

$$\mathbf{M}_{3 \times 3} = \mathbf{X}^T \mathbf{X} = \begin{pmatrix} 18 & 42 & 60 & 31 \\ 22 & 27 & 25 & 29 \\ 108 & 125 & 117 & 132 \end{pmatrix}$$

The matrix $\mathbf{M}_{3 \times 3}$ is calculated as the product of \mathbf{X}^T and \mathbf{X} . The calculation involves the following steps:

- The first row of \mathbf{X}^T is $[18, 22, 108]$. The first column of \mathbf{X} is $[18, 42, 60, 31]^T$. The dot product is:

$$18 \times 18 + 22 \times 42 + 108 \times 60 = 324 + 924 + 6480 = 7728$$
- The second row of \mathbf{X}^T is $[42, 27, 125]$. The second column of \mathbf{X} is $[22, 27, 25, 29]^T$. The dot product is:

$$42 \times 22 + 27 \times 42 + 125 \times 25 = 924 + 1134 + 3125 = 5183$$
- The third row of \mathbf{X}^T is $[60, 25, 117]$. The third column of \mathbf{X} is $[60, 25, 25, 29]^T$. The dot product is:

$$60 \times 60 + 25 \times 42 + 117 \times 25 = 3600 + 1050 + 2925 = 7575$$
- The fourth row of \mathbf{X}^T is $[31, 29, 132]$. The fourth column of \mathbf{X} is $[31, 29, 117, 132]^T$. The dot product is:

$$31 \times 31 + 29 \times 42 + 132 \times 25 = 961 + 1218 + 3300 = 5479$$

The final result is the 3×3 matrix:

$$\mathbf{M}_{3 \times 3} = \begin{pmatrix} 7728 & 5183 & 7575 \\ 5183 & 5479 & 6649 \\ 7575 & 6649 & 6649 \end{pmatrix}$$