Gut Instinct
Creating Scientific Theories with Online Learners

UC San Diego
The Design Lab

Vineet Pandey
Scott Klemmer

@GutInstinctUCSD

Amnon Amir
Justine Debelius
Embriette R. Hyde
Tomasz Kosciolek
Rob Knight
Citizen scientists have successfully solved expert-defined problems as “sensors” or “algorithms”

- Tracking bird migration
  - eBird [Sullivan et al. 2009]

- Folding proteins
  - Foldit [Cooper et al. 2010]
Powerful ideas emerge when people combine data with personal insights.

Genomics
23andMe

Microbiome
American Gut

Medicine effects
Patientslikeme
A Baffling Brain Defect Is Linked to Gut Bacteria, Scientists Say

By GINA KOLATA  MAY 10, 2017

Related Coverage
- Exciting Microbe Research? Temper That Giddy Feeling in Your Gut  MARCH 6, 2017
- Say Hello to the 100 Trillion Bacteria That Make Up Your Microbiome  MAY 15, 2013
- Scientists Urge National Initiative on Microbiomes  OCT. 28, 2015
- 40 Trillion Bacteria on and in Us? Fewer Than We Thought  FEB. 15, 2016
Scientists’ questions can miss contextual insights

Do you think you'd perform better in a sprint or in a longer distance race?

- Sprint race
- Longer distance race
- Both - I'm like the wind
- Neither
How might people’s situated knowledge supplement ivory tower science?

Please chew with your mouth shut.
Can curious people perform scientific work while meeting their needs?

Contribute scientific hypotheses based on lifestyle

Use scientific knowledge to identify lifestyle choices
Gut Instinct integrates learning and asking questions about nascent science

gutinstinct.ucsd.edu
Understanding the human microbiome requires insights into people’s lifestyles

- Microbiome = Collection of all microbes and their genes in our body

- Extremely personal; shows drastic effects on health

  Men infected with Toxoplasma gondii tend to be rule-breakers, while infected women are more sociable [Flegr et al. 1996]
Results: 10 of 29 participants' questions matched researchers' questions (we think this is good)
Step 1: Answer questions created by other participants
Step 1a: Answer follow-up questions created by other participants

Dive deeper with these follow-up questions!

What type of alcoholic drinks (ex wine, beer, liquor, mixed with sugar) affect your bowel movements?

- [ ] wine
- [ ] beer
- [ ] liquor
- [ ] sugary mixed drinks
- [ ] Add my option

How many drinks does it take to notice a difference in your bowel movements?

- [ ] 1-2
- [ ] 3-4
- [ ] 5+
- [ ] Add my option

Save my choice(s)  Skip
Step 2: Ask questions
Step 2a: Ask questions

Add your Gut Instinct here!

Step 1: Add top-level question and options

Think of interesting questions that are personally relevant to you! Many crazy ideas have led to amazing discoveries, esp for gut microbiome - so don’t shy away!

Sample: How frequently do you eat probiotic yogurt?

Option 1:

Enter your option here

ADD MORE OPTIONS  SAVE&NEXT
Step 3: Learn about the scientific domain
Step 3a: Learn about #antibiotics
Hypotheses for Dual-objective online learning systems

H1 Learning improves quality of work on relevant problems.

H2 Working on relevant real-world problems improves learning.
Between-subjects experiment (N=44) w/ 3 conditions; Lab study followed by 3-day use
Between-subjects experiment (N=44) w/ 3 conditions: Contribute, Learn, & Combined
Between-subjects experiment (N=44) w/ 3 conditions: Contribute, Learn, & Combined

(1) Contribute

(2) Learn
Between-subjects experiment (N=44) w/ 3 conditions: **Contribute, Learn, & Combined**

(1) Contribute

(2) Learn

(3) Combined
Measures

• Questions: Novelty and usefulness (measured by blind, independent raters)

• Learning: Score on summative test
Results: 10 of 29 participants’ questions match official American Gut survey

(we think this is good)
Challenge: Gut Instinct questions are not framed as hypotheses

Score: 5/6
(Novelty: 2, Usefulness: 3)

Score: 2/6
(Novelty: 1, Usefulness: 1)
Results: H1. Did learning improve quality of questions? No.

Participants in Contribute and Combined conditions created questions of similar quality.
Results: H2. Did asking questions improve learning scores? No.

Participants in Learn condition performed the best on a summative test.

Learning did not show a significant effect on score but working did.
Combined condition did not perform better because..

- Multiple criteria of success
- Cognitive overload of multiple tasks
- Short "incubation" time for "scientists"
- Personalized learning and need for feedback
- …
Systems with two objectives often achieve one but not the other

- **Duolingo**
  Language learning + translation
  [Hacker 2014]

- **Have your cake**
  Language learning + translation
  [Culbertson et al. 2017]

- **Crowdclass**
  Decision-trees + galaxy classification
  [Lee et al. 2016]
Dual-objective online learning systems: Promise and challenges

- Learning & working
  - Integrate objectives and provide clear criteria of success
  - Task-specific scaffolding (aka how to generate good hypotheses)

- Make learning & work personally relevant
  - Working with intrinsically motivated participants
From the gut microbiome… to where?
Calling out to potential collaborators..

gutinstinct.ucsd.edu
americangut.org

Cultural psychology

Transcranial direct-current stimulation
References

- [Cooper et al. 2010] Predicting protein structures with a multiplayer online game.
- [Flegr et al. 1996] Induction of changes in human behaviour by the parasitic protozoan Toxoplasma gondii.
Extra slides