Proposal for Biobased Industry Center Grants Program

Project Title: An Interactive Decision Support Tool for Identifying the Most Preferred Policies

Project Leadership

<table>
<thead>
<tr>
<th>Name (PI/Co-PI)</th>
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<tbody>
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Research Priority Addressed by this Project:

- Impact of broader Public Policy (e.g. Agricultural, Energy, Environmental) on Biobased Industry market outcomes
- Impact of Bioenergy policy on broader agricultural markets and other biobased industries

Objectives

Economic, environmental and societal sustainability are key issues in many problems such as urban planning, the design of buildings, and deployment and management of renewable energy sources. The policy makers in these domains have to choose between multiple alternative policies with respect to their impact on the sustainability of the resulting solutions. Typically, the sustainability of an alternative is assessed with respect to a set of sustainability attributes that describe various aspects of the alternative such as its initial and maintenance cost, the amount of pollutants (e.g., toxic, greenhouse gases) it releases into the environment, and the amount of renewable energy used to source the energy needs.

The proposed research aims to develop decision support tools founded on qualitative decision theory that enable:

1. Each of the different stakeholders from the bio-based industry, government and regulatory authorities to:
   a. Specify their preferences and tradeoffs over the factors of environmental, economic and societal sustainability.
   b. Compare several alternative regulatory policies and (rationally) choose the most preferred policy based on the specified preferences.
2. Multiple stakeholders to arrive at a consensus on the choice of policies that are consistent with their preferences.

Approach

Stakeholder preferences are often expressed in qualitative terms. For example, consider the problem of choosing between alternative ways meeting the energy needs of a community. The choice of one energy source over another may be influenced by the stakeholder preferences over factors such as their renewability, their impact on environment (e.g., greenhouse gases), agricultural markets (e.g., affordable food supply), and even global economic and foreign policy. Hence there is a need for decision support tools that empower various stakeholders to choose the policies that are most preferred, i.e., optimally satisfy their preferences.

We propose to design and implement \textit{i-PrefR} (interactive preference reasoner), a decision support tool that builds on recent advances in decision theory by several research groups, including ours\(^1\). Specifically, we start with a set of attributes (e.g., renewability and cost of an

energy source) that correspond to the factors that affect the stakeholders’ preferences. Each alternative is described in terms of the values of each of these attributes. For example, the attributes that correspond respectively to the renewability and (production and maintenance) cost of an energy source may take the following values: High, Moderate, Low; and Affordable, Expensive, Unaffordable. We consider several types of stakeholder preferences, and tradeoffs among preferences in qualitative terms, including:

1. Intra-attribute preferences, i.e., preferences over the various possible values that can be taken by each attribute, e.g., with respect to renewability, High > Moderate > Low (where > denotes ‘is preferred to’);
2. Relative importance of the attributes, e.g., some stakeholders may consider maintenance cost to be more important than production cost.

While intra-attribute preferences make one alternative preferred over another in terms of a particular attribute, relative importance preferences allow one attribute to be traded off against others. Furthermore, the intra-attribute as well as relative importance preferences can be conditional, e.g., when the production cost of an alternative is Affordable, then the renewability may be more important than the maintenance cost; on the other hand, when the production cost is Expensive, then maintenance cost may become more important than renewability.

Given a set of alternative policies and a stakeholder’s preferences, i-PrefR will compute the (provably) most preferred alternative(s). The tool will also identify subsets of alternatives that are indistinguishable with respect to the stakeholder preferences. In addition to allowing each of the stakeholders to identify his/her most preferred policy, i-PrefR can compute one or more consensus policies that maximally satisfy the collective preferences of all the stakeholders.

i-PrefR will offer decision support capabilities based on the latest advances in qualitative decision theory that empower various stakeholders to arrive at informed choices regarding policies that impact the economic, environmental and societal sustainability of bio-based industries.

**Workplan and Schedule**

<table>
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<tr>
<th>Workplan</th>
<th>Dates</th>
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<tr>
<td>Design of i-PrefR</td>
<td>July 2011 – Sep 2011</td>
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**Budget** (indirect not allowed)

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<tr>
<th>CATEGORY</th>
<th>AMT REQUESTED</th>
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<tbody>
<tr>
<td>Salaries (Post-Doc – Half Time)</td>
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<td>Benefits (20.2%)</td>
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<td>Sub-total</td>
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<td>Supplies &amp; Services</td>
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<td>Travel</td>
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<td>TOTAL</td>
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*Includes telecomm, computer use, print/copy, honoraria, services/user fees, postage, etc.*
Vasant G. Honavar

Education
Ph.D., 1990  Computer Science  University of Wisconsin-Madison

Selected Professional Experience

2010- Program Director (on IPA), Information Integration & Informatics  NSF
2005- Director, Center for Computational Intelligence, Learning, & Discovery  Iowa State Univ.
2003-05 Chair, Bioinformatics & Computational Biology Graduate Program  Iowa State Univ.
2002 Visiting Professor, Biomedical Informatics & Biological Statistics  Univ. of Wisconsin
2001- Professor, Computer Science; Bioinformatics & Computational Biology  Iowa State Univ.
1998 Visiting Professor, Computer Science  Carnegie Mellon U.
1990-01 Asst. Professor (90-06), Assoc. Professor (06-01), Computer Science  Iowa State Univ.

Research Interests
Artificial Intelligence, Bioinformatics, Data Mining, Machine Learning, Information Integration, Knowledge Representation and Inference, Semantic Web, Service-Oriented Computing, e-Science.

Selected Awards and Honors: Research Excellence Award, College of Liberal Arts and Sciences, Iowa State Univ., 2008; Iowa State Board of Regents Award for Faculty Excellence, 2007; Best Paper Awards, IEEE ICTAI 2006, Asian Semantic Web Conference, 2006; NSF Research Initiation Award, 1994-99.

Five publications most closely related to the project (Selected from over 220 refereed publications during 1990-2011)


Synergistic Activities

(a) Professor, Graduate Programs in Computer Science, Bioinformatics & Computational Biology, Neuroscience, Information Assurance, and Human-Computer Interaction; Undergraduate Programs in Computer Science and Bioinformatics & Computational Biology.
(b) Founder and Director, Center for Computational Intelligence, Learning, and Discovery (www.cild.iastate.edu), (2005-present), Iowa State University.
(c) Cross-disciplinary Graduate Training in Bioinformatics: Co-PI (with Dan Voytas, Susan Carpenter, Drena Dobbs), Computational Molecular Biology Training Group (Supported by a National Science Foundation Integrative Graduate Education and Research Training (IGERT) award, 1999-2004; 2005-2010). Co-PI (with Volker Brendel, Julie Dickerson Robert Jernigan, Karin Dorman), Summer Institute in Bioinformatics and Computational Biology (Supported by National Science Foundation and the National Institutes of Health, 2003-2006; 2006-2009).
(d) Student Research Supervision and Mentoring: Currently supervising 10 Ph.D. students Supervised research of 22 Ph.D. graduates (9 in academic tenure-track positions, 5 in academic research positions, 8 in industrial R&D), 4 postdoctoral fellows (all now in academia), and 22 M.S. graduates. Supervised research experiences for 12 undergraduates; Mentored 3 high school and junior high school student groups in Adventures in Supercomputing projects (including one that was placed first in the National Competition)
SAMIK BASU

Education

State University of New York at Stony Brook. Computer Science. M.S., Dec 2001

Appointments

08/2003-06/2009. Assistant Professor, Department of Computer Science, ISU.
08/2010-12/2010. Visiting Faculty, Department of Computer Science, UC at Santa Barbara.
06/2009-present. Associate Professor, Department of Computer Science, ISU.

Relevant Publications


Collaborators

University of California at Santa Barbara: Tevfik Bultan and Oscar Ibarra.
State University of New York at Stony Brook: C. R. Ramakrishnan, Scott A. Smolka and R. C. Sekar.
Auckland University, New Zealand: Partha S. Roop and Zoran Salcic.

Graduate Students

Curtis W. Keller (MS, 2005), Natalia Stakhanova (PhD, 2007), Lucas Witt (MS, 2008), Christopher Strasburg (MS, 2009), Sayan Mitra (PhD, 2009)
Michele Ruse (PhD), Zach Oster (MS, 2009, PhD), Tanmoy Sarkar (PhD), Paul Jennings (MS), Yuly Suvorov (MS)
**FACILITIES, EQUIPMENT, AND OTHER RESOURCES: IOWA STATE UNIVERSITY**

**Research Laboratory Facilities**

**Office Space**

All of the faculty, postdoctoral research associate, and graduate student offices are equipped with high-speed Internet access that can be used to connect to research computing facilities, other computing facilities, library, and other resources on campus. Graduate research assistants will have offices in close proximity to each other and the PI and Co-PIs.

**PI and Co-PI Research Laboratory Facilities**

The Artificial Intelligence Research Laboratory (AI Lab) which is directed by Dr. Honavar is part of the Center for Computational Intelligence, Learning, and Discovery. The AI Lab has 18 Linux and Windows workstations. These are connected to centrally administered file servers. The installation and maintenance of the research computing facilities is performed by a research computing systems support specialist in the Computer Science department. Facilities in Computer Science include interconnected LANs of file/compute workstation servers, and a few hundred workstations. Undergraduate Students, Graduate students, faculty, and staff have physical and remote access to the facilities. The departmental networks are bridged to a university-wide fiber-optics backbone which in turn is connected to the Internet.

**Other Resources**

**Virtual Reality Facilities:** The Virtual Reality Applications Center (VRAC) is located in the new Engineering Teaching and Research Complex (ETRC) which is a $60 million facility. VRAC contains the C4 and the C6 fully immersive virtual reality facilities. The C4 is a three-dimensional, immersive, synthetic environment that supports multiple screen configurations. The C4 and the C6 are linked by dedicated fiber between Black Engineering, the location of the C4, and Howe Hall, enabling C6/C4-based research in collaboration across geographically separated virtual reality systems.