In [2]:
```
pip install matplotlib
```

```
Collecting matplotlib
  Using cached matplotlib-3.7.2-cp310-cp310-win_amd64.whl (7.5 MB)
Collecting kiwisolver>=1.0.1
  Using cached kiwisolver-1.4.4-cp310-cp310-win_amd64.whl (55 kB)
Requirement already satisfied: numpy>=1.20 in c:\users\nikki chauhan\appdata
\local\programs\python\python310\lib\site-packages (from matplotlib) (1.24.
3)
Collecting fonttools>=4.22.0
  Using cached fonttools-4.41.1-cp310-cp310-win_amd64.whl (2.1 MB)
Collecting cycler>=0.10
  Using cached cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Using cached contourpy-1.1.0-cp310-cp310-win_amd64.whl (470 kB)
Collecting pyparsing<3.1,>=2.3.1
  Using cached pyparsing-3.0.9-py3-none-any.whl (98 kB)
Collecting pillow>=6.2.0
  Using cached Pillow-10.0.0-cp310-cp310-win_amd64.whl (2.5 MB)
Requirement already satisfied: packaging>=20.0 in c:\users\nikki chauhan\app
data\local\programs\python\python310\lib\site-packages (from matplotlib) (2
3.0)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\nikki chauha
n\appdata\local\programs\python\python310\lib\site-packages (from matplotli
b) (2.8.2)
Requirement already satisfied: six>=1.5 in c:\users\nikki chauhan\appdata\lo
cal\programs\python\python310\lib\site-packages (from python-dateutil>=2.7->
matplotlib) (1.16.0)
Installing collected packages: pyparsing, pillow, kiwisolver, fonttools, cyc
ler, contourpy, matplotlib
Successfully installed contourpy-1.1.0 cycler-0.11.0 fonttools-4.41.1 kiwiso
lver-1.4.4 matplotlib-3.7.2 pillow-10.0.0 pyparsing-3.0.9
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip available: 22.3.1 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [4]:
```
pip install seaborn
```

```
Collecting seaborn
  Downloading seaborn-0.12.2-py3-none-any.whl (293 kB)
     ------------------------------------- 293.3/293.3 kB 9.1 MB/s eta 0:0
0:00
Requirement already satisfied: pandas>=0.25 in c:\users\nikki chauhan\appdat
a\local\programs\python\python310\lib\site-packages (from seaborn) (2.0.3)
Requirement already satisfied: numpy!=1.24.0,>=1.17 in c:\users\nikki chauha
n\appdata\local\programs\python\python310\lib\site-packages (from seaborn)
(1.24.3)
Requirement already satisfied: matplotlib!=3.6.1,>=3.1 in c:\users\nikki cha
uhan\appdata\local\programs\python\python310\lib\site-packages (from seabor
n) (3.7.2)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\nikki chauha
n\appdata\local\programs\python\python310\lib\site-packages (from matplotli
b!=3.6.1,>=3.1->seaborn) (2.8.2)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\nikki chauhan\a
ppdata\local\programs\python\python310\lib\site-packages (from matplotlib!=
3.6.1,>=3.1->seaborn) (4.41.1)
Requirement already satisfied: packaging>=20.0 in c:\users\nikki chauhan\app
data\local\programs\python\python310\lib\site-packages (from matplotlib!=3.
6.1,>=3.1->seaborn) (23.0)
Requirement already satisfied: pyparsing<3.1,>=2.3.1 in c:\users\nikki chauh
an\appdata\local\programs\python\python310\lib\site-packages (from matplotli
b!=3.6.1,>=3.1->seaborn) (3.0.9)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\nikki chauhan\a
ppdata\local\programs\python\python310\lib\site-packages (from matplotlib!=
3.6.1,>=3.1->seaborn) (1.4.4)
Requirement already satisfied: pillow>=6.2.0 in c:\users\nikki chauhan\appda
ta\local\programs\python\python310\lib\site-packages (from matplotlib!=3.6.
1,>=3.1->seaborn) (10.0.0)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\nikki chauhan\ap
pdata\local\programs\python\python310\lib\site-packages (from matplotlib!=3.
6.1,>=3.1->seaborn) (1.1.0)
Requirement already satisfied: cycler>=0.10 in c:\users\nikki chauhan\appdat
a\local\programs\python\python310\lib\site-packages (from matplotlib!=3.6.1,
>=3.1->seaborn) (0.11.0)
Requirement already satisfied: pytz>=2020.1 in c:\users\nikki chauhan\appdat
a\local\programs\python\python310\lib\site-packages (from pandas>=0.25->seab
orn) (2023.3)
Requirement already satisfied: tzdata>=2022.1 in c:\users\nikki chauhan\appd
ata\local\programs\python\python310\lib\site-packages (from pandas>=0.25->se
aborn) (2023.3)
Requirement already satisfied: six>=1.5 in c:\users\nikki chauhan\appdata\lo
cal\programs\python\python310\lib\site-packages (from python-dateutil>=2.7->
matplotlib!=3.6.1,>=3.1->seaborn) (1.16.0)
Installing collected packages: seaborn
Successfully installed seaborn-0.12.2
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip available: 22.3.1 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [6]:
```
pip install tqdm
```

```
Collecting tqdm
  Using cached tqdm-4.65.0-py3-none-any.whl (77 kB)
Requirement already satisfied: colorama in c:\users\nikki chauhan\appdata\lo
cal\programs\python\python310\lib\site-packages (from tqdm) (0.4.6)
Installing collected packages: tqdm
Successfully installed tqdm-4.65.0
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip available: 22.3.1 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [8]:
```
# Import necessary modules first.
import tensorflow as tf
from tensorflow.keras.utils import load_img
from keras.models import Sequential, Model
from keras.layers import Dense, Conv2D, Dropout, Flatten, MaxPooling2D, Input
import numpy as np
import random
import matplotlib.pyplot as plt
import os
import seaborn as sns
import warnings
from tqdm.notebook import tqdm
warnings.filterwarnings('ignore')
%matplotlib inline
```

In [9]:
```
import os

# Specify the path to the folder using double backslashes
folder_path = "C:\\Users\\Nikki Chauhan\\Downloads\\archive"

# List all files in the folder
files_in_folder = os.listdir(folder_path)
print(files_in_folder)
```

```
['crop_part1', 'UTKFace', 'utkface_aligned_cropped']
```

In [23]:
```
import os
import random
from tqdm import tqdm

# Specify the path to the folder using forward slashes or double backslashes
BASE_DIR = r"C:\Users\Nikki Chauhan\Downloads\archive\UTKFace"

age_labels = []
gender_labels = []
image_paths = []

# List all files in the folder
image_filenames = os.listdir(BASE_DIR)
random.shuffle(image_filenames)

for image in tqdm(image_filenames):
    # Create the full image path by joining the folder path and image filenam
    image_path = os.path.join(BASE_DIR, image)

    # Split the image filename to extract age and gender labels (with error h
    img_components = image.split('_')
    try:
        age_label = int(img_components[0])
        gender_label = int(img_components[1].split('.')[0])  # Remove the fil
    except ValueError:
        # Skip this image if it doesn't follow the expected format
        continue

    # Append the image_path, age_label, and gender_label to their respective
    age_labels.append(age_label)
    gender_labels.append(gender_label)
    image_paths.append(image_path)
```

```
100%|
| 23708/23708 [00:00<00:00, 255531.52it/s]
```

In [24]:
```
print(f'Number of age_labels: {len(age_labels)}, Number of gender_labels: {le
```

```
Number of age_labels: 23708, Number of gender_labels: 23708, Number of image
_paths: 23708
```

In [25]:
```
gender_mapping = {
    1: 'Female',
    0: 'Male'
}
```

In [26]:
```
import pandas as pd
df = pd.DataFrame()
df['image_path'], df['age'], df['gender'] = image_paths, age_labels, gender_l
df.head(5)
```

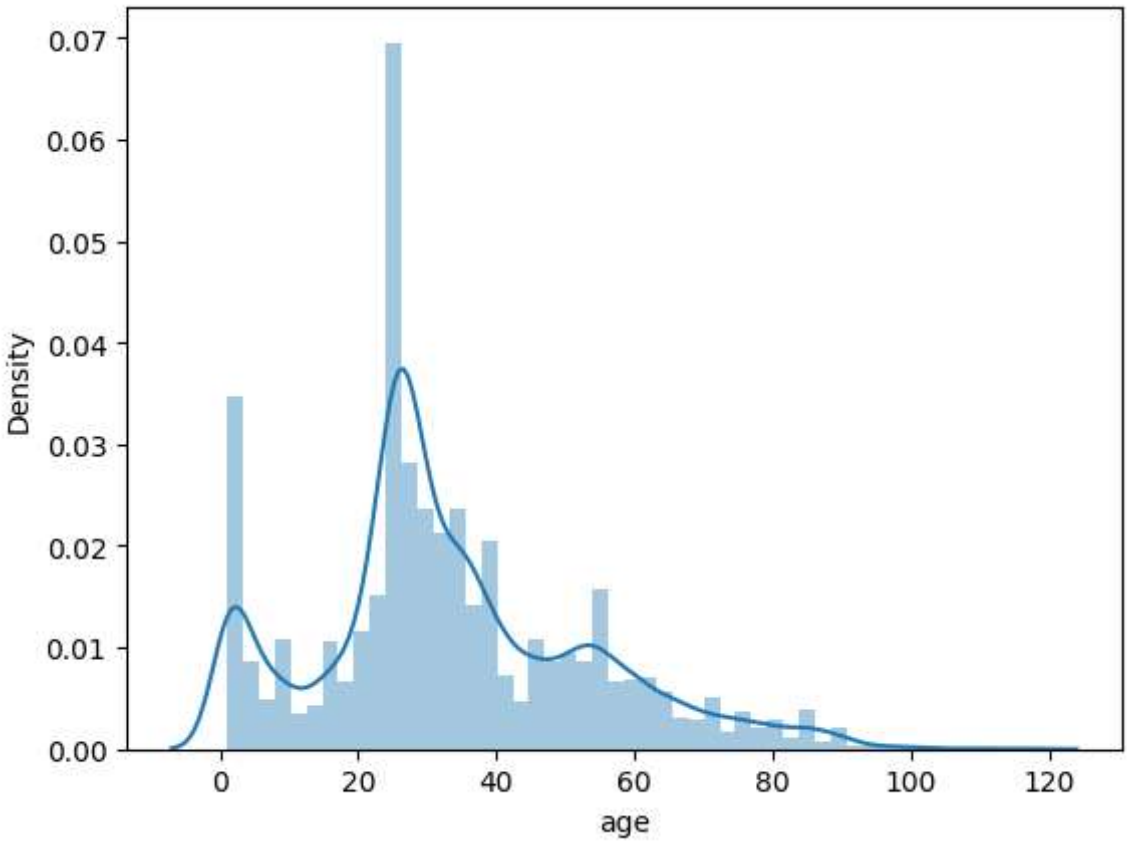
Out[26]:

	image_path	age	gender
0	C:\Users\Nikki Chauhan\Downloads\archive\UTKFa...	1	1
1	C:\Users\Nikki Chauhan\Downloads\archive\UTKFa...	38	1
2	C:\Users\Nikki Chauhan\Downloads\archive\UTKFa...	36	1
3	C:\Users\Nikki Chauhan\Downloads\archive\UTKFa...	4	1
4	C:\Users\Nikki Chauhan\Downloads\archive\UTKFa...	1	0

In [27]:
```
from PIL import Image
import matplotlib.pyplot as plt
if not image_paths:
    print("No image paths found.")
else:

    rand_index = random.randint(0, len(image_paths) - 1)


    if 0 <= rand_index < len(age_labels) and 0 <= rand_index < len(gender_lab
        age = age_labels[rand_index]
        gender = gender_labels[rand_index]
        image_path = image_paths[rand_index]

        IMG = Image.open(image_path)

        gender_mapping = {0: 'Male', 1: 'Female'}
        plt.title(f'Age: {age} Gender: {gender_mapping[gender]}')
        plt.axis('off')
        plt.imshow(IMG)
        plt.show()
    else:
        print("Invalid index or age/gender labels not available for the selec
```

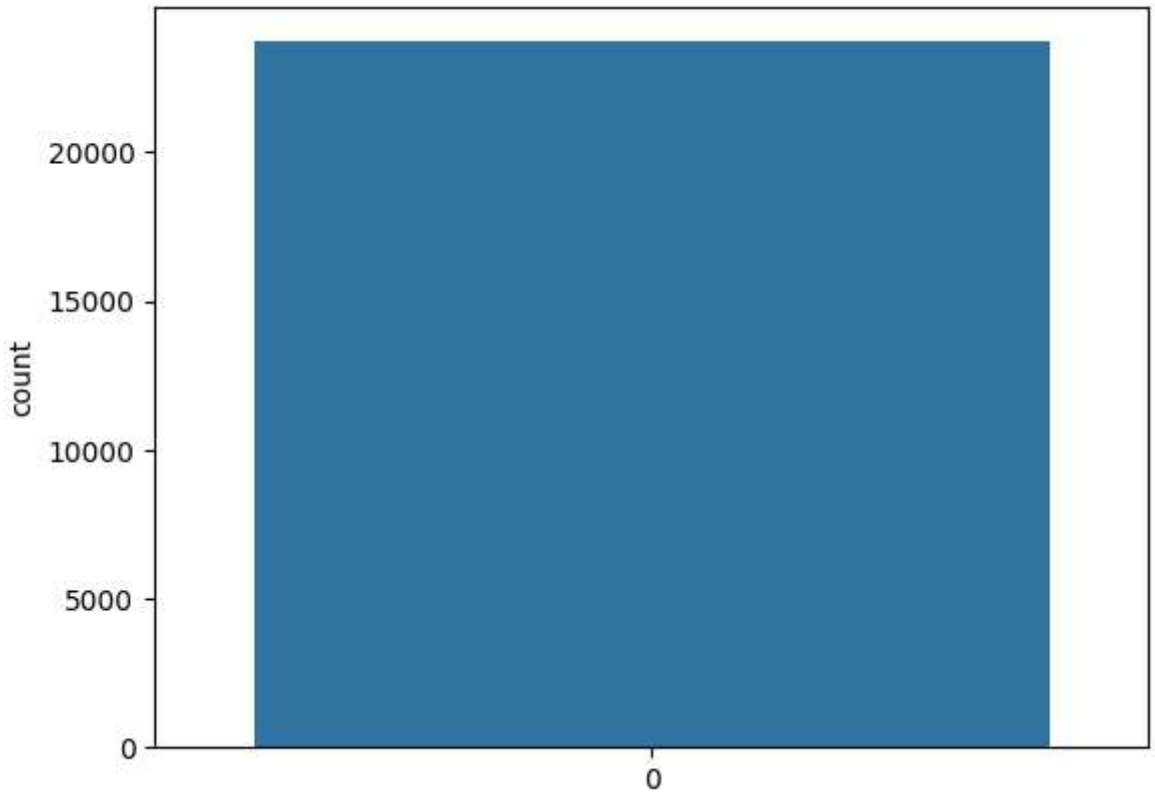
In [28]:
```
# Age distribution
sns.distplot(df['age'])
```

Out[28]: <Axes: xlabel='age', ylabel='Density'>



In [29]:
```
sns.countplot(df['gender'])
```

Out[29]: <Axes: ylabel='count'>



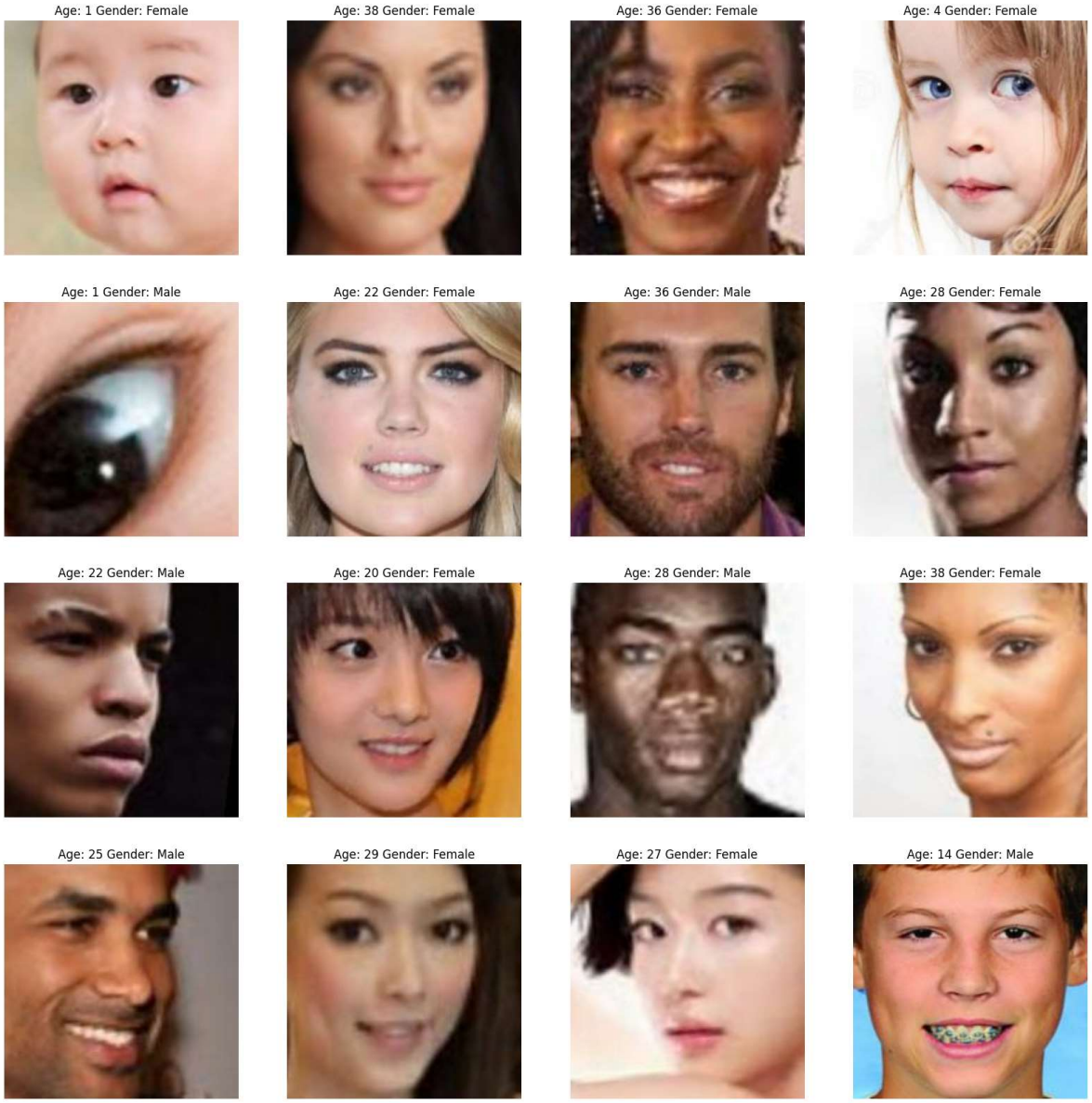
In [37]:
```
import sys
print(sys.executable)
!pip show Pillow
```

```
C:\Users\Nikki Chauhan\AppData\Local\Programs\Python\Python310\python.exe
Name: Pillow
Version: 10.0.0
Summary: Python Imaging Library (Fork)
Home-page: https://python-pillow.org (https://python-pillow.org)
Author: Jeffrey A. Clark (Alex)
Author-email: aclark@aclark.net
License: HPND
Location: c:\users\nikki chauhan\appdata\local\programs\python\python310\lib
\site-packages
Requires:
Required-by: matplotlib
```

In [38]:
```
pip install Pillow
```

```
Requirement already satisfied: Pillow in c:\users\nikki chauhan\appdata\loca
l\programs\python\python310\lib\site-packages (10.0.0)
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip available: 22.3.1 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [39]:
```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np

plt.figure(figsize=(20, 20))
samples = df.iloc[0:16]

for index, row in enumerate(samples.itertuples()):
    sample = row.image_path
    age = row.age
    gender = row.gender

    plt.subplot(4, 4, index + 1)
    img = mpimg.imread(sample)
    plt.axis('off')
    plt.title(f'Age: {age} Gender: {gender_mapping[gender]}')
    plt.imshow(img)

plt.show()
```



In [49]:
```
def extract_image_features(images):
    features = list()

    for image in tqdm(images):
        img = load_img(image, grayscale=True)
        img = img.resize((128, 128), Image.ANTIALIAS)
        img = np.array(img)
        features.append(img)

    features = np.array(features)
    features = features.reshape(len(features), 128, 128, 1)
    return features
```

In [55]:
```
!pip install Pillow
```

```
Requirement already satisfied: Pillow in c:\users\nikki chauhan\appdata\loca
l\programs\python\python310\lib\site-packages (10.0.0)


[notice] A new release of pip available: 22.3.1 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [56]:
```
import PIL
print(PIL.__version__)
```

```
10.0.0
```

In [57]:
```
import sys
print(sys.modules['PIL'])
```

```
<module 'PIL' from 'C:\\Users\\Nikki Chauhan\\AppData\\Local\\Programs\\Pyth
on\\Python310\\lib\\site-packages\\PIL\\__init__.py'>
```

In [59]:
```
import numpy as np
from PIL import Image
from tqdm import tqdm

def extract_image_features(images):
    features = list()

    for image in tqdm(images):
        img = Image.open(image).convert('L')
        img = img.resize((128, 128), Image.LANCZOS)
        img = np.array(img)
        features.append(img)

    features = np.array(features)
    features = features.reshape(len(features), 128, 128, 1)
    return features

image_path = r"C:\Users\Nikki Chauhan\Downloads\archive\crop_part1\9_1_0_2017
image_list = [image_path]

X = extract_image_features(image_list)
```

```
100%|
| 1/1 [00:00<00:00, 66.92it/s]
```

In [60]:
```
X.shape
```

Out[60]:
```
(1, 128, 128, 1)
```

In [61]:
```
X = X / 255.0
```

In [63]:
```
import numpy as np

y_gender = np.array(df['gender'])
y_age = np.array(df['age'])
```

In [64]:
```
input_shape = (128, 128, 1)
```

In [65]:
```
inputs = Input((input_shape))
conv_1 = Conv2D(32, kernel_size=(3, 3), activation='relu')(inputs)
max_1 = MaxPooling2D(pool_size=(2, 2))(conv_1)
conv_2 = Conv2D(64, kernel_size=(3, 3), activation='relu')(max_1)
max_2 = MaxPooling2D(pool_size=(2, 2))(conv_2)
conv_3 = Conv2D(128, kernel_size=(3, 3), activation='relu')(max_2)
max_3 = MaxPooling2D(pool_size=(2, 2))(conv_3)
conv_4 = Conv2D(256, kernel_size=(3, 3), activation='relu')(max_3)
max_4 = MaxPooling2D(pool_size=(2, 2))(conv_4)

flatten = Flatten()(max_4)

# fully connected layers
dense_1 = Dense(256, activation='relu')(flatten)
dense_2 = Dense(256, activation='relu')(flatten)

dropout_1 = Dropout(0.3)(dense_1)
dropout_2 = Dropout(0.3)(dense_2)

output_1 = Dense(1, activation='sigmoid', name='gender_out')(dropout_1)
output_2 = Dense(1, activation='relu', name='age_out')(dropout_2)

model = Model(inputs=[inputs], outputs=[output_1, output_2])

model.compile(loss=['binary_crossentropy', 'mae'],
              optimizer='adam', metrics=['accuracy'])
```

In [66]:
```
# plot the model
from tensorflow.keras.utils import plot_model
plot_model(model)
```

```
You must install pydot (`pip install pydot`) and install graphviz (see instr
uctions at https://graphviz.gitlab.io/download/) (https://graphviz.gitlab.i
o/download/)) for plot_model to work.
```

In [74]:
```
print("Shape of X:", X.shape)
print("Shape of y_gender:", y_gender.shape)
print("Shape of y_age:", y_age.shape)
```

```
Shape of X: (1, 128, 128, 1)
Shape of y_gender: (23708,)
Shape of y_age: (23708,)
```

In [71]:
```
pip install scikit-learn
```

```
Collecting scikit-learn
  Downloading scikit_learn-1.3.0-cp310-cp310-win_amd64.whl (9.2 MB)
     ---------------------------------------- 9.2/9.2 MB 6.4 MB/s eta 0:00:0
0
Requirement already satisfied: numpy>=1.17.3 in c:\users\nikki chauhan\appda
ta\local\programs\python\python310\lib\site-packages (from scikit-learn) (1.
24.3)
Collecting threadpoolctl>=2.0.0
  Downloading threadpoolctl-3.2.0-py3-none-any.whl (15 kB)
Requirement already satisfied: scipy>=1.5.0 in c:\users\nikki chauhan\appdat
a\local\programs\python\python310\lib\site-packages (from scikit-learn) (1.1
1.1)
Collecting joblib>=1.1.1
  Downloading joblib-1.3.1-py3-none-any.whl (301 kB)
     ---------------------------------------- 302.0/302.0 kB 6.2 MB/s eta 0:0
0:00
Installing collected packages: threadpoolctl, joblib, scikit-learn
Successfully installed joblib-1.3.1 scikit-learn-1.3.0 threadpoolctl-3.2.0
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip available: 22.3.1 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [100]:
```
import numpy as np
X_new = np.repeat(X, 23708, axis=0)

print(X_new.shape)
print(y_gender.shape)
print(y_age.shape)

# Train the model
history = model.fit(x=X_new, y=[y_gender, y_age], batch_size=32, epochs=10)
```

```
(23708, 128, 128, 1)
(23708,)
(23708,)
Epoch 1/10
741/741 [==============================] - 505s 671ms/step - loss: 16.2808 -
gender_out_loss: 0.7014 - age_out_loss: 15.5794 - gender_out_accuracy: 0.517
7 - age_out_accuracy: 0.0474
Epoch 2/10
741/741 [==============================] - 505s 681ms/step - loss: 15.9776 -
gender_out_loss: 0.6923 - age_out_loss: 15.2854 - gender_out_accuracy: 0.522
4 - age_out_accuracy: 0.0474
Epoch 3/10
741/741 [==============================] - 431s 582ms/step - loss: 15.9154 -
gender_out_loss: 0.6922 - age_out_loss: 15.2232 - gender_out_accuracy: 0.522
1 - age_out_accuracy: 0.0474
Epoch 4/10
741/741 [==============================] - 310s 418ms/step - loss: 15.8764 -
gender_out_loss: 0.6922 - age_out_loss: 15.1842 - gender_out_accuracy: 0.522
7 - age_out_accuracy: 0.0474
Epoch 5/10
741/741 [==============================] - 327s 441ms/step - loss: 15.8842 -
gender_out_loss: 0.6922 - age_out_loss: 15.1921 - gender_out_accuracy: 0.522
7 - age_out_accuracy: 0.0474
Epoch 6/10
741/741 [==============================] - 329s 444ms/step - loss: 15.8795 -
gender_out_loss: 0.6922 - age_out_loss: 15.1874 - gender_out_accuracy: 0.522
7 - age_out_accuracy: 0.0474
Epoch 7/10
741/741 [==============================] - 308s 416ms/step - loss: 15.8485 -
gender_out_loss: 0.6922 - age_out_loss: 15.1563 - gender_out_accuracy: 0.522
5 - age_out_accuracy: 0.0474
Epoch 8/10
741/741 [==============================] - 309s 417ms/step - loss: 15.8863 -
gender_out_loss: 0.6922 - age_out_loss: 15.1942 - gender_out_accuracy: 0.522
7 - age_out_accuracy: 0.0474
Epoch 9/10
741/741 [==============================] - 308s 415ms/step - loss: 15.8872 -
gender_out_loss: 0.6922 - age_out_loss: 15.1950 - gender_out_accuracy: 0.522
7 - age_out_accuracy: 0.0474
Epoch 10/10
741/741 [==============================] - 305s 412ms/step - loss: 15.8602 -
gender_out_loss: 0.6922 - age_out_loss: 15.1680 - gender_out_accuracy: 0.522
7 - age_out_accuracy: 0.0474
```

In [107]:
```
print(history.history.keys())
```

```
dict_keys(['loss', 'gender_out_loss', 'age_out_loss', 'gender_out_accuracy',
'age_out_accuracy'])
```

In [118]:
```
def get_image_features(image):
  img = load_img(image, grayscale=True)
  img = img.resize((128, 128), Image.ANTIALIAS)
  img = np.array(img)
  img = img.reshape(1, 128, 128, 1)
  img = img / 255.0
  return img
```