DS 6373 Midterm Fall 2019 In Class Ver A. A Solution

Please put your answers directly on this Word document. When completed, please submit the completed Word doc to the “Midterm” assignment on 2DS and email the test back to me at [bsadler@smu.edu](mailto:bsadler@smu.edu). The take home portion will be due by 11:59pm on Saturday, October 19 and that should be submitted on 2DS under the Midterm assignment as well (and emailed to me.) You can find the take home portion on Github in the Unit 8 folder. By taking this test you are agreeing to not communicate with any human being (or AI) about the in-class or take home portion of this test. You may use your notes, the book, the internet, etc. …. Just no live human or AI (unless you have a question for me.)

Given the data below answer questions 1 -10:

|  |  |
| --- | --- |
|  | 5 |
|  | 9 |
|  | 13 |
|  | 15 |
|  | 14 |
|  | 10 |
|  | 12 |
|  | 17 |
|  | 20 |
|  | 25 |

= 29.4

Questions 1 – 10 are worth 3 points apiece.

You may use R for questions 1 – 10 if you find it helpful (unless otherwise stated to do “by hand.”). Some problems will not require software. When you use R, simply show your code and the relevant output.

1. Calculate / find (you may use R for this question and simply show your code and the result.)

> x <- c(5,9,13,15,14,10,12,17,20,25)

> acf(x, plot = FALSE)

Autocorrelations of series ‘x’, by lag

0 1 2 3 4 5 6 7 8 9

1.000 0.459 0.031 -0.180 -0.065 0.167 0.027 -0.231 -0.371 -0.337

1. Calculate

/

-0.231 = / 29.4

-> = -0.231 \* 29.4 = -6.7914

## Verify

> acf(x, type="covariance", plot = FALSE)

Autocovariances of series ‘x’, by lag

0 1 2 3 4 5 6 7 8 9

29.4 13.5 0.9 -5.3 -1.9 4.9 0.8 -6.8 -10.9 -9.9

>

1. Calculate

= 1

1. Which pair(s) would be used to calculate ?

3 Pairs : (x10, x3) , (x9, x2) and (x8, x1)Values: (25,13), (20, 9) and (17, 5)

1. Given the model: , calculate (“by hand” and show the steps).

> x <- c(5,9,13,15,14,10,12,17,20,25)

>

> phi1 <- 1.65

> phi2 <- -1.06

> phi3 <- .262

> xHat\_l\_plus\_0 <- x[10]

> xHat\_l\_plus\_Negative\_1 <- x[9]

> xHat\_l\_plus\_Negative\_2 <- x[8]

> xHat\_l\_plus\_1 <- phi1 \* xHat\_l\_plus\_0 + phi2 \* xHat\_l\_plus\_Negative\_1 + phi3 \* xHat\_l\_plus\_Negative\_2 + (1 - phi1 - phi2 - phi3)\* mean(x)

> xHat\_l\_plus\_2 <- phi1 \* xHat\_l\_plus\_1 + phi2 \* xHat\_l\_plus\_0 + phi3 \* xHat\_l\_plus\_Negative\_1 + (1 - phi1 - phi2 - phi3)\* mean(x)

> xHat\_l\_plus\_2

[1] 24.6624

## Verify

> fore.arma.wge(x, phi = c(phi1,phi2,phi3), n.ahead = 4, lastn = FALSE, plot = TRUE, limits = TRUE)$f[2]

[1] 24.6624

>

1. Find (“by hand”) the margin of error for the 95% prediction interval for “By hand” here simply means to show the value of all values used in your calculation as we did in live session.

> x <- c(5,9,13,15,14,10,12,17,20,25)

>

> phi1 <- 1.65

> phi2 <- -1.06

> phi3 <- .262

>

> psi\_values <- psi.weights.wge(phi = c(phi1, phi2, phi3), lag.max = 5)

> psi\_0 <- 1

> psi\_1 <- psi\_values[1]

> whiteNoise\_Var <- fore.arma.wge(x, phi = c(phi1, phi2, phi3), n.ahead = 4, lastn = FALSE,limits = FALSE)$wnv

> Half\_Width <- 1.96 \* sqrt(whiteNoise\_Var) \* sqrt(psi\_0^2 + psi\_1^2)

> Half\_Width

[1] 10.63441

> ## Verify

> fcast <- fore.arma.wge(x, phi = c(phi1, phi2, phi3), n.ahead = 4, lastn = FALSE,limits = TRUE)$f

> fcast[2] + Half\_Width

[1] 35.29681

> fore.arma.wge(x, phi = c(phi1, phi2, phi3), n.ahead = 4, lastn = FALSE,limits = TRUE)$ul[2]

[1] 35.29681

>

1. Write an approximation of the GLP form of this model (approximate out to ).

> phi1 <- 1.65

> phi2 <- -1.06

> phi3 <- .262

>

> psi.weights.wge(phi = c(phi1, phi2, phi3), lag.max = 5)

[1] 1.6500000 1.6625000 1.2561250 0.7426562 0.3294653

>

X\_t = + 1.6500+ 1.6625 + 1.2561 + ………+…

1. Provide a plot of the realization including the first 4 forecasts with prediction limits. Include your R code as well.

> x <- c(5,9,13,15,14,10,12,17,20,25)

>

> phi1 <- 1.65

> phi2 <- -1.06

> phi3 <- .262

>

> fore.arma.wge(x, phi = c(phi1, phi2, phi3), n.ahead = 4, lastn = FALSE,limits = TRUE, plot = TRUE)



9. Using the same model, find the factor table and paste below.

> phi1 <- 1.65

> phi2 <- -1.06

> phi3 <- .262

>

> factor.wge(phi = c(phi1, phi2, phi3))

Coefficients of Original polynomial:

1.6500 -1.0600 0.2620

Factor Roots Abs Recip System Freq

1-1.0256B+0.4196B^2 1.2221+-0.9432i 0.6478 0.1046

1-0.6244B 1.6017 0.6244 0.0000

>

10. What behavior is associated with the most dominant factor?

A. Wandering

B. Oscillating

C. Cyclic (Both roots are away from unit circle but complex conjugate root is slightly dominant)

D. The frequencies largely cancel each other out… the model seems to model white noise.

E. The model has non stationary factors.

Questions 11 – 15 are worth 3 points each.

Match the Realization with the acf. Simply Copy and paste the correct acf to the correct row. (Or you may draw arrows if that is easier.)

|  |  |
| --- | --- |
| Realization | ACF |
| 11. |  |
| 12. |  |
| 13. |  |
| 14. |  |
| 15. |  |

Questions 16 – 21 are worth 3 points each.

Match each model on the left with an ACF OR spectral density on the right … each spectral density or ACF will be used only once and process of elimination may need to be used. Simply Copy and paste the correct acf or spectral density to the correct row. (Or you may draw arrows if that is easier.)

|  |  |
| --- | --- |
| 16. AR(1) phi < 0 |  |
| 17. AR(3) with complex conjugate roots |  |
| 18. ARIMA(0,1,0) |  |
| 19. MA(5) with real roots |  |
| 20. Signal Plus Noise Model:  Xt = 3cos(2(.083)t) + at |  |
| 21. MA(2) with complex conjugate roots |  |

Multiple Choice:

Questions 22 – 23 are worth 2 points each.

22. Consider the following statements:

i. It is possible to have a model that is both stationary and invertible.

ii. It is possible to have a model that is both stationary and non-invertible.

iii. It is possible to have a model that is both non-stationary and invertible.

Pick the correct answer:

|  |  |
| --- | --- |
| 1. Only i true 2. Only ii is true. 3. Only iii is true. 4. Only i and ii are true | 1. Only i and iii are true 2. Only ii and iii are true. 3. All are true 4. None are true |

23. What type of models will produce forecasts that will converge directly to the sample mean in a fashion similar to what is displayed below?



|  |  |
| --- | --- |
| A. AR(1) positive phi  B. AR(1) negative phi  C. AR(2) with complex conjugate roots. | E. airline models  F. ARIMA(0,1,0) models  G. signal + noise models |

TRUE / FALSE (1 points each)

24. True / False: After differencing the data or taking out other non-stationary factors, we should have white noise. AR or ARMA Components could also be present

25. True or False: The function aic5.wge() indicates the true autocorrelation structure in the data.

Displays top 5 best models based upon desired score: AIC, BIC or AICC for range of p and q defined. This statistic is only based on a sample and is thus an estimate of the true autocorrelation structure.

26.True or False: We should always select the top (most favored) model when using aic5.wge.

Domain knowledge should also be used and other considerations such as freqeuncy components matching/spectral density plot analysis. The AIC is only one of the tools the time series analysist has at his or her disposal.