$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}\begin{bmatrix} e & f \\ g & h \end{bmatrix} = \begin{bmatrix} ae+bg & af+bh \\ ce+dg & cf+dh \end{bmatrix}$$

Given:

$m_1 = (a+d)(e+h) = ae + ah + de + dh$

$m_2 = (c-a)(e+f) = ce + cf - ae - af$

$m_3 = (b-d)(g+h) = bg + bh - dg - dh$

Form:

$m_1 + m_2 = ah + de + dh + ce + cf - af$

$m_1 + m_3 = ae + ah + de + bg + bh - dg$

Need:

$ae + bg = m_1 + m_3 - ah - de - bh + dg$

$af + bh = ?$

$ce + dg = ?$

$cf + dh = m_1 + m_2 - ah - de - ce + af$

Find:

$m_4 = -ah - bh = -h(a+b)$

$m_5 = -de + dg = -d(e-g)$

$m_6 = -ah + af = -a(h-f)$

$m_7 = -de - ce = -e(d+c)$

So:

$ae + bg = m_1 + m_3 + m_4 + m_5$

$af + bh = -ah + af - (-ah - bh) = m_6 - m_4$

$ce + dg = -de + dg - (-de - ce) = m_5 - m_7$

$cf + dh = m_1 + m_2 + m_6 + m_7$

Compute:

$$\begin{bmatrix}5 & 7\\ 4 & 2\end{bmatrix}\begin{bmatrix}9 & 1\\ 3 & 6\end{bmatrix} = \begin{bmatrix}m_1 + m_3 + m_4 + m_5 & m_6 - m_4\\ m_5 - m_7 & m_1 + m_2 + m_6 + m_7\end{bmatrix}$$

$$m_1 = (5)(9) + (5)(6) + (2)(9) + (2)(6) = 45 + 30 + 18 + 12 = 105$$

$$m_2 = (4)(9) + (4)(1) - (5)(9) - (5)(1) = 36 + 4 - 45 - 5 = -10$$

$$m_3 = (7)(3) + (7)(6) - (2)(3) - (2)(6) = 21 + 42 - 6 - 12 = 45$$

$$m_4 = -(5)(6) - (7)(6) = -30 - 42 = -72$$

$$m_5 = -(2)(9) + (2)(3) = -18 + 6 = -12$$

$$m_6 = -(5)(6) + (5)(1) = -30 + 5 = -25$$

$$m_7 = -(2)(9) - (4)(9) = -18 - 36 = -54$$

$$\begin{bmatrix}105 + 45 - 72 - 12 & -25 + 72\\ -12 + 54 & 105 - 10 - 25 - 54\end{bmatrix} = \begin{bmatrix}66 & 47\\ 42 & 16\end{bmatrix}$$