**Описание файлов:**

**best\_model.hdf5 –** модель обученной нейросети, ее можно скачать по ссылке <https://drive.google.com/file/d/1JZ9sVCTxeEIOsNjafZ9lwej17nla0GIu/view?usp=sharing>

**train\_model.ipynb –** ноутбук с тренировкой нейросети

**process.py –** скрипт для предсказания результата

**Запуск тренировки**

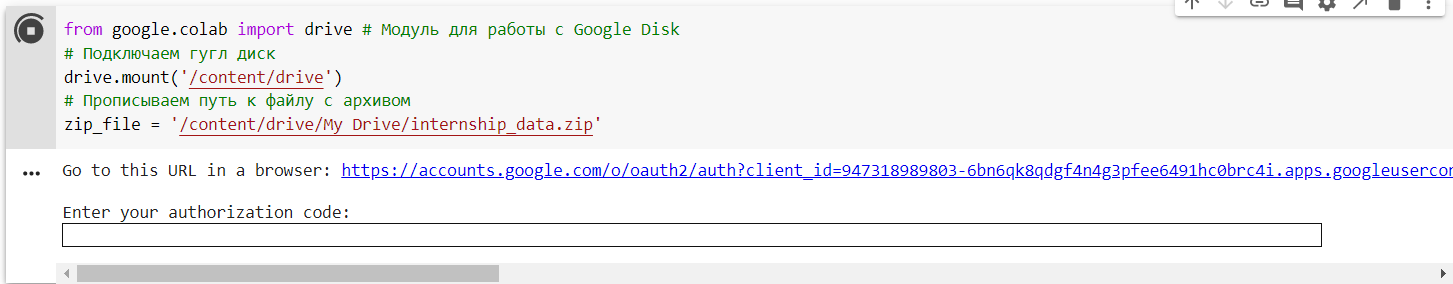
Для запуска тренировочного ноутбука необходимо открыть Google Collab и загрузить файл «train\_model.ipynb»

**Подготовка данных**

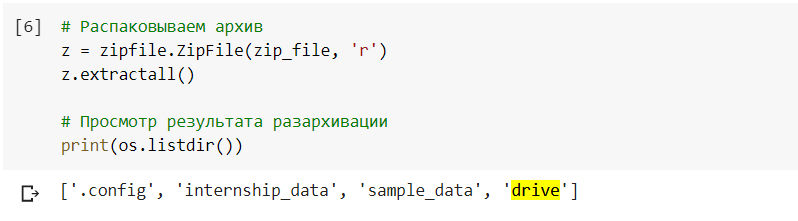
В качестве тренировочных данных были предоставлены 100002 картинки, 50001 из которых – фотографии мужчин, они находятся в папке «male», а другие 50001 – фотографии женщин, находятся в папке female. Обе папки располагаются в папке «internship\_data». Папки «male» и «female» не должны содержать подпапок.

Для обучения модели использовался ноутбук в Collab, поэтому данные (папку «internship\_data») нужно заархивировать и загрузить на Google Drive.

Для того, чтобы копировать данные с Google Drive в среду выполнения Collab необходимо монтировать Google Drive:



Нужно пройти аутентификацию: нажать на ссылку, затем скопировать сгенерированный код и вставить в предложенное поле. Затем данные необходимо распаковать:



После выполнения кода в папке «content» появится папка «internship\_data».

**Используемая нейросеть**

В качестве базовой модели выбрана Xception. К ней добавлены:

* Pooling-слой
* плотный слой, состоящий из 128 нейронов, в качестве функции активации указана «relu»
* слой пакетной нормализации
* Dropout-слой, исключающий 25% нейронов
* Выходной слой, состоящий из двух нейронов, в качестве функции активации выбрана «softmax»

Описание итоговой модели находится в приложении.

**Параметры обучения**

EPOCHS               = 10  # эпох на обучение

BATCH\_SIZE           = 64 # уменьшаем batch если сеть большая, иначе не влезет в память на GPU

LR                   = 1e-2 #сначала выберем не очень маленький LR, затем #уменьшим при необходимости

VAL\_SPLIT            = 0.15 # сколько данных выделяем на тест = 15%

CLASS\_NUM            = 2  # количество классов в нашей задаче

IMG\_SIZE             = 224 # какого размера подаем изображения в сеть

IMG\_CHANNELS         = 3   # у RGB 3 канала

input\_shape          = (IMG\_SIZE, IMG\_SIZE, IMG\_CHANNELS)

loss = "categorical\_crossentropy" #функция потерь – категориальная кросс-энтропия

optimizer = Adamax #оптимизатор для шага градиентного спуска

metrics = "accuracy" #метрика для определения точности

**Полученные результаты**

На тестовой выборке (15000 изображений) получен результат Accuracy = 98.13%

**Запуск нейросети**

Необходимо скачать файл best\_model.hdf5 ( <https://drive.google.com/file/d/1JZ9sVCTxeEIOsNjafZ9lwej17nla0GIu/view?usp=sharing> ) и поместить его в рабочую директорию. Так же в рабочую директорию необходимо поместить файл process.py. В командной строке нужно набрать:

python process.py folder/to/process/

где folder/to/process/ - это путь к папке с фотографиями, для которых требуется выполнить предсказание. Должен быть указан полный путь или путь относительно рабочей директории. В результате исполнения скрипта в рабочей директории будет создан файл с предсказаниями «process\_results.json».

**Приложение**

Model: "functional\_1"

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Layer (type) Output Shape Param # Connected to

==================================================================================================

input\_1 (InputLayer) [(None, 224, 224, 3) 0

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block1\_conv1 (Conv2D) (None, 111, 111, 32) 864 input\_1[0][0]

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block1\_conv1\_bn (BatchNormaliza (None, 111, 111, 32) 128 block1\_conv1[0][0]

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block1\_conv1\_act (Activation) (None, 111, 111, 32) 0 block1\_conv1\_bn[0][0]

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block1\_conv2 (Conv2D) (None, 109, 109, 64) 18432 block1\_conv1\_act[0][0]

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block1\_conv2\_bn (BatchNormaliza (None, 109, 109, 64) 256 block1\_conv2[0][0]

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block1\_conv2\_act (Activation) (None, 109, 109, 64) 0 block1\_conv2\_bn[0][0]

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block2\_sepconv1 (SeparableConv2 (None, 109, 109, 128 8768 block1\_conv2\_act[0][0]

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block2\_sepconv1\_bn (BatchNormal (None, 109, 109, 128 512 block2\_sepconv1[0][0]

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block2\_sepconv2\_act (Activation (None, 109, 109, 128 0 block2\_sepconv1\_bn[0][0]

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block2\_sepconv2 (SeparableConv2 (None, 109, 109, 128 17536 block2\_sepconv2\_act[0][0]

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block2\_sepconv2\_bn (BatchNormal (None, 109, 109, 128 512 block2\_sepconv2[0][0]

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conv2d (Conv2D) (None, 55, 55, 128) 8192 block1\_conv2\_act[0][0]

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block2\_pool (MaxPooling2D) (None, 55, 55, 128) 0 block2\_sepconv2\_bn[0][0]

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batch\_normalization (BatchNorma (None, 55, 55, 128) 512 conv2d[0][0]

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add (Add) (None, 55, 55, 128) 0 block2\_pool[0][0]

batch\_normalization[0][0]

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block3\_sepconv1\_act (Activation (None, 55, 55, 128) 0 add[0][0]

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block3\_sepconv1 (SeparableConv2 (None, 55, 55, 256) 33920 block3\_sepconv1\_act[0][0]

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block3\_sepconv1\_bn (BatchNormal (None, 55, 55, 256) 1024 block3\_sepconv1[0][0]

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block3\_sepconv2\_act (Activation (None, 55, 55, 256) 0 block3\_sepconv1\_bn[0][0]

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block3\_sepconv2 (SeparableConv2 (None, 55, 55, 256) 67840 block3\_sepconv2\_act[0][0]

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block3\_sepconv2\_bn (BatchNormal (None, 55, 55, 256) 1024 block3\_sepconv2[0][0]

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conv2d\_1 (Conv2D) (None, 28, 28, 256) 32768 add[0][0]

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block3\_pool (MaxPooling2D) (None, 28, 28, 256) 0 block3\_sepconv2\_bn[0][0]

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batch\_normalization\_1 (BatchNor (None, 28, 28, 256) 1024 conv2d\_1[0][0]

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add\_1 (Add) (None, 28, 28, 256) 0 block3\_pool[0][0]

batch\_normalization\_1[0][0]

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block4\_sepconv1\_act (Activation (None, 28, 28, 256) 0 add\_1[0][0]

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block4\_sepconv1 (SeparableConv2 (None, 28, 28, 728) 188672 block4\_sepconv1\_act[0][0]

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block4\_sepconv1\_bn (BatchNormal (None, 28, 28, 728) 2912 block4\_sepconv1[0][0]

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block4\_sepconv2\_act (Activation (None, 28, 28, 728) 0 block4\_sepconv1\_bn[0][0]

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block4\_sepconv2 (SeparableConv2 (None, 28, 28, 728) 536536 block4\_sepconv2\_act[0][0]

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block4\_sepconv2\_bn (BatchNormal (None, 28, 28, 728) 2912 block4\_sepconv2[0][0]

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conv2d\_2 (Conv2D) (None, 14, 14, 728) 186368 add\_1[0][0]

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block4\_pool (MaxPooling2D) (None, 14, 14, 728) 0 block4\_sepconv2\_bn[0][0]

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batch\_normalization\_2 (BatchNor (None, 14, 14, 728) 2912 conv2d\_2[0][0]

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add\_2 (Add) (None, 14, 14, 728) 0 block4\_pool[0][0]

batch\_normalization\_2[0][0]

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block5\_sepconv1\_act (Activation (None, 14, 14, 728) 0 add\_2[0][0]

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block5\_sepconv1 (SeparableConv2 (None, 14, 14, 728) 536536 block5\_sepconv1\_act[0][0]

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block5\_sepconv1\_bn (BatchNormal (None, 14, 14, 728) 2912 block5\_sepconv1[0][0]

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block5\_sepconv2\_act (Activation (None, 14, 14, 728) 0 block5\_sepconv1\_bn[0][0]

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block5\_sepconv2 (SeparableConv2 (None, 14, 14, 728) 536536 block5\_sepconv2\_act[0][0]

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block5\_sepconv2\_bn (BatchNormal (None, 14, 14, 728) 2912 block5\_sepconv2[0][0]

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block5\_sepconv3\_act (Activation (None, 14, 14, 728) 0 block5\_sepconv2\_bn[0][0]

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block5\_sepconv3 (SeparableConv2 (None, 14, 14, 728) 536536 block5\_sepconv3\_act[0][0]

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block5\_sepconv3\_bn (BatchNormal (None, 14, 14, 728) 2912 block5\_sepconv3[0][0]

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add\_3 (Add) (None, 14, 14, 728) 0 block5\_sepconv3\_bn[0][0]

add\_2[0][0]

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block6\_sepconv1\_act (Activation (None, 14, 14, 728) 0 add\_3[0][0]

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block6\_sepconv1 (SeparableConv2 (None, 14, 14, 728) 536536 block6\_sepconv1\_act[0][0]

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block6\_sepconv1\_bn (BatchNormal (None, 14, 14, 728) 2912 block6\_sepconv1[0][0]

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block6\_sepconv2\_act (Activation (None, 14, 14, 728) 0 block6\_sepconv1\_bn[0][0]

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block6\_sepconv2 (SeparableConv2 (None, 14, 14, 728) 536536 block6\_sepconv2\_act[0][0]

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block6\_sepconv2\_bn (BatchNormal (None, 14, 14, 728) 2912 block6\_sepconv2[0][0]

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block6\_sepconv3\_act (Activation (None, 14, 14, 728) 0 block6\_sepconv2\_bn[0][0]

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block6\_sepconv3 (SeparableConv2 (None, 14, 14, 728) 536536 block6\_sepconv3\_act[0][0]

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block6\_sepconv3\_bn (BatchNormal (None, 14, 14, 728) 2912 block6\_sepconv3[0][0]

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add\_4 (Add) (None, 14, 14, 728) 0 block6\_sepconv3\_bn[0][0]

add\_3[0][0]

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block7\_sepconv1\_act (Activation (None, 14, 14, 728) 0 add\_4[0][0]

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block7\_sepconv1 (SeparableConv2 (None, 14, 14, 728) 536536 block7\_sepconv1\_act[0][0]

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block7\_sepconv1\_bn (BatchNormal (None, 14, 14, 728) 2912 block7\_sepconv1[0][0]

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block7\_sepconv2\_act (Activation (None, 14, 14, 728) 0 block7\_sepconv1\_bn[0][0]

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block7\_sepconv2 (SeparableConv2 (None, 14, 14, 728) 536536 block7\_sepconv2\_act[0][0]

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block7\_sepconv2\_bn (BatchNormal (None, 14, 14, 728) 2912 block7\_sepconv2[0][0]

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block7\_sepconv3\_act (Activation (None, 14, 14, 728) 0 block7\_sepconv2\_bn[0][0]

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block7\_sepconv3 (SeparableConv2 (None, 14, 14, 728) 536536 block7\_sepconv3\_act[0][0]

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block7\_sepconv3\_bn (BatchNormal (None, 14, 14, 728) 2912 block7\_sepconv3[0][0]

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add\_5 (Add) (None, 14, 14, 728) 0 block7\_sepconv3\_bn[0][0]

add\_4[0][0]

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block8\_sepconv1\_act (Activation (None, 14, 14, 728) 0 add\_5[0][0]

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block8\_sepconv1 (SeparableConv2 (None, 14, 14, 728) 536536 block8\_sepconv1\_act[0][0]

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block8\_sepconv1\_bn (BatchNormal (None, 14, 14, 728) 2912 block8\_sepconv1[0][0]

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block8\_sepconv2\_act (Activation (None, 14, 14, 728) 0 block8\_sepconv1\_bn[0][0]

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block8\_sepconv2 (SeparableConv2 (None, 14, 14, 728) 536536 block8\_sepconv2\_act[0][0]

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block8\_sepconv2\_bn (BatchNormal (None, 14, 14, 728) 2912 block8\_sepconv2[0][0]

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block8\_sepconv3\_act (Activation (None, 14, 14, 728) 0 block8\_sepconv2\_bn[0][0]

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block8\_sepconv3 (SeparableConv2 (None, 14, 14, 728) 536536 block8\_sepconv3\_act[0][0]

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block8\_sepconv3\_bn (BatchNormal (None, 14, 14, 728) 2912 block8\_sepconv3[0][0]

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add\_6 (Add) (None, 14, 14, 728) 0 block8\_sepconv3\_bn[0][0]

add\_5[0][0]

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block9\_sepconv1\_act (Activation (None, 14, 14, 728) 0 add\_6[0][0]

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block9\_sepconv1 (SeparableConv2 (None, 14, 14, 728) 536536 block9\_sepconv1\_act[0][0]

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block9\_sepconv1\_bn (BatchNormal (None, 14, 14, 728) 2912 block9\_sepconv1[0][0]

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block9\_sepconv2\_act (Activation (None, 14, 14, 728) 0 block9\_sepconv1\_bn[0][0]

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block9\_sepconv2 (SeparableConv2 (None, 14, 14, 728) 536536 block9\_sepconv2\_act[0][0]

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block9\_sepconv2\_bn (BatchNormal (None, 14, 14, 728) 2912 block9\_sepconv2[0][0]

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block9\_sepconv3\_act (Activation (None, 14, 14, 728) 0 block9\_sepconv2\_bn[0][0]

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block9\_sepconv3 (SeparableConv2 (None, 14, 14, 728) 536536 block9\_sepconv3\_act[0][0]

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block9\_sepconv3\_bn (BatchNormal (None, 14, 14, 728) 2912 block9\_sepconv3[0][0]

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add\_7 (Add) (None, 14, 14, 728) 0 block9\_sepconv3\_bn[0][0]

add\_6[0][0]

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block10\_sepconv1\_act (Activatio (None, 14, 14, 728) 0 add\_7[0][0]

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block10\_sepconv1 (SeparableConv (None, 14, 14, 728) 536536 block10\_sepconv1\_act[0][0]

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block10\_sepconv1\_bn (BatchNorma (None, 14, 14, 728) 2912 block10\_sepconv1[0][0]

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block10\_sepconv2\_act (Activatio (None, 14, 14, 728) 0 block10\_sepconv1\_bn[0][0]

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block10\_sepconv2 (SeparableConv (None, 14, 14, 728) 536536 block10\_sepconv2\_act[0][0]

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block10\_sepconv2\_bn (BatchNorma (None, 14, 14, 728) 2912 block10\_sepconv2[0][0]

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block10\_sepconv3\_act (Activatio (None, 14, 14, 728) 0 block10\_sepconv2\_bn[0][0]

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block10\_sepconv3 (SeparableConv (None, 14, 14, 728) 536536 block10\_sepconv3\_act[0][0]

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block10\_sepconv3\_bn (BatchNorma (None, 14, 14, 728) 2912 block10\_sepconv3[0][0]

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add\_8 (Add) (None, 14, 14, 728) 0 block10\_sepconv3\_bn[0][0]

add\_7[0][0]

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block11\_sepconv1\_act (Activatio (None, 14, 14, 728) 0 add\_8[0][0]

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block11\_sepconv1 (SeparableConv (None, 14, 14, 728) 536536 block11\_sepconv1\_act[0][0]

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block11\_sepconv1\_bn (BatchNorma (None, 14, 14, 728) 2912 block11\_sepconv1[0][0]

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block11\_sepconv2\_act (Activatio (None, 14, 14, 728) 0 block11\_sepconv1\_bn[0][0]

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block11\_sepconv2 (SeparableConv (None, 14, 14, 728) 536536 block11\_sepconv2\_act[0][0]

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block11\_sepconv2\_bn (BatchNorma (None, 14, 14, 728) 2912 block11\_sepconv2[0][0]

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block11\_sepconv3\_act (Activatio (None, 14, 14, 728) 0 block11\_sepconv2\_bn[0][0]

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block11\_sepconv3 (SeparableConv (None, 14, 14, 728) 536536 block11\_sepconv3\_act[0][0]

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block11\_sepconv3\_bn (BatchNorma (None, 14, 14, 728) 2912 block11\_sepconv3[0][0]

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add\_9 (Add) (None, 14, 14, 728) 0 block11\_sepconv3\_bn[0][0]

add\_8[0][0]

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block12\_sepconv1\_act (Activatio (None, 14, 14, 728) 0 add\_9[0][0]

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block12\_sepconv1 (SeparableConv (None, 14, 14, 728) 536536 block12\_sepconv1\_act[0][0]

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block12\_sepconv1\_bn (BatchNorma (None, 14, 14, 728) 2912 block12\_sepconv1[0][0]

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block12\_sepconv2\_act (Activatio (None, 14, 14, 728) 0 block12\_sepconv1\_bn[0][0]

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block12\_sepconv2 (SeparableConv (None, 14, 14, 728) 536536 block12\_sepconv2\_act[0][0]

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block12\_sepconv2\_bn (BatchNorma (None, 14, 14, 728) 2912 block12\_sepconv2[0][0]

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block12\_sepconv3\_act (Activatio (None, 14, 14, 728) 0 block12\_sepconv2\_bn[0][0]

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block12\_sepconv3 (SeparableConv (None, 14, 14, 728) 536536 block12\_sepconv3\_act[0][0]

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block12\_sepconv3\_bn (BatchNorma (None, 14, 14, 728) 2912 block12\_sepconv3[0][0]

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add\_10 (Add) (None, 14, 14, 728) 0 block12\_sepconv3\_bn[0][0]

add\_9[0][0]

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block13\_sepconv1\_act (Activatio (None, 14, 14, 728) 0 add\_10[0][0]

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block13\_sepconv1 (SeparableConv (None, 14, 14, 728) 536536 block13\_sepconv1\_act[0][0]

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block13\_sepconv1\_bn (BatchNorma (None, 14, 14, 728) 2912 block13\_sepconv1[0][0]

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block13\_sepconv2\_act (Activatio (None, 14, 14, 728) 0 block13\_sepconv1\_bn[0][0]

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block13\_sepconv2 (SeparableConv (None, 14, 14, 1024) 752024 block13\_sepconv2\_act[0][0]

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block13\_sepconv2\_bn (BatchNorma (None, 14, 14, 1024) 4096 block13\_sepconv2[0][0]

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conv2d\_3 (Conv2D) (None, 7, 7, 1024) 745472 add\_10[0][0]

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block13\_pool (MaxPooling2D) (None, 7, 7, 1024) 0 block13\_sepconv2\_bn[0][0]

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batch\_normalization\_3 (BatchNor (None, 7, 7, 1024) 4096 conv2d\_3[0][0]

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add\_11 (Add) (None, 7, 7, 1024) 0 block13\_pool[0][0]

batch\_normalization\_3[0][0]

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block14\_sepconv1 (SeparableConv (None, 7, 7, 1536) 1582080 add\_11[0][0]

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block14\_sepconv1\_bn (BatchNorma (None, 7, 7, 1536) 6144 block14\_sepconv1[0][0]

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block14\_sepconv1\_act (Activatio (None, 7, 7, 1536) 0 block14\_sepconv1\_bn[0][0]

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block14\_sepconv2 (SeparableConv (None, 7, 7, 2048) 3159552 block14\_sepconv1\_act[0][0]

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block14\_sepconv2\_bn (BatchNorma (None, 7, 7, 2048) 8192 block14\_sepconv2[0][0]

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block14\_sepconv2\_act (Activatio (None, 7, 7, 2048) 0 block14\_sepconv2\_bn[0][0]

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global\_average\_pooling2d (Globa (None, 2048) 0 block14\_sepconv2\_act[0][0]

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dense (Dense) (None, 128) 262272 global\_average\_pooling2d[0][0]

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batch\_normalization\_4 (BatchNor (None, 128) 512 dense[0][0]

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dropout (Dropout) (None, 128) 0 batch\_normalization\_4[0][0]

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dense\_1 (Dense) (None, 2) 258 dropout[0][0]

==================================================================================================

Total params: 21,124,522

Trainable params: 21,069,738

Non-trainable params: 54,784