Hi to all!!!

I have prepared a notebook that works on both COLAB and KAGGLE!!!

In versions 3 and 4 I show the model I treated on Google COLAB for this notebook https://www.kaggle.com/aikhmelnytskyy/bagging-rainforest

IMPORTANTLY! This notebook didn't work after the changes to kaggle, but thanks to a discussion by Martin Görner and Allohvk (https://www.kaggle.com/c/rfcx-species-audio-detection/discussion/216408), I made the necessary changes in version 4 and now everything works. Here are the changes: from

@tf.function

def _preprocess_img(x, training=False, test=False):

to

@tf.function def _preprocess_img(x, training=False, test=False):

And from

def _specaugment(image):

```
    image = tfa.image.cutout(image, [HEIGHT, xsize[0]], offset=
    [HEIGHT//2, xoff[0]])
    image = tfa.image.cutout(image, [HEIGHT, xsize[1]], offset=
    [HEIGHT//2, xoff[1]])
    image = tfa.image.cutout(image, [ysize[0], WIDTH], offset=
    [yoff[0], WIDTH//2])
    image = tfa.image.cutout(image, [ysize[1], WIDTH], offset=
    [yoff[1], WIDTH//2])
    image = tf.squeeze(image, axis=0)
    return image
```

to

```
    #image = tfa.image.cutout(image, [HEIGHT, xsize[0]], offset=
    [HEIGHT//2, xoff[0]])
    #image = tfa.image.cutout(image, [HEIGHT, xsize[1]], offset=
    [HEIGHT//2, xoff[1]])
    #image = tfa.image.cutout(image, [ysize[0], WIDTH], offset=
    [yoff[0], WIDTH//2])
    #image = tfa.image.cutout(image, [ysize[1], WIDTH], offset=
    [yoff[1], WIDTH//2])
    image = tf.squeeze(image, axis=0)
    return image
```

Version 5 changes as shown in this discussion https://www.kaggle.com/c/rfcx-species-audio-

detection/discussion/218930 (special thanks to the author)
I used these notebooks as a basis: https://www.kaggle.com/mekhdigakhramanian/rfcx-resnet50-tpu https://www.kaggle.com/khoongweihao/resnet34-more-augmentations-mixup-tta-inference

It is important to work with colab you need kaggle.json (https://www.kaggle.com/docs/api)

I also created a folder called Models on my Google Drive and put the kaggle.json file in it.

In [1]:
```
import os

COLAB=False
models_path=''

if not os.path.exists('../input/rfcx-species-audio-detection'):# Let's che
    COLAB=True
    import gc
    from google.colab import drive
    drive.mount('/content/drive')# You must grant COLAB access to your Goo

    #!!!!!!!!!!!!!!!!!!!!!!!!!!!

    GCS_DS_PATH = 'gs://kds-5c677f76ce55440722b2a474a5492faa70847c05a8f5d7
    #This is a path to a dataset that changes over time, so you need to co
    #GCS_DS_PATH = KaggleDatasets (). Get_gcs_path ()
    #print (GCS_DS_PATH)
    models_path='/content/drive/MyDrive/Models/'# I created a folder calle
else:
    from kaggle_datasets import KaggleDatasets
    GCS_DS_PATH = KaggleDatasets().get_gcs_path('rfcx-species-audio-detect
    print (GCS_DS_PATH)
```

```
gs://kds-a7dd8b09d52950714bee1818d843af117accc125d4d289d9afcebfab
```

In [2]:
```
if COLAB:# Prepare the kaggle.json file for use
    from google.colab import files
    if not os.path.exists('/.kaggle/kaggle.json'):
        !mkdir ~/.kaggle
        if not os.path.exists('/content/drive/My Drive/Models/kaggle.json'
            files.upload()
            !cp kaggle.json ~/.kaggle/
        else:
            !cp '/content/drive/My Drive/Models/kaggle.json' ~/.kaggle/
        !chmod 600 ~/.kaggle/kaggle.json
```

In [3]:
```
if COLAB:# force TF to 2.2
    !pip install -q tensorflow~=2.2.0 tensorflow_gcs_config~=2.2.0
    import tensorflow as tf
    import requests
    import os
    resp = requests.post("http://{}:8475/requestversion/{}".format(os.envi
    if resp.status_code != 200:
      print("Failed to switch the TPU to TF {}".format(version))
```

In [4]:
```
if COLAB:    #%tensorflow_version 2.x
    import tensorflow as tf
    print("Tensorflow version " + tf.__version__)

    try:
      tpu = tf.distribute.cluster_resolver.TPUClusterResolver()  # TPU det
      print('Running on TPU ', tpu.cluster_spec().as_dict()['worker'])
    except ValueError:
      raise BaseException('ERROR: Not connected to a TPU runtime; please s

    tf.config.experimental_connect_to_cluster(tpu)
    tf.tpu.experimental.initialize_tpu_system(tpu)
    tpu_strategy = tf.distribute.experimental.TPUStrategy(tpu)
    #tpu_strategy = tf.distribute.TPUStrategy(tpu)
```

In [5]:
```
!pip install -q tensorflow_io
import tensorflow_io as tfio
import tensorflow as tf
import gc
!pip install image-classifiers
!pip install tensorflow_addons==0.10.0
#0.11.2
import tensorflow_addons as tfa
#import tfa as tfa
import numpy as np
from pathlib import Path
import io
import matplotlib.pyplot as plt
!pip install soundfile
import soundfile as sf
import librosa
#!pip install kaggle_datasets

#from kaggle_datasets import KaggleDatasets
from tqdm import tqdm
import pandas as pd
from sklearn.model_selection import StratifiedKFold
import seaborn as sns
from IPython.display import Audio

from classification_models.keras import Classifiers
tf.__version__
```

```
WARNING: You are using pip version 21.0; however, version 21.0.1 is availab
le.
You should consider upgrading via the '/opt/conda/bin/python3.7 -m pip inst
all --upgrade pip' command.
Collecting image-classifiers
  Downloading image_classifiers-1.0.0-py3-none-any.whl (19 kB)
Collecting keras-applications<=1.0.8,>=1.0.7
  Downloading Keras_Applications-1.0.8-py3-none-any.whl (50 kB)
     |████████████████████████████████| 50 kB 1.5 MB/s
Requirement already satisfied: numpy>=1.9.1 in /opt/conda/lib/python3.7/sit
e-packages (from keras-applications<=1.0.8,>=1.0.7->image-classifiers) (1.1
9.5)
Requirement already satisfied: h5py in /opt/conda/lib/python3.7/site-packag
es (from keras-applications<=1.0.8,>=1.0.7->image-classifiers) (2.10.0)
Requirement already satisfied: six in /opt/conda/lib/python3.7/site-package
s (from h5py->keras-applications<=1.0.8,>=1.0.7->image-classifiers) (1.15.
0)
```

```
Installing collected packages: keras-applications, image-classifiers
Successfully installed image-classifiers-1.0.0 keras-applications-1.0.8
WARNING: You are using pip version 21.0; however, version 21.0.1 is availab
le.
You should consider upgrading via the '/opt/conda/bin/python3.7 -m pip inst
all --upgrade pip' command.
Collecting tensorflow_addons==0.10.0
  Downloading tensorflow_addons-0.10.0-cp37-cp37m-manylinux2010_x86_64.whl
(1.0 MB)
     |████████████████████████████████| 1.0 MB 2.9 MB/s
Requirement already satisfied: typeguard>=2.7 in /opt/conda/lib/python3.7/s
ite-packages (from tensorflow_addons==0.10.0) (2.10.0)
Installing collected packages: tensorflow-addons
  Attempting uninstall: tensorflow-addons
    Found existing installation: tensorflow-addons 0.12.0
    Uninstalling tensorflow-addons-0.12.0:
      Successfully uninstalled tensorflow-addons-0.12.0
Successfully installed tensorflow-addons-0.10.0
WARNING: You are using pip version 21.0; however, version 21.0.1 is availab
le.
You should consider upgrading via the '/opt/conda/bin/python3.7 -m pip inst
/opt/conda/lib/python3.7/site-packages/tensorflow_addons/utils/ensure_tf_in
stall.py:68: UserWarning: Tensorflow Addons supports using Python ops for a
ll Tensorflow versions above or equal to 2.2.0 and strictly below 2.3.0 (ni
ghtly versions are not supported).
 The versions of TensorFlow you are currently using is 2.4.0 and is not sup
ported.
Some things might work, some things might not.
If you were to encounter a bug, do not file an issue.
If you want to make sure you're using a tested and supported configuration,
either change the TensorFlow version or the TensorFlow Addons's version.
You can find the compatibility matrix in TensorFlow Addon's readme:
https://github.com/tensorflow/addons
  UserWarning,
Requirement already satisfied: soundfile in /opt/conda/lib/python3.7/site-p
ackages (0.10.3.post1)
Requirement already satisfied: cffi>=1.0 in /opt/conda/lib/python3.7/site-p
ackages (from soundfile) (1.14.4)
Requirement already satisfied: pycparser in /opt/conda/lib/python3.7/site-p
ackages (from cffi>=1.0->soundfile) (2.20)
WARNING: You are using pip version 21.0; however, version 21.0.1 is availab
le.
You should consider upgrading via the '/opt/conda/bin/python3.7 -m pip inst
all --upgrade pip' command.
```

Out[5]: '2.4.0'

In [6]:
```
from classification_models.keras import Classifiers
```

In [7]:
```
#SEED = 42
import random
SEED = random.randint(0, 10000)# !!!!
def seed_everything(seed):
    random.seed(seed)
    os.environ['PYTHONHASHSEED'] = str(seed)
    np.random.seed(seed)
    tf.random.set_seed(seed)

seed_everything(SEED)
```

In [8]:
```
# from https://github.com/qubvel/classification_models
ResNet34, preprocess_input = Classifiers.get('resnet34')
```

In [9]:
```
cfg = {
    'parse_params': {
        'cut_time': 10,
    },
    'data_params': {
        'sample_time': 6, # assert 60 % sample_time == 0
        'spec_fmax': 24000.0,
        'spec_fmin': 40.0,
        'spec_mel': 300,
        'mel_power': 2,
        'img_shape': (300, 670)
    },
    'model_params': {
        'batchsize_per_tpu': 8,
        'iteration_per_epoch': 128,
        'epoch': 25,#  1 epoch just for example
        'arch': ResNet34,
        'arch_preprocess': preprocess_input,
        'freeze_to': 0,  # Freeze to backbone.layers[:freeze_to]. If None,
        'loss': {
            'fn': tfa.losses.SigmoidFocalCrossEntropy,
            'params': {},
        },
        'optim': {
            'fn': tfa.optimizers.RectifiedAdam,
            'params': {'lr': 2e-3, 'total_steps': 18*64, 'warmup_proportio
        },
        'mixup': True # False
    }
}
```

In [10]:
```
# detect and init the TPU
if not COLAB:
    tpu = tf.distribute.cluster_resolver.TPUClusterResolver()
    tf.config.experimental_connect_to_cluster(tpu)
    tf.tpu.experimental.initialize_tpu_system(tpu)
    print("All devices: ", tf.config.list_logical_devices('TPU'))
    tpu_strategy = tf.distribute.experimental.TPUStrategy(tpu)
```

```
All devices:  [LogicalDevice(name='/job:worker/replica:0/task:0/device:TPU:
5', device_type='TPU'), LogicalDevice(name='/job:worker/replica:0/task:0/de
vice:TPU:4', device_type='TPU'), LogicalDevice(name='/job:worker/replica:0/
task:0/device:TPU:3', device_type='TPU'), LogicalDevice(name='/job:worker/r
eplica:0/task:0/device:TPU:2', device_type='TPU'), LogicalDevice(name='/jo
b:worker/replica:0/task:0/device:TPU:6', device_type='TPU'), LogicalDevice
(name='/job:worker/replica:0/task:0/device:TPU:7', device_type='TPU'), Logi
calDevice(name='/job:worker/replica:0/task:0/device:TPU:1', device_type='TP
U'), LogicalDevice(name='/job:worker/replica:0/task:0/device:TPU:0', device
_type='TPU')]
```

In [11]:
```
AUTOTUNE = tf.data.experimental.AUTOTUNE


TRAIN_TFREC = GCS_DS_PATH + "/tfrecords/train"
TEST_TFREC = GCS_DS_PATH + "/tfrecords/test"
```

In [12]:
```
CUT = cfg['parse_params']['cut_time']
SR = 48000     # all wave's sample rate may be 48k

TIME = cfg['data_params']['sample_time']

FMAX = cfg['data_params']['spec_fmax']
FMIN = cfg['data_params']['spec_fmin']
N_MEL = cfg['data_params']['spec_mel']

HEIGHT, WIDTH = cfg['data_params']['img_shape']

CLASS_N = 24
```

Explore the tfrecords, Create dataset

In [13]:
```
raw_dataset = tf.data.TFRecordDataset([TRAIN_TFREC + '/00-148.tfrec'])
raw_dataset
```

Out[13]:
```
<TFRecordDatasetV2 shapes: (), types: tf.string>
```

parse tfrecords

In [14]:

```
feature_description = {
    'recording_id': tf.io.FixedLenFeature([], tf.string, default_value='')
    'audio_wav': tf.io.FixedLenFeature([], tf.string, default_value=''),
    'label_info': tf.io.FixedLenFeature([], tf.string, default_value=''),
}
parse_dtype = {
    'audio_wav': tf.float32,
    'recording_id': tf.string,
    'species_id': tf.int32,
    'songtype_id': tf.int32,
    't_min': tf.float32,
    'f_min': tf.float32,
    't_max': tf.float32,
    'f_max':tf.float32,
    'is_tp': tf.int32
}

@tf.function
def _parse_function(example_proto):
    sample = tf.io.parse_single_example(example_proto, feature_description
    wav, _ = tf.audio.decode_wav(sample['audio_wav'], desired_channels=1)
    label_info = tf.strings.split(sample['label_info'], sep='"')[1]
    labels = tf.strings.split(label_info, sep=';')

    @tf.function
    def _cut_audio(label):
        items = tf.strings.split(label, sep=',')
        spid = tf.squeeze(tf.strings.to_number(items[0], tf.int32))
        soid = tf.squeeze(tf.strings.to_number(items[1], tf.int32))
        tmin = tf.squeeze(tf.strings.to_number(items[2]))
        fmin = tf.squeeze(tf.strings.to_number(items[3]))
        tmax = tf.squeeze(tf.strings.to_number(items[4]))
        fmax = tf.squeeze(tf.strings.to_number(items[5]))
        tp = tf.squeeze(tf.strings.to_number(items[6], tf.int32))

        tmax_s = tmax * tf.cast(SR, tf.float32)
        tmin_s = tmin * tf.cast(SR, tf.float32)
        cut_s = tf.cast(CUT * SR, tf.float32)
        all_s = tf.cast(60 * SR, tf.float32)
        tsize_s = tmax_s - tmin_s
        cut_min = tf.cast(
            tf.maximum(0.0,
                tf.minimum(tmin_s - (cut_s - tsize_s) / 2,
                           tf.minimum(tmax_s + (cut_s - tsize_s) / 2, all_s
            ), tf.int32
        )
        cut_max = cut_min + CUT * SR

        _sample = {
            'audio_wav': tf.reshape(wav[cut_min:cut_max], [CUT*SR]),
            'recording_id': sample['recording_id'],
            'species_id': spid,
            'songtype_id': soid,
            't_min': tmin - tf.cast(cut_min, tf.float32)/tf.cast(SR, tf.flo
            'f_min': fmin,
            't_max': tmax - tf.cast(cut_min, tf.float32)/tf.cast(SR, tf.flo
            'f_max': fmax,
            'is_tp': tp
        }
        return _sample

    samples = tf.map_fn(_cut_audio, labels, dtype=parse_dtype)
```

In [15]:

```
@tf.function
def _cut_wav(x):
    # random cut in training
    cut_min = tf.random.uniform([], maxval=(CUT-TIME)*SR, dtype=tf.int32)
    cut_max = cut_min + TIME * SR
    cutwave = tf.reshape(x['audio_wav'][cut_min:cut_max], [TIME*SR])
    y = {}
    y.update(x)
    y['audio_wav'] = cutwave
    y['t_min'] = tf.maximum(0.0, x['t_min'] - tf.cast(cut_min, tf.float32)
    y['t_max'] = tf.maximum(0.0, x['t_max'] - tf.cast(cut_min, tf.float32)
    return y

@tf.function
def _cut_wav_val(x):
    # center crop in validation
    cut_min = (CUT-TIME)*SR // 2
    cut_max = cut_min + TIME * SR
    cutwave = tf.reshape(x['audio_wav'][cut_min:cut_max], [TIME*SR])
    y = {}
    y.update(x)
    y['audio_wav'] = cutwave
    y['t_min'] = tf.maximum(0.0, x['t_min'] - tf.cast(cut_min, tf.float32)
    y['t_max'] = tf.maximum(0.0, x['t_max'] - tf.cast(cut_min, tf.float32)
    return y
```

In [16]:

```
@tf.function
def _filtTP(x):
    return x['is_tp'] == 1
```

In [17]:

```
def show_wav(sample, ax):
    wav = sample["audio_wav"].numpy()
    rate = SR
    ax.plot(np.arange(len(wav)) / rate, wav)
    ax.set_title(
        sample["recording_id"].numpy().decode()
        + ("/%d" % sample["species_id"])
        + ("TP" if sample["is_tp"] else "FP"))

    return Audio((wav * 2**15).astype(np.int16), rate=rate)

fig, ax = plt.subplots(figsize=(15, 3))
show_wav(next(iter(parsed_dataset)), ax)
```

Out[17]:

0:00:00 / 12:25:39

003bec244/14TP

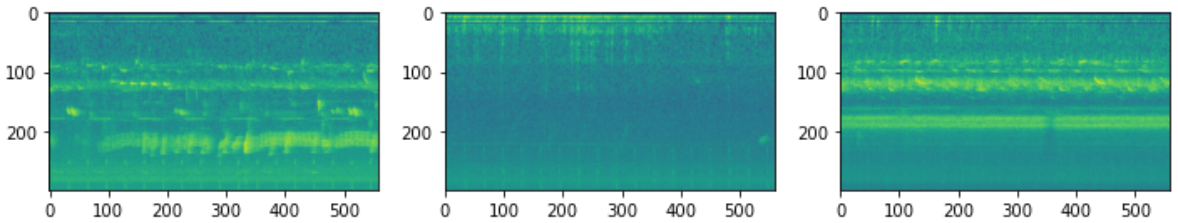
create mel-spectrogram

In [18]:

```
@tf.function
def _wav_to_spec(x):
    mel_power = cfg['data_params']['mel_power']

    stfts = tf.signal.stft(x["audio_wav"], frame_length=2048, frame_step=5
    spectrograms = tf.abs(stfts) ** mel_power

    # Warp the linear scale spectrograms into the mel-scale.
    num_spectrogram_bins = stfts.shape[-1]
    lower_edge_hertz, upper_edge_hertz, num_mel_bins = FMIN, FMAX, N_MEL

    linear_to_mel_weight_matrix = tf.signal.linear_to_mel_weight_matrix(
      num_mel_bins, num_spectrogram_bins, SR, lower_edge_hertz,
      upper_edge_hertz)
    mel_spectrograms = tf.tensordot(
      spectrograms, linear_to_mel_weight_matrix, 1)
    mel_spectrograms.set_shape(spectrograms.shape[:-1].concatenate(
      linear_to_mel_weight_matrix.shape[-1:]))

    # Compute a stabilized log to get log-magnitude mel-scale spectrograms
    log_mel_spectrograms = tf.math.log(mel_spectrograms + 1e-6)

    y = {
        'audio_spec': tf.transpose(log_mel_spectrograms), # (num_mel_bins,
    }
    y.update(x)
    return y

spec_dataset = parsed_dataset.filter(_filtTP).map(_cut_wav).map(_wav_to_spe
```

In [19]:

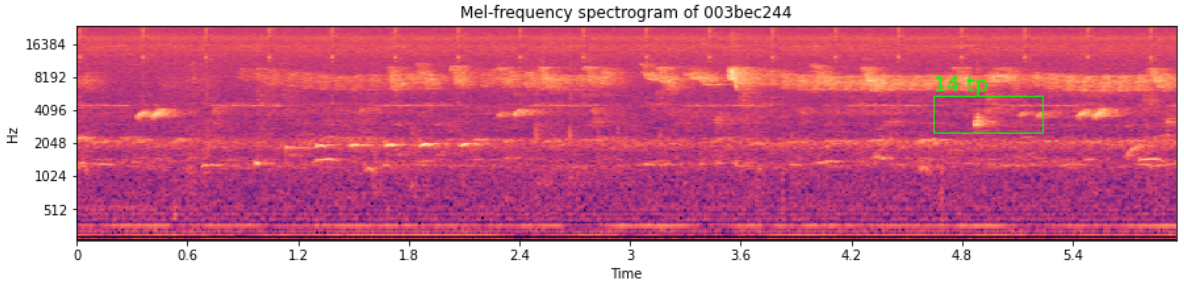
```
plt.figure(figsize=(12,5))
for i, s in enumerate(spec_dataset.take(3)):
    plt.subplot(1,3,i+1)
    plt.imshow(s['audio_spec'])
plt.show()
```



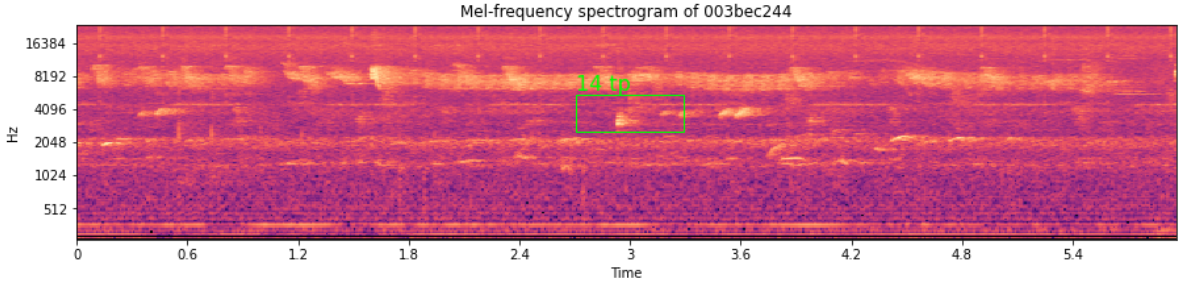
In [20]:
```
import librosa.display
import matplotlib.patches as patches

def show_spectrogram(sample, ax, showlabel=False):
    S_dB = sample["audio_spec"].numpy()
    img = librosa.display.specshow(S_dB, x_axis='time',
                                   y_axis='mel', sr=SR,
                                   fmax=FMAX, fmin=FMIN, ax=ax, cmap='magma')
    ax.set(title=f'Mel-frequency spectrogram of {sample["recording_id"].nu
    sid, fmin, fmax, tmin, tmax, istp = (
            sample["species_id"], sample["f_min"], sample["f_max"], sample
    ec = '#00ff00' if istp == 1 else '#0000ff'
    ax.add_patch(
        patches.Rectangle(xy=(tmin, fmin), width=tmax-tmin, height=fmax-fm
    )

    if showlabel:
        ax.text(tmin, fmax,
        f"{sid.numpy().item()} {'tp' if istp == 1 else 'fp'}",
        horizontalalignment='left', verticalalignment='bottom', color=ec,
```

In [21]:
```
fig, ax = plt.subplots(figsize=(15,3))
show_spectrogram(next(iter(spec_dataset)), ax, showlabel=True)
```

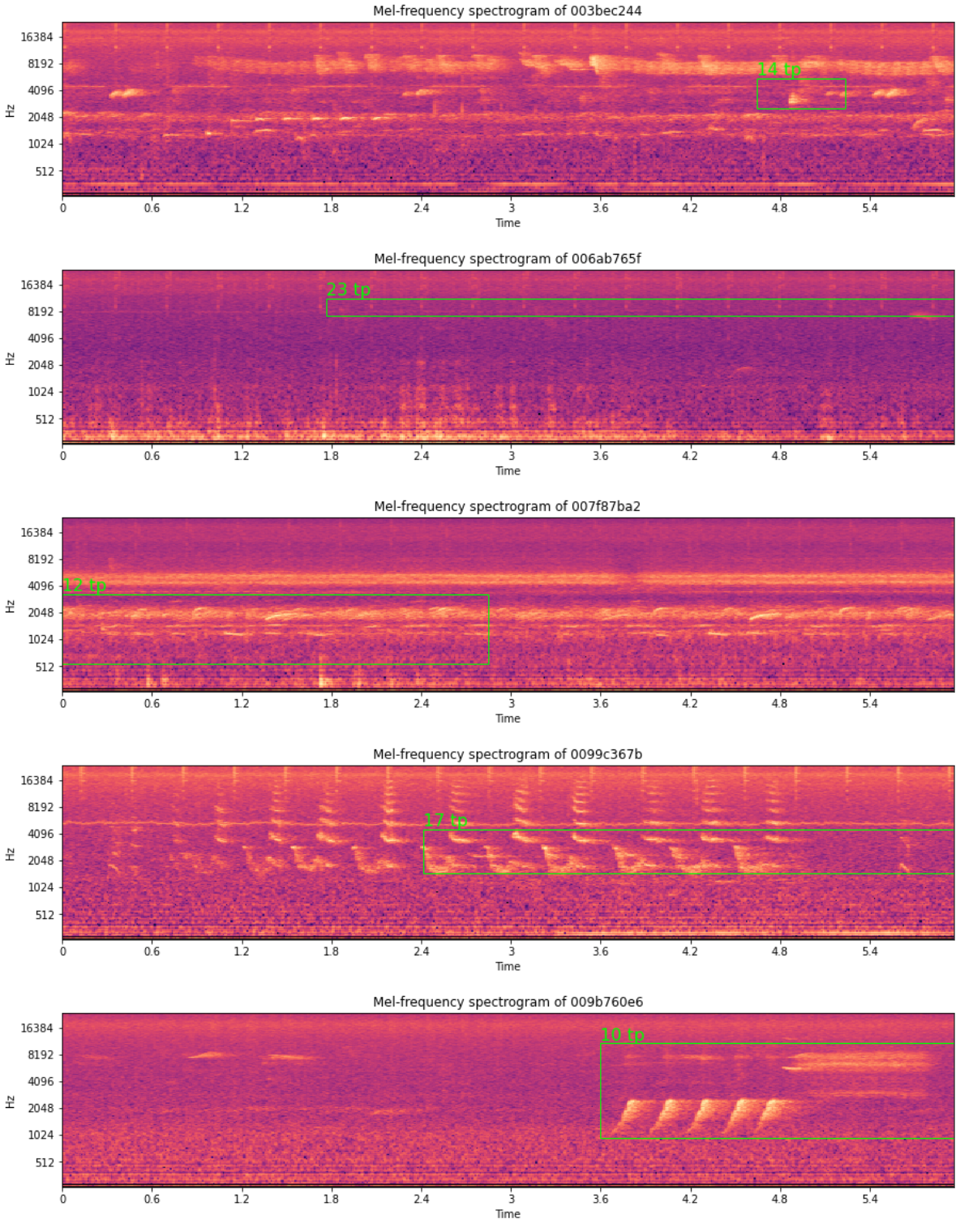
```
/opt/conda/lib/python3.7/site-packages/librosa/display.py:974: MatplotlibDe
precationWarning: The 'basey' parameter of __init__() has been renamed 'bas
e' since Matplotlib 3.3; support for the old name will be dropped two minor
releases later.
  scaler(mode, **kwargs)
/opt/conda/lib/python3.7/site-packages/librosa/display.py:974: MatplotlibDe
precationWarning: The 'linthreshy' parameter of __init__() has been renamed
'linthresh' since Matplotlib 3.3; support for the old name will be dropped
two minor releases later.
  scaler(mode, **kwargs)
```



In [22]:
```
# in validation, annotations will come to the center
fig, ax = plt.subplots(figsize=(15,3))
show_spectrogram(next(iter(parsed_dataset.filter(_filtTP).map(_cut_wav_val
```



In [23]:
```
for sample in spec_dataset.take(5):
    fig, ax = plt.subplots(figsize=(15,3))
    show_spectrogram(sample, ax, showlabel=True)
```



create labels

In [24]:

```
@tf.function
def _create_annot(x):
    targ = tf.one_hot(x["species_id"], CLASS_N, on_value=x["is_tp"], off_v

    return {
        'input': x["audio_spec"],
        'target': tf.cast(targ, tf.float32)
    }

annot_dataset = spec_dataset.map(_create_annot)
```

proprocessing and data augmentation

In training, I use

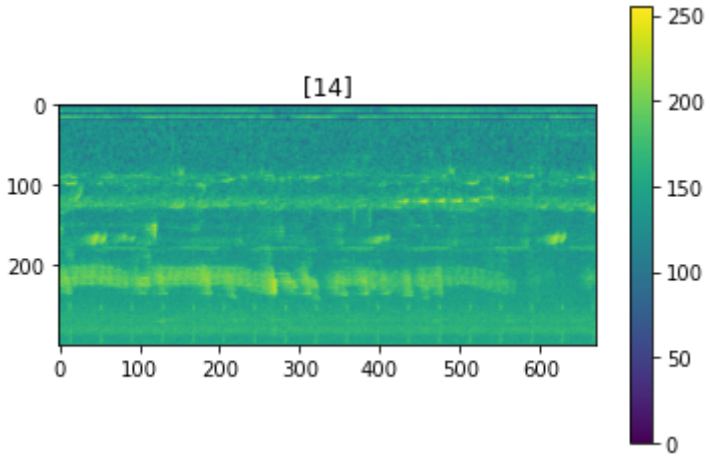
- gaussian noise
- random brightness
- specaugment

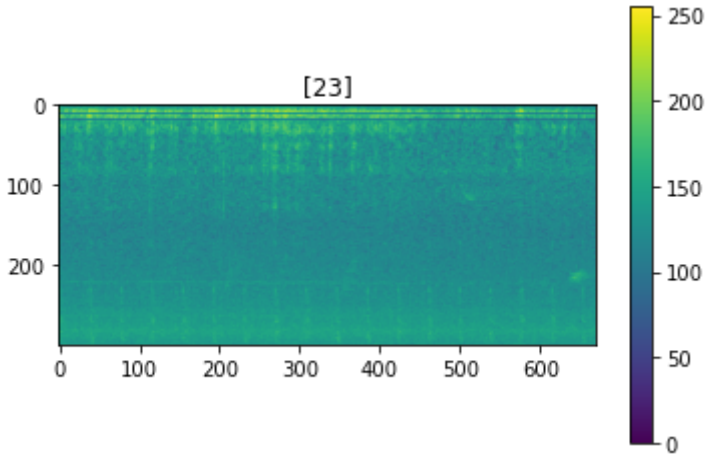
In [25]:

```
#@tf.function
def _preprocess_img(x, training=False, test=False):
    image = tf.expand_dims(x, axis=-1)
    image = tf.image.resize(image, [HEIGHT, WIDTH])
    image = tf.image.per_image_standardization(image)

    @tf.function
    def _specaugment(image):
        ERASE_TIME = 50
        ERASE_MEL = 16
        image = tf.squeeze(image, axis=2)
        image = tfio.experimental.audio.time_mask(image, param=ERASE_TIME)
        image = tfio.experimental.audio.freq_mask(image, param=ERASE_MEL)
        image = tf.expand_dims(image, axis=2)
        return image

    if training:
        # gaussian
        gau = tf.keras.layers.GaussianNoise(0.3)
        image = tf.cond(tf.random.uniform([]) < 0.5, lambda: gau(image, tra
        # brightness
        image = tf.image.random_brightness(image, 0.2)
        # random left right flip (NEW)
        image = tf.image.random_flip_left_right(image)
        # specaugment
        image = tf.cond(tf.random.uniform([]) < 0.5, lambda: _specaugment(i

    if test:
        # specaugment
        image = tf.cond(tf.random.uniform([]) < 0.5, lambda: _specaugment(i

    image = (image - tf.reduce_min(image)) / (tf.reduce_max(image) - tf.red
    image = tf.image.grayscale_to_rgb(image)
    image = cfg['model_params']['arch_preprocess'](image)

    return image

@tf.function
def _preprocess(x):
    image = _preprocess_img(x['input'], training=True, test=False)
    return (image, x["target"])

@tf.function
def _preprocess_val(x):
    image = _preprocess_img(x['input'], training=False, test=False)
    return (image, x["target"])

@tf.function
def _preprocess_test(x):
    image = _preprocess_img(x['audio_spec'], training=False, test=True)
    return (image, x["recording_id"])
```

In [26]:

```
for inp, targ in annot_dataset.map(_preprocess).take(2):
    plt.imshow(inp.numpy()[:,:,0])
    t = targ.numpy()
    if t.sum() == 0:
        plt.title(f'FP')
    else:
        plt.title(f'{t.nonzero()[0]}')
    plt.colorbar()
    plt.show()
```





Model

In [27]:

```
from tensorflow.keras.layers import *
from tensorflow.keras import losses, models, optimizers
from tensorflow.keras.optimizers import Adam
def create_model():
    #with strategy.scope():
    #backbone = cfg['model_params']['arch'](include_top=False, weights='im

    def Classifier(shape_):

        backbone = cfg['model_params']['arch']((shape_), include_top=False



        def cbr(x, out_layer, kernel, stride, dilation):
            x = Conv2D(out_layer, kernel_size=kernel, dilation_rate=dilati
            x = BatchNormalization()(x)
            x = Activation("relu")(x)
            return x

        def wave_block(x, filters, kernel_size, n):
            dilation_rates = [2**i for i in range(n)]
            x = Conv2D(filters = filters,
                       kernel_size = 1,
                       padding = 'same')(x)
            res_x = x
            for dilation_rate in dilation_rates:
                tanh_out = Conv2D(filters = filters,
                                  kernel_size = kernel_size,
                                  padding = 'same',
                                  activation = 'tanh',
                                  dilation_rate = dilation_rate)(x)
                sigm_out = Conv2D(filters = filters,
                                  kernel_size = kernel_size,
                                  padding = 'same',
                                  activation = 'sigmoid',
                                  dilation_rate = dilation_rate)(x)
                x = Multiply()([tanh_out, sigm_out])
                x = Conv2D(filters = filters,
                           kernel_size = 1,
                           padding = 'same')(x)
                res_x = Add()([res_x, x])
            return res_x


        #out1
        def wavenet(layer):

          x = cbr(layer, 192, 7, 1, 1)
          x = BatchNormalization()(x)
          x = wave_block(x, 192, 3, 1)
          x = cbr(x, 96, 7, 1, 1)
          x = BatchNormalization()(x)
          x = wave_block(x, 96, 3, 1)
          x = cbr(x, 48, 5, 1, 1)
          x = BatchNormalization()(x)
          x = wave_block(x, 48, 3, 1)
          return x

        def wavenet1(layer):

          x = cbr(layer, 4, 7, 1, 1)
          x = BatchNormalization()(x)
```

```
        x0 = backbone#model
        print('1')
        #backbone.summary()
        x1 = tf.keras.layers.GlobalAveragePooling2D()(x0.layers[-1].output
        #x2 = tf.keras.layers.GlobalAveragePooling2D()(x0.layers[-3].outpu
        x3 = tf.keras.layers.GlobalAveragePooling2D()(x0.layers[-7].output
        #x4 = tf.keras.layers.GlobalAveragePooling2D()(x0.layers[-12].outp
        x5 = tf.keras.layers.GlobalAveragePooling2D()(x0.layers[-18].outpu
        print('2')
        x1=wavenet(x0.layers[-1].output)
        x3=wavenet(x0.layers[-7].output)
        x5=wavenet(x0.layers[-18].output)

        x1 = tf.keras.layers.GlobalAveragePooling2D()(x1)
        x3 = tf.keras.layers.GlobalAveragePooling2D()(x3)
        x5 = tf.keras.layers.GlobalAveragePooling2D()(x5)



        print('4')
        #x =  tf.concat([x1,x2,x3,x4,x5],axis = 1)

        x =  tf.concat([x1,x3,x5],axis = 1)

        x = tf.keras.layers.Dropout(0.7)(x)
        x = tf.keras.layers.Dense(192)(x)
        #x =  tf.keras.layers.BatchNormalization()(x)
        x = tf.keras.layers.Dropout(0.4)(x)
        #x =  margin([x , label])

        output = tf.keras.layers.Softmax(dtype='float32')(x)
        output =tf.keras.layers.Dense(CLASS_N)(x)
        print('5')
        model = tf.keras.models.Model(inputs = x0.input, outputs = output)
        #model.compile(optimizer=optimizer, loss=loss_fn, metrics=[LWLRAP(



        return model
    return Classifier([HEIGHT,WIDTH,3])


model = create_model()
model.summary()
```

```
Downloading data from https://github.com/qubvel/classification_models/relea
ses/download/0.0.1/resnet34_imagenet_1000_no_top.h5
85524480/85521592 [==============================] - 1s 0us/step
1
2
4
5
Model: "model_1"
__________________________________________________________________________
```

```
__________________________
Layer (type)                 Output Shape         Param #     Connected
to
==========================================================================
======================
data (InputLayer)            [(None, 300, 670, 3) 0
__________________________________________________________________________
__________________________
bn_data (BatchNormalization) (None, 300, 670, 3)  9           data[0][0]
__________________________________________________________________________
__________________________
zero_padding2d (ZeroPadding2D) (None, 306, 676, 3)  0         bn_data
[0][0]
__________________________________________________________________________
__________________________
conv0 (Conv2D)               (None, 150, 335, 64) 9408        zero_paddi
ng2d[0][0]
__________________________________________________________________________
__________________________
bn0 (BatchNormalization)     (None, 150, 335, 64) 256         conv0
[0][0]
__________________________________________________________________________
__________________________
relu0 (Activation)           (None, 150, 335, 64) 0           bn0[0][0]
__________________________________________________________________________
__________________________
zero_padding2d_1 (ZeroPadding2D (None, 152, 337, 64) 0        relu0
[0][0]
__________________________________________________________________________
__________________________
pooling0 (MaxPooling2D)      (None, 75, 168, 64)  0           zero_paddi
ng2d_1[0][0]
__________________________________________________________________________
__________________________
stage1_unit1_bn1 (BatchNormaliz (None, 75, 168, 64)  256      pooling0
[0][0]
__________________________________________________________________________
__________________________
stage1_unit1_relu1 (Activation) (None, 75, 168, 64)  0        stage1_uni
t1_bn1[0][0]
__________________________________________________________________________
__________________________
zero_padding2d_2 (ZeroPadding2D (None, 77, 170, 64)  0        stage1_uni
t1_relu1[0][0]
__________________________________________________________________________
__________________________
stage1_unit1_conv1 (Conv2D)  (None, 75, 168, 64)  36864       zero_paddi
ng2d_2[0][0]
__________________________________________________________________________
__________________________
stage1_unit1_bn2 (BatchNormaliz (None, 75, 168, 64)  256      stage1_uni
t1_conv1[0][0]
__________________________________________________________________________
__________________________
stage1_unit1_relu2 (Activation) (None, 75, 168, 64)  0        stage1_uni
t1_bn2[0][0]
__________________________________________________________________________
__________________________
zero_padding2d_3 (ZeroPadding2D (None, 77, 170, 64)  0        stage1_uni
t1_relu2[0][0]
__________________________________________________________________________
__________________________
stage1_unit1_conv2 (Conv2D)  (None, 75, 168, 64)  36864       zero_paddi
ng2d_3[0][0]
```

```
__________________________________________________________________________________________________
____________________________
stage1_unit1_sc (Conv2D)        (None, 75, 168, 64)  4096        stage1_uni
t1_relu1[0][0]
__________________________________________________________________________________________________
____________________________
add (Add)                       (None, 75, 168, 64)  0           stage1_uni
t1_conv2[0][0]
                                                                 stage1_uni
t1_sc[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit2_bn1 (BatchNormaliz (None, 75, 168, 64)  256         add[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit2_relu1 (Activation) (None, 75, 168, 64)  0           stage1_uni
t2_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_4 (ZeroPadding2D (None, 77, 170, 64)  0           stage1_uni
t2_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit2_conv1 (Conv2D)     (None, 75, 168, 64)  36864       zero_paddi
ng2d_4[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit2_bn2 (BatchNormaliz (None, 75, 168, 64)  256         stage1_uni
t2_conv1[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit2_relu2 (Activation) (None, 75, 168, 64)  0           stage1_uni
t2_bn2[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_5 (ZeroPadding2D (None, 77, 170, 64)  0           stage1_uni
t2_relu2[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit2_conv2 (Conv2D)     (None, 75, 168, 64)  36864       zero_paddi
ng2d_5[0][0]
__________________________________________________________________________________________________
____________________________
add_1 (Add)                     (None, 75, 168, 64)  0           stage1_uni
t2_conv2[0][0]
                                                                 add[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit3_bn1 (BatchNormaliz (None, 75, 168, 64)  256         add_1
[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit3_relu1 (Activation) (None, 75, 168, 64)  0           stage1_uni
t3_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_6 (ZeroPadding2D (None, 77, 170, 64)  0           stage1_uni
t3_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage1_unit3_conv1 (Conv2D)     (None, 75, 168, 64)  36864       zero_paddi
ng2d_6[0][0]
__________________________________________________________________________________________________
____________________________
```

```
stage1_unit3_bn2 (BatchNormaliz (None, 75, 168, 64)  256         stage1_uni
t3_conv1[0][0]
__________________________________________________________________________
_____________________
stage1_unit3_relu2 (Activation) (None, 75, 168, 64)  0           stage1_uni
t3_bn2[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_7 (ZeroPadding2D (None, 77, 170, 64)  0           stage1_uni
t3_relu2[0][0]
__________________________________________________________________________
_____________________
stage1_unit3_conv2 (Conv2D)     (None, 75, 168, 64)  36864       zero_paddi
ng2d_7[0][0]
__________________________________________________________________________
_____________________
add_2 (Add)                     (None, 75, 168, 64)  0           stage1_uni
t3_conv2[0][0]
                                                                 add_1
[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_bn1 (BatchNormaliz (None, 75, 168, 64)  256         add_2
[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_relu1 (Activation) (None, 75, 168, 64)  0           stage2_uni
t1_bn1[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_8 (ZeroPadding2D (None, 77, 170, 64)  0           stage2_uni
t1_relu1[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_conv1 (Conv2D)     (None, 38, 84, 128)  73728       zero_paddi
ng2d_8[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_bn2 (BatchNormaliz (None, 38, 84, 128)  512         stage2_uni
t1_conv1[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_relu2 (Activation) (None, 38, 84, 128)  0           stage2_uni
t1_bn2[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_9 (ZeroPadding2D (None, 40, 86, 128)  0           stage2_uni
t1_relu2[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_conv2 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_9[0][0]
__________________________________________________________________________
_____________________
stage2_unit1_sc (Conv2D)        (None, 38, 84, 128)  8192        stage2_uni
t1_relu1[0][0]
__________________________________________________________________________
_____________________
add_3 (Add)                     (None, 38, 84, 128)  0           stage2_uni
t1_conv2[0][0]
                                                                 stage2_uni
t1_sc[0][0]
__________________________________________________________________________
_____________________
```

```
stage2_unit2_bn1 (BatchNormaliz (None, 38, 84, 128)  512         add_3
[0][0]
__________________________________________________________________________________________________
stage2_unit2_relu1 (Activation) (None, 38, 84, 128)  0           stage2_uni
t2_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_10 (ZeroPadding2 (None, 40, 86, 128)  0           stage2_uni
t2_relu1[0][0]
__________________________________________________________________________________________________
stage2_unit2_conv1 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_10[0][0]
__________________________________________________________________________________________________
stage2_unit2_bn2 (BatchNormaliz (None, 38, 84, 128)  512         stage2_uni
t2_conv1[0][0]
__________________________________________________________________________________________________
stage2_unit2_relu2 (Activation) (None, 38, 84, 128)  0           stage2_uni
t2_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_11 (ZeroPadding2 (None, 40, 86, 128)  0           stage2_uni
t2_relu2[0][0]
__________________________________________________________________________________________________
stage2_unit2_conv2 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_11[0][0]
__________________________________________________________________________________________________
add_4 (Add)                     (None, 38, 84, 128)  0           stage2_uni
t2_conv2[0][0]
                                                                 add_3
[0][0]
__________________________________________________________________________________________________
stage2_unit3_bn1 (BatchNormaliz (None, 38, 84, 128)  512         add_4
[0][0]
__________________________________________________________________________________________________
stage2_unit3_relu1 (Activation) (None, 38, 84, 128)  0           stage2_uni
t3_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_12 (ZeroPadding2 (None, 40, 86, 128)  0           stage2_uni
t3_relu1[0][0]
__________________________________________________________________________________________________
stage2_unit3_conv1 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_12[0][0]
__________________________________________________________________________________________________
stage2_unit3_bn2 (BatchNormaliz (None, 38, 84, 128)  512         stage2_uni
t3_conv1[0][0]
__________________________________________________________________________________________________
stage2_unit3_relu2 (Activation) (None, 38, 84, 128)  0           stage2_uni
t3_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_13 (ZeroPadding2 (None, 40, 86, 128)  0           stage2_uni
t3_relu2[0][0]
```

```
__________________________________________________________________________________________________
____________________________
stage2_unit3_conv2 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_13[0][0]
__________________________________________________________________________________________________
____________________________
add_5 (Add)                     (None, 38, 84, 128)  0           stage2_uni
t3_conv2[0][0]
                                                                 add_4
[0][0]
__________________________________________________________________________________________________
____________________________
stage2_unit4_bn1 (BatchNormaliz (None, 38, 84, 128)  512         add_5
[0][0]
__________________________________________________________________________________________________
____________________________
stage2_unit4_relu1 (Activation) (None, 38, 84, 128)  0           stage2_uni
t4_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_14 (ZeroPadding2 (None, 40, 86, 128)  0           stage2_uni
t4_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage2_unit4_conv1 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_14[0][0]
__________________________________________________________________________________________________
____________________________
stage2_unit4_bn2 (BatchNormaliz (None, 38, 84, 128)  512         stage2_uni
t4_conv1[0][0]
__________________________________________________________________________________________________
____________________________
stage2_unit4_relu2 (Activation) (None, 38, 84, 128)  0           stage2_uni
t4_bn2[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_15 (ZeroPadding2 (None, 40, 86, 128)  0           stage2_uni
t4_relu2[0][0]
__________________________________________________________________________________________________
____________________________
stage2_unit4_conv2 (Conv2D)     (None, 38, 84, 128)  147456      zero_paddi
ng2d_15[0][0]
__________________________________________________________________________________________________
____________________________
add_6 (Add)                     (None, 38, 84, 128)  0           stage2_uni
t4_conv2[0][0]
                                                                 add_5
[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit1_bn1 (BatchNormaliz (None, 38, 84, 128)  512         add_6
[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit1_relu1 (Activation) (None, 38, 84, 128)  0           stage3_uni
t1_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_16 (ZeroPadding2 (None, 40, 86, 128)  0           stage3_uni
t1_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit1_conv1 (Conv2D)     (None, 19, 42, 256)  294912      zero_paddi
ng2d_16[0][0]
```

```
__________________________________________________________________________________________________
____________________________
stage3_unit1_bn2 (BatchNormaliz (None, 19, 42, 256)  1024        stage3_uni
t1_conv1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit1_relu2 (Activation) (None, 19, 42, 256)  0           stage3_uni
t1_bn2[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_17 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t1_relu2[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit1_conv2 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_17[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit1_sc (Conv2D)        (None, 19, 42, 256)  32768       stage3_uni
t1_relu1[0][0]
__________________________________________________________________________________________________
____________________________
add_7 (Add)                     (None, 19, 42, 256)  0           stage3_uni
t1_conv2[0][0]
                                                                 stage3_uni
t1_sc[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit2_bn1 (BatchNormaliz (None, 19, 42, 256)  1024        add_7
[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit2_relu1 (Activation) (None, 19, 42, 256)  0           stage3_uni
t2_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_18 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t2_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit2_conv1 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_18[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit2_bn2 (BatchNormaliz (None, 19, 42, 256)  1024        stage3_uni
t2_conv1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit2_relu2 (Activation) (None, 19, 42, 256)  0           stage3_uni
t2_bn2[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_19 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t2_relu2[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit2_conv2 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_19[0][0]
__________________________________________________________________________________________________
____________________________
add_8 (Add)                     (None, 19, 42, 256)  0           stage3_uni
t2_conv2[0][0]
                                                                 add_7
[0][0]
```

```
__________________________________________________________________________________________________
____________________________
stage3_unit3_bn1 (BatchNormaliz (None, 19, 42, 256)  1024        add_8
[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit3_relu1 (Activation) (None, 19, 42, 256)  0           stage3_uni
t3_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_20 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t3_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit3_conv1 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_20[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit3_bn2 (BatchNormaliz (None, 19, 42, 256)  1024        stage3_uni
t3_conv1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit3_relu2 (Activation) (None, 19, 42, 256)  0           stage3_uni
t3_bn2[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_21 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t3_relu2[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit3_conv2 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_21[0][0]
__________________________________________________________________________________________________
____________________________
add_9 (Add)                     (None, 19, 42, 256)  0           stage3_uni
t3_conv2[0][0]
                                                                 add_8
[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit4_bn1 (BatchNormaliz (None, 19, 42, 256)  1024        add_9
[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit4_relu1 (Activation) (None, 19, 42, 256)  0           stage3_uni
t4_bn1[0][0]
__________________________________________________________________________________________________
____________________________
zero_padding2d_22 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t4_relu1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit4_conv1 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_22[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit4_bn2 (BatchNormaliz (None, 19, 42, 256)  1024        stage3_uni
t4_conv1[0][0]
__________________________________________________________________________________________________
____________________________
stage3_unit4_relu2 (Activation) (None, 19, 42, 256)  0           stage3_uni
t4_bn2[0][0]
__________________________________________________________________________________________________
____________________________
```

```
zero_padding2d_23 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t4_relu2[0][0]
__________________________________________________________________________
_____________________
stage3_unit4_conv2 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_23[0][0]
__________________________________________________________________________
_____________________
add_10 (Add)                    (None, 19, 42, 256)  0           stage3_uni
t4_conv2[0][0]
                                                                 add_9
[0][0]
__________________________________________________________________________
_____________________
stage3_unit5_bn1 (BatchNormaliz (None, 19, 42, 256)  1024        add_10
[0][0]
__________________________________________________________________________
_____________________
stage3_unit5_relu1 (Activation) (None, 19, 42, 256)  0           stage3_uni
t5_bn1[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_24 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t5_relu1[0][0]
__________________________________________________________________________
_____________________
stage3_unit5_conv1 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_24[0][0]
__________________________________________________________________________
_____________________
stage3_unit5_bn2 (BatchNormaliz (None, 19, 42, 256)  1024        stage3_uni
t5_conv1[0][0]
__________________________________________________________________________
_____________________
stage3_unit5_relu2 (Activation) (None, 19, 42, 256)  0           stage3_uni
t5_bn2[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_25 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t5_relu2[0][0]
__________________________________________________________________________
_____________________
stage3_unit5_conv2 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_25[0][0]
__________________________________________________________________________
_____________________
add_11 (Add)                    (None, 19, 42, 256)  0           stage3_uni
t5_conv2[0][0]
                                                                 add_10
[0][0]
__________________________________________________________________________
_____________________
stage3_unit6_bn1 (BatchNormaliz (None, 19, 42, 256)  1024        add_11
[0][0]
__________________________________________________________________________
_____________________
stage3_unit6_relu1 (Activation) (None, 19, 42, 256)  0           stage3_uni
t6_bn1[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_26 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t6_relu1[0][0]
__________________________________________________________________________
_____________________
```

```
stage3_unit6_conv1 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_26[0][0]
__________________________________________________________________________
_____________________
stage3_unit6_bn2 (BatchNormaliz (None, 19, 42, 256)  1024        stage3_uni
t6_conv1[0][0]
__________________________________________________________________________
_____________________
stage3_unit6_relu2 (Activation) (None, 19, 42, 256)  0           stage3_uni
t6_bn2[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_27 (ZeroPadding2 (None, 21, 44, 256)  0           stage3_uni
t6_relu2[0][0]
__________________________________________________________________________
_____________________
stage3_unit6_conv2 (Conv2D)     (None, 19, 42, 256)  589824      zero_paddi
ng2d_27[0][0]
__________________________________________________________________________
_____________________
add_12 (Add)                    (None, 19, 42, 256)  0           stage3_uni
t6_conv2[0][0]
                                                                 add_11
[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_bn1 (BatchNormaliz (None, 19, 42, 256)  1024        add_12
[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_relu1 (Activation) (None, 19, 42, 256)  0           stage4_uni
t1_bn1[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_28 (ZeroPadding2 (None, 21, 44, 256)  0           stage4_uni
t1_relu1[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_conv1 (Conv2D)     (None, 10, 21, 512)  1179648     zero_paddi
ng2d_28[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_bn2 (BatchNormaliz (None, 10, 21, 512)  2048        stage4_uni
t1_conv1[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_relu2 (Activation) (None, 10, 21, 512)  0           stage4_uni
t1_bn2[0][0]
__________________________________________________________________________
_____________________
zero_padding2d_29 (ZeroPadding2 (None, 12, 23, 512)  0           stage4_uni
t1_relu2[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_conv2 (Conv2D)     (None, 10, 21, 512)  2359296     zero_paddi
ng2d_29[0][0]
__________________________________________________________________________
_____________________
stage4_unit1_sc (Conv2D)        (None, 10, 21, 512)  131072      stage4_uni
t1_relu1[0][0]
__________________________________________________________________________
_____________________
add_13 (Add)                    (None, 10, 21, 512)  0           stage4_uni
t1_conv2[0][0]
```

```
                                                                    stage4_uni
t1_sc[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit2_bn1 (BatchNormaliz (None, 10, 21, 512)  2048        add_13
[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit2_relu1 (Activation) (None, 10, 21, 512)  0           stage4_uni
t2_bn1[0][0]
__________________________________________________________________________________________
_____________________________
zero_padding2d_30 (ZeroPadding2 (None, 12, 23, 512)  0           stage4_uni
t2_relu1[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit2_conv1 (Conv2D)     (None, 10, 21, 512)  2359296     zero_paddi
ng2d_30[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit2_bn2 (BatchNormaliz (None, 10, 21, 512)  2048        stage4_uni
t2_conv1[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit2_relu2 (Activation) (None, 10, 21, 512)  0           stage4_uni
t2_bn2[0][0]
__________________________________________________________________________________________
_____________________________
zero_padding2d_31 (ZeroPadding2 (None, 12, 23, 512)  0           stage4_uni
t2_relu2[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit2_conv2 (Conv2D)     (None, 10, 21, 512)  2359296     zero_paddi
ng2d_31[0][0]
__________________________________________________________________________________________
_____________________________
add_14 (Add)                    (None, 10, 21, 512)  0           stage4_uni
t2_conv2[0][0]
                                                                    add_13
[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit3_bn1 (BatchNormaliz (None, 10, 21, 512)  2048        add_14
[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit3_relu1 (Activation) (None, 10, 21, 512)  0           stage4_uni
t3_bn1[0][0]
__________________________________________________________________________________________
_____________________________
zero_padding2d_32 (ZeroPadding2 (None, 12, 23, 512)  0           stage4_uni
t3_relu1[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit3_conv1 (Conv2D)     (None, 10, 21, 512)  2359296     zero_paddi
ng2d_32[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit3_bn2 (BatchNormaliz (None, 10, 21, 512)  2048        stage4_uni
t3_conv1[0][0]
__________________________________________________________________________________________
_____________________________
stage4_unit3_relu2 (Activation) (None, 10, 21, 512)  0           stage4_uni
t3_bn2[0][0]
```

```
__________________________________________________________________________________________________
__________________________
zero_padding2d_33 (ZeroPadding2 (None, 12, 23, 512)  0           stage4_uni
t3_relu2[0][0]
__________________________________________________________________________________________________
__________________________
stage4_unit3_conv2 (Conv2D)     (None, 10, 21, 512)  2359296     zero_paddi
ng2d_33[0][0]
__________________________________________________________________________________________________
__________________________
add_15 (Add)                    (None, 10, 21, 512)  0           stage4_uni
t3_conv2[0][0]
                                                                 add_14
[0][0]
__________________________________________________________________________________________________
__________________________
bn1 (BatchNormalization)        (None, 10, 21, 512)  2048        add_15
[0][0]
__________________________________________________________________________________________________
__________________________
relu1 (Activation)              (None, 10, 21, 512)  0           bn1[0][0]
__________________________________________________________________________________________________
__________________________
conv2d (Conv2D)                 (None, 10, 21, 192)  4817088     relu1
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_15 (Conv2D)              (None, 10, 21, 192)  4817088     stage4_uni
t3_bn2[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_30 (Conv2D)              (None, 12, 23, 192)  4817088     zero_paddi
ng2d_30[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization (BatchNorma (None, 10, 21, 192)  768         conv2d
[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_6 (BatchNor (None, 10, 21, 192)  768         conv2d_15
[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_12 (BatchNo (None, 12, 23, 192)  768         conv2d_30
[0][0]
__________________________________________________________________________________________________
__________________________
activation (Activation)         (None, 10, 21, 192)  0           batch_norm
alization[0][0]
__________________________________________________________________________________________________
__________________________
activation_3 (Activation)       (None, 10, 21, 192)  0           batch_norm
alization_6[0][0]
__________________________________________________________________________________________________
__________________________
activation_6 (Activation)       (None, 12, 23, 192)  0           batch_norm
alization_12[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_1 (BatchNor (None, 10, 21, 192)  768         activation
[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_7 (BatchNor (None, 10, 21, 192)  768         activation
```

```
_3[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_13 (BatchNo (None, 12, 23, 192)  768         activation
_6[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_1 (Conv2D)               (None, 10, 21, 192)  37056       batch_norm
alization_1[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_16 (Conv2D)              (None, 10, 21, 192)  37056       batch_norm
alization_7[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_31 (Conv2D)              (None, 12, 23, 192)  37056       batch_norm
alization_13[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_2 (Conv2D)               (None, 10, 21, 192)  331968      conv2d_1
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_3 (Conv2D)               (None, 10, 21, 192)  331968      conv2d_1
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_17 (Conv2D)              (None, 10, 21, 192)  331968      conv2d_16
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_18 (Conv2D)              (None, 10, 21, 192)  331968      conv2d_16
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_32 (Conv2D)              (None, 12, 23, 192)  331968      conv2d_31
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_33 (Conv2D)              (None, 12, 23, 192)  331968      conv2d_31
[0][0]
__________________________________________________________________________________________________
__________________________
multiply (Multiply)             (None, 10, 21, 192)  0           conv2d_2
[0][0]
                                                                 conv2d_3
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_3 (Multiply)           (None, 10, 21, 192)  0           conv2d_17
[0][0]
                                                                 conv2d_18
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_6 (Multiply)           (None, 12, 23, 192)  0           conv2d_32
[0][0]
                                                                 conv2d_33
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_4 (Conv2D)               (None, 10, 21, 192)  37056       multiply
[0][0]
__________________________________________________________________________________________________
```

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__________________________
conv2d_19 (Conv2D)              (None, 10, 21, 192)  37056       multiply_3
[0][0]
__________________________________________________________________________
__________________________
conv2d_34 (Conv2D)              (None, 12, 23, 192)  37056       multiply_6
[0][0]
__________________________________________________________________________
__________________________
add_16 (Add)                    (None, 10, 21, 192)  0           conv2d_1
[0][0]
                                                                 conv2d_4
[0][0]
__________________________________________________________________________
__________________________
add_19 (Add)                    (None, 10, 21, 192)  0           conv2d_16
[0][0]
                                                                 conv2d_19
[0][0]
__________________________________________________________________________
__________________________
add_22 (Add)                    (None, 12, 23, 192)  0           conv2d_31
[0][0]
                                                                 conv2d_34
[0][0]
__________________________________________________________________________
__________________________
conv2d_5 (Conv2D)               (None, 10, 21, 96)   903264      add_16
[0][0]
__________________________________________________________________________
__________________________
conv2d_20 (Conv2D)              (None, 10, 21, 96)   903264      add_19
[0][0]
__________________________________________________________________________
__________________________
conv2d_35 (Conv2D)              (None, 12, 23, 96)   903264      add_22
[0][0]
__________________________________________________________________________
__________________________
batch_normalization_2 (BatchNor (None, 10, 21, 96)   384         conv2d_5
[0][0]
__________________________________________________________________________
__________________________
batch_normalization_8 (BatchNor (None, 10, 21, 96)   384         conv2d_20
[0][0]
__________________________________________________________________________
__________________________
batch_normalization_14 (BatchNo (None, 12, 23, 96)   384         conv2d_35
[0][0]
__________________________________________________________________________
__________________________
activation_1 (Activation)       (None, 10, 21, 96)   0           batch_norm
alization_2[0][0]
__________________________________________________________________________
__________________________
activation_4 (Activation)       (None, 10, 21, 96)   0           batch_norm
alization_8[0][0]
__________________________________________________________________________
__________________________
activation_7 (Activation)       (None, 12, 23, 96)   0           batch_norm
alization_14[0][0]
__________________________________________________________________________
__________________________
batch_normalization_3 (BatchNor (None, 10, 21, 96)   384         activation
```

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_1[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_9 (BatchNor (None, 10, 21, 96)   384         activation
_4[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_15 (BatchNo (None, 12, 23, 96)   384         activation
_7[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_6 (Conv2D)               (None, 10, 21, 96)   9312        batch_norm
alization_3[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_21 (Conv2D)              (None, 10, 21, 96)   9312        batch_norm
alization_9[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_36 (Conv2D)              (None, 12, 23, 96)   9312        batch_norm
alization_15[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_7 (Conv2D)               (None, 10, 21, 96)   83040       conv2d_6
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_8 (Conv2D)               (None, 10, 21, 96)   83040       conv2d_6
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_22 (Conv2D)              (None, 10, 21, 96)   83040       conv2d_21
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_23 (Conv2D)              (None, 10, 21, 96)   83040       conv2d_21
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_37 (Conv2D)              (None, 12, 23, 96)   83040       conv2d_36
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_38 (Conv2D)              (None, 12, 23, 96)   83040       conv2d_36
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_1 (Multiply)           (None, 10, 21, 96)   0           conv2d_7
[0][0]
                                                                 conv2d_8
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_4 (Multiply)           (None, 10, 21, 96)   0           conv2d_22
[0][0]
                                                                 conv2d_23
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_7 (Multiply)           (None, 12, 23, 96)   0           conv2d_37
[0][0]
                                                                 conv2d_38
[0][0]
__________________________________________________________________________________________________
```

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__________________________
conv2d_9 (Conv2D)               (None, 10, 21, 96)   9312        multiply_1
[0][0]
__________________________________________________________________________
__________________________
conv2d_24 (Conv2D)              (None, 10, 21, 96)   9312        multiply_4
[0][0]
__________________________________________________________________________
__________________________
conv2d_39 (Conv2D)              (None, 12, 23, 96)   9312        multiply_7
[0][0]
__________________________________________________________________________
__________________________
add_17 (Add)                    (None, 10, 21, 96)   0           conv2d_6
[0][0]
                                                                 conv2d_9
[0][0]
__________________________________________________________________________
__________________________
add_20 (Add)                    (None, 10, 21, 96)   0           conv2d_21
[0][0]
                                                                 conv2d_24
[0][0]
__________________________________________________________________________
__________________________
add_23 (Add)                    (None, 12, 23, 96)   0           conv2d_36
[0][0]
                                                                 conv2d_39
[0][0]
__________________________________________________________________________
__________________________
conv2d_10 (Conv2D)              (None, 10, 21, 48)   115248      add_17
[0][0]
__________________________________________________________________________
__________________________
conv2d_25 (Conv2D)              (None, 10, 21, 48)   115248      add_20
[0][0]
__________________________________________________________________________
__________________________
conv2d_40 (Conv2D)              (None, 12, 23, 48)   115248      add_23
[0][0]
__________________________________________________________________________
_________________________
batch_normalization_4 (BatchNor (None, 10, 21, 48)   192         conv2d_10
[0][0]
__________________________________________________________________________
_________________________
batch_normalization_10 (BatchNo (None, 10, 21, 48)   192         conv2d_25
[0][0]
__________________________________________________________________________
_________________________
batch_normalization_16 (BatchNo (None, 12, 23, 48)   192         conv2d_40
[0][0]
__________________________________________________________________________
__________________________
activation_2 (Activation)       (None, 10, 21, 48)   0           batch_norm
alization_4[0][0]
__________________________________________________________________________
__________________________
activation_5 (Activation)       (None, 10, 21, 48)   0           batch_norm
alization_10[0][0]
__________________________________________________________________________
__________________________
activation_8 (Activation)       (None, 12, 23, 48)   0           batch_norm
```

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alization_16[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_5 (BatchNor (None, 10, 21, 48)   192         activation
_2[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_11 (BatchNo (None, 10, 21, 48)   192         activation
_5[0][0]
__________________________________________________________________________________________________
__________________________
batch_normalization_17 (BatchNo (None, 12, 23, 48)   192         activation
_8[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_11 (Conv2D)              (None, 10, 21, 48)   2352        batch_norm
alization_5[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_26 (Conv2D)              (None, 10, 21, 48)   2352        batch_norm
alization_11[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_41 (Conv2D)              (None, 12, 23, 48)   2352        batch_norm
alization_17[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_12 (Conv2D)              (None, 10, 21, 48)   20784       conv2d_11
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_13 (Conv2D)              (None, 10, 21, 48)   20784       conv2d_11
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_27 (Conv2D)              (None, 10, 21, 48)   20784       conv2d_26
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_28 (Conv2D)              (None, 10, 21, 48)   20784       conv2d_26
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_42 (Conv2D)              (None, 12, 23, 48)   20784       conv2d_41
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_43 (Conv2D)              (None, 12, 23, 48)   20784       conv2d_41
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_2 (Multiply)           (None, 10, 21, 48)   0           conv2d_12
[0][0]
                                                                 conv2d_13
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_5 (Multiply)           (None, 10, 21, 48)   0           conv2d_27
[0][0]
                                                                 conv2d_28
[0][0]
__________________________________________________________________________________________________
__________________________
multiply_8 (Multiply)           (None, 12, 23, 48)   0           conv2d_42
```

```
[0][0]
                                                                 conv2d_43
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_14 (Conv2D)              (None, 10, 21, 48)   2352        multiply_2
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_29 (Conv2D)              (None, 10, 21, 48)   2352        multiply_5
[0][0]
__________________________________________________________________________________________________
__________________________
conv2d_44 (Conv2D)              (None, 12, 23, 48)   2352        multiply_8
[0][0]
__________________________________________________________________________________________________
__________________________
add_18 (Add)                    (None, 10, 21, 48)   0           conv2d_11
[0][0]
                                                                 conv2d_14
[0][0]
__________________________________________________________________________________________________
__________________________
add_21 (Add)                    (None, 10, 21, 48)   0           conv2d_26
[0][0]
                                                                 conv2d_29
[0][0]
__________________________________________________________________________________________________
__________________________
add_24 (Add)                    (None, 12, 23, 48)   0           conv2d_41
[0][0]
                                                                 conv2d_44
[0][0]
__________________________________________________________________________________________________
__________________________
global_average_pooling2d_3 (Glo (None, 48)           0           add_18
[0][0]
__________________________________________________________________________________________________
__________________________
global_average_pooling2d_4 (Glo (None, 48)           0           add_21
[0][0]
__________________________________________________________________________________________________
__________________________
global_average_pooling2d_5 (Glo (None, 48)           0           add_24
[0][0]
__________________________________________________________________________________________________
__________________________
tf.concat (TFOpLambda)          (None, 144)          0           global_ave
rage_pooling2d_3[0][0]
                                                                 global_ave
rage_pooling2d_4[0][0]
                                                                 global_ave
rage_pooling2d_5[0][0]
__________________________________________________________________________________________________
__________________________
dropout (Dropout)               (None, 144)          0           tf.concat
[0][0]
__________________________________________________________________________________________________
__________________________
dense (Dense)                   (None, 192)          27840       dropout
[0][0]
__________________________________________________________________________________________________
__________________________
dropout_1 (Dropout)             (None, 192)          0           dense
```

```
[0][0]
_________________________________________________________________
dense_1 (Dense)              (None, 24)                4632      dropout_1
[0][0]
=================================================================
Total params: 41,756,881
Trainable params: 41,737,483
```

In [28]:

```
@tf.function
def _mixup(inp, targ):
    indice = tf.range(len(inp))
    indice = tf.random.shuffle(indice)
    sinp = tf.gather(inp, indice, axis=0)
    starg = tf.gather(targ, indice, axis=0)

    alpha = 0.2
    t = tf.compat.v1.distributions.Beta(alpha, alpha).sample([len(inp)])
    tx = tf.reshape(t, [-1, 1, 1, 1])
    ty = tf.reshape(t, [-1, 1])
    x = inp * tx + sinp * (1-tx)
    y = targ * ty + starg * (1-ty)
#     y = tf.minimum(targ + starg, 1.0) # for multi-label???
    return x, y
```

In [29]:

```
tfrecs = sorted(tf.io.gfile.glob(TRAIN_TFREC + '/*.tfrec'))
parsed_trainval = (tf.data.TFRecordDataset(tfrecs, num_parallel_reads=AUTO
                   .map(_parse_function, num_parallel_calls=AUTOTUNE).unba
                   .filter(_filtTP).enumerate())
```

Stratified 5-Fold

In [30]:

```
indices = []
spid = []
recid = []

for i, sample in tqdm(parsed_trainval.prefetch(AUTOTUNE)):
    indices.append(i.numpy())
    spid.append(sample['species_id'].numpy())
    recid.append(sample['recording_id'].numpy().decode())
```

```
1216it [00:36, 33.18it/s]
```

In [31]:

```
table = pd.DataFrame({'indices': indices, 'species_id': spid, 'recording_i
table
```

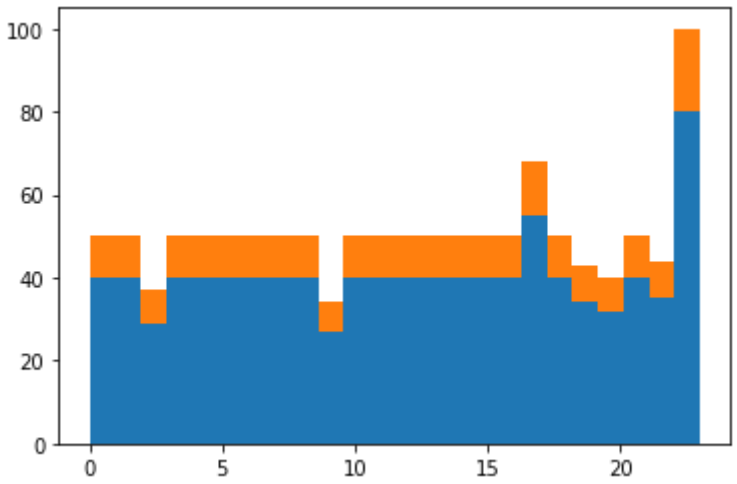
Out[31]:

	indices	species_id	recording_id
0	0	14	003bec244
1	1	12	2026bced7
2	2	21	422de4e4d
3	3	6	60a493ad4
4	4	13	8080b2283

	indices	species_id	recording_id
...	...	...	...
1211	1211	3	807efd6bb
1212	1212	20	a6610076b
1213	1213	23	c91cae4aa
1214	1214	3	c91cae4aa
1215	1215	1	e755e15ec

In [32]:
```
skf = StratifiedKFold(n_splits=5, random_state=SEED, shuffle=True)
splits = list(skf.split(table.index, table.species_id))

plt.hist([table.loc[splits[0][0], 'species_id'], table.loc[splits[0][1], '
plt.show()
```



In [33]:
```
def create_idx_filter(indice):
    @tf.function
    def _filt(i, x):
        return tf.reduce_any(indice == i)
    return _filt

@tf.function
def _remove_idx(i, x):
    return x
```

Other setup

In [34]:

```
def create_train_dataset(batchsize, train_idx):
    global parsed_trainval
    parsed_train = (parsed_trainval
                    .filter(create_idx_filter(train_idx))
                    .map(_remove_idx))

    dataset = (parsed_train.cache()
        .shuffle(len(train_idx))
        .repeat()
        .map(_cut_wav, num_parallel_calls=AUTOTUNE)
        .map(_wav_to_spec, num_parallel_calls=AUTOTUNE)
        .map(_create_annot, num_parallel_calls=AUTOTUNE)
        .map(_preprocess, num_parallel_calls=AUTOTUNE)
        .batch(batchsize))

    if cfg['model_params']['mixup']:
        dataset = (dataset.map(_mixup, num_parallel_calls=AUTOTUNE)
                    .prefetch(AUTOTUNE))
    else:
        dataset = dataset.prefetch(AUTOTUNE)
    return dataset

def create_val_dataset(batchsize, val_idx):
    global parsed_trainval
    parsed_val = (parsed_trainval
                  .filter(create_idx_filter(val_idx))
                  .map(_remove_idx))

    vdataset = (parsed_val
        .map(_cut_wav_val, num_parallel_calls=AUTOTUNE)
        .map(_wav_to_spec, num_parallel_calls=AUTOTUNE)
        .map(_create_annot, num_parallel_calls=AUTOTUNE)
        .map(_preprocess_val, num_parallel_calls=AUTOTUNE)
        .batch(8*tpu_strategy.num_replicas_in_sync)
        .cache())
    return vdataset
```

Metrics

In [35]:

```
# from https://www.kaggle.com/carlthome/l-lrap-metric-for-tf-keras
@tf.function
def _one_sample_positive_class_precisions(example):
    y_true, y_pred = example

    retrieved_classes = tf.argsort(y_pred, direction='DESCENDING')
    class_rankings = tf.argsort(retrieved_classes)
    retrieved_class_true = tf.gather(y_true, retrieved_classes)
    retrieved_cumulative_hits = tf.math.cumsum(tf.cast(retrieved_class_true

    idx = tf.where(y_true)[:, 0]
    i = tf.boolean_mask(class_rankings, y_true)
    r = tf.gather(retrieved_cumulative_hits, i)
    c = 1 + tf.cast(i, tf.float32)
    precisions = r / c

    dense = tf.scatter_nd(idx[:, None], precisions, [y_pred.shape[0]])
    return dense

class LWLRAP(tf.keras.metrics.Metric):
    def __init__(self, num_classes, name='lwlrap'):
        super().__init__(name=name)

        self._precisions = self.add_weight(
            name='per_class_cumulative_precision',
            shape=[num_classes],
            initializer='zeros',
        )

        self._counts = self.add_weight(
            name='per_class_cumulative_count',
            shape=[num_classes],
            initializer='zeros',
        )

    def update_state(self, y_true, y_pred, sample_weight=None):
        precisions = tf.map_fn(
            fn=_one_sample_positive_class_precisions,
            elems=(y_true, y_pred),
            dtype=(tf.float32),
        )

        increments = tf.cast(precisions > 0, tf.float32)
        total_increments = tf.reduce_sum(increments, axis=0)
        total_precisions = tf.reduce_sum(precisions, axis=0)

        self._precisions.assign_add(total_precisions)
        self._counts.assign_add(total_increments)

    def result(self):
        per_class_lwlrap = self._precisions / tf.maximum(self._counts, 1.0
        per_class_weight = self._counts / tf.reduce_sum(self._counts)
        overall_lwlrap = tf.reduce_sum(per_class_lwlrap * per_class_weight
        return overall_lwlrap

    def reset_states(self):
        self._precisions.assign(self._precisions * 0)
        self._counts.assign(self._counts * 0)
```

Testset and Inference function

In [36]:

```
def _parse_function_test(example_proto):
    sample = tf.io.parse_single_example(example_proto, feature_description
    wav, _ = tf.audio.decode_wav(sample['audio_wav'], desired_channels=1)

    @tf.function
    def _cut_audio(i):
        _sample = {
            'audio_wav': tf.reshape(wav[i*SR*TIME:(i+1)*SR*TIME], [SR*TIME
            'recording_id': sample['recording_id']
        }
        return _sample

    return tf.map_fn(_cut_audio, tf.range(60//TIME), dtype={
        'audio_wav': tf.float32,
        'recording_id': tf.string
    })

def inference(model):
    tdataset = (tf.data.TFRecordDataset(tf.io.gfile.glob(TEST_TFREC + '/*.
        .map(_parse_function_test, num_parallel_calls=AUTOTUNE).unbatch()
        .map(_wav_to_spec, num_parallel_calls=AUTOTUNE)
        .map(_preprocess_test, num_parallel_calls=AUTOTUNE)
        .batch(128*(60//TIME)).prefetch(AUTOTUNE))

    rec_ids = []
    probs = []
    for inp, rec_id in tqdm(tdataset):
        with tpu_strategy.scope():
            pred = model.predict_on_batch(tf.reshape(inp, [-1, HEIGHT, WID
            prob = tf.sigmoid(pred)
            prob = tf.reduce_max(tf.reshape(prob, [-1, 60//TIME, CLASS_N])

        rec_id_stack = tf.reshape(rec_id, [-1, 60//TIME])
        for rec in rec_id.numpy():
            assert len(np.unique(rec)) == 1
        rec_ids.append(rec_id_stack.numpy()[:,0])
        probs.append(prob.numpy())

    crec_ids = np.concatenate(rec_ids)
    cprobs = np.concatenate(probs)

    sub = pd.DataFrame({
        'recording_id': list(map(lambda x: x.decode(), crec_ids.tolist()))
        **{f's{i}': cprobs[:,i] for i in range(CLASS_N)}
    })
    sub = sub.sort_values('recording_id')

    return sub
```

Now start training!

In [37]:

```
def plot_history(history, name):
    plt.figure(figsize=(8,3))
    plt.subplot(1,2,1)
    plt.plot(history.history["loss"])
    plt.plot(history.history["val_loss"])
    plt.legend(['Train', 'Test'], loc='upper left')
    plt.title("loss")
    # plt.yscale('log')

    plt.subplot(1,2,2)
    plt.plot(history.history["lwlrap"])
    plt.plot(history.history["val_lwlrap"])
    plt.legend(['Train', 'Test'], loc='upper left')
    plt.title("metric")

    plt.savefig(name)
```

In [38]:

```
def train_and_inference(splits, split_id):
    print(split_id)

    batchsize = cfg['model_params']['batchsize_per_tpu'] * tpu_strategy.nu
    print("batchsize", batchsize)
    loss_fn = cfg['model_params']['loss']['fn'](from_logits=True, **cfg['m

    idx_train_tf = tf.constant(splits[split_id][0])
    idx_val_tf = tf.constant(splits[split_id][1])

    dataset = create_train_dataset(batchsize, idx_train_tf)
    vdataset = create_val_dataset(batchsize, idx_val_tf)

    optimizer = cfg['model_params']['optim']['fn'](**cfg['model_params']['

    with tpu_strategy.scope():
        model = create_model()
        model.compile(optimizer=optimizer, loss=loss_fn, metrics=[LWLRAP(C

    if split_id not in (10,10):#!!!!!!!!!!!! For convenience: If your Col

        history = model.fit(dataset,
                            steps_per_epoch=cfg['model_params']['iteration_p
                            epochs=cfg['model_params']['epoch'],
                            validation_data=vdataset,
                            callbacks=[
                                tf.keras.callbacks.ReduceLROnPlateau(
                                    'val_lwlrap', patience=10
                                ),
                                tf.keras.callbacks.ModelCheckpoint(
                                    filepath=models_path+'model_best_%d.h5' %
                                    save_weights_only=True,
                                    monitor='val_lwlrap',
                                    mode='max',
                                    save_best_only=True),
                            ]
                            )
        plot_history(history, 'history_%d.png' % split_id)
        best_score = max(history.history['val_lwlrap'])
        print (best_score)
    ### inference ###

    model.load_weights(models_path+'model_best_%d.h5' % split_id)
    sub=inference(model)
    del model
    gc.collect()
    return sub,best_score
```

In [39]:
```
# train and inference
# sub, _ = train_and_inference(splits, 0)

# N-fold ensemble


""" Delete this line to start training the model
print(SEED)
train_n=0
df = pd.DataFrame(columns=["train_n",'split_id','best_score','CSV','SEED'])
for split_id in range(len(splits)):
    sub, best_score=train_and_inference(splits, split_id)
    sub.set_index('recording_id').to_csv(models_path+f"submission_train_n_{train_n}_split_id_{split_id}.csv")
    df = df.append({'train_n': train_n,'split_id': split_id,'best_score': best_score,'CSV': f"submission_train_n_{train_n}_split_id_{split_id}.csv",'SEED':SEED}, ignore_index=True)
df.to_csv(models_path+f"train_n_{train_n}.csv", index=False)
#"""
```

Out[39]:
```
' Delete this line to start training the model\nprint(SEED)\ntrain_n=0\ndf
= pd.DataFrame(columns=["train_n",\'split_id\',\'best_score\',\'CSV\',\'SEE
D\'])\nfor split_id in range(len(splits)):\n    sub, best_score=train_and_i
nference(splits, split_id)\n    sub.set_index(\'recording_id\').to_csv(mode
ls_path+f"submission_train_n_{train_n}_split_id_{split_id}.csv", index=Fals
e)\n    df = df.append({\'train_n\': train_n,\'split_id\': split_id,\'best_
score\': best_score,\'CSV\': f"submission_train_n_{train_n}_split_id_{split
_id}.csv",\'SEED\':SEED}, ignore_index=True)\ndf.to_csv(models_path+f"train
_n_{train_n}.csv", index=False)\n#'
```

In [40]:
```
#sub.describe()
```

If you like my notebook don't forget to upvoted it

If you have questions then ask, I will help as I can