Keras input and dense layers

ADVANCED DEEP LEARNING WITH KERAS

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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

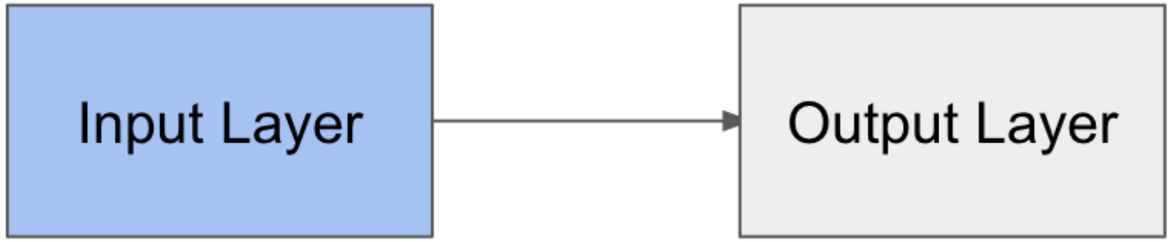
Course Datasets: College basketball data, 1989-2017

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

Out[1]:
   season  team_1  team_2  home  score_diff  score_1  score_2  won
0    1985    3745    6664     0          17       81       64    1
1    1985     126    7493     1           7       77       70    1
2    1985     288    3593     1           7       63       56    1
3    1985    1846    9881     1          16       70       54    1
4    1985    2675   10298     1          12       86       74    1

games_tourney = pd.read_csv('datasets/games_tourney.csv')
games_tourney.head()

Out[2]:
   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
```

Inputs and outputs

Two fundamental parts:

- Input layer
- Output layer

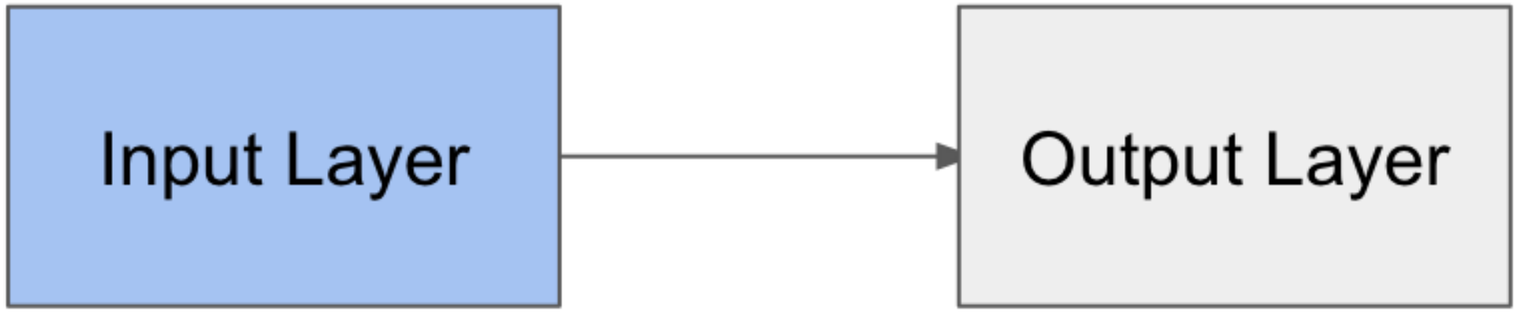


Inputs

```
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

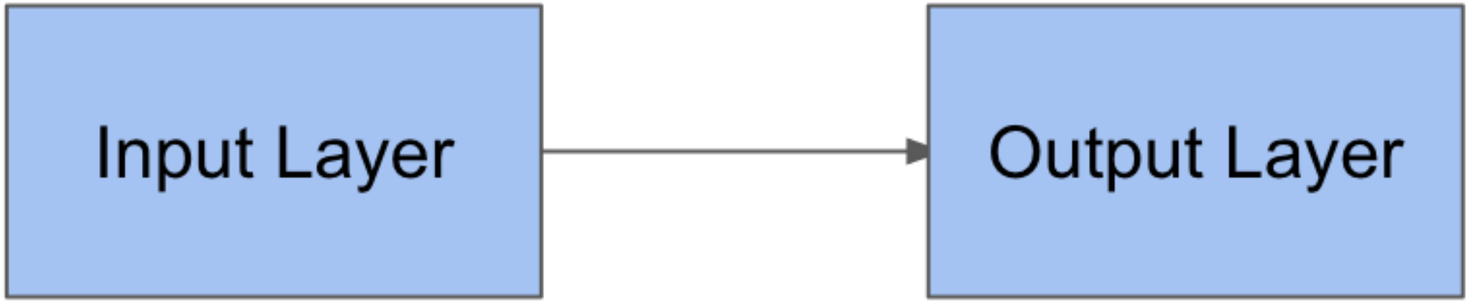
```
from keras.layers import Dense
output_layer = Dense(1)
```

Outputs

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

<keras.layers.core.Dense at 0x7f22e0295a58>
```

Connecting inputs to outputs

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



Connecting inputs to outputs

```
print(output_tensor)


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

Let's practice!

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Keras models

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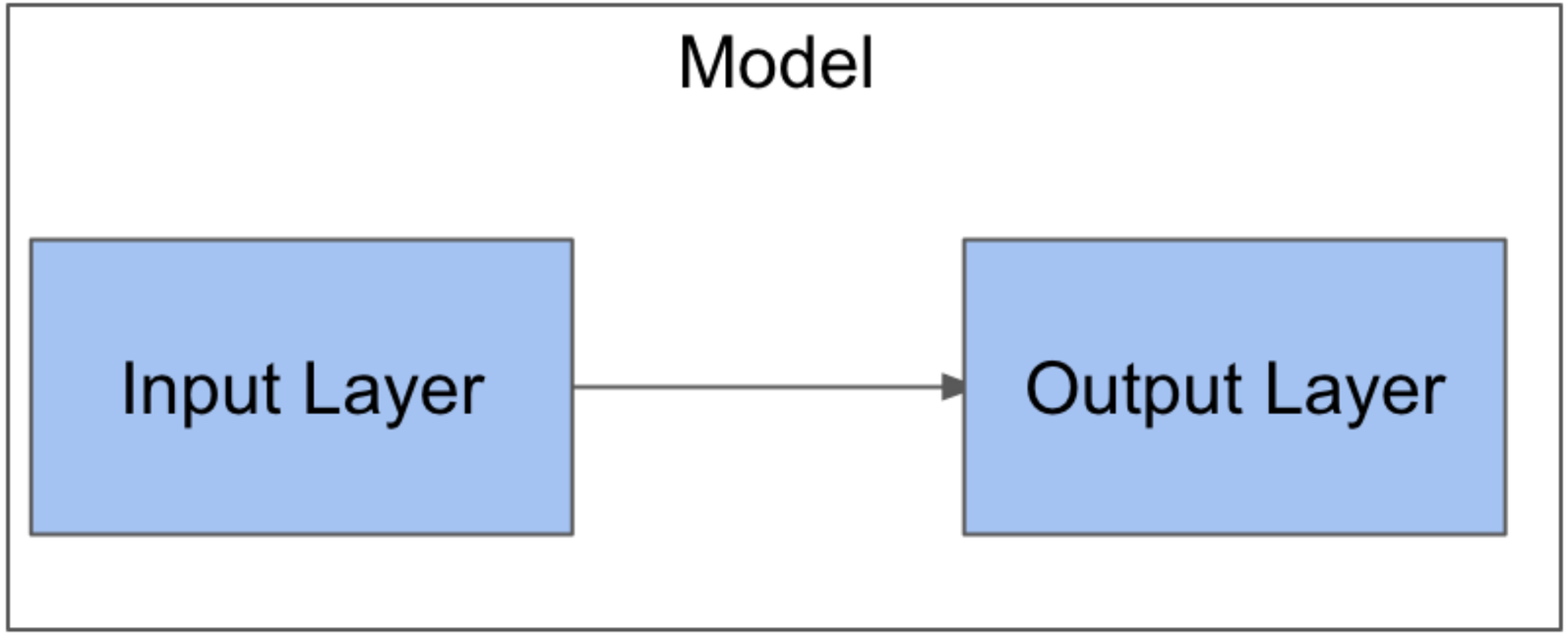
Keras models

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

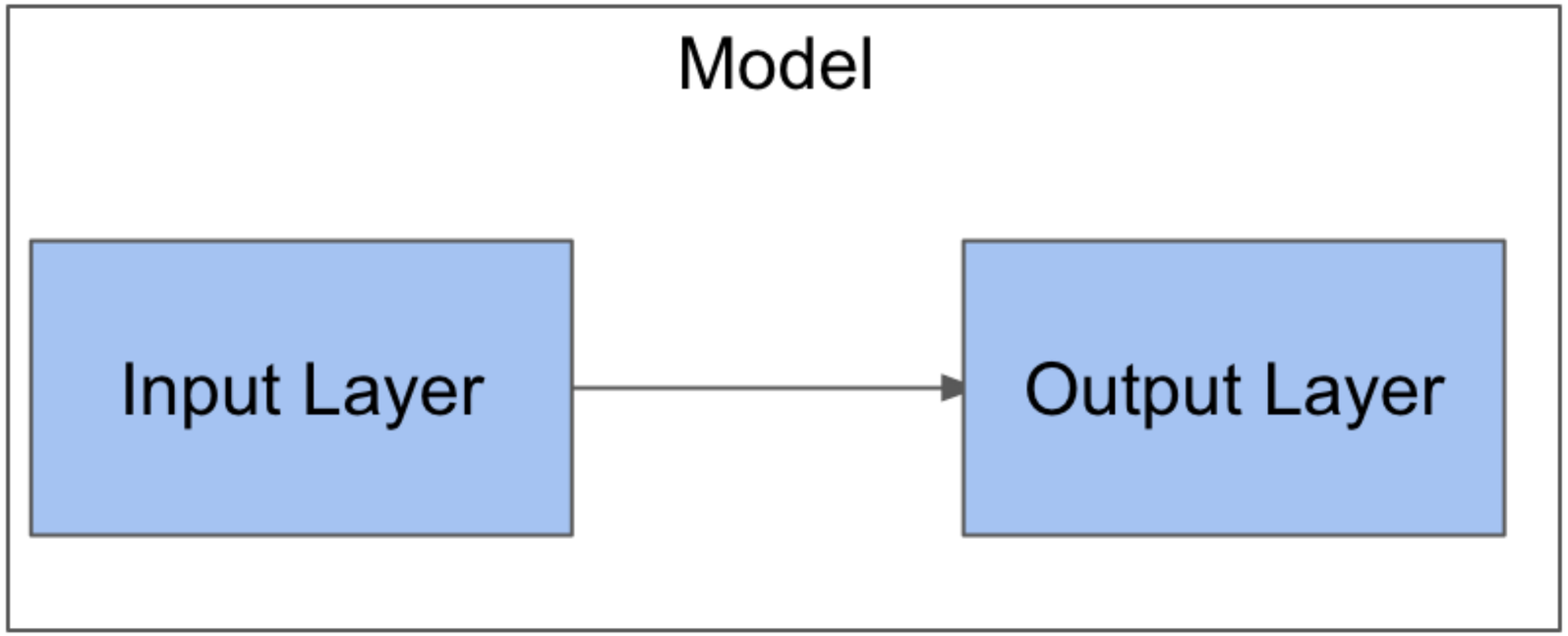
Keras models

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



Compile a model

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



Summarize the model

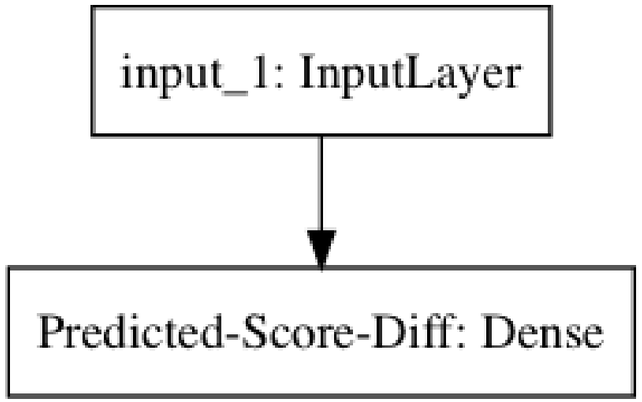
```
model.summary()


_________________________________________________________________
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

```
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

```
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

```
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

```
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:

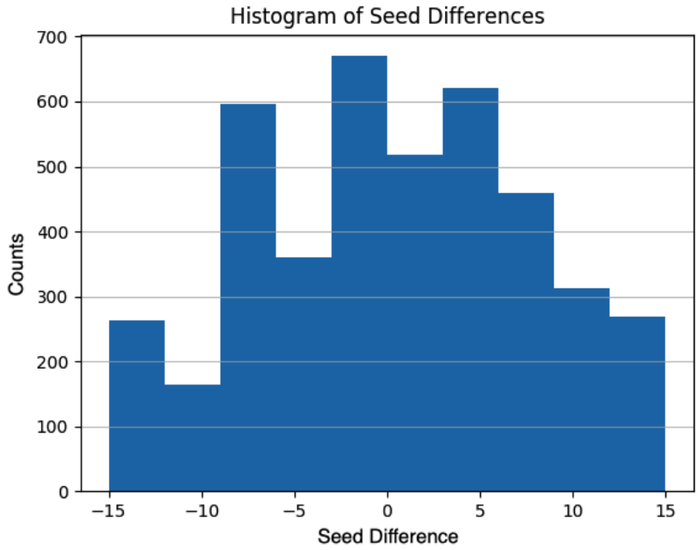
- Seed difference - one number: -15 to +15
- Seed range from 1-16
- Highest difference is 16-1 = +15
- Lowest difference is 1-16 = -15

Output:

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

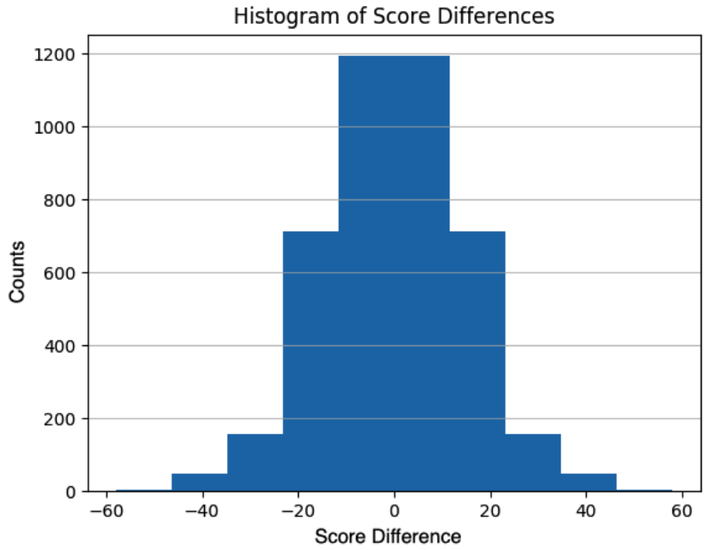
Basketball Data

- Seed difference: 15
  - Team 1: 16
  - Team 2: 1
- Seed difference: -15
  - Team 1: 1
  - Team 2: 16



Basketball Data

- Score difference: -9
  - Team 1: 41
  - Team 2: 50
- Score difference: 6
  - Team 1: 61
  - Team 2: 55



Basketball Data

```
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

```
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

```
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
```

Let's practice!

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