Performance Testing Chrome

Lessons learned from 4 years in the trenches

Hi, I'm Annie!

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Led performance testing on Chrome from 2015-2018 after contributing since 2011.

Previously worked on web performance for Google Search and Google Docs.

Now work on metrics for Chrome.

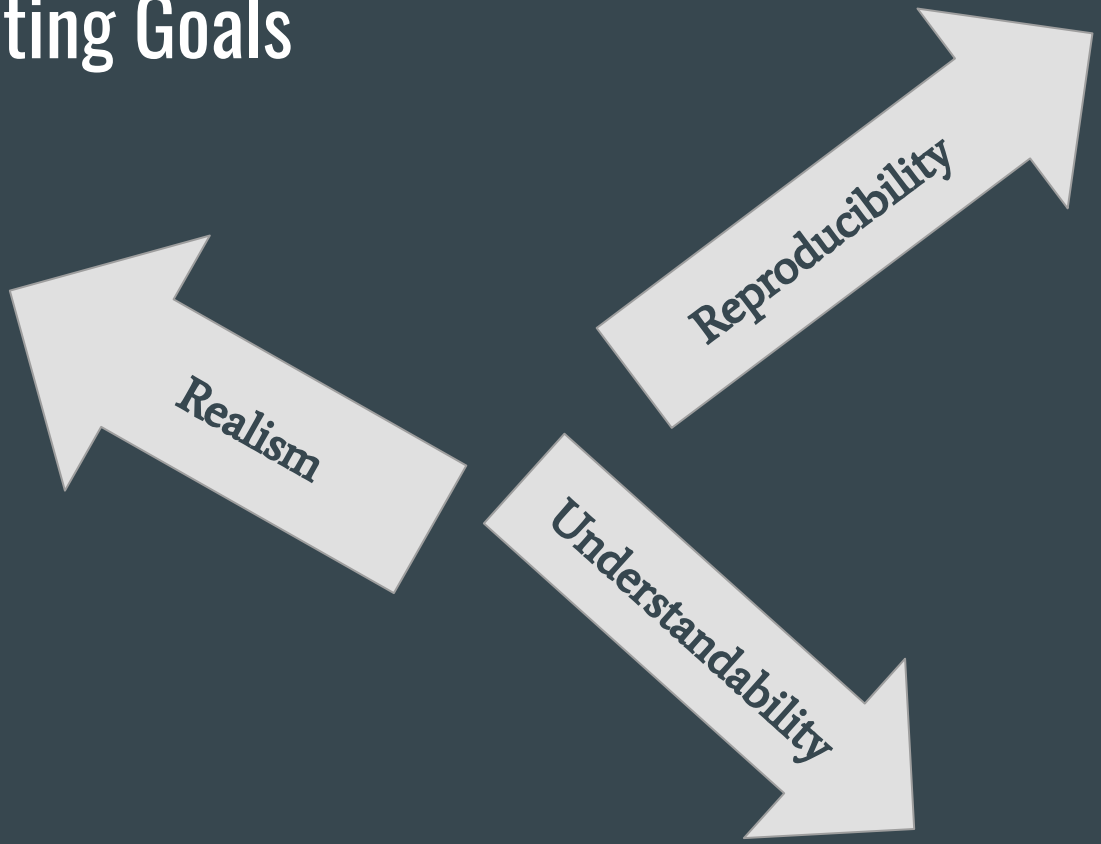
Wait, how do we define performance?

- Speed (page load speed, JavaScript speed, etc)
- Smoothness (animations, scrolling, etc)
- Memory usage
- Battery usage
- Binary size

Why do we do performance testing, anyway?

- First and foremost, to **detect regressions**.
  - Improving performance doesn't help if you always regress.
  - Lab tests can narrow down regressions to **specific commits**.
- Performance tests can sometimes be used to **measure improvements.**
  - Most useful early in development.
  - In most cases, we prefer A/B testing with end users to measure improvements.

Competing Goals



Reproducibility

- Is this a real regression, or just noise?
- Can we repeat the test to narrow down to a commit?
- Can a developer reproduce the problem locally?

Realism


Octane
Speedometer
Average Page
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
adwords.google.com
linkedin.com
facebook.com
twitter.com
cnn.com
wikiwand.com
discourse.org
maps.google.co.jp
wikipedia.org
reddit.musicplayer.io
ebay.fr
yandex.ru
taobao.com
msn.com
baidu.com
bcc.co.uk-amp
weibo.com
reddit.com
instagram.com
bing.com
sina.com.cn
google.de
youtube.com
qq.com
inbox.google.com
yahoo.co.jp
wikipedia.org-visual-e...
JavaScript
DOM / Chrome C++
Parsing
V8 Runtime/ C++
Compilation
Inline Cache
GC
Optimization
Background Parsing
V8 API

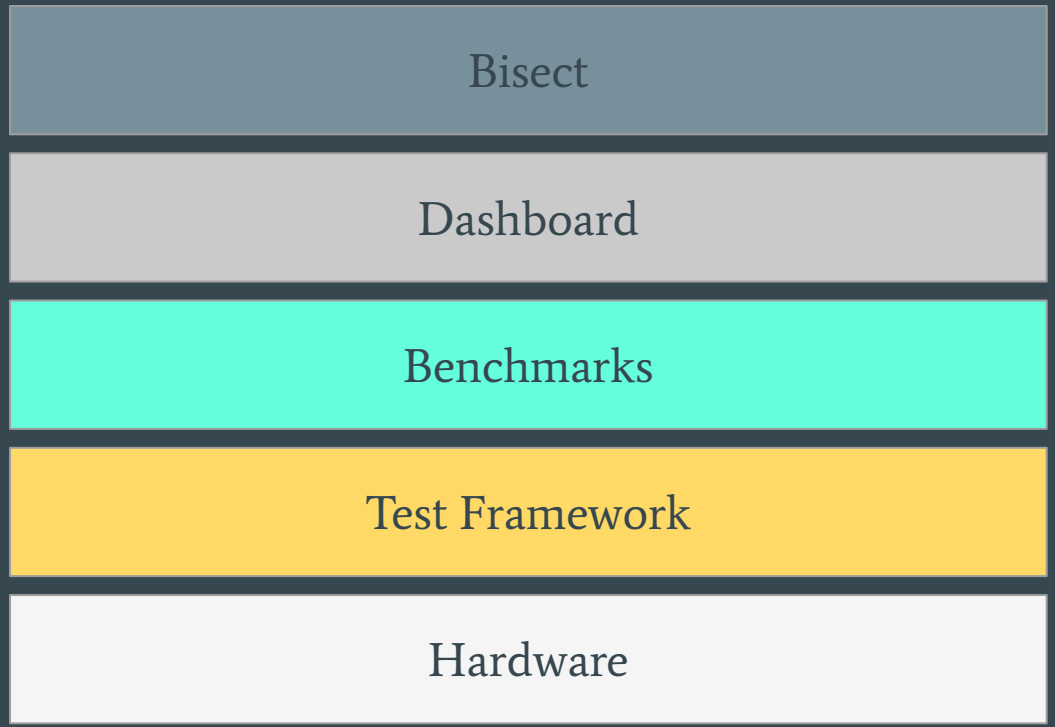
Reality changes over time

- Web content changes
- Devices users browse the web on change
- Network quality and speed changes

Understandability

- What does the test measure?
- What diagnostic information is available?
- What tools are available for local debugging?

Our Performance Testing Stack



Hardware: Realism

- Test on real devices
  - Android
  - Windows
  - Mac
  - ChromeOS
  - Linux
- Use release official builds (unsigned)

Hardware: Reproducibility

- Each run of a test case on exact same device
- Run a “reference build” (Chrome stable) side-by-side with build under test.
- Turn off things running in background as much as possible
- On Android, wait for device to cool between runs
- On Android, often throttle CPU

Test framework: Telemetry

- We call it **telemetry.**
- Source code: https://github.com/catapult-project/catapult/tree/master/telemetry
- Cross-platform
  - Android
  - Windows
  - Mac
  - ChromeOS
  - Linux

Test framework: Telemetry

Two parts of a benchmark

- Metrics
  - Performance measurements
  - Generally independent of story
- Stories
  - The test case
  - Usually a web page
  - Supports user input, multi-page navigations, multi-app on Android

Telemetry: Realism

- Use **WprGo** to record/replay **real web pages**.
- End-to-end testing of thousands of real web pages
- Simulate network conditions like 3G
- Simulate user input, multi-page navigations.

Telemetry: Reproducibility

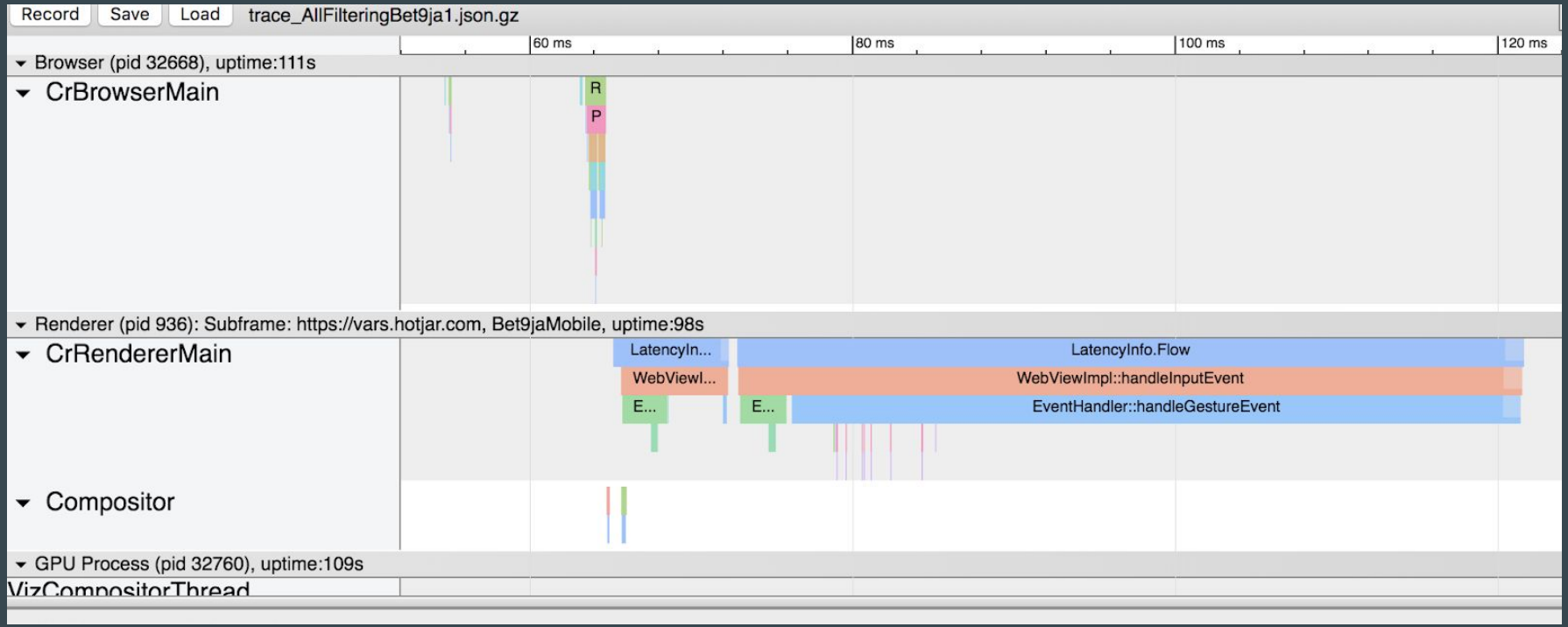
Provides a deterministic environment for repeatable results.

- Set up browser profile, caching, etc the same on each run.
- Replay recorded sites instead of live sites
- Network simulation for consistent network speed

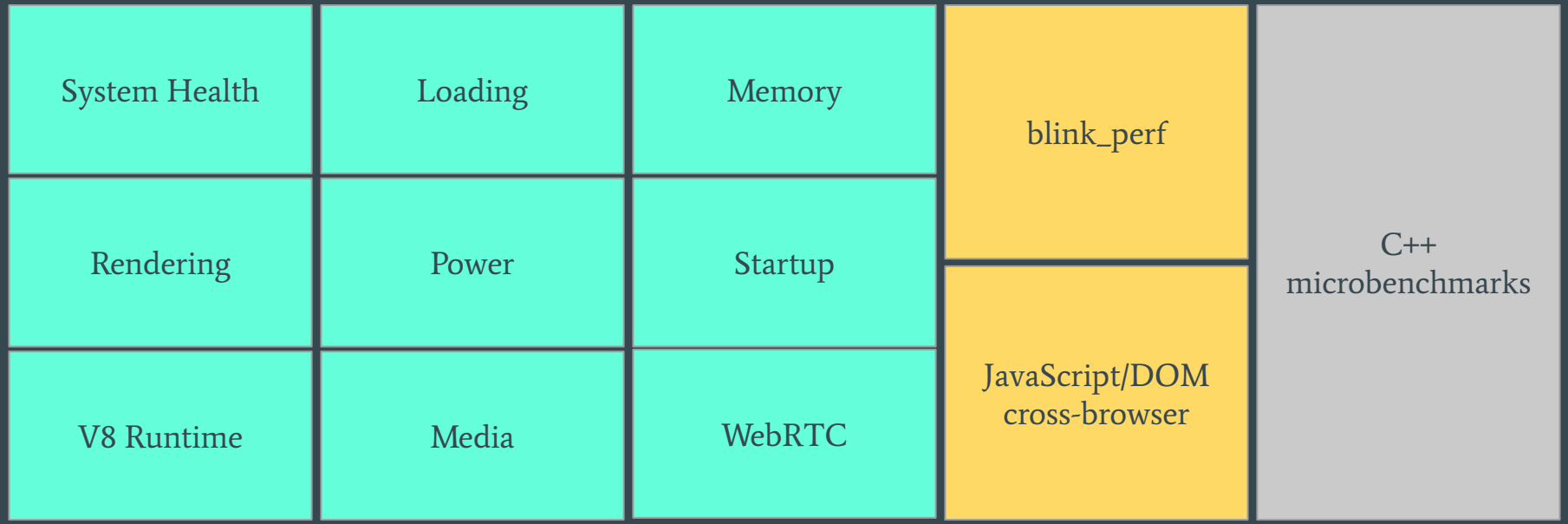
Telemetry: Understandability

- Metrics are generated from **chrome traces**, which are available to developers.
- Metrics can be broken down so it's clear which components contributed.
- Benchmark **owner**, **documentation**, and **bug component** required in definition.

Telemetry: Understandability



Benchmarks: harnesses



User-facing benchmarks focus on realism

- Measuring key metrics on thousands of real web pages
- Get end-to-end performance measurements across the entire codebase

In-page Microbenchmarks focus on Usability

- Easy to compare results between browsers
- Can easily read source and inspect in devtools
- Easy to profile/trace

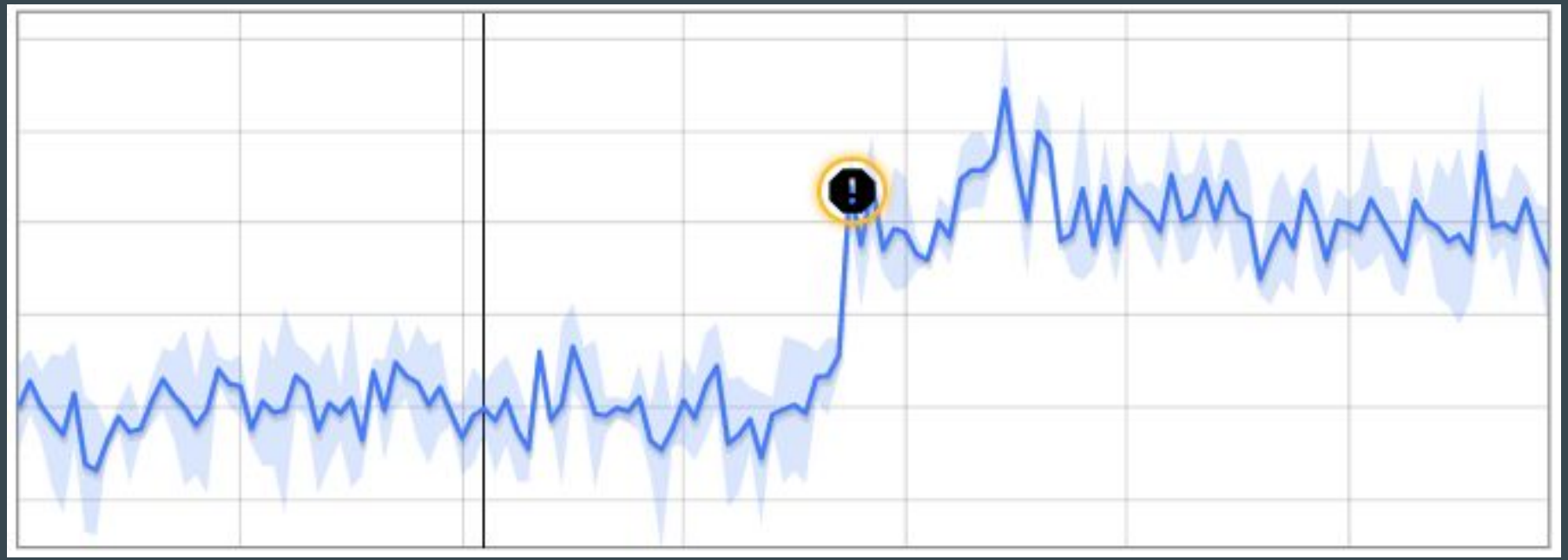
C++ Microbenchmarks have reproducibility and usability

- Easy to profile
- Smallest amount of code under test

Perf Dashboard

- Source code: https://github.com/catapult-project/catapult/tree/master/dashboard
- Benchmark results uploaded after every run.
- Automatically detects and groups regressions in timeseries.
- Integrates with bug tracker.
- Integrates with bisect tool.

Perf Dashboard Reproducibility: Regression detection



Perf Dashboard Reproducibility: Regression Detection

- Uses a sliding-window step detection algorithm.
  - Runs each time a new data point is added
  - Divide each window into two possible segments, trying every possible division
  - Find the greatest difference between two segments
  - Check if greatest difference passes filters
- Filters are user-configurable
  - Segment size
  - Absolute change
  - Relative change
  - Multiple of standard deviation
  - Steppiness

Perf Dashboard: Understandability

- Automatically links traces generated by telemetry
- Allows users to re-run test on same bot with additional trace categories
- Links test ownership and documentation
- Shows list of performance regressions/improvements at each commit

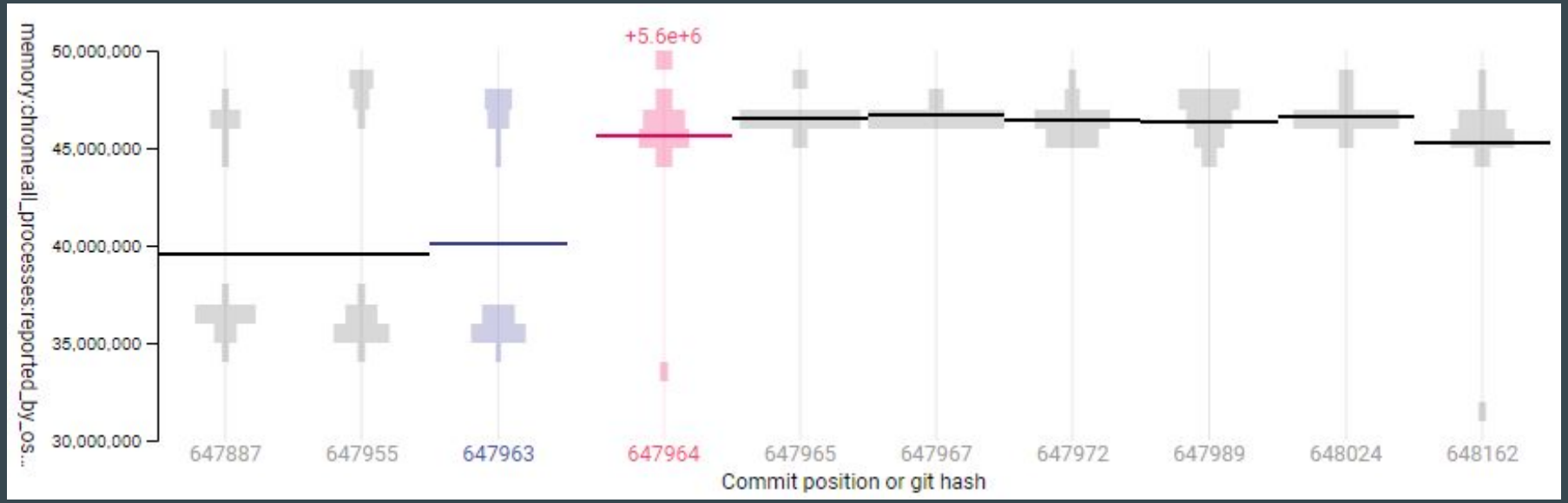
Bisection: Pinpoint

- Source code: https://github.com/catapult-project/catapult/tree/master/dashboard/dashboard/pinpoint
- Bisection kicked off by perf dashboard for regressions
- Also supports test failure/flakiness

Pinpoint Reproducibility: Bisection algorithm

- Algorithm explainer
- Considers the set of results from all runs at a given revision as a **distribution of samples**.
- Uses **multiple hypothesis tests** in comparing distributions. T-test isn't appropriate because data is not normally distributed.
- Has **custom sharding** algorithm to make use of multiple devices

Pinpoint Reproducibility: Bisection Results



Pinpoint Understandability

- Links to traces from all runs
- Allows re-run with more tracing categories
- Integrates with bugs database
- Can run A/B test on any benchmark/bot on unsubmitted change