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11.3.2 Example: Determining the Jacobian for a system of two equations

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MO2.8 MO2.10

In this section, we illustrate how to calculate the Jacobian of a system of two equations. Specifically, consider the following two equations,

$$x_0^2 + x_1^2 = 1 \tag{11.9}$$

$$x_1 - \sin(x_0) = 0 \tag{11.10}$$

Write this as a root-finding problem: $r_0 = r_1 = 0$ with

$$r_0(x_0, x_1) = x_0^2 + x_1^2 - 1, \tag{11.11}$$

$$r_1(x_0, x_1) = x_1 - \sin(x_0). \tag{11.12}$$

Then, the Jacobian matrix is

$$J = \nabla \underline{r}(\underline{x}) = \begin{pmatrix} \frac{\partial r_0}{\partial x_0} & \frac{\partial r_0}{\partial x_1} \\ \frac{\partial r_1}{\partial x_0} & \frac{\partial r_1}{\partial x_1} \end{pmatrix} = \begin{pmatrix} 2x_0 & 2x_1 \\ -\cos(x_0) & 1 \end{pmatrix}. \tag{11.13}$$

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