

Wearables in Healthcare

AGE

17-18

Year 12
Year 13

CURRICULUM

IT
ICT

OFQUAL

AO1

AO2

Assessment
Objectives

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Extension Work
Subject IAG



Delivered in
partnership
with:

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For Pupils Welcome



To get into the best universities, you must demonstrate that you are intellectually curious, and will make the most of the wonderful academic opportunities available to you.

One of the best ways of demonstrating this, is by going above and beyond what is taught in school and studying something that is not on the curriculum.

This resource will give you exactly such an opportunity. You will have something interesting to write about in your application to university, something interesting to talk about in a university interview, and open whole new areas of study you might be interested in!

You will develop valuable academic skills as you go, that we have marked out with gold badges (see the next page on university skills). As you work through the resource you can look out for these badges so that you can explain which skills you have developed and what you did to demonstrate them. Developing these skills will help you get university ready!

If you have any questions while you are using the resources in this pack, you can contact your teacher or email us directly at schools@access-ed.ngo.

Good luck with your journey to higher education!



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INFORMATION FOR PUPILS

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Good luck with your journey to higher education!



For Pupils University Skills



To complete this resource, you will have to demonstrate impressive academic skills. When universities are looking for new students, they will want young people who can study independently and go above and beyond the curriculum. All of these skills that you will see here will demonstrate your abilities as a university student – while you're still at school!

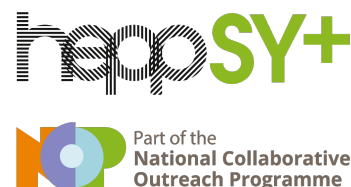
Every time you have to look something up, or write up a reference you are showing that you can work independently. Every time that you complete a challenging problem or write an answer to a difficult question, you might demonstrate your ability to think logically or build an argument. Every time that you evaluate the sources or data that you are presented with, you are showing that you can “dive deep” into an unfamiliar topic and learn from it.



Here are the skills that you will develop in this course:

independent research other books creativity	your ability to work on your own and find answers online or in
problem solving	your ability to create something original and express your ideas
building an argument	your ability to apply what you know to new problems
providing evidence	your ability to logically express yourself
academic referencing	your ability to refer to sources that back up your opinions/ ideas
deep dive and credit them	your ability to refer to what others have said in your answer, and credit them for their ideas
source analysis new areas of knowledge	your ability to go above and beyond the school curriculum to new areas of knowledge
data interpretation	
active reading	your ability to evaluate sources (e.g. for bias, origin, purpose)
	your ability to discuss the implications of what the numbers show
and annotating	your ability to engage with what you are reading by highlighting and annotating

For Teachers RBC Guide



Programme	Aims	<p>The Research-Based Curriculum aims to support student attainment and university progression by providing classroom resources about cutting-edge research at local universities. The resources are designed to:</p> <ul style="list-style-type: none">✓ promote intellectual curiosity through exposure to academic research✓ stretch and challenge students to think deeply about content that may be beyond the confines of the curriculum✓ develop core academic skills, including critical thinking, metacognition, and written and verbal communication✓ inform students about how subjects are studied at university, and provide information, advice and guidance on pursuing subjects at undergraduate level
	Content	<p>The programme represents a unique collaboration between universities and schools. Trained by AccessEd, PhD Researchers use their subject expertise to create rich resources that help bring new discoveries and debates to students.</p> <p>The Research-Based Curriculum offers ten modules suitable for either KS4 or KS5 study. The modules span a range of disciplines, including EBacc and A-level subjects, as well as degree subjects like biochemistry. Each module includes six hours of teaching content, supported by student packs, teacher notes and slides. All modules are available online and free of charge for teachers at select schools.</p> <p>Resources are designed to be used flexibly by teachers. The resources can be completed by students individually or in groups, in or out of the classroom.</p>
	Delivery	

For Teachers

RBC Guide



Here are five examples of delivery options:

Extra-Curricular Subject Enrichment Clubs

The resources can be completed in small groups (4-8 pupils) across a series of weekly lunch clubs or after-school clubs. Groups can reflect on their learning by presenting a talk or poster on the subject matter at the end of the course.

University Access Workshops

The resources can be used by students to explore subjects that they are interested in studying at university. This can inform their decision making with regards to university degree courses, and allow students to write more effective personal statements by including reflections on the Research-Based Curriculum.

Research Challenge

The resources can be used to ignite curiosity in new topics and encourage independent research. Schools could hold a research challenge across a class or year group to submit a piece of work based on the resources. Pupils could submit individually or in small groups, with a final celebration event.

Summer Project

Resource packs can function as 'transition' projects over the summer, serving as an introduction to the next level of study between KS3 and KS4, or KS4 and KS5. Students could present their reflections on the experience in a journal.

Evidence

The Research-Based Curricula programme builds on the University Learning in Schools programme (ULiS), which was successfully delivered and evaluated through the London Schools Excellence Fund in 2015. The project was designed in a collaboration between Achievement for All and The Brilliant Club, the latter of which is the sister organisation of AccessEd. ULiS resulted in the design and dissemination of 15 schemes of work based on PhD research for teachers and pupils at Key Stage 3. The project was evaluated by LKMCo. Overall, pupils made higher than expected progress and felt more engaged with the subject content. The full evaluation can be found here: [ULiS Evaluation](#).

For more information contact hello@access-ed.ngo

Questions?

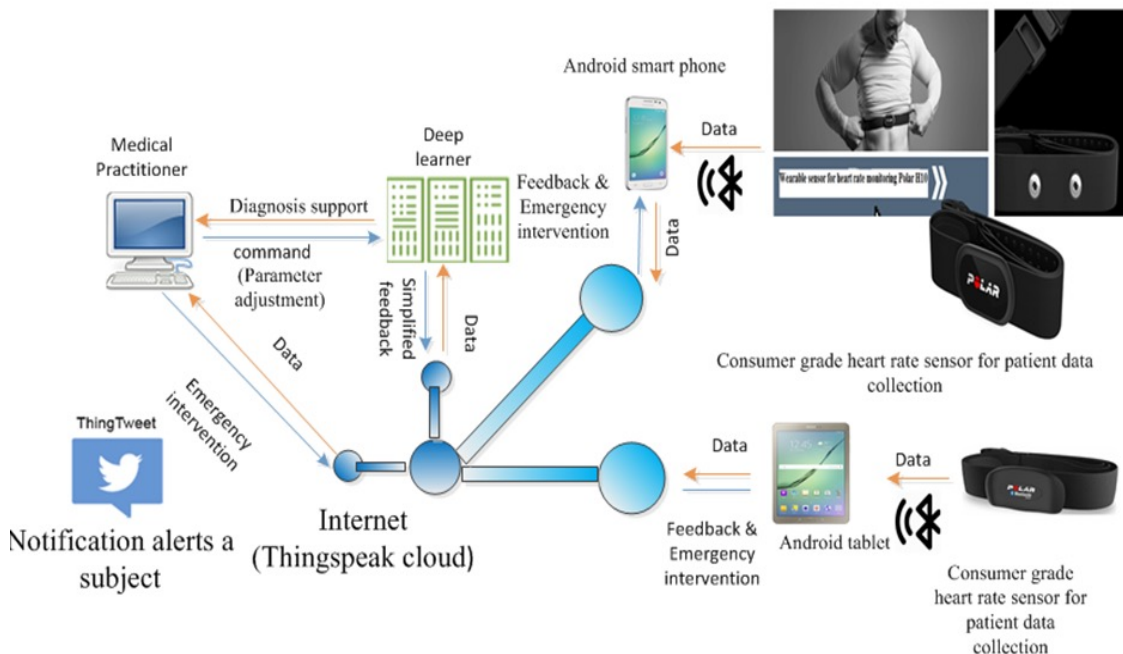
Introduction to Topic Wearables in Healthcare



Each lesson has a specific link to the GCSE curriculum. The motivation for writing this pack of lessons is to let students link their current textbook knowledge to state-of-the-art research work or cutting-edge applications in computer science, deep learning and internet of things technology. The proposed system is composed of commercial wearable sensors for patient data collection. Cloud computing was used to store and process the data. A smartphone relays the sensor data to a cloud server for storage and processing. The data interpretation can be done by a medical practitioner or a DL algorithm. The service informs patients when their status has changed through appropriate feedback channels. The wireless health monitoring system offers benefits, for people who suffer from Chronic heart diseases such as Atrial Fibrillation (AF) and Congestive Heart Failure (CHF), in the home environment. In addition, the service protects human life by monitoring the stroke risk and thereby it aids physicians as well during the early stage disease diagnosis while the subject is still in the home environment. The following figure below shows the main components of wireless heart health monitoring system.

Figure 1

Shows the architecture of long term heart health monitoring system



Introduction to Subject ICT at University



While a computer science degree focuses on the theoretical aspects of computing, ICT at university is usually much more practical, drawing on a wide range of academic disciplines to address organisational, technical and business problems. An ICT degree involves hands-on projects and an opportunity to be innovative. Course content includes topics like computer hardware, computer networks in business, and database design and management. Some ICT degrees also include modules on business and project management, to help prepare students for the roles they will take in providing ICT services in business and industry. ICT graduates leave university with a broad set of transferrable skills, which puts them in a good position in the job market.

Find out more about studying ICT by exploring the further reading at the end of each resource, and the university ready links at the end of pack.

Meet the PhD Researcher Murtadha Kareem



Murtadha Kareem is currently doing full-time research at Sheffield Hallam University. He is working with the department of Materials and Engineering Research Institute (MERI). Murtadha has achieved the degree of BSc and MSc in Telecommunication and Electronic Engineering. Currently, his interest in research is based on a wireless heart health monitoring system for stroke risk mitigation. His approach combines deep learning and Internet of Things which have the main role of data interpretation and distribution. For the first time, he employed a deep learning system to detect AF beats in Heart Rate (HR) signals. This research should help physicians in diagnosing the disease at the early stage. He received the best presentation award in the International Conference entitled Wearable Healthcare Monitoring Systems that took place in Paris. He is investigating a route to market for his application with Grow-Med-Tech.

Glossary



Term	Definition
AF	Atrial Fibrillation
AI	Artificial intelligence
DL	Deep Learning
BLE	Bluetooth Low Energy
HR	Heart Rate
IoT	Internet of Things
ANN	Artificial Neural Network
LAN	Local Area Network

Resource One Overview



Topic The structure of a wireless heart health monitoring system

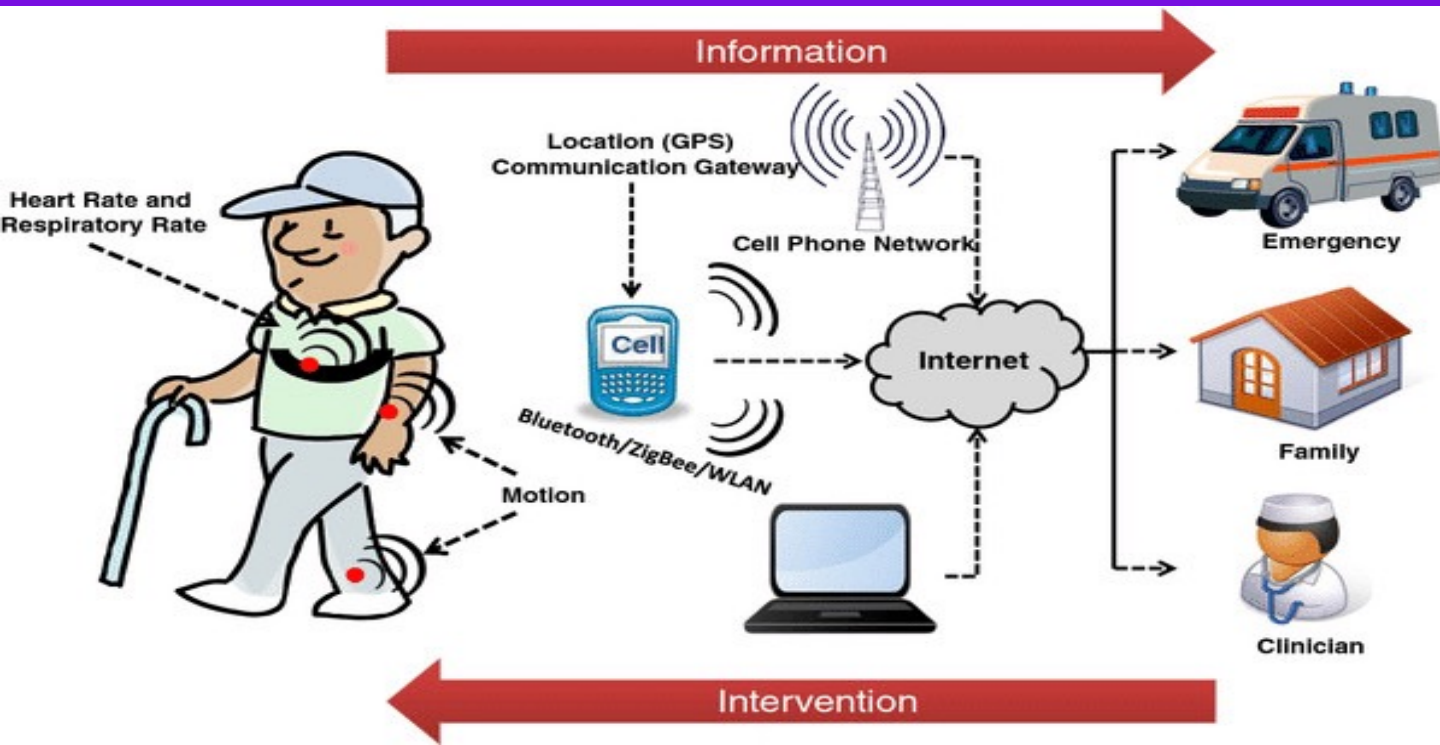
GCSE Modules Representing algorithms

Objectives After completing this resource you should be able to:

- ✓ Understand the main components that form a life protect system, and how they interconnect with each other.
- ✓ Understand how algorithms are used in the system.

Instructions

1. Read the data source
2. Complete the activities
3. Explore the further reading



Resource One

Data Source



A stroke is a serious life-threatening medical condition that occurs when the blood supply to part of the brain is cut off. Strokes are a medical emergency and urgent treatment is essential. The sooner a person receives treatment for a stroke, the less damage is likely to happen. Clinical studies showed that Atrial Fibrillation (AF), either permanent or intermittent (paroxysmal), increases the risk of cardio-embolic stroke. AF is the most common sustained heartbeat disorder in adults, causing an irregular and abnormally fast heartbeat. AF changes the blood flow dynamics and these changes can cause stroke. Even for stroke survivors, the quality of life is reduced through mental and physical disability. That impacts negatively upon care givers and loved ones. This is a big and growing public health problem, because stroke prevalence is predicted to increase.

AF diagnosis and long term monitoring can help to establish and mitigate stroke risk. However, in the past it was difficult and, in many cases, very intrusive to monitor a patient's heart beat. That difficulty came from the absence of wireless-health technology that covers wide geographical areas. Today, we are in a position to address the heart beat measurement problem with a wireless-heart rate monitoring system. The proposed system is based on internet of things technology and advanced artificial intelligence. The purpose of utilising wireless networks is to establish continuous long-term monitoring for an AF affected subject in a cost-effective way

Resource One

Data Source



We propose a continuous real time monitoring system for the cardiac activity of a patient with the ability to automatically detect signs of AF. Once such signs are detected, patients and carers get informed about the increased stroke risk. That early warning system helps to shorten the response time to medical intervention and thereby limits or in some cases prevents stroke damage through these interventions. We propose to address the problem outlined above with Internet of Things (IoT) technology and advanced artificial intelligence. MATLAB thingspeak will be used to collect heart rate data from android phones. Deep learning will analyse that data in real-time. The analysis results will be disseminated via Twitter.

The flowchart below is composed of the main components of building a life protection system. To be specific, the proposed system would be useful for people who sit in their home environments. In this study, AF disease would be detected through the following steps:

Step 1 Collect the Heart Rate measurements from a subject using a wearable sensor placed on the chest of the subject.

Step 2 An android smart phone or tablet can be used to communicate with HR sensor via Bluetooth in order to visualise HR recordings.

Step 3 Data Dissemination, storing and processing based on using Internet of Things (IoT) technology.

Resource One

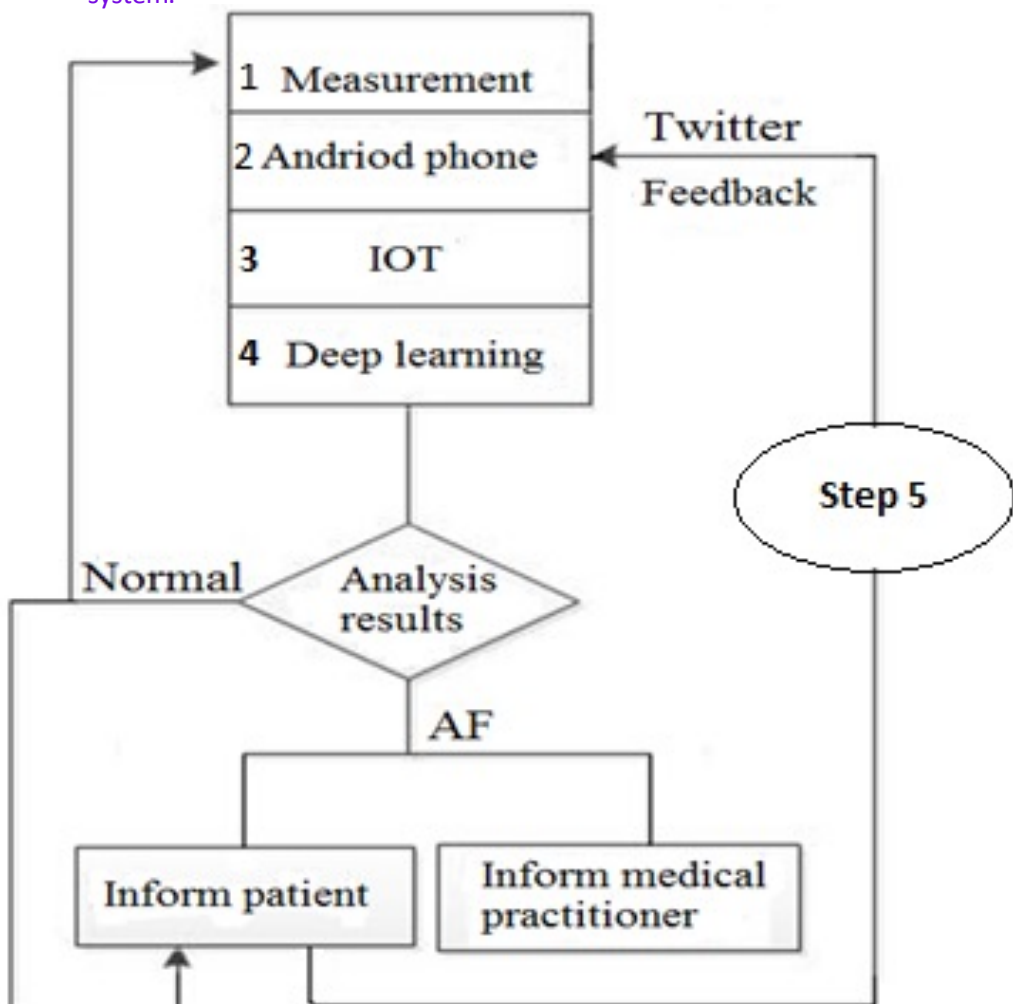
Data Source



Step 4 A deep learning system analyses the received data and classifies data segments as Normal or AF. The normal signal has consistent beats – the time interval between beats is roughly constant. The AF signal has variable beats – the time interval between beats varies.

Step 5 The classification of an AF sequence will trigger a feedback message via twitter that informs both patient and medical practitioner of the increased stroke risk.

Flowchart shows the main components of wireless heart health monitoring system.



Resource One Activities



Activities

1. Explain what a stroke is and how atrial fibrillation (AF) increases stroke risk.

2. Describe the five steps of an automated stroke detection system.

3. Write an algorithm (a set of steps) that a computer could follow to detect AF in heart beat data. A suggested first step is below.



Step 1: Take one minute of heart beat data.

Resource One Further Reading



Explore **Search for these videos on YouTube:**



- a) Apple heart Study, Apple Watch 2017, atrial fibrillation, analyse arrhythmias.
- b) IoT Based Health Monitoring System using Raspberry Pi.
- c) IOT Heart Attack Detection & Heart Rate Monitor.

Resource Two Overview



Topic	Polar H10 Monitor: a wearable device
GCSE Modules	Supra-curricular
Objectives	After completing this resource you should be able to: <ul style="list-style-type: none">✓ Understand the benefits of using a wearable sensor✓ Use heart rate signals to solve problems
Instructions	<ol style="list-style-type: none">1. Read the data source2. Complete the activities3. Explore the further reading



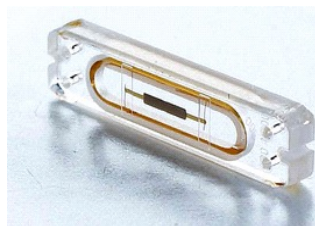
Resource Two

Data Source



Compared to implantable sensors, which are implanted in the body, wearable sensors are non-invasive. Wearable sensors come in different forms. One type is a wrist sensor, which can be worn as a wristband or embedded in a wrist watch. Another type is a chest-strap sensor, worn around the chest. In the future, it might be possible to have ambient sensors, that work from a distance and do not require contact with the body.

Sensor types. Clockwise from top-left: an implantable sensor; a wrist sensor; a chest-strap sensor; ambient sensors in the home



signal from a patient. The measurement setup is straight forward. The patient wears a chest strap that has an embedded HR sensor. The sensor must be worn on the chest and not on the back, because heart rate signal does not go through the human body. The figure below shows the wearable HR sensor placed on the chest. Bluetooth Low Energy (BLE) is used to transfer the data from the HR sensor to an android smart phone or tablet.

Resource Two

Data Source



Wearable HR sensor worn
by subject



Polar is a manufacturer of heart rate monitoring equipment and is known for developing the world's first wireless heart rate monitor. From Polar's Wikipedia page:

“In 1975, there was no accurate way to record heart rates during training, and the idea of a wireless, portable heart rate monitor was conceived on a cross country skiing track in Finland. Polar was founded in 1977, and filed its first patent for wireless heart rate measurement three years later. Its late founder Seppo Säynäjäkangas (1942–2018) was the inventor of the first wireless EKG heart rate monitor. In 1982, Polar launched the world's first wearable wire-free heart rate monitor, the Sport Tester PE 2000. Polar technology and devices are widely used in various scientific studies as well as being adopted by many university research departments. In part due to its own history and the affiliation with universities and the scientific community, Polar offers a research co-operation programme focused on supporting studies in exercise science”.

We chose to use the Polar H10, a popular and affordable wireless heart rate monitor. The H10 has improved electrodes for more accurate monitoring with less interference. The

Resource Two

Data Source



device has on-board memory to record one training session, making it convenient for athletes and healthcare monitoring. The H10 can receive software updates wirelessly. It uses an easily replaceable watch battery so doesn't need recharging, and the battery life is long at 400 hours. The H10 is also waterproof to 30 m, so can be used when swimming, which is something you cannot do with some types of HR monitoring sensor. The H10 is held by the Polar Pro strap, a soft textile strap that is comfortable to wear, with silicone dots and improved buckle to prevent slippage and keep the sensor firmly in place.

Resource Two Activities



Activities

1. Describe a brief history of the first wireless heart rate monitor.
2. Explain three features of the Polar H10 device that make it a good heart rate monitor.
3. The table below is from the Polar website. An 'X' means that the device has the feature. Compare the earlier H7 to the H10 devices.

	Polar H10 heart rate sensor	Polar H7 heart rate sensor
Bluetooth Low Energy	X	X
5 kHz transmission (Gymlink)	X	X
Two simultaneous Bluetooth connections	X	
Updatable software (over the air)	X	
HR measurement method	ECG, chest strap	ECG, chest strap
Built-in memory	For 1 training session	
Training analysis in Polar Flow	When session is saved in internal memory and transferred to Flow via Beat	Only when training with Beat
Compatible with 3rd party apps	X	X
Operation time	400 h (replaceable battery)	150 h (replaceable battery)
Polar Pro strap (with extra electrodes and slip-preventing silicone dots)	X	
Waterproof	30 m	30 m
Weight	Connector 21 g, Polar Pro Strap 39 g	Connector 25,3 g; Soft Strap 30,7

4. Suggest advantages and disadvantages of:

- Implantable sensors
- Wrist sensors
- Chest-strap sensors
- Ambient sensors



Resource Two

Further Reading



Explore

Further reading



Polar H10

https://support.polar.com/uk-en/support/h10_heart_rate_sensor?category=getting_started

Watching videos:

1. Polar H10 Heart Rate Sensor REVIEW. The Best Bluetooth HRM sensor of 2018.

<https://www.youtube.com/watch?v=380nATiUN9s>

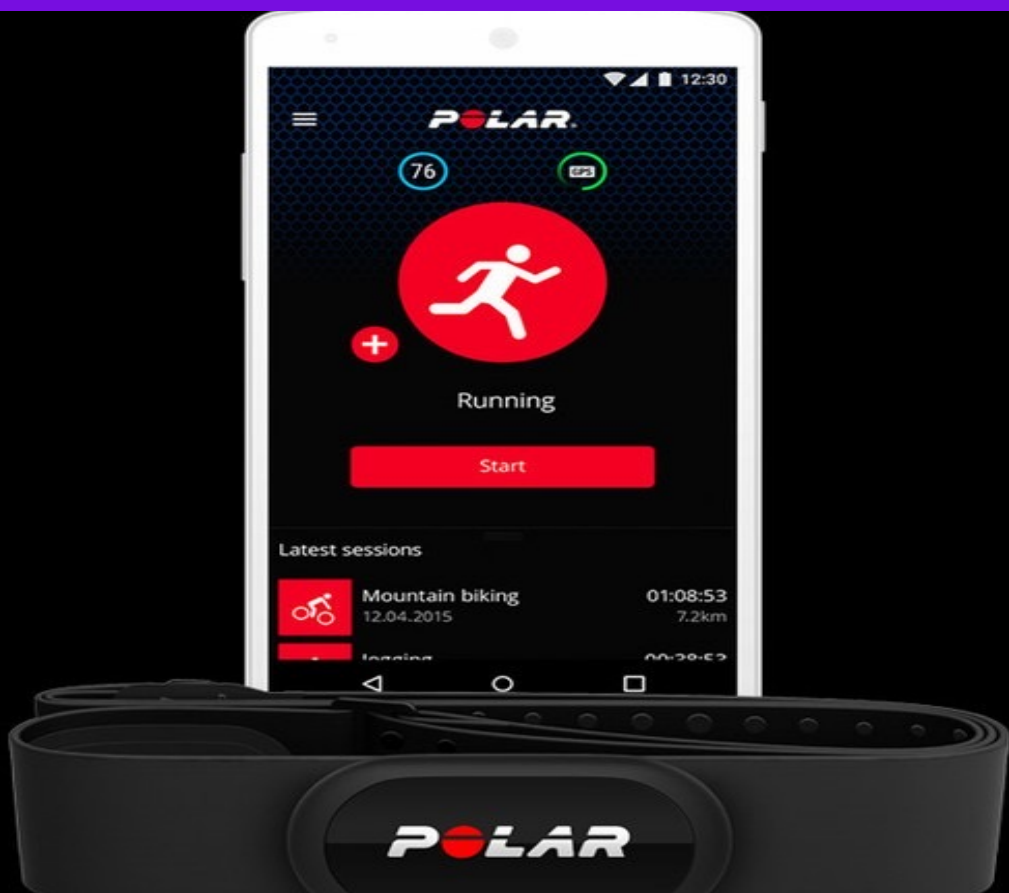
2. Polar H10 | Training with built-in memory and Polar Beat

<https://www.youtube.com/watch?v=vw0WV-PWtcw>

Resource Three Overview



Topic	Linking wearable technology to smart phones
GCSE Modules	Aspect of software development
Objectives	After completing this resource students should be able to: <ul style="list-style-type: none">✓ Demonstrate knowledge and understanding of the key concepts and principles of communication via Bluetooth Low Energy✓ Understand the concept of BLE applications that facilitate the connection between the wearable HR sensor and an android smart phone
Instructions	<ol style="list-style-type: none">1. Read the data source2. Complete the activities3. Explore the further reading



Resource Three

Data Source



Bluetooth technology is now widely used. From Wikipedia: “Bluetooth is a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz, and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables”.

Left: RS-232 to USB cable.
Right: typical Bluetooth mobile phone headset, showing the Bluetooth symbol.



Bluetooth Low Energy (BLE, formerly marketed as Bluetooth Smart) is aimed at novel applications in healthcare, fitness, beacons, security and home entertainment industries. Mobile operating systems including iOS, Android, Windows Phone and BlackBerry, as well as macOS, Linux, Windows 8 and Windows 10, natively support Bluetooth Low Energy. Compared to Classic Bluetooth, BLE provides reduced power consumption and cost. BLE achieves this by transmitting data in small packets which requires less power when compared to normal Bluetooth packets. As a result, Bluetooth Smart devices could be operated for short term (months) or even long term (years) on tiny, coin-cell batteries.

We have designed an android application that receives, displays and shares heart rate sensor data. Our Bluetooth Low Energy application establishes the connection between an android smart device and our biomedical HR sensor (Polar H10) via Bluetooth technology. The figure below illustrates

Resource Three

Data Source



visualising the heart rate signals which were collected from Polar H10 by using an android smart phone S6. The HR sensor must be placed on the chest by patient in order to pick up the electrical activity of human's heart.

HR signal acquired from Polar H10 and displayed via BLE application by using Samsung S6.



Thingspeak is an open cloud data platform where the collected data can be stored retrieved, processed and analysed. According to its developers, "ThingSpeak is an open-source Internet of Things (IoT) application and Application Programming Interface (API) to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates." A Thingspeak account can be created with an email and password, and data can be processed using the Matlab language.

Resource Three

Activities



Activities

1. Describe the purpose of Bluetooth technology.
2. Explain the difference between Bluetooth and Bluetooth Low Energy
3. Estimate the following values from the smartphone heart rate data in the figure
 - a. Resting rate
 - b. Maximum rate (during physical activity)
 - c. Range
 - d. Mean
4. From the smartphone heart rate data, estimate the number of times the person's heart will beat in a lifetime.
5. Your heart rate increases when you are active, and returns to resting rate when you are inactive. Sketch a graph to show how you expect your heart varies over the course of a day.



Resource Three

Further Reading



Explore



1. Bluetooth Low Energy:

https://en.wikipedia.org/wiki/Bluetooth_Low_Energy

2. Bluetooth Low Energy Modules, Solutions and Applications - Bluetooth LE, BLE:

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

Resource Four Overview



Topic	Healthcare monitoring and the Internet of Things
GCSE Modules	Hardware and software
Objectives	<p>After completing this resource students should be able to:</p> <ul style="list-style-type: none">✓ Understand and demonstrate knowledge of the key concepts and principles of the Internet of Thing (IoT).✓ Understand the concept of Thingspeak applications for data processing.✓ Understand the impact of digital technology to the individual and to wider society.
Instructions	<ol style="list-style-type: none">1. Read the data source2. Complete the activities3. Explore the further reading



Resource Four

Data Source

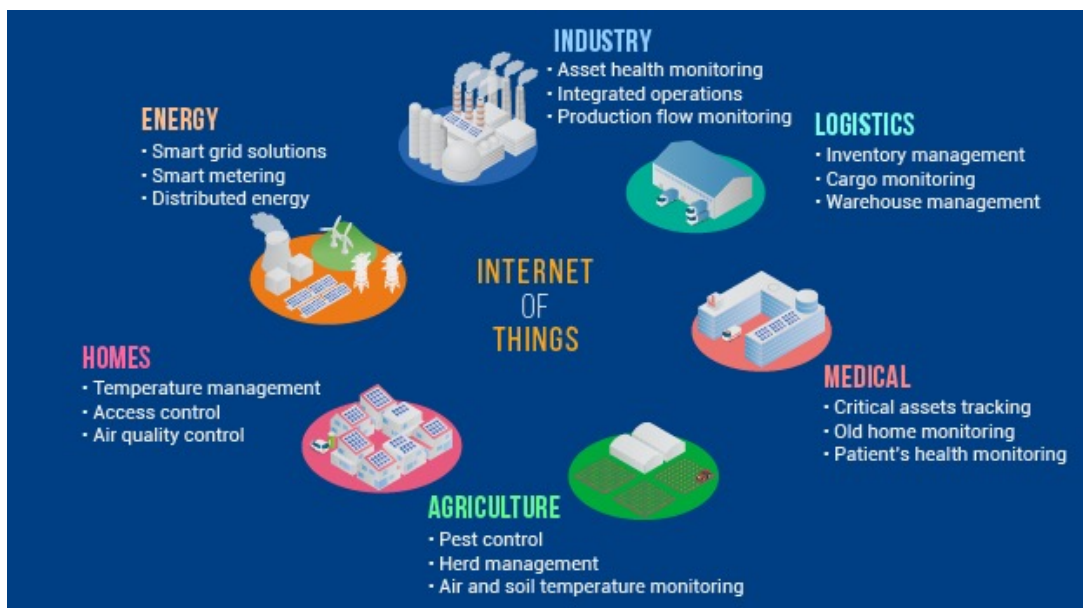


This resource focuses on how we interact with machines, and provokes thought on what kind of relationship we want to have with technology on a daily basis.

According to Wikipedia “The Internet of things (IoT) refers to the concept of extending Internet connectivity beyond conventional computing platforms such as personal computers and mobile devices, and into any range of traditionally "dumb" or non-internet-enabled physical devices and everyday objects. Embedded with electronics, Internet connectivity, and other forms of hardware (such as sensors), these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled”. As such, the IoT has the potential to connect people, electronic devices and sensors, at any time, in any place and for any service. It is considered to be a megatrend that affects the entire business spectrum.

The IoT offers a convenient solution for a wide range of applications, such as health care, structural health, smart cities, traffic congestion, logistic retails, emergency serviced and industrial control. A listing of possible applications to create smart homes, smart cities, smart industry and other smart services are shown in the figure below.

Internet of things applications



Resource Four

Data Source



The Internet of Medical Things (also called the internet of health things) is an application of the IoT for medical and health related purposes, data collection and analysis for research, and monitoring. This smart healthcare, as it can also be called, represents a digitized healthcare system, connecting available medical resources and healthcare services. IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized wearable technology. Some hospitals have begun implementing "smart beds" that can detect when they are occupied and when a patient is attempting to get up. It can also adjust itself to ensure appropriate pressure and support is applied to the patient without the manual interaction of nurses. A 2015 Goldman Sachs report indicated that healthcare IoT devices "can save the United States more than \$300 billion in annual healthcare expenditures by increasing revenue and decreasing cost.

When building our heart rate monitoring system, we used Thingspeak, an open source application associated with IOT technology. Storing and retrieving information from things (smartphones, tablets, sensors...) is performed through HTTP protocol over the internet network or via a Local Area Network (LAN). Data is transmitted to the cloud platform where it is stored in both a private or public channel. The private channel is used to store thingspeak data by default; however, public channels can be employed to share data with others.

Once data is in Thingspeak, we can analyse and visualize it, calculate new data, or interact with social media, web

Resource Four

Data Source



services, and other devices. The ThingTweet application links the Thingspeak account to a Twitter account. As such, things, sensors, devices and channels can be update to Twitter or be updated through Twitter by using the Tweeter-Control application programme interface (API). For instance, we can make a device tweet us by giving alerts notification when the atrial fibrillation is detected.

Resource Four Activities



Activities

1. Describe the Internet of Things in a sentence.
2. Suggest how the Internet of Things can support the development of a:
 - a. smart home
 - b. smart city
 - c. smart hospital
3. Explain the benefits of an Internet of Medical Things.
4. Explain how Thingspeak and ThingTweet can support a wireless heart rate monitoring system



Resource Four

Further Reading



Explore



1. https://thingspeak.com/pages/learn_more
2. <https://en.wikipedia.org/wiki/ThingSpeak>
3. International journal: Thingspeak Based Sensing and Monitoring System for IoT with Matlab Analysis.

Watching videos:

1. Internet of Things explained simply.

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

2. Internet of Things (IoT) | What is IoT | How it Works | IoT Explained | Edureka.

<https://www.youtube.com/watch?v=LlhmzVL5bm8>

Resource Five Overview



Topic Applications of Deep Learning systems

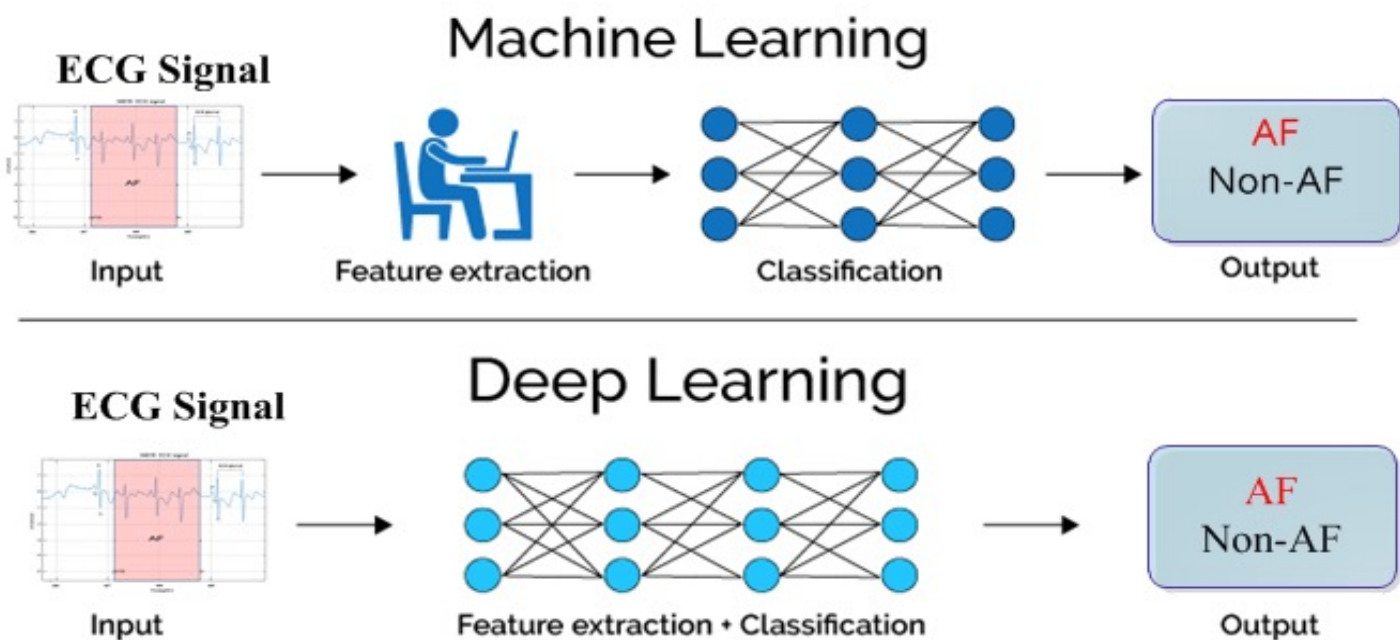
GCSE Modules Impacts of digital technology on wider society

Objectives After completing this resource student should be able to:

- ✓ Demonstrate knowledge and understanding Deep Learning
- ✓ Understand Deep Learning applications

Instructions

1. Read the data source
2. Complete the activities
3. Explore the further reading



Resource Five

Data Source



Deep Learning (DL) is a class of machine learning which makes use of Artificial Neural Networks (ANN). The approach is vaguely inspired by information processing and communication patterns observed in biological nervous systems. According to Wikipedia, DL and ANN systems:

“learn” to perform tasks by considering examples, generally without being programmed with any task-specific rules. For example, in image recognition, they might learn to identify images that contain cats by analyzing example images that have been manually labeled as “cat” or “no cat” and using the results to identify cats in other images. They do this without any prior knowledge about cats, for example, that they have fur, tails, whiskers and cat-like faces. Instead, they automatically generate identifying characteristics from the learning material that they process”.

So similarly to how we learn from experience, the DL algorithm performs a task repeatedly, each time tweaking it a little to improve the outcome. The term “deep” is derived from the numerous hidden layers in the ANN structure. Just about any problem that requires “thought” to figure out is a problem DL can learn to solve.

Deep learning has been applied to fields including computer vision, speech recognition, audio recognition, social network filtering, drug design and medical image analysis, where they have produced results similar to and in some cases better than human experts. Here are some practical examples:

1. Virtual assistants:

For instance, Siri, Cortana and Alexa. Online service providers apply deep learning in order to understand your speech and the language humans use when they interact with them.

Resource Five

Data Source



2. Translations:

Similarly, deep learning algorithms can automatically translate between languages. This can be powerful for travellers, business people and those in government.

3. Computer Vision:

For driverless delivery trucks, drones and autonomous cars. The way an autonomous vehicle understands the realities of the road and how to respond to them, whether it's a stop sign, a ball in the street or another vehicle, is through deep learning algorithms. The more data the algorithms receive, the better they are able to act human-like in their information processing, for example, knowing a stop sign covered with snow is still a stop sign.

4. Facial recognition:

Deep learning is being used for facial recognition not only for security purposes but for tagging people on Facebook posts and we might be able to pay for items in a store just by using our faces in the near future. The challenges for deep-learning algorithms for facial recognition is knowing it's the same person even when they have changed hairstyles, grown or shaved off a beard or if the image taken is poor due to bad lighting or an obstruction.

5. Medicine and pharmaceuticals:

From disease and tumour diagnoses to personalized medicines created specifically for an individual's genome, deep learning in the medical field has the attention of many of the largest pharmaceutical and medical companies.

Resource Five

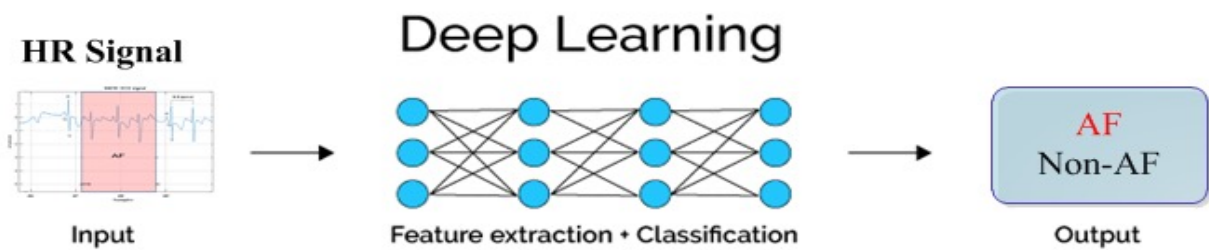
Data Source



6. Personalized shopping and entertainment:

Ever wonder how Netflix comes up with suggestions for what you should watch next? Or where Amazon comes up with ideas for what you should buy next and those suggestions are exactly what you need but just never knew it before? Yes, it's deep-learning algorithms at work.

We used a DL system in our heart monitoring application. Using examples of heart rate signals with and without atrial fibrillation, the system learned to classify both types. The figure below shows how the DL system is now integrated into our IoT platform. A heart rate signal is fed into the DL system, which is able to determine whether atrial fibrillation is present or not with a high degree of accuracy..



Resource Five Activities



Activities



1. Describe how a DL and ANN system learns to distinguish between a cat and a dog.
2. Explain how DL is similar to human learning.
3. Discuss the challenges and risks associated with DL in autonomous vehicles.
4. Explain how DL is used in the heart rate monitoring system of our research.
5. If you could design a DL application for your everyday life, what would it be?

Resource Five

Further Reading



Explore



1. Deep learning Wikipedia website

https://en.wikipedia.org/wiki/Deep_learning

2. Deep Learning - CS229

<http://cs229.stanford.edu/materials/CS229-DeepLearning.pdf>

Watching videos

Detection of Paroxysmal Atrial Fibrillation using Attention based Bidirectional Recurrent Neural Net

<https://www.youtube.com/watch?v=1m8Kt6xPttI>

Data Preparation Step for Automated Diagnosis based on HRV Analysis and Machine Learning

<https://www.youtube.com/watch?v=KzReHJ-BJxU>

Resource Six Overview



Topic Connecting patients to a healthcare centre remotely

GCSE Modules Impacts of digital technology on wider society

Objectives After completing this resource students should be able to:

- ✓ Discuss contemporary issues facing the NHS
- ✓ Analyse the output of an IoT system designed to support clinical decision making

Instructions

1. Read the data source
2. Complete the activities
3. Explore the further reading



Resource Six

Data Source



NHS funding statistics:

- When the NHS was launched in 1948 it had a budget of £437 million (roughly £9 billion at today's prices). In 2008/9 it received over 10 times that amount (more than £100 billion).
- 98.8% of the NHS budget is funded from general taxation and National Insurance contributions, plus small amounts from patient charges for some services.
- Some 60% of the NHS budget is used to pay staff. A further 20% pays for drugs and other supplies, with the remaining 20% split between buildings, equipment, training costs, medical equipment, catering and cleaning.
- In 1955/6 health spending was 11.2% of the public services budget. In 2015/6 it was 29.7%.
- This equates to an average rise in spending over the full 60-year period of about 4% a year once inflation has been taken into account.
- Under the Blair government spending levels increased by around 6% a year on average. Since 2010 spending growth has been constrained to just over 1% a year.

The slowdown in spending is increasing the pressure on the NHS.

According to Wikipedia:

“The NHS is under-resourced compared to health provision in other developed nations. A King's Fund study of OECD data from 21 nations, revealed that the NHS has among the lowest numbers of doctors, nurses and hospital beds per capita in the western world...The NHS performs below average in preventing deaths from cancer, strokes and heart disease...

Resource Six

Data Source



The Guardian has said that GPs face excessive workloads throughout Britain, and that this puts the GP's health and that of their patients at risk. The Royal College of Physicians did a survey of doctors in England, Wales, Scotland and Northern Ireland. Two thirds of doctors surveyed maintained patient safety had deteriorated during the year to 2018, 80% feared they would be unable to provide safe patient care in the coming year while 84% felt increased pressure on the NHS was demoralising the workforce”.

Reducing pressures on overstretched medical services could be achieved via automated monitoring systems. These systems would be designed for home environments of patients who are discharged from hospitals. Medical practitioners could continue to monitor the patients remotely, and allocate limited hospital resources for emergency cases.

The IoT system does not replace the expertise of doctors, but would facilitate decision making. All services would have clinical oversight, with alerts being raised if a patient reading falls outside of their safe range. Therefore, a doctor can check patient's status regularly and notify them in case of an emergency.

We made the monitoring system setup straightforward for medical practitioners. By logging into Thingspeak they can access a patient's heart recordings easily. The proposed system offers an automated diagnosis and decision support, but also requires further checking by the medical team. The system classifies heart rate measurements as either 'atrial fibrillation' or 'non-atrial-fibrillation' (normal). The figure below shows the classification output. A binary 0 sequence indicates a normal condition, while a binary 1 episode indicates the presence of AF. A short episode of AF does not necessarily mean the patient is suffering from AF disease – the clinician would diagnose this on the basis of longer-term data, and a medical examination.

Resource Six

Data Source



Deep learning results of HR measurements using IoT platform, to support clinician decision making



Resource Six Activities



Activities Activity One



1. Explain why remote healthcare monitoring can support patients and the NHS.
2. Describe the DL results in the figure above.
3. Draw the HR signal of the following digital sequence: 10000001100111100 and label which segments are AF and non-AF.
4. We used ThingTweet to alert the patient of the disease. Can you suggest another method that allows notifying the subjects without using wireless technology?

Activity Two

1. In machine learning and medical testing, we need to think about the test state (whether the test indicates the presence of disease or not) and the actual state (whether the disease is actually present or not). There are four possible outcomes:

False Positive (FP):

The test indicates the disease is present, but the disease is actually not present

False Negative (FN):

The test indicates the disease is not present, but the disease is actually present

True Positive (TP):

The test indicates the disease is present, and the disease is actually present

True Negative (TN):

The test indicates the disease is not present, and the disease is actually not present

Resource Six Activities



Activities Complete the confusion matrix below using the terms FP, FN, TP and TN:

Actual state		
	Test state	

2. Which results in the confusion matrix are unfavourable? Explain your answer.

Resource Six

Further Reading



Explore



1. Website to clarify the concept of Home Health Monitoring system

<https://www.telushealth.co/health-solutions/patient-and-consumer-health-platforms/products/home-health-monitoring/>

2. Remote health monitoring: the benefits of keeping in touch

<https://www.medicaldevice-network.com/features/remote-health-monitoring-benefits/>

3. Monitoring Your Heart at Heart Central

<https://www.youtube.com/watch?v=dslVWj7ubg0>

Final Reflection



Topic How can Machine Learning and the Internet of Things influence the future?

Instructions Create a poster about how the Internet of Things can support healthcare through wearable technology. Your poster could contain the following elements:

- An overview of the Internet of Things
- How the Internet of Things could support healthcare
- An overview of the wireless heart monitoring system described in this pack, as an example of an IoT application, including:
 - A flowchart of how the system functions
 - The sensor used in the system
 - BLE communication
 - What information Deep Learning provides



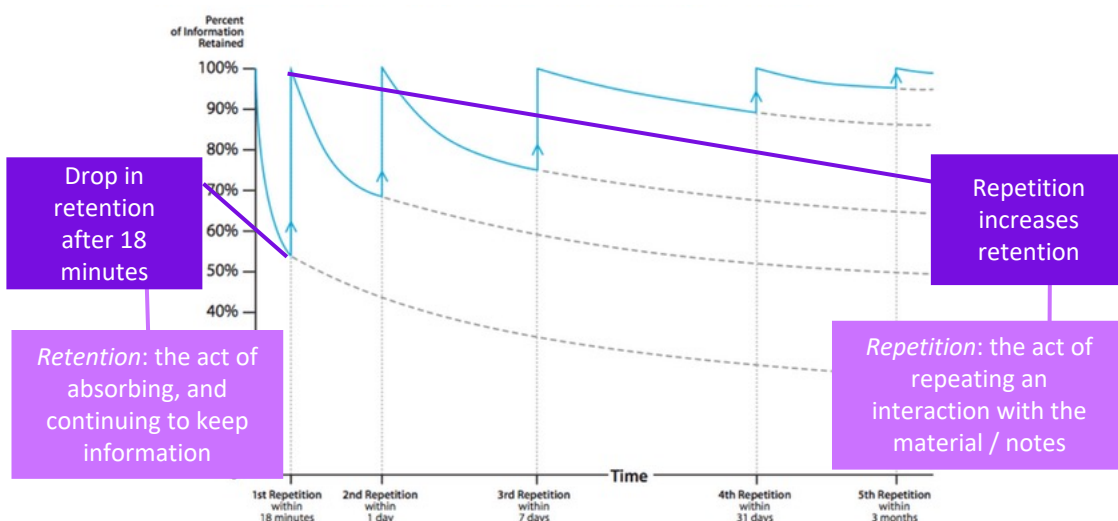
University Study Skills Cornell Notes



Why is good note taking important?

If it feels like you forget new information almost as quickly as you hear it, even if you write it down, that's because we tend to lose almost 40% of new information within the first 24 hours of first reading or hearing it.

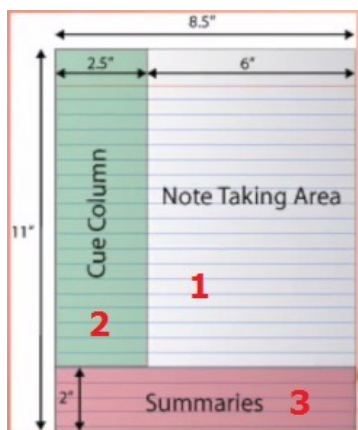
If we take notes effectively, however, we can retain and retrieve almost 100% of the information we receive. Consider this graph on the rate of forgetting with study/repetition:



Learning a new system

The Cornell Note System was developed in the 1950s at the University of Cornell in the USA. The system includes interacting with your notes and is suitable for all subjects. There are three steps to the Cornell Note System.

Step 1: Note-Taking



1. **Create Format:** Notes are set up in the Cornell Way. This means creating 3 boxes like the ones on the left. You should put your name, date, and page of the page.

2. **Write and Organise:** You then take your notes in the area on the right side of the page. You should write notes by keeping a line or a space between 'links' / main ideas of information. You should use bullet points for lists of information to summarise your notes.

Step 2 Note-Making

1. Revise and Edit Notes: Go back to box 1, the note taking area and spend some time revising and editing. You can do this by: highlighting 'chunks' of information with a number or a colour; circling all key words in a different colour; highlighting main ideas; adding new information in another colour

2. Note Key Idea: Go to box 2 on the left hand side of the page and develop some questions about the main ideas in your notes. The questions should be 'high level'. This means they should encourage you to think deeper about the ideas. Example 'high level' questions would be:

- Which is most important / significant reason for...
- To what extent...
- How does the (data / text / ideas) support the viewpoint?
- How do we know that...

Here is an example of step 1 and step 2 for notes on the story of Cinderella:

Questions:	Notes:
How does C's mother die?	<ul style="list-style-type: none"> • Cinderella is an only child • Cinderella's dad might <u>spoil</u> her • Cinderella's Step-Mother is <u>jealous</u> of her beauty • Maybe Cinderella becomes the <u>woman of the house</u>
Why does C make the Step-M so angry?	<ul style="list-style-type: none"> ↳ BUT then the <u>Step-Mother</u> wants that <u>position</u>.
↓ what language shows this?	<ul style="list-style-type: none"> * <u>Key point</u> → fairy takes teach ↳ <u>morals</u>
* What is the moral of 'C'?	<ul style="list-style-type: none"> • Cinderella is <u>kind</u> → her Step-M is not
How do I know?	<ul style="list-style-type: none"> • Is there a <u>reason</u> for C to be badly B treated?
Is this just one side of the story?	

Step 3 Note-Interacting

1. Summary: Go to box 3 at the bottom of the page and summarise the main ideas in box 1 and answer the essential questions in box 2.

<p>Summary: Because C is an only child, she takes over as 'woman of the house' when her real M die. Her Step-M is jealous and angry. We only get C's side of the story so it is difficult to know whether C is really badly treated for no reason.</p>
--

Give the Cornell Note Taking System a try and see if it works for you!

University Study Skills

Key Instruction Words



These words will often be used when university tutors set you essay questions - it is a good idea to carefully read instruction words before attempting to answer the question.

Analyse – When you analyse something you consider it carefully and in detail in order to understand and explain it. To analyse, identify the main parts or ideas of a subject and examine or interpret the connections between them.

Comment on – When you comment on a subject or the ideas in a subject, you say something that gives your opinion about it or an explanation for it.

Compare – To compare things means to point out the differences or similarities between them. A comparison essay would involve examining qualities/characteristics of a subject and emphasising the similarities and differences.

Contrast – When you contrast two subjects you show how they differ when compared with each other. A contrast essay should emphasise striking differences between two elements.

Compare and contrast – To write a compare and contrast essay you would examine the similarities and differences of two subjects.

Criticise – When you criticise you make judgments about a subject after thinking about it carefully and deeply. Express your judgement with respect to the correctness or merit of the factors under consideration. Give the results of your own analysis and discuss the limitations and contributions of the factors in question. Support your judgement with evidence.

Define – When you define something you show, describe, or state clearly what it is and what it is like, you can also say what its limits are. Do not include details but do include what distinguishes it from the other related things, sometimes by giving examples.

Describe – To describe in an essay requires you to give a detailed account of characteristics, properties or qualities of a subject.

Discuss – To discuss in an essay consider your subject from different points of view. Examine, analyse and present considerations for and against the problem or statement.

University Study Skills

Key Instruction Words



Evaluate – When you evaluate in an essay, decide on your subject’s significance, value, or quality after carefully studying its good and bad features. Use authoritative (e.g. from established authors or theorists in the field) and, to some extent, personal appraisal of both contributions and limitations of the subject. Similar to **assess**.

Illustrate – If asked to illustrate in an essay, explain the points that you are making clearly by using examples, diagrams, statistics etc.

Interpret – In an essay that requires you to interpret, you should translate, solve, give examples, or comment upon the subject and evaluate it in terms of your judgement or reaction. Basically, give an explanation of what your subject means. Similar to **explain**.

Justify – When asked to justify a statement in an essay you should provide the reasons and grounds for the conclusions you draw from the statement. Present your evidence in a form that will convince your reader.

Outline – Outlining requires that you explain ideas, plans, or theories in a general way, without giving all the details. Organise and systematically describe the main points or general principles. Use essential supplementary material, but omit minor details.

Prove – When proving a statement, experiment or theory in an essay, you must confirm or verify it. You are expected to evaluate the material and present experimental evidence and/or logical argument.

Relate – To relate two things, you should state or claim the connection or link between them. Show the relationship by emphasising these connections and associations.

Review – When you review, critically examine, analyse and comment on the major points of a subject in an organised manner



Exploring Careers and Study Options

- ✓ Find job descriptions, salaries and hours, routes into different careers, and more at <https://www.startprofile.com/>
- ✓ Research career and study choices, and see videos of those who have pursued various routes at <http://www.careerpilot.org.uk/>
- ✓ See videos about what it's like to work in different jobs and for different organisations at <https://www.careersbox.co.uk/>
- ✓ Find out what different degrees could lead to, how to choose the right course for you, and how to apply for courses and student finance at <https://www.prospects.ac.uk/>
- ✓ Explore job descriptions and career options, and contact careers advisers at <https://nationalcareersservice.direct.gov.uk/>
- ✓ Discover which subjects and qualifications (not just A levels) lead to different degrees, and what careers these degrees can lead to, at <http://www.russellgroup.ac.uk/media/5457/informed-choices-2016.pdf>

Comparing Universities

- ✓ <https://www.whatuni.com/>
- ✓ <http://unistats.direct.gov.uk/>
- ✓ <https://www.thecompleteuniversityguide.co.uk/>
- ✓ Which? Explorer tool – find out your degree options based on your A level and BTEC subjects: <https://university.which.co.uk/>

UCAS

- ✓ Key dates and deadlines: <https://university.which.co.uk/advice/ucas-application/ucas-deadlines-key-application-dates>
- ✓ Untangle UCAS terminology at <https://www.ucas.com/corporate/about-us/who-we-are/ucas-terms-explained>
- ✓ Get advice on writing a UCAS personal statement at <https://www.ucas.com/ucas/undergraduate/getting-started/when-apply/how-write-ucas-undergraduate-personal-statement>
- ✓ You can also find a template to help you structure a UCAS statement, at <https://www.ucas.com/sites/default/files/ucas-personal-statement-worksheet.pdf>
- ✓ How to survive Clearing: <https://university.which.co.uk/advice/clearing-results-day/the-survivors-guide-to-clearing>

Subject Guidance



ICT at University



- ✓ You can find out more about different courses and entry requirements by exploring the UCAS Computer Science Guide online: <https://www.ucas.com/ucas/subject-guide-list/computer-science>
- ✓ You can find out more about the different careers by exploring the UCAS Careers portal online: <https://www.ucas.com/ucas/after-gcses/find-career-ideas/explore-jobs>

A Deeper Look Into ICT

- ✓ Listen: Podcast about IoT and AI <https://www.iotforall.com/category/podcast/>
- ✓ Listen: List of ML podcasts <https://www.shopify.co.uk/partners/blog/machine-learning-podcast>
- ✓ Read: Read about various sub-topics in Computer Science (use the search option or browse through the categories) <https://medium.com/>
- ✓ Read: Read about ML, AI etc. <https://www.kdnuggets.com/>
- ✓ Browse: Have a look through some AI talks <https://www.computerworlduk.com/galleries/data/must-watch-ted-talks-on-ai-3652708/>



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