Short Description VaR / Expected Shortfall (CVaR) Toolkit (CLI) Mario Innocente

I) Overview

Interactive command-line toolkit to compute Value at Risk (VaR) and Expected Shortfall (ES/CVaR). It ingests user data as losses or returns, normalizes to a loss distribution, and reports VaR/ES using multiple methods. NumPy is required; pandas is optional for clipboard/CSV intake. No SciPy needed.

II) Capabilities

- Historical Simulation (empirical quantile and tail mean).
- Parametric Normal (closed-form formulas).
- Parametric Student-t via Monte Carlo (rescaled to empirical σ).
- Demo portfolio (multivariate Normal) using Cholesky to model correlations.

Note: Cholesky-based portfolio MC is available in the demo mode; pasted multi-column data is treated as a single series unless extended.

III) Data Intake & Normalization

Modes: Losses, Returns, Mixed, or Demo.

Sources: paste multi-line text; or Clipboard/CSV if pandas is installed.

Normalization: returns R are mapped to losses $L = -R$; negative losses are made positive via $|L|$; NaNs are dropped.

IV) Methods (quick reference)

Historical: VaR_α = empirical quantile of L at α; ES_α = mean($L \mid L \geq VaR_\alpha$).

Normal (analytical): estimate μ = mean(R), σ = stdev(R); $VaR_\alpha = -(\mu - z_\alpha \sigma)$, $ES_\alpha = (\phi(z_\alpha)/(1-\alpha))\cdot\sigma - \mu$, where $z_\alpha = \Phi^{-1}(\alpha)$.

Student-t (MC): draw $T \sim t(df)$, rescale to match empirical σ, convert to losses, then compute empirical VaR/ES on simulations.

Portfolio MC (demo): simulate $R \sim N(\mu, \Sigma)$ via Cholesky(Σ); given weights w, portfolio return $R_p = R\cdot w$, losses $L = -R_p$.

V) Key Functions

historical_var_es(losses, alpha) → (var, es)

normal_var_es_from_returns(returns, alpha) → (var, es, mu, sig)

student_t_var_es_mc_from_returns(returns, df, alpha, n_sims, seed) → (var, es, mu, sig)

mc_portfolio_var_es_from_cov(mu_vec, cov_mat, weights, horizon_days, alpha, n_sims, seed) → (var, es)

normalize_to_losses_interactive() → prompts, parses, and returns (L, source_kind)

demo_portfolio_returns(T, seed) → synthetic 3-asset returns with target μ/σ/correlation

VI) Quick Usage
Follow prompts to set α and paste a column of returns or choose the demo portfolio.

VII) Validation & Sanity Checks
▪ ES ≥ VaR at the same α for the loss definition used here.

▪ For Normal returns, analytical VaR/ES should match empirical estimates for large samples.

▪ Portfolio MC requires Σ to be positive-definite (a small jitter is added for numerical stability).

VIII) Assumptions & Limitations
▪ Historical assumes stationarity; no volatility clustering modeled.

▪ Normal can understate tails; Student-t improves fit but still i.i.d.

▪ Linear Gaussian portfolio demo; no non-linear instruments or path-dependent P&L.

IX) Performance Notes
▪ MC is compute-intensive; tune n_sims for the accuracy/speed trade-off (100k–300k is a good balance).

▪ Clipboard/CSV intake depends on pandas; otherwise paste numeric text tables.