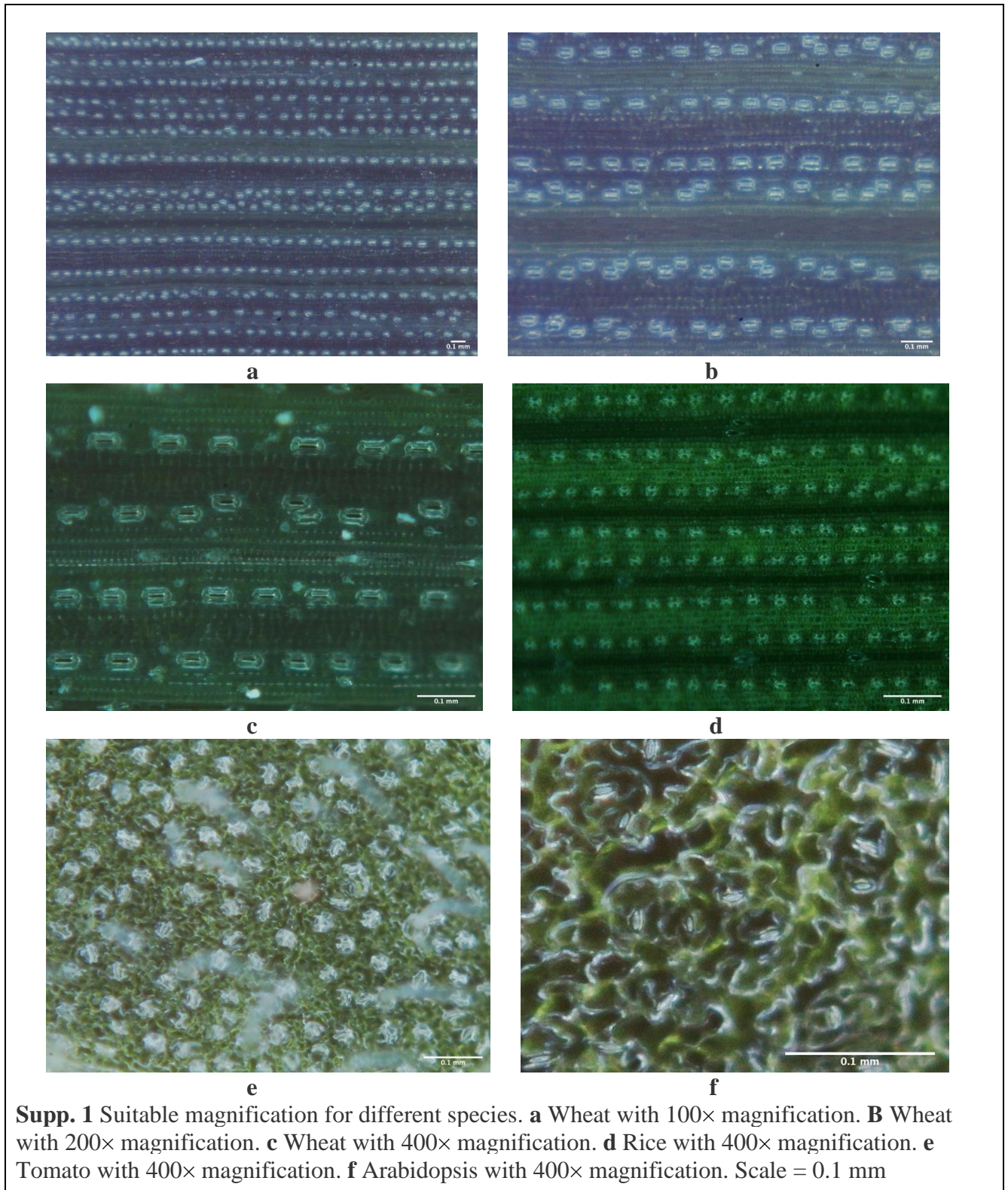
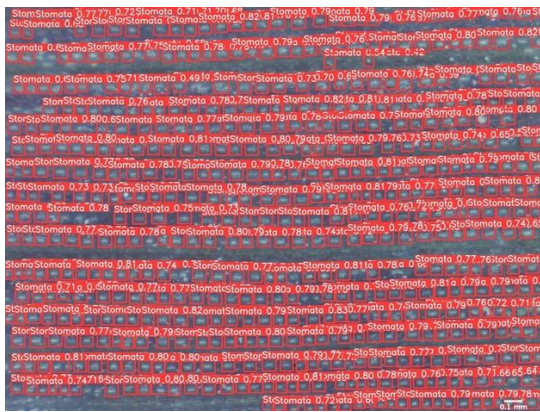


1 **Supplementary figures**

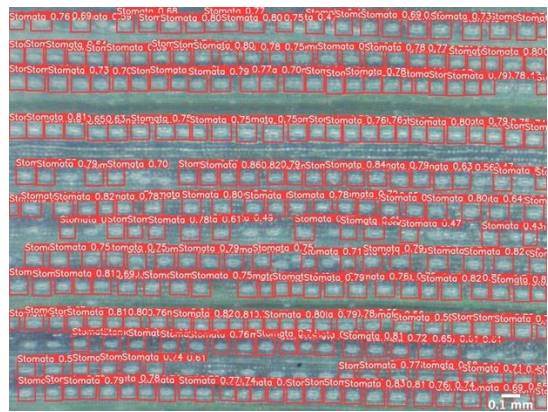
2



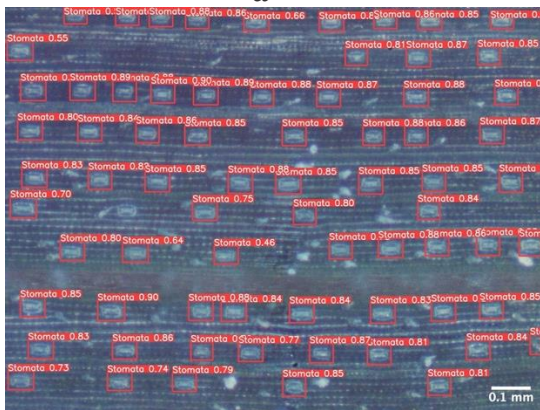
3
4
5



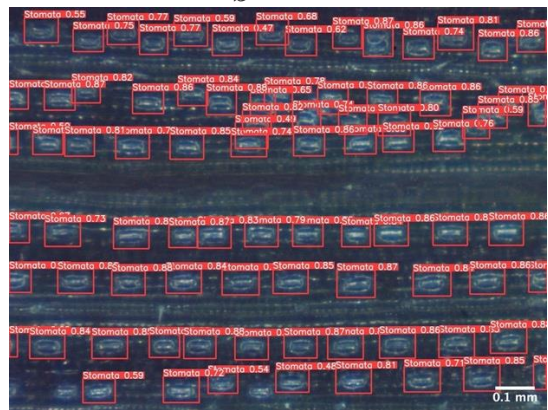
a



b



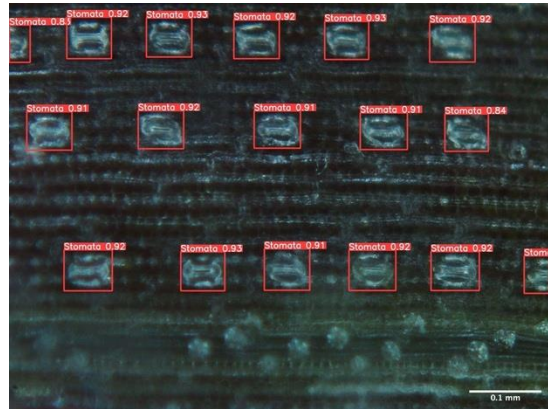
c



d



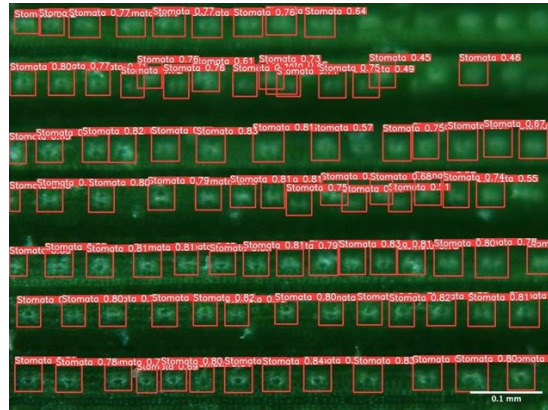
e



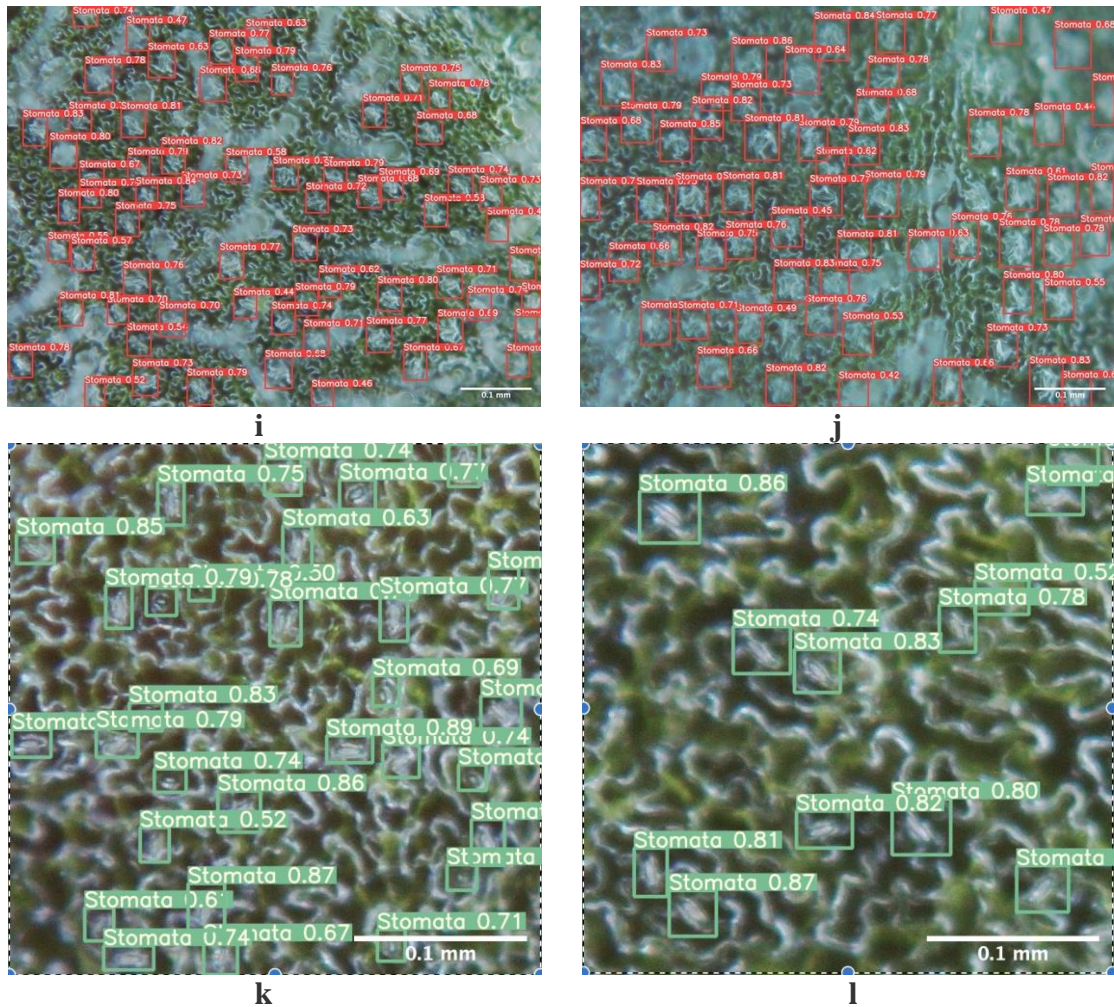
f



g



h



Supp. 2 Stomata detection models identify the differences in stomata size within the same data set. **a** 100x wheat smallest stomata trait. **b** 100x wheat largest stomata trait. **c** 200x wheat smallest stomata trait. **d** 200x wheat largest stomata trait. **e** 400x wheat smallest stomata trait. **f** 400x wheat largest stomata trait. **g** 400x Rice smallest stomata trait. **h** 400x Rice largest stomata trait. **i** 400x Tomato smallest stomata trait. **j** Tomato largest stomata trait. **k** 400x Arabidopsis smallest stomata trait. **l** Arabidopsis biggest stomata trait. Scale bar = 0.1 mm

6

7 **Supp. 3** Link to Stomata detection model Google Colab

8 <https://drive.google.com/drive/folders/1MX->

9 <PBICtKsBIjkJSN9PQQf3gfAVX4mNZ?usp=sharing>

10

11

12

13 **USER GUIDE**

14 **Rapid non-destructive method to phenotype stomatal traits**

15 Phetdalaphone Pathoumthong¹, Zhen Zhang², Stuart Roy¹, Abdeljalil El Habti^{1*}

16 ¹School of Agriculture, Food and Wine, The University of Adelaide, Urrbrae 5064, Australia

17 ²Australian Institute for Machine Learning, The University of Adelaide, Adelaide 5000,
18 Australia

19 * Corresponding author: abdeljalil.elhabti@adelaide.edu.au

20

21 It is important to have good quality images that allow the model to recognise stomata.

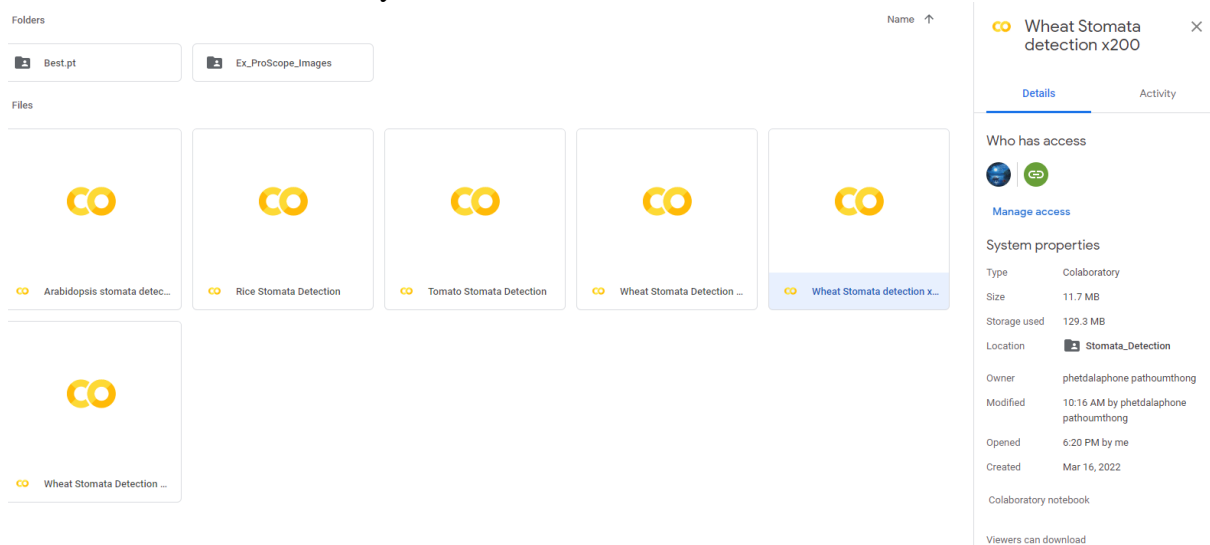
22

23

24 Click on the link [https://drive.google.com/drive/folders/1MX-](https://drive.google.com/drive/folders/1MX-PBICtKsBIjkJSN9PQQf3gfAVX4mNZ?usp=sharing)

25 [PBICtKsBIjkJSN9PQQf3gfAVX4mNZ?usp=sharing](https://drive.google.com/drive/folders/1MX-PBICtKsBIjkJSN9PQQf3gfAVX4mNZ?usp=sharing). If you can't open it using Chrome,
26 open in Microsoft Edge

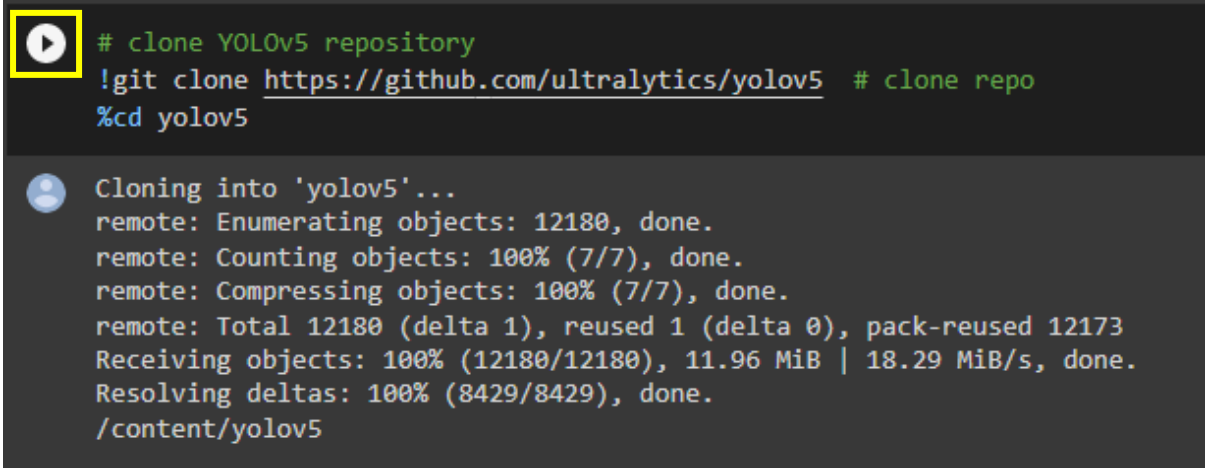
27 Copy Collab folder “Wheat Stomata detection x200” on your Google Drive so you don't
28 have to look for the link every time



29

30

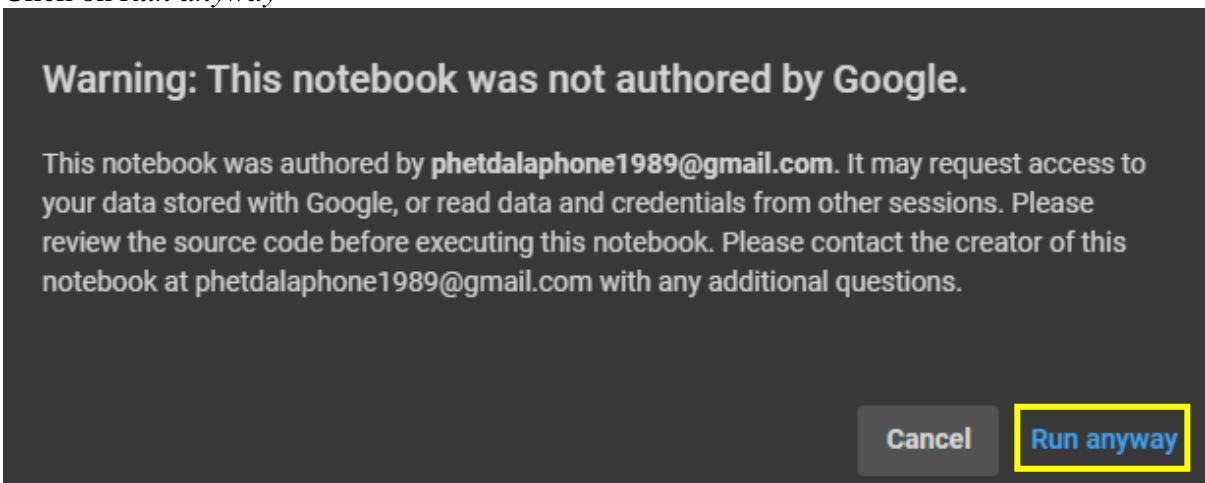
31 Click on the start button of the first script



```
# clone YOLOv5 repository
!git clone https://github.com/ultralytics/yolov5 # clone repo
%cd yolov5
```

Cloning into 'yolov5'...
remote: Enumerating objects: 12180, done.
remote: Counting objects: 100% (7/7), done.
remote: Compressing objects: 100% (7/7), done.
remote: Total 12180 (delta 1), reused 1 (delta 0), pack-reused 12173
Receiving objects: 100% (12180/12180), 11.96 MiB | 18.29 MiB/s, done.
Resolving deltas: 100% (8429/8429), done.
/content/yolov5

32
33 Click on *Run anyway*

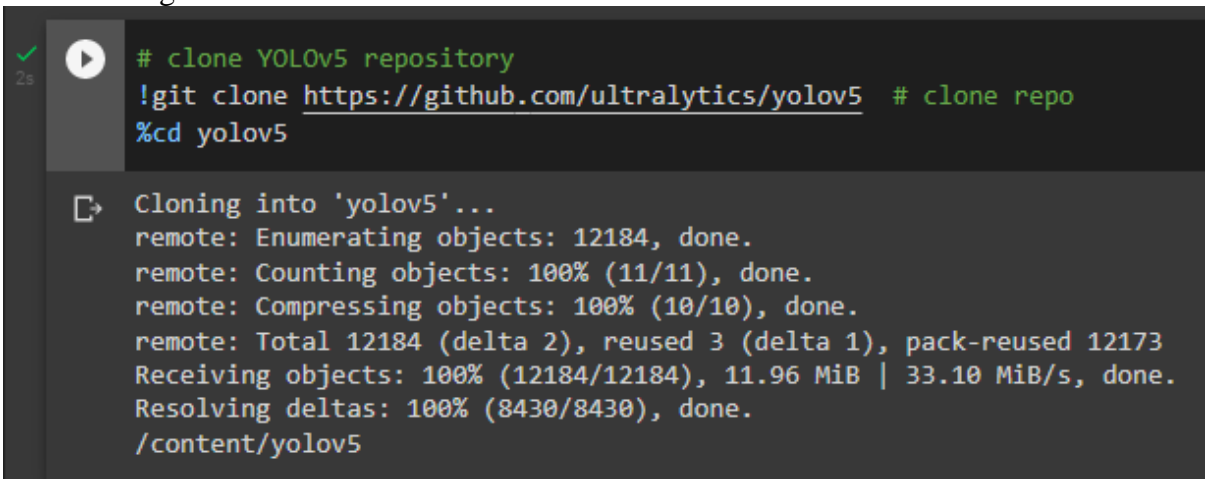


Warning: This notebook was not authored by Google.

This notebook was authored by phetdalaphone1989@gmail.com. It may request access to your data stored with Google, or read data and credentials from other sessions. Please review the source code before executing this notebook. Please contact the creator of this notebook at phetdalaphone1989@gmail.com with any additional questions.

Cancel Run anyway

34
35 You should get



```
# clone YOLOv5 repository
!git clone https://github.com/ultralytics/yolov5 # clone repo
%cd yolov5
```

Cloning into 'yolov5'...
remote: Enumerating objects: 12184, done.
remote: Counting objects: 100% (11/11), done.
remote: Compressing objects: 100% (10/10), done.
remote: Total 12184 (delta 2), reused 3 (delta 1), pack-reused 12173
Receiving objects: 100% (12184/12184), 11.96 MiB | 33.10 MiB/s, done.
Resolving deltas: 100% (8430/8430), done.
/content/yolov5

36

37 Click on the second script

```
# install dependencies as necessary
!pip install -qr requirements.txt # install dependencies (ignore errors)
import torch

from IPython.display import Image, clear_output # to display images
from utils.google_utils import gdrive_download # to download models/datasets

# clear_output()
print('Setup complete. Using torch %s %s' % (torch.__version__, torch.cuda.get_
```

38
39 You should get

```
# install dependencies as necessary
!pip install -qr requirements.txt # install dependencies (ignore errors)
import torch

from IPython.display import Image, clear_output # to display images
from utils.google_utils import gdrive_download # to download models/datasets

# clear_output()
print('Setup complete. Using torch %s %s' % (torch.__version__, torch.cuda.get_device_p
```

596 kB 29.0 MB/s

```
ModuleNotFoundError                               Traceback (most recent call last)
<ipython-input-2-d9ae8b9a3cb3> in <module>()
    4
    5 from IPython.display import Image, clear_output # to display images
----> 6 from utils.google_utils import gdrive_download # to download models/datasets
    7
    8 # clear_output()

ModuleNotFoundError: No module named 'utils.google_utils'
```

NOTE: If your import is failing due to a missing package, you can manually install dependencies using either !pip or !apt.

To view examples of installing some common dependencies, click the "Open Examples" button below.

[OPEN EXAMPLES](#) [SEARCH STACK OVERFLOW](#)

40
41 Ignore the error message

42 Click on the third script

```
▶ # Download google drive to google colab
from google.colab import drive
drive.mount('/content/drive')
```

43
44 Connect to Google Drive

Permit this notebook to access your Google Drive files?

This notebook is requesting access to your Google Drive files. Granting access to Google Drive will permit code executed in the notebook to modify files in your Google Drive. Make sure to review notebook code prior to allowing this access.

No thanks **Connect to Google Drive**

45
46 Choose the account that will contain images
47 Sign in
48 Allow

Make sure you trust Google Drive for desktop

You may be sharing sensitive info with this site or app. You can always see or remove access in your [Google Account](#).

Learn how Google helps you [share data safely](#).

See Google Drive for desktop's [Privacy Policy](#) and [Terms of Service](#).

Cancel **Allow**

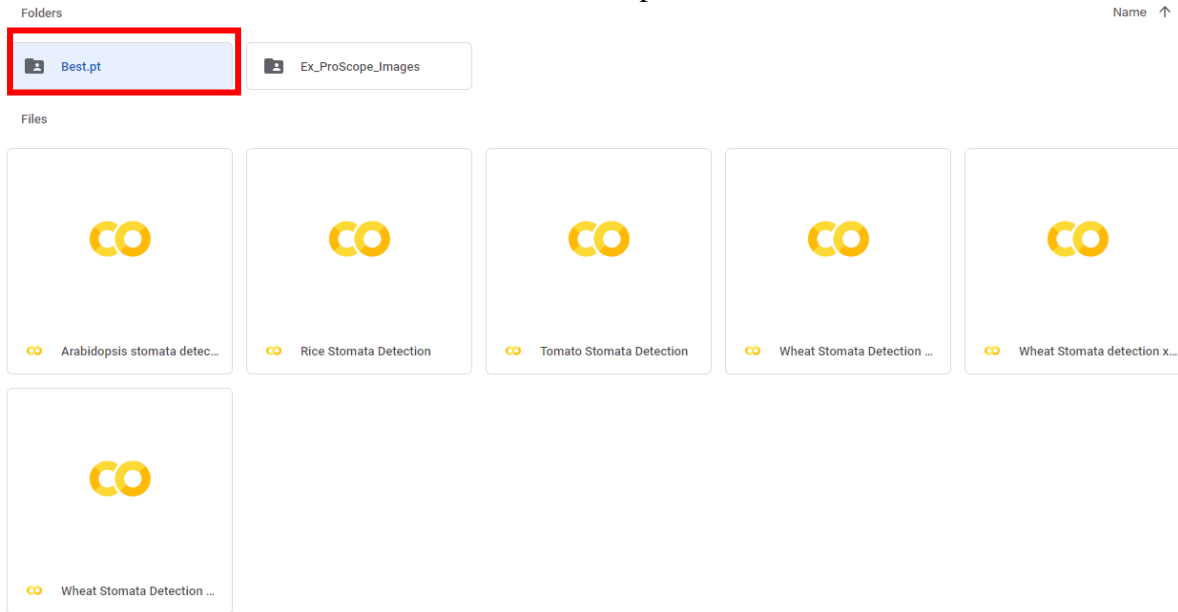
49
50 You should get

```
✓ 3m ▶ # Download google drive to google colab
from google.colab import drive
drive.mount('/content/drive')

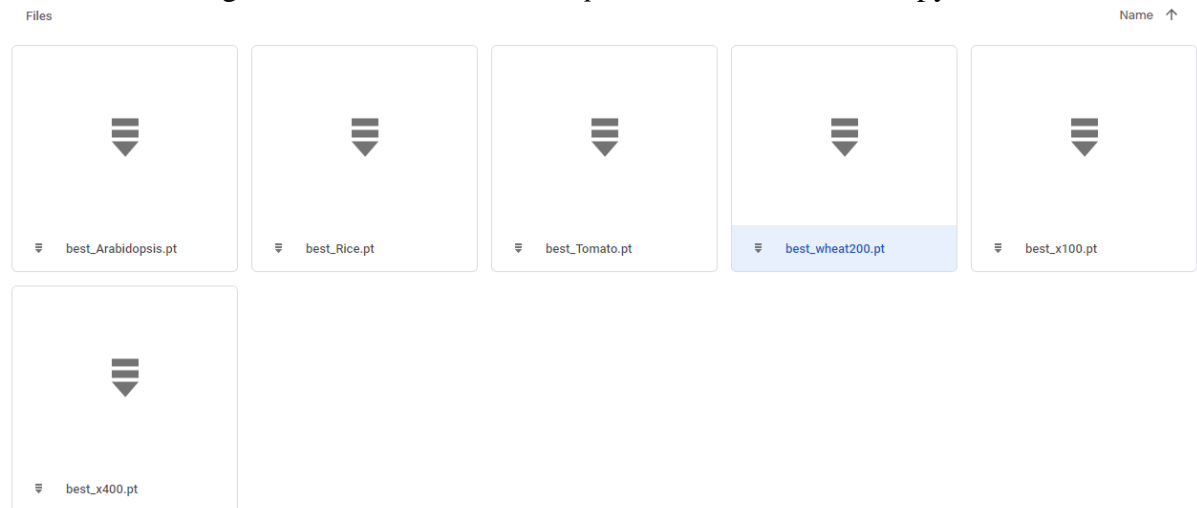
Mounted at /content/drive
```

51

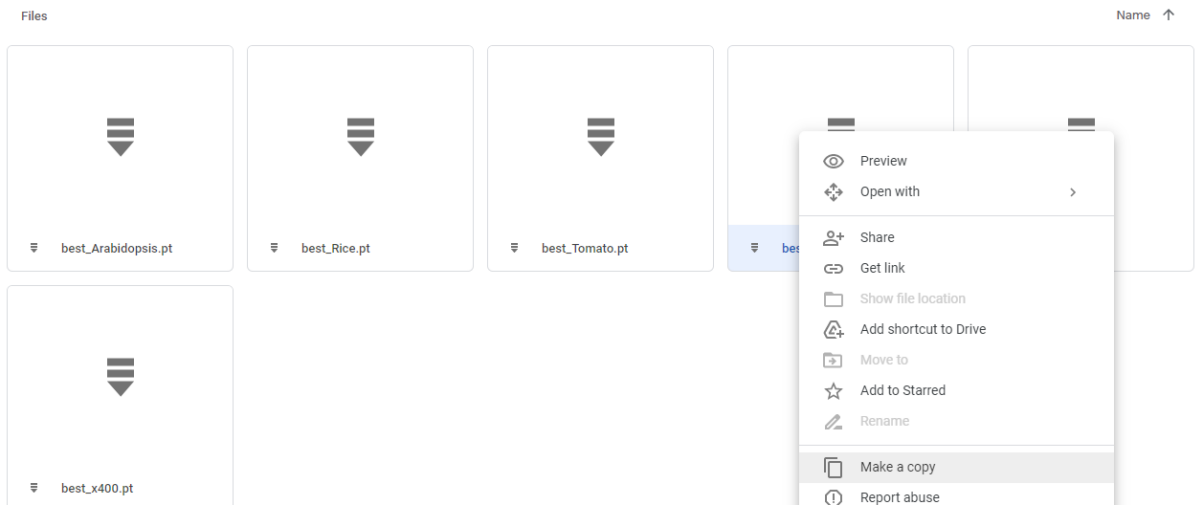
52 Before clicking on the fourth script
53 Copy machine learning model to your Google Drive.
54 In our folder, double click on Best.pt



55
56 Right click on *best_Wheat200.pt* and click on Make a copy.



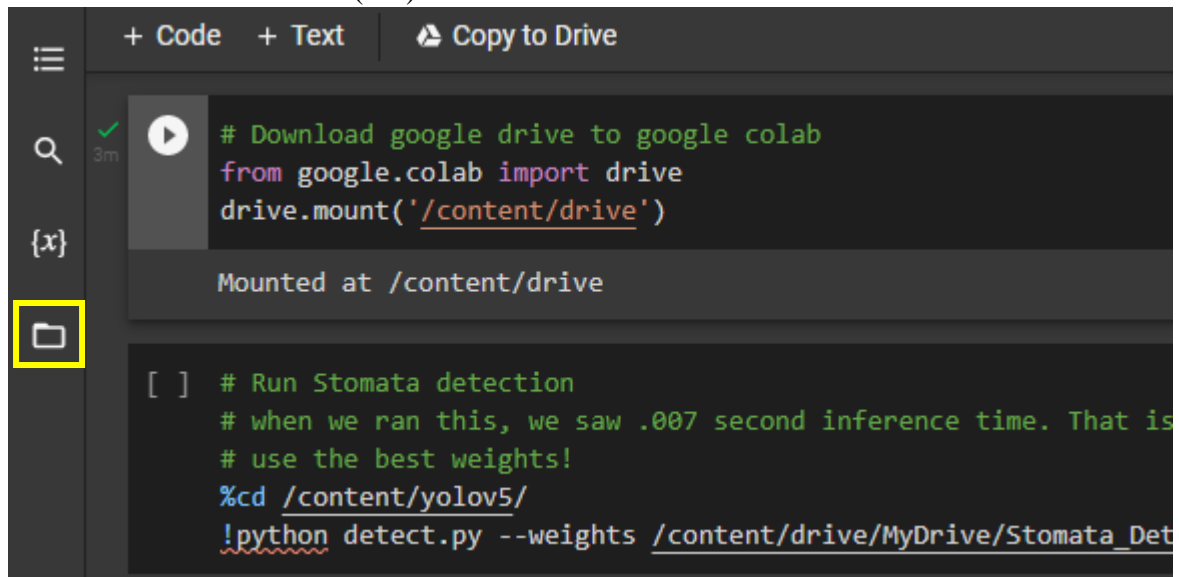
57



58 This folder will now appear in your Google Drive. No need to paste the file in your Google
59 Drive.
60

61
62 Create new folder in your Google Drive and transfer images you would like to
63 analyse

64
65 Click on folder tab (left)

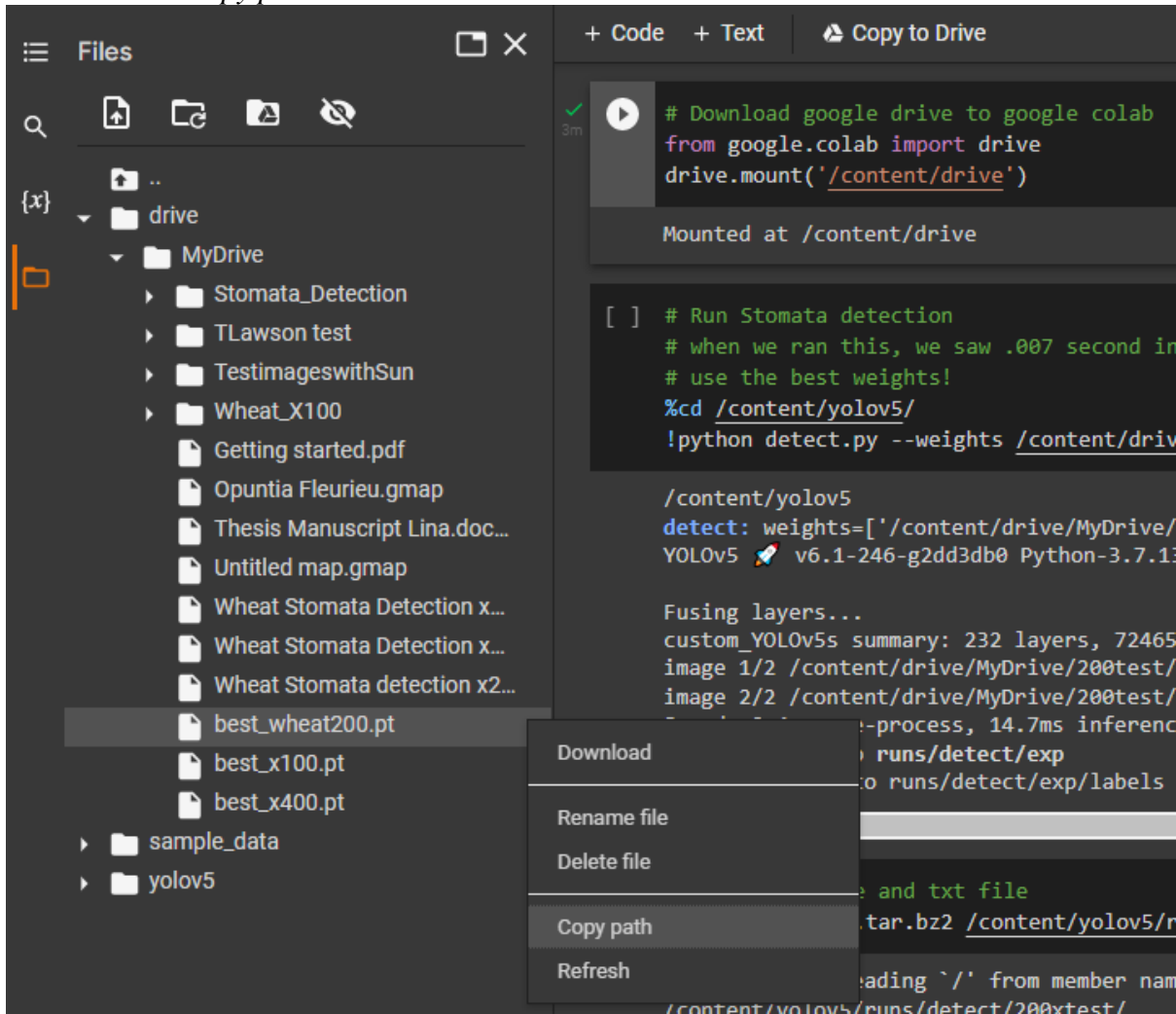


The screenshot shows the Google Colab interface. At the top, there are tabs for '+ Code', '+ Text', and 'Copy to Drive'. Below the tabs, there is a search icon, a play button with a '3m' timer, and a close button '{x}'. The main area displays code execution output. The first output block shows the code: `# Download google drive to google colab`, `from google.colab import drive`, and `drive.mount('/content/drive')`. Below the code, it says 'Mounted at /content/drive'. The second output block shows the code: `[] # Run Stomata detection`, `# when we ran this, we saw .007 second inference time. That is`, `# use the best weights!`, `%cd /content/yolov5/`, and `!python detect.py --weights /content/drive/MyDrive/Stomata_Det`. On the left side of the interface, there is a folder icon highlighted with a yellow box.

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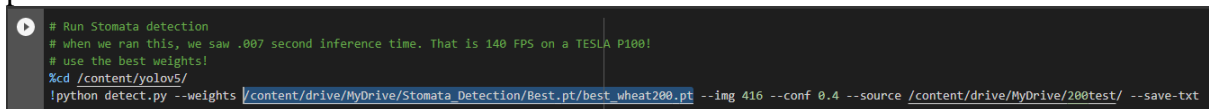
69
70
71

Specify model location
Click on *drive – MyDrive* – click on three dots next to *best_wheat200.pt* –
copy path



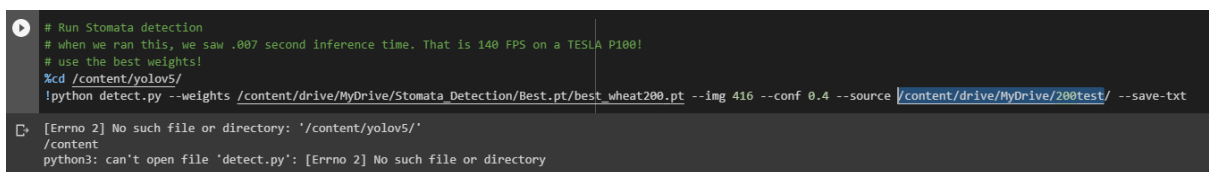
72
73
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75

Replace
“/content/drive/MyDrive/Stomata_Detection/Best.pt/best_wheat200.pt” by pasting the copied path



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79
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81

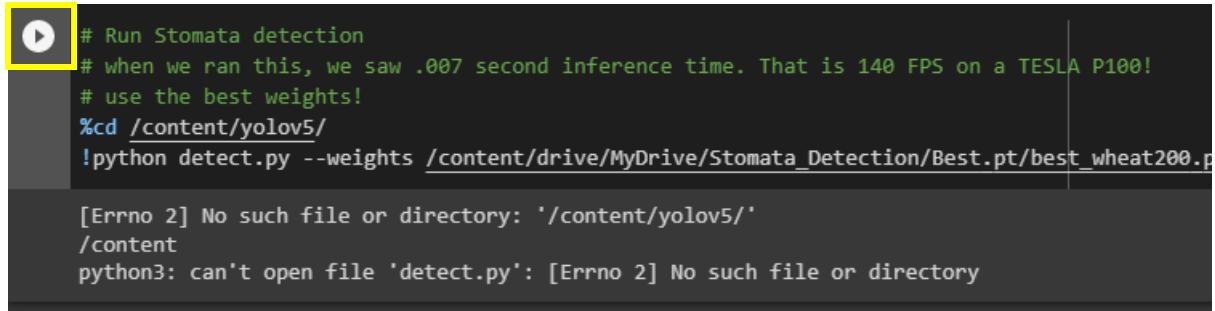
Specify image set location
Click on *drive – MyDrive* – click on three dots next to the image folder – *copy path*
path
Paste after source. Add \ when there is a space, add / at the end before save txt



82
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85

For example, if the file path is
“/content/drive/MyDrive/TLawson test”, it will become
“/content/drive/MyDrive/TLawson\ test”

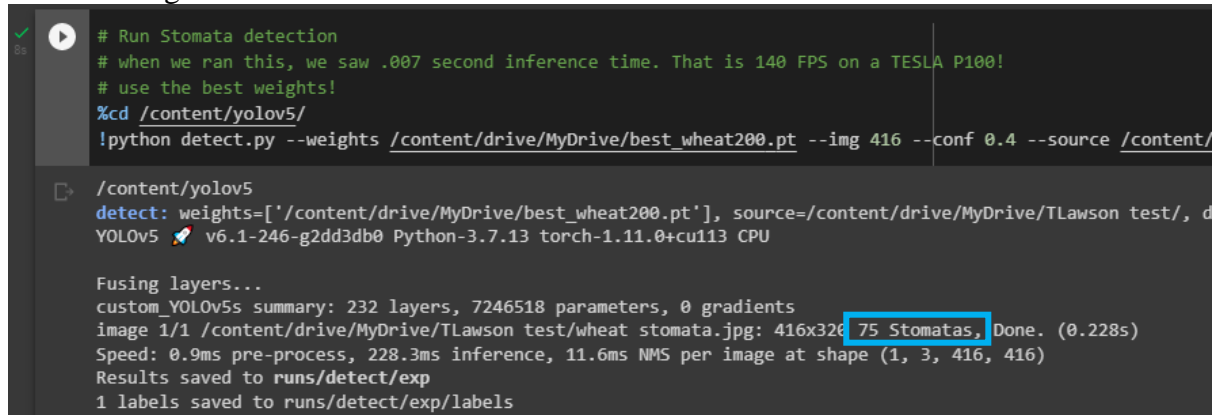
86 Click on the start button



```
# Run Stomata detection
# when we ran this, we saw .007 second inference time. That is 140 FPS on a TESLA P100!
# use the best weights!
%cd /content/yolov5/
!python detect.py --weights /content/drive/MyDrive/Stomata_Detection/Best.pt/best_wheat200.p

[Errno 2] No such file or directory: '/content/yolov5/'
/content
python3: can't open file 'detect.py': [Errno 2] No such file or directory
```

87 You should get
88



```
# Run Stomata detection
# when we ran this, we saw .007 second inference time. That is 140 FPS on a TESLA P100!
# use the best weights!
%cd /content/yolov5/
!python detect.py --weights /content/drive/MyDrive/best_wheat200.pt --img 416 --conf 0.4 --source /content/

/content/yolov5
detect: weights=['/content/drive/MyDrive/best_wheat200.pt'], source=/content/drive/MyDrive/TLawson test/, d
YOLOv5 🚀 v6.1-246-g2dd3db0 Python-3.7.13 torch-1.11.0+cu113 CPU

Fusing layers...
custom_YOLOv5s summary: 232 layers, 7246518 parameters, 0 gradients
image 1/1 /content/drive/MyDrive/TLawson test/wheat stomata.jpg: 416x320 75 Stomatas, Done. (0.228s)
Speed: 0.9ms pre-process, 228.3ms inference, 11.6ms NMS per image at shape (1, 3, 416, 416)
Results saved to runs/detect/exp
1 labels saved to runs/detect/exp/labels
```

89 The number of stomata for each image is highlighted in blue. Copy the results and paste it in
90 an Excel file.
91
92
93

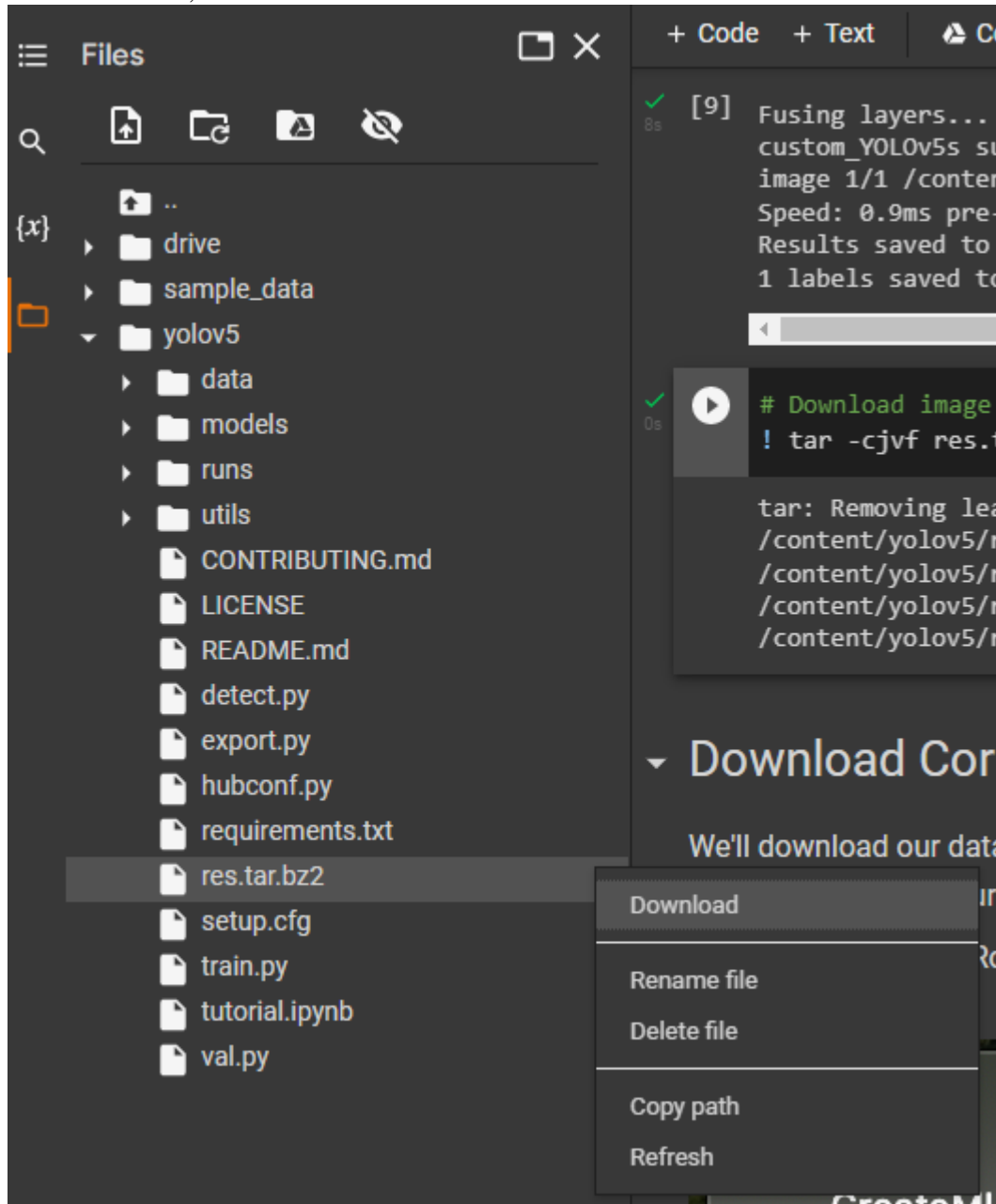
94 Click on the fifth script

```
# Download image and txt file  
! tar -cjvf res.tar.bz2 /content/yolov5/runs/detect/*
```

95
96 Go to folder at the left

97 Yolov5 – runs – detect – rename exp

98 Yolov5, three dots on res.tar.bz2 – download



99 You will find this folder in your Downloaded folder.

100 This folder contains: stomata size in a txt file, one file per image; labelled images.

102