Homework 8 Optimization

1. MPP search by optimization

Find the MPP using optimization for the problem in Homework 5. The original problem is stated as follows:

Consider the limit-state function of a shaft in a speed reducer defined by

$$Y = g(\mathbf{X}) = S - \frac{16}{\pi d^3}\sqrt{4F^2l^2 + 3T^2} \tag{1}$$

where d = 39 mm is the diameter of the shaft, l = 400 mm is the length of the shaft, F is the external force, T is the external torque, and S is the yield strength.

Distributions of Random Variables

Variables	Mean	Std	Distribution
External force F	2000 N	220 N	Normal
Torque T	450 N·m	50 N·m	Normal
Strength S	250 MPa	30 MPa	Normal

2. Optimization

(1) Solve the following optimization problem graphically.

$$\min f(\mathbf{x}) = x_1^2 + x_2^2 - 2x_1 - 2x_2$$

$$\text{s.t. } g_1(\mathbf{x}) = x_1 + x_2 - 4 \le 0$$

$$g_2(\mathbf{x}) = 2 - x_1 \le 0$$

$$x_1, x_2 \ge 0$$

(2) Solve the above problem by a numerical method. You may use any optimization software. Attach the code you used.

3. Optimization for worse case analysis

If the three variables F, T, and S in problem 1 are interval values. Find the range of Y defined in Eq. (1). Use the following lower and upper bounds for the interval variables:

$$X_{\min} = \mu_X - 2\sigma_X,\ X_{\max} = \mu_X + 2\sigma_X$$

where X is F, T, or S.