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Opinion

# Two great sciences could converge in the near future

**Ivan Robert Enriquez Guzman***

Graduate at Statistical Engineering from National University of Engineering and master's at Probability and Statistics from University of Sao Paulo, Brazil

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***Corresponding author**: Ivan Robert Enriquez Guzman, Graduate at Statistical Engineering from National University of Engineering and master's at Probability and Statistics from University of Sao Paulo, Brazil, Email: ivan.guzman@ufes.br ; ivan.guzman@ufes.com.br ; ivanrobertenriquez@gmail.com



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Like most young people in the 90s, I expected to work with computers, so I applied to the Faculty of Systems Engineering of the National Engineering University in my country. At this time, passing the test was a very difficult task because there were only 20 places available and thousands of applicants.

Unfortunately, my score only allowed me to get accepted into my second choice, statistics, which I'd picked at random. Without knowing what exactly statistics was, I accepted the course and graduated. Logically, the first time, I did not understand that working as a statistician I could solve problems using the computer in various areas of knowledge.

After I graduated, I felt the need to understand how the internal programs of different statistical packages worked. I got very interested in knowing the internals of those statistical programs. So I studied the underlying algorithms of diverse statistics packages, in order to create my own statistical programs, hopefully, more efficient.

In college, I studied mathematics, Real Analysis, and Complex Variable Analysis, which provided me with a very strong mathematical base. Computer programs were just being developed, with the arrival of the computer. Then Computer Science began to develop significantly. Various theories could be put into practice, and among those questions were statistical efficiency and computational speed, some parallel definitions, many of the techniques developed in both sciences were shared, something similar to feedback. The precision of the predictions of statistical models is another challenge. Moreover, the interpretation of the parameters of the models regarding the prediction. Currently, more emphasis is given only to prediction, and little to interpretation or how we arrive at those values. In many occasions, modern researchers are only interested in the value of prediction, no matter the method, which is a bit dangerous for both sciences today.

With the idea of creating my own statistics packages, I applied to the faculty of Mathematics, Statistics, and Computer Science, but due to my background in statistics, I was accepted to the master's degree in statistics, for the second time in my life.

Anyway, I continued the post-graduation program, and my close friends, who were postgraduate students in computer science, interchanged ideas with me in our spare time.

For example, Boolean Mathematics has similar concepts in statistics. Many other concepts of both sciences influence each other.

Also, many methods for pattern recognition are variations or extensions of statistical tools, namely, logistic regression, LDA, PCA, ICA among others. The generalizations of these methods, SVM or even Deep Learning solve similar problems. Recently, a kind of oracle that knows everything has been developed. I remember that we had the intention to develop our own tools to work on the internet, maybe similar to ChatGPT, now there are many services that provide similar tools.

Certainly, all the time, both sciences exchanged advances for their growth.

In the last years, the first concepts of artificial intelligence were gaining space in computer science. With time, the idea



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of trying to replicate the functioning of the human brain, initially to play checkers, is without a doubt one of the greatest adventures that many human brains in the world spend their time to discover.

Once understanding how the human mind works and how we make decisions was achieved, then there would be no limits to what could be done. Getting to the truth of things was perhaps an obsession of George Boole, who may not have been able to unravel the theory of truth, but he did contribute to solving more complex problems by translating them into possible answers of 0 and 1, True or False. With the advances in computer science, many systems help solve problems so complex that they lead back to trying to solve the question, how are the decisions of the best machine in the world already created? The human brain.

Currently, Artificial Intelligence (AI) uses the concepts of machine learning, as an extension of the definition of the Perceptron Rosemblatt (1958). The activation function and others considered current standards, give rise to neural networks (NN), which then grew in layer variations and different propagation algorithms. When we choose to use the Backpropagation algorithm (Rumelhart, et al. 1986) it is necessary to choose initial forms of regularization, including Ridge, Lasso, or Elastic Net, widely used in regression analysis in statistics. Initially, NN are mainly applied to bivariate classification models, 0 or 1, however, it is more complex when the classification or response variable is more than 2. The model is extended to adjust M neural networks, considering, One Against All, One Against One, or P against Q. This way a quick way to learn is guaranteed.

Deep Learning has as its idea precisely the use of multiple layers of multiple perceptrons, and the composition of linear functions. This method also uses machine learning, as well as resorts to statistical concepts to update the prediction or classification based on an objective function and a classification error, the algorithm calculates millions of parameters and converges when the objective function enters equilibrium. So to speak.

Maybe, never known the future, and paradoxically, it sounds like an absolute truth, but the truth is that Data Science, or Statistics will use more and more computational tools every day for the implementation of new models that will bring new probabilistic theories, which will support the convergence of computational methods in accuracy and efficient way that are being developed in computer science. In my view, classical and Bayesian estimation methods will be left aside in a few years, and non-parametric methods will prevail, not because they are better, but because they do not presuppose the theoretical assumptions required by the previous ones. But for this, probabilistic theories will have to be developed that give theoretical support to these.

That's right, it seems that the current paradox is to try to understand how the human brain works from new concepts of networks, new concepts of layers, new types of distributions, new hypotheses to validate, new ways of reaching optimal values, for which, new learning criteria, new forms of convergence will be used, that the future will not be probabilistic or computational, perhaps they will have to be both or a new mixture of both, and all this from what we call artificial intelligence, machine learning, and other concepts associated with the mind or functioning or some function (such as learning) of the brain. Again, along with computational methods, computer science and statistics or data science will continue to contribute to each other.





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