Theoretical Models for Computing

Lab #4

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Lab. Procedure

Activity #1: Golden Section Search

Objective: Minimize the function:

$$f(x) = (x-2)^2 + \sin(5x), \quad x \in [0, 4]$$

Task:

- Implement Golden Section Search
- Use a tolerance of ε=10−5
- Plot the function and mark the minimum found.

Activity #2: Gradient Descent in 1D

Objective: Minimize the function:

$$f(x) = x^4 - 3x^3 + 2, \quad \text{starting at } x_0 = 0.5$$

Task:

- Implement gradient descent:

$$x_{k+1} = x_k - \alpha f'(x_k)$$

- Derive

$$f'(x) = 4x^3 - 9x^2.$$

- Try different learning rates a=0.01,0.1,0.3
- Plot x_k vs iterations. Analyze convergence.

Activity #3: Newton's Method

Objective: Minimize the function:

$$f(x) = \ln(x) + x^2, \quad x > 0, \quad x_0 = 2$$

Task:

- Compute derivatives:

$$f'(x) = \frac{1}{x} + 2x$$
$$f''(x) = -\frac{1}{x^2} + 2$$

- Use Newton's update:

$$x_{k+1} = x_k - \frac{f'(x_k)}{f''(x_k)}$$

- Plot convergence of $f(x_k)$ and number of iterations.
- Discuss behavior near minimum.