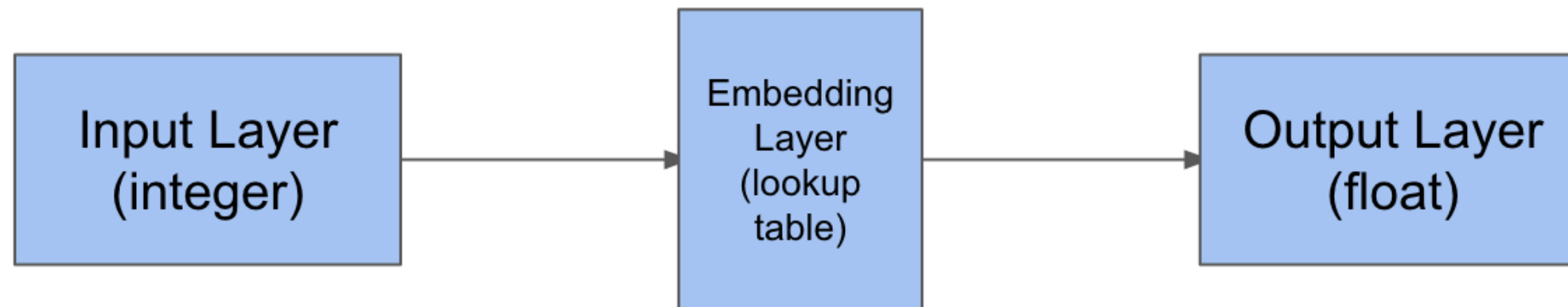# Category embeddings

ADVANCED DEEP LEARNING WITH KERAS

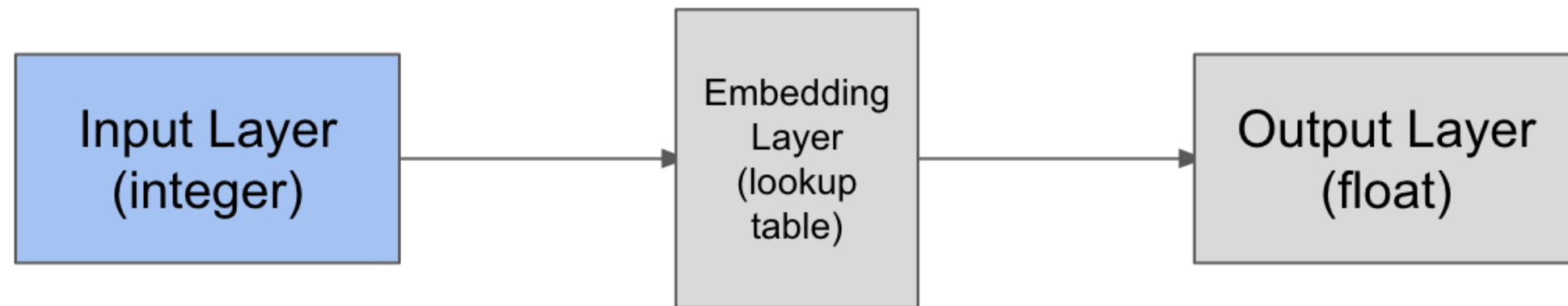**Zach Deane Mayer**
Data Scientist

Category embeddings

- Input: integers

- Output: floats

- Note: Increased dimensionality: output layer flattens back to 2D

Inputs

```
input_tensor = Input(shape=(1,))
```
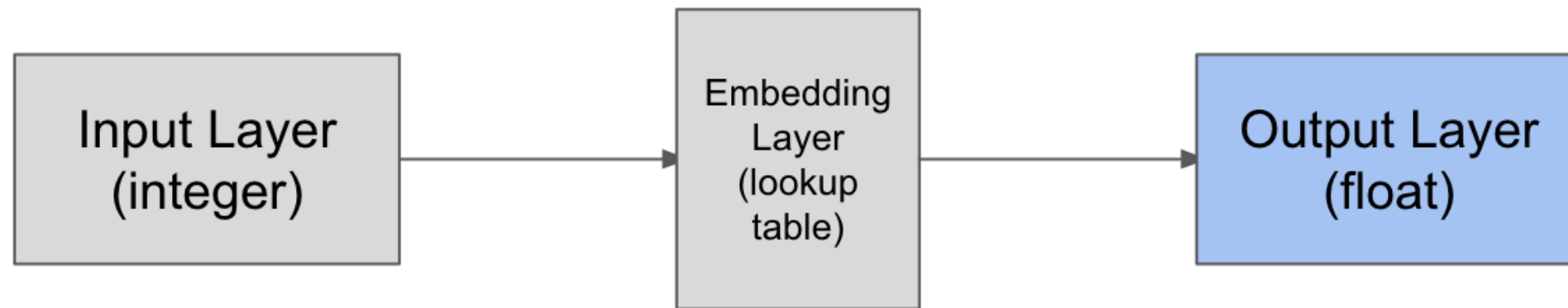
Embedding Layer

```python
from keras.layers import Embedding
input_tensor = Input(shape=(1,))
n_teams = 10887
embed_layer = Embedding(input_dim=n_teams,
                        input_length=1,
                        output_dim=1,
                        name='Team-Strength-Lookup')
embed_tensor = embed_layer(input_tensor)
```

Input Layer (integer) → Embedding Layer (lookup table) → Output Layer (float)
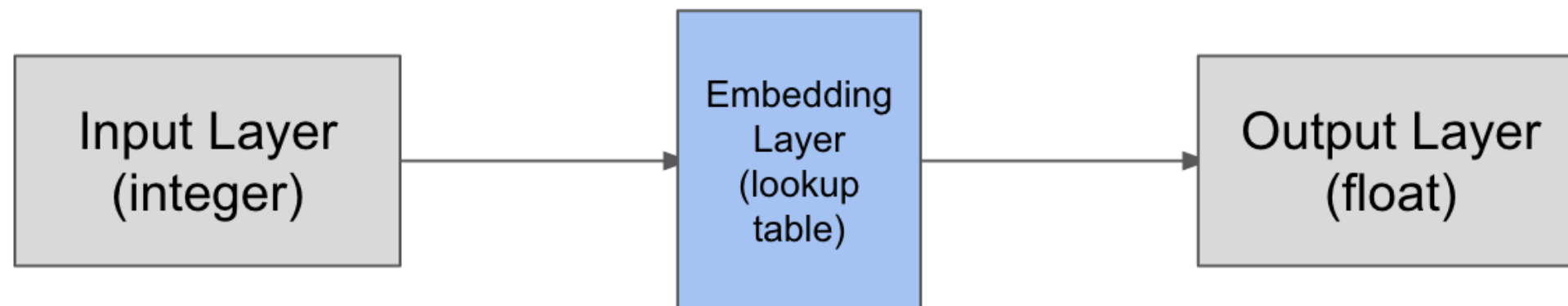
Flattening

```
from keras.layers import Flatten

flatten_tensor = Flatten()(embed_tensor)
```

Put it all together

```python
input_tensor = Input(shape=(1,))
n_teams =  10887
embed_layer = Embedding(input_dim=n_teams,
                        input_length=1,
                        output_dim=1,
                        name='Team-Strength-Lookup')
embed_tensor = embed_layer(input_tensor)
flatten_tensor = Flatten()(embed_tensor)
model = Model(input_tensor, flatten_tensor)
```
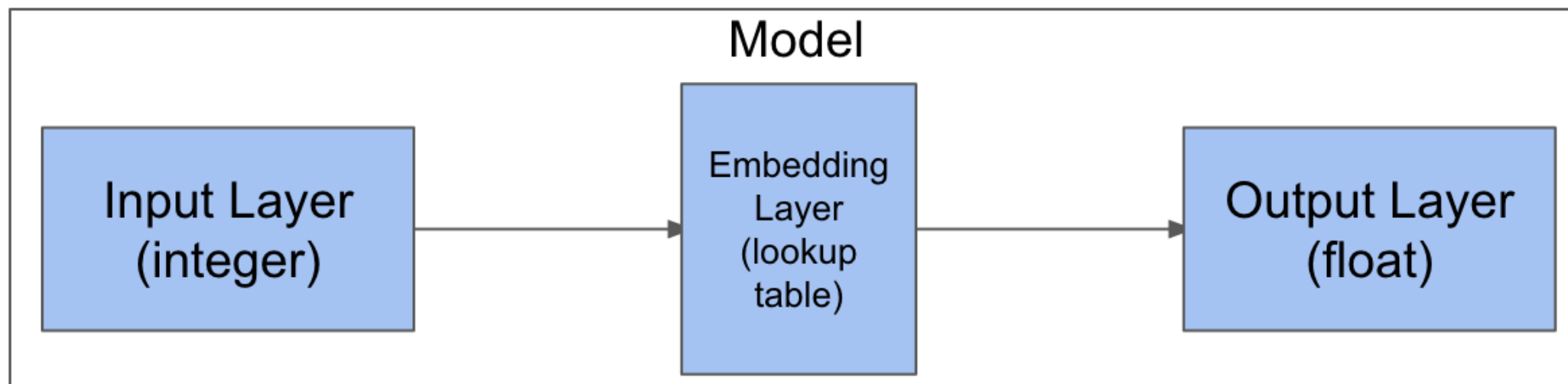
Model

| Input Layer (integer) | → | Embedding Layer (lookup table) | → | Output Layer (float) |

Let's practice!

ADVANCED DEEP LEARNING WITH KERAS
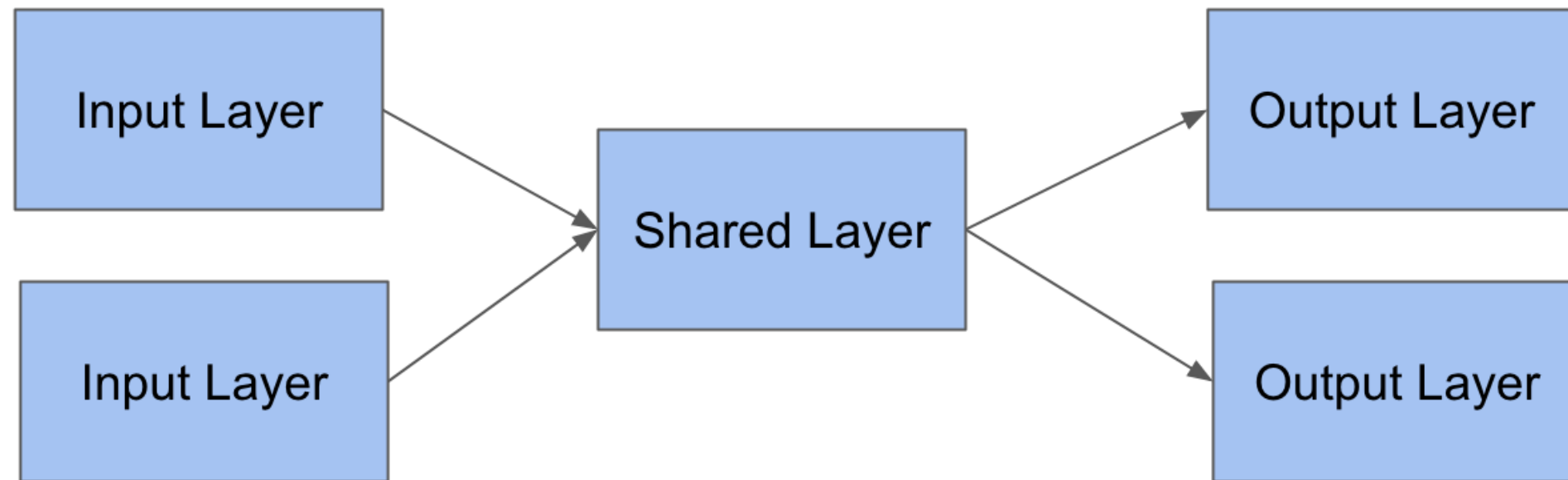
Shared layers

ADVANCED DEEP LEARNING WITH KERAS
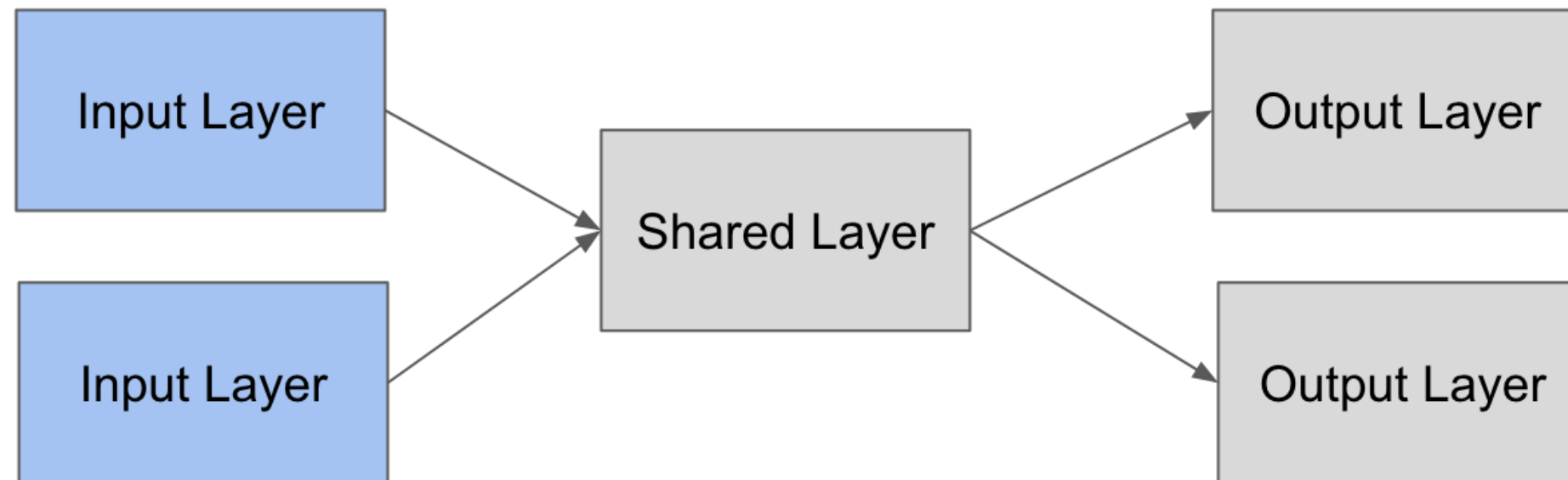
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Shared layers

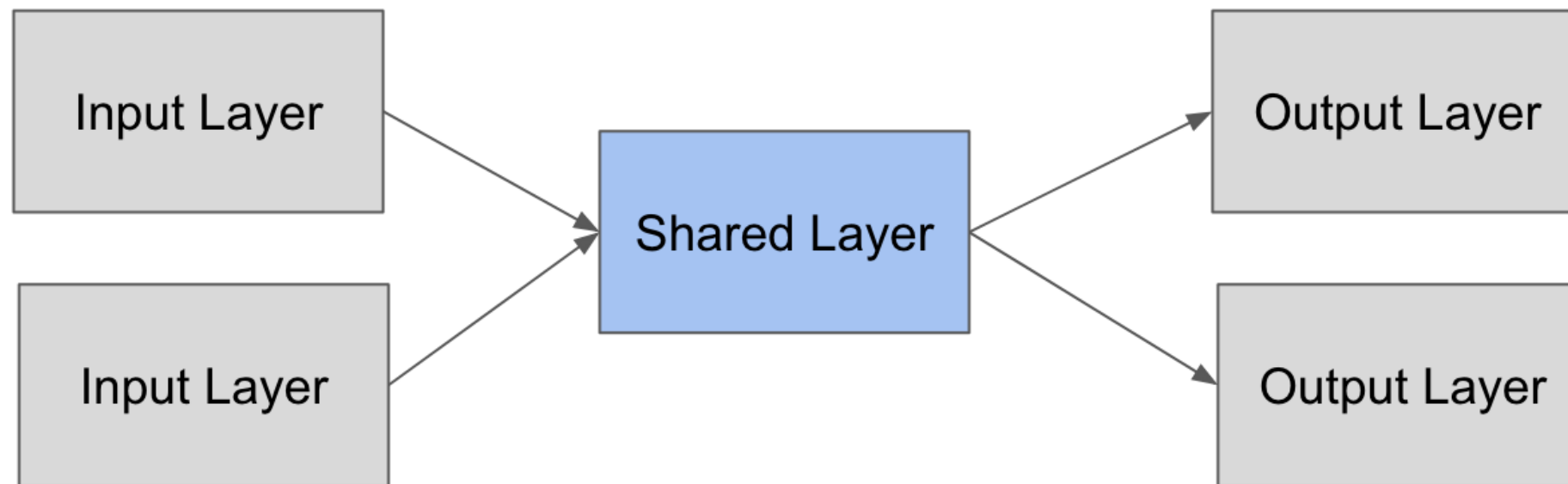- Require the functional API

- Very flexible

Shared layers

```
input_tensor_1 = Input((1,))

input_tensor_2 = Input((1,))
```

Shared layers

```
shared_layer = Dense(1)
output_tensor_1 = shared_layer(input_tensor_1)
output_tensor_2 = shared_layer(input_tensor_2)
```

Sharing multiple layers as a model

```python
input_tensor = Input(shape=(1,))
n_teams = 10887
embed_layer = Embedding(input_dim=n_teams,
                        input_length=1,
                        output_dim=1,
                        name='Team-Strength-Lookup')
embed_tensor = embed_layer(input_tensor)
flatten_tensor = Flatten()(embed_tensor)
model = Model(input_tensor, flatten_tensor)
```

```python
input_tensor_1 = Input((1,))
input_tensor_2 = Input((1,))
output_tensor_1 = model(input_tensor_1)
output_tensor_2 = model(input_tensor_2)
```

Sharing multiple layers as a model
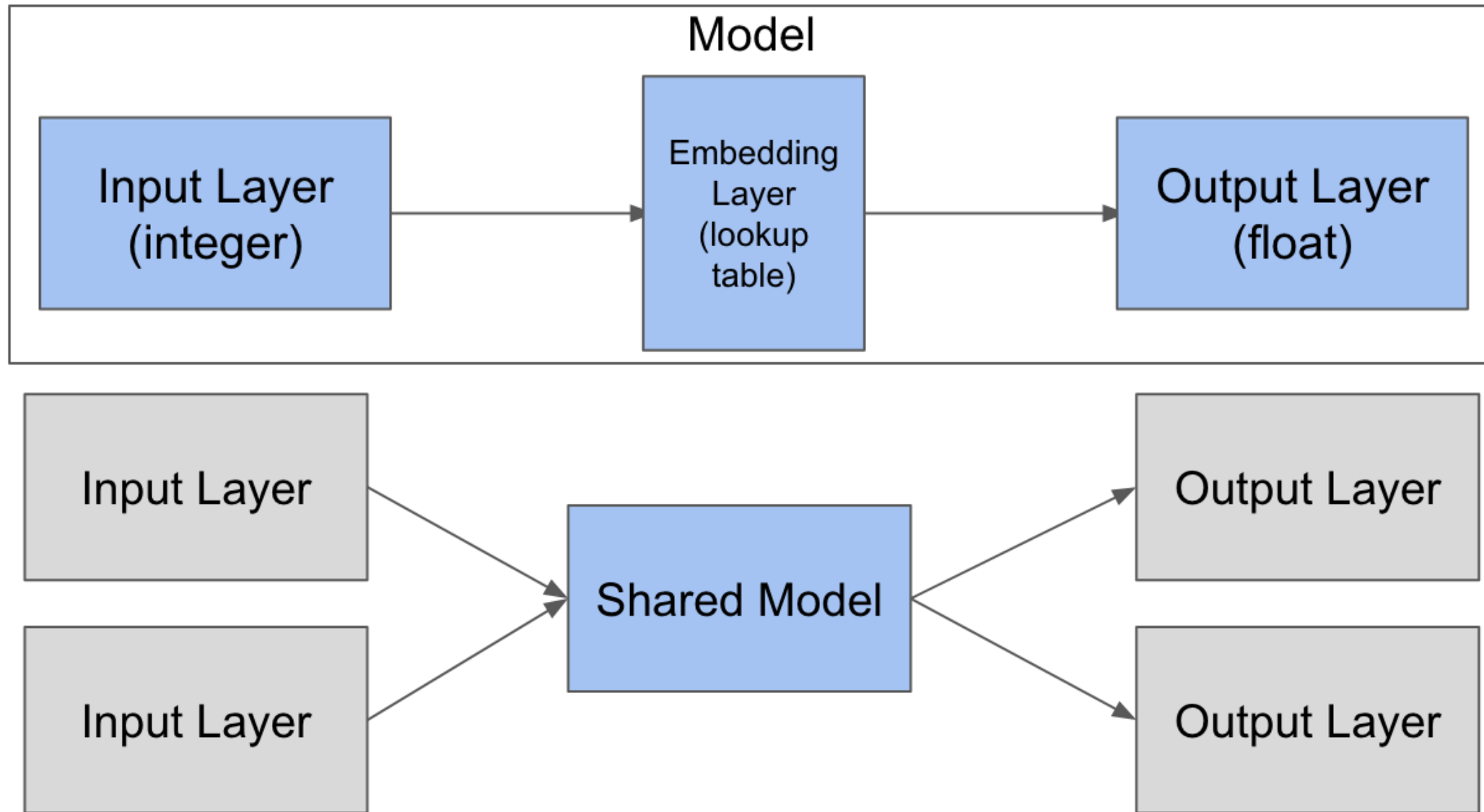
Let's practice!

ADVANCED DEEP LEARNING WITH KERAS

Merge layers

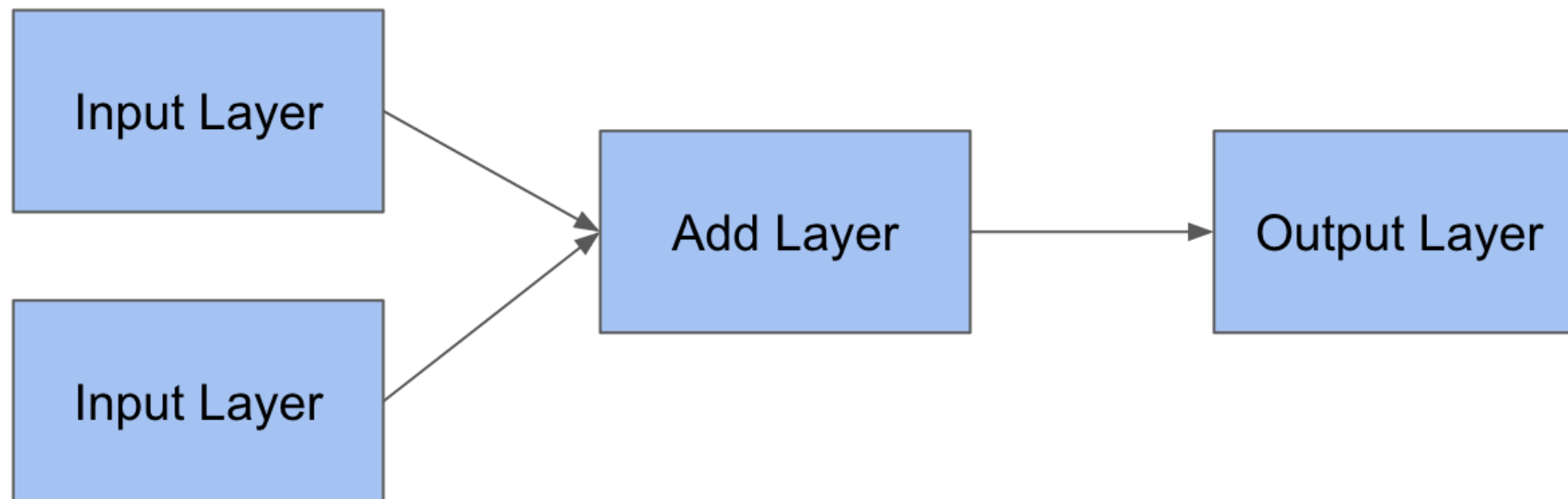## ADVANCED DEEP LEARNING WITH KERAS

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Merge layers

- Add
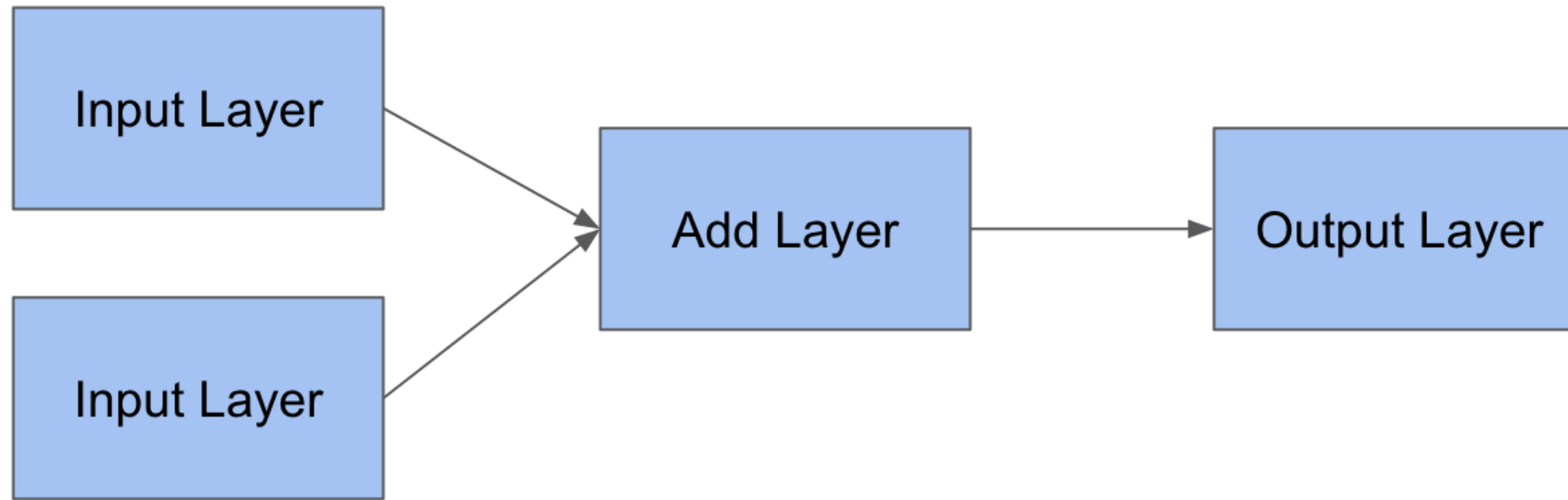
- Subtract

- Multiply

- Concatenate

Merge layers

```python
from keras.layers import Input, Add
in_tensor_1 = Input((1,))
in_tensor_2 = Input((1,))
out_tensor = Add()([in_tensor_1, in_tensor_2])
```
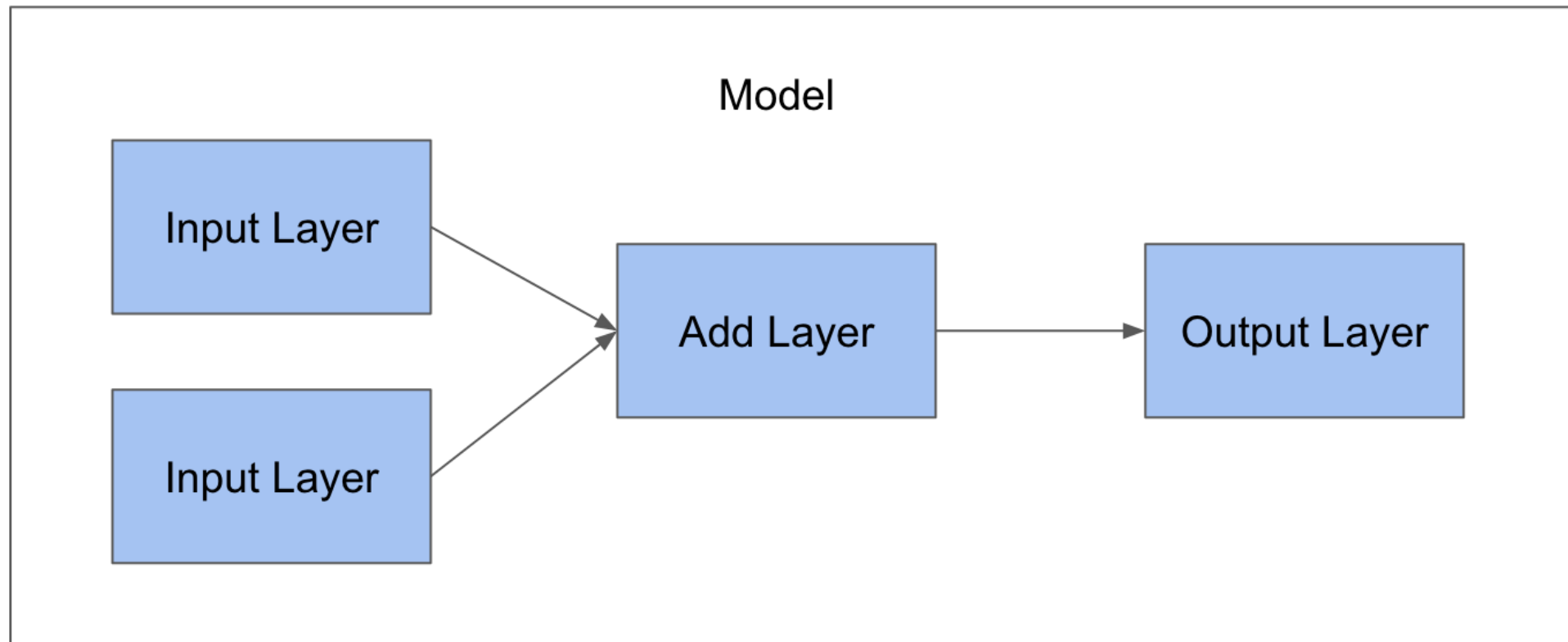
Merge layers

```
in_tensor_3 = Input((1,))
out_tensor = Add()([in_tensor_1, in_tensor_2, in_tensor_3])
```
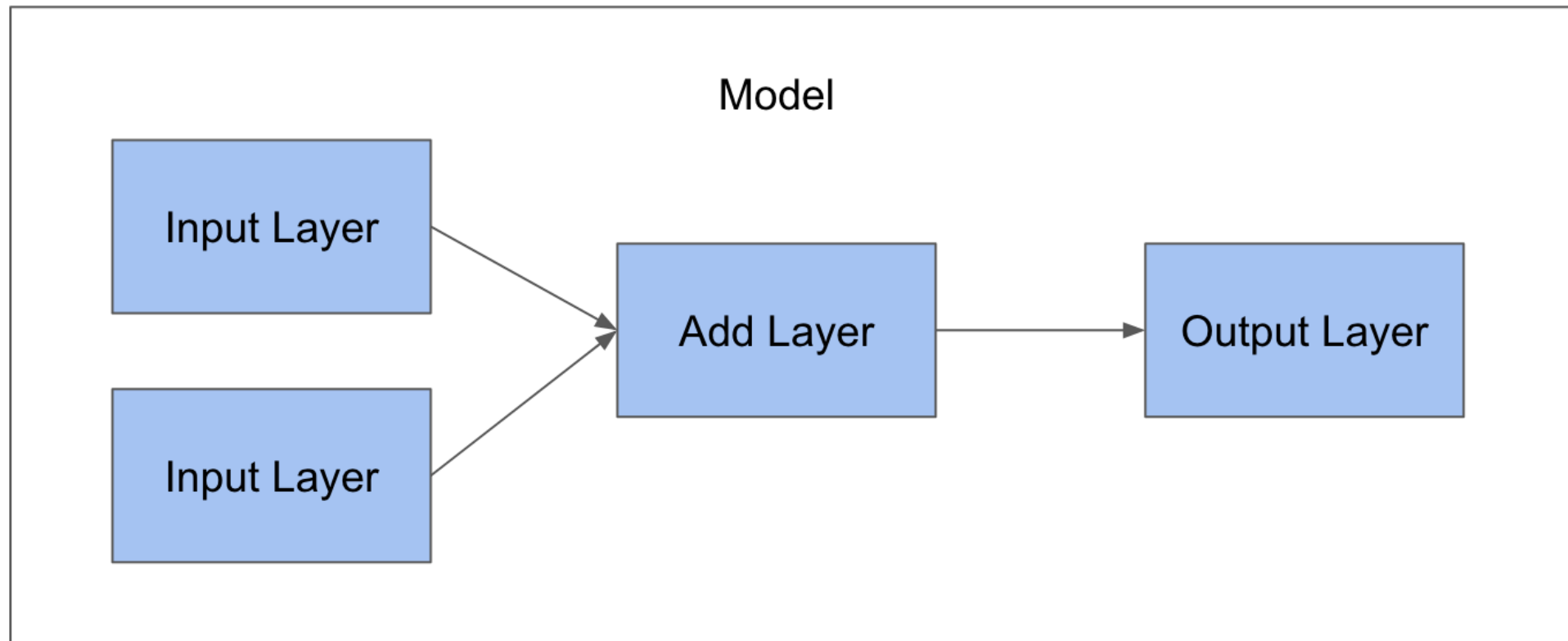
Create the model

```
from keras.models import Model

model = Model([in_tensor_1, in_tensor_2], out_tensor)
```

Model

Compile the model

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

Let's practice!

ADVANCED DEEP LEARNING WITH KERAS
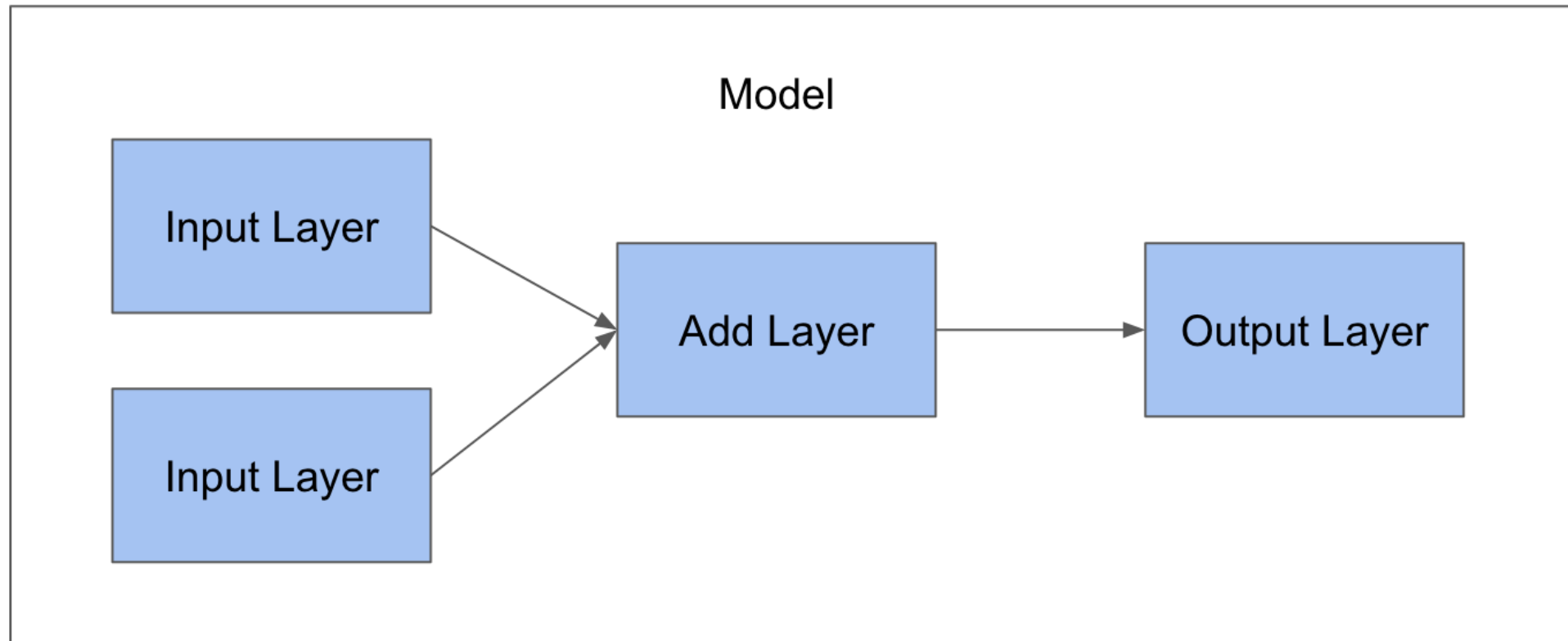
Fitting and Predicting with multiple inputs

ADVANCED DEEP LEARNING WITH KERAS

Zach Deane Mayer
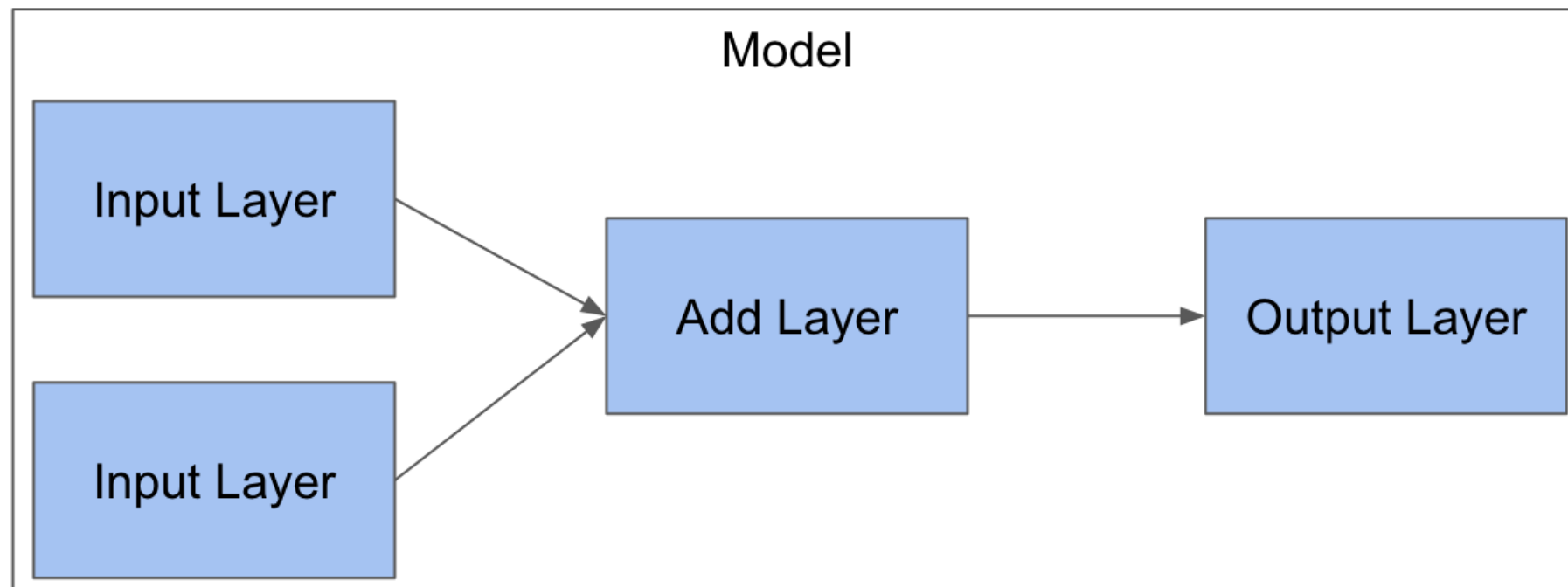Data Scientist

Fit with multiple inputs

```
model.fit([data_1, data_2], target)
```

Predict with multiple inputs

```
model.predict([np.array([[1]]), np.array([[2]])])
array([[3.]], dtype=float32)
```
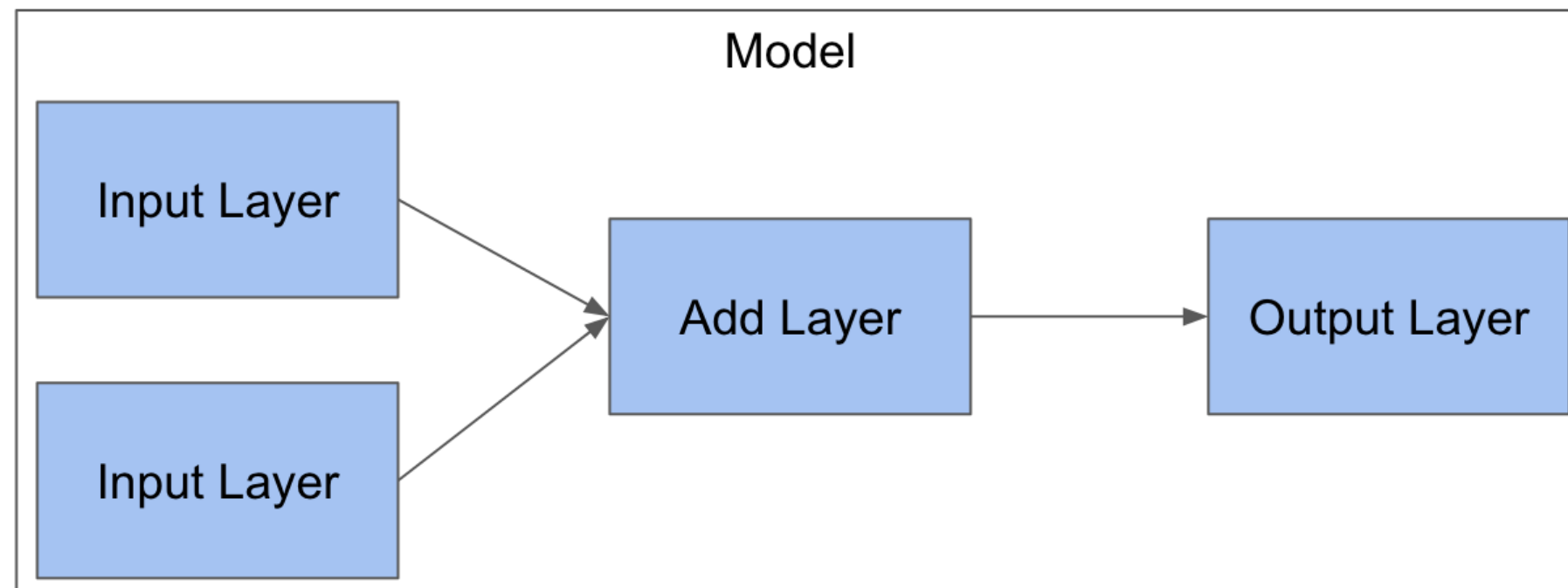
```
model.predict([np.array([[42]]), np.array([[119]])])
array([[161.]], dtype=float32)
```

Evaluate with multiple inputs

```
model.evaluate([np.array([[-1]]), np.array([[-2]])], np.array([[-3]]))
```

```
1/1 [==============================] - 0s 801us/step
Out[21]: 0.0
```

Let's practice!

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