Computational Ecosystems
Tech-enabled communities to advance human values at scale

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How can we create scalable solutions to human problems and advance desired human values in the absence of a technology that can overcome real-world constraints?
Design, Technology, and Research (DTR)
Spring 2014
How can a single faculty mentor train 20+ students scale solutions
How can a single faculty mentor train 20+ students to cultivate self-directed learners and build new knowledge that will scale solutions and advance desired human values?
How can a single faculty mentor train 20+ students to cultivate self-directed learners and build new knowledge in the absence of a technology that scales mentor time?
Best human solution

“apprenticeship requires a very small teacher-to-learner ratio that is not realistic in the large educational systems of modern economies.”

[Collins & Kapur, 2005]
Best machine solution

No AI technology can replace the mentor in the foreseeable future.

[Jarvela & Hadwin, 2013]
Options

- Wait for a technological silver bullet
- Compromise
- Or...?
Computational Ecosystems

Community Process

Social Structures & Interactions

Intelligent Systems & User Interfaces

Phases

Individuals

Community

Leads

Group

Crowd

End-user Interfaces

Enabling Technology

Collaborative Interface

Mixed-Initiative System

Monitoring System

Task Routing

Notification & Feedback

Coordination Mechanism
A call for systems: having great components is not enough.

“...We’ve been obsessed in medicine with components. We want the best drugs, the best technologies, the best specialists, but we don't think too much about how it all comes together. It's a terrible design strategy actually.”

Atul Gawande

TED 2012
A call for systems: having great components is not enough.

“Making systems work is the great task of our generation of physicians and scientists. I would go further to say that making systems work - whether in health care, education, climate change, and making a pathway out of poverty - is the great task of our generation as a whole.”

Atul Gawande
A call for systems thinking in AI

“'I'm pretty sure that the next leaps in AI will come from integrative systems, rather than wedges. [We need to] focus on building a system where the whole is greater than the parts.’

Eric Horvitz

TechRepublic, 2015
A call for systems thinking in HCI

“It is likely that our designs will be more successful if we become more mindful of this bigger picture, [the mosaic of responsive, adaptive systems].”

Future Design Mindful of the MoRAS, 2000

George Furnas
Advancing the approach...
Typically...
Typically...
Advancing the approach...
Typically...
Advancing the approach...
Computational ecosystems are systems, designed as integrative solutions.
Computational ecosystems are systems, designed as integrative solutions.

- **Computational thinking**: decompose and distribute problem solving to diverse people or machines across the ecosystem.

- **Ecological thinking**: create sustainable processes and interactions that support ecosystem members and proper ecosystem function.
Rest of the talk

- Two examples:
  - Community-based planning
  - Research training
- What’s next in computational ecosystems
- (Limited) role of technology in advancing human values
Community-informed planning
an inclusive process that scales and advances the goals of its members
Challenges for organizers

- Lack information about the diverse preferences, constraints and knowledge held by community members
- Lack tools for managing the complexity of planning.
Cobi: Community-informed planning

1. Engage the entire community in the planning process

2. Give organizers tools to manage the complexity of planning and resolve conflicts
1. Engage the entire community in the planning process

Committeesourcing
- make sessions
  [Chilton et al.]

Authorsourcing
- collect affinities
  [Andre et al.]

Attendeesourcing
- collect preferences
  [Bhardwaj et al.]
Core idea: incentive chaining
2. Help organizers resolve conflicts
2. Help organizers resolve conflicts
Core idea: Community-informed mixed-initiative interface [Kim et al]
Outcomes

1. inclusive process that engaged 1500 community members in planning

2. reduced organizers’ time from 100 hours to 5 hours

3. organizers produced better schedules by resolving 100+ previously hidden conflicts while also advancing other planning goals
Computational Ecosystem: Community-Informed Planning

- Collaborative planning across crowds, groups, and organizers
- Chain contributions across the ecosystem
- Mixed-initiative interfaces empower organizers to make informed decisions using community input, system recommendations, and their tacit knowledge
scale research training: cultivating self-directed learners
Students need regulation skills

- **Regulation skills**: cognitive, metacognitive, motivational, and emotional skills for reaching a goal [Jarvela & Hadwin. 2013]

- Independent research requires regulation skills including **planning** and **seeking help** to overcome challenges.

- Students lacking these skills are confined to rote tasks, or can struggle to make progress.
Agile Research Studio (ARS)

- Model for research training in a learning community
- All students, regardless of seniority, conduct independent research and receive authentic research practice.
ARS scales faculty time

Apprenticeship

Hierarchical, 1:1:1

very small teacher to student ratio
[Collins, 2005]

grad students are novice mentors
[Shulman, 1986]

The ARS approach: Dispersed Control

overcome 1:X
[Bain & Weston, 2012]
ARS is a computational ecosystem for developing regulation skills

ZR, Easterday, Gerber, Rees Lewis, Maliakal
ARS: planning

Process: Sprint planning
Social structure: SIG meeting
Studio tool: Sprint log

2 weeks
ARS: Help & Collaboration

Process: Distributed help

Social structure: Studio meeting

Studio tool: Pair research

[Miller, Z., Gilbert, Gerber]
Welcome to Delta Lab, Haoqi Zhang.

What do you need help with?

ENTER POOL

Some cool things your group has been working on:

10 23 25 citations proxy baseline outside stand pretend spectator weeklife every day Figure rebuttal CSSJSHTML accept installing ffmpeg onto
Distributed help is not one tool...

Jennie 🌸 10:50 AM
❤️ Mentorship heartbeat for week 3! ❤️ As a reminder you should:
- After first SIG meeting: have a 15-30min 1:1 to debrief what happened, share reactions, and adjust the mentee's sprint plan for the upcoming week
- Anytime: sit down together for 15 minutes to set personal goals for DTR together (both mentor and mentee)

What did you learn about collaboration, teamwork, and helping/receiving help this quarter?

I learned that it's important to collaborate on things that aren't obvious blockers, because a lot of the best ideas and confirmation or rejection of my own ideas that I received this quarter was just from other people watching me or commenting on stuff I was doing, even though I wasn't "stuck" per se. I also learned that asking research-related questions mid week is way better than just trying to muddle through until SIG...
Outcomes (8 yrs)

- 120 students (108U, 12G), 40% women
- 53 student-led research projects
- 56 undergrad research grants
- 20+ publications at major conferences and 6 winners at major student research competitions
- ~40% placement at Apple, Google, Microsoft and Facebook
- 85% of students stayed in DTR for 2+ quarters; most continue till graduation.
Planning Strategies

- building at the fidelity appropriate for the current stage of research
- prioritizing important features and research questions
- sequencing tasks
- moving on despite uncertainty or imperfect knowledge.
Help & Help-seeking

- Students helped more than a third of their studio each quarter
- “I can ask for help and that everyone asks for help and it doesn’t make them stupid to need help.”
Thanks so much for teaching me how to advocate for myself and my ideas, embrace failure and inexperience, and search for truth rather than bullshit.
Computational Ecosystem: Agile Research Studios

- Develop regulation skills for research planning and help-seeking across ecosystem interactions
- Extends the scale and capacity of a community to produce and learn
What's next

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time

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Task Routing
Enabling technology for coordinating activities across ecosystem components and subsystems
Example: Networked Orchestration Technologies [Garg et al]

S - Subjective
- worked on building prototype
- was not able to finish all research tasks

O - Objective
- has 2 prototyping tasks (saving feature and interface) not completed due to bugs
- [script] research plan went well over allocated time

A - Assessment
- student got stuck on a bug, and tried to power through it vs. asking for help
- strategy: when stuck for more than 30 mins, ask for help

P - Plan for follow-up
- [script] prompt John to get tech help during the community-wide meeting this week

SOAP Notes for John

<table>
<thead>
<tr>
<th>Need</th>
<th>Last Discussed</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeking help when stuck</td>
<td>2 weeks ago</td>
<td>In-Progress</td>
</tr>
<tr>
<td>Research plan went over time, didn't seek help</td>
<td>N/A</td>
<td>Ineffective (new)</td>
</tr>
</tbody>
</table>

Coaching Session | Ad-Hoc Meeting with Peer | Office Hours with Claire | Community-Wide Meeting
Enabling technology for recognizing and facilitating situations for human interactions
Example: Opportunistic Collective Experiences [Louie et al]
Example: Opportunistic Collective Experiences  [Louie et al]

Expression tools for defining interactional opportunities

Execution engines aware of interactional resources

Diagram:
- Human’s Concept of a Situation
  - Expression Layer
    - Grabbing food that is good for a cold day
      - Warm Liquid or Broth
      - Spicy Food
    - Machine’s Available Context-Features
      - Ramen
      - Parks
      - Indian
      - Tea
      - Hotdogs
      - Football
      - Thai

Text:

* WHEN YOUR FRIEND LEAVES YOU HANG FROM A HIGH FIVE

- unlikely to complete; don’t activate
  - go: 92% likely to complete
  - 80% 80%
Ecosystem-level thinking

- Computational ecosystems consider jointly the design of human processes, interaction structures, and intelligent systems.

- Beyond designing the ecosystem, we need ecosystem-level and interactional intelligence that support ecosystem members and proper ecosystem function.

- Such ecosystem-level thinking will be increasingly critical for devising scalable solutions to address a diverse range of human concerns.
Limited role of technology in advancing human values at scale

- Digital computers are insufficient for advancing human values
- Scaling amplifies compromises
Understand the limitations of the digital computers
Understand the limitations of the digital computers

Computers reliably produce desired consequential outcomes
But there is more to advancing human value than achieving desired outcomes

“This suggests a certain diagnosis of the **modern mania** that perceives the point of a life’s work in some set of **listable achievements**, the point of parenting in the **production of children with some desired set of characteristics and capacities**, and the point of intimate relationships in some **status** to whose production and stabilization the participants ought to commit themselves. This outlook is a formula for **indefinitely postponing the good life** by dint of a ceaseless, determined pursuit of its static simulacrum…”

Talbot Brewer
*Retrieval of Ethics*
Example: fostering self-direction

Interviews with:

- Child Development Experts
- Therapists and Counselors
- Yoga and Meditation Teachers
- Art/Music/Dance Teachers
- Entrepreneurship coaches
- Intimacy Coaches
- ...

To be authentic without alienating other people.

To be open to other people’s influence and to be open to discovering things about ourselves.

To persist under peer pressure to continue on a lonely act.

To erase the shame from social messaging and not shove our feelings down.

To stop pretending.

...

...
Claim: input-output machines, used to condition and produce desired outcomes, can never be the in-all-and-end-all for advancing human values

Input  →  Output

Computers encode consequentialist thinking
Scaling amplifies compromise

“The Machine Stops, 1909

“Something ‘good enough’ had long since been accepted by our race.”

“That the Machine may progress, that the Machine may progress eternally.”

The Machine Stops, 1909
The hopes that are in my mind

"The Machine is much, but it is not everything. I see something like you in this plate, but I do not see you. I hear something like you through this telephone, but I do not hear you. That is why I want you to come. Pay me a visit, so that we can meet face to face, and talk about the hopes that are in my mind."
Values you wish to scale

Technological solutions
“Technological values”
Values you wish to scale
Mindful of values.
Accept the limits of technology.
Learn to scale.

- **Ecological thinking**: create sustainable processes and interactions that support ecosystem members and proper ecosystem function.

- **Computational thinking**: decompose and distribute problem solving to diverse people or machines across the ecosystem.
Cobi

Community Informed Planning

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Networked Orchestration Technologies

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Opportunistic Collective Experiences

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System-level thinking


- Hope Reese. Mastery of AI has been 'harder than expected' and 'future is uncertain,' says Microsoft's AI chief. TechRepublic, 2015.


References

Community-Informed Planning


- Paul André, Haoqi Zhang, Juho Kim, Lydia B. Chilton, Steven P. Dow, and Robert C. Miller. Community clustering: Leveraging an academic crowd to form coherent conference sessions. HCOMP 2013.


References

Agile Research Studios


Computational ecosystem preview


Technology’s role in advancing human values at scale


- [See also: Nicholas Carr. The Shallows: What the Internet is doing to our brains. WW Norton & Company, 2011]

- [See also: Batya Friedman and Peter H. Kahn. Human values, ethics, and design. The human-computer interaction handbook (2003): 1177-1201]