



# TEMPO Summer School on Hardware Implementation of Embedded Optimisation

July 17 - 21, 2017

Slovak University of Technology in Bratislava, Slovakia

<http://www.uiam.sk/temposchool17>

Lecturers: **Eric Kerrigan** (Imperial College, London), **Michal Kvasnica**, and **Gergely Takács** (Slovak University of Technology in Bratislava)

The aim of this intensive five-days summer schools is to give hands-on experience in implementation of model predictive controllers (MPC) on embedded hardware like field-programmable gateway arrays (FPGAs), programmable logic controllers (PLCs), and Arduino microcontrollers. The course is recommended for both industrial and academic researchers as well as for master and PhD students of engineering, computer science, mathematics, and physics.



**Content:** The school will be composed of three modules:

- The **FPGA module** will give participants hands-on experience in implementing a model predictive controller on a FPGA. The course will include an introduction to hardware description languages, such as VHDL, and the student will implement simple circuits, such as counters, on an FPGA using high level synthesis tools from Xilinx. By the end of the course, the student should be able to implement matrix-vector multiplications within a quadratic programming solver and perform Processor-in-the-Loop tests of a predictive controller.
- The **PLC module** will introduce participants to logic-based programming of PLCs and show how simple controllers can be implemented using basic building blocks. Moreover, in this module students will learn how to implement optimisation-based control strategies using the PicoC interpreter. The module will feature hands-on labs devoted to implementation of an intelligent, optimisation-based thermostat for residential buildings that can run on industrial-grade hardware.
- The **Arduino module** will be a practical, hands-on introduction to programming embedded devices. Participants will learn fundamental ideas and concepts about the intertwined world of microcontroller programming and electronics via the popular Arduino prototyping system. Besides the basics, the module will also offer a particular focus on control-engineering related use of microcontrollers, detailing sensor and actuator interfacing and reliable real-time sampling.

**Prerequisites:** Participants are expected to possess basic knowledge in the areas of optimisation-based control design and Matlab programming. Additionally, a good command of the C language is required. Participants are expected to bring their own notebooks with following software installed:

- For the FPGA module: Vivado, Vivado HLS, and Xilinx SD (<https://goo.gl/gzVrb5>)
- For the PLC module: Loxone Config (<https://goo.gl/1W719w>)
- For the Arduino module: Arduino IDE (<https://goo.gl/LD8F3n>)

**Location and Schedule:** The course takes place from Monday to Friday, July 17-21, 2017, from 9:00-18:00, at the Slovak University of Technology in Bratislava (STUBA). For more information on how to get to Bratislava and STUBA, please visit <http://goo.gl/89YOkf>.

**Registration:** Participation in the course is limited to **50** places. The registration fee is **250 Euro** and covers printed and electronic course materials, guided lab tours, social dinner, coffee breaks, and a free Arduino board for each participant. The application form together with detailed instructions can be found at <https://goo.gl/61020l>. The registration deadline is **May 31, 2017**.

**Internet/Wi-Fi:** Eduroam is available across all STUBA campuses. Please make sure you have registered for eduroam at your home institution before arrival. If you do not have access to eduroam, a guest account can be created for you.

**Accommodation and Meals:** To be organised by each participant individually, there are several hotels in Bratislava, see, e.g., <https://www.visitbratislava.com/> <http://www.hostels.com/> <http://www.booking.com/>

