M8 : Control Using Petri Nets
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The objective of this course is that of presenting Petri nets as a model for the analysis and control of discrete event and hybrid systems, with a particular emphasis on the use of linear algebraic and integer optimizations techniques. The basic model (place/transition nets) is presented and two classical analysis techniques (based on the coverability graph or on the incidence matrix) are presented. Two different approaches for the control of discrete event systems using Petri nets are re viewed. In the first approach, directly inspired by supervisory control theory, a Petri net is seen as a language generator that must be controlled to enforce a given language specification. In a second approach, a state specification is given and the net must be controlled to ensure that no forbidden state is reached. An interesting approach based on integer optimization can also be used to estimate the state of a net: this procedure can be used to design an observer to insert in the control loop, or to de sign a diagnoser for fault analysis. The last part of the course will briefly introduce hybrid Petri nets and the techniques that can be used to control these nets.

- Introduction to place/transitions nets: analysis by coverability graph and by incidence ma trix.
- Supervisory control using Petri nets. Language specifications.
- Control for Generalized Mutual Exclusion Constraints. Monitor places.
- Discrete-event observers using Petri nets. Applications to diagnosis/control
- Hybrid Petri nets

Alessandro Giua is professor of Automatic Control at the Department of Electrical and Electronic Engineering of the University of Cagliari, Italy. He received the Laurea degree in electric engineering from the University of Gagliari, Italy in 1988, and the M.S. and Ph .D. degrees in computer and systems engineering from Rensselaer Polytechnic Institute, Troy, New York, in 1990 and 1992. He has been with the University of Cagliari since 1994. He has been a visiting researcher at the Universidad de Zaragoza (Spain), INRIA Rocquencourt and Lorraine (France), Université d'Angers (France), Université de Metz (France), CINVESTAV Guadalajara (Mexico), Ecole Normale Supérieure de Cachan (France), Université de Reims Champagne -Ardenne (France), Otto-von-Guericke Universitaet Magd eburg, Germany. His research interests include discrete event systems, hybrid systems, automated manufacturing, Petri nets, control of mechanical systems, failure diagnosis. He has published over 150 papers and two text books on these topics. He is a membe r of the editorial board of the journals "Discrete Event Dynamic Systems: Theory and Applications", "IEEE Trans. on Control Systems Technology", "Nonlinear Analysis: Hybrid Systems and Applications"; and he is a reviewer for Mathematical Reviews. He is vic e-chair of the IFAC technical committee on Discrete Event and Hybrid Systems, member of the IFAC technical committee on SAFEPROCESS and chair of the IEEE Control System Society committee on Chapter Activities. He was an associate editor of the "European J ournal of Control", of the "IEEE Trans. on Automatic Control" and a member of the WODES Steering Committee (workshop series on discrete event systems).

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