

3. Deep learning tools

3.9 TensorFlow and Keras

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Elements of Tensorflow

Introduction

- Open-source machine learning library developed by the Google Brain team in 2012.
- It has tools and libraries for developing deep learning applications.
- It uses multidimensional arrays (tensors) as the basic elements.
- Efficient management of large-scale datasets.
- GPU support.

Elements of Tensorflow

Term	Definition	Examples
Tensor	Array containing the data in multiple dimensions.	<pre>Scalar = 25, shape = [] Vector = [1,2], shape = [2] Matrix = [[3,4], [5,5]], shape = [2,2]</pre>
Shape	Number of elements in each dimension of a tensor.	<pre>Tensor = [[[1,2], [2,5], [3,2]] [[4,5], [7,8], [4,1]]], shape = [2, 3, 2]</pre>

Elements of Tensorflow

Terms and definitions

Term	Definition	Examples
Type	Data structure to represent tensors.	
	Common tensor types:	<code>tf.constant(5)</code>
	1. Constant : Fixed values	<code>tf.Variable([[1,1],[5,5]], name = 'matrix')</code>
	2. Variables : Values can be updated over time.	<code>tf.placeholder(tf.float64, shape = {[None,5]})</code>
	3. Placeholder: Initialization not required.	

Elements of Tensorflow

Terms and definitions

Term	Definition	Examples
Graph	Data structures consisting of nodes that allows the flow of computational operations.	<code>a = 10</code> <code>b = 6</code> <code>out = tf.subtract(a,b)</code>
Session	Used to evaluate the computational operations in a graph.	<code>s = tf.Session()</code> <code>s.run(out)</code> <code>s.close()</code>

Examples are provided in separate notebooks.

Elements of Keras

Introduction

- TensorFlow is a low-level language with high complexity.
- Keras can be used to simplify these complexities.
- Developed at Google by Francois Chollet.
- High-level deep learning library. It can run on top of Tensorflow, Cognitive Toolkit (CNTK), Theano, etc.
- Minimalistic structure for faster implementation of complex structures.
- Supports CPU and GPU.
- Widely used in machine learning, computer vision, and time series-related applications.
- The components of Keras are Models, Layers and Core.

- Keras Models are composed of layers.
- The different layers constitute the Neural network.
- The simple sequential composition models are called Sequential models.
- Sequential are added with *model.add*.
- Sub-classing technique can be used to develop further complex models. To be discussed further.
- Function API models are used to develop more flexible, complex models. It uses graphs of layers.

Elements of Keras

Layers

- Layers are next in the hierarchy of the Keras structure.
- They are input, hidden and output layer in neural network models.
- Most common available pre-defined layers are:
 - **Convolutional,**
 - **Pooling,**
 - **Recurrent**
 - **Core.**
- In between the previous layers, **dropout** layers can be added to reduce overfitting.

- Basic building blocks of any keras model architecture.
- They are built-in functions that support the Keras model ensuring its proper functioning.
- The modules used include:
 - *Activation functions* such as softmax, relu, etc,
 - *loss function module* (mean square error, Poisson, likelihood, mean absolute error etc.),
 - *optimizer module* that uses optimizers such as adam, Stochastic gradient descent (SGD), etc. and *regularizers* (L1 and L2 regularizers).
- These pre-defined modules support the training of the Neural network models.