

**Problem 1. ARMA models (50 points)** Simulate 5 years worth of daily data (1826 observations) for an ARMA(4,4) model using the following coefficients values.

$$r_t = \phi_0 + \sum_{i=1}^4 \phi_i r_{t-i} + a_t - \sum_{i=1}^4 \theta_i a_{t-i} \quad (1)$$

Where,

$$\left\{ \begin{array}{l} \phi_0 = 0 \\ \phi_1 = 0.3 \\ \phi_2 = 0.1 \\ \phi_3 = 0.2 \\ \phi_4 = 0.3 \end{array} \right. \quad \left\{ \begin{array}{l} \theta_1 = 0.3 \\ \theta_2 = 0.1 \\ \theta_3 = 0.2 \\ \theta_4 = 0.3 \end{array} \right. \quad (2)$$

- (a) Please show the ACF and PACF plot, as well as the EACF table. What is the recommended order of the corresponding model based on the graphs you plotted?
- (b) Perform a brute force search where you look for the best order of a model fitting the data using the AIC criterion. Please select and write down the orders of the best 5 models from the AIC perspective.
- (c) Use the recommended order from 1.(a) or 1.(b) to estimate the parameters values of the ARMA(4,4) model. Benchmark the estimations with respect to the known parameter values. Comments on your findings.

**Problem 2. Empirical data (50 points)**

- (a) Download Exxon Mobil Corp (XOM) stock daily prices from 2018 March to 2022 Feb and calculate the log returns (using the adjusted close price).
- (b) Please determine the optimal order for an ARMA model (set the max order of AR and MA equal to 10). What's the optimal order of your ARMA model?
- (c) Please use the optimal order you find in question 2.(b) to an ARMA model on the stock data. Analyze the coefficients of the model you selected. Please comment on your findings.