WHY ARE MOOCS INTERESTING?
(1) IMPROVE MOOCS WITH NEW TOOLS AND TECHNIQUES.
(2) TEACHING WITH MOOCS MAY HELP SOLVE RESEARCH PROBLEMS.
MY TRANSFORMATIONAL MOMENT:
CS188.1x Artificial Intelligence
Example: N-Queens

**Formulation 1:**

- **Variables:** $X_{ij}$
- **Domains:** $\{0, 1\}$
- **Constraints**

\[
\forall i, j, k \ (X_{ij}, X_{ik}) \in \{(0, 0), (0, 1), (1, 0)\}
\]
QUIZ 1: CONSTRAINTS  (1/1 point)

Consider the problem of arranging the schedule for an event. There are three time slots: 1, 2, and 3. There are also three presenters: A, B, and C. The variables for the CSP will then be A, B, and C, each with domain {1, 2, 3}. The following constraints need to be satisfied:

1. A, B, C need to all take on different values
2. A ≤ C

Which of the following is an explicit encoding of the constraints between A and C?

- (A, C) ∈ (1, 2), (2, 3)
- (A, C) ∈ (1, 2), (2, 3), (1, 3)  
- (A, C) ∈ (1, 1), (1, 2), (1, 3), (2, 2), (2, 3), (3, 3)
Eric Mazur, Abridged "Confessions of a Converted Lecturer"
Students AND Instructors Work Out In Class
Researching Active & Peer Learning
Peer Learning Core Ideas

- Students learn better by explaining to others
- Extended group work should be *structured*
- Must promote *both*:
  - Positive Interdependence
  - Individual Accountability
- Group makeup:
  - Best if heterogeneous
  - Groups can change frequently
The Evidence

- Pausing frequently during lecture for 2 minute discussions leads to better comprehension (1-2 grade points higher) [Ruhl et al.]

- A meta-analysis over 60 physics courses and 6,500 students found improvements of almost 2 std.dev. [Hake, Am. J. Physics, 1998]

- Controlled experiment with > 500 physics students found improved attendance, engagement, and more than twice the learning. [Deslauries et al., Science 2011]
The Evidence

Even if no one in the group knows the answer, discussing improves results (genetics)

[Smith et al, Science 323, Jan 2, 2009]
The Evidence

[Smith et al, Science 323, Jan 2, 2009]

Three-point Cross Question Q1/Q1_ad (ranked as easy): Phenotypically wild-type female flies heterozygous for each of three different mutations [purple eyes (pr), dumpy wings (dp), and hairy (h)] were crossed to male flies that have purple eyes, have dumpy wings, and are hairy. The number of progeny in eight different phenotypic classes is:

- Wild-type = 298
- Hairy = 8
- Purple eyes = 28
- Dumpy wings = 161
- Dumpy wings & Hairy = 30
- Vision defects & Purple eyes = 165
- Dumpy wings & Purple eyes = 10
- Dumpy wings, Purple eyes, & Hairy = 300

Which of the three genes is in the middle?
A. hairy
B. purple
C. dumpy

Three-point Cross Question Q2: Phenotypically wild-type female flies heterozygous for each of three different mutations [curly wings (c), short bristles (b), and sepia eyes (s)] were crossed to male flies that have curly wings, short bristles, and sepia eyes. The number of progeny in eight different phenotypic classes is:

- Wild-type = 446
- Curly wings = 42
- Sepia eyes = 2
- Short bristles = 10
- Sepia eyes & Curly wings = 10
- Sepia eyes & Short bristles = 40
- Short bristles & Curly wings = 1
- Sepia eyes, Curly Wings, & Short bristle = 449

Which of the three genes is in the middle?
A. curly
B. short bristle
C. sepia
Peer Learning

“QUICK THINKS”

STRUCTURED GROUPS
Structured Peer Learning Example

- From Deslauriers et al:
  - Pre-class reading assignments and quizzes
  - (CQ) In-class clicker questions with student-student discussion
  - (GT) Small-group active learning tasks
    - Turn in individual written response
  - (IF) Targeted in-class instructor feedback

- Typical schedule for 50-min class:
  - CQ1, 2 min; IF, 4 min.
  - CQ2, 2 min; IF, 4 min; CQ2 (continued), 3 min; IF, 5 min; Revote CQ2, 1 min.
  - CQ3, 3 min; IF, 6 min.
  - GT1, 6 min; IF with a demonstration, 6 min; GT1 (continued), 4 min; and IF, 3 min.
Structured Peer Learning Example

From Deslauriers et al., for a one-week intervention
PROBLEM: MOOC EXPERIENCE IS TOO ISOLATED.

Joint work with Bjorn Hartmann, Armando Fox, Derrick Coetzee, Taek Lim, to appear in CSCW 2015. Sponsored in part by a Google Social Interactions Grant
MOOCs from the Student POV

**PROS**
- Free (ish)
- Self-paced
- Work from location of choice

**CONS**
- Isolating
- Impersonal
- No cohort to motivate
MOOC Collaboration Today

- Forums
  - Really Q&A Tools
  - Low participation
  - Participants do well: correlation or causation?
- Informally Organized Groups
  - Google Hangouts, Facebook groups, in-person meetings
- Formal Project Groups
  - NovoEd
- Peer Assessment (anonymous, asynchronous)
  - Kulkarni, Klemmer et al. TOCHI 2013
HW1, Question 10: A*-CSCS (Help Thread)

discussion posted 2 years ago by ITgulherme

This post is visible to everyone.

As this is, probably, the hardest question of Homework 1: Search I decided to help you guys a bit. First of all, if you are having trouble with this question, make sure to review the Admissibility (Part 10: Creating Admissible Heuristics) and Consistency (Part 14: Consistency and Optimality of A* Graph Search) concepts. It's very important to understand how those properties influences the A* Graph Search.

One way to approach this question is knowing how Admissibility makes the A* Search Tree optimal, and what occurs when it changes to a A* Graph Search. The same thing about Consistency. After that, you can simulate the difference between both A* Graph Search and A*- CSCS algorithms. Using the graphs bellow, simulate the nodes expansion and fringes for both algorithms:

ADMISSIBLE (INCONSISTENT)

State space graph
ronbarak
2 years ago

Did you mean "Assuming that, for a specific h, A* expands at most as many nodes as A* graph search,"?

Yes, sir... updated post. Thank you.
posted 2 years ago by ITguilherme

Add a comment...

pabbeel STAFF
2 years ago

Great choice of hints! Thanks @ITguilherme!

You're welcome Pieter! I tried to help without telling too much about the results. English is not my native language, so feel free to edit the thread content if there's any grammar mistakes or if something is not clear.
I'm going to try to release at least one of these "Help Threads" for each Homework, that's my way to give something back to the community
posted 2 years ago by ITguilherme

Fantastic!
Discussion Forums in MOOCs
Alternative: Small Group Discussions
Our Hypotheses

- Students working together collaboratively and synchronously in MOOCs will
  - Learn better
  - Have better morale
  - And otherwise replicate much of the peer learning literature results
Experiment Flow Diagram

E1

Minimal

Mini-lesson

E2

Mini-lesson + Discuss Question
EXPERIMENT 1:
CROWDWORKERS
NO STUDY
MATERIALS
First Step: Try Mechanical Turk

- Hypothesis:
  - People in groups will get answers right more often than those working alone
- Expectations:
  - The chats will be on topic
  - People will try to solve the problems
First Step: Try MTurk

- Issues?
  - How to motivate the workers?
  - How to coordinate the workers?
  - What kinds of questions to use?
  - How to structure the conversation?
  - Is this a valid comparison group?
How To Motivate?

• Experimental Manipulation:
  • If entire group gets the right answer, everyone gets a bonus

• Control Group:
  • No mention of a bonus (no incentive for helping others)
1) Recording Agent: Music industry representatives often advance the claim that “online file sharing,” (which allows someone who purchased a music CD to share contents with others using their computers—at no additional cost), hurts their business.

Since the advent of file sharing, however, music CD sales have actually risen; therefore, file sharing does not hurt the music business. In fact, file sharing seems to have had a positive effect on the music industry.

The argument above is most vulnerable to criticism on the grounds that it

A. is a circular argument, assuming what the argument sets out to prove
B. defies common sense, since people will not pay for music they can acquire for free
C. fails to specify how much music CD sales have risen since the advent of file sharing
D. assumes a causal relationship between variables with a high correlation without examining other potential factors
E. denies the legitimacy of a claim on the basis of the bias interest of those (music industry representatives) making the claim
Other students' responses to the question are shown below. Discuss these responses. You will be able to revise your response on the next screen. You will receive a $1 bonus if all members of your group provide a correct final response.

Epidemiologist: Malaria passes into the human population when a mosquito carrying the virus bites a human who has no immunity. The malaria parasite can remain for up to forty days in the blood of an infected person. The disease cannot be passed from person to person, unless a non-infected person is exposed to the blood of an infected person. Theoretically, malaria could be eradicated in any given area, if all the mosquitoes carrying malaria in that area are exterminated. If such a course of action is carried out at a worldwide level, then the global eradication of malaria is possible.

Student 2 responded: Since I feel that it is necessary to show how you can ensure that malaria is eradicated all mosquitoes in an area then I don't see how it's possible to have this be a viable statement.

Student 1 responded: Justification: it is unlikely that blood to blood transmission will happen between people.

Student 3 responded: Justification: Eliminating all the malaria carrying mosquitoes doesn't do anything about the ones who aren't carrying malaria, but bite someone with malaria after the fact and become infected.

A person who is infected with malaria can infect a mosquito that is not carrying malaria, if that mosquito bites such a person.

Unless a mosquito bites an infected person, and then bites a non-infected person, malaria cannot be passed directly from human to human.

Malaria is still endemic in many parts of the world, and many health workers believe that the global eradication of malaria is not possible.

Some people in areas where malaria is rife have developed an immunity to mosquitoes, yet they also show a higher incidence of genetic disorders such as sickle-cell anemia.
System Workflow

Group A, Question 1

Worker 1: I think the right answer is A, because...

Worker 2: But have you considered...

Choose: A)... B)...

Choose: A)... B)...

Choose: A)... B)...

Choose: A)... B)...

Choose: A)... B)...

Choose: A)... B)...

Workers

Wait Page

Initial Answer (2 min)

Group Discussion (5 min)

Final Answer (20 sec)
Experimental Setup

- 226 worker sessions (12.8 min avg).
- 169 solo workers
- 25 discussions of size 2
- 73 discussions of size 3
- Each session consisted of 2 questions.
- 2 minutes alone, 5 minutes in discussion, 20 seconds for final answer choice
- 56% of the 452 attempts to answer questions were answered correctly.
RESULTS FOR EXPERIMENT 1
Results in Summary

- All hypotheses confirmed
- Engaging in discussion leads to more correct answers.
- The bonus incentive leads to more correct changed answers.
- The participants have substantive discussions.
Results in Detail

- Engaging in Discussion Leads to More Correct Answers
- The mean percentage of correct responses is higher in chatrooms with more than one student (Fisher’s exact test, p < 0.01)
Changing Answers After Discussion

• 138 workers (61%) made no changes.
• 74 (33%) changed one answer.
• 14 (6%) changed both answers.
• 50% who changed improved their score.
• 18% who changed lowered their score.
• 86% who changed both answers improved.
Bonus Worked as an Incentive to Help Other Workers

• Bonus Incentive Leads to More Correct Answers:
  • In the control condition, participants changed 33 out of 121 (27%) answers.
  • In the bonus condition they changed 44 out of 139 answers (32%). No significant difference (Fisher’s exact test, two-tailed p = 0.50).

• However, among the changed answers,
  • 14 answers (12%) changed from incorrect to correct in the control condition,
  • while 31 (22%) changed from incorrect to correct in the bonus condition, a significant difference (Fisher’s exact test, two-tailed p < 0.04)
Sample Conversation

- **S2**: I think E is the right answer
- **S1**: Hi! I think E is right, too
- **S3**: Hi! This seems to be a nurture vs nature question.
- **S3**: Can scent be learned, or only at birth?
- **S2**: Yea, but answer A supports the author’s conclusion
- **S1**: I felt that about A too
- **S2**: But the question was, which statement would weaken the author’s conclusion
- **S3**: So I choose A, showing that scent can be learned a not only AT BIRTH.
- **S2**: That’s why I think E is right
- **S3**: Are you real, or fake?
- **S2**: real
- ...
Who talked the most?

- In the groups of three, on average:
  - 1\textsuperscript{st} most talkative: 50.0\% of the time
  - 2\textsuperscript{nd} most talkative: 32.1\% of the time
  - 3\textsuperscript{rd} most talkative: 17.9\% of the time
Observation:
If one person is correct, others more likely to change to correct than the converse.

Bonus condition, experiment 1, triads only

<table>
<thead>
<tr>
<th>Num Initial C..</th>
<th>Num Final Choice Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

# correct initially -> # correct after discussion

1 -> 0 | 1
2 -> 0 | 1
3 -> 0 | 1
2 -> 1 | 1
3 -> 2 | 1
0 -> 2 | 1
1 -> 2 | 1
1 -> 3 | 6
2 -> 3 | 7
Coming Next: Grouping Based on Responses

- Experiment with grouping people ...
  - based on which answer they chose initially
  - give a hint as to what that choice is wrong
  - keep sending them to groups with fewer choices

- with one correct chooser
- with two correct choosers, etc
EXPERIMENT 2: CROWDWORKERS WITH STUDY MATERIALS
Experiment Flow Diagram

E1

Minimal

Read Essay; Select Answer
Discuss / Reflect on Answer
Reconsider Answer

E2

Mini-lesson

Read Mini-Lesson
Read Essay; Generate Assumption
Discuss / Reflect on Assumption
Read Essay; Select Answer

Mini-lesson + Discuss Question

Read Mini-Lesson
Read Essay; Generate Assumption
Discuss / Reflect on Assumption
Read Essay; Select Answer
Discuss / Reflect on Answer
Reconsider Answer
Second Experiment

Let’s first teach the workers / students something.

In this task, you’ll learn a critical reasoning skill commonly called identifying hidden assumptions. Read the following carefully.

You see arguments every day in statements by politicians, businesses, and advertisements. These arguments are a way of trying to convince you that something is true. Here is an example:

Many mobile phone companies protect their technology with patents, and mobile phones continue to become more technically advanced every year. Therefore, patents lead to strong competition in the marketplace.

This statement contains the key components of an argument: at least one premise and a conclusion. But often there are gaps in logic between the premises and the conclusion. These gaps can include assumptions, and identifying the unstated assumptions helps you spot the logical flaw in the reasoning:

Premise(s) + Assumption(s) = Conclusion(s)

If the assumptions are incorrect, then the conclusion might not follow. There are several unstated or hidden assumptions in the example above which may be not actually be true:

- **Assumption**: we have plenty of innovation in the presence of patents.
  - Perhaps defending against patents takes away resources from making even more innovative inventions.
- **Assumption**: strong competition is the biggest reason for the advanced technology in the mobile phone business.
  - However, patents award a monopoly (exclusive rights) to the patent holder, thus reducing competition.
Second Experiment

Then have them study the text, identify assumptions, and justify their answers.
Second Experiment

When everyone is ready, discuss the assumptions.
Second Experiment

When everyone is ready, discuss the assumptions.

Other students' responses are shown below. Discuss these assumptions in order to prepare for a question shown on the next screen.

Epidemiologist: Malaria passes into the human population when a mosquito carrying the virus bites a human who has no immunity. The malaria parasite can remain for up to forty days in the blood of an infected person. The disease cannot be passed from person to person, unless a non-infected person is exposed to the blood of an infected person. Theoretically, malaria could be eradicated in any given area, if all the mosquitoes carrying malaria in that area are exterminated. If such a course of action is carried out at a worldwide level, then the global eradication of malaria is possible.

Student 1 responded: 'Malaria can still be passed from a person infected with malaria to an uninfected mosquito if it comes in contact with the blood. So every mosquito would have to be killed before another one bites an already infected person.'

Student 2 responded: 'How to ensure all mosquitoes are killed.'

Student 3 responded: 'The assumption is that non-infected people won't be exposed to the blood of an infected person often enough for the virus to survive.'

Student 1 joined discussion.

Student 2 joined discussion.

You joined discussion as Student 3.

Me: Hi

Student 2: Hello

Student 1: I think points 2 and 3 are good. Maybe #3 needs to be elaborated on a little more.

Student 1: By the way hello.
Second Experiment

Finish discussing the assumptions.

Other students' responses are shown below. Discuss these assumptions in order to prepare for a question shown on the next screen.

Epidemiologist: Malaria passes into the human population when a mosquito carrying the virus bites a human who has no immunity. The malaria parasite can remain for up to forty days in the blood of an infected person. The disease cannot be passed from person to person, unless a non-infected person is exposed to the blood of an infected person. Theoretically, malaria could be eradicated in any given area if all the mosquitoes carrying malaria in that area are exterminated. If such a course of action is carried out at a worldwide level, then the global eradication of malaria is possible.

Student 1 responded: "Malaria can still be passed from a person infected with malaria to an uninfected mosquito if it comes in contact with the blood. So every mosquito would have to be killed before another one bites an already infected person."

Student 2 responded: "How to ensure all mosquitoes are killed."

Student 3 responded: "The assumption is that non-infected people won't be exposed to the blood of an infected person often enough for the virus to survive."

Student 2: Yeah my point is similar to the point of Student 2 in that you need to ensure all mosquitoes are killed.

Me: Ok, got it

Student 1: yes before they can be infected....

Student 2: agreed

Student 1: there has to be some uninfected mosquitoes

Student 1: well I guess we are all in agreement then... Jets end the chat?

Me: Sure
Second Experiment

Then answer the question directly alone and justify answer.

For the essay below, select among the five choices of A, B, C, D, or E.

Epidemiologist: Malaria passes into the human population when a mosquito carrying the virus bites a human who has no immunity. The malaria parasite can remain for up to forty days in the blood of an infected person. The disease cannot be passed from person to person, unless a non-infected person is exposed to the blood of an infected person. Theoretically, malaria could be eradicated in any given area, if all the mosquitoes carrying malaria in that area are exterminated. If such a course of action is carried out at a worldwide level, then the global eradication of malaria is possible.

Which of the following, if true, suggests that the epidemiologist's plan for eliminating malaria is not viable?

A. A person who is infected with malaria can infect a mosquito that is not carrying malaria, if that mosquito bites such a person.

B. Unless a mosquito bites an infected person, and then bites a non-infected person, malaria cannot be passed directly from human to human.

C. Malaria is still endemic in many parts of the world, and many health workers believe that the global eradication of malaria is not possible.

D. Some people in areas where malaria is rife have developed an immunity to mosquitoes, yet they are also show a higher incidence of genetic disorders such as sickle-cell anemia.

E. Mosquitoes in many developing parts of the world are responsible for passing on a variety of viruses to human hosts.

Submit your answer and justification before the timer runs out.

Justify your answer.

Eliminating all the malaria carrying mosquitoes doesn't do anything about the people who aren't carrying malaria, but bite someone with malaria after the fact and become infected.
Second Experiment
Finally, discuss the question prompts as a group.
Results

• Mini-lesson improves performance (from 11% correct to 58% correct)
  
  7 to 17 times more likely to answer the question right, Fisher’s exact test

• Discussing in group improves results only when question prompts shown (from 61% correct before discussion to 74% correct after).
  
  1.2 to 2.6 times more likely to answer correctly

• Better English speakers performed better (58% correct for “very good” speakers vs 29% for “poor”)

• People familiar with logical reasoning tasks performed better, no evidence of improvement for those without this background.
Results: Subjective Responses

Discussing Questions with Others was...

- Enjoyable: 234
- Neutral: 167
- Not Enjoyable: 42
TESTING WITH LARGE ONLINE COURSES
Moving to MOOCs

• Test in a Hybrid course
• >1000 students, flipped classroom

• 615 used the MOOCChat tool to review
• 53% responded Enjoyable (4 or 5) on a 5 point scale to “This activity was” prompt.
• 33% Neutral, 14% Not Enjoyable
Moving To MOOCS

Initial Tests in a MOOC: Strong positive subjective responses from students

<table>
<thead>
<tr>
<th>Question</th>
<th>(Strongly) Agree</th>
<th>Neutral</th>
<th>(Strongly) Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helpfulness of Discussion for final choice</td>
<td>11</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I Was Able to Help Others Learn</td>
<td>9</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Other Students Helped Me Learn</td>
<td>9</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>I Liked Discussing Questions in a Small Group and Would Like to Again</td>
<td>14</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Sample Conversation (Hybrid Engineering Course)

- S3: Hello.
- S1: Hello there
- S2: hey
- S3: So I’m sure the answer is A because it feels like the most plausible, but what do you think?
- S2: thought c was best because ceramic is brittle and could crack underground
- S3: yes, B is a bad choice
- S1: Agreed
- S3: But would the ants still eat through the the Polymer?
- S2: aren't polymers actually used?
- S2: i don’t think so
- S3: on normal Copper lines they are coated in a plastic (Polymer) already I think?
- ...
- [No one’s mind was changed in this case]
IS THIS A VALID COMPARISON?
Crowd Workers vs MOOC Takers

- **Environment:** both are rarely co-located in space and time and few know their peers
- **Education and demographics:** average age, education level, and performance on critical thinking tests are similar.

- HOWEVER:
  It might be hard to motivate MOOC-takers to show up at the right time to do the task.
- **AND** we want MOOCs to educate less sophisticated students.
IMPLICATIONS FOR CROWD WORK
Implications for Crowd Work

- Discussion may improve problem solving-style crowdsourcing work
  - Zhu et al. CSCW 2014 for math problems but not other types
- Brief training on an abstract task that evokes meta-cognitive processes may improve work.
- More evidence that self-assessments in crowd work can improve quality over no feedback
  - Builds on Dow et al. 2012
- More generally: the learning literature may hold many ideas to improve crowd sourcing.
(1) IMPROVE MOOCS WITH NEW TOOLS AND TECHNIQUES.
Reputation Systems in MOOC Forums?

Joint work with Bjorn Hartmann, Armando Fox, Derrick Coetzee, Taek Lim, CSCW 2014
Reputation Systems in MOOC Forums?

• Conclusions: Produce faster response times and more responses per posts.

• But no difference in grades or other measures of performance, or in sense of community.

• We did find that the version without reputation had more usage of language to try to induce help explicitly.

Joint work with Bjorn Hartmann, Armando Fox, Derrick Coetzee, Taek Lim, CSCW 2014
(2) TEACHING WITH MOOCS MAY HELP SOLVE RESEARCH PROBLEMS.
Virtuous teaching/research cycle

EXPLORATORY DATA ANALYSIS

PROGRAM DEBUGGING

WRITING TUTOR
Conclusions

• MOOCs are a good laboratory for improving all aspects of teaching.
  • Tutoring, automating feedback, grading.
• Peer interaction may be able to improve the isolation of online learning, as well as improving the learning.
  • Potential to automatically group people based on what misperceptions they currently have.
• Pedagogy literature might have a lot to say about how to improve crowdsourcing.
  • Example of incentivizing by awarding a bonus when all in the group get the answer right.
• Psychology most likely has a lot more to say too!
Thank you!

Marti Hearst
UC Berkeley