Explorations in Computer Vision

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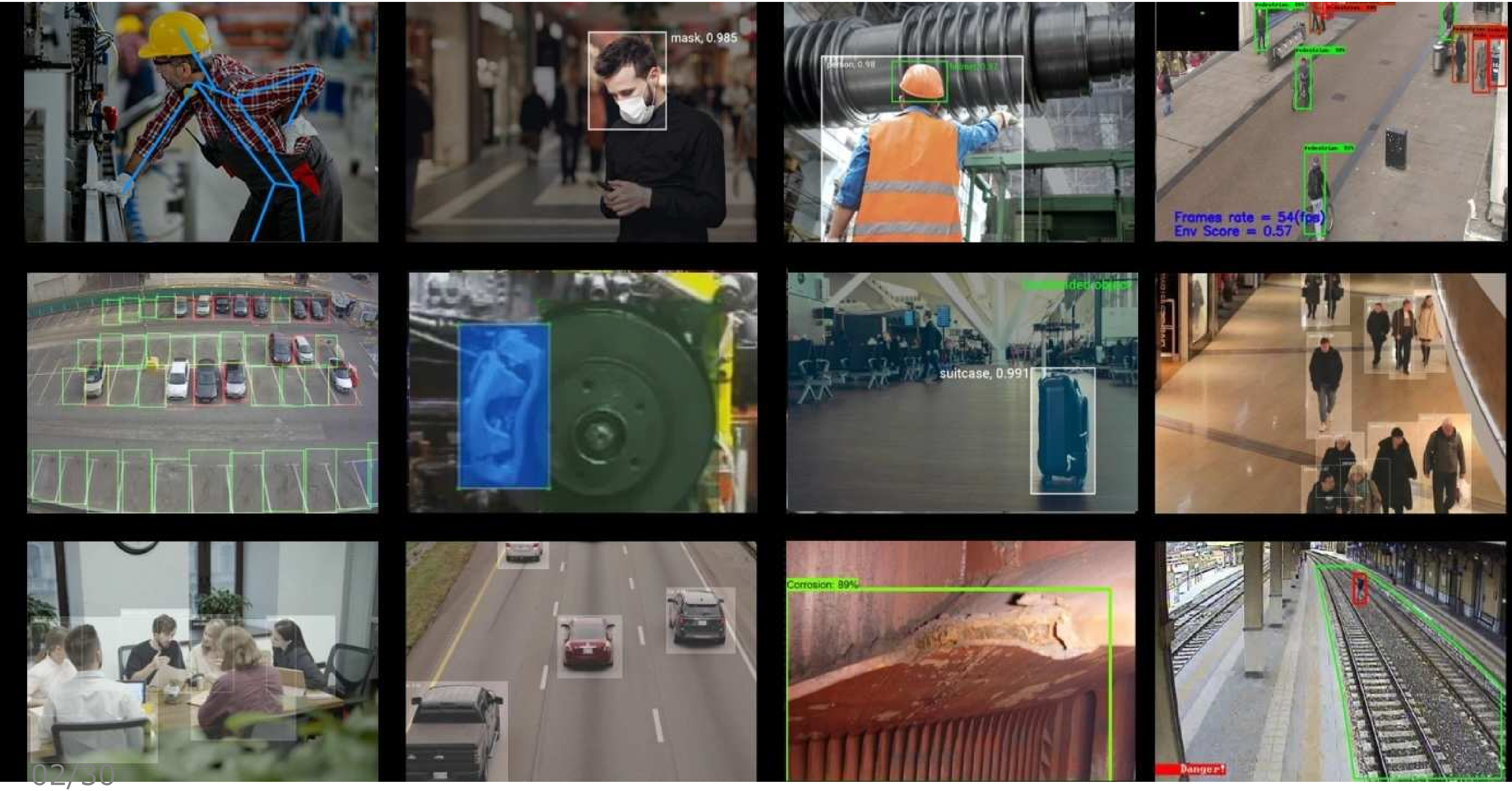
Example Computer Vision Applications



Different Levels of Comprehension

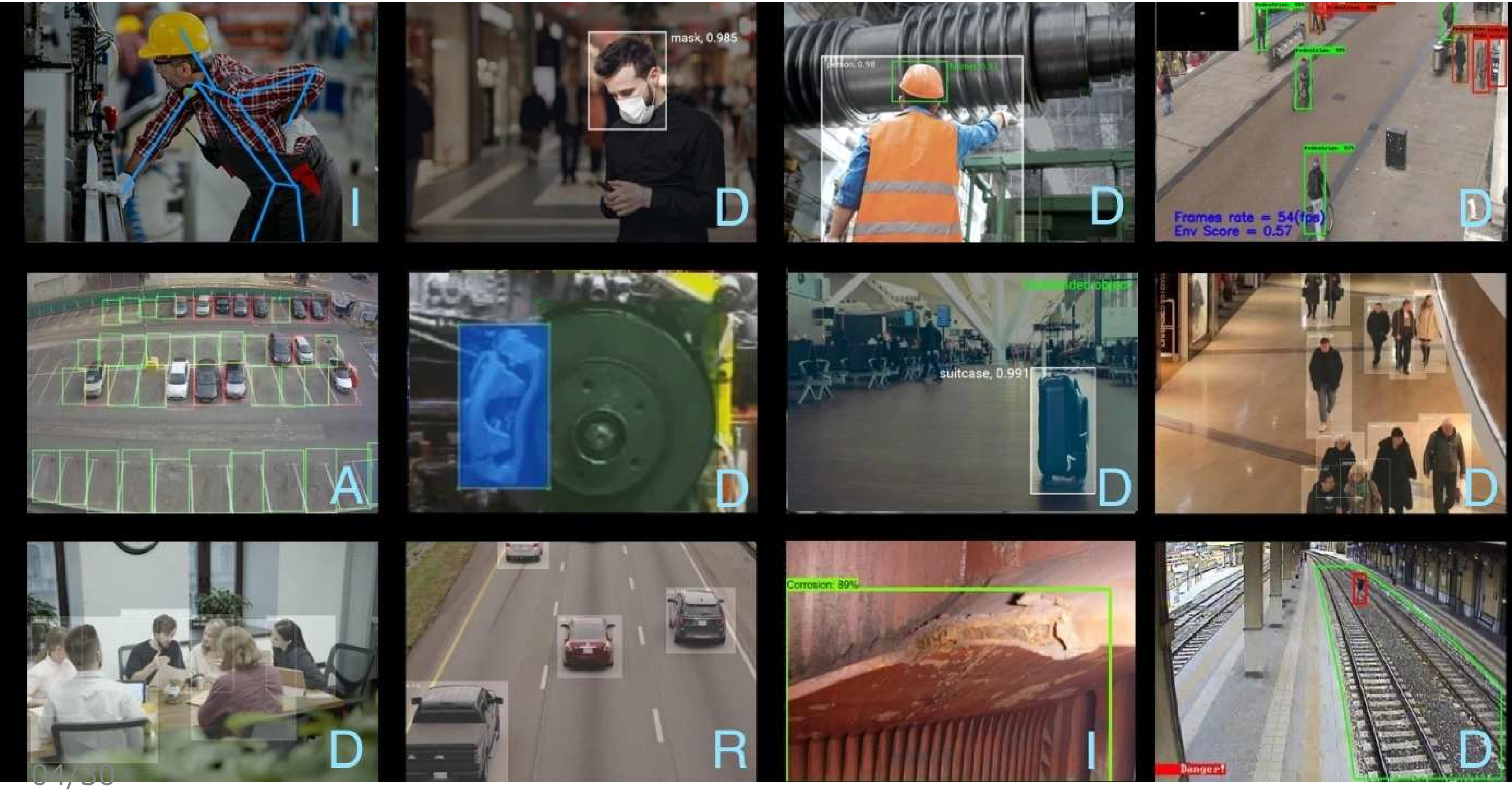
Attention: is there *something* (anything) present ?

Detection: specific *type* of thing (car, person etc) ?

Recognition: which *individual* thing (car, face etc) ?

Interpretation: what is the thing actually *doing* ?

Classification



Our Approach

We *could* try to train a machine learning model
In order to identify objects/structures in an image
But this wouldn't give much insight into the process
(We'd just be training, rather than experimenting)

Instead we will take a much lower-level approach
Focusing on writing code to analyse images/video
Using a number of pixel manipulation techniques...

Pixel Manipulation Techniques

- Searching for specific colours (RGB, Hue, Sat. etc.)
- Frame differencing (change in Brightness, Hue etc.)
- Scanning for specific shapes (person, car, letter etc.)
- Matching relative structures (e.g. face detection)

The Application

We need some form of visual material to process

We'll make use of a recording of a webcam stream

From the "Marine Biological Association" in Plymouth:

3m5!1s0x486c935311b11e0b:0xd40b5a4f7f597d10!8m2!3

It's a nice view, with lots of activity going on !

PlymouthWebcam

Processing Template

To get you started, we've provided a template to:

- Load in an MP4 video file
- Extract a single image ("frame") from the video
- Draw that frame onto the screen
- "Mask off" unwanted areas of the frame
- Define a colour range for analysis
- Analyse remaining "umasked" pixels within the frame

PlymouthCamTemplate

Drawing Pixels onto a Frame

- Before any drawing, call "beginDraw" on the frame
- To mask off areas set "fill" colour to black
- Mask off Rectangle, Triangle or Polygon areas
- To draw individual pixels set "stroke" colour...
- Then draw an individual "point" (pixel) in that colour
- After drawing, be sure to call "endDraw" on Frame

Checking the Colour of Individual Pixels

We can get the colour of a particular pixel using:

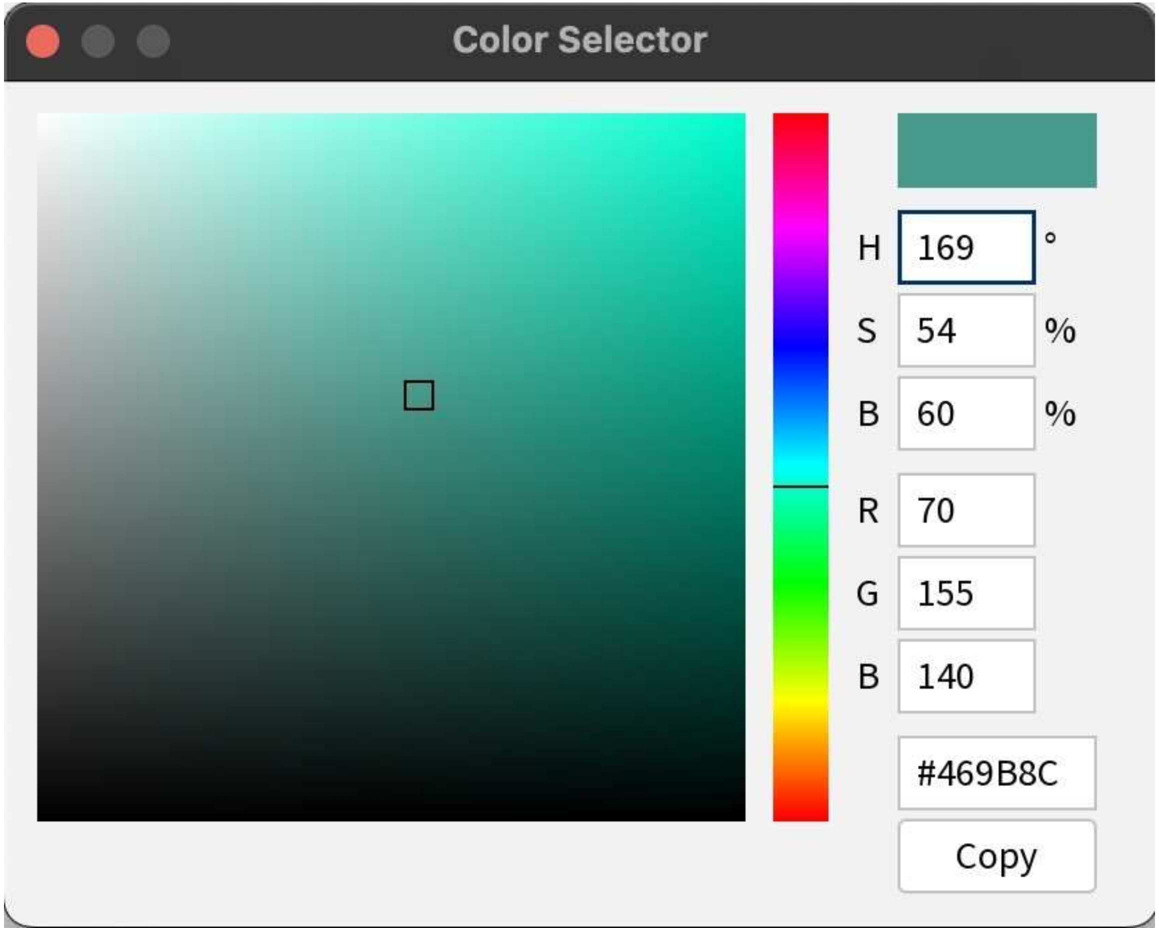
```
int pixelColour = currentFrame.get(x,y);
```

Then extract various properties of the pixel using:

```
int redness = red(pixelColour);
int greenness = green(pixelColour);
int blueness = blue(pixelColour);
int whichColour = hue(pixelColour);
int howBright = brightness(pixelColour);
int howSaturated = saturation(pixelColour);
```

Hue / Saturation / Brightness / RGB

Warning: All values in Processing are in range 0-255



H 169 °

S 54 %

B 60 %

R 70

G 155

B 140

#469B8C

IMPORTANT NOTE

This is a very processor-intensive activity !
280k pixels per frame requires a LOT of calculation

If you do not have a fast laptop
We advise you to use a lab machine !!!
(otherwise it will be painfully slow !)

Download

Download the template code (and these slides) here:

https://tinyurl.com/BristolCamera

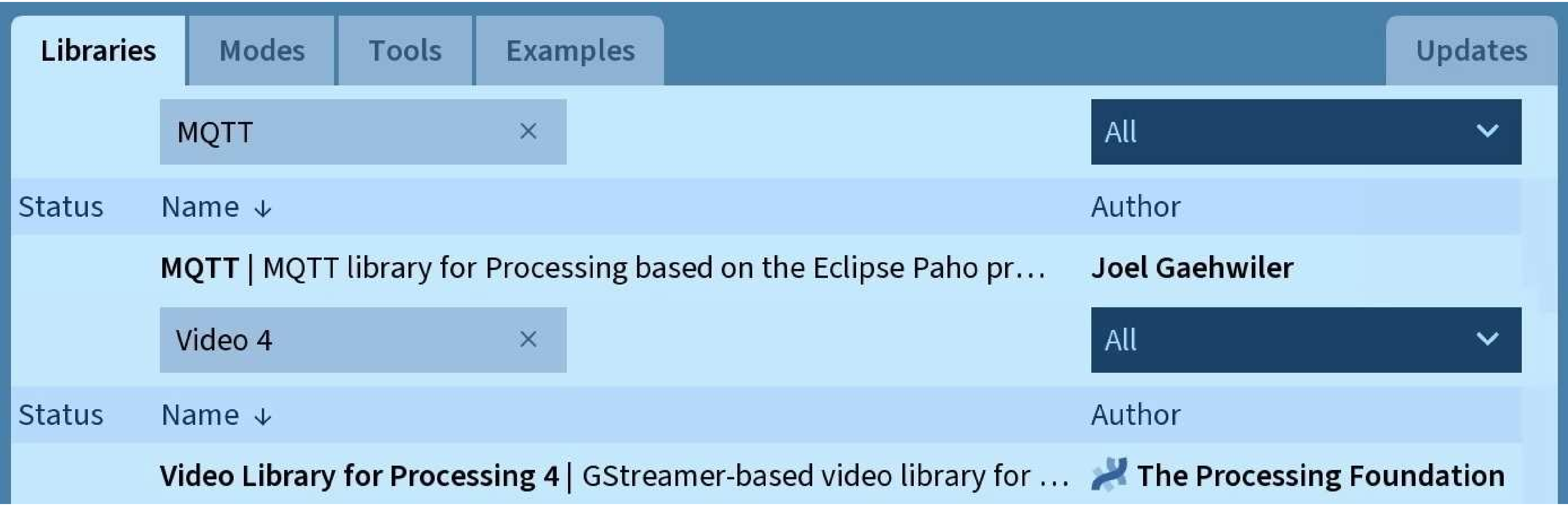
https://tinyurl.com/BristolCamera

Libraries

In order to run the template project

You will need to install a couple of libraries:

`Sketch > Import Library > Manage Libraries`



MQTT ×

All

Status	Name ↓	Author
	MQTT | MQTT library for Processing based on the Eclipse Paho pr…	**Joel Gaehwiler**

Video 4 ×

All

Status	Name ↓	Author
	Video Library for Processing 4 | GStreamer-based video library for …	**The Processing Foundation**

Your Objective

Select an aspect of the scene to analyse/monitor
You are free to choose any element that you like...
But try to choose something with a clear "purpose"
(Something it might actually be useful to monitor !)

Later, we will be send someone a notification
When a particular situation occurs in the scene

What Will You Choose ?

To Work !

Blob Detection

Blob Detection is a more advanced technique
(But something still achievable within this session)

Involves scanning for coherent clusters of pixels
(Based on the pixel brightness or colour)
Narrowing down the bounding box to get a tight fit

BlobDetection

Day 2

Remote Notifications

It's no good being able to detect something...
If nobody actually realises the event has occurred !

We might even want to notify multiple remote users
(In case many people are interested in the event)

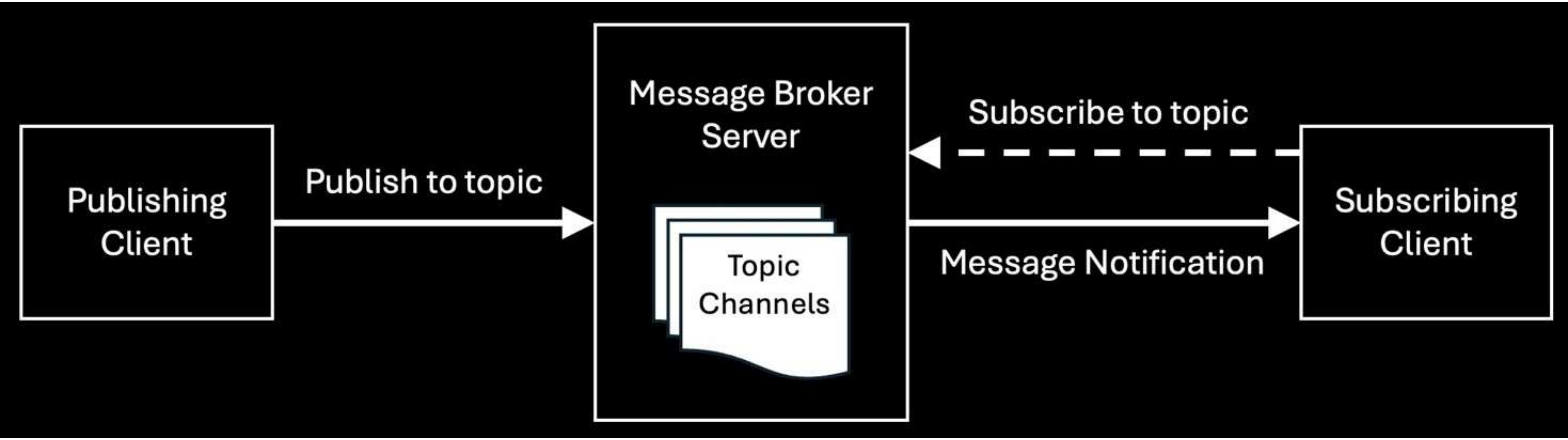
There are various mechanisms available to do this
We use a communication mechanism called MQTT...

Message Queue Telemetry Transport (MQTT)

Message passing protocol (ideal for notifications !)

You can "publish" messages to "topics" (channels)

Other people "subscribe" to receive notifications



Message Queue Telemetry Transport (MQTT)

Connect to broker by adding this to setup method:

```
mqtt = new MQTTClient(this);
mqtt.connect("mqtt://broker.hivemq.com:1883");
```

To publish a notification message to a topic we use:

```
mqtt.publish(topic, parameter);
```

Topic should start with "plymouth/" for example:

```
mqtt.publish("plymouth/birds", "3");
```

Alternative Servers

A server that gathers messages is called a "Broker"
(Arbitrates between publishers and subscribers)

For this activity we are using a free public broker
Since it's free there are no guarantees of availability
Sometimes the server is not operational :o(

That's fine - there are other alternatives available:

```
mqtt://broker.emqx.io:1883
mqtt://broker.hivemq.com:1883
mqtt://test.mosquitto.org:1883
mqtt://public-mqtt-broker.bevywise.com:1883
```

MQTT Demo

PlymouthCamSolution

MultiNotificationMonitor

To Work !

Alternative Video

Your code may work with the original video, but...
Is it flexible enough to operate in other conditions ?
What if it is a cloudy day ? Or even raining ?

Try your analysis on an alternative video stream
(there are another two videos in the "data" folder)

If your code doesn't work, you will need to adapt it !
(But make sure it still works with the original video !)

What is happening right now ?

https://www.mba.ac.uk/mbawebcam/

Want test your code analysing the live video feed ?
Find all instances of: drawMovieOntoFrame
And replace them with: drawLiveFeedOntoFrame

For example, the following line:

```
drawMovieOntoFrame(currentFrame);
```

Would now become:

```
drawLiveFeedOntoFrame(currentFrame);
```

Be careful - try not to behave like a DoS attack !

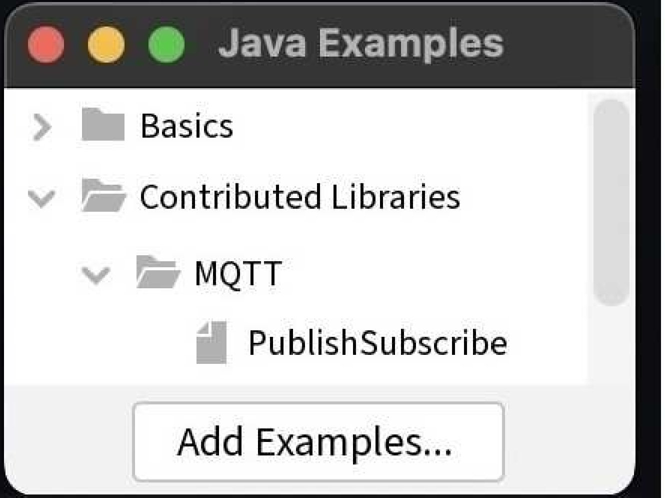
Bonus Tasks

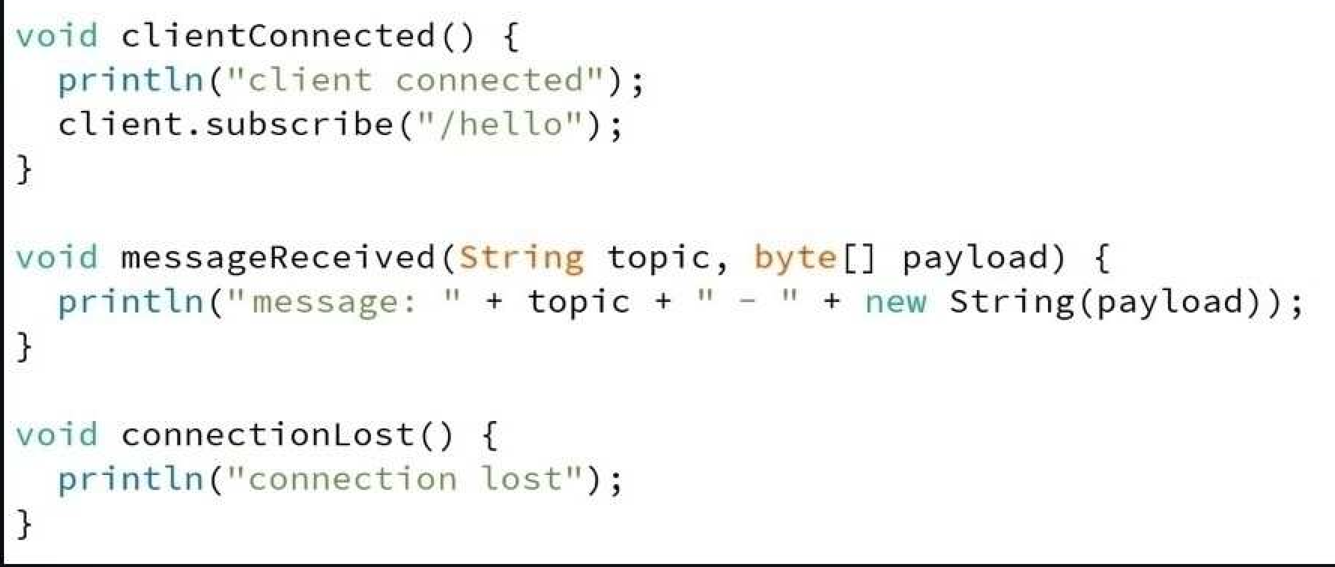
What else is going on ?

Do you want to see what everyone else is doing ?

You can create a new Processing project to find out !

Take a look at the MQTT examples (File>Examples...)





```
void clientConnected() {
  println("client connected");
  client.subscribe("/hello");
}

void messageReceived(String topic, byte[] payload) {
  println("message: " + topic + " - " + new String(payload));
}

void connectionLost() {
  println("connection lost");
}
```

Audible Notifications

It's no good being able to detect something...

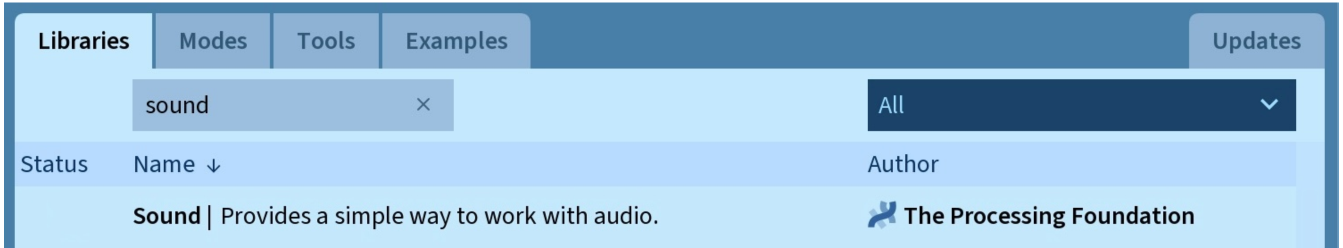
If nobody actually realises the event has occurred !

Add an audible alert using the "SoundFile" class:

tps://processing.org/reference/libraries/sound/SoundFile.ht

Note that you will need to install the "sound" library:

`Sketch > Import Library... > Manage Libraries...`



sound ×

Status	Name ↓	Author
	Sound | Provides a simple way to work with audio.	**The Processing Foundation**