Statistical and Data Analysis Package in SWIFT

Claude A. Pruneau
Department of Physics and Astronomy
Wayne State University

Abstract

We present the design and implementation of an Object-Oriented Math + Statistics package designed for rapid and robust data analysis, with a comprehensive suite of statistical tools, fitting tools, and modeling functions. The package design is centered on abstract interfaces (with Protocols) and comprehensive, carefully designed class structures. The package includes features such as multidimensional functions, including common functions such as Bessel functions, Laguerre, and Legendre polynomials, classes for vectors, matrices and related linear algebra tools, a limited set of physics tools including rotations, Lorentz vectors, etc., multi-dimensional histograms, fast and robust moment calculation, and calibration of correlation functions, frequentist and Bayesian statistics, maximum likelihood and least square fits, and extensible random number generation tools, as well as basic plotting capabilities.

Given SWIFT’s interoperability with other languages, the presented package should be easy to integrate within existing computing environments such as ROOT.

Functions, PDFs, Random Numbers

PDFs
- PDFs include: Normal, Student, Pareto, Chi-Square, Poisson, Gamma, Bessel, Beta, Gamma, Fibonacci
- Functions for PDFs: mean, variance, etc.
- Probability density functions, cumulative distribution functions, etc.
- Random number generation.

PDFAbstract
- Abstract Class implements most required functions

RandomScalar
- RandomScalar

RandomVector
- RandomVector

RandomGenerator
- RandomGenerator

RootFinder
- RootFinder

Interpolator
- Interpolator

Laguerre
- Laguerre

Legendre
- Legendre

Polynomial
- Polynomial

Bessel
- Bessel

Beta
- Beta

Gamma
- Gamma

Pareto
- Pareto

ChiSquare
- ChiSquare

Gaussian
- Gaussian

Student
- Student

Uniform
- Uniform

Normal
- Normal

Poisson
- Poisson

Exponential
- Exponential

Gamma
- Gamma

Beta
- Beta

Laplace
- Laplace

LogNormal
- LogNormal

Maxwell
- Maxwell

Boltzmann
- Boltzmann

Compo
- Compo

Conduit
- Conduit

Abstract Class
- Concrete Class

Protocol (Interface Definition)
- Implements/Inherits
- Extends (Protocols)
- Uses

Basic and Special Functions
- Basic and Special Functions
- Numerical Integration
- Numerical Interpolation
- Function Derivatives
- Basic and Special Functions
- PDFs, Random Numbers
- Robust Moments, Histograms (1D, 2D, 3D), Profile Histograms,
- E.g., PDFs evaluation, moments, differentiation, integration,
- Numerical Interpolation
- Numerical Integration
- Root Finding
- Function Fitting and Optimization
- Random Number Generation
- Probability
- Wide set of PDFs and Tools (for statistical tests)
- Statistics
- Robust Moments, Histograms (1-D), Profile Histograms, Statistical Tests
- Linear Algebra Module
- Task and Work Flow Control
- Logging Module
- Particle Physics Module
- Note: NOT ALL classes and components of the package can be represented on this poster.

Laguerre
- Laguerre

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