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

01 Getting the System Up and Running

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 get the system running after powering 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

02 Working with Limited Resources

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.

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Faculty of Science and Engineering
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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. C.G. would like to acknowledge the support of the EPSRC (EP/V061798/1).

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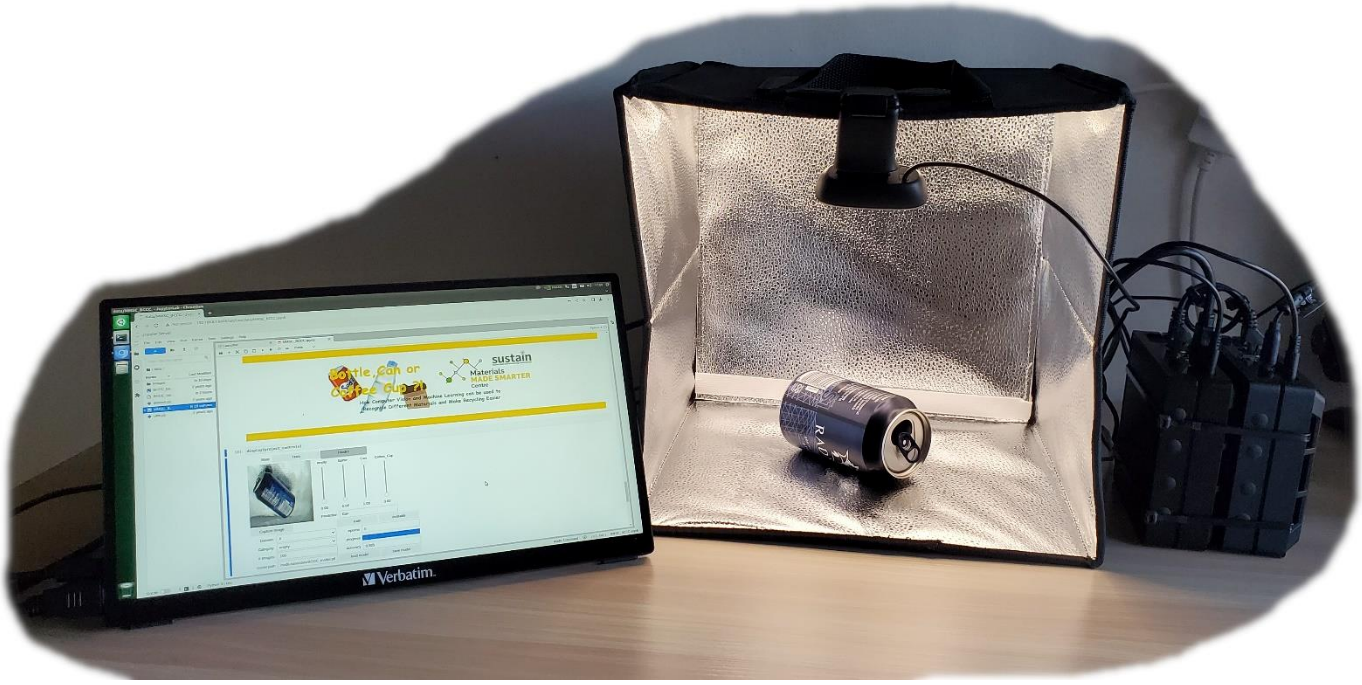
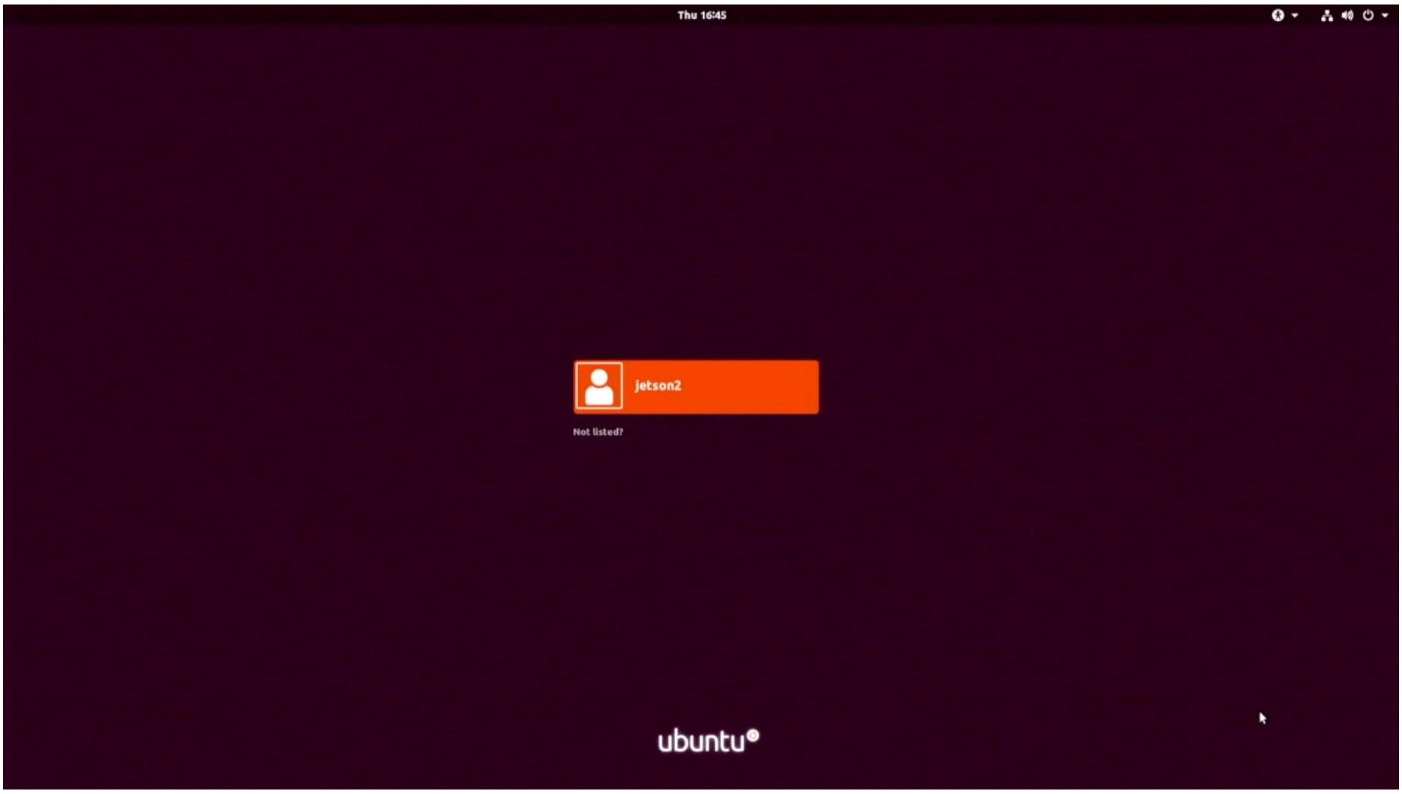
It is assumed that you have set up the equipment hardware according to the guide **00 Setting up the Demonstration Hardware** available on the website.



As we power on both units together, we have the video connected to the second of the Seeed Studios reComputers. These are based on the Jetson Nano 2 GB platform from NVIDIA and they are running Ubuntu 18.

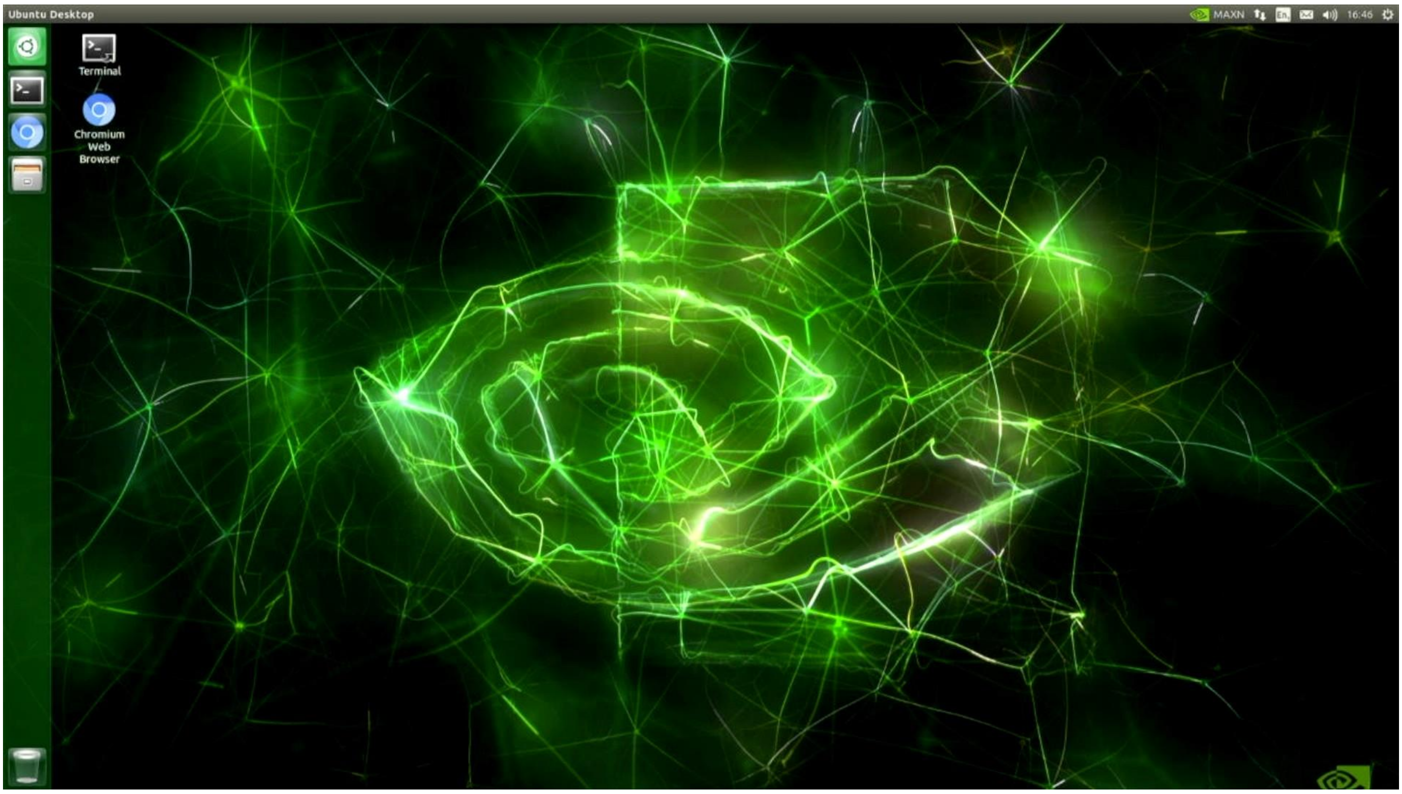
We use one of the computers to drive the video display and the web interface, and the other computer, with its own GPU, is providing the machine learning capability and the code behind the models, provided by the NVIDIA DLI environment.



So we log into the system with the username **jetson2** and the password **jnano23**

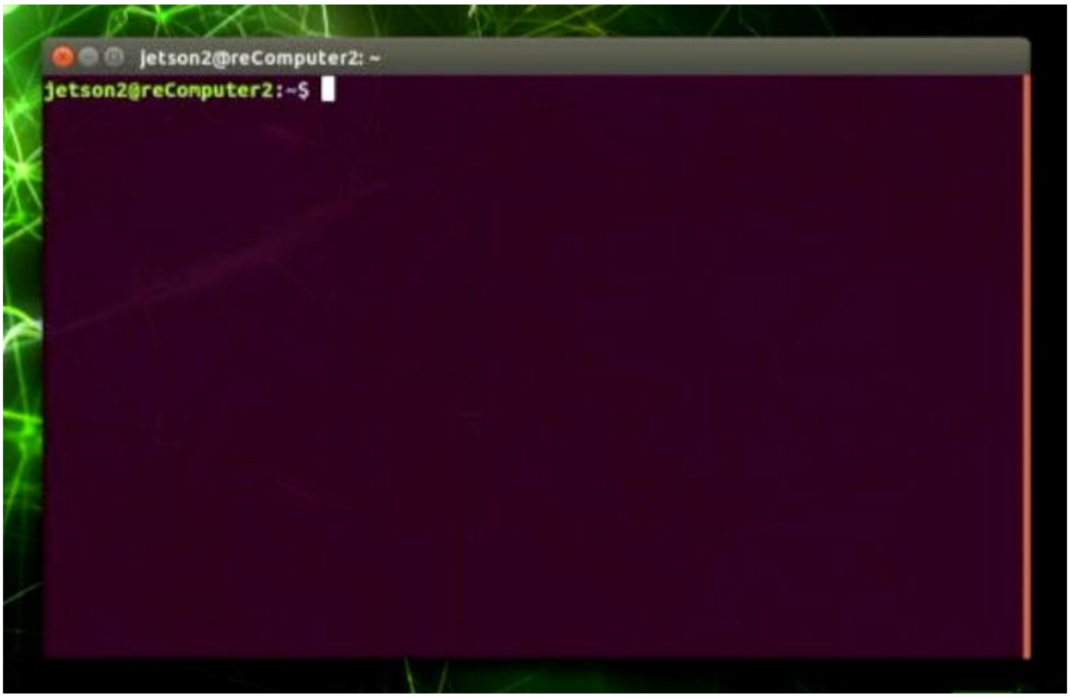
Neither of the computers are connected to the Internet and that should remain the case so that the system doesn't break itself.

However, the two machines are communicating to each other over a private internal network using the short ethernet cable.



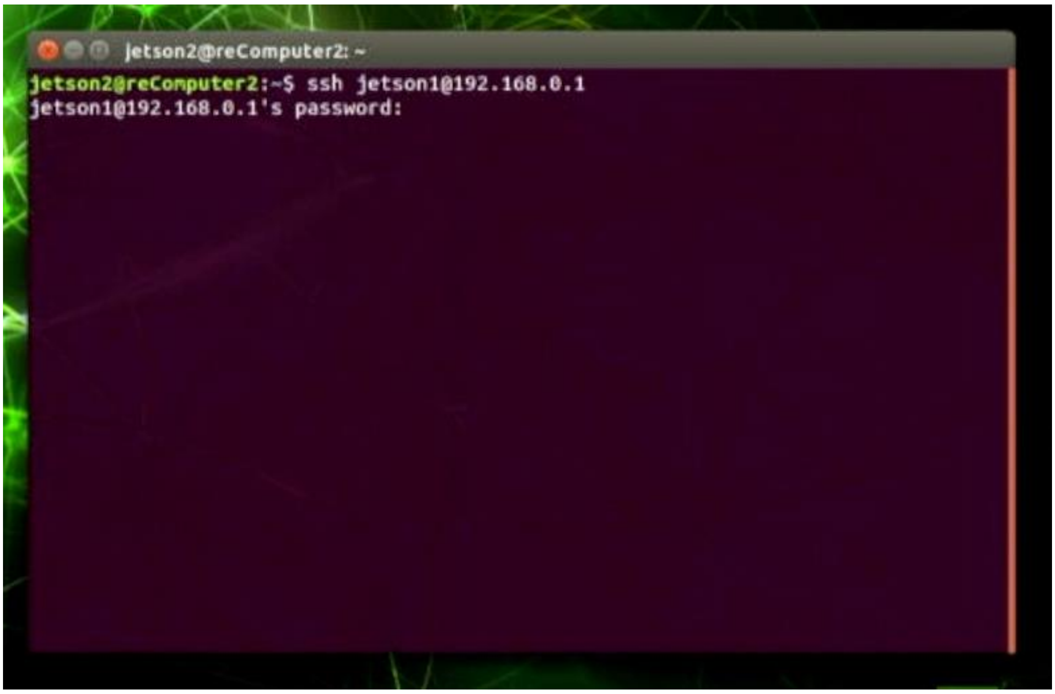
At the initial interface there are only two applications that we need to run for this demonstration.

First we launch the terminal by double clicking on the icon.



This is the terminal for **jetson2@reComputer2** on the second unit.

We need to begin communication with the connected first unit that runs the machine learning environment.



We do this with the command;

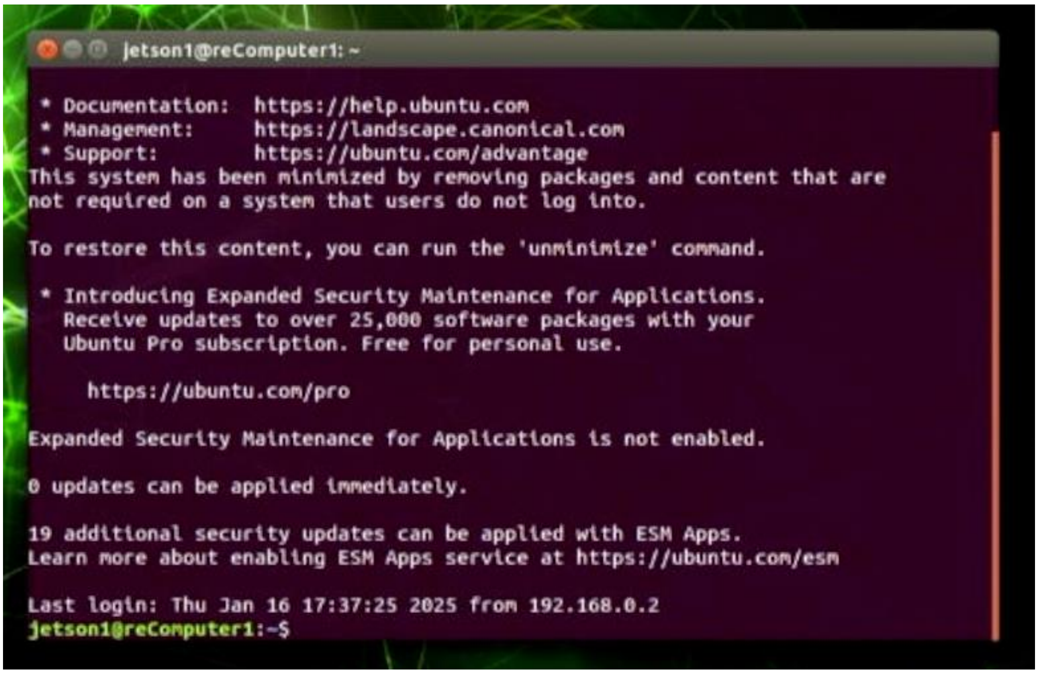
```
jetson2@reComputer2:~ ssh jetson1@192.168.0.1
```

and password `jnano23`

This is the IP address for the private network between the two machines. jetson2 has an IP address 192.168.0.2

You don't need to type in this command because it is already in the history, so you can just press the up arrow to recover the command stored in history.

It won't display the password, but if you press return we are now logged in as the jetson1 user on reComputer1, which is the first unit.



This is the unit that will be running the python code and the docker environment for the machine learning.

Again, the following commands are stored in the history, so you just need to press the up and down arrow, or you can type them in. But if we press up once we get

```
jetson1@reComputer1:~ exit
```

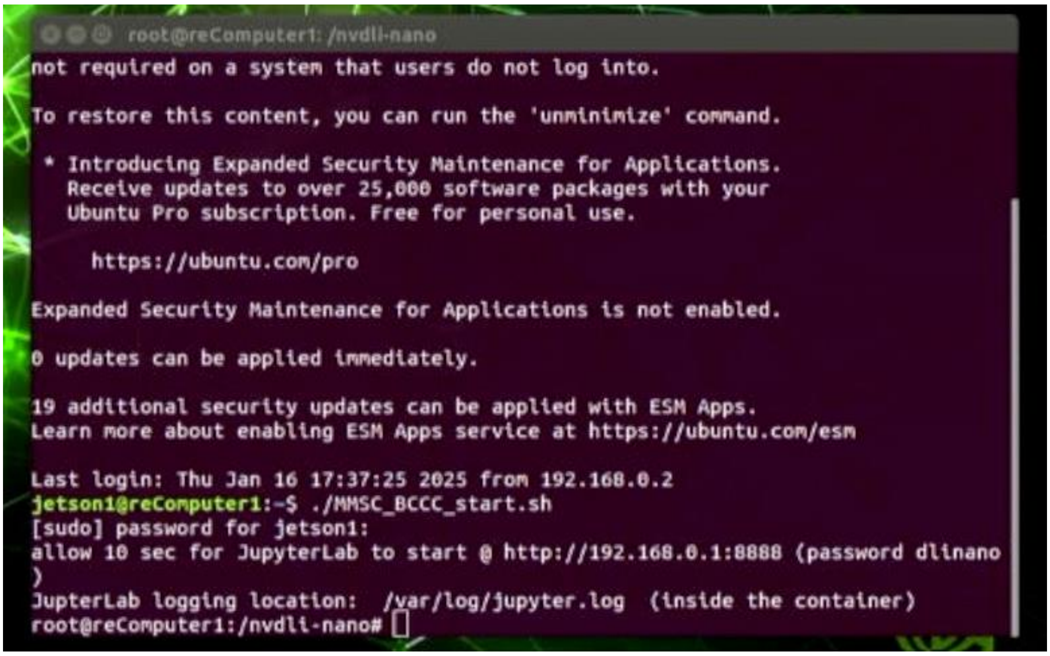
because that was the last command we used to leave the system on shutting down.

We press up again and we get;

```
jetson1@reComputer1:~ ./MMSC_BCCC_start.sh
```

this is a shell script that starts the Machine Learning environment on reComputer1.

the password is again `jnano23`



The docker environment that launches is for the machine learning code that is written in **Python**. A discussion of the code used is provided in the guide **03 Investigation of the Code** available on the website.

The docker environment is provided as part of the NVIDIA Deep Learning Institute's course, and it starts a **Jupiter lab server** at the IP address

`http://192.168.0.1:8888`

with a password for access

`dlinano`

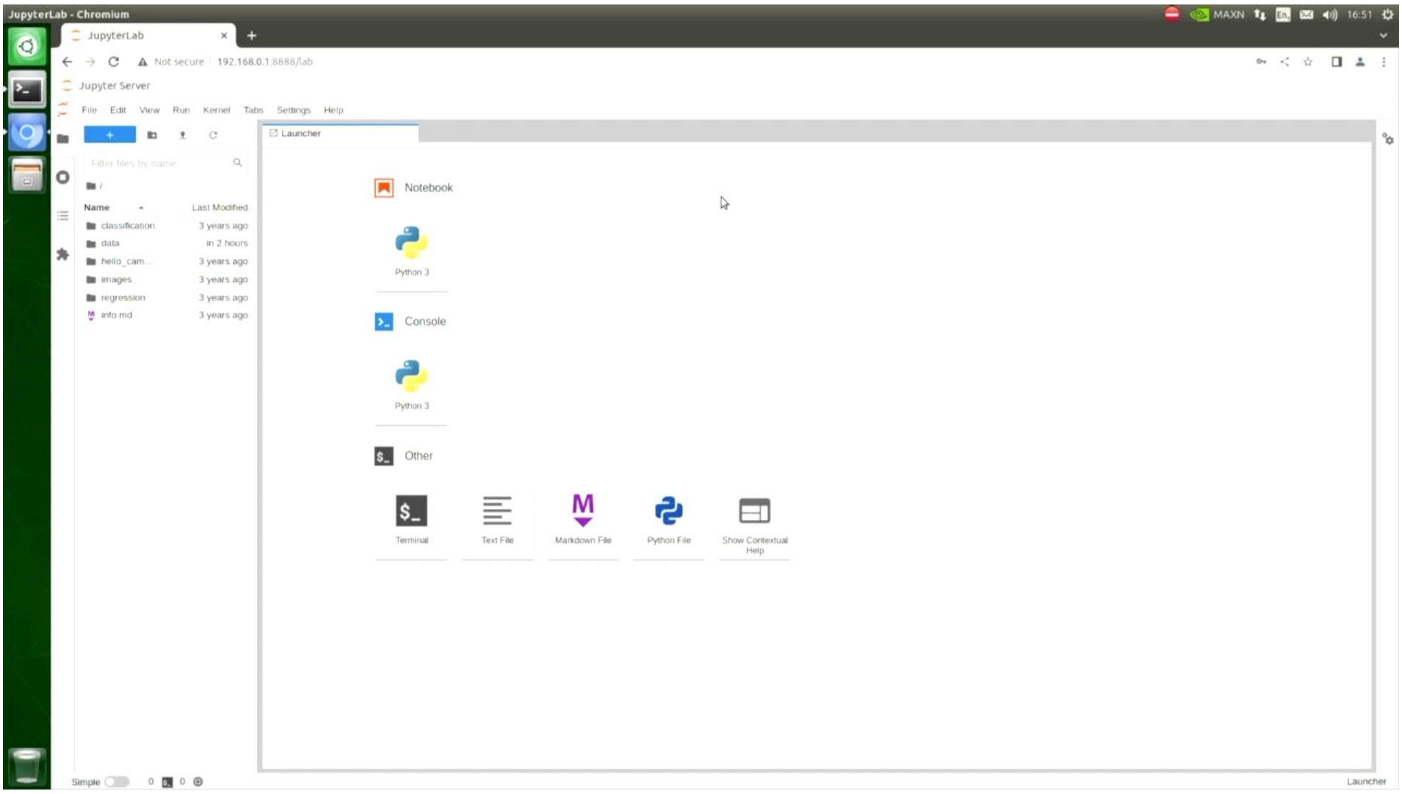
We leave the terminal running so **reComputer1** maintains the docker environment, and we now access that docker environment through the **Jupiter lab Server**.

We double click the chromium web browser which launches in full screen.

The shortcut to the **Jupyter lab Server** will take us to the login page with the password

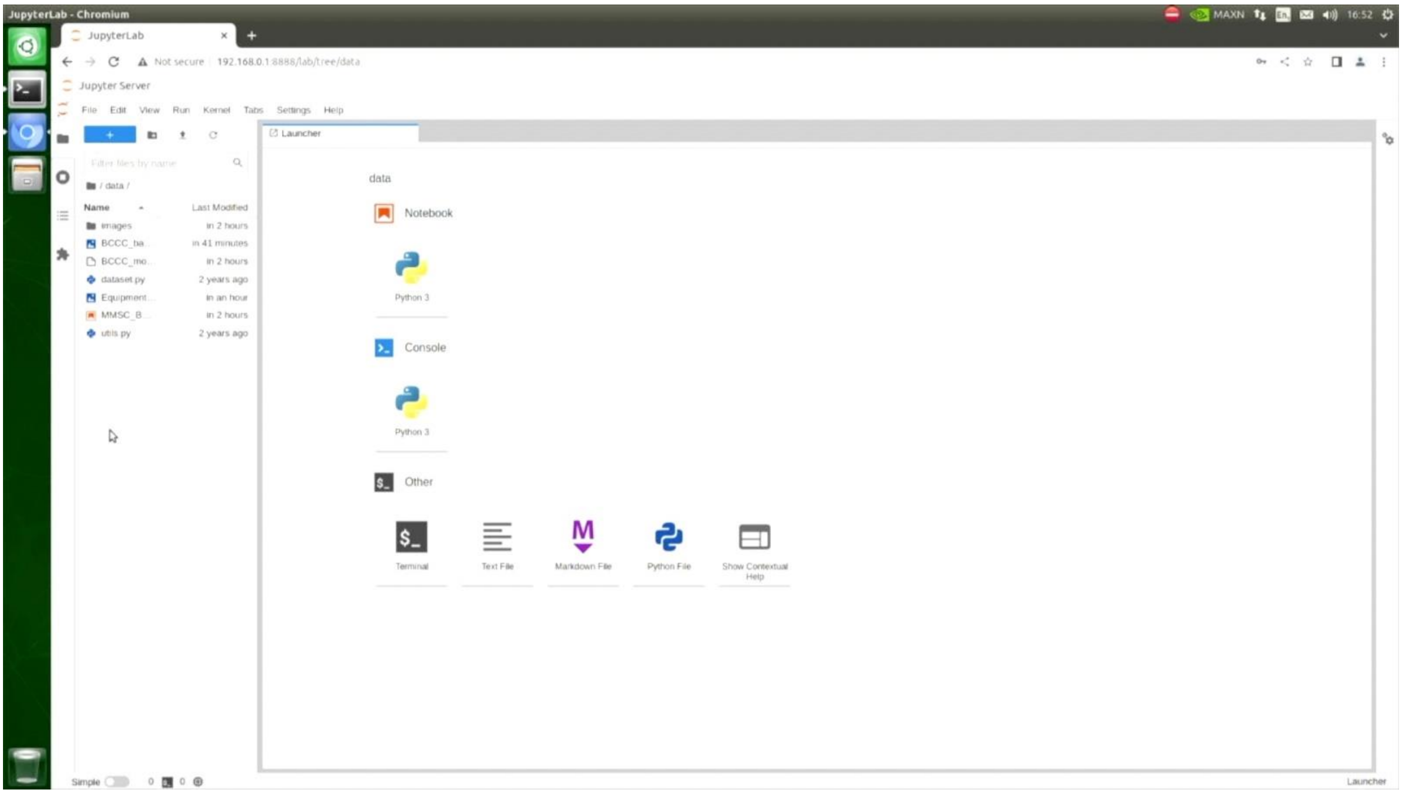
`dlinano`

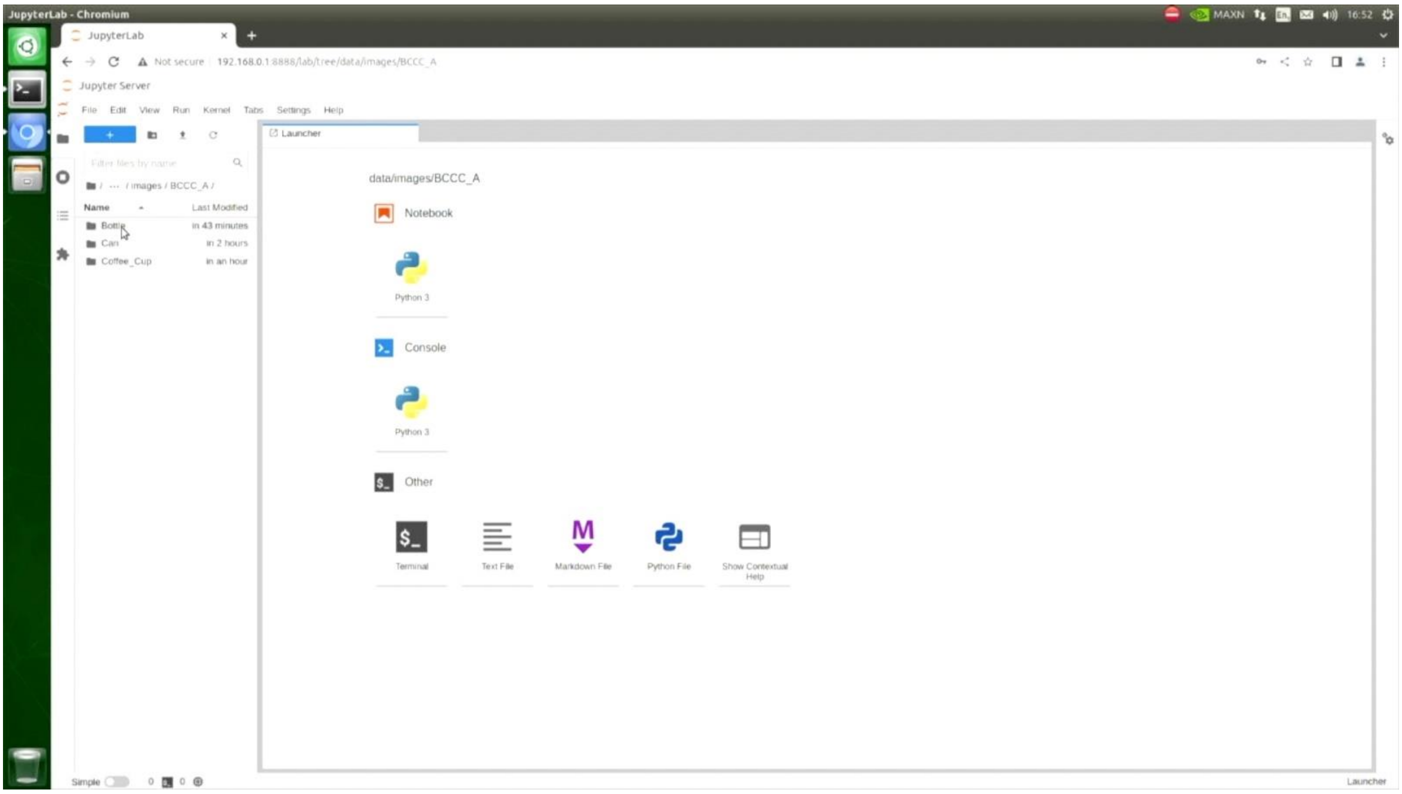
The **Jupyter** environment is running on **reComputer1** with **reComputer2** providing the graphics display and web interface to the headless python environment. When using computing platforms with limited resources it is common to have multiple units and dedicate one task to each unit. The GPU on the 2GB Jetson Nano platform has enough memory and compute power to drive the graphical display or the machine learning task, but not both. By pairing multiple units together both tasks can be completed at the same time. The key is managing the communication and timing between the different components and communicating only the limited information that is necessary. The **Jupyter Server** on **reComputer1** sends only small text based **html** descriptions of how to draw the graphics, which are quick to send, with the web browser on **reComputer2** doing the hard work of interpreting those instructions and drawing the interface. The large amount of data which the webcam generates, and the hard work of the machine learning processing, is handled by **reComputer1**, so that the **reComputer2** can concentrate on just the creation of the visual display.



The files contained in the docker are those from the **DLI** course and are renewed every time the docker starts.

Our project is found in **data**, which is an environment that is stored outside of the docker and remains in place even when the system is shutdown. Further details of this architecture can be understood from the detailed technical files found in this project's **github** arxive, accessible from the website.





Inside **data** is another folder, **images,** which contains **BCCC_A**, which contains 50 examples of each of the categories of objects. These are our training data set. There are named folders with example images of the **bottle**, the **can** and the **coffee_cup**.

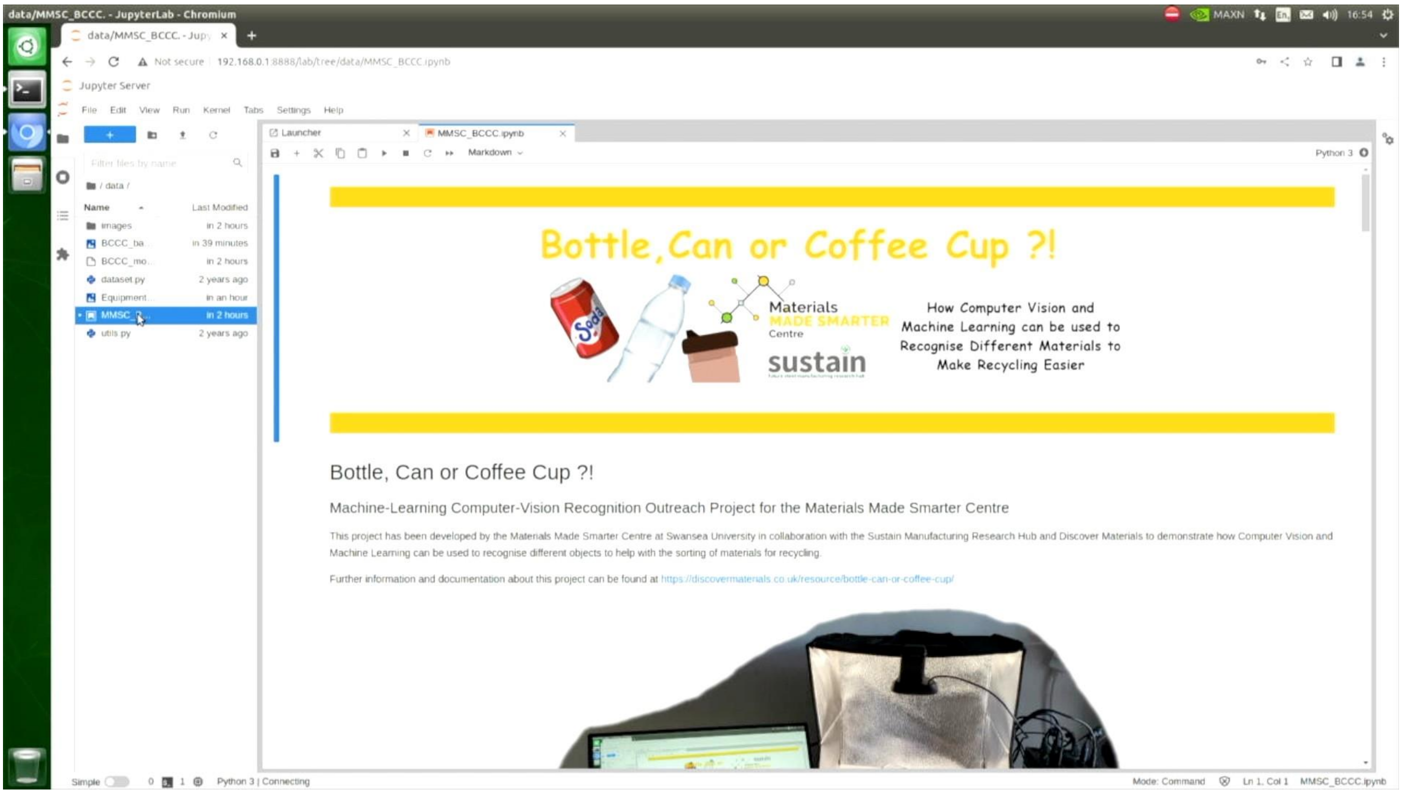
This is the training data set that is already stored on the machine.

It is stored in a folder **BCCC_A**. In the guide 04 Improving the Performance for New Objects (available on the website) it is possible to see how we can create a B or a C dataset, if we want to experiment with alternative images of new examples of the objects.

In general, the training data set is a picture of each object at many different orientations. Thumbnails of all the **BCCC_A** training images are presented at the end of this guide.

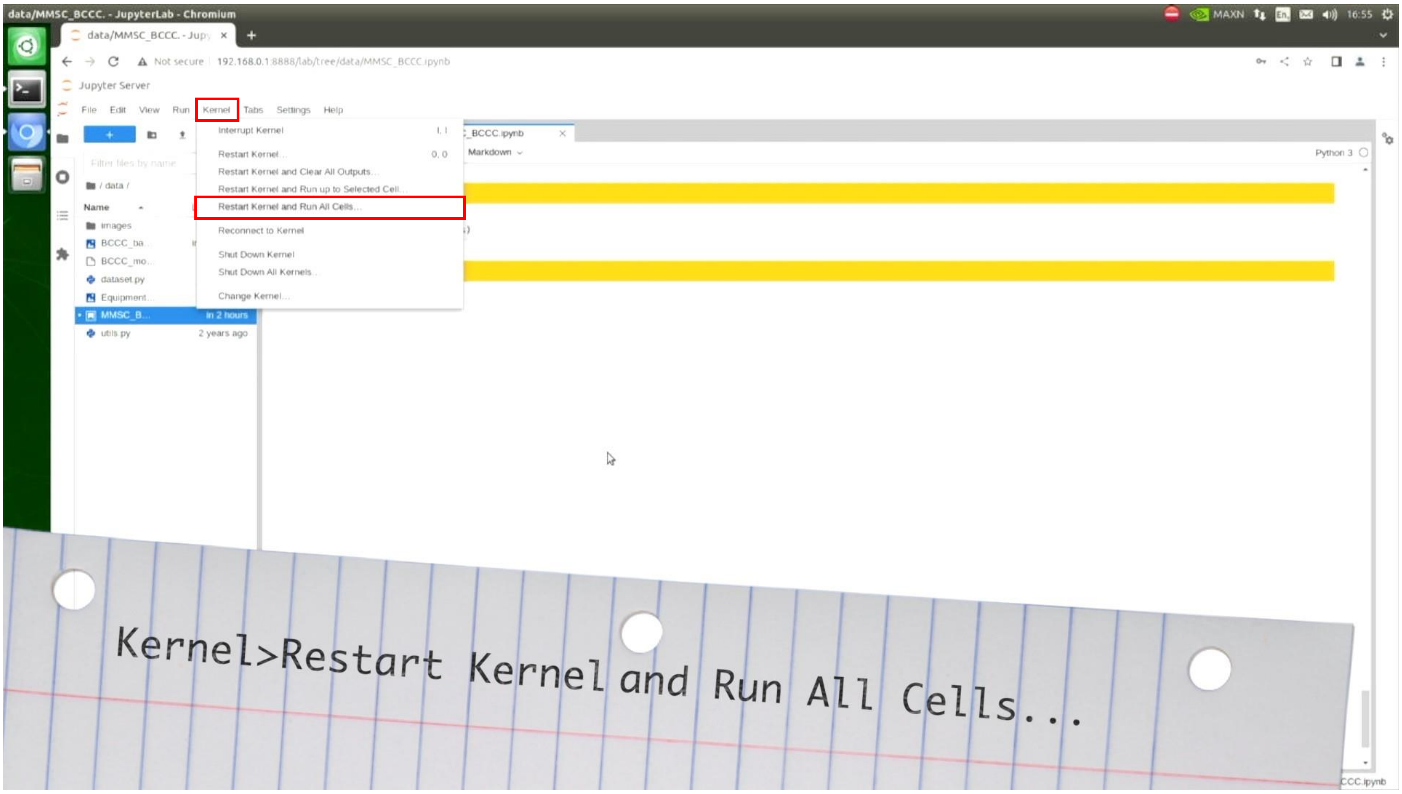
The **utils.py** code and the **dataset.py** code are libraries that we need in the system.

The **BCCC_banner** is the image at the top of the code, **Experimental_setup** is the photograph of the equipment.



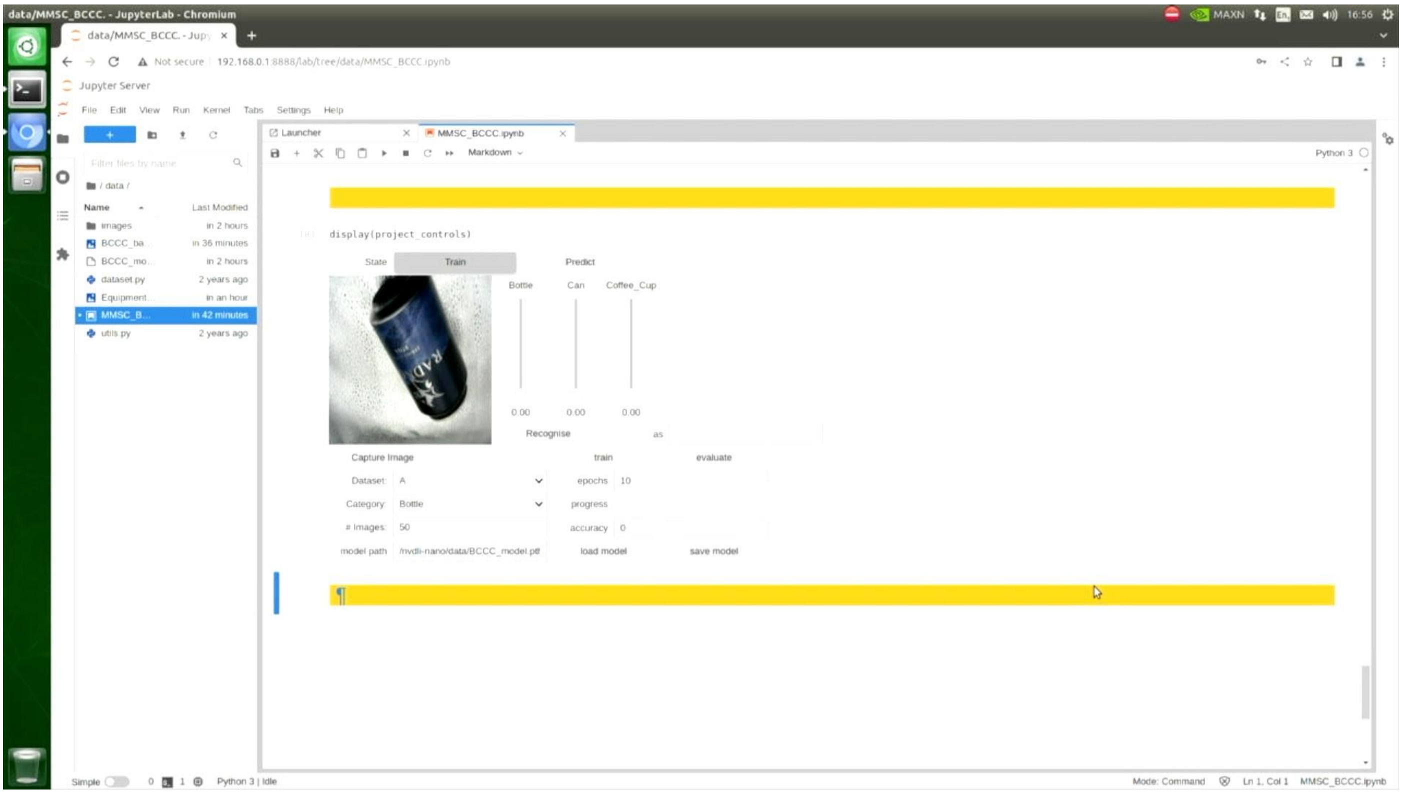
The code itself is **MMSC_BCCC.ipynb**. Double-click to open.

A detailed description of the code is provided in the guide the guide **03 Investigating the Code** available on the website.



To get the system up and running and be able to operate the identification, go to **Kernel>Restart Kernel and Run All Cells…** and click on **Restart** when it appears.

It takes approximately 50 seconds for all the code to run and the system to get up and running.



The system provides this interface, which has a live view of our object inside the photographic cube. A guide on how to use the interface to identify objects is provided in the guide **02 How to Use the Project Controls to Identify Objects** available on the website.

See you there.

./data/images/BCCC_A/Bottle/


0e51f56e-d430-11ef-9eca-48b02d9b1de8


1c4c3b2a-d430-11ef-9eca-48b02d9b1de8


02fdf0f4-d440-11ef-ad7d-48b02d9b1de8


2c5d7042-d430-11ef-9eca-48b02d9b1de8


2f018d06-d430-11ef-9eca-48b02d9b1de8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32c15034-d430-11ef-9eca-48b02d9b1de8


093ed168-d440-11ef-ad7d-48b02d9b1de8


204fe1ae-d430-11ef-9eca-48b02d9b1de8


230ff56e-d430-11ef-9eca-48b02d9b1de8


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a28e7276-d42f-11ef-9eca-48b02d9b1de8


a743f25a-d42f-11ef-9eca-48b02d9b1de8


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bc6d9f0a-d42f-11ef-9eca-48b02d9b1de8


bf7bf19c-d42f-11ef-9eca-48b02d9b1de8


c2a84faa-d42f-11ef-9eca-48b02d9b1de8


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./data/images/BCCC_A/Can/

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./data/images/BCCC_A/Coffee_Cup

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