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Prelude of Astrostatistics

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Abstract: ***In present paper, I have tried to explain the role of statistics in Astronomy. In Astronomy, there is huge use of statistics for massive data like galaxies, stars and planet etc. Bayesian statistics, least square regression, Auto correlation, Koloronzaro- Mann Whitenny test, Markov chain Monte Carlo method (MCMC) and estimate the problems in Astronomy. In future, scope of statistics in astronomy will be increase. Present time there is some author who spread the knowledge of astrostatistics like Thomas J. Loredo, John Rice, Michael L. Stein and Jogesh Babu, etc.***

Keywords: Bayesian Statistics, LSR, Auto correlation, KMW Test, MCMC method, estimate

1. Introduction

There are some questions in our mind like:
- How are the universe forms?
- How is old it?
- What is it composed of and how wide ranging is it in scope?

Cosmologists are trying to find answer by comparing data from horde astronomical objects to theories of the universe's formation and evolution. For example, before the 1990 invention of the Hubble Space telescope, the Hubble constant- unit of measurement used to describe the expansion of the universe could only be inferred ever so slightly, and cosmologists had to make do performing simple statistical analysis. Now a days, advancement of technology flood of new data, escort in the era of precision cosmology.

The Solan digital sky survey alone has collected basic data for more than 200 million objects. By the help of statistics, cosmologists become statistician and developed the broad range of answers and infant interdisciplinary has arisen called Astrostatistics. In Astrostatistics, there are more use of statistical methods like Bayesian statistics, least square regression, Auto correlation, Koloronzaro- Mann Whitenny test, Markov chain Monte Carlo method and estimate the problems in Astronomy. The use of statistics to validate results and evaluate models is large scale in modern astronomy. An advanced statistical tool has been hugely applied across cosmology, high energy astrophysics, solar physics, large surveys, etc.

Now a day, new methods of data collection and the swiftly increasing amounts of data that are (the Big data problem), create new challenges of analysis and interpretation.

Astronomer's measures:
There are some astronomy measures used by astronomers.
- Astrometry (Angular position on sky, for example Gaia)
- Photometry (How bright is it?)
- Flux = Photons (or energy) per second per meter^2
- Magnitude = - 2.5 x Log_{10} (Flux x Constant)
- Absolute Magnitude = - 2.5 x Log_{10} (Luminosity) + Constant
- = Apparent magnitude at fixed distance of 10 PC
- Spectroscopy (Brightness versus wavelength)
- Time series (light curves): Transients & Variables (for example Stars, Quasars, Supernova, Exoplanets, Moving objects (asteroids)

Statistical Measures in Astronomy:
- Availability of stars/galaxies sources an unbiased sample of the vast underling population. (Sampling)
- By use of Multivariate classification we can divide these objects into 2/3/4….. classes.
- By Multivariate regression tries to find the intrinsic relationship between two properties of a class especially with confounding variables.
- We can answer such questions in the presence of observations with measurement errors & flux limits by Censoring, truncation & measurement errors.
- Through Time series analysis we can estimate the vast range of variable objects.
- With the help of spatial point processes & image processing we can make 2-6 dimensional points like galaxies in the universe, photons in detector.
- Through density estimation and regression, we can estimate the continuous structures like cosmic microwave background fluctuations, interstellar medium.

Thomas J. Loredo et al. (2009), they introduce the Statistics and astronomy in Annals of Applied Statistics. They represent the long history of fruitful interaction between astronomy and statistics with its problems and interaction with various forms of statistics which can be used in Astronomy. They told that the Sloan Digital Sky Survey has cataloged nearly a billion galaxies (with detailed data for about 100 million), using a camera composed of 30 CCD chips each with a resolution of 2048 × 2048 pixels. With advancements in instrumentation and information technology, future surveys will produce data sets of almost amazing sheer size. For example, the Large Synoptic Survey Telescope (LSST), expected to begin operation in 2015, will produce around 30 terabytes of data per night from its three billion pixel camera, as it monitors everything from near-Earth asteroids to billions of remote galaxies. How to effectively deal with such massive datasets presents fundamental challenges to the discipline of statistics in the twenty-first century.

Thomas J. Loredo (2012) presented a paper at Pennsylvania State University in June 2011 "On the future of astrostatistics: statistical foundations and statistical practice" summarizes a held at the Statistical Challenges in Modern Astronomy V conference. He discussed that the emerging needs of astrostatistics may both motivate and benefit from fundamental developments in statistics. He emphasize some recent work within statistics on fundamental topics relevant to astrostatistical practice, including the Bayesian/frequentist debate (and ideas for a synthesis), multilevel models, and multiple testing. As an important direction for future work in statistics, he accentuate that astronomers need a statistical framework that unambiguously supports unfolding chains of discovery, with attainment, cataloging, and modeling of data not seen as isolated tasks, but rather as parts of an ongoing, integrated sequence of analyses, with information and uncertainty propagating forward and backward through the chain.

References

[1] Bayarri, M. J. & Berger, J. O. (2004) The interplay of Bayesian and frequentist analysis, Statist. Science, 19, 58–80
[2] Efron, B. (2005) Bayesians, frequentists, and scientists, J. Am. Stat. Assoc., 100, 1–5
[3] Efron, B. (2010) The future of indirect evidence, Statistical Science, 25, 145–157
[4] Gelman, A. (2010) Bayesian statistics then and now (discussion of Efron's "The future of indirect evidence"), Statistical Science, 25, 162–165
[5] Little, R. (2006) Calibrated Bayes: a Bayes/frequentist roadmap, Amer. Statist., 60, 213–223
[6] Loredo, Thomas J. (2012), " On the future of astrostatistics: statistical foundations and statistical practice" *Statistical Challenges in Modern Astronomy V conference* at Pennsylvania State University in June 2011.
[7] Loredo, Thomas J., R., John and Stein, Michael L. (2009), "Introduction To Papers On Astrostatistics", *The Annals of Applied Statistics*, Vol. 3, No. 1, 1–5.
[8] Meinshausen, N. & Rice, J. (2006) Estimating the proportion of false null hypotheses among a large number of independently tested hypotheses, Annals Statistics, 34, 373–393
[9] Miller, C. J., Genovese, C., Nichol, R. C., et al. (2001) Controlling the False- Discovery Rate in astrophysical data analysis, Astron. J., 122, 3492-3505
[10] Scott, J. G. & Berger, J. O. (2006) An exploration of aspects of Bayesian multiple testing, J. Statist. Plann. Inference, 136, 21442162.