Latent variables

A latent variable is a variable which is not directly observable and is assumed to affect the response variables.

Latent variables are typically included in an econometric/statistical model (latent variable model) with different aims:

1. representing the effect of unobservable covariates/factors and then accounting for the unobserved heterogeneity between subjects
2. accounting for measurement errors
3. summarizing different measurements of the same

These models are typically classified according to:

1. nature of the response variables (discrete or continuous) .
2. nature of the latent variables (discrete or continuous) .
3. inclusion or not of individual covariates

Factor analysis model:, Item Response Theory models: are some of the well known latent variable methods

Train-Test Split for Evaluating Machine Learning Algorithms

1. The train-test split is a technique for evaluating the performance of a machine learning algorithm. It can be used for classification or regression problems and can be used for any supervised learning algorithm.
2. The procedure involves taking a dataset and dividing it into two subsets. The first subset is used to fit the model and is referred to as the training dataset. The second subset is not used to train the model; instead, the input element of the dataset is provided to the model, then predictions are made and compared to the expected values. This second dataset is referred to as the test dataset.
3. Train Dataset: Used to fit the machine learning model.
4. Test Dataset: Used to evaluate the fit machine learning model. The objective is to estimate the performance of the machine learning model on new data: data not used to train the model.

The train-test procedure is appropriate when there is a sufficiently large dataset available.

If you have insufficient data, then a suitable alternate model evaluation procedure would be the **k-fold cross-validation :** If you have insufficient data, then a suitable alternate model evaluation procedure would be the k-fold cross validation

Multi-Layer Perceptrons

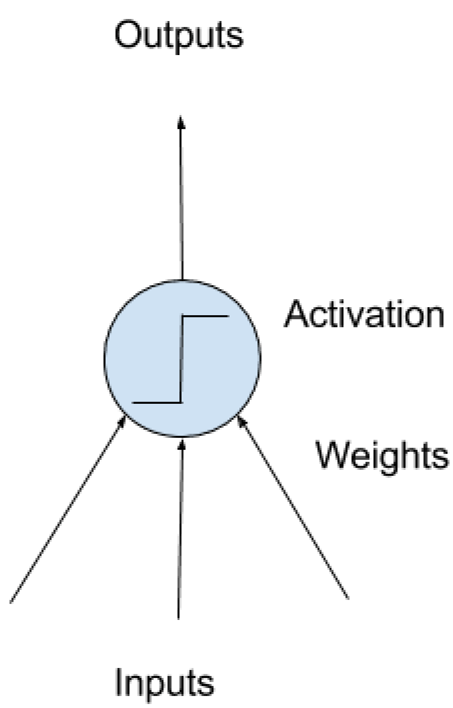
The field of artificial neural networks is often just called neural networks or multi-layer perceptrons after perhaps the most useful type of neural network. A perceptron is a single neuron model that was a precursor to larger neural networks.

The predictive capability of neural networks comes from the hierarchical or multi-layered structure of the networks. The data structure can pick out (learn to represent) features at different scales or resolutions and combine them into higher-order features. For example from lines, to collections of lines to shapes.

Neurons

The building block for neural networks are artificial neurons.

These are simple computational units that have weighted input signals and produce an output signal using an activation function.



Neuron Weights

You may be familiar with linear regression, in which case the weights on the inputs are very much like the coefficients used in a regression equation.

Like linear regression, each neuron also has a bias which can be thought of as an input that always has the value 1.0 and it too must be weighted.

Activation

The weighted inputs are summed and passed through an activation function, sometimes called a transfer function.

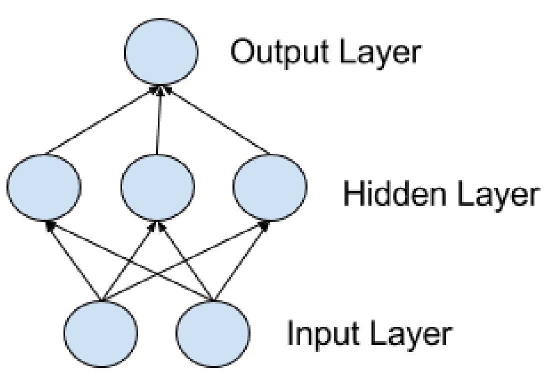
An activation function is a simple mapping of summed weighted input to the output of the neuron. It is called an activation function because it governs the threshold at which the neuron is activated and strength of the output signal.

Historically simple step activation functions were used where if the summed input was above a threshold, for example 0.5, then the neuron would output a value of 1.0, otherwise it would output a 0.0.

Networks of Neurons

Neurons are arranged into networks of neurons.

A row of neurons is called a layer and one network can have multiple layers. The architecture of the neurons in the network is often called the network topology.



Input or Visible Layers

The bottom layer that takes input from your dataset is called the visible layer, because it is the exposed part of the network. Often a neural network is drawn with a visible layer with one neuron per input value or column in your dataset. These are not neurons as described above, but simply pass the input value though to the next layer.

Hidden Layers

Layers after the input layer are called hidden layers because that are not directly exposed to the input. The simplest network structure is to have a single neuron in the hidden layer that directly outputs the value.

Given increases in computing power and efficient libraries, very deep neural networks can be constructed. Deep learning can refer to having many hidden layers in your neural network. They are deep because they would have been unimaginably slow to train historically, but may take seconds or minutes to train using modern techniques and hardware.

Output Layer

The final hidden layer is called the output layer and it is responsible for outputting a value or vector of values that correspond to the format required for the problem.

Training Networks

Once configured, the neural network needs to be trained on your dataset.

Data Preparation

You must first prepare your data for training on a neural network.

Data must be numerical, for example real values. If you have categorical data, such as a sex attribute with the values “male” and “female”, you can convert it to a real-valued representation called a one hot encoding. This is where one new column is added for each class value (two columns in the case of sex of male and female) and a 0 or 1 is added for each row depending on the class value for that row.

Stochastic Gradient Descent

The classical and still preferred training algorithm for neural networks is called stochastic gradient descent.

This is where one row of data is exposed to the network at a time as input. The network processes the input upward activating neurons as it goes to finally produce an output value. This is called a forward pass on the network. It is the type of pass that is also used after the network is trained in order to make predictions on new data.

Weight Updates

The weights in the network can be updated from the errors calculated for each training example and this is called online learning. It can result in fast but also chaotic changes to the network.

Alternatively, the errors can be saved up across all of the training examples and the network can be updated at the end. This is called batch learning and is often more stable.

Prediction

Once a neural network has been trained it can be used to make predictions.

You can make predictions on test or validation data in order to estimate the skill of the model on unseen data. You can also deploy it operationally and use it to make predictions continuously.