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November 21, 2022

[ ]:
```python
from jmd_imagescraper.core import *
from jmd_imagescraper.imagecleaner import *
from pathlib import Path
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import tensorflow as tf
import numpy as np
import os
import time
```

1 Dyskryminator

[ ]:
```python
def disc_block(channels):
    conv = tf.keras.layers.Conv2D(filters=channels, kernel_size=(4,4),␣
 ↪padding='same', strides=2)
    batch_norm = tf.keras.layers.BatchNormalization()
    leaky_relu = tf.keras.layers.LeakyReLU(0.2)

    return [conv, batch_norm, leaky_relu]
```

[ ]:
```python
discriminator = tf.keras.Sequential([
    tf.keras.layers.Input(shape=(64,64,3))]+
    disc_block(64)+
    disc_block(128)+
    disc_block(128)+[
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(1,activation='sigmoid')
])
```

```
Metal device set to: Apple M1 Pro

systemMemory: 32.00 GB
maxCacheSize: 10.67 GB


2022-11-10 12:20:47.203383: I
tensorflow/core/common_runtime/pluggable_device/pluggable_device_factory.cc:306]
```

```
Could not identify NUMA node of platform GPU ID 0, defaulting to 0. Your kernel
may not have been built with NUMA support.
2022-11-10 12:20:47.203499: I
tensorflow/core/common_runtime/pluggable_device/pluggable_device_factory.cc:272]
Created TensorFlow device (/job:localhost/replica:0/task:0/device:GPU:0 with 0
MB memory) -> physical PluggableDevice (device: 0, name: METAL, pci bus id:
<undefined>)
```

[ ]:
```
discriminator.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 32, 32, 64)        3136

 batch_normalization (BatchN  (None, 32, 32, 64)       256
 ormalization)

 leaky_re_lu (LeakyReLU)     (None, 32, 32, 64)        0

 conv2d_1 (Conv2D)           (None, 16, 16, 128)       131200

 batch_normalization_1 (Batc  (None, 16, 16, 128)      512
 hNormalization)

 leaky_re_lu_1 (LeakyReLU)   (None, 16, 16, 128)       0

 conv2d_2 (Conv2D)           (None, 8, 8, 128)         262272

 batch_normalization_2 (Batc  (None, 8, 8, 128)        512
 hNormalization)

 leaky_re_lu_2 (LeakyReLU)   (None, 8, 8, 128)         0

 flatten (Flatten)           (None, 8192)              0

 dropout (Dropout)           (None, 8192)              0

 dense (Dense)               (None, 1)                 8193

=================================================================
Total params: 406,081
Trainable params: 405,441
Non-trainable params: 640
_________________________________________________________________
```

Tworzę model dyskryminatora jako keras.Sequential, ponieważ chcemy by wszystkie warstwy były wykonane po kolei.

Warstwy ustawiam tak jak w poleceniu, przy pomocy warstw z tf.keras.layers: Input, Flatten, Dropout, Dense, oraz bloków, które zwracają listy Conv2D, BatchNormalization, LeakyReLu.

2 Generator

[ ]:
```
def gen_block(channels):
    conv = tf.keras.layers.
  ↪Conv2DTranspose(filters=channels,kernel_size=(4,4),strides=2,padding='same')
    leaky_relu = tf.keras.layers.LeakyReLU(0.2)

    return [conv, leaky_relu]
```

[ ]:
```
generator = tf.keras.Sequential([
    tf.keras.layers.Dense(128*8*8, input_shape=(128,)),
    tf.keras.layers.Reshape((8,8,128))]+
    gen_block(128)+
    gen_block(256)+
    gen_block(512)+[
    tf.keras.layers.
  ↪Conv2D(filters=3,kernel_size=(5,5),strides=1,padding='same',activation='sigmoid')
])
```

[ ]:
```
generator.summary()
```

```
Model: "sequential_3"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_2 (Dense)             (None, 8192)              1056768

 reshape_1 (Reshape)         (None, 8, 8, 128)         0

 conv2d_transpose (Conv2DTra  (None, 16, 16, 128)      262272
 nspose)

 leaky_re_lu_9 (LeakyReLU)   (None, 16, 16, 128)       0

 conv2d_transpose_1 (Conv2DT  (None, 32, 32, 256)      524544
 ranspose)

 leaky_re_lu_10 (LeakyReLU)  (None, 32, 32, 256)       0

 conv2d_transpose_2 (Conv2DT  (None, 64, 64, 512)      2097664
 ranspose)

 leaky_re_lu_11 (LeakyReLU)  (None, 64, 64, 512)       0
 conv2d_10 (Conv2D)          (None, 64, 64, 3)         38403

=================================================================
Total params: 3,979,651
Trainable params: 3,979,651
Non-trainable params: 0
_________________________________________________________________
```

Tworzę model generatora jako keras.Sequential, ponieważ chcemy by wszystkie warstwy były wykonane po kolei.
Warstwy ustawiam tak jak w poleceniu, przy pomocy warstw z tf.keras.layers: Input, Dense, Reshape, Conv2D oraz bloków, które zwracają listy Conv2DTranspose, LeakyReLu.

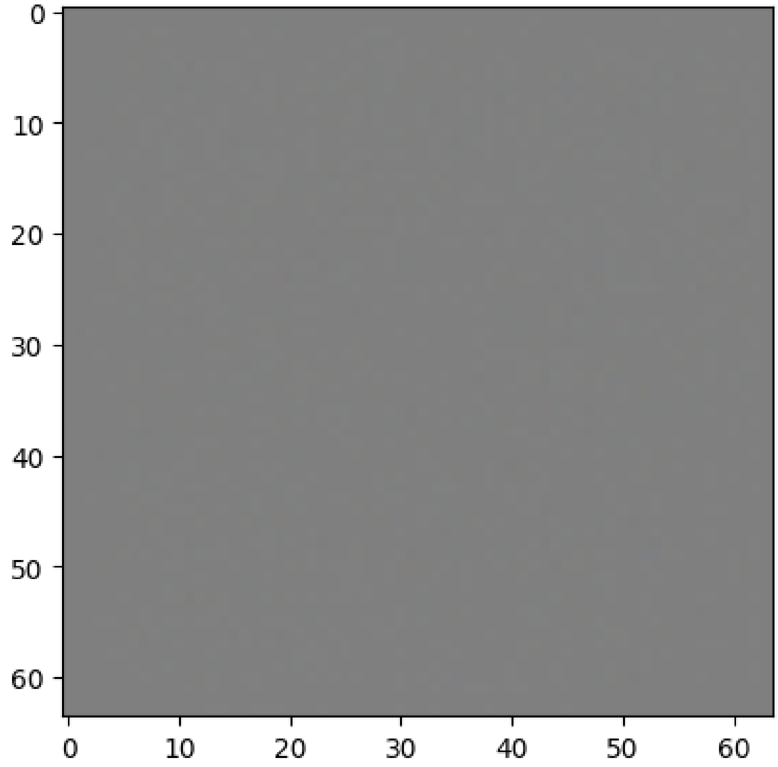
[ ]:
```
tmp1 = tf.random.normal(shape=(1,128), mean=0, stddev=1)
```

[ ]:
```
tmpimg = generator.predict(tmp1)
```

```
1/1 [==============================] - 0s 113ms/step

2022-11-09 22:29:39.023079: W
tensorflow/core/platform/profile_utils/cpu_utils.cc:128] Failed to get CPU
frequency: 0 Hz
2022-11-09 22:29:39.081701: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

[ ]:
```
def print_image(img, figsize=None):
    if figsize:
        plt.figure(figsize=figsize)
    plt.imshow(img)
    plt.show()
```

[ ]:
```
print_image(tmpimg[0])
```



Bardzo dziwne, spodziewałem się szumu, a nie wszędzie szarości, ale może taki jest efekt tego szumu…

3 Dataset

Próbowałem poszukać innych zdjęć, ale zawsze miałem problemy, żeby zdjęcia były w miarę podobne, ale miały również dosyć charakterystyczne cechy(próbowałem oczy, galaktyki, sushi - może za bardzo przejąłem się by nie były zbyt różnorodne…).
Dlatego zdecydowałem się również na ciasto marchewkowe.

[ ]:
```
root = Path().cwd()/"cake"
if not os.path.isdir(root):
    duckduckgo_search(root, 'cake', 'carrot cake', 700)
display_image_cleaner(root)
```

```
HBox(children=(Button(description='|<<', layout=Layout(width='60px'),␣
 ↪style=ButtonStyle()), Button(description…
```

```
HTML(value='<h2>No images left to display in this folder.</h2>',␣
 ↪layout=Layout(visibility='hidden'))
```

```
GridBox(children=(VBox(children=(Image(value=b'',␣
 ↪layout="Layout(width='150px')"), Button(description='Delete'…
```

[ ]:

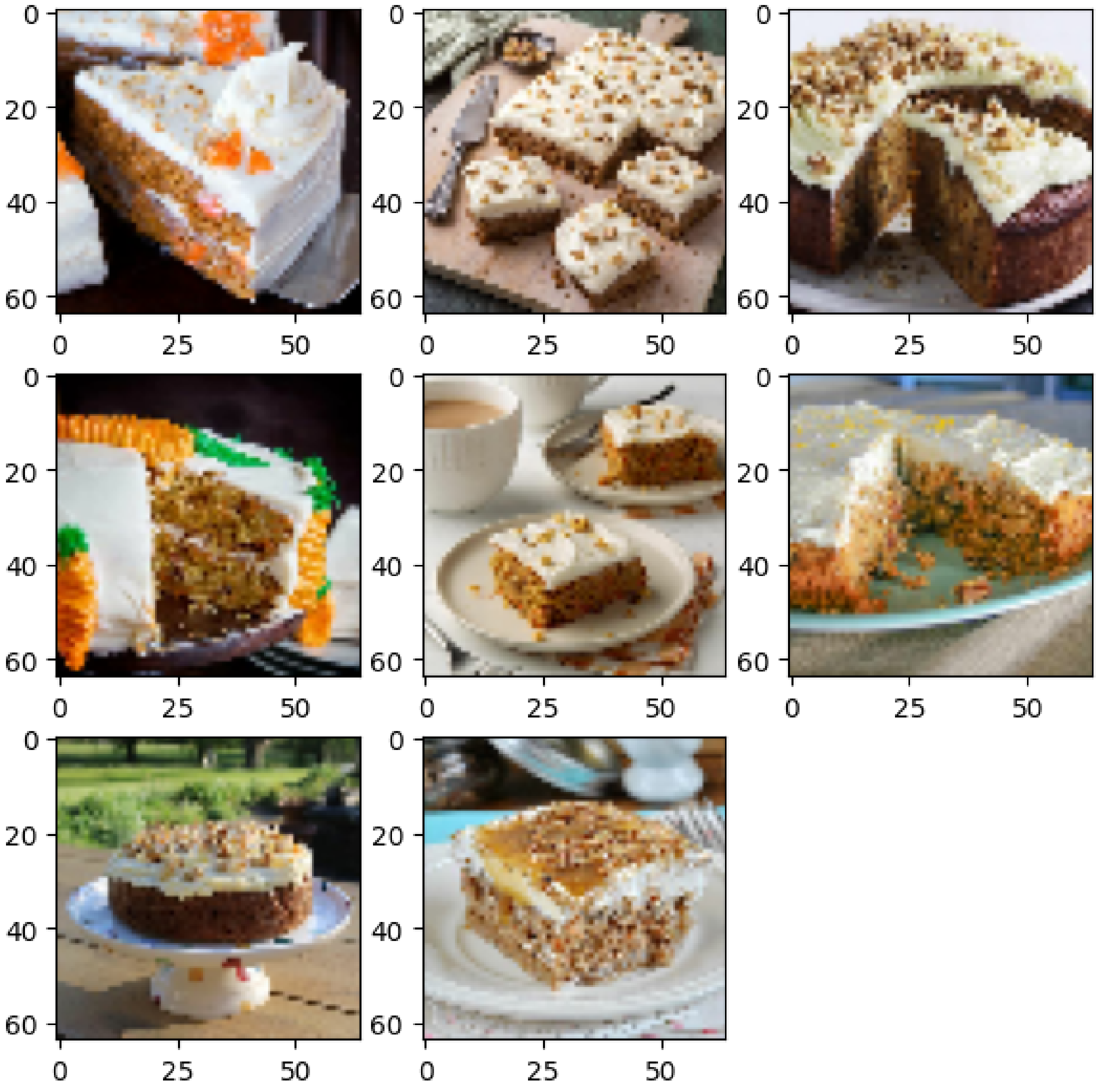
```
seed = 666

def normali(image):
    return image/255.

def load_ds(root=root, image_size=(64,64)):
    ds = tf.keras.preprocessing.image_dataset_from_directory(
        root, label_mode=None, batch_size=8, image_size=image_size,
        seed=seed)
    return ds.map(normali)

ds = load_ds()
```

```
Found 400 files belonging to 1 classes.
```

[ ]:

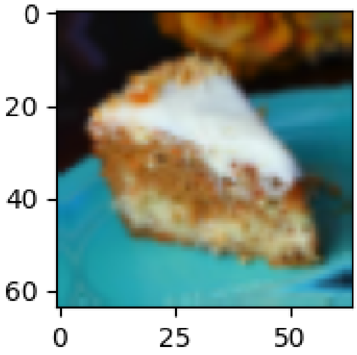
```
plt.figure(figsize=(7, 7))
for image in ds.take(1):
  for i in range(8):
    ax = plt.subplot(3, 3, i + 1)
    plt.imshow(image[i])
  plt.show()
```

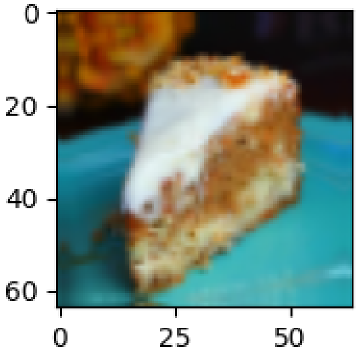
```
2022-11-10 12:20:54.830438: W
tensorflow/core/platform/profile_utils/cpu_utils.cc:128] Failed to get CPU
frequency: 0 Hz
```

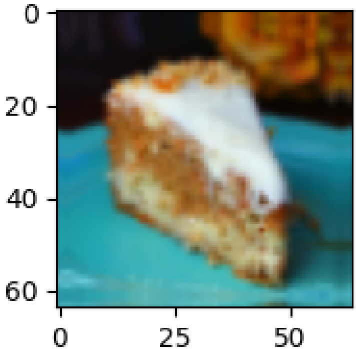


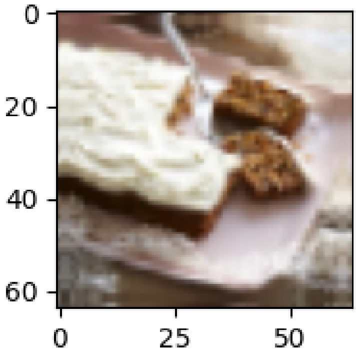
[ ]:
```
data_augmentation = tf.keras.Sequential([
    tf.keras.layers.RandomFlip(mode='horizontal'),
    tf.keras.layers.RandomRotation(factor=0.1),
    tf.keras.layers.RandomZoom(0.1)
])
```

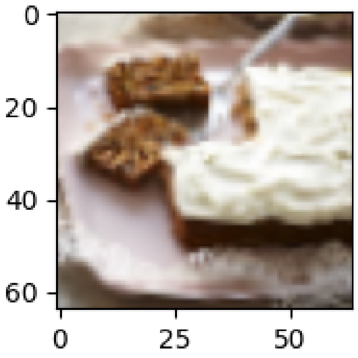
[ ]:
```
for batch in ds.take(1):
    for i in range(3):
        plt.figure(figsize=(2,2))
        plt.imshow(data_augmentation(batch[i], training=True))
        plt.show()
        plt.figure(figsize=(2,2))
        plt.imshow(data_augmentation(batch[i], training=True))
        plt.show()
        plt.figure(figsize=(2,2))
        plt.imshow(data_augmentation(batch[i], training=True))
        plt.show()
```

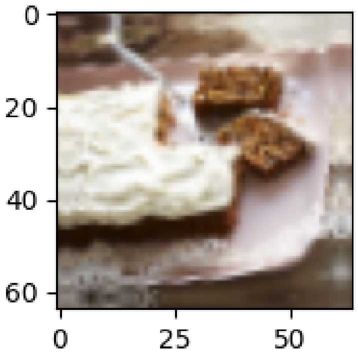


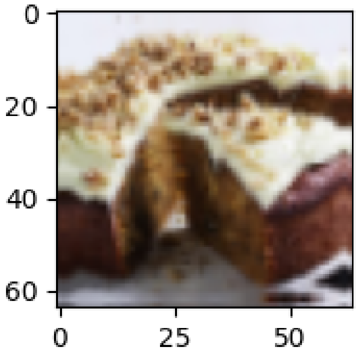


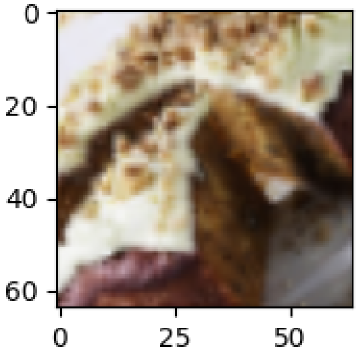


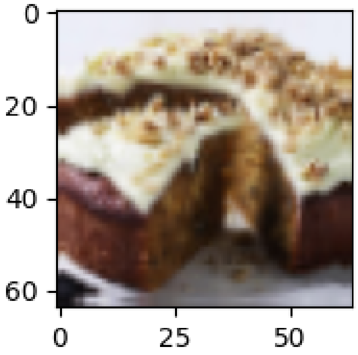

0
20
40
60
0
25
50


0
20
40
60
0
25
50


0
20
40
60
0
25
50







Wydaje się działa, ale musiałem ustawić Training na true.
Stworzyłem model do augmentacji danych, bardzo podobnie do zwykłego modelu, korzystając z keras.Sequential, lecz zamiast normalnych warstw użyłem: RandomFlip, RandomRotation, RandomZoom

4 Uczenie

4.0.1 Test

```
[ ]: tmp_model = tf.keras.Sequential([
         tf.keras.layers.Dense(3),
         tf.keras.layers.Dense(2)
     ])
     tmp = tf.random.normal((5,3))
```

```
[ ]: tmp_model(tmp)
```

```
[ ]: <tf.Tensor: shape=(5, 2), dtype=float32, numpy=
     array([[ 0.7794367 , -0.40827325],
            [-0.85448563,  0.67164075],
            [-0.2704121 ,  0.5809953 ],
            [ 0.40158522,  0.2539319 ],
            [ 0.6180287 , -0.97065103]], dtype=float32)>
```

```
[ ]: print(tmp_model.layers[0].trainable_weights)
     print(tmp_model.layers[1].trainable_weights)
```

```
[<tf.Variable 'dense_2/kernel:0' shape=(3, 3) dtype=float32, numpy=
array([[-0.12693548, -0.27203465,  0.00496244],
       [-0.84573627,  0.84611654, -0.4908874 ],
       [ 0.53634214, -0.31878066, -0.9396374 ]], dtype=float32)>, <tf.Variable
'dense_2/bias:0' shape=(3,) dtype=float32, numpy=array([0., 0., 0.],
dtype=float32)>]
[<tf.Variable 'dense_3/kernel:0' shape=(3, 2) dtype=float32, numpy=
array([[-0.2783603 ,  1.0072887 ],
       [ 0.00788045,  0.25725663],
       [ 0.13284278,  0.6137775 ]], dtype=float32)>, <tf.Variable
'dense_3/bias:0' shape=(2,) dtype=float32, numpy=array([0., 0.],
dtype=float32)>]
```

```
[ ]: print(tmp_model.layers[0].trainable_weights)
     print(tmp_model.layers[1].trainable_weights)
```

```
[<tf.Variable 'dense_2/kernel:0' shape=(3, 3) dtype=float32, numpy=
array([[-2.737655  , -0.5221699 , -0.08830219],
       [ 3.1534595 ,  2.81526   , -0.23918754],
       [ 1.6967098 ,  0.06172218, -0.4356367 ]], dtype=float32)>, <tf.Variable
'dense_2/bias:0' shape=(3,) dtype=float32, numpy=array([ 7.363396 ,  5.262966 ,
-0.3055476], dtype=float32)>]
[<tf.Variable 'dense_3/kernel:0' shape=(3, 2) dtype=float32, numpy=
array([[ 0.47335184,  0.11571991],
       [-0.23483163,  0.6558689 ],
       [ 0.3540933 , -0.37853712]], dtype=float32)>, <tf.Variable
'dense_3/bias:0' shape=(2,) dtype=float32, numpy=array([0., 0.],
dtype=float32)>]
```

Te dwie cellki powyżej, były uruchomione w takiej kolejności by się upewnić, że tylko pierwsza warstwa się zmieniła podczas uczenia.
To znaczy, że najpierw uruchomiłem pierwszą cellkę, później uczenie a na sam koniec drugą cellkę.

[ ]:

```
def tmp_loss(exp, pred):
    return exp-tf.math.reduce_mean(pred, axis=1)

tmp_loss(42, tmp_model(tmp))
```

[ ]:

```
<tf.Tensor: shape=(5,), dtype=float32, numpy=
array([41.81442 , 42.091423, 41.844707, 41.67224 , 42.17631 ],
      dtype=float32)>
```

[ ]:

```
tmp_opt = tf.keras.optimizers.SGD(learning_rate=0.5)

print(tf.reduce_mean(tmp_loss(42, tmp_model(tmp))))
for _ in range(10):
    with tf.GradientTape() as tape:
        preds = tmp_model(tmp)
        loss_tmp = tmp_loss(42, preds)
        print(tf.reduce_mean(loss_tmp))
    tmp_grads = tape.gradient(loss_tmp, tmp_model.layers[0].trainable_weights)
    tmp_opt.apply_gradients(zip(tmp_grads, tmp_model.layers[0].
 ↪trainable_weights))

print(tf.reduce_mean(loss_tmp))
```

```
tf.Tensor(41.91982, shape=(), dtype=float32)
tf.Tensor(41.91982, shape=(), dtype=float32)
tf.Tensor(41.504265, shape=(), dtype=float32)
tf.Tensor(41.088707, shape=(), dtype=float32)
tf.Tensor(40.673153, shape=(), dtype=float32)
tf.Tensor(40.257595, shape=(), dtype=float32)
tf.Tensor(39.842037, shape=(), dtype=float32)
tf.Tensor(39.426483, shape=(), dtype=float32)
tf.Tensor(39.010925, shape=(), dtype=float32)
tf.Tensor(38.595367, shape=(), dtype=float32)
tf.Tensor(38.17981, shape=(), dtype=float32)
tf.Tensor(38.17981, shape=(), dtype=float32)
```

Wygląda na to, że działa.
Stworzyłem funkcję loss oraz pętlę uczenia, która wykorzystuje GradientTape do wyliczenia gradientu, po wymienionych parametrach oraz apply_gradients po wymienionych parametrach.

4.0.2 Real

Dyskryminator

[ ]:

```
disc_loss_metric = tf.keras.metrics.Mean()
gen_loss_metric = tf.keras.metrics.Mean()
```

[ ]:

```
for tmp in ds:
    tmp_batch = tmp
    break
```

[ ]:

```
def prep_data(batch):
    # aug_imgs = [data_augmentation(img, training=True) for img in batch for␣
 ↪batch in ds.take(1)]
    # aug_imgs = [data_augmentation(img, training=True) for img in batch]
    aug_imgs = data_augmentation(batch, training=True)
    # aug_imgs = batch
    gen_imgs = generator(tf.random.normal(shape=(8,128), mean=0, stddev=1),␣
 ↪training=True)
    label_changes = tf.concat([-tf.math.abs(tf.random.normal((8,1),stddev=0.
 ↪05)), tf.math.abs(tf.random.normal((8,1),stddev=0.05))], axis=0)
    labels = tf.concat([tf.ones((8,1)),tf.zeros((8,1))], axis=0) + label_changes
    imgs = tf.concat([aug_imgs,gen_imgs],axis=0)
    return imgs,labels

tf.reduce_all(prep_data(tmp_batch)[0]==prep_data(tmp_batch)[0]) # Images are␣
 ↪different each time
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there
is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3
cause there is no registered converter for this op.
```

```
2022-11-10 12:21:51.479719: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there
is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3
cause there is no registered converter for this op.
```

```
2022-11-10 12:21:51.925714: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there
is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there
is no registered converter for this op.
```

```
2022-11-10 12:21:52.576285: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

```
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3
cause there is no registered converter for this op.
```

```
2022-11-10 12:21:53.086901: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

```
[ ]: <tf.Tensor: shape=(), dtype=bool, numpy=False>
```

```
[ ]: discriminator_optimizer = tf.keras.optimizers.Adam(learning_rate=0.00001)
     loss_fn = tf.keras.losses.BinaryCrossentropy()
```

```
[ ]: def discriminator_step(batch):
         with tf.GradientTape() as tape:
             imgs,labels=prep_data(batch)
             preds = discriminator(imgs)
             loss = loss_fn(labels, preds)
         # print('Discriminator loss:',loss)
         gradients = tape.gradient(loss, discriminator.trainable_weights)
         discriminator_optimizer.apply_gradients(zip(gradients, discriminator.
       ↪trainable_weights))
         # if disc_loss_metric:
```

```
    disc_loss_metric.update_state(loss)

discriminator_step(tmp_batch)
disc_loss_metric.reset_states()
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there
is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3
cause there is no registered converter for this op.
WARNING:tensorflow:5 out of the last 5 calls to <function pfor.<locals>.f at
0x2be636670> triggered tf.function retracing. Tracing is expensive and the
excessive number of tracings could be due to (1) creating @tf.function
repeatedly in a loop, (2) passing tensors with different shapes, (3) passing
Python objects instead of tensors. For (1), please define your @tf.function
outside of the loop. For (2), @tf.function has reduce_retracing=True option that
can avoid unnecessary retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.
```

```
2022-11-10 12:21:53.701917: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there
is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no
registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2
cause there is no registered converter for this op.
WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3
cause there is no registered converter for this op.
WARNING:tensorflow:6 out of the last 6 calls to <function pfor.<locals>.f at
0x29dc3a700> triggered tf.function retracing. Tracing is expensive and the
excessive number of tracings could be due to (1) creating @tf.function
repeatedly in a loop, (2) passing tensors with different shapes, (3) passing
Python objects instead of tensors. For (1), please define your @tf.function
outside of the loop. For (2), @tf.function has reduce_retracing=True option that
can avoid unnecessary retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.
```

```
2022-11-10 12:21:54.164852: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

Upewniam się, że labels są w zakresie [0,1]. oraz są zmienone o +-0.05.
Korzystam z optimizers.Adam z learning rate podanym w treści zadania, oraz funkcji losses.BinaryCrossentropy().
Dodatkowo podobnie jak wcześniej, upewniam się że tylko dyskryminator ma poprawiane wagi, dzięki GradientTape, GradientTape().gradient i optimizers.Adam().apply_gradients.
Niestety nie umiem sobie poradzić z retracingiem - nie wiem z czego tutaj wynika... (Może być związane z "WARNING:tensorflow:Using a while_loop for converting StatelessRandomUniformV2 cause there is no registered converter for this op.", którego też nietety nie umiem rozwiązać... - jeśli wyciągnę augmentację przed uczenie, to działa znacznie lepiej, ale augmentacja jest gorsza...)

Generator

[ ]:
```python
def gen_batch():
    return generator(tf.random.normal(shape=(8,128), mean=0, stddev=1)), tf.
 ↪ones(8)
```

[ ]:
```python
generator_optimizer = tf.keras.optimizers.Adam(learning_rate=0.00001)
```

[ ]:
```python
def generator_step():
    with tf.GradientTape() as tape:
        imgs,labels = gen_batch()
        preds = discriminator(imgs)
        loss = loss_fn(labels, preds)
    # print('Generator loss:', loss)
    gradients = tape.gradient(loss, generator.trainable_weights)
    generator_optimizer.apply_gradients(zip(gradients, generator.
 ↪trainable_weights))
    # if gen_loss_metric:
    gen_loss_metric.update_state(loss)

generator_step()
gen_loss_metric.reset_states()
```

Korzystam z optimizers.Adam z learning rate podanym w treści zadania, oraz funkcji losses.BinaryCrossentropy().
Dodatkowo podobnie jak wcześniej, upewniam się że tylko generator ma poprawiane wagi, dzięki GradientTape, GradientTape().gradient i optimizers.Adam().apply_gradients.

Checkpoints

[ ]:
```python
checkpoint_dir = './training_checkpoints'
checkpoint_prefix = os.path.join(checkpoint_dir, "ckpt")
checkpoint = tf.train.Checkpoint(generator_optimizer=generator_optimizer,
                                 ␣
 ↪discriminator_optimizer=discriminator_optimizer,
                                 generator=generator,
                                 discriminator=discriminator)
# checkpoint.restore(checkpoint_prefix+'-71')
```

[ ]:

```
<tensorflow.python.checkpoint.checkpoint.CheckpointLoadStatus at 0x2dbd3f7f0>
```

[ ]:

```
@tf.function(reduce_retracing=True)
def train_step(batch):
    discriminator_step(batch)
    generator_step()
```

[ ]:

```
def print_images(imgs, epoch=None):
    plt.figure(figsize=(7, 7))
    for ix,img in enumerate(imgs):
        ax = plt.subplot(3, 3, ix + 1)
        plt.imshow(img)
    if epoch:
        plt.savefig(f'./cmpimages/cmpnew{epoch}.png')
    # else:
    plt.show()


# print_images(generator(tf.random.normal(shape=(9,128), mean=0, stddev=1)), 1)
```

[ ]:

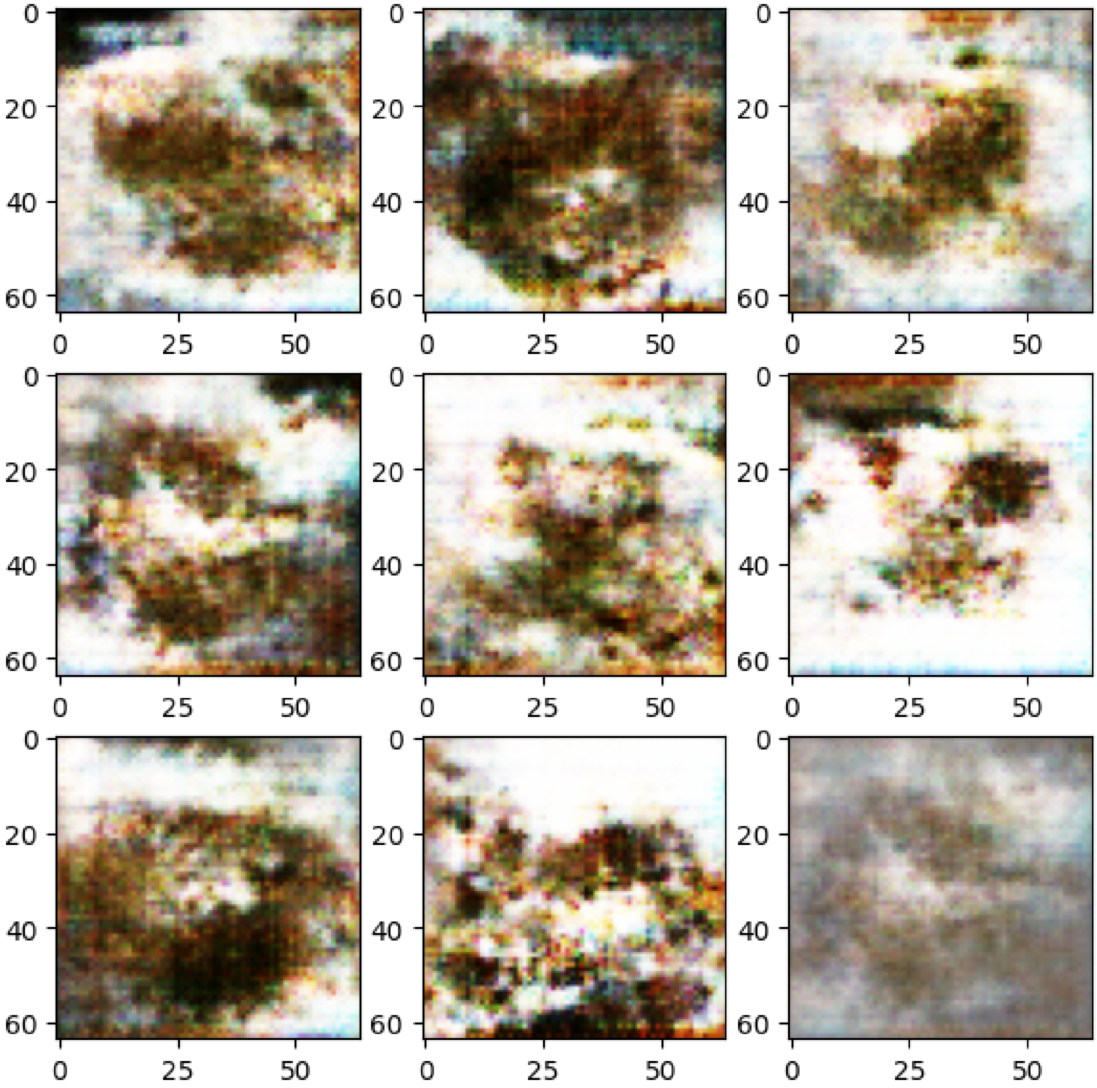
```
tf.get_logger().setLevel('ERROR')
```

[ ]:

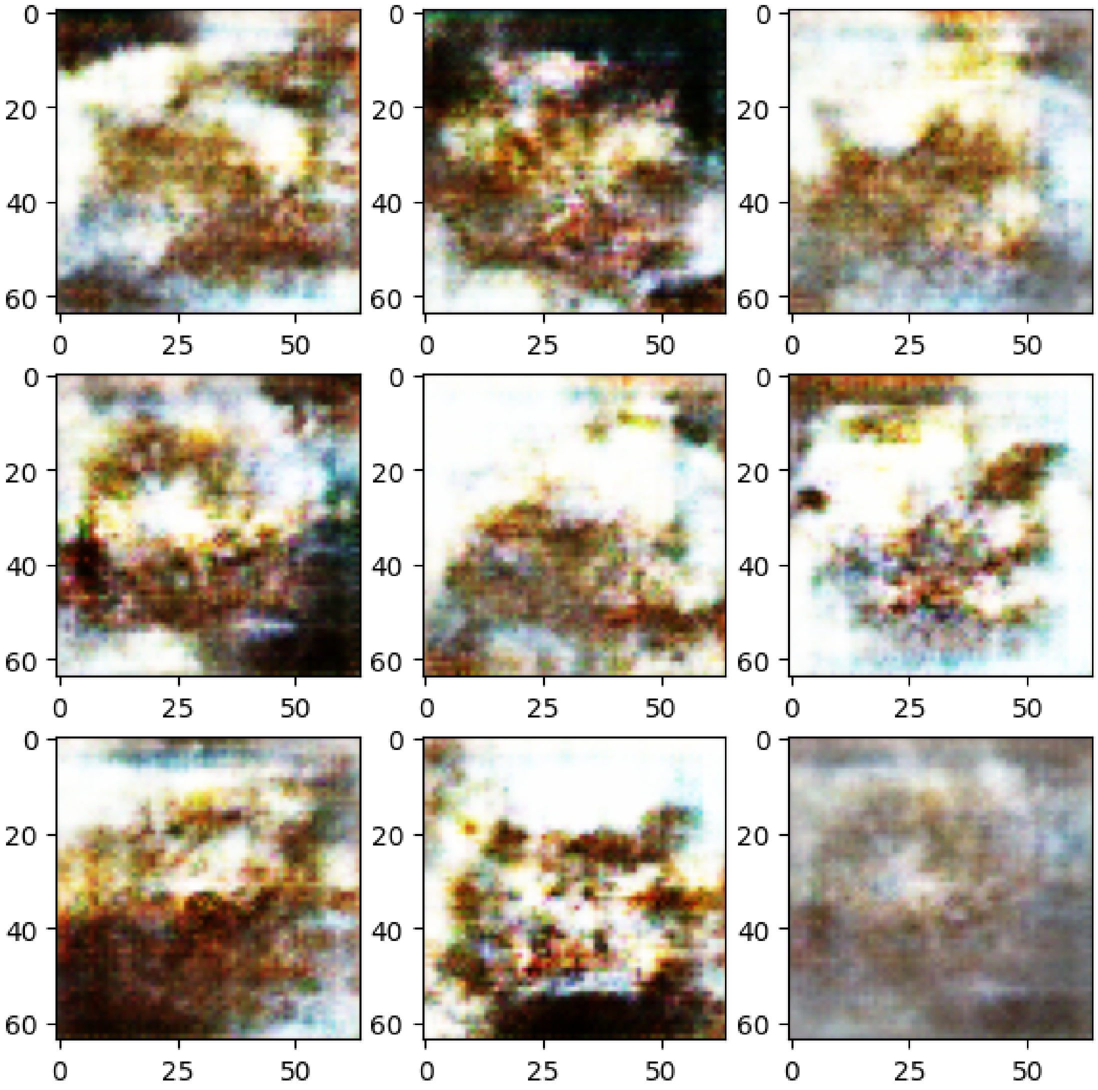
```
def train(ds=ds, last_checkpoint=0, epochs=200):
    cmp = tf.random.normal(shape=(9,128), mean=0, stddev=1)
    for epoch in range(last_checkpoint, last_checkpoint+epochs):
        start = time.time()
        for batch in ds:
            train_step(batch)
        if (epoch+1)%50 == 0:
            checkpoint.save(file_prefix=checkpoint_prefix)#+str(epoch))
            print(epoch)
            print_images(generator(cmp), epoch=epoch)
            print(f'Time for epoch {epoch + 1} is {time.time()-start} sec\t\tdisc loss: {disc_loss_metric.result()} \t gen loss: {gen_loss_metric.result()}')
        else:
            print(f'Time for epoch {epoch + 1} is {time.time()-start} sec\t\tdisc loss: {disc_loss_metric.result()} \t gen loss: {gen_loss_metric.result()}', end='\r')
        disc_loss_metric.reset_states()
        gen_loss_metric.reset_states()

# train(last_checkpoint=1599, epochs=205)
# train(last_checkpoint=1199+205, epochs=205)
# train(last_checkpoint=599+205+205, epochs=3000-(599+205+205)+1)
```

```
[ ]: train(last_checkpoint=1800, epochs=205)
```

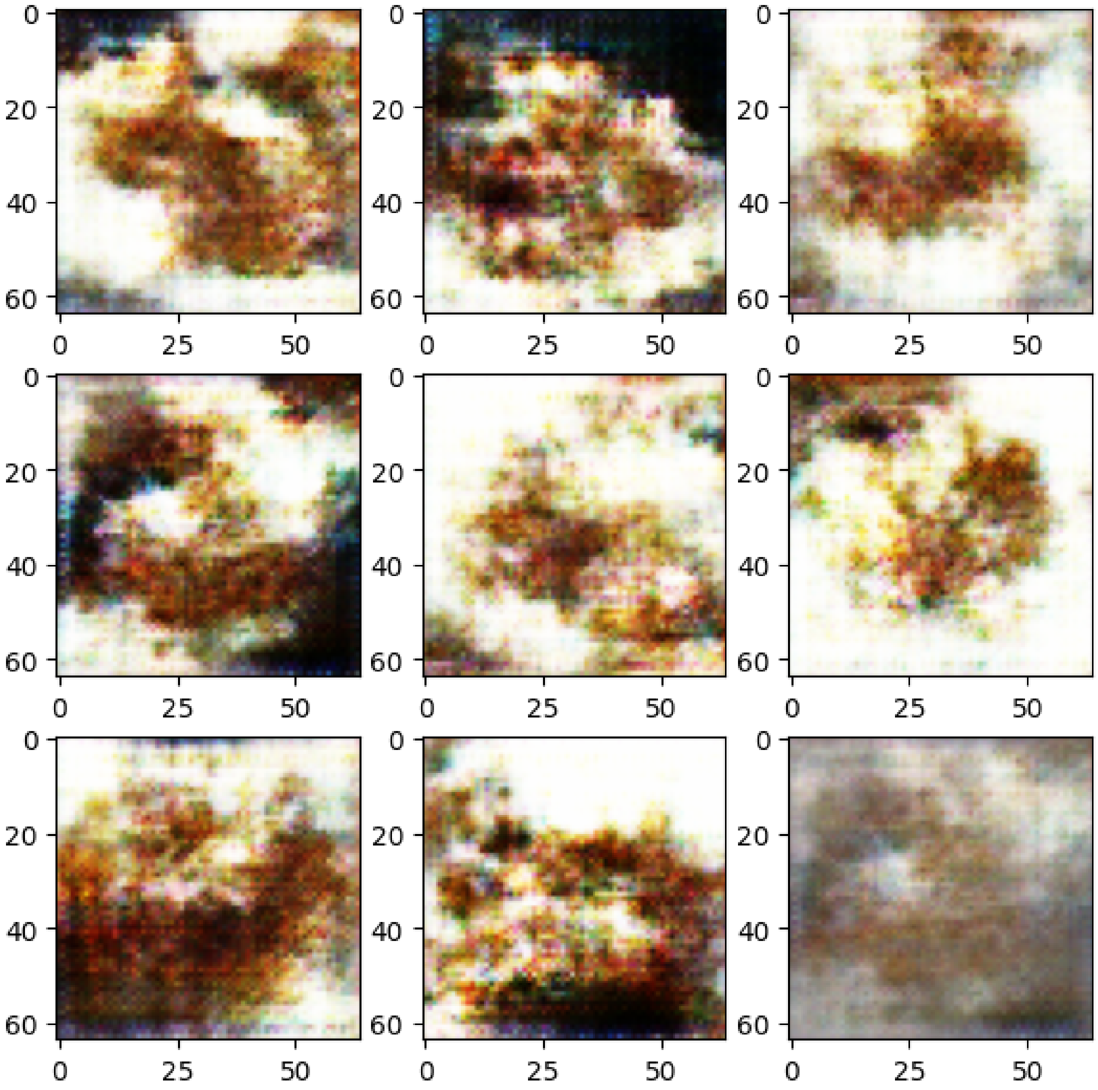
```
1849 for epoch 1849 is 7.870222091674805 sec            disc loss:
0.6847546100616455    gen loss: 0.70808315277099611
```



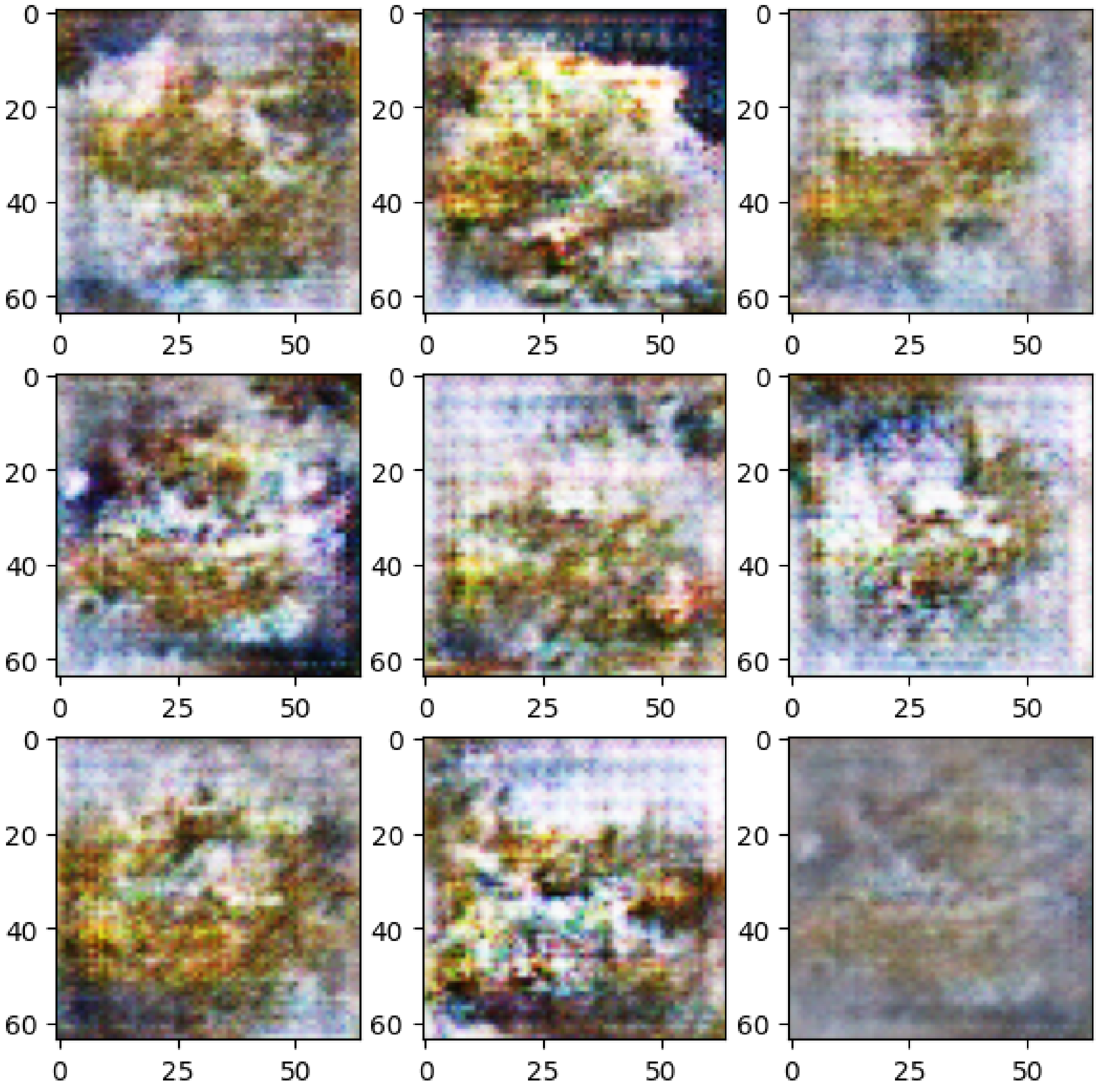
```
Time for epoch 1850 is 8.703847885131836 sec            disc loss:
0.706365704536438     gen loss: 0.680846631526947
1899 for epoch 1899 is 7.862710237503052 sec            disc loss:
0.7164195775985718    gen loss: 0.68780887126922613
```



```
Time for epoch 1900 is 8.699362993240356 sec          disc loss:
0.6677471995353699    gen loss: 0.730352520942688
1949 for epoch 1949 is 7.863271236419678 sec          disc loss:
0.6947044730186462    gen loss: 0.67001944780349734
```



```
Time for epoch 1950 is 8.809884071350098 sec            disc loss:
0.6881653666496277    gen loss: 0.7099426984786987
1999 for epoch 1999 is 7.862722873687744 sec            disc loss:
0.6851894855499268    gen loss: 0.70945745706558239
```



```
Time for epoch 2000 is 8.664951086044312 sec             disc loss:
0.7046759724617004    gen loss: 0.670852780342102
Time for epoch 2005 is 7.857033967971802 sec             disc loss:
0.6901464462280273    gen loss: 0.67678540945053116
```

[ ]:
```
ds = ds.repeat(4)
```

[ ]:
```
ds = ds.map(data_augmentation)
```

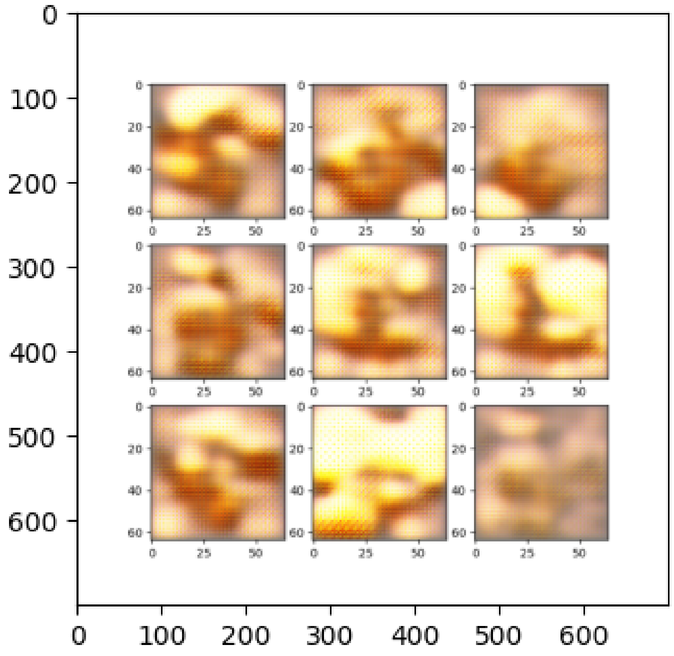
[ ]:
```
checkpoint.restore(checkpoint_prefix+'-71')
train(last_checkpoint=1800, epochs=1200)
```

Przez pierwsze 1600, przez warstwy augmentacji zdjęć musiałem resetować uczenie co 200 epok i trwało uczenie trochę dłużej. Następnie przez ponad 200 epok przetestowałem czy będzie działać

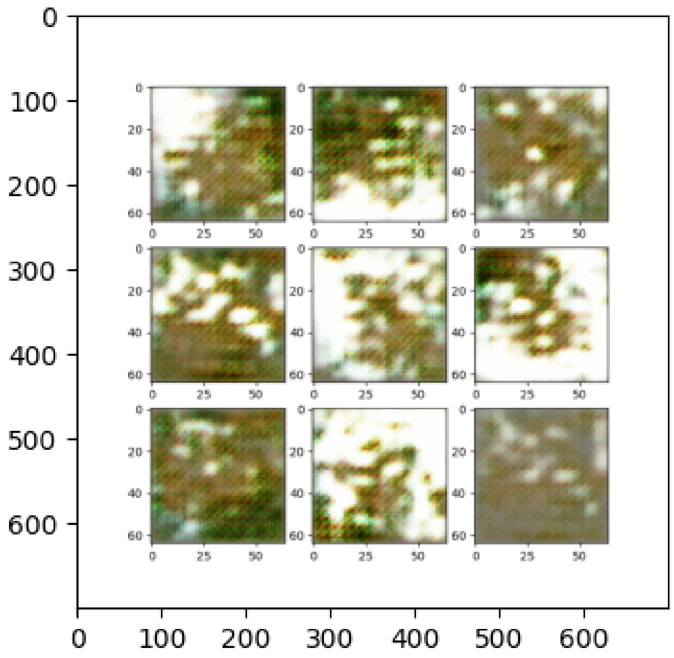
lepiej bez augemntacji danych i działało lepiej. Następnie skopiowałem zbiór danych 4-krotnie i nałożyłem mapą augemntację danych i zaczęło działać lepiej, niestety augmentacja nie jest tak dobra, na kolejnym 1000 epok.
Usunąłem trochę outputów, żeby było czytelniej.
Niestety resety kernela związane z popsutymi warstwamy augmentacji usunęły inne outputy...

[ ]:

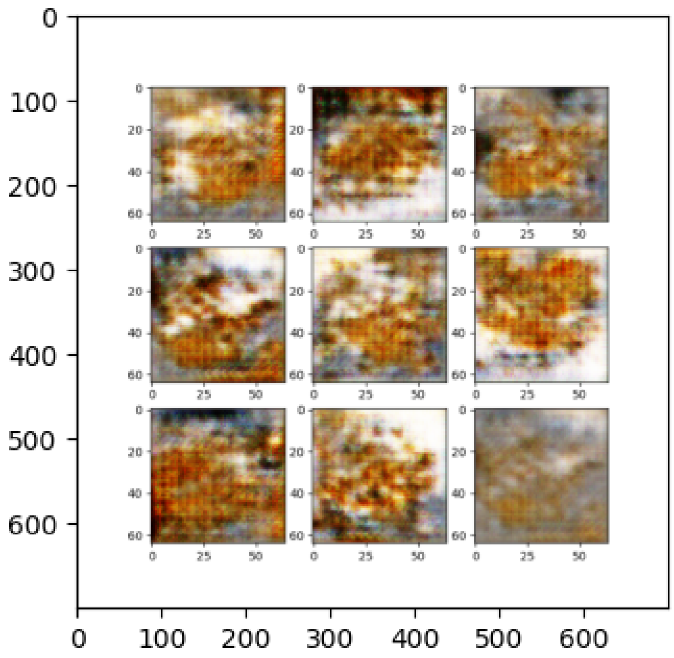
```
print_image(plt.imread('cmpimages/cmp49.png'), figsize=(4,4))
for i in range(299, 3000, 300):
    print('epoka:', i)
    print_image(plt.imread(f'cmpimages/cmp{i}.png'), figsize=(4,4))
```



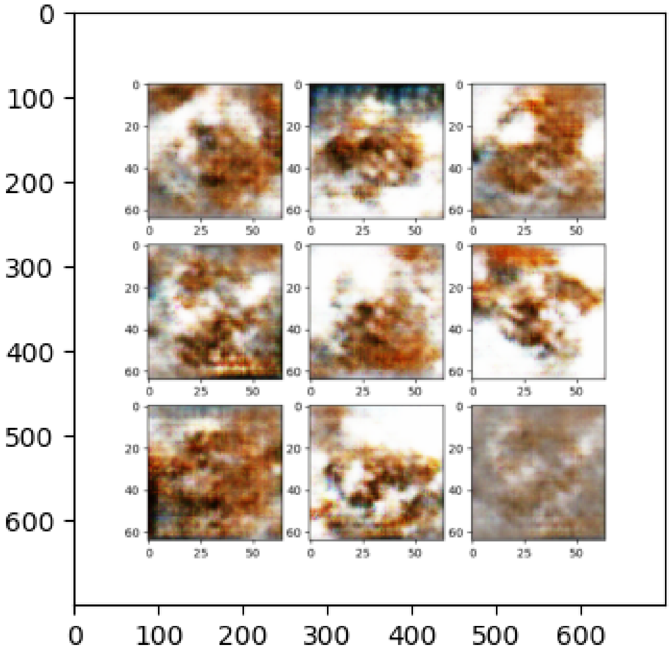
```
epoka: 299
```



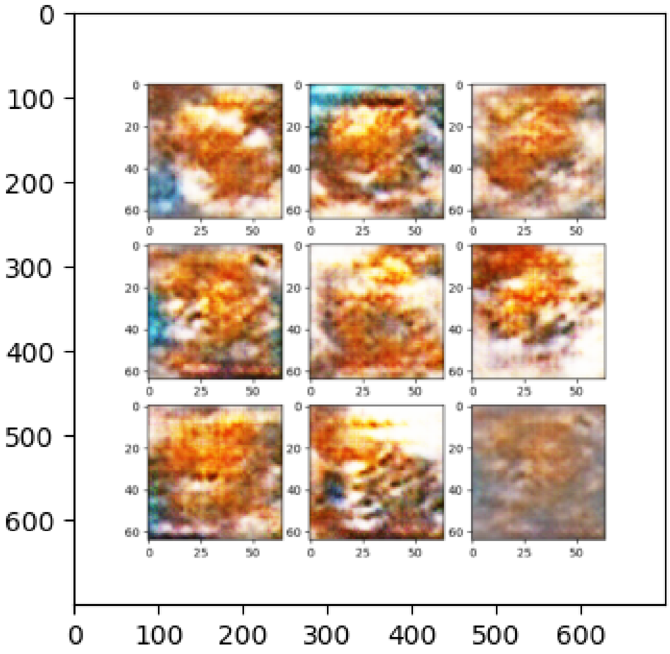
```
epoka: 599
```



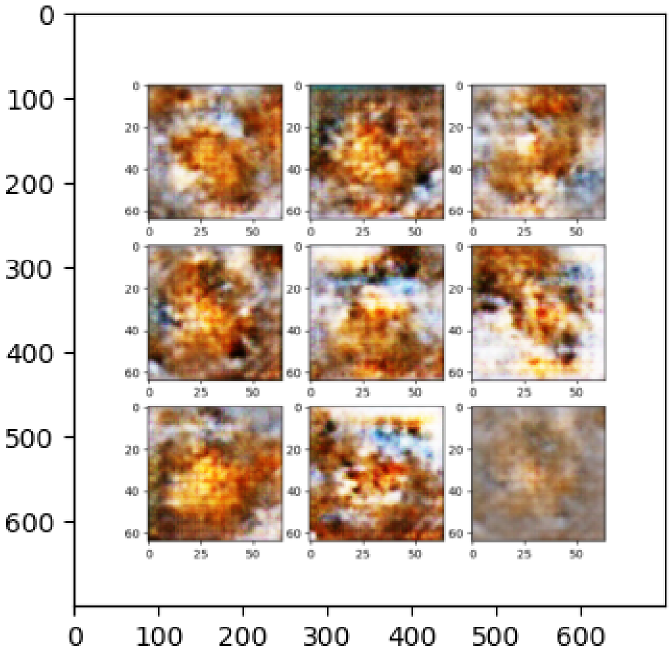
```
epoka: 899
```



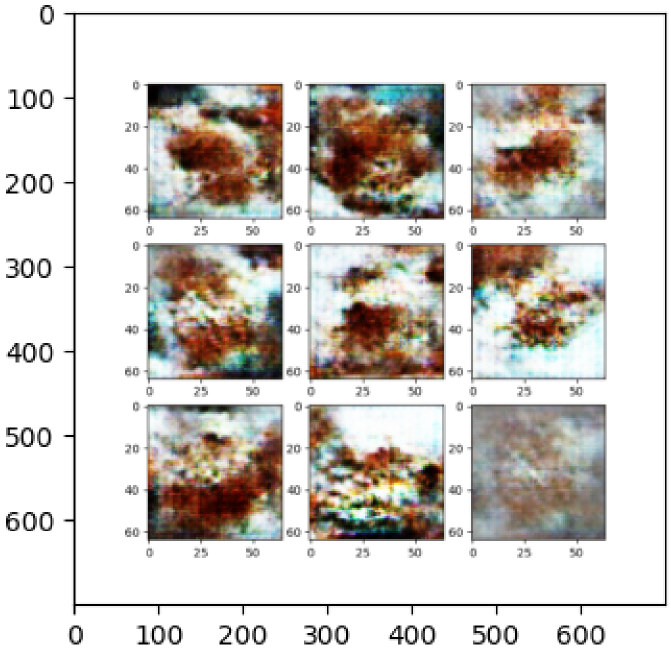
```
epoka: 1199
```



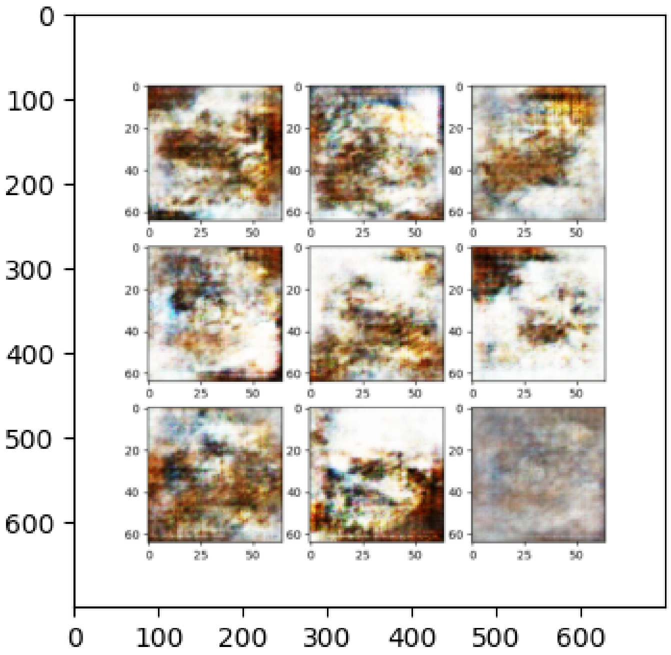
```
epoka: 1499
```



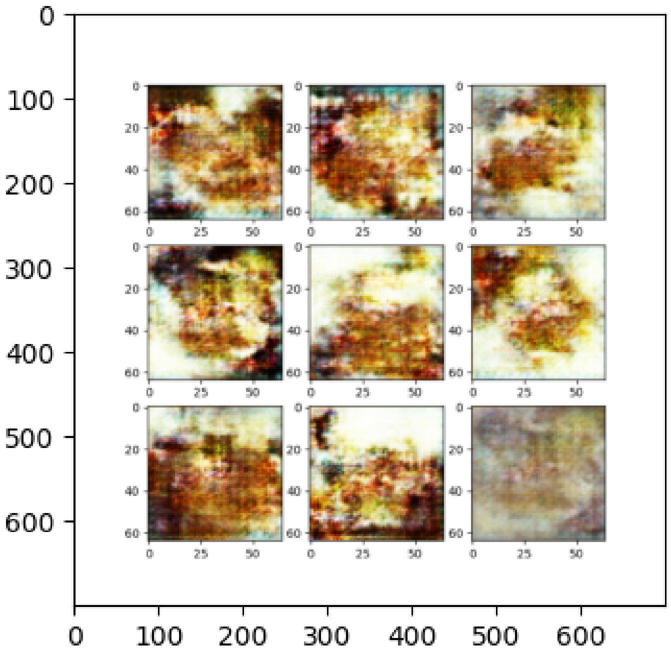
```
epoka: 1799
```



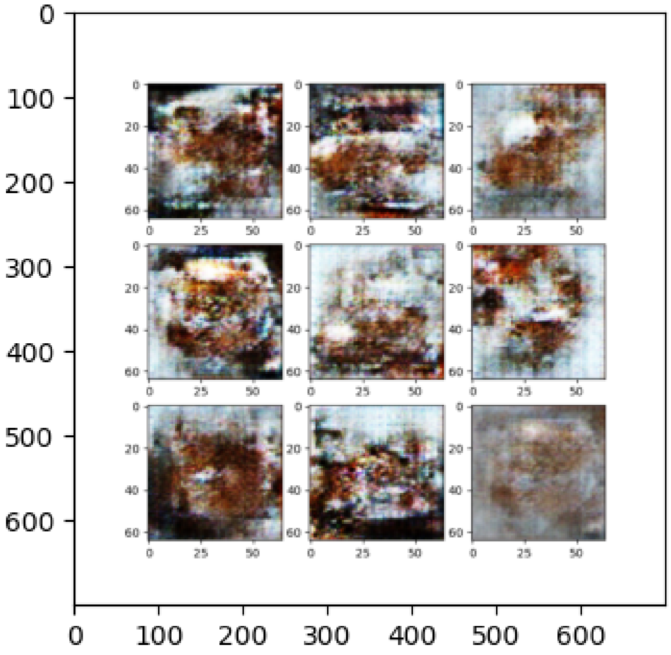
```
epoka: 2099
```



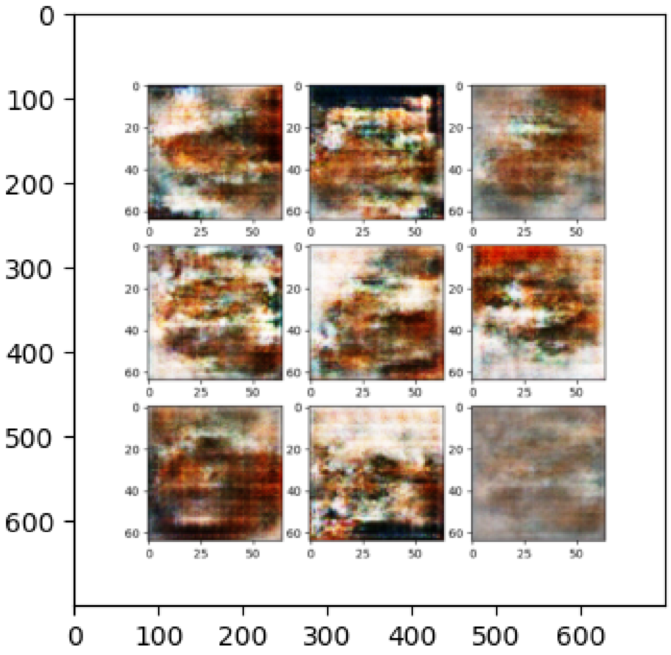
```
epoka: 2399
```



```
epoka: 2699
```



epoka: 2999



Szczególnie na początku wartości wektorów generujących input do generator się niestety zmieniały, w związku z crashami kernela(których później udało się uniknąć). Wyniki nie są idealne, ale wydają

mi się wystarczająco dobre.
Ewidentnie widać "szkocką kratę".

4.0.3 New Generator

[ ]:

```python
def upsampling_block(channels):
    upsamp = tf.keras.layers.UpSampling2D(size=(2,2))
    conv1 = tf.keras.layers.
 ↪Conv2D(filters=channels,kernel_size=(3,3),strides=1,padding='same')
    batch_norm1 = tf.keras.layers.BatchNormalization()
    leaky_relu1 = tf.keras.layers.LeakyReLU(alpha=0.2)
    conv2 = tf.keras.layers.
 ↪Conv2D(filters=channels,kernel_size=(3,3),strides=1,padding='same')
    batch_norm2 = tf.keras.layers.BatchNormalization()
    leaky_relu2 = tf.keras.layers.LeakyReLU(alpha=0.2)


    return [upsamp, conv1, batch_norm1, leaky_relu1, conv2, batch_norm2,␣
 ↪leaky_relu2]
```

[ ]:

```python
generator = tf.keras.Sequential([
    tf.keras.layers.Dense(128*8*8, input_shape=(128,)),
    tf.keras.layers.Reshape((8,8,128))]+
    upsampling_block(64)+
    upsampling_block(128)+
    upsampling_block(256)+[
    tf.keras.layers.
 ↪Conv2D(filters=3,kernel_size=(5,5),strides=1,padding='same',activation='sigmoid')
])
generator.summary()
```

```
Model: "sequential_2"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_1 (Dense)             (None, 8192)              1056768

 reshape (Reshape)           (None, 8, 8, 128)         0

 up_sampling2d (UpSampling2D  (None, 16, 16, 128)      0
 )

 conv2d_3 (Conv2D)           (None, 16, 16, 64)        73792

 batch_normalization_3 (Batc  (None, 16, 16, 64)       256
 hNormalization)

 leaky_re_lu_3 (LeakyReLU)   (None, 16, 16, 64)        0
 conv2d_4 (Conv2D)           (None, 16, 16, 64)        36928

 batch_normalization_4 (Batc  (None, 16, 16, 64)       256
 hNormalization)

 leaky_re_lu_4 (LeakyReLU)   (None, 16, 16, 64)        0

 up_sampling2d_1 (UpSampling  (None, 32, 32, 64)       0
 2D)

 conv2d_5 (Conv2D)           (None, 32, 32, 128)       73856

 batch_normalization_5 (Batc  (None, 32, 32, 128)      512
 hNormalization)

 leaky_re_lu_5 (LeakyReLU)   (None, 32, 32, 128)       0

 conv2d_6 (Conv2D)           (None, 32, 32, 128)       147584

 batch_normalization_6 (Batc  (None, 32, 32, 128)      512
 hNormalization)

 leaky_re_lu_6 (LeakyReLU)   (None, 32, 32, 128)       0

 up_sampling2d_2 (UpSampling  (None, 64, 64, 128)      0
 2D)

 conv2d_7 (Conv2D)           (None, 64, 64, 256)       295168

 batch_normalization_7 (Batc  (None, 64, 64, 256)      1024
 hNormalization)

 leaky_re_lu_7 (LeakyReLU)   (None, 64, 64, 256)       0

 conv2d_8 (Conv2D)           (None, 64, 64, 256)       590080

 batch_normalization_8 (Batc  (None, 64, 64, 256)      1024
 hNormalization)

 leaky_re_lu_8 (LeakyReLU)   (None, 64, 64, 256)       0

 conv2d_9 (Conv2D)           (None, 64, 64, 3)         19203

=================================================================
Total params: 2,296,963
Trainable params: 2,295,171
Non-trainable params: 1,792
```

```
-----------------------------------------------------------------
```

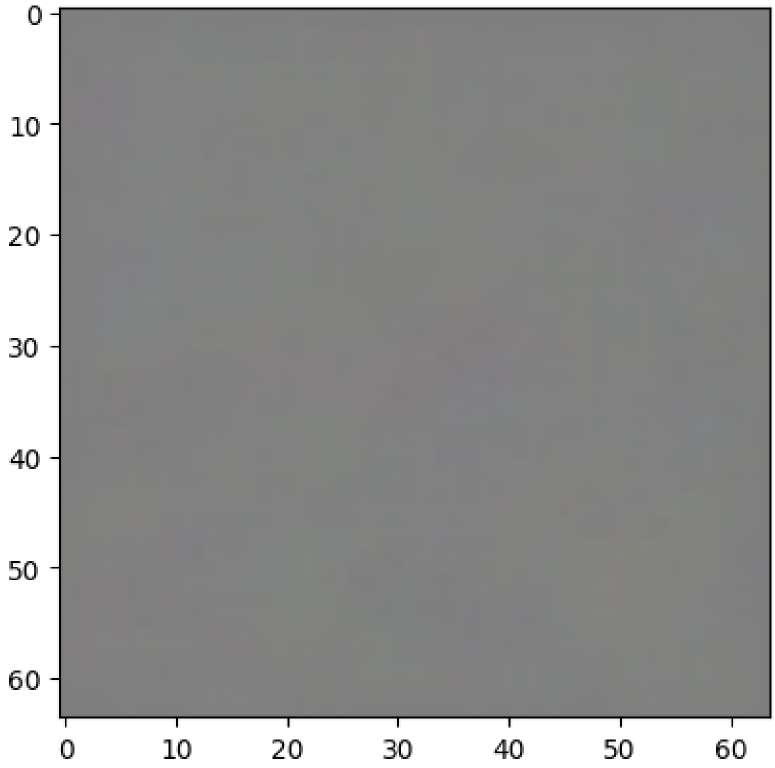
```
[ ]: tmp1 = tf.random.normal(shape=(1,128), mean=0, stddev=1)
```

```
[ ]: tmpimg = generator.predict(tmp1)
```

```
1/1 [==============================] - 0s 161ms/step
```

```
2022-11-10 12:21:41.713385: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:114]
Plugin optimizer for device_type GPU is enabled.
```

```
[ ]: print_image(tmpimg[0])
```



```
[ ]: ds = load_ds()
```

```
Found 400 files belonging to 1 classes.
```

Uczenie planuję zrobić analogicznie do poprzedniego.
Pierwsze ~1600 epok policzymy z lepszą augmentacją, później ~200 bez augmentacji, później do 3000 z średnią augmentacją.
To wymaga rekompilacji wyższych cellek.

[ ]:

```
checkpoint_dir = './training_checkpoints_new_gen'
checkpoint_prefix = os.path.join(checkpoint_dir, "ckpt")
checkpoint = tf.train.Checkpoint(generator_optimizer=generator_optimizer,
                                 ␣
  ↪discriminator_optimizer=discriminator_optimizer,
                                 generator=generator,
                                 discriminator=discriminator)
# checkpoint.restore(checkpoint_prefix+'-4')
```

[ ]:

```
train(last_checkpoint=0, epochs=205)
# train(last_checkpoint=205, epochs=205)
```

Niestety generator zaczął się uczyć znacznie lepiej przez co musiałem trochę popróbować różnych rzeczy by może zadziałało lepiej.
Niestety nie udało mi się doprowadzic GANA do działania

[ ]:

```

```