ADVANCED DEEP LEARNING WITH KERAS IN PYTHON

Keras input and dense layers

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Data Scientist

Course outline

- Chapter 1: Introduction to the Keras functional API (Refresher)

- Chapter 2: Models with 2 inputs

- Chapter 3: Models with 3 inputs

- Chapter 4: Multiple outputs

Course Datasets: College basketball data, 1989-2017

Dataset 1: Regular season

- Team ID 1

- Team ID 2

- Home vs Away

- Score Difference (Team 1 - Team 2)

- Team 1 Score

- Team 2 Score

- Won vs Lost

Dataset 2: Tournament games

- Same as Dataset 1

- Also has difference in Seed

Course Datasets: College basketball data, 1989-2017

Inputs and outputs

Two fundamental parts:

- Input layer

- Output layer

Inputs

```python
from keras.layers import Input
input_tensor = Input(shape=(1,))
```

Inputs

```
from keras.layers import Input
input_tensor = Input(shape=(1,))
print(input_tensor)

<tf.Tensor 'input_1:0' shape=(?, 1) dtype=float32>
```

Outputs

```python
from keras.layers import Dense
output_layer = Dense(1)
```
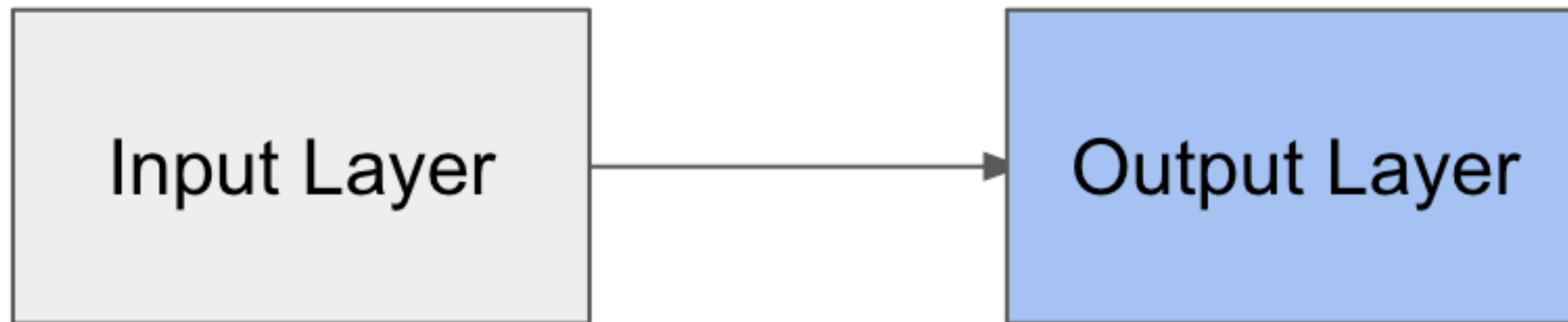
Outputs

```python
from keras.layers import Dense
output_layer = Dense(1)
print(output_layer)

<keras.layers.core.Dense at 0x7f22e0295a58>
```
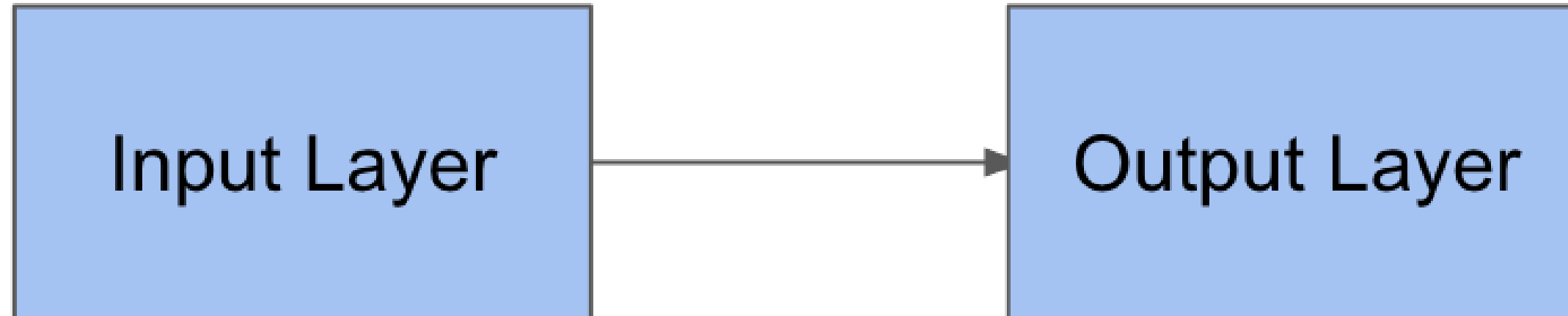
Connecting inputs to outputs

```python
from keras.layers import Input, Dense
input_tensor = Input(shape=(1,))
output_layer = Dense(1)
output_tensor = output_layer(input_tensor)
```

| Input Layer | → | Output Layer |

Connecting inputs to outputs

```
print(output_tensor)

<tf.Tensor 'dense_1/BiasAdd:0' shape=(?, 1) dtype=float32>
```

Input Layer → Output Layer

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Let's practice!

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Keras models

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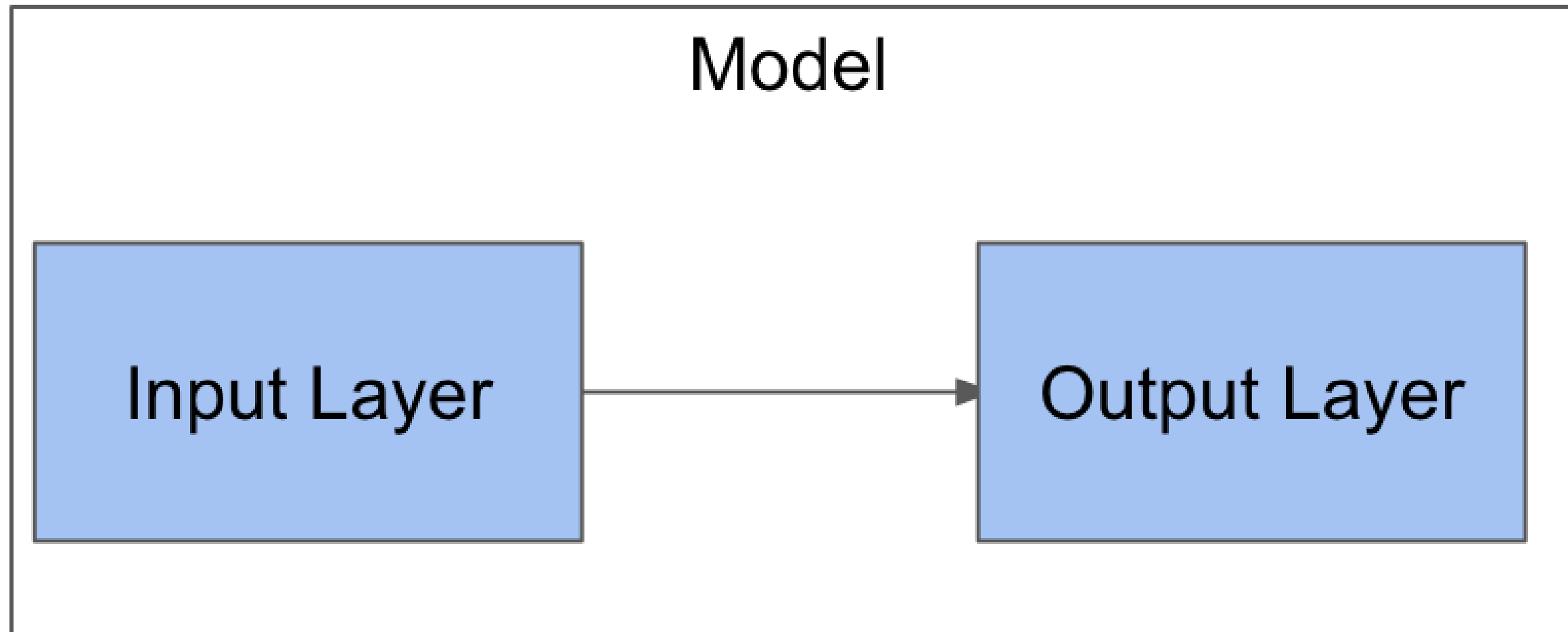
Keras models

```python
from keras.layers import Input, Dense
input_tensor = Input(shape=(1,))
output_tensor = Dense(1)(input_tensor)
```
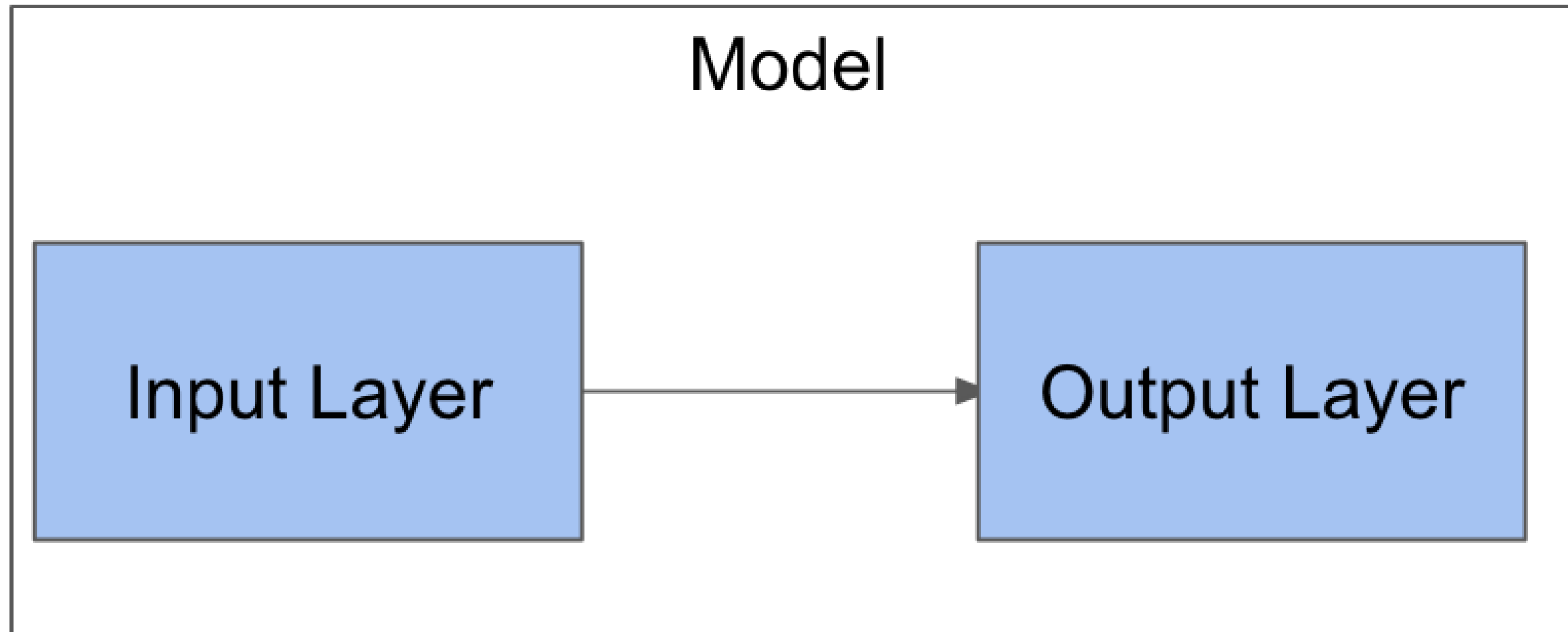
Keras models

```python
from keras.models import Model
model = Model(input_tensor, output_tensor)
```

Compile a model

```
model.compile(optimizer='adam', loss='mae')
```

Summarize the model

```
model.summary()


_____
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         (None, 1)                 0
_____
dense_1 (Dense)              (None, 1)                 2
=================================================================
Total params: 2
Trainable params: 2
Non-trainable params: 0
_____
```

Plot model using keras

```python
input_tensor = Input(shape=(1,))
output_layer = Dense(1, name='Predicted-Score-Diff')
output_tensor = output_layer(input_tensor)
model = Model(input_tensor, output_tensor)
plot_model(model, to_file ='model.png')

from matplotlib import pyplot as plt
img = plt.imread('model.png')
plt.imshow(img)
plt.show()
```
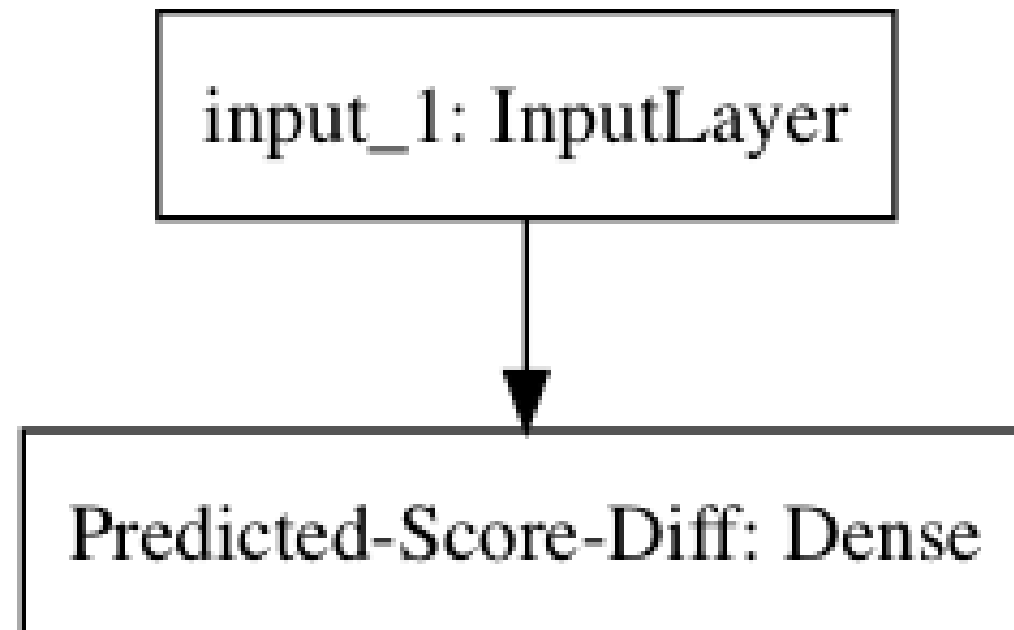
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Fit and evaluate a model

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Basketball Data

Goal: Predict tournament outcomes

Data Available: team ratings from the tournament organizers

```python
import pandas as pd
games_tourney = pd.read_csv('datasets/games_tourney.csv')
games_tourney.head()

Out[1]:
   season  team_1  team_2  home  seed_diff  score_diff  score_1  score_2  won
0    1985     288      73     0         -3          -9       41       50    0
1    1985    5929      73     0          4           6       61       55    1
2    1985    9884      73     0          5          -4       59       63    0
3    1985      73     288     0          3           9       50       41    1
4    1985    3920     410     0          1          -9       54       63    0
```

Basketball Data

Input: Seed difference

```python
import pandas as pd
games_tourney = pd.read_csv('datasets/games_tourney.csv')
games_tourney.head()
```

```
Out[1]:
    season  team_1  team_2  home  seed_diff  score_diff  score_1  score_2  won
0   1985    288     73      0     -3          -9          41       50       0
1   1985    5929    73      0     4           6           61       55       1
2   1985    9884    73      0     5           -4          59       63       0
3   1985    73      288     0     3           9           50       41       1
4   1985    3920    410     0     1           -9          54       63       0
```

Basketball Data

Output: Score difference

```python
import pandas as pd
games_tourney = pd.read_csv('datasets/games_tourney.csv')
games_tourney.head()
```

```
Out[1]:
   season  team_1  team_2  home  seed_diff  score_diff  score_1  score_2  won
0    1985     288      73     0         -3          -9       41       50    0
1    1985    5929      73     0          4           6       61       55    1
2    1985    9884      73     0          5          -4       59       63    0
3    1985      73     288     0          3           9       50       41    1
4    1985    3920     410     0          1          -9       54       63    0
```

Basketball Data

Input:

- Seed difference - one number: -15 to +15

- Seed range from 1-16

- Highest difference is 16-1 = +15
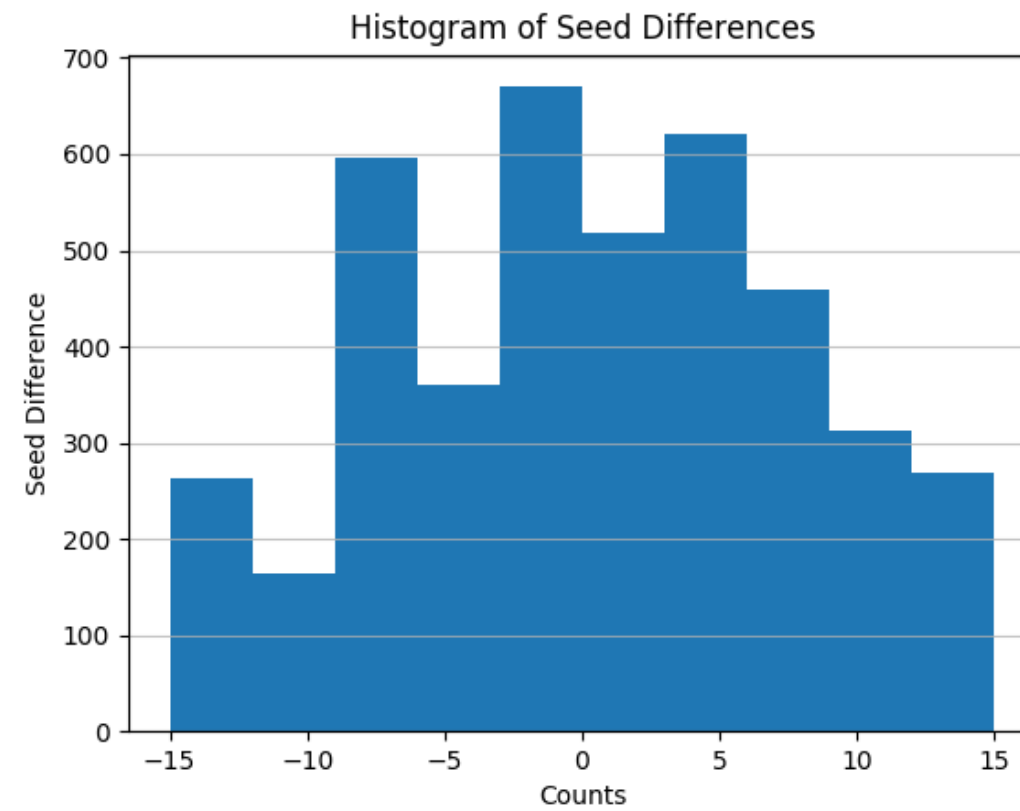
- Lowest difference is 1-16 = -15

Output:

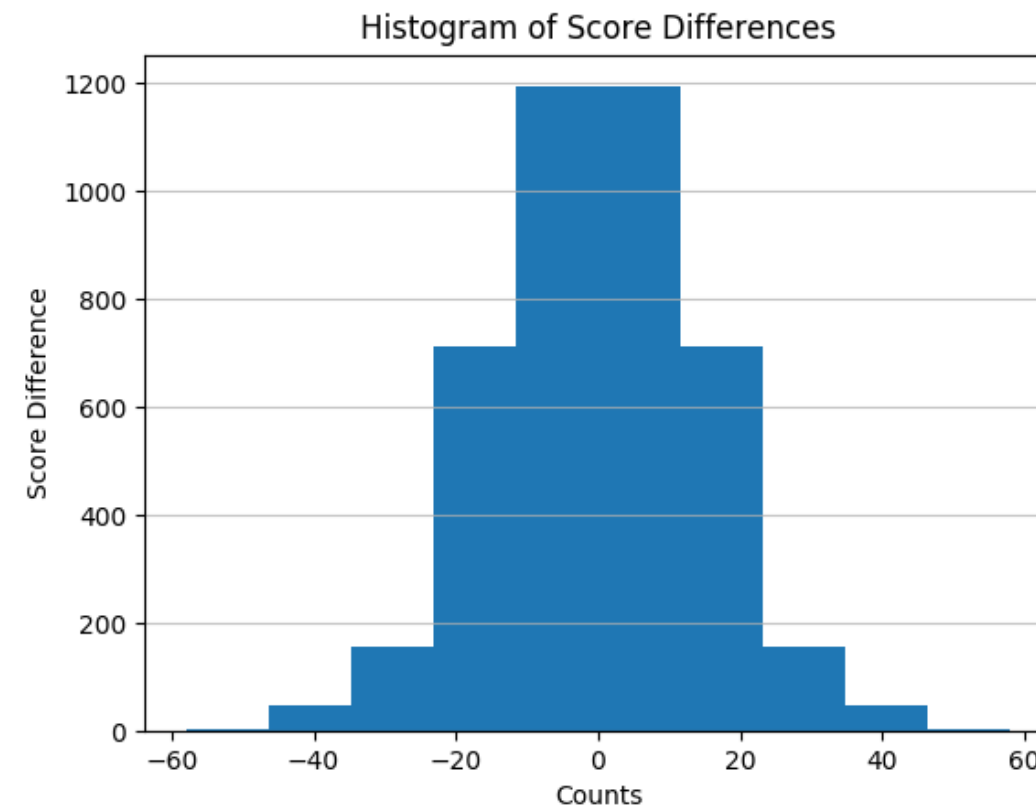- Score difference - one number: -50 to +50

Basketball Data

- Seed difference: 15

    - Team 1: 16

    - Team 2: 1

- Seed difference: -15

    - Team 1: 1

    - Team 2: 16

Histogram of Seed Differences

Basketball Data

- Score difference: -9

  - Team 1: 41

  - Team 2: 50

- Score difference: 6

  - Team 1: 61

  - Team 2: 55

Histogram of Score Differences

Basketball Data

```python
import pandas as pd
games_tourney = pd.read_csv('datasets/games_tourney_samp.csv')
games_tourney.head()

Out[1]:
   season  team_1  team_2  home  seed_diff  score_diff  score_1  score_2  won
0    2017     320    6323     0         13          18      100       82    1
1    2017    6323     320     0        -13         -18       82      100    0
```

Build the model

```python
from keras.models import Model
from keras.layers import Input, Dense
input_tensor = Input(shape=(1,))
output_tensor = Dense(1)(input_tensor)
model = Model(input_tensor, output_tensor)
model.compile(optimizer='adam', loss='mae')
```
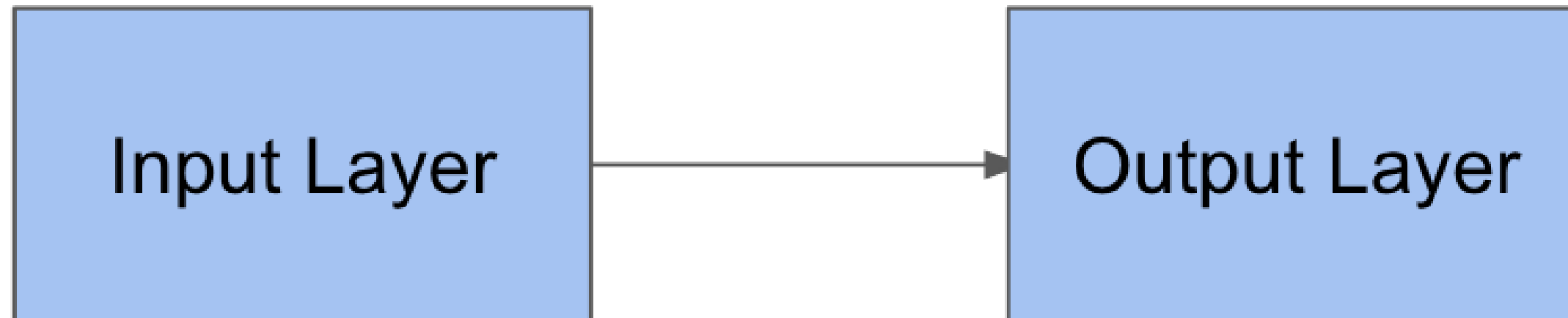
Fit the model

```python
from pandas import read_csv
games = read_csv('datasets/games_tourney.csv')
model.fit(games['seed_diff'],
          games['score_diff'],
          batch_size=64,
          validation_split=.20,
          verbose=True)
```

Evaluate the model

```
model.evaluate(games_test['seed_diff'],
               games_test['score_diff'])

1000/1000 [==============================] - 0s 26us/step
Out[1]: 9.742335235595704
```

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Let's practice!