Getting Started with ML Kit

SierraOBryan

SIERRA OBRYAN (SHE/HER)

@_sierraOBryan (she/her)

Where can I get the materials?

https://bit.ly/momentum-ml-kit

What is it??

“ML Kit brings Google’s machine learning expertise to mobile developers in a powerful and easy-to-use package.”

Built By Google

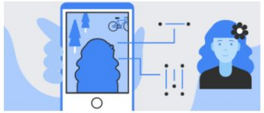
Optimized for Mobile

Easy to Use

Okay.. But what can it do?

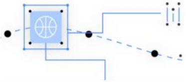
Vision APIs

Face Detection



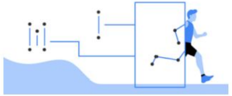
Selfie Segmentation

Barcode Scanning



Object Tracking

Pose Detection



Text Recognition

Digital Ink Recognition

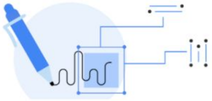
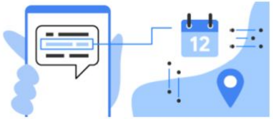


Image Labeling

Natural Language APIs

Language ID



Entity Extraction

Smart Reply

On-Device Translation

Who can use it??

Everyone!

ML Kit is available for both Android and iOS!

Meet our Client: Steve

Steve is my Dad.

He really likes gardening.

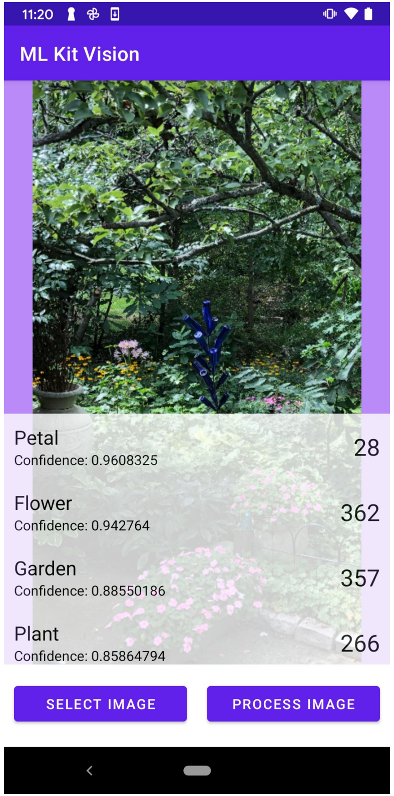
He plants a lot of things and can’t always remember what everything is.

He finally knows what I do for work.

He ask if we could write an app to help.

With ML Kit the answer is YES

Let’s get our app started!



Petal 28
Confidence: 0.9608325

Flower 362
Confidence: 0.942764

Garden 357
Confidence: 0.88550186

Plant 266
Confidence: 0.85864794

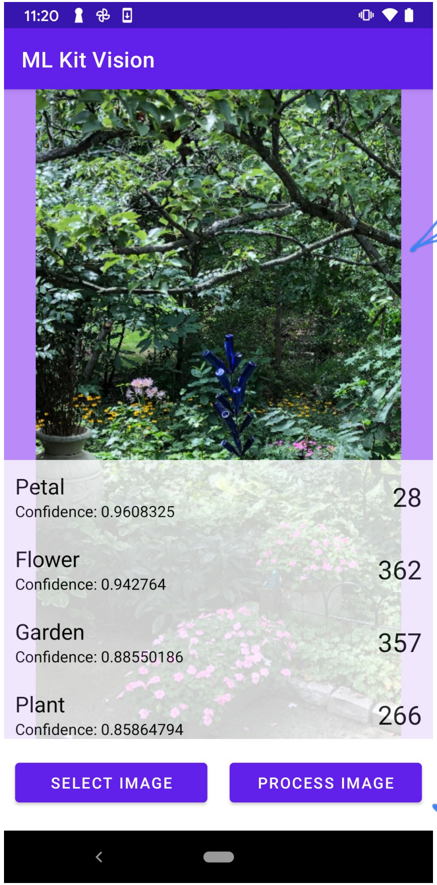
First, a little vocabulary + background

We'll be writing a **native Android** app using **Kotlin**. All of our code is will be in our **Activity**.

What are we building?

We're going to build a simple single Activity app

ConstraintLayout



11:20

ML Kit Vision

Petal 28
Confidence: 0.9608325

Flower 362
Confidence: 0.942764

Garden 357
Confidence: 0.88550186

Plant 266
Confidence: 0.85864794

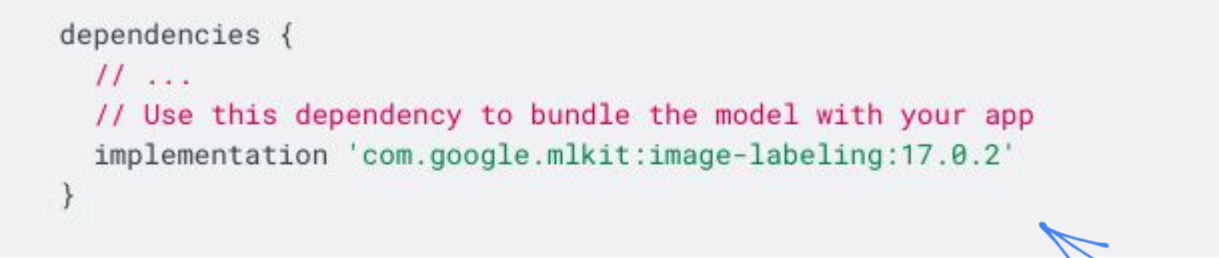
ImageView

RecyclerView

Some Buttons

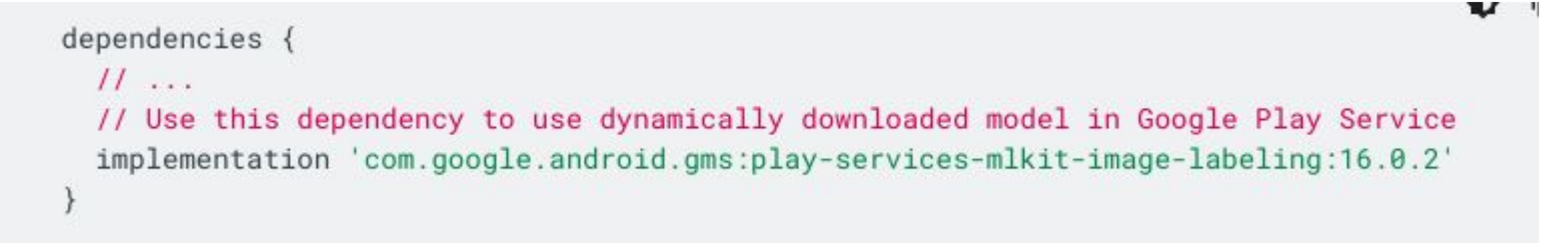
How do we use it?

We need to add the Image Labeling dependency to our gradle

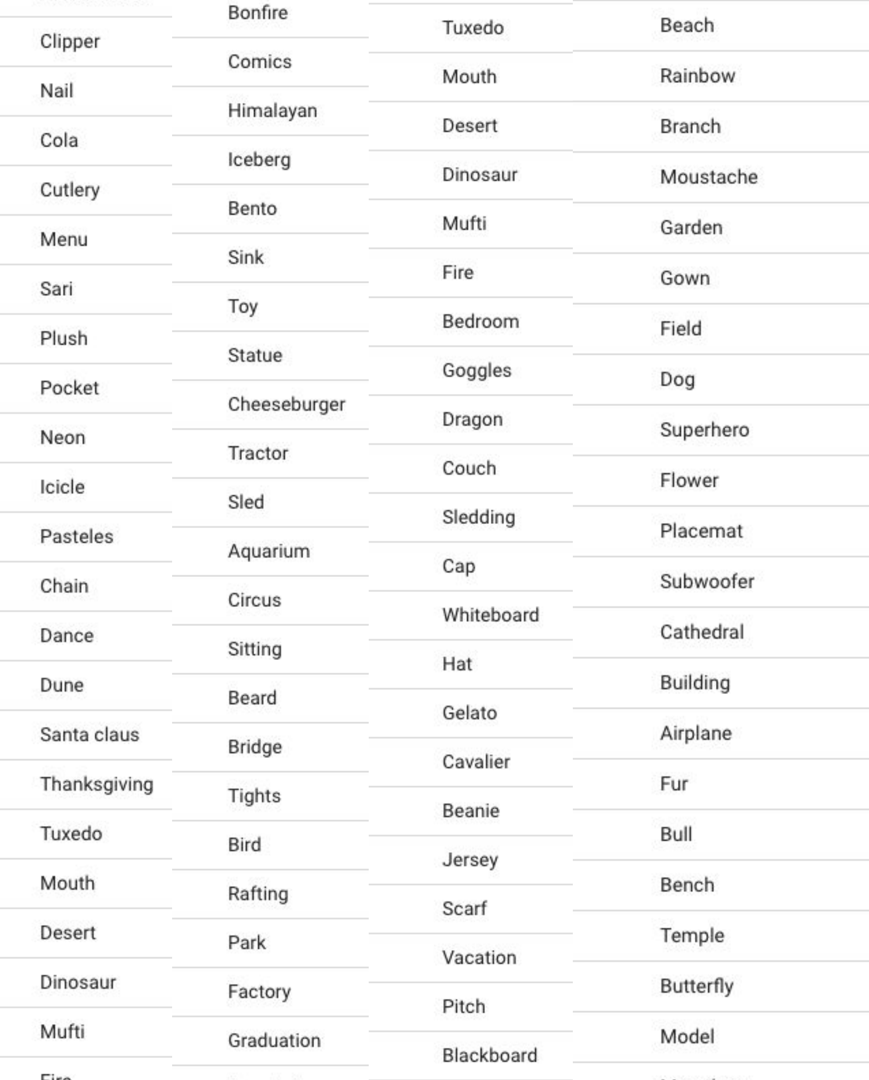


```
dependencies {
  // ...
  // Use this dependency to bundle the model with your app
  implementation 'com.google.mlkit:image-labeling:17.0.2'
}
```

I’m going to bundle it with the app



```
dependencies {
  // ...
  // Use this dependency to use dynamically downloaded model in Google Play Service
  implementation 'com.google.android.gms:play-services-mlkit-image-labeling:16.0.2'
}
```



Clipper
Nail
Cola
Cutlery
Menu
Sari
Plush
Pocket
Neon
Icicle
Pasteles
Chain
Dance
Dune
Santa claus
Thanksgiving
Tuxedo
Mouth
Desert
Dinosaur
Mufti
Fire

Bonfire
Comics
Himalayan
Iceberg
Bento
Sink
Toy
Statue
Cheeseburger
Tractor
Sled
Aquarium
Circus
Sitting
Beard
Bridge
Tights
Bird
Rafting
Park
Factory
Graduation

Tuxedo
Mouth
Desert
Dinosaur
Mufti
Fire
Bedroom
Goggles
Dragon
Couch
Sledding
Cap
Whiteboard
Hat
Gelato
Cavalier
Beanie
Jersey
Scarf
Vacation
Pitch
Blackboard

Beach
Rainbow
Branch
Moustache
Garden
Gown
Field
Dog
Superhero
Flower
Placemat
Subwoofer
Cathedral
Building
Airplane
Fur
Bull
Bench
Temple
Butterfly
Model

We’re just going to use the Base Model

Step One
Prepare the Input Image

First, we need to let Steve pick an Image from his photos.

Then, we need to take that URI and transform it into a Bitmap.

```
private fun startChooseImageIntentForResult () {
   val intent = Intent()
   intent.type = "image/*"
   intent.action = Intent.ACTION_GET_CONTENT
   startActivityForResult(
       Intent.createChooser(intent, "Select
Picture"),
       REQUEST_CHOOSE_IMAGE
   )
}

override fun onActivityResult(
   requestCode: Int,
   resultCode: Int,
   data: Intent?
) {
   onSelectImageResult(data?. data != null)
   if (requestCode == REQUEST CHOOSE IMAGE &&
       resultCode == Activity.RESULT_OK
   ) {
       val imageUri = data!!.data
       setPreview(imageUri)
   } else {
       super.onActivityResult(
           requestCode, resultCode, data
        )
   }
}
```

Step One
Prepare the Input Image

First, we need to let Steve pick an Image from his photos

Then, we need to take that URI and transform it into a Bitmap

```
private fun setPreview(imageUri: Uri?) {
   try {
       if (imageUri == null) return

       val preview = findViewById<ImageView>(R.id.preview)

       val imageBitmap = getBitmapFromUri(imageUri) ?: return

       this.imageBitmap = imageBitmap

       preview.setImageBitmap(imageBitmap)

   } catch (e: IOException) {
       Toast.makeText(this,
           getString(R.string.something_went_wrong),
           Toast.LENGTH_SHORT
       ).show()
   }
}

@Throws(IOException::class)
private fun getBitmapFromUri(uri: Uri): Bitmap? {
   val parcelFileDescriptor =
       contentResolver.openFileDescriptor(uri, "r")
   val fileDescriptor = parcelFileDescriptor?.fileDescriptor
   val image = BitmapFactory
      .decodeFileDescriptor(fileDescriptor)
   parcelFileDescriptor?.close()
   return image
}
```

Process the image

Now that we have our bitmap, we can convert that to an imageInput.

Then we can create our labeler. In this case, we're just using the default options.

```
if (imageBitmap != null) {
   val imageInput = InputImage.fromBitmap(imageBitmap!!, 0)

   val labeler = ImageLabeling.getClient(ImageLabelerOptions.DEFAULT_OPTIONS)

   labeler.process(imageInput).addOnSuccessListener { labels ->

      // do something with our labels

   }.addOnFailureListener {
       Toast.makeText(this, getString(R.string.nothing_found), Toast.LENGTH_SHORT).show()
   }
}
```

Finally, we can can process our imageInput with our labeler

We add an onSuccessListener for when it works YAY!

And a onFailureListener for when it doesn't):

Send our labels to our view

```
if (imageBitmap != null) {
    val imageInput = InputImage.fromBitmap(imageBitmap!!, 0)

    val labeler = ImageLabeling.getClient(ImageLabelerOptions.DEFAULT_OPTIONS)

    labeler.process(imageInput).addOnSuccessListener { labels ->

        val recyclerView = findViewById<RecyclerView>(R.id.labels)
        recyclerView.layoutManager = LinearLayoutManager(this)
        recyclerView.adapter = LabelAdapter(labels)
        recyclerView.visibility = View.VISIBLE

    }.addOnFailureListener {
        Toast.makeText(this, getString(R.string.nothing_found), Toast.LENGTH_SHORT).show()
    }
}
```

When we successfully process our image, we get back a list of labels

For our simple app, we’re going to display our list of labels in a recyclerView so we pass them into an adapter

Display the Labels

Each ImageLabel (in our list of ImageLabels) has a

Text (String)
Confidence (Float)
Index (Integer)

```
fun bind(imageLabel: ImageLabel) {
    label.text = imageLabel.text
    confidence.text = String.format(
        itemView.resources.getString(R.string.confidence_format),
        imageLabel.confidence.toString()
    )
    index.text = imageLabel.index.toString()
}
```

In our simple example, we bind those to our row view and we're good to go!

And with that we have an app!

Let’s try it out!

Where to go from here

Maybe make a custom data model to label plants

Let’s do it!

How do we get started with custom models?

The docs for Custom Models with ML Kit tell you there are four different ways to get started:

- TensorFlow Hub
- TensorFlow
- AutoML Vision Edge
- TensorFlow Lite Model Maker.

What are the differences??

How do we get started with custom models?

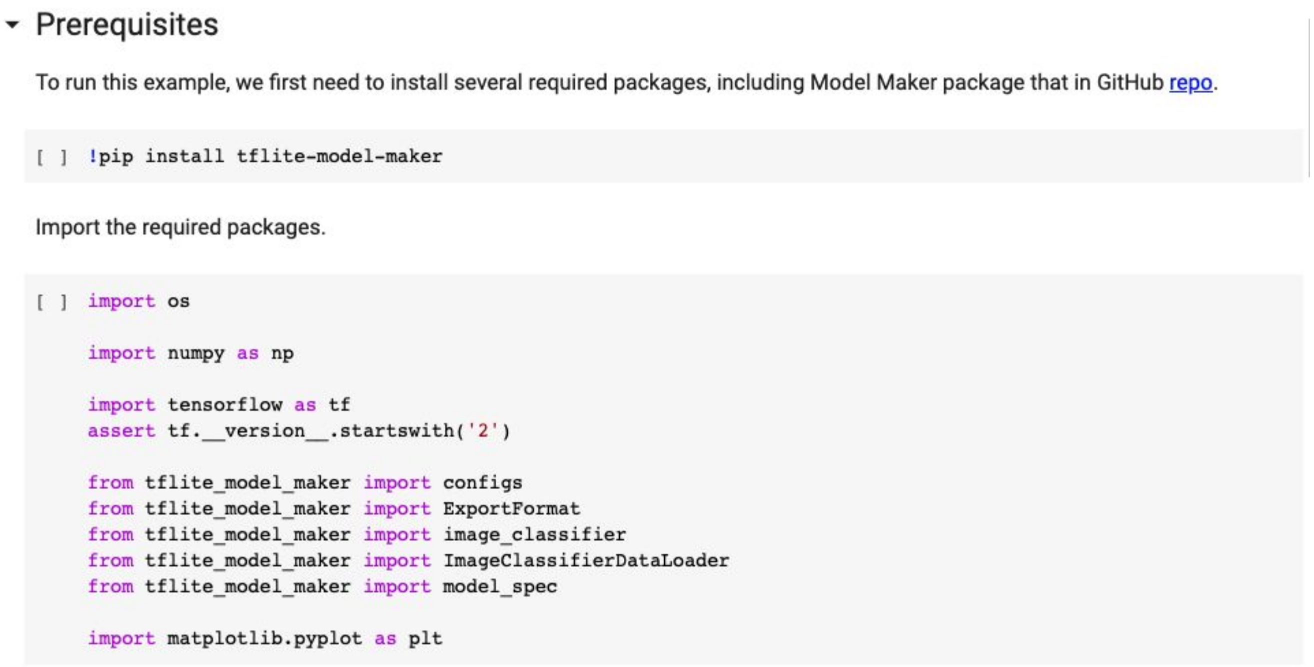
The docs for Custom Models with ML Kit tells you there are four different ways to get started:

- TensorFlow Hub
- TensorFlow
- AutoML Vision Edge
- TensorFlow Lite Model Maker.

Re-train a model (transfer learning), takes less time and requires less data than training a model from scratch

We're going to use this model maker

Creating a Custom Model



Prerequisites

To run this example, we first need to install several required packages, including Model Maker package that in GitHub repo.

```
[ ]  !pip install tflite-model-maker
```

Import the required packages.

```
[ ]  import os

     import numpy as np

     import tensorflow as tf
     assert tf.__version__.startswith('2')

     from tflite_model_maker import configs
     from tflite_model_maker import ExportFormat
     from tflite_model_maker import image_classifier
     from tflite_model_maker import ImageClassifierDataLoader
     from tflite_model_maker import model_spec

     import matplotlib.pyplot as plt
```

Creating a Custom Model

```
image_path = tf.keras.utils.get_file(
     'flower_photos.tgz',
     'https://path/to/flower_photos.tgz',
     extract=True
)
image_path = os.path.join(
     os.path.dirname(image_path),
     'Flower_photos'
)
```

Creating a Custom Model

First we load the data

```
data = ImageClassifierDataLoader.from_folder(image_path)
 INFO:tensorflow:Load image with size: 3670, num_label: 5, labels: daisy,
 dandelion, roses, sunflowers, tulips.
```

Then we split our data into 90% training and 10% test

```
train_data, test_data = data.split(0.9)
```

```
model = image_classifier.create(train_data)
```

Create a custom image classifier model from our training data

```
loss, accuracy = model.evaluate(test_data)
```

Use our test data to test evaluate the accuracy of model

```
model.export(export_dir='.')
```

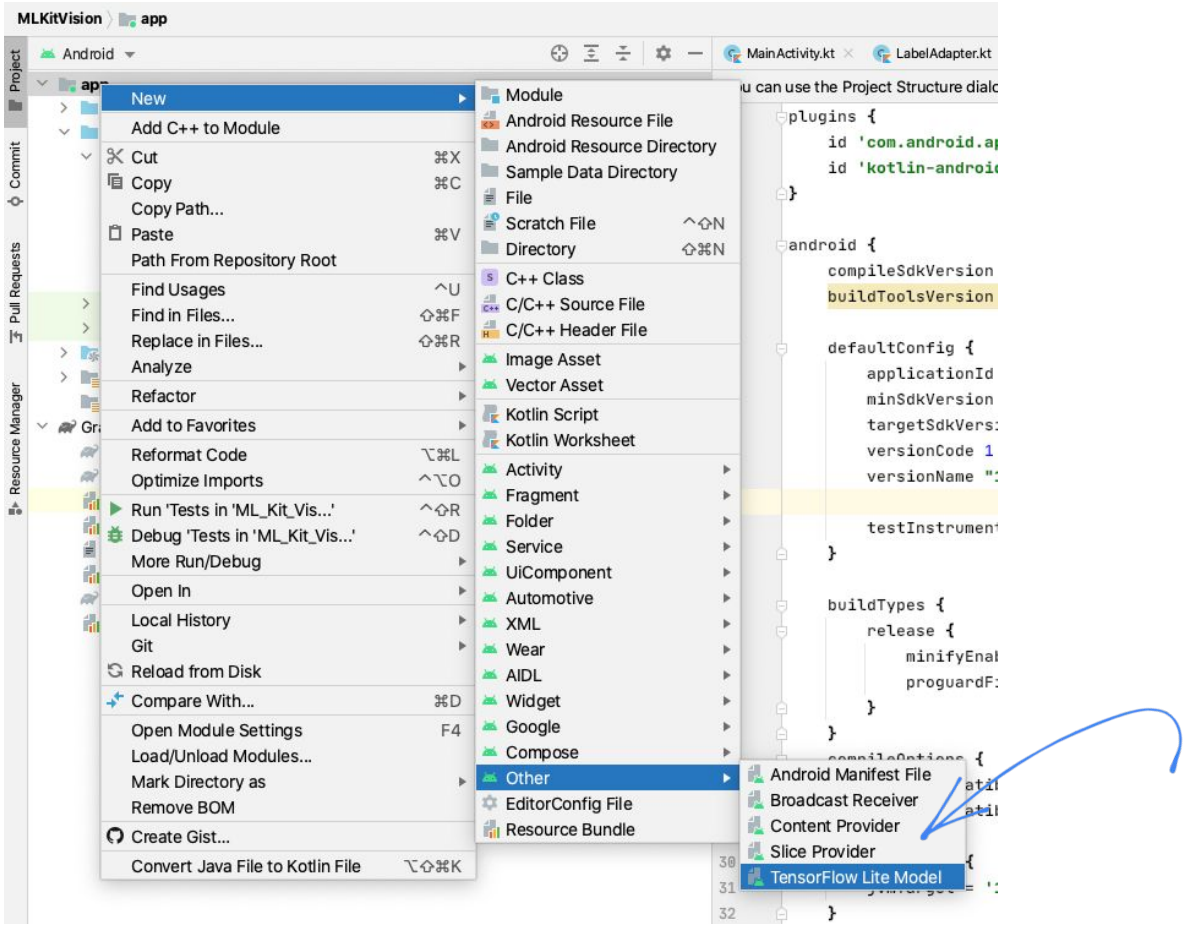
We're done! Export our model!

Creating a Custom Model

```
model = image_classifier.create(train_data)
```

Learn more about transfer learning here

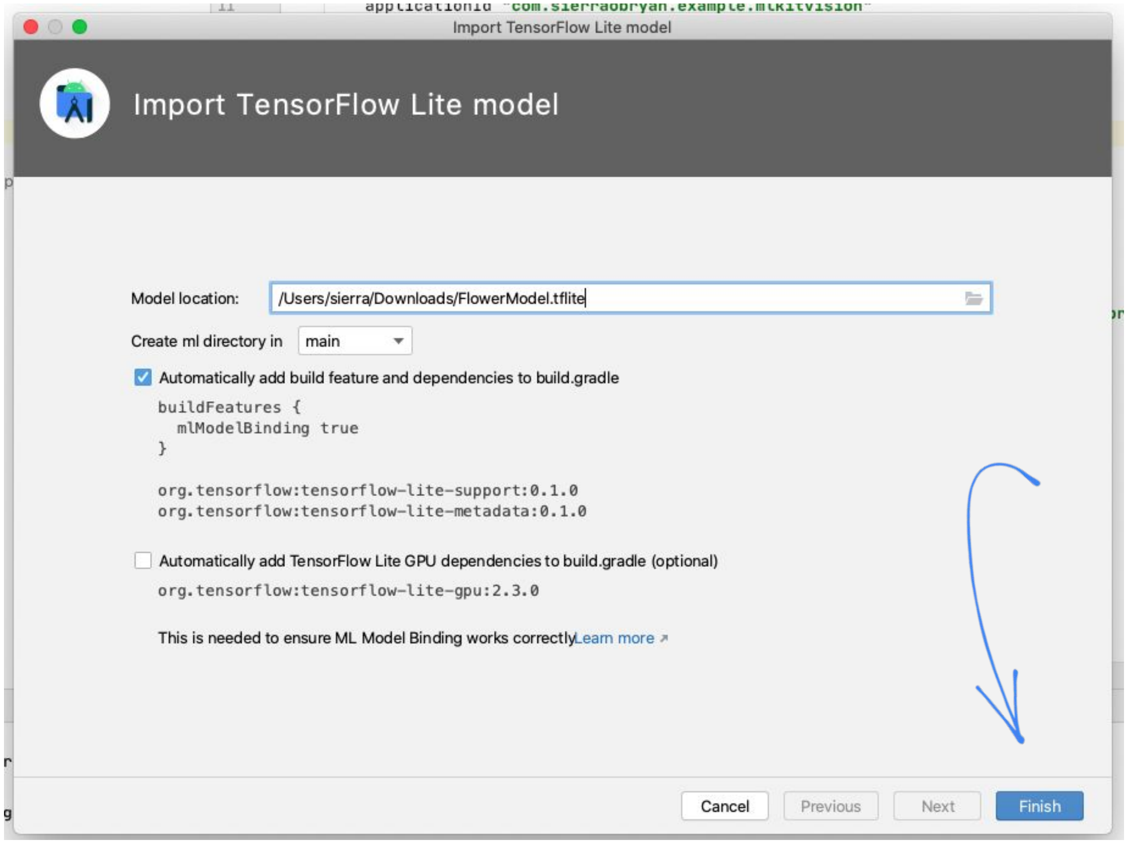
Adding the model to your project



```
u can use the Project Structure dialo
plugins {
    id 'com.android.ap
    id 'kotlin-androi
}

android {
    compileSdkVersion
    buildToolsVersion

    defaultConfig {
        applicationId
        minSdkVersion
        targetSdkVers:
        versionCode 1
        versionName ":

        testInstrument
    }

    buildTypes {
        release {
            minifyEnal
            proguardF:
        }
    }
    compileOptions {
```

All the way down here

Adding the model to your project



applicationId "com.sierraobryan.example.mlkitvision"

Import TensorFlow Lite model

Import TensorFlow Lite model

Model location: /Users/sierra/Downloads/FlowerModel.tflite

Create ml directory in main

☑ Automatically add build feature and dependencies to build.gradle

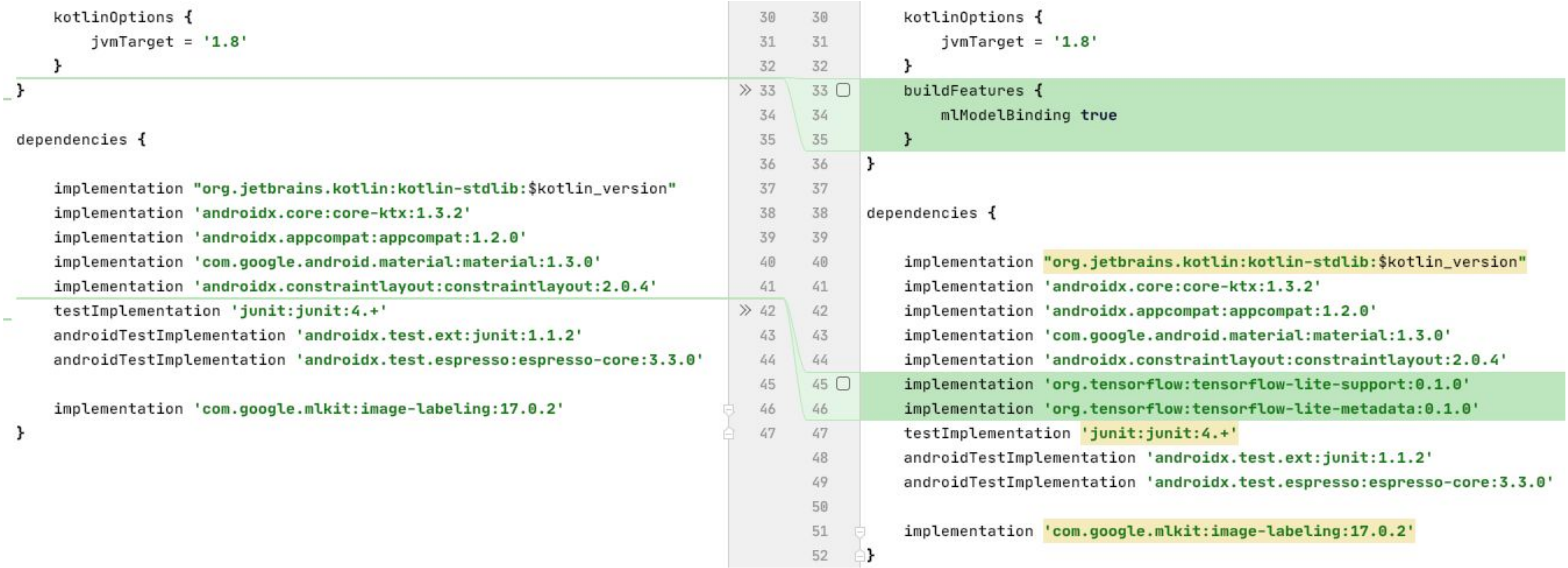
```
buildFeatures {
  mlModelBinding true
}

org.tensorflow:tensorflow-lite-support:0.1.0
org.tensorflow:tensorflow-lite-metadata:0.1.0
```

□ Automatically add TensorFlow Lite GPU dependencies to build.gradle (optional)

```
org.tensorflow:tensorflow-lite-gpu:2.3.0
```

This is needed to ensure ML Model Binding works correctlyLearn more ↗

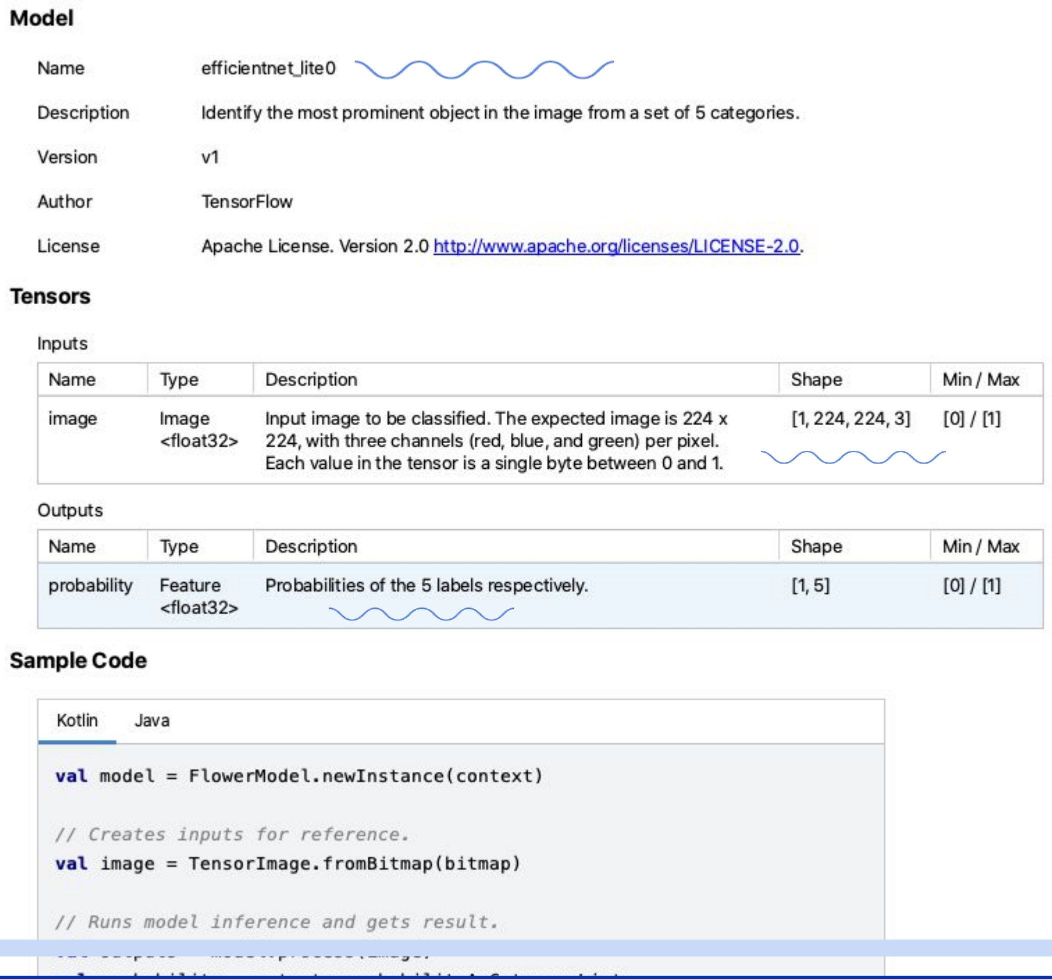
Adding the model to your project



```
    kotlinOptions {
        jvmTarget = '1.8'
    }
}

dependencies {

    implementation "org.jetbrains.kotlin:kotlin-stdlib:$kotlin_version"
    implementation 'androidx.core:core-ktx:1.3.2'
    implementation 'androidx.appcompat:appcompat:1.2.0'
    implementation 'com.google.android.material:material:1.3.0'
    implementation 'androidx.constraintlayout:constraintlayout:2.0.4'
    testImplementation 'junit:junit:4.+'
    androidTestImplementation 'androidx.test.ext:junit:1.1.2'
    androidTestImplementation 'androidx.test.espresso:espresso-core:3.3.0'

    implementation 'com.google.mlkit:image-labeling:17.0.2'
}
```

```
    kotlinOptions {
        jvmTarget = '1.8'
    }
    buildFeatures {
        mlModelBinding true
    }
}

dependencies {

    implementation "org.jetbrains.kotlin:kotlin-stdlib:$kotlin_version"
    implementation 'androidx.core:core-ktx:1.3.2'
    implementation 'androidx.appcompat:appcompat:1.2.0'
    implementation 'com.google.android.material:material:1.3.0'
    implementation 'androidx.constraintlayout:constraintlayout:2.0.4'
    implementation 'org.tensorflow:tensorflow-lite-support:0.1.0'
    implementation 'org.tensorflow:tensorflow-lite-metadata:0.1.0'
    testImplementation 'junit:junit:4.+'
    androidTestImplementation 'androidx.test.ext:junit:1.1.2'
    androidTestImplementation 'androidx.test.espresso:espresso-core:3.3.0'

    implementation 'com.google.mlkit:image-labeling:17.0.2'
}
```

Adding the model to your project



Model

Name	efficientnet_lite0
Description	Identify the most prominent object in the image from a set of 5 categories.
Version	v1
Author	TensorFlow
License	Apache License. Version 2.0 http://www.apache.org/licenses/LICENSE-2.0.

Tensors

Inputs

Name	Type	Description	Shape	Min / Max
image	Image <float32>	Input image to be classified. The expected image is 224 x 224, with three channels (red, blue, and green) per pixel. Each value in the tensor is a single byte between 0 and 1.	[1, 224, 224, 3]	[0] / [1]

Outputs

Name	Type	Description	Shape	Min / Max
probability	Feature <float32>	Probabilities of the 5 labels respectively.	[1, 5]	[0] / [1]

Sample Code

```kotlin
val model = FlowerModel.newInstance(context)

// Creates inputs for reference.
val image = TensorImage.fromBitmap(bitmap)

// Runs model inference and gets result.
val outputs = model.process(image)
```

Let’s use our new model!

This time we’ll convert our bitmap to a TensorImage

```
val tfImage = TensorImage.fromBitmap(bitmap)
```

We’ll create a new instance of our Model

```
val flowerModel = FlowerModel.newInstance( this)
```

And now we’ll process

```
val outputs = flowerModel.process(tfImage)
    .probabilityAsCategoryList.apply {
        sortByDescending { it.score }
    }

if (outputs.isNotEmpty()) {
    val recyclerView = findViewById<RecyclerView>(R.id. labels)
    recyclerView. layoutManager = LinearLayoutManager( this)
    recyclerView. adapter = TFImageAdapter(outputs)
    recyclerView. visibility = View. VISIBLE
}
```

Let’s use our new model!

```
fun bind(category: Category) {
    label.text = category.label
    confidence.text = String.format(
        itemView.resources.getString(R.string.confidence_format),
        category.score * 100
    )
}
```

This time we’re going to get a list of Categories passed into our adapter

Each Category has a label and a confidence

And with that we have an app with a custom model!

Let’s try it out!

And on our original backyard image

Let’s try it out!

YAY! We can label five flowers

Daisies

Dandelion

Roses

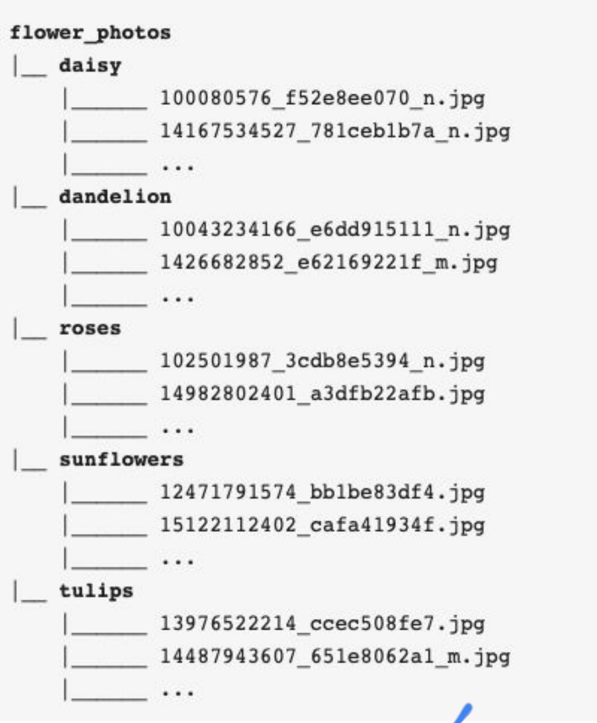
Sunflowers

Tulips

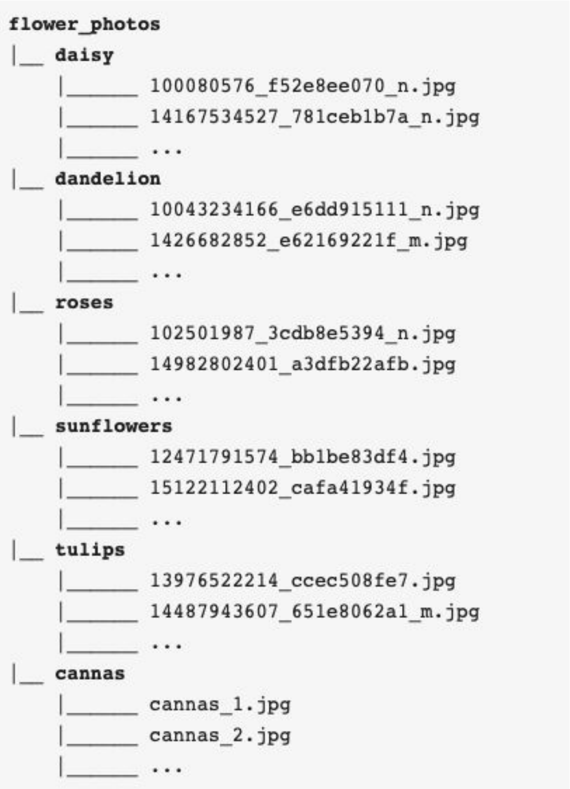
Cannas

But what happens if we want to label a sixth?

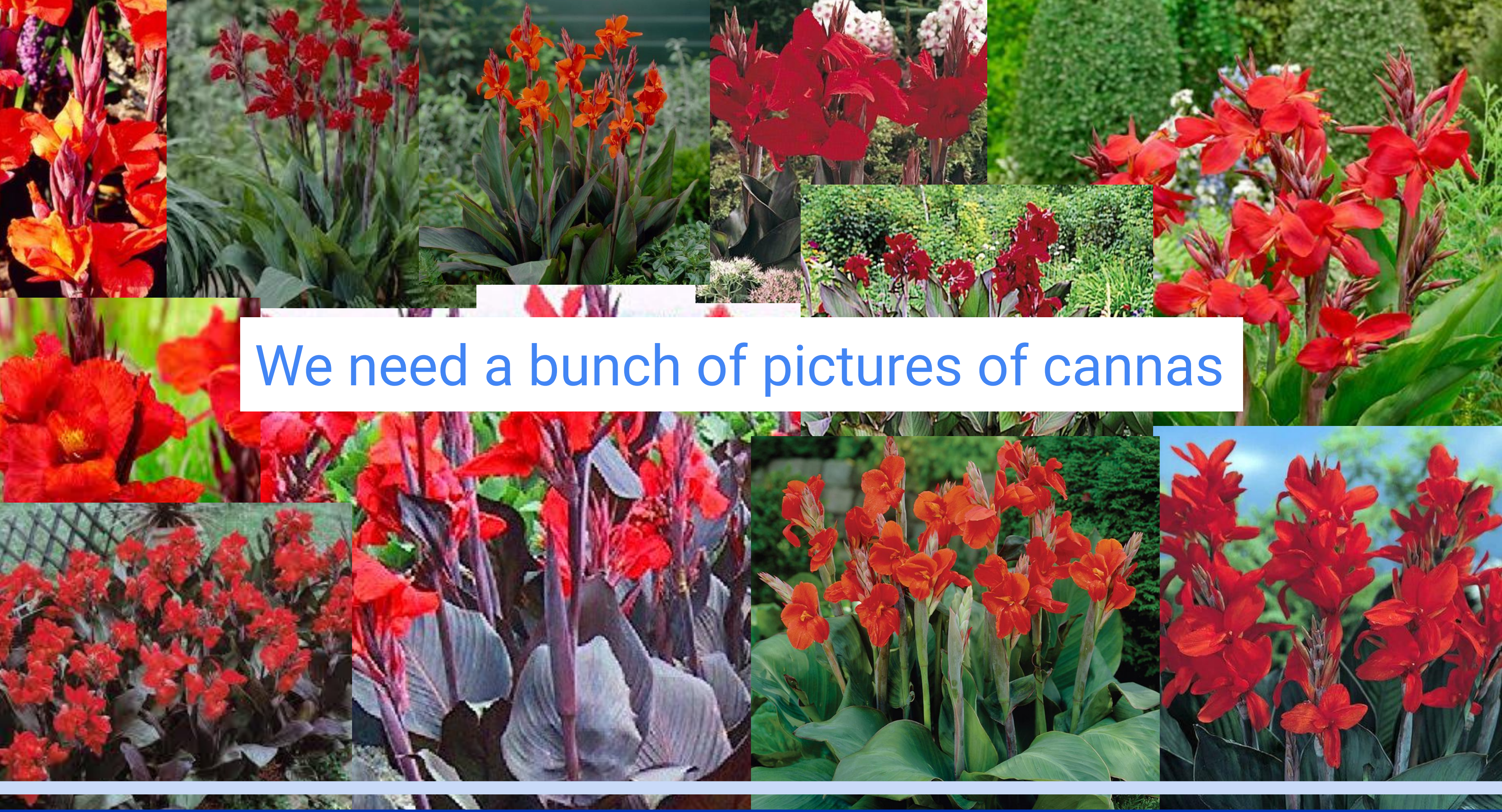
Easy - we're ML Kit experts now



```
flower_photos
|__ daisy
    |______ 100080576_f52e8ee070_n.jpg
    |______ 14167534527_781ceb1b7a_n.jpg
    |______ ...
|__ dandelion
    |______ 10043234166_e6dd915111_n.jpg
    |______ 1426682852_e62169221f_m.jpg
    |______ ...
|__ roses
    |______ 102501987_3cdb8e5394_n.jpg
    |______ 14982802401_a3dfb22afb.jpg
    |______ ...
|__ sunflowers
    |______ 12471791574_bb1be83df4.jpg
    |______ 15122112402_cafa41934f.jpg
    |______ ...
|__ tulips
    |______ 13976522214_ccec508fe7.jpg
    |______ 14487943607_651e8062a1_m.jpg
    |______ ...
```



```
flower_photos
|__ daisy
    |______ 100080576_f52e8ee070_n.jpg
    |______ 14167534527_781ceb1b7a_n.jpg
    |______ ...
|__ dandelion
    |______ 10043234166_e6dd915111_n.jpg
    |______ 1426682852_e62169221f_m.jpg
    |______ ...
|__ roses
    |______ 102501987_3cdb8e5394_n.jpg
    |______ 14982802401_a3dfb22afb.jpg
    |______ ...
|__ sunflowers
    |______ 12471791574_bb1be83df4.jpg
    |______ 15122112402_cafa41934f.jpg
    |______ ...
|__ tulips
    |______ 13976522214_ccec508fe7.jpg
    |______ 14487943607_651e8062a1_m.jpg
    |______ ...
|__ cannas
    |______ cannas_1.jpg
    |______ cannas_2.jpg
    |______ ...
```



We need a bunch of pictures of cannas

Adding the model to your project

```
image_path = tf.keras.utils.get_file(
          'flowers-new.zip',
          'file:///content/flowers-new.zip',
          extract=True)
image_path = os.path.join(
          os.path.dirname(image_path),
          'Flowers-new')
```

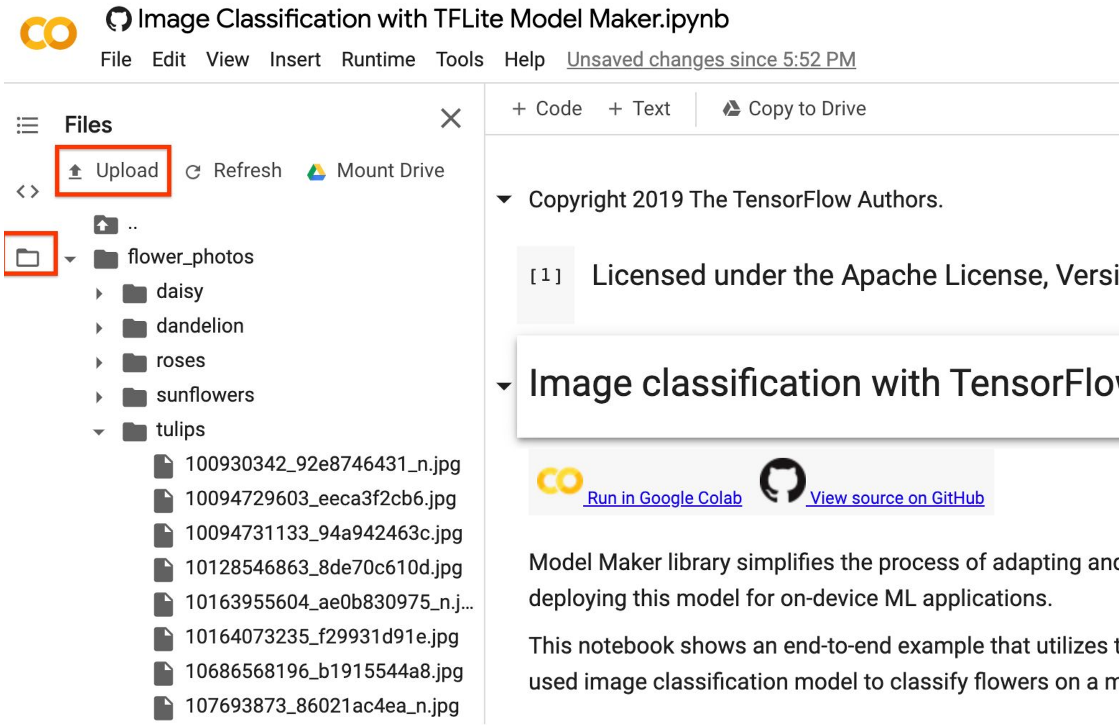


Image Classification with TFLite Model Maker.ipynb

..
flower_photos
daisy
dandelion
roses
sunflowers
tulips
100930342_92e8746431_n.jpg
10094729603_eeca3f2cb6.jpg
10094731133_94a942463c.jpg
10128546863_8de70c610d.jpg
10163955604_ae0b830975_n.j...
10164073235_f29931d91e.jpg
10686568196_b1915544a8.jpg
107693873_86021ac4ea_n.jpg

Copyright 2019 The TensorFlow Authors.

[1] Licensed under the Apache License, Versi

Image classification with TensorFlo

Model Maker library simplifies the process of adapting anc deploying this model for on-device ML applications.

This notebook shows an end-to-end example that utilizes t used image classification model to classify flowers on a m

And with that we have an app with our custom model!

Let’s try it out!

Where to go from here

~~Maybe make a custom data model to label plants~~

Maybe use the camera so that I don’t have to load an image

Let’s do it!

How do we get started with the camera?

Well actually this turns out to be a pretty frustrating and in depth process but here are the basics:

- You'll need to add the camera dependencies to your gradle for the camera, lifecycle, and view
- You'll also need to add the permission to your manifest and ask the user for permission
- Then we'll add some code to the activity to process the image

How do we get started with the camera?

Well actually this turns out to be a pretty frustrating and in depth process but here are the basics (cont.) :

- We’ll use the ProcessCameraProvider and the ImageAnalysis classes to bind the camera to our activity and build an image analyzer that will convert the imageProxy to a bitmap that can then be passed into the process function of our model and then back into our RecyclerView (and display in the PreviewView)

There’s a lot happening in this sentence - this is completed on branch ml-kit-camera

Once all that is implemented, we have a really cool app!

Let’s try it out!

Where to go from here

~~Maybe make a custom data model to label plants~~

~~Maybe use the camera so that I don’t have to load an image~~

Maybe overlay the image with the labels

Rewrite in Jetpack Compose!

Convince my dad to use an Android Phone so he can use it):

With great power comes great responsibility

Thank you!

Where can you find this code?

https://github.com/sierraobryan/examples/tree/main/MLKitVision

Where can you find me?

@_sierraOBryan

https://sierraobryan.dev/

SierraOBryan

SIERRA OBRYAN

Questions?

A very happy client