Challenges for CPAIOR in Computational Sustainability

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The notions of sustainability and sustainable development were first introduced in the seminal report of the United Nations World Commission on Environment and Development, known as the Brundtland report or Our Common Future [3]. Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their needs." Sustainability and sustainable development concern balancing environmental, economic, and societal needs for a sustainable future.

The development of policies for sustainable development often involves decision making and policy making problems concerning the management of our natural resources involving significant computational challenges that fall into the realm of computing and information science and related disciplines (e.g., operations research, applied mathematics, and statistics).

Computational Sustainability is a new emerging field that aims to apply techniques from computer science and related disciplines to help manage the balance of environmental, economic, and societal needs for sustainable development[1]. The focus of Computational Sustainability is on developing computational and mathematical models, methods, and tools for a broad range of sustainability related applications: from decision making and policy analysis concerning the management and allocation of resources to the design of new sustainable techniques, practices and products. The range of problems that fall under Computational Sustainability is therefore rather wide, encompassing computational challenges in disciplines as diverse as environmental sciences, economics, sociology, and biological and environmental engineering.

In this talk I will provide examples of computational sustainability challenge domains ranging from wildlife preservation and biodiversity, to balancing socio-economic needs and the environment, to large-scale deployment and management of renewable energy sources. I will discuss how computational sustainability problems offer challenges but also opportunities for the advancement of the state of the art of computing and information science and related fields, highlighting some overarching computational themes in constraint reasoning and optimization, machine learning, and dynamical systems. I will also discuss the need for a new approach to study such challenging problems in which computational problems are viewed as "natural" phenomena, amenable to a scientific methodology in which principled experimentation, to explore problem parameter

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spaces and hidden problem structure, plays as prominent a role as formal analysis [2]. Such an approach differs from the traditional computer science approach, based on abstract mathematical models, mainly driven by worst-case analyzes. While formulations of real-world computational tasks lead frequently to worst-case intractable problems, often such real world tasks contain hidden structure enabling scalable methods. It is therefore important to develop new approaches to identify and exploit real-world structure, combining principled experimentation with mathematical modeling, that will lead to scalable and practically effective solutions.

In summary, the new field of Computational Sustainability brings together computer scientists, operation researchers, applied mathematicians, biologists, environmental scientists, and economists, to join forces to study and provide solutions to computational problems concerning sustainable development, offering challenges but also opportunities for the advancement of the state of the art of computing and information science and related fields.

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