Name of Course: Statistical Methods and Applications to Astrophysics and High Energy Physics
September 24, 2015

Description: With the advance of digital imaging techniques, astronomy has become a data science in which knowledge creation depends on applying and developing sophisticated statistical methodology. This course brings together students in the fields of astronomy and statistics to collaborate on analyses of large, complex astronomy data sets. This course will be jointly taught by James Long (Statistics, email: jlong@stat.tamu.edu) and Lifan Wang (Physics & Astronomy, email: lifan@tamu.edu)

Required text book: Feigelson and Babu: Modern Statistical Methods for Astronomy, ISBN 9780521767279

Instructors: James Long and Lifan Wang

Lecture room: MPHY 107

Lecture time: TR, 17:30-18:45

Course Website: Material posted on `http://stat.tamu.edu/~jlong/astrostat`

Course Calendar: (subject to change) The first four weeks of the course will provide basic statistical and astronomy background knowledge. The remainder of the course is broken into projects which will be determined by student interest. Lectures during these weeks will focus on statistical methodology and astronomical context of the projects. Students will work together in groups of 2 or 3 to complete the projects.

- **Sept. 1 – 15**: Statistical Background (Chapters 1–4 in book)
  - **Project # 1 Assigned**
  - Statistical Topics: Statistical Challenges in Astronomy, R, Data Visualization, Distributions, Central Limit Theorem, Law of Large Numbers, Maximum Likelihood Estimation, Density Estimation, Error Propagation, Bayesian and Frequentist Uncertainty Quantification, Hypothesis Testing, Bootstrap, Jackknife
  - Astronomy Topics: Applications to SDSS Stripe 82 Data
- **Sept. 17 – Oct. 8**: Astronomy in the Time Domain
  - **Project # 2 Assigned** Students will present data for project
  - Statistical Topics: Clustering, classification, cross validation, period estimation, hypothesis testing, feature extraction, modeling, censoring, truncation
  - Astronomy Topics: Variable stars, transients, period luminosity relations, cosmic distance ladder
- **Oct. 13 – Nov. 5**: Statistics in Cosmology

  - **Project # 3 Assigned** Students will present data for project
  - Statistics Topics: Linear and non–linear regression, Fisher Information, Bayesian statistics, MCMC
  - Astronomy Topics: Big Bang and the Inflation Theory, The formation of Galaxies, The Cosmic Triangle, Supernovae, Weak Lensing, Baryonic Acoustic Oscillation, Cosmic Microwave Background Radiation, The ΛCDM Model with Supernova Data

- **Nov. 10 – Dec. 8**: Statistics in Extragalactic Astronomy
  - **Project # 4 Assigned** Students will present data for project
  - Statistics Topics: Clustering, functional data, regression
  - Astronomy Topics: Photometric redshift estimation, composite spectral energy distributions

Grading

There will be no exams. The grade is determined by the completion of four sets of homework. Each of these homework will count 25%. Grading scale: A=90-100%, B=80-90%, C=70-80%, D=55-70%, F=0-55%.

ADA statement: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learn- ing environment that provides for reasonable accomodation of their disabilities. If you believe you have a disability requiring an accomodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room B118 of Cain Hall or call 845-1637.

Aggie Honor Code: "An Aggie does not lie, cheat, or steal or tolerate those who do." Academic and personal integrity are very important. For more information go to: http://www.tamu.edu/aggiehonor.