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Q4 Q linear model lm()
Arima model Arima()
exponential smoothing model HoltWinters()
plot TSdisplay()

5 b trend, no seasonality

c Try first order differencing ⇒ no trend and seasonality

d ARIMA(3,1,0)
↳ integrated differencing, TS is stationary
↳ PACF should have lags at spike 1, 2, 3 ⇒ continuing above dotted line are part considered significant

E ARIMA (3,1,0) write with backshift operator
$(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3)(1-B)^1 y_t = C+\varepsilon_t$
AR(3) I(1) (0)

F. Minitab AIC, best model ARIMA(3,1,0) AIC of 509
next best ARIMA(4,1,1) aic = 510
next best ARIMA(4,1,0) aic = 511

Q6 Explain $ARIMA(1,1,1)(1,1,1)_4$

(1) AR(1)
(2) SAR seasonality of 4 (1)
(3) Integrated differencing of order 1
(4) I_4 (1)
(5) MA (1)
(6) SMA_4 (1)

6 ii. RHS $(1-\theta_1 B)(1-\alpha_1 B^4)\varepsilon_t$
$= (1-\alpha_1 B^4-\theta_1 B+\alpha_1\theta_1 B^5)\varepsilon_t$
$= \varepsilon_t - \alpha_1\varepsilon_{t-4} - \theta\varepsilon_{t-1} + \alpha_1\theta_1\varepsilon_{t-5}$

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LHS: $(1-\Phi_1 B)(1-\Phi_1 B^4)(1-\beta)(1-B^4)y_t$

$(1-\Phi_1 B)(1-\Phi_1 B^4)[1-B^4-B+B^5]y_t$

$(1-\Phi_1 B)[1-B^4-B+B^5-\Phi_1 B^4+\Phi_1 B^5+\Phi_1 B^8-\Phi_1 B^9]y_t$

$=1-B^4-B+B^5-\Phi_1 B^4+\Phi_1 B^5+\Phi_1 B^8-\Phi_1 B^9-\Phi_1 B+\Phi_1 B^5+\Phi_1 B^8-\Phi_1 B^9$

$\Phi_1^2 B^5+\Phi_1^2 B^9)y_t$

$=y_t-y_{t-4}-y_{t-1}+y_{t-5}-\Phi y_{t-4}+\Phi y_{t-5}+\Phi y_{t-5}-\Phi y_{t-8}-\Phi y_{t-1}+$

$\Phi y_{t-5}+\Phi y_{t-4}-\Phi y_{t-6}+\Phi \Phi y_{t-5}-\Phi_1 \Phi y_{t-9}-\Phi_1 \Phi y_{t-6}+\Phi_1 \Phi y_{t-10}$

c.

t	X_t	L_t	b_t	$F_t = L_t + b_{t-1}$	$X_t - F_t$
1	3	3	1	3	0
				4	0
2	4	4	1		0
3	2	3.5	0.85	5	-3
4				4.35	

i. DES ⇒ Used but no seasonality

$L_2 = 0.5(X_2) + 0.5(L_1 + b_1) = 0.5(4) + 0.5(3+1) = 4$

$b_2 = 0.1(L_2 - L_1) + 0.9(b_1) = 0.1(4-3) + 0.9(1) = 1$

$F_3 = L_2 + b_2 = 4+1 = 5$

$L_3 = 0.5(X_3) + 0.5(L_2 + b_2) = 0.5(2) + 0.5(3) = 3.5$

$b_3 = 0.1(L_3 - L_2) + 0.9 b_2 = 0.1(3.5-4) + 0.9(1) = 0.85$

$F_4 = L_3 + b_3 = 3.5 + 0.85$

ii. Minimal SES OR MSE Sum of Squared Err.