Assignment 5

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1) Find the perpendicular distance from the origin to the line $x–y = 4$ and angle between perpendicular and the positive x-axis.
Solution: The given problem can be expressed as

$$\min_{\mathbf{x}} g(\mathbf{x}) = \|\mathbf{x} - \mathbf{P}\|^2 \tag{0.0.1}$$

$$\text{s.t.} \quad \mathbf{n}^T\mathbf{x} = c \tag{0.0.2}$$

where

$$\mathbf{P} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \tag{0.0.3}$$

$$\mathbf{n} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{0.0.4}$$

$$c = 4 \tag{0.0.5}$$

Solving the equation (0.0.1) using cvxpy we get the solution as,

$$\mathbf{x} = \begin{pmatrix} 2 \\ -2 \end{pmatrix} \tag{0.0.6}$$

The direction vector of the perpendicular is given by,

$$\mathbf{m} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{0.0.7}$$

The angle between the perpendicular and the positive x-axis is given by,

$$\mathbf{e_1} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \tag{0.0.8}$$

$$\cos\theta = \frac{\mathbf{m}^\top\mathbf{e_1}}{\|\mathbf{m}\|\,\|\mathbf{e_1}\|} \tag{0.0.9}$$

$$= \frac{1}{\sqrt{2}} \tag{0.0.10}$$

$$\implies \theta = 45 \tag{0.0.11}$$