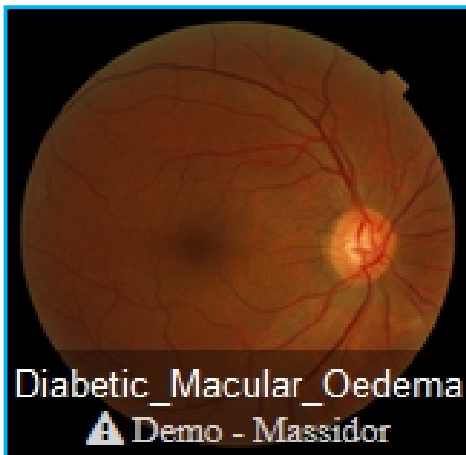


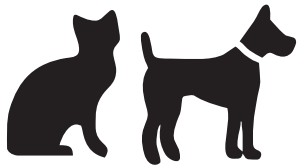
CLASSIFIER



Add new classifier

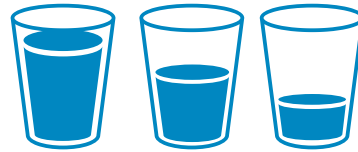
The classifier page creates and displays classifiers. Click on the demo classifier 'Diabetic Macular Oedema' to view the images for the classifier and evaluate it. To create your own classifier click on 'Add new classifier'. There's four types of classifiers to choose from. One is the **grading classifier**, the **labeled classifier**, the **multi class classifier** and **YOLO**. When deciding on which classifier to use, ask the following question are you classifying by type, amount or locality? For example classifying whether an image is a dog or cat is classifying by type and is known as classifying by class. Classifying by amount is classifying on how full a glass of water is, or the level of haemoglobin in a patient's face or retinal grade. This is known as classifying by grade. Classifying about where an object is in an image is by locality. When classifying by locality use **YOLO**. When classifying by class use the **multiclass classifier**. When classifying by grade choose between the **grading classifier** or **labeled classifier**. The last two classifiers classify by grade but when images are in directories sorted into grades, for example a folder of images with retinal grade 0, another folder with retinal grade 1 and other with retinal grade 2 then use the **grading classifier**. If on the other hand all the images are mixed in one folder and there is a CSV file with the retinal grades from 0, 1,2 for each image then use the **labeled classifier**. The following diagram illustrates how to choose the type of classifier to use:

CHOOSING THE TYPE OF CLASSIFIER



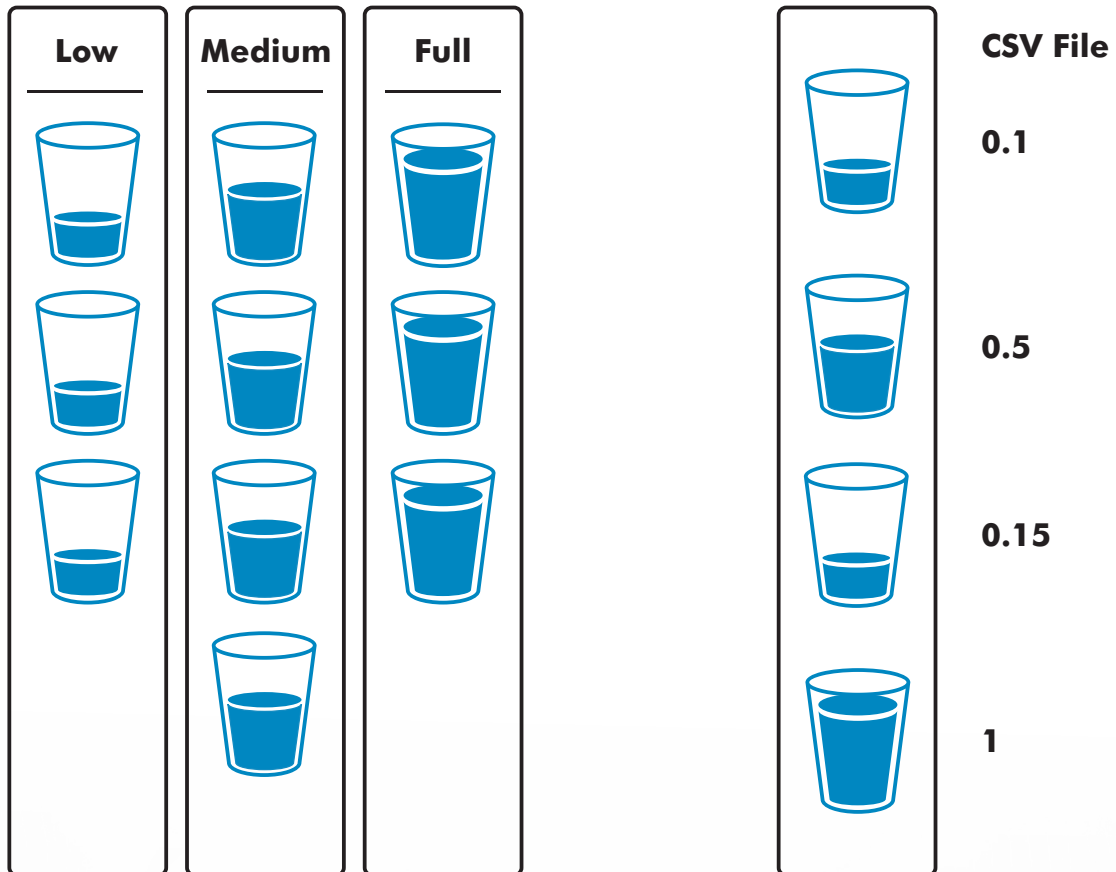
Multi Class Classifier

Classifying by type such as a dog or cat, type of melanoma



Level Classifier

Classifying by amount or level such as how full a glass is or retinal grade



Grading Classifier

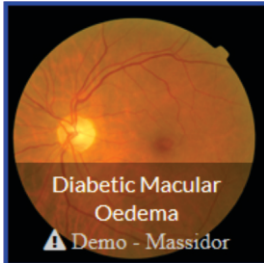
Images are in their own folders by lever. For example "low", "medium", "full".

Labelled Classifier

Images are in one folder and a CSV file includes the level

Clicking on 'Add new classifier' displays four types of classifiers at the bottom of the page. Click on the type of classifier required and enter the name of the classifier such as 'glaucoma' in the popup.

CLASSIFIER



Add new classifier

Create new classifier

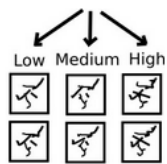
Creating a YOLO classifier
Enter name of classifier:

Continue
Cancel

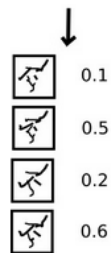
Create a new classifier by entering name of your new classifier. Click on the cla

CREATE NEW CLASSIFIER

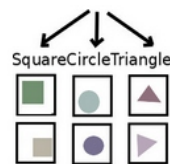
Create Grading Classifier



Create Labeled Classifier



Create Multi-class Classifier



Create YOLO Classifier



ALL CLASSIFIER



Rename Classifier

Change the name of your classifier.



Delete Classifier

Delete the classifier in its entirety.



Set Description

Sets the description of the classifier.

Description

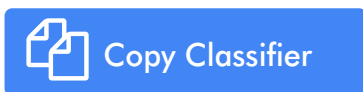
Description

Category:

Heading:

Save Description

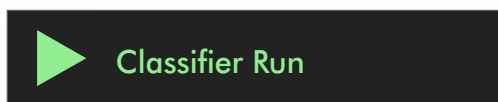
The description dialog also sets the classifiers category, such as being in the field of neurology. The heading sets heading to be displayed above a classifier on the classifier page. This is useful if the classifier page gets too cluttered. By default a classifier has no heading



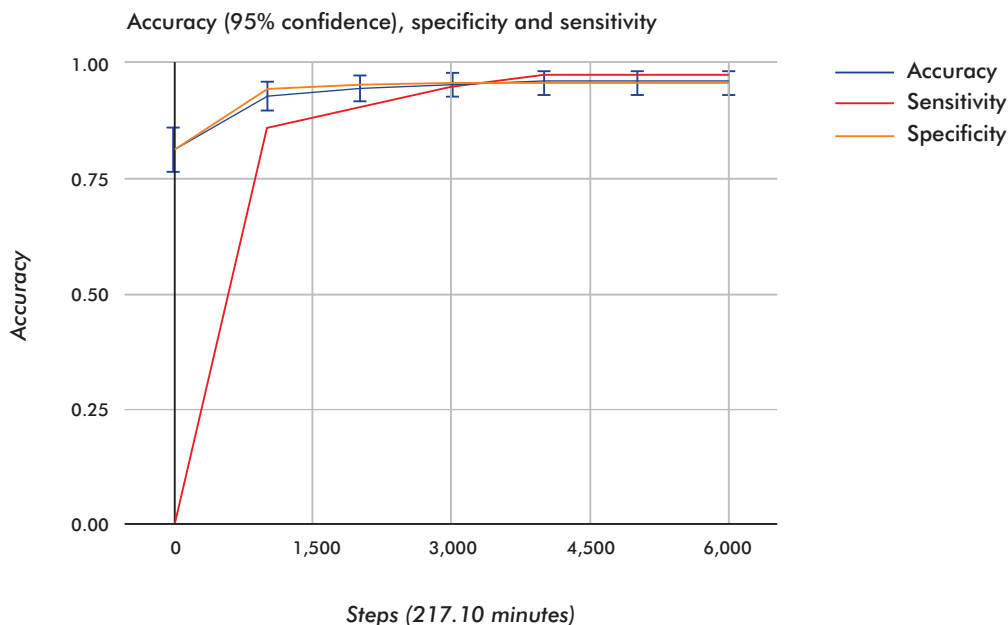
Copies a classifier in its entirety to a classifier with a different name

TRAINING YOUR CLASSIFIER

If sufficient images have been uploaded into the classifier bin(s) click on the 'Classifier Run' button to begin training. The training will be queued and an email will be sent when complete.



When training commences a graph similar to below is displayed showing the accuracy of your classifier over time. Typically training takes about half an hour.



	Step	Accuracy	Sensitivity	Specificity	Loss
1	0	0.813	-1	0.813	-1
2	1,000	0.93	0.86	0.944	0.362
3	2,000	0.945	0.905	0.953	0.486
4	3,000	0.953	0.95	0.954	0.375
5	4,000	0.957	0.974	0.954	0.398
6	5,000	0.957	0.974	0.954	0.384
7	6,000	0.957	0.974	0.954	0.337

The graph the progress of training displays accuracy, confidence of your accuracy and specificity and sensitivity of your neural network improves over time. Accuracy is calculated by training on 80% of the image dataset while leaving 20% outside of training to be used for calculating accuracy. For example if the dataset has 500 images cat images and 500 dog images, 200 of the dog and cat images will be used to test accuracy while 800 of the dog and cat images will be trained upon. The example below shows how the accuracy started off at 81% and finished at 95%. Note, that for YOLO only loss is shown.

To increase your accuracy use higher quality images. As a rule of thumb, if a human has difficulty telling if an image is a dog or a cat, the CNN will have similar difficulty.

Accuracy is calculated for grading and labeled classifiers by taking the minimum and maximum values of the grades (eg 0 and 1) and then take a half way point. If the ground truth value is less than 0.5 and the predicted value is less than 0.5 then the prediction is correct. Likewise if the ground truth is over 0.5 and the prediction is over 0.5 then it is also considered correct. The grading and labeled classifiers are both binary classifiers therefore is it is possible to also get specificity and sensitivity since we get the number of true positives, true negatives, false positives and false negatives from your test set.

In the case of multiclass it is simple in that if the ground truth is a dog and the prediction is a dog then it is considered correct.

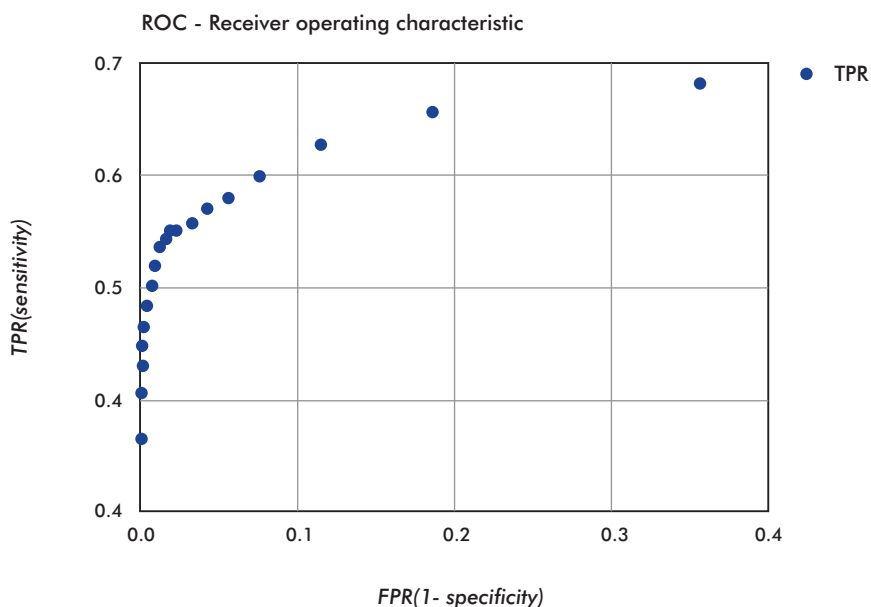
The graph showing accuracy has confidence intervals and the confidence interval is calculated with the formula:

$$\hat{p} \pm 1.96 \times \sqrt{\frac{\hat{p}(1 - \hat{p})}{n}}$$

where p is the calculated accuracy and n is the number of images in the validation set. The more images in the validation set the higher the confidence in the accuracy (eg 200 images in the validation set will give higher confidence than 100).

RECEIVER OPERATING CHARACTERISTIC

Medicmind provides ROC curves to demonstrate the diagnostic ability of a binary classifier.



RAW STATISTICS

Medicmind provides the raw predictions and ground truth for each epoch of the training. This allows the user to calculate their own statistics. Click on the 'Load RAW CSV' link at the bottom of the page listing the prediction and ground truth for every image in the test set of images. The following is the format of the CSV file generated.

Epoch	Time	File name	Prediction	Ground truth	tp	tn	fp	fn
1500	2018-01-25 16:03:38.490485	'101.jpg'	0.59447914	0.51340002	1	0	0	0
1500	2018-01-25 16:03:38.490540	'178.jpg'	0.60121161	0.5844	1	0	0	0
1500	2018-01-25 16:03:38.490595	'338.jpg'	0.65350461	0.6911	1	0	0	0
1500	2018-01-25 16:03:38.490664	'403.jpg'	0.64054883	0.63990003	1	0	0	0

EVALUATION

After training is complete it is possible to evaluate your trained neural network with new images. For example if you've trained a multiclass classifier on dogs and cats you can upload your own pictures of dogs and cats and see the result. To evaluate, click on the evaluate folder on the right:

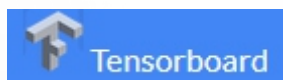


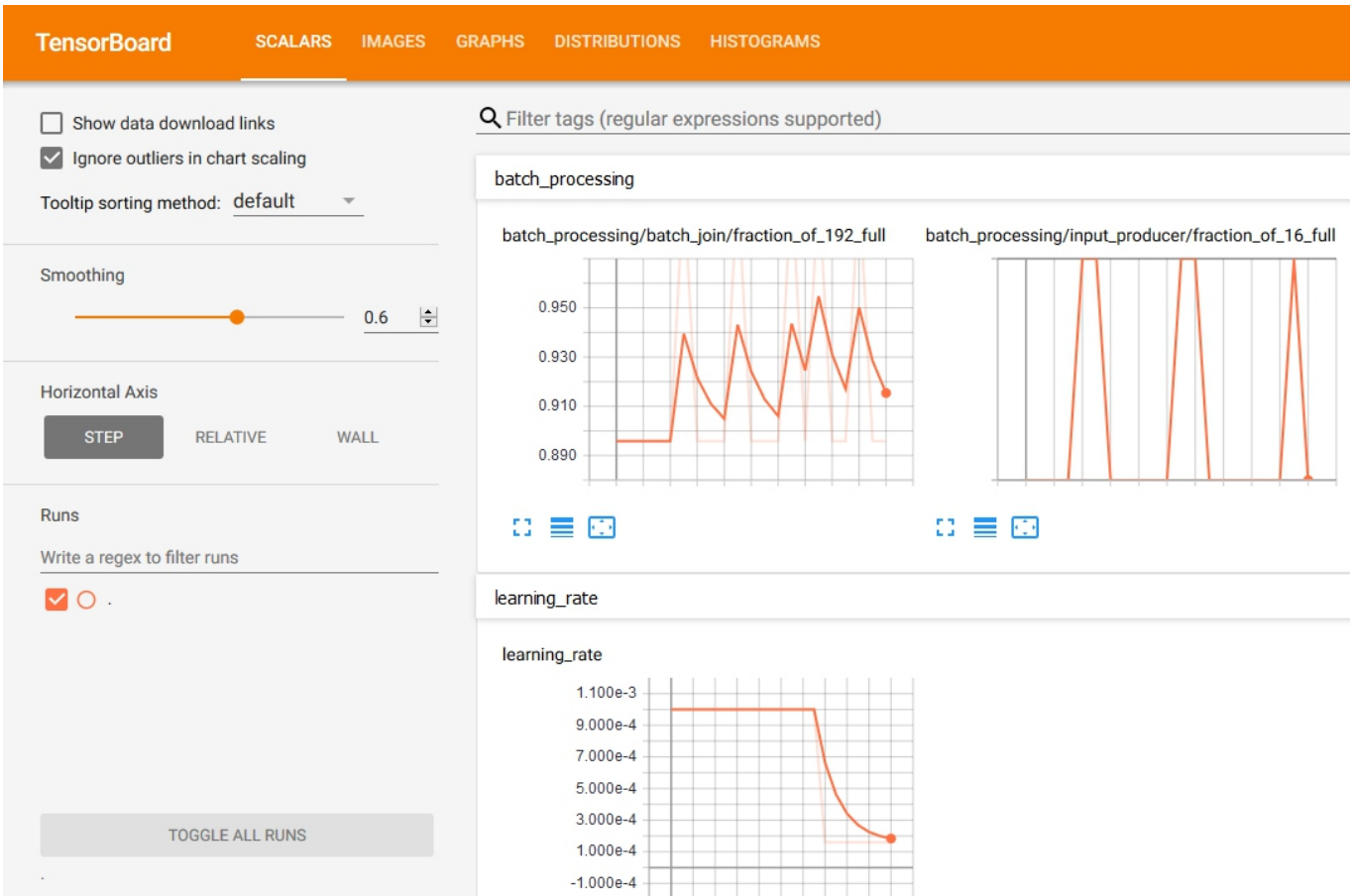
id 1.0 if binary)



TENSORBOARD

Tensorboard displays the much more information on the training process such as the change in learning rate, loss, graph structure. To view the tensorboard click on the Tensorboard in the menu:





EVALUATION

After a neural network has been trained you can evaluate your neural network with new images. For example if a neural network has been trained to classify dogs and cats the evaluator can classify new pictures of dogs and cats.

To evaluate drag an image onto the spy glass:

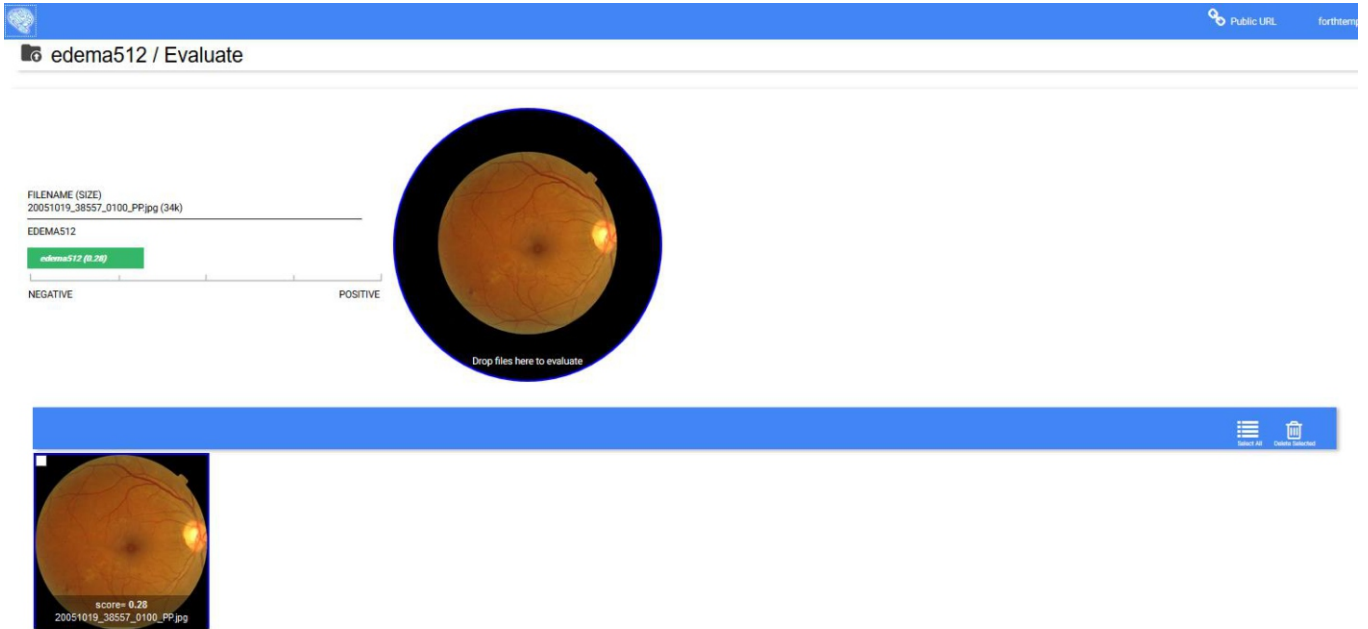
The screenshot shows the evaluation interface for 'edema512 / Evaluate' with the following elements:

- Header:** edema512 / Evaluate, Public URL.
- Instructions:** Drag zip file containing images or individual images into 'Upload images here' box.
- Table:**

FILENAME (SIZE)
N/A
EDEMA512
- Progress Bar:** A progress bar for 'EDEMA512' ranging from 0.00 to 1.00.
- Drop Zone:** A large circular area with a magnifying glass icon and the text 'Drop files here to evaluate'.

GRADING AND LABELED CLASSIFIERS

For labelled and grading classifiers it will display the grade of the image. In the case of a grading classifier the axis will show the grades such as positive or negative. In a labeled classifier the numbers will be between the min and max of the values of the CSV file.



The screenshot shows the 'edema512 / Evaluate' interface. At the top, there is a blue header with a public URL icon and the text 'Public URL' and 'for this item'. Below the header, the interface displays a file upload area with a circular drop zone containing a retinal fundus image. To the left of the drop zone, there is a progress bar and a table with the following data:

FILENAME (SIZE)
20051019_38557_0100_PP.jpg (34k)
EDEMA512
edema512 (0.28)

Below the table, there is a scale from 'NEGATIVE' to 'POSITIVE'. The 'edema512 (0.28)' value is positioned between these two points. At the bottom of the drop zone, it says 'Drop files here to evaluate'. Below the main interface, there is a smaller thumbnail of the same image with a score of 0.28 and the filename '20051019_38557_0100_PP.jpg'.

YOLO CLASSIFIER

In the case of YOLO it will place a box around the object it finds.



The screenshot shows the 'yolo / Evaluate' interface. At the top, there is a blue header with a public URL icon and the text 'Public URL' and 'for this item'. Below the header, the interface displays a file upload area with a circular drop zone containing a magnifying glass icon. To the left of the drop zone, there is a rectangular image of a skin lesion with a white bounding box around it. Below the image, there is a 'Feedback' button. At the bottom of the drop zone, it says 'Drop files here to evaluate'. Below the main interface, there is a smaller thumbnail of the same image with a score of 0.28 and the filename '20051019_38557_0100_PP.jpg'.

Box 1 x=213, y=258, w=73, h=85

Multiclass Classifier


In the case of multiclass it will show the class.

afms / Evaluate


FILENAME (SIZE)
20170730_234730.jpg (33k)

CLASS
mug


AFMS



0.00 1.00





Drop files here to evaluate

 [Download RAW CSV](#) Columns: time, id, filename, classifier, score, class

In many cases, rather than just run a single classifier on an image, you may wish to run a few at once. For example, with a retinal image you can evaluate on CDR ratio and glaucoma level from a single image.


Group Evaluators

The 'Group Evaluators' icon at the top of the screen will display a dialog listing all of the other classifiers on the left with your current evaluator on the right in black. By drag classifiers from the left to the right you can include them in the current classifier. On the right hand side you can also reorder the classifiers. For example if you want the CDR ratio calculated last you can drag it to the bottom. After you have dragged the classifiers, click save. Now instead of only the current classifier being used on a dragged image, instead as many as you like can be run on the image.


 Diabetic Macular Oedema / Evaluate  Group Evaluators

FILENAME (SIZE)
20051020_44598_0100_PP.jpg (32k)

DIABETIC MACULAR OEDEMA



CDR MULTILABEL



NEGATIVE

Group Evaluators

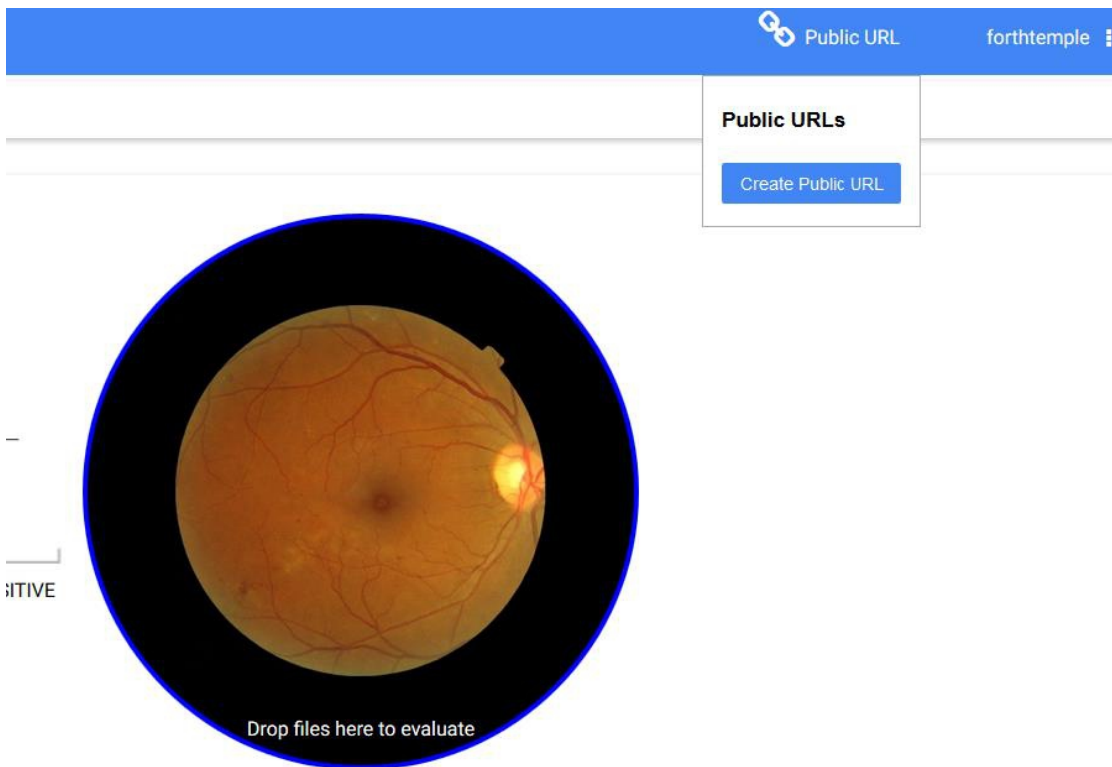
Drag from 'Available Classifiers' to 'Group Evaluator Classifiers'.
Drag with 'Group Evaluator Classifiers' to reorder:

Available Classifiers	Group Evaluator Classifiers
17_Dec_17_DR_Grading_Classifier	Diabetic Macular Oedema
Choroidal_Neovascularization	CDR_Multilabel
Emboli	
Exp3.2_ClassificationTest_1	
glaucoma	
kaggle	
multilabel	
Naevus_and_Melanoma	
Optic_disc_classification	
Trial_Dec_17	
VERSION1_ClassificationTest_1	

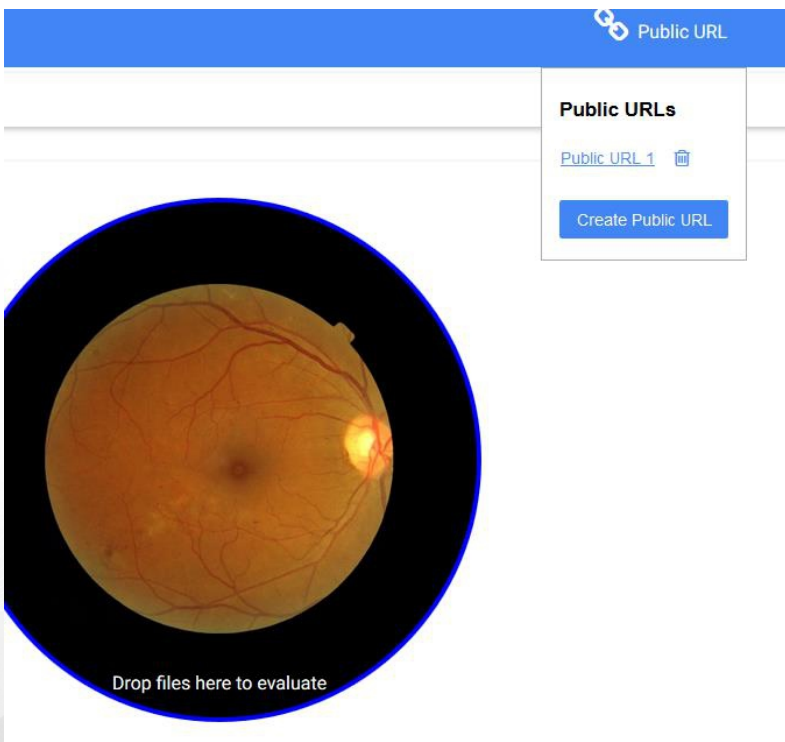
[Save](#)

PUBLIC URL

In order to make the classifier publicly available for others to use without creating an account use public URL's. Click on the 'public url' icon at the top of the screen:

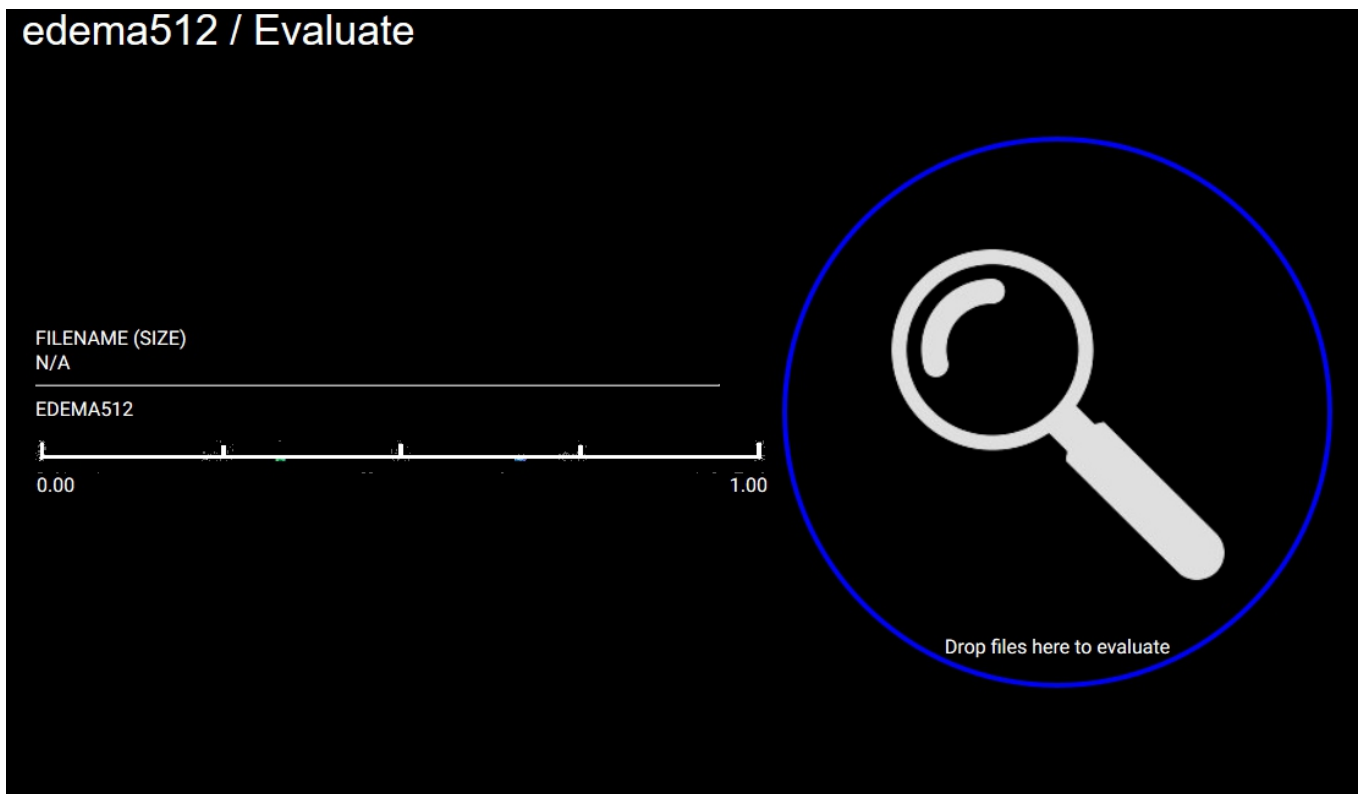


Click on the 'Create public URL' button to create a URL:

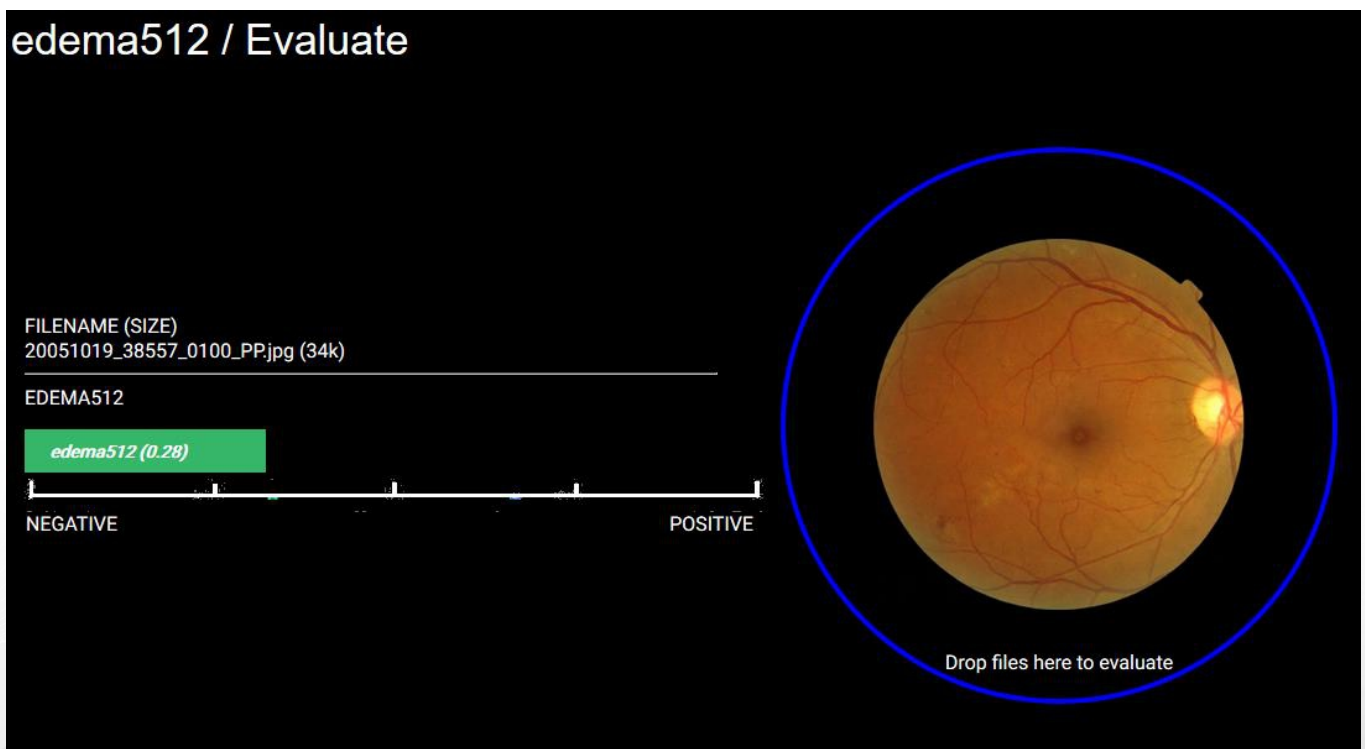


Right click on the 'public URL 1' link and click on 'copy link location', then paste the link into an email to mail to a colleague for them to use. They will be able to use the classifier without needing an account. The public URL can be deleted by clicking on the bin icon next to it and the URL will no longer be able for use.

Clicking on the public URL link shows a more basic evaluation screen compared to a registered user:



The public user can then drag images on the page and will see something like the following:



 glaucoma

Grading folders Image values are defined by the bin they're in (eg 0.0 and 1.0 if binary)

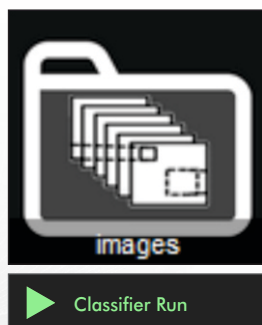


The grading classifier classifies by amount, for example how full a glass of water is. By default the classifier has two folders 'Positive' and 'Negative'. In the positive folder upload positive images such as glaucoma images and in the negative folder non glaucoma images. By clicking on the bin (eg negative) you can rename and change the value of the bin. For example instead of position being 1 you can set it to 2. Click on the 'Add new bin' icon to create a new bin. For example you could create a bin called 'medium' with a value of 0.5.

LABELLED CLASSIFIER

 labelled

Multi label Image values are defined by values specified by a csv file or space separated text file



Text file containing images and values is missing

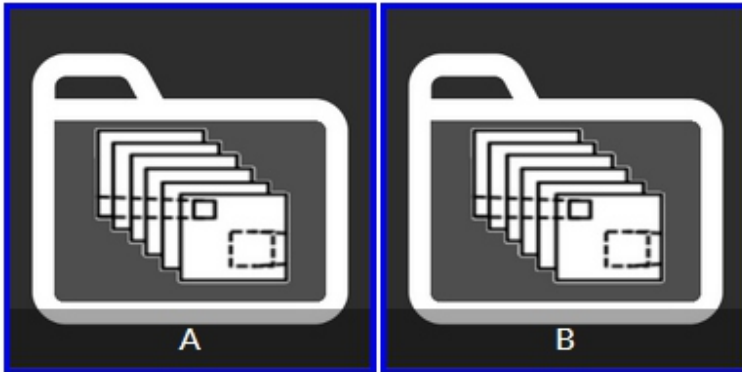
The labeled classifier has a single images bin where all the images are uploaded. An CSV or text file must also be uploaded that gives the grade for each image uploaded. For example a CSV as follows:

```
images1.jpg,0.2  
images2.jpg,0  
images3.jpg,1.0  
images4.jpg,0.6
```

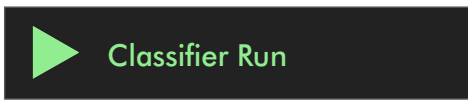
where images1.jpg has a grading of 0.2

This file can be upload in the images bin. It is also possible to upload a single zip file containing all images and the csv file.

MULTI CLASS



Add new class

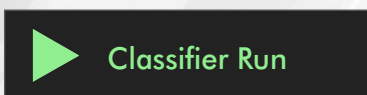
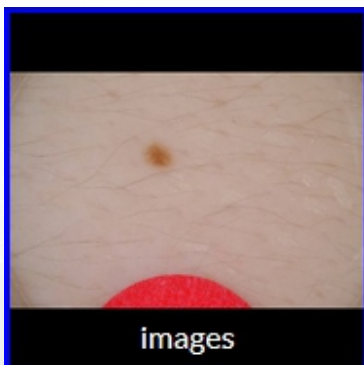


The multiclass classifier classifies an image by its class, for example whether or not it is a dog or cat.

The default multiclass classifier has two bins A and B. For example you can put pictures of apples in bin A and pictures of dogs in bin B. These bins can be renamed by click on the bin and changing the name in the menu. More classes can be added by clicking on 'Add new class'.

YOLO

 Yolo  All classifiers



The YOLO classifier puts a box around an object it detects. For example, putting a box around a dog in an image. To train YOLO, upload images and then click on the image and put boxes around the objects in each image. For example, to train YOLO to put a box around a dog, supply many pictures of dogs and put boxes around each dog. Click on the images directory to upload images.

Yolo / images

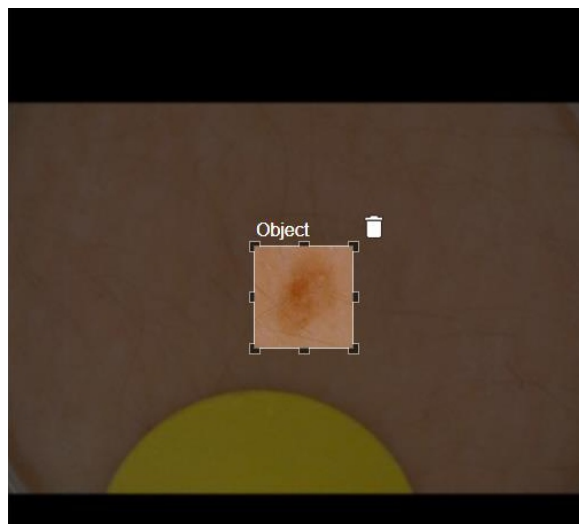
ISIC_0000558.jpg

Region has been selected.

← left arrow Previous image

→ right arrow Next image

⌨ S Save

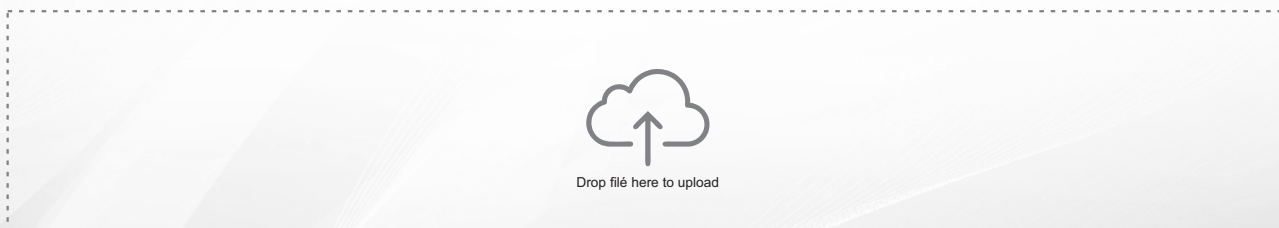


To train a YOLO classifier, images with boxes around the object in question need to be generated. To create a box on an object click on left click and drag over the image to create the box. To delete it click on the trash button on the boxes top right. To save the box, press the 'S' key. To move to the next image in your list press the arrow key.

UPLOADING

glaucoma / positive

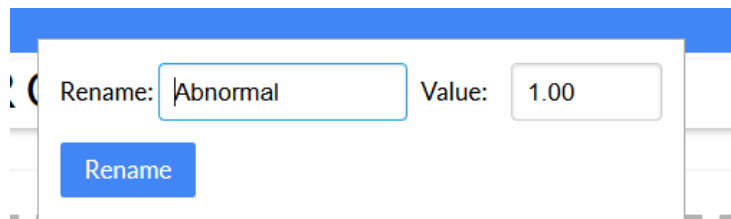
Drag zip file containing images or individual images into 'Upload images here' box



0 Images

Upload your dataset into classifier by clicking on the upload icon and choose the images you wish to upload. Images can also be dragged onto the upload icon. Images which can be uploaded include png, jpg, gif, ppm, tiff, dcm (dicom). These images can be placed in a zip file and the zip file uploaded also. For labeled classifiers a CSV or TXT file can also be uploaded containing the grading for each image.

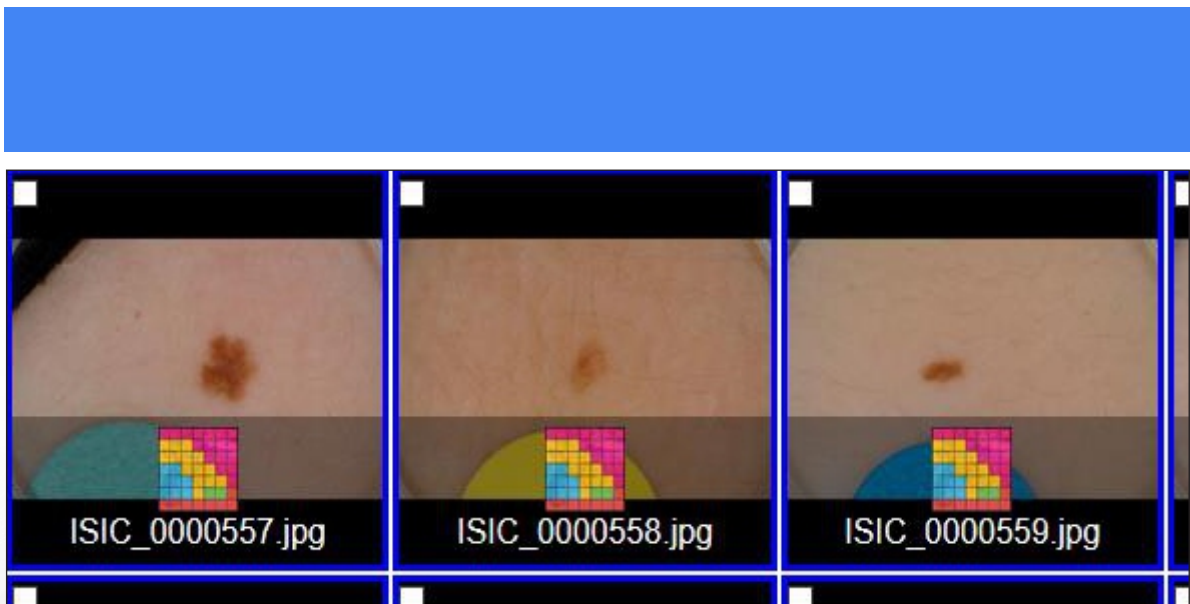
If it's not YOLO or a labelled classifier it is possible to rename the bin by clicking on 'rename bin'. For example rather than the bin name 'A' it could be renamed 'dog'. In the case of the grading classifier a value can be entered for the bin



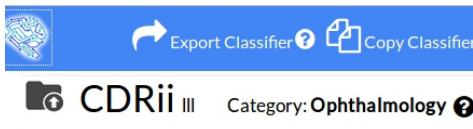
Rename: Value:

For YOLO classifiers, images that have been supplied will have a purple box in it such as below:

428 Images (8 annotations of 428 complete)



To incorporate a trained neural network onto your smartphone or any other kind of system download the trained model as a Tensorflow frozen pb model. This allows the neural network to be evaluated completely locally. To download the model click on the export classifier button in your classifier. This is only shown after training.



After it is complete the icon will change to 'Download complete' and you can download the frozen model.

Grading classifier

Refer to the following grading demo to incorporate the frozen model onto your smartphone:
https://github.com/Medicmind/grading_demo



Simply rename the 'frozen_graph.pb' file with 'stripped_graph.pb' and use it in place of the https://ai.medicmind.tech/models/grading_demo/stripped_graph.pb frozen model.

Multiclass classifier

For a multiclass classifier refer to the following demo
https://github.com/Medicmind/multiclass_demo

YOLO classifier

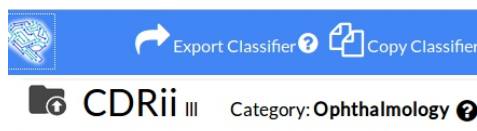
For a YOLO classifier refer to the following demo

https://github.com/Medicmind/yolo_demo

DOWNLOADING SEGMENTATION CLASSIFIER FOR LOCAL USE



To incorporate a trained neural network onto your smartphone or any other kind of system download the trained model as a metal checkpoint_weight.mlmodel. This allows the neural network to be evaluated completely locally. To download the model click on the export classifier button in your classifier. This is only shown after training.



After it is complete the icon will change to 'Download complete' and you can download the metal model.

Refer to the following segmentation demo to incorporate the model onto your smartphone:

https://github.com/Medicmind/segmentation_demo

