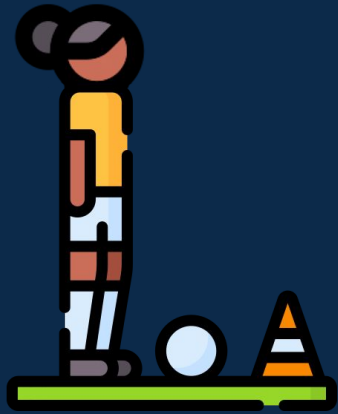


Lesson 5

Training and Testing



CS IN SCHOOLS

Learning objectives

By the end of this lesson, you should be able to:

- Understand how to formally test a classifier for accuracy
- Draw a confusion matrix and generate summary statistics
- Train, test and evaluate an image classifier



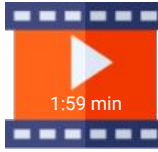
Demo: Let There Be Light!



Exploratory Activity

What other sounds might trigger the light bulb to turn on / off?

Double Clap to Turn The light On or Off!



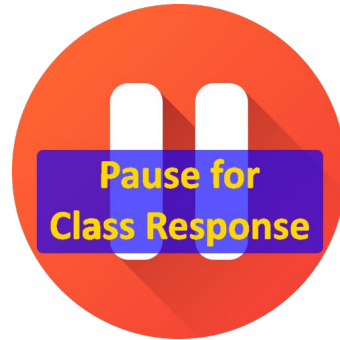
Tests

- Have you ever wondered why you have to sit tests at the end of topics?
- What do you think makes a **good** test - from the teachers' perspective!



Tests

- Have you ever wondered why you have to sit tests at the end of topics?
- What do you think makes a **good** test - from the teachers' perspective!



Tests

- Have you ever wondered why you have to sit tests at the end of topics?
- What do you think makes a **good** test - from the teachers' perspective!
 - Doesn't have exactly the same questions as you covered in class exercises!
 - Contains questions which require to you extend and build upon learning in class



Tests

- Let's pretend our “student” is the classifier, and we are the “teacher”
- We've trained it using our training images
- Now we want to **test** how well it did.
- What type of images would we use?



Data: Training Set vs Testing Set

- Test set: You “hold back” a set of labelled samples to “test” the quality of your prediction
- What might happen if you just reuse all the training data, and test the classifier with the same data you trained on?

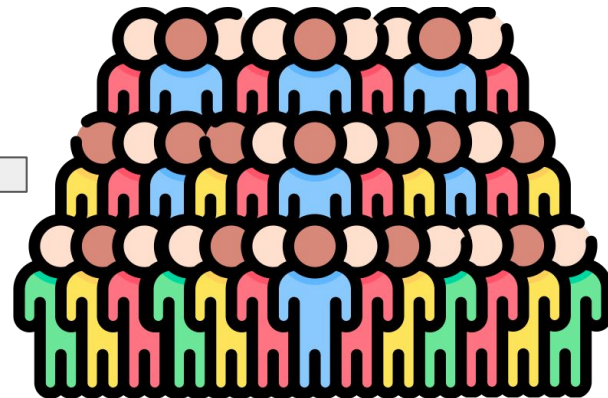
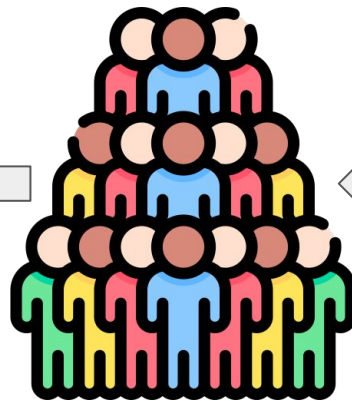
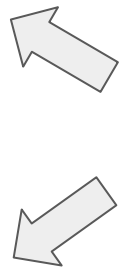
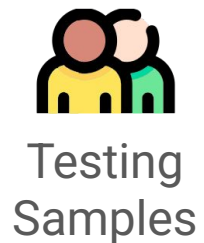
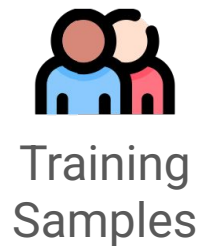


Data: Training Set vs Testing Set

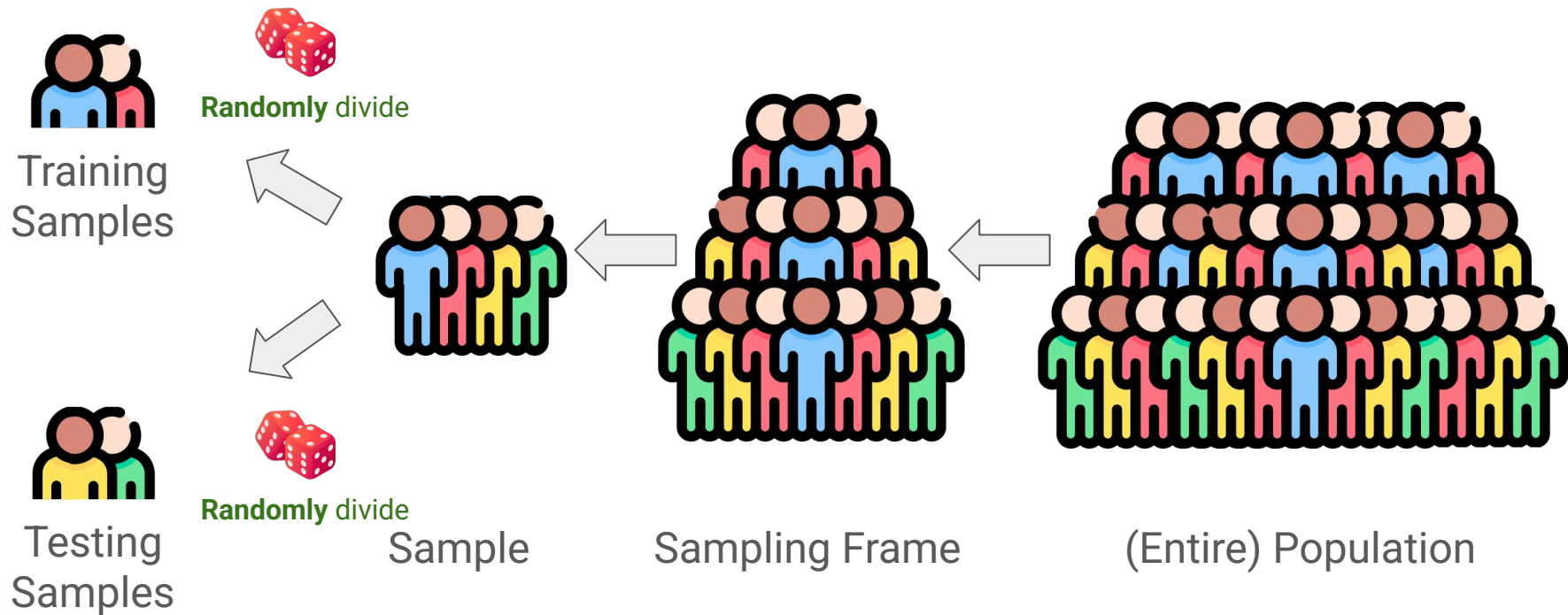
- Test set: You “hold back” a set of labelled samples to “test” the quality of your prediction
- What might happen if you just reuse all the training data, and test the classifier with the same data you trained on?
 - What happens if your maths teacher gives you all the test questions as a practice exercise to do before the test?



Population vs Sampling Frame vs Sample



Population vs Sampling Frame vs Sample

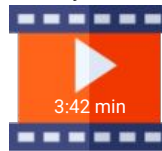


Worksheet Activity



Complete Question 1

([PDF](#), [MS Word](#))



Confusion Matrix

- We now have our testing data separated from our training data
- How can we measure how well our classifier is performing?
- To quantify testing measurements (just like how you get scores from a test)
we use a **confusion matrix**

		Predicted	
			
Actual		8	2
		3	7

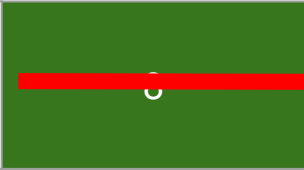
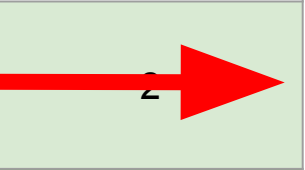
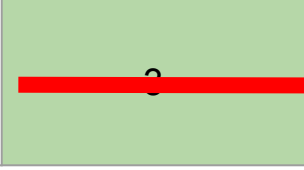
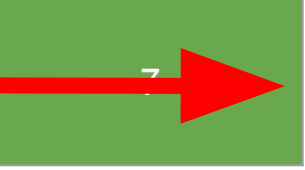
Confusion Matrix

- Below we see an example confusion matrix recorded for a classifier which predicts clap and whistle sounds

		Predicted	
			
Actual		8	2
		3	7

Confusion Matrix

		Predicted	
			
Actual		8	2
		3	7

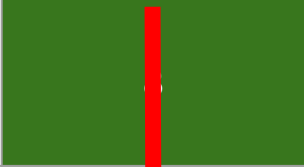
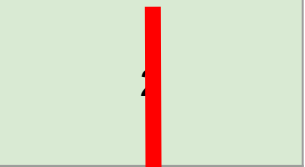
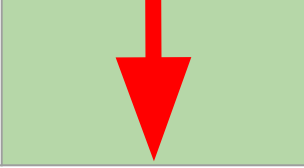
		Predicted	
			
Actual		 	
		 	

This is what the actual, correct classification is...

		Predicted	
Actual			
		8	2
		There were $8 + 2 = 10$ actual claps sounds used to test this classifier.	

		Predicted	
			
Actual		8	2
		3	7

There were $3 + 7 = 10$ actual whistle sounds used to test this classifier.

		Predicted	
Actual			
			
			

This is what the classifier predicted...

Predicted

Actual

			
		8	2
		3	7

		Predicted	
Actual			
		8	2
		3	

There were 8 actual claps...

		Predicted	
Actual			
		8	2
		3	

There were 8 actual claps which were predicted as claps!

		Predicted	
Actual			
		8	2
		3	

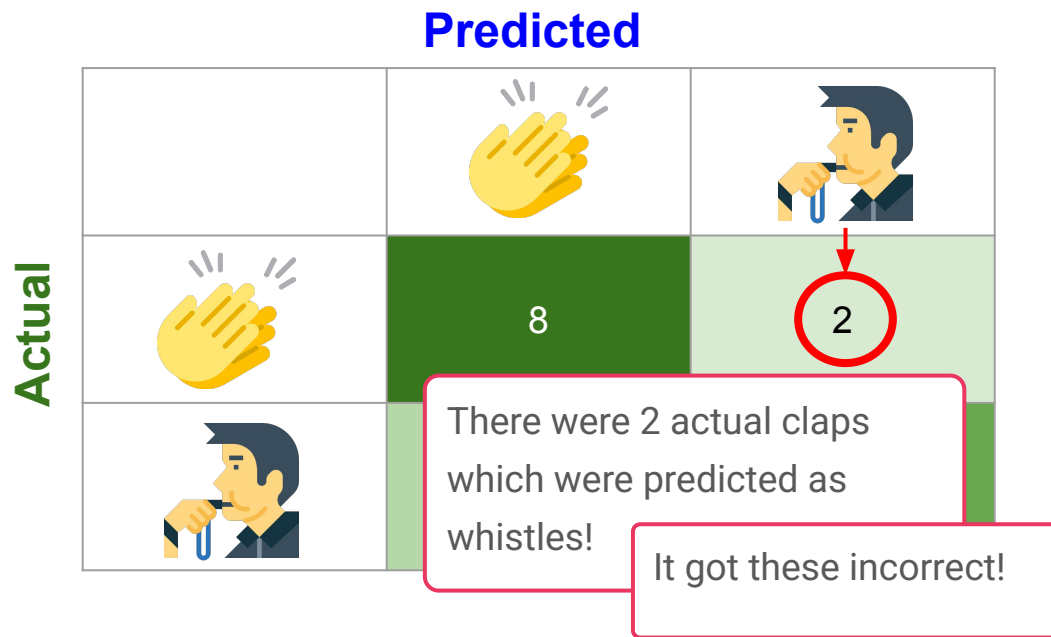
There were 8 actual claps which were predicted as claps!

It got these correct!

		Predicted	
Actual			
		8	2
		3	7

		Predicted	
Actual			
		3	2
		There were 2 actual claps...	

		Predicted	
Actual			
		8	2
		There were 2 actual claps which were predicted as whistles!	



Predicted

Actual

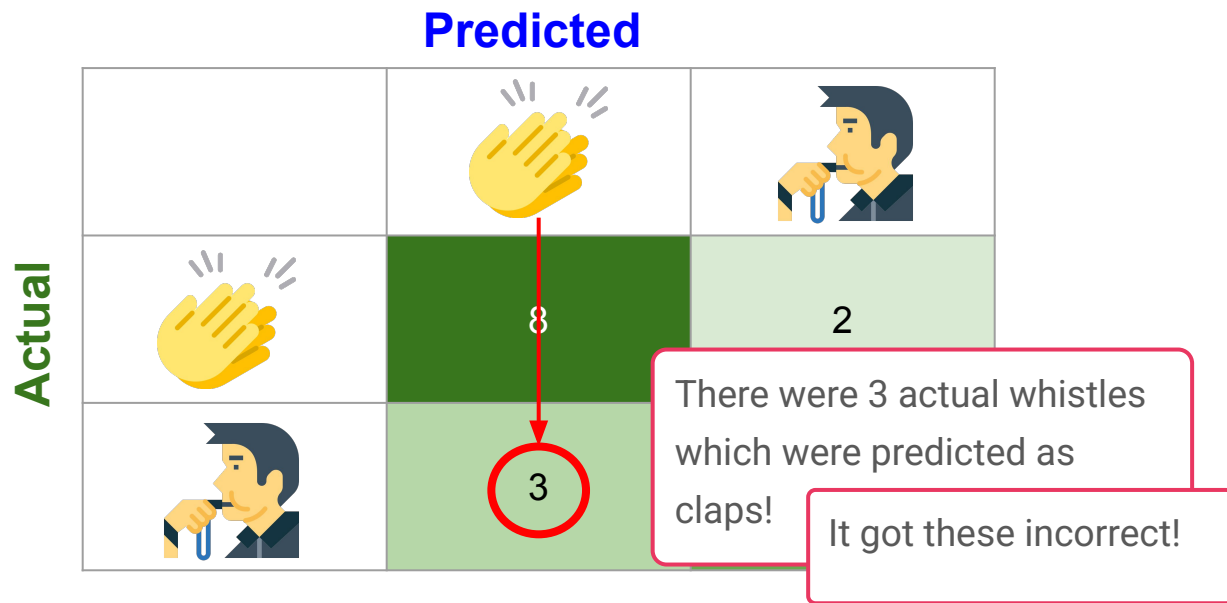
		
	8	2
	3	7

		Predicted	
Actual			
		8	2
		3	

There were 3 actual whistles
...

		Predicted	
Actual			
		3	2
		3	

There were 3 actual whistles which were predicted as claps!



Predicted

Actual

		
	8	2
	3	7

		Predicted	
Actual			
		8	2
		3	7

There were 7 actual whistles

...

		Predicted	
Actual			
		8	2
		3	7

There were 7 actual whistles which were predicted as whistles!

		Predicted	
Actual			
		8	2
		3	7

There were 7 actual whistles which were predicted as whistles!

It got these correct!

		Predicted	
			
Actual		8	2
		3	7

- There were 8 actual claps which were predicted as claps.
- There were 2 actual claps which were predicted as whistles.
- 10 clap sounds were used to test this classifier.
- There were 3 actual whistles which were predicted as claps.
- There were 7 actual whistles where were predicted as whistles.
- 10 whistle sounds were used to test this classifier.

The Ideal Classifier Confusion Matrix

		Predicted	
			
Actual		10	0
		0	10

In the ideal classifier, the confusion matrix would have values only on a diagonal. This would mean all the classes were correctly classified.

The Ideal Classifier Confusion Matrix

		Predicted	
			
Actual		10	0
		0	10

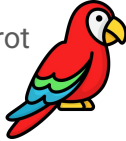
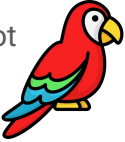
In the ideal classifier, the confusion matrix would have values only on a diagonal. This would mean all the classes were correctly classified.

Another Confusion Matrix

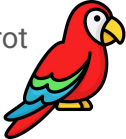
- Below we see another example of a confusion matrix.
- This one is for a classifier which predicts images of parrots or eagles

		Predicted	
		parrot 	eagle 
Actual	parrot 	12	3
	eagle 	4	16

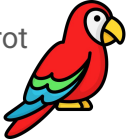
		Predicted	
Actual		parrot 	eagle 
	parrot 	12	3
	eagle 	4	16

		Predicted	
		parrot 	eagle 
Actual	parrot 	12	3
	eagle 	4	16

This is what the actual, correct classification is...

		Predicted	
		parrot 	eagle 
Actual	parrot 	12	3
	eagle 	4	16

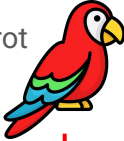
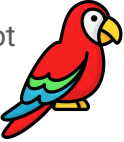
12 + 3 = 15 images of parrots were used to test this classifier.

		Predicted	
Actual		parrot 	eagle 
	parrot 	12	3
	eagle 	4	16

4 + 16 = 20 images of eagles were used to test this classifier.

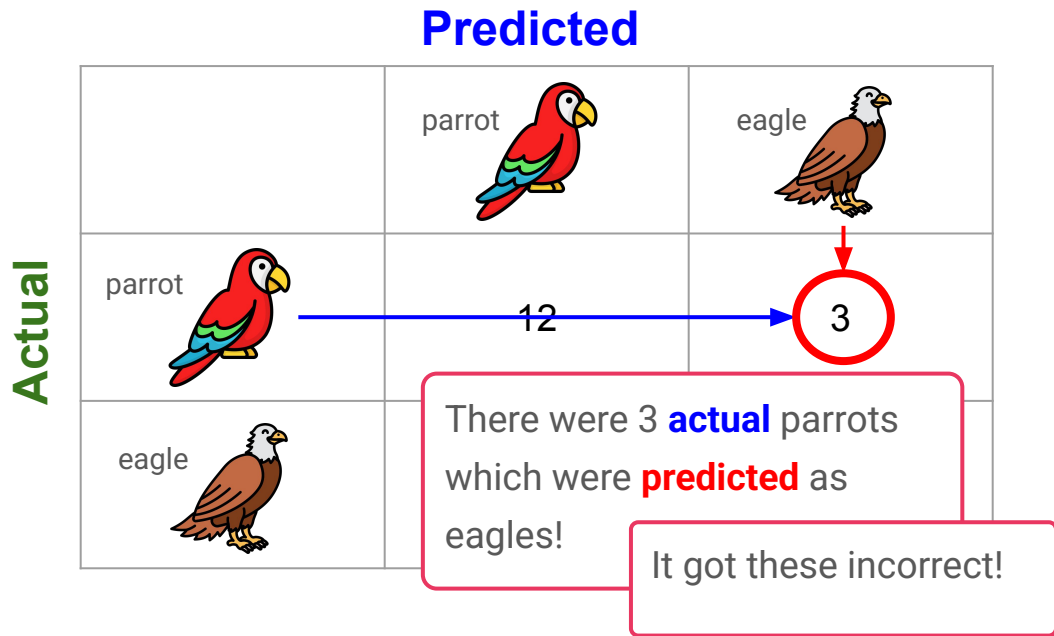
		Predicted	
Actual		parrot 	eagle 
	parrot 	12 	3 
	eagle 		

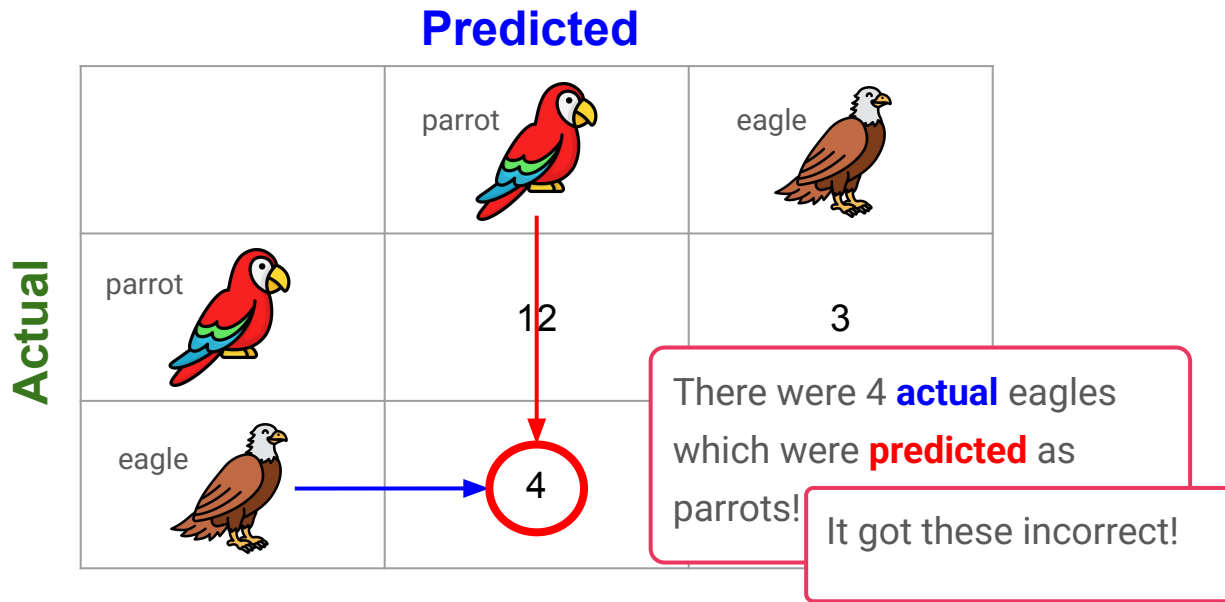
This is what the classifier predicted...

		Predicted	
Actual		parrot 	eagle 
	parrot 	12	3
	eagle 	4	

There were 12 **actual** parrots which were **predicted** as parrots!

It got these correct!

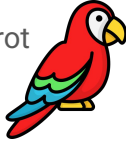
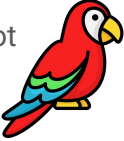




		Predicted	
		parrot 	eagle 
Actual	parrot 	12	3
	eagle 	4	16

There were 16 **actual** eagles
which were **predicted** as
eagles!

It got these correct!

		Predicted	
Actual		parrot 	eagle 
	parrot 	12	3
	eagle 	4	16

- There were 12 parrot images which were predicted as parrots.
- There were 3 parrot images which were predicted as eagles.
- 15 parrot images were used to test this classifier.
- There were 16 eagle images which were predicted as eagles.
- There were 4 eagle images which were predicted as parrots.
- 20 eagle images were used to test this classifier.

Worksheet Activity



Complete Questions 2 - 4

([PDF](#), [MS Word](#))

Summary

You should now be able to:

- Understand how to formally test a classifier for accuracy
- Draw a confusion matrix and generate summary statistics
- Train, test and evaluate an image classifier



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