Norwegian University of Science
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Department of Mathematical
Sciences

TMA4180 Optimization Theory
Spring 2013

Exercise set 4

Tutorial: No tutorial on February 14. If you have questions, contact Markus directly.

1 **a)** Find the global minima (in $\mathbb{R}^2$) of the function

$$f(x, y) = 2x^2 + y^2 - 2xy - 2x^3 + x^4. \tag{1}$$

List the general results you are using.

b) Estimate the drop in the error per iteration (expressed in terms of the appropriate norm) of the steepest descent method near the global minima in **a)**.

2 When it is easy to compute first and second derivatives of a one-dimensional function (that is, $x \in \mathbb{R}$ and $f(x) \in \mathbb{R}$), it is possible to combine a trust region algorithm with Newton's method for finding the minimum. Outline an algorithm for this.
Hint: First derive a quadratic approximation to the function. Show that minimizing this function corresponds to the Newton step, plus an investigation involving the endpoints of the domain.

3 Solve the following problems by use of the trust region method, using the file `trustdemo.m` which can be found on the lecture plan.

Try using the Cauchy point, the dogleg method as well as the exact solution of the TR problem.

$$f(x) = x_1^2 - 5x_1x_2 + x_2^4 - 25x_1 - 8x_2 \tag{2}$$
$$f(x) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2 \tag{3}$$
$$f(x) = e^{x_1}(4x_1^2 + 2x_2^2 + 4x_1x_2 + 2x_2 + 1) \tag{4}$$

Compare these methods with the ones you tried in Exercise 2.