Due date is August 6, 11 a.m. in class. Report the script and relevant output (no screen shots).

1. *R* library `huge` contains two files with the stock closing prices (during 5 years) and information of most of the S&P 500 companies. These files, `names.csv` and `prices.csv`, are available on D2L. Consider a financial portfolio of $100,000 on these stocks.

   The weights of the minimum variance portfolio of two stocks are given by

$$w_2 = \frac{\sigma_1^2 - \sigma_{12}}{\sigma_1^2 + \sigma_2^2 - 2\sigma_{12}} \qquad w_1 = 1 - w_2$$

   For portfolios with n stocks, the weights are given by

$$\underline{w} = \frac{J^T \Sigma^{-1}}{J^T \Sigma^{-1} J}$$

   where $\underline{w}$ is a $n \times 1$ vector with the portfolio's weights, Σ is the covariance matrix of the stock *returns*, and J is a vector of ones.

a) (20 pts.) Find the weights of the minimum variance portfolio. Report the annual volatility of this portfolio. Report the ticker symbols of the six companies with the largest weights, and those with the smallest six weights.

b) (20 pts.) Report the portfolio's 10-day 99% VaR and CVaR.

2. A financial institution has the following *naked* portfolio of European options, on a stock with current price 50 dollars and annual volatility 0.32 (annual risk free rate is 0.05).

	Option type	positions	lifetime (months)	strike price
1	Call	-1000	3	$45
2	Call	-500	6	$50
3	Put	2000	6	$45
4	Call	-1500	12	$55

   Two call options, A and B, on the same stock, are available. Option A is a one-year call with $K = 45$, and, option B is a 9-month call with $K = 50$.

   a) (20 pts.) What position z in the number of options A would make the portfolio delta neutral? What is the gamma of this portfolio?

   b) (20 pts.) What positions z in the number of options A, and in the number of shares x, would make the *naked* portfolio delta-gamma neutral? What is the vega of this portfolio?

   c) (20 pts.) What positions in the number of options A and B, and in the number of shares x, would make the *naked* portfolio delta-gamma-vega neutral?