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TYPE:	Article CC:CCL
JOURNAL TITLE:	Mathematical and computer modelling
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ARTICLE TITLE:	Application of natural computing (computational intelligence) methods to water resources and environmental modelling
ARTICLE AUTHOR:	Maier, Holger R
VOLUME:	44
ISSUE:	5
MONTH:	
YEAR:	2006
PAGES:	413-414
ISSN:	0895-7177
OCLC #:	AFU OCLC #: 16753450
CROSS REFERENCE ID:	[TN:224979][ODYSSEY:130.86.12.238/ILL]
VERIFIED:	

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Preface

Application of natural computing (computational intelligence) methods to water resources and environmental modelling

Over the last 10 to 15 years, natural computing methods have been applied extensively to the modelling and management of our natural and built environments. Data-driven approaches, such as artificial neural networks (ANNs), have been used for prediction and forecasting and evolutionary algorithms (EAs), such as genetic algorithms, have been applied to a range of optimisation problems. More recently, agent based models (ABMs) have been used to gain a better understanding of complex systems, as they enable the inclusion of social and behavioural aspects in the modelling process.

Although ANNs and EAs have found wide acceptance in the research community, a number of obstacles have to be overcome before they can be used routinely by the wider modelling community. Firstly, their success has to be demonstrated for a range of realistic applications, including their advantages over more conventional techniques. Secondly, their transparency needs to be increased, which can be achieved by gaining a better understanding of how they operate and behave. Thirdly, guidelines need to be developed that help users to (i) choose an appropriate method from the ever-growing list of available options and (ii) implement the methods in an efficient manner.

The papers in this issue make a significant contribution towards overcoming some of the obstacles mentioned above. The versatility of EAs for optimisation is highlighted in a number of papers, with applications including the calibration of urban drainage (Siriwardene and Perera), catalyst emission (Whitcombe et al.) and water quality (Gibbs et al.) models, the optimal design of water distribution systems (Zecchin et al.), determination of the optimal length of fishing seasons and the optimal investment in fishing vessel capital (Elliston and Cao), the optimal clustering of ecological data (Maier et al.) and the optimisation of behavioural rules (Purnomo and Guizol). The utility of ANNs for prediction and forecasting is also demonstrated by their successful application to the prediction and forecasting of river flow (Kingston et al.) and water quality in distribution systems (Bowden et al., Gibbs et al.), as well as their favourable performance compared with more traditional modelling approaches.

In relation to the second point, the paper by Kingston et al. addresses the important issue of knowledge extraction from ANNs by introducing a novel stochastic approach for determining the relative contribution of each of the model inputs. The paper by Zecchin et al. also contributes to increasing the understanding, and hence transparency and acceptance, of natural computing methods by conducting an in-depth comparison between the behaviours of two ant-colony optimisation algorithms.

With regard to the third point, a number of the papers in this issue make substantial contributions towards increasing the ease of applicability of natural computing methods by conducting comparative studies between algorithms (e.g. Gibbs et al., Kingston et al., Maier et al. and Zecchin et al.), the development or assessment of parameter guidelines for EAs (Perera et al., Zecchin et al.) or the introduction of methodological advances, such as a new method for determining inputs to ANN models (Bowden et al.) and a novel approach for determining the relative contributions of inputs to ANN models (Kingston et al.), as mentioned previously.

The challenges facing agent based modelling are somewhat different, as the approach is less well established. The papers in this issue provide further evidence of the utility of ABMs for a range of applications, particularly in relation to gaining an understanding of (i) the behaviour of fishing vessels (Elliston and Cao) and of the response of fishing fleets to various regulatory environments (Soulie et al.), (ii) the dynamics between social, economic and biophysical factors in the management of forest plantations (Purnomo and Guizol) and (iii) the utilisation of land and resources

by various stakeholders in the Sahel region of Senegal (Bah et al.). In addition, both Elliston and Cao and Purnomo et al. use GAs to optimise decisions, as mentioned above.

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