



Conducting highly principled data science: A statistician's job and joy^a

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This article is dedicated to the 20th Birthday of CHASC¹ and to the memory of Alanna Connors, a founding astrophysicist of CHASC.

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ABSTRACT

Highly Principled Data Science insists on methodologies that are: (1) scientifically justified; (2) statistically principled; and (3) computationally efficient. An astrostatistics collaboration, together with some reminiscences, illustrates the increased roles statisticians can and should play to ensure this trio, and to advance the science of data along the way.

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1. Proactive co-investigators/partners, not passive consultants

On March 26, 2015, I received the following email from an organizer of the 10th International Astronomical Consortium for High-Energy Calibration (IACHEC) meeting, which contains the following question:

"Systematic errors in comparing effective areas: Speaking hypothetically, if we label the instruments by numbers $i = 1, \dots, N$ and each has an attribute A that is used to measure the same $j = 1, \dots, M$ astrophysical sources, with intrinsic attribute F_j where $C_{ij} = A_i F_j$ are the instrumental measurements, then the question is: Is there a way to decide how (or whether) to change A_i when the values C_{ij}/A_i do not agree with F_j to within their statistical uncertainties s_i . In other words, each instrument provides an estimator \hat{F}_j of F_j with statistical uncertainty s_j but $|\hat{F}_j - F_j|/s_j$ is often large, not distributed as a Gaussian with unit variance ... How to estimate the systematic error on the A_i ?"

^a This article is prepared for the special issue on "The Role of Statistics in the Era of Big Data" organized by Statistics and Probability Letters. I thank the editor Laura M. Sangalli for inviting me, my Astrostatistics collaborators for making my adventure possible, Joe Bitunstein, Yang Chen, Radu Craio, Francesca Dominici, Vinay Kashyap, Todd Kuffner, Bharmar Mukherjee, Aneta Siemiginowska, Lei Sun and a reviewer for comments and encouragements, Steve Finch for proofreading, and the US National Science Foundation (DMS-1513492) for partial financial support.

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¹ California Harvard Astro-Statistics Collaboration, established in 1997 by statistician David van Dyk and astrophysicists Alanna Connors (Wellesley College), Vinay Kashyap and Aneta Siemiginowska (Harvard-Smithsonian Center for Astrophysics). I helped to lead the statistical team on the Harvard side after David moved to the University of California at Irvine in 2003, and subsequently to Imperial College of London in 2011, which brought CHASC to the international arena. Alanna was a driving force of CHASC's education mission and outreach effort, helping statisticians understand science and scientists understand statistics. She devoted herself to such causes to the very end of her life. She wrote on January 28, 2013, "My cancer is not responding to any treatment, so I am going into Hospice (at home) today. I am very tired, so I may not be able to participate much. I'll try sleeping in tomorrow. With many thanks for everything". She passed away on February 2, 2013, after more than a decade fighting with breast cancer.

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