

**BRONZE
LEVEL**



Resource pack

Machine learning



COLLECTION



IN PARTNERSHIP WITH



THE
**ROYAL
SOCIETY**

Contents

6-7



8-9



10-11



How to complete CREST using these activities	3
Background	4
Instructions for teachers	5
Project 1: Digital health	6-7
Project 2: AI agriculture	8-9
Project 3: Taught by technology	10-11
Project 4: How can you create a trustworthy machine?	12-13
Top tips for completing a Bronze project	14

How to run CREST using these activities



Preparation

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

Create a new Bronze Award project with the name(s) of the student(s) 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 workbooks and profiles for your student(s) to use when running a CREST Award. You can download these when you create your CREST account by following the link above. Encourage your student(s) 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 student(s) 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 workbook. 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 Bronze Award

Hard work deserves a reward! Celebrate and certify your student(s)' achievements by entering their project for a CREST Bronze Award. Simply log in again to your CREST account at www.crestawards.org/sign-in

Select the project and upload a sample of the student(s)' workbooks or other project evidence. Check the participating student(s) have met each of the criteria on the teacher assessment page. Finally, complete the delivery and payment details to order your snazzy certificates. Congratulations on completing CREST Bronze!

What next?

The scientific discovery doesn't need to end here. Students can have a go at the next level up – CREST Silver. 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 www.crestawards.org

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 Bronze resources.

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

Artificial intelligence (AI) is when a computer system is 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 10 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 14 to help students complete their CREST Bronze 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 sserc.org.uk.

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



In this pack

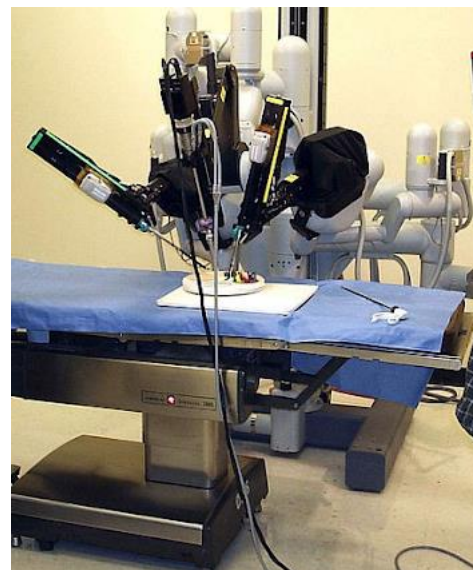
This collection of resources contains four different project ideas that can each be used to gain a CREST Bronze Award. Each project has a Teacher Guide, which outlines the project from a teacher's perspective, and then a student brief, which can be given to the student when they are ready to do the project. Check out the [CREST resource library](#) for more support.



In this project, focussed more widely on digital technologies supporting healthcare (not only those using AI), students will choose a recent digital healthcare development to research, such as telemedicine, web-based analysis, email, mobile phones and applications, text messages, wearable devices, and clinic or remote monitoring sensors.

Students will research the use of digital technologies in healthcare delivery, with particular focus on the development of interconnected health systems utilising smart devices and data analysis to aid healthcare professionals and patients to both manage illnesses and health risks, and promote health and wellbeing.

Students will be challenged to evaluate the potential of the latest developments in digital healthcare, and investigate the wider impact this might have.



Prompts

- Can you word your project title as a question? What are you trying to find out?
- What issues are there with digital technology in healthcare? Healthcare is a service, so remember to think not only about whether the technology will work, but also how patients might react.
- What factors might influence the decision to use a digital healthcare tool? Think about cost, time-saving, ease of use, trust and reliability.
- How might new technological developments, like AI and machine learning, bring further changes in future?





Digital technologies are already transforming our healthcare systems. In the future, new developments, including those using AI and machine learning, have the potential to lead to faster and more accurate clinical decision making, making medicine more personalised and precise, as well as increasing and improving research and development.

Imagine you work in a busy GP surgery. You have too many patients and not enough doctors and nurses. Other surgeries in your area are starting to use digital healthcare tools like telemedicine, healthcare apps, online services, wearable devices and remote monitoring sensors to reduce the workload of surgery staff. Your boss has asked you to look into these tools and produce a report explaining how they work and evaluating the pros and cons of the most promising tools.

Getting started

In this project you will select a range of new developments in digital technology to investigate, finding out how they work. You will then select one to focus on in more depth, and evaluate its potential utility, limitations, advantages and disadvantages.

Start by finding out what telemedicine, mHealth and wearable devices there are. You could read up online using one of the links below or see if you can interview someone at a local surgery or hospital about what new technology they are using.

Things to think about

- What technology does this tool use? Does it incorporate AI or machine learning?
- As well as thinking about the immediate impact on the patient, you might like to look into the long term implications of your chosen technology. Could the data be used to improve treatments or understand more about the causes in the future?
- Does your technology protect patient privacy?
- Not everyone is tech savvy. Would your technology exclude certain patients?

- There are so many healthcare tools out there, how will doctors and patients know yours can be trusted?
- How might technologies like AI bring further changes in future?

Useful resources

Find out what the NHS has to say about digital healthcare

- <https://digital.nhs.uk/services/nhs-apps-library>
- <https://www.longtermplan.nhs.uk/online-version/chapter-5-digitally-enabled-care-will-go-mainstream-across-the-nhs/>

Healthcare apps

apptentive.com/blog/2017/05/25/5-apps-changing-healthcare-in-2017/

Digital health in the UK

<https://www2.deloitte.com/uk/en/pages/life-sciences-and-healthcare/articles/digital-health-in-the-uk.html>

Data privacy and digital healthcare

<https://www.medicaldevice-network.com/features/data-privacy-advertising-amazon-and-artificial-intelligence/>

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.



The latest developments in machine learning for farming include: autonomous robots for harvesting crops; the use of drones, software based tech, and algorithms to capture and process data about crop and soil health; and, machine learning models to track and predict environmental impacts on crop yield such as weather changes.

In this project students will be challenged to think of innovative ways that image, sound and movement recognition could be used for farming and agriculture, and to then design and make their own simple AI powered tool using the teachable machine app.



Prompts

- What routine jobs are there on a farm? How does the farmer know when they need doing?
- How does a farmer use sight and sound in their job? Think about whether a tool that uses image, sound or movement recognition could help them to do that task.
- How will you test whether your tool works?





Factors such as climate change, population growth and food security concerns have propelled the agriculture industry into seeking more innovative approaches to protecting and improving crop yield. The latest developments in machine learning for farming include: autonomous robots for harvesting crops; the use of drones, software based tech, and algorithms to capture and process data about crop and soil health; and, machine learning models to track and predict environmental impacts on crop yield.

Imagine you are a farmer. You have heard about some new technologies that other farmers are using. One farm has started using moisture sensors, which connect to an app to tell you when your crops need watering, to help reduce water usage. Another has agricultural drones, with near infrared view, to spot blight in a few plants before it spreads.

You want to come up with a new way that farming tech could help make your farm more efficient. Design a machine learning powered tool to help improve farming and agriculture.

Getting started

In this project you will design an innovative way that machine learning could be useful for farming and agriculture. Try out the teachable machine app (see Useful Resources) to help get to grips with how machine learning systems work.

Start by reading up on the latest high-tech farming equipment using the 'Useful resources' links. Brainstorm ideas for different jobs that farmers need to do regularly, resources that farms use a lot of, and common problems for farms. Maybe you can interview a local farmer.

Is there a way that data from images, sound or movement could be used to help do a job a human normally does, reduce the use of expensive resources, or solve a problem? Use your research to come up with a concept that uses machine learning.

Things to think about

- What kinds of tasks need doing regularly on a farm? How regularly are they done? How do farmers know when to do them?

- Farmers have to deal with lots of things that are out of their control - floods, droughts, pests. What measures could they take to protect their crops and animals if they could better predict these events?
- What types of things do farmers need to predict? How could data help inform these predictions?
- Do your ideas use machine learning? Do they learn from examples, data, and experience?

Useful resources

- Teachable machine tool
<https://teachablemachine.withgoogle.com/>
- Watch this video about high tech farming
<https://www.bbc.com/reel/video/p07dgymk/the-high-tech-farming-revolution>
- Follow the food
<https://www.bbc.com/future/bespoke/follow-the-food/>
- How high tech is transforming farming
<https://www.nytimes.com/2019/09/06/business/farming-technology-agriculture.html>

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.



AI in education generally focuses on identifying what students do and don't know through testing, and developing personalised curricula based on students' specific needs.

In this project students will find and try out a range of educational applications that use AI for one or more of the following: generating smart content (e.g. condensing text book content into quizzes); intelligent tutoring systems (personalised to the learning styles of the pupil); and/or virtual learning environments (virtual tutors).

Students will be challenged to design and conduct an investigation to compare and evaluate AI powered education apps, conducting tests, surveys and interviews to gather data about the effectiveness of educational apps. They will need to think about what indicators they will use as measures, how to conduct a fair test, and how to collect and analyse their data.



Prompts

- How many participants will you use? How long will your study be?
- Will participants use the app once for a long duration, or lots of times but for short durations? Why?
- Remind students to think about all the variables in their investigation.
- Students should think about how they will measure their results before starting any practical investigation.





AI is being used in education to help identify what students do and don't know through testing, and developing personalised curricula based on students' specific needs. There are apps that gamify learning through quizzes, AI tutors that you can have conversations with, and school management systems to help teachers understand how their students are performing.

Imagine you are a headteacher. Some of your students want to learn a new instrument, and others want to learn a new language, but you can't find the teachers to teach it.

Some other schools in the area are starting to offer lessons without teachers, where students learn from apps that use machine learning, and you want to find out more. Conduct an experiment to find out how effective apps are and how they compare to learning from a teacher.

Getting started

Start by choosing either a musical instrument or a language for the apps you will investigate. Next you will need to find some apps to test, do some research online and pick at least 2 apps to compare.

Then you will need to recruit participants for your experiment. There will be lots of variables in your experiment. Where possible you should try to control these, or make sure you are only changing one at a time.

Before starting your experiment, make sure you have planned how you will measure your results and how you will keep your test fair.

Things to think about

- Do your participants have any knowledge of the subject before starting your experiment? Try to find people with no previous knowledge in the subject, so that everyone is starting from the same point.
- How many participants will you recruit for each group? Will they all be from the same year group or will you use students from different year groups? Try to make sure each group has a similar number and type of participants.

- How long will they spend on the apps? What time of day will they use the apps?
- How will you measure the results? Can you create some kind of test that participants take before and after using the app, so that you can measure how much progress they make?
- Will you also compare your results to students that had no lessons? How could this technology complement the role of the teacher for the overall benefit to the student?

Useful resources

- Apps for students bigdata-madesimple.com/how-apps-for-students-are-using-ai-for-doing-lessons-better/
- Duolingo research ai.duolingo.com/
- Machine learning in education trueinteraction.com/ai-and-the-classroom-machine-learning-in-education/
- Second language learning medium.com/@sanalabs/the-unreasonable-effectiveness-of-deep-learning-in-language-learning-bededd4cba10
- AI tutor <https://www.korbit.ai/>

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

How can you create a trustworthy machine?



Based on the current growth of machine learning and AI technologies across the globe, it is very likely that in the future these tools will be embedded into our everyday lives.

In this project, students will investigate the levels of trust people have in machines making decisions about their lives, including which decisions they would be more comfortable with a machine making and how useful it would be.

Students will be challenged to develop a survey asking people about their views on this. They will then design a way to communicate their findings to developers who work on artificially intelligent computer systems.



Prompts

- What do you need to understand about machine learning and AI in order to carry out this project?
- What makes systems trustworthy or not?
- How much do your audience know about machine learning?
- What are people's main concerns about machine learning?
- How important is it to ask the public what they think?



Student brief

How can you create a trustworthy machine?



Project brief

In this project you will select a target audience and create a survey to find out what they know & feel about machine learning and what would be needed to create machine learning systems that people trust. You will then use your survey findings to make recommendations to developers to ensure artificially intelligent computer systems are trustworthy.

Consider the following questions. How far would you trust a machine to:

- Help with your shopping?
- Teach you a foreign language?
- Diagnose an illness?
- Post photos on your social media page?
- Drive your car?

For each one, consider how *useful* it would be for a machine to carry out the task and what value or *risks* there might be in using these systems.

You need to find out how other people feel about machine learning and what they would consider a 'trustworthy' machine too.

Do some research into machine learning to find out what it is, how it relates to people's lives and what people might have different views about. What might computers be able to do for us in the future? What might the risks or opportunities be?

Next you need to create your survey. Make sure your questions are balanced and unbiased. Think of ways you could make your survey interesting and engaging and allow people to express their views on a scale.

Once you have collected together the responses you will need to present the results and recommendations in an informative way.

Useful resources

- What is machine learning?
<https://royalsociety.org/topics-policy/projects/machine-learning/what-is-machine-learning-infographic/>
- Machine learning in the world around you
royalsociety.org/topics-policy/projects/machine-learning/machine-learning-in-the-world-around-you-infographic/
- How to design a survey
<https://www.sciencebuddies.org/science-fair-projects/references/how-to-design-a-survey>

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.

TOP TIPS

For completing a Bronze 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 your 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

Consider finding 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.

Managed by



www.crestawards.org
email: crest@britishscienceassociation.org

The British Science Association is the operating name and trade mark
of the British Association for the Advancement of Science
Registered charity: 212479 and SC039236