SILVER LEVEL

CREST AWARDS

Resource pack

MACHINE LEARNING

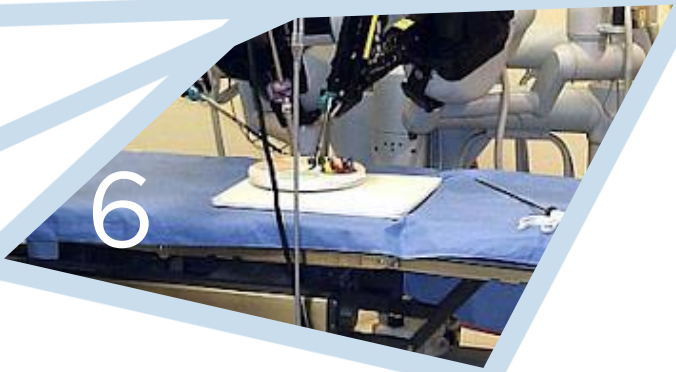
COLLECTION

IN PARTNERSHIP WITH

BRITISH SCIENCE ASSOCIATION

THE ROYAL SOCIETY

Contents



How to run CREST using these activities

Preparation

Ready to get going with CREST? Enter your student's Award by signing up for a CREST Account here: crestawards.org/sign-in

Create a new Silver Award project with the name of the student and the title of their project. If you don't have all the details, you can fill these in later.

Run the project

We have some super handy profile forms for your students to use when running a CREST Award. You can download these when you create your CREST account by following the link above. Encourage your students to use the workbook or profile to plan and carry out their project, keeping a record of all their amazing progress. Make sure you consider safety and risks!

Reflection

Once your students have completed their CREST project, don't let that be the end of their learning. They should now fill in any remaining sections of their profile form. This is a chance for them to reflect on all the interesting things they've learnt and the invaluable skills they have used.

Enter your project for a CREST Silver Award

Hard work deserves a reward! Celebrate and certify your student's achievements by entering their project for a CREST Silver Award. Simply:

Log in to your CREST account at crestawards.org/sign-in

Select the project and upload a profile form per student and other project evidence, to be assessed by our trained assessors online. Check the participating students have met each of the criteria. Finally, complete the delivery and payment details to order your snazzy certificates. Congratulations on completing CREST Silver!

What next?

The scientific discovery doesn't need to end here. Students can have a go at the next level up – CREST Gold. Don't keep all the fun to yourselves, encourage others to take part in CREST projects and share the wonder of science. For free ideas on how to get started, see crestawards.org.

Entering your project without a teacher or facilitator? No problem! You can enter your work yourself by following this link: crestawards.org/sign-in

Looking for some support?

Find a mentor by contacting your local STEM Ambassador hub: https://www.stem.org.uk/stem-ambassadors/local-stem-ambassador-hubs

Background

The Royal Society

The Royal Society is the world's oldest independent scientific academy in continuous existence, dedicated to promoting excellence in science. The Society works to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Royal Society's machine learning policy project is investigating the potential of machine learning over the next 5-10 years and exploring how this technology can be developed in a way that benefits everyone. The Royal Society has launched a report setting out the action needed to maintain the UK's role in advancing this technology while ensuring careful stewardship of its development.

The Royal Society has supported the development of these CREST Silver resources.

How can a computer recognise your voice or face, or predict what films you'd like to watch?

Artificial intelligence (AI) is when computer systems are designed to carry out complex tasks or make decisions in ways that we would normally associate with humans or animals. Machine learning is a form of AI that allows computer systems to learn from examples, data, and experience.

Machine learning is all around us

Many of us now interact with systems using machine learning on a daily basis, such as image and voice recognition on social media, recommendations on online shopping platforms, and virtual personal assistants.

These technologies are already a part of your life and are starting to transform the global economy. They can identify better ways of doing complex tasks – from helping doctors diagnose medical conditions more effectively, to helping people communicate through instantaneous speech recognition and translation software.

In the future, it is likely we will continue to see advances in the capabilities of machine learning, and this exciting technique has the potential to change the way we use data in a range of areas. Tools are already being developed to support healthcare, policing, telecommunications, driving and farming.

Instructions for teachers

The topic

The topic of machine learning is a great way to get your students thinking about the future.

What do they imagine the world will look like in 10, 20 or 50 years' time? What challenges will we face?

This pack contains project ideas to suit a range of interests, enabling students to investigate machine learning in a real life context, and to explore innovative ideas and solutions for the future.

Project outcomes

Your students could design and make a new product, carry out a practical investigation, do a research project or create a communication campaign for their target audience.

Encourage them to consider the impact of their project on people's lives now and in the future.

Students should record their work in a final project report or presentation.

Supporting students to complete their project

Each project should involve approximately 30 hours of student work from start to finish. The project should be led by the students. As a teacher or mentor your role is to:

- Act as a sounding board for students' ideas and nurture the students' work;
- Check your students' project plans before they begin the next stage;
- Help students see mistakes and setbacks as an opportunity for positive learning and lateral thinking (leading to creativity);
- Where relevant, support students to access professionals or experts who could support them;
- Provide access to the Internet, library books and magazines;
- Help students to complete their project and record their findings;
- Encourage them to reflect on their own performance and learning;
- Use the tips on page 11 to help students complete their CREST Silver project report.

Health and safety

Students should be encouraged to make their own risk assessment before they carry out any activity, including surveys. They can use the CLEAPSS student safety sheets to help them science.cleapss.org.uk/Resources/Student-Safety-Sheets

They should write out their project plan, identifying the risks involved in each stage and the control measures and precautions they will take.

In all circumstances this must be checked by a competent person.

Students using specialised equipment should be supervised at all times. Students may want to set up unorthodox experiments and you may need to seek specialist advice. Contact CLEAPSS directly cleapss.org.uk for advice if you are unsure. Teachers in Scotland should refer to SSERC www.sserc.org.uk.

- Unless stated, no external links have been checked by CLEAPSS.
- Safety checked but not trialled by CLEAPSS.

In this pack

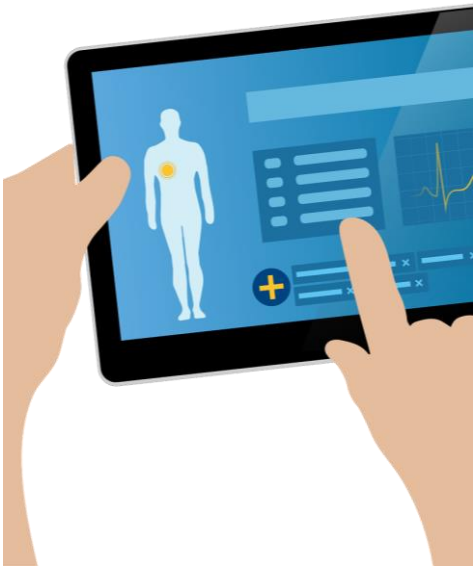
This collection of resources contains three different project ideas that can each be used to gain a CREST Silver Award. Each project has a Teacher Guide, which outlines the project from a teacher's perspective, and then a student brief, which can be given to the student when they are ready to do the project. Check out the CREST resource library for more support on running a CREST project if you need to as well.

Teacher guide

Disease detection

COMMUNICATION PROJECT

Machine learning is already being used to diagnose lung cancer, pneumonia, and other diseases by the healthcare industry. It has proven to be incredibly accurate and efficient at diagnosis, and it is likely that continued development will mean that these technologies will be even more accurate in the future.



However, awareness and understanding of machine learning amongst the general population is still relatively low, and trust is a big issue for the use of artificial intelligence and machine learning in the healthcare industry.

In this project, students will create a communication campaign to raise awareness about how machine learning can fight disease. Students will need to think about what form their campaign will take, how to conduct a fair test to evaluate the effectiveness of their campaign, and how to collect and analyse their data.

Prompts

- What format will your communication campaign take? Have you thought about the most effective way to reach your target audience? Find out what kinds of media your target audience consumes.
- What will be the key messages? Research what makes an effective campaign and consider how many messages are you trying to get across. What wording will work best?
- How will you use your understanding of people's hopes and fears to help shape your work? How will you involve people in the decision making?

Student brief

Disease detection

COMMUNICATION PROJECT

Machine learning is already being used to diagnose lung cancer, pneumonia, and other diseases by the healthcare industry. It has proven to be incredibly accurate and efficient at diagnosis, and it is likely that continued development will mean that these technologies will be even more accurate in the future.

But awareness and understanding of machine learning amongst the general population is still relatively low, and trust is a big issue for the use of AI and machine learning in the healthcare industry.

Imagine you work for the public health department of your local council. The doctors in your area are unhappy because when they send test samples to the laboratory for analysis the results are taking longer and longer to come back. Other areas are starting to use machine learning tools to analyse all kinds of test results: x-rays, MRI scans, eye tests, and more. You want to start using these tools in your area too, but before you do, you want to consult local people.

Create a communication campaign to raise awareness about how machine learning can fight disease and start a conversation about how machine learning should be used in healthcare.

Getting started

In this project, you will need to create a communication campaign to raise awareness about how machine learning can be used to detect illnesses and diseases. You will also need to think about ways of including different stakeholders in the decisions about how machine learning should be used.

You could do a survey of people from different demographics about their views on machine learning and healthcare. Find out what their hopes or concerns are, and design a process that engages with those concerns.

Useful resources

- Spotting early warning signs https://www.bbc.com/future/article/20190116-the-invisible-warning-signs-that-predict-your-future-health
- Eye disease https://www.bbc.com/news/health-44924948
- AI pacemakers https://www.bbc.com/future/article/20191216-how-hacking-the-human-heart-could-replace-pill-popping
- Malaria, cancer and sight loss https://www.bbc.com/future/article/20170914-spotting-cancer-stopping-shootings-how-ai-protects-us
- Trust and machine learning in healthcare https://edition.cnn.com/2019/07/15/business/artificial-intelligence-healthcare/index.html
- Towards trustable machine learning: https://www.nature.com/articles/s41551-018-0315-x

Health and safety

To avoid any accidents, make sure you stick to the following health and safety guidelines before getting started:

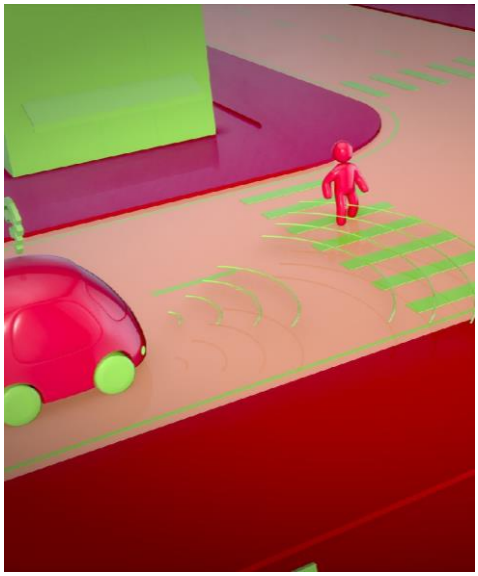
- Find out if any of the materials, equipment or methods are hazardous using http://science.cleapss.org.uk/Resources/Student-Safety-Sheets/ to assess the risks (think about what could go wrong and how serious it might be).
- Decide what you need to do to reduce any risks (such as wearing personal protective equipment, knowing how to deal with emergencies and so on).
- Make sure there is plenty of space to work.
- Clear up slip or trip hazards promptly.
- Make sure your teacher agrees with your plan and risk assessment.

Teacher guide

A world without driving

RESEARCH PROJECT

In recent years, developments in self-driving car technology has progressed significantly. Current models use a variety of sensors to perceive their surroundings, and have advanced control systems to interpret sensory information in order to identify safe routes, avoid obstacles and respond to relevant signage.



Many countries already have vehicles on the road with 'self-driving features', and although there is a lot of debate about when, it seems inevitable that we will see increasing numbers of self-driving vehicles in the future.

In this project, students will research the predicted potential implications of a world with predominantly driverless cars, such as safety (traffic collisions), driver welfare, time-saving, mobility for the elderly, car interior design, traffic management, speed limits, vehicle insurance, environmental impacts (fuel usage), parking spaces, employment (driving jobs) and so on.

Prompts

- Can you find data about existing fleets that are using self-driving features? What impact has this had?
- As well as thinking about the implications for the lorry company, you should also consider the wider impacts of switching to self-driving.
- What would need to change about the way we organise driving and vehicle regulation if self-driving vehicles were widely used?

Student brief

A world without driving

RESEARCH PROJECT

Many countries already have vehicles on the road with 'self-driving features', and although there is a lot of debate about when, it seems likely that we will see increasing numbers of self-driving vehicles on the road in the future.

Imagine you work for a company that provides long distance lorries to transport goods across Europe. You have heard a lot about self-driving lorries, and think that in order to stay competitive you might need to switch in the future.

Your initial research found that many people predict a change to self-driving vehicles would have huge implications in terms of safety (traffic collisions), time-saving, mobility for the elderly, car interior design, traffic management, speed limits, vehicle insurance, environmental impacts (fuel usage), parking spaces, and employment (driving jobs).

You now want to do some more in-depth research into the issues that would most affect your business.

Getting started

Start by reading up about the different predicted implications of self-driving lorry fleets. Find out about the potential benefits and challenges. Based on your research choose two or three areas to focus on, and conduct some in-depth research using the links below as a starting point. Use data to support your arguments.

Useful resources

- Impact of self-driving trucks https://www.dfds.com/en/about/insights/newsletters/self-driving-trucks
- Impact on professional drivers https://www.theguardian.com/technology /2016/jun/17/self-driving-trucks-impact-on-drivers-jobs-us

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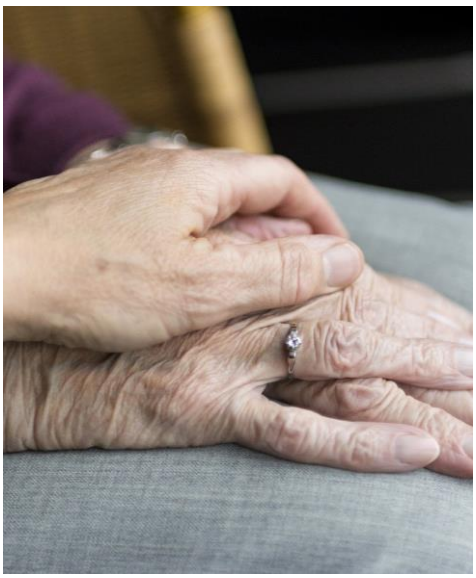
Teacher guide

Personal assistant

DESIGN & MAKE PROJECT

Many of us already have virtual personal assistants in our homes. Some virtual assistants are able to interpret human speech and respond via synthesised voices. Users can ask their assistants questions, control home automation devices and media playback via voice, and manage other basic tasks such as email, to-do lists, and calendars with verbal commands.

More and more new developments and bespoke products are emerging to meet specific needs, including personal assistants for older people. Current products can perform tasks or services like: health monitoring; wearable biometric tracking (such as fitbits); slip, trip and fall detection; and, provide virtual companionship. Moreover, companies are continuously working on new developments to meet the needs of older people.



In this project, students will design their own personal assistant for an older person. They will need to research what the needs of older people are, and come up with innovative solutions to meet those needs.

Prompts

- What routine challenges do elderly people face? Find out what kinds of task(s) might present older people with difficulties.
- What tasks might digital devices be well suited to help with? What tasks need a human touch?
- How would you manage concerns about privacy or dignity?
- How will you control your assistant? Remember, it needs to be easy to use.
- Try experimenting with using existing virtual assistants and connecting them to devices to perform tasks in the home.

Student brief

Personal assistant

DESIGN & MAKE PROJECT

Many of us already have virtual personal assistants in our homes. Some virtual assistants are able to interpret human speech and respond to questions, control other electronic and home automation devices, and manage some basic tasks. More and more new developments and bespoke products are emerging to meet specific needs including: health monitoring; wearable biometric tracking (like fitbits); slip, trip and fall detection; and, virtual companionship.

Imagine you are a carer that visits elderly people in their homes. You know that, for some of them, you are the only help they have, and that for a large part of the day they are alone in the house. Design your own personal assistant specifically for the needs of older people.

Getting started

Start by researching what the needs of older people are. You could interview some older people that you know, or contact an organisation that works with older people in your area. Think about how a virtual assistant and smart devices might be able to meet those needs.

Useful resources

- Connecting roomba to Google assistant https://hackernoon.com/how-i-set-up-room-cleaning-automation-with-google-home-home-assistant-and-xiaomi-vacuum-cleaner-9149e0267e6d
- Chatterbot https://chatterbot.readthedocs.io/en/stable/

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TOP TIPS

For completing a Silver project

1. Understand the problem

Do your research! Make sure you plan your time effectively and find out as much as you can about machine learning before you start. And make sure you are clear about the problem you need to solve. If you are developing you own project idea, discuss your ideas with your teacher or mentor before you start your project.

2. Plan your approach

Draw or write a plan showing how you will approach the problem, the tasks you will complete, the resources you'll need and how long you will spend on each task. Ask your teacher or mentor for feedback on your plan.

3. Watch out!

Identify any risks to health and safety or ethical concerns you think there will be. Decide how you will limit or overcome these risks. Show your risk assessment to your teacher.

4. Research

Find a professional mentor

https://www.stem.org.uk/stem-ambassadors/local-stem-ambassador-hubs

Find out more by doing some research using the suggested links on the project page.

Research relevant news articles, blog posts and other media sources.

5. Use your research to improve your plan and generate ideas

Use your research to help you come up with a possible solution or to select the best experiments to use in your practical work.

6. Finalise your idea and carry out practical work

Carry out any practical work including experiments, surveys, designing and making activities. When testing your ideas, make sure you make it a fair test and record all your results clearly. You could also use photos and a diary to record your project activities.

7. Concluding your project

What have you found out by doing your project?

Did you come across any problems? How did you overcome them?

What is the impact of your project for other people? How could it be developed further?

Has it changed how you feel about machine learning?

8. Choose the best way to communicate it

Tell others about what you did. You could use a written report, a digital presentation, a blog or a poster display. Make sure you include each stage from planning through to the conclusion.

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