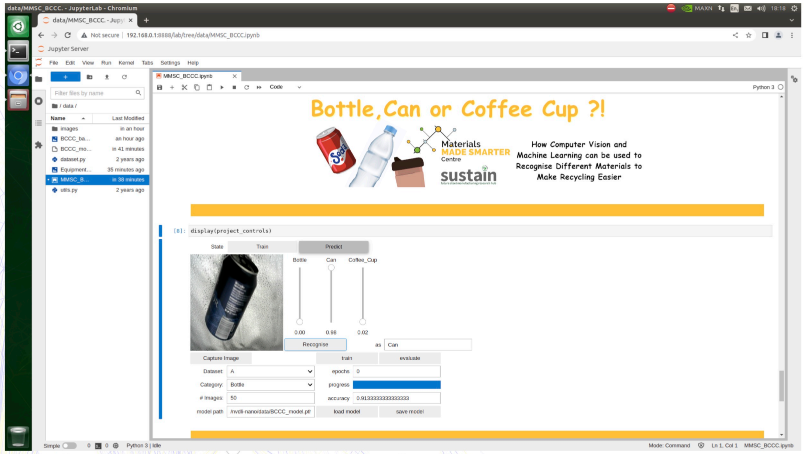
04 Training for Different Materials



By using an existing transferred model, already trained to recognise general features in an image, only the final layer of the network needs to be re-trained on the specific task required.

In this demonstration the final layer is trained to recognise the difference between a bottle, can or coffee cup; initially using 50 images of examples of each object. On pressing the **Recognise** button, the system makes a prediction of the likelihood that the image it sees belongs to each category from its training data, and the most likely category is used as the identification. Here you can investigate how well the identification works, re-train on other examples of the objects and learn how to improve the performance by including more training images or more training epochs. Or, if you delve into the Python code, you can even try using different transfer models!

Instructions on how to use the demonstration and glossary of the highlighted technical terms are available at Discover Materials by scanning the QR code on the front...

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developed by Dr R. Gibbs and Prof. C. Giannetti for Materials Made Smarter, based upon the NVIDIA DLI "Getting Started with AI on Jetson Nano" course.
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Bottle, Can or Coffee Cup ?!

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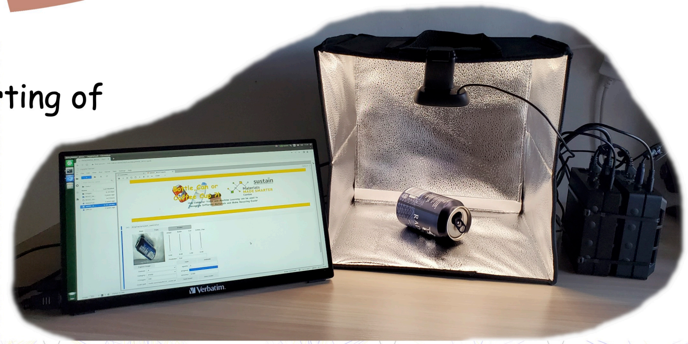
How Computer Vision and Machine Learning can be used to Recognise Different Materials to Make Recycling Easier

Introduction

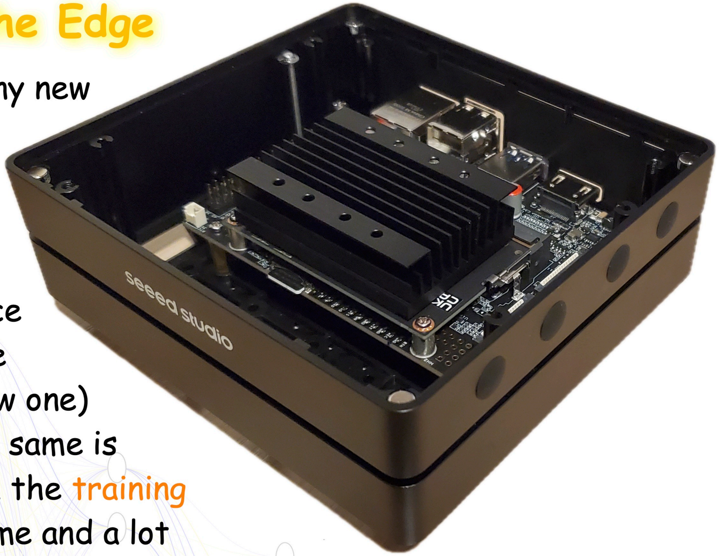


In the past, the sorting of materials for recycling has been performed by people - who observe the objects as they pass by on a very fast-moving conveyor belt, and make quick decisions about which bin to push the objects into. This is a very tiring and unpleasant job, if you have ever tried to watch the nearby scenery go past whilst travelling in a car, bus or train then you can imagine how tiring and damaging to the eyes this work is. As the amount of recycling increases, the speed it must be processed at increases, and soon no human will be able to cope.

This is exactly the type of work Machine Learning and Computer Vision can help with. This project also demonstrates how, with modern advances in hardware, the task no longer requires large expensive computer systems and can be performed by modest, low-powered, edge-computing devices which are cheap enough to enable hundreds of independent smart sensors, close to the action, each performing a specific task. This project is divided into four sections. **Further information about each section can be found by scanning the QR code...**

Discover Materials

01 Computing on the Edge



The process of learning any new skill, like riding a bike, takes a lot of time and effort, but once your brain has learnt all the tiny corrections-to-balance that it needs, you can ride any bike (even a brand-new one) almost straight away. The same is true when machines learn, the training of a model takes a long time and a lot of computing power, but once trained, the process of prediction, or inference, takes much less effort and can be performed in real-time with only a relatively modest computing platform.

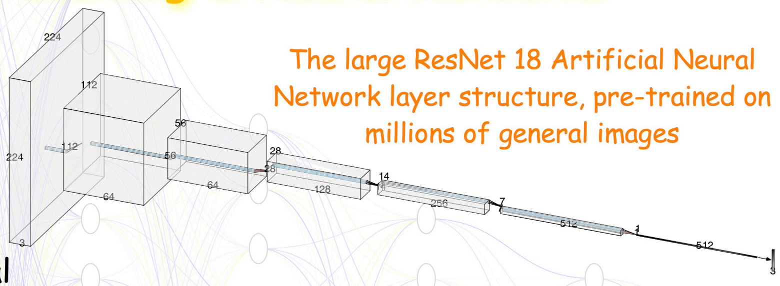
02 Working with Limited Resources

When using computing platforms with limited resources it is common to have multiple units and dedicate one task to each unit.

By pairing multiple units together many tasks can be completed at the same time. This technique is used even for the multi-core processors of an expensive smartphone or the many nodes that make up the large supercomputers in today's High Performance Computing data-centres. Sharing the task into many smaller parts, which can be carried out at the same time as each other (in parallel) makes the whole process much faster. Like having many different people, with different specialist skills, work on setting up a concert, instead of just the musician. The key is managing the communication and timing between the different components and communicating only the limited information that is necessary.

This demonstration is built on two NVIDIA Jetson Nano 2GB based Seeed Studio reComputer J1010s each with an Arm Cortex A57 CPU and NVIDIA Maxwell GPU

03 Machine Learning & Neural Networks



The large ResNet 18 Artificial Neural Network layer structure, pre-trained on millions of general images

The human brain is a web of ~ 86 billion interconnected neurons which collect electrical impulse signals of different weights, or importance, and send on a signal only once a sufficient bias charge has been reached.

Artificial versions of these neural networks were first developed in the 1940s, but it is only in the last decade that computers have become powerful enough to simulate the millions of neurons needed to make them useful. The networks are trained by optimising, over thousands of examples, the billions of weight and bias values in a process called back-propagation so that particular inputs map correctly through the network to chosen learnt outputs. Much of the heavy work of training for computer vision problems can be short-cut by transfer learning - using large general-purpose models such as ResNet 18, that have already been trained on millions of images, to first extract the general features of objects in an image.

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