Risk analysis lab 9 2019. 11. 26. (Modern Portfolio Theory)

1. Load the supplied data from `s.csv`, containing daily returns for N asset and T days. Calculate its mean vector as $\mathbf{m} = \{E(s_1), E(s_2), ..., E(s_N)\}$, and its covariance matrix **K**.

2. Generate a random portfolio vector $\boldsymbol{w} = \{w_1, w_2, \ldots, w_N\}$, where $\|\mathbf{w}\|_1 = \sum_{i=1}^{N} |w_i| = 1$ and $-1 < w_i < 1$ (short selling is allowed).

   If we define $x(t) = \sum_{i=1}^{N} w_i s_i(t)$, then $x \sim N(\mu, \sigma)$ (CLT), where $\mu = \mathbf{w}^T\mathbf{m}$ and $\sigma^2 = \mathbf{w}^T\mathbf{K}\mathbf{w}$.

   Display the expected daily return and the variance of the given portfolio.

3. Determine the optimal portfolio to minimize the risk:

$$\mathbf{w}_{opt} = \min_{\mathbf{w}} \frac{\mathbf{w}^T\mathbf{K}\mathbf{w}}{\mathbf{w}^T\mathbf{w}}$$

   The optimal portfolio can be calculated as that eigenvector of matrix **K** which belongs to the smallest non-zero (>10^{-6}) eigenvalue. Don't forget to normalize this portfolio as well: $\|\mathbf{w}\|_1 = \sum_{i=1}^{N} |w_i| = 1$.

   Display the expected daily return and the variance of the given portfolio.