

# Numerical Optimization in Robotics

## homework 1 Hints



主讲人 Jinqi Jiang

Bachelor in Control Science&Engineering  
Harbin Institute of Technology (HIT)



# Gradient

$$f(x_1, x_2) = 100(x_1^2 - x_2)^2 + (x_1 - 1)^2$$

$$\nabla f(x_1, x_2) = \begin{bmatrix} 400x_1^3 - 400x_1x_2 + 2x_1 - 2 \\ 200(x_2 - x_1^2) \end{bmatrix}$$

$$\nabla^2 f(x_1, x_2) = \begin{bmatrix} 1200x_1^2 - 400x_2 + 2 & -400x_1 \\ -400x_1 & 200 \end{bmatrix}$$

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**算法 1:** Steepest Gradient Descent with Armijo Condition

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$k := 0, c := c_0, \mathbf{x} := \mathbf{x}_0, found := false;$

**while** *not found* **do**

$\mathbf{g} := \nabla f(\mathbf{x});$

**if**  $\|\mathbf{g}\| < \epsilon$  **then**

$found := true;$

**else**

$\alpha := 1, \mathbf{x}_{new} := \mathbf{x} - \alpha \mathbf{g};$

**while**  $f(\mathbf{x}_{new}) > f(\mathbf{x}) - c\alpha \mathbf{g}^\top \mathbf{g}$  **do**

$\alpha := \alpha/2, \mathbf{x}_{new} := \mathbf{x} - \alpha \mathbf{g};$

**end**

$\mathbf{x} := \mathbf{x}_{new}, k := k + 1;$

**end**

**end**

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# Suggestion

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- You should try different parameters to find an optimal combination for your program to get a better performance.
- It is a great method to visualize your function as well as the workflow of the optimization, then you will discover why the SGD method performance poor or Newton method can not handle the problem with some specific Initial value.
- The most important thing is that you have to check if your homework is submitted in the required format.



感谢各位聆听 !  
Thanks for Listening

