Trends in control theory at the interface of Systems & Synthetic Biology

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Abstract: Biology offers exciting opportunities for new research in feedback control. This synergy has produced a large body of bioinspired control theory and, moreover, classic control concepts such as robustness and integral control are rapidly becoming commonplace in systems biology research. Currently we are amidst a groundbreaking wave of new control applications in biology, inspired by the birth of synthetic biology as a new paradigm in biological engineering. This open track will collate submissions on control applied to the analysis and design of biomolecular systems. We welcome theoretical contributions in systems biology, as well as applications in synthetic biology, biotechnology and biomedicine. Given the breadth and popularity of this field, the track will help establishing systems and synthetic biology as core domains in the control community.
Technical committee: 8.4 Biosystems and Bioprocesses

Website: `http://homepages.inf.ed.ac.uk/doyarzun/news/IFAC2020-ControlSynSysBio/`

DESCRIPTION

In the early 2000s the field of **Systems Biology** caught the attention of the control community. The interface between biology and control has proven to be a rich hotbed for new control theory to reverse-engineer cellular processes. Almost twenty years on, the field stays healthy and generations of students, postdocs and faculty members have grown within it. Control theory has enabled discoveries across many biological scales, from stochastic dynamics (Lestas et al., 2010; Aoki et al., 2019) to cell signalling (Ma et al., 2009; Angeli et al., 2004) and metabolism (Chandra et al., 2011). This success reflect the ability of control theory to seep through scientific spaces traditionally occupied by life sciences.

Most recently we are witnessing a renaissance in the field, thanks to the birth of **Synthetic Biology** as a new paradigm in biological engineering. One of its most prominent application is the manipulation of microbes for sustainable chemical production and next-generation therapeutics. A key challenge, however, is the lack of predictive methods for designing robust circuits that perform as expected. Unlike more established engineering disciplines, synthetic biology still relies largely on trial-and-error iterations between system design, implementation and testing. The root of this challenge lies in the sheer scale and complexity of living systems. Biomolecular systems are typically made up of hundreds of components that interact in nonlinear and poorly characterized ways. Moreover, biological circuits interact with the cellular host where they reside and, as a result, changes to circuit components cause system-wide perturbations that are challenging to predict and control.

This **general aim** of this open track is to collate the latest developments at the interface of control and biological networks. The track will showcase new theory and computational methods for the analysis and design of biochemical circuits. We aim to attract a wide range contributions and design a bespoke programme that takes maximal advantage of such diversity. We envision a programme that includes contributed talks and panel discussions on current opportunities and challenges in the field. Submissions will be solicited via various networks, including the members of the IFAC TC 8.4 Biosystems and Bioprocesses, the IEEE CSS TC Systems and Synthetic Biology and the CSS Newsletter.

We are looking for submissions of **contributed papers** and **extended abstracts** on topics that include, but are not limited to:

- Stability and robustness of genetic and signalling systems.
- Stochastic analysis of biological networks.
- Identification of biochemical models.
- Nonlinear control design for intracellular systems.
- Design of synthetic gene circuits.
- Control problems in microbial systems.
- Optimal control inspired by biological questions.
- Closed-loop control of cell populations.

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