Deep Learning with Keras and the Microsoft Cognitive Toolkit

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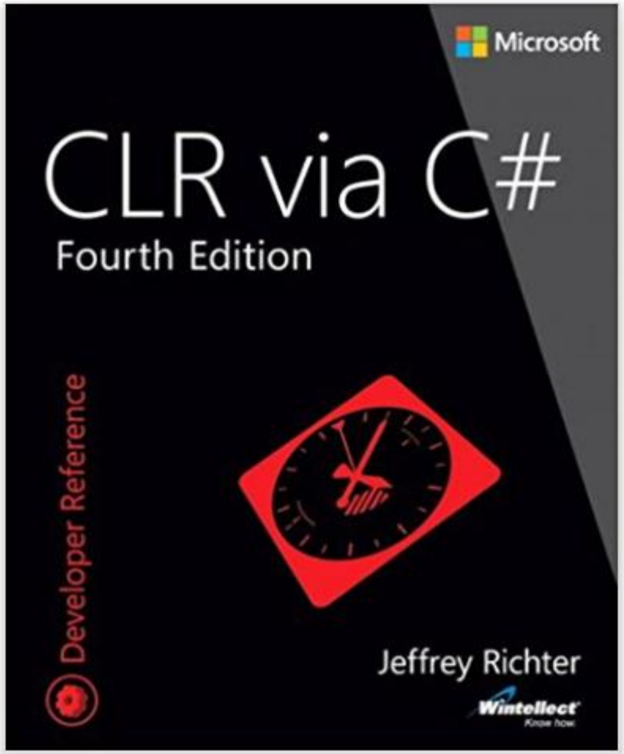

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Some Highlights

- **Gold Cloud Platform Partner, Gold DevOps Partner, Gold Data Platform Partner**
  - Multiple ALM Rangers
- 2018 IAMCP Gold Partner of the Year Worldwide announced at WPC
- CEO is Microsoft Regional Director (RD) for Atlanta
- Software Development competency partner
- Xamarin Premier Consulting Partner
  - Multiple Xamarin Certified Engineers
  - Chosen to teach the 2-day Xamarin University pre-con at Evolve 2016
- Other: Visual Studio Integration Partner, Azure Circle Partner, ALM Inner Circle Partner, MVP of the Year, and more…

Agenda

- Basics of Machine Learning
- Basics of Deep Learning
- What is the Cognitive Toolkit?
    - When to use the Cognitive Toolkit
- Demos
    - Create model with Keras
    - Read model and predict with CNTK

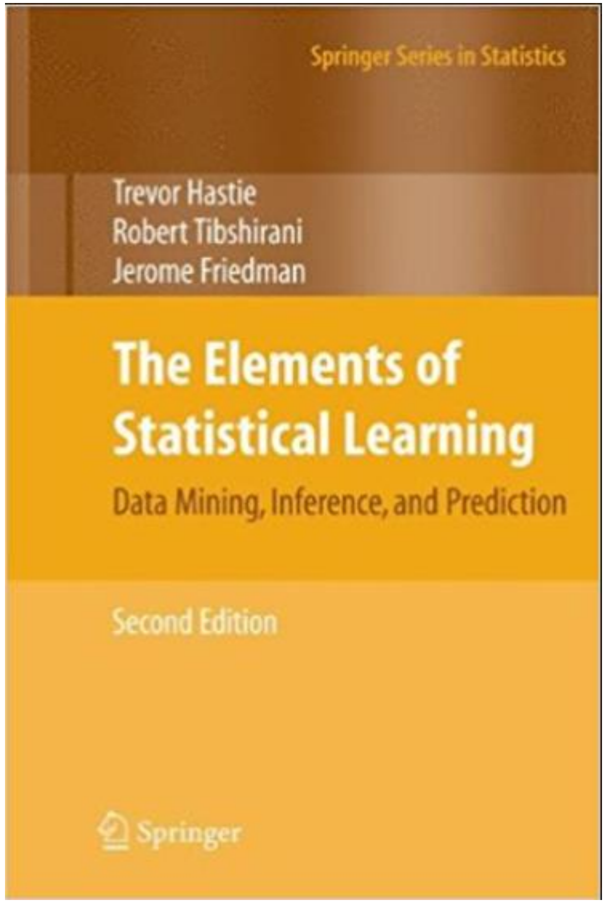
Machine Learning Basics

Main definition is machine learning is the field of study that gives computers the ability to learn without being explicitly programmed.

-Arthur Samuel, 1959

Machine Learning Basics

Originated from statistics as Statistical Learning.



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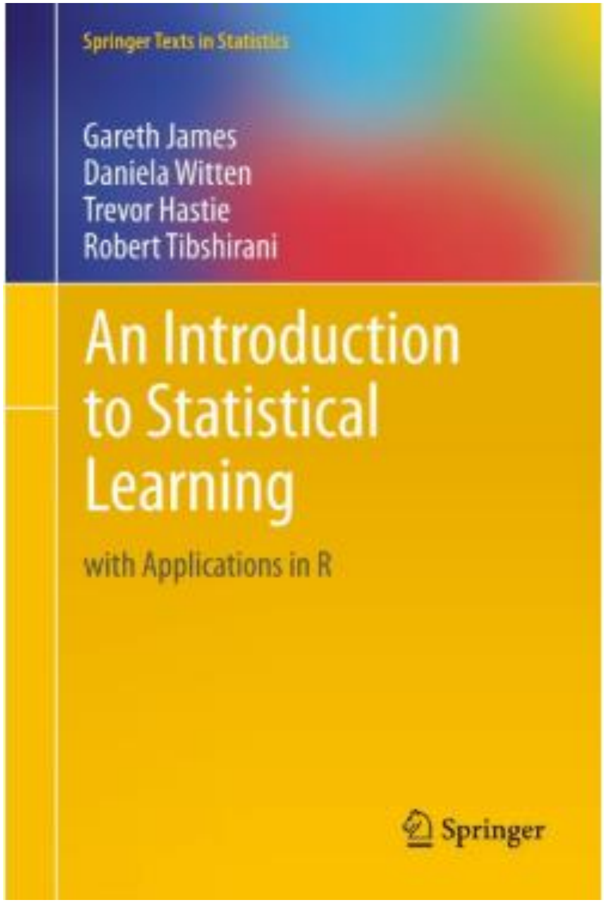

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with Applications in R

Springer

Machine Learning Basics

Machine learning models need three important things…

- Data
- Data
- Data

Machine Learning Basics

Quality machine learning models need three important things…

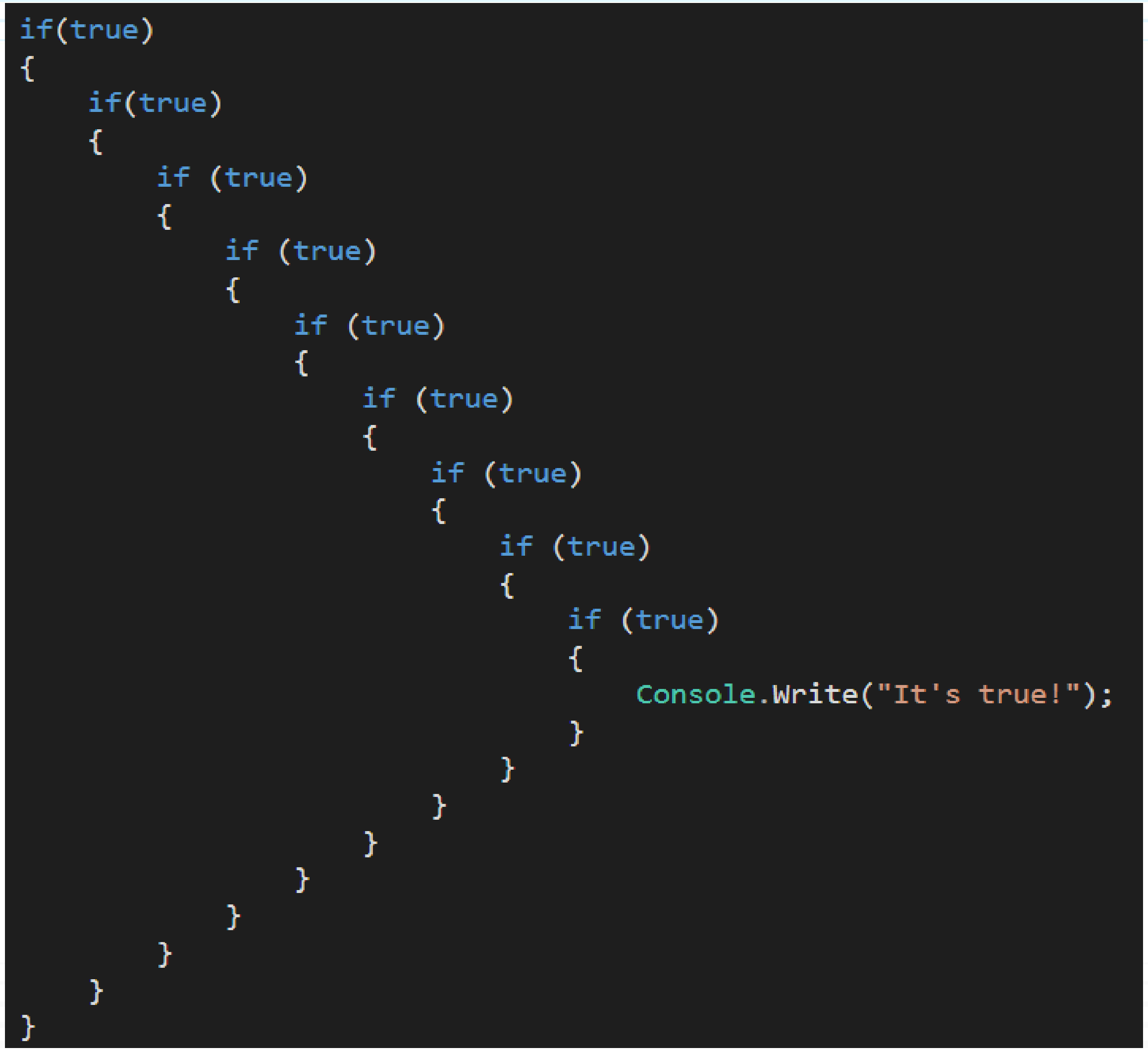
- **Good** Data
- **Good** Data
- **Good** Data

Machine Learning Basics

The first big form of machine learning was…

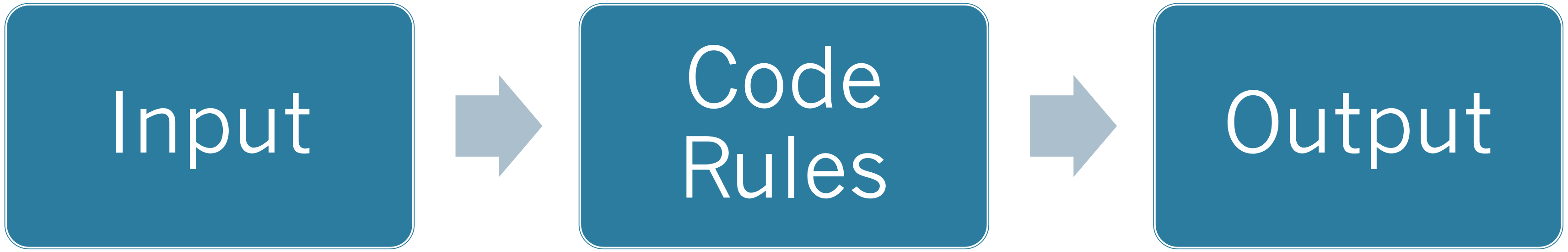
The spam filter

Machine Learning Basics



```
if(true)
{
    if(true)
    {
        if (true)
        {
            if (true)
            {
                if (true)
                {
                    if (true)
                    {
                        if (true)
                        {
                            if (true)
                            {
                                if (true)
                                {
                                    Console.Write("It's true!");
                                }
                            }
                        }
                    }
                }
            }
        }
    }
}
```

Machine Learning Basics



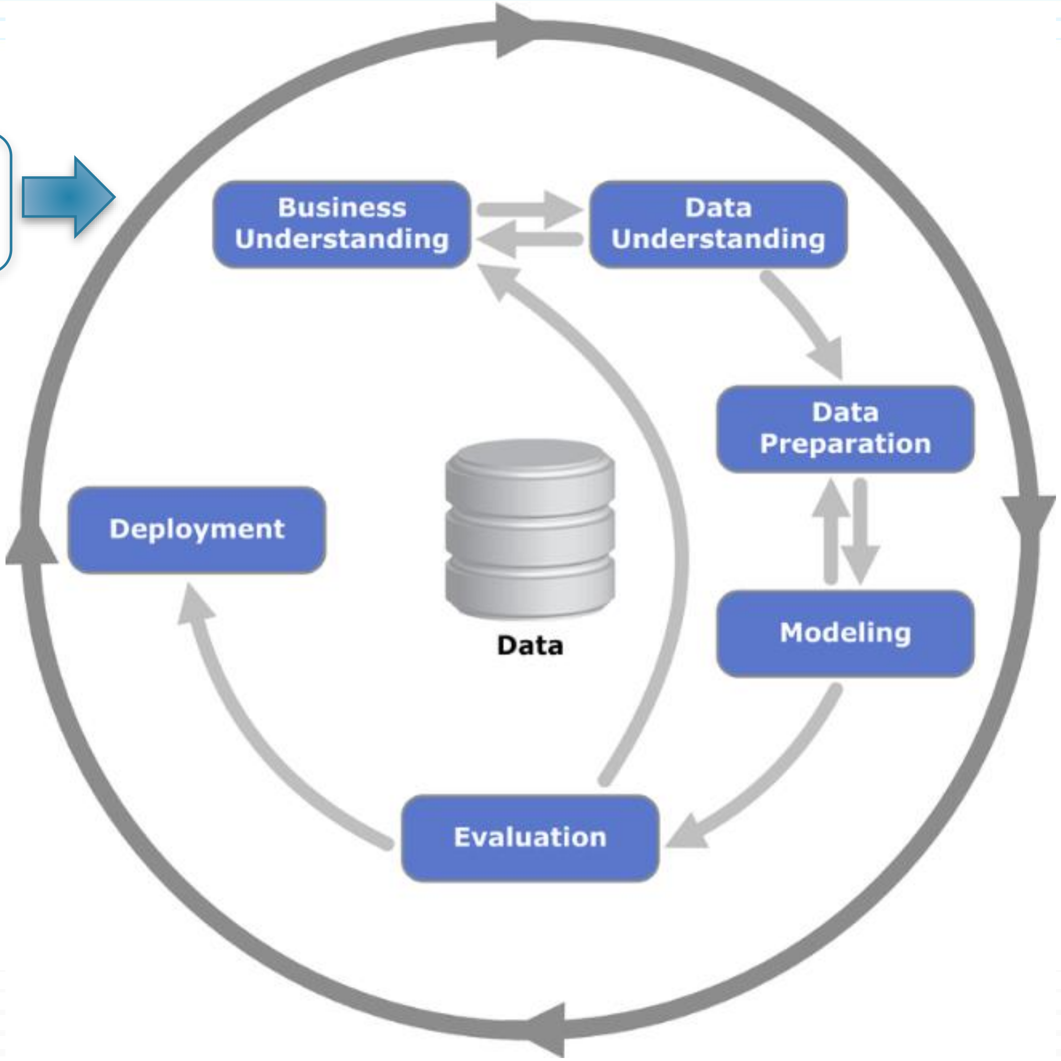
Input

Code Rules

Output

Machine Learning Basics

Getting Data



Kenneth Jensen - Own work based on: ftp://public.dhe.ibm.com/software/analytics/spss/documentation/modeler/18.0/en/ModelerCRISPDM.pdf (Figure 1)

Machine Learning Basics

Machine Learning is like cooking…

Machine Learning Basics

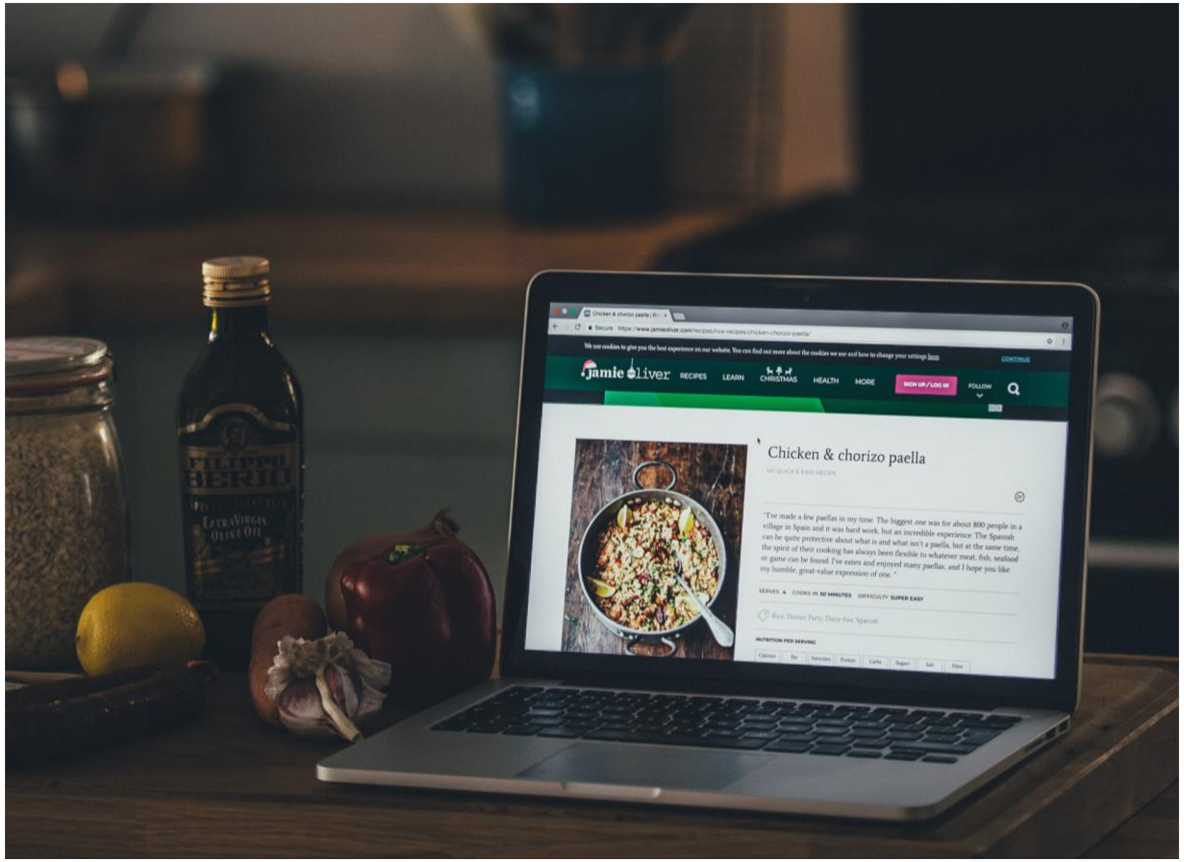
Getting data

Machine Learning Basics

Preprocessing data

Machine Learning Basics

Chosen algorithm to use



Machine Learning Basics

Evaluate the model

Machine Learning Basics

Iterate

Demo

Scikit-learn Model

Deep Learning Basics

Deep Learning Basics

$$\textstyle\sum_{i=1}^{n}[w_{1i}^{(m)}\exp(-y_i\beta h(\boldsymbol{x}_i))+w_{2i}^{(m)}\exp(y_i\beta h(\boldsymbol{x}_i))]$$

$$=\textstyle\sum_{\{i:h(\boldsymbol{x}_i)=y_i\}}^{n}[w_{1i}^{(m)}e^{-\beta}+w_{2i}^{(m)}e^{\beta}]$$

$$+\textstyle\sum_{\{i:h(\boldsymbol{x}_i)\neq y_i\}}^{n}[w_{1i}^{(m)}e^{\beta}+w_{2i}^{(m)}e^{-\beta}]$$

$$=\textstyle\sum_{i=1}^{n}[w_{1i}^{(m)}e^{-\beta}+w_{2i}^{(m)}e^{\beta}]$$

$$+(e^{\beta}-e^{-\beta})\textstyle\sum_{\{i:h(\boldsymbol{x}_i)\neq y_i\}}^{N}[w_{1i}^{(m)}-w_{2i}^{(m)}].$$

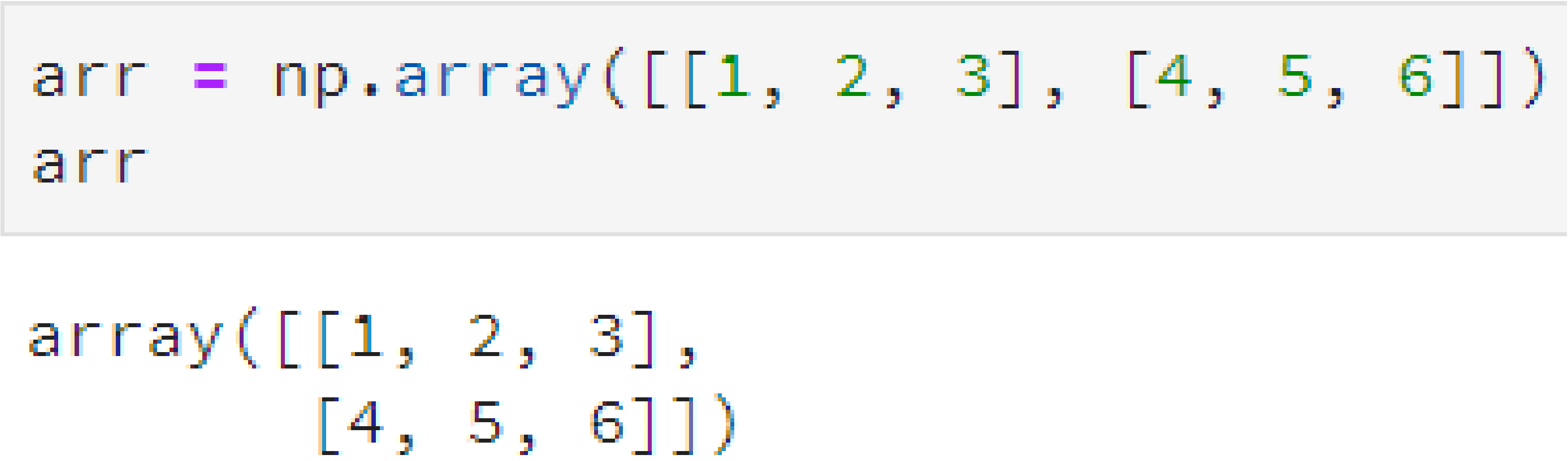
Equation from Robust and Efficient Boosting Method using the Conditional Risk - arXiv:1806.08151 **[stat.ML]**

Deep Learning Basics

It is good to know about matrices

Deep Learning Basics

2D Array in Numpy

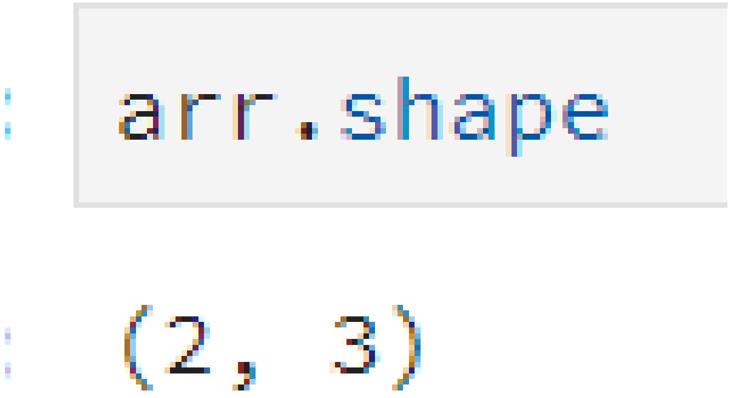


```
arr = np.array([[1, 2, 3], [4, 5, 6]])
arr
```

```
array([[1, 2, 3],
       [4, 5, 6]])
```

Deep Learning Basics

2D Array’s Shape



```
arr.shape
```

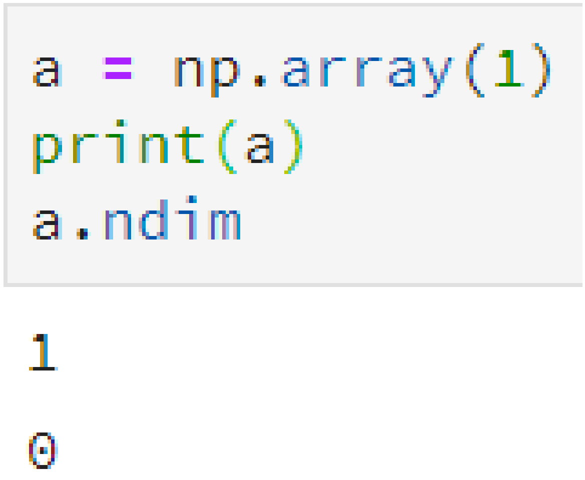
```
(2, 3)
```

Deep Learning Basics

And then there's tensors

Deep Learning Basics

0D tensor

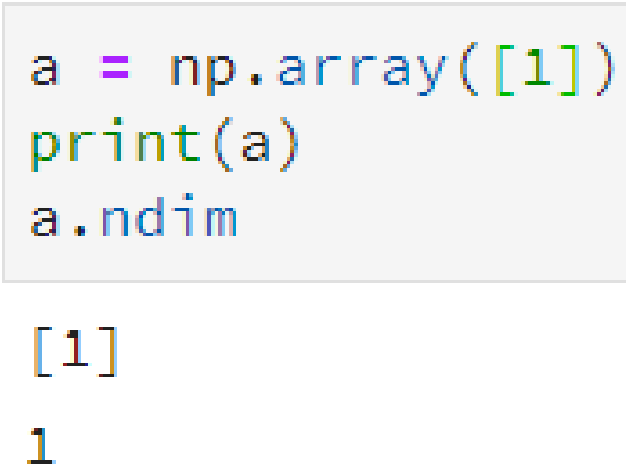


```
a = np.array(1)
print(a)
a.ndim
```

```
1

0
```

1D tensor

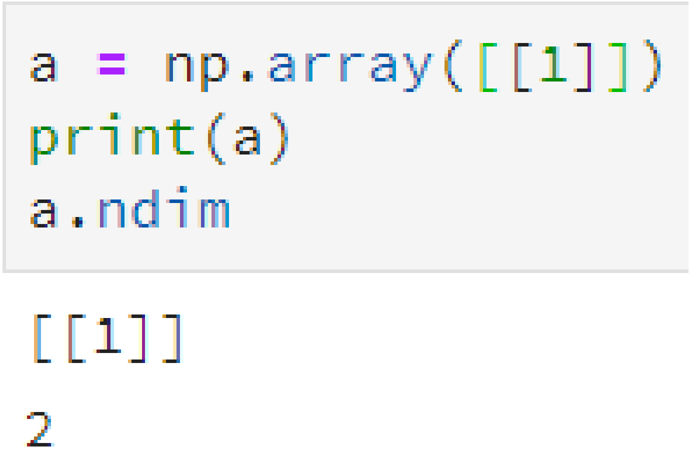


```
a = np.array([1])
print(a)
a.ndim
```

```
[1]

1
```

2D tensor

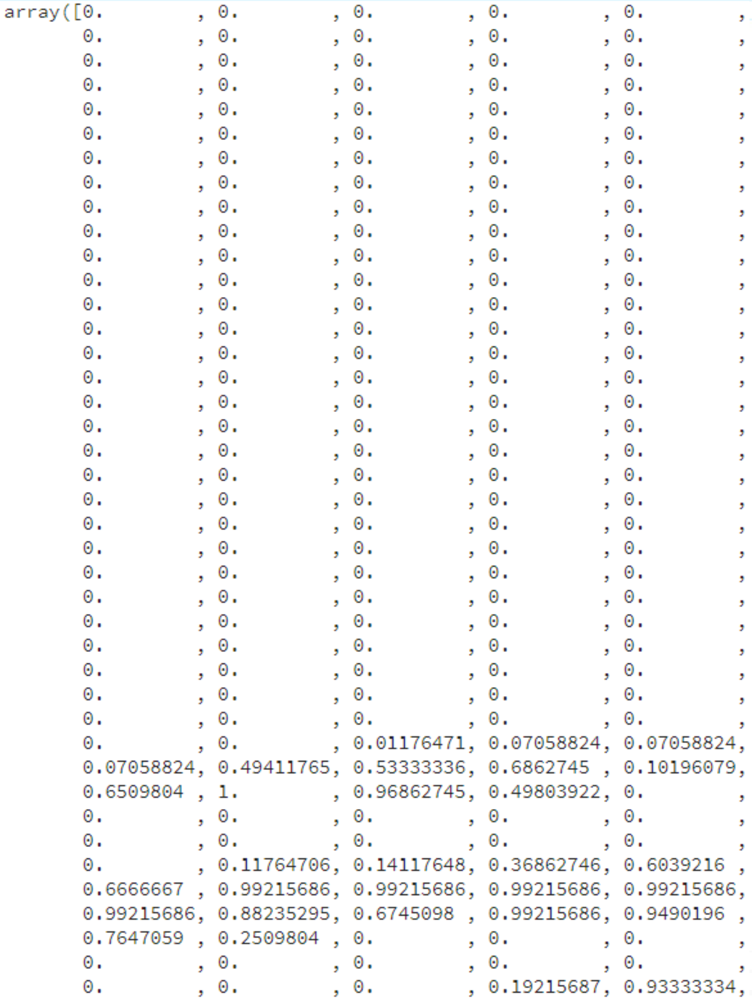


```
a = np.array([[1]])
print(a)
a.ndim
```

```
[[1]]

2
```

Deep Learning Basics



```
array([0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.01176471, 0.07058824, 0.07058824,
       0.07058824, 0.49411765, 0.53333336, 0.6862745 , 0.10196079,
       0.6509804 , 1.        , 0.96862745, 0.49803922, 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.11764706, 0.14117648, 0.36862746, 0.6039216 ,
       0.6666667 , 0.99215686, 0.99215686, 0.99215686, 0.99215686,
       0.99215686, 0.88235295, 0.6745098 , 0.99215686, 0.9490196 ,
       0.7647059 , 0.2509804 , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.19215687, 0.93333334,
```

Deep Learning Basics

Neural Networks

Deep Learning Basics

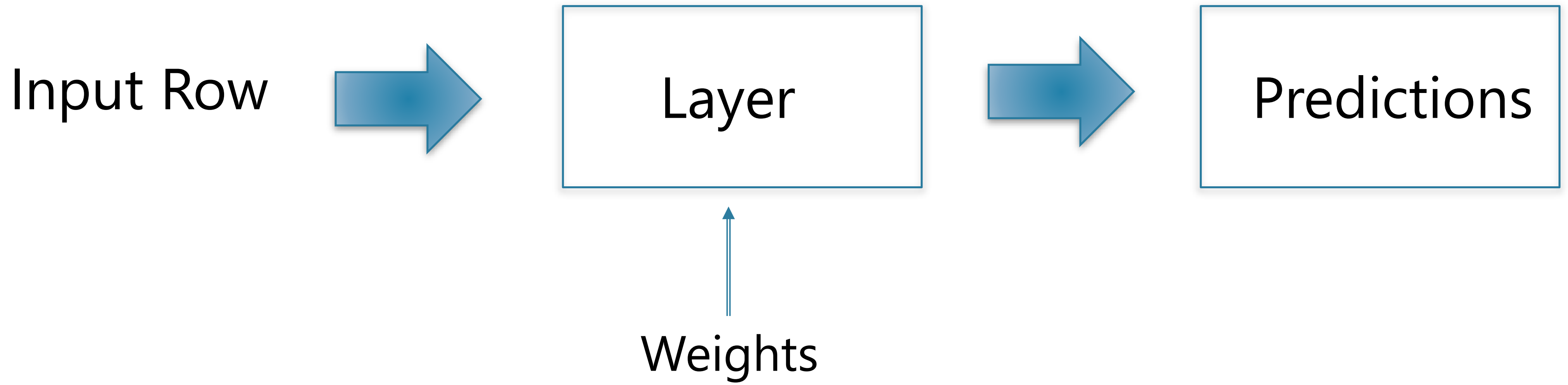
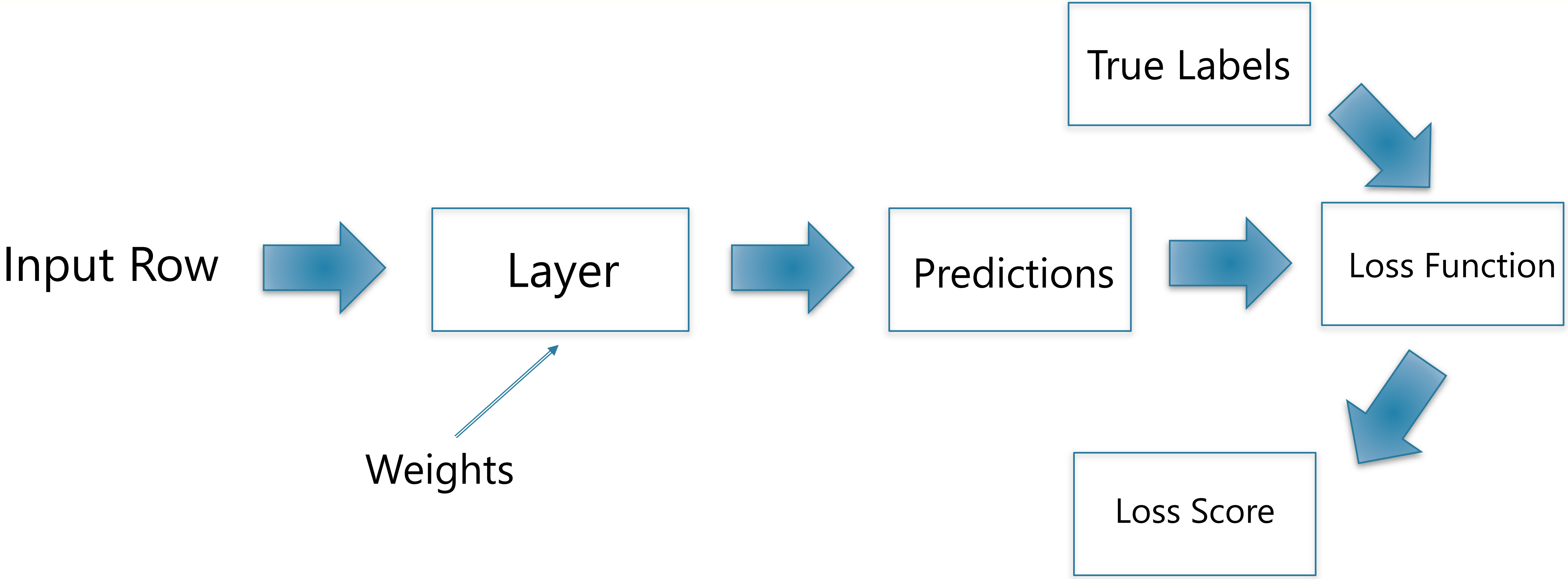
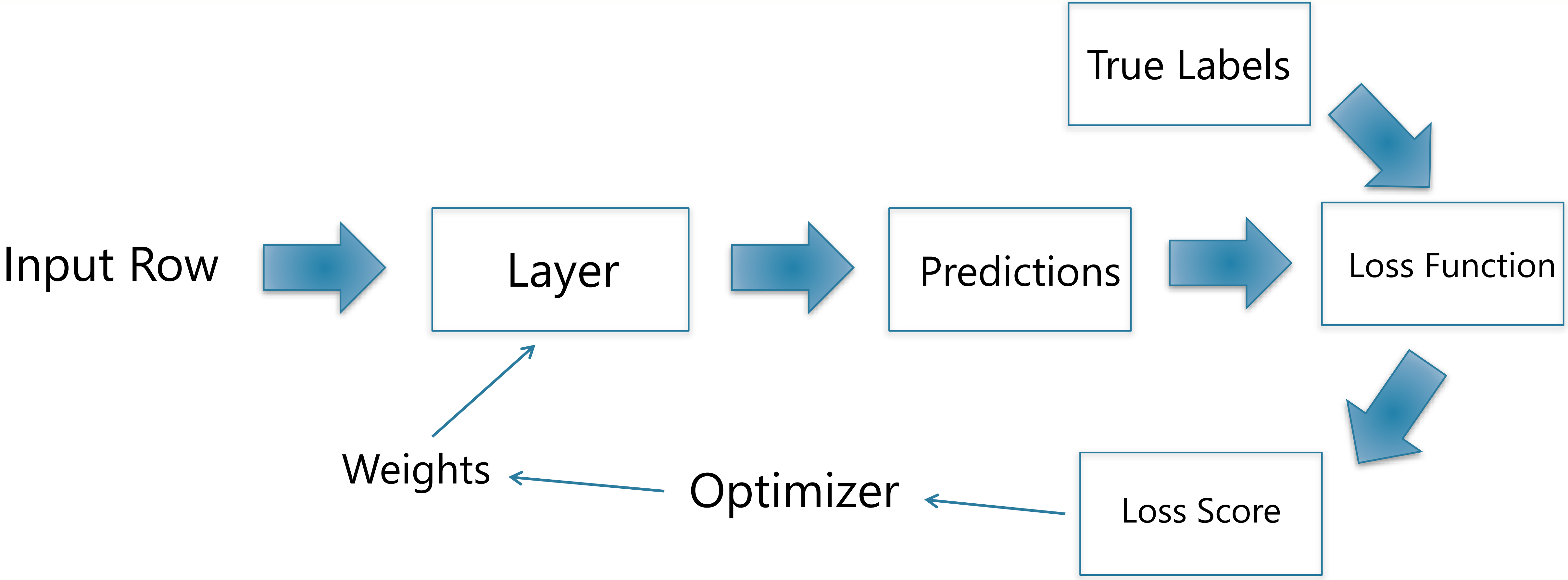


Diagram from *Deep Learning with Python*, p.10-11

Deep Learning Basics



Deep Learning Basics



Deep Learning Basics

What activation and loss functions to use?

Model Type	Activation Function	Loss Function
Binary classification	sigmoid	binary_crossentropy
Multiclass, single classification	softmax	categorical_crossentropy
Multiclass, multilabel classification	sigmoid	binary_crossentropy
Regression, arbitrary values	None	mse
Regression, values between 0 and 1	sigmoid	mse or binary_crossentropy

Table from *Deep Learning with Python*, p.114

Demo

MNIST Model in Keras

ONNX

Cognitive Toolkit can read CNTK and ONNX models

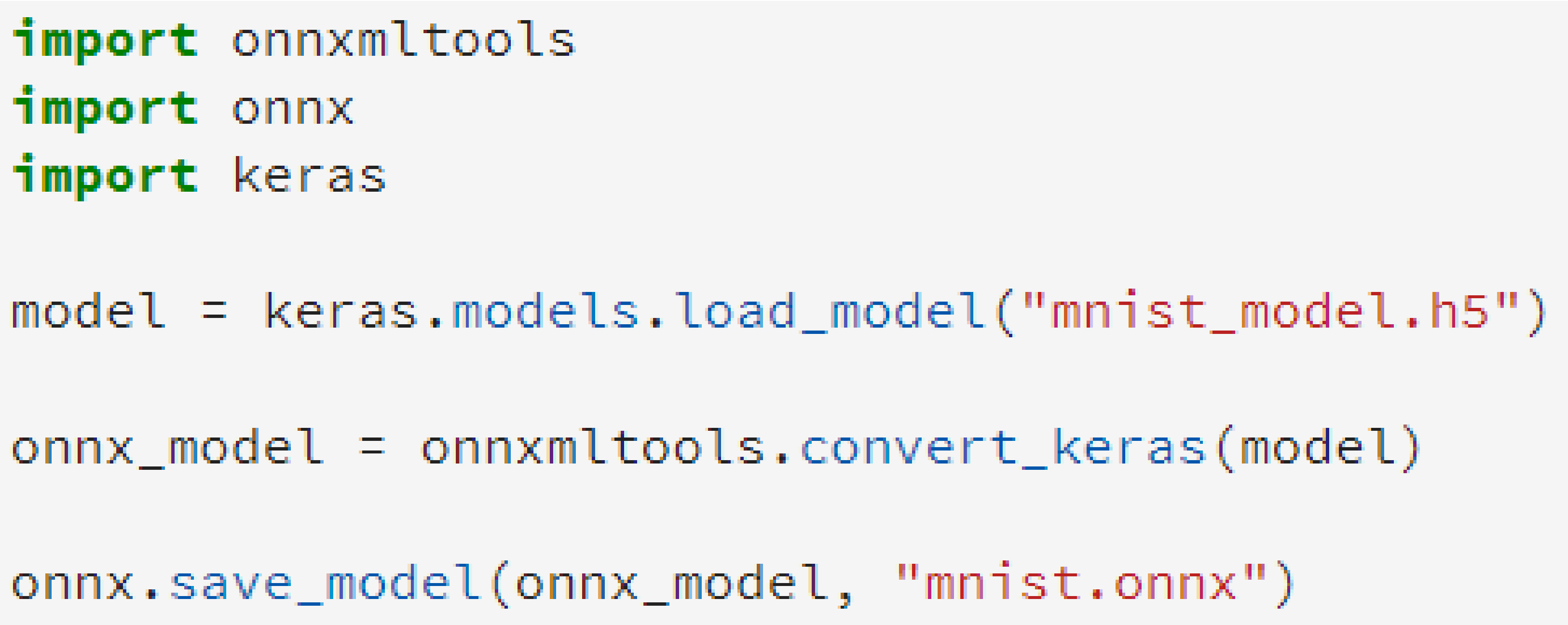
ONNX

OPEN NEURAL NETWORK EXCHANGE FORMAT

The new open ecosystem for interchangeable AI models

ONNX

Convert Keras model so the Cognitive Toolkit can read it.



```
import onnxmltools
import onnx
import keras

model = keras.models.load_model("mnist_model.h5")

onnx_model = onnxmltools.convert_keras(model)

onnx.save_model(onnx_model, "mnist.onnx")
```

What is the Cognitive Toolkit?

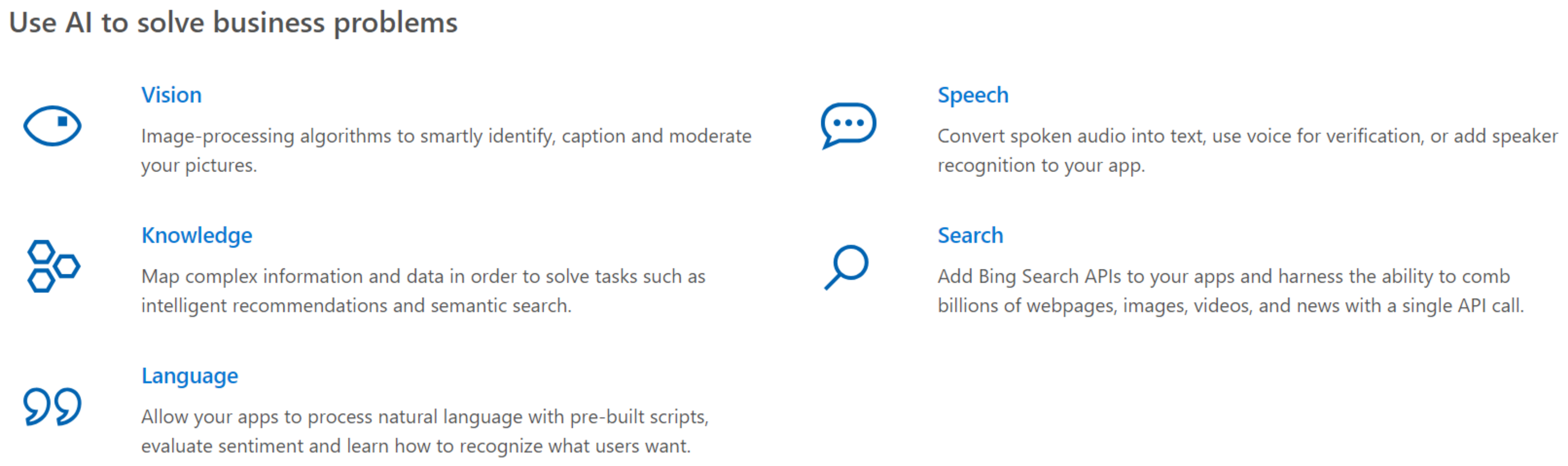
Deep learning framework developed by Microsoft Research

The Microsoft Cognitive Toolkit

A free, easy-to-use, open-source, commercial-grade toolkit that trains deep learning algorithms to learn like the human brain.

What is the Cognitive Toolkit?

Used to create the Cognitive Services



Use AI to solve business problems

Vision

Image-processing algorithms to smartly identify, caption and moderate your pictures.

Speech

Convert spoken audio into text, use voice for verification, or add speaker recognition to your app.

Knowledge

Map complex information and data in order to solve tasks such as intelligent recommendations and semantic search.

Search

Add Bing Search APIs to your apps and harness the ability to comb billions of webpages, images, videos, and news with a single API call.

Language

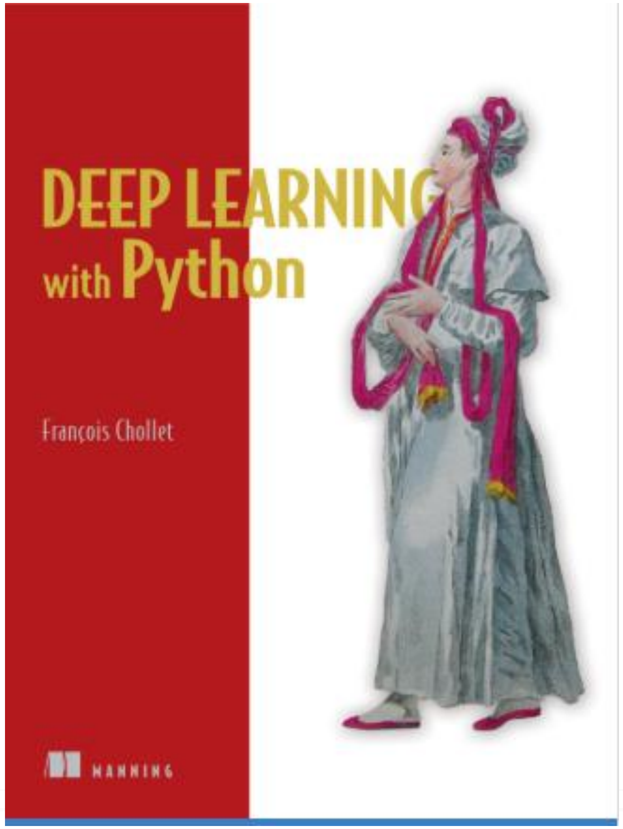
Allow your apps to process natural language with pre-built scripts, evaluate sentiment and learn how to recognize what users want.

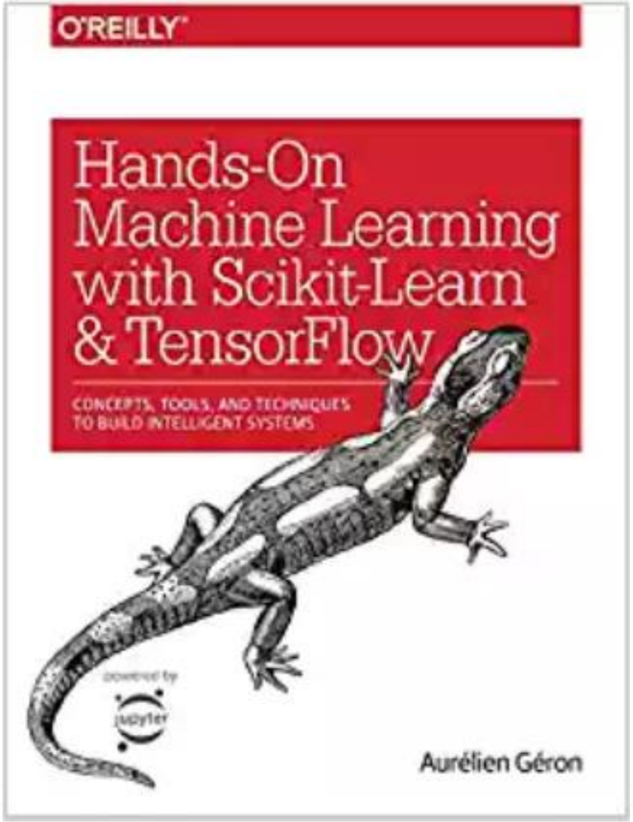
Demo

Read model with the Cognitive Toolkit

Resources

Books

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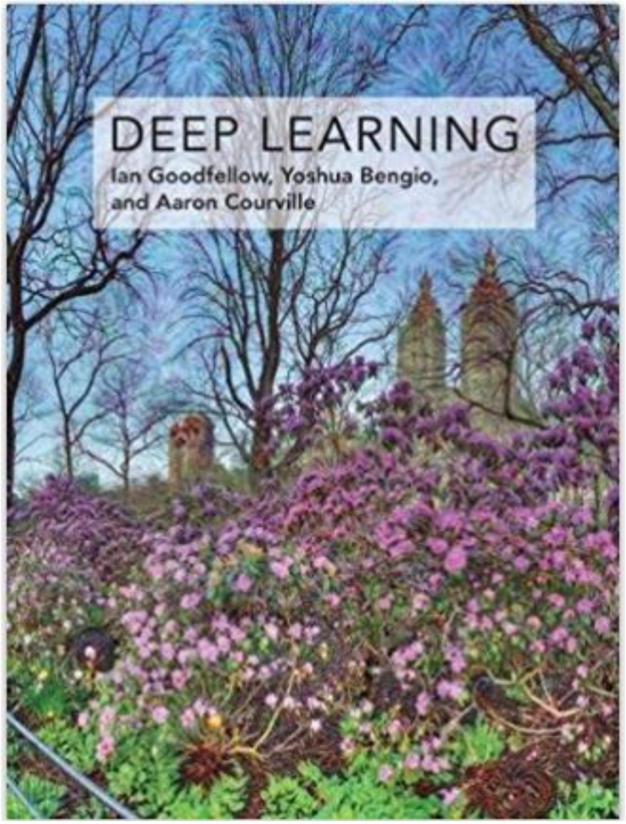
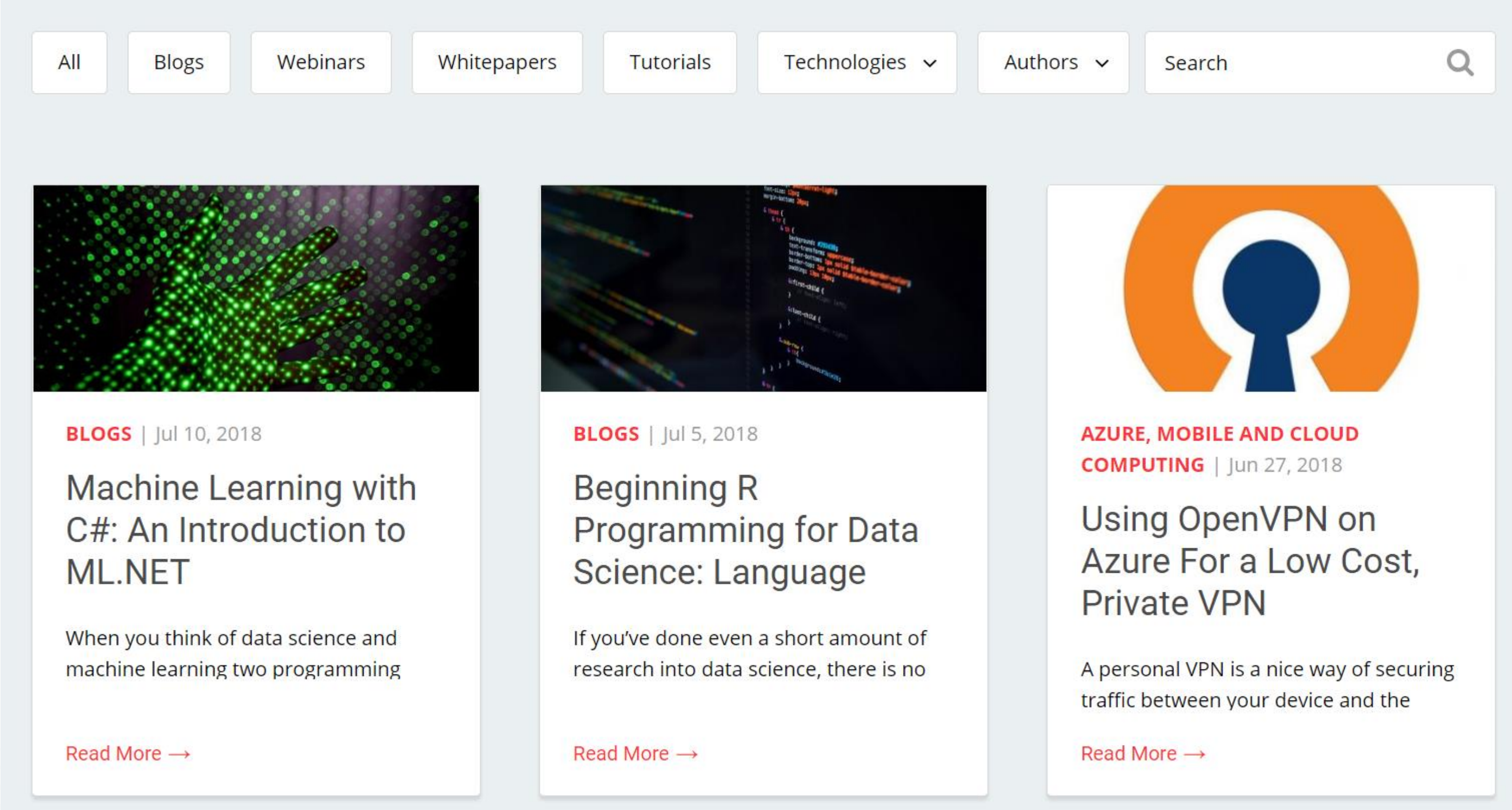


Resources

Wintellect DevCenter - https://www.wintellect.com/devcenter/



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Jonathan Wood
Software Consultant
@JWood