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of a neuron to a smaller set of values. This set is usually [0, 1]. Typical functions are the sigmoid function or singularity functions like the step or ramp.

active contour a deformable template matching method that, by minimizing the energy function associated with a specific model (i.e., a specific characterization of the shape of an object), deforms the model in conformation to salient image features.

active device a device that can convert energy from a DC bias source to a signal at an RF frequency. Active devices are required in oscillators and amplifiers.

active filter (1) a filter that has an energy gain greater than one, that is, a filter that outputs more energy than it absorbs.

(2) a form of power electronic converter designed to effectively cancel harmonic currents by injecting currents that are equal and opposite to, or 180° out of phase with, the target harmonics. Active filters allow the output current to be controlled and provide stable operation against AC source impedance variations without interfering with the system impedance.

The main type of active filter is the series type in which a voltage is added in series with an existing bus voltage. The other type is the parallel type in which a current is injected into the bus and cancels the line current harmonics.

active impedance the impedance at the input of a single antenna element of an array with all the other elements of the array excited.

active layer See [active region](#).

active learning a form of machine learning where the learning system is able to interact with its environment so as to affect the generation of training data.

active load a transistor connected so as to replace a function that would conventionally be performed by a passive component such as a resistor, capacitor, or inductor.

active load-pull measurement a measurement method where transfer characteristics of a device can be measured by electrically changing the load impedance seen from the device. In an active load-pull measurement, the load impedance is defined by using an output signal from the device and an injected signal from the output of the device.

active logic a digital logic that operates all of the time in the active, dissipative region of the electronic amplifiers from which it is constructed. The output of such a gate is determined primarily by the gate and not by the load.

active magnetic bearing a magnetic bearing that requires input energy for stable support during operation. Generally implemented with one or more electromagnets and controllers.

active mixer a mixer that uses three terminal devices such as FET rather than diodes as nonlinear element. One advantage of active mixers is that they can provide conversion gain.

active network an electrical network that contains some solid state devices such as bipolar junction transistors (BJTs) or metal-oxide-silicon field effect transistors (FETs) operating in their active region of the voltage vs. current characteristic. To ensure that these devices are operating in the active region, they must be supplied with proper DC biasing.

active neuron a neuron with a non-zero output. Most neurons have an activation threshold. The output of such a neuron has zero output until this threshold is reached.

active power See [real power](#).

changes around the accelerator. There are separate beta functions for the x and y planes. The square root of b_x is proportional to the beam's x -axis extent in phase space.

beta particle an electron or positron emitted from a radioactive source.

betatron oscillation stable oscillations about the equilibrium orbit in the horizontal and vertical planes. First studied in betatron oscillators, betatron oscillation is the transverse oscillation of particles in a circular accelerator about the equilibrium orbit. The restoring force for the oscillation is provided by focusing components in the magnetic field that act to bend a particle that is off the equilibrium orbit back toward it.

Beverage antenna simple traveling wave antenna consisting of an electrically long horizontal wire above ground with a termination resistance between the end of the wire and ground equal to the characteristic impedance of the wire/ground transmission line.

Bezout identity of 2-D polynomial matrices a systems identity defined as follows: let $N_R(z_1, z_2)$, $D_R(z_1, z_2)$ ($N_L(z_1, z_2)$, $D_L(z_1, z_2)$) be two right (left) coprime polynomial matrices, then there exists a polynomial matrix in z_2 , say $E_R(z_2)$, ($E_L(z_2)$) and two polynomial matrices $X_R(z_1, z_2)$, $Y_R(z_1, z_2)$ ($X_L(z_1, z_2)$, $Y_L(z_1, z_2)$) such that

$$\begin{aligned} X_R(z_1, z_2) D_R(z_1, z_2) \\ + Y_R(z_1, z_2) N_R(z_1, z_2) &= E_R(z_2) \\ (N_L(z_1, z_2) Y_L(z_1, z_2) \\ + D_L(z_1, z_2) X_L(z_1, z_2)) &= E_L(z_2) \end{aligned}$$

BGA See [ball grid array](#).

BI See [bandwidth improvement](#).

bi-anisotropic media (1) a class of material in which the electric and magnetic flux densities, $\mathbf{D}$ and $\mathbf{B}$, are each linearly related to both the electric and magnetic field intensities, $\mathbf{E}$ and $\mathbf{H}$, via dyadic constitutive parameters. The permittivity, permeability, and magnetoelectric coupling parameters are tensor quantities.

(2) media for which the electric and magnetic fields displacements, $\mathbf{D}$ and $\mathbf{B}$ respectively, are related to the electric and magnetic field strength $\mathbf{E}$ and $\mathbf{H}$ by general dyadics.

bi-isotropic media media for which the electric and magnetic fields displacements, $\mathbf{D}$ and $\mathbf{B}$, respectively, are scalarly dependent by both the electric and magnetic field strength $\mathbf{E}$ and $\mathbf{H}$. For these media the constitutive relations are

$$\begin{aligned} \mathbf{D} &= \epsilon \mathbf{E} + (\chi - j\kappa) \sqrt{\mu_0 \epsilon_0} \mathbf{H} \\ \mathbf{B} &= \epsilon \mathbf{H} + (\chi + j\kappa) \sqrt{\mu_0 \epsilon_0} \mathbf{E} \end{aligned}$$

where ϵ is the permittivity, μ the permeability, and the subscript 0 refers to free-space. Bi-isotropic media can be reciprocal ($\chi = 0$) or nonreciprocal ($\chi \neq 0$); nonchiral ($\kappa = 0$) or chiral ($\kappa \neq 0$).

bi-stable pertaining to a device with two stable states, e.g., bi-stable multivibrator; circuit that has two possible output states and that will remain in its current state without requiring external inputs; a flip-flop.

bi-stable device See [flip-flop](#).

bias the systematic (as opposed to random) error of an estimator.

bias current the arithmetic average of the currents that flow in the input leads of an op-amp.

bias lighting technique used in video tubes to correct for undesirable artifacts such as lag. Applying a uniform light source to the surface of the tube (the photoconductive layer) will create a bias current in the tube, thereby minimizing the undesirable characteristics.

bias network a key aspect of microwave circuit design is to apply the proper DC bias

to the appropriate terminals of transistors (e.g., FETs) without disturbing the AC microwave operation of the circuit. In some cases, “on-chip” DC circuitry needs to be designed so as to provide stable bias voltage/current conditions for the device even when the chip DC supply voltages vary (due to weakening batteries, etc.). The other aspect of bias network design is to isolate the DC network from interfering with the AC or RF/microwave operation of the circuit, and vice-versa. In a lumped element design, this is generally accomplished by a combination of spiral inductors and MIM capacitors.

bias voltage or current the DC power applied to a transistor allowing it to operate as an active amplifying or signal generating device. Typical voltage levels in GaAs FETs used in receivers are 1 to 7 volts between the drain and source terminals, and 0 to –5 volts on, or between, the gate and source terminals. For microwave systems, DC voltages and currents, provided by batteries or AC/DC converters required to “bias” transistors to a region of operation where they will either amplify, mix or frequency translate, or generate (oscillators) microwave energy. Since energy can be neither created nor destroyed, microwave energy amplification or creation is accomplished at the expense of DC energy.

biasing the technique of applying a direct-current voltage to a transistor or an active network to establish the desired operating point.

bible nickname for the National Electrical Code.

BIBO stability See [bounded-input bounded-output stability](#).

BIBO stability of 2-D linear system a system described by the equation

$$y_{i,j} = \sum_{k=0}^i \sum_{l=0}^j g_{i-k,j-l} u_{k,l}$$

$i, j \in Z_+$ (the set of nonnegative integers) is said to be bounded-input bounded-output (BIBO) stable if for every constant $M > 0$ there exist a constant $N > 0$ such that if $\|u_{k,l}\| \leq M$ for all $k, l \in Z_+$, then $\|y_{i,j}\| \leq N$ for all $i, j \in Z_+$ where $u_{k,l} \in R^m$ is the input, $y_{i,j} \in R^p$ is the output, $g_{i,j} \in R^{p \times m}$ is the matrix impulse response of the system and $\|v\|$ denotes a norm of the vector v . The system is BIBO stable if and only if

$$\sum_{i=0}^{\infty} \sum_{j=0}^{\infty} \|g_{i,j}\| < \infty$$

BIBS See [bounded-input bounded-state stability](#).

BiCMOS integrated circuit technology/process that incorporates bipolar and complementary metal oxide semiconductor devices on the same die.

bicycle a chain-driven drill for boring holes.

bidirectional bus a bus that may carry information in either direction but not in both simultaneously.

bi-directional laser a ring laser with both clockwise and counter-clockwise circulating waves. Useful as a rotation rate sensor.

bidirectional pattern a microphone pickup pattern resembling a figure eight, in which the device is most sensitive to sounds on either side of the pickup element.

bi-directional resonator a standing-wave resonator or a ring-resonator in which the electromagnetic waves circulate in both the clockwise and counter-clockwise directions.

bidirectional transducer a surface acoustic wave (SAW) transducer which launches energy from both acoustic ports which are located at either end of the transducer structure.

G

G (giga) a prefix indicating a quantity of 10^9 . For instance, a gigabyte (GB) of storage is 1,000,000,000 (typically implemented as 2^{30}) bytes.

G_{CR} common notation for compression. See [compression](#).

g_d common notation for DC drain conductance.

G_I common notation for current gain. G_I is dimensionless.

g_m common notation for DC transconductance.

G_P common notation for power gain in decibels.

G_T common notation for transducer gain in amperes/volt.

G_V common notation for voltage gain. G_V is dimensionless.

G-line a line of the mercury spectrum corresponding to a wavelength of about 436 nm.

GaAlSb/InGaAlAsSb nearly lattice matched semiconductor heterostructure system capable of “staggered” band lineups in which the electrons and holes congregate in separate layers. Unique transport properties are utilized in optical devices and tunnel structures.

GaAs periodic table symbol for gallium arsenide. See [gallium arsenide](#).

GaAs laser a semiconductor laser for wavelengths in the near infrared. The active

medium is a gallium-arsenide semiconductor alloy.

GaAs/AlGaAs most commonly grown semiconductor epitaxial heterostructure due to its lattice match, common anion, and existing technology base of GaAs devices.

Gabor transform a short-time Fourier transform in which the window function is the Gaussian function.

gain (1) the ratio of the output variable of a device to its input variable. For calculation purposes, the dimensionality of the gain is simply the unit of the output variable divided by the unit of the input variable. The gain of a device is a dimensionless value only when the electrical units of both the input and output variables are the same (e.g., voltage gain, current gain, power gain, etc.). In this case, a gain greater than one indicates an increase from input to output, while a value for gain less than one is indicative of a decrease (or attenuation). The overall gain of several cascaded components is found by multiplying the individual gains of each component in the system. Gain is often expressed in decibels to facilitate calculation of cascaded gains in a system. See also [decibel](#).

(2) the ratio of the radiation intensity of a particular antenna to that of an isotropic radiator, in the same direction and at the same distance.

gain circles circles of constant gain plotted on the Smith chart that can be used to graphically impedance match a device to achieve a desired gain. The circles are generated by plotting on the Smith chart the solution for the source reflection coefficient, Γ_S , or load reflection coefficient, Γ_L , in the transducer gain equation for a fixed value of

$$G = \frac{|S_{21}|^2(1-|\Gamma_S|^2)(1-|\Gamma_L|^2)}{|(1-S_{11}\Gamma_S)(1-S_{22}\Gamma_L)-S_{12}S_{21}\Gamma_L\Gamma_S|^2}$$

traffic by “decomposing” it into long- and short-term behavior.

trailing edge when a pulse waveform switches from high to low, it is called a trailing edge.

trailing-edge triggered a device that is activated by the trailing edge of a signal.

trainability the property of an algorithm or process by which it can be trained on sample data and thus rendered adaptable to different situations. *See also* [training procedure](#), [supervised learning](#), [unsupervised learning](#).

training algorithm of self-generating neural network given as follows:

1. Initially, the network contains nothing. When the first training example comes in, the system creates a neuron for it.

2. When a new training example comes in, the neurons in the hierarchy are examined for similarity to the training example, hierarchically from the root(s). Each time, the last winner and all the neurons in its child networks are examined to find a new winner. If the new winner is the old winner, the examination stops and the old winner is the final winner; otherwise, the new winner and its child network are examined until a leaf node is found to be the winner. During this process, the weights of all the winners and their neighbors should be updated according to the same rule as that of self-organizing network. After the final winner is found, the network structure should be updated according to the following rules:

3. If the winner is a terminal node (i.e., it has no child network(s)), generate two new neurons, and copy the training vector and the original winner into them, respectively. Make them as two neurons in a new child network of the updated winner.

If the winner is a nonterminal node (i.e., it has a child network), generate only one neuron, copy the training vector into it, and put it in the child network of the updated winner.

4. Repeat the above process until all the training examples are exhausted. One training epoch has been completed at this point, and more than one epoch may be required for the network of neural networks to reach an equilibrium. *See also* [self-generating neural network](#).

training procedure the method of calculating the set of free parameters of a function given a set of training data.

training sequence a sequence of transmitted symbols known at the receiver, which is used to train an adaptive equalizer or echo canceller.

training set data used as the basis for determining the best set of free parameters. Typically used in iterative training algorithms.

trajectory a path on which a time law is specified for instance in terms of velocities and/or accelerations at each point.

trajectory planning a trajectory planning algorithm is the path description, the path constraints imposed by manipulator dynamics as inputs and position, velocity, and accelerations of the joint (end-effector) trajectories as the outputs. *See also* [path](#).

transceiver a device that can serve as both transmitter and receiver.

transco contraction of "transmission company," a firm which owns electric power transmission lines but does not engage in power generation or distribution.

transconductance a quantity used to specify a field-effect transistor, defined as the differential change in drain current upon a differential change in gate voltage.

transducer a device that converts a physical quantity into an electrical signal. Typically, transducers are electromechanical en-