Modern Algorithms for Convex Optimisation (Interior Point Methods)

Michal Kočvara

http://web.mat.bham.ac.uk/kocvara
kocvara@maths.bham.ac.uk

DCAMM Course, June 2007

Software for large-scale nonlinear optimization

LANCELOT

Authors:	A. Conn, N. Gould, P. Toint
www:	`http://www.numerical.rl.ac.uk/lancelot/distribution.html`
method:	classic Augmented Lagrangian method
interface:	Fortran/C, CUTE, AMPL
availability:	commercial and academic version, NEOS
remark:	older

SNOPT

Authors:	P. Gill, W. Murray, M. Sounders
www:	`http://www.sbsi-sol-optimize.com/products_snopt.htm`
method:	SQP-BFGS
interface:	Fortran/C, AMPL, GAMS, Matlab
availability:	commercial and academic version, NEOS
remark:	one of the most efficient codes for highly nonlinear problems, 1st order method

KNITRO

Authors:	R. Byrd, J. Nocedal
www:	`http://www.ziena.com/knitro.html`
method:	penalty method for $\leq$ constraints, subproblems solved by SQP-Trust Region
interface:	Fortran/C, AMPL, GAMS, Matlab
availability:	commercial, test version free, NEOS
remark:	one of the most efficient codes for large-scale nonconvex problems

Software for large-scale nonlinear optimization

IPOPT

Authors:	A. Wächter, L. Biegler
www:	`http://www-124.ibm.com/developerworks/oss/coin/Ipopt/index`
method:	interior point
interface:	Fortran/C, CUTE, AMPL
availability:	commercial, test version free, NEOS
remark:	one of the most efficient codes for large-scale nonconvex problems

LOQO

Authors:	H. Benson, R. Vanderbei
www:	`http://orfe.princeton.edu/~loqo/`
method:	interior point
interface:	Fortran/C, AMPL, Matlab
availability:	commercial, test version free, NEOS
remark:	very efficient for convex problems, not so robust for nonconvex ones

PENNON

Authors:	M. Kočvara, M. Stingl
www:	`www.penopt.com`
method:	generalized Augmented Lagrangian method
interface:	Fortran/C, AMPL, matlab
availability:	commercial, test version free, NEOS

AMPL (www.ampl.com)

AMPL (A Modeling Language for Mathematical Programming) is a higher programming language (based on C syntax) specially developed for formulation of optimization problems.

Includes algorithms of automatic differentiation, formulation of mixed-integer problems, complementarity problems and many others.

Most of modern optimization codes include AMPL interface.

A rich source of problems formulated in AMPL can be found on `http://plato.la.asu.edu/topics/testcases.html` (top).

The problems are written in a "natural" way, for instance the problem

$$\min[\sin(x_1 + x_2) + (x_1 - x_2)^2 - 1.5x_1 + 2.5x_2 + 1]$$
$$\text{s.t.} -1.5 \leq x_1 \leq 4, \quad -3 \leq x_2 \leq 3$$

is defined in AMPL:

```
var x {1..2};
minimize obj:
  sin(x[1]+x[2]) + (x[1]-x[2])^2 - 1.5*x[1] + 2.5*x[2] + 1;
subject to constr1: -1.5 <= x[1] <= 4;
subject to constr2: -3 <= x[2] <= 3;
```

NEOS (http://www-neos.mcs.anl.gov/neos/)

NEOS Server for Optimization is a server for online solution of optimization problems. The user just defines his/her problem (e.g. in AMPL), chooses his/her favorable code and send the data to NEOS. The problem is solved on NEOS computers and the results are sent to the user. NEOS interfaces the currently most efficient optimization codes. For instance, codes for nonlinear optimization on
http://www-neos.mcs.anl.gov/neos/solvers/index.html
include

```
* Nonlinearly Constrained Optimization

* CONOPT [GAMS Input]
* FILTER [AMPL Input]
* KNITRO (AMPL input)
* LANCELOT [AMPL Input] [SIF Input]
* LOQO [AMPL Input]
* MINOS [AMPL Input] [GAMS Input]
* MOSEK [AMPL Input] [GAMS Input]
* PATHNLP [GAMS Input]
* PENNON [AMPL Input]
* SNOPT [Fortran Input] [AMPL Input] [GAMS Input]
```

The service is free.