



Test Your Code as a Crime Scene

CodeScene™

Powered by Empear



Intro:

My road to psychology

Problem:

**The challenges of large-scale software systems
The rise and fall of code complexity metrics**

What can we do instead?

Applying forensic profiling to code: behavioral code analysis

Evaluation: how good are hotspots at guiding tests and improvements?

Tooling: identify hotspots in your code

Learn more:

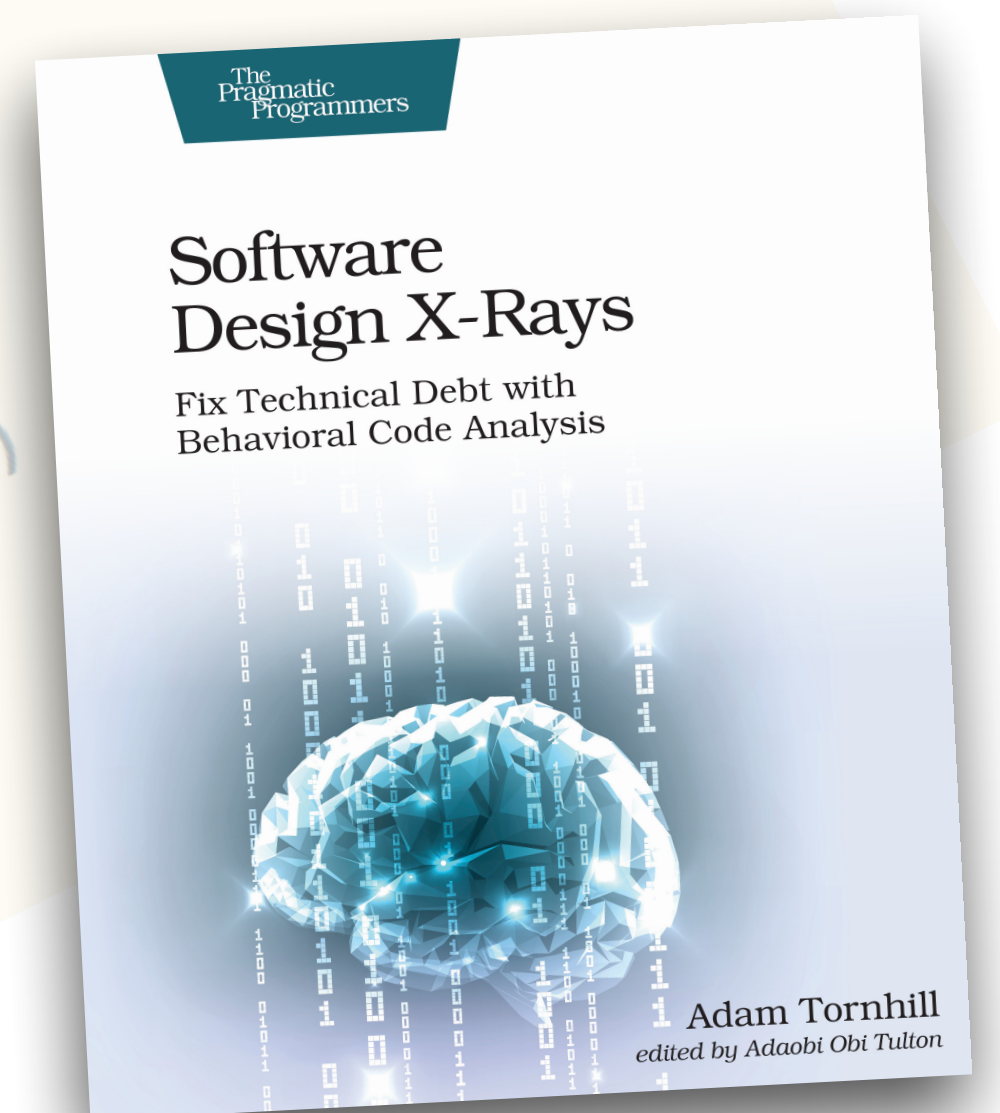
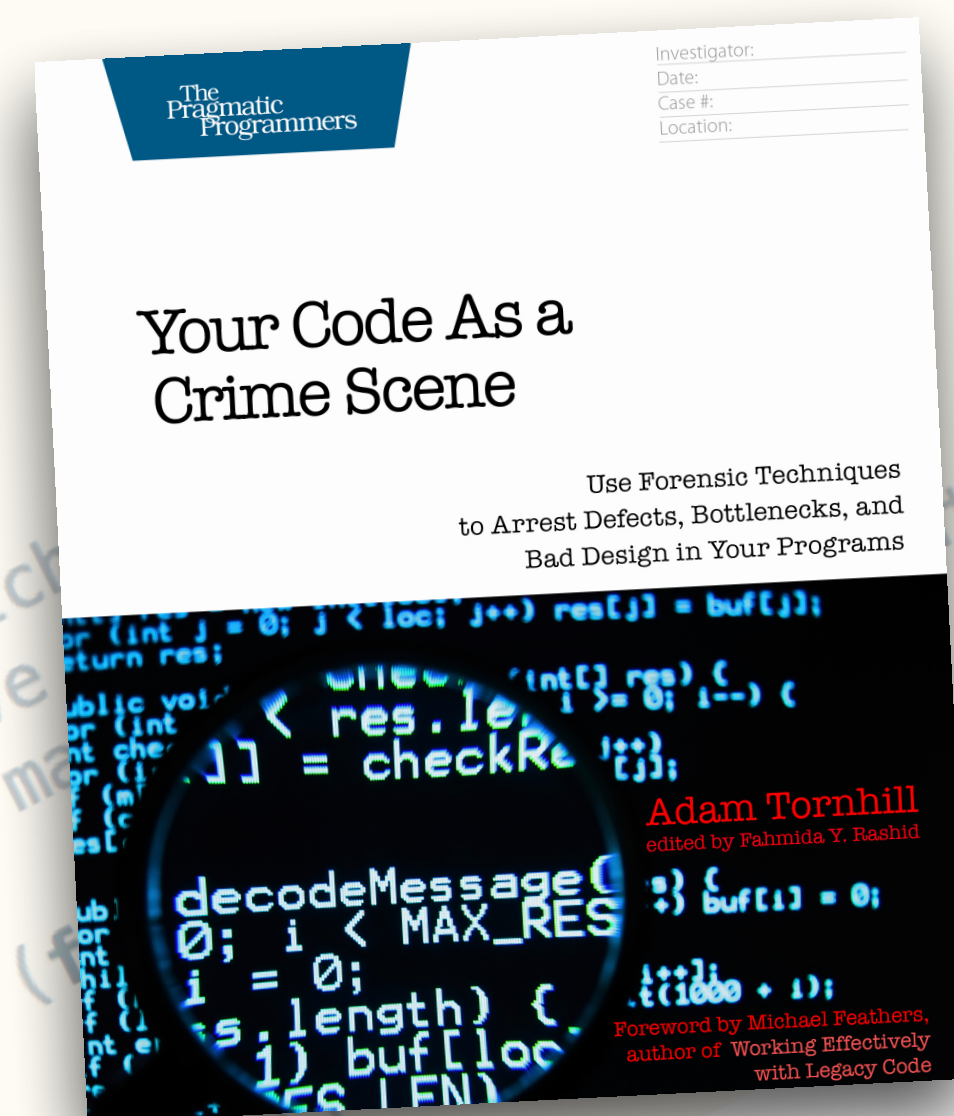
Beyond code: Predicting defects with behavioural patterns

Ask me anything: Q&A



My Road To Psychology

A Psychological Programmer?





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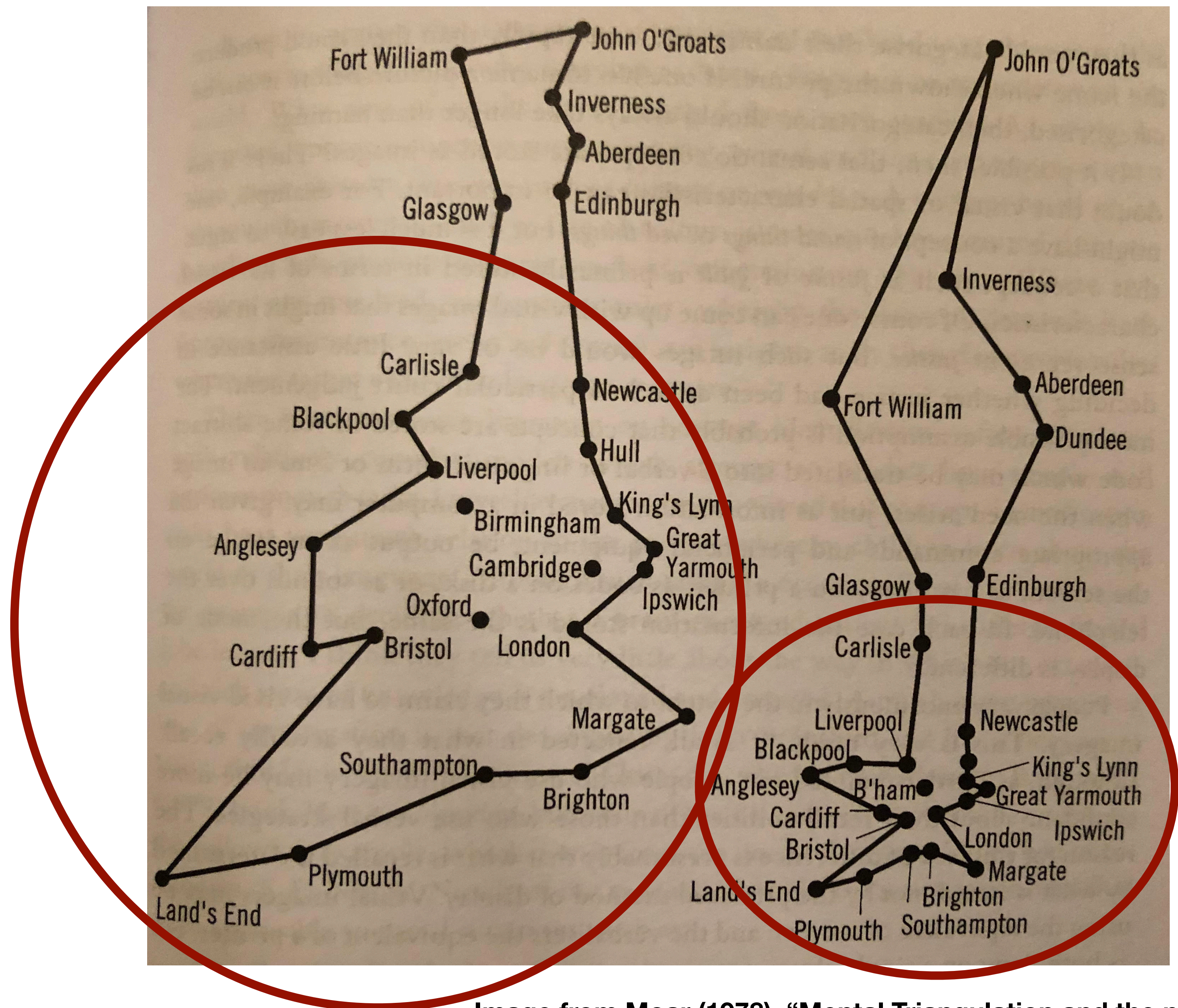
Reality is a Rorschach Blot



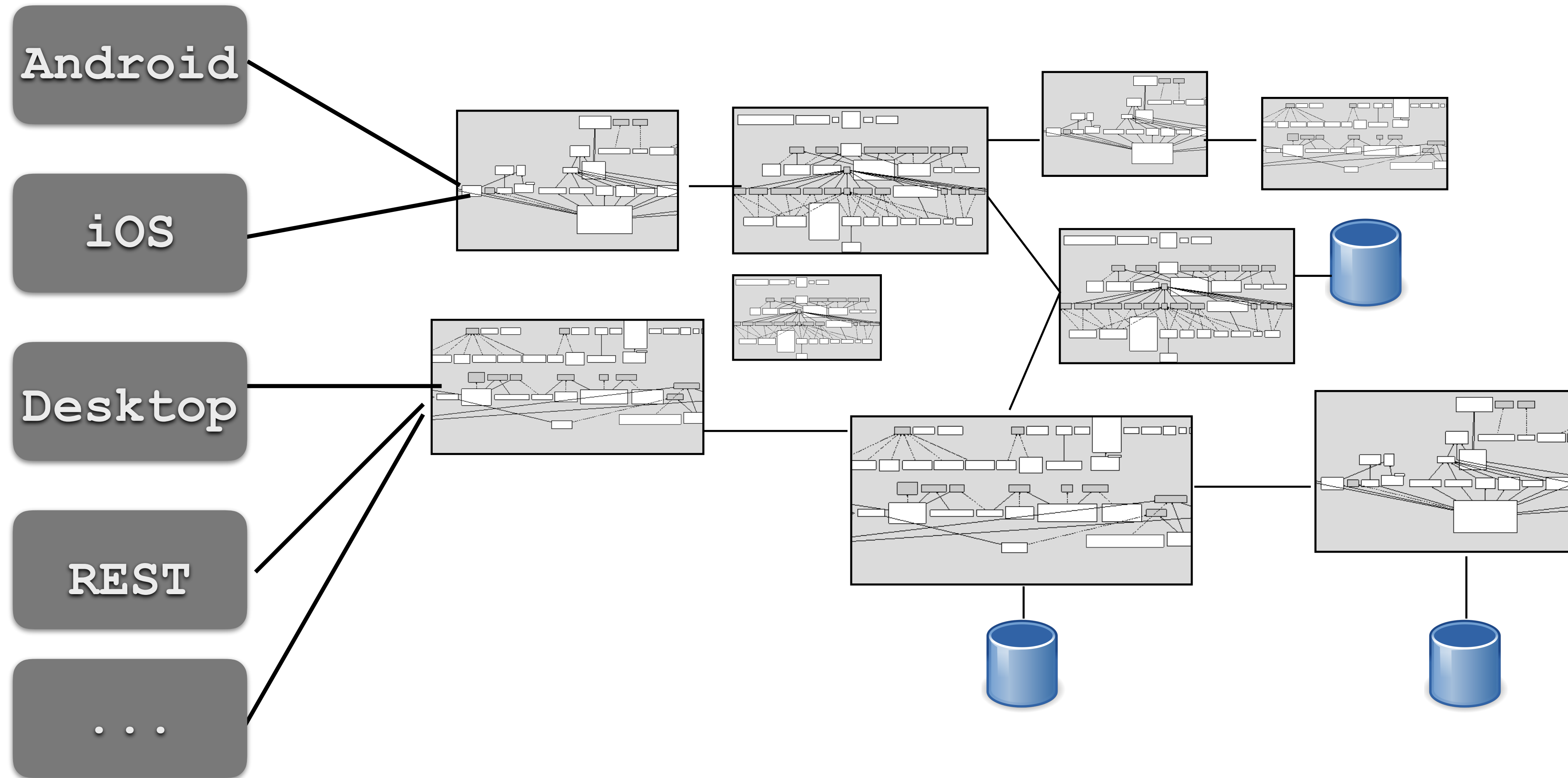
“Humans seem to be driven at least as much by fantasy as reality.”

(Baars, In The Theatre Of Consciousness, 1997)

Representation of Space and Mental Models



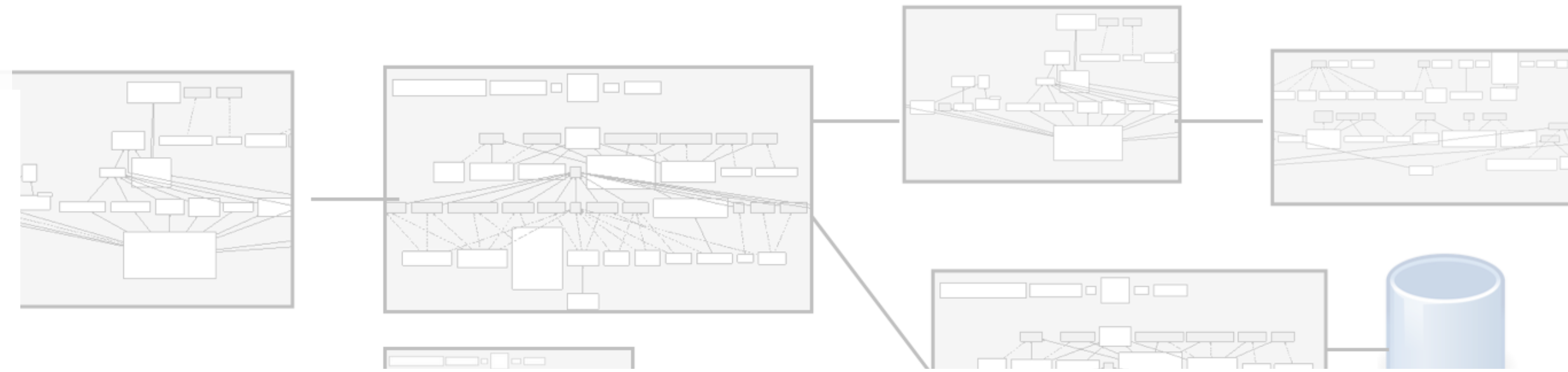
Software Development: How Can We Get Situational Awareness?



Do we have time to re-test everything all the time?

Do we have to?

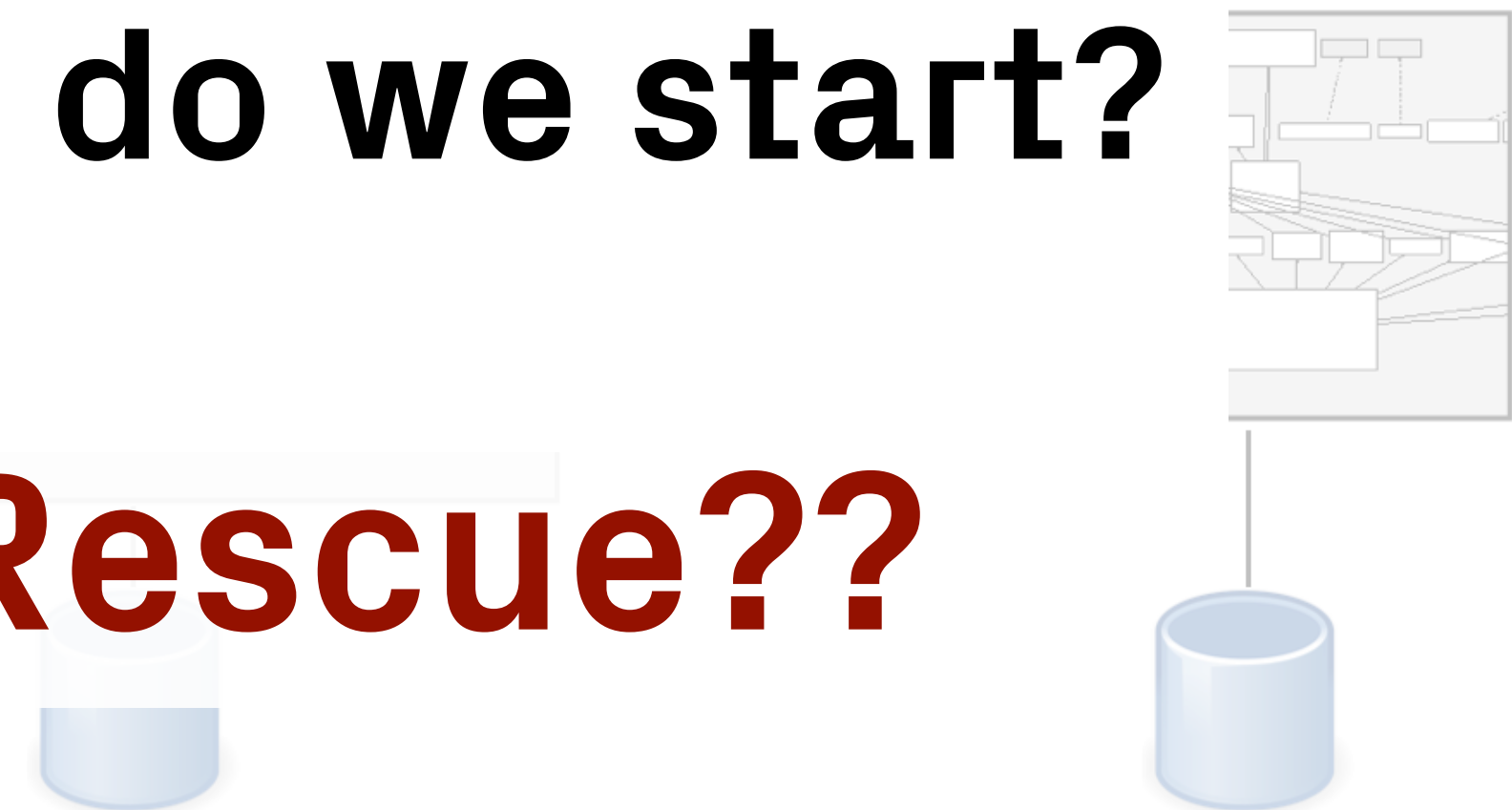
Do we want to?



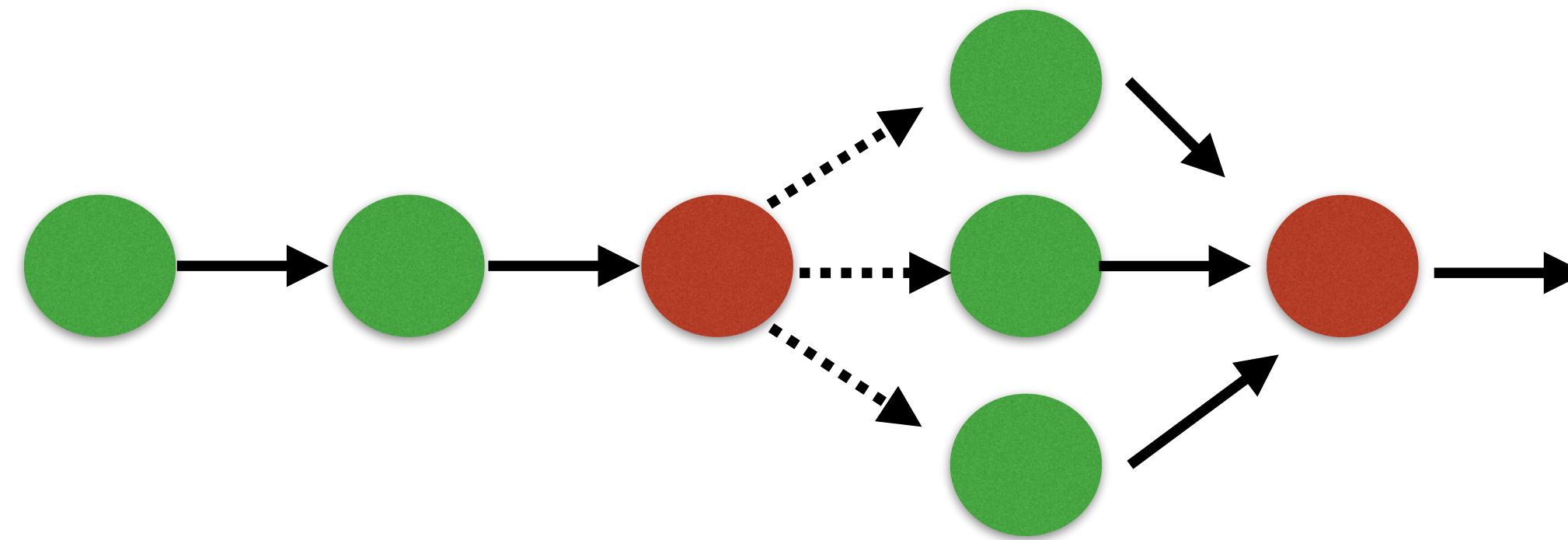
We can automate, but where do we start?



Metrics to the Rescue??



Code Complexity to guide Testing?



Cyclomatic Complexity

“Syntactic complexity metrics cannot capture the whole picture of software complexity”

(Herraiz & Hassan, “Making Software”)

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“The use of metrics to manage software projects has not even reached a state of infancy”

(Glass, “Facts and Fallacies of Software Engineering”)

“Syntactic complexity metrics cannot capture the whole picture of software complexity”

(Herraiz & Hassan, “Making Software”)

“The use of metrics to manage software projects has not even reached a state of infancy”

(Glass, “Facts and Fallacies of Software Engineering”)

“Complexity metrics lack context; complexity is only a problem when we need to deal with it.”

(me)



Intuition Doesn't **Scale**



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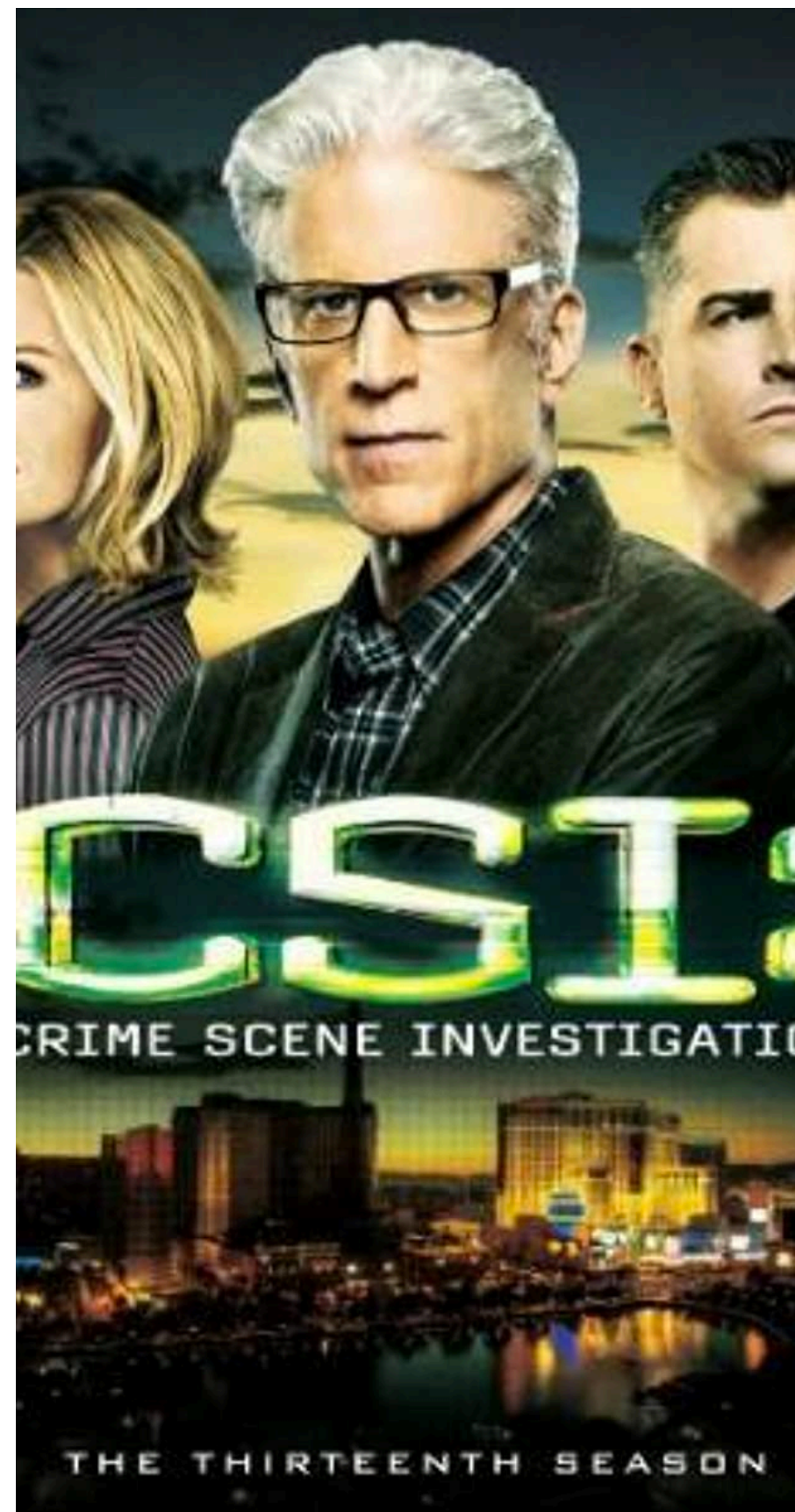
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Forensic Psychology

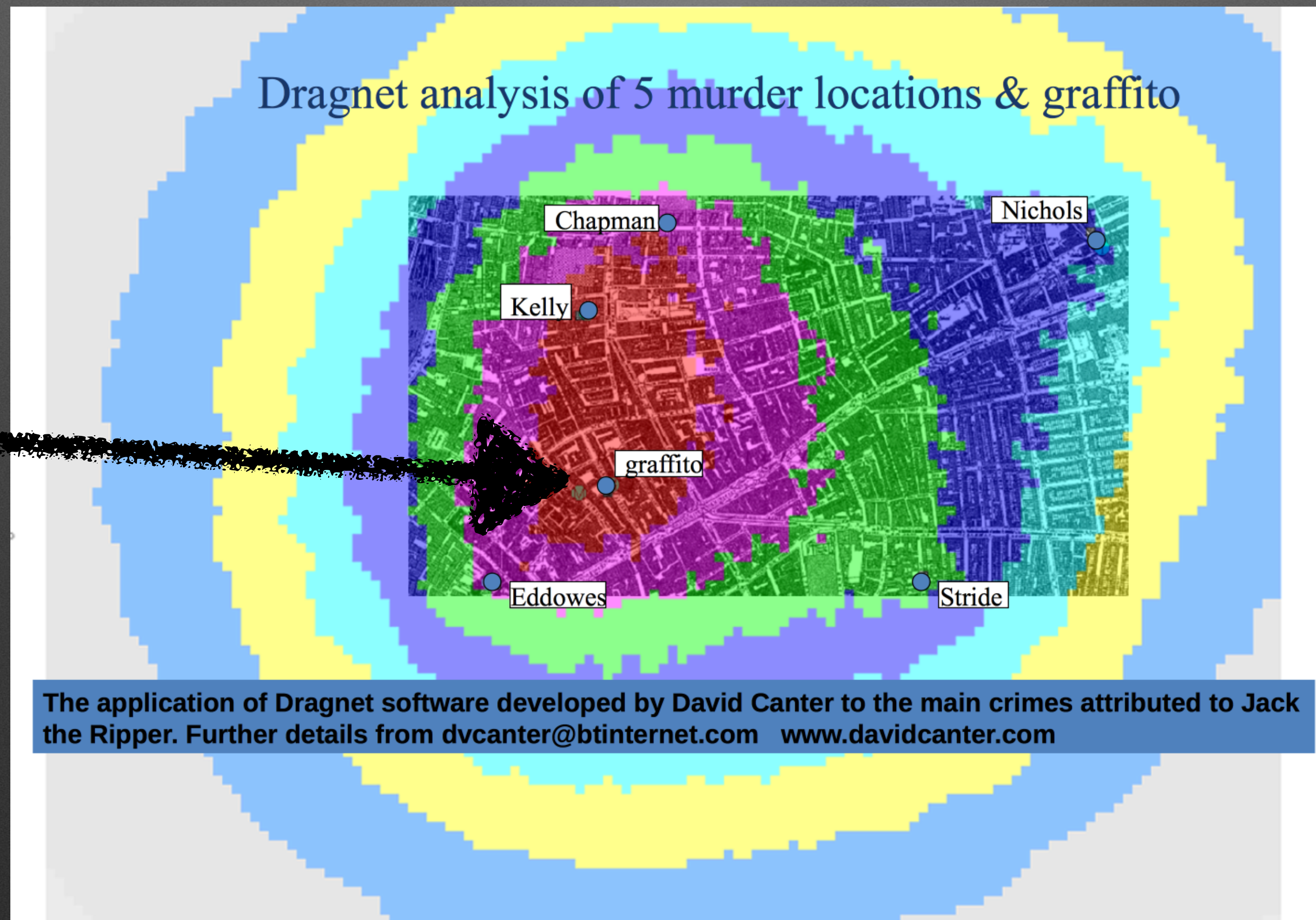


HOLLYWOOD

A person in a dark jacket and hooded sweatshirt is walking away from the camera down a dirt path. The path is surrounded by trees and bushes, and the entire scene is shrouded in a thick, grey fog. The lighting is dim, creating a somber and mysterious atmosphere.

Geographical Offender Profiling - a 2 Minutes Introduction

Profiling the Ripper



How can we use this in Code?

```
actual_mailbox(*this, make_pid(), io_service));
mailboxes.insert(std::make_pair(mbox->self(), mbox)).second;
shared_ptr<actual_mailbox> mbox(new actual_mailbox(*this, make_pid(), io_service, registered_name));
const mutex_guard guard(mailboxes_lock);
mailboxes.insert(std::make_pair(mbox->self(), mbox));
Loki::ScopeGuard insert_guard = Loki::MakeGuard(insert_guard.Dismiss());
insert_guard.insert(std::make_pair(registered_name, mbox));
return mbox;
}

void actual_node::close_mailbox(const e_pid& id, const std::string& name)
{
    const std::string reason = "normal";
    close_mailbox(id, name, reason);
}

// This function is invoked as a mailbox gets closed due to an exception
// We must take extreme care not to fire another exception, which
void actual_node::close_mailbox_async(const e_pid& id, const std::string& name)
{
    const std::string reason = "error";
    io_service.post(bind(&actual_node::close_mailbox, this, id, name, reason));
}
```


Version Control: Behavioral Data over Software Developers

Social Information

```
Commit: b557ca5
Date: 2016-02-12
Author: Kevin Flynn
    Fix behavior of StartsWithPrefix

src/Mvc.Abstractions/ModelBinding/ModelStateDictionary.cs
src/Mvc.Core/ControllerBase.cs
src/Mvc.Core/Internal/ElementalValueProvider.cs
1   39  src/Mvc.Core/Internal/PrefixContainer.cs

Commit: fd6d28d
Date 2016-02-10
Author: Professor Falken
    Make AddController not overwrite existing IControllerTypeProvider

8   1   src/Core/Internal/ControllersAsServices.cs
48  0   test/Core.Test/Internal/ControllerAsServicesTest.cs
13  0   test/Mvc.FunctionalTests/ControllerFromServicesTests.cs

Commit: 910f013
Date :2016-02-05
Author Lisbeth Salander
    Fixes #4050: Throw an exception when media types are empty.

20  1   src/Mvc.Core/Formatters/InputFormatter.cs
```

A Time Dimension

CASE STUDY: Offender Profiling of Code

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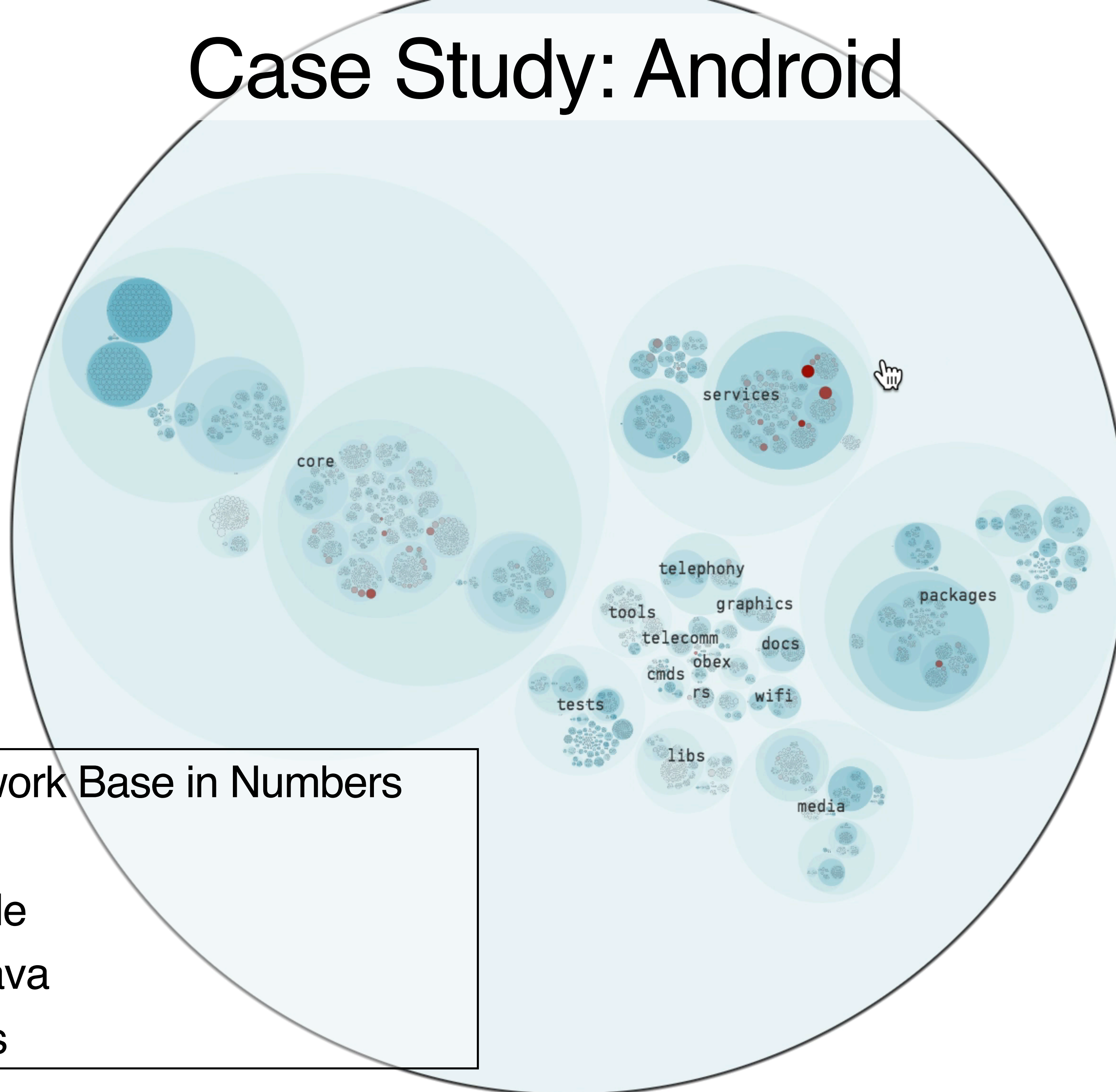
Case Study: Android



The Platform Framework Base in Numbers

3 Million Lines of Code
2,1 Million Lines of Java
2,000 Unique Authors

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ActivityManagerService.java

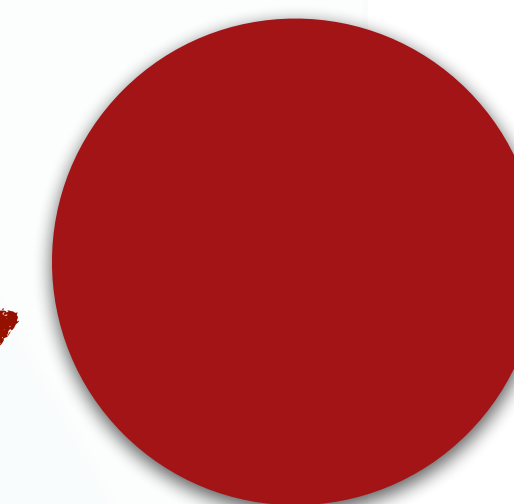


Code Complexity



Code Change Frequency

Hotspot



Focus: Identify Problematic Hotspots

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Focus on High Risk Areas: Modules with low Code Health

ActivityManagerService.java

Symptoms of low Code Health == Risk

Low Cohesion, many responsibilities

Overall Complex Methods, many conditionals

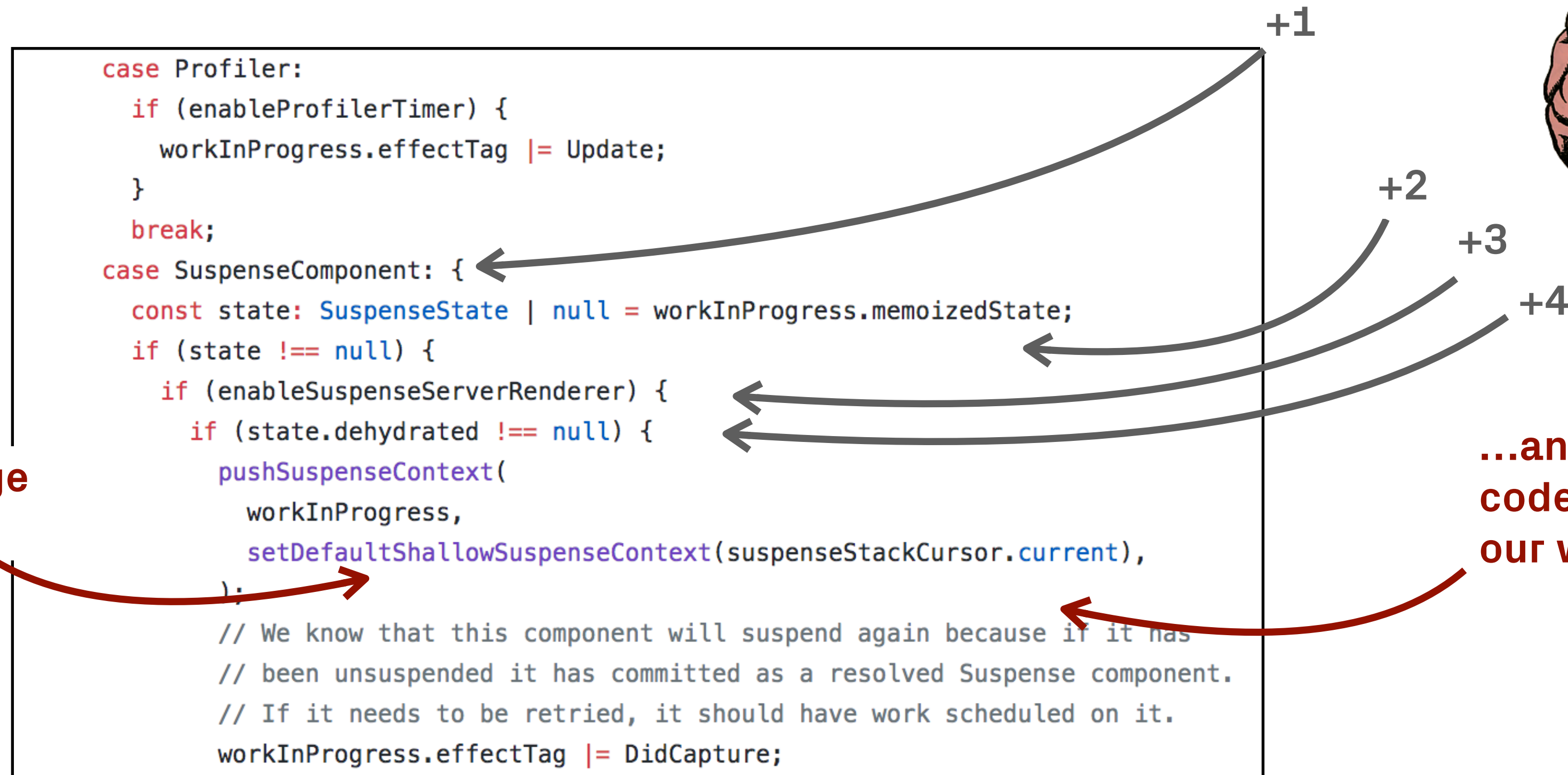
Deeply Nested Logic, if-statements inside if-statements

Bumpy Road, lack of modularity

Excess Function Arguments, missing abstractions



Working Memory: A Cognitive Bottleneck



We want to change
some code here

...and now we need to tweak
code while keeping 4(!) things in
our working memory...

Example

High Risk Code: The Bumpy Road Code Smell

bump>>>

bump>>>

```
let inst;
if (isClass) {
  inst = new Component(element.props, publicContext, updater);

  if (typeof Component.getDerivedStateFromProps === 'function') {
    if (__DEV__) {
      if (inst.state === null || inst.state === undefined) {
        const componentName = getComponentName(Component) || 'Unknown';
        if (!didWarnAboutUninitializedState[componentName]) {
          warningWithoutStack(
            false,
            '%s' uses `getDerivedStateFromProps` but its initial state is ' +
              '%s'. This is not recommended. Instead, define the initial state by ' +
              'assigning an object to `this.state` in the constructor of `%s`. ' +
              'This ensures that `getDerivedStateFromProps` arguments have a consistent shape.',
            componentName,
            inst.state === null ? 'null' : 'undefined',
            componentName,
          );
          didWarnAboutUninitializedState[componentName] = true;
        }
      }

      let partialState = Component.getDerivedStateFromProps.call(
        null,
        element.props,
        inst.state,
      );

      if (__DEV__) {
        if (partialState === undefined) {
          const componentName = getComponentName(Component) || 'Unknown';
          if (!didWarnAboutUndefinedDerivedState[componentName]) {
            warningWithoutStack(
              false,
              '%s.getDerivedStateFromProps(): A valid state object (or null) must be returned. ' +
                'You have returned undefined.',
              componentName,
            );
            didWarnAboutUndefinedDerivedState[componentName] = true;
          }
        }

        if (partialState !== null) {
          inst.state = Object.assign({}, inst.state, partialState);
        }
      }
    }
  }
}
```



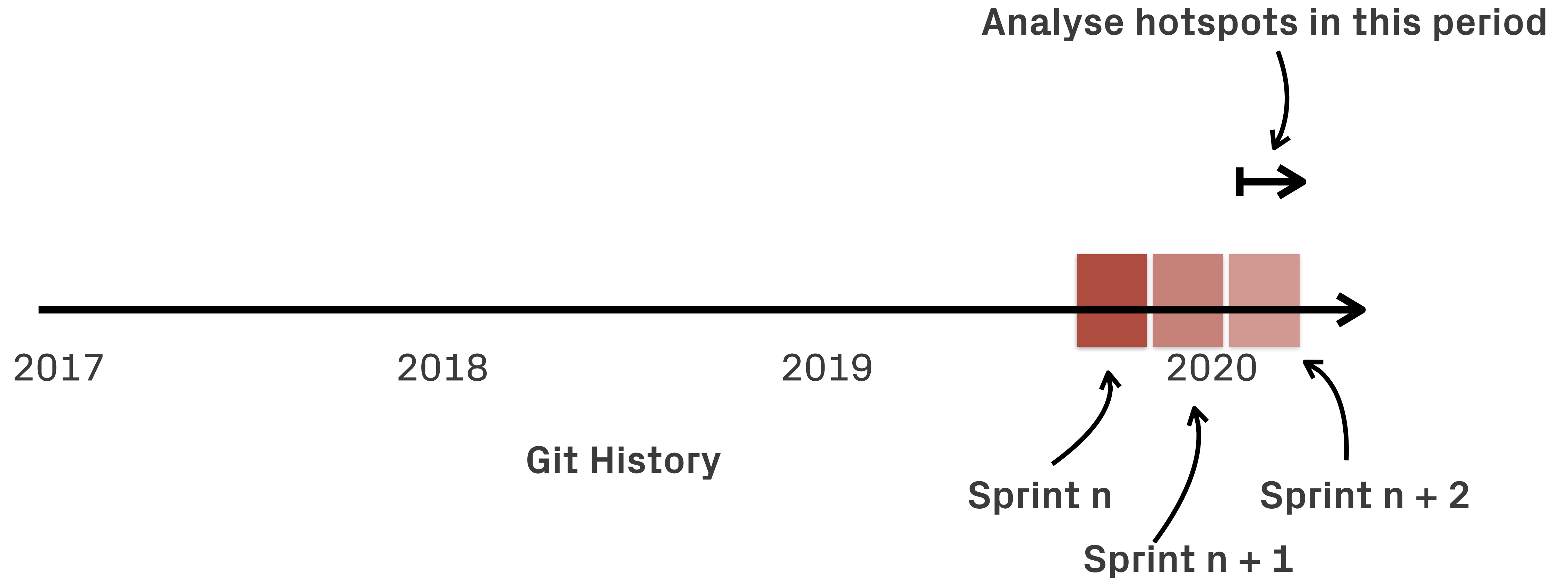
The Bumpy Road code smell is a function that contains multiple logical chunks of logic, driving the real code complexity (example from React).

Make it Actionable: Guide Testing by Hotspots

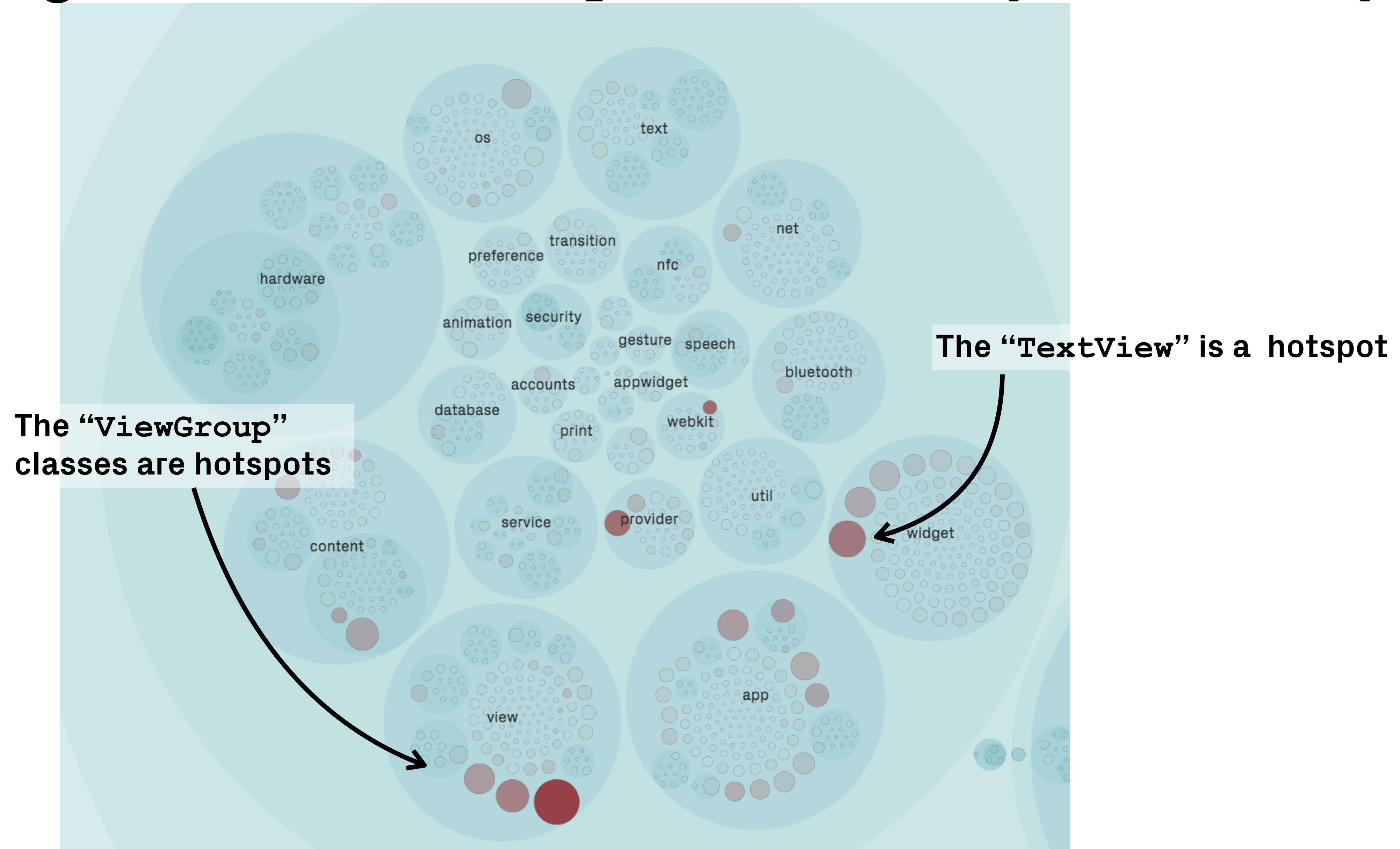
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Sliding Windows: Analyse the Hotspots in a Sprint



Sliding Windows: Analyse the Hotspots in a Sprint



Scale: Hotspots all the Way Up

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Hotspots in Spinnaker: +30 Git repos, 7 Languages

The orca git repository
(Orchestration Engine)

Kotlin, Java, Groovy

Client library

Go lang

Read/write operations for
Google cloud

Java

Read/write operations for aws

Groovy, Java

Read/write operations for
Kubernetes

The deck git repository
(Management UI)

TypeScript and JavaScript

deck

halyard

rosco

keel

igor

roer

swabbie

gate

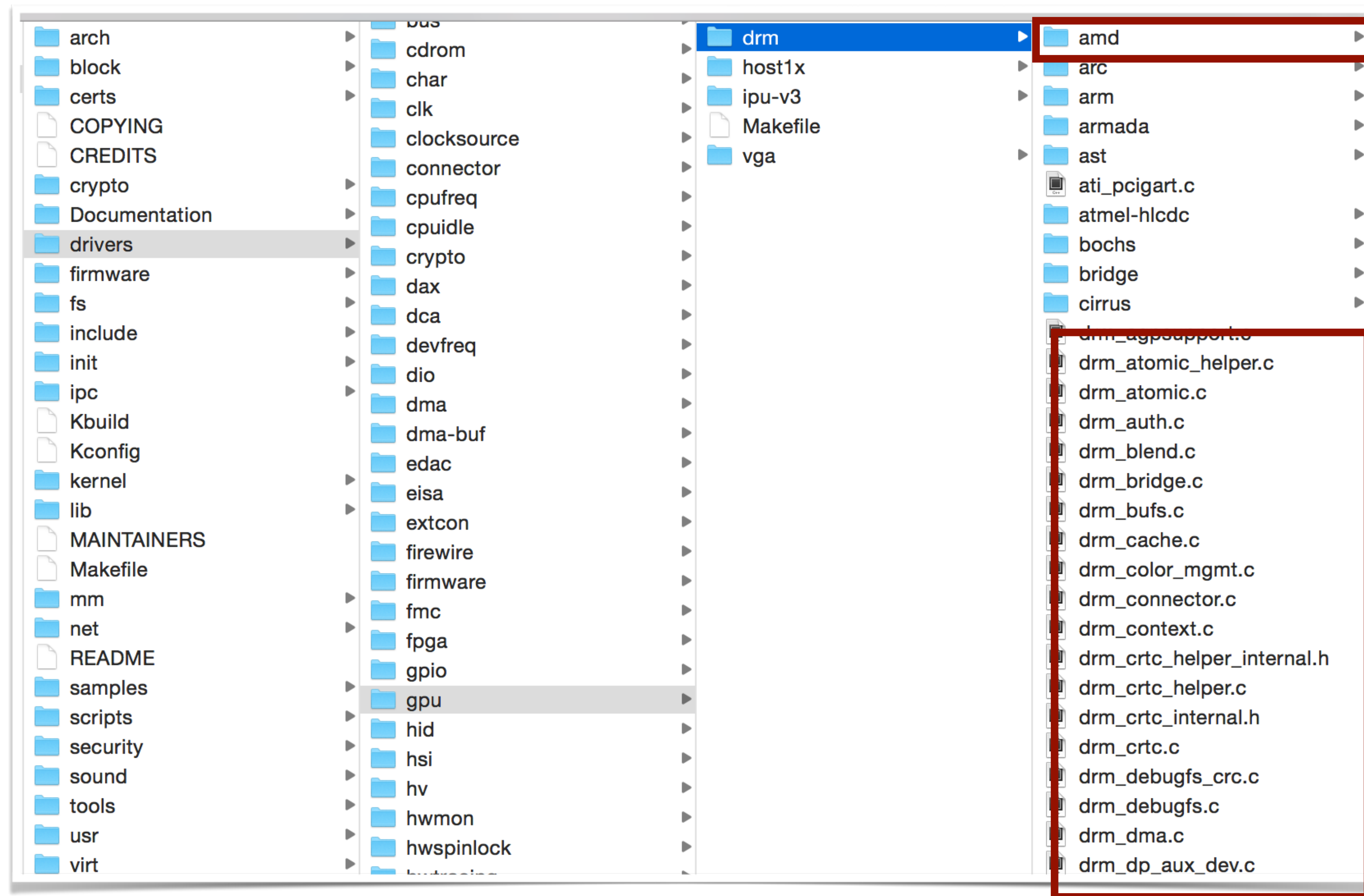
echo

front50

fiat

clouddriver

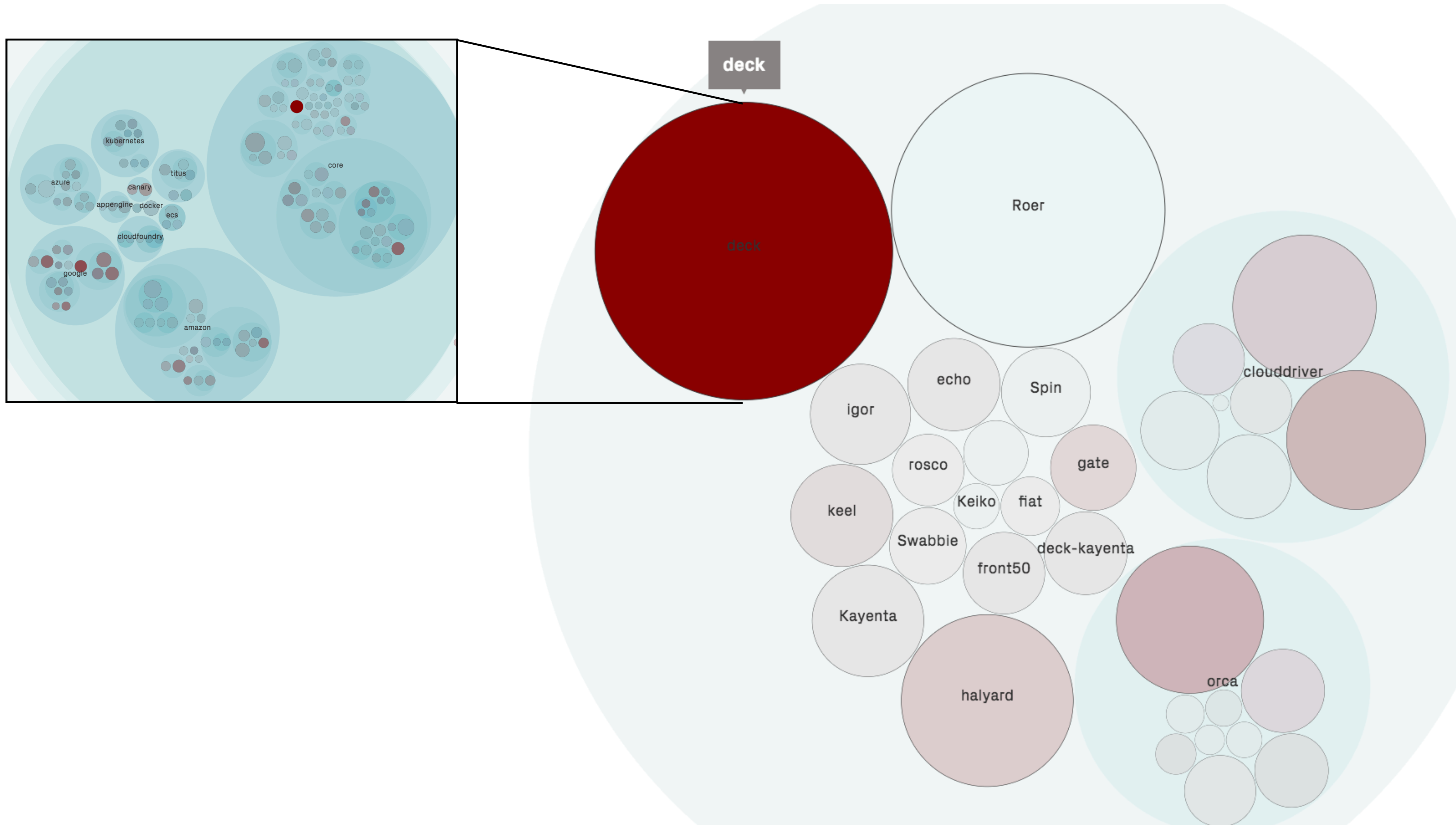
Specify Logical Components



DRM/AMD
...

DRM Shared

Aggregation: Architectural Hotspots in Spinnaker



Why Hotspots Work

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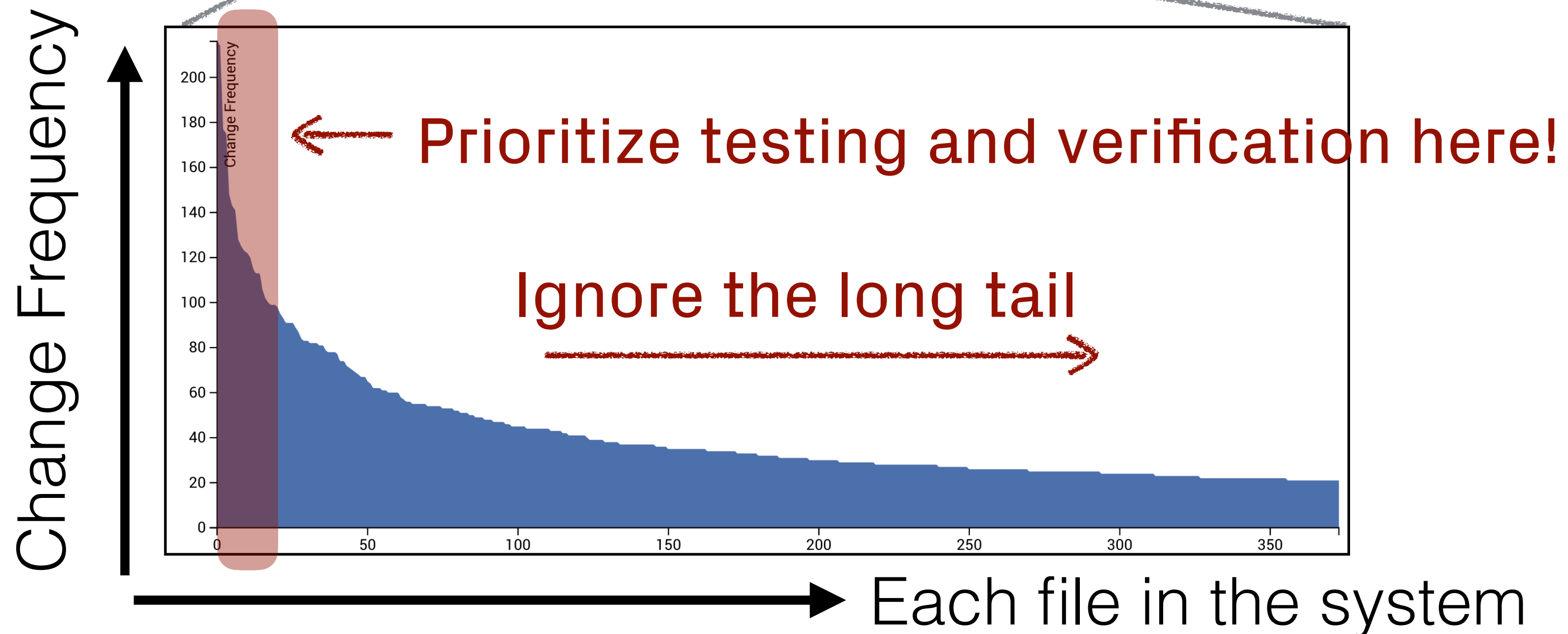
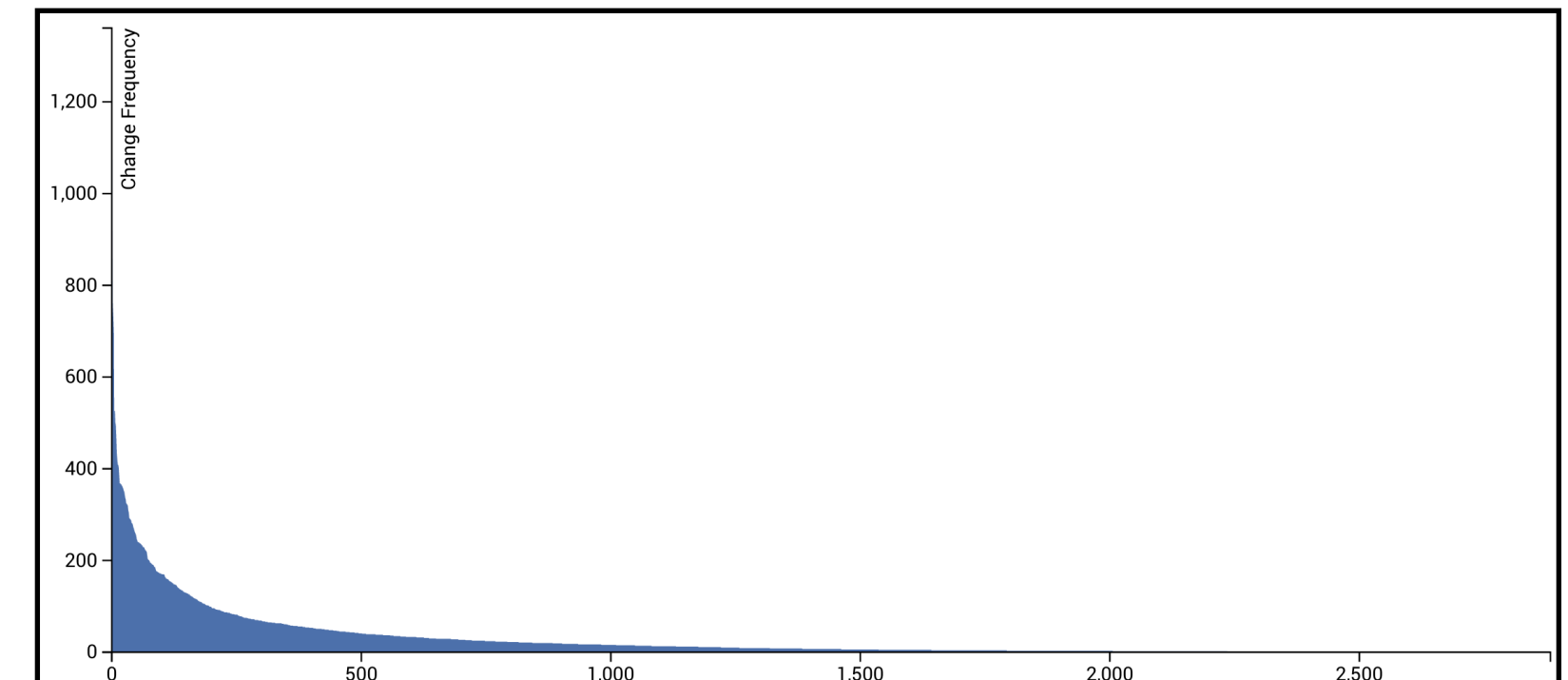
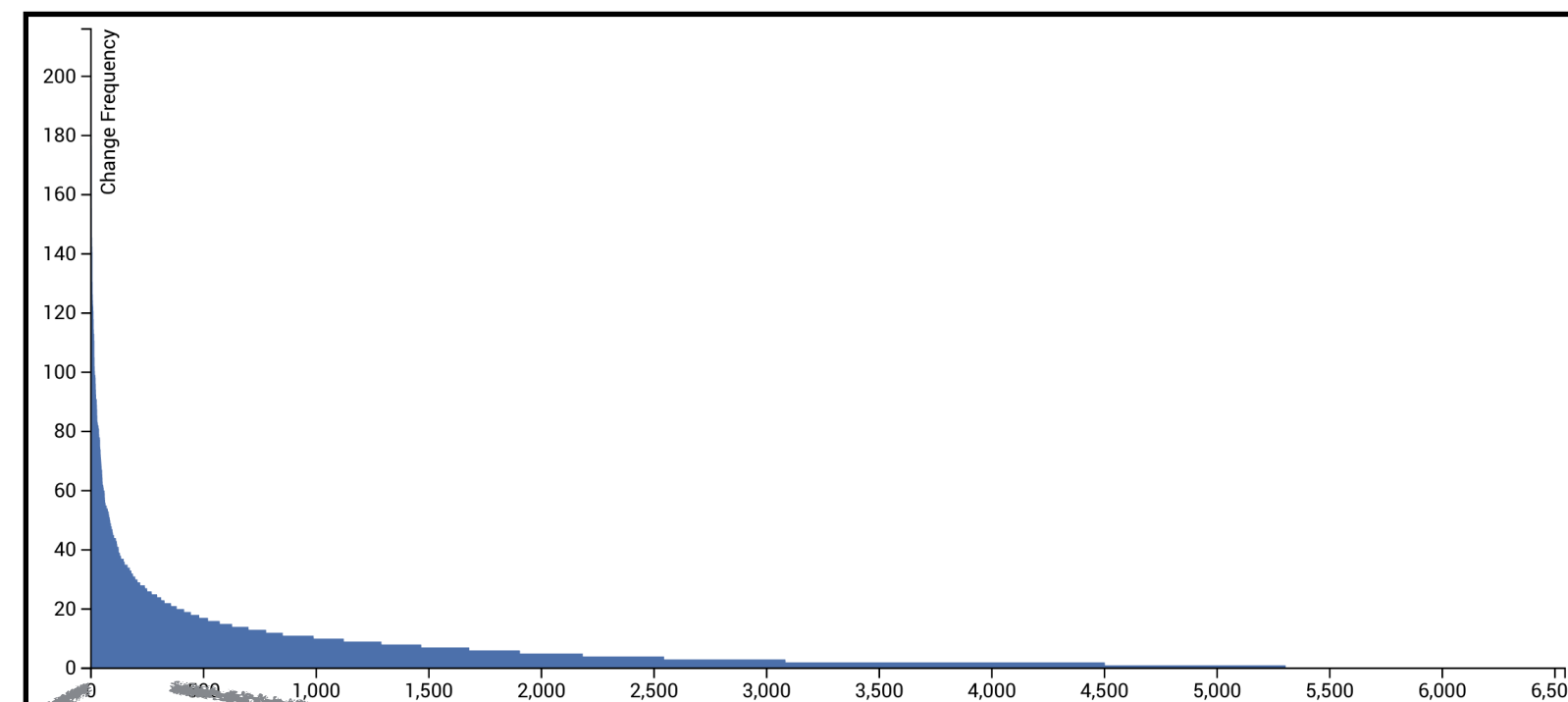
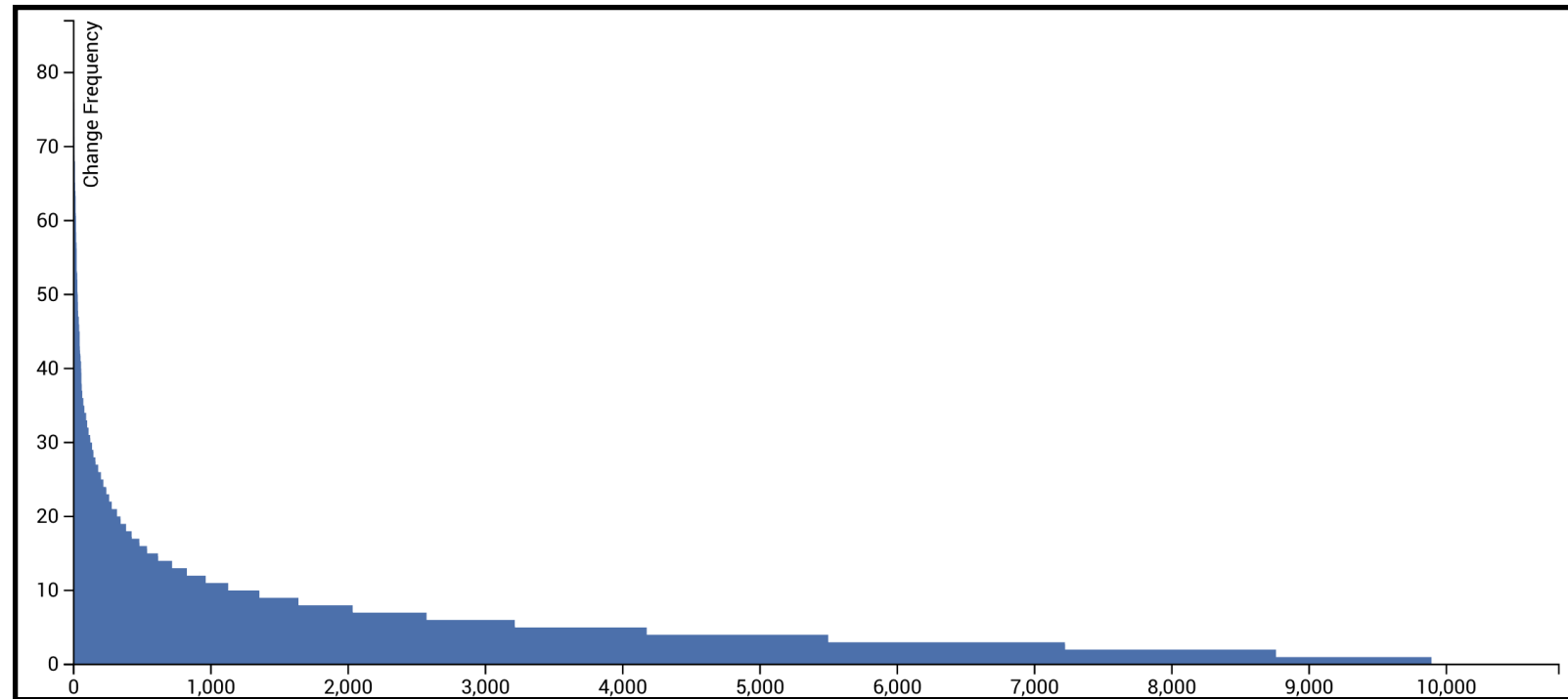
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Hotspots: Focus Tests on the Largest Impact

1 Year in Roslyn (C#, VB)

6 Years of Erlang

12 Years of Ruby on Rails

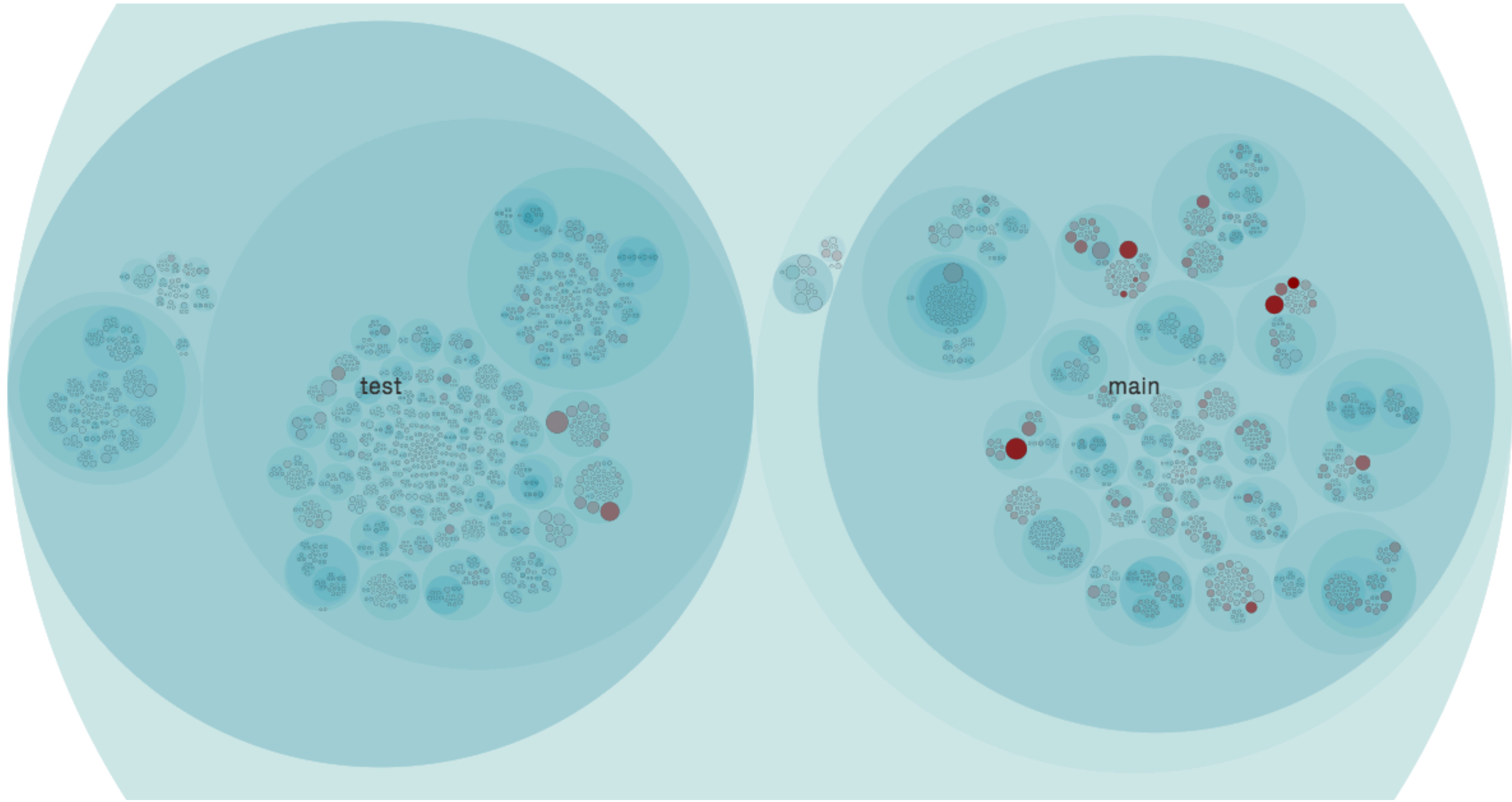


CASE STUDY: Hotspots and Defects

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A Travel in Time



Hotspots and Defects

7 out of 8 most defect dense parts

4% of the Code, 72% of all defects!



Defect Mining

Only one rule:

Reference tickets — Jira/Trello issues — in all commit messages*

```
commit 103506e1236f396452fdcf368452edf160c29637
```

```
Author: Alan Kay
```

```
Date: Thu Apr 2 20:47:59 2020 +0300
```

```
MARKET-1068: ensure text boxes have a minimum width
```

```
commit 5a9e0c8466acb5ea89185aa25d88db87dac3a713
```

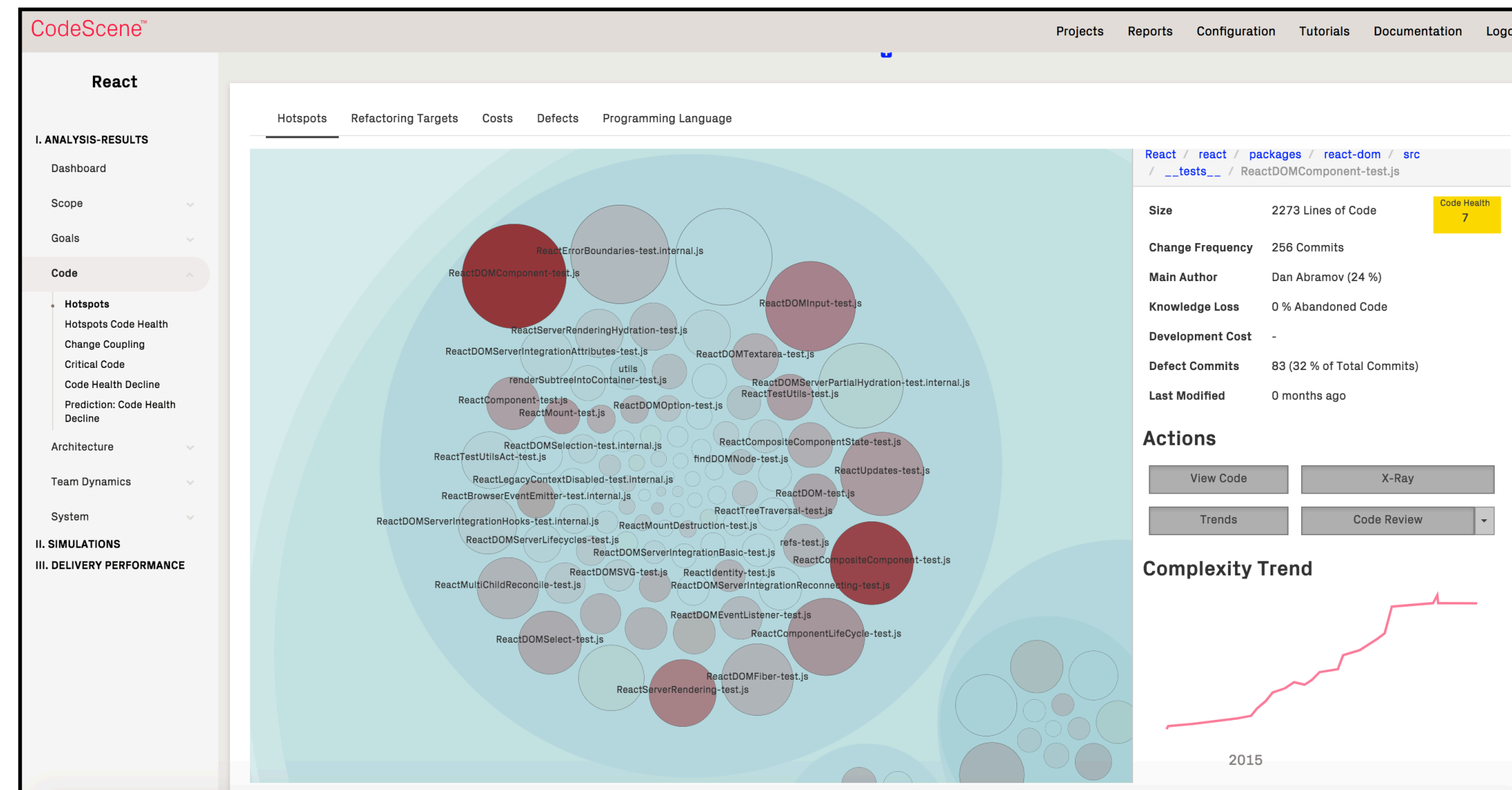
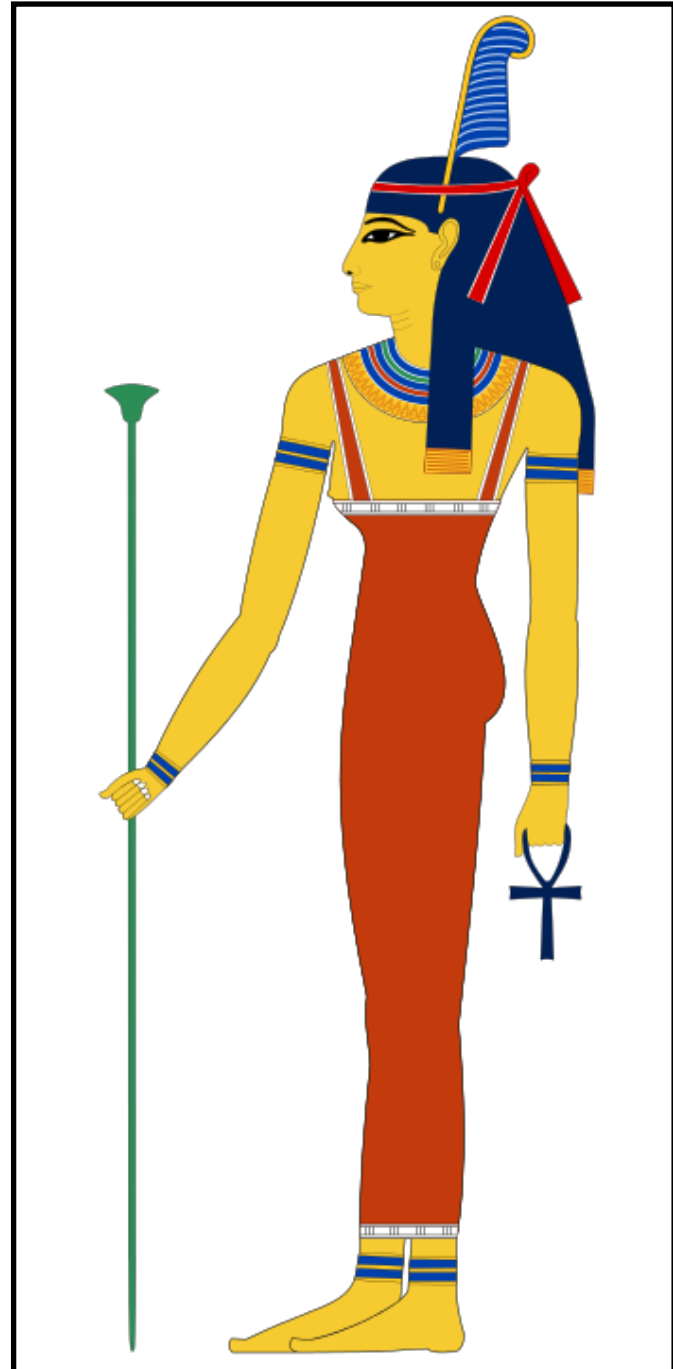
```
Author: Kevin Flynn
```

```
Date: Thu Apr 2 20:39:33 2020 +0300
```

```
MARKET-911: fix degradation in of load times
```

*Note: can be automated for development (e.g. Git pre-commit hooks)

Tooling: Try it on your own Code



<https://codescene.io/>

Hotspots from the command line

```
git log --format=format: --name-only |  
egrep -v '^$' | sort | uniq -c |  
sort -r |  
head -10
```

Source Code:

<https://github.com/adamtornhill/code-maat>



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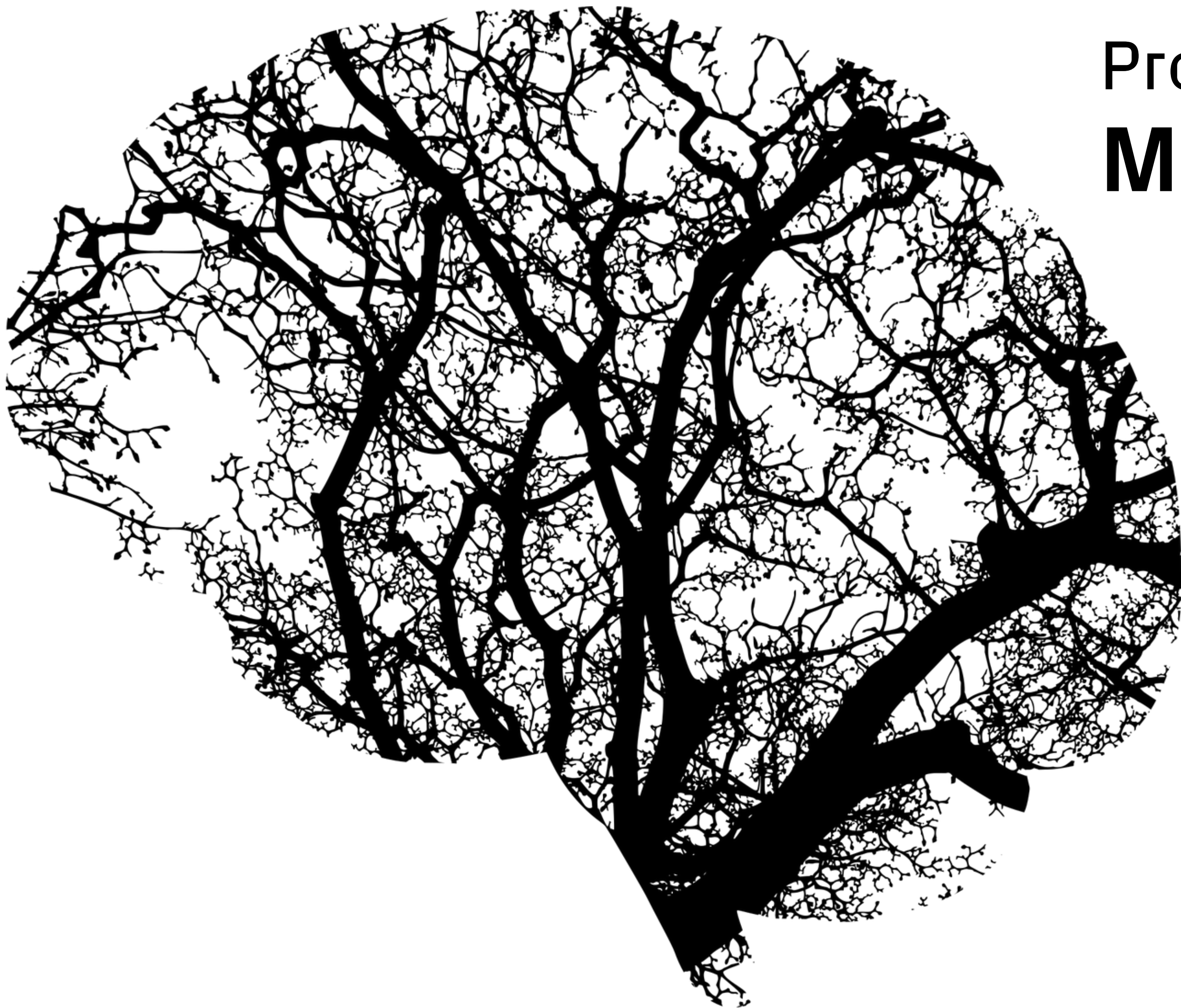
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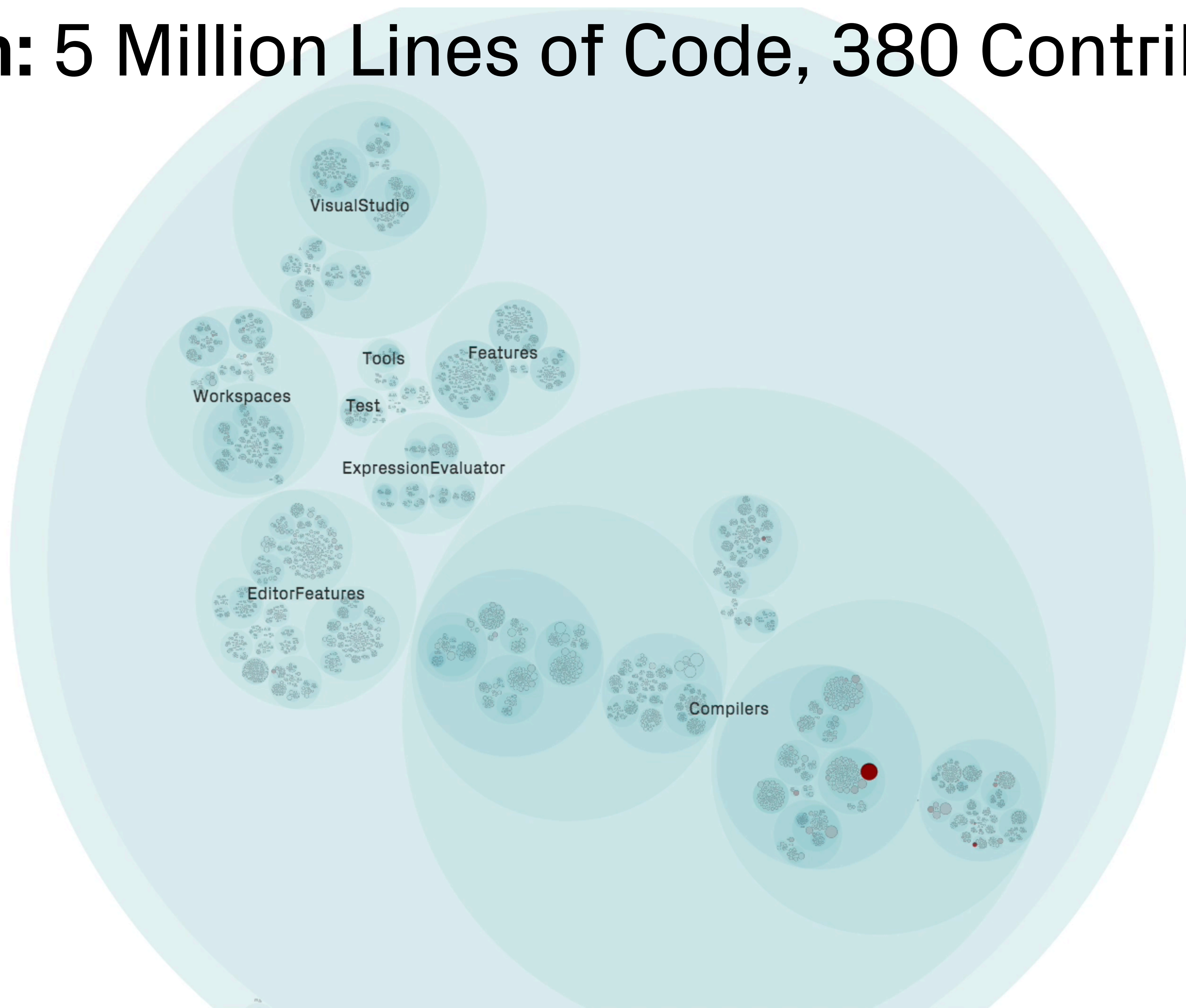
Beyond code: Predicting defects with behavioural patterns

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Process Loss: **Mental Models of Code**

Roslyn: 5 Million Lines of Code, 380 Contributors



C# Nullable Reference Types: In Context

NullableReferenceTypesTests.cs **93,000 Lines of Code**

Apollo 11 Guidance Computer **115,000 Lines of Code**



Source code: <https://github.com/chrislgarry/Apollo-11>

NullableReferenceTypesTests.cs



Emit

Syntax

Semantic

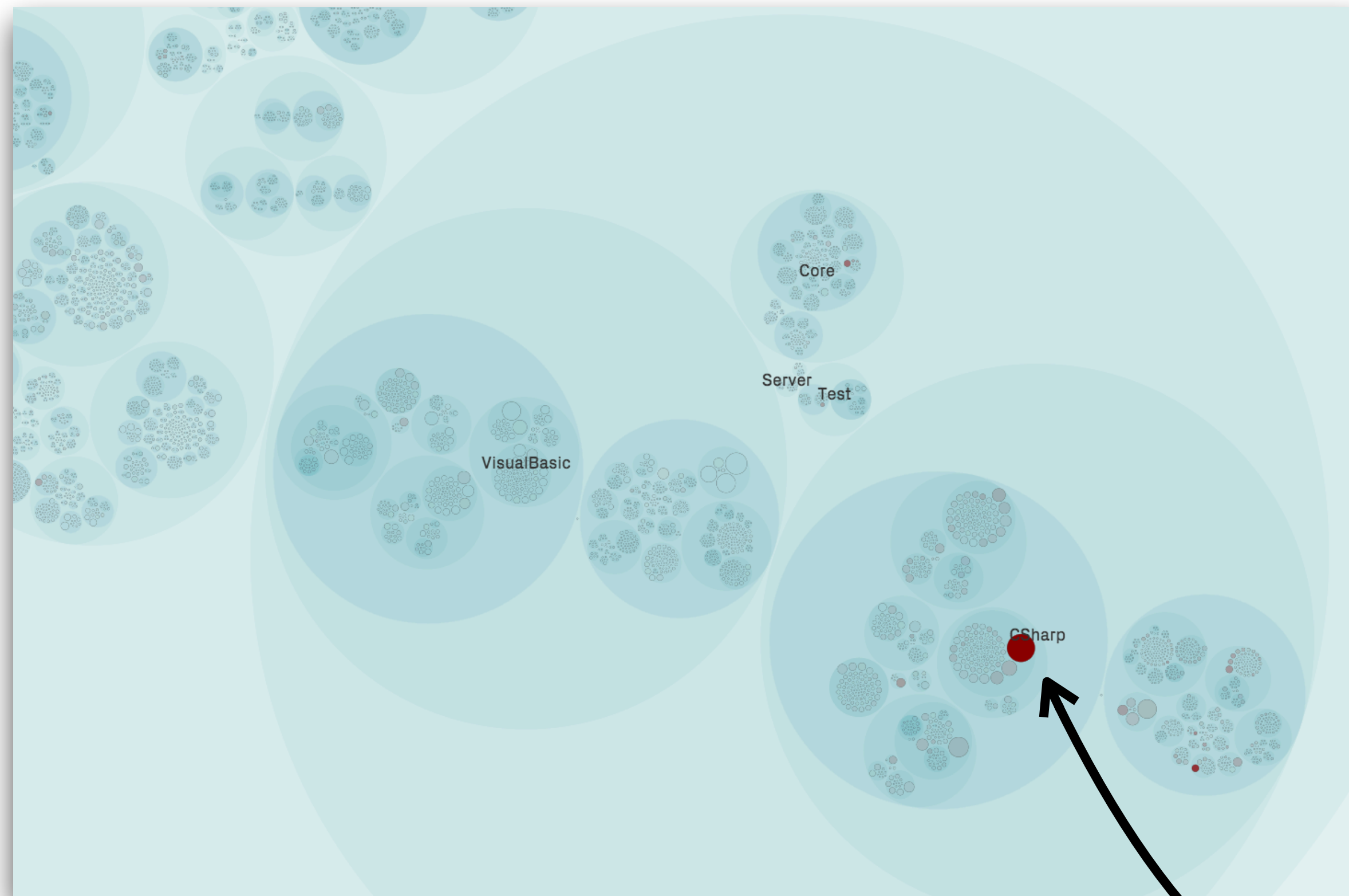
WinRT

IOperation

Symbol

Hotspots become Coordination Magnets

Hotspots: Development Activity

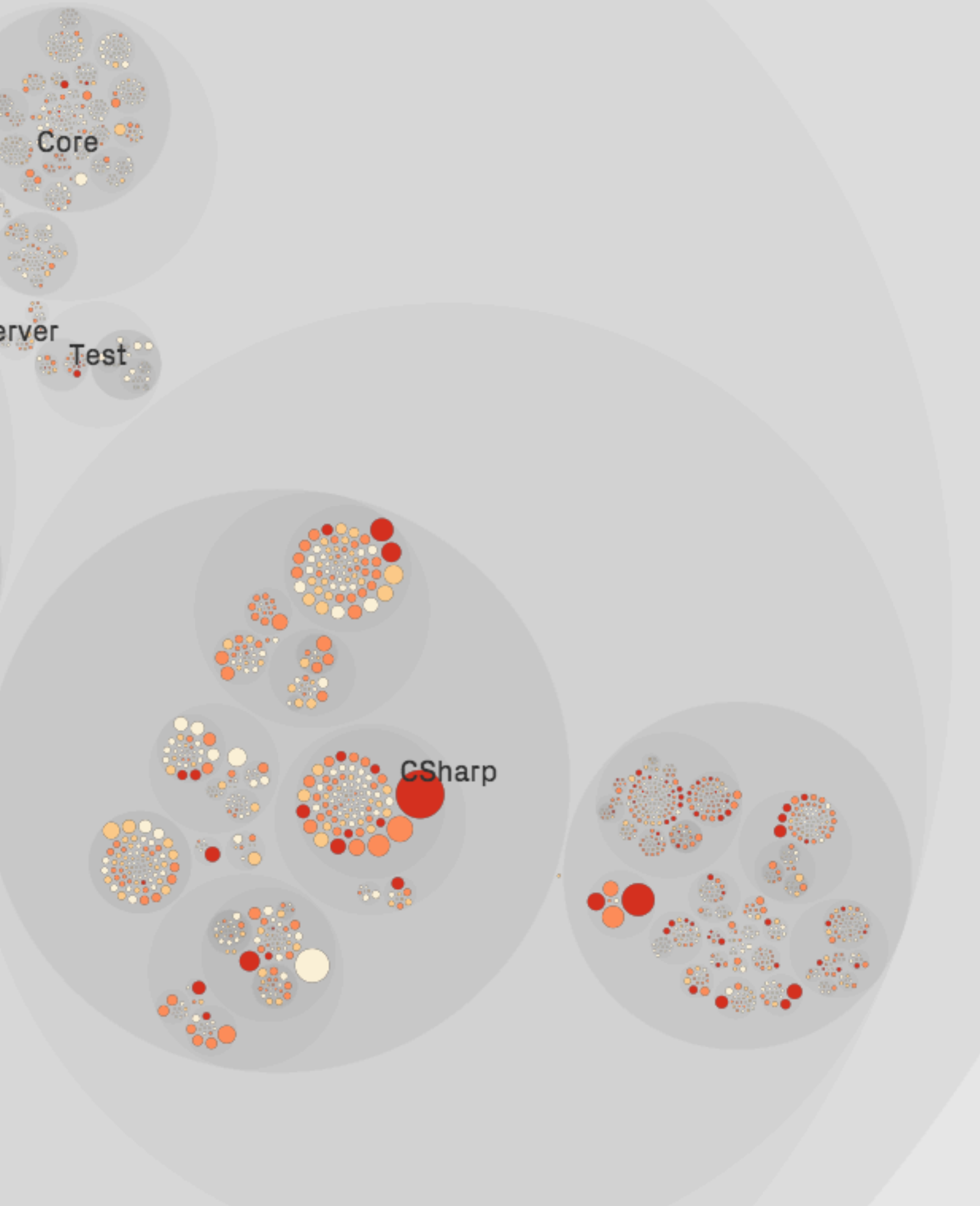


Coordination: Developer Congestion



`NullableReferenceTypesTests.cs`

Organizational factors are some of the best predictors of defects



The structure of the development organization is a stronger predictor of defects than any code metrics.

(N. Nagappan, B. Murphy, and V. Basil, 2008)

The risk that a commit introduces a defect increases with the number of developers who have previously worked on the modified code.

(M. Tufano, G. Bavota, D. Poshyvanyk, M. Di Penta, R. Oliveto, and A. De Lucia, 2015)

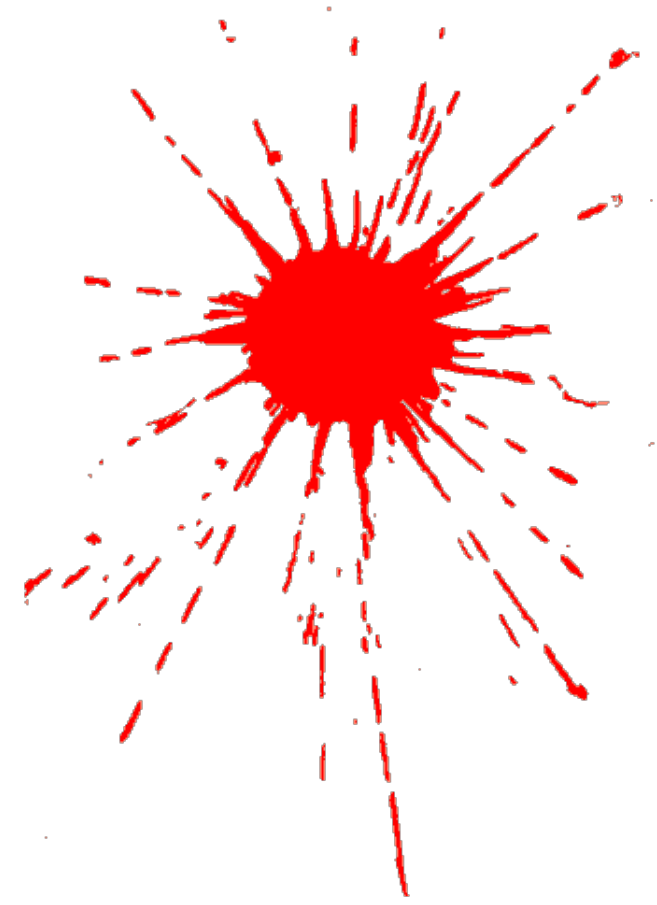
These factors affect us even within a strong quality culture of peer reviews.

(A. Meneely and L. Williams, 2009)

Social Factors Influence how we Perceive a Codebase



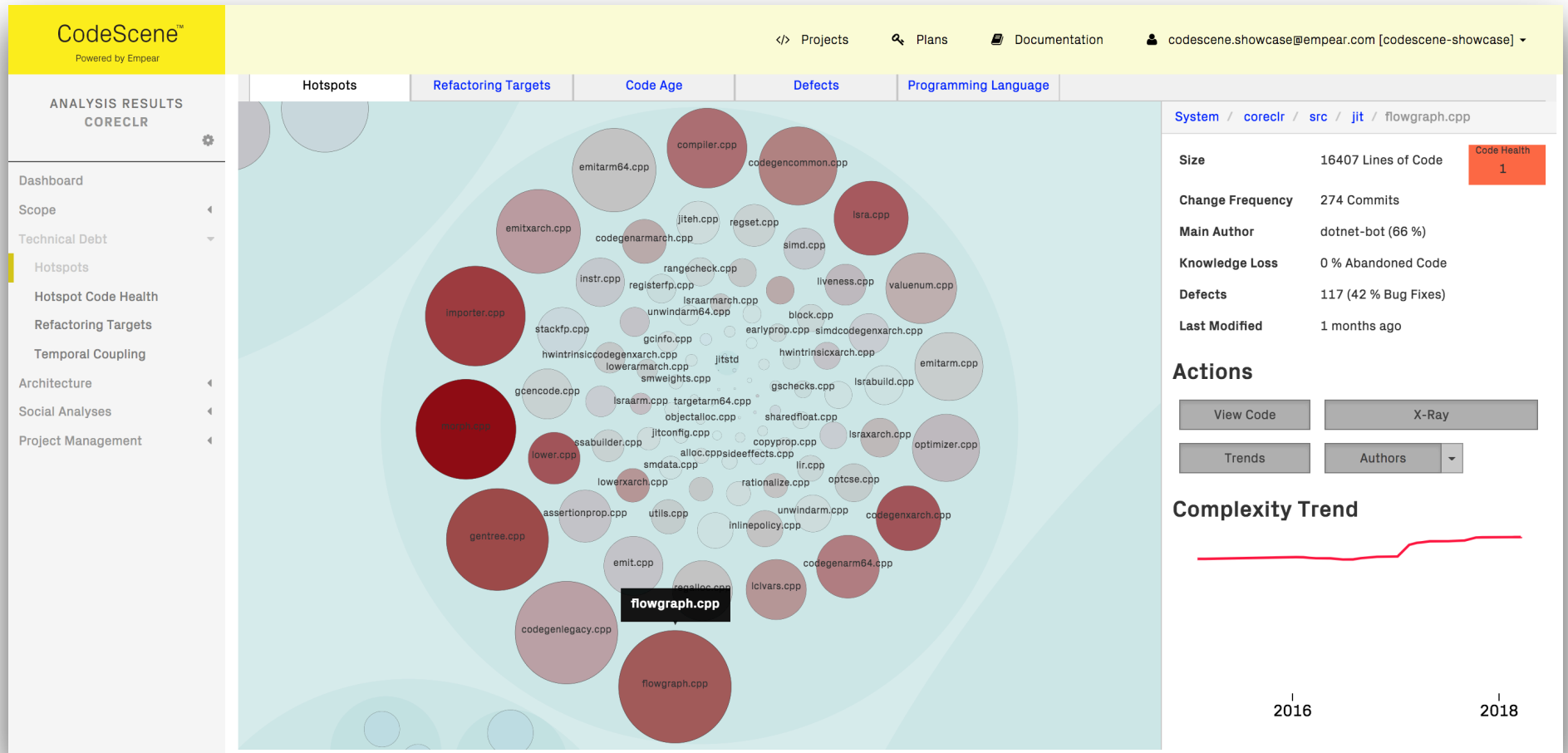
**The more developers working on the same code,
the harder to maintain stable mental models**



Behavioral Code Analysis <3 Testing

Analysis tools

<https://codescene.io/>



Blogs on Software Analysis, Technical Debt, and Programming

<https://www.empear.com/blog/>

<https://adamtornhill.com/>

@AdamTornhill

LinkedIn: <https://www.linkedin.com/company/empear-ab/>

Twitter: <https://twitter.com/codescene>

