Comment on: Stupid Statistics (Editorial)

Harold E. Ascher and Christian K. Hansen

THE editorial [4], *Stupid Statistics*, contains much useful advice on failure-data analysis. For example, the editorial's discussion of its stage 2 stresses the importance of distinguishing between:

1) times to failure of nonrepairable items (henceforth, parts), which have been reordered by magnitude, and
2) the successive times to failures of a repairable system (henceforth, system) all measured from the same origin and hence, naturally ordered by magnitude (called "sequential data").

Ref [1] shows how difficult it can be to distinguish between these two cases, and it stresses the importance of incorporating time-line information in the analysis of case #2.

After the editorial emphasizes the need to understand the data in stage 2, however, stage 3 reads in its entirety, "Modeling (Choosing and fitting a distribution)!" But a stochastic point process [2]—rather than a distribution—must be fitted to repairable-system[1] failure data.

If the "times between successive failures" (interarrival times) of a repairable-system tend to get larger (or smaller), mistakenly fitting **any** distribution **totally** distorts the analysis. For example, consider the artificial case of 101 interarrival times of a repairable-system, each an order of magnitude **smaller** than the previous interarrival time:

$$10^{100},\ 10^{99},\ \cdots,\ 10,\ 1 \tag{1}$$

Clearly, the ROCOF (rate of occurrence of failures) increases very rapidly. This artificially extreme example has been chosen to show—conclusively—that successive interarrival times are not identically distributed. (For a real example showing strong evidence of increasing ROCOF, see the voluminous Toyota Camry failure data-set in [1].) Now consider the numbers of the data-set (1) but in exactly reversed chronological order, so that each interarrival time is an order of magnitude **larger** than the previous one:

$$1,\ 10,\ \cdots,\ 10^{99},\ 10^{100} \tag{2}$$

Obviously, now the ROCOF decreases very rapidly. Fitting a distribution to a set-of-numbers is valid when there is no information in the original data-set's chronological order. However, if there is information in the chronological order, this information is ignored when a distribution is fitted to the data. Hence, if **any** distribution is mistakenly fitted to data-set (1), **exactly** the same result is obtained when the same distribution is fitted to data-set (2). Clearly, at least one of these results must be wrong. Both results are wrong. The interarrival times in both data-sets are not samples from the same distribution so—contrary to the editorial's stage 3—it is incorrect to fit a distribution to either data-set.

In discussing a case where chronological order was important, Deming [3] stated: ". . . we turn attention to a 'distribution' that appears to have all the good qualities that one could ask for, but which was misleading, not just useless."[2] However, mistakenly fitting a distribution to nonidentically distributed interarrival times is even more misleading in repairable-system failure-data analyzes, than in Deming's quality control context! As shown in [2], ignoring the crucial information in the chronological order of interarrival times, by fitting a distribution to the numbers in the data-set, often leads to spurious exponentiality. Since the exponential distribution is the only continuous distribution without memory, this spurious exponentiality **seems**—totally incorrectly—to provide the maximum possible retroactive justification for having begun the analysis by fitting a distribution.

In summary, the editorial's discussion of its stage 2 correctly stresses the need to:

- look for information in the chronological order of interarrival times, and
- ascertain how many items are at risk of failing [1].

However, stage 3 ignores the information sought in stage 2. In other words, stage 3 perpetuates the chronic delusion that repairable-system failure data can be analyzed exactly like part failure data.

I. Editorial Response

The "title" of stage 3 and the discussion of stage 4 each use the word "distribution" once; it is used in one of its ordinary, not statistical, senses (see a dictionary). It was intended to mean: the way the amplitude is distributed over time. Ascher & Hansen are quite correct in their discussion of the stochastic point process. Their comments show why this *Transactions* does not allow certain words (eg, expected, significant) to be used in their ordinary meaning, and requires that they be preceded by *s*- when used in their statistical meaning.

The word "distribution" is not used elsewhere in the editorial at all.

Regardless, however, it is useful for the *Transactions* readers to be exposed again to the very important points that Ascher & Hansen are making in their commentary here.

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[1]The term "repairable-system" is used here to emphasize the definition of "system" in [4].

[2]Quotation marks are added to the word: distribution.

REFERENCES

[1] H. E. Ascher, "A set-of-numbers is NOT a data-set," *IEEE Trans. Reliability*, vol. 48, pp. 135–140, Jun. 1999.
[2] H. E. Ascher and C. K. Hansen, "Spurious exponentiality observed when incorrectly fitting a distribution to nonstationary data," *IEEE Trans. Reliability*, vol. 47, pp. 451–459, Dec. 1998.
[3] W. E. Deming, *Out of the Crisis*: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1986.
[4] R. A. Evans, "Stupid statistics (Editorial)," *IEEE Trans. Reliability*, vol. 48, p. 105, Jun. 1999.

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