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We have three parts in this homework. From this homework, you can learn how to programming in R and perform a Q test.

1. **Technical**: Write a program => Q* test (you may refer to Professor Kuan's *lecture on time series diagnostic test*. Page 2 ~5)

In this part, I would like you to learn:

- How to write a function by your own (input data, loop, return data)
- Call function (source)

2. **Methodological**: download data set on Professor Kuan's website. Plot each data and plot their autocorrelation functions. Perform Ljung-Box test, Box-Pierce test, and Q* test.

In this part, I would like you to learn:

- Input/output data, extract a data type which you want to calculate (read.table, write.table, attributes, \$)
- Plot data and Plot autocorrelation function (plot, acf)
- Recall hypothesis test and perform a statistical test by using R (Box.test(... type="Ljung"...), Box.test(... type="Box-Pierce"...))

3. **Interpretative**: Compare results from three q tests. For each series, are results the same by using these 3 Q tests? If yes, what does result show you? If no, please explain why **in detail**.

DGP :

1. AR(1) : $y_t = ay_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, 1)$, $a = (0.2, 0.5, 0.8)$
2. MA(1) : $y_t = \varepsilon_t - a\varepsilon_{t-1}$, $\varepsilon_t \sim N(0, 1)$, $a = (0.2, 0.5, 0.8)$
3. ARMA(1, 1) :
 $y_t - ay_{t-1} = \varepsilon_t - b\varepsilon_{t-1}$, $\varepsilon_t \sim N(0, 1)$, $a = (0.2, 0.5, 0.8)$, $b = 0.2$
4. ARCH(1) :
 $h_t = a_0 + a_1y_{t-1}^2$, $y_t = \sqrt{h_t}\varepsilon_t$, $\varepsilon_t \sim N(0, 1)$, $a_0 = 0.5$, $a_1 = (0.2, 0.5, 0.8)$
5. GARCH(1)
 $h_t = a_0 + a_1y_{t-1}^2 + b_1h_{t-1}$, $y_t = \sqrt{h_t}\varepsilon_t$, $\varepsilon_t \sim N(0, 1)$,
 $a_0 = 0.5$, $a_1 = (0.2, 0.5, 0.8)$, $b_1 = (0.75, 0.45, 0.15)$

Tips :

1. Attributes() function can help user to know what kinds of data type in a variable, say xxx. So, user may choose a data type (for example, num) by using xxx\$num to

extract information they want.

2. Suppose you write `qstarLobato()` in `Q_star_test.r` and save this script in `C:\econ`. Then, if you want to call `qstarLobato()`, you have to type `source(C:/econ/Q_star_test.r)` at R command line. After that, you can use `qstarLobato()`
3. If you gave following questions, such as how to write a function/perform a hypothesis test/how to write a loop/read.table/plot/acf ➔ Please read *lectures on getting started with R*