REPLs All The Way Up

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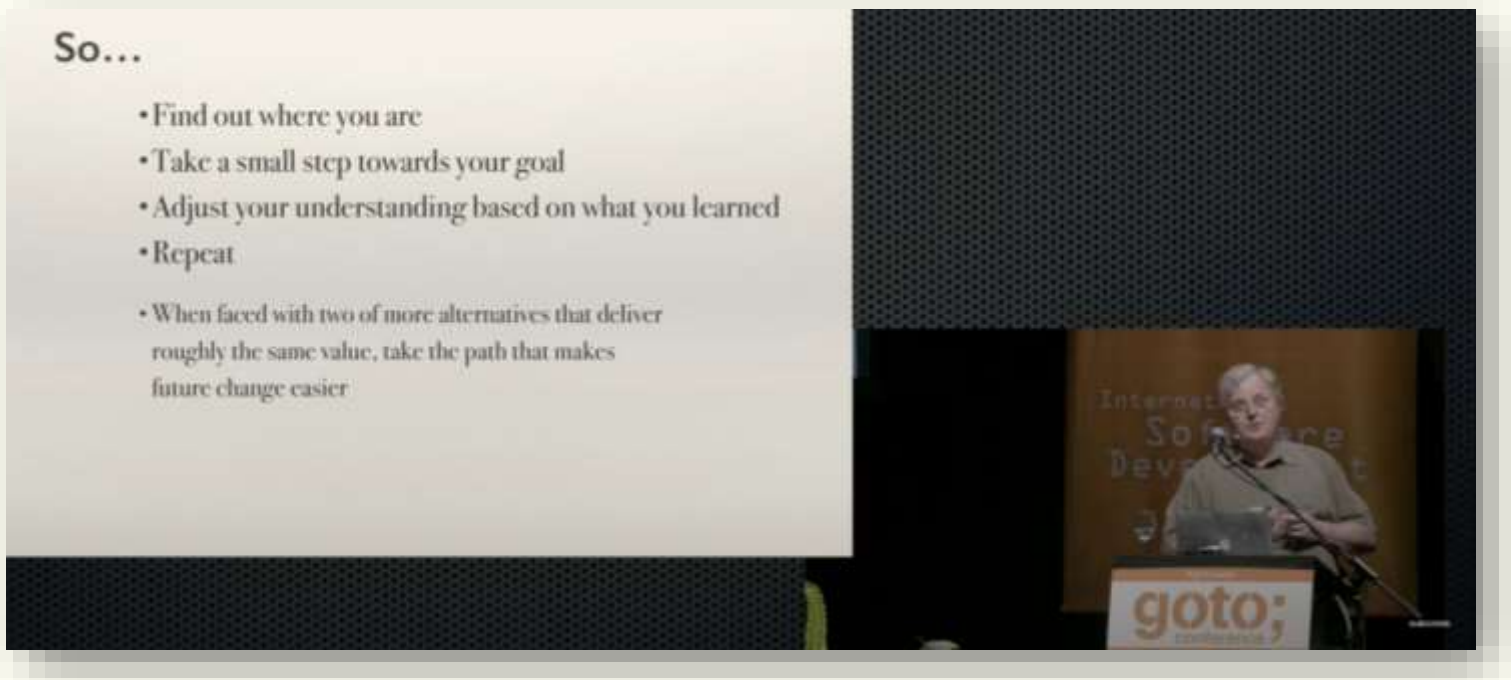
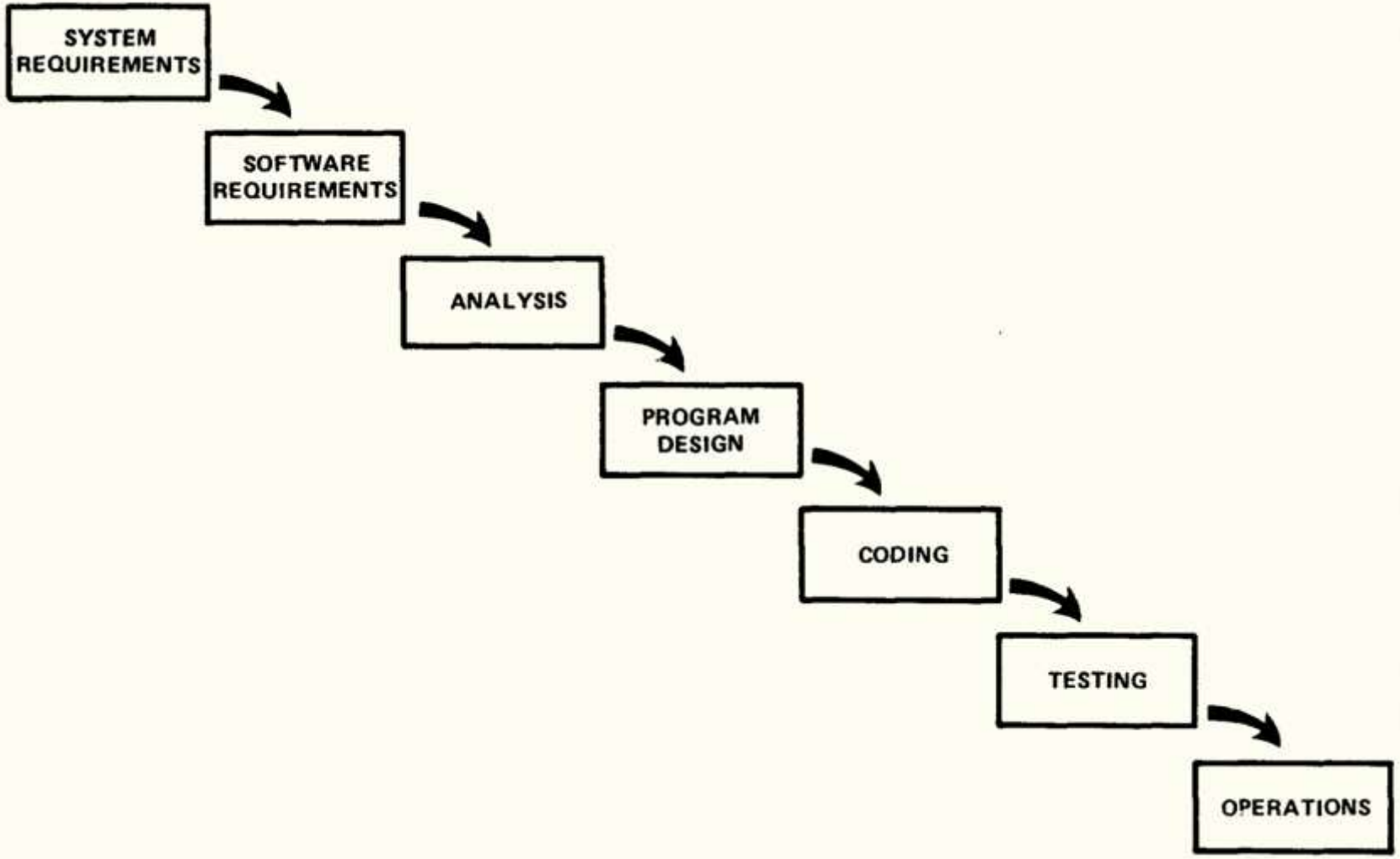
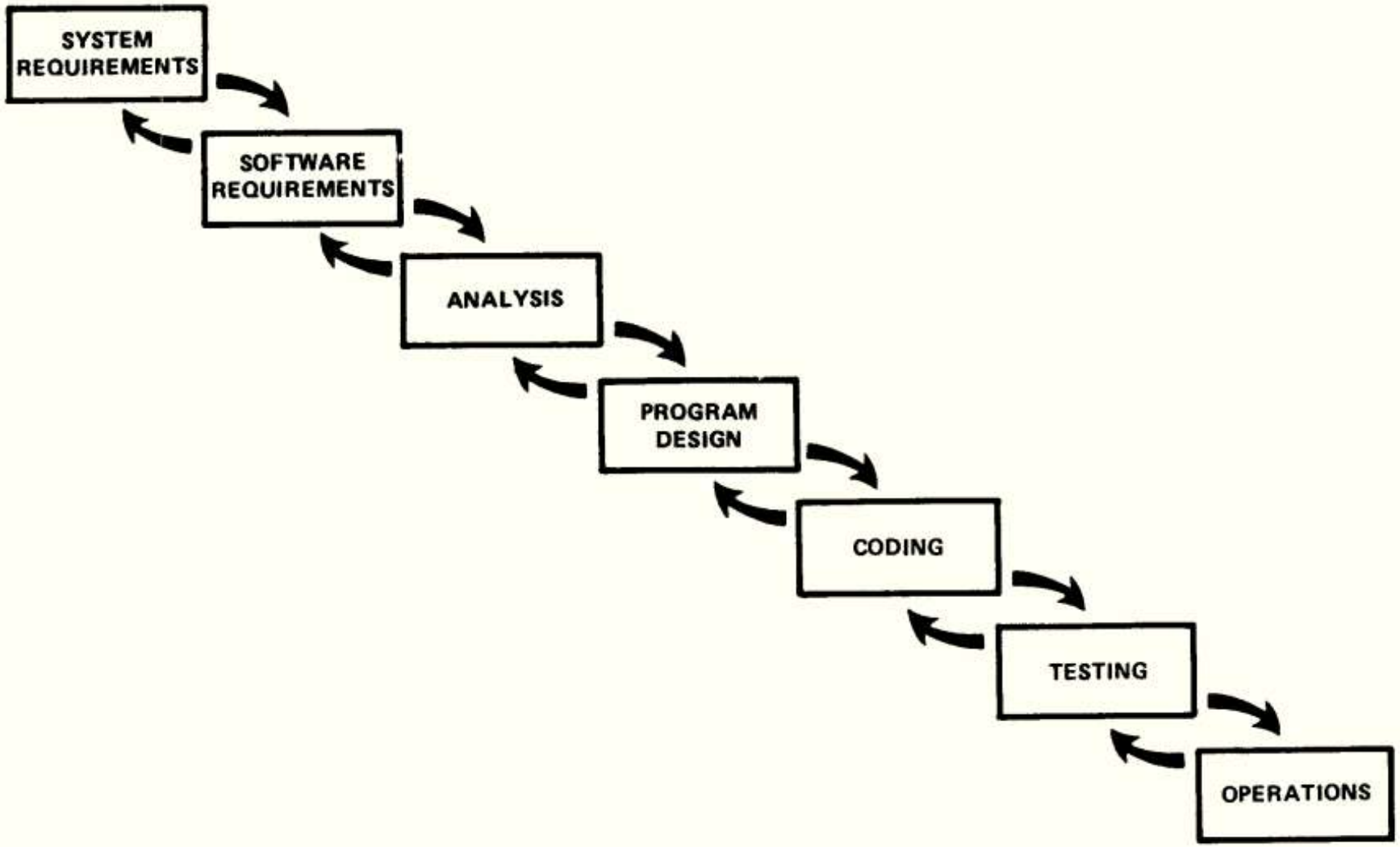
Feedback Loops



“Agile”

“Agile is Dead, Long Live Agility”: Dave Thomas, GOTO 2015


SYSTEM REQUIREMENTS
SOFTWARE REQUIREMENTS
ANALYSIS
PROGRAM DESIGN
CODING
TESTING
OPERATIONS


SYSTEM REQUIREMENTS
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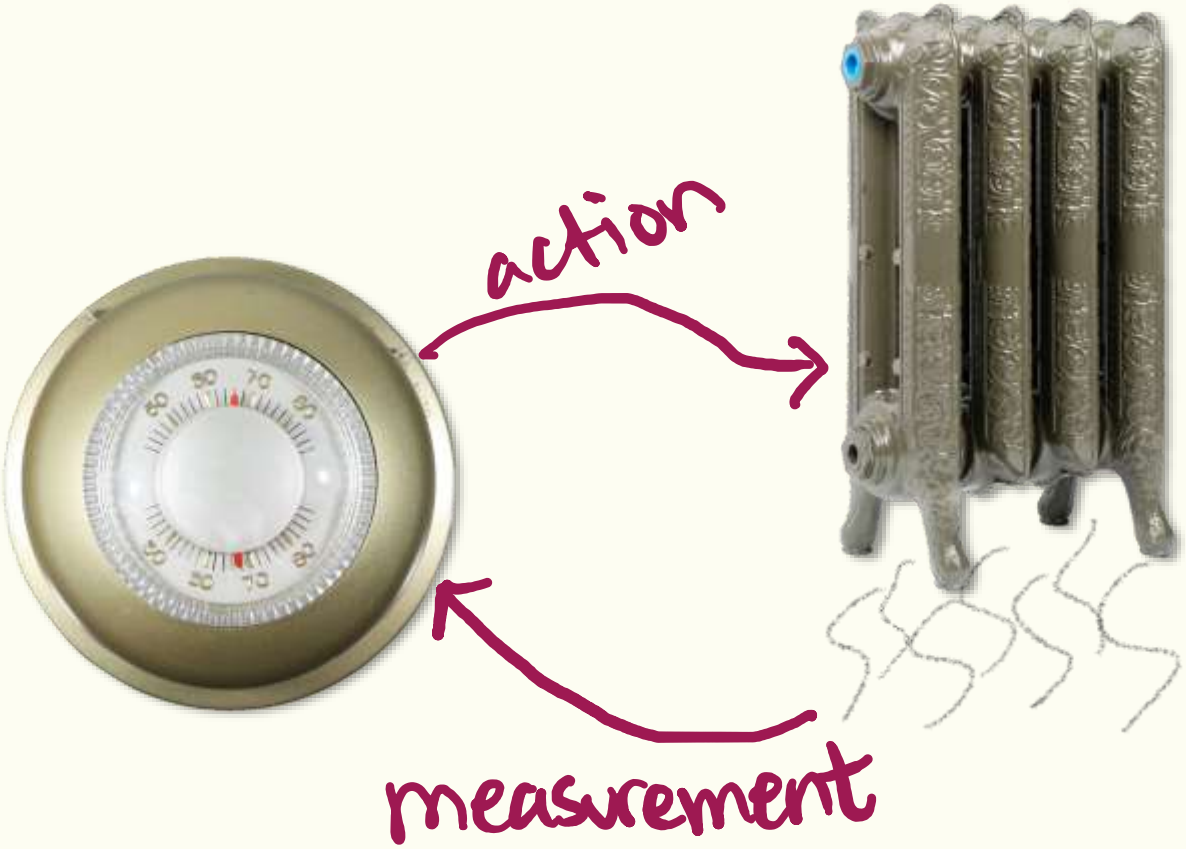
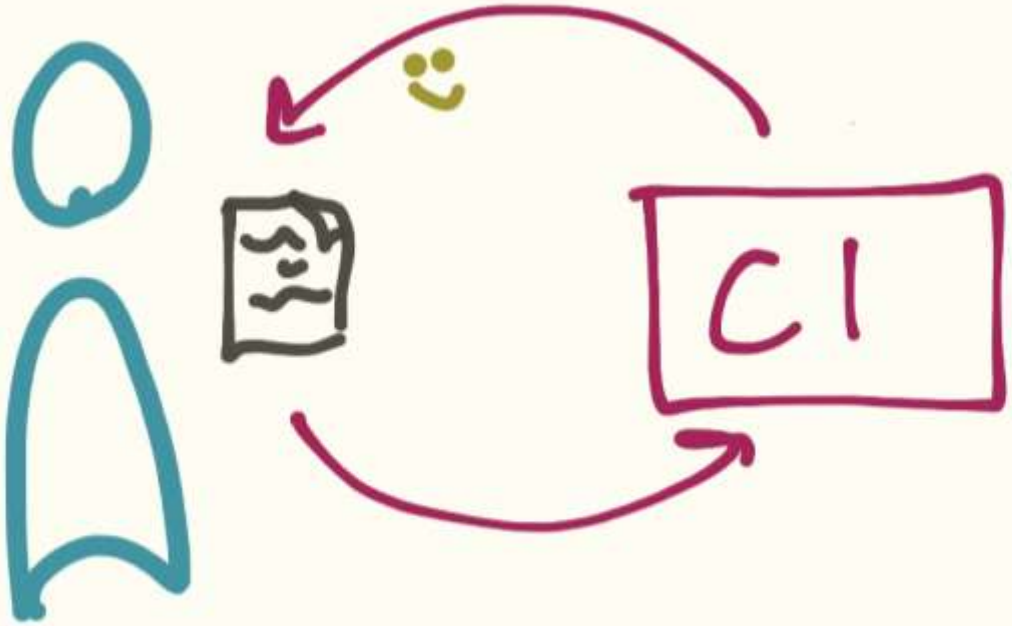
Feedback Loops

We like them!

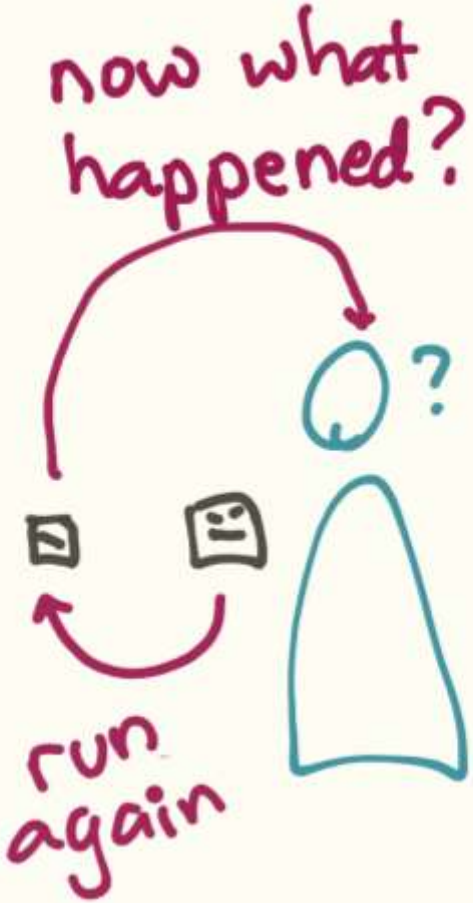
Control Loop



Control Loop



Exploratory Loop



Not all exploratory loops are created equal

What do good exploratory loops look like?

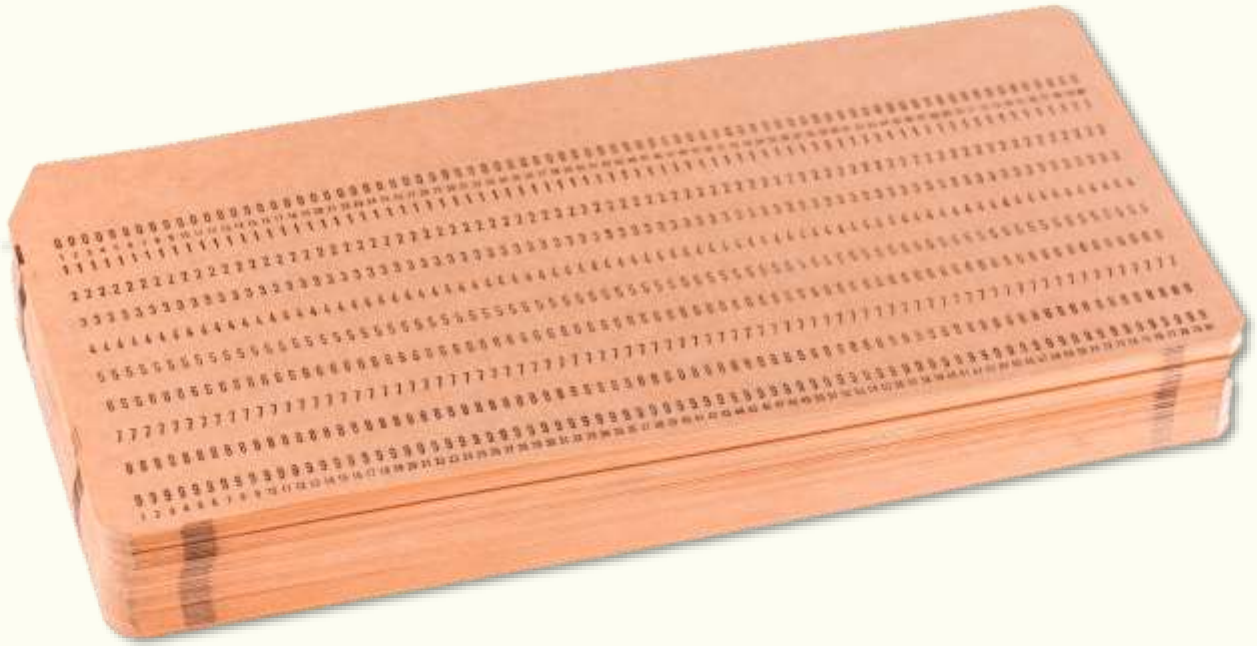
“Touch (Not Vision) is the Foundation of Human Cognition”

“At the foundation of human cognition is how we interact with our world. Perception is not passive, but rather it is an active conversation and this is fundamentally how we can ‘feel’ the world.”

-- Carlos E. Perez

What do good exploratory loops FEEL like?

Once upon a time...



1964: LISP on the PDP-1

As soon as the basic PDP-1 LISP system is read into the computer, control stops at register 4. Turn up sense switch 5 for typewriter input; press CONTINUE; and the system enters a waiting loop which causes lamps to light in the program counter, looking like 1335. At this point, the LISP system is ready for manual typewriter input. As soon as the operator types, for example:

```
(CAR (QUOTE (A B C D)))
```

together with a final space at the end of the last right parenthesis, the computer takes control of the typewriter, impulses a carriage return, and then types out:

```
A
```

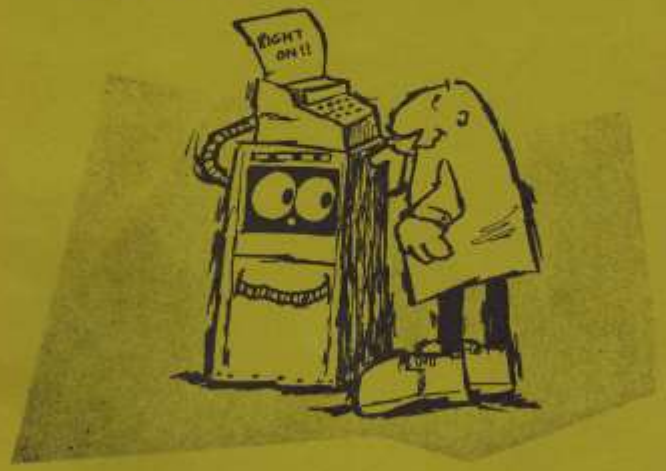
which of course is the correct answer. Similarly, for the other suggested test sequences in Table 2 below.

Read, Eval, Print, Loop

Late 1960s - Early 1970s: BASIC and the DTSS

MY COMPUTER LIKES ME*

by BOB ALBRECHT



*when i speak in BASIC

Dr. Dobb's Journal of

COMPUTER Calisthenics & Orthodontia

Running Light Without Overbyte

Volume One People's Computer Company, Box E, Menlo Park, CA 94025 1976

A Reference Journal
for Users of
Home Computers

Volume One

People's Computer Company

```
SCR

10 PRINT "MY HUMAN UNDERSTANDS ME"
20 END
```

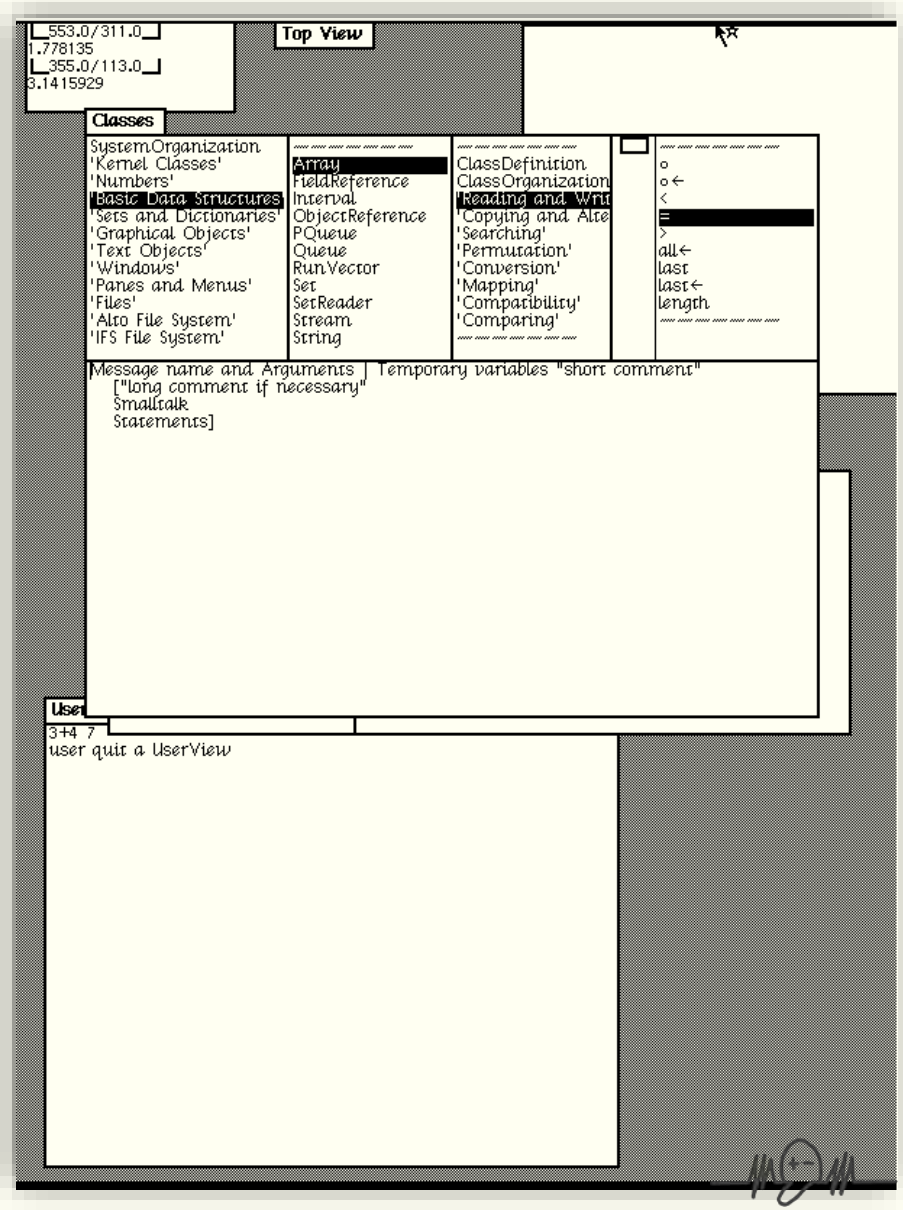
then type

```
RUN
```

and the computer will type

```
MY HUMAN UNDERSTANDS ME
```

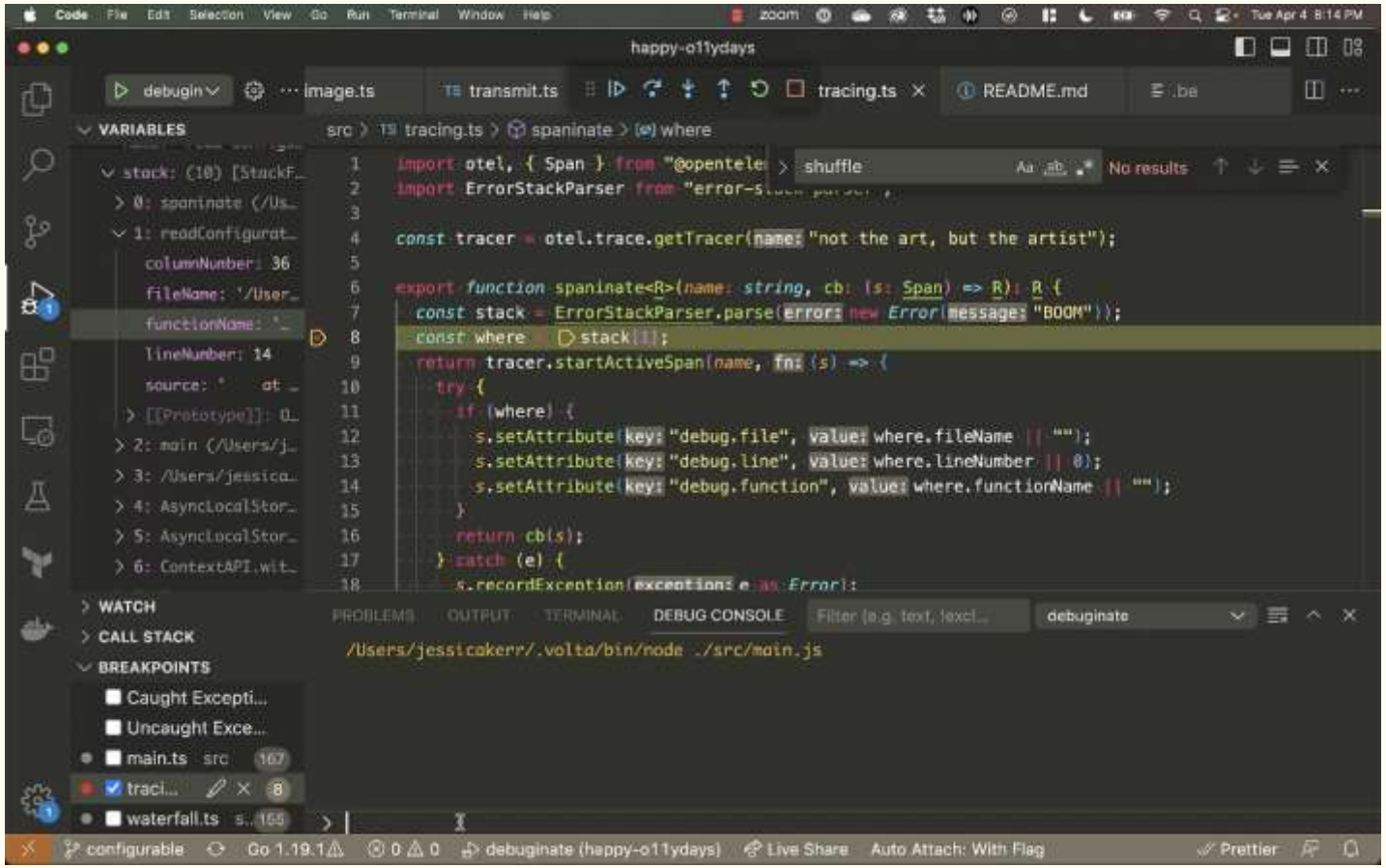
1970s: Smalltalk



1980-2000: C, C++, Pascal, Java

Compile and Integration Times Increase

Debugger-Driven Develop-ment



~2000: Test-Driven Development!

app_test.rb M test/app_test.rb/...

```ruby
require "frobozz/app"
require "json"

describe Frobozz::App do
  include Rack::Test::Methods

  You, 22 minutes ago | 1 author (You)
  def app
    Frobozz::App.app
  end

  it "responds to a hello world request" do
    get "/hello"

    assert last_response.ok?
    assert_match(/hello, world/i, last_response.body)
  end      You, 22 minutes ago • get started on tests …
end
```

app_test.rb M test/app_test.rb/...

```ruby
require "frobozz/app"
require "json"

describe Frobozz::App do
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  You, 22 minutes ago | 1 author (You)
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    get "/hello"

    assert last_response.ok?
    assert_match(/hello, world/i, last_response.body)
  end      You, 22 minutes ago • get started on tests …
end
```

2000s:
“Scripting Languages”

TCL, Scheme, Perl, Python, Ruby, PHP, JavaScript, Groovy…

TERMINAL PROBLEMS 50 OUTPUT DEBUG CONSOLE PORTS 2 GITLENS COMMENTS irb - frobozz

```
irb(main):007:0> Faker::Name.name
=> "Earle Donnelly"
irb(main):008:0> Faker::Name.name
=> "Garrett Stanton PhD"
irb(main):009:0> Faker::Name.name
=> "Pete Feeney"
irb(main):010:0>
```

We keep trying to get back to this state of grace

- Because it’s approachable
- Because it’s satisfying
- Because it’s productive
- Because it *feels good*

It feels good because it matches how humans evolved to think

*"human interaction with software is embedded in **a task-artifact cycle**"*

— John M. Carroll, 1992

Ideas are formed: *"when expressed [in] conversation with… representations, artifacts, or **objects-to-think with**"*

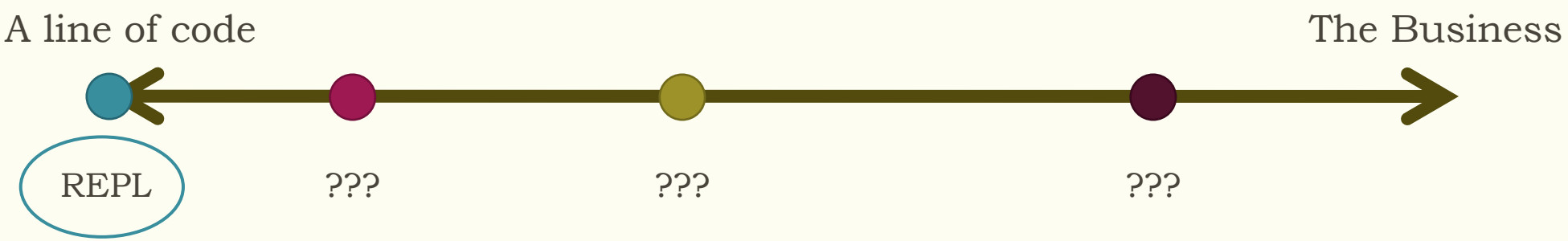
— Edith Ackermann (on Seymour Papert), 2001

"Knowledge fluidly grows through action taken in a complex system"

— Kit Martin (z"l), 2020

REPL: The gold standard of exploratory feedback in-the-small

Can we have this feeling at larger scopes?



REPL Nature

What qualities make REPLs feel so good?

READ

There is a prompt, welcoming you

Invitational. Approachable.

What can you enter? Anything!

It's *Open-ended*

Most REPLs provide autocomplete or suggestions

Discoverable. Serendipitous.

You can always hit the up-arrow

No pausing for perfection. It’s highly *incremental*.

REPLs are SAFE

This is a private, intimate place to try silly things.

EVAL

Use the language **you're** used to

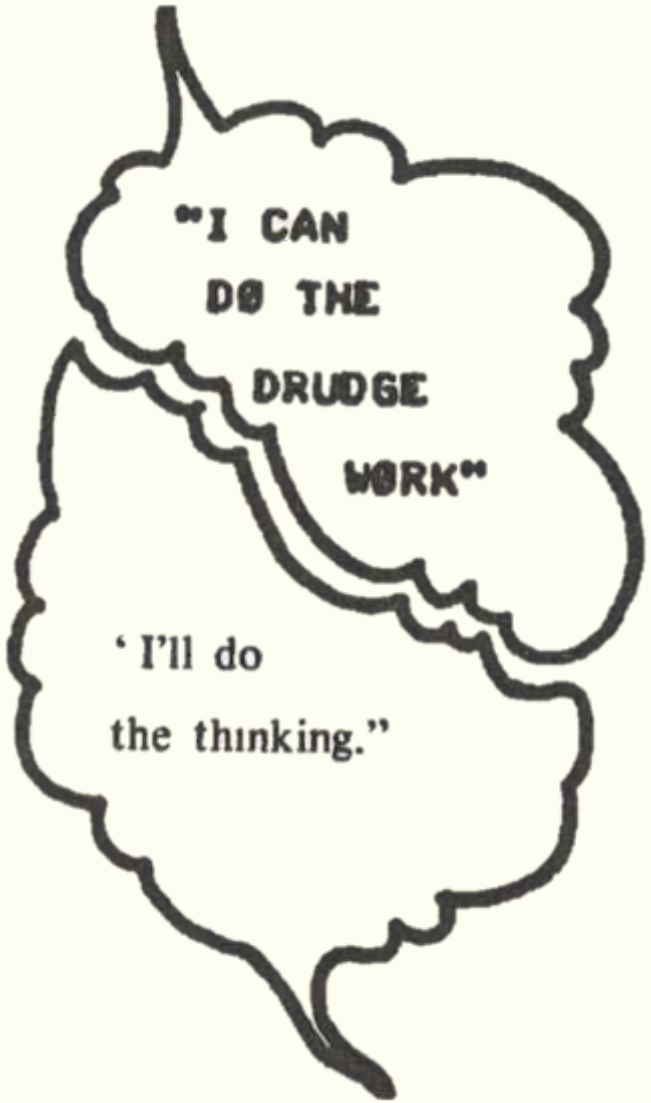
No further abstractions. REPLs are *familiar*, *concrete*, and the knowledge you build is directly *transferable*.

```
r/local/bin/irb:25:in `load'
sr/local/bin/irb:25:in `<main>'
0> Faker::Internet.email
rde@crist.name"
4:0> DB[:accounts].insert email: Fake

15:0> DB[:accounts].to_a


id=>2,
"avdi@avdi.codes",
d_hash=>"$2a$04$ZOzJ4xyf2rtgh18gOi3J..l
:status_id=>1, :email=>"jamison.ledner@
016:1* 100.times do
017:1*   DB[:accounts].insert email: Fa
018:0> end

9:0>
```

Poke the system with a stick

Don’t just ask questions, *perturb* the system and see what falls out.

REPLs are AUTOMANUAL

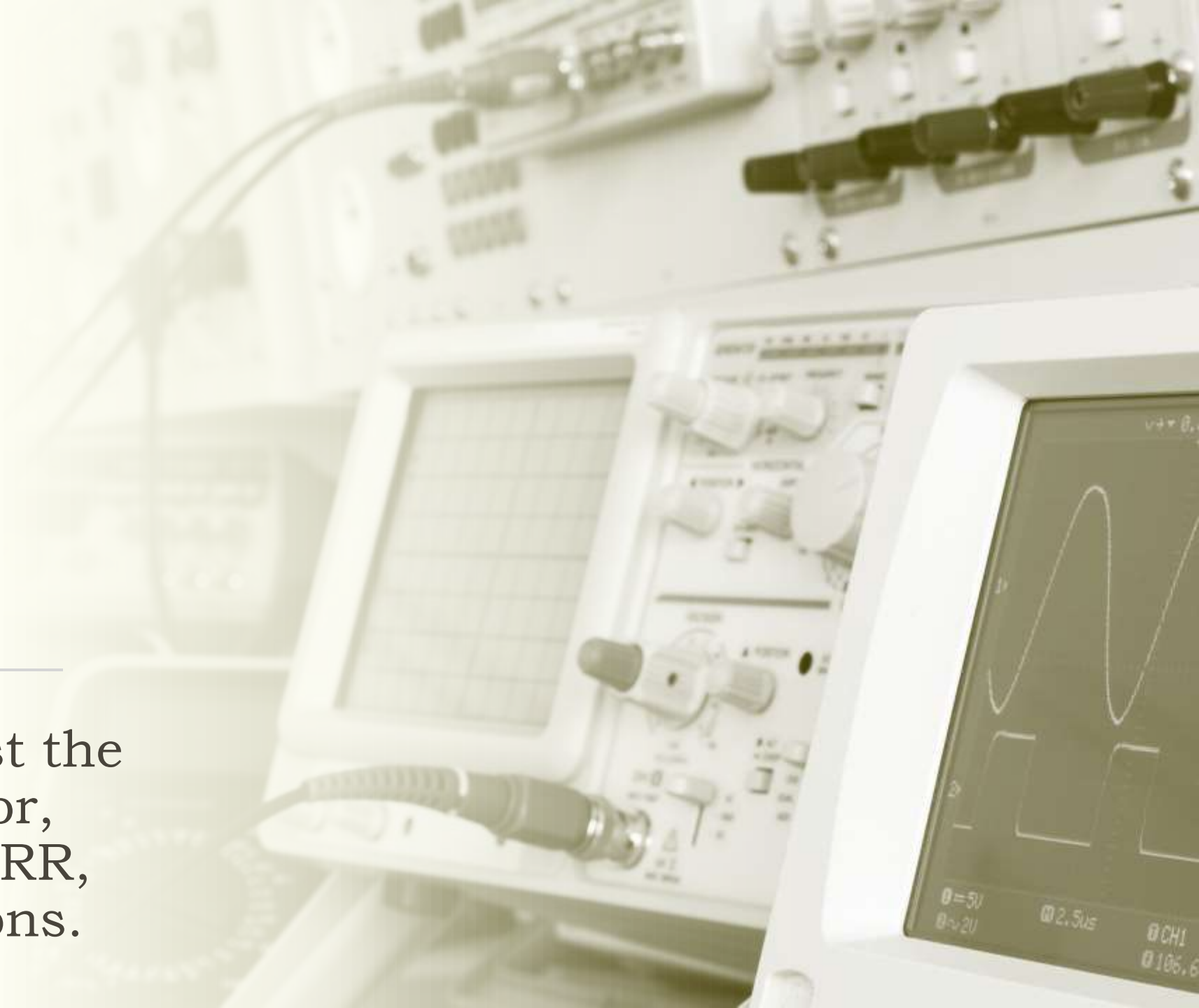


PRINT

```
irb(main):012:0> Faker::Email
(irb):12:in `<main>': uninitialized constant Faker::Email (NameError)
        from /usr/local/lib/ruby/gems/3.2.0/gems/irb-1.6.2/exe/irb:11:in `<top (required)>'
        from /usr/local/bin/irb:25:in `load'
        from /usr/local/bin/irb:25:in `<main>'
```

Multi-Channel

Rich output: Not just the answers we asked for, but STDOUT, STDERR, and caught exceptions.



Arbitrary length output

Enables *gradual refinement.*

Scroll-back history

A story, but an ephemeral one. A narrative.

```
irb(main):015:0> DB[:accounts].to_a
=>
[{:id=>1,
  :status_id=>2,
  :email=>"avdi@avdi.codes",
  :password_hash=>"$2a$04$ZOzJ4xyf2rtgh18gOi3J.
 {:id=>2, :status_id=>1, :email=>"jamison.ledne
```

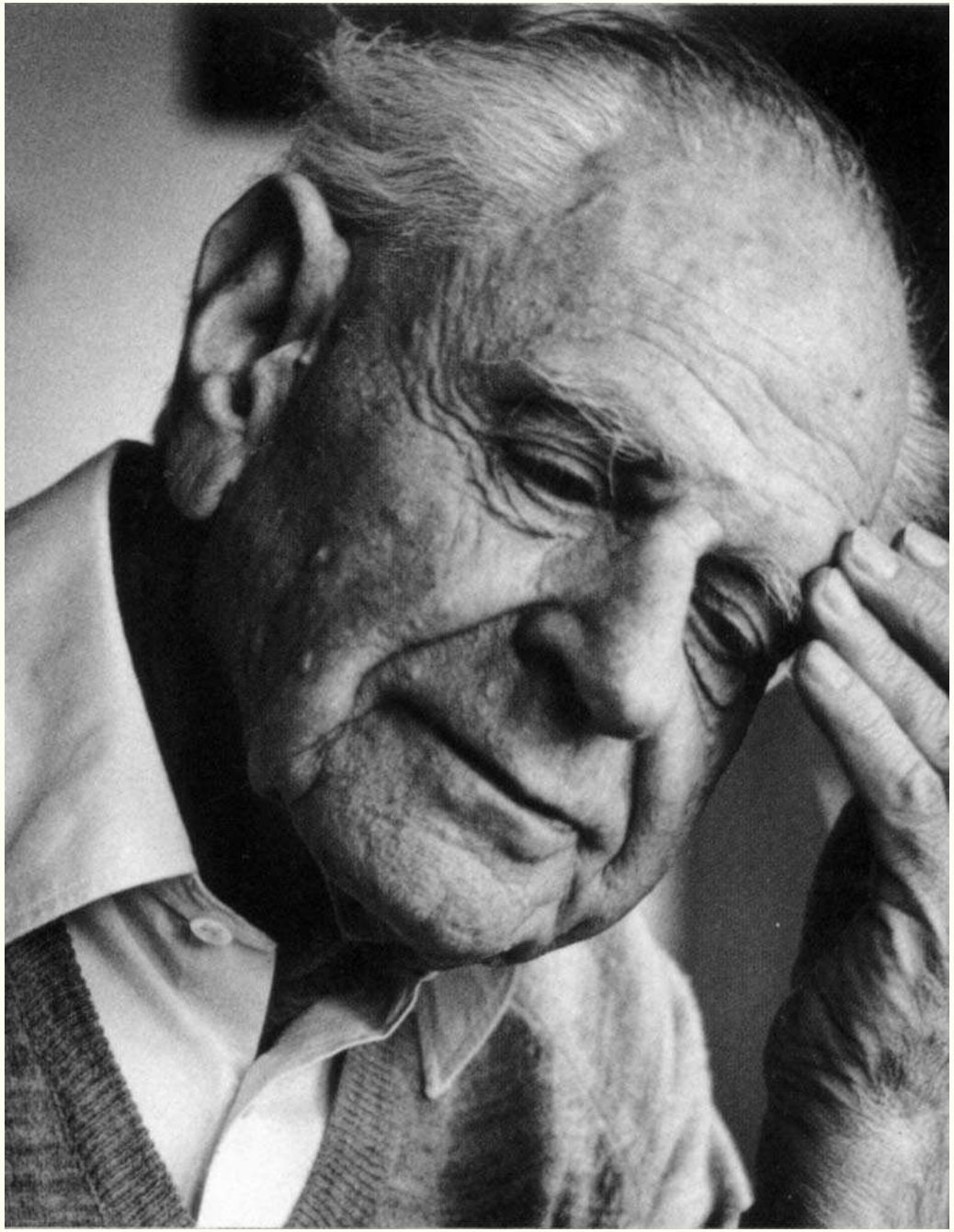
Serialized data structures

This is *exposed ductwork:* it gives you a clue about further questions you might ask.

You get stuff you **didn't expect**

The REPL is *open to surprise*.

Are REPLs science?



Science progresses with falsifiable theories.

SCIENCE PROGRESSES WITH SURPRISE!

REPLs are EXPLORAMENTAL!

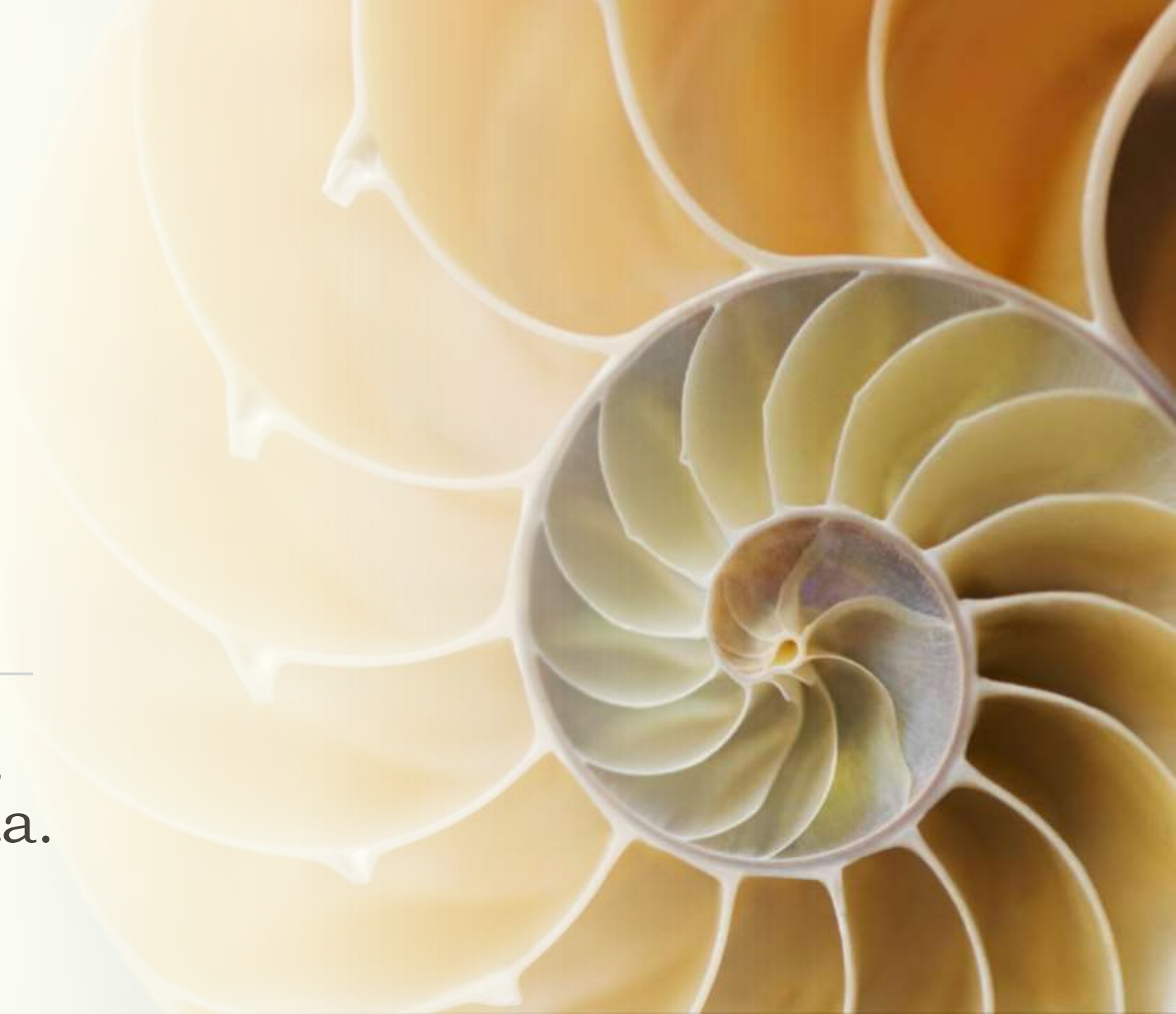
LOOP

Try Again

REPLs have infinite depth

REPLs build up context over time

Variables, helpers, changes to the data.



REPL Interactions are Lossy

REPLs are fast

This is not “must go faster”

REPLs ~~are fast~~ move at the speed of your questions

REPLs are *responsive*: they provide a pacing of iteration appropriate to the scope.

REPLs are CONVERSATIONAL

REPL NATURE

READ

- Invitational
- Approachable
- Open-Ended
- Discoverable
- Incremental
- Private

Safe

EVAL

- Familiar
- Transferable
- Concrete
- Reflective
- Reactive

Automanual

PRINT

- Ductwork Exposed
- Gradually Refined
- Rich
- Narrative
- Open to Surprise

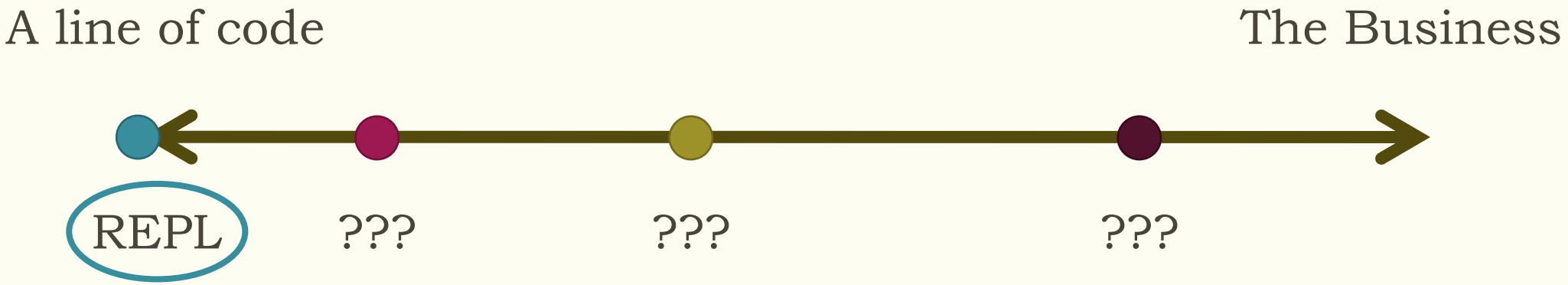
Exploramental

LOOP

- Contextual
- Ongoing
- Infinitely Deep
- Lossy
- Responsive

Conversational

Movin' **on up...**




A line of code
The Business
REPL

REPL

TERMINAL PROBLEMS 50 OUTPUT DEBUG CONSOLE PORTS 2 GITLENS COMMENTS irb - frobozz

```
irb(main):007:0> Faker::Name.name
=> "Earle Donnelly"
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=> "Garrett Stanton PhD"
irb(main):009:0> Faker::Name.name
=> "Pete Feeney"
irb(main):010:0>
```


A line of code
The Business
A Unit

Practice test-driven design

app_test.rb M test/app_test.rb/...

```ruby
require "frobozz/app"
require "json"

describe Frobozz::App do
  include Rack::Test::Methods

  You, 22 minutes ago | 1 author (You)
  def app
    Frobozz::App.app
  end

  it "responds to a hello world request" do
    get "/hello"

    assert last_response.ok?
    assert_match(/hello, world/i, last_response.body)
  end      You, 22 minutes ago • get started on tests
end
```

Read your test failures and stack traces

app_test.rb M test/app_test.rb/...

```
include Rack::Test::Methods

You, 26 minutes ago | 1 author (You)
def app
  Frobozz::App.app
end

it "responds to a hello world request" do
  get "/hello
```

TERMINAL PROBLEMS OUTPUT DEBUG CONSOLE PORTS 2 GITLENS COMMENTS

irb frobozz

rake: tes...

```
  1) Failure:
Frobozz::App#test_0002_saves and returns new rooms [/workspaces/frobozz/test/app_test.
rb:26]:
Expected: [{:name=>"Kitchen"}]
  Actual: {"name"=>"Kitchen"}

2 runs, 4 assertions, 1 failures, 0 errors, 0 skips
rake aborted!
Command failed with status (1): [/usr/local/bin/ruby -Ilib:test:. -w -e 're...]
/usr/local/rvm/gems/default/gems/minitest-5.18.0/lib/minitest/test_task.rb:164:in `blo
ck in define'
/usr/local/rvm/gems/default/gems/rake-13.0.6/exe/rake:27:in `<top (required)>'
```


A line of code
The Business
A Feature

Beware of Sherlock Holmes

Tracing

Another view. Below is a **TRACE** of the program. *(Trace? Sure! A TRACE traces the path the computer takes through the program it is working on, and shows what values are assigned to the variables at any step in the program. Ain't it obvious?)* In the column marked N we show the value of N *after* the statement on the same line has been carried out by the computer.

STATEMENT	N	REMARKS
10 LET N=1	1	
20 PRINT N	1	Print the value of N.
30 LET N=N+1	2	Increase N by 1 *(add 1 to the old value of N).*
40 GØ TØ 20	2	Go to beginning of loop.
20 PRINT N	2	Print the value of N.
30 LET N=N+1	3	Increase N by 1.
40 GØ TØ 20	3	Go to beginning of loop.
20 PRINT N	3	Print the value of N.
30 LET N=N+1	4	Increase N by 1.
40 GØ TØ 20	4	Go to beginning of loop.

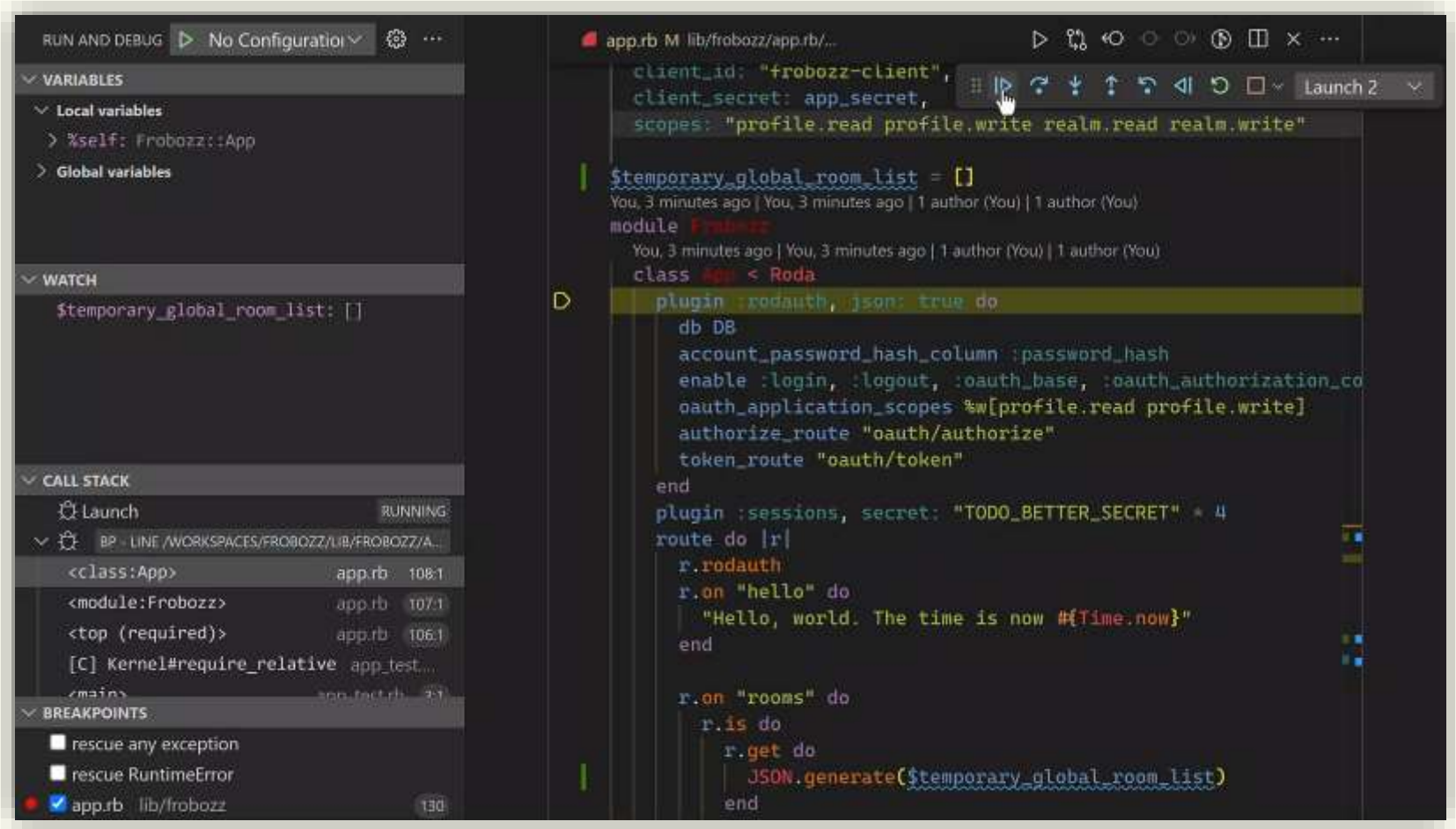
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

2: bash

```
root@9677044702e7:/workspaces/examples#
```

```
root@9677044702e7:/workspaces/examples# strace -e open bundle 2>&1 | less
root@9677044702e7:/workspaces/examples# strace -f -e open bundle 2>&1 | less
root@9677044702e7:/workspaces/examples# strace -f -e openat bundle 2>&1 | less
```

Use the debugger (judiciously)



RUN AND DEBUG No Configuratio

VARIABLES

Local variables

%self: Frobozz::App

Global variables

WATCH

$temporary_global_room_list: []

CALL STACK

Launch RUNNING

BP - LINE /WORKSPACES/FROBOZZ/LIB/FROBOZZ/A...

<class:App> app.rb 108:1

<module:Frobozz> app.rb 107:1

<top (required)> app.rb 106:1

[C] Kernel#require_relative app_test....

<main> app_test.rb 3:1

BREAKPOINTS

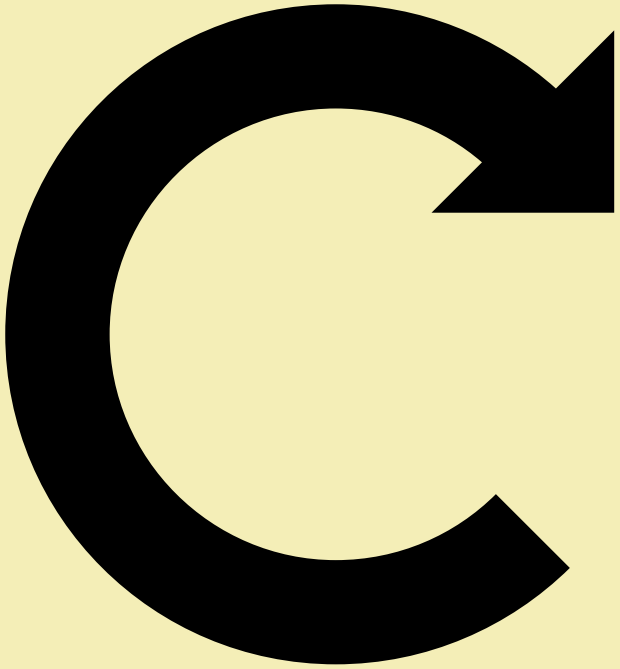
- [ ] rescue any exception
- [ ] rescue RuntimeError
- [x] app.rb lib/frobozz 130

app.rb M lib/frobozz/app.rb/...

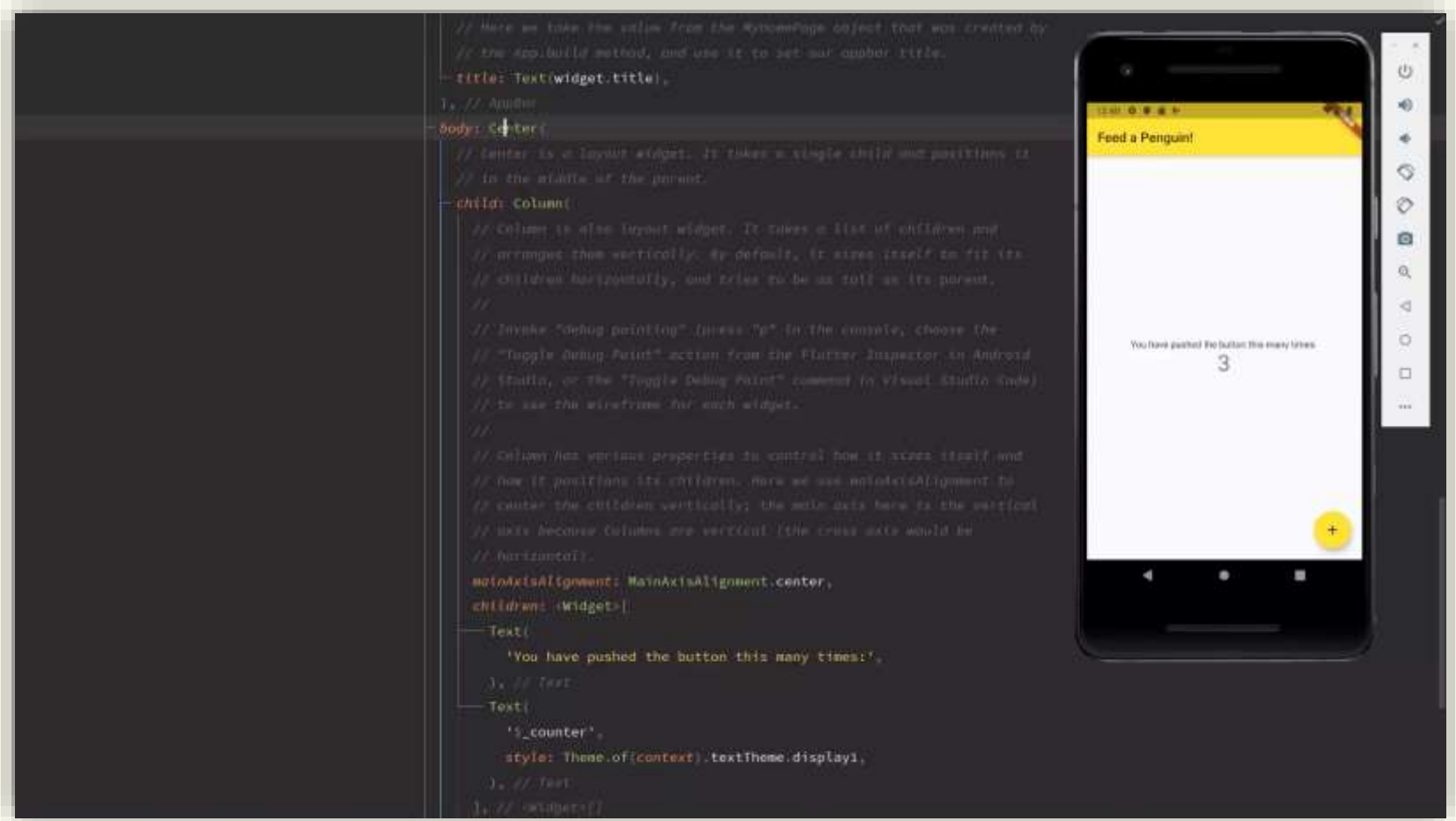
Launch 2

```
  client_id: "frobozz-client",
  client_secret: app_secret,
  scopes: "profile.read profile.write realm.read realm.write"

$temporary_global_room_list = []
You, 3 minutes ago | You, 3 minutes ago | 1 author (You) | 1 author (You)
module Frobozz
  You, 3 minutes ago | You, 3 minutes ago | 1 author (You) | 1 author (You)
  class App < Roda
    plugin :rodauth, json: true do
      db DB
      account_password_hash_column :password_hash
      enable :login, :logout, :oauth_base, :oauth_authorization_co
      oauth_application_scopes %w[profile.read profile.write]
      authorize_route "oauth/authorize"
      token_route "oauth/token"
    end
    plugin :sessions, secret: "TODO_BETTER_SECRET" * 4
    route do |r|
      r.rodauth
      r.on "hello" do
        "Hello, world. The time is now #{Time.now}"
      end

      r.on "rooms" do
        r.is do
          r.get do
            JSON.generate($temporary_global_room_list)
          end
```

Reload-driven development



Leverage hot-reload




A line of code
The Business
A Service

Make friends with SQL

gracefuldev.session.sql

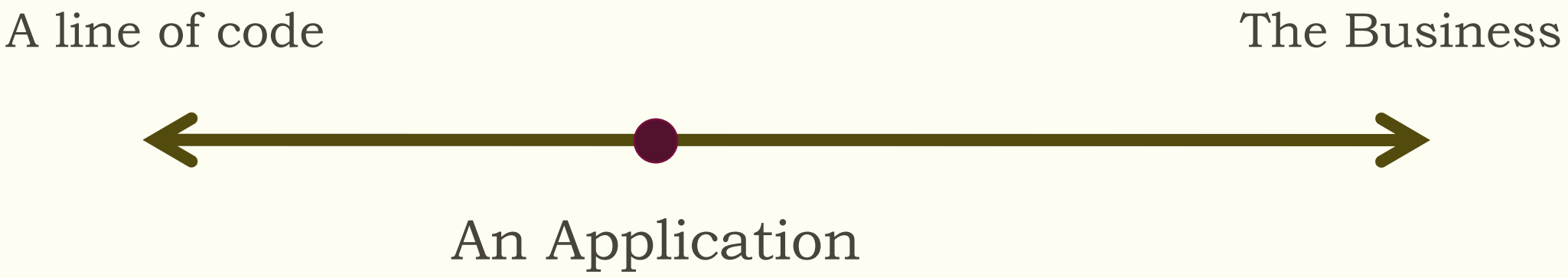
Detach file from gracefuldev | Run on active connection | Select block

```
1  select * from wp_postmeta where meta_key like "wpf%";
2
3
```

gracefuldev: select * from wp... | gracefuldev: select * from wp... | gracefuldev: select * from wp...

meta_id	post_id	meta_key	meta_value
Filter...	Filter...	Filter...	Filter...
126997	28154	wpf_settings_buddypress	a:1:{s:10:"apply_tags";a:1:{i:0;s:26:"gracefuldev:grouptype:team";}}
127009	28155	wpf_settings_buddypress	a:1:{s:10:"apply_tags";a:1:{i:0;s:30:"gracefuldev:grouptype:interest";}}
127021	28156	wpf_settings_buddypress	a:1:{s:10:"apply_tags";a:1:{i:0;s:29:"gracefuldev:grouptype:special";}}
128534	28322	wpf_settings_buddypress	a:0:{}
128548	28323	wpf_settings_buddypress	a:1:{s:8:"tag_link";a:1:{i:0;s:34:"gracefuldev:profiletype:instructor";}}
128562	28324	wpf_settings_buddypress	a:1:{s:8:"tag_link";a:1:{i:0;s:34:"gracefuldev:profiletype:pro-member";}}
109443	25668	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109637	26169	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109670	26172	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109711	26186	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109734	26193	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109774	26203	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109809	26209	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109978	25670	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
109997	25679	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
110016	25681	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}
110035	25683	wpf-settings	a:4:{s:8:"redirect";i:0;s:12:"redirect_url";s:0:"";s:11:"apply_delay";i:0;s:12:"lock_content";b:0;}

Develop in containers


A line of code
The Business
An Application

Design with tactile, conversational methods

- CRC Cards
- Event Storming
- Whiteboards

Automate scenario reproduction

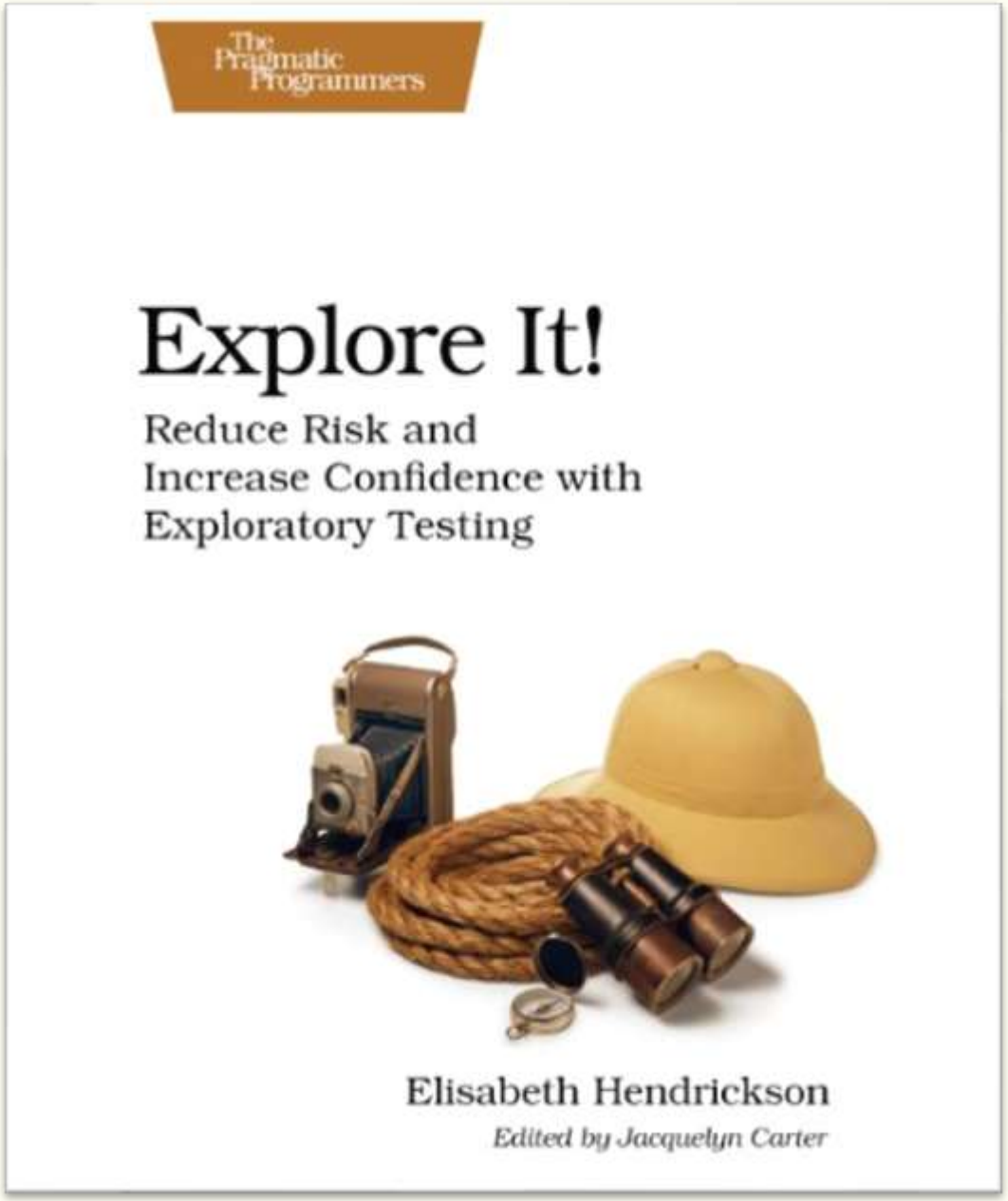
```yaml
options:
  courses:
    shared_steps: true
lessons:
  - name: Lesson A
  - name: Lesson B
  - name: Shared Lesson
    primary_course: Course A
courses:
  - name: Course A
    lessons:
      - Lesson A
      - Shared Lesson
  - name: Course B
    lessons:
      - Lesson B
      - Shared Lesson
students:
  - name: Avdi
    current_step: Lesson B
```

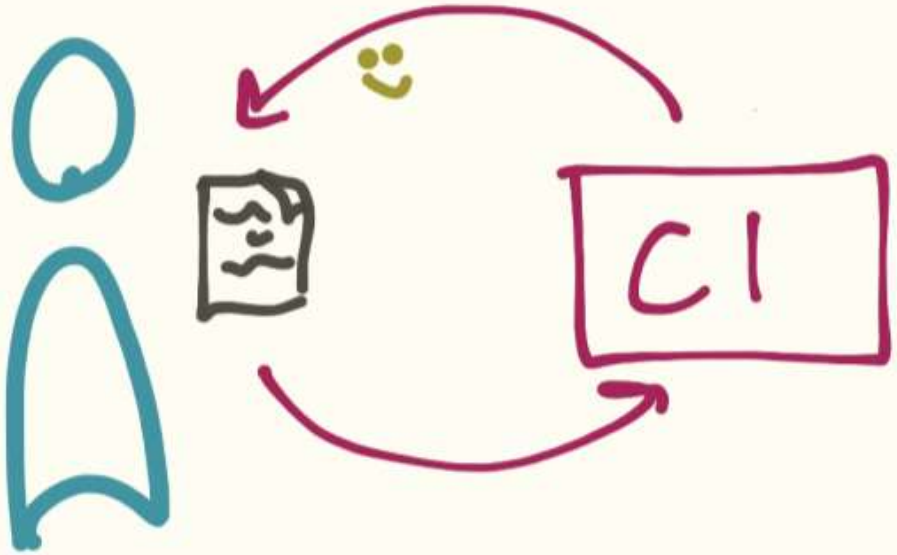
Automate scenario reproduction

*This does NOT imply automating end-to-end tests!

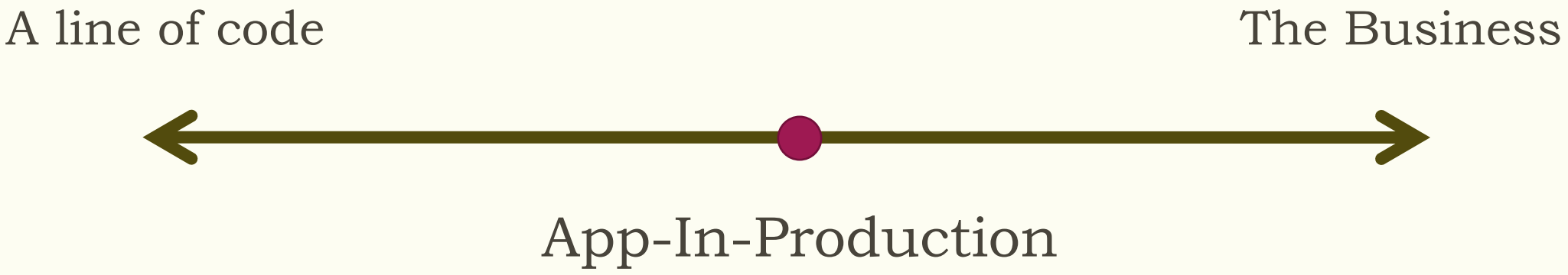
```yaml
options:
  courses:
    shared_steps: true
lessons:
  - name: Lesson A
  - name: Lesson B
  - name: Shared Lesson
    primary_course: Course A
courses:
  - name: Course A
    lessons:
      - Lesson A
      - Shared Lesson
  - name: Course B
    lessons:
      - Lesson B
      - Shared Lesson
students:
  - name: Avdi
    current_step: Lesson B
```

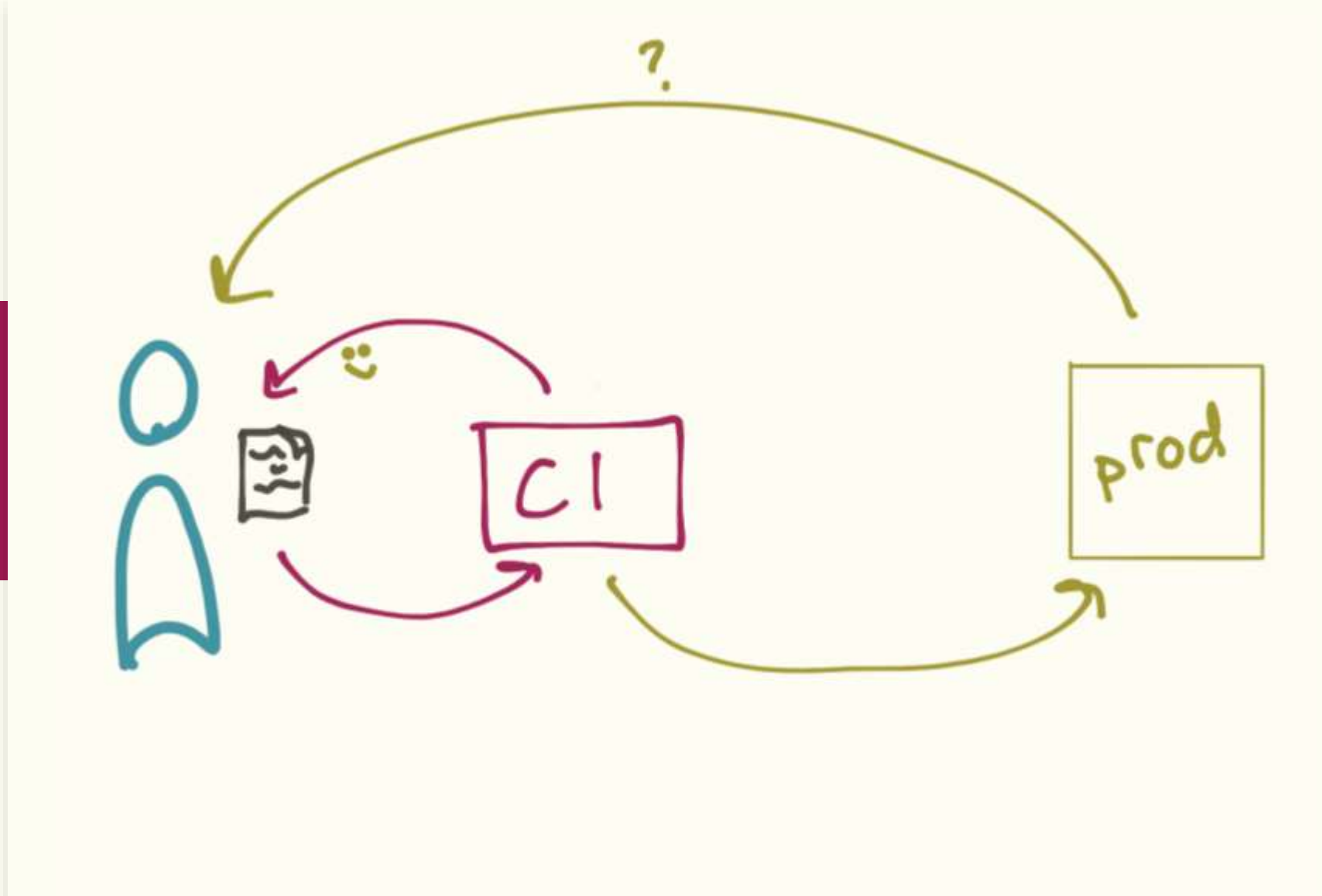
Practice exploratory testing



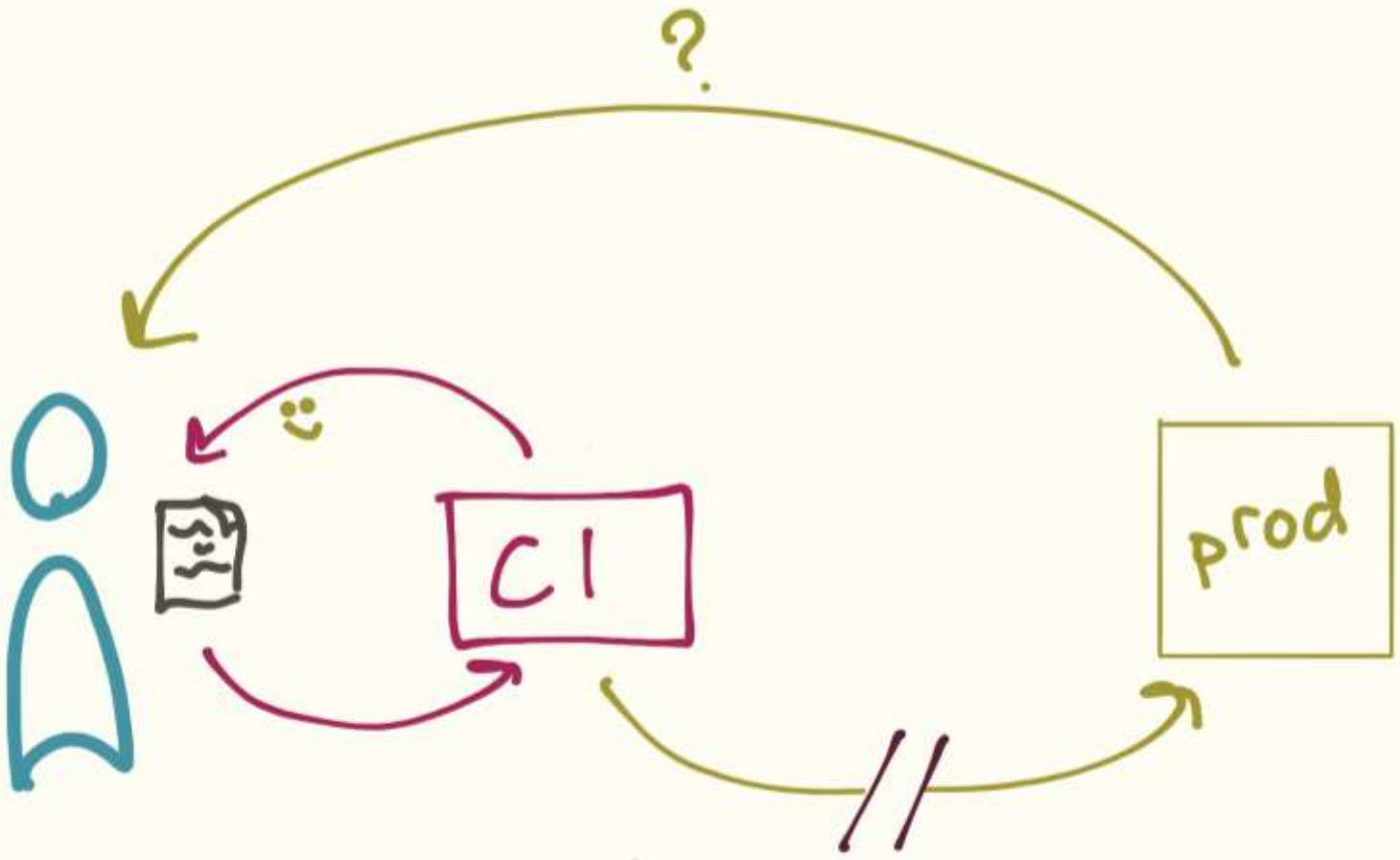


Use continuous integration

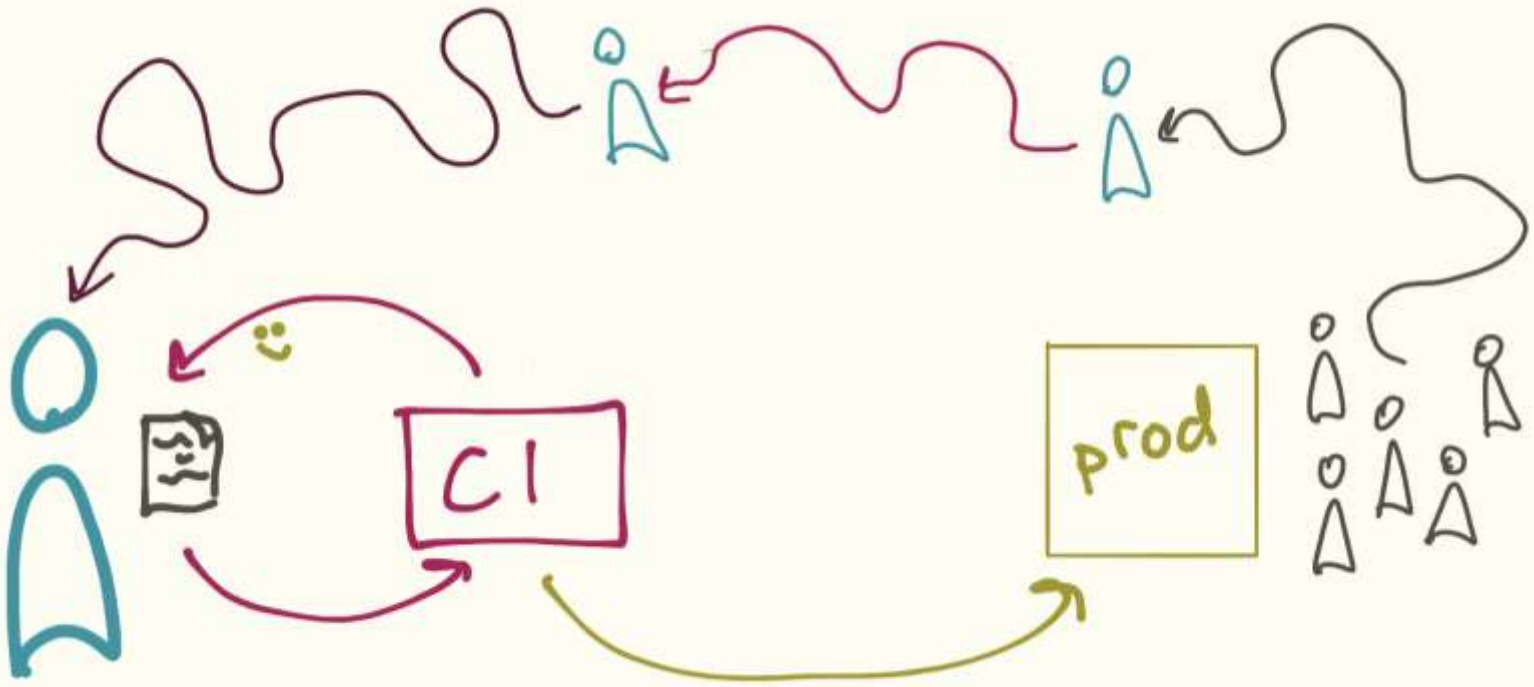

A line of code
The Business
App-In-Production



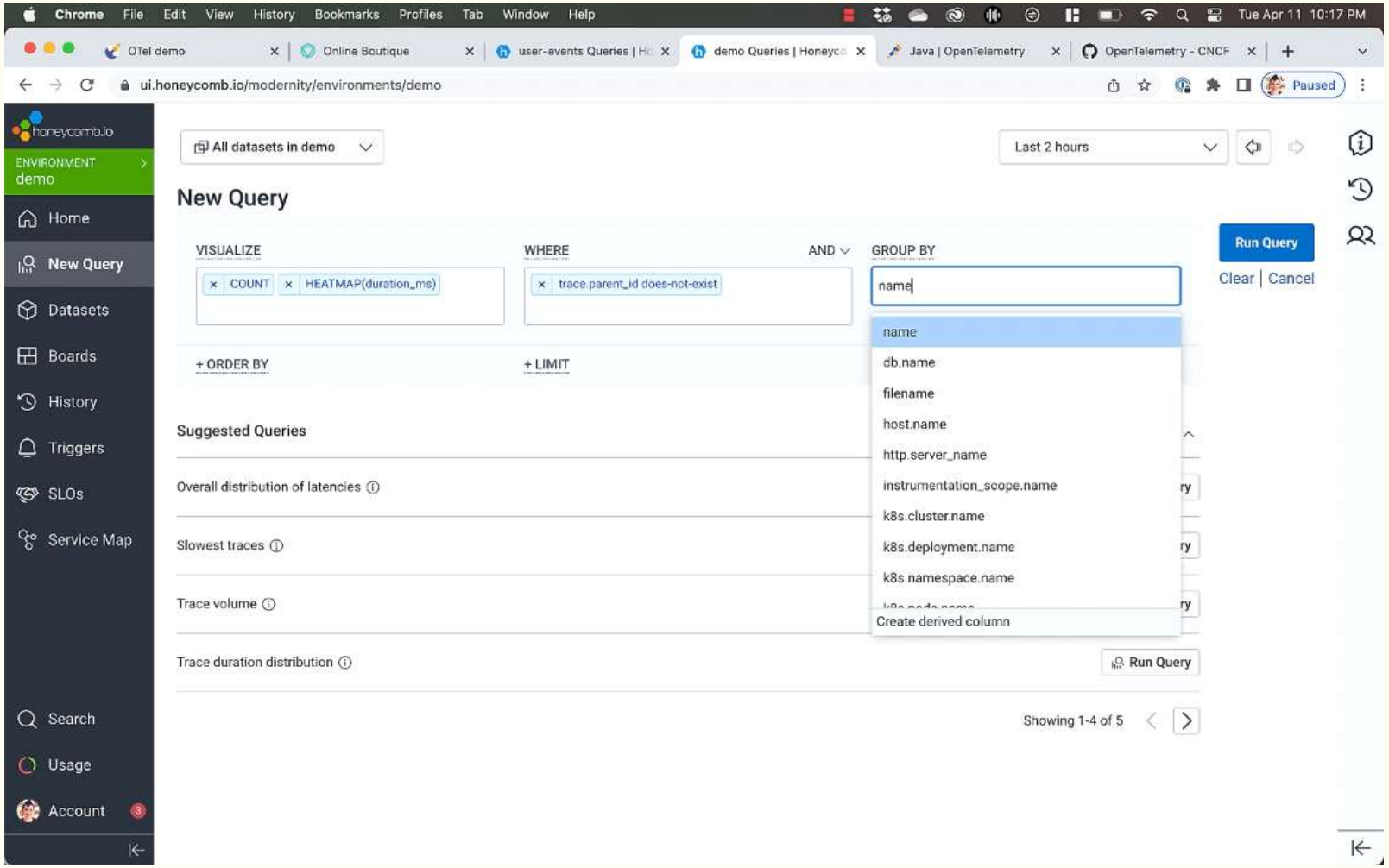
Use continuous deployment



...but beware!



...also
beware!



Use distributed tracing

ui.honeycomb.io/modernity/environments/demo

honeycomb.io

ENVIRONMENT
demo

- Home
- New Query
- Datasets
- Boards
- History
- Triggers
- SLOs
- Service Map
- Search
- Usage
- Account

All datasets in demo

Last 2 hours

New Query

VISUALIZE

× COUNT × HEATMAP(duration_ms)

WHERE AND

× trace.parent_id does-not-exist

GROUP BY

name

- name
- db.name
- filename
- host.name
- http.server_name
- instrumentation_scope.name
- k8s.cluster.name
- k8s.deployment.name
- k8s.namespace.name
- k8s.node.name

Create derived column

Run Query

Clear | Cancel

+ ORDER BY

+ LIMIT

Suggested Queries

Overall distribution of latencies

Slowest traces

Trace volume

Trace duration distribution

Run Query

Showing 1-4 of 5

Release with feature flags


A line of code
The Business
Product Team

Make friends with customer support

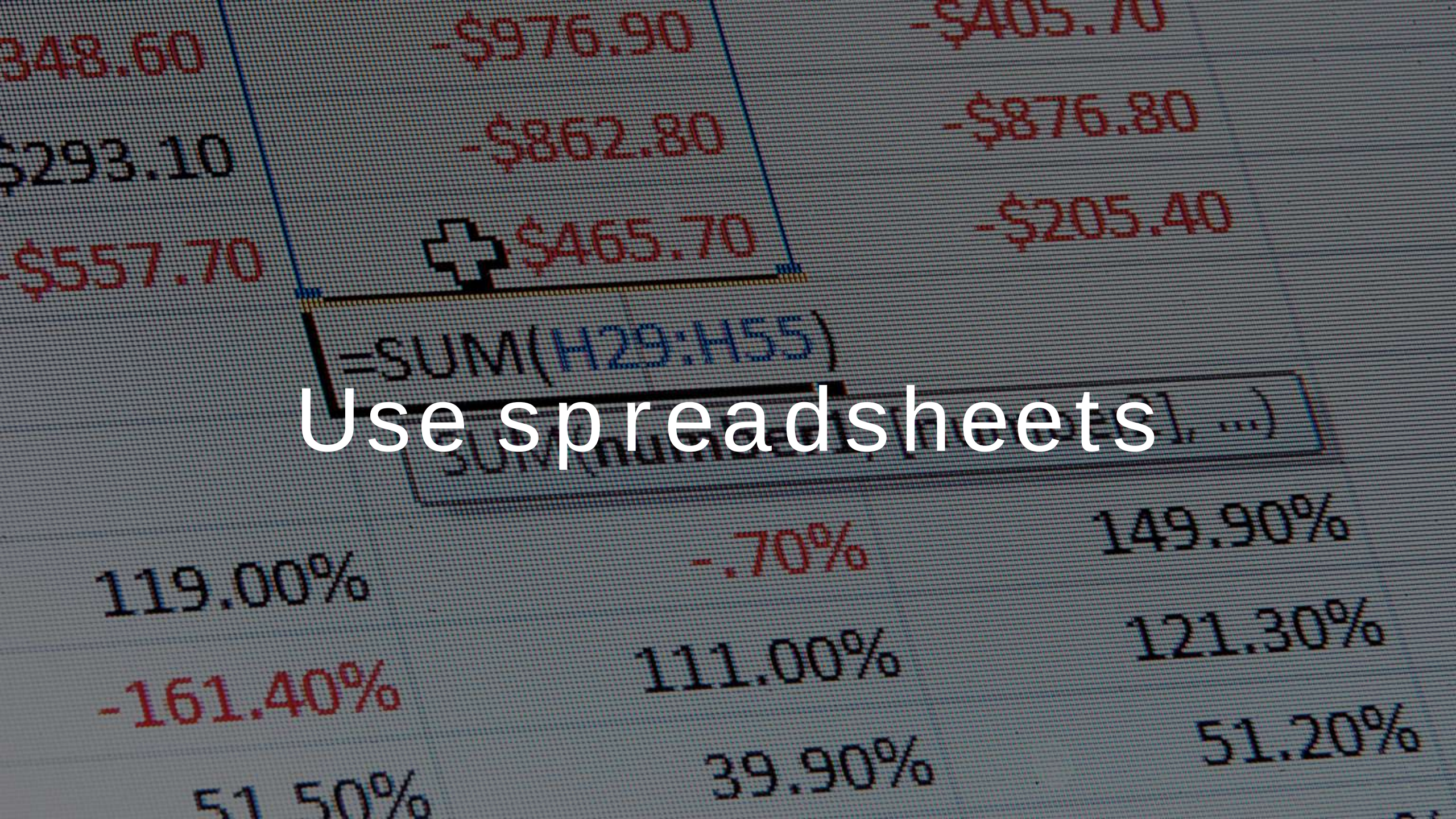
Make friends with your salesperson

“Embed the customer”


A line of code
The Business

Facilitate REPL Nature

(because it’s not all about you)



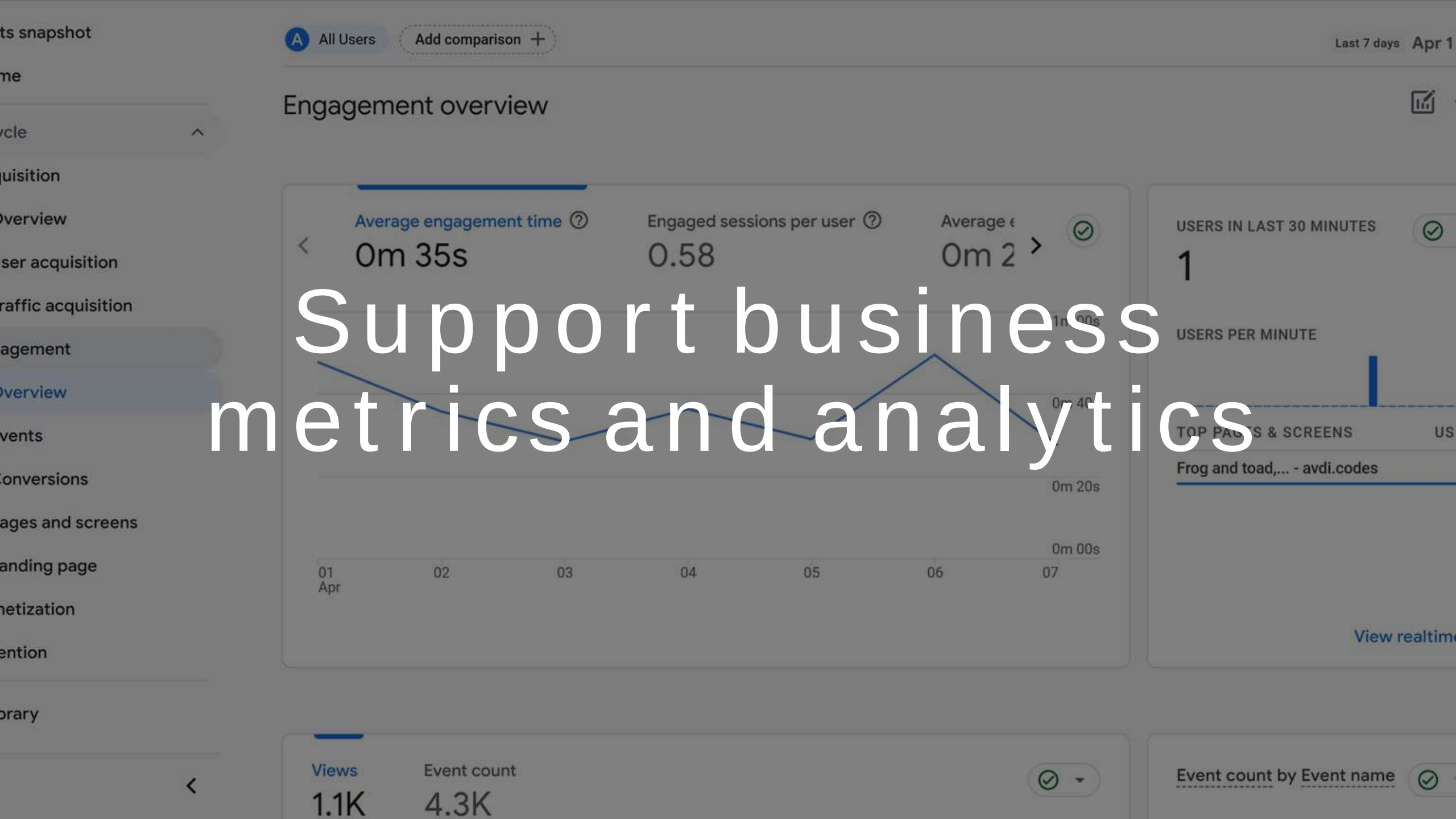
Use spreadsheets

WordPress

Commodity Software for Commodity Needs

Stop making engineering the bottleneck for business experiments!

Support business metrics and analytics



Seek Exploratory Feedback

READ

- Cultivate safe ways to play

EVAL

- Automate the repetitive, leave the rest open-ended

PRINT

- Hope for surprise
- Manufacture serendipity

LOOP

- Keep trying
- Seek new questions, not mere answers.

Safe

Automanual

Exploramental

Conversational

Chase new questions.

You'll get better answers.

TYPE STOP AND PRESS RETURN. IF THAT DOESN'T WORK, HOLD THE CTRL KEY DOWN AND PRESS THE C KEY. THEN LET GO AND PRESS RETURN. IF THAT DOESN'T WORK, PRESS ESC OR ALT MODE. IF THAT DOESN'T WORK, YELL FOR HELP!

Good luck!

GRACEFUL DEV

graceful.dev/phillyete2023/

References

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Credits

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