Universal Metrology (Measure and Measurement Sciences)
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Measurement along with probabilistic and statistical analysis is based on measures.

In classical and modern mathematics [1] and physics [2], there is no perfectly sensitive universal measure with conservation laws in the finite, infinite, and infinitesimal and even for sets with parts of different dimensions. The real numbers cannot fill the number line because of gaps between them. The sets, fuzzy sets, multisets, and set operations express and form not all collections. Infinity is a heap of very different infinities the cardinality only can very roughly discriminate and no tool can exactly measure. Operations are considered for natural numbers or countable sets of operands only. In each concrete (mixed) physical magnitude, e.g. 5 liter fuel, there is no known operation unifying "5 L" and "fuel". The absolute error is noninvariant. The relative error applies to the simplest formal equalities of two numbers only and even then is ambiguous and can be infinite. Measurement theory leads to losing information via artificially limiting precision and ignoring systematic errors, as well as to precision illusions. Let us 10^6 times measure a bolt length (of 5.3 cm unknown for us) via a ruler of 100 cm length with centimeter divisions. Then 10^6 times we obtain exactly 5 cm and the same mean with its illusive quadratic mean error $0.5/3^{1/2}$ cm$/(10^6)^{1/2} < 3 * 10^{-3}$ mm (and the same precision by measuring the length of a large hall with building errors of at least 1 cm). There is no weighting a posteriori possibly equiprecise data a priori via using their already available errors.

Universal physics [3, 4] including material unistrength introduces invariant and universal dimensionless physical quantities such as ion implantation unidoses and mechanical unistresses. They provide for the first time discovering universal strength laws of nature. They hold for any anisotropic materials with different resistance to tensions and compressions and for any variable loads with possibly rotating the principal directions of the stress state at a point of such a material during loading.

Universal mathematics [3, 5] provides the uninumbers generalizing the real numbers via including some infinite cardinal numbers as canonic positive infinities and signed zeroes reciprocals as canonic overinfinities. Include, e.g., ω (the first Cantorian cardinal $\aleph_0$) and Ω (the continuum cardinality $\mathbb{C}$). Quantification builds algebraically quantioperable quantielements qa (e.g. $_5{_L}$fuel) and quantisets $\{_{q(j)}a(j) \mid j \in J\}$ with any quantity $q(j) = q_j$ of each element $a(j) = a_j$ which both are any objects indexed via any (possibly uncountable) index set J. Quantiset uniquantities $Q = \Sigma_{j \in J} q_j$ are universal, perfectly sensitive, and even uncountably algebraically additive measures with universal conservation laws. Canonic sets interpret canonic positive infinities, e.g. via $Q(N) = Q\{n \mid n \in N = \{1, 2, 3, \ldots\}\} = \omega$ and $Q]0, 1] = Q\{r \mid r \in R, 0 < r \le 1\} = \Omega$ (R the reals). In created uniarithmetics, quantialgebra, and quantianalysis of the finite, the infinite, and the overinfinite with quantioperations and quantirelations, the uninumbers evaluate, precisely measure, and are interpreted by quantielements and quantisets with uniquantities. Then, e.g., $Q\{a + bn \mid n \in N\} = \omega/|b| - a/b - 1/2 + 1/(2|b|)$, $Q]a, b[^n = ((b - a)\Omega - 1)^n$, and $Q(R^n) = 2^n\omega^n\Omega^n$ ($a, b \in R$). They provide adequately setting and solving many typical urgent problems. The unierror corrects and generalizes the relative error. The unireserve, unireliability, and unirisk additionally estimate exact objects, models, and solutions by exactness confidence.

Universal metrology [3] adequately sets and analytically solves nontrivial general and specific metrological problems. Their solutions provide adequately determining the true values of measured quantities with eliminating averaging and partition errors and exactly expressing any uninumber (Figs. 1, 2). Temporary overprecision (e.g. 5 cm,

5.33 cm, … in that bolt measurement) excludes losing measurement information. Reducing the end result precision to the instrument precision (e.g. giving 5 cm or in the best case 5.3 cm in that bolt length measurement) excludes precision illusions.
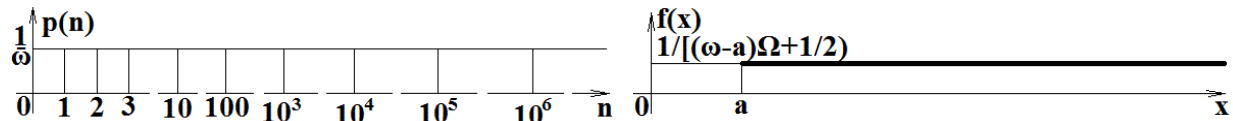

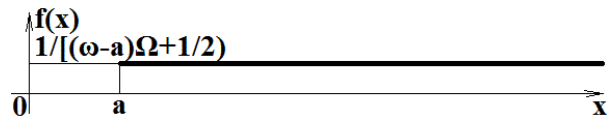Figure 1. Probability of selecting any $n \in \mathbf{N}$

Figure 2. Probability density f(x) for [a, ∞)

Unimetrology creates fundamentally new opportunities in measurement by great data scatter, e.g. in aeronautical fatigue, to discover new phenomena and laws of nature.

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