Bottle, Can or Coffee Cup ?!

Materials MADE SMARTER Centre

sustain
future steel manufacturing research hub

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

Discover Materials

02 How to Use the Project Controls to Identify Objects

This Materials Made Smarter Outreach Demonstration of How Computer Vision and Machine Learning can be used to Recognise Different Materials to Make Recycling Easier has been developed by Dr Robert Gibbs with Professor Cinzia Giannetti of Swansea University [↲] for Materials Made Smarter [↲], based upon the NVIDIA DLI "Getting Started with AI on Jetson Nano" course [↲].

This guide describes how to use the project controls to identify objects after setting it up. An accompanying walkthrough video is available at Discover Materials by scanning the QR code or at

https://discovermaterials.co.uk/resource/bottle-can-or-coffee-cup/

The video forms part of the section

04 Training for Different Materials

A playlist of all 4 videos is at

https://www.youtube.com/playlist?list=PLyl3ubsSP6pUkBdTephBtqL7UfIFfGQ_Z

Also available on the Discover Materials website are a glossary of the highlighted technical terms, an electronic version of the printed booklet and further information about the code, the equipment and progressively more detailed project documentation.

Prifysgol Abertawe Swansea University
Y Gyfadran Gwyddoniaeth a Pheirianneg
Faculty of Science and Engineering
Materials and Manufacturing Research Institute

UKRI Engineering and Physical Sciences Research Council

NVIDIA DEEP LEARNING INSTITUTE

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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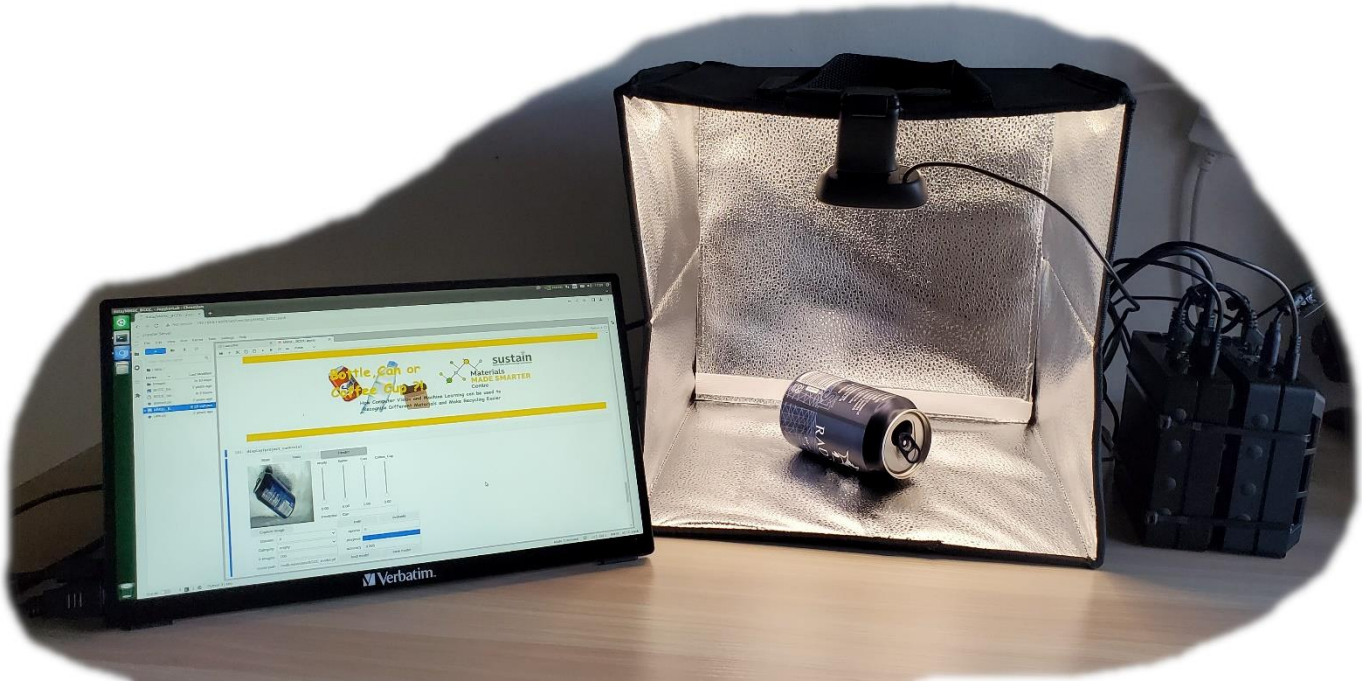
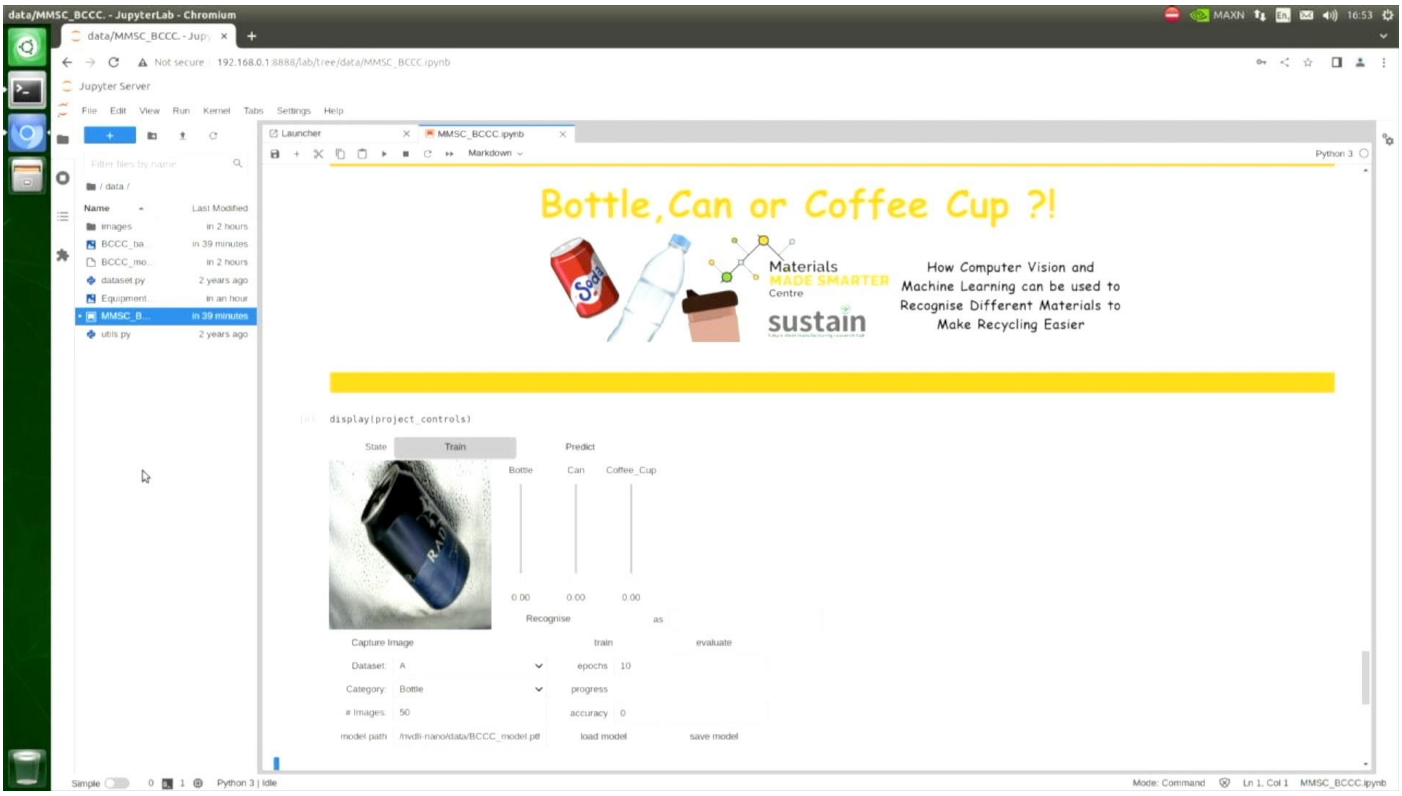
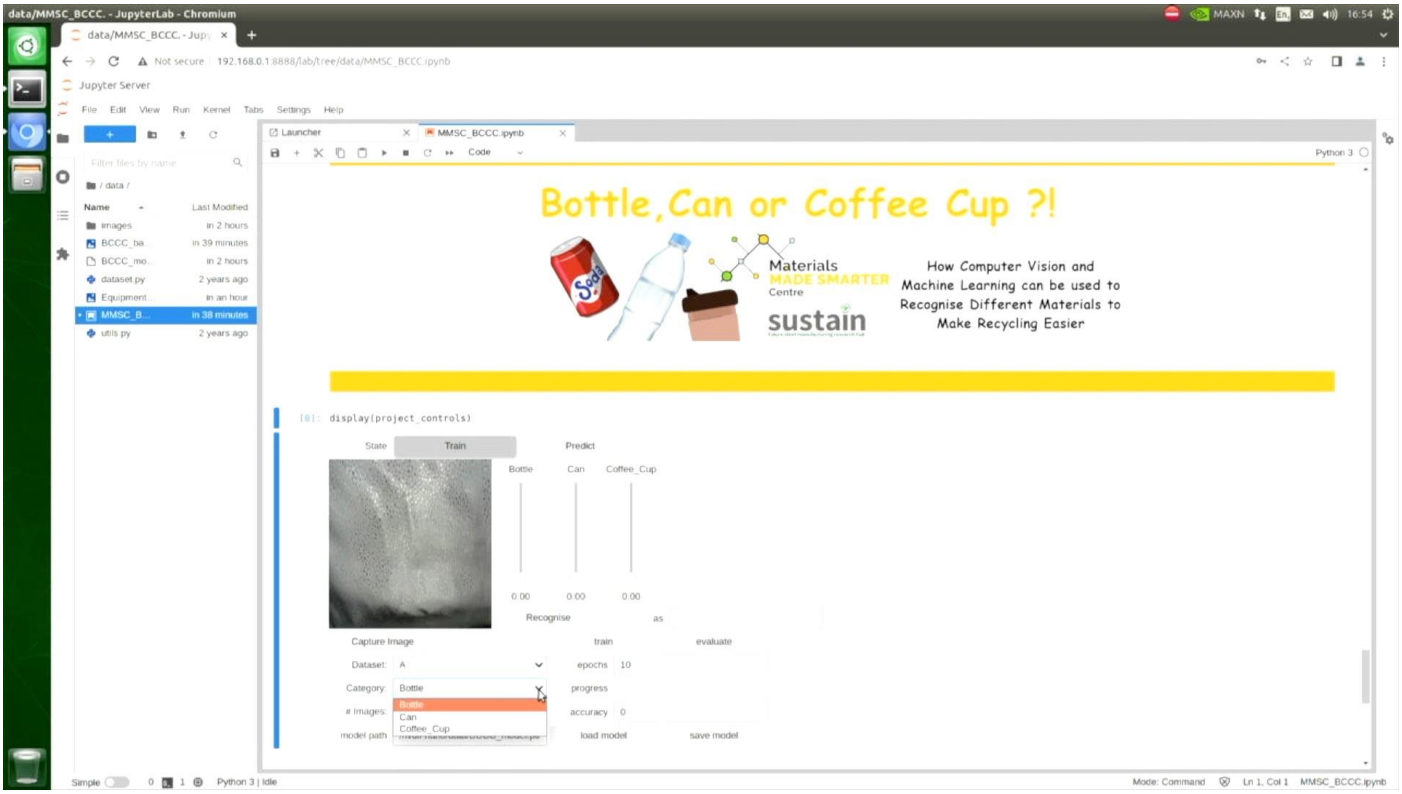
It is assumed that you have the system up and running according to the guide **01 Getting the System Up and Running** available on the website.





There is a live view of objects as we put them inside the photo box.

The system has two states, the **train state** and the **predict state**. At the moment we're in the training state.

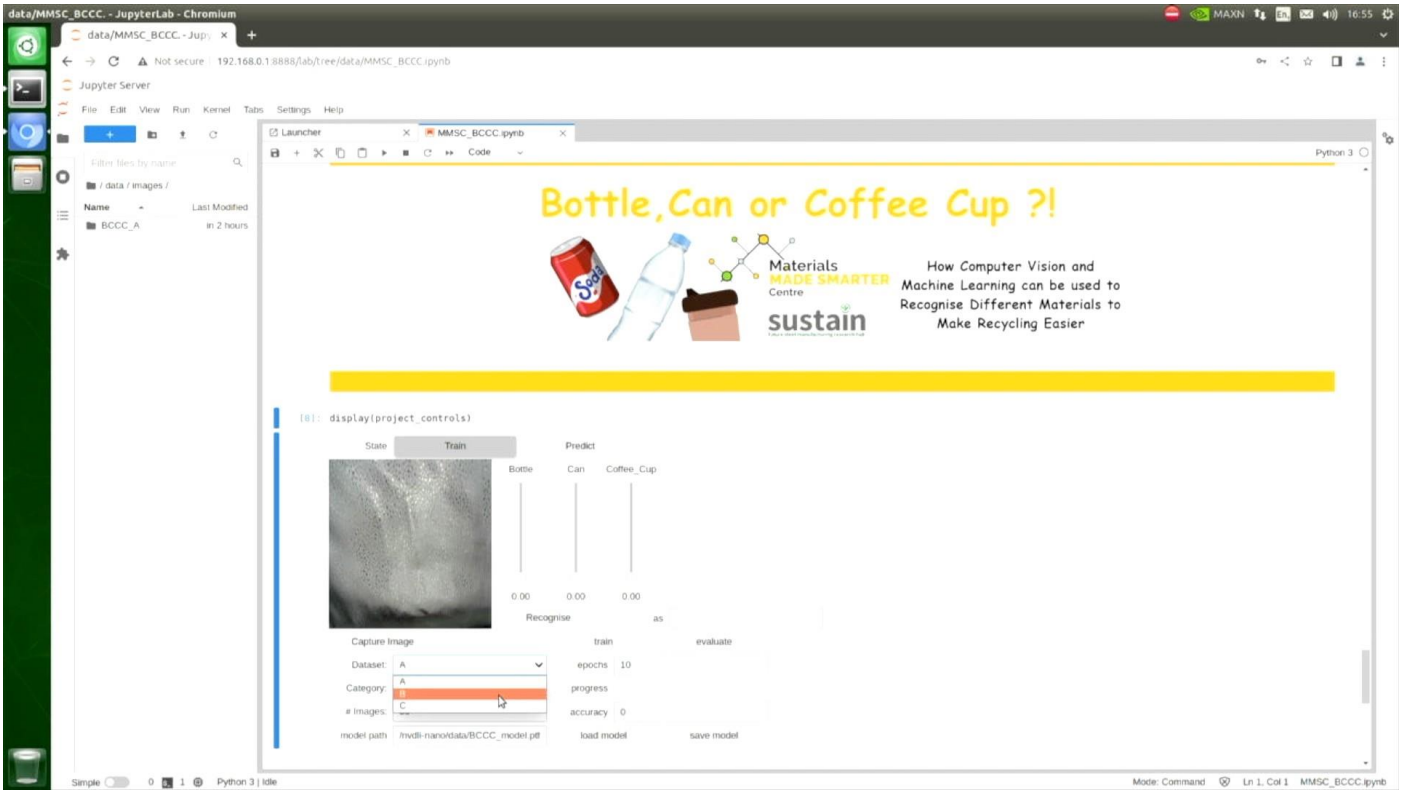


There are three possible data sets, A,B and C. The categories in each dataset are bottle, can or coffee cup.

The BCCC_A dataset contains 50 images of one example object from each of the categories, at different orientations

Thumbnails of all the **BCCC_A** training images are presented at the end of this guide.

These are the training images that the system comes with and these images are stored in the folder **images** under a sub folder **BCCC_A** and subfolders **Bottle**, **Can** and **Coffee_Cup**.



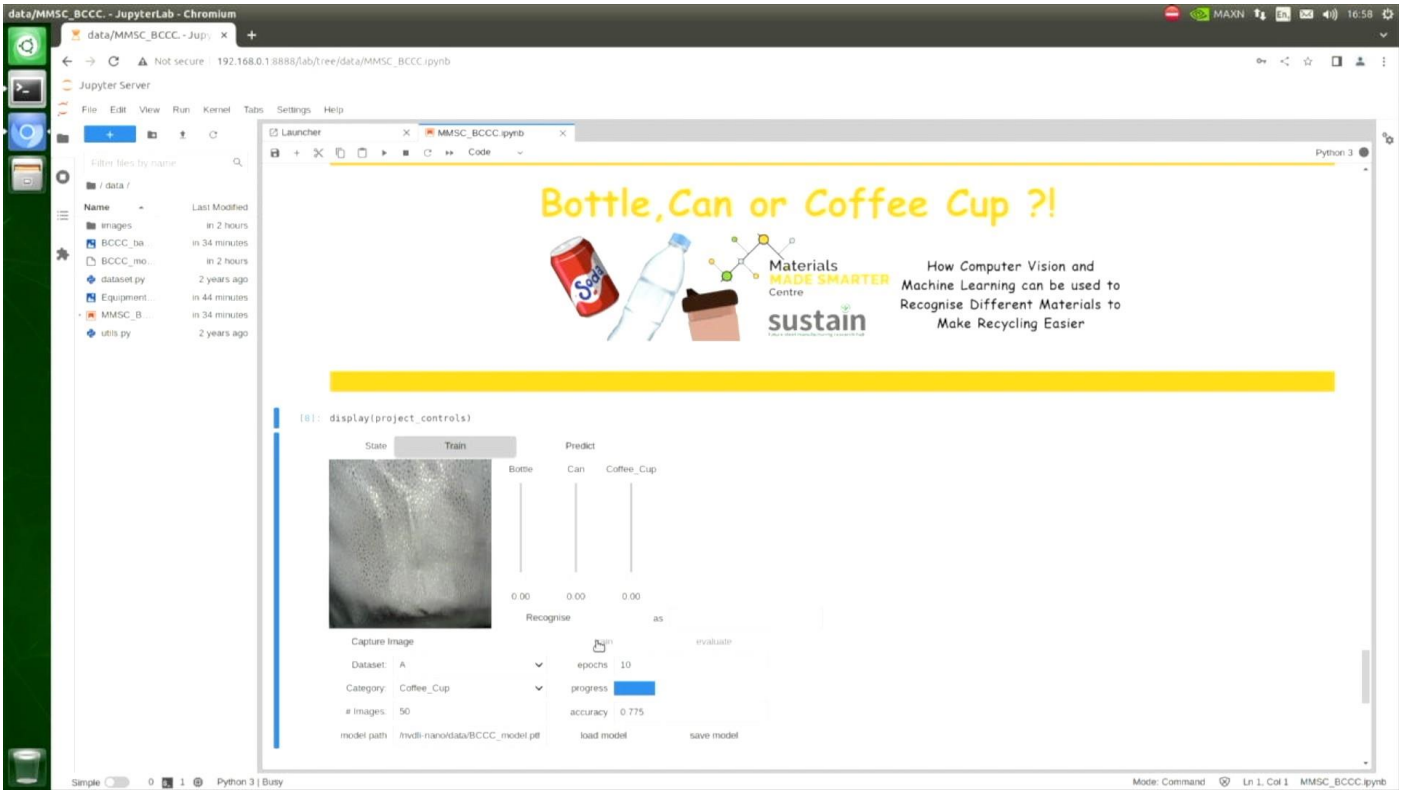
If you wanted to train for your own objects, you could select dataset B or C, and it would store that data in the relevant folder so you do not disturb the original training data set that the system comes with.

In this guide we will use the existing BCCC_A training dataset to train the model. The guide **04 Improving the Performance for New Objects** (available on the website) discussed the addition of new training images and new training datasets.

There are adjustable settings for the training of the model. The default setting for the number of epochs, the number of times it runs through the training data, is 10 we'll leave it at that for now but you can experiment with how this hyperparameter can be changed to affect the performance.

The progress bar shows us the state of the progress of training, and the accuracy reports how well the system is recognises the objects in it has been trained on.

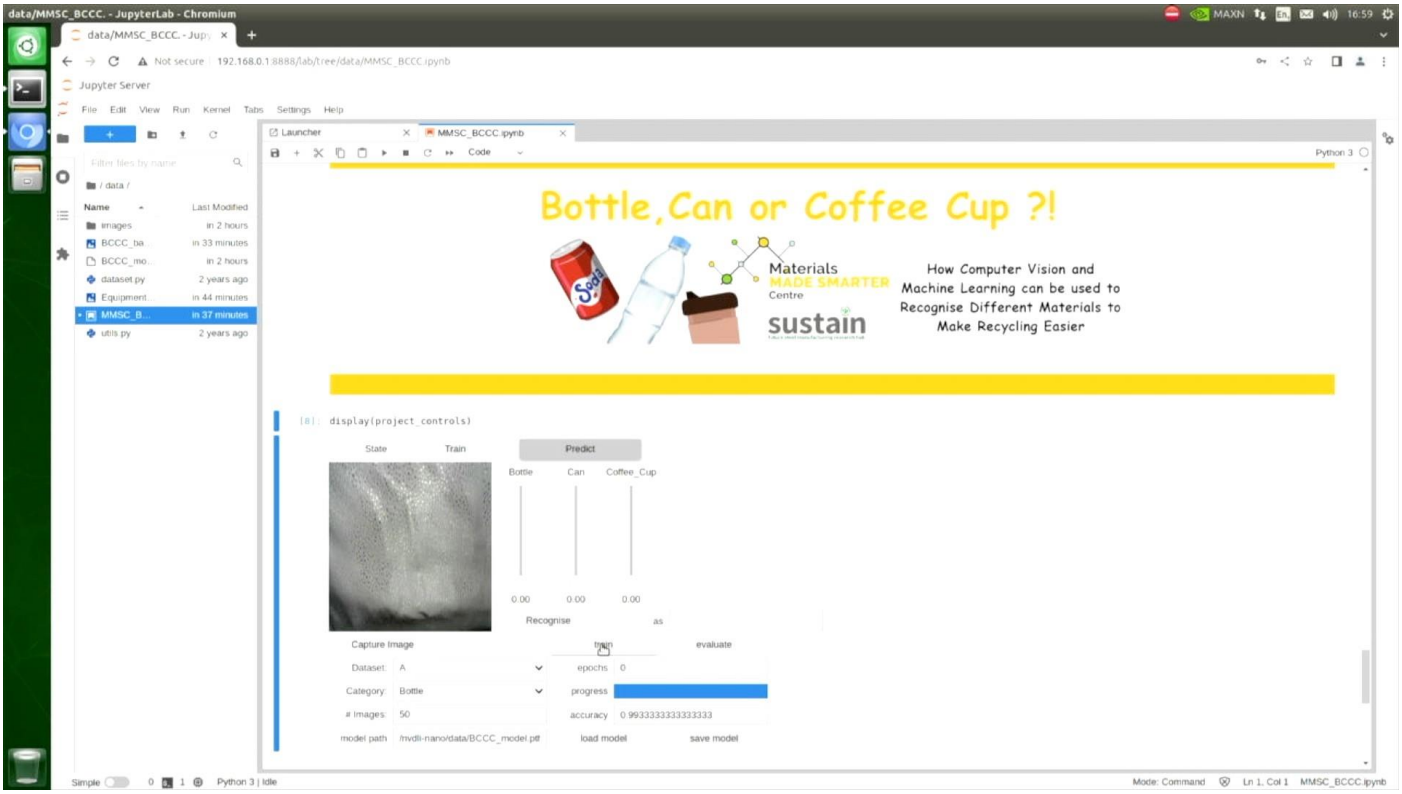
There is a balance between 100% accuracy where it correctly recognises every image it has seen before, or less than 100% accuracy, which enables it to have some generality and maybe recognise images it hasn't seen before. You want to have an accuracy above 90% in this situation



Press train to train the model. The first time you press train, the first epoch takes longer than the remaining 9 as it loads all the 150 images into memory. The training process will take approximately 4.6 minutes and you can see the progress of each epoch.

As described in the booklet (electronic version available on the website) the process of training or learning takes a long time, but once the machine has learnt, each of the objects from its training data set, it can then recognise them in real time.

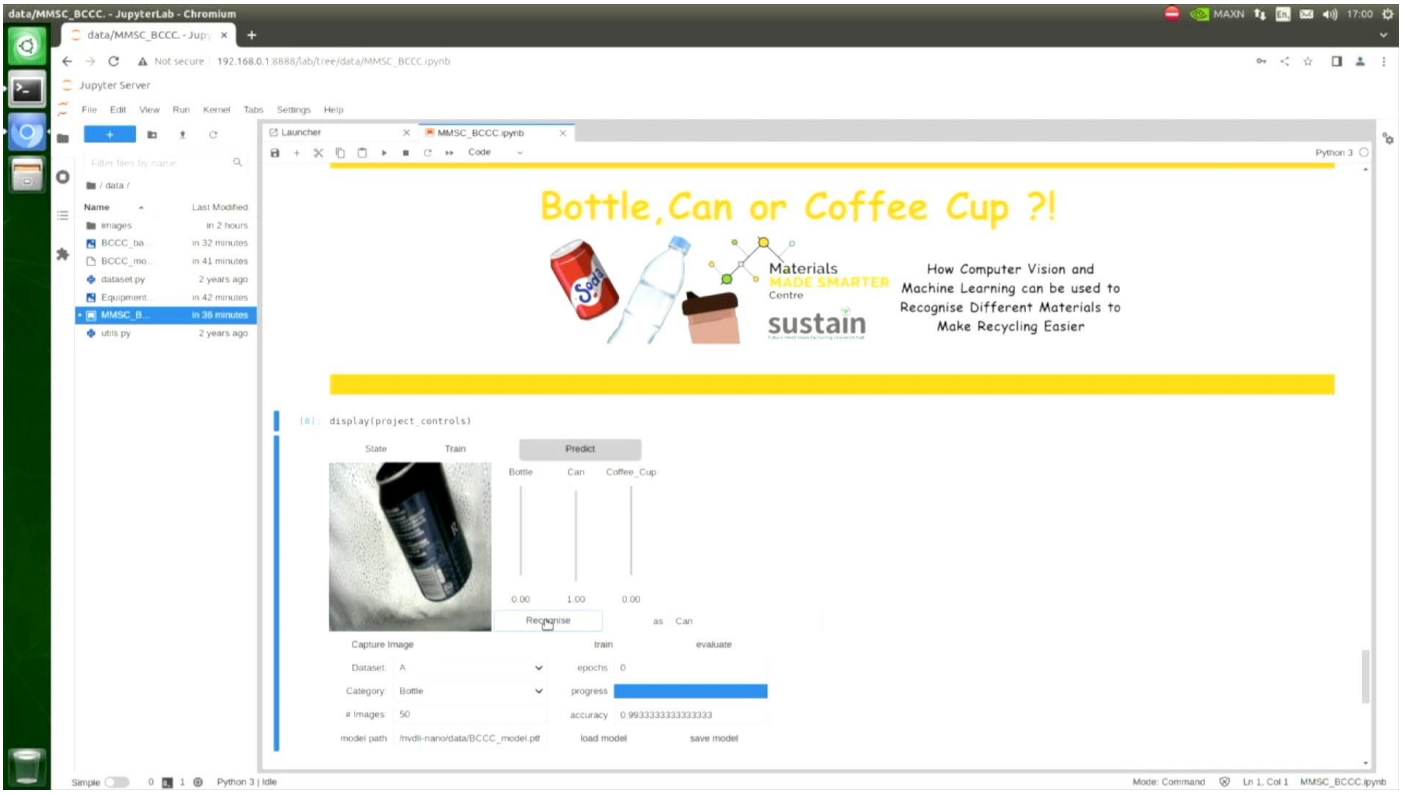
The system comes with an existing saved model, but if you wish to save your own model, press the save model button. This will save the model under the filename and location written in the model path box. You can give the model your own name if you wish.



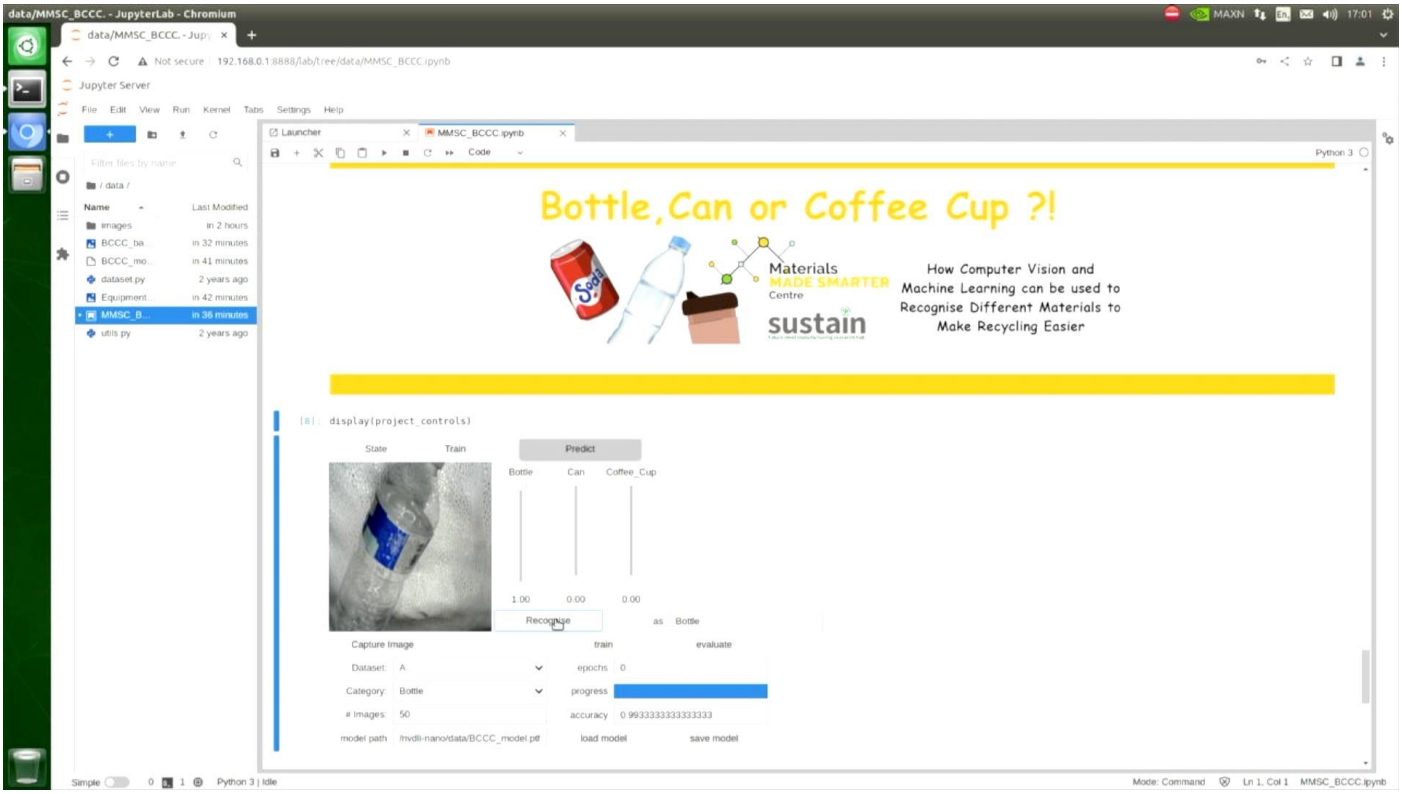
Following training, the system moves to the **predict state**, and it's ready to recognise objects now.

We still have our live feed from the camera in the photo box, if you put the provided example **Bottle**, **Can** or **Coffee Cup** into the photo box and then press the **Recognise** button, you can see that the system will recognized it.

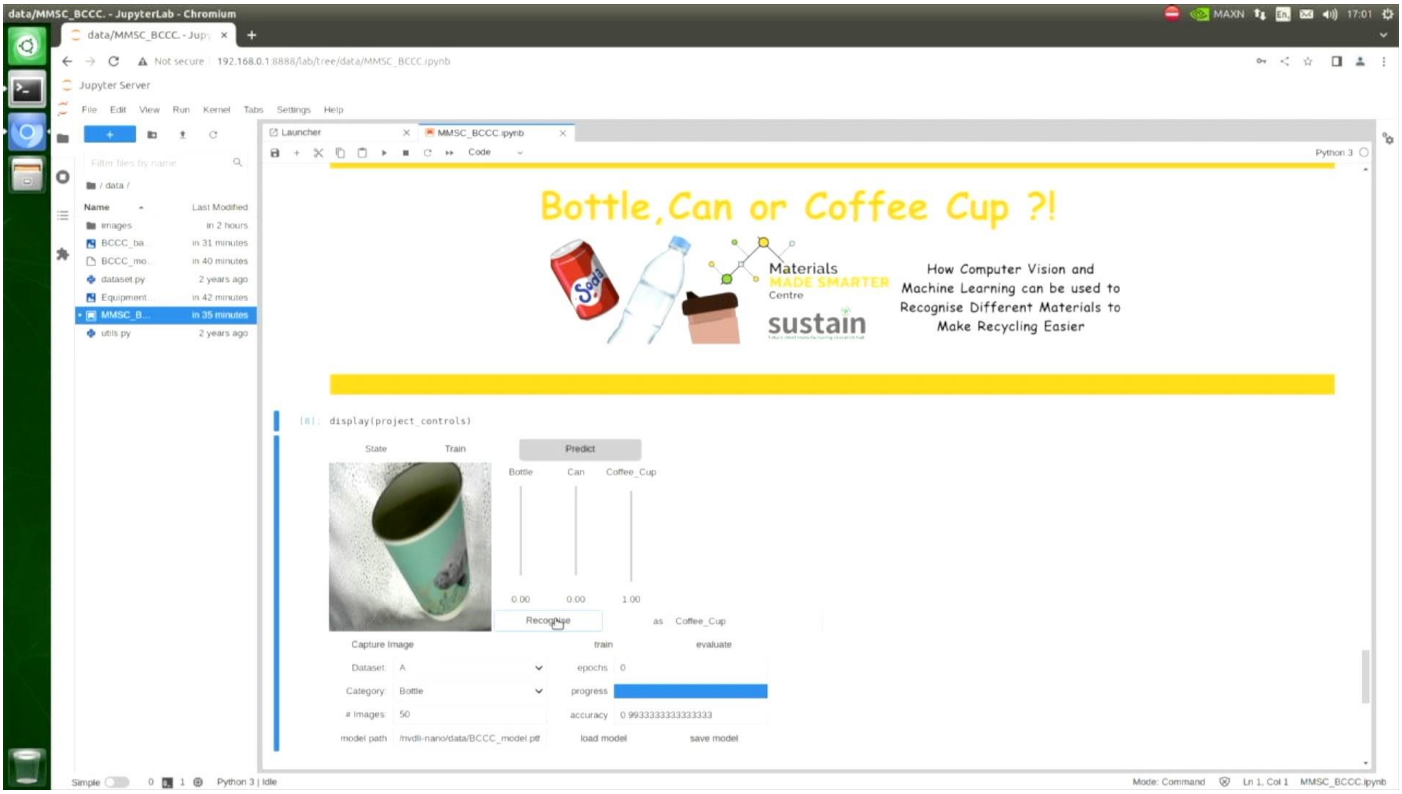
The first time you press the **Recognise** button it takes a little time to react as it loads the new model data into memory, but every other recognition is nearly instantaneous, providing real-time recognition.



Here the system has recognised that this object is a can, and it's recognized it with 100% certainty that it is a can, not a bottle, not a coffee cup.

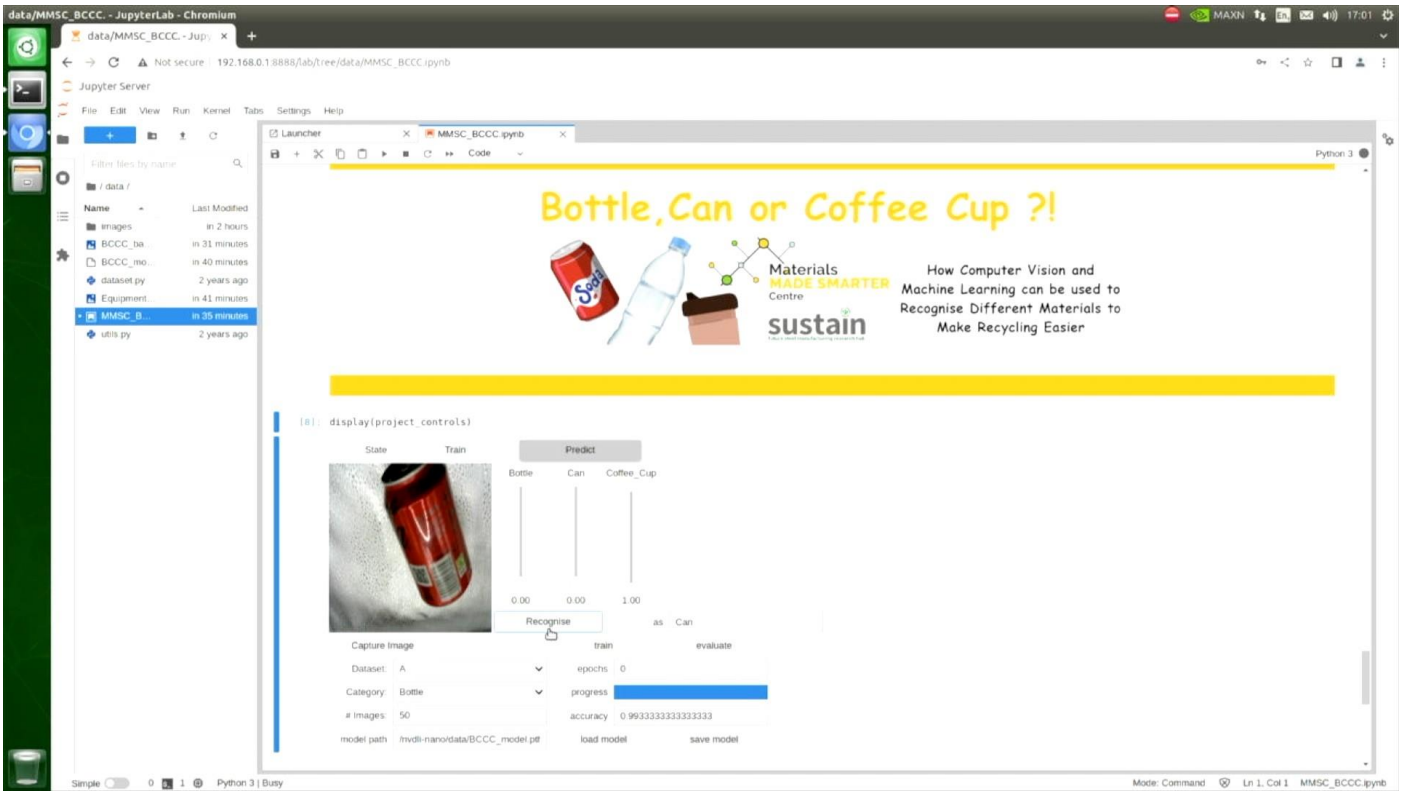


The system has very quickly now recognized that the object is a the bottle from its training data set



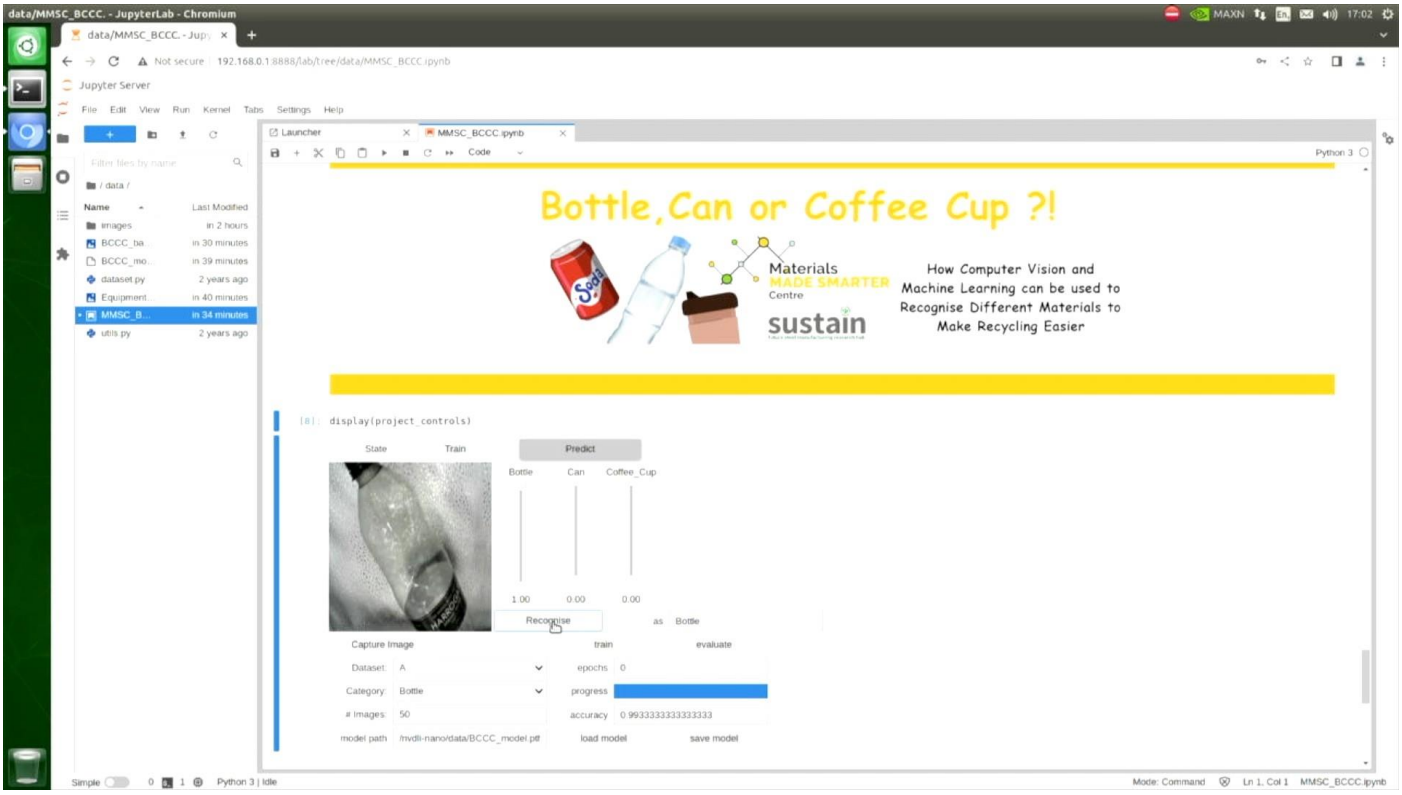
The third type of object, the coffee cup, has been recognised with 100% certainty.

You can experiment with putting different examples of the objects in and seeing what the system thinks they are.



If, for example, we put in a different type of can and the system still recognises it as a can, even though it's never seen this can before and it is even a different colour to the previous can.

It has 92% confidence that it is a can 8% confidence that it might be a coffee cup, but the important thing for machine learning is that it uses the most likely category for its final recognition of an object.



If we try the experiment again, with a bottle that it's never seen before the system recognizes it as a bottle, and this time with 100% confidence, even though it has never seen this bottle before it is not the bottle that it is that is in its training data set. It has clearly found some features of bottles that it definitely identify the as bottles compared to other things.

We can play with how the system works with different objects and see what the system thinks they are.

In the guide **04 Improving the Performance for New Objects** (available on the website) we'll investigate how you can improve the performance on recognising objects it has never seen before.

In the meantime have fun with the system on the three objects it's been trained to recognise.

See you there.

./data/images/BCCC_A/Bottle/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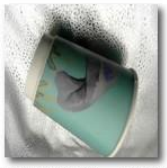
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