AI and Developing Socially-Engaged Computational Thinkers

Douglas H. Fisher

Department of Electrical Engineering and Computer Science
Vanderbilt University
Nashville, TN 37235

douglas.h.fisher@vanderbilt.edu
http://www.vuse.vanderbilt.edu/~dfisher/

The author is supported by and serving as a Program Director at the National Science Foundation (CISE/IIS/RI). Any opinion, findings, and conclusions are those of the author and do not necessarily reflect the views of the National Science Foundation.

dhfisher@nsf.gov

Outline

Personal history/perspective

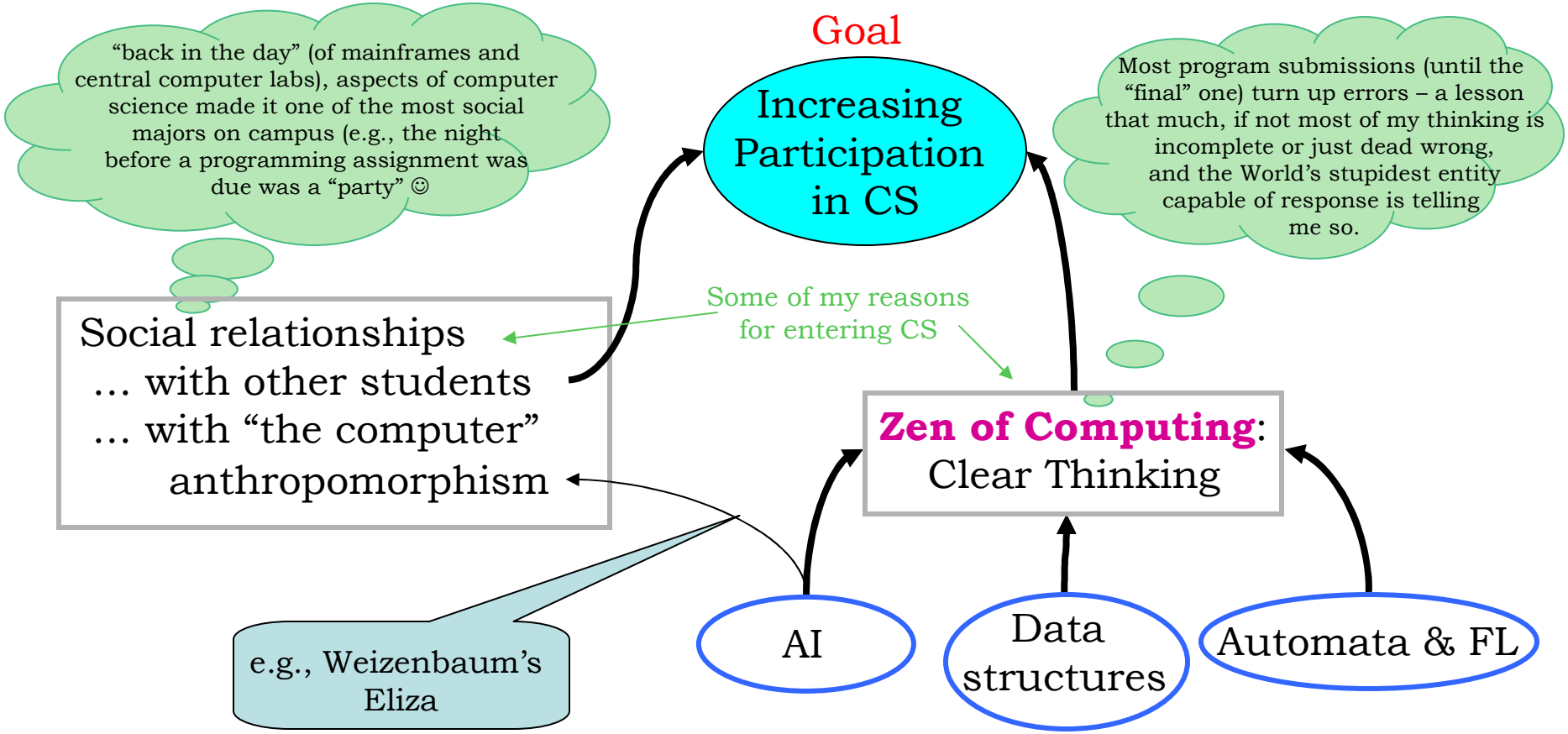
Three slides informed by and created after listening to previous talks of the Symposium; these talks reminded me of reasons that I got into CS to begin with, and brought me to a (re)new(ed) appreciation of the importance of these motivations today, as well as the importance of social and environmental embedding that I stress in my position paper.

Summary of the Position Paper

- Why do we want greater participation in Computing?
- What do we and should we mean by 'greater participation'?
- How might we achieve greater participation?
- Attraction and Retention: Guarding against bait and switch
- Why AI?

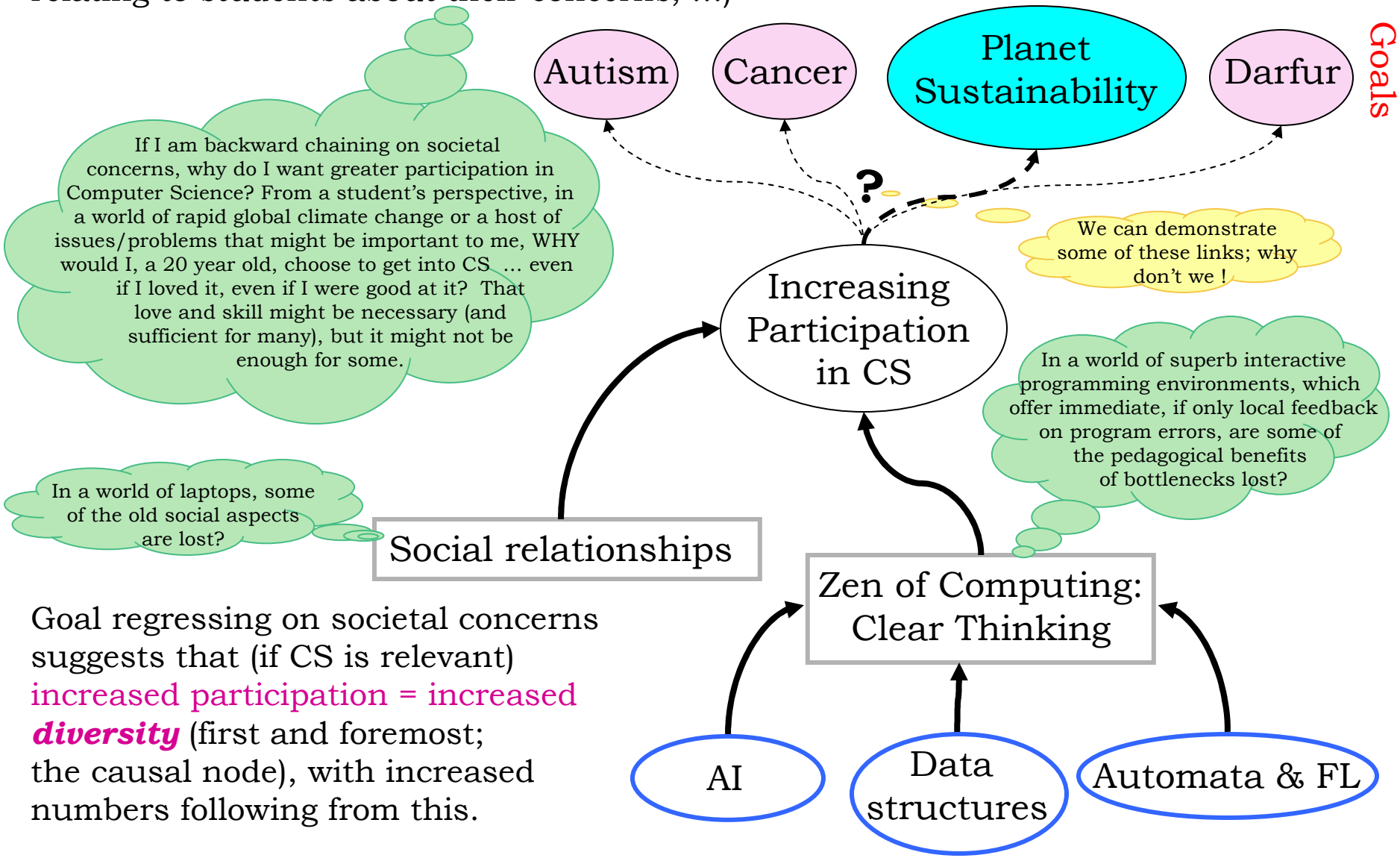
A proposed course that illustrates societal embedding: ***"Computing, Sustainability, and the Environment"***

My **"early years"** as an instructor: much time spent backward chaining on the goal of "increasing (participation =) **satisfaction** of those who chose to stay in CS after a winnowing process" (My attitude/approach was informed by my graduate experience at a large public university in a CS heyday, and my own reasons for getting into CS)



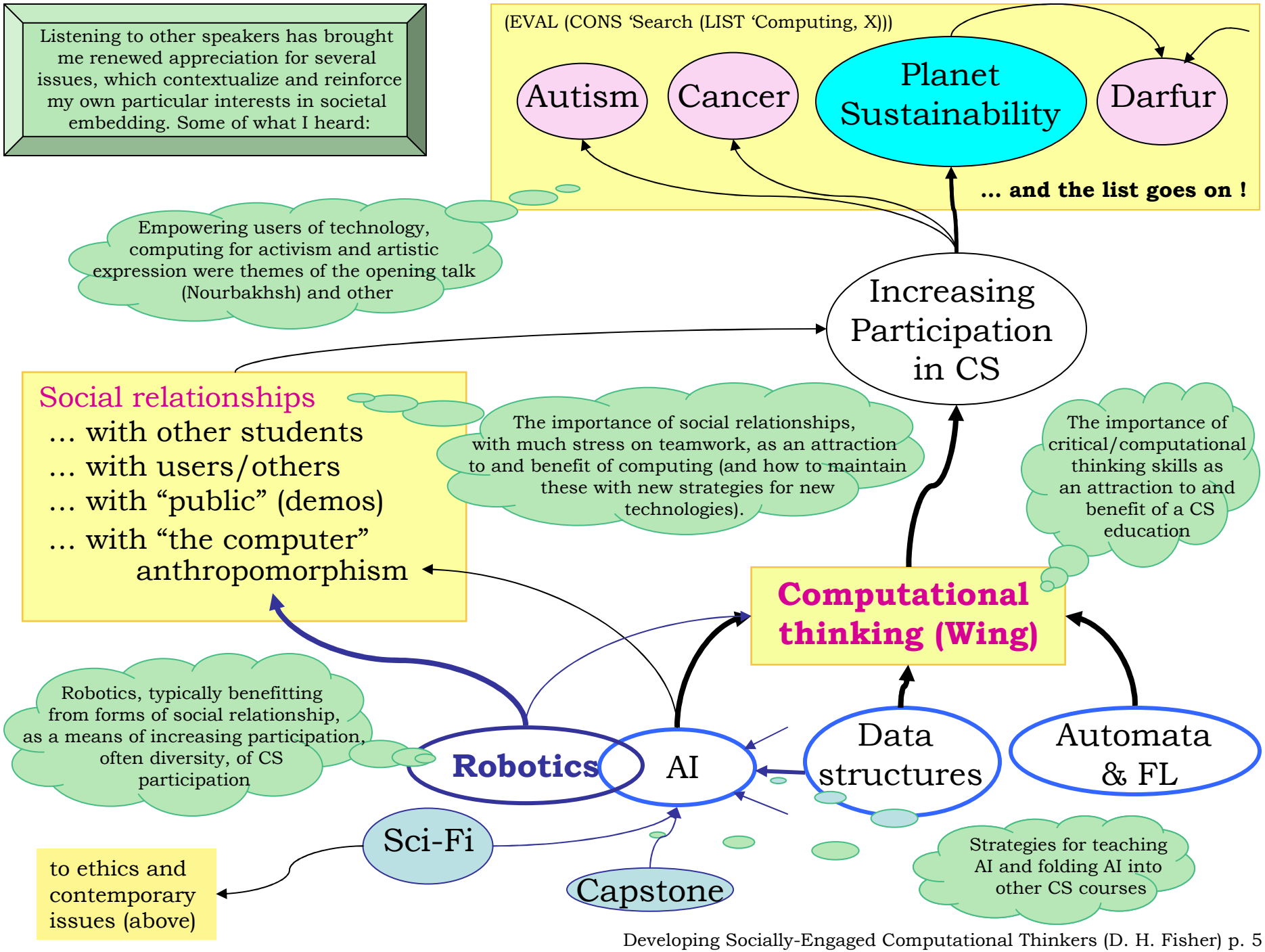
My **"middle years"** : much time spent backward chaining on "increasing (participation =) **satisfaction and numbers** in CS" (Informed by experience at a private university, reactive to changes in undergraduate satisfaction and tuition).

My **recent years**: backward chaining on a whole new set of goals (informed by my experience with ABET, and as a faculty member living in Vanderbilt dorms, talking and relating to students about their concerns, …)



Goal regressing on societal concerns suggests that (if CS is relevant) increased participation = increased ***diversity*** (first and foremost; the causal node), with increased numbers following from this.

Theme: Contextualizing computing by societal relevance to increase participation


Listening to other speakers has brought me renewed appreciation for several issues, which contextualize and reinforce my own particular interests in societal embedding. Some of what I heard:
(EVAL (CONS 'Search (LIST 'Computing, X)))
Autism
Cancer
Planet Sustainability
Darfur
... and the list goes on !
Empowering users of technology, computing for activism and artistic expression were themes of the opening talk (Nourbakhsh) and other
Increasing Participation in CS
Social relationships
... with other students
... with users/others
... with "public" (demos)
... with "the computer" anthropomorphism
The importance of social relationships, with much stress on teamwork, as an attraction to and benefit of computing (and how to maintain these with new strategies for new technologies).
The importance of critical/computational thinking skills as an attraction to and benefit of a CS education
Computational thinking (Wing)
Robotics, typically benefitting from forms of social relationship, as a means of increasing participation, often diversity, of CS participation
Robotics
AI
Data structures
Automata & FL
Sci-Fi
Capstone
to ethics and contemporary issues (above)
Strategies for teaching AI and folding AI into other CS courses

Summary of the Position Paper

Why do we want greater participation in Computing?

To develop socially-engaged *computational thinkers* (Wing, 2007) because
(a) such people are beneficial to society independent of computers,
(b) computing is here to stay, is pervasive, and it will get done one way of the other,
(c) hopefully by skilled, conscientious people.

What is greater participation?

Diversity first, numbers will follow

Synergistic

How might we achieve greater participation?

Diversity of strategies: Layers of an onion
e.g., Robotics may bring some to CS and Human-assistive robotics may bring more; societal meaningfulness may cinch the deal for some.

Dismantling compartmentalization
Beyond "CS150: Computers and Society" type courses – let's not model the kind of compartmentalization in our curriculum that we would hate to see in our professionals

Attraction and Retention: Guarding against bait and switch

Societal embedding may be more robust against bait and switch than 'fun'

Why AI?

To illustrate, assist, improve human intelligent behavior – 'greater participation' as deeper, higher-quality participation.

Confounds in crediting AI with drawing power (e.g., the anthropomorphic draw of robotics; the societal-utility draw of computational biology and economics)

A course that illustrates societal embedding

Computing, Sustainability and the Environment
(1 credit, under review)

Douglas H. Fisher, EECS, Vanderbilt University

Overview:
Participants will explore issues relating to the burden of computing on the environment, and relief of burden on the environment that might be reaped from computing use. Thus, discussion goes beyond so-called 'green computing', which is concerned with minimizing the burden of computing manufacture, use, and disposal, and explores *how computing and related communications technologies can be part of larger sustainability strategies*.

Submitted to be considered for Vanderbilt's first-year COMMONS seminar series on Energy, Sustainability, and the Environment

Course Topics:

1) Variety and extent of computers, computer use, and infrastructure

2) Ecological footprints and other measures of environmental burden (power, energy)

3) Estimating environmental burdens of common computing practices, tools, and infrastructure

4) Characterizing growth in computing activity and infrastructure (e.g., over the last 50 years) and change (reduction) in ecological cost per unit (e.g., storing a KB of memory)

5) Estimating gross ecological burden stemming from computing over time

6) Uses of computing to reduce overall ecological footprint – computing as part of the solution (several sessions): ecological modeling and data analysis, smart cars and buildings, CAD for energy-efficient devices, education and awareness, offsets in other sectors, notably travel, through telework, conferencing, and the like.

7) A history of (and cautions from) techno-optimism about sustainability in the face of human population explosion

8) Throughout, critical thinking and questioning of assumptions will be an important aspect of class; case studies will be used to initiate discussion.

Class Organization: Each week, *prior to class*, students will be expected to read an article, often prepared by the instructor to fit the class session, and to blog and to post to a Wiki on issues raised by the reading and their experience and ideas. Class (1 hour each week) will be open discussion and debate. The course Wiki and blogs can be revised and expanded following class. *There will be a fixed meeting time but no meeting place*. All participants will participate remotely, by different means from week to week: standard teleconference, Skype, standard video conferencing, web cams, webex, virtual worlds.

Project: Student teams of 2-3 will estimate an ecological footprint (gross and net) of computing within a context – e.g., the Featheringill second floor computer lab for one year, 24hrs a day, 7 days a week, 52 weeks a year, based on actual conditions and what is possible with conservation); one aspect of the project, in part left to the students, will be determining the relevant, often 'non-local' factors (e.g., energy-source portfolio of lab power supply, air conditioning control throughout building) in this analysis and in defining contrast circumstances from which net savings can be estimated.

Relationships to other computing courses

(for purposes of intuitive illustration in this class and projects in later CS classes)

1) The variety and extent of computers, computer use, and computing infrastructure.

2) Ecological footprints and other measures of environmental burden

*energy, power, other units (**Computer Organization**)*
*utility and heuristic functions; illustrate search, case-based reasoning in case studies like a cradle-to-grave footprint analysis of corn-based ethanol production and use (**Artificial Intelligence**)*

3) Estimating environmental burdens of common computing practices, tools, and infrastructure (e.g., of a laptop on versus asleep versus off versus unplugged, running a one-minute YouTube video, paying a bill over the Internet, running a query on Google, accessible storage of a Terabyte of memory for 1 day, ….).

basic statistical concepts: e.g., mean, variance, correlation;
*exercising **Computer Organization** material*

4) Characterizing growth in computing activity and infrastructure and change (reduction) in ecological cost per unit (e.g., storing a KB of memory)

*Intuitive understanding of exponentials, polynomial and other function classes to characterize growth/change rate; intuitive understanding of complexity analysis (e.g., O-notation) to bin growth rates; discussion of points such as "a conservation strategy that reduces a quadratic fn by a constant factor, still results in a quadratic function" and the like (**Algorithm Analysis**)*

5) Estimating gross ecological burden stemming from computing over time

*"Project": An ecological footprint complexity analysis of search costs using a trie versus some other possible strategies (**Data Structures, Algorithm Analysis, Computer Organization, Artificial Intelligence**)*

6) Overview of strategic and tactical uses of computing to reduce overall ecological footprint – computing as part of the solution (several sessions). Some (overlapping) areas are:

Computing for ecological monitoring, modeling, data analysis (e.g., to inform policy or individual decision making)

*Recalling invited talk: teaching with sensors (**Computer Organization**), Data Mining (**Artificial Intelligence, Database**)*

Computing for design, optimization, intervention (e.g., to increase efficiency of heat exchangers; smart buildings and cars)

Artificial Intelligence

Computing for education and awareness

***Database**, e.g., design a DB back-end to a site such as: http://www.oberlin.edu/dormenergy/);*
Artificial Intelligence

6) Continued
Computing to offset ecological burden in other sectors (e.g., travel)

- *Technology-mediated work*
- *Technology-mediated conferencing and meetings*
- *Technology-mediated vacation*
- *Case studies: contrasting Internet banking and Internet shopping (+ shipping) – case-based, analogical reasoning*

*(**Artificial Intelligence, Human-Computer Interfaces, Database**)*

7) A history of (and cautions from) techno-optimism about sustainability in the face of human population explosion

Science Fiction !

8) Throughout, critical thinking and questioning of assumptions will be an important aspect of class; 'straw' case studies will be used to initiate discussion.

For example, some estimates of cradle-to-grave bio-fuel footprint count solar energy in the creation of biomass as "free"; the footprint of a single individual's airplane flight is often counted as 1/plane-capacity times the footprint of the flight. These analyses make debatable assumptions. What are the near and more distant implications? For example, are airplane savings more accurately modeled by a step function? How do assumptions interact?

Concluding Remarks

♦ Why Computing? Because it has societal importance – if you believe that, teach it – make the connections.

♦ What is 'greater participation? Diversity before numbers.

♦ AI for the social good may bring and/or keep some in computing for whom AI per se would not; in general, societal embedding will likely have additive benefits (i.e., cinch the deal) relative to other worthy strategies

♦ Societal embedding (of AI and other computing material) will increase diversity (and numbers); check out organizations such as 'Engineers without Borders' and 'Engineers for a Sustainable World.' Regardless of why you think students currently get into CS, why might students in the future?

♦ What is special about AI as a way into computing? To illustrate, assist, improve human intelligent behavior – 'greater participation' as deeper, higher-quality participation.