Assignment of Data Mining (4) May 10, 2022

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Object function $f(x) = x \cdot \cos(x \cdot \pi)$, $x \in [0, 4]$ to be minimized is assumed.

1. Calculate the gradient of $f(x)$ with respect to x.

$$\nabla f(x) = cos\left(\pi \cdot x\right) + x\left(-\pi \sin\left(\pi \cdot x\right)\right)$$

$$= \cos\left(\pi \cdot x\right) - \pi x sin\left(\pi \cdot x\right)$$

2. Compute 10 updated values $x^1, x^2, \ldots, x^{10}$ by gradient descent with three setting (a) initial value $x^0 = 0.5$ and step size $\alpha = 0.25$, (b) $x^0 = 0.5$ and $\alpha = 0.1$ and (c) $x^0 = 3.75$ and $\alpha = 0.05$.

(a)

$$x^1 = x^0 - \alpha \nabla f(x^0) = 0.892699082$$

$$x^2 = x^1 - \alpha \nabla f(x^1) = 1.360524121$$

$$x^3 = x^2 - \alpha \nabla f(x^2) = 0.498992713$$

$$x^4 = x^3 - \alpha \nabla f(x^3) = 0.890107592$$

$$x^5 = x^4 - \alpha \nabla f(x^4) = 1.361941961$$

$$x^6 = x^5 - \alpha \nabla f(x^5) = 0.496380823$$

$$x^7 = x^6 - \alpha \nabla f(x^6) = 0.883369775$$

$$x^8 = x^7 - \alpha \nabla f(x^7) = 1.36533559$$

$$x^9 = x^8 - \alpha \nabla f(x^8) = 0.490182253$$

$$x^{10} = x^9 - \alpha \nabla f(x^9) = 0.867277769$$

(b)

$$x^1 = x^0 - \alpha \nabla f(x^0) = 0.657079633$$

$$x^2 = x^1 - \alpha \nabla f(x^1) = 0.886247703$$

$$x^3 = x^2 - \alpha \nabla f(x^2) = 1.077323787$$

$$x^4 = x^3 - \alpha \nabla f(x^3) = 1.092977459$$

$x^5 = x^4 - \alpha\nabla f(x^4) = 1.089864673$

$x^6 = x^5 - \alpha\nabla f(x^5) = 1.09052162$

$x^7 = x^6 - \alpha\nabla f(x^6) = 1.090413184$

$x^8 = x^7 - \alpha\nabla f(x^7) = 1.090413184$

$x^9 = x^8 - \alpha\nabla f(x^8) = 1.090407184$

$x^{10} = x^9 - \alpha\nabla f(x^9) = 1.090408439$

$x = 1.09\ldots$に収束しているといえる.

(c)

$x^1 = x^0 - \alpha\nabla f(x^0) = 3.298124385$

$x^2 = x^1 - \alpha\nabla f(x^1) = 2.910427121$

$x^3 = x^2 - \alpha\nabla f(x^2) = 3.085417311$

$x^4 = x^3 - \alpha\nabla f(x^3) = 3.005127364$

$x^5 = x^4 - \alpha\nabla f(x^4) = 3.047517474$

$x^6 = x^5 - \alpha\nabla f(x^5) = 3.025765475$

$x^7 = x^6 - \alpha\nabla f(x^6) = 3.037171903$

$x^8 = x^7 - \alpha\nabla f(x^7) = 3.031245236$

$x^9 = x^8 - \alpha\nabla f(x^8) = 3.034341081$

$x^{10} = x^9 - \alpha\nabla f(x^9) = 3.032728176$

$x = 3.03\ldots$に収束しているといえる.