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

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Artificial Intelligence for Computational Sustainability: A Lab Companion

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Preamble

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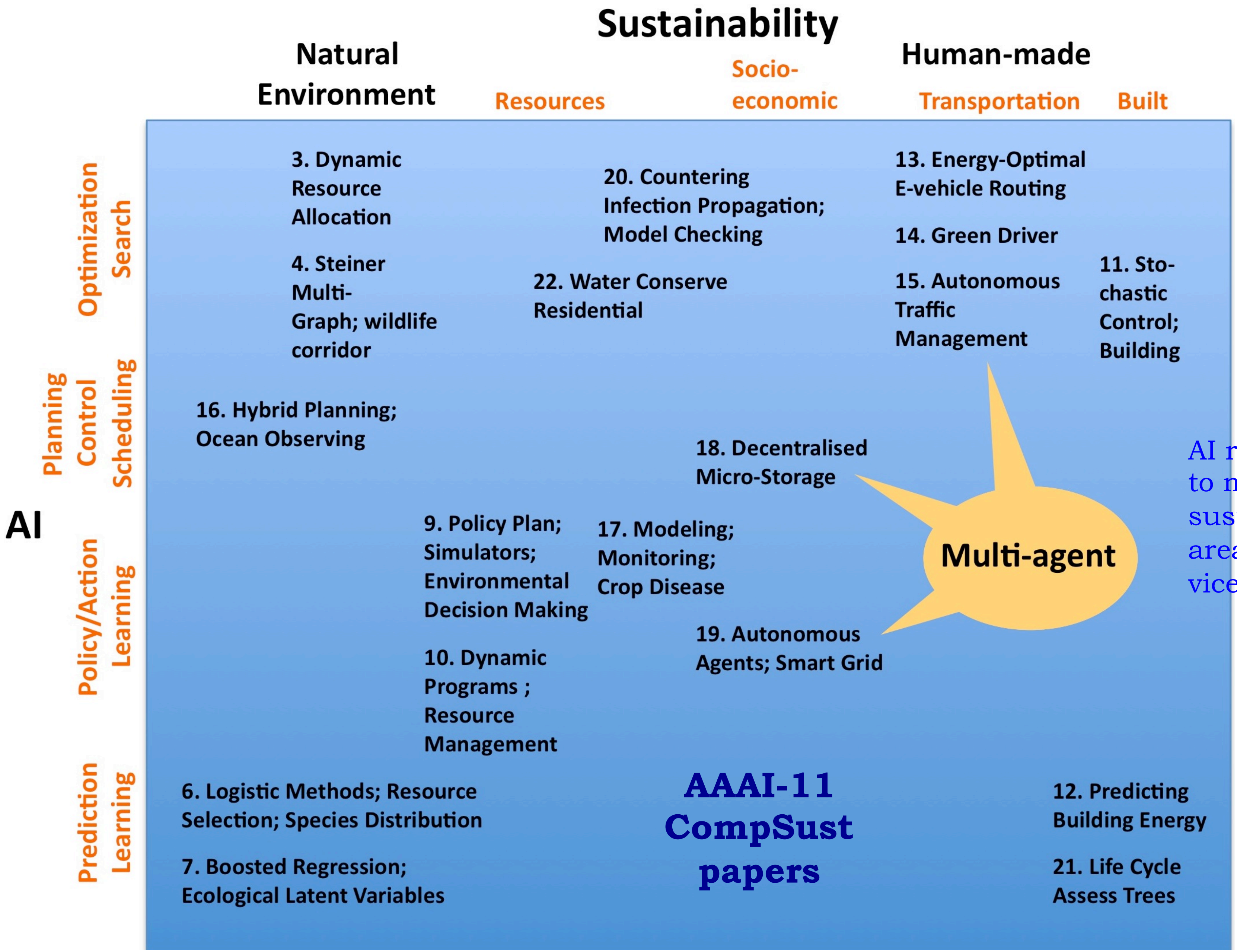
This laboratory companion is designed to introduce students of artificial intelligence (AI) to problems of environmental and societal sustainability, together with projects and problem sets at the intersection of AI and sustainability. The lab text can accompany any primary AI textbook, or can be used independently, though the material in it will typically assume selected knowledge of AI at an undergraduate level. The material in the text is organized primarily around AI topics, and includes explanatory and illustrative material concerning specific sustainability problems, together with *projects* (of several weeks duration), *assignments* (of duration on the order of a week) and *exercises* . . .

https://en.wikibooks.org/wiki/Artificial_Intelligence_for_Computational_Sustainability:_A_Lab_Companion

Examples of Artificial Intelligence for Computational Sustainability



AI relevant to many/all sustainability areas, and vice versa

Artificial Intelligence for Computational Sustainability: A Lab Companion

Please see how you can contribute: Guide for Contributors

AI Chapters

Sustainability Chapters

Motivations for (AI, Wikibook) Lab Companion(s)

Educational support for

- *Deep infusion of sustainability into non-sustainability focused courses*
- Sustainability-focused AI courses

More generally, support for

- Integration of research and education (research suggests educational exercises, and students have ideas for extensions)
- Communication of science to public, encouraging contributions elsewhere (e.g., Wikipedia)
- a survey of the field, associated data sets, opportunities for broader impact plans (e.g., of federal agency proposals)
- the growing community of Computational Sustainability

Motivations for (AI, Wikibook) Lab Companion(s)

Why AI (as a start)?

- Sustainability depends on rational, timely, strategic, long-term thinking and decision making under uncertainty – AI is the most relevant area of computing to this sustainability necessity

Why a Wikibook?

- existing infrastructure for open, transparent, and community contributions, another best fit to sustainability desiderata

Desirable Characteristics of (AI, Wikibook) Lab Companion(s)

portable, a supplement to any primary textbook and other resources;

online and freely available, for use in courses world-wide, as well as for use in broader impact plans by research teams/projects ;

compartmentalized into self-contained sections/exercises, so instructors can easily "snip out" portions of the textbook for use in their courses;

interlinked with other resources (e.g., Wikipedia articles, textbooks, online courses and lectures, online research papers);

community-developed, evolving as projects, assignments, and explanatory material at the intersection of computing and sustainability evolve;

multi-perspective, indexing by both computing and sustainability themes.

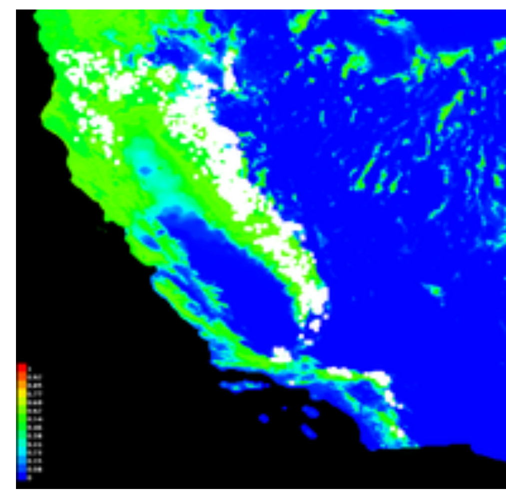
Sample Lab Assignment: Species Distribution Modeling Using Maxent*

Lab Summary:

1. Students examine the effect of climate and climate change on the distribution of several species of tree
2. Using species-range data, students model species distributions using maximum entropy (Maxent)

AI Concepts:

distribution modeling, Maxent, ROC analysis



Sustainability Concepts:

species distribution modeling, climate change

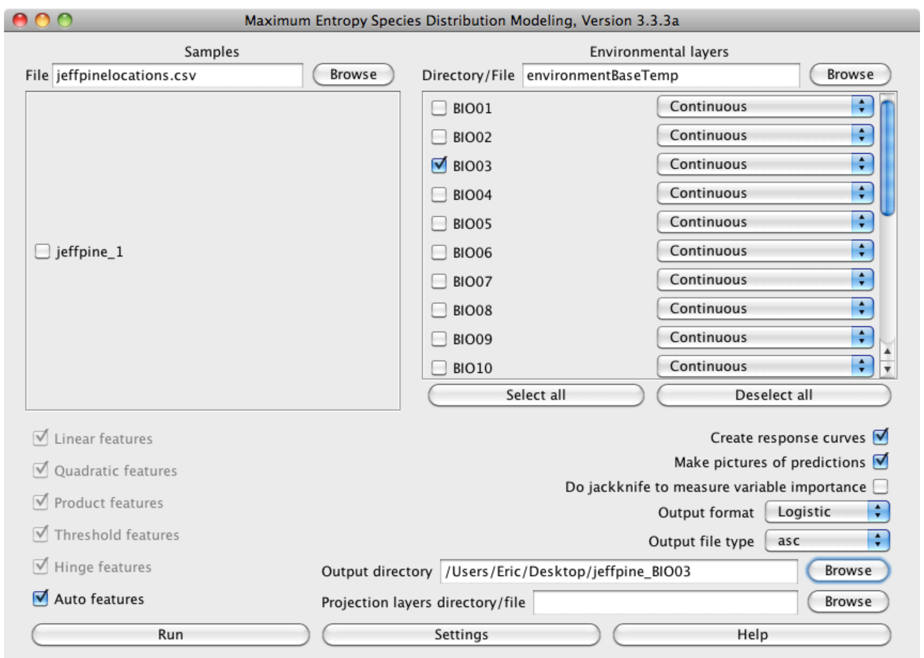
Cross-referenced in *Machine Learning for Prediction* and *Biodiversity*

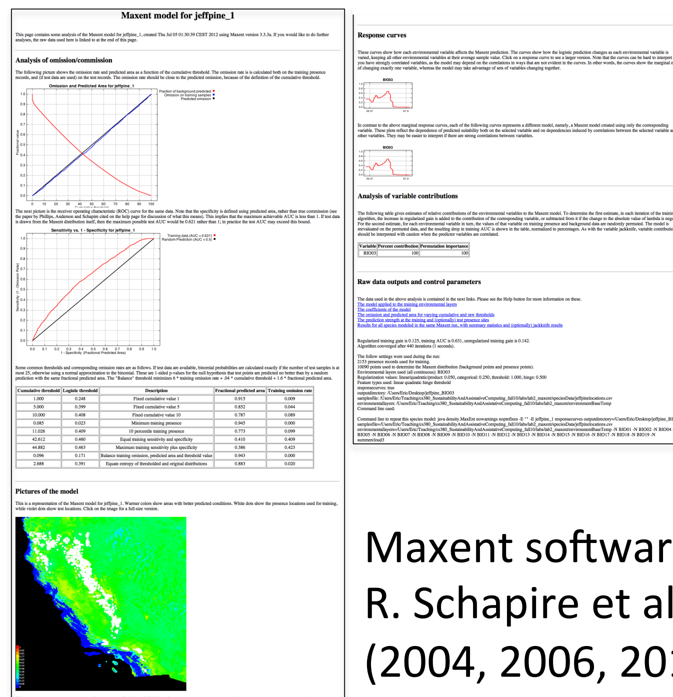
* This lab is based on an assignment by Park Williams (UCSB Geography), and was extended for an AI audience and posted to the Wikibook with his permission.

Sample Assignment:
Species Distribution Modeling Using Maxent

Design philosophy:

- Each section contains background material and exercises
- Lab walks students step-by-step through each exercise
- Lab is easily adapted to different course levels, from Intro CS through an advanced AI/ML course
- Maxent software is freely available in Java





Maxent software by R. Schapire et al. (2004, 2006, 2011)

Sample Assignment:
Species Distribution Modeling Using Maxent

Introduction

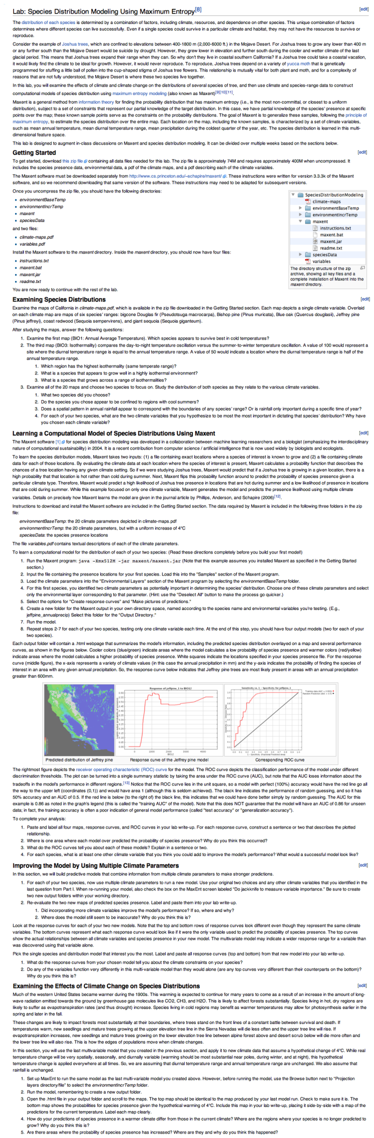
Getting started

Examining species range maps

Modeling species distributions using Maxent

Improving the model using multiple climate parameters

Examining the effects of climate change


Lab: Species Distribution Modeling Using Maximum Entropy

Getting Started

Examining Species Distributions

Learning a Computational Model of Species Distributions Using Maxent

Improving the Model by Using Multiple Climate Parameters

Examining the Effects of Climate Change on Species Distributions

Sample Assignment: Species Distribution Modeling Using Maxent

Introduction

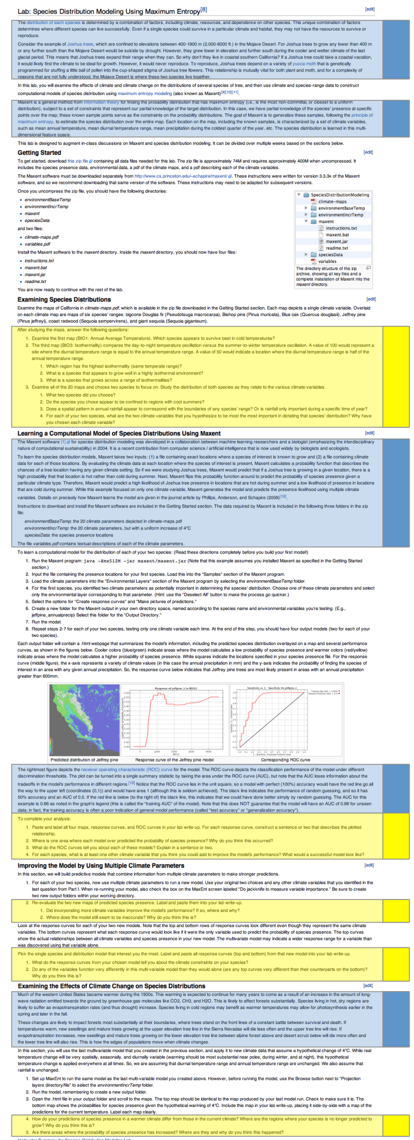
Getting started

Examining species range maps

Modeling species distributions using Maxent

Improving the model using multiple climate parameters

Examining the effects of climate change



Species Distribution Modeling

Maxent

Maxent & Distribution Modeling

ROC Analysis

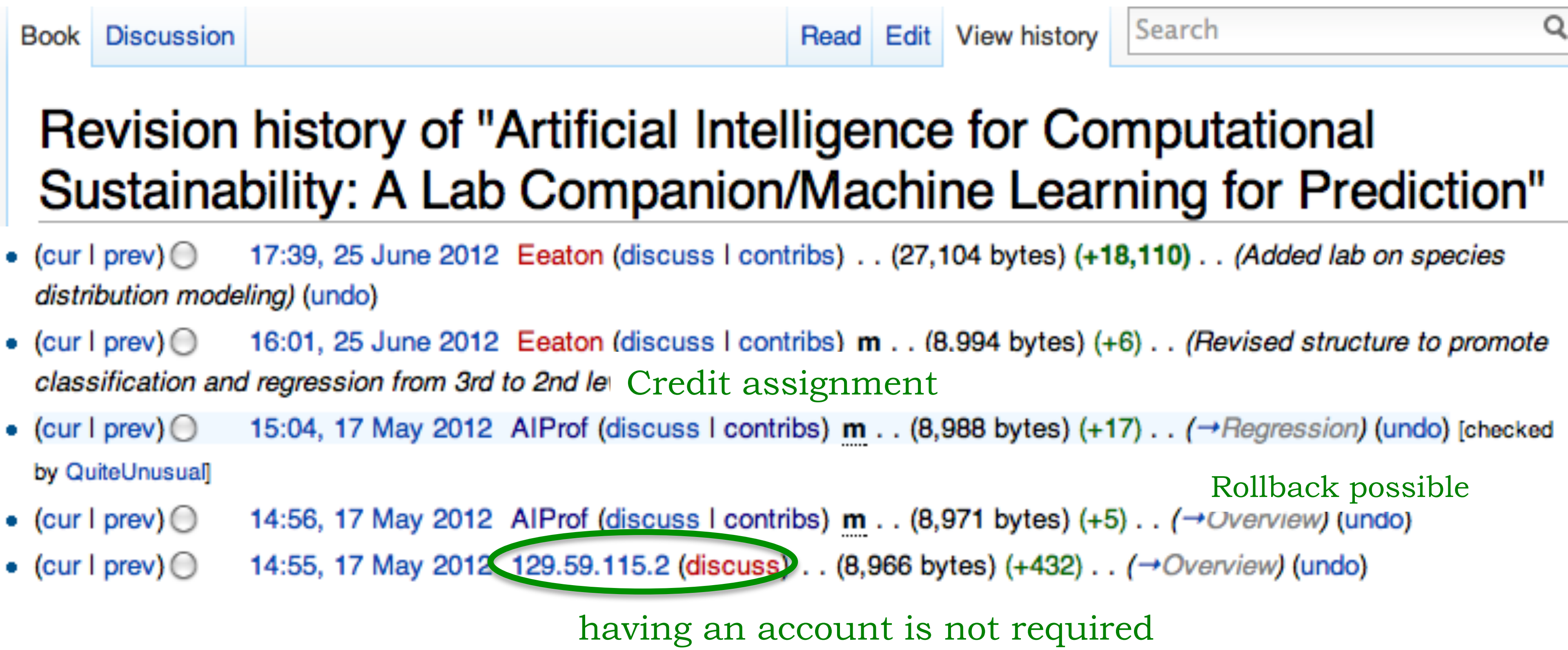
Climate Change

Background

Questions

You can contribute!

- the Wikibook is open to contributions by anyone, from small edits to creating new sections;
- with organization and scope still evolving;
- with monthly video getting-over-the-contribution-hump sessions for new contributors (of exercises or simply editing);



Summary
AI for Computational Sustainability Lab Companion

- intended to infuse sustainability into AI coursework through class exercises and projects

- is open, free, community-driven and guided, continually evolving

- is currently very incomplete

- needs contributors of exercises, data, and challenges!

- can be a basis for other community-composed texts,
    - in other areas of computing for computational sustainability,
    - of computational sustainability generally (beyond “lab companions”)
    - and a seed for computational sustainability growth generally

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Conclusions
AI for Computational Sustainability Lab Companion