



D'Agostino's test— A test of **normality** based on **order statistics** from **sample data**. It is a modification of the **Shapiro–Wilk W test**, and it is readily calculated without the **coefficients** of the order statistics. It is based on the **ratio** of a linear **unbiased estimator** of the **standard deviation** (using order statistics) to the usual mean square estimator. The test was originally proposed for moderate **sample sizes** and can detect departures from normality both for **skewness** and **kurtosis**. See also *Anderson–Darling test*, *Cramér–von Mises test*, *Michael's test*, *Shapiro–Francia test*.

Darling test— A test that a **random sample** is drawn from an **exponential distribution**.

data— Numerical **observations** collected in some systematic manner by assigning numbers or **scores** to **outcomes** of a **variable(s)**. The term “data” is a plural form of “datum” and usually takes a plural verb. Sometimes the word is used informally as a synonym for “information.”

data analysis— Usually, the process of reducing accumulated **data** to a manageable size, developing summaries, looking for patterns, and performing statistical analysis.

Database— A structured collection of information comprising numeric and nonnumeric values about any topic that can be used for storage, modification, editing, and retrieval, and can be readily accessed by a variety of applications **software**.

data dependent stopping rule— Same as *stopping rule*.

data editing— A term used to denote the process of correcting any **errors** from **data** or modifying the data structure.

data elements— The items of information extracted for some statistical purposes, e.g., sex and age.

data matrix— A **rectangular array** that represents a collection of **measurements** taken on several **variables** for a number of subjects. Let x_{ij} be the **observation** corresponding to the

i th individual and the j th variable. Then the data matrix is displayed in the form

$$\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}$$

Data matrix

where n is the number of subjects and p is the number of variables.

data mining– The term used to describe the concepts of discovering knowledge from **databases**. The idea behind data mining is to identify valid, useful, and recognizable patterns in **data**.

data points– Same as *data values*.

data reduction– The process of summarizing a large quantity of **data** by means of **tables**, **charts**, and **descriptive statistics**.

data screening– An initial examination of a **data set** to check for any **errors** or discrepancies in the **data**. The technique is also useful for checking the quality of the data and identifying any possible **outliers**. See also *exploratory data analysis*, *initial data analysis*.

data set– A collection of **observations** about one or more characteristics of interest, for one or more **elementary units** during any type of scientific investigation. A general term used to refer to any set of observations.

data transformation– The use of algebraic **transformation** on the **data values** in order to make them appear more normally distributed and make the **variances** of the **error terms** constant. Data transformations are used to correct for the violations of **assumptions** of a statistical procedure. Conclusions derived from the statistical analyses performed on the transformed data are generally applicable to the original data. See also *arc-sine transformation*, *logarithmic transformation*, *power transformation*, *reciprocal transformation*, *square-root transformation*, *square transformation*.

data validation– See *validity checks*.

data values– The values assigned to all the **observations** in a **data set**.

datum– A single numerical **observation** about a particular characteristic of interest measured on an **elementary unit**.

death rate– Same as *crude death rate*.

deciles– The deciles divide a **data set** into 10 equal parts, each of which contains 10% of the total **observations**. The **percentile points** at the 10th, 20th, 30th, . . . , and 90th **percentiles** are called the first decile (D_1), second decile (D_2), third decile (D_3), . . . , and ninth decile (D_9), respectively. See also *quartiles*.

The data arranged in increasing order of magnitude

10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	

Schematic representation of deciles of a data set

decision analysis– A formal and systematic procedure for describing and analyzing a process for making a decision by **ranking** several possible mutually exclusive courses of actions in order of merit, in accordance with some criterion such as profitability, and in choosing one of them. An important concept in decision analysis is that of decision maker's **payoff**, i.e., of the relative value of each **outcome**. It is commonly known as decision making. A decision analysis is usually carried out with the help of a **decision tree**.

decision branches– Same as *action branches*.

decision fork– Same as *action point*.

decision making– See *decision analysis*.

decision-making under uncertainty– Any situation in which the ultimate **outcome** of a decision maker's choice depends on **chance**.

decision node– Same as *action point*.

decision point– Same as *action point*.

decision rule– In **hypothesis testing**, a decision rule states the values of the **test statistic** at which the **null hypothesis** is to be rejected or not rejected. For all possible values of a test statistic, a decision rule specifies in advance when the null hypothesis should be rejected or not rejected.

decision theory– A variety of quantitative methods and techniques employed in the formulation, analysis, and solution of decision-making problems that arise because **uncertainty** exists about future course of **events** over which the decision maker has no control, but which will affect the ultimate **outcome** of a decision. It is based on the concept of forming a decision as to what action to take for each possible outcome. Statistical decision theory was introduced by Abraham Wald in 1939 as a generalization of the classical statistical theories of **estimation** and **hypothesis testing**. It has extended the scope of **statistics** to embrace the science of **decision-making under uncertainty**. It provides a unified approach to all problems of estimation, hypothesis testing, and **prediction**.

decision tree– A **graphical representation** of a set of possible **actions**, their corresponding **probabilities**, and the values of the **outcomes** as foreseen by the decision maker. It shows graphically in chronological order from left to right every potential action, outcome, and **payoff**. It is used to analyze a decision process and gives a concise summary of a **decision-making** situation under **uncertainty**. The analysis is carried out by starting from the outcomes and working back to the expected payoffs of different courses. Different possible courses of actions represented by squares and circles show the resulting outcomes. The expected payoff is calculated to each one of the outcomes. The probabilities of the different outcomes are calculated from the historical data and are shown on the branches of

the tree. To give an example of a decision tree, consider a hypothetical case where a physician must choose between two courses of action—surgery and no surgery. The patient is known to have one of two diseases, *A* or *B*, with a probability of 0.3 and 0.7, respectively. A simple decision tree for this problem is depicted below.

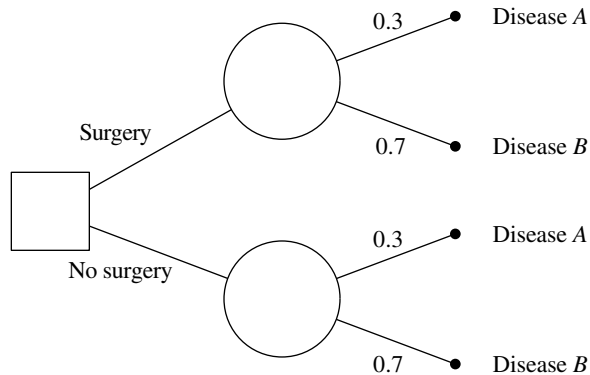


Illustration of a simple decision tree

deduction— An act or process of deriving a conclusion from a known principle to an unknown or from the general to the particular. Compare *induction*.

deductive inference— The drawing of **inference** about the particular proposition based on information about the general. Compare *inductive inference*.

deductive reasoning— Same as *deductive inference*.

definitional formula— The algebraic formula that directly displays the meaning of the procedure it symbolizes. Compare *computational formula*.

degrees of freedom— The number of independent units of information in a **sample** that are free to vary in calculating a **statistic** when certain restrictions are imposed on the **data set**. Degrees of freedom measure the quantity of information available in **sample data** for estimating the **population parameters**. It is a characteristic of the statistic being employed and is equal to the number of values that can be freely chosen when calculating the statistic. The appropriate degree of freedom for each statistical procedure appears with the formula defining the **test statistic**. For example, in a 2×2 **contingency table** with fixed **marginals**, only one of the four **cell frequencies** is free to vary, and therefore the table has single degree of freedom associated with it. Similarly, whenever the ***t* distribution** is used to make **inferences** about a **population mean** with unknown **variance**, the required *t* distribution has $n - 1$ degrees of freedom, where n is the **sample size**. Although many people find the concept of degree of freedom a bit difficult to understand, the practical application is relatively easy.

Delphi method— A qualitative **forecasting** method that obtains forecasts through a group consensus.

demand function— An equation used in economic analysis that expresses the quantity of a commodity in demand as a function of price by $Q = Cp^{-e}$ where Q is the quantity in demand, p is the price, e is the price elasticity, and C is the constant.

demographic transition— The process by which continuous changes in **fertility**, **mortality**, and migratory rates, over a number of years in the population, produce changes in the characteristics and structure of the population under study.

demography— The study of human populations with respect to age, sex, size, density, migration, **fertility**, **mortality**, and other **vital statistics** by statistical methods, and techniques. Demographic studies are based on **data** from **population censuses** and increasingly from **sample surveys**. The methods of demography are **empirical** and statistical and frequently make use of advanced mathematical techniques.

DeMoivre–Laplace theorem— A form of **central limit theorem** that establishes large sample **normality** of a **binomial distribution**. More specifically, the theorem states that if X is a **binomial random variable** with **parameters** n and p , then as n increases the **distribution** of X can be approximated by a **normal distribution** with **mean** np and **variance** $np(1 - p)$.

density— Same as *probability density*.

density curve— Same as *probability density curve*.

density estimation— Any of several **nonparametric procedures** for estimating **density function** of a **probability distribution**. Some of the simplest and classical methods for density estimation are **histogram** and **frequency polygon**. More modern and sophisticated procedures include kernel methods and spline techniques for smoothing histograms. Density estimates provide valuable information regarding characteristics and features of a **distribution**, such as **skewness** and multimodality.

density function— Same as *probability density function*.

dependent events— Two **outcomes** or **events** are said to be dependent when the occurrence of one affects the **probability** of occurrence of another. For two dependent events A and B , $P(A) \neq P(A|B)$ or $P(B) \neq P(B|A)$. Compare *independent events*. See also *conditional probability*.

dependent groups— Groups of one or more *samples* in which the values in one sample are related to the values in the other sample. **Paired** or **matched samples** are examples of dependent groups.

dependent-groups t test— Same as *paired t -test*.

dependent samples— Same as *dependent groups*.

dependent variable— The **variable** in an **experiment** or study that is affected by the **treatment(s)** or the choice of the **independent variable(s)**. In a **regression analysis**, it is usually a response that is being predicted by the **regression equation**. It is a variable of primary importance since one of the objectives of many research investigations is to predict the values of the dependent variable in terms of the known values of the independent variables. See also *criterion variable*, *predictor variable*.

description— Same as *statistical description*.

descriptive statistics— (1) The type of **statistics** used to organize and describe the **sample data** and not for inferring any characteristics of a **parent population** or **universe** from which they are derived. Some of the descriptive statistics procedures include calculating **means, proportions, and variance** and plotting **histograms, scatter diagrams**, and other graphs and charts. (2) Statistical methods and techniques that deal with the collection, organization, description, and presentation of numerical information. See also *exploratory data analysis, inferential statistics, initial data analysis*.

design of experiment— A statement of the purpose of and proposed approach to an **experiment** or investigation involving statistical analysis. More specifically, it refers to a set of rules or restrictions for allocating **treatments** to **experimental units**. Each rule or restriction for allocating treatments has a definite purpose. Some general principles of a good design are **control group, randomization, and replication**.

detection bias— Same as *ascertainment bias*.

deterministic model— A **mathematical model** based on a **deterministic relationship**. A deterministic model does not involve any **random** or probabilistic term. Compare *probability model*.

deterministic relationship— A relationship between any two **outcomes** or **variables**, such that the value of one is uniquely determined whenever the value of the other is specified.

deviance— A **statistic** used to assess the **goodness of fit** of a **regression model** fitted by the **method of maximum likelihood**. Larger values of deviance indicate that the **model** in question provides a poor fit while smaller values support the adequacy of the model. The importance of a given set of **predictor variables** is tested by the difference in deviance between any two **hierarchical models**, one with the set of predictors included and the other without the predictors. The deviance has asymptotically a **chi-square distribution** with **degrees of freedom** equal to the difference in the number of **parameters** in the two hierarchical models. The term “deviance” was originally proposed by M. G. Kendall to denote the **sum of squares of observations** about their **mean**. See also *G² statistic, likelihood ratio statistic*.

deviate— The value of a **score** measured from its group **average**, usually the **mean**. It is generally expressed as a **standardized score**, i.e., as a multiple of the **standard deviation**.

deviation— The distance or difference between a **score** and its respective group **average** such as **mean, median, or mode**. In general, the difference between any two quantities. See also *deviation from the mean*.

deviation from the mean— The difference (positive or negative) between an individual observed value and the **mean** of the group. The total of all such deviations from the mean is equal to zero. Deviations may also be measured from the **median** or the **mode**. Algebraically, the deviation of the *i*th **observation** from the **sample mean** \bar{x} is given by $x_i - \bar{x}$ and $\sum_{i=1}^n (x_i - \bar{x}) = 0$. The **absolute value** of $x_i - \bar{x}$, namely $|x_i - \bar{x}|$, is known as an **absolute deviation**. See also *average absolute deviation*.

deviation score— Same as *deviation*.

DFBETA— A **diagnostic measure** commonly used in **regression analysis** to detect the presence of an **outlier**. It is designed to measure the standardized change in a **regressional**

coefficient when a certain observation is deleted from the analysis. See also *Cook's distance*, *DFFITs*.

DFFITs— A **diagnostic measure** commonly used in **regression analysis** to detect the presence of an **outlier**. It is closely related to **Cook's distance** and is designed to measure the **influence** of an **observation** on the predicted **response value**. See also *DFBETA*.

diagnostic measure— A **goodness-of-fit statistic** that indicates how well a **regression** or any other **statistical model** fits a given set of **data**.

diagnostic procedure— Same as *diagnostic test*.

diagnostic testing— See *diagnostic tests*.

diagnostic tests— Medical procedures, such as clinical, laboratory, or other tests, that are performed to establish an actual diagnosis as regards to the presence or absence of a disease. A diagnostic test may result in a positive or negative finding. An ideal diagnostic test should classify all the cases with the disease as positive and all those without the disease as negative. Two measures of performance of a test to determine how often the test leads to correct classification are **sensitivity** and **specificity**. See also *predictive value negative*, *predictive value positive*.

diagram— A general term that now appears to be used generically to refer to all types of charts and graphs employed in the representation of **statistical data**.

dichotomous attribute— A characteristic classified into only two categories or groups, usually defined by the presence or absence of a certain condition (e.g., sick or not sick; improved or not improved). Some characteristics are inherently dichotomous by nature (e.g., male/female, alive/dead), but all characteristics, whether or not inherently dichotomous, can be made dichotomous by defining and identifying one category and putting all other observations into a second category. See also *dichotomous variable*.

dichotomous data— These are **data** arising from **measurements** that can assume only one of two values. The values are conventionally represented as 0 and 1 but they need not be a number. Dichotomous data can arise in many different forms and generally require specialized techniques for their analysis.

dichotomous measure— Same as *dichotomous variable*.

dichotomous variable— A **qualitative variable** or **nominal measure** that has only two **outcomes** or about which **observations** can be made in only two categories. Some examples are gender: male or female; marital status: married or not married. Dichotomous variables are frequently encountered in many medical and health studies. **Data** involving dichotomous **response variable** often require specialized techniques for their analysis. Often the **response values** are coded as zero or one for the purpose of analysis. See also *dichotomous attribute*.

dichotomy— A division into two mutually exclusive subclasses or categories.

diffuse prior— Same as *vague prior*.

digital computer— A computer that stores, retrieves, and processes information in digital form, using the familiar Arabic numerals from 0 to 9. Electronic digital computers usually employ **binary notation** and perform operations at high speeds by making repeated use of the conventional arithmetic process of addition, subtraction, multiplication, and division.

directional hypothesis– An **alternative hypothesis** that specifies the direction of the possible differences from the **parameter** value being tested under the **null hypothesis**. It is also referred to as one-sided or one-tailed hypothesis.

directional test– Same as *one-tailed test*.

directly standardized rate– See *standardization*.

direct relationship– A relationship between any two **variables**, such that the values of one increase or decrease according to increase or decrease in the values of the other. Compare *inverse relationship*.

direct standardization– See *standardization*.

Dirichlet distribution– The **random variables** X_1, X_2, \dots, X_q are said to have a Dirichlet distribution if their joint probability density function is given by

$$f(x_1, x_2, \dots, x_q) = \frac{\Gamma(\ell_1 + \ell_2 + \dots + \ell_{q+1})}{\Gamma(\ell_1)\Gamma(\ell_2) \dots \Gamma(\ell_{q+1})} x_1^{\ell_1-1} x_2^{\ell_2-1} \dots x_q^{\ell_q-1} (1 - x_1 - x_2 - \dots - x_q)^{\ell_{q+1}-1}$$

where $x_i \geq 0$, $\ell_i > 0$, $i = 1, 2, \dots, q$, and $x_1 + x_2 + \dots + x_q \leq 1$. It is a multivariate extension of the **beta distribution**. The distribution has many important applications in statistics.

Dirichlet function–The Dirichlet function denoted by $D(\ell_1, \ell_2, \dots, \ell_q, \ell_{q+1})$ is defined as

$$\int_{\substack{x_i \geq 0, i=1,2,\dots,q \\ x_1+x_2+\dots+x_q \leq 1}} \dots \int x_1^{\ell_1-1} x_2^{\ell_2-1} \dots x_q^{\ell_q-1} (1 - x_1 - x_2 - \dots - x_q)^{\ell_{q+1}-1} dx_1 dx_2 \dots dx_q$$

It is a multivariate extension of the **beta function**. Dirichlet functions have been found useful in the solution of many statistical problems.

discordant pairs– See *Kendall's tau*.

discrete data– **Data** obtained on measures of a **discrete variable**, i.e., using a **discrete scale** of measurement. See also *continuous data, nominal data, numerical data, qualitative data*.

discrete distribution– Same as *discrete probability distribution*.

discrete probability distribution– A table, graph, or algebraic equation showing the values of a **discrete random variable** and the associated **probabilities**.

Probability distribution of the number of dots when a pair of fair dice is tossed

x	2	3	4	5	6	7	8	9	10	11	12
$p(x)$	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$

Some examples of other discrete probability distributions

x	0	1
$p(x)$	0.5	0.5

x	-2	-1	0	-1	2
$p(x)$	0.2	0.2	0.2	0.2	0.2

x	1	2	3	4	5	6
$p(x)$	0.1	0.1	0.3	0.3	0.1	0.1

discrete scale— A scale used to measure a numerical characteristic that entails only integer values.

discrete stochastic process— See *stochastic process*.

discrete uniform distribution— See *uniform distribution*.

discrete (random) variable— A quantitative (random) variable that can be measured only in terms of a whole number (integer) such as the number of children per family, the number of cars per household, and so on. A discrete variable can assume only a finite or, at most, a countable number of possible values. The scales of discrete random variables contain gaps where no real values of the variable, such as “1.65 children,” occur.

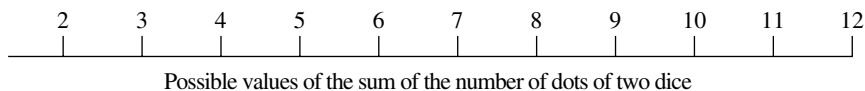
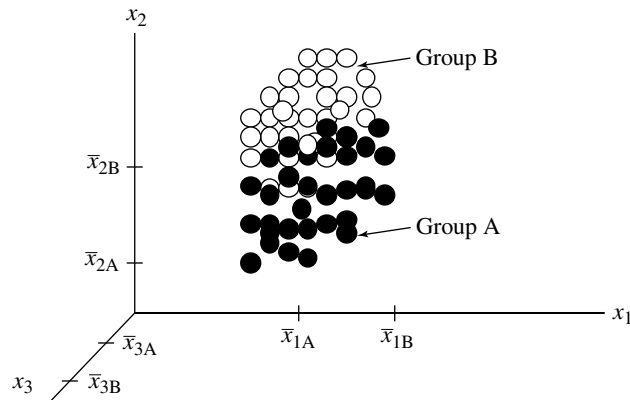
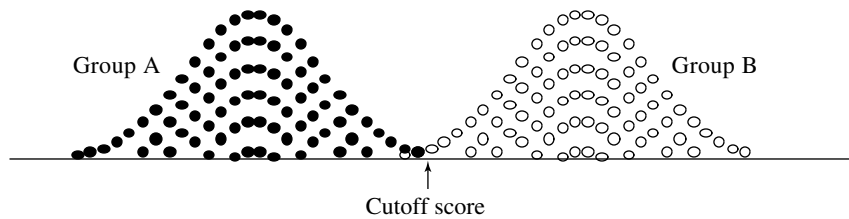


Figure illustrating a discrete random variable

discriminant analysis— A **multivariate technique** for predicting a nominal outcome that has two or more values. It uses two or more continuous **independent variables**, known as **predictors**, to classify subjects or objects into different groups with minimal **probability** of misclassification. It is also called discriminant function analysis. When subjects are to be classified into more than two groups, it is known as multiple discriminant analysis. In the case of two groups, the most commonly used procedure is Fisher's linear discriminant function in which a **linear function** of the **variables** resulting in maximum separation between the two groups is determined. This provides a classification rule that may be used to allocate a new object into one of the two groups. In cases involving more than two groups, there are several possible linear functions of the variables that can be used for separating them. In a discriminant analysis, it is important to assess its misclassification rate, i.e., the **proportion** of cases that are incorrectly classified. Ideally a **sample** of new cases should be used in order to assess the **error rate**. When there are many predictors, the search for the best subset of predictors is usually done by a **stepwise procedure**.



(a)



(b)

Schematic illustration of discriminant analysis: two groups compared on (a) three predictor variables and (b) the derived discriminant function

discriminant function analysis– Same as *discriminant analysis*.

disjoint events– Same as *mutually exclusive events*.

disjoint sets– In **set theory**, two or more **sets** are said to be disjoint if they have no common elements between them.

dispersion– Same as *variability*.

distance sampling– A method of **sampling** employed to determine the number of certain species of plants or animals in a given geographic area.

distribution– The values of a characteristic or **variable** along with the **frequency** or **probability** of their occurrence, often plotted on a graph. Distributions may be based on **empirical** results or may be theoretical **probability distributions**. Examples of some well-known theoretical distributions are **normal**, **binomial**, and **Poisson**, among others. Classical statistical procedures are based on the assumption that the **data** have an empirical distribution, which is closely approximated by the theoretical ones. See also *frequency distribution*.

distribution-free methods– A term sometimes used for **nonparametric methods**, since they usually do not require assumptions about the underlying population distributions (such as the **normal**), but will work for a wide range of different distributions.

distribution function– For any **random variable** X , the distribution function of X , denoted by $F(x)$, is defined by $F(x) = P(X \leq x)$; that is, the distribution function is equal to the **probability** that a random variable assumes a value less than or equal to x for $-\infty < x < \infty$.

Dixon's test– A **test procedure** based on **order statistics** used to test for an **outlier**.

dominant action– In **decision** or **game theory**, an action that is undoubtedly superior to an alternative action because it generates **payoffs** that are as good as or superior to those of the alternative action under any condition.

dominant strategy– Same as *dominant action*.

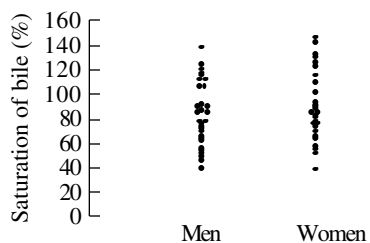
Doolittle method– A computational **algorithm** employed in solving a system of linear equations. The procedure is fairly straightforward to implement and enables one immediately to detect any arithmetic errors being made. Its use is recommended whenever there are more than two **variables** involved in the equations.

dose-finding trial– A pharmaceutical trial with a primary objective of identifying the optimal dose of a drug. The term is synonymous with **phase I trial**.

dose-response curve– A two dimensional graph displaying the relationship between the values of dose of a drug plotted on the horizontal **x axis** and the corresponding values of a **response variable** plotted on the vertical **y axis**.

dose-response relationship– See *dose-response curve*.

dot-plot– A **graphical procedure** for displaying the **frequency distribution** of numerical **observations** for one or more groups of **data** in which each dot (.) designates one observation. It is usually a more effective method for displaying **quantitative data** that are labeled.



Two dot plots for percentage saturation of bile for men and women

double-blind study– Same as *double-blind trial*.

double-blind trial– A **clinical trial** in which neither the physician nor the investigator nor the patient have any knowledge of the particular **treatment** being assigned to patients in the study, so that subjective **biases** are avoided. See also *blind study*, *single-blind trial*, *triple-blind trial*.

double-entry table– A **statistical table** requiring two entries, such as two values of **degrees of freedom**, one for columns and one for rows, is referred to as a double-entry table. The value at the intersection of the appropriate column and row is the **critical value** of the **statistic**. The percentiles of the **F distribution** require a double-entry table.

double exponential distribution– A **continuous probability distribution** defined by the **probability density function** of the form

$$f(x) = \frac{1}{2\beta} \exp\left(-\frac{|x - \alpha|}{\beta}\right) \quad -\infty < x < \infty, \alpha > x, \beta > 0$$

It can be derived as the distribution of the difference between two **random variables** each having an identical **exponential distribution**.

double-logarithmic chart– See *logarithmic chart*.

double-masked study– Same as *double-blind trial*.

double-masked trial– Same as *double-blind trial*.

double Poisson distribution– A **Poisson distribution** in which the **parameter** λ is itself regarded a **random variable** having a Poisson-type distribution.

double sampling– A **sampling** procedure in which first a preliminary **sample** is selected for the purpose of obtaining certain auxiliary information only; and subsequently a second sample, usually a subsample of the first, is selected for measuring the **variable** of interest in addition to the auxiliary information. The purpose of this type of sampling is to increase the **precision** of the **estimate** by exploiting the **correlation** between the auxiliary variable and the variable of interest. The procedure is particularly useful when the information on the auxiliary variable can be obtained by an inexpensive and easy-to-use procedure. Such a sampling is also known as two-phase sampling.

double-tailed test– Same as *two-tailed test*.

doubly censored data– A term sometimes applied to **survival data** to indicate that both the time of the originating **event** of interest and the failure of the event (relapse, death, etc.) are **censored**.

doubly ordinal contingency table– See *ordinal contingency table*.

drop-ins– Same as *crossovers*.

drop-outs– In a **clinical trial**, drop-outs are patients who decide to withdraw from the study, for whatever reason, either voluntarily or because asked to do so by the physician conducting the study, possibly because of an adverse side effect associated with the **intervention**. The drop-outs have important implications in terms of how the **data** should be analyzed, and whenever possible such cases should be located and their **outcome** ascertained.

D^2 statistic– Same as *Mahalanobis D^2* .

Duckworth test– A quick and simple test, proposed by John W. Tukey in 1959, for comparing the **medians** of two **populations** that does not require any table of **critical values**. Suppose that the smallest **observation** is from the x population having m observations and the largest from the y population having n observations. The **test statistic** D is the sum of the following two overlaps: (1) The number of x observations that are smaller than the smallest y and (2) the number of y observations that are larger than the largest x . If either $3 + 4n/3 \leq m \leq 2n$ or vice versa, the statistic D is reduced by one. The table of critical values consists of three numbers, 7, 10 and 13, corresponding to $\alpha = 0.05, 0.01, \text{ and } 0.001$

respectively. The **null hypothesis** of equal medians is rejected if D exceeds the critical values at respective **levels of significance**.

dummy coding– A procedure in which a code of 0 or 1 is assigned to a nominal response and **predictor** or **independent variable** used in a **regression analysis**.

dummy variable– A **dichotomous variable** that is coded as 1 to indicate the presence of an attribute and 0 to indicate its absence. In performing a **regression analysis**, a dummy variable is created to incorporate a **binary variable** into a **model** by means of **dummy coding**. **Categorical variables** with more than two categories are incorporated by a series of dummy variables.

Duncan multiple range test– A type of **multiple comparison** procedure for making **pairwise comparisons** between **means** following a significant F test in the **analysis of variance**. The procedure involves a step-by-step approach where the **sample ranges** are tested in exactly the same way as the **Newman–Keuls test** except that the observed ranges are based on Duncan's multiple range distribution. The procedure has been found to be somewhat more conservative than the Newman–Keuls test. See also *Bonferroni procedure*, *Dunnett multiple comparison test*, *Scheffe's test*, *Tukey's test*.

Dunnett multiple comparison test– A **multiple comparison** procedure for comparing several **treatment groups** in which each of a number of treatment groups is compared with a single **control group** following a significant F test in an **analysis of variance**. See also *Bonferroni procedure*, *Duncan multiple range test*, *Newman–Keuls test*, *Scheffe's test*, *Tukey's test*.

Dunnett's test– Same as *Dunnett multiple comparison test*.

Dunn multiple comparison procedure– Same as *Bonferroni procedure*.

Durbin–Watson test– A procedure for testing **independence** of **error terms** in **least squares regression** against the alternative of **autocorrelation** or **serial correlation**. The **test statistic** d is a simple **linear function** of **residual autocorrelations**, and its value decreases as the autocorrelation increases. It is calculated by dividing the sum of the squared first differences of **residuals** by the sum of the squared residuals. Exact **significant levels** for d are not available, but Durbin and Watson have tabulated lower and upper **critical bounds** for various values of n (the number of **paired observations**) and k (the number of **explanatory variables**). If the computed value of d falls below the lower limit (d_1), there seems to be evidence for the presence of autocorrelation. If it falls above the upper limit (d_2), there is lack of any autocorrelation. And if it lies between the lower and upper limits, then the test is inconclusive.