amazing cafes
cool art
somewhere to read
...
amazing cafes
cool art
somewhere to read
…
amazing cafes
cool art
somewhere to read
…
amazing cafes
cool art
somewhere to read

...
Computational Environment Design
the problem of constructing decision environments on the Web that elicit effective user actions
Computational Environment Design

the problem of constructing decision environments on the Web that elicit effective user actions
decision environment

interface or workflow incentives
feedback to users
constraints on actions

.....
decision environment

interface or workflow incentives feedback to users constraints on actions

.....

participants

knowledge and abilities interests and motivations availability

.....
decision
environment

interface or workflow incentives
feedback to users
constraints on actions

participants
knowledge and abilities
interests and motivations
availability

actions
planning an itinerary
answering a question
routing a task to another user
crowds
crowds
crowds
data-driven iterative design
data-driven iterative design
my contributions

crowdsourcing complex tasks

automated environment design
my approach: reason and learn about participants
this talk

human computation tasks with global constraints

task routing

automated workflow synthesis
human computation with global constraints

many small contributions
difficult to decompose
human computation algorithms

[Little et al., UIST 2010]

[Bernstein et al., UIST 2010]

[Kittur et al., UIST 2011]

[Noranha et al., UIST 2011]
Mobi

[Zhang, Law, Miller, Gajos, Parkes, Horvitz, CHI ‘12]
Going to San Francisco
Saturday, 11am to 10pm

What I am looking for:
I am going to San Francisco for a conference and have a day to explore the city before the conference starts. I’d love to go to some amazing cafes, check out some cool artsy things, and also just to relax and read a little.

Specific requirements:
- have at least 2 cool artsy things activities.
- have at least 1 place to read activity.
- have at least 1 amazing coffee/cafe activity.
- spend at least 3 hours on fresh local foods.
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- have at least 2 cool artsy things activity
- have at least 1 place to read activity
- have at least 1 amazing coffee/caffe activity
- spend at least 3 hours on fresh local food

arrive at Hyatt Regency (11:00am)
1 Cool cafe + People watching (11:15am–11:45am)
2 place to read (11:55am–12:25pm)
3 Ferry Plaza Farmers Market (12:35pm–2:05pm)
4 San Fran Museum of Modern Art (2:20pm–4:20pm)
5 Art at Grace Cathedral (4:35pm–5:05pm)
6 Stop at Philz Coffee (5:25pm–6:10pm)
7 balmy alley murals (6:40pm–7:10pm)
8 Local food at unique Localvore restaurant (7:25pm–8:55pm)
9 Westin St. Francis glass elevators (9:15pm–9:45pm)
arrrive at Hyatt Regency (9:55pm)
Our Brainstream

- Fresh local food restaurants
- Cool artsy things
- People watch
- Amazing coffee/cafes
- Somewhere to read
- Todo
- Activity
- Note

Add more things to the itinerary

There is still 5 hours and 3 minutes left empty in the itinerary. The trip can go till 10:00 pm.

Todo time

Add more 'amazing coffee/cafes' to the itinerary

We need at least 2 amazing coffee/cafes activities. The current itinerary contains 1 amazing coffee/cafes activities. [...]

Todo amazing coffee/cafes

Add more 'cool artsy things' to the itinerary

We need at least 2 cool artsy things activities. The current itinerary contains 1 cool artsy things activities. The [...]

Todo cool artsy things

Cool cafe + People watching

Check out this North Beach cafe for great coffee and even better people watching!

Activity people watch amazing coffee/cafes

Art at Grace Cathedral

See the triptych created by world famous artist Keith Haring, marvel at the murals and the beautiful stained glass [...]

Activity cool artsy things

Starbucks for coffee

Get some coffee

Activity amazing coffee/cafes

Ferry Plaza Farmers Market

Fresh local food. The back walkway, which has views of the bay and the coming and going of the ferries, is also a great [...]

Activity fresh local food restaurants

People watch somewhere to read

---

Map

Trip time: 5 hours and 57 minutes

Itinerary

- Arrive at Hyatt Regency (11:00 am)
- Cool cafe + People watching (11:05 am - 11:35 am)
- Place to read (11:45 am - 12:15 pm)
- Ferry Plaza Farmers Market (12:25 pm - 1:55 pm)
- Balmy alley murals (2:05 pm - 2:35 pm)
- Local food at unique Localvore restaurant (2:40 pm - 4:10 pm)
- Westin St. Francis glass elevators (4:25 pm - 4:55 pm)
- Arrive at Hyatt Regency (5:00 pm)
Our brainstream

#fresh local food restaurants  #cool artsy things
#people watch  #amazing coffee/cafes
#somewhere to read  #todo  #activity  #note

search or add an idea, or click on one below

Add more things to the itinerary
There is still 5 hours and 3 minutes left empty in the itinerary. The trip can go till 10:00pm.
#todo  #time

Add more 'amazing coffee/cafes' to the itinerary
We need at least 2 amazing coffee/cafes activities. The current itinerary contains 1 amazing coffee/cafes activities. [...]  
#todo  #amazing coffee/cafes

Add more 'cool artsy things' to the itinerary
We need at least 2 cool artsy things activities. The current itinerary contains 1 cool artsy things activities. The [...]  
#todo  #cool artsy things

Cool cafe + People watching
Check out this North Beach cafe for great coffee and even better people watching!  
#activity  #people watch  
#amazing coffee/cafes

Art at Grace Cathedral
See the triptych created by world famous artist Keith Haring, marvel at the murals and the beautiful stained glass [...]
video demo
crowdware

(a) the crowd contributes opportunistically given the current solution context

(b) the system indirectly coordinates the problem solving effort
Groupware
[Ellis et al., CACM 1991]

Wikipedia
[Cosley et al., IUI ’07]
[Hoffman et al., CHI ‘09]
experiment

Mechanical Turk workers paid $0.15 for any micro-contribution
TODO condition resolves quantitative constraints quicker

[*] the notodo condition never satisfied all the constraints
Chicago

TODO

NO TODO

- breakfast (=1)
- lunch (=1)
- architecture (≥1)
- kid-friendly (≥6h)
- dinner (=1)
- break (≥4)
- total time (≈12h)
end-to-end user study

Study: 10 subjects enter missions into Mobi

Result: All subjects found crowd-generated itineraries to satisfy their mission, and would use them in real life.
human computation tasks with global constraints

task routing

automated workflow synthesis
human computation tasks
with global constraints

**task routing**

automated workflow synthesis
How do I prove this theorem?
How do I prove this theorem?

You need to reduce it to something...
How do I prove this theorem?

try Michael. He might know.
How do I prove this theorem?

sometimes when you can’t prove A or B, you need to prove C.
task routing over social networks
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]

✦ will Obama win in 2012?

✦ will the iPhone 5 be taller than the iPhone 4S?
Will Obama win in 2012?

task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]
Will Obama win in 2012?

40%

task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]

Will Obama win in 2012?
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]

Will Obama win in 2012?
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]

Design incentives such that in equilibrium:
✧ people report honestly
✧ people make good routing decisions

Will Obama win in 2012?
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]

Will Obama win in 2012?

1 0 1 1 1 0 1 0 0 0 1
task routing for prediction tasks

[Zhang, Horvitz, Chen, Parkes, AAMAS ‘12]

Will Obama win in 2012?

Juliet

40%

57%

55%

1 0

1 1 1 0 1 0

0 0 1

_players observe conditionally independent bits of signal based on true state

_Bayesian model; assume common prior and known signal distribution_
incentives

report honestly, route effectively

local knowledge of others’ expertise
incen\textsuperscript{ves} report honestly, route effectively

Local common knowledge
everyone knows how many bits of information people within \textit{m}-hops hold, and this is common knowledge.
strictly proper scoring rules
[Good ‘52, Winkler ‘69, Savage ‘71]

Will Obama win in 2012?

\[ S(q) = 1 - (1 - q)^2 \quad \text{if win} \]
\[ 1 - q^2 \quad \text{if lose} \]

40%
Will Obama win in 2012?

\[ S(q_i) + S(q_{i+k}) \]

routing scoring rules

[Zhang, Horvitz, Chen, Parkes, AAMAS '12]
people may only know others’ expertise within a local neighborhood.
myopic routing rule
local routing rules

routing payment for player $i$ must:

(a) stay within $m$-hops
local routing rules

routing payment for player $i$ must:

(a) stay within $m$-hops

(b) only reach players whose routing payment stays within $m$-hops of player $i$
Local routing rules induce equilibrium in which players report honestly and route based on local information.
benefit of local routing scoring rules

[graphs generated using the Watts-Strogatz model, with $\beta = 0.1$, $n = 100$, $d = 10$]
human computation tasks with global constraints

task routing

automated workflow synthesis
human computation tasks
with global constraints

task routing

automated workflow synthesis
human computation algorithms

[Little et al., UIST 2010]

[Bernstein et al., UIST 2010]

[Kittur et al., UIST 2011]

[Noranha et al., UIST 2011]
many ways to solve a problem
(many possible tasks)

humans can make mistakes
(need to allocate effort across tasks)
example: human sorting tasks
human quicksort

> < > P < < < >

P P

... ...

...
automated workflow synthesis
automated workflow synthesis

models of task performance
automated workflow synthesis

experiment on task/input

models of task performance

Which is darker, or ?
automated workflow synthesis

models of task performance

experiment on task/input

observe the crowd’s output

Which is darker, or ?

is darker
automated workflow synthesis

experiment on task/input

models of task performance

observe the crowd’s output

Which is darker, or ? is darker
automated workflow synthesis

experiment on task/input

models of task performance

observe the crowd’s output

Which is darker, or ?
is darker
synthesize efficient algorithms that are tailored to the crowd
learning leads to better algorithms
learning smart leads to better algorithms sooner
human computation tasks with global constraints

task routing

automated workflow synthesis
reason and learn about participants
Thank you.
reason and learn about participants