Glossary and Terminology

Bayesian approach: Usually an optimal statistical procedure depends on the population parameters, which are often unknown. Assuming a prior distribution of the unknown parameters, it is sometimes possible to predict a value of the parameter and hence employ the near-optimal procedure. Prior experience, local knowledge, and expert opinion usually lead to a prior probability distribution of the parameter(s) of the random variable under observation. The method which uses the prior distribution of the parameter(s) to optimize the statistical decision is known as a Bayesian approach to the concerned problem.

Binary factor: If a factor that is likely to affect the sample values has two possible levels, then it is called a binary factor. That is, a binary factor affects the sample values through its presence or absence in the samples.

Binary split retesting: After a composite sample tests positive, indicating that at least one of the constituent individual sampling units possesses the trait, the composite sample is split into two composite subsamples, as equal in size as possible, and each composite subsample is subjected to measurement. Each composite subsample that indicates the presence of the trait is similarly subjected to binary split and subsequent measurement. The procedure continues until every individual sampling unit that formed the original composite sample is classified.

Classification error: The error of misclassifying an individual sample. That is, either classifying a sampling unit possessing the trait as not possessing it or classifying a sampling unit not possessing the trait as possessing it.

Classification problem: The problem of classifying every (individual) sampling unit into one of the two possible categories, usually identified by the "presence" and "absence" of the trait, even if the measurement is not necessarily of the presence/absence type.

Cleanup evaluation: A statistical investigation to determine if a cleanup activity has been effective in that whether or not a previously hazardous site is not hazardous any more, after the cleanup activity was undertaken.

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Composite sample measurement: The measurement on the variable of interest obtained from a composite sample. Note that, as in the case with individual sampling units, a composite sample measurement need not be the same as the corresponding composite sample value unless the measurement is made without error. Also, if the composite sample is made homogeneous by mixing it thoroughly, then the composite sample measurement is expected to be a simple or weighted average of the constituent individual sample values, provided the measurement is made without error.

Composite sample size: The number of individual sampling units that are used to form a single composite sample.

Composite sample value: The value of the variable of interest for a composite sample. If the composite sample is thoroughly mixed, then the composite sample value is expected to be a simple or weighted average of the constituent individual sample values.

Composite sampling: A sampling procedure where several individual sampling units are selected and procured, but are not immediately subjected to measurement. Composite samples are formed by pooling and physically mixing a predetermined number of sampling units or subunits for making measurement.

Composite subsample: A composite sample formed from a subset of individual samples that constituted a composite sample.

Conjugate prior distribution: If the posterior distribution of parameters belongs to the same family of distributions as their prior distribution, then the prior distribution is called a conjugate prior distribution.

Continuous measurement: A measurement that gives the numerical value of the variable of interest is called a continuous measurement.

Covariogram: Consider the spatial process $\{Z(s), s \in D\}$, where $D \subset R^d$. Suppose

$$\operatorname{cov}(Z(s_1), (s_2)) = C(s_1 - s_2)$$

depends only on the difference $s_1 - s_2$ for all $s_1, s_2 \in D$. The function $C(\cdot)$ is called a covariogram or a stationary covariance function.

Curtailed retesting: When a composite sample of size k has indicated the presence of the trait, some form of retesting is employed. If the first $k-1$ of the constituent individual sampling units indicate the absence of the trait, then the kth individual sampling units is classified as possessing the trait without actually making a measurement on this sampling unit.

Data quality objectives (DQO) Process: A statistical procedure to ensure that the data collection will be most effective in the sense of collecting maximal information at a minimal cost.

Entropy-based retesting: The procedure assumes a large collection of unclassified individual sampling units. The procedure begins by forming a composite sample of a predetermined size k. If the composite sample tests negative, then all its constituent individual samples are classified as not possessing the trait. However, if this composite sample tests positive, indicating that at least one constituent individual sample possesses the trait, then the composite sample is split into two composite subsamples as equal in size as possible, and subjected to measurement. If the first of the two composite subsamples indicates the absence of the trait, then the second is assumed to posses the trait and is, therefore, subjected to further binary split. On the other hand, if the first composite subsample indicates the presence of the trait, then the individual sampling units that form the other composite subsample are not classified and are returned to the pool of unclassified individual sampling units. Continuing in this way, each of the k individual sampling units used to form the composite sample is either classified as not possessing the trait or is returned to the pool of unclassified individual sampling units, except for exactly one individual sampling unit that is classified as possessing the trait. At this stage, another composite sample of size k is formed from the pool of unclassified individual sampling units. The procedure continues until all the individual sampling units are classified. Although this classification procedure is not hierarchical like the other classification procedures, it is optimal in that it maximizes the entropy.

Equal and unequal allocations in ranked set sampling: In the ranked set sampling protocol, the total sample size can be allocated to different ranks in several ways. If all the ranks are selected with equal frequency, we call it an equal allocation; otherwise, there is an unequal allocation.

Exhaustive retesting: This procedure begins by forming a composite sample of a predetermined size k. If the composite sample tests negative, then all the k constituent individual sampling units are classified as not possessing the trait. On the other hand, if the composite sample tests positive, indicating that at least one of the constituent individual sampling units possesses the trait, then every individual sampling units is separately subjected to measurement and is classified accordingly.

Identification of sample maximum: The procedure that identifies the individual sampling unit having the largest measurement. This procedure identifies the sample maximum with certainty, but the total number of measurements required to do so is not fixed.

Individual sample measurement: The measurement on the variable of interest obtained from an individual sampling unit. Note that an individual sample measurement is different from the corresponding individual sample value unless the measurement is made without error. Also note that, while every individual sample has a value for the variable of interest, every individual sample may not provide a measurement, since some individual sampling units are not necessarily subjected to measurement.

Individual sample value: The value of the variable of interest for an individual sampling unit. Note that every individual sampling unit has a fixed value for the variable of interest, even though only a few selected individual sampling units are subjected to measurement.

Kriging: Kriging is a minimum-mean-squared-error method of spatial prediction that (usually) depends on the second-order properties of the spatial process under study. Matheron (1963) named this method after D. G. Krige, a South African mining engineer who developed empirical methods for determining true ore-grade distributions from distributions based on sampled ore grades (Krige, 1951).

Linear model for composited data: A linear model is used to express the relationship between individual sample values and composite sample values.

Nugget effect: Suppose $\gamma(h)$ is the semivariogram for a spatial process $\{Z(s), s \in D\}$. That is, $\gamma(h) = E[Z(s+h) - Z(s)]^2$. It is then easy to note that $\gamma(0) = 0$. If $\gamma(h) \to c_0 \neq 0$ as $h \to 0$, then c_0 is called the nugget effect.

Optimal composite design: A design for forming composite samples from individual sampling units in order to maximize the efficiency of the inference drawn from the composite sample data.

Posterior distribution: The conditional probability distribution of population parameters, given the observed value(s) of the random variable(s), is called the posterior distribution of population parameters. The posterior distribution is derived from the prior distribution of the parameters and the observed value(s) of the random variable(s).

Prediction of sample maximum: The procedure that predicts the largest individual sample value. This procedure has a fixed number of measurements, but may fail to identify the largest individual sample value with a positive probability. That is, there is a positive, though usually small, probability that the predicted sample maximum is not the actual sample maximum in that there is some individual sampling unit having a measurement larger than the predicted sample maximum.

Presence/absence measurement: A measurement that indicates the presence or absence of the trait under study.

Prevalence: The proportion of (individual) sampling units that possess the trait under study. Note that the prevalence is the true proportion in the population and will differ from the observed proportion in any particular case.

Prior distribution: The belief, usually based on some prior information, local knowledge, and expert opinion, about the possible variation in the values of population parameters is sometimes expressed in terms of a probability distribution of these parameters. Such a postulated probability distribution of population parameters is called their prior distribution.

Random weights: The composite sample value is a simple or weighted average of the constituent individual sample values. If the proportions of individual

sampling units or subunits that are used to form a composite sample are not fixed, then these proportions are treated as random variables. In this case, the composite sample value is weighted average of the constituent individual sample values with random weights.

Ranked set sampling: A method of sampling, where large samples are initially selected for judgmentally ranking their members without involving costly laboratory procedures and are followed by subsequent quantification of a few individual sampling units with selected ranks.

Retesting: After obtaining measurement on a composite sample, some or all of the constituent individual sampling units may be subjected to measurement, either individually or in the form of composite subsamples. This stage of measuring some or all of the individual sampling units that have already been subjected to measurement as part of a composite sample is called retesting.

Semivariogram: See **Variogram**.

Sequential retesting: This procedure begins by forming a composite sample of a predetermined size k. If the composite sample tests negative, then every constituent individual sampling unit is classified as not possessing the trait. On the other hand, if the composite sample tests positive, indicating that at least one of the constituent individual sampling units possesses the trait, then the individual sampling units are sequentially subjected to measurement until an individual sampling unit tests positive. At this stage, all the unclassified individual sampling units are pooled into a single composite subsample, which is then measured for the trait. If the trait is present in the composite subsample, then the same procedure is repeated, until all the individual sampling units that formed the original composite sample are classified.

Sill: Let $C(\cdot)$ be the covariogram of the spatial process $\{Z(s), s \in D\}$ (see **Covariogram** and **Variogram**). It is easy to establish that the semivariogram function satisfies $\gamma(h) = C(0) - C(h)$. If $C(h) \to 0$ as $\| h \| \to \infty$, then $\gamma(h) \to C(0)$. The limit $C(0)$ is then called the sill of the semivariogram.

Site characterization: Characterization of a (waste) site as hazardous or not hazardous.

Spatial autocorrelation: Any dependence, as measured by a correlation coefficient, among sampling units that form a sequence of points on the sampling site in a specific direction is called the spatial autocorrelation for the corresponding spatial process. Note that the spatial autocorrelation usually depends on both the direction and the spatial lag.

Spatial contiguity: When the locations of certain sampling units form a contiguous set on the sampling site, we call these sampling units spatially contiguous. Spatial contiguity usually ensures that the values of the concerned sampling units are close to each other.

Spatial structures: Any structure in the values of the variable of interest on the sampling site as depending on the locations of sampling units.

Subsampling a composite sample: It is sometimes desired to investigate the homogeneity of a composite sample. In such a case, a subsample is extracted from the composite sample for making measurement. This procedure is called subsampling of the composite sample.

Sweep-out method: A method used to identify the individual sampling unit having the largest measurement. In this procedure, any individual sampling unit that is not likely to have the largest measurement is eliminated from the potential search so as to avoid unnecessary measurements.

Variogram: Consider the spatial process $\{Z(s), s \in D\}$, where $D \subset R^d$. Suppose

$$\text{Var}(Z(s_1) - Z(s_2)) = 2\gamma(s_1 - s_2)$$

depends only on the difference $s_1 - s_2$ for all $s_1, s_2 \in D$. The function $2\gamma(\cdot)$, which is a function only of the difference $s_1 - s_2$, is called a variogram and $\gamma(\cdot)$ is called a semivariogram of the spatial process $\{Z(s), s \in D\}$.

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