CAS PhD student statistics course

- **Lecture 1: Introductory comments and basic descriptive statistics**

  - What is the point of statistics?
  - Common pitfalls (confirmation bias, *a posteriori* statistics, systematic errors, low sample sizes)
  - Calculating the mean, variance, median of a sample, and errors on those quantities
  - Simple probability distributions: binomial, Poisson, Gaussian
  - Error propagation (linear and non-linear)
  - Optimal combination of data

- **Lecture 2: searching for correlations**

  - Correlation coefficient and its error, regression lines
  - How to quantify the significance of a correlation
  - Bootstrap error estimates
  - Non-parametric correlation tests (Spearman rank cross-correlation coefficient)
  - Common mistakes: selection effects, outliers, cause & effect
  - Comparing two distributions (K-S test, comparison of means or variances)

- **Lecture 3: hypothesis testing and model-fitting**

  - Hypothesis testing and goodness-of-fit: χ^2 statistic and distribution, degrees of freedom, p-value, reduced χ^2, inclusion of correlated errors, common mistakes in interpretation
  - Parameter estimation, relation between χ^2 and likelihood
  - Quoting 68% and 95% confidence limits, how to describe skewed distributions and asymmetric errors, correlations between parameters
  - Is adding another parameter justified by the data?
  - Marginalization of parameters

- **Lecture 4: Bayesian inference**

  - What is meant by "Bayesian" and "Frequentist" statistics?
  - Bayesian inference, conditional probabilities, importance of priors, model selection, information criteria
  - Monte Carlo methods