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Research paper

Maintaining Electric Power Quality Using Integrated S-Transform with Xenogeneic Composition Neural Network

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Abstract

Electric power quality is one of a most important factor in industrial applications because it consists of collection of frequency, voltage and waveform information that used to enhance the electric power distribution. But the quality of power system has been affected by different factors such as swell, impulsive transients, momentary interruptions, swag, harmonics, notch and spike which leads to reducing the quality of power. So, the power quality is enhanced with the help of optimized machine learning techniques. Initially, the S-transform has been combined by particle multi-perceptron neural network (PMPNN) which examines the high and low-frequency components for analyzing the disturbance parameter and the further process is improved by integrating the S-transform with xenogeneic composition neural network (XGCNN) which train the power system features for eliminating the disturbance factors with effective manner. Finally, the simulation results are discussed for examining the power quality distribution factor with effective manner.

Keywords:Electric power quality, frequency, voltage and waveform, S-transform, particle multi-perceptron neural network, xenogeneic composition neural network

1. Introduction

In the previous two decades, power quality thinks about have increased huge consideration of the scientists and the industry [1]. The essential purpose of the expanded worry for the power quality is the overwhelming use of nonlinear burdens, strong state control gadgets, power electronic converters, vitality sparing lights, and customizable speed drives. Utilization of these previously mentioned gadgets brings about mutilation of supply voltage and streams, which in a perfect world ought to be unadulterated sinusoids [2]. If not precisely recognized and alleviated, the power quality unsettling influences may prompt mal task or even disappointment of modern electronic gadgets. All the more thus, in the present deregulated control framework condition, Power quality[3] observing turns into a basic advance in giving a quality support of the clients and also to bring in the intensity among utilities. Recognition of Power quality unsettling influences and their arrangement assumes an imperative part in the advancement of Power quality relief strategies. For this reason, Power quality unsettling influences [4], for example, music, glimmer, score, spike, list, swell, and interference are dealt with as measurably nonstationary signals. A few flag handling strategies, to be specific, here and now Fourier change (STFT) , wavelet change (WT),M-band orthogonal wavelet, scientific morphology, enhanced unscented channel, observational mode deterioration (EMD) with Hilbert change group EMD, and Hilbert change alongside fluffy rationale have been accounted for in the writing for depicting time restricting unearthly variety of nonstationary power quality signals. Plainly, there is a broad writing on the power quality identification methods utilizing distinctive flag handling systems, among which Integrated S-Transform (ST) [5] has been utilized widely. The ST utilizes the idea of recurrence subordinate window for the examination of nonstationary signals and, henceforth, has been broadly utilized as a part of the past for power quality aggravation recognition.

ST utilizes Gaussian window to examine power quality aggravations with various time-recurrence determination in each extraordinary frequencies. The aggravations signals havea diverse trademark in various recurrence region. Thepowerqualityunsettling influence signals change quickly in the high recurrence territory and gradually in low recurrence [6]. Considering the time-recurrence characters of power quality unsettling influence flags, the time-recurrence window used to break down power quality signs should limit in the high recurrence region to accomplish the high time determination and extend in the low recurrence territory to get the high recurrence determination, keeping in mind the end goal to get the best examination result. The width of Gaussian window [7] has a variable window width at various recurrence which is conversely corresponding to the recurrence. It is extremely fulfilled for power qualityexamination.Inpower, quality maintain process the neural network generally have a large comprises of various interconnected preparing components or neurons. The arrangements and qualities of between neuron associations decide the conduct of the entire system. The weights are balanced amid the way toward preparing the system. As of late, a few strategies in view of manmade brainpower have been connected keeping in mind the end goal to diminish the recognition time of symphonious current [8]. The previous decade has seen a sensational increment in the utilization of compositional neural network which is because of their learning capacity and rapid acknowledgment yet straightforward structure. It has high computational interest for actualizing such an identifier since they utilize countless and neurons.

2. Literature Survey

In this section discusses the various author's opinion regarding the power quality management process in the industrial applications. [9] presented another order approach in view of adjusted Fourier neural systems (FNN) and Hyperbolic S-change (HST) was intended for PQ unsettling influences arrangement. HST has preferable a period recurrence determination over S-Transform. The highlights extricated from HST come about making the info vectors out of classifier. The DFP emendatory Quasi-Newton strategy is utilized to enhance the learning capacity of FNN and keep away from nearby least issue. Recreation comes about demonstrate that the new classifier has preferred arrangement precision over different classifiers in view of BP neural systems and Fourier neural systems. MotakatlaVenkateswara[10] presented an altered ideal quick discrete Stockwell transform (ST) with arbitrary backwoods (RF) classifier based PQ recognition system. This work goes for the exact discovery and grouping of different single and various power quality (PQ) unsettling influences. In altered ST, a solitary flag subordinate window is presented, with ideally chosen window parameters by means of vitality focus expansion based limitation advancement. Because of which precise time-recurrence limitation of different PQ occasions is accomplished, with more keen vitality fixation. In order organize, the proposed PQ structure uses the RF-based classifier, which takes after the stowing approach by an arbitrary choice of highlights and information focuses, at every hub, to prepare the classifier.

[11] suggested another approach for the pressure of vast amount information got for examination of energy quality infringement in dissemination systems. The outcomes introduced in the paper obviously uncover that the flag can be flawlessly remade from the compacted information so as to spare vitality utilizing splines. Because of the predominant time-recurrence determination property, the - change forms show altogether enhanced examples to distinguish, confine, and outwardly characterize the kinds of aggravations. Be that as it may, for mechanized grouping of energy quality unsettling influences, the change yield grid is sought to give a couple of basic highlights which when utilized as a part of a control based framework yields the aggravation class. Henceforth, wellsprings of such unsettling influences can be recognized and controlled to enhance electric power quality. [12] acquainted this paper was directed with identifying and characterizing the diverse power quality unsettling disturbance (PQD) utilizing Half and One-Cycle Windowing Technique (WT) in view of Continuous S-Transform (CST) and Neural Network (NN). The framework utilizing 14 transport bars in view of IEEE standard had been outlining utilizing MATLAB©/Simulink to give PQD information. The datum of PQD is investigated by utilizing WT in light of CST to separate highlights and its attributes. After the element extraction, the arranged procedure had been finished utilizing NN to demonstrate the level of characterization PQD either voltage hangs or homeless people. The examination indicates which choice of the cycle for windowing strategy can give the smooth discovery of PQD and the appropriate trademark to give the most astounding level of grouping of PQD.

[13]presentedan SVC is in the task in the Electric Arc Furnace (EAF) based liquefy shop of Ferriere Nord. The SVC was introduced to moderate glimmer created by the EAF, in any case, additionally different advantages, for example, expanded heater efficiency and diminished vitality misfortunes were considered. By methods for the SVC, with the EAF and Ladle Furnace in the task, the glimmer seriousness factor at the 220 kV purpose of regular association has been restricted to Pst95 = 1.3.The SVC establishment has additionally prompted better heater execution in regard to expanded accessible power and less anode utilization. According to the above discussions, power quality has been managed by applying the optimization technologies which help to manage the low and high-frequency components. Then the detailed explanation of S-transform based power quality process is discussed in the following section. The rest of the paper is organized as follows, section 3 discusses the integrating the S-transform with xenogeneic composition neural network process, section 4 analyze the efficiency of the integrating the S-transform with the xenogeneic composition neural network system and concludes in section 5.

3. Managing Electric Power Quality Using Integrated S-Transform with Xenogeneic Composition Neural Network

In this section discusses the electric power quality managing process because the quality of the power should be very important for both customers and electric utilities. In addition to this, the distributed power should be managed consumers loads that improve the distribution of power effectively. So, in this paper introduced the S-transform with xenogeneic composition neural network for managing the quality of electric power. Initially, S-transform [14] is defined before transmitting the power to the distribution process because; the power distribution process includes the different types of frequencies which placed a major role while maintaining the quality of the power. The S-transform is also defined as the Short-time Fourier transforms which works according to the concept of scalable Gaussian window dilation. In addition to this, the S-transform method minimizes the computational time as well as effectively utilizes the resources while distributing the power to the customers. Then the discussed S-transform has been defined by utilizing the Gaussian window which is represented as follows,

$$\boldsymbol{S_x(t,f)} = \int_{-\infty}^{\infty} \boldsymbol{x(\tau)|f|e^{-\pi(t-\tau)^2 f^2} e^{-j2\pi f\tau} d\tau} \quad (1)$$

The above defined S-transform, it has been further modified which is expressed in terms of convolution form of $\left(\boldsymbol{x(\tau)e^{-j2\pi f\tau}}\right)$ and $\left(\boldsymbol{|f|e^{-\pi t^2 f^2}}\right)$

$$\boldsymbol{S_x(t,f)} = \int_{-\infty}^{\infty} \boldsymbol{X(f+\propto)e^{-\pi\alpha^2/f^2} e^{j2\pi\alpha t}} \; \boldsymbol{d\alpha} \quad (2)$$

According to the above eq. (1 and 2), the frequencies are analyzed from the power in the particular window size. From the derived S-transform frequencies, lower and higher frequencies are examined along with the electric power parameters such as amplitude, spectrum, source impedance, the rate of occurrence and so on which is further analyzed by using particle multi-perceptron neural network which analyzes the quality of the power frequencies. The network consists of three layers [15] such as input, hidden and output layers. These layers utilize the non-linear activation function along with training function for examines the quality of the network with effective manner. The introduced activation function utilizes the entire neurons that have been mapped into the weighted inputs for generating the output about the power qualities. Then the activation function is generated as follows,

$$y(v_i) = \tanh(v_i) \tag{3}$$

$$y(v_i) = (1 + e^{-v_i})^{-1} \tag{4}$$

The eq. (3 and 4) used to generate the output for particular power which has ranged from -1 to 1. In this eq. (3 and 4) y_i is denoted as the output of pathe rticular node, v_i is represented as the weighted sum of the inputs. During this output estimation process, weights and bias value has been updated continuously for getting the exact output for each computed S-transform output. The updating process is done by applying the particle swarm optimization [16] process which works according to the concept of position and velocity of the particle. Initially, each feature, velocity and and position is defined as follows,

$$pbest\,(i,t) = arg\,min_{k=1,\ldots,t}[f(P_i(k))], i \in \{1,2,\ldots..N_P\} \tag{5}$$

$$gbest\,(t) = argmin_{i=1,2,3\ldots Np}[f(P_i(k))] \tag{6}$$

Where *i*is the feature (particle) index, N_P- toa tal number of particle, *f* is the fitness function and *P* is the position of the particle, *V* is the velocity of the particle. According to the particle position [17], each node input has been analyzed by applying following probability fitness function that is defined as follows,

$$v_{ij} = x_{ij} + \Phi_{ij}(x_{ij} - x_{k(i),j}) \tag{7}$$

$$P_i = \frac{f_i}{\sum_{i=1}^{N} f_i} \tag{8}$$

$k(i)$is the best selected weight, which is having the random number from [-1 1]

Based on the above equation 7 and 8 the new weights and bias values are chosen and update their position and velocity as follows,

$$V_i(t+1) = \omega V_i(t) + c_1 r_1\big(pbest(i,t) - P_i(t)\big) + c_2 r_2(gbest(t) - P_i(t)) \tag{9}$$

$$P_i(t+1) = P_i(t) + V_i(t+1) \tag{10}$$

This process is repeated continuously until to reach the maximum termination condition which helps to update the weights and bias value. The updated process is reduces the error rate also improves the parameter distribution process for electric power. Before making the electric power distribution parameter examination process, S-transform parameter has been integrated with the xenogeneic composition neural network which trains the network for generating effective power quality related parameters. The network has been generated along with different parameters such as selection, crossover and mutation operator. Initially, the S-transform related power parameters are gathered which is fed into the convolution neural networks (CNN). The CNN network [18] chooses and fixes the number of neurons and weights that are trained by applying effective training function as training and trainlm. The output has been generated from the defined weights and bias value as follows,

$$Net\ output = \sum_{i=1}^{N} x_i * w_i + b \tag{10}$$

During the net output calculation, the neural network is trained by using the particular learning and activation function which updates the weights and bias as defined as,

$$G(a_i, x_j, b_i) = \frac{1}{1 + e^{-(-a_i x_j + b_i)}} \tag{11}$$

Based on the above process, the S-integrated neural network function is defined in the following figure 1.

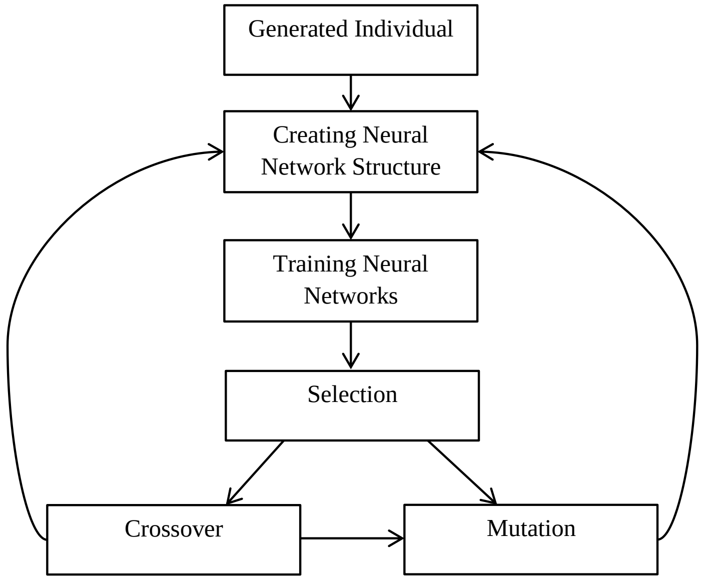

Figure 1: Block Diagram for XenogeneticConvolution Neural Networks

Based on the above figure 1, the quality parameter has been selected from the convolution network; the defined parameters are used to optimize the weights and bias value. Then the selected features are optimized by above-definedeq. (11) and output is getting from the inverse operation to the output of the hidden layer. According to the output value, electric power parameters are trained which are processed by defined particle-multi perceptron neural network to detect the quality of frequencies with effective manner. Then the excellence of the system is evaluated with the help of experimental results and discussions which are explained as follows.

4. Results and Discussions

In this section evaluates the efficiency of S-transform has been combined by particle multi-perceptron neural network and integrating the S-transform with xenogeneic composition neural network for managing the quality of the electric power. The introduced integrating the S-transform with xenogeneic composition neural network system is implemented using MATLAB tool for examining the efficiency of the system with effective manner. The introduced neural network based electric power quality parameter distribution is examined effectively when compared to the other methods. The distribution of frequencies of electric power quality is shown in table 1.

Table 1: Frequency Distribution of Electric Power Quality

Decomposition level	**Frequency range**	
(fs = 6.4 KH z)	**Approximation(a)**	**Detailed(d)**
1	0 to 1.6KHz	1.6K to 3.2 KHz
2	0 to 800 KHz	800Hz to 1.6 KHz
3	0 to 400 Hz	400 Hz to 800 Hz
4	0 to 200 Hz	200Hz to 400 Hz
5	0 to 100 Hz	100 Hz to 200Hz
6	0 to 50Hz	50 Hz to 100 Hz
7	0 to 25Hz	25 Hz to 50Hz
8	0 to 12.5 Hz	12.5Hz to 25Hz

The above table 1, clearly shows that the frequency distribution of electric power quality with 6.4KHz sampling rate. The distributed frequencies are examined by using the defined neural network which evaluates the derived frequencies parameter and the efficiency of the system is examined in terms of error rate and accuracy of parameter distribution. During the training process, the xeno-genic compositional neural network (XGCNN) effectively integrates S-transform quality parameter with minimum error rate. Then the trained network error rate is compared with the several electric power quality parameters which are shown in figure 2.

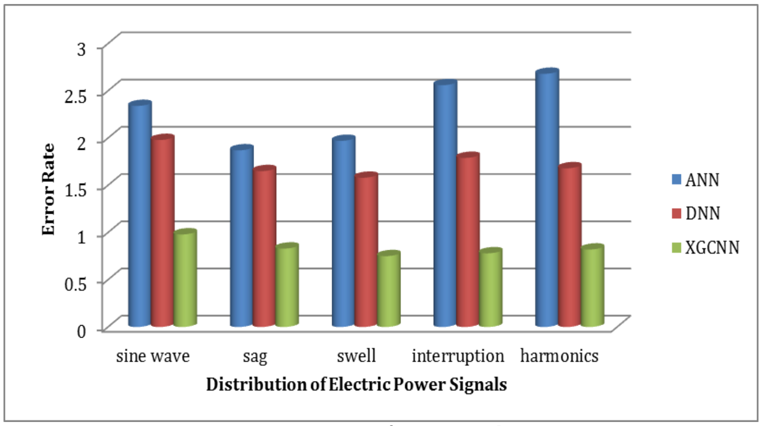

Figure 2: Error Rate of S-integrated XGNN

The reduced error rate leads to improves the overall training accuracy of electric power signal distribution parameter examination and the training accuracy is shown in figure 3.

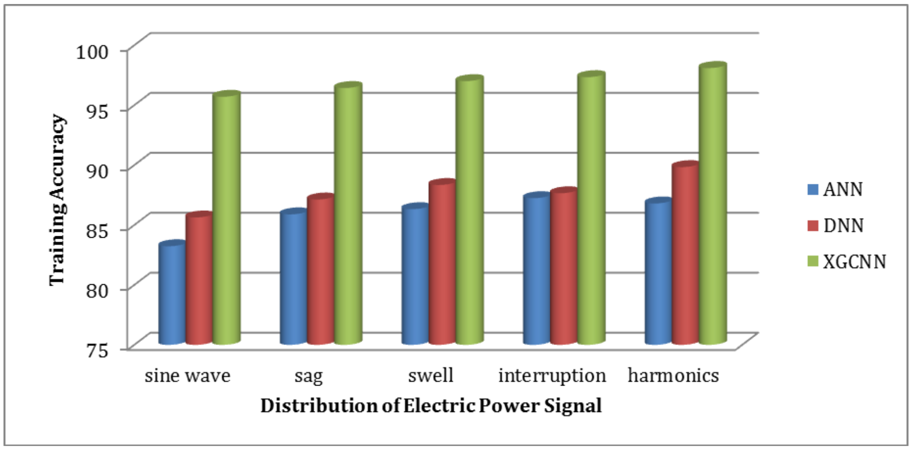

Figure 3: Training Accuracy

The above figure clearly shows that XGNN method attains the higher training accuracy of a different distribution of electric power signal when compared to the other classifiers such as artificial neural network and deep neural network. The improved training accuracy indicates that enhance the distribution of electric power which helps to manage the quality of power. According to the discussions, the quality of the power parameters is successfully recognized with higher accuracy which is shown in figure 4.

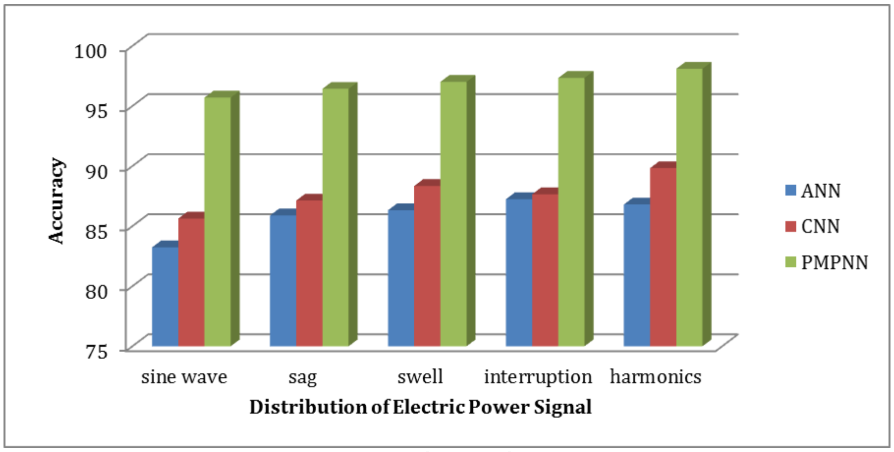

Figure 4: Power Quality Distribution Accuracy

Thus the above figure 4 depicted that particle multiperceptron neural network successfully examines the S-transform based power parameters. The examined parameters are efficiently trained that used to get the quality power attributes from the collection of electric power attributes. The obtained parameters are used to manage the quality while distributing power with effective manner.

5. Conclusion

Thus the paper analyzes the S-transform based electric power distribution process along with the quality metrics. During the transmission process, S-transform based power parameters such as sine wave, sag, frequency, the range of occurrence, swells, interruptions and harmonics are examined which is trained by applying the xeno-genic composition neural network that analyzes the attributes according to the selection, cross-over and mutation parameter. In addition to this, the selected attributes are further trained by sigmoid base activation function that helps to get the quality related power parameter while analyzing the S-transform based power signal. Finally, the obtained signals are examined by particle multi-perceptron neural network which gets the quality based power parameter that used to maintain the power distribution quality with effective manner. In future, the work has been further enhanced by examining the list of power attributes by using the optimization techniques.

Reference

[1] S.Santoso, W.M.Grady, E.J.Powers, and A.C.Parsons, "Power Quality Disturbance Waveform Recognition Using Wavelet- Based neural Classifier part .I. Theoretical Foundation," IEEE Trans. on Power Delivery, Vol. 15,pp. 222-228, Jan. 2000.

[2] P.K.Dash, B.K.Panigrahi and G.Panda," Power Quality Analysis Using S-Trans" IEEE Trans. on Power Delivery, vol. 18, no. 2, pp 406-409, April 2003.

[3] L.C.Saikia, S.M.Borah, S.Pait,"detection and classification of power quality disturbances using wavelet transform and neural network," IEEE annual india conference 2010.

[4] I.W.C.Lee, P.K.Dash, "S-Transform-Based Intelligent System for Classification of Power Quality Disturbance" IEEE Transaction on Industrial Electronics, Vol. 50, No. 4, 2003.

[5] Sejdic, Ervin; Djurovic, Igor; Jiang, Jin (January 2008). "A Window Width Optimized S-transform". EURASIP J. Adv. Signal Process. 2008: 59:1–59:13. doi:10.1155/2008/672941. ISSN 1110-8657.

[6] E. Sejdić, I. Djurović, J. Jiang, "Time-frequency feature representation using energy concentration: An overview of recent advances," Digital Signal Processing, vol. 19, no. 1, pp. 153-183, January 2009.

[7] M. Valtierra-Rodriguez, R. de Jesus Romero-Troncoso, R.A. OsornioRios, and A. Garcia-Perez, "Detection and classification of single and combined power quality disturbances using neural networks," IEEE Transactions on Industrial Electronics, vol. 61, no. 5, pp. 2473–2482, May 2014.

[8] A. Bayod-Rujula, "Future development of the electricity systems with distributed generation," Energy, vol. 34, no. 3, pp. 377 – 383, 2009.

[9] Lin Lin, Xiaohuan Wu, Jiajin Qi, and Hongxin C, "Power Quality Disturbance Classification Based on A NovelFourier Neural Network and Hyperbolic S-transform", International Journal of Signal Processing, Image Processing and Pattern Recognition Vol.9, No.1 (2016), pp.111-124

[10] MotakatlaVenkateswaraReddyRanjanaSodhi, "A rule-based S-Transform and AdaBoost based approach for power quality assessment",Electric Power Systems Research, Volume 134, May 2016, Pages 66-79

[11] P.K. Dash ; B.K. Panigrahi ; D.K. Sahoo ; G. Panda, "Power quality disturbance data compression, detection, and classification using integrated spline wavelet and S-transform", IEEE Transactions on Power Delivery (Volume: 18, Issue: 2, April 2003)

[12] K. Daud et al., "Classification of Power Quality Disturbance Based on Continuous S-Transform-Windowing Technique (CST-WT) and ANOVA as a Feature Selection", Applied Mechanics and Materials, Vol. 785, pp. 368-372, 2015

[13] R. Grünbau, T. Gustafsson, Hasler, T. Larsson M. Lahtinen, "Statcom For Safeguarding Of Power Quality In Feeding Grid In Conjunction With Steel Plant Expansion", http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.114.9683&rep=rep1&type=pdf

[14] R.G.Stockwell, "A basis for efficient representation of the S-transform", Digital Signal Processing, Volume 17, Issue 1, January 2007, Pages 371-393

[15] Quan, H., Dai, Y.: Harmonic and interharmonic signal analysis based on generalized S-transform. Chin. J. Electron. 19(4), 656–660 (2010)

[16] R. Collobert and S. Bengio (2004). Links between Perceptrons, MLPs and SVMs. Proc. Int'l Conf. on Machine Learning (ICML).

[17] Cazzaniga, P.; Nobile, M.S.; Besozzi, D. (2015). "The impact of particles initialization in PSO: parameter estimation as a case in point, (Canada)". Proceedings of IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology,.

[18] LeCun, Yann; Bengio, Yoshua; Hinton, Geoffrey (2015). "Deep learning". Nature. 521 (7553): 436–444.