Problem Statement:
In maritime operations, tugboats are used to maneuver large ships by pulling them with ropes. The strength of the rope is critical to ensure safe and efficient operations. The goal is to maximize the strength of the rope used by the tugboat to pull a wooden ship. The strength of the rope depends on several factors, such as the material composition, thickness, and length of the rope.

To solve this problem, we will use a Genetic Algorithm (GA), which is a heuristic optimization technique inspired by the process of natural selection. The GA will evolve a population of candidate solutions (ropes) over generations to find the optimal combination of parameters that maximizes the rope's strength.

Parameters and Their Valid Ranges:
Material Composition (M): The percentage of high-strength fibers (e.g., Kevlar) in the rope.

Range: [0, 100] (0% to 100%)

Thickness (T): The diameter of the rope in millimeters.

Range: [10, 50] mm

Length (L): The length of the rope in meters.

Range: [10, 100] meters

Twist Factor (F): The number of twists per meter in the rope.

Range: [5, 20] twists/meter

Objective Function:
The objective function calculates the strength of the rope based on the parameters. The strength can be modeled as:

Strength (S) $=(M\times 0.8)+(T\times 1.5)+(L\times 0.2)+(F\times 0.5)$

Here, the coefficients represent the relative contribution of each parameter to the overall strength.

Constraints:
Material Composition Constraint: The rope must contain at least 20% high-strength fibers to ensure durability. *Constraint:* $M \geq 20$

Thickness Constraint: The rope must not exceed a thickness of 40 mm to remain flexible. *Constraint:* $T \leq 40$

Length Constraint: The rope must be at least 20 meters long to maintain a safe distance between the tugboat and the ship. *Constraint:* $L \geq 20$

Twist Factor Constraint: The twist factor must be at least 10 twists per meter to ensure structural integrity. *Constraint:* $F \geq 10$