Numerical Optimisation (COMP0120)

**Description**

**Aims:**
The aim is to provide the students with an overview of the optimization landscape and a practical understanding of most popular optimization techniques and an ability to apply these methods to problems they encounter in their studies e.g. MSc project/dissertation and later in their professional carrier.

**Learning outcomes:**
On successful completion of the module, a student will be able to:

1. practically understand a comprehensive set of optimization techniques and their range of applicability;
2. implement mathematical methods;
3. apply these techniques to problems they encounter in their studies e.g. MSc project/dissertation and later in their professional carrier;
4. critically evaluate the results, which the methods produced for a given problem;

**Content:**
This module teaches a comprehensive range of state of the art numerical optimization techniques. It covers a number of approaches to unconstrained and constrained problems, methods for smooth and non-smooth convex problems as well as basics of non-convex optimisation;

**Syllabus:**

- Mathematical formulation and types of optimisation problems;
- Unconstrained optimization theory e.g.: local minima, first and second order conditions;
- Unconstrained optimization methods e.g.: line-search, trust region, gradient descent, conjugate gradient, Newton, Quasi-Newton, inexact Newton;
- Least Squares problems;

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**Key information**

- **Year**: 2019/20
- **Credit value**: 15 (150 study hours)
- **Delivery**: PGT L7, Campus-based
- **Reading List**: View on UCL website
- **Tutor**: Dr Marta Betcke
- **Term**: Term 2
- **Timetable**: View on UCL website

**Assessment**

- Report: 40%
- Coursework: 20%
- Coursework: 40%

**Find out more**

For more information about the department, programmes, relevant open days and to browse other modules, visit [ucl.ac.uk](http://ucl.ac.uk).
Constrained optimization theory e.g.: local and global solutions, first order optimality, second order optimality, constraints qualification, equality and inequality constraints, duality, KKT conditions;

Constrained optimization methods for equality and inequality constraints e.g.: constraints elimination, feasible and infeasible Newton, primal-dual method, penalty, barrier and augmented Lagrangian methods, interior point methods;

Non-smooth optimization e.g. subgradient calculus, proximal operator, operator splitting, ADMM, non-smooth penalties e.g. L1 or TV;

**Requisites:**
In order to be eligible to select this module, a student must be registered on a programme for which it is a formally-approved option or elective choice AND must have (i) strong competency in Linear Algebra and Analysis; (ii) fluency in matrix calculus; and (iii) working knowledge of Matlab.

The Coursework needs to be completed using Matlab and all the solutions are provided in Matlab.