13-123-922
Elias Wipfli
13-933-262
Lorenzo Wipfli
16-124-836
Marcel Zauder

Applied Optimization
Exercise 05

5.1 Exact line search for the convex quadratic function

5.2 Gradient descent with exact line search

Given properties:

(i) **objective function:** $f(x) \;=\; \frac{1}{4}x_1^2 + x_2^2$

(ii) **starting point:** $x^{(0)} \;=\; (2,1)$

With this we can calculate the following:

$$
\begin{aligned}
&& \bigtriangledown f(x) &= \begin{pmatrix} \frac{1}{2}x_1 \\ 2x_2 \end{pmatrix} \\
\Rightarrow && \bigtriangledown f(x^{(0)}) &= \begin{pmatrix} \frac{1}{2}\cdot 2 \\ 2\cdot 1 \end{pmatrix} = \begin{pmatrix} 1 \\ 2 \end{pmatrix} =: \Delta x \\
\Rightarrow && x^{(1)} &:= x^{(0)} + t\Delta x \\
&& &= \begin{pmatrix} 2 \\ 1 \end{pmatrix} + t\cdot \begin{pmatrix} 1 \\ 2 \end{pmatrix} \\
&& &= \begin{pmatrix} 2+t \\ 1+2t \end{pmatrix} \\
\Rightarrow && \| \bigtriangledown f(x^{(1)}\|_2 = \| \begin{pmatrix} 2+t \\ 1+2t \end{pmatrix} \|_2 &= \sqrt{(1+\frac{1}{2}t)^2 + (2+4t)^2} \\
&& &= \sqrt{1+t+\frac{1}{4}t^2 + 4 + 8t + 16t^2} \\
&& &= \sqrt{5 + 9t + \frac{65}{4}t^2}
\end{aligned}
$$

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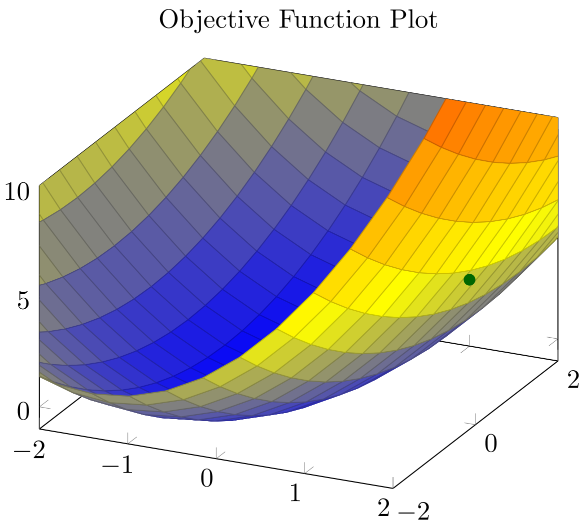

5.3 Programming Exercise: Constrained Mass Spring System