The original `eqnarray*` would give this (we have to split it in separate lines):

$$\begin{aligned} A &= B, \\ \sin x &= \cos x, \\ \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} = 0 &\left|\begin{matrix} \iff \\ \neq \end{matrix}\right| \text{FALSE}, \\ C &\iff D, \\ \text{foo} &= \text{bar}. \end{aligned}$$

Proof. `eqnarray*` works in the same way as `align*`, even in `proof`:

$$\begin{aligned} A &= B, & \sin x &= \cos x, \\ \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} = 0 &\left|\begin{matrix} \iff \\ \neq \end{matrix}\right| \text{FALSE}, & C &\iff D, & \text{foo} &= \text{bar}. \end{aligned}$$ □

Proof. And the original `align*`:

$$\begin{aligned} A &= B, & \sin x &= \cos x, \\ \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} = 0 &\left|\begin{matrix} \iff \\ \neq \end{matrix}\right| \text{FALSE}, & C &\iff D, & \text{foo} &= \text{bar}. \end{aligned}$$ □

Numbered variants — `eqnarray` first:

$$\begin{aligned} A &= B, \sin x & &= \cos x, & & & (1) \\ \begin{pmatrix} 1 & 2 \\ 34 & \end{pmatrix} = 0 &\left|\begin{matrix} \iff \\ \neq \end{matrix}\right| \text{FALSE}, & C &\iff D, \text{foo} & &= \text{bar}. & (2) \end{aligned}$$

and `align` second:

$$\begin{aligned} A &= B, & \sin x &= \cos x, & & (3) \\ \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} = 0 &\left|\begin{matrix} \iff \\ \neq \end{matrix}\right| \text{FALSE}, & C &\iff D, & \text{foo} &= \text{bar}. & (4) \end{aligned}$$