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1. Assume all of following R functions are relevant to a time series which you want to build an Arima model over (not using auto.arima)

R functions: ndiffs, nsdiffs, diff, tsdisplay, autoplot, monthdays, BoxCox, Arima, checkresiduals

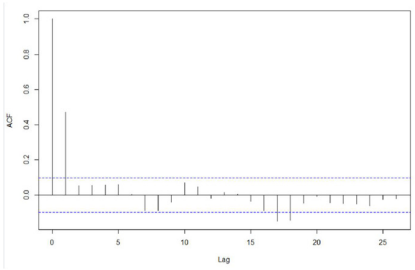
Discuss briefly what order you should call these functions in to estimate an Arima model. Assume all functions must be called exactly once except for diff (which you can use as few or as many times). There may be more than 1 correct answer, focus on whether your sequence will work in practice.

(**6 points**)

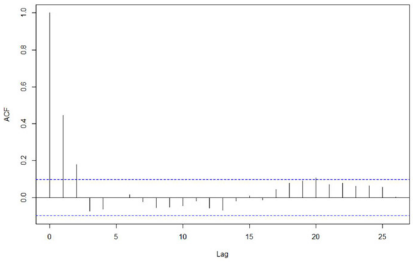
2. The following 3 ACFs have been estimated over artificially simulated time series. Propose possible ARIMA model(s). There may be more than 1 correct answer, although combining clearly 'impossible' suggestions with feasible answers may result in net 0 points awarded

(**10 points total**)

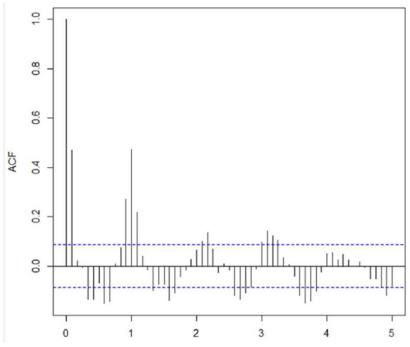
B2a) Propose just 1 possible model based on ACF below



B2b) Propose just 1 possible model based on ACF below



B2c) Propose 1 or more models based on ACF



Possible choices:
SAR(1/2)
SMA(0/1/2)
AR(1/2/3)
MA(0/1/2/3)

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3. We wish to forecast two variables into the future, and both depend on each other. We consider whether to build a VECM. As a feasibility test, we run the Johansen procedure. How many cointegrating relationships are there in the data, based on output below? [**4 points**]

Ans: 1

```
######################
# Johansen-Procedure #
######################

Test type: maximal eigenvalue statistic (lambda max) , with linear trend

Eigenvalues (lambda):
[1] 0.073463811 0.005621199

Values of teststatistic and critical values of test:

          test 10pct  5pct  1pct
r <= 1 |  2.71  6.50  8.18 11.65
r = 0  | 36.63 12.91 14.90 19.19

Eigenvectors, normalised to first column:
(These are the cointegration relations)

             short.run.l2 long.run.l2
short.run.l2     1.000000   1.0000000
long.run.l2     -1.022065  -0.2409262

Weights W:
(This is the loading matrix)

            short.run.l2  long.run.l2
short.run.d  -0.01161738 -0.009806832
long.run.d    0.08880969 -0.014155748
```

Cointegration relationship

4. Regardless of your answer to B3, outline an appropriate course of action if there are no cointegrating relationships. i.e. what model should we then build, should we render the data stationary, outline how we go about building such a model [**5 points**]

5. Regardless of your answer to B3, outline an appropriate course of action if:

1. There is exactly 1 cointegrated relationship
2. We are unable to reject hypothesis that there is more than 1 cointegrating relationship

[**5 points**]

Q4 Correct Answer

1. Render data stationary (applies to all variables)
2. Run vars::VARselect which uses BIC to select initial starting point (lag) order
3. Estimate model based on VARselect
4. Run Ljung-Box test and if pass, done, if fail, increase lag order and iterate until pass
5. If incremented order to very high number and still fail, consider differencing all the variables again

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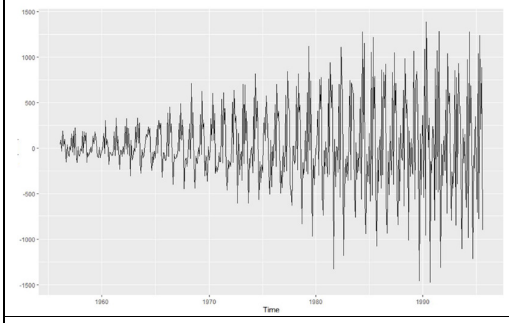
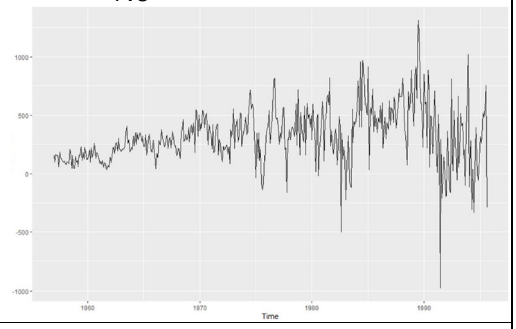
6. Discuss whether following time series are covariance stationary [**10 points**]

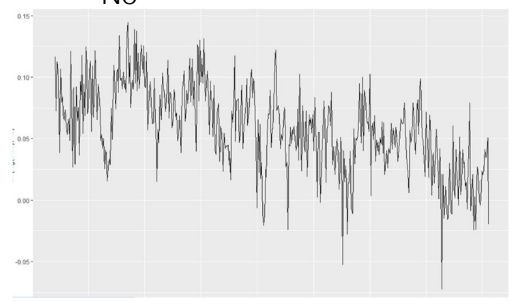
B8a No



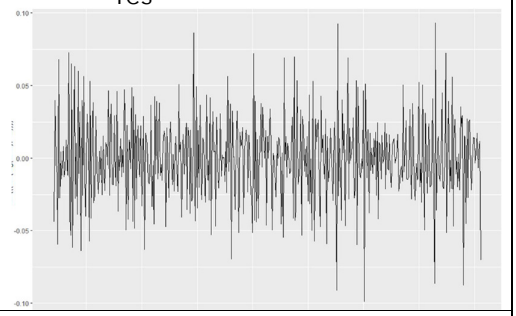
B8b No



B8c No



B8d Yes



B8e Yes