Universität Konstanz
Fachbereich Mathematik und Statistik
Prof. Dr. Stefan Volkwein
Martin Gubisch, Roberta Mancini, Stefan Trenz

25th April 2011

# Optimization
# Programming 1

**Part 1** (Armijo step size algorithm)

Implement the Armijo step size algorithm from the lecture using MATLAB. Generate a file `armijo.m` for the function

```
function t = armijo(fhandle, x0, d, t0, alpha, beta)
```

with `fhandle` the handle to a function, initial point `x0`, descent direction `d`, initial step size `t0` and parameters `alpha` and `beta` as known from the lecture. The program should return a step size `t`, that complies with the Armijo condition.

Test your program by using the Rosenbrock function

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

with $x = (x_1, x_2)^T \in \mathbb{R}^2$ and the following parameters:

(a) `x0=[1.7;1.5]`, `d=[-1;0]`, `t0=4`, `alpha=0.1` and `beta=0.5`

(b) `x0=[0;0]`, `d=[1;0]`, `t0=1`, `alpha=0.1` and `beta=0.5`.

Define them in single function files (e.g. `rosenbrock.m`) and call them from a short "main program".

**Tip:** Here it is useful to return the value of the derivative in addition to the function value.

---

**Part 2** (General descent method)

Implement now the general descent method (Algorithmus 3.4) with direction

$$d^k := -\frac{\nabla f(x_k)}{\|\nabla f(x_k)\|}$$

using the Armijo step size strategy.

Generate a file `gradmethod.m` for the function

```
function X = gradmethod(fhandle, x0, epsilon, t0, alpha, beta).
```

with initial point `x0`, parameter `epsilon` for the termination condition $\|\nabla f(x_k)\| < \epsilon$, and parameters `t0`, `alpha` and `beta` for the Armijo rule.

The program should return a matrix `M = [x0; x1; x2; ...]` containing the whole iterations.

Test your program by using the following functions:

a) function $f(x) = \cos(x)$ with `x0 =1.1656`, `epsilon=1.0e-3`, `t0=1`, `alpha=1.0e-2` and `beta=0.5`

b) the Rosenbrock function with `x0 =[1;-0,5]`, `epsilon=1.0e-2`, `t0=1`, `alpha=1.0e-2` and `beta=0.5`

---

**Please note:** Don't forget to comment your code in detail!

- What is this variable for?
- How is the function defined (input arguments and return value)?
- What is the defined function doing?
- What is computed in the loop?
- etc.

**Deadline:** Tuesday, 3$^{\text{rd}}$ May, 10:00 am