HW4

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1 Exercise 2

Consider the function $f(x) = x^2e^{-x} - x$ With $x \in \mathbb{R}$. Determining the behavior of the Armijo gradient method on this function when $x_0 = 0.5$ and $x_0 = 2$.

1.1 Step 1 - Compute the Descent Direction

$h_i = h(x_i) = -\nabla f(x_i)$, stop if $\nabla f(x_i) = 0$
$\nabla f(x) = -x^2e^{-x} + 2e^{-x}x - 1$

1.2 Step 2 - Compute the Step Size rule

$\lambda_i = \lambda(x_i) \triangleq \arg \underset{k\in\mathbb{N}}{max}\{\beta^k | f(x_i + \beta^k h_i) - f(x_i) \leq -\beta^k \cdot \alpha||\nabla f(x_i)||^2\}$
$f(x_i + \lambda h_i) - f(x_i) + \lambda\alpha||\nabla f(x_i)||^2 \leq 0$ for $\lambda = \beta^k$
if $\lambda \in (0, \frac{2(1-\alpha)}{M})$, then $f(x_i + \lambda h_i) - f(x_i) + \lambda\alpha||\nabla f(x_i)||^2 \leq 0$

1.3 Step 3 - Update

Update $x_{i+1} = x_i + \lambda_i h_i$ replace i by i + 1 and goto Step 1.
$f(x_i + \lambda h_i) - f(x_i) + \lambda\alpha||\nabla f(x_i)||^2 \leq \lambda||\nabla f(x_i)||^2(\frac{M}{2}\lambda - (1 - \alpha))$

To Calculate Armijo gradient algorithm when $x_0 = 0.5$, h0 becomes -0.5451. [h1, h2, h3...]
= [0.02001627842295628, 2.658723154969067e07, 1.3633538742396922e12,0.0,0.0,,,]
Eventually, hi converges to be 0.

when $x_0 = 2$, [h1, h2, h3...] = [5.0693825587533325, 3.5393665775984573e07, 1.5543122344752192, 0.0, 0.0, , ,]
Eventually, hi converges to be 0.