Software Engineers are People Too: Applying Human Centered Approaches to Improve Software Development

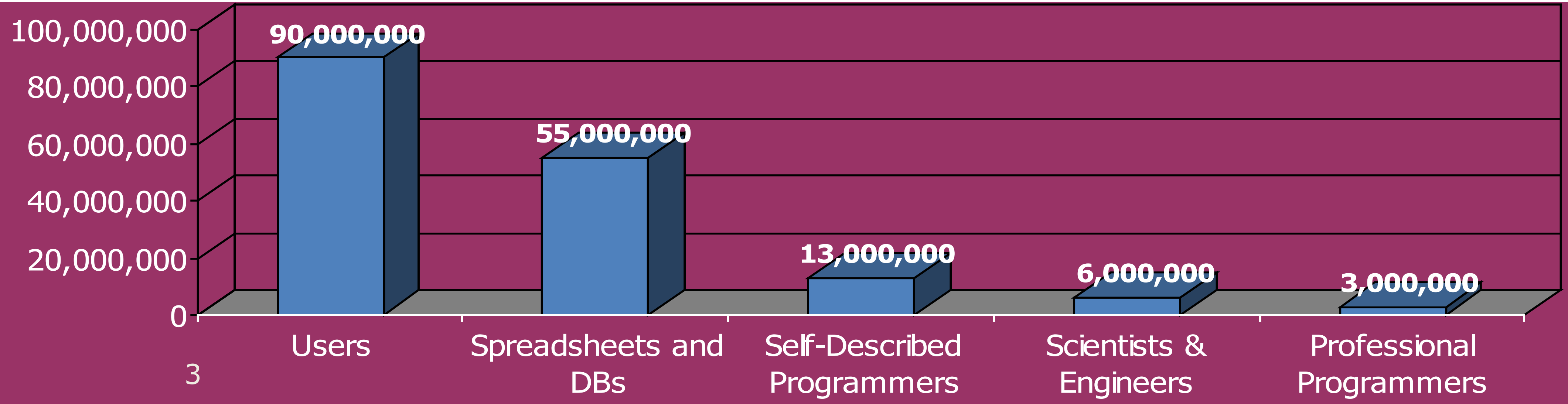
Brad A. Myers
Human-Computer Interaction Institute
School of Computer Science
Carnegie Mellon University
http://www.cs.cmu.edu/~bam
bam@cs.cmu.edu

Natural Programming Project

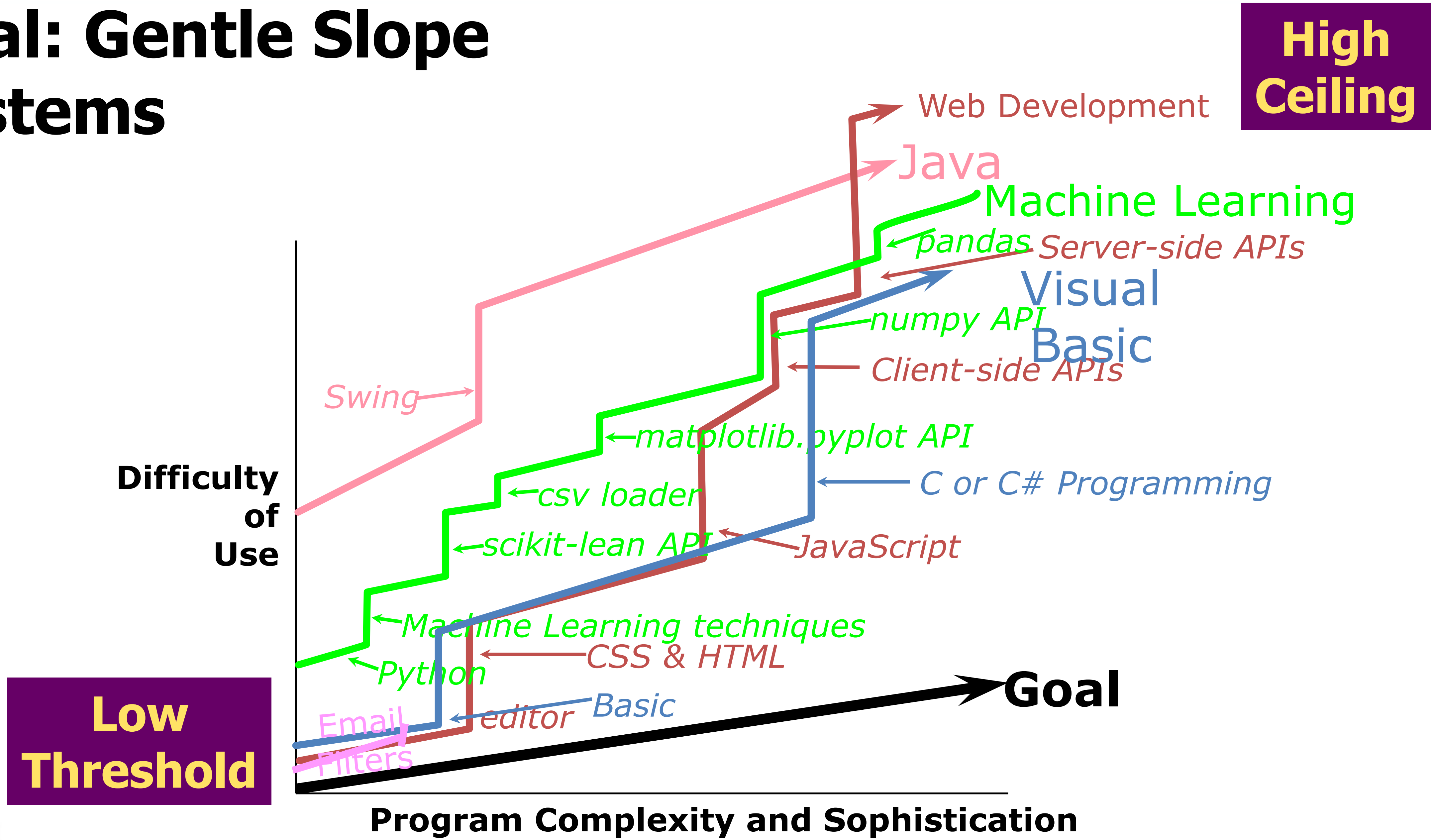
- Researching better tools for programming since 1978
- Natural Programming project started in 1995
- Make programming easier and more correct by making it more *natural*
  - Closer to the way that people think about algorithms and solving their tasks
- Methodology – human-centered approach
  - Perform *studies* to inform design
    - Provide new knowledge about what people do and think, & barriers
  - Guide the designs from the data
    - Design of programming *languages* and *environments*
  - Iteratively evaluate and improve the tools
- Target expert, novice and end-user programmers

End User Programming

- People whose primary job is *not* programming
- *[Scaffidi, Shaw and Myers 2005] (and confirmed recently)*
  - 90 million computer users at work in US
  - 55 million will use spreadsheets or databases at work (and therefore may potentially program)
  - 13 million will describe themselves as programmers
  - 3 million professional programmers



Goal: Gentle Slope Systems



Why Human Centered Approaches?

- Developers are people
- HCI can impact everything the developer encounters:
  - Tools – IDEs & their user interfaces
  - Languages themselves
    - Not necessarily just "taste", "intuition"
    - Error-proneness
  - APIs
    - "Interface" between developer and functionality
    - "Languages" by themselves can do very little these days
  - Documentation for all of the above
  - Processes & context of development
- ➢ New as well as legacy systems
- ➢ DX or DevX – developer experience (as in UX)

Dangers of *Not* Applying Human Centered Approaches

- Tools may show no measurable impact
  - Desired advantage overwhelmed by problems with other parts
  - Example: Emerson Murphy-Hill found that refactoring tools are under-utilized and programmers do not configure them due to usability issues

    [Emerson Murphy-Hill, Chris Parnin, Andrew P. Black. *How we refactor, and how we know it.* In ICSE '09: Proceedings of the 2009 IEEE 31st International Conference on Software Engineering (2009), pp. 287-297.]
- Hard-to-use APIs and tools have resulted in bugs and security problems
- Usability and quality are key influencers for the decision about which APIs and tools to use

Many HCI Methods

for answering different questions

- Contextual Inquiry
- Contextual Analysis
- Paper prototypes
- Think-aloud protocols
- Heuristic Evaluation
- Affinity diagrams
- Personas
- Wizard of Oz
- Task analysis
- A/B testing
- Cognitive Walkthrough
- Cognitive Dimensions
- KLM and GOMS (CogTool)
- Video prototyping
- Body storming
- Expert interviews
- Questionnaires
- Surveys
- Interaction Relabeling
- Log analysis
- Storyboards
- Focus groups
- Card sorting
- Diary studies
- Improvisation
- Use cases
- Scenarios
- "Speed Dating"
- Journey Maps
- …

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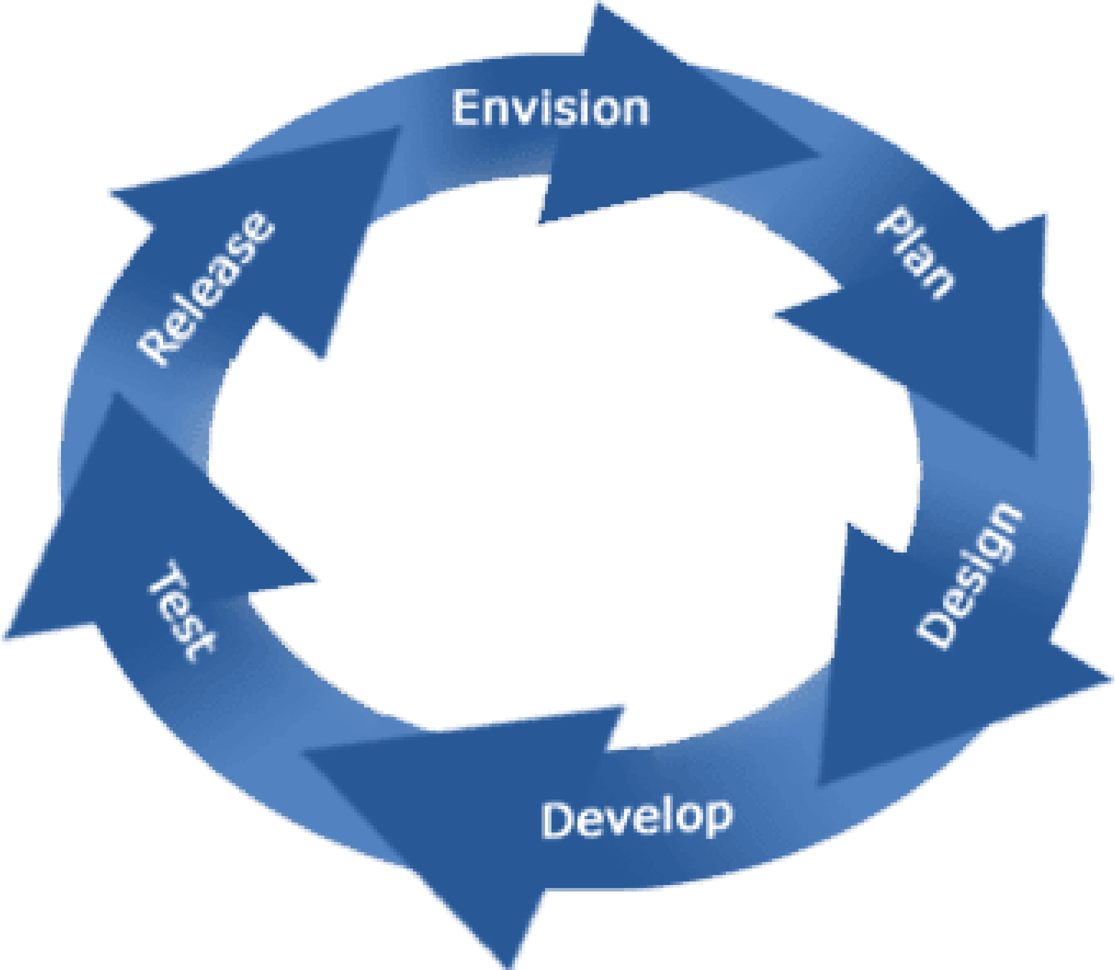
Product Lifecycle



Source: http://www.accordtech.co.in/Product%20Development%20Lifecycle.htm

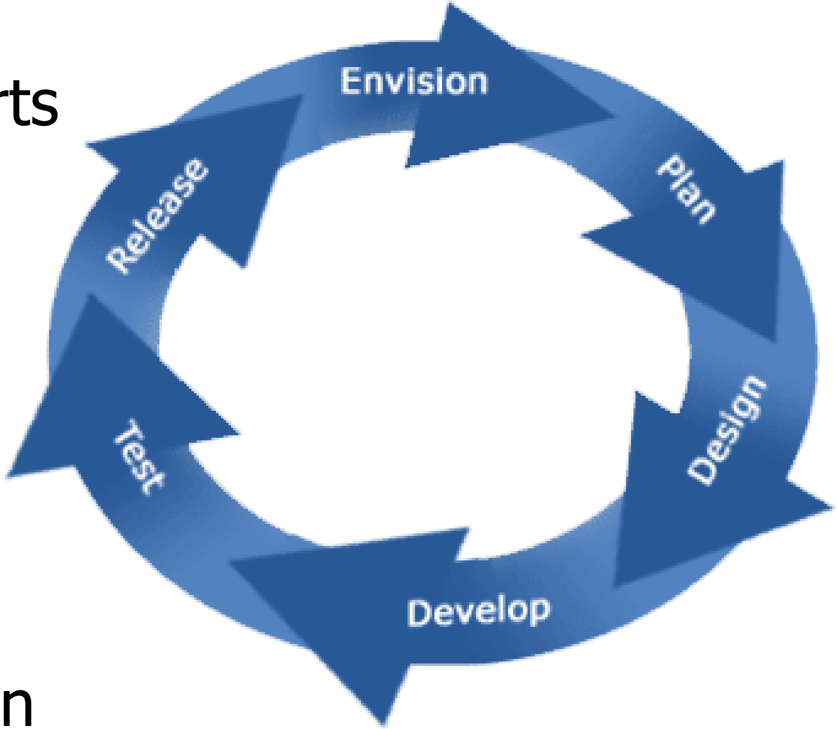
Product Lifecycle

Field Studies

- Logs & error reports

Evaluative Studies

- Expert analyses
- Usability Evaluation
- Formal A/B Lab Testing



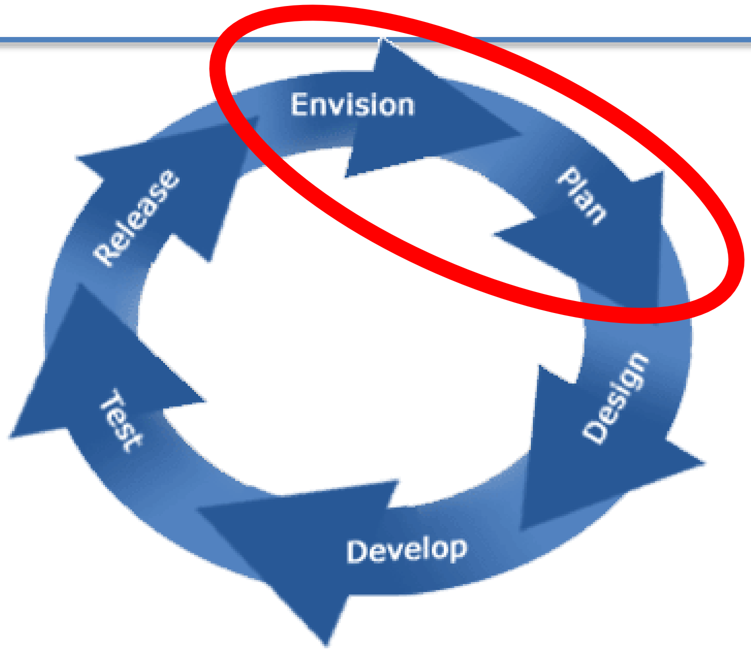
Formative Studies

- Contextual Inquiries
- Interviews
- Surveys
- Lab Studies
- Corpus data mining

Design Practices

- “Natural programming”
- Prototyping

Formative Studies



- Identify what is really happening
- Discover important problems
- Quantify need
- Develop use cases based on data

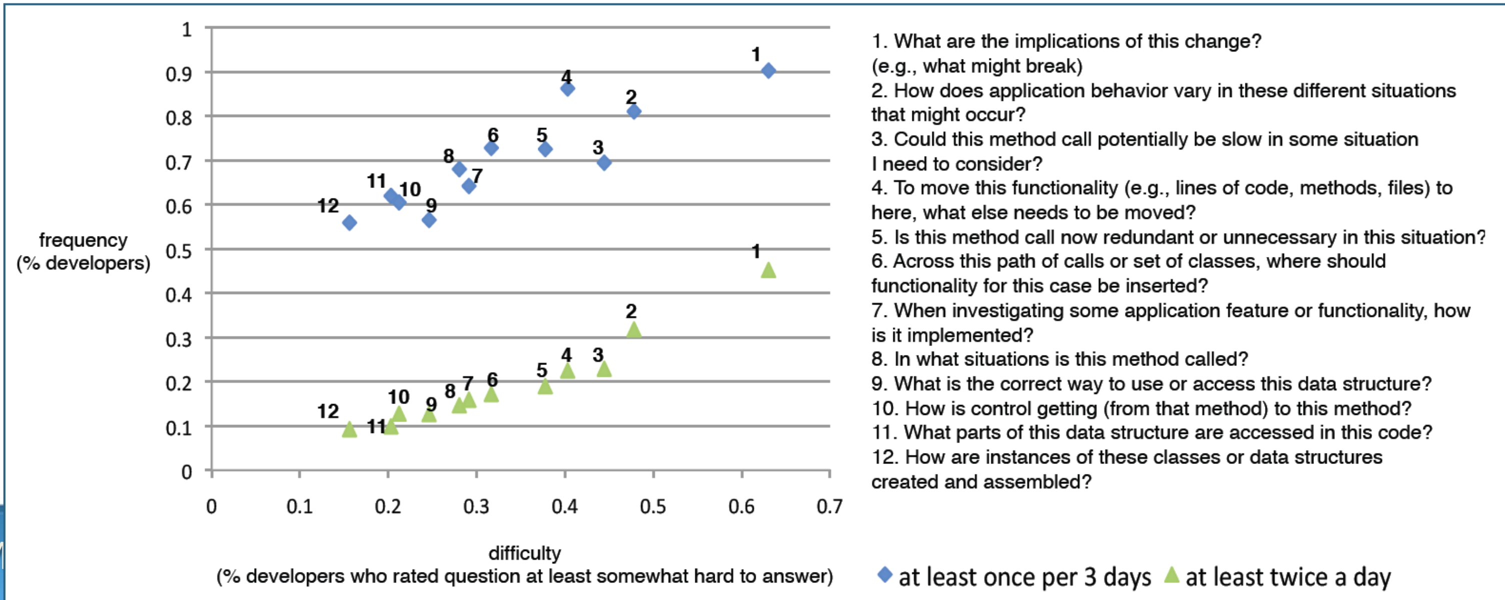
Contextual Inquiry (CI)

[Beyer, H. and Holtzblatt, K., *Contextual Design: Defining Custom-Centered Systems.* 1998, San Francisco, CA: Morgan Kaufmann Publishers, Inc.]

- Watch developers while they are performing their real tasks
- Objective, concrete data about real activities
- May be followed by a survey, to establish generality of the issues
- Reveals many barriers and problems in current practice
- API Designers told us that identifying developer's real needs was a key barrier [Murphy, Kery, Alliyu, Macvean & Myers, VL/HCC'18]

Example of Contextual Inquiry & Surveys

- "Developers Ask Reachability Questions"
  [Thomas D. LaToza, Brad Myers, *ICSE'2010*, Cape Town, South Africa, 2-8 May 2010. pp. 185-194.]
  - "Search across feasible paths through a program for target statements matching search criteria"
    - Watched 17 developers investigating unfamiliar code
    - Also surveyed 460 developers
    - Over 100 other hard-to-answer questions



1. What are the implications of this change? (e.g., what might break)
2. How does application behavior vary in these different situations that might occur?
3. Could this method call potentially be slow in some situation I need to consider?
4. To move this functionality (e.g., lines of code, methods, files) to here, what else needs to be moved?
5. Is this method call now redundant or unnecessary in this situation?
6. Across this path of calls or set of classes, where should functionality for this case be inserted?
7. When investigating some application feature or functionality, how is it implemented?
8. In what situations is this method called?
9. What is the correct way to use or access this data structure?
10. How is control getting (from that method) to this method?
11. What parts of this data structure are accessed in this code?
12. How are instances of these classes or data structures created and assembled?

Many hard-to-answer questions about code

[LaToza & Myers, PLATEAU'2010]

Rationale (42)

Why was it done this way? (14) [15][7]
Why wasn't it done this other way? (15)
Was this intentional, accidental, or a hack? (9)[15]
How did this ever work? (4)

Debugging (26)

How did this runtime state occur? (12) [15]
What runtime state changed when this executed? (2)
Where was this variable last changed? (1)
How is this object different from that object? (1)
Why didn't this happen? (3)
How do I debug this bug in this environment? (3)
In what circumstances does this bug occur? (3) [15]
Which team's component caused this bug? (1)

Intent and Implementation (32)

What is the intent of this code? (12) [15]
What does this do (6) in this case (10)? (16) [24]
How does it implement this behavior? (4) [24]

Refactoring (25)

Is there functionality or code that could be refactored? (4)
Is the existing design a good design? (2)
Is it possible to refactor this? (9)
How can I refactor this (2) without breaking existing users(7)? (9)
Should I refactor this? (1)
Are the benefits of this refactoring worth the time investment? (3)

Testing (20)

Is this code correct? (6) [15]
How can I test this code or functionality? (9)
Is this tested? (3)
Is the test or code responsible for this test failure? (1)
Is the documentation wrong, or is the code wrong? (1)

Implementing (19)

How do I implement this (8), given this constraint (2)? (10)
Which function or object should I pick? (2)
What's the best design for implementing this? (7)

Control flow (19)

In what situations or user scenarios is this called? (3) [15][24]
What parameter values does each situation pass to this method? (1)
What parameter values could lead to this case? (1)
What are the possible actual methods called by dynamic dispatch here? (6)
How do calls flow across process boundaries? (1)
How many recursive calls happen during this operation? (1)
Is this method or code path called frequently, or is it dead? (4)
What throws this exception? (1)
What is catching this exception? (1)

Contracts (17)

What assumptions about preconditions does this code make? (5)
What assumptions about pre(3)/post(2)conditions can be made?
What exceptions or errors can this method generate? (2)
What are the constraints on or normal values of this variable? (2)
What is the correct order for calling these methods or initializing these objects? (2)
What is responsible for updating this field? (1)

Performance (16)

What is the performance of this code (5) on a large, real dataset (3)? (8)
Which part of this code takes the most time? (4)
Can this method have high stack consumption from recursion? (1)
How big is this in memory? (2)
How many of these objects get created? (1)

Type relationships (15)

What are the composition, ownership, or usage relationships of this type? (5) [24]
What is this type's type hierarchy? (4) [24]
What implements this interface? (4) [24]
Where is this method overridden? (2)

Data flow (14)

What is the original source of this data? (2) [15]
What code directly or indirectly uses this data? (5)
Where is the data referenced by this variable modified? (2)
Where can this global variable be changed? (1)
Where is this data structure used (1) for this purpose (1)? (2) [24]
What parts of this data structure are modified by this code? (1) [24]
What resources is this code using? (1)

Location (13)

Where is this functionality implemented? (5) [24]
Is this functionality already implemented? (5) [15]
Where is this defined? (3)

Building and branching (11)

Should I branch or code against the main branch? (1)
How can I move this code to this branch? (1)
What do I need to include to build this? (3)
What includes are unnecessary? (2)
How do I build this without doing a full build? (1)
Why did the build break? (2)[59]
Which preprocessor definitions were active when this was built? (1)

Architecture (11)

How does this code interact with libraries? (4)
What is the architecture of the code base? (3)
How is this functionality organized into layers? (1)
Is our API understandable and flexible? (3)

History (23)

When, how, by whom, and why was this code changed or inserted? (13)[7]
What else changed when this code was changed or inserted? (2)
How has it changed over time? (4)[7]
Has this code always been this way? (2)
What recent changes have been made? (1)[15][7]
Have changes in another branch been integrated into this branch? (1)

Concurrency (9)

What threads reach this code (4) or data structure (2)? (6)
Is this class or method thread-safe? (2)
What members of this class does this lock protect? (1)

Dependencies (5)

What depends on this code or design decision? (4)[7]
What does this code depend on? (1)

Method properties (2)

How big is this code? (1)
How overloaded are the parameters to this function? (1)

Teammates (16)

Who is the owner or expert for this code? (3)[7]
How do I convince my teammates to do this the "right way"? (12)
Did my teammates do this? (1)

Policies (15)

What is the policy for doing this? (10) [24]
Is this the correct policy for doing this? (2) [15]
How is the allocation lifetime of this object maintained? (3)

Implications (21)

What are the implications of this change for (5) API clients (5), security (3), concurrency (3), performance (2), platforms (1), tests (1), or obfuscation (1)? (21) [15][24]

Many opportunities for better tools

- Of all the reported questions
  - 34% addressed by commercial tools
  - 25% addressed by research tools
  - 41% unaddressed by any tools

Example of Interviews: Immutability

- Experts recommend making classes *immutable* so instances cannot change accidentally *[Coblenz, et al, ICSE'2016]*
  - Thread safe, more secure, no unexpected state changes, etc.
- Many relevant language features
  - C++ `const`, Java `final`, Obj-C immutable collections, .NET `Freezable`, etc.
- Usability studies suggest programmers prefer classes that can change
- Semi-structured interviews with a convenience sample of 8 software engineers
  - Agreed that mutability is a frequent source of bugs
  - But *none* of these features are what is needed
  - Preferred *transitive, class-based immutability*
    - So we provided this in the **Glacier** language extension *[Coblenz, et al, ICSE'2017]*
      - **G**reat **L**anguages **A**llow **C**lass **I**mmutability **E**nforced **R**eadily
    - User study showed *none* made errors enforcing immutability, vs *all* in control condition using Java `final`

Exploratory Lab Studies

- To understand what is happening
- More controlled than Contextual Inquiries
  - Can compare multiple people on same tasks
- Example: studying Eclipse for maintenance tasks

  [Andrew J. Ko, Htet Htet Aung, and Brad A. Myers. "Eliciting Design Requirements for Maintenance-Oriented IDEs: A Detailed Study of Corrective and Perfective Maintenance Tasks". *ICSE'2005*. pp. 126-135.
  Winner, Distinguished Paper Award.]
  - Detailed study of fixing bugs and adding features
  - Dataset used for 3 different award-winning papers: interruptions, navigation, code editing behaviors

Interactive Bottleneck	Overall Cost
Navigating to fragment in *same* file (*via scrolling*)	~ 11 minutes
Navigating to fragment in *different* file (*via tabs and explorer*)	~ 7 minutes
Recovering working set after returning to a task	~ 1 minute
Total Costs	~19 minutes

=35%

Corpus Data Mining

- Studied 11 million Java try/catch blocks from GitHub using Boa tool
- 12% of catch blocks were completely empty. [Kery, Le Goues, & Myers, 2016]
- 25% of all exceptions caught are simply `Exception`
- Motivated a new tool to help programmers write better exception handling code
  - **Moonstone**: **M**aking **O**bject **O**riented **N**ovel **S**oftware **T**ools **O**ptimized for **N**oting **E**xceptions [Kistner, Kery, Puskas, Moore & Myers, VL/HCC'17]

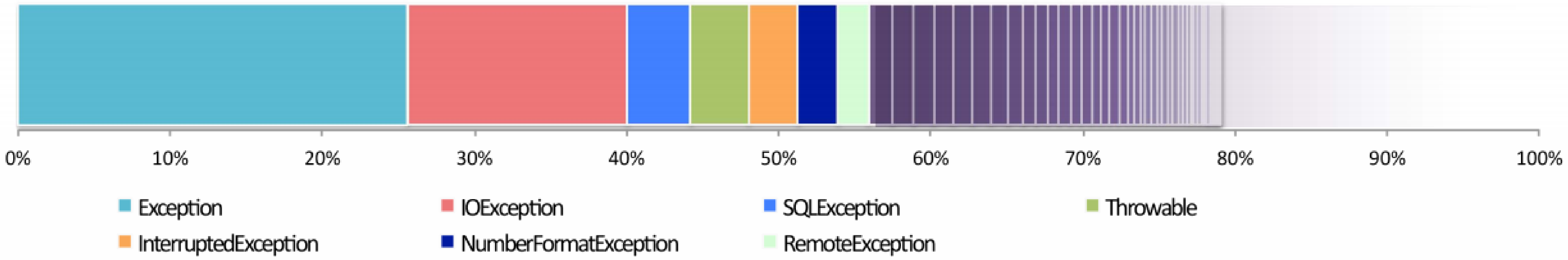
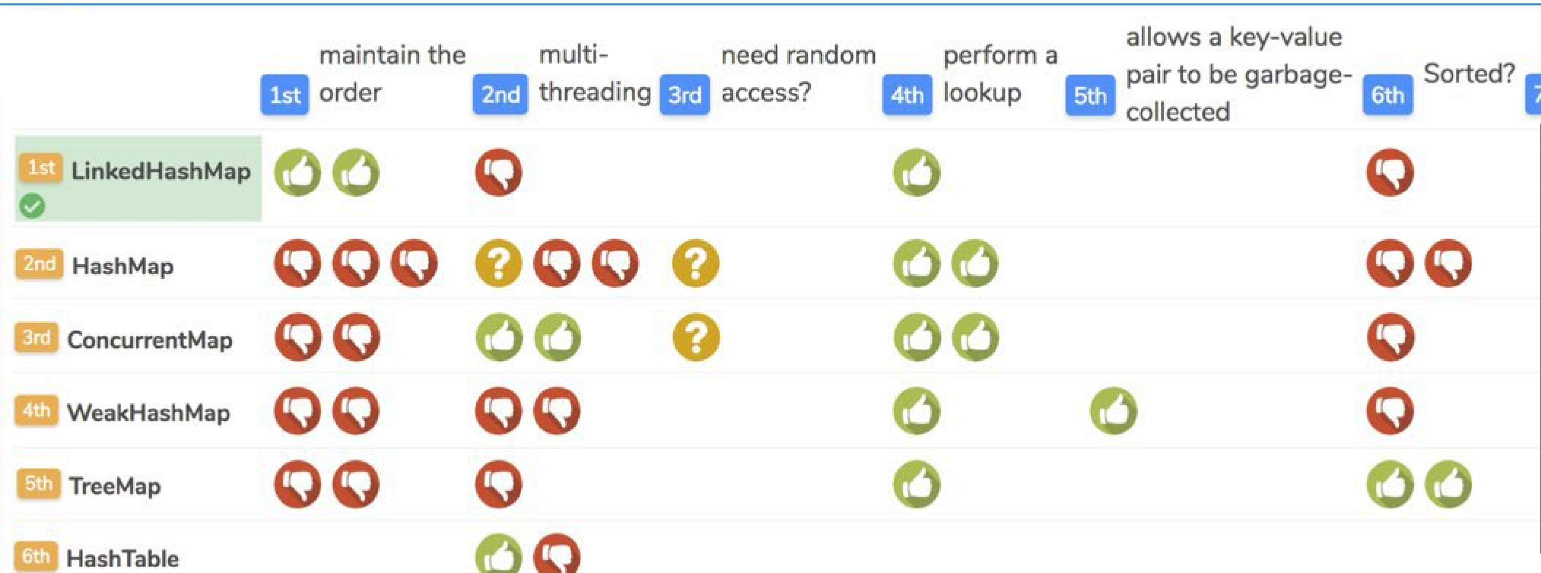


Figure 3: Exceptions caught by catch blocks on GitHub. Exceptions that occur more than 1% of the time are labeled. The rest, in purple, are thousands of exceptions that only rarely occur.

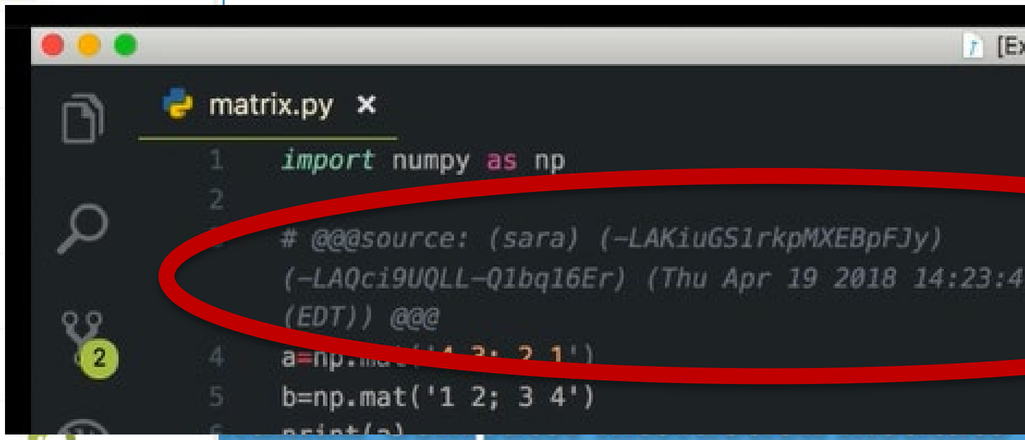
Data Mining Stack Overflow

- Want to help developers *organize* information after finding it
- Study what kinds of questions people express on Stack Overflow
  - 51% involved *decisions* with multiple options and criteria
- Motivated new web & IDE tool: **Unakite**: **U**sers **N**eed **A**ccelerators for **K**nowledge for **I**mplementations in **T**echnology **E**nvironments
  - Programmers clip snippets of information from the web
  - Organizes information into a table
  - When paste into code, creates back pointers to the table as *design rationale*



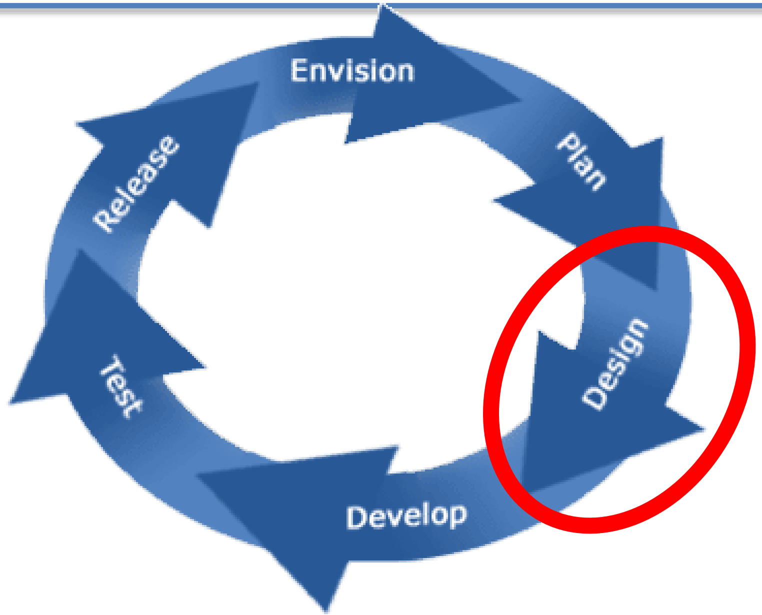
	1st maintain the order	2nd multi-threading	3rd need random access?	4th perform a lookup	5th allows a key-value pair to be garbage-collected	6th Sorted?	7th permits nulls
1st LinkedHashMap ✓	👍 👍	👎		👍		👎	
2nd HashMap	👎 👎 👎	? 👎 👎	?	👍 👍		👎 👎	
3rd ConcurrentMap	👎 👎	👍 👍	?	👍 👍		👎	
4th WeakHashMap	👎 👎	👎 👎		👍	👍	👎	
5th TreeMap	👎 👎	👎		👍		👍 👍	
6th HashTable		👍 👎					

[Liu, et al, 2019]



```
import numpy as np

# @@@source: (sara) (-LAKiuGS1rkpMXEBpFJy)
(-LAQci9UQLL-Q1bq16Er) (Thu Apr 19 2018 14:23:4
(EDT)) @@@
a=np.mat('1 2; 2 1')
b=np.mat('1 2; 3 4')
print(a)
```

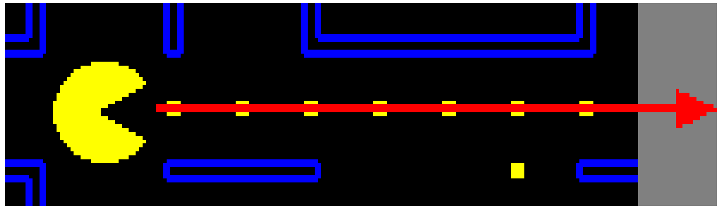
Design Methods

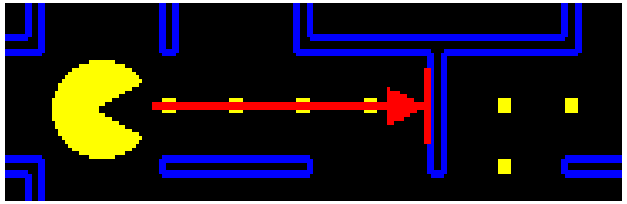


- Now know the problem, what is the solution?
- How do I design it so it is easy to learn and effective?

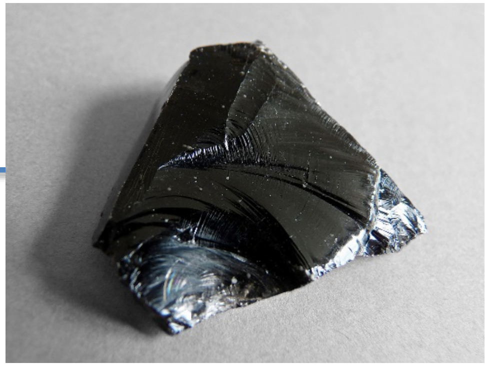
“Natural Programming” Elicitation Method

- Technique developed by my group to discover developer’s “natural” expressions
  - Mental models of tasks, vocabulary, etc.
- A form of participatory design
- Blank paper tests
- Must prompt for the tasks in a way that doesn’t bias the answers
- Examples:
  - PacMan before and after
    - Mostly rule-based (if-then)
  - API designs
    - Architecture, names used, which methods are on which classes



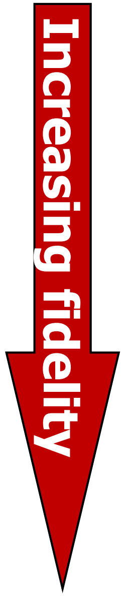


Example of use of Natural Programming



- Obsidian is a new domain specific language (DSL) for blockchains [Coblenz, et al, 2019]
  - **O**bject-oriented **B**lockchain **S**tate **I**nteraction and **D**evelopment **I**mplementation **A**nd **N**otation
- Combining state transition language *("TypeStates")* with *resources ("linear types")* all checked statically
- 11 different NatProg studies on how to present these complex concepts

Prototyping

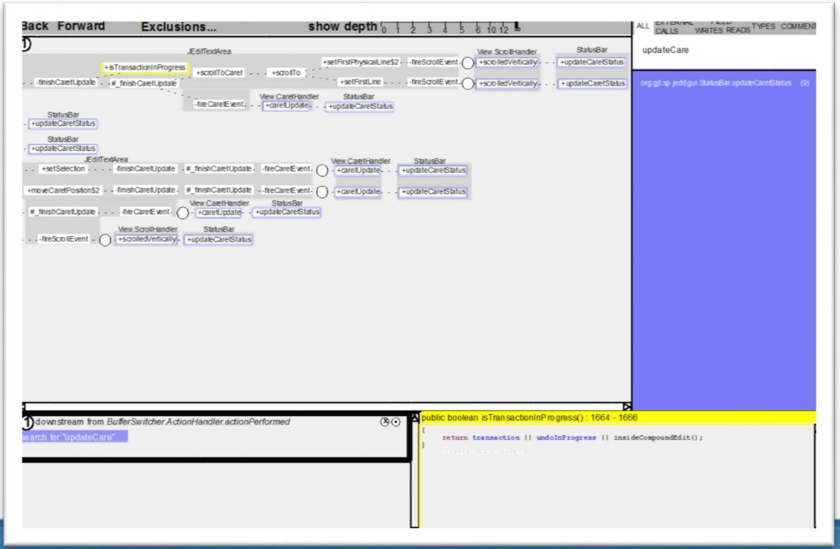


- Try out designs with developers before implementing them
  - Paper
    - “Low fidelity prototyping”
    - Often surprisingly effective
    - Experimenter plays the computer
    - Drawn on paper → drawn on computer
  - Implemented Prototype (“Click through”)
    - Balsamiq, Axure, PowerPoint, Web tools (even for non-web UIs)
    - (no database)
  - Real system

- Need to test these with users!
- Better if sketchier for early design
  - Use paper or “sketchy” tools, not real widgets
  - People focus on wrong issues: colors, alignment, labels
  - Rather than overall structure and fundamental design

Example of Early Prototyping

- Thomas LaToza designing new visualization tool to try to help answer Reachability Questions [LaToza & Myers, VL/HCC'11]
- Prototypes created with Omnigraffle and printed
- Revealed significant usability problems that were fixed
  - Basic concepts
  - Graphical presentation
  - Controls

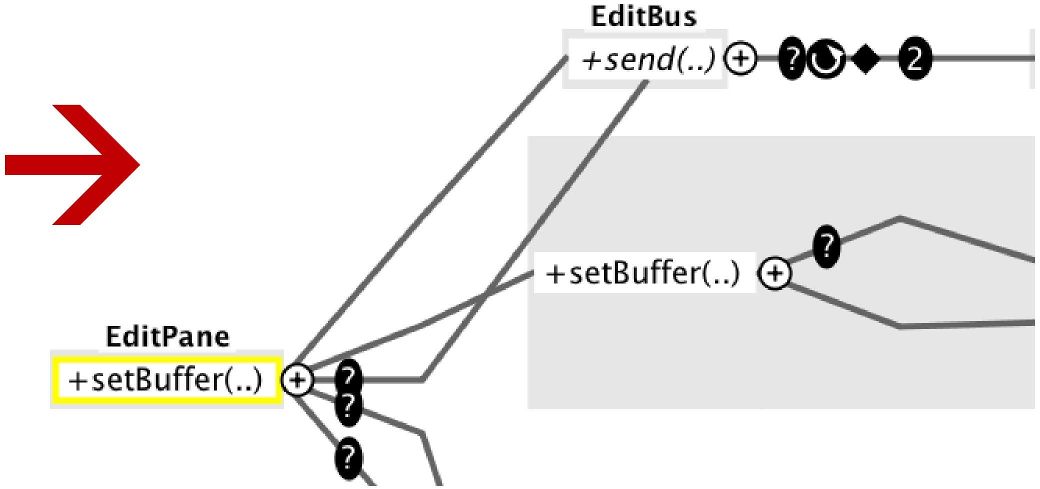


downstream from *BufferSwitcher.ActionHandler.actionPerformed*

search for "updateCare"

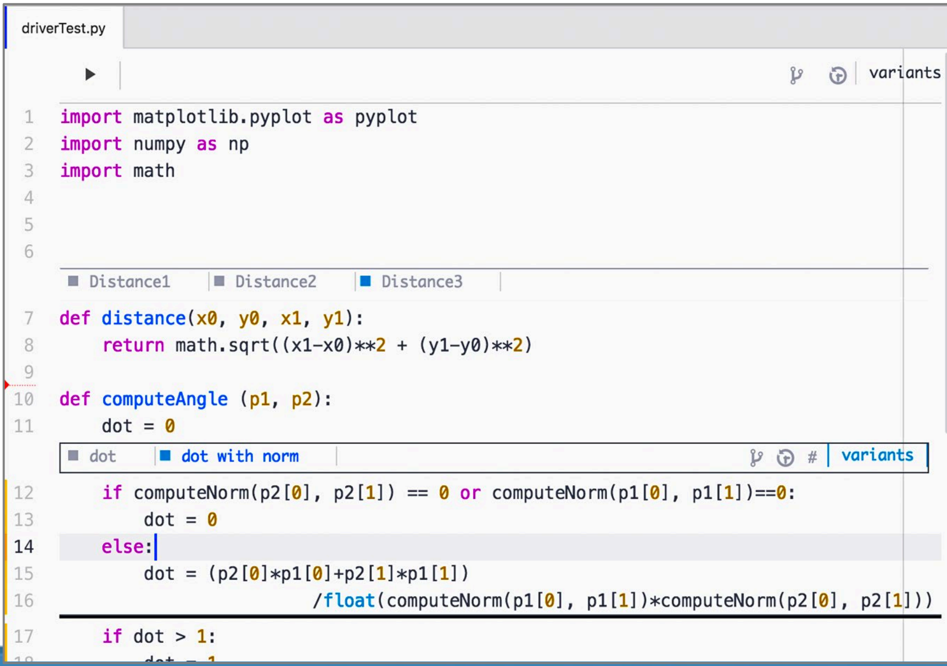
public boolean isTransactionInProgress() : 1664 - 1666

```
{
    return transaction || undoInProgress || insideCompoundEdit();
}
```



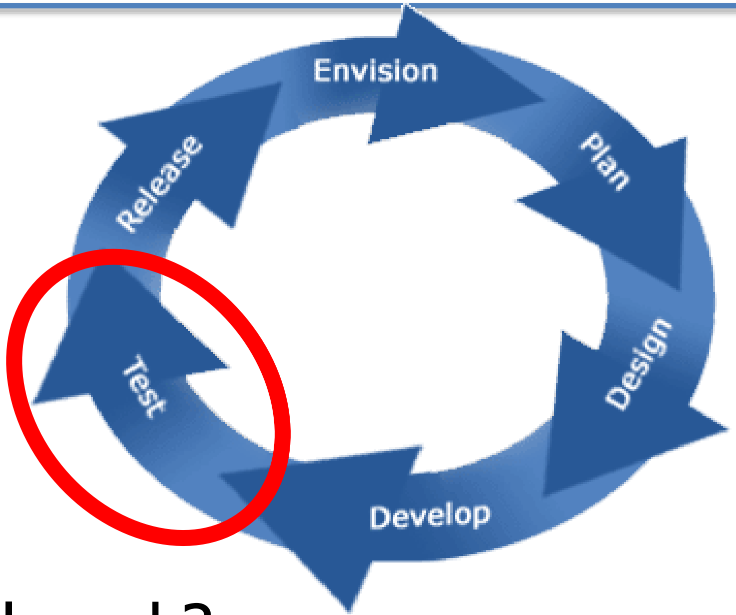
Another Example: Variolite

- How to support data scientists with exploratory programming?
- What kind of version control support would be useful?
  - Interviews and CIs showed that conventional approaches like Git are too heavy-weight [Kery, Horvath & Myers, CHI'2017]
- Showed dozens of sketches to target users to get feedback on which seemed usable and useful
- Final design appeared at CHI’2017 🏅
- **V**ariations **A**ugment **R**eal **I**terative **O**utcomes **L**etting **I**nformation **T**ranscend **E**xploration



```
import matplotlib.pyplot as pyplot
import numpy as np
import math



def distance(x0, y0, x1, y1):
    return math.sqrt((x1-x0)**2 + (y1-y0)**2)

def computeAngle (p1, p2):
    dot = 0
    if computeNorm(p2[0], p2[1]) == 0 or computeNorm(p1[0], p1[1])==0:
        dot = 0
    else:
        dot = (p2[0]*p1[0]+p2[1]*p1[1])
                    /float(computeNorm(p1[0], p1[1])*computeNorm(p2[0], p2[1]))

    if dot > 1:
        dot = 1
```

Evaluation Methods



- Does my tool work?
- Does it solve the developer's problems?
- How much better than alternatives?
- "If the user can't use it, it doesn't work!"
  – Susan Dray

Dray & Associates
Human Centered Innovation

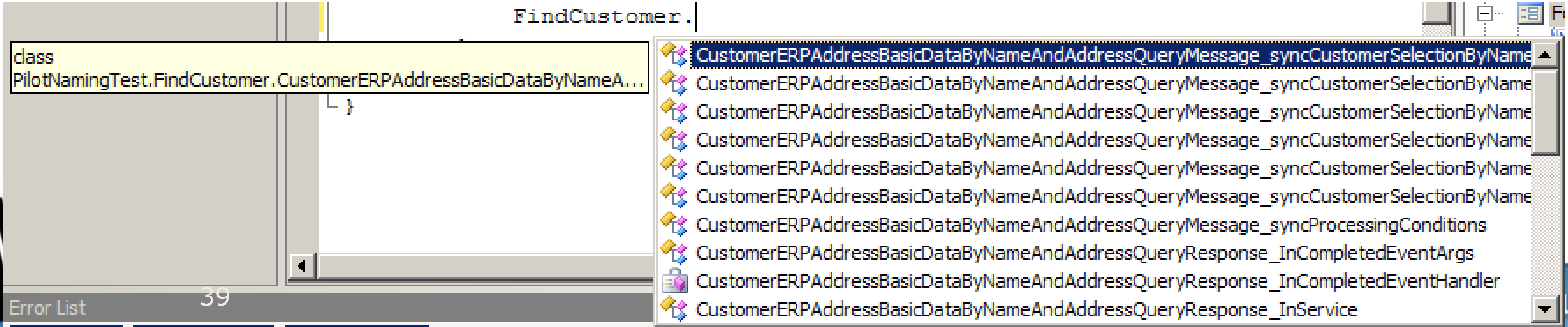
Expert Analyses

- Usability experts evaluating designs to look for problems
  - Heuristic Analysis – [Nielsen] set of guidelines
  - Cognitive Dimensions – [T.R.G. Green] another set of guidelines
  - Cognitive Walkthroughs – evaluate a task
- Can be inexpensive and quick
- However, experienced evaluators are better
  - 22% vs. 41% vs. 60% of errors found [Nielsen]
- Disadvantage: “just” opinions, open to arguments

Our Use of Expert Analyses

- Collaborating with SAP on their APIs and tools
- We studied SAP’s Enterprise Service-Oriented Architecture (eSOA) APIs & Documentation

  [Jack Beaton, Sae Young Jeong, Yingyu Xie, Jeffrey Stylos, Brad A. Myers. "Usability Challenges for Enterprise Service-Oriented Architecture APIs," *2008 IEEE Symposium on Visual Languages and Human-Centric Computing, VL/HCC'08*. Sept 15-18, 2008, Herrsching am Ammersee, Germany. pp. 193-196.]
- Naming problems:
  - Too long `MaterialSimpleByIDAndDescriptionQueryMessage_syncMaterialSimpleSelectionByIDAndDescriptionSelectionByMaterialDescription`
  - Not understandable



```
FindCustomer.
```

class
PilotNamingTest.FindCustomer.CustomerERPAddressBasicDataByNameA...

CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncCustomerSelectionByName
CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncCustomerSelectionByName
CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncCustomerSelectionByName
CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncCustomerSelectionByName
CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncCustomerSelectionByName
CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncCustomerSelectionByName
CustomerERPAddressBasicDataByNameAndAddressQueryMessage_syncProcessingConditions
CustomerERPAddressBasicDataByNameAndAddressQueryResponse_InCompletedEventArgs
CustomerERPAddressBasicDataByNameAndAddressQueryResponse_InCompletedEventHandler
CustomerERPAddressBasicDataByNameAndAddressQueryResponse_InService

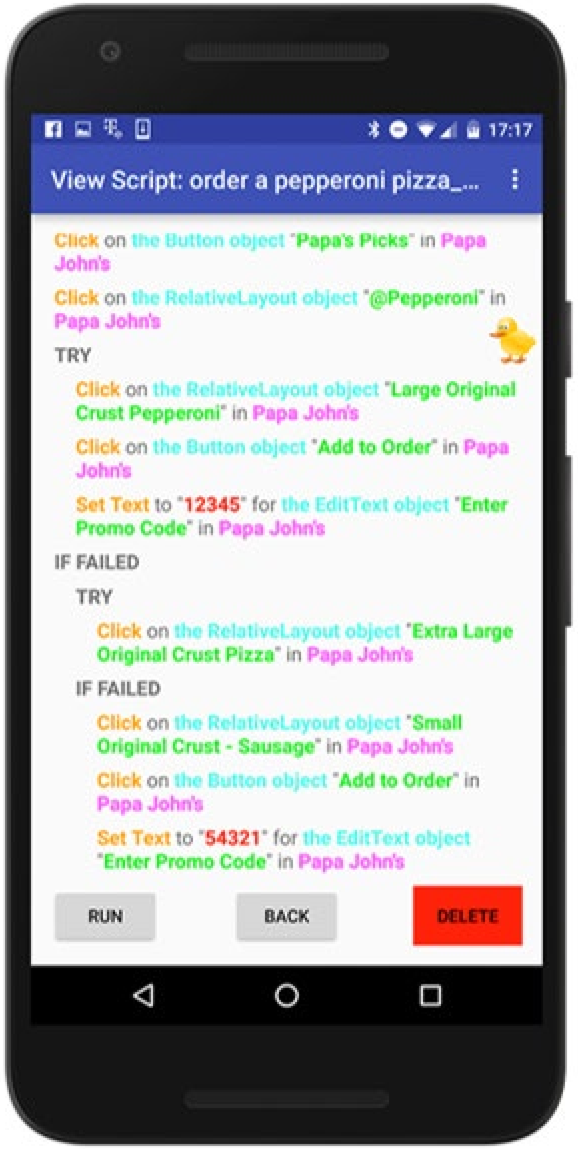
Usability Evaluations

- Let representative target users use the system or a prototype of the system
- Also called "think aloud" protocols
- Different from formal A/B "user testing"
  - Understand usability issues
  - Get qualitative feedback about issues; not numbers
- Should be done early and often
  - Doesn't have to be "finished" to let people try it
- Demonstrates that users *can* use the system
  - Show that novel features of the UI are understandable

Example Use of Usability Analysis

- **Sugilite**: **S**martphone **U**sers **G**enerating **I**ntelligent **L**ikeable **I**nterfaces **T**hrough **E**xamples
- Allow end-users to create automations on Smartphones
- Initiate with speech commands
- Record scripts by example
- Generalizes from one or more examples
- 19 participants attempted 5 tasks
  - All completed at least 2 tasks successfully
  - 8 (42.1%) succeed in all 4 tasks
  - Overall, 65 out of 76 (85.5%) scripts worked
  - Feedback on what we need to improve

[Li, Azaria, & Myers, CHI'2017]



View Script: order a pepperoni pizza_...

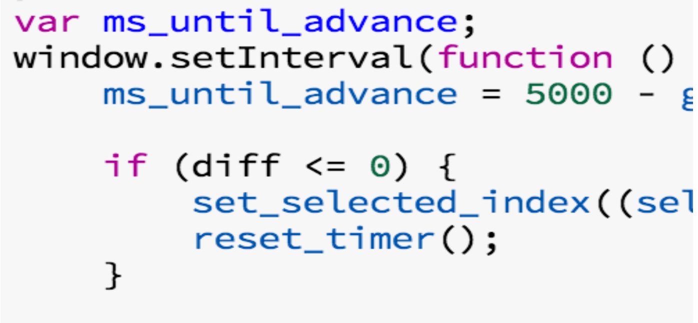
```
Click on the Button object "Papa's Picks" in Papa John's
Click on the RelativeLayout object "@Pepperoni" in Papa John's
TRY
  Click on the RelativeLayout object "Large Original Crust Pepperoni" in Papa John's
  Click on the Button object "Add to Order" in Papa John's
  Set Text to "12345" for the EditText object "Enter Promo Code" in Papa John's
IF FAILED
  TRY
    Click on the RelativeLayout object "Extra Large Original Crust Pizza" in Papa John's
  IF FAILED
    Click on the RelativeLayout object "Small Original Crust - Sausage" in Papa John's
    Click on the Button object "Add to Order" in Papa John's
    Set Text to "54321" for the EditText object "Enter Promo Code" in Papa John's
```

Formal A/B testing

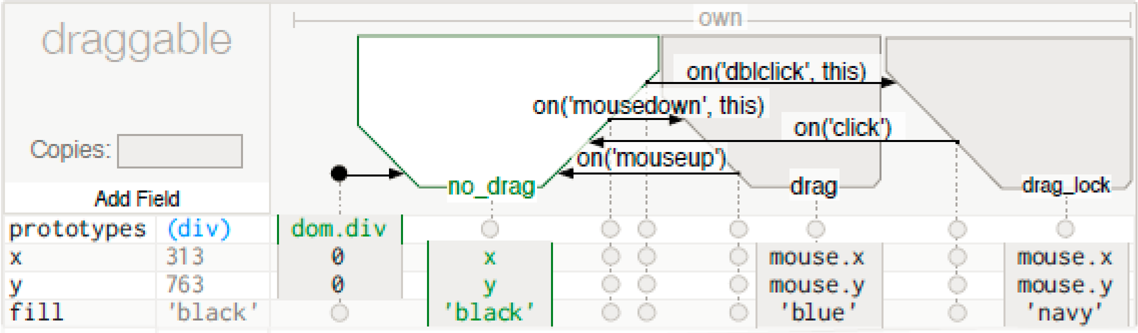
- Formal *A/B* lab user tests are "gold standard" for academic papers – to show something is better
- But many issues in the study design
  - "Confounding" factors which were not controlled and are not relevant to study, but affect results
  - Tasks or instructions are misunderstood
  - Use prototypes & pilot studies to find these
- Statistical significance doesn't mean real savings
- Be sure to collect qualitative data too
  - Strategies people are using
  - Why users did it that way
  - Especially when unexpected results

Example of A/B testing

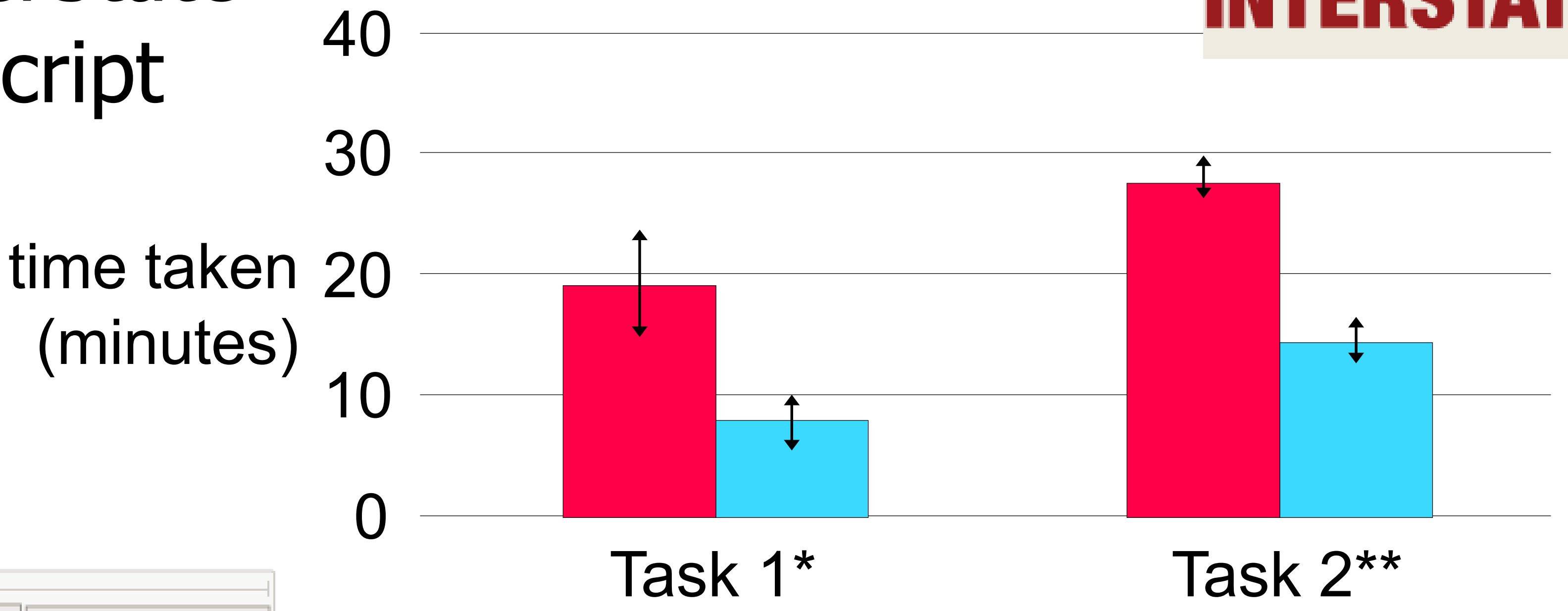
- User testing of InterState compared to JavaScript
  [Oney, Brandt, Myers, UIST'2012]



```
var ms_until_advance;
window.setInterval(function ()
    ms_until_advance = 5000 - g
    
    if (diff <= 0) {
        set_selected_index((sel
        reset_timer();
    }
```



prototypes (div) dom.div
x 313 0 x mouse.x mouse.x
y 763 0 y mouse.y mouse.y
fill 'black' 'black' 'blue' 'navy'



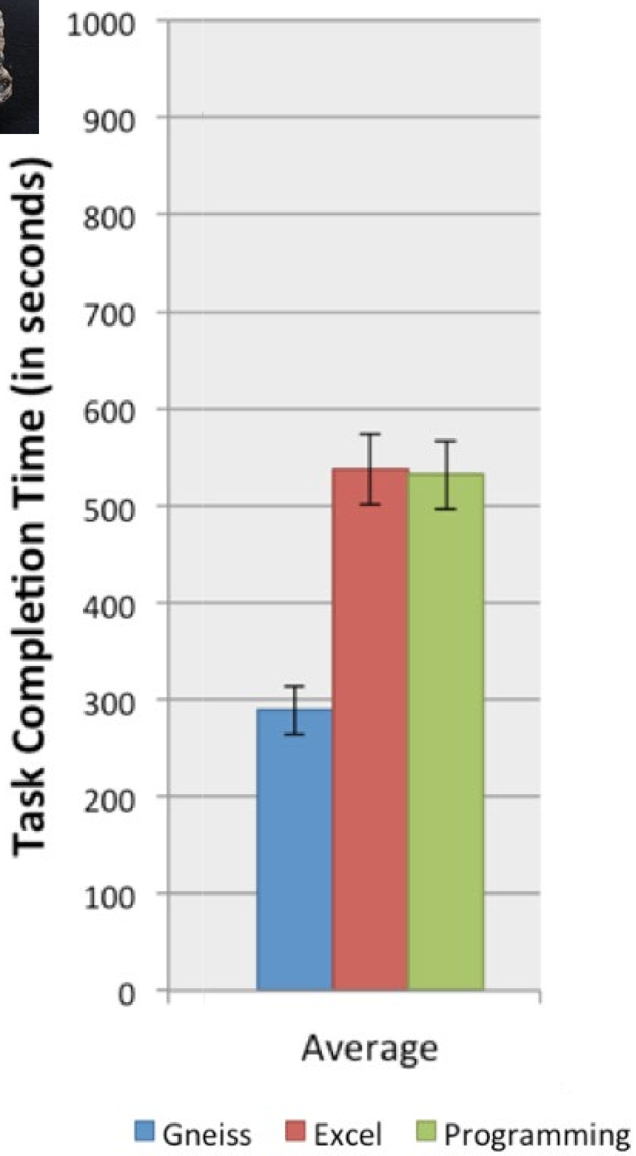
🟥 JavaScript
🟦 InterState

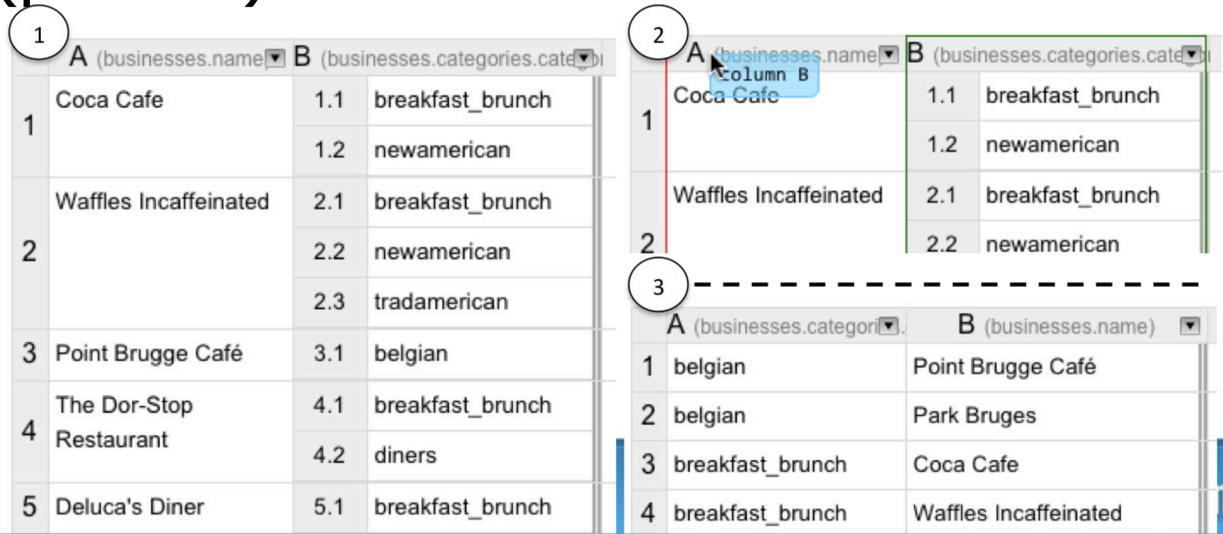
smaller is better

p < .01**
p < .05 *

Another Example of A/B testing

- Gneiss: **G**athering **N**ovel **E**nd-user **I**nternet **S**ervices using **S**preadsheets [Chang & Myers, CHI'2016]
- Novel spreadsheet interface for investigating hierarchical (e.g., JSON) data
  - Investigate using conventional spreadsheet formulas and drag-and-drop of columns
- Gneiss users significantly outperformed Excel users and programmers (p<.001)





1

	A (businesses.name		B (businesses.categories.cate
1	Coca Cafe	1.1	breakfast_brunch
		1.2	newamerican
2	Waffles Incaffeinated	2.1	breakfast_brunch
		2.2	newamerican
		2.3	tradamerican
3	Point Brugge Café	3.1	belgian
4	The Dor-Stop Restaurant	4.1	breakfast_brunch
		4.2	diners
5	Deluca's Diner	5.1	breakfast_brunch

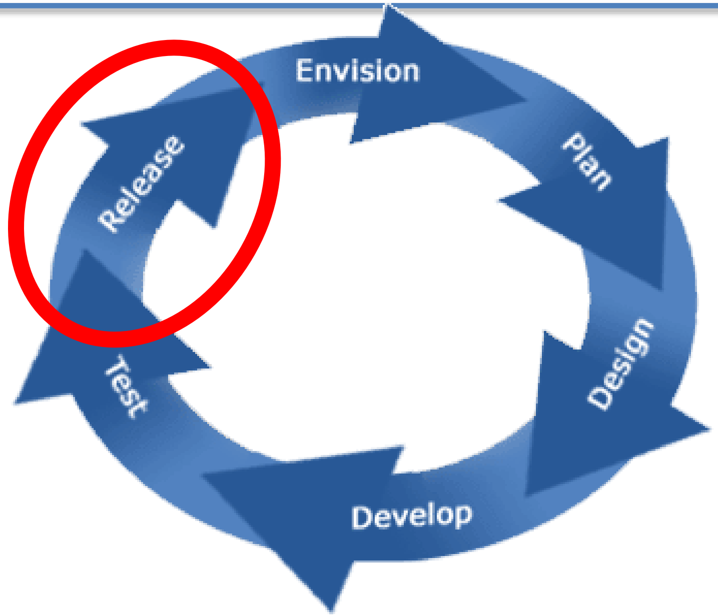
2

	A (businesses.name		B (businesses.categories.cate
1	Coca Cafe	1.1	breakfast_brunch
		1.2	newamerican
2	Waffles Incaffeinated	2.1	breakfast_brunch
		2.2	newamerican

3

	A (businesses.categori	B (businesses.name)
1	belgian	Point Brugge Café
2	belgian	Park Bruges
3	breakfast_brunch	Coca Cafe
4	breakfast_brunch	Waffles Incaffeinated

Field Studies of System in Use



- Find out what happens when the tool is really used
- Requires significant effort to make the tool sufficiently solid

Logging Actual Use

- Easier if instrument your tools
- Objective use data better than users' recollections and opinions
- Many levels of data can be collected
  - Privacy issues
- Easy to log and analyze web data
- Example: Fluorite logger for Eclipse [Yoon & Myers, PLATEAU 2011]
  - Fluorite: Full of Low-level User Operations Recorded In The Editor
  - Records all edits and events, including scrolling operations & source code,
  - Has been used by multiple studies

Summary of Insights

- Formative field and lab studies can reveal the real questions
  - Answering these questions creates tools that are actually useful
- Human centered design methods help insure workable designs
- Researcher’s intuitions about what might be useful may be wrong
- Our experience highlights:
  - Developers often have specific questions in mind, which can be exploited in tools
  - Code views are central
  - Visualizations are often useful as navigation aides for code
  - Ability to search is key
    - Not just through code, but also through dynamic and static call-graphs, through time, etc.

More on This Topic

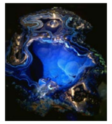
- Our current tools: www.natprog.org
- Brad A. Myers, Andrew J. Ko, Thomas D. LaToza, and YoungSeok Yoon. "Developers are Users Too: Human Centered Methods to Improve Software Development," *IEEE Computer*, Special issue on UI Design, 49, issue 7, July, 2016, pp. 44-52.
- Brad A. Myers and Jeffrey Stylos, "Improving API Usability", *Communications of the ACM*, vol 59, No. 6, June, 2016, pp. 62-69.
- In general: CHASE and WAPI workshops at ICSE; PLATEAU at SPLASH/OOPSLA; IEEE VL/HCC conference

Acronyms are fun!

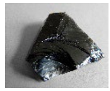
And there are lots of Gemstones!!

Fluorite:
Full of
Low-level
User
Operations
Recorded In
The
Editor

Azurite:
Adding
Zest to
Undoing and
Restoring
Improves
Textual
Exploration



Euklas:
Eclipse
Users'
Keystrokes
Lessened by
Attaching from
Samples



Variolite:
Variations
Augment
Real
Iterative
Outcomes
Letting
Information
Transcend
Exploration

Obsidian:
Object-oriented
Blockchain
State
Interaction and
Development
Implementation
And
Notation

Apatite:
Associative
Perusing of
APIs
That
Identifies
Targets
Easily

Euclase:
End
User
Centered
Language,
APIs
System and
Environment

Calcite:
Construction
And
Language
Completion
Integrated
Throughout

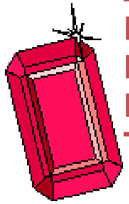
Jadeite:
Java
API
Documentation with
Extra
Information
Tacked-on for
Emphasis

Crystal:
Clarifications
Regarding
Your
Software using a
Toolkit,
Architecture and
Language

Jasper:
Java
Aid with
Sets of
Pertinent
Elements for
Recall

Mica:
Makes
Interfaces
Clear and
Accessible

Aquamarine:
Allowing
Quick
Undoing of
Any
Marks
And
Repair
Improving
Novel
Editing



GARNET
Generating an
Amalgam of
Real-time,
Novel
Editors and
Toolkits

Pebbles
PDAs for
Entry of
Both
Bytes and
Locations from
External
Sources

Gneiss:
Gathering
Novel
End-user
Internet
Services using
Spreadsheets

Sugilite
Smartphone
Users
Generating
Intelligent
Likeable
Interfaces
Through
Examples

Glacier
Great
Languages
Allow
Class
Immutability
Enforced
Readily

C32
CMU's
Clever and
Compelling
Contribution to
Computer Science in
CommonLisp which is
Customizable and
Characterized by a
Complete
Coverage of
Code and
Contains a
Cornucopia of
Creative
Constructs, because it
Can
Create
Complex,
Correct
Constraints that are
Constructed
Clearly and
Concretely, and
Communicated using
Columns of
Cells, that are
Constantly
Calculated so they
Change
Continuously, and
Cancel
Confusion

For more, see: www.cs.cmu.edu/~bam/acronyms.html

Thanks to:

- Funding:
  - NSF under IIS-1814472, CCF-1814826, CNS-1423054, IIS-1314356, IIS-1116724, IIS-0329090, CCF-0811610, IIS-0757511, IIS-0329090, ITR CCR-0324770, IRI-9900452
  - SAP
  - Adobe
  - IBM
  - Microsoft Research
  - Yahoo! InMind
  - Google
- >40 students & visitors:
  - Oluwatosin (Tosin) Alliyu
  - Htet Htet Aung
  - Jack Beaton
  - Ruben Carbonell
  - John R. Chang
  - Kerry S. Chang
  - Polo Chau
  - Luis J. Cota
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  - Marissa Radensky
  - Chotirat (Ann) Ratanamahatana
  - André L. Santos
  - Christopher Scaffidi
  - Jeff Stylos
  - David A. Weitzman
  - Yingyu (Clare) Xie
  - Zizhuang (Zizzy) Yang
  - YoungSeok Yoon

Thank You!

Software Engineers are People Too: Applying Human Centered Approaches to Improve Software Development

Brad A. Myers
Human-Computer Interaction Institute
School of Computer Science
Carnegie Mellon University
http://www.cs.cmu.edu/~bam
bam@cs.cmu.edu

Carnegie Mellon University

HCII