LITTLE BIG FUTURES

Algorithmic thinking and the Internet of Things

INTRODUCTORY COMPUTING LESSON: TEACHER GUIDE

While the Internet of Things (IoT) is composed of physical devices, they are of little use without algorithms. Taking data from sensors and other IoT devices, different algorithms run across an IoT system and govern the behaviour of each device. The algorithms may result in a particular device doing something, using motors, displays, sound outputs, valves or other means. The device may also send messages to other IoT devices, activating other parts of the network.

This lesson examines the design of IoT algorithms, considering how devices can be programmed to work together to achieve improved, 'smarter' outcomes. The activity develops computational thinking, and does not involve actual programming of devices.

Learning outcomes

- creatively solve problems that connect computerised 'smart' devices
- understand the fundamentals of the event-driven programming architecture
- recognise the different networking media used to connect smart devices
- be able to devise simple yet efficient algorithms to utilise the internet of things

Resources

- work mats (A3 format) one per student-group
- smart device cards (enough for 2-3 per student-group) cut out before lesson
- writing frame worksheet (one per student-group)
- teacher presentation (projector or other display needed)
- access to YouTube "Cisco pep talk" commercial

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Lesson activities

(1 hour duration; may be extended if appropriate)

	Activity	Resources
Activity 1 (5 mins)	Choose one (or more) of the eight Cisco 'Internet of Everything' commercials – these cover different themes. Explain that previously unconnected devices are being connected to bring about huge changes in how the world works. This is the basis of the 'internet of things'.	Streaming videos: General introduction to the 'Internet of Everything' Cycling accident Basketball Bananas Rock concert New year's eve power DIY store Cats and milk
Activity 2 (15 mins)	Arrange the class into small groups of two or three. Hand out one work mat to each student group, along with two 'device cards'. You have been provided with a large selection of both IoT scenarios (workmats) and IoT device cards – you may not choose to use them all. Challenge the students to think how these two devices could be connected to solve an existing problem, for example: Add facial recognition to the fridge, fitted with an electronic lock, which will prevent snacking in-between meals and only allow access by authorised adults. The same camera could recognise products as they are put into the fridge and add the items to a database. This would generate recipes using the ingredients nearest to going out of date. To extend the activity, give students additional device cards and challenge them to integrate these into their IoT innovation.	Work mats Smart device cards
Activity 3 (15 mins)	Use the teacher presentation to introduce the idea of event-driven programming as a means to write software for the internet of things. This uses sensors, connected to processors, to 'watch for' certain conditions. Once the condition is reached an event is triggered, such as sending a message across a network. The message may be picked-up by another device that has been programmed to 'watch' for it. This would then trigger another action such as powering an actuator (such as a motor) or displaying information via a screen or other output. This device may also send out further messages, propagating across the network. Programs can use loops to test for specific conditions, or can use 'interrupts' to force a program to do something different (computer keyboards use interrupts).	Teacher presentation

Activity 4 (15 mins)	Using what they now know about IoT event-driven architecture, ask the students to create an algorithm that will make their chosen IoT innovation (from activity 1) function. They can use the writing frame to structure this. A completed example is provided – teachers may wish to remove some of the completed answers to provide the appropriate degree of assistance. Extension – students can create a flowchart (as instructed on the worksheet) Further extension / homework: Research finite-state diagrams; create a diagram to represent the possible states of the IoT innovation.	Writing frame Writing frame (completed example)
Activity 5 (10 mins)	Students share their IoT innovations with the rest of the class and explain how it works.	

Additional notes

During the design of the algorithm it may help if students are prompted using terms such as:

- Actions: monitor, trigger, minimise, maximise, secure, switch on / off, guide, locate, vary, notify…
- Conditions / logic: while, until, after, before, if, for (number), loop, greater than, less than, equal to, AND, NOT, OR…

Examples: A smart speaker uses a microphone to monitor sound. If it recognises the command 'turn on the lamp' then send signal to the switch on the smart mains socket to switch on.

Student handouts contain the following information:

Smart devices

- **REFRIGERATOR:** Powered by electricity to lower the temperature of contents. May have a frozen compartment, some dispense ice or chilled water.
- **SMART WATCH:** a sensor-equipped wristwatch able to run computer programs. Sensors might include cameras, temperature and motion sensors, heart monitors, compass and location. Can output sound and visual information. Some can operate as phones.
- **SMART THERMOSTAT:** controls temperature by switching heaters on and off. They can connect remotely via the internet. Some can learn patterns of use such as days when the building is empty.
- **FACIAL RECOGNITION CAMERA:** Finds facial features in an image or video and finds a record in a database of people. They can be used to identify other objects
- **SMART MAINS SOCKET:** Can control the power to appliances using a timer, or by control from another device such as a smartphone. Some can also monitor electricity use.

- **SMART TV:** internet-connected television that also has features found on computer devices, such as on-demand and interactive media
- **CONNECTED CAR:** connected via wireless internet to provide additional services such as route planning, communication, vehicle monitoring, entertainment and driving assistance. Some can monitor driver well-being to improve safety.
- **SMART SPEAKER:** a voice-controlled, networked device able to communicate and share media with other devices. Can also use internet services such as streaming, and can communicate using synthesised speech.
- **SMART PHONE:** a mobile personal computer able to place audio and video calls, receive text messages and other application data. Many contain video cameras, GPS navigation, media players and can be used for games and other apps. They usually have a colour touchscreen
- **SMART LIGHTING:** standard bulb with networking technology allowing them to connect to other devices. They use data such as room occupancy, time, daylight levels to be more useful and to minimise energy use.
- **SMART LOCK:** electro-mechanical device that locks or unlocks on a signal from another device, which is usually encrypted. It can also notify other devices of its current state or other data such as battery power or attempted break-in.
- **ENVIRONMENTAL MONITOR:** monitors data such as water quality, air pollution levels, movement of animals, or events such as tsunami, earthquakes or avalanches.

Work mats

- **PUBLIC TRANSPORT:** shared passenger transport that can be used by the general public, such as over-ground and underground trains, buses, trams, cable cars, ferries, airlines and share taxis.
- **HEALTHCARE:** improving the diagnosis, treatment and prevention of disease, injury and mental health conditions. Services might include doctors, dentists, midwifes, nurses, optometrists, psychologists, speech therapists and many other specialist areas.
- **SCHOOL:** improve school services such as learning, catering, sports participation, students performances, health of young people, and family communication or support.
- **PERSONAL PROTECTION AND SECURITY:** keep people safe from accidental or deliberate harm while in dangerous situations, or prevent their loss of valuable possessions.
- **NATURAL ENVIRONMENT:** preserve or promote the improvement of living or non-living natural things around you. Think about animals, plants, soil, rocks, water such as seas, rivers and lakes, the atmosphere, and even people.
- **LEISURE AND PLAY:** make free time more fun! Think about the places people go and the things they do for fun, such as sports and games, creative activities and hobbies.
- **FIRE SAFETY:** Make fire safety systems smarter, to improve fire detection, reduce casualties and help fire-fighters carry out their role.