<img style="width : 100%;margin: auto;" src="https://www.google.com/search?q=leaf+disease&sxsrf=ALiCzsb-Fr5LvT82eoxXJt3fDQmP8Qo_cA:1654161628719&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiGpZ-iuI74AhVKBaYKHYEJBIMQ_AUoAXoECAIQAw&biw=1707&bih=806&dpr=1.13#imgrc=BJHS-ZYd7zmuTM&imgdii=O8NuCBPDZa8ipM>

```
import warnings
warnings.filterwarnings("ignore")
import tensorflow as tf
import matplotlib.pyplot as plt
tf.compat.v1.set_random_seed(0)
from tensorflow import keras
import numpy as np
np.random.seed(0)
import itertools
from keras.preprocessing.image import image_dataset_from_directory
from tensorflow.keras.layers.experimental.preprocessing import
Rescaling
from sklearn.metrics import precision_score, accuracy_score,
recall_score, confusion_matrix, ConfusionMatrixDisplay
```

Setting up Image Data Generators

```
#train_gen = image_dataset_from_directory(directory="../input/new-
plant-diseases-dataset/train",image_size=(256, 256))
#test_gen = image_dataset_from_directory(directory="../input/new-
plant-diseases-dataset/valid",image_size=(256, 256))

train_gen = image_dataset_from_directory(directory="../input/new-
plant-diseases-dataset/New Plant Diseases Dataset(Augmented)/New Plant
Diseases Dataset(Augmented)/train",
                                         image_size=(256, 256))
test_gen = image_dataset_from_directory(directory="../input/new-plant-
diseases-dataset/New Plant Diseases Dataset(Augmented)/New Plant
Diseases Dataset(Augmented)/valid",
                                        image_size=(256, 256))

rescale = Rescaling(scale=1.0/255)
train_gen = train_gen.map(lambda image,label:(rescale(image),label))
test_gen  = test_gen.map(lambda image,label:(rescale(image),label))
```

```
Found 70295 files belonging to 38 classes.
```

```
2022-06-02 09:49:51.830329: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:51.990947: I
```

```
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:51.991830: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:51.994026: I
tensorflow/core/platform/cpu_feature_guard.cc:142] This TensorFlow
binary is optimized with oneAPI Deep Neural Network Library (oneDNN)
to use the following CPU instructions in performance-critical
operations:  AVX2 AVX512F FMA
To enable them in other operations, rebuild TensorFlow with the
appropriate compiler flags.
2022-06-02 09:49:51.994343: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:51.995141: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:51.995803: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:54.246926: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:54.247814: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:54.248494: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be
at least one NUMA node, so returning NUMA node zero
2022-06-02 09:49:54.249073: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1510] Created
device /job:localhost/replica:0/task:0/device:GPU:0 with 15403 MB
memory:  -> device: 0, name: Tesla P100-PCIE-16GB, pci bus id:
0000:00:04.0, compute capability: 6.0
```

```
Found 17572 files belonging to 38 classes.
```

```
model = keras.Sequential()

model.add(keras.layers.Conv2D(32,
(3,3),activation="relu",padding="same",input_shape=(256,256,3)))
```

```
model.add(keras.layers.Conv2D(32,
(3,3),activation="relu",padding="same"))
model.add(keras.layers.MaxPooling2D(3,3))

model.add(keras.layers.Conv2D(64,
(3,3),activation="relu",padding="same"))
model.add(keras.layers.Conv2D(64,
(3,3),activation="relu",padding="same"))
model.add(keras.layers.MaxPooling2D(3,3))

model.add(keras.layers.Conv2D(128,
(3,3),activation="relu",padding="same"))
model.add(keras.layers.Conv2D(128,
(3,3),activation="relu",padding="same"))
model.add(keras.layers.MaxPooling2D(3,3))

model.add(keras.layers.Conv2D(256,
(3,3),activation="relu",padding="same"))
model.add(keras.layers.Conv2D(256,
(3,3),activation="relu",padding="same"))

model.add(keras.layers.Conv2D(512,
(5,5),activation="relu",padding="same"))
model.add(keras.layers.Conv2D(512,
(5,5),activation="relu",padding="same"))

model.add(keras.layers.Flatten())

model.add(keras.layers.Dense(1568,activation="relu"))
model.add(keras.layers.Dropout(0.5))

model.add(keras.layers.Dense(38,activation="softmax"))

opt = keras.optimizers.Adam(learning_rate=0.0001)
model.compile(optimizer=opt,loss="sparse_categorical_crossentropy",met
rics=['accuracy'])
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 256, 256, 32)      896
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 256, 256, 32)      9248
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 85, 85, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 85, 85, 64)        18496
_________________________________________________________________
```

```
conv2d_3 (Conv2D)            (None, 85, 85, 64)        36928
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 28, 28, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 28, 28, 128)       73856
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 28, 28, 128)       147584
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 9, 9, 128)         0
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 9, 9, 256)         295168
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 9, 9, 256)         590080
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 9, 9, 512)         3277312
_________________________________________________________________
conv2d_9 (Conv2D)            (None, 9, 9, 512)         6554112
_________________________________________________________________
flatten (Flatten)            (None, 41472)             0
_________________________________________________________________
dense (Dense)                (None, 1568)              65029664
_________________________________________________________________
dropout (Dropout)            (None, 1568)              0
_________________________________________________________________
dense_1 (Dense)              (None, 38)                59622
=================================================================
Total params: 76,092,966
Trainable params: 76,092,966
Non-trainable params: 0
_________________________________________________________________
```

```
ep = 10
history = model.fit_generator(train_gen,
          validation_data=test_gen,
          epochs = ep)
```

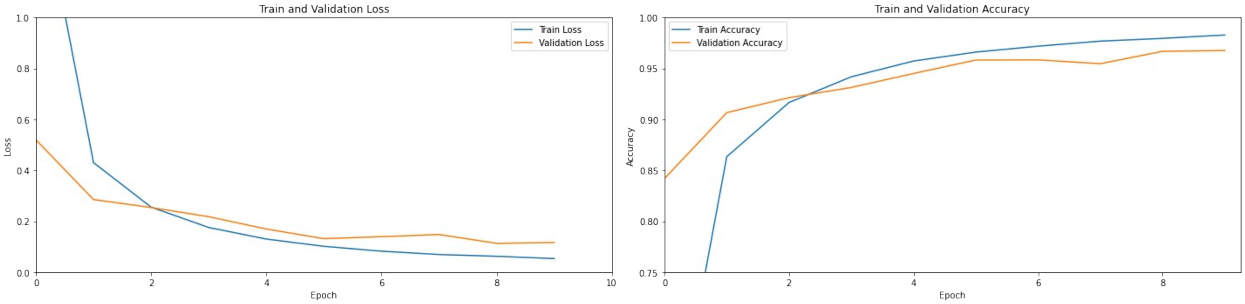
```
Epoch 1/10
```

```
2022-06-02 09:49:57.725110: I
tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:185] None of
the MLIR Optimization Passes are enabled (registered 2)
2022-06-02 09:50:00.285178: I
tensorflow/stream_executor/cuda/cuda_dnn.cc:369] Loaded cuDNN version
8005
```

```
2197/2197 [==============================] - 316s 140ms/step - loss:
1.6022 - accuracy: 0.5339 - val_loss: 0.5197 - val_accuracy: 0.8419
Epoch 2/10
2197/2197 [==============================] - 195s 89ms/step - loss:
0.4302 - accuracy: 0.8633 - val_loss: 0.2852 - val_accuracy: 0.9066
```

```
Epoch 3/10
2197/2197 [==============================] - 194s 88ms/step - loss:
0.2553 - accuracy: 0.9166 - val_loss: 0.2539 - val_accuracy: 0.9214
Epoch 4/10
2197/2197 [==============================] - 195s 88ms/step - loss:
0.1754 - accuracy: 0.9418 - val_loss: 0.2177 - val_accuracy: 0.9314
Epoch 5/10
2197/2197 [==============================] - 193s 88ms/step - loss:
0.1299 - accuracy: 0.9573 - val_loss: 0.1694 - val_accuracy: 0.9451
Epoch 6/10
2197/2197 [==============================] - 194s 88ms/step - loss:
0.1014 - accuracy: 0.9661 - val_loss: 0.1315 - val_accuracy: 0.9583
Epoch 7/10
2197/2197 [==============================] - 194s 88ms/step - loss:
0.0823 - accuracy: 0.9719 - val_loss: 0.1392 - val_accuracy: 0.9585
Epoch 8/10
2197/2197 [==============================] - 204s 93ms/step - loss:
0.0691 - accuracy: 0.9769 - val_loss: 0.1477 - val_accuracy: 0.9547
Epoch 9/10
2197/2197 [==============================] - 194s 88ms/step - loss:
0.0623 - accuracy: 0.9796 - val_loss: 0.1131 - val_accuracy: 0.9668
Epoch 10/10
2197/2197 [==============================] - 194s 88ms/step - loss:
0.0532 - accuracy: 0.9829 - val_loss: 0.1166 - val_accuracy: 0.9677
```

```
plt.figure(figsize = (20,5))
plt.subplot(1,2,1)
plt.title("Train and Validation Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.plot(history.history['loss'],label="Train Loss")
plt.plot(history.history['val_loss'], label="Validation Loss")
plt.xlim(0, 10)
plt.ylim(0.0,1.0)
plt.legend()

plt.subplot(1,2,2)
plt.title("Train and Validation Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.plot(history.history['accuracy'], label="Train Accuracy")
plt.plot(history.history['val_accuracy'], label="Validation Accuracy")
plt.xlim(0, 9.25)
plt.ylim(0.75,1.0)
plt.legend()
plt.tight_layout()
```

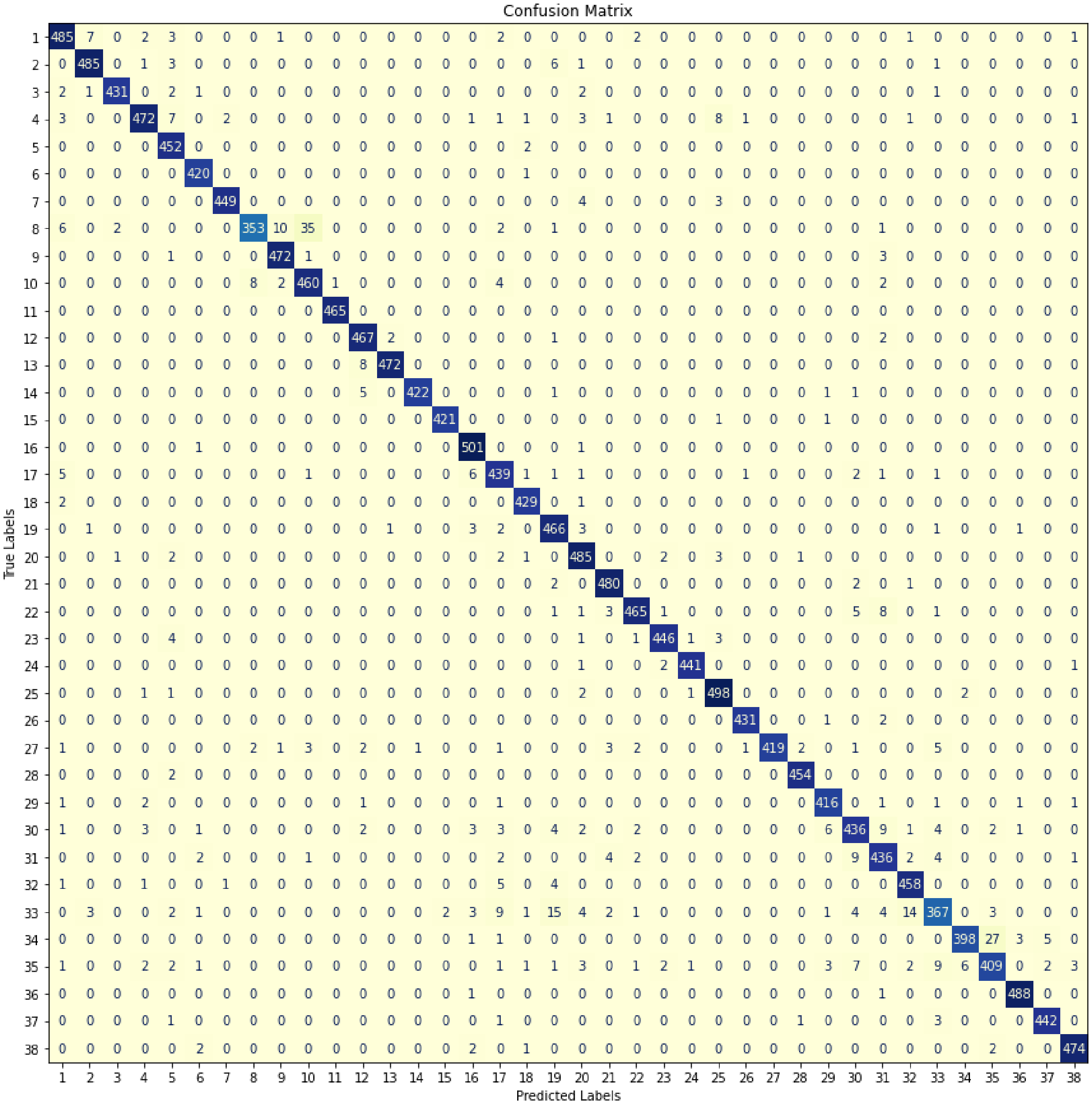


```
labels = []
predictions = []
for x,y in test_gen:
    labels.append(list(y.numpy()))
    predictions.append(tf.argmax(model.predict(x),1).numpy())

predictions = list(itertools.chain.from_iterable(predictions))
labels = list(itertools.chain.from_iterable(labels))

print("Train Accuracy  : {:.2f} %".format(history.history['accuracy']
[-1]*100))
print("Test Accuracy   : {:.2f} %".format(accuracy_score(labels,
predictions) * 100))
print("Precision Score : {:.2f} %".format(precision_score(labels,
predictions, average='micro') * 100))
print("Recall Score    : {:.2f} %".format(recall_score(labels,
predictions, average='micro') * 100))
```

```
Train Accuracy  : 98.29 %
Test Accuracy   : 96.77 %
Precision Score : 96.77 %
Recall Score    : 96.77 %
```

```
plt.figure(figsize= (20,5))
cm = confusion_matrix(labels, predictions)
disp = ConfusionMatrixDisplay(confusion_matrix=cm,
                              display_labels=list(range(1,39)))
fig, ax = plt.subplots(figsize=(15,15))
disp.plot(ax=ax,colorbar= False,cmap = 'YlGnBu')
plt.title("Confusion Matrix")
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```

```
<Figure size 1440x360 with 0 Axes>
```



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	485	7	0	2	3	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
2	0	485	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
3	2	1	431	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
4	3	0	0	472	7	0	2	0	0	0	0	0	0	0	0	1	1	1	0	3	1	0	0	0	8	1	0	0	0	0	0	1	0	0	0	0	0	1
5	0	0	0	0	452	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	420	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	449	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
8	6	0	2	0	0	0	0	353	10	35	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
9	0	0	0	0	1	0	0	0	472	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	8	2	460	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	465	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	467	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	8	472	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	5	0	422	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	421	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	501	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	439	1	1	1	0	0	0	0	0	1	0	0	0	2	1	0	1	0	0	0	0	0
18	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	429	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	3	2	0	466	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
20	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0	485	0	0	2	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	480	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	465	1	0	0	0	0	0	0	5	8	0	1	0	0	0	0	0
23	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	446	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	441	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	498	0	0	0	0	0	0	0	0	2	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	431	0	0	1	0	2	0	0	0	0	0	0	0
27	1	0	0	0	0	0	0	2	1	3	0	2	0	1	0	0	1	0	0	0	3	2	0	0	0	1	419	2	0	1	0	0	5	0	0	0	0	0
28	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	454	0	0	0	0	0	0	0	0	0	0
29	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	416	0	1	0	1	0	0	1	0	1
30	1	0	0	3	0	1	0	0	0	0	0	2	0	0	0	3	3	0	4	2	0	2	0	0	0	0	0	0	6	436	9	1	4	0	2	1	0	0
31	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	2	0	0	0	4	2	0	0	0	0	0	0	0	9	436	2	4	0	0	0	0	1
32	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	5	0	4	0	0	0	0	0	0	0	0	0	0	0	0	458	0	0	0	0	0	0
33	0	3	0	0	2	1	0	0	0	0	0	0	0	0	2	3	9	1	15	4	2	1	0	0	0	0	0	0	1	4	4	14	367	0	3	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	398	27	3	5	0
35	1	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	1	1	1	3	0	1	2	1	0	0	0	0	3	7	0	2	9	6	409	0	2	3
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	488	0	0
37	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	442	0
38	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	474