Workshop #2

Classification & Color

Appalachian A. I. Corps @ UTK

Notes

Lesson Objective

In this lesson, you will learn about and apply ideas around image classification, neural nets, color, as well as how they can be used to monitor water quality.

Materials Needed:

A computer with a webcam
A web browser (Chrome, Firefox, or Safari)

Notes

Workshop Structure

Navigate to: https://tinyurl.com/aaic-wq-2

Notes

Review

Last workshop we learned:

Role of Nitrogen in Water
- Nitrogen

Using Statistics to Summarize Data
Using Python to store, summarize, and visualize data

Notes

Meet the Buoy!

Later this semester, we will be deploying these Smokey Buoys!

Some Important Parts:

Motorized unit to move test strips
Camera to analyze those strips on the spot

Notes

The Buoy: Test Strips

Smokey Buoy also uses test strips to monitor nitrate concentrations in water
Strips are on a roll rather than small strips
We place each pad on a very long piece of material and roll it up inside the buoy to keep it dry until dispensed

Notes

The Buoy: Test Strips

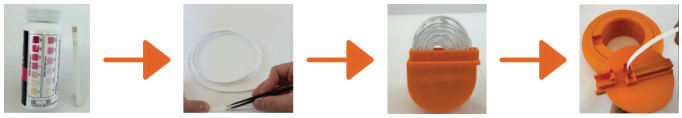


Figure 1: 1. We begin with commercial test strips and remove the pads. 2. The pads are carefully spaced out and placed on a very long piece of material. 3. The material is rolled up inside the buoy. 4. The roll is carefully positioned to be fed through the motorized roller.

Notes

The Buoy: Motor & Camera

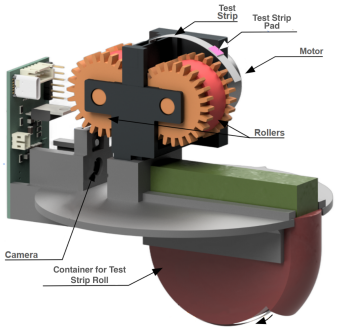


Figure 2: Modified from INSERT PAPER CITATION

Motor

Locate the motor near the top of the diagram. The motor drives the roller, which grips and advances the test strip roll.

Camera

When a test pad is in front of the camera, it takes a picture.

Notes

See It In Action!

Notes

Think Pair Share:

Thinking back to the nitrates activity from last week, What are the benefits to using a computerized buoy to conduct water quality tests? Drawbacks?

Notes

Intro to Classification

Checkpoint 2. a: Which banana(s) would you eat?

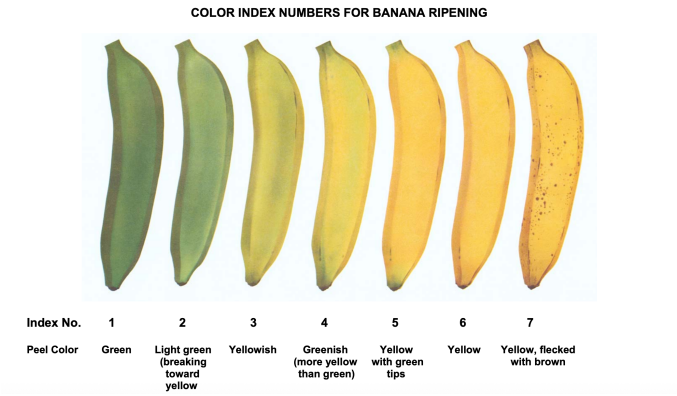


Figure 3: Source: US Department of Agriculture

Notes

Intro to Classification

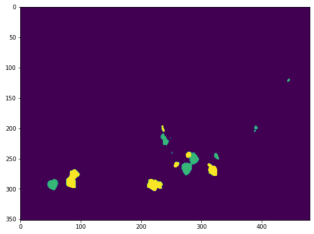
People make decisions about ripeness daily: grocery shoppers & farmers alike.
These decisions—judging if a fruit/vegetable is ripe—are called **classification**.
Classification = sorting items into groups based on appearance or behavior.

Notes

Use of Classification in Agriculture

Computers can help us make classification decisions
AI can help make classification decisions, saving time and labor for farmers
Example: At University of Maryland, AI is used to identify ripe crops in fields

(a)

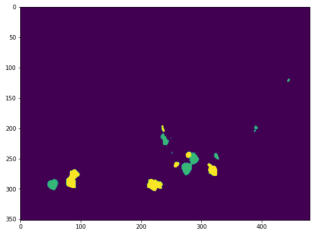


(b)

Notes

Use of Classification in Agriculture

(a)



(b)

Checkpoint 2. b: Review the figure above. In image (b), what do you think the yellow represents? The green?

Notes

Types of Classification

Classification of Strawberries

Binary Classification: Two possible outcomes (e.g., Ripe vs. Not Ripe)
Multiclass Classification: More than two possible outcomes (e.g., Underripe, Ripe, Overripe)

Notes

Binary Classification

Two possible Outcomes:

Not Ripe
Ripe

Notes

Multiclass Classification

More than Two Outcomes:

Underripe
Ripe
Molded

Notes

Example of Multiclass Classification in Agriculture

Project from University of Georgia, Athens [^2]

Uses multiclass classification to sort lemons

Discards underripe or molded lemons, retains only ripe ones

Your browser does not support the video tag.

Notes

More on Classification with AI

Computers make classification decisions very quickly

Using AI has advantages and disadvantages

Notes

Pros of Using AI for Classification

Notes

Pros:

Handles millions of items quickly
Spots tiny differences humans miss

Cons of Using AI for Classification

Notes

Cons:

Needs tons of examples to train the computer
Bad examples = bad decisions (e.g., train only on sunny photos, it fails on cloudy days).

Checkpoint 2. c

Checkpoint 2. c: If farmers use a certain company to train and decide when to pluck or harvest fruits/veggies, who gets to own that data? why?

Notes

Checkpoint 2. d

Checkpoint 2. d: Let's say the company becomes better at identifying ripe fruits because they used data from your farm. Now, they want to up their subscription fees for farmers to use their model. Is that fair? Do you have any suggestions or solutions?

Notes

Classification Activityfourtyeightpt-font - Train

Now it's your turn!

Notes

Classification Activity - Train

1 Apple and 1 Orange per pair
1 Distractor (fruit, ball, etc.) per pair
1 Device per pair/group
1 lab sheet per person

Notes

Teachable Machine

Teachable Machine

Uses Python in the background
Helps users build classification models

Notes

Steps

1. Go to Teachable Machine at https://teachablemachine.withgoogle.com/

Notes

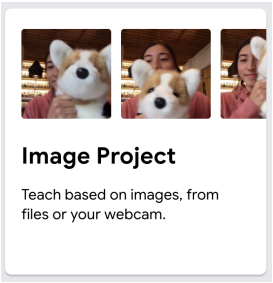
Steps

2. **Click “Get Started”**

Notes

Steps

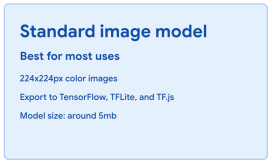
3. **Choose “Image Project”**



Notes

Steps

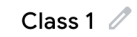
4. **Select “Standard Image Model”**



Notes

Steps

5. To the right of "Class 1", click the pencil and type "Apple"



Notes

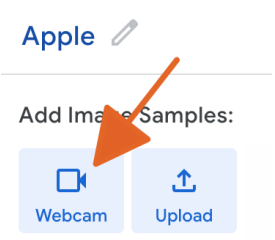
Steps

6. Grab your apple and get ready!!

Notes

Steps

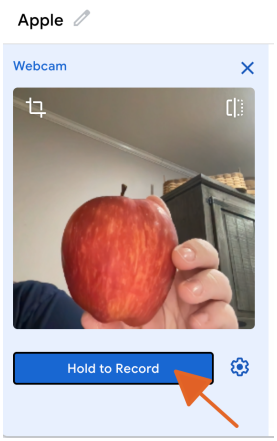
7. Click "webcam" to turn on and allow the computer to begin capturing images of the apple.



Notes

Steps

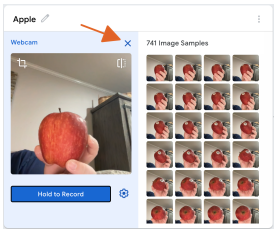
8. Position your apple within the frame and click the "Hold to Record" button to begin capturing images of the apple. You will want to move the apple around so it captures different angles and distances. Capture 100-200 images.



Notes

Steps

9. When finished, release the "Hold to Record" button and click the "x" in the top right corner to exit the Apple class.



Notes

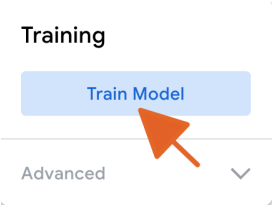
Steps

Put your apple aside and grab your orange. Repeat the process above to train your model for Class 2. Try to capture **roughly** the same number of images for the orange as you did for the apple.

Notes

Steps

11. When finished capturing data for both classes, click the "Train Model" button. The website will train your own custom classification model, based on your data!



Notes

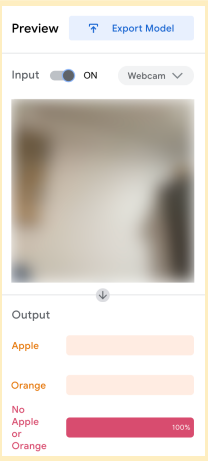
Evaluate Your Classifier

Some models can be very accurate, while others might struggle
Let's put your model to the test!

Notes

Evaluate Your Classifier

Use the "Preview" pane on the right side of the Teachable Machine screen



Notes

Putting it to the Test

> **Note**
>
> Get your lab sheet ready. Let's record some results!

Notes

Steps for testing

Trade your apple and orange with another group. No group should have the exact same fruits you trained the model with.

Notes

Steps for testing

Take your lab sheet and review the observation table. The first item to test is an apple. If the model works well, what will it predict? Record this in the second column.

Notes

Steps for testing

Next, hold the apple up to your camera. What does the model predict it is? Record this in the third column of your lab sheet.

Notes

Steps for testing

The model also reports confidence in its prediction. Record this percent confidence in the fourth column of your sheet.

Notes

Steps for testing

Repeat this process for all other objects on the lab sheet.

Notes

Reflecting

Discuss these Questions

How did your model perform?
Were any objects classified incorrectly?
Were any objects classified with low confidence ($< 80\%$)?

Notes

Classification Activity - Buoy

How a classification model works.

Notes

Your Turn: Be the Buoy

Materials Needed:
- 1 test strip

Notes

Your Turn: Be the Buoy

Train Model with two classes:

Classes:
- strip present - strip not present

Notes

How Does It Work?

Checkpoints on this Page:

Checkpoint 5.a: Neural Network Layers

Notes

How Does Your Model Work?

Under the hood of a classification model is a **Convolutional Neural Net (CNN)**
CNNs are trained to recognize patterns in images

Notes

How Does Your Model Work?

Prioritize understanding big picture over math

Notes

How Does Your Model Work?

Notes

Checkpoint 5. a: Neural Network Layers

Compare and contrast the input layer, the hidden layers, and the output layer. What function do they each have in a neural net?

Notes

Color Activity

Notes

Checkpoints on this Page:

Checkpoint 6.a: Pixels & RGB

Understanding RGB

Notes

Computers understand color through numbers, not like humans with eyes
When a computer displays or processes an image, that image is really a combination of millions of little squares called pixels

Understanding RGB

Notes

Each pixel has a value for Red (R), Green (G), and Blue (B)
The color of each pixel is a combination of these three values

Pixels and RGB Values

Checkpoint 6. a: Exploring pixels and RGB Values

Notes

Materials Needed

Materials Needed:

APPLET
- This will open in a new tab.
- You may need to grant access to your camera for it to work.
- Apple, Orange, Lime (from previous activity)

Handout
Pencil

Notes

Pixels and RGB Values

Use the applet and follow the instructions on the handout, which are also listed below.

Notes

Pixels and RGB Values

The applet starts with "What Humans See" selected. Hold the apple up to the camera. Notice it captures its likeness?

Notes

Pixels and RGB Values

Change the mode to "What Computers See". It will default to the Red channel first.

Notes

Pixels and RGB Values

Focus on an area at the center of the apple and record the value for R.

Notes

Pixels and RGB Values

Use the dropdown menu to change the channel to G. Look at the same area (or as close to possible) on the apple, record the value for G.

Notes

Pixels and RGB Values

Change the channel to B and record the value for B.

Notes

Pixels and RGB Values

Repeat this process for the orange, lime, and each of the purple cards.

Notes

How Do Computers See Color?

Notes

Checkpoints on this Page:

Checkpoint 7.a: Using RGB Values to Create Color
Checkpoint 7.b: Using Color to Predict Fruit

How Do Computers See Color?

Notes

We learned every pixel has a value for Red (R), Green (G), and Blue (B)
Each value can range from 0 to 255

Creating Color with RGB Values

Notes

Slide the sliders to create different colors!

Using RGB Values to Create Color

Use the slider tool above to answer the RGB questions
Record your answers on the handout

Notes

Using RGB Values to Create Color

Slide all values to zero. When R = 0, G = 0, and B = 0, what color do you see?
Slide all values to 255. When R = 255, G = 255, and B = 255, what color do you see?

Notes

Using RGB Values to Create Color

Slide all values to 0. Change R to 255. What happens to the color?
Slide all values to 0. Change G to 255. What happens to the color?

Notes

Using RGB Values to Create Color

Slide all values to 0. Change B to 255. What happens to the color?

Notes

Using RGB Values to Create Color

Now let's try some of the colors you observed in the last activity. Get your handout ready!

Notes

Using RGB Values to Create Color

Adjust the sliders to the RGB values you recorded for your apple. What color do you see? Is it similar to your apple?

Notes

Using RGB Values to Create Color

Repeat this for your orange's RGB values. What color do you see? Is it similar to your orange?

Notes

Using RGB Values to Create Color

Finally, repeat this for your lime's RGB values. What color do you see? Is it similar to your lime?

Notes

Using RGB Values to Create Color

Checkpoint 7. b: What color does this RGB value represent? (110, 164, 212) Just like the computer, predict what fruit this could be from!

Notes

Exit Ticket

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