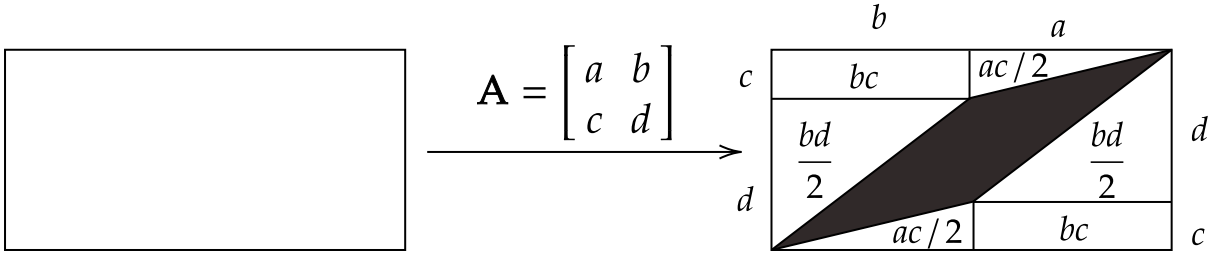

$$\det\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+b)(c+d) - ac - bd - 2bc = ad - bc$$