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;
  - Constrained optimization theory e.g.: local and global solutions, first order optimality, second order optimality, constraints qualification, equality and inequality constraints, duality, KKT conditions;

**Key information**

**Year** 2019/20
**Credit value** 15 (150 study hours)
**Delivery** PGT L7, Campus-based
**Reading List** [View on UCL website](http://www.ucl.ac.uk)
**Tutor** Dr Marta Betcke
**Term** Term 1
**Timetable** [View on UCL website](http://www.ucl.ac.uk)

**Assessment**

For more information about the department, programmes, relevant open days and to browse other modules, visit [ucl.ac.uk](http://www.ucl.ac.uk)

**Disclaimer:** All information correct as of June 2019. Please note that aspects of the module may be subject to change. UCL will make best efforts to inform applicants of major changes.
- 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.