Please load the data "HW06.RData" for this assignment.

There are 3 objects, `rt`, `yt` and `wt`, use command `ls()` to see the list of object names. **Important:** Both `rt` and `yt` are daily returns in percentage (%).

1. The object `rt` contains the daily log returns of 8 stocks, Advanced Micro Devices (AMD), Johnson & Johnson (JNJ), Coca-Cola (KO), Mcdonald's (MCD), Oracle (ORCL), Procter & Gamble (PG), Tesla (TSLA), UnitedHealth (UNH) between January 4, 2011 and December 31, 2020.

```
> cat("Starting dates:\n"); head(rt,2)

Starting dates:

               AMD       JNJ       KO       MCD     ORCL       PG    TSLA     UNH
2011-01-04 3.4806  0.840134 -2.09166 -3.03517 -0.44371  0.27752 0.18765 0.91148
2011-01-05 1.5837 -0.063165 -0.59672  0.46992 -1.40762 -0.23122 0.59813 0.31976

> cat("Ending dates:\n"); tail(rt,2)

Ending dates:

                AMD     JNJ      KO      MCD      ORCL       PG   TSLA      UNH
2020-12-30  1.82608 1.23152 0.57106 -0.54211 -0.093121 -0.47069 4.2321 -0.68176
2020-12-31 -0.63044 0.84868 0.73207  1.41740  0.449300  0.98950 1.5552  1.63587
```

   (a) Fit a multivariate-t model to the returns in `rt`. Show all the MLE's.

   (b) The annual risk free rate is 3%, there are 253 trading days in a year (the daily rate is 3/253). The object `wt` is a portfolio that has 0.10 proportion of risk free asset and 0.90 of risky assets of AMD, JNJ, KO, MCD, ORCL, PG, TSLA, UNH stocks.

```
> wt
risk_free      ORCL       MCD      TSLA        KO       UNH       JNJ        PG      AMD
   0.1000   -0.0437    0.4367    0.1128   -0.0768    0.3305    0.0764    0.0865  -0.0224
```

   What is the distribution of the return of this portfolio? Please include all the parameter estimates.
   **Note:** In `R`, a matrix product operation will return a value in a matrix form including a scalar. E.g. For 2 vectors `a, b` and a matrix A, the product `t(a)%*%A%*%b` returns a $1 \times 1$ matrix. Remove the matrix form of a scalar by applying `as.vector()`.

   (c) For an investment of \$500,000, what are estimates of the one-day Value at Risk (VaR) and Expected Shortfall (ES) at $\alpha = 0.01, 0.02, 0.03, 0.04, 0.05$ (`alpha = seq(.01,.05, .01)`) based on the estimated distribution in part (b)?
   **Note:** Since the return data are in %, please convert the investment `S = 500000/100`. Please do NOT change the return data.

2. The object `yt` is the daily log returns of Goldman Sachs from January 4, 2011 and December 31, 2020.

```
> cat("Starting dates:\n"); head(yt,2)

Starting dates:
```

```
                GS
2011-01-04 0.01734
2011-01-05 0.53014

> cat("Ending dates:\n"); tail(yt,2)

Ending dates:

                GS
2020-12-30 0.55656
2020-12-31 1.62860
```

For an investment of \$200,000, compute the estimated one-day VaR and ES at $\alpha = 0.01, 0.02, 0.03, 0.04, 0.05$ using the following procedures.

(a) Nonparametric estimation.

(b) Parametric estimation with a $t$ distribution.

(c) Semiparametric regression estimation. Use the following candidate bandwidths $m = 50, 100, 200, 300, 400$.

`R` commands for superimposing a fitted line on a scatter plot of `x` and `y`

```
> plot(x,y)
> abline(lsfit(x,y)$coef)
```