

Advanced Methods in Applied Statistics 2016

as of 01/19/16

- Block 3 - Timetable A
- Odd-numbered classes are 4-hours while even-numbered consist of 2 blocks of 4-hours.
- Classes will be composed of 30-40% lecture, with the remainder devoted to demonstrations and exercises
- While assignments, projects, and exercises can be done in the programming language of the students choice, the examples and demonstrations will be mainly in Python and/or scientific packages thereof, e.g. SciPy, NumPy, PyROOT, etc.

Week 1

Class 1 – Start

- Chi-square
- Code chi-square
- Review of 'basic' statistics

Class 2 – Regression & Systematics

- Data fitting (1D, 2D, etc...)
- Residuals
- Uncorrelated systematics
- p-value (trials factors?)

Week 2

Class 3 – Bayes

- Theorem
- priors
- prior/posteriori

Class 4 – Bayesian & Frequentist

- Comparisons, appropriateness, biases
- Likelihoods and interpretation
- Feldman-Cousins method

Week 3

Class 5 – Goodness-of-fit

- Kolmogrov-Smirnov test, Cramer-Rao, and other 'goodness-of-fit' estimators
- Review of test-statistic properties (Poisson, chi-squared w/ effective D.O.F.)
- [Covered in only 1D in “Applied Statistics: From Data to Results”, but redone here for completeness.]

Class 6 – Confidence Intervals

- Maximum Likelihood Estimators
- Upper/Lower limits
- Neyman
- Wilk's Theorem

Week 4

Class 7 – Data Processing

- Uniform distributions
- Binned and discrete distributions
- Truncated/limited distributions

Class 8 – Data Processing II

- De-noise/Amplify (Kernel Density Estimators, Wavelets, etc.)
- Spline functions
- Time Series

Week 5

Class 9 – TBD

- Guest lecture/topic or make-up day to review past material

Class 10 – In-class presentations & Bayesian II

- More Bayes
- Review and presentation from students about statistical article in their respective field

Week 6

Class 11 – Minimizers/Optimizers I

- Simulated annealing
- Markov Chains

Class 12 – Minimizers/Optimizers II

- Steepest Descent (SIMPLEX, MIGRAD)
- MultiNest
- Example of 2D fitting going awry
- Application

Week 7

Class 13 – TBD

- Guest lecture/topic or make-up day to review past material

Class 14 – Multi-Variate Machine Methods

- Decision Trees
- Random Forest
- Neural-Networks
- Support Vector Machines

Week 8

Class 15 – Advanced Topics

- Kulback-Leibler Divergence?
- Unfolding procedures?
- Principal Component Analysis?

Class 16 – Recap and Review