Stanford

Bernard Widrow

Professor of Electrical Engineering, Emeritus

Bio

BIO

Bernard Widrow is Professor Emeritus in the Electrical Engineering Department at Stanford University. His research focuses on adaptive signal processing, adaptive control systems, adaptive neural networks, human memory, cybernetics, and human-like memory for computers. Applications include signal processing, prediction, noise cancelling, adaptive arrays, control systems, and pattern recognition. Before coming to Stanford in 1959, he taught at MIT where he received the Doctor of Science Degree in 1956.

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Electrical Engineering
- Member, Bio-X

HONORS AND AWARDS

- Citation Classic for paper "Adaptive Antenna Systems," Proceedings of the IEEE, December 1967, Institute of Electrical and Electronics Engineers (IEEE)
- Benjamin Franklin Medal, The Franklin Institute (2001)
- IEEE Millenium Medal, Institute of Electrical and Electronics Engineers (IEEE) (2000)
- Donald O. Hebb Award, International Neural Network Society,
- Signal Processing Society Award, Institute of Electrical and Electronics Engineers (IEEE) (1999)
- Silicon Valley Engineering Hall of Fame, Silicon Valley Engineering Council (1999)
- Member, National Academy of Engineering (1995)
- Neural Networks Pioneer Medal, Institute of Electrical and Electronics Engineers (IEEE) (1991)
- Alexander Graham Bell Medal, Institute of Electrical and Electronics Engineers (IEEE) (1986)
- Centennial Medal, Institute of Electrical and Electronics Engineers (IEEE) (1984)
- Fellow, American Association for the Advancement of Science (1980)
- Fellow, Institute of Electrical and Electronics Engineers (IEEE) (1976)
- Franqui Lecture Chair, University of Louvain, Belgium, (1967)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Editorial Board, Neural Networks (2014 - 2018)
- Associate Editor, Information Sciences (2014 - 2015)
- Associate Editor, Circuits, Systems and Signal Processing (2014 - 2015)
- Associate Editor, Pattern Recognition (2014 - 2016)

- Chair, Silicon Valley Engineering Council Hall of Fame Awards Committee (2006 - 2008)
- President, International Neural Network Society (1989 - 1990)
- Governing Board Member, International Neural Network Society (1988 - 1991)
- Chairman, DARPA Neural Network Study (1987 - 1988)

PROFESSIONAL EDUCATION

- Sc.D., Massachusetts Institute of Technology , Electrical Engineering (1956)
- S.M., Massachusetts Institute of Technology , Electrical Engineering (1953)
- S.B., Massachusetts Institute of Technology , Electrical Engineering (1951)

PATENTS

- B. Widrow, J.C. Aragon, B.M. Percival. "United States Patent 7,333,963 Cognitive Memory and Auto-Associative Neural Network Based Search Engine for Computer and Network Located Images and Photographs", Feb 1, 2008
- B. Widrow. "United States Patent 7,187,907 Simultaneous Two-Way Transmission of Information Signals in the Same Frequency Band", Mar 1, 2007
- M.A. Lehr and B. Widrow. "United States Patent 5,793,875 Directional Hearing System", Aug 1, 1998
- B. Widrow. "United States Patent 5,737,430 Directional Hearing Aid", Apr 1, 1998
- J. Rector, B. Marion, B. Widrow, and I.A. Salehi. "United States Patent 5,191,557 Signal Processing to Enable Utilization of a Rig Reference Sensor with a Drill Bit Seismic Source", Mar 1, 1993
- J. Rector, B. Marion, B. Widrow, and I.A. Salehi. "United States Patent 5,050,130 Signal Processing to Enable Utilization of a Rig Reference Sensor with a Drill Bit Seismic Source", Sep 1, 1991
- B. Widrow. "United States Patent 4,964,087 Seismic Processing and Imaging with a Drill-Bit Source", Oct 1, 1990
- J. Rector, B. Marion, B. Widrow, and I.A. Salehi. "United States Patent 4,926,391 Signal Processing to Enable Utilization of a Rig Reference Sensor with a Drill Bit Seismic Source", May 1, 1990
- B. Widrow. "United States Patent 4,858,130 Estimation of Hydraulic Fracture Geometry f rom Pumping Pressure Measurements", Aug 1, 1989
- B. Widrow. "United States Patent 4,849,945 Seismic Processing and Imaging with a Drill- Bit Source", Jul 1, 1989
- B. Widrow and M.N. Brearley. "United States Patent 4,751,738 Directional Hearing Aid", Jun 1, 1988
- B. Widrow. "United States Patent 4,556,962 Seismic Exploration Method and Apparatus for Cancelling Interference from Seismic Vibration Source", Dec 1, 1985
- B. Widrow. "United States Patent 4,537,200 ECG Enhancement by Adaptive Cancellation of Electrosurgical Interference", Aug 1, 1985
- B. Widrow. "United States Patent 4,363,112 Apparatus and Method for Determining the Posi tion of a Gas-Saturated Porus Rock in the Vicinty of a Deep Borehole in the Earth", Dec 1, 1982
- B. Widrow. "United States Patent 4,365,322 Apparatus and Method for Determining the Position of a Gas-Saturated Porus Rock in the Vicinty of a Deep Borehole in the Earth", Dec 1, 1982
- J.R. Zeidler, J.M. McCool, and B. Widrow. "United States Patent 4,355,368 Adaptive Correlator", Oct 1, 1982
- J.M. McCool, B. Widrow, J.R. Zeidler, R.H. Hearn, D.M. Cha bries, and R.H. Moore. "United States Patent 4,243,935 Adap- tive Detector", Jan 1, 1981
- J.M. McCool, B. Widrow, J.R. Zeidler, R.H. Hearn, and D.M. Chabries. "United States Patent 4,238,746 daptive Line Enhancer", Dec 1, 1980
- B. Widrow, M.E. Hoff, Jr.. "United States Patent 3,454,753 Analog Multiplier and Modulati ng Circuits Employing Electrolytic Elements", Jul 1, 1969
- B. Widrow, G. Frick, R.H. Gordon. "United States Patent 3,395,402 Adaptive Memory Element", Jul 1, 1968
- B. Widrow and M.E. Hoff, Jr. "United States ogic Circuit and Electrolyt ic Memory Element", Dec 1, 1965

LINKS

- My list of publications: https://isl.stanford.edu/people/widrow/publications.html
- B. Widrow, ``Adaptive Filters," Aspects of Network and System Theory, pp. 563-586, 1971.: http://www-isl.stanford.edu/people/widrow/papers/b1971adaptivefilters.pdf
- Oral-History:Bernard Widrow, IEEE Global History Network: http://www.ieeeghn.org/wiki/index.php/Oral-History:Bernard_Widrow
- "Nonlinear Control with Neural Networks," in Backpropagation, 1995: http://www-isl.stanford.edu/people/widrow/papers/bc1995nonlinearcontrol.pdf

- "Noise Canceling and Channel Equalization," in Handbook of Brain Theory and Neural Networks, 1995: http://www-isl.stanford.edu/people/widrow/papers/bc1995noisecanceling.pdf
- "Perceptrons, Adalines, and Backpropagation," Handbook of Brain Theory and Neural Networks, 1995: http://www-isl.stanford.edu/people/widrow/papers/bc1995perceptronsadalines.pdf

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Prof. Widrow's research focuses on adaptive signal processing, adaptive control systems, adaptive neural networks, human memory, and human-like memory for computers. Applications include signal processing, prediction, noise cancelling, adaptive arrays, control systems, and pattern recognition. Recent work is about human learning at the synaptic level.

PROJECTS

- Hearing Aid Device - Stanford University
- Quantization Noise - Stanford University

Publications

PUBLICATIONS

- **The Hebbian-LMS Learning Algorithm** *IEEE COMPUTATIONAL INTELLIGENCE MAGAZINE*
  Widrow, B., Kim, Y., Park, D.
  2015; 10 (4): 37-53
- **The Back-Prop and No-Prop Training Algorithms** *COGNITIVE COMPUTATION*
  Widrow, B.
  2015
- **Cognitive memory** *NEURAL NETWORKS*
  Widrow, B., Aragon, J. C.
  2013; 41: 3-14
- **The No-Prop algorithm: a new learning algorithm for multilayer neural networks.** *Neural networks*
  Widrow, B., Greenblatt, A., Kim, Y., Park, D.
  2013; 37: 182-188
- **Quantization Noise: Round Off Error in Digital Computation, Signal Processing, Control and Communications**
  Widrow, B., Kollar, I.
  Cambridge University Press.2008
- **Statistical efficiency of adaptive algorithms** *INNS/IEEE International Joint Conference on Neural Networks (IJCNN 03)*
  Widrow, B., Kamenetsky, M.
  PERGAMON-ELSEVIER SCIENCE LTD.2003: 735–44
- **Least-Mean-Square Adaptive Filters**
  Widrow, B., Haykin, S.
  Wiley-Interscience.2003
- **Statistical Efficiency of Adaptive Algorithms** *Neural Networks*
  Widrow, B., Kamenetsky, M.
  2003: 735-744
- **Neurointerfaces** *IEEE Transactions on Control Systems Technology*
  Widrow, B.
  2002: 221-228
- **A Microphone Array for Hearing Aids** *IEEE Circuits and Systems Magazine*

Widrow, B.
2001: 26-32

- **Adaptive inverse control based on linear and nonlinear adaptive filtering** *International Workshop on Neural Networks for Identification, Control, Robotics, and Signal/Image Processing*
  Widrow, B., Plett, G. L.
  IEEE COMPUTER SOC.1996: 30–38
- **Nonlinear Control with Neural Networks** *Backpropagation: Theory, Architectures, and Applications*
  Chauvin, Y., D. Rumelhart, D.
  Erlbaum Associates.1995
- **Noise Canceling and Channel Equalization** *Handbook of Brain Theory and Neural Networks*
  Widrow, B., Lehr, M.
  MIT Press.1995
- **30 Years of Adaptive Neural Networks: Perceptron, Madaline, and Backpropagation** *Neural Networks: Theoretical Foundations and Analysis*
  Lau, C.
  IEEE Press.1992
- **30 Years of Adaptive Neural Networks: Perceptron, Madaline, and Backpropagation** *Artificial Neural Networks: Paradigms, Applications, and Hardware Implemenation*
  Sanchez-Sinencio, E., Lau, C.
  IEEE Press.1992: 82–108
- **30 Years of Adaptive Neural Networks: Perceptron, Madaline, and Backpropagation**
  Widrow, B., Lehr, M.
  1990: 1415–42
- **Fundamental Relations Between the LMS Algorithm and the DFT** *IEEE Transactions on Circuits and Systems*
  Widrow, B., Baudrenghien, P., Vetterli, M., Titchener, P.
  1987: 814-820
- **Adaptive Signal Processing**
  Widrow, B., Stearns, S.
  Prentice Hall.1985
- **On the Statistical Efficiency of the LMS Algorithm with Nonstationary Inputs** *IEEE Transactions on Information Theory*
  Widrow, B., Walach E.
  1984: 211-221
- **Adaptive Filters** *Aspects of Network and System Theory*
  Kalman, R., DeClaris, N.
  Holt, Rinehart and Winston.1971
- **Adaptive Antenna Systems [a citation classic]**
  Widrow, B., Mantey, P.
  1967: 2143–59
- **Statistical Analysis of Amplitude-Quantized Sampled-Data Systems** *AIEE Transactions on Applications and Industry*
  Widrow, B.
  1961: 1-14
- **Adaptive Switching Circuits** *RE WESCON Convention Record*
  Widrow, B.
  1960: 96–104
- **A Study of Rough Amplitude Quantization by Means of Nyquist Sampling Theory** *IRE Transactions on Circuit Theory*
  Widrow, B.
  1956; CT-3(4): 266-276