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Quantitative Portfolio Management

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Multivariate statistics

- Glivenko-Cantelli theorem and Monte Carlo simulations
- Copulas vs. marginal factorization of a joint distribution
- Shape summary statistics
 - Expected value – covariance
 - Mode – modal dispersion
 - Location – dispersion ellipsoid
- Taxonomy of distributions

Estimation techniques

- Estimators
 - general definitions
 - evaluation: bias, inefficiency, error
- Non-parametric estimators
 - Sample quantile and order statistics.
 - Sample mean/covariance and best-fitting ellipsoid
 - Sample factor loadings and ordinary least squares
 - Kernel estimators
- Maximum-likelihood estimators
 - Normal hypothesis: sample estimators
 - Non-normal hypothesis: outlier rejection
- Shrinkage estimators
 - Stein mean
 - Ledoit-Wolf covariance
- Robust estimators
 - Assessing robustness: the influence function
 - Huber's "M" robust estimators
 - Outlier detection and high-breakdown estimators
 - Minimum-volume ellipsoid and minimum-covariance determinant
- Bayesian estimators
 - Analytically tractable examples
 - Numerical techniques

Optimization techniques

- Mean-variance optimization
 - Analytical solutions: total return vs. benchmark allocation
 - Numerical solutions: quadratic programming
 - Pitfalls of the mean-variance approach
- Prior allocation
- Sample-based allocation
 - Error in satisfaction and constraint assessment
 - Leverage of estimation risk
- Bayesian allocation
 - Predictive return allocation
 - Classical-equivalent allocation
- Black-Litterman allocation
 - Views on market parameters
 - Views on the market realizations
- Copula-opinion pooling allocation
- Resampled allocation
- Robust allocation
 - Second-order cone programming problems
 - Semi-definite programming problems
- Robust Bayesian allocation