Covariance Matrix Calculator in Python

1 Objective

The objective of this program is as follows:

- Read data from an Excel file and store into arrays $[X_1\ X_2\ X_n]$, where $n = 3$ states $[V\ h\ \alpha]$.
- Sort each array and plot the CDF.
- For each array: calculate:

$$\text{Mean: } \mu_{X_i} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

$$\text{Standard Deviation: } \sigma_{X_i} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu_{X_i})^2}$$

$$\text{Variance: } \sigma_{X_i}^2$$

$$\text{Covariances: } COV(X_m, X_n) = \frac{1}{N}\sum_{i=1}^{N}(x_m - \mu_{x_m})(x_n - \mu_{x_n}),\ m \neq n$$

$$\text{Correlation Coefficient: } (\rho_{X_m X_n}) = \frac{Cov(X_m, X_n)}{\sigma_{x_m}\sigma_{x_n}}$$

- Output the values to the screen
- Output the Covariance Matrix to the screen

For 3 elements, the covariance matrix is given by:

$$C_X = \begin{bmatrix} Var(X_1) & Cov(X_1, X_2) & Cov(X_1, X_3) \\ Cov(X_2, X_1) & Var(X_2) & Cov(X_2, X_3) \\ Cov(X_3, X_1) & Cov(X_3, X_2) & Var(X_3) \end{bmatrix}$$

	A	B	C	D
1	Time	Velocity	Altitude	AoA
2	0	X1 135	X2 2000	X3 0
3	1.5E-06	135	2000	6.3E-08
4	8.9E-06	135	2000	3.8E-07
5	4.6E-05	135	2000	2E-06
6	0.00023	135	2000	9.8E-06
7	0.00116	135	2000	4.8E-05
8	0.00581	134.999	2000	0.00023
9	0.02907	134.993	2000	0.00078
10	0.13451	134.971	1999.94	-0.00323
11	0.27224	134.923	1999.75	-0.02139
12	0.47224	134.642	1999.1	-0.0648
13	0.67224	133.865	1997.82	-0.1181