Programming by Demonstration for the Browser

Shaon Barman, Sarah Chasins, Ras Bodik
UC Berkeley

Sumit Gulwani
Microsoft Research
Problem: Repetitive Tasks

• Web is filled with repetitive tasks
  – Ex: data scraping, form filling
Problem: Repetitive Tasks

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  – Ex: data scraping, form filling
  – Walled garden
Problem: Repetitive Tasks

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• Daily tasks
  – Same actions
  – Solution: Record and replay
Now accepting reservations through October 31, 2014. All fares are rounded up to the nearest dollar.

<table>
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<th>Sun</th>
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</tbody>
</table>

**Show Me:**

- **Business Select**
  - Starting at $549
- **Anytime**
  - Starting at $521
- **Wanna Get Away**
  - Starting at $192

[Update Calendar]
Problem: Repetitive Tasks

• Web is filled with repetitive tasks
  – Ex: data scraping, form filling

• Daily tasks
  – Same actions
  – Solution: Record and replay

• Iterative tasks
  – Similar actions on multiple pages
  – Solution: Relational Generalization
Want to iterate over all your friends
Want to iterate over all your friends
Grab the phone number

1 (832) 971-9204
Grab the phone number

1 (832) 971-9204
Problem: Repetitive Tasks

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Record and Replay

• Input: user demonstration
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- Input: user demonstration
- Output: executable script

- Typed “SFO” into arrivals text box
- Clicked “SFO link”
- ...
- Clicked “Submit” button
Record and Replay

- **Input:** user demonstration
- **Output:** executable script

- Goal: faithfully replay user’s actions

  - Typed “SFO” into arrivals text box
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Solution

- User demonstration creates an event trace

- Make event trace executable
  - Replaying events will drive the page’s program to the same state

```javascript
function callback(event) {
  // update the page
}
```
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Challenge - Causality

• Actual user program

   Wait for node ‘a’ to display ‘b’, then send event ‘c’ to node ‘d’
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• What we record

  send event ‘c’ to node ‘d’
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• Actual user program

  Wait for node ‘a’ to display ‘b’, then send event ‘c’ to node ‘d’

• What we record

  send event ‘c’ to node ‘d’

• Solutions
  – Timing
  – User feedback
  – Observing other page events (loads, quiescence)
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  – Solution: Relational Generalization
Relational Generalization

• Input: user demonstration
• Output: executable script

- Go to friend’s page
- Click “About” link
- Scrape off phone number

- Bob: 123-456-7890
Relational Generalization

- Input: user demonstration
- Output: executable script
- Goal: repeat actions on a set of similar pages
Relational Generalization

- Input: user demonstration + user queries
- Output: executable script

- Goal: repeat actions on a set of similar pages

- Go to friend’s page
- Click “About” link
- Scrape off phone number

- Bob: 123-456-7890
- Sue: 098-765-4321
- Alice: 567-123-7890
- ...
Relational Generalization

• Input: user demonstration + user queries
• Output: executable script

• Goal: repeat actions on a set of similar pages

- Go to friend’s page
- Click “About” link
- Scrape off phone number

- Bob: 123-456-7890
- Sue: 098-765-4321
- Alice: 567-123-7890
- ...
Demo!

Scraping information off of Facebook
Relational Generalization

• Work on structured data
• Take a single recording of a task and apply it to a set of elements.

• Two coupled steps
  – Inferring domains
    • Find a set of elements (ex: links) to apply script on
  – Parameterization
    • Modify script to work on similar pages
Inferring Domains

- Input: one or more examples of targets
- Output: list of all target elements
Inferring Domains

- Input: one or more examples of targets
- Output: list of all target elements

- Solutions
  - Use structure of DOM tree
  - Use class and id names
  - Query user to resolve ambiguity
Data for one friend
SPEC

Demonstration for one element + Selection of a few other elements

TOOL

Infer Domains + Parameterization

Script which executes on all elements
Summary

• Enable end-users to automate repetitive tasks

• Solutions
  – Record and replay
  – Generalization

• Take advantage of page’s regular structure and query the user when multiple viable options exist