Incorporating Computational Sustainability into AI Education through a Freely-Available, Collectively-Composed Supplementary Lab Text

Douglas H. Fisher[1] Bistra Dilkina[2] Eric Eaton[3] Carla Gomes[2]

[1]Vanderbilt University, [2]Cornell University, [3]Bryn Mawr College

douglas.h.fisher@vanderbilt.edu, bistra@cs.cornell.edu, eeaton@cs.brynmawr.edu, gomes@cs.cornell.edu

Abstract

We introduce a laboratory text on environmental and societal sustainability applications that can be a supplemental resource for any undergraduate AI course. The lab text, entitled *Artificial Intelligence for Computational Sustainability: A Lab Companion,* is brand new and incomplete; freely available through Wikibooks; and open to community additions of projects, assignments, and explanatory material on AI for sustainability. The project adds to existing educational efforts of the computational sustainability community, encouraging the flow of knowledge from research to education and public outreach. Besides summarizing the laboratory book, this paper touches on its implications for integration of research and education, for communicating science to the public, and other broader impacts.

Introduction

To help increase the size and diversity of the computing community engaged in environmental and societal sustainability, we have initiated a lab text entitled *Artificial Intelligence for Computational Sustainability: A Lab Companion* (AISustBook, 2012) as a resource for undergraduate AI courses. We intend the text as an exemplar for other computational sustainability supplements, in areas ranging from hardware architecture to database to algorithms.

The AI and sustainability lab text is freely available through the Wikibooks project via a link given in the references. As noted in AISustBook (2012), it is intended to be:

1) "*portable*, a supplement to any primary textbook and other resources used in an undergraduate AI course;"

2) "*online and freely available*, for use in courses worldwide, as well as for use in *broader impact* plans (NSF, 2007) by research teams/projects;"

3) "*compartmentalized* into self-contained sections and exercises, enabling instructors to easily 'snip out' portions of the lab text for use in their courses;"

4) "*interlinked* with AI-related Wikipedia articles, textbooks (e.g., Poole and Mackworth, 2010), online

courses and lectures (e.g., Ng, 2011), online research papers, and other resources (e.g., AAAI, 2012); and"

5) "*community developed*, evolving as projects, assignments, and explanatory material at the intersection of AI and sustainability are written into the text."

The lab text is in early development and can be edited by anyone. Wikibooks' infrastructure supports community-driven content development. Wikibooks fall under a Creative Commons Attribution ShareAlike license, allowing copying and redistribution, with attribution.

After summarizing the content of the lab text, the paper touches on intended broader impacts of the project. All of these points of content and broader impacts are taken from and discussed in greater depth in the "Introduction" of AISustBook (2012).

Overview of Lab Text Contents

The lab text is organized as a collection of self-contained chapters, sections, and exercises, where each explores sustainability applications of an AI topic, including search, constraint-based reasoning, optimization, propositional and first-order inference, deterministic planning, reasoning and planning under uncertainty, sequential decision making, games and mechanism design, machine learning, agent-based modeling, and more. This structure corresponds to the contents of popular AI textbooks (e.g., Russell and Norvig, 2010; Poole and Mackworth, 2010), enabling instructors to selectively use one or more sections to augment the standard AI course material. AI-centric indexing will encourage incorporation of sustainability content into other AI resources; and highlight sustainability problems that share similar or identical problem structure, but which may be in very different sustainability domains. Additionally, there will be secondary indexing through sustainability topics. In this way, the content of the text will be accessible through the two alternative lenses of AI and sustainability, facilitating dialogue between these communities.

Sections and exercises will include explanatory and illustrative material to orient readers on sustainability content and applications. Explanatory text will be accompa-

nied by AI assessment instruments that are relevant to the sustainability topic, including both programming and written exercises of a variety of durations (e.g., in-class, week-long, and multi-week assignments).

Throughout the lab text, there will be pointers to source material and other external references. A "Guidelines for Contributors" section suggests that projects, assignments, and exercises be formatted using the EAAI (2012) conventions for "model assignments," though these guidelines will likely evolve with experience.

Broader Impacts of the Lab Companion

The lab text will facilitate the infusion of environmental and societal sustainability into the AI curriculum, and in the longer term, computer science generally. This represents deep infusion of sustainability into non-sustainability focused courses (e.g., in AI). The intent is not to detract from AI content, but to offer sustainability-contextualized AI material for use as instructors and students see fit. Such course-level infusion differs from and complements curriculum-level infusion (e.g., a course on "Computing and the Environment"). We anticipate other broader impacts too, summarized here and expanded in the lab text.

Integration of Research and Education

Research publications in computational sustainability (ICS, 2012; AAAI, 2011; AAAIb, 2012) typically explain their AI relevance to a larger sustainability (non-AI) audience, often with a particular application in mind. Thus, they are good starting points for translation of research into educational material. Ideally, researchers and educators who follow this translation trajectory will contribute to the lab text. Also, the evolving lab text may be a focal point for broader impact and education plans of research projects, such as NSF proposals and awards.

Communicating Science to the Public

Wikipedia's popularity as a source for students makes accurate and complete communication of science in the medium critical. Thus, various discipline specific efforts, such as the Association for Psychological Science Wikipedia initiative (APS, 2012), are calling upon scientists to contribute to Wikipedia to better insure quality. This activity also exercises scientists in communicating science to the public. We expect that the lab text will lead to contributions to Wikipedia and other online material on AI.

Speaking to Authentic Audiences

Students are more motivated to do quality work when the products of their labors are for *authentic audiences* (e.g., Bruff, 2011), which carry greater social relevance. Ideally,

students who participate as Wikibookians and Wikipedians will see their efforts as contributing to global pedagogy on both sustainability and AI, contributing to a self-image as people who can make a difference in society.

In addition, universities are facing questions of how to embrace and contribute to the ever-increasing freely available educational resources. The lab text is a conduit for AI community contributions to these resources, motivated by reasons of good World and scientific citizenship, as well as to maintain the visibility and vibrancy of educational institutions.

References

AAAI (2011). List of Accepted Papers: **Special Track on Computational Sustainability and AI, r**etrieved from http://www.aaai.org/Conferences/AAAI/2011/aaai11accepts.php

AAAI (2012). Resources for Educators, AAAI. Retrieved from aaai.org/AITopics/EducatorResources

AAAIb (2012). List of Accepted Papers: **Special Track on Computational Sustainability and AI, r**etrieved from http://www.aaai.org/Conferences/AAAI/2011/aaai11accepts.php

AISustBook (2012). Artificial Intelligence for Computational Sustainability: A Lab Companion. Created February 2012, http://en.wikibooks.org/wiki/Artificial Intelligence for Computational Sustainability: A Lab Companion

APS (2012). Association for Psychological Sciences Wikipedia Initiative. Retrieved February 2012 from www.psychologicalscience.org/index.php/members/aps wikipedia initiative

Bruff, D. (2011). A Social Network can be a Learning Network, chronicle.com/article/A Social Network Can Be a/129609 .

EAAI (2012). Model AI Assignments, EAAI. Retrieved from modelai.gettysburg.edu/.

ICS (2012). Institute for Computational Sustainability. Retrieved from www.cis.cornell.edu/ics/projects/overview.php .

Ng, A. (2011) Machine Learning video lectures. Retrieved from www.ml class.org/course/video/preview list .

NSF (2007). Merit Review Broader Impacts Criterion: Representative Activities, www.nsf.gov/pubs/gpg/broaderimpacts.pdf .

Poole, D. and Mackworth, A. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press is freely available on the Web (http://artint.info/index.html)

Russell, S. & Norvig, P. (2010). Artificial Intelligence: A Modern Approach (Third Edition). Prentice Hall, NJ.