



**REPORT**

# 140TH European Study Group with Industry

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The 140th European Study Group with Industry (ESGI140) was held at Barreiro, from the 4th to the 8th of June 2018, and it was organized by the Barreiro School of Technology of the Polytechnic Institute of Setúbal along with PT-MATHS-IN. This has been the 12th time that this successful European instrument for cooperation between Mathematics and the Industry took place in Portugal.

During a week, nearly 40 participants, from several nationalities and areas of Mathematics, worked collaboratively in challenges posed by this year participant companies: Infraquinta and Lap2go.

Infraquinta manages the water and the wastewater services of a well-known tourist place in Algarve, known as Quinta do Lago. Tourism increase trend and climate change scenarios can be identified as two predominant drivers which strongly influence Infraquinta's activity and the company presented two of their challenges.

The first one was related to determining which is the desirable balance between fixed and variable revenues, considering the costs and financial structure of the company as well as the consumption uncertainty. The group that has worked in this challenge developed an optimiza-

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tion model that minimizes the maximum price increase while satisfying the recommendations of ERSAR, the Portuguese Water and Waste Services Regulation Authority, also taking into account the financial sustainability of the company. Based on that model several scenarios have been tested, characterized by sales decrease due to climate changes and also changes in the consumer's behaviour.

A second challenge posed by Infraqinta was the evaluation of water meter performance by analysing historical data from water consumption. The goal was to anticipate the need of replacing the water meters before their breakpoint. The main challenge was the decomposition of the monthly time series provided by the company into seasonality, trend and irregular components. A combination of two existing methodologies was able to detect the water meter break points which, if incorporated in a system that automatically analyses the data, might lead to automatic detection of the need of replacing the meters.

*Lap2go* is a timekeeping company for sports events and the challenge they presented was related to the management of road running events with thousands of participants. In this type of events it is usual to use a strategy of starting waves in order to avoid congestions and runners falling down. The goal was to come up with a model that could take into account each participant running pace, the

total number of participants and, if possible, the topography and width of the road, to avoid the aforementioned problems that may be caused by a less suitable starting wave strategy. The group proposed a model based on a system of ordinary differential equations and performed some numerical simulations using also the data provided by the company for a particular race. The model is able to simulate race conditions on arbitrary tracks and can help the organizers to decide the best way to distribute runners into waves and when to release each wave.

The companies' representatives had the chance to work along with groups during the week and were quite satisfied during the final presentations due to the quality of the achieved results. A set of suggestions for future developments has been presented by the groups and some further collaboration between some of the participants and the companies has been envisioned.

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More information about ESGI140 in [www.esgi140.ips.pt](http://www.esgi140.ips.pt).