Intelligent and Adaptable Software Systems

Advanced Algorithms: Optimization and Search Methods

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14/15

Course organization

course notes

- Homepage:
  `http://formella.webs.uvigo.es/doc/ssia14`
- whiteboard
  (illustrations, notations, ideas for proofs, algorithms etc.)
- very short introduction to certain aspects related to optimization and search methods, and some applications

Course organization

class room hours (preliminary)

Optimization and Search Methods
initially, fridays, 16:00–18:00, but ...

Course organization

class room hours

- Dr. Arno Formella
  office hours: tuesdays, 09:30-13:30 and 17-19

Bibliography

books

- OUR 519.8.15, OUR 519.8/23, OUR 519.8/24, OUR 519.8/46, OUR 519/17, OUR 519/20

Your work

homework, lab hours, presentations

- browse through the web pages provided in the following slides
- sort the information provided into the categories of optimization methods as mentioned below
- find a web service that allows you to compute the derivation of a function
- use the NEOS–server to find the minimum of the function

$$f(x) = a(x-b)^2 + c + d\cos(e(x-f)+g)$$

for some (different) values of the parameters (maybe you start with $d = e = f = g = 0$).

Your work

more extensive research task I

1. form a group with at most one other student
2. select in accordance with Prof. Arno Formella one of the proposed algorithms on the next slide
3. elaborate a not too short and not too long article (6 to 10 pages) about the algorithm, including at least the aspects stated on the next but one slide.

Your work

more extensive research task II, examples

- Nelder Mead algorithm
- Newton Raphson
- Rodríquez García-Palomares algorithm
- Levenberg Marquardt algorithm
- great deluge algorithm
- local unimodel sampling

Your work

more extensive research task III

your article should treat the following issues

- description of the algorithm
- main field of application
- advantages and disadvantages compared to other algorithms
- available software/implementations
- critical discussion of their APIs
- references on the algorithm and its applications

Bibliography I

links

(working in september 2012)

- `http://www.neos-server.org`
  online optimization project
- `http://www.coin-or.org/index.html`
  pperation research
- `http://www.cs.sandia.gov/opt/survey`
  global optimization
- `http://www.mat.univie.ac.at/~neum/glopt.html`
  global optimization

Bibliography II

links

- `http://www.stanford.edu/~boyd/index.html`
  Stephen P. Boyd, Stanford
- `http://iridia.ulb.ac.be/~mdorigo/ACO/`
  ant colony optimization
- `http://plato.asu.edu/gom.html`
  continuous global optimization software
- `http://www.swarmintelligence.org/index.php`
  particle swarm optimization
- Rui Mendes. *Population topologies and their influence in particle swarm performance*. PhD Thesis, Universidad de Minho, 2004.
  `http://www.di.uminho.pt/~rcm/`

Motivation

what is it?

Optimizing means

- search for (at least) one solution
- which is different from other possible solutions
- in the sense of being (sufficiently) extreme
- within an ordering
- possibly taking into account certain restrictions
- (within a certain limit of computing time).

Example: hiking in a mountain ridge (with fog).

Motivation

examples

Problems which one wants to solve:

- minimizing cost
- maximizing earnings
- maximizing occupation
- minimizing energy
- minimizing resources

Basic concepts

observations

the search space and/or the objective function can be

- discrete or continous
- total or partial
- simple or complex, especially in respect to evaluation time
- explicite, implicite, experimental
- linear or non-linear
- convex or non-convex
- differentiable or non–differentiable
- constrained or unconstrained
- static or dynamic

The objective function must be confined.

Basic concepts

objective functions

- Minimization
- Maximization
- Obviously any maximization problem can be converted to a minimization problem.

Basic concepts

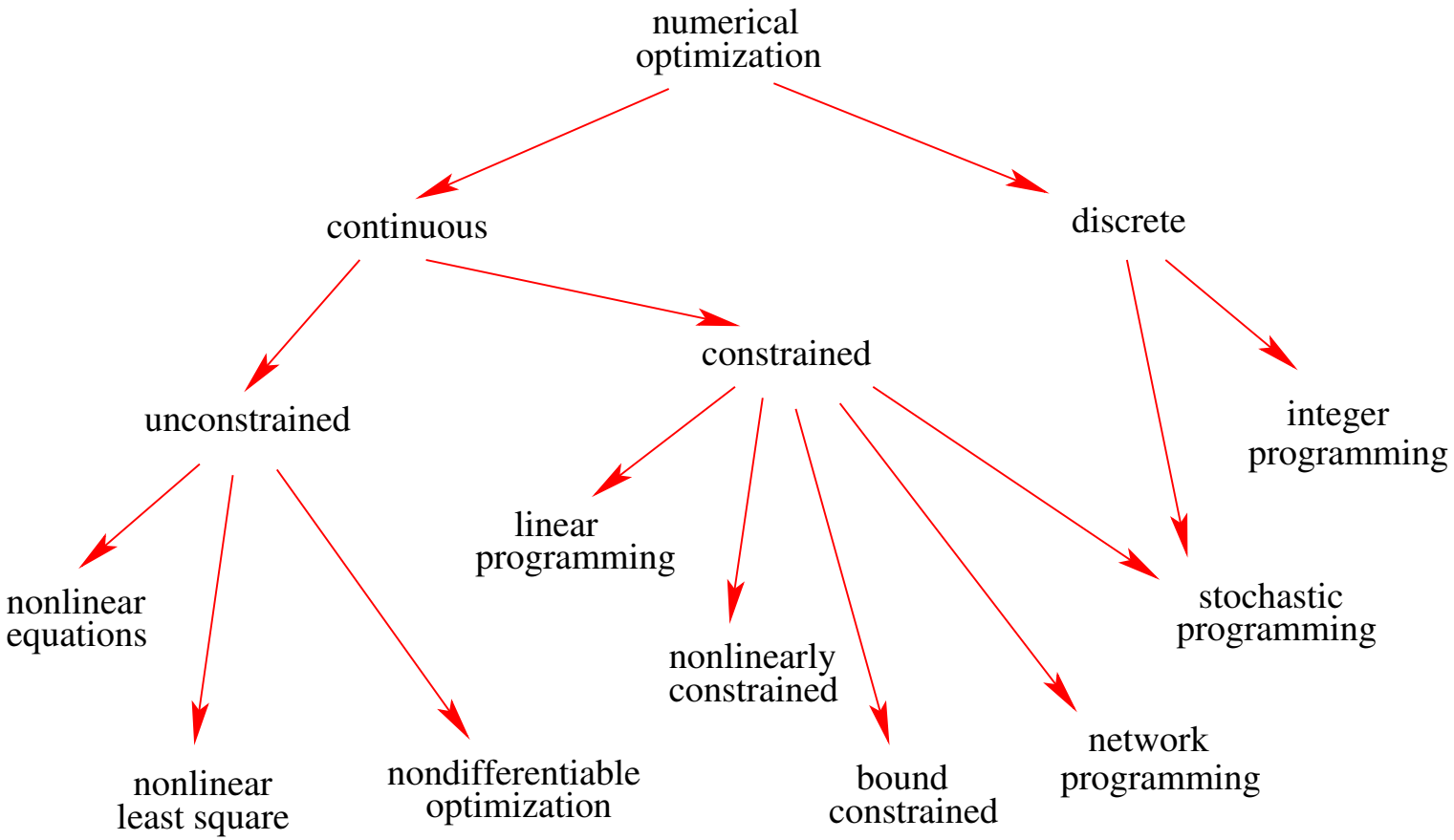
conditions

- restrictions
- feasable solution (feasibility problem)
- coding of the solutions

Basic concepts

classification

(after NEOS server (almost), Argonne National Laboratory)



Basic concepts

types

to be distinguished

local optimization: usually one starts from an initial solution and stops when having found a local (close) minimum

global optimization: one tries to find the best solution globally (among all possible solutions)

- The main problem of global optimization is: getting trapped in a local minimum (premature convergence)

Basic concepts

global optimization (incomplete intent)