Decision-making in a Fuzzy Environment: are the uncertainties coincidences or fuzzy constraints?

None of this

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Systemic Thinking

Systemic thinking is a way of thinking that:

• Considers and places particular emphasis of attention to the interdependence(s)

• It is integrative thinking, which forms bridges between specialists

• Neither challenges nor nullifies the importance of specialization, but it complements it by cooperation between specialists that would lead to synergies

• Do not conceal the real complexity or complications, so that over-simplification would not lead to the oversights and therefore, to complicated consequences ***Mulej, 2008***

Holism

Holism covers:

(1) The Whole (<u>Systemic</u>)
(2) Parts (<u>Systematic</u>)
(3) Relations (<u>Correlation, Dialectics, Interdependence</u>) and
(4) Realism (<u>Closeness to reality, Materialism</u>)

As a system (i.e. interlacement), i.e. everything simultaneously and interlaced, interdependently and with interaction

Definition of Holism after the Dialectical systems theory, Mulej, 2008

Scientific Uncertainty – Accuracy vs. Precision

The mental state: perplexity, doubt, skepticism, mystification, ambivalence …

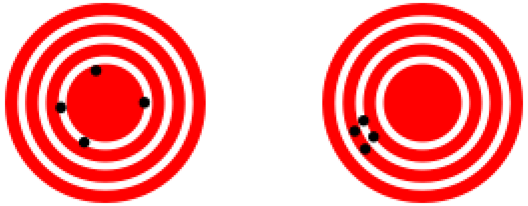
„Just about everything / whole or nothing at all „…

***However,* scientific measurements incorporate variability, and scientists report this as uncertainty in a effort to share with others the level of error that they found acceptable**

Scientific uncertainty is a <u>quantitative measurement of variability</u> in the data i.e. uncertainty in science refers to the idea that all data have a range of expected values as opposed to a precise value

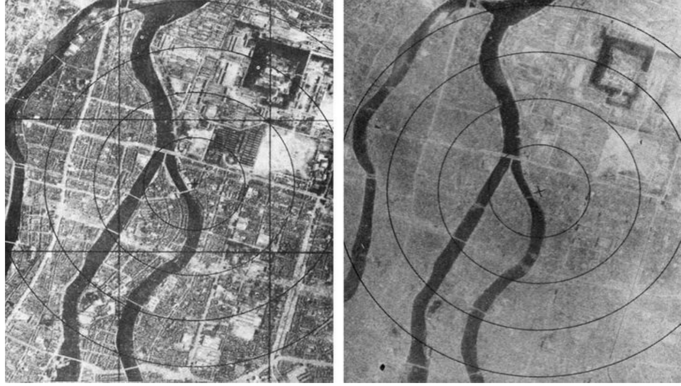
Such uncertainty can be categorized in two ways:

Accuracy and Precision



(left: GOOD ACCURACY BUT POOR PRECISION; right. GOOD PRECISION BUT POOR ACCURACY)

Uncertainty in Nature



Karl Pearson is commonly credited with first describing the concept of uncertainty as a measure of data variability in the late 1800s (before assumed that this variability was simply due to error)

Pere-Simon Laplace discussed a method for quantifying error distribution of astronomical measurements caused by small errors associated with instruments shortcoming as early as 1820. As technology improved, astronomers realized that they could reduce, but not eliminate this error in their measurements

Pearson = revolutionary idea: Uncertainty he proposed, was not simply due to the limits of technology in measuring certain events – it was inherent in nature

Uncertainty in Nature

Whether it is the flight path of an arrow, the resting heart rate of an adult, or the age of a historical artifact, measurements do not have exact values, but instead always exhibit a range of values, and that range can be quantified as uncertainty. This uncertainty can be expressed as a plot of the probability of obtaining a certain value, and the probabilities are distributed about some central, or mean value

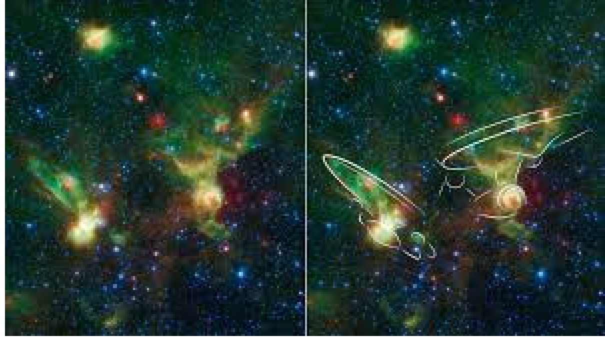
I am quantified Uncertainty,

Uncertainty is just my name …

Quantified, valued, statistical,

description of my mental state?

Uncertainty and Error in practice



Willard F. Libby and colleagues do not use the word *error* as we do in common language, where it refers to a mistake such as typographical error or a baseball error

The Latin origin of the word error - *errorem* - means *wandering or straying*, and the scientific use of the word is closer to this original meaning

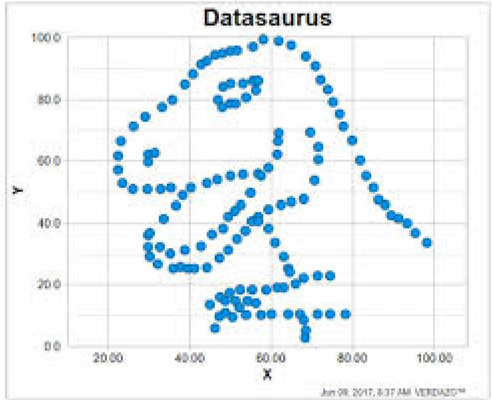
In science, *error* is the difference between the true value and the measured value, and the difference can have many different causes

Libby calculated the error associated with his measurements by counting the number of decay events in the sample in a known amount of time, repeating the measurement over multiple periods, and then using statistical techniques to quantify the error

Uncertainty and Error in practice

Arnold and Libby stated: „The errors quoted for the specific activity measurements are standard deviations as computed from the Poisson statistics of counting random events.“

In other words, the individual error is calculated from the expected uncertainties associated with decay for each sample



Statistical versus Systematic Error

The error reported alongside of the specific activity provides a measure of the precision of the value, and is commonly referred to as statistical error which cannot be eliminated, but can be measured and reduced by conducting repeated observations of a specific event

Systematic error (Libby) is due to an unknown but non-random fluctuation, like instrumental bias or a faulty assumption

Unlike statistical error, systematic error can be compensated for, or sometimes even eliminated if its source can be identified

Confidence:
Reporting Uncertainty and Error

As a result of error, scientific measurements are not reported as a single values, but rather as ranges of averages with errors bars in a graph or *plus / minus sign* in a table

Statistical techniques (Pearson) allow us to estimate and report the error surrounding a value after repeated measurements of that value

Libby and Wu reported their estimates as a range of one standard deviation around the mean, or average, measurement

The standard deviation of a range of measurements can be used to compute confidence interval around the value (Morimoto et al., 2013: examined the average pitch speed of 8 college baseball players)

In this case there is no „theoretical correct“ value, but confidence interval provides an estimate of the probability that a similar results will be found if the study is repeated

In science, an important indication of confidence is the number of significant figures, reported

Error Propagation

As Pearson recognized, uncertainty is inherent in scientific research, and for that reason it is critically important for scientists to recognize and account for the errors within a dataset

Edward Norton Lorenz (1960) was working on a mathematical model for predicting the weather. Unexpectedly, Lorenz found that the resulting weather prediction was completely different from original pattern he observed. What he did not realize at that time was that while his computer stored the numerical values of the model parameters to six significant figures (0.639172), his printout, and this numbers he inputted when restarting the model, were rounded to three significant figures (0.639. At first, error appears to remain small, but after a few hundred iterations it grows exponentially until reaching a magnitude equivalent to the value of the measurement itself

This work motivated others to begin looking at other dynamic systems that are similar sensitive to initial starting conditions ..

Error Propagation

James York and Tien-Yien Li (1975), coined the term *CHAOS* to describe this systems. Again, unlike the common use of the term *Chaos*, which implies randomness or a state of disarray, the science of *Chaos* is not about randomness – is a work to understand underlying patterns of behavior in complex systems toward understanding and quantifying this uncertainty (phenomena?)

Scientist should look for the source of error within a dataset:

- **Only when the error is very large**
- **Even when the error is very small**

Error reduction: *quality assurance, quality control, repeating a research*

Uncertainty as a State of Nature

In teh first half of 20th Century, the concept of uncertainty reached new heights with the discovry of Quantum Mechanics. In the *Quantum World uncertainty is not an inconvinience; it is a state of being*

***Heinsenberg Uncertainty Principle* in Quantum Physics**

Once we understand the concept of uncertainty as it applies in Science, we can begin to see the purpose of scientific data analysis is to identify error variability toward uncovering the relationships, patterns, and behaviors that occur in nature

There is uncertainty in all scientific data, and even the best scientists find some degree of error in their measurements …

To show how scientists identify and measure error and uncertainty, which are reported in terms!!! of confidence

Uncertainties

<u>Quantitative</u> estimations of error present in data

Acknowledging the uncertainty of data : important component in reporting the scientific outcomes

Commonly misunderstood : scientists are not certain

Careful methodology can reduce uncertainty by correcting systematic error and minimizing the random error

Uncertainty can never be reduced to zero

Known : Known

Known : Unknown

Unknown : Unknown

NonScientific Uncertainties …

SO, how should we suppose to feel about that?

Will be back to this issue a bit later … in the end … soon

Decision making in a Fuzzy Environment

Bellman, Zadeh (1970) **By decision-making in a FUZZY environment is meant a decision process in which the goals an/or the constraints, <u>but not necessarily the system under control,</u> are fuzzy in nature. This means that the goals and/or the constraints constitute classes of alternatives whose boundaries are not sharply defined**

An example of fuzzy constraint:

„The cost of A should not be *substantially* higher than α," „where α is a specified constant; an example of fuzzy goal is: „X should be in the *vicinity* of Xo", „where Xo is a constant"

***Sources* of FUZZINESS**

Fuzzy

Fuzzy Goals and constraints can be defined precisely as a fuzzy sets in the space of alternatives. A fuzzy decision, then, may be viewed as an intersection of the given goals and constraints. A maximum decision is defined as a point in the space of alternatives at which the membership function of a fuzzy decision attains its maximum value

The use of this concept is illustrated by examples involving multistage decision processes in which the system under control is either deterministic or stochastic but not fuzzy

Fuzzy - Fuzziness

There is a need for differentiation between randomness and fuzziness, with later being a major source of imperfection / imprecision in many decision processes

Fuzziness: a type of imprecisions which is associated with the use of fuzzy sets – classes in which there is no sharp transition from membership to non-membership

Randomness has to do with uncertainty concerning membership or non-membership of an object in a non-fuzzy set

Fuzziness has to do with classes in which there may be grades of membership intermediate between full membership and non-membership

The mathematical techniques for dealing with fuzziness are quite different than those of probability theory

Fuzzy Goals, Constraints and Decisions

Decision-making in a fuzzy environment: the most important feature of this framework is its symmetry with respect to goals and constraints – a symmetry, which erases the difference between them and makes it possible to relate in a relatively simple way the concept of a decision to those of the goals and constraints of a decision process

Linguistic hedge: Type I – on a single fuzzy set: (very much, more or less, slightly etc.) Type II (technically, essentially, practically etc.) –requires a consideration of a metric or proximity relation in the space of its operand

NOW WHAT?

Uncertainty in a Scientific measurement is a,

is a rigorously defined and quantifiable thing; it‘s less an admission of ignorance than an expression of confidence: we‘re saying how tightly we‘re able to constrain what we don‘t know

NonScientific Uncertainty is than … Ignorance/Arrogance, Dangerous Oversights, Unacquaintance, Need to Know Non-Systematic, Non-Systemic approach, lack of Holism, the Mightiest Lie of all = Half-True?

Rigorously defined and Quantifiable Thing is named as Scientific Uncertainty = numbers are named Uncertainty … just a name, just a TERM, just another confusing (unnecessary) word : figure of speech?

Should then be NonScientific Uncertainty named ANGST?

It's freedom of speech - as long as you don't say too much
… We gonna meet up with the truth face to face …
(The Neville Brothers)

Replication Crisis in Psychology **among the Scientists**

Cold, certain numbers reflexing a certain Scientific uncertainty versus nonScientific uncertainty: human being : heart, soul, emotional intelligence …

We dare to be quite certain that uncertainty (as a term, name, word) should/must be removed from Science, while in Science this very word causing certain (in different magnitudes) uncertainty in nonScientific certain uncertainty: human beings

Science should ease, heal (not ignite the uncertainty with term uncertainty) uncertainty in nonScientific places where ancient uncertainty : ANGST : already exist

It's Not Over Yet … Join me in this ENDEAVOR Cause, I am invited to leave …