

The conclusions emphasise the significance of monitoring activities, such as sleep, diet and exercise, through wearable devices. The positive impact these devices can have on users' lifestyle and health status cannot be underestimated and this point is supported through statistical, experimental evidence. They underline the role of big data analytics in interpreting the collected health data effectively.

The study calls for increased assessment and improvement efforts in key areas, such as ensuring high-quality data, meaningful data visualisation, health monitoring, communication, and feedback leading to user behavioural improvement. The proposal of their framework serves as a valuable tool for users seeking to actively manage their health and well-being. I could easily see this being adopted as a standardised approach.

## A Framework for AI-Powered Low Cost Wearable Health Tracker Targetted towards elderly in Developing Countries

This paper contained detailed section on limitations and future recommendations which I found very insightful and self-aware. The conclusion I took away from this paper is the importance of accessibility of the technology and how the use of AI should not be focused on the select few. It highlighted how the knowledge of this domain can be utilised to improve the quality of live of those in developing countries.

The focus on ESG considerations throughout the paper was refreshing and this is something I hope to take into my own projects.

## Big data architecture for pervasive healthcare: a literature review

The study identifies a number of key research themes, common throughout a number of case studies, and proposes a conceptual big data architecture (for pervasive healthcare). The study attempts to address a known literature gap by incorporating big data practices, addressing data-related challenges in the implementation of big data. The limitations, highlighted, allow a straightforward pathway for future research.

Overall, the conclusions contribute significantly to the guidance available to healthcare organisations who wish to adopt big data processes for the benefit of their patients.

## Deep neural architectures for prediction in healthcare

Whilst this paper may deviate from my problem area slightly, it allowed me access to a deeper insight into various neural networks, which is an area I was particularly keen to educate myself on.

It showcases the unsupervised clustering approach which enhances adaptability and transparency in decision-making. Ongoing efforts aim to correlate clusters with medical data for better explanations. The success in Parkinson's disease diagnostics suggests the scalability of these methods to other degenerative diseases. I can easily see how this innovative approach could be translated to the health-monitoring or injury prevention scenario.

## Wearable IoT enabled real-time health monitoring system

I acknowledge the challenges such as data transmission optimisation, security concerns and the need for sophisticated data mining techniques. The integration of wearable IoT in healthcare is seen as transformative but requires addressing scalability, security, and privacy issues. The conclusion also highlights the importance of advancing data mining algorithms, incorporating physical activity recognition for holistic health assessments, and enhancing real-time service delivery for various stakeholders.

Overall, a very engaging paper which highlighted important issues that were not discussed in many other papers I came across.

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