| **Computational Intelligence and Control Systems** | | | | | | **WSE/HI06 HIFRM** |
|---|---|---|---|---|---|---|
| **4-23 March 2013** | | | | | | **5 ECTS Credit Points** |
| ***Mentor:*** | D. P. Solomatine | | | | | |
| ***Tuition form & study load:*** | *Topic* | *Contact hours* | | | *Study load [hrs]* | *Examination/weight* |
| | | *Lec-ture* | *Exer cise* | *Work shop* | | |
| | Introduction to optimisation | 4 | 2 | 4 | 20 | Exercise report (10%) |
| | Real time control of water systems | 16 | | 12 | 60 | Written exam & exercises (45%) |
| | Data driven modelling and computational intelligence | 14 | | 18 | 60 | Written exam (25%) Exercise report (20%) |
| | (total contact hours 70) | | | | Total 140 | |
| ***Pre-requisites:*** | Module 5 | | | | | |
| ***Learning objectives:*** | After completing the module participants should be able to:<br>1. Understand the main optimisation techniques<br>2. Understand and explain how real-time control systems work<br>3. Identify the potential of control to solve hydrological problems<br>4. Sketch a general plan for a regional real-time control system<br>5. Know the main techniques of data-driven modelling from machine learning (neural networks, model trees, fuzzy systems, etc.)<br>6. Correctly classify a modelling problem as a physically-based, data-driven, or hybrid<br>7. Select proper methods and tools for building data-driven models | | | | | |
| ***Content:*** | **Introduction to optimisation, D. P. Solomatine (IHE)**<br>Classical optimisation. Linear and non-linear optimisation. Derivative-based and direct methods. Dynamic programming. Global (multi-extremum) optimisation. Genetic and evolutionary approaches. Multi-objective optimization. Applications in water sector. Exercises and workshops: optimal water allocation; automatic model calibration | | | | | |
| | **Real time control of water systems, A. Lobbrecht (IHE), S.J. van Andel (IHE), L. Alfonso (IHE)**<br>Introduction to Real-Time Control; Modelling hydrological systems and optimal control problems with AQUARIUS; Control-systems functions and techniques; Hardware and software components; Control systems in industry; Identifying control system components**;** One day field trip to North-West Netherlands. | | | | | |
| | **Data driven modelling and computational intelligence, D. P. Solomatine (IHE) and B. Bhattacharya (IHE)**<br>Modelling in the framework of Hydroinformatics. Data-driven and physically based models.<br>Overview of machine learning and computational intelligence.<br>Main types of machine learning: classification, association, clustering, numeric prediction. Decision, regression and model trees. Artificial neural networks. MLP and RBF networks. Instance-based learning. Fuzzy logic and fuzzy rule-based systems.<br>Exercises and workshops: using data driven methods in hydrological forecasting. | | | | | |
| ***Course materials:*** | Solomatine. *Lecture notes on Data-driven modelling*.<br>Solomatine. *Reader on optimization*.<br>Mitchell. Machine learning. McGraw-Hill, 1997.<br>Witten and Frank. Data mining. Morgan-Kaufman, 2000.<br>Lobbrecht: *Lecture notes on Real time control of water systems*<br>Modelling software: AQUARIUS; Exercises<br>Modelling software: WEKA; GLOBE; Exercises<br>Optimisation software: LINGO; Exercises | | | | | |
| ***Didactics*** | Formal lectures; classroom exercises; home assignments; exercises and workshops in computer lab; classroom workshops on case study analysis | | | | | |
| ***Additional reading:*** | Proceedings of the Hydroinformatics Conferences. Selected papers.<br>Practical Hydroinformatics (Abrahart, See, Solomatine, eds.). Springer, 2008.<br>Artificial neural networks in hydrology, Govindaraju, Rao (eds). Kluwer, 2000. | | | | | |