

252-0538-00L, Spring 2018

Shape Modeling and Geometry Processing

Shape Optimization



CRL

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Overview

- Review constrained optimization
- How to install OOQP
- Quick look at the code

Questions

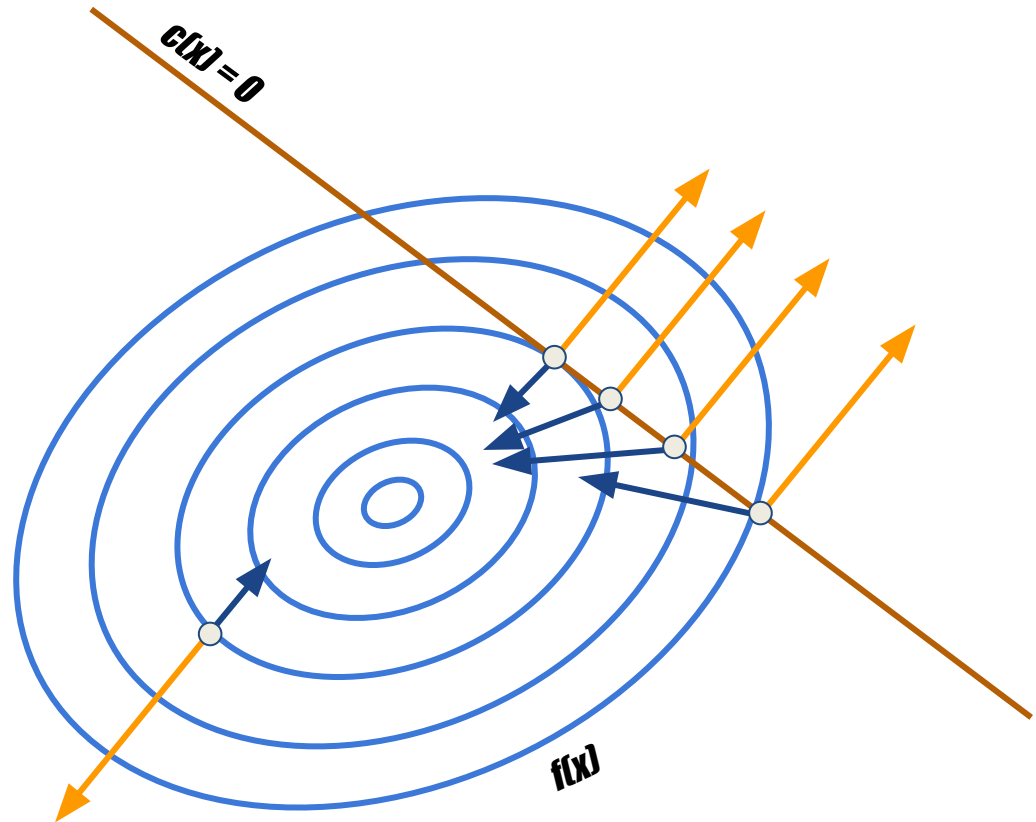
If you have questions about the assignment:

moritzge@inf.ethz.ch

Constrained Optimization

$$\begin{aligned} \min f(x) \\ \text{s.t. } c(x) = 0 \end{aligned}$$

$$\begin{aligned} \nabla f(x) &= \nabla c(x)^T \lambda \\ c(x) &= 0 \end{aligned}$$



Constrained Optimization

$$\begin{array}{ll}\min & f(x) \\ \text{s.t.} & c(x) = 0\end{array}$$

$$\min_{x, \lambda} \underbrace{f(x) - c(x)^T \lambda}_{\mathcal{L}(x, \lambda)}$$

$$\begin{array}{ll}\nabla f(x) = \nabla c(x)^T \lambda \\ c(x) = 0\end{array} \longrightarrow \begin{bmatrix} \nabla f(x) - \nabla c(x)^T \lambda \\ c(x) \end{bmatrix} = 0$$

↑

Quadratic Programming

$$\min_x \frac{1}{2} x^T H x + g^T x$$

$$\text{s.t. } Ax = b$$



$$\begin{bmatrix} \nabla f(x) - \nabla c(x)^T \lambda \\ c(x) \end{bmatrix} = 0$$

linear system of equations

Sequential Quadratic Programming

```
while  $\begin{bmatrix} \nabla f(x) - \nabla c(x)^T \lambda \\ c(x) \end{bmatrix} \neq 0$  do
```

```
    compute H, g, A
```

```
    solve  $\min_x \frac{1}{2} x^T H x + g^T x$   
          s.t.  $Ax = b$ 
```

```
    do line search on  $\phi(\mathbf{x})$ 
```

```
    x += dx
```

merit function

For more details, have a look at chapter 18 in
**Nocedal, Jorge, and Stephen Wright. "Numerical
optimization" Springer, New York, USA, 2006 (2006).**

Setting up OOQP (1)

1. Download precompiled OOQP libraries.
username: crl, password: sm2018

Windows:

<http://crl.ethz.ch/teaching/shape-modeling-18/exercises/libraries/OOQP-windows.zip>

Linux:

<http://crl.ethz.ch/teaching/shape-modeling-18/exercises/libraries/OOQP-linux.zip>

MacOS:

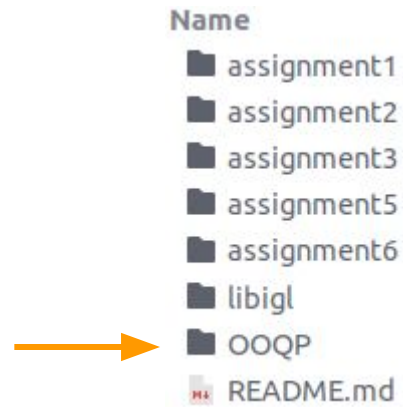
<http://crl.ethz.ch/teaching/shape-modeling-18/exercises/libraries/OOQP-macos.zip>

or compile it yourself:

<https://github.com/emgertz/OOQP>

Setting up OOQP (2)

2. Extract zip to root folder of repository:



3. Linux: install `libgfortran-7-dev` and `libblas-dev`

Ubuntu: `apt install libgfortran-7-dev libblas-dev`

Let's look at the code

```
class YourObjective : public ObjectiveFunction { };

class YourConstraints : public FunctionConstraints { };

ObjectiveFunction* objective = new YourObjective;
FunctionConstraints* constraints = new YourConstraints;

SQPFunctionMinimizer minimizer;
VectorXd x(2); x << 100, -100;
minimizer.minimize(objective, constraints, x);
```

Good luck!

any questions?
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