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THE STATISTICAL DRAKE EQUATION

Abstract

We provide the statistical generalization of the Drake equation from a simple product of seven positive numbers into the product of seven positive random variables. This new equation we call the "Statistical Drake Equation". Our mathematical proof, given in this paper, is based on the Central Limit Theorem (CLT) of Statistics. In particular, we show that: 1) The new random variable yielding the number of communicating civilizations in the Galaxy is log-normally distributed. The mean value of this log-normal is N in the ordinary Drake equation. The standard deviation of this N log-normal random variable is given also. 2) The seven factors in the ordinary Drake equation now become seven positive random variables. The probability distribution of each random variable may be, in general, arbitrary, because the CLT allows for that. Even a higher number of random variables may be compatible with the CLT, so our theory allows for a generalization of the ordinary Drake equation to many more factors that will be added in the future as long as more refined scientific knowledge about each factor is obtained by researchers. This capability to allow for more future factors in the statistical Drake equation we call the "Data Enrichment Principle" and it is the key towards more profound mathematical and physical analyses in the field of Astrobiology. 3) Finally, as a practical example of application of our statistical Drake equation, we work out in detail the case when each of the seven random variables is uniformly distributed around its own mean value and with a given standard deviation. For instance, the number of stars in the Galaxy is assumed to be uniformly distributed around (say) 300 billions with a standard deviation of (say) 100 billions. Then, the resulting log-normal distribution of N is computed numerically by virtue of a MathCad file that the author has written and is given in the paper. This shows that the mean value of the log-normal random variable N is actually of the same order as the classical N given by the ordinary Drake equation, as one might expect from a good statistical generalization.