NEW TYPES OF ACTIVATION FUNCTIONS FOR RBF NEURAL NETWORKS

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Abstract

This article deals with activation functions for Cloud model's type of neural networks. Cloud model offers a new perspective on qualitative–quantitative reasoning and represent the natural way of expressing the fuzziness and randomness close to human thinking.

1 Cloud Activation Function

The activation function is a mechanism which activates the information in hidden layer neurons and transforms it into the desired output. Dozens of activation functions are used in neural networks. The most similar to the Cloud model activation function is Radial Basis Function used in RBF networks, especially the Gaussian one:

$$\phi(x_i) = e^{-\frac{\|x_i - c_i\|^2}{2\sigma^2}} \tag{1}$$

where *c* is the vector of centers.

Cloud model was inspired by a real raining cloud. The real cloud consists of millions of rain drops, but from distance, only the shape of a cloud is recognizable. And the Cloud model is made in similar way; each drop is defined by expected value *Ex*, the entropy *En* and the hyperentropy *He*.

- The expected value *Ex*: The mathematical expectation of the cloud drop, the point, which represent the qualitative and quantitative concept form given sample
- The entropy *En*: The uncertainty measurement of the qualitative concept. *En* reflects the dispersing extent of the drops and delimitating the region, in which the drop is representative for values or data with similar characteristic.
- The Hyperentropy *He*: The uncertainty measurement of entropy *En*. It determines the variance of the entropy, means the region of a drop gain second dimension.

The qualitative concept "approximately 10" can be understood by 1000 drops described quantitatively in the Figure 1.

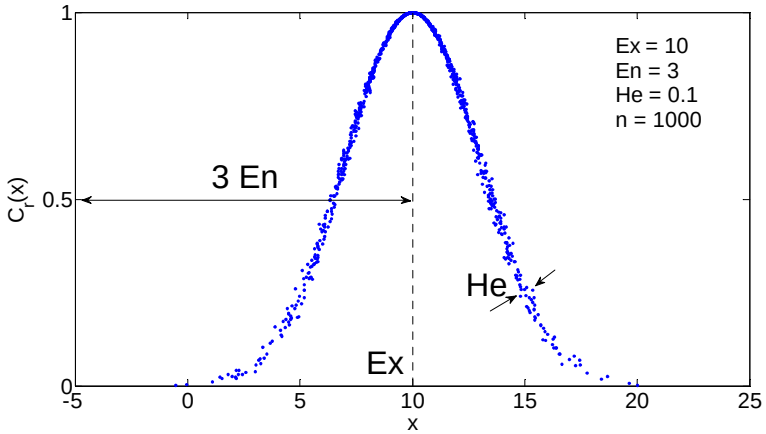

Figure 1: Gaussian Cloud model

Many phenomena seems to follow or can be approximated by the normal (Gaussian) distribution and this makes it the most common distribution. Also in our first example, in Figure 1, the Normal distribution was used to generate the random numbers.

2 GED distribution

But when the financial data are examined, the assumption of Normal distribution seems to be violated. One of the specific feature of the financial data or financial time series (observations on financial variables such as prize of commodities, currency pairs, bonds, etc…) is called "fat tails". It means that the probability distribution of time series exhibit the "fatter tails" than the Normal (Gaussian) distribution.

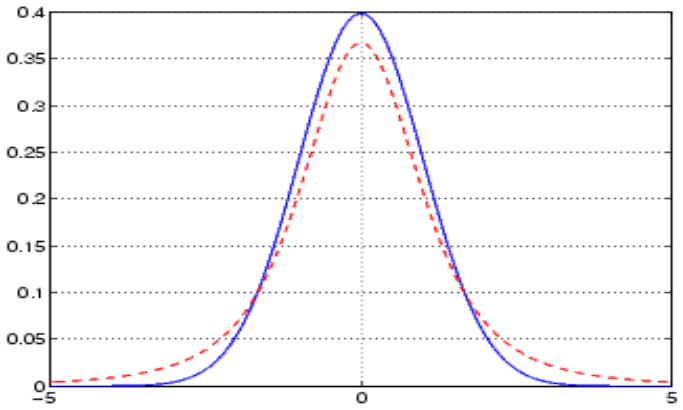

Figure 2: Solid blue line: Normal distribution, dotted red line – distribution with fatter tails

Financial time series usually show asymmetric in observations and excess kurtosis. These evidences lead us to GED (Generalized error distribution), which is favorite choice in financial modeling, because it's flexible depends on shape parameter p and it includes, as a special case, Normal distribution too. It is also called the power exponential distribution. GED distribution is given by

$$f(x;\mu,\sigma,\mathrm{p}) = \frac{1}{2\sigma p^{1/p-1}\Gamma(1/p)} \exp\left(-\frac{1}{p}\left|\frac{x-\mu}{\sigma}\right|^{p}\right);\ p,\sigma>0 \qquad (2)$$

where $\Gamma()$ is a Gamma function, p is the order of the distribution and σ is a scale parameter related to variance.

The enhancement of the Cloud model concept by this type of kurtosis distribution (GED) can lead to improvement of the prediction ability of the Cloud model neural network. Figure 3 depicts GED distribution, with shape parameter set to 3. Increasing the value of p causes the "shallow" shape of the distribution, on the other hand, decreasing the value makes the shape more peaked.

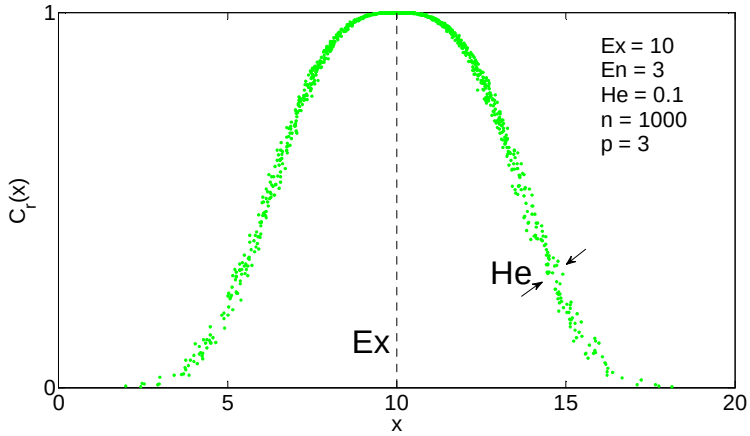

Figure 3: Alternative type of Cloud model activation function

Various shapes can be made just by changing the p value. The drops are generated randomly from GED distribution so the GED random number generator is necessary. In this article I use the UCSD_Garch toolbox for Matlab, copyrighted by Kevin Sheppard, which includes the GED random number generator.

This and other proposed types or shapes of activation function must be further tested in RBF neural network with Cloud model activation function to confirm or refute the assumption about the improvement of the ability in approximation and prediction tasks.

References

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