2018

CPSE Summer School
Optimisation under uncertainty

CPSE Summer School 2018
Optimisation under uncertainty

Dates: 3rd-6th of September 2018

Location: Room 266, Level 4, Roderic Hill Building
                    Imperial College London
                    South Kensington Campus

Organisers: Cristina Bertulli, Antonio del Rio Chanona, Niall Mac Dowell,
                    Carlos Pozo Fernandez, Diana Iruretagoyena Ferrer, Andres
                    Gonzalez Garay, Clara F Heuberger, Angel Galan Martin,
                    Senait Selassie, Wolfram Wiesemann

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Internet access: eduroam, for more information see section 5

Contents:

1   Welcome Address

On behalf of the Centre for Process Systems Engineering (CPSE), we would like to welcome all the students, experts and student mentors to this inaugural CPSE Summer School. We hope that you find the technical programme to be of value and that you enjoy the summer school atmosphere as a whole.

Globally, we are beginning to see process systems engineering (PSE) concepts being used in a panoply of industry and social applications around the globe, and in particular the facility of this discipline to quantitatively describe complex systems under uncertain conditions is of increasing value in our world today. We hope, therefore, that you will find this introductory programme to optimisation under uncertainty encouraging and of great value – be it when you start to look for a career in the near future or when facing challenging optimisation problems in your organisation.

We would like to take this opportunity to thank the commitment and significant support offered by the sponsors and hosts, without whom this event would not be possible:

Finally, we would like to extend our thanks to the hosts, the Department of Chemical Engineering at Imperial College London, for all their assistance in helping to develop this event and in arranging the local logistics.

Cristina Bertulli
Antonio del Rio Chanona
Niall Mac Dowell
Carlos Pozo Fernandez
Diana Iruretagoyena Ferrer
Andres Gonzalez Garay
Clara F Heuberger
Angel Galan Martin
Senait Selassie
Wolfram Wiesemann

2   Detailed Schedule of the Summer School

Time	Monday 3rd	Tuesday 4th	Wednesday 5th	Thursday 6th	Friday 7th
9:00 - 10:30		Ali Mesbah (P1)	Alexander Mitsos (P1)	Boris Houska (P1)	PSE@ ResearchDay UK
10:30 - 11:00		Coffee break	Coffee break	Coffee break	
11:00 - 12:30		Ali Mesbah (P2)	Alexander Mitsos (P2)	Boris Houska (P2)	
12:30 - 14:30		Lunch Break	Lunch Break	Lunch Break	
14:30 - 16:00		Panos Parpas (P1)	Wolfram Wiesemann (P1)	Efstratios N. Pistikopoulos (P1)	
16:00 - 16:30		Coffee break	Coffee break	Coffee break	
16:30 - 18:00		Panos Parpas (P2)	Wolfram Wiesemann (P2)	Efstratios N. Pistikopoulos (P2)	
18:00 - 21:00	Registration, Welcome address & BBQ dinner				

All lectures are taking place at Room 266, Level 4, Roderic Hill Building. Please note, however, that the event on Monday evening takes place at 170 Queen's Gate.

Maps of Imperial College can be found further below.

3   Speaker Information

Ali Mesbah

Arbitrary Polynomial Chaos for Uncertainty Quantification of Stochastic Nonlinear Systems

Traditional sample-based uncertainty propagation methods are generally computationally expensive for optimization applications. In this talk, we will introduce the concept of polynomial chaos, which has emerged as an efficient uncertainty propagation method for analysis, estimation, and control of nonlinear systems with probabilistic uncertainties. In particular, we will discuss arbitrary polynomial chaos (aPC) for quantification of probabilistic uncertainties with arbitrary measures (e.g., uncertainties with correlated multivariate or multi-modal distributions). We will demonstrate the application of aPC for the design and performance verification of model predictive control (MPC) and optimal experiment design problems for stochastic nonlinear systems.

Model Predictive Control under Uncertainty

Model predictive control (MPC) is the most widely used approach for optimization-based control of multivariable systems with state and input constraints. MPC relies on a model to predict the behavior of the system. Whether data driven or based on first principles, this model is uncertain to some extent, generally because of incomplete knowledge of the system. In this talk, we will discuss: (i) various robust and stochastic MPC formulations under model structure and parameter uncertainty, and (ii) how learning can be incorporated into MPC to reduce model uncertainty. The formulations and concepts will be demonstrated on several chemical engineering benchmark problems.

Ali Mesbah is Assistant Professor of Chemical and Biomolecular Engineering at the University of California at Berkeley. Before joining UC Berkeley, he was a senior postdoctoral associate at MIT. He holds a Ph.D. degree in systems and control from Delft University of Technology. He is a senior member of the IEEE Control Systems Society and AIChE. He is on the IEEE Control Systems Society conference editorial board as well as the editorial board of IEEE Transactions on Radiation and Plasma Medical Sciences. He is the recipient of the AIChE's 35 Under 35 Award in 2017, the IEEE Control Systems Outstanding Paper Award in 2017, and the AIChE CAST W. David Smith, Jr. Graduation Publication Award in 2015. His research interests are in the areas of optimization-based systems analysis, fault diagnosis, and predictive control of uncertain systems.

Panos Parpas

Introduction to Dynamic Programming - The Curse of Dimensionality and Recent Developments

In the first part of the talk, we introduce fundamental concepts from dynamic programming such as the principle of optimality, closed/open feedback control and finite/infinite horizon problems. In the second part of the talk, we discuss recent developments for DP algorithms based on randomisation and aggregation. These algorithmic developments lie at the core of the recent success of deep neural network-based approximate methods in the AlphaZero program, which attained superhuman levels of play for the games of chess, Go, and others.

Panos Parpas is a Senior Lecturer in the Computational Optimisation Group of the Department of Computing at Imperial College London. Before joining Imperial College, he was a postdoctoral fellow at the MIT Energy Initiative (2009-2011). He is interested in the development and analysis of algorithms for large-scale optimisation problems.

Alexander Mitsos

Global Optimization of Hierarchical Programs: Bilevel and (G)SIP

The presentation gives an introduction into hierarchical programming in general and the global solution of problems belonging to that family in particular. Bilevel programs (BLPs) and (generalized) semi-infinite programs ((G)SIPs) and their distinguishing properties are introduced. Relations and reformulations between the different forms of hierarchical programs are given before recent advances in discretization algorithms for their global solution are presented. After a brief introduction into the general concept of discretization algorithms, recent advances in algorithms with guaranteed feasibility for SIPs are discussed. Furthermore, a method for the extension of discretization algorithms for GSIPs and BLPs to coupling equality constraints is presented. The presentation closes with application examples from current research in process and power systems engineering, which rely on the advances discussed previously.

Alexander Mitsos is a Full Professor (W3) in RWTH Aachen University, and the Director of the Laboratory for Process Systems Engineering (AVT.SVT), comprising 40 research and administrative staff. He also has a joint appointment at Forschungsentrum Juelich where he is a director of IEK-10 Energy Systems Engineering. Mitsos received his Dipl-Ing from University of Karlsruhe in 1999 and his Ph.D. from MIT in 2006, both in Chemical Engineering. Prior appointments include military service, free-lance engineering, involvement in a start-up company, a junior research group leader position in the Aachen Institute of Computational Engineering Science and the Rockwell International Assistant Professorship at MIT. His research focuses on optimization of energy and chemical systems and development of enabling numerical algorithms.

Wolfram Wiesemann

Introduction to Robust Optimization

Traditionally, uncertainty-affected decision problems are solved by modelling the uncertain problem data as random variables and subsequently discretising the outcomes of these random variables. Although this is a very natural approach, it has several shortcomings: it requires the exact specification of the underlying stochastic process (which is rarely available in practice), and it results in a curse of dimensionality for dynamic (multi-stage) problems, which implies that the computation times grow exponentially with problem size. In this lecture, we review the rapidly growing literature on robust and distributionally robust optimization, which aims to alleviate the aforementioned shortcomings. A robust optimization problem specifies an uncertainty set that contains all possible values for the uncertain problem parameters, and it seeks the best decision in view of the worst parameter realization. A distributionally robust optimization problem, on the other hand, specifies an ambiguity set that contains all possible probability distributions that could govern the uncertain problem parameters, and it seeks the best decision in view of the worst probability distribution. Topics covered include the reformulation and solution of static and dynamic (distributionally) robust optimization problems as well as discrete robust optimization.

Wolfram Wiesemann is Associate Professor of Management Science and Operations as well as Fellow of the KPMG Centre for Advanced Business Analytics at Imperial College Business School, London. Before joining the faculty of Imperial College Business School in 2013, he was a post-doctoral researcher at Imperial College London (2010-2011) and an Imperial College Research Fellow (2011-2012). He was a visiting researcher at the Institute of Statistics and Mathematics at Vienna University of Economics and Business, Austria, in 2010, the Computer-Aided Systems Laboratory at Princeton University, USA, in 2011, and the Industrial Engineering and Operations Research Department at Columbia University, USA, in 2012. Wolfram's research interests revolve around the methodological aspects of decision-making under uncertainty, as well as applications in operations management, energy and finance.

Boris Houska

Robust Model Predictive Control

This lecture aims to give a concise overview of model predictive control (MPC) methods for both linear and nonlinear dynamic systems that are affected by external disturbances. We discuss strategies for formulating and approximately solving robust MPC problems in practice. In detail, we review and discuss convex approximations of linear robust MPC but then also move on to compare generic approaches based on min-max dynamic programming and scenario-trees as well as Tube MPC based on modern set-propagation methods. Because this lecture will have a strong focus on numerical methods and their practical implementation, we also review a number of existing software packages for set computations, which can be used as building blocks for the implementation of robust MPC solvers. Towards the end of this lecture, we will discuss how to implement robust MPC by using an automatic C-code generation strategy for real-time nonlinear model predictive control as implemented in ACADO Toolkit.

Boris Houska is an assistant professor at the School of Information Science and Technology at ShanghaiTech University. He received a diploma in Mathematics from the University of Heidelberg in 2007, and a Ph.D. in Electrical Engineering from KU Leuven in 2011. From 2012 to 2013 he was a postdoctoral researcher at the Centre for Process Systems Engineering at Imperial College London. His research interests include numerical optimization and optimal control, robust and global optimization, as well as fast model predictive control algorithms.

Efstratios N. Pistikopoulos

Multi-Parametric Optimization & Control

Model based multi-parametric optimization provides a complete map of solutions of an optimization problem as a function of, unknown but bounded, parameters in the model, in a computationally efficient manner, without exhaustively enumerating the entire parameter space. In a Model-based Predictive Control (MPC) framework, multi-parametric optimization can be used to obtain the governing control laws – the optimal control variables as an explicit function of the state variables. The main advantage of this approach is that it reduces repetitive on-line control and optimization to simple function evaluations, which can be implemented on simple computational hardware, such as a microchip, thereby opening avenues for many applications in chemical, energy, automotive, and biomedical equipment, devices and systems.

In this lecture, we will first provide a historical progress report of the key developments in multi-parametric optimization and control. We will then describe (i) the underlying theory of multi-parametric linear/quadratic programming, and its extensions to the mixed integer continuous case, (ii) the underlying theory of representing, posing and solving Model Predictive Control (MPC) problems with multi-parametric optimization algorithms and tools, (iii) an overview of Parametric OPtimization (POP) software toolbox, and PARametric Optimization and Control (PAROC) framework, which allows for the representation, modelling and solution of advanced control problems, the integration of design, control and scheduling, and classes of bi-level and tri-level optimization problems, amongst others. Applications in sustainable energy systems, process intensification, smart manufacturing and personalized healthcare engineering will be also briefly discussed.

Professor Pistikopoulos is the Director of the Texas A&M Energy Institute and an Eminent Professor in the Artie McFerrin Department of Chemical Engineering. He was a Professor of Chemical Engineering at Imperial College London, UK (1991-2015) and the Director of its Centre for Process Systems Engineering (2002-2009). At Texas A&M, he is also the Course Director of the Master of Science in Energy, the Director of the Gulf Coast Regional Manufacturing Centre, and the Texas A&M Principal Investigator of the RAPID Manufacturing USA Institute on Process Intensification, co-leading the Modeling & Simulation Focus Area. He holds a Ph.D. degree from Carnegie Mellon University and he worked with Shell Chemicals in Amsterdam before joining Imperial. He has authored or co-authored over 400 major research publications in the areas of modelling, control and optimization of process, energy and systems engineering applications, 10 books and 2 patents. He is a co-founder of Process Systems Enterprise (PSE) Ltd, a Fellow of AIChE and IChemE and the current Editor- in-Chief of Computers & Chemical Engineering. He is the past Chair of the Computing and Systems Technology (CAST) Division of AIChE and he serves as a trustee of the Computer Aids for Chemical Engineering (CACHE) Organization. In 2007, Prof. Pistikopoulos was a co-recipient of the prestigious MacRobert Award from the Royal Academy of Engineering. In 2012, he was the recipient of the Computing in Chemical Engineering Award of CAST/AIChE. He received the title of Doctor Honoris Causa from the University Politehnica of Bucharest in 2014, and from the University of Pannonia in 2015. In 2013, he was elected Fellow of the Royal Academy of Engineering in the UK.

4   Participant Profiles

Name: Adriaen Verheyleweghen **Position:** PhD Student **Year:** 4th **Research:** Health-aware control of subsea processes **Research description:** Developing methods to optimize long-term operation of subsea processes subject to degradation and uncertainties. **Email:** verheyle@ntnu.no
Name: Alireza Eshani **Position:** PhD **Affiliation:** RWTH Aachen University **Research:** Modelling of bioprocesses **email:** alireza.ehsani@bayer.com
Name: Amjad Alqahtani **Position:** PhD **Affiliation:** Imperial College London **Research:** Life cycle assessment of carbon-mitigation technologies **email:** amjad.alqahtani14@imperial.ac.uk
Name: Andrea Bernardi **Position:** Research Associate **Affiliation:** Imperial College London **Research:** Development of detailed kinetic models in the catalytic conversion of CO_2 and hydrogen into fuels **email:** a.bernardi13@imperial.ac.uk
Name: Andrea Gayon Lombardo **Position:** PhD **Year:** 1st **Affiliation:** Imperial College London **Research:** Modelling of electrochemical energy storage (EES) technologies for large scale applications. **email:** a.gayon-lombardo17@imperial.ac.uk
Name: Andreas Hüttermann **Position:** PhD **Affiliation:** RWTH Aachen University **Research:** Operational optimisation of energy systems **email:** andreas.huettermann@ltt.rwth-aachen.de
Name: Andres Chico Proano **Position:** PhD Student **Year:** 1fst **Affiliation:** University College London **Research:** Many-objectives optimization in biorefineries **Research description:** Assessing the optimization of second generation biorefineries for multiple conflicting objectives and demand uncertainty. **email:** andres.chico.17@ucl.ac.uk
Name: Ariel Uribe-Rodriguez **Position:** PhD Student **Year:** 1fst **Affiliation:** Imperial College London **Research:** Global Optimization of Mixed Integer Bilinear Programming models. **Research description:** Developing algorithms to solve large scale MIBP problems arising in the petroleum supply chain such as refinery planning and crude oil logistics. **email:** a.uribe-rodriguez17@imperial.ac.uk

Name: Asmaa Harraz **Position:** PhD **Affiliation:** Imperial College London **Research:** Optimisation of the performance of thermally-driven diffusion-absorption refrigeration cycle using intermittent heat sources **email:** a.harraz17@imperial.ac.uk
Name: Avinash Vijay **Position:** Research Associate **Affiliation:** University of Oxford **Research:** Flexibility in Low Carbon Energy Systems **Research description:** Algorithms that manage distributed energy resources in energy markets of the future. **email:** avinash.vijay@eng.ox.ac.uk
Name: Azeem Janjua **Position:** Double MSc **Year:** 2nd **Research** Modelling and optimisation of a district heating network & energy centre **Research description** Working on a spatial development strategy to optimise the design and expansion of a heat network which utilises waste heat from data centres. **Email:** ajanjua17@gmail.com
Name: Carlos Valero **Position:** PhD Student **Affiliation:** STU FCHPT Institute of Information Engineering, Automation, and Mathematics **Year:** 1st **Research:** Guarantee Estimation over Nonlinear Systems **Research description:** Developing new algorithms and/or theories to optimize nonlinear systems with bound uncertainties. Especially over Chemical Processes. **email:** qvalero@stuba.sk
Name: Caroline Blocher **Position:** PhD **Affiliation:** Imperial College London **Research:** Fault detection and diagnosis in dynamically adaptive water distribution networks **email:** c.blocher16@imperial.ac.uk
Name: Chryssa Kappatou **Position:** PhD **Affiliation:** RWTH Aachen University **Research:** Advanced Optimization Strategies for Bioreactors **email:** Chryssa.Kappatou@avt.rwth-aachen.de
Name: Daniel Rodriguez Vallejo **Position:** PhD **Year:** 2nd **Affiliation:** Imperial College London **Research:** Economic and environmental assessment and optimisation of chemical processes **Research description**: Developing new algorithms to optimize chemical engineering models which present a high degree of nonlinearity and stiffness. **email:** d.rodriguez16@imperial.ac.uk
Name: Di Zhang **Position:** Research Associate **Affiliation:** Imperial College London **Research:** Biomass supply chain for power plants in the UK / low carbon fuels/chemicals pathways from Solar **email:** di.zhang@imperial.ac.uk

Name: Dimitrios Nerantzis **Position:** Research Associate **Affiliation:** Imperial College London **Research:** Pump scheduling problems in water distribution networks, with combination of renewable energy resources **email:** dimitrios.nerantzis10@imperial.ac.uk
Name: Eduardo Nolasco **Position:** PhD **Year:** 1st **Affiliation:** University of Cambridge **Research:** Oil-refinery process optimisation **email:** en307@cam.ac.uk
Name: Fabian Neumann **Position:** PhD **Affiliation:** Karlsruhe Institute of Technology (KIT) **Year:** 1st **Research:** Energy System Modelling and Optimisation **Research Description:** Developing methodologies to improve power network representations in cross-sectoral decarbonised energy system models that co-optimise generation, transmission and storage expansion. **email:** fabian.neumann@kit.edu
Name: Fariba Rahimi **Position:** PhD **Affiliation:** Karlsruhe Institute of Technology (KIT) **Year:** 4th **Research:** Integrated Design and Optimization of Mechatronic Systems **Research description:** Developing models and tools to integrate design and optimization of mechatronic systems in an early phase to avoid time and cost consuming iterations of detecting the errors in the system in the later design stages. **email:** frahimi@kth.se
Name: Federico d'Amore **Position:** PhD **Affiliation:** University of Padova **Year:** 2nd **Research:** Optimisation of European supply chains for CCS **Research description:** Optimisation of a European supply chain for carbon capture, transport and storage under uncertainty on local sequestration capacity. **email:** federico.damore@phd.unipd.it / f.damore18@imperial.ac.uk
Name: Filippo Pecci **Position:** Research Associate **Affiliation:** Imperial College London **Research:** Optimisation, optimal control and estimation problems for water supply networks **email:** f.pecci14@imperial.ac.uk
Name: Francesca Belfiore **Position:** PhD **Year:** 2nd **Affiliation:** EPFL Valais Wallis **Research:** Optimisation of the deep energy retrofits in complex systems **email:** francesca.belfiore@epfl.ch
Name: Gbemi Oluleye **Position:** Research Associate **Affiliation:** Imperial College London **Research:** Role of low carbon technologies in domestic and industrial energy systems **email:** o.oluleye@imperial.ac.uk

Name: George Maraveleas **Position**: MSc Student **Affiliation:** Imperial College London **Research**: Crystal Structure Prediction **Research Description**: Application of the Crystal Predictor and Crystal Optimizer algorithms on blind test molecules using improved parameters for repulsion-dispersion potentials. **email**: maraveleas@gmail.com
Name: Gyula Dorgo **Position:** PhD Student **Affiliation:** University of Pannonia **Year:** 2nd **Research:** Development of advanced alarm management solutions **Research description:** Frequent sequence mining, process mining and deep learning algorithms for effective fault diagnosis and event prediction in industrial alarm management. **email:** gydorgo@fmt.uni-pannon.hu
Name: Ibrahim M. Algunaibet **Position:** PhD Student **Affiliation:** Imperial College London **Year:** 1st **Research:** Energy systems modelling **Research description:** Contribution to the optimisation of energy systems considering life cycle sustainability criteria **email:** i.algunaibet18@imperial.ac.uk
Name: Jack Speakman **Position:** PhD **Year:** 1st **Affiliation:** The University of Edinburgh **Research:** Real-time optimisation **email:** s1310295@sms.ed.ac.uk
Name: Jochen Cremer **Position:** PhD **Year:** 2nd **Research:** Machine-Learning based Reliable Power System Operation **Research description:** Operational uncertainties introduced by renewables renders the need for radical new tools to operate reliably the power system. We use data-driven methods to learn predictors that can be used in optimizations to define a reliable (feasible) region to operate the system. **email:** j.cremer16@imperial.ac.uk
Name: Johannes Wiebe **Position:** PhD **Affiliation:** Imperial College London **Research:** Optimization under uncertainty of processes with degrading equipment **email:** j.wiebe17@imperial.ac.uk
Name: Jude Onu Ejeh **Position:** PhD **Year:** 2nd **Affiliation:** University College London **Research:** Optimisation models for the multi-floor process plant layout problem **email:** jude.ejeh.16@ucl.ac.uk
Name: Konrad Fischer **Position:** PhD **Affiliation:** Friedrich-Alexander University Erlangen-Nürnberg **Year:** 2nd **Research:** Dynamic methanation of CO_2 **Research description:** Modelling, simulation and optimisation of the catalytic CO_2 methanation for different reactor concepts. **email:** konrad.L.fischer@fau.de

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|---|
| **Name:** Lauren Yeseol Lee
Position: PhD Student
Year: 1st
Research: Integrated computer-aided molecular and process design
Research description: Developing new mixed integer nonlinear programming algorithms to design new chemical solvents and process units simultaneously.
email: ye.lee17@imperial.ac.uk |
| **Name:** Luis Badesa
Position: PhD
Affiliation: Imperial College London
Year: 3rd
Research: Mapping dynamics into optimisation
Research description: obtaining rules for dynamic security in low-carbon electric grids and implementing these rules into optimisation of the system's operation
email: luis.badesa@imperial.ac.uk |
| **Name:** Luise Middelhauve
Position: PhD
Affiliation: EPFL Valais Wallis
Year: 1st
Research: Mixed Integer Optimization Strategies for Multi Energy Systems
Research description: Defining optimal designs of urban energy systems and devising a roadmap from today's system to the energy system of the future while including a multi-objective approach, model predictive control and the impact of uncertainty.
email: luise.middelhauve@epfl.ch |
| **Name:** Mandar Thombre
Position: PhD Student
Affiliation: Norwegian University of Science and Technology (NTNU)
Year: 2nd
Research: Optimizing energy-efficiency in large industrial systems under uncertainty.
Research description: Developing a systematic framework for realizing optimal energy-efficiency in clusters of process plants via a thermal storage system, in the presence of uncertainty.
email: mandar.thombre@ntnu.no |
| **Name:** Maria Yliruka
Position: MSc
Affiliation: ETH Zurich
email: maria.yliruka@gmail.com |
| **Name:** Mark Nicholas
Position: PhD
Affiliation: Technical University of Denmark (DTU)
Research: Design and Optimisation of Oleochemical Processes
Research description: Superstructure Optimisation with General Disjunctive Programming and Surrogate Models
email: markj@kt.dtu.dk |
| **Name**: Masoumeh Paseh
Position: PhD student
Affiliation: KTH Royal institute of Technology in Sweden
Year: 2nd
Research: Safety analysis for autonomous heavy vehicles
Research description: vehicle control and maneuver planning for highly automated vehicles in order to reach a minimal risk condition in Pre-Crash scenarios
email: mparseh@kth.se |

Name: Mathilde Fajardy **Position:** PhD **Affiliation:** Imperial College London **Research:** Region-specific modelling and optimisation of Bioenergy with Carbon Capture and Storage (BECCS) value chain **email:** mathilde.fajardy16@imperial.ac.uk
Name: Michael Ehrenstein **Position:** PhD **Affiliation:** Imperial College London **Research:** Supply chain risk management and stochastic optimization **email:** me3316@ic.ac.uk
Name: Ayo Olayinka O **Position:** PhD Student **Affiliation:** Imperial College London **Year:** 1st **Research:** Stochastic Integrated Generation-Transmission Expansion Planning Problem **Research description:** Developing a novel risk averse multistage integrated expansion planning model considering uncertainties in renewable energy generation, energy storage and demand-side technologies. **email:** o.ayo17@imperial.ac.uk
Name: Papasavvas Aris **Position:** PhD **Year:** 1st **Affiliation:** The University of Edinburgh **Research:** Real-Time Optimization (RTO) **email:** aris.papasavvas.epfl@gmail.com
Name: Pedro I. O. Filho **Position:** PhD Student **Affiliation:** University College London **Year:** 3rd **Research:** On the design and implementation of a process modelling language for uncertainty **Research description:** Development, implementation and application of a language for modelling uncertainty in design and process optimisation. Our main case study is on the Aerosol-Assisted Chemical Vapour Deposition (AACVD) process. **email:** pedro.filho.15@ucl.ac.uk
Name: Peng Fu **Position:** PhD student **Affiliation:** Imperial College London **Year:** 2nd **Research:** Multi-energy systems **Research description:** Developing a whole system model to optimize the operation and investment problem in multi-energy systems. **email:** p.fu16@imperial.ac.uk
Name: Phantisa Limleamthong **Position:** PhD **Year:** 4th **Affiliation:** Imperial College London **Research:** Systematic Computer Aided Process Engineering Tools for the Optimal Design and Planning of Sustainable Chemical Processes **email:** pl1313@ic.ac.uk
Name: Praveen Bains **Position:** Research Assistant **Affiliation:** Imperial College London **Research:** Modelling and optimisation of energy systems capacity expansion in the UK **email:** p.bains@imperial.ac.uk

Name: Riccardo Benaglia
Position: Data Scientist
Affiliation: Energy Way SRL
Research: Power plant energy production optimization
Research description: Developing statistical models to simulate real systems optimizing the energy production or reducing the energy consumption
email: riccardo.benaglia@energyway.it

Name: Ruth Misener
Position: Senior Lecturer
Affiliation: Imperial College London
Research: Numerical optimisation algorithms and computational software frameworks
Research description: Applications include bioprocess optimisation under uncertainty and petrochemical process network design and operations.
email: r.misener@imperial.ac.uk

Name: Saeed Rahimpour
Position: PhD Student
Affiliation: Lappeenranta University of Technology
Year: 2nd
Research: Supply Chain of Critical Materials: Analysis and Modelling
Research description: Developing new dynamic models for supply chain of critical materials: a) to analyze the environmental benefits and limitations of recycling. b) to optimize the environmental behavior of the system.
email: Saeed.Rahimpour.Golroudbary@lut.fi

Name: Shubhechyya Ghosal
Position: PhD
Year: 1st
Affiliation: Imperial College London
Research: Robust optimisation where the optimal decision is made with respect to the realisation of the worst case by the uncertain parameters
email: s.ghosal16@imperial.ac.uk

Name: Temitayo Oderinwale
Position: PhD
Year: 3rd
Affiliation: Imperial College London
Research: Market-based Generation Investment Planning
Research Description: Developing novel market-based investment planning models to understand the evolution of investment strategy of self-interested generation companies
Email: to514@imperial.ac.uk

Name: Tiago Rodrigues
Position: Research Assistant
Affiliation: Imperial College London
Research: Long-term MILP Stochastic Optimization Models
Research description: Development of new long-term investment models for coordination of energy storage and renewable energy resources using stochastic optimization and decomposition techniques.
email: tiago.a.rodrigues@imperial.ac.uk

Name: Victoria Morgado Mutran
Position: PhD
Year: 3rd
Affiliation: Imperial College London
Research: Optimization Methods applied to Brazilian Sugarcane Mills
Research description: Developing optimization models based on Portfolio Theory to assist investment and production decisions in the Brazilian Sugarcane Sector.
email: v.morgado-mutran18@imperial.ac.uk

Name: Yijun Li **Position:** PhD **Year:** 1st **Affiliation:** Imperial College London **Research:** Future Power Networks **email:** yijun.li16@imperial.ac.uk
Name: Yingjian Guo **Position:** PhD Student **Affiliation:** Imperial College London **Year:** 3rd **Research:** Modelling global natural gas trading and transmission system during low-carbon energy transitioning **Research description:** Developing an agent-based global gas logistic model considering gas market features and policy uncertainties to examine future development and risks in natural gas international trade. **email:** yingjian.guo@imperial.ac.uk
Name: Yingzhao Lian **Position:** MSc **Affiliation:** École polytechnique fédérale de Lausanne (EPFL) **Research:** Stochastic MPC and data-driven control **email:** yingzhao.lian@epfl.ch
Name: Yukun Wang **Position:** PhD **Year:** 3rd **Affiliation:** Imperial College London **Research:** Optimal control of dynamic systems, global optimization of dynamic processes **email:** yukun.wang11@imperial.ac.uk
Name: Zhimian Hao **Position:** Ph.D. Student **Affiliation:** University of Cambridge **Year:** 2nd **Research:** Design of experiment for the kinetic study **Research description:** apply the gradient-free algorithm to identify initials for parameter estimation; apply DoE to predict experimental conditions **email:** zh303@cam.ac.uk

5   Campus Map and Directions

Map of the South Kensington Campus of Imperial College London:
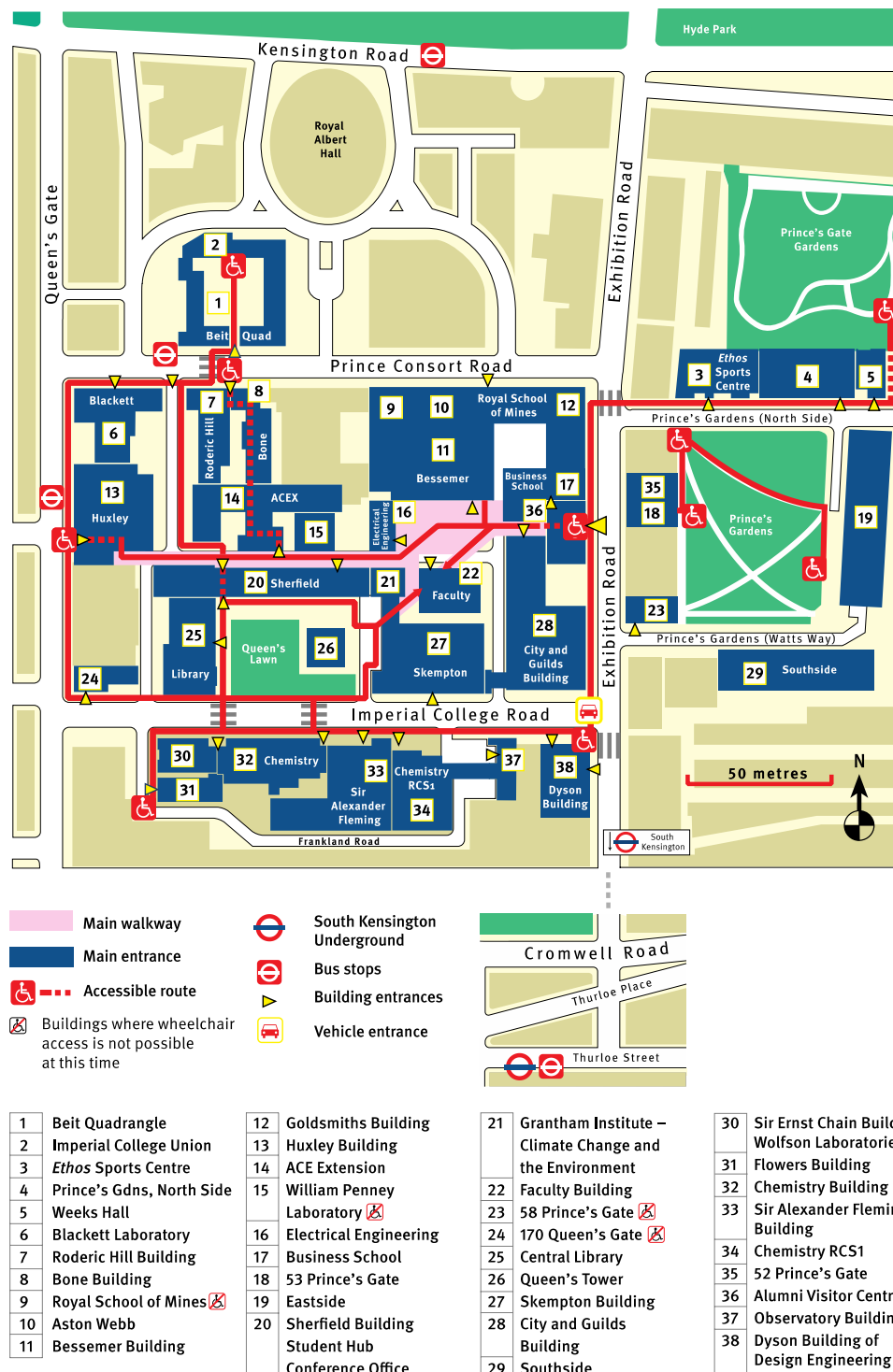
All lectures are taking place at Room 266, Level 4, Roderic Hill Building **[7]**. Please note, however, that the event on Monday evening takes place at 170 Queen's Gate **[24]**.

Directions to Room 266, Level 4, Roderic Hill Building:

The easiest way to get to Roderic Hill Building is from the Sherfield walkway.

The entrance to ACEX is adjacent to the Union shop (selling stationery and clothing) and directly opposite a doorway into the senior common room.

Walking with the common rooms on your left hand side, you will eventually reach the entrance to the ACE Extension on your right hand side.

Walk through the ACEX's glass doors main entrance, up the short flight of stairs and zig-zag through to the foyer of Chemical Engineering. Ahead you will see into the control room of the Chemical Engineerig pilot plant (a large pipework system visible beyond the control room).

Turn left, walking around-and-beyond the enclosed staircase, and into a long social area with seating under the windows. Head through towards the whole length of the breakout seating and go through the double doors at the end, into a corridor of offices.
Continue along the corridor through to the Department of Aeronautics.
Follow the corridor around to the right. At the end, go through the left-hand set of double doors that connect the ACEX to a stairwell of the Roderic Hill Building, marked level 2.

Walk ahead through double doors into the corridor, along to the end and turn right. Room 266 is on the left hand side.

NB: The floor numbers are confusing - stairwell level 4 leads to RODH Building floor 2!

Floor Plan of Level 4, Roderic Hill Building:
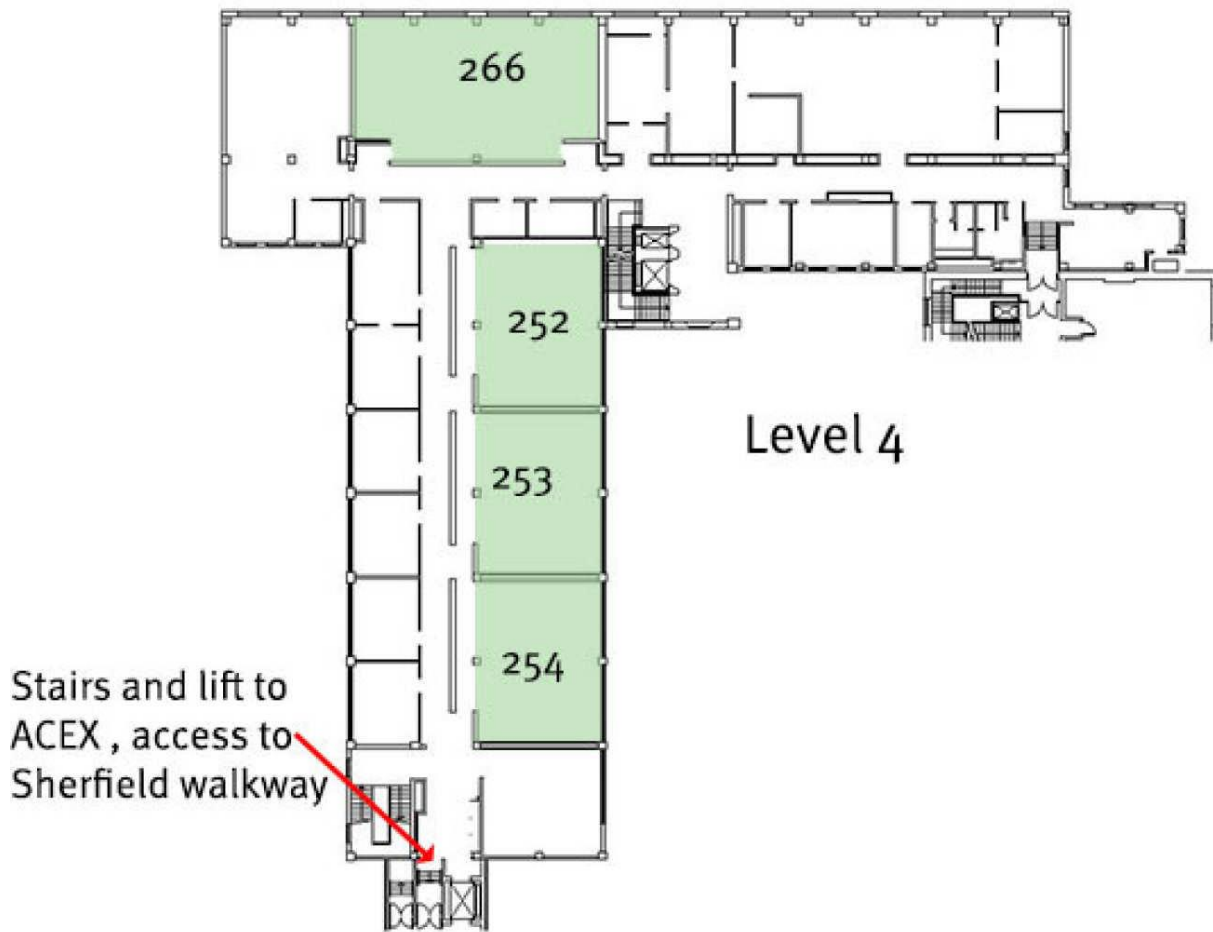
6   Internet Instructions

To connect to eduroam at Imperial, please follow the eduroam instructions provided by your home institution. If your institution does not provide eduroam, please contact the conference organisers.

7   Lunch Locations Around Imperial

Imperial College offers several lunch options on campus: https://www.imperial.ac.uk/food-and-drink/daily-menus/. Moreover, there are several off-campus lunch options nearby. The restaurants and cafés highlighted in orange are within 10 minutes walking distance.

Restaurant Index

☆ Summer School

1. Med Kitchen (Restaurant)
2. Coco Momo (Restaurant)
3. Queen's Arms (Pub)
4. Da Mario (Restaurant)
5. Jakob's (Restaurant/Cafe)
6. L' Etranger (Restaurant $)
7. Pierino Pizza & Pasta (Restaurant)
8. Le Pain Quotidien (Café/Restaurant)
9. East Side (Imperial College Bar/Restaurant)
10. Senior Common Room (Imperial College Restaurant/Cafe)