In [2]:
```
import tensorflow as tf
from tensorflow import keras
```

In [3]:
```
from keras.models import Sequential
from keras.layers import Dense, Activation
model = Sequential ([
    Dense (units = 5, input_shape = (3,), activation = 'relu'),
    Dense (units = 2, activation = 'softmax')
])
```

# OR

In [4]:
```
from keras.models import Sequential
from keras.layers import Dense, Activation
layers = [
    Dense (units = 5, input_shape = (3,), activation = 'relu'),
    Dense (units = 2, activation = 'softmax')
]
model = Sequential (layers)
```

# OR

In [5]:
```
from keras.models import Sequential
from keras.layers import Dense, Activation
model = Sequential ()
model.add(Dense (units = 4, input_shape = (3,), activation = 'relu')),
model.add(Dense (units = 2, activation = 'softmax'))
```

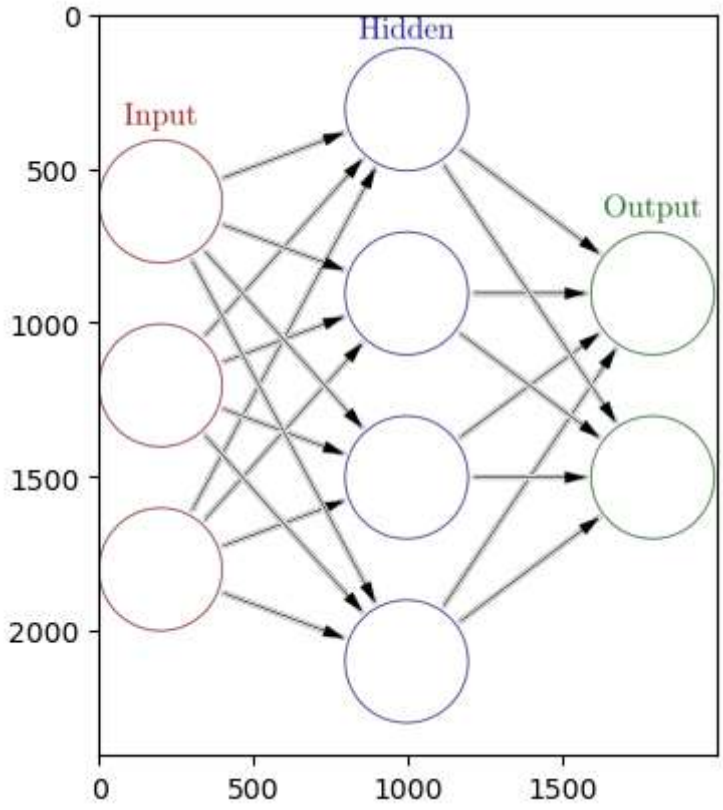
In [6]:
```
import numpy as np
a= np.array ([0,0,1,1,1,1,1,1,1])
print(a.shape)
```

```
(9,)
```

In [7]:
```
import numpy as np
from scipy import *
import matplotlib.pyplot as plt
%matplotlib inline
import imageio
imag = np.expand_dims (imageio.imread("neural_network.png"),0)
plt.imshow (imag[0])
```

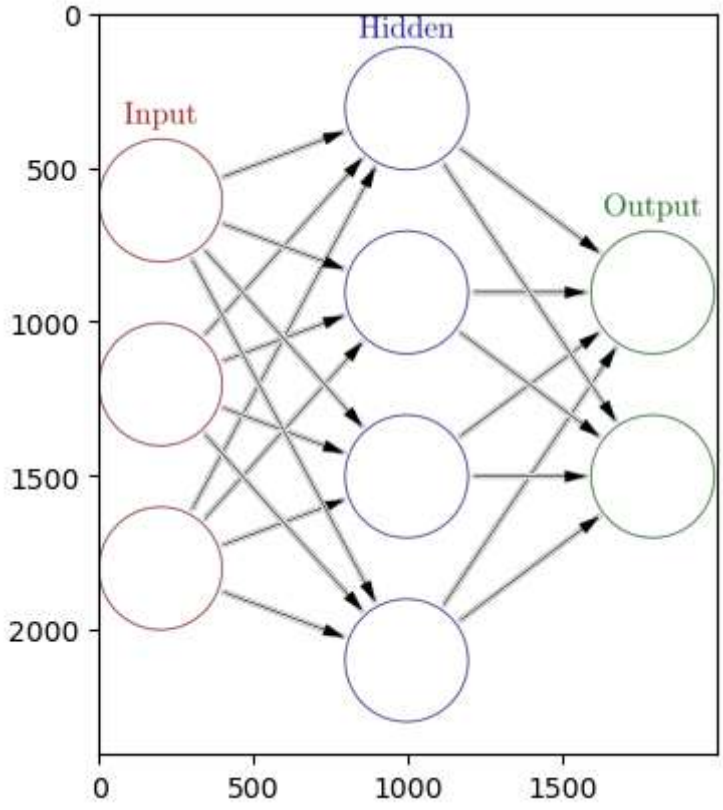
```
C:\Users\shalini193091\.conda\envs\tf\lib\site-packages\ipykernel_launcher.py:6: Deprecationwarning: Starting with ImageIO v3 the behavior of this function will switch to that of iio.v3.imread. To keep the current behavior (and make this warning dissapear) use `import imageio.v2 as imageio` or call `imageio.v2.imread` directly.
```

Out[7]:
```
<matplotlib.image.AxesImage at 0x20139502608>
```




In [8]:
```
import matplotlib.image as mpimg
img = mpimg.imread ("neural_network.png")
plt.imshow(img)
```

Out[8]:
```
<matplotlib.image.AxesImage at 0x2013c873f08>
```



In [9]:
```
from PIL import Image
image = Image.open("neural_network.png")
print (image.format)
print (image.size)
print (image.mode)
image.show()
```

```
PNG
(2000, 2405)
RGBA
```

In [28]:
```
from tensorflow import keras
from keras.models import Sequential
from keras.layers import Activation
from keras.layers.core import Dense
from keras.optimizers import Adam
from keras import metrics

model = Sequential ([
    Dense (units = 16, input_shape = (1,), activation = 'relu'),
    Dense (units = 32, activation = 'relu'),
    #Dense (units = 32, activation = 'relu'),
    #Dense (units = 16, activation = 'relu'),
    Dense (units = 2, activation = 'sigmoid')
])

model.compile(
    optimizer = Adam (learning_rate = 0.0001),
    loss = 'sparse_categorical_crossentropy',
    metrics = ['accuracy']
)
```

In [29]:
```
import numpy as np
from random import randint
from sklearn.preprocessing import MinMaxScaler
train_labels = []
train_samples = []

for i in range (1000):
    random_younger = randint (13,64)
    train_samples.append(random_younger)
    train_labels.append(0)

    random_older = randint (65,100)
    train_samples.append(random_older)
    train_labels.append(1)

for i in range (50):
    random_younger = randint (13,64)
    train_samples.append(random_younger)
    train_labels.append(1)

    random_older = randint (65,100)
    train_samples.append(random_older)
    train_labels.append(0)

#print raw data
for i in train_samples:
    print (i)
```

```
train_labels = np.array (train_labels)
train_samples = np.array (train_samples)

scaler = MinMaxScaler(feature_range = (0,1))
scaled_train_samples = scaler.fit_transform ((train_samples).reshape(-1,1))
```

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In [30]:

```
model.fit (
    x = scaled_train_samples,
    y = train_labels,
    epochs = 30,
    batch_size = 10,
    shuffle = False,
    verbose = 2
)
```

```
Epoch 1/30
210/210 - 1s - loss: 0.6707 - accuracy: 0.6900 - 840ms/epoch - 4ms/step
Epoch 2/30
210/210 - 0s - loss: 0.6401 - accuracy: 0.8233 - 270ms/epoch - 1ms/step
Epoch 3/30
210/210 - 0s - loss: 0.6045 - accuracy: 0.8490 - 249ms/epoch - 1ms/step
Epoch 4/30
210/210 - 0s - loss: 0.5644 - accuracy: 0.8629 - 308ms/epoch - 1ms/step
Epoch 5/30
210/210 - 0s - loss: 0.5238 - accuracy: 0.8733 - 239ms/epoch - 1ms/step
Epoch 6/30
210/210 - 0s - loss: 0.4838 - accuracy: 0.8800 - 293ms/epoch - 1ms/step
Epoch 7/30
210/210 - 0s - loss: 0.4473 - accuracy: 0.8895 - 385ms/epoch - 2ms/step
Epoch 8/30
210/210 - 0s - loss: 0.4157 - accuracy: 0.8938 - 369ms/epoch - 2ms/step
Epoch 9/30
210/210 - 0s - loss: 0.3894 - accuracy: 0.8995 - 303ms/epoch - 1ms/step
Epoch 10/30
210/210 - 0s - loss: 0.3680 - accuracy: 0.9033 - 283ms/epoch - 1ms/step
Epoch 11/30
210/210 - 0s - loss: 0.3508 - accuracy: 0.9076 - 379ms/epoch - 2ms/step
Epoch 12/30
210/210 - 0s - loss: 0.3371 - accuracy: 0.9095 - 385ms/epoch - 2ms/step
Epoch 13/30
210/210 - 0s - loss: 0.3260 - accuracy: 0.9119 - 306ms/epoch - 1ms/step
Epoch 14/30
210/210 - 0s - loss: 0.3171 - accuracy: 0.9133 - 277ms/epoch - 1ms/step
Epoch 15/30
210/210 - 0s - loss: 0.3098 - accuracy: 0.9138 - 237ms/epoch - 1ms/step
Epoch 16/30
210/210 - 0s - loss: 0.3038 - accuracy: 0.9152 - 274ms/epoch - 1ms/step
Epoch 17/30
210/210 - 0s - loss: 0.2988 - accuracy: 0.9176 - 358ms/epoch - 2ms/step
Epoch 18/30
210/210 - 0s - loss: 0.2947 - accuracy: 0.9190 - 317ms/epoch - 2ms/step
Epoch 19/30
210/210 - 0s - loss: 0.2911 - accuracy: 0.9205 - 317ms/epoch - 2ms/step
Epoch 20/30
210/210 - 0s - loss: 0.2881 - accuracy: 0.9210 - 254ms/epoch - 1ms/step
Epoch 21/30
210/210 - 0s - loss: 0.2855 - accuracy: 0.9210 - 262ms/epoch - 1ms/step
Epoch 22/30
210/210 - 0s - loss: 0.2833 - accuracy: 0.9214 - 228ms/epoch - 1ms/step
Epoch 23/30
210/210 - 0s - loss: 0.2813 - accuracy: 0.9219 - 221ms/epoch - 1ms/step
Epoch 24/30
210/210 - 0s - loss: 0.2795 - accuracy: 0.9219 - 147ms/epoch - 702us/step
Epoch 25/30
210/210 - 0s - loss: 0.2779 - accuracy: 0.9224 - 142ms/epoch - 676us/step
Epoch 26/30
210/210 - 0s - loss: 0.2766 - accuracy: 0.9238 - 344ms/epoch - 2ms/step
Epoch 27/30
210/210 - 0s - loss: 0.2753 - accuracy: 0.9248 - 394ms/epoch - 2ms/step
Epoch 28/30
210/210 - 0s - loss: 0.2741 - accuracy: 0.9262 - 332ms/epoch - 2ms/step
Epoch 29/30
210/210 - 0s - loss: 0.2731 - accuracy: 0.9276 - 385ms/epoch - 2ms/step
Epoch 30/30
210/210 - 0s - loss: 0.2721 - accuracy: 0.9276 - 385ms/epoch - 2ms/step
```

Out[30]: <keras.callbacks.History at 0x20795f399c8>

In [31]:
```
test_samples = []

for i in range (50):
    random_younger = randint (13,64)
    test_samples.append(random_younger)

    random_older = randint (65,100)
    test_samples.append(random_older)

for i in test_samples:
    print (i)

test_samples = np.array (test_samples)

scaler = MinMaxScaler(feature_range = (0,1))
scaled_test_samples = scaler.fit_transform ((test_samples).reshape(-1,1))

for i in scaled_test_samples:
    print (i)
```

64
91
49
70
54
68
22
75
55
67
14
94
60
93
44
96
30
94
31
66
62
84
56
99
45
80
21
98
18
90
35
85
61
70
31
90
25
71
16
99
24
89
46
70
62
89
50
70
51
88
36
76
37
82
43
93
25
97
30
71

20
75
52
75
53
75
39
76
46
93
35
71
24
89
51
89
56
98
46
67
25
79
53
83
28
90
51
97
27
68
48
93
54
71
44
75
46
72
37
100
[0.58139535]
[0.89534884]
[0.40697674]
[0.65116279]
[0.46511628]
[0.62790698]
[0.09302326]
[0.70930233]
[0.47674419]
[0.61627907]
[0.]
[0.93023256]
[0.53488372]
[0.91860465]
[0.34883721]
[0.95348837]
[0.18604651]
[0.93023256]
[0.19767442]
[0.60465116]

[0.55813953]
[0.81395349]
[0.48837209]
[0.98837209]
[0.36046512]
[0.76744186]
[0.08139535]
[0.97674419]
[0.04651163]
[0.88372093]
[0.24418605]
[0.8255814]
[0.54651163]
[0.65116279]
[0.19767442]
[0.88372093]
[0.12790698]
[0.6627907]
[0.02325581]
[0.98837209]
[0.11627907]
[0.87209302]
[0.37209302]
[0.65116279]
[0.55813953]
[0.87209302]
[0.41860465]
[0.65116279]
[0.43023256]
[0.86046512]
[0.25581395]
[0.72093023]
[0.26744186]
[0.79069767]
[0.3372093]
[0.91860465]
[0.12790698]
[0.96511628]
[0.18604651]
[0.6627907]
[0.06976744]
[0.70930233]
[0.44186047]
[0.70930233]
[0.45348837]
[0.70930233]
[0.29069767]
[0.72093023]
[0.37209302]
[0.91860465]
[0.24418605]
[0.6627907]
[0.11627907]
[0.87209302]
[0.43023256]
[0.87209302]
[0.48837209]
[0.97674419]
[0.37209302]
[0.61627907]

```
[0.12790698]
[0.75581395]
[0.45348837]
[0.80232558]
[0.1627907]
[0.88372093]
[0.43023256]
[0.96511628]
[0.15116279]
[0.62790698]
[0.39534884]
[0.91860465]
[0.46511628]
[0.6627907]
[0.34883721]
[0.70930233]
[0.37209302]
[0.6744186]
[0.26744186]
[1.]
```

In [32]:

```
predictions = model.predict(
    x = scaled_test_samples,
    batch_size = 10,
    verbose = 0)
for p in predictions:
    print (p)
```

```
[0.5648297  0.59331715]
[0.27852812 0.89253867]
[0.75505406 0.32088315]
[0.478713   0.69607157]
[0.6979238  0.40759602]
[0.50753176 0.66336775]
[0.85641414 0.17045613]
[0.40769047 0.769318  ]
[0.68562967 0.4258627 ]
[0.52193433 0.646383  ]
[0.85578513 0.16884887]
[0.26141167 0.90622616]
[0.62044656 0.5192536 ]
[0.26701218 0.9019699 ]
[0.8044077  0.24498883]
[0.25044078 0.91424435]
[0.8570408  0.17207551]
[0.26141167 0.90622616]
[0.857119   0.17227879]
[0.53630054 0.6290205 ]
[0.59293586 0.55659986]
[0.32114983 0.85295784]
[0.6730697 0.444334 ]
[0.23456877 0.9251095 ]
[0.79517555 0.25915614]
[0.34788144 0.8251245 ]
[0.85633564 0.17025456]
[0.23978087 0.9216362 ]
[0.8560999 0.169651 ]
[0.28440112 0.8875205 ]
[0.85003924 0.17924349]
[0.31485185 0.8592735 ]
[0.6067759 0.53798  ]
[0.478713   0.69607157]
[0.857119   0.17227879]
[0.28440112 0.8875205 ]
[0.8566494  0.17106198]
[0.46434468 0.71173406]
[0.8559426  0.16924955]
[0.23456877 0.9251095 ]
[0.856571   0.17085983]
[0.29034814 0.88229895]
[0.7856237  0.27384555]
[0.478713   0.69607157]
[0.59293586 0.55659986]
[0.29034814 0.88229895]
[0.7442331  0.33747756]
[0.478713   0.69607157]
[0.733103   0.35448223]
[0.29636797 0.87686855]
[0.84776527 0.18214285]
[0.3938433 0.7823859]
[0.8447999  0.18565916]
[0.33394137 0.8396242 ]
[0.8124939  0.23275463]
[0.26701218 0.9019699 ]
[0.8566494  0.17106198]
[0.24507168 0.91801614]
[0.8570408  0.17207551]
[0.46434468 0.71173406]
```

```
[0.8562571  0.17005318]
[0.40769047 0.769318  ]
[0.7216697  0.37186277]
[0.40769047 0.769318  ]
[0.70994043 0.38958117]
[0.40769047 0.769318  ]
[0.83731914 0.1958783 ]
[0.3938433 0.7823859]
[0.7856237  0.27384555]
[0.26701218 0.9019699 ]
[0.85003924 0.17924349]
[0.46434468 0.71173406]
[0.856571   0.17085983]
[0.29034814 0.88229895]
[0.733103   0.35448223]
[0.29034814 0.88229895]
[0.6730697 0.444334 ]
[0.23978087 0.9216362 ]
[0.7856237  0.27384555]
[0.52193433 0.646383  ]
[0.8566494  0.17106198]
[0.35527778 0.8174197 ]
[0.70994043 0.38958117]
[0.32751358 0.84640944]
[0.85688436 0.17166954]
[0.28440112 0.8875205 ]
[0.733103   0.35448223]
[0.24507168 0.91801614]
[0.8568061  0.17146681]
[0.50753176 0.66336775]
[0.76556146 0.3047294 ]
[0.26701218 0.9019699 ]
[0.6979238  0.40759602]
[0.46434468 0.71173406]
[0.8044077  0.24498883]
[0.40769047 0.769318  ]
[0.7856237  0.27384555]
[0.4500353 0.7269061]
[0.8447999  0.18565916]
[0.22943577 0.9284408 ]
```

# CNN (CONVOLUTIONAL NEURAL NETWORK)

In [33]:
```
# CNN have hidden layers called as convolutional layers
```

In [34]:
```
from tensorflow import keras
from keras.models import Sequential
from keras.layers import Activation
from keras.layers.core import Dense, Flatten
from keras.layers.convolutional import *

model_val = Sequential ([
    Dense (units = 16, input_shape = (20,20,3), activation = 'relu'),
    Conv2D (32,kernel_size = (3,3),activation = 'relu', padding = 'same'),
    Conv2D (64,kernel_size = (5,5),activation = 'relu', padding = 'same'),
```

```
    Conv2D (128,kernel_size = (7,7),activation = 'relu', padding = 'same'),
    Flatten(),
    Dense (units = 2, activation = 'sigmoid')
])

model_val.summary()
```

```
Model: "sequential_20"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_50 (Dense)            (None, 20, 20, 16)        64

 conv2d_30 (Conv2D)          (None, 20, 20, 32)        4640

 conv2d_31 (Conv2D)          (None, 20, 20, 64)        51264

 conv2d_32 (Conv2D)          (None, 20, 20, 128)       401536

 flatten_10 (Flatten)        (None, 51200)             0

 dense_51 (Dense)            (None, 2)                 102402

=================================================================
Total params: 559,906
Trainable params: 559,906
Non-trainable params: 0
_________________________________________________________________
```

In [35]:

```
model_val = Sequential ([
    Dense (units = 16, input_shape = (20,20,3), activation = 'relu'),
    Conv2D (32,kernel_size = (3,3),activation = 'relu'),
    Conv2D (64,kernel_size = (5,5),activation = 'relu', padding = 'valid'),
    Conv2D (128,kernel_size = (7,7),activation = 'relu', padding = 'valid'),
    Flatten(),
    Dense (units = 2, activation = 'sigmoid')
])

model_val.summary()
```

```
Model: "sequential_21"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_52 (Dense)            (None, 20, 20, 16)        64

 conv2d_33 (Conv2D)          (None, 18, 18, 32)        4640

 conv2d_34 (Conv2D)          (None, 14, 14, 64)        51264

 conv2d_35 (Conv2D)          (None, 8, 8, 128)         401536

 flatten_11 (Flatten)        (None, 8192)              0

 dense_53 (Dense)            (None, 2)                 16386

=================================================================
Total params: 473,890
Trainable params: 473,890
Non-trainable params: 0
_________________________________________________________________
```

In [36]:

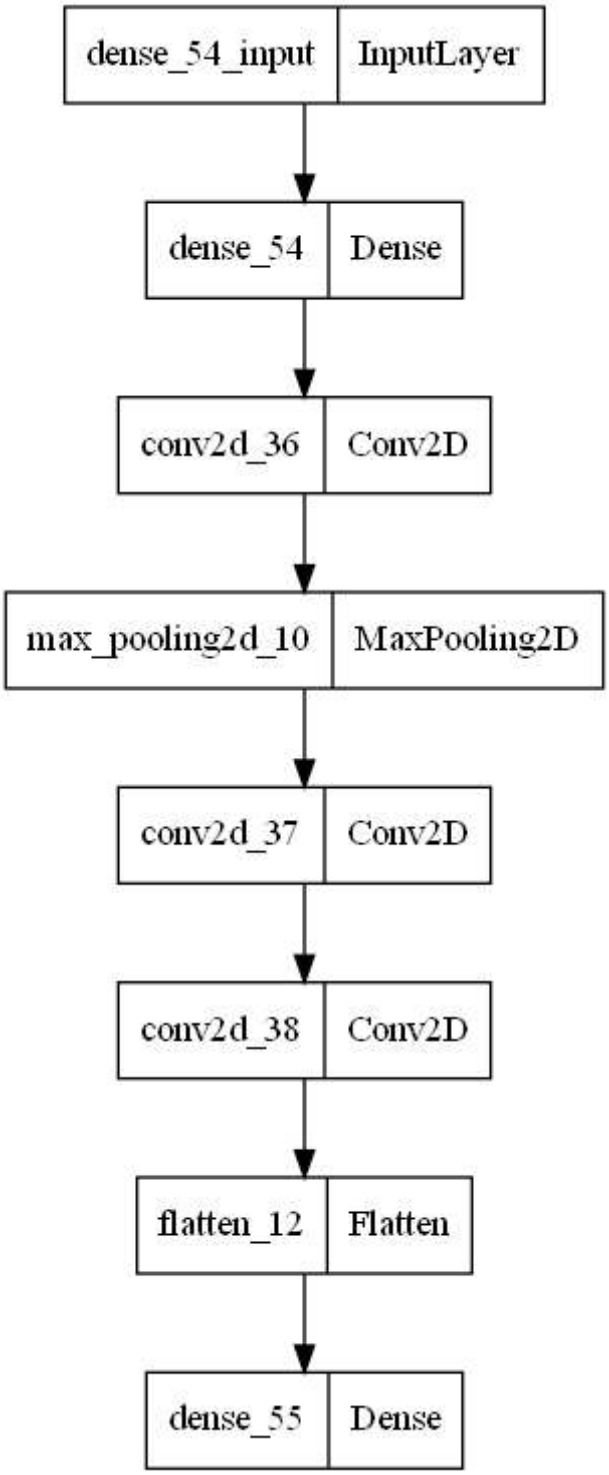
```python
from tensorflow import keras
from keras.models import Sequential
from keras.layers import Activation
from keras.layers.core import Dense, Flatten
from keras.layers.convolutional import *
from keras.layers.pooling import *


model_valid = Sequential ([
    Dense (units = 16, input_shape = (20,20,3), activation = 'relu'),
    Conv2D (32,kernel_size = (3,3),activation = 'relu', padding = 'same'),
    MaxPooling2D (pool_size = (2,2), strides = 2, padding = 'same'),
    Conv2D (64,kernel_size = (5,5),activation = 'relu', padding = 'same'),
    Conv2D (128,kernel_size = (7,7),activation = 'relu', padding = 'same'),
    Flatten(),
    Dense (units = 2, activation = 'sigmoid')
])
print(model_valid.layers)
print()
print(model_valid.inputs)
print()
print(model_valid.outputs)
print()
print(model_valid.get_weights)
print()
print(model_valid.summary())
```

```
[<keras.layers.core.dense.Dense object at 0x0000020791927208>, <keras.layers.convolut
ional.conv2d.Conv2D object at 0x0000020791927988>, <keras.layers.pooling.max_pooling2
d.MaxPooling2D object at 0x00000207919026C8>, <keras.layers.convolutional.conv2d.Conv
2D object at 0x00000207905A5DC8>, <keras.layers.convolutional.conv2d.Conv2D object at
0x0000020795F5FCC8>, <keras.layers.reshaping.flatten.Flatten object at 0x0000020791AE
0EC8>, <keras.layers.core.dense.Dense object at 0x0000020791B56908>]

[<KerasTensor: shape=(None, 20, 20, 3) dtype=float32 (created by layer 'dense_54_inpu
t')>]

[<KerasTensor: shape=(None, 2) dtype=float32 (created by layer 'dense_55')>]

<bound method Model.get_weights of <keras.engine.sequential.Sequential object at 0x00
00020791B56088>>

Model: "sequential_22"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_54 (Dense)            (None, 20, 20, 16)        64

 conv2d_36 (Conv2D)          (None, 20, 20, 32)        4640

 max_pooling2d_10 (MaxPoolin  (None, 10, 10, 32)       0
 g2D)

 conv2d_37 (Conv2D)          (None, 10, 10, 64)        51264

 conv2d_38 (Conv2D)          (None, 10, 10, 128)       401536

 flatten_12 (Flatten)        (None, 12800)             0

 dense_55 (Dense)            (None, 2)                 25602

=================================================================
Total params: 483,106
Trainable params: 483,106
Non-trainable params: 0
_________________________________________________________________
None
```

In [37]:

```
from keras.utils import plot_model
plot_model(model_valid,to_file = 'image.png')
```

Out[37]:




In [38]:

```
from tensorflow import keras
from keras.models import Sequential
from keras.layers import Activation
from keras.layers.core import Dense
from keras.optimizers import Adam
from keras.metrics import categorical_crossentropy

model = Sequential ([
    Dense (units = 16, input_shape = (8,), activation = 'relu'),
    Dense (units = 32, activation = 'relu'),
    #Dense (units = 32, activation = 'relu'),
    #Dense (units = 16, activation = 'relu'),
    Dense (units = 2, activation = 'sigmoid')
```

```
])
print(model.layers)
print(model.inputs)
print(model.outputs)
```

```
[<keras.layers.core.dense.Dense object at 0x0000020791756788>, <keras.layers.core.den
se.Dense object at 0x000002079172A548>, <keras.layers.core.dense.Dense object at 0x00
00020791A71B88>]
[<KerasTensor: shape=(None, 8) dtype=float32 (created by layer 'dense_56_input')>]
[<KerasTensor: shape=(None, 2) dtype=float32 (created by layer 'dense_58')>]
```

In [ ]:

In [ ]: