Pythia: A Just-in-Time Instrumentation Framework for Distributed Systems

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Emotionally evocative weather

Distributed System

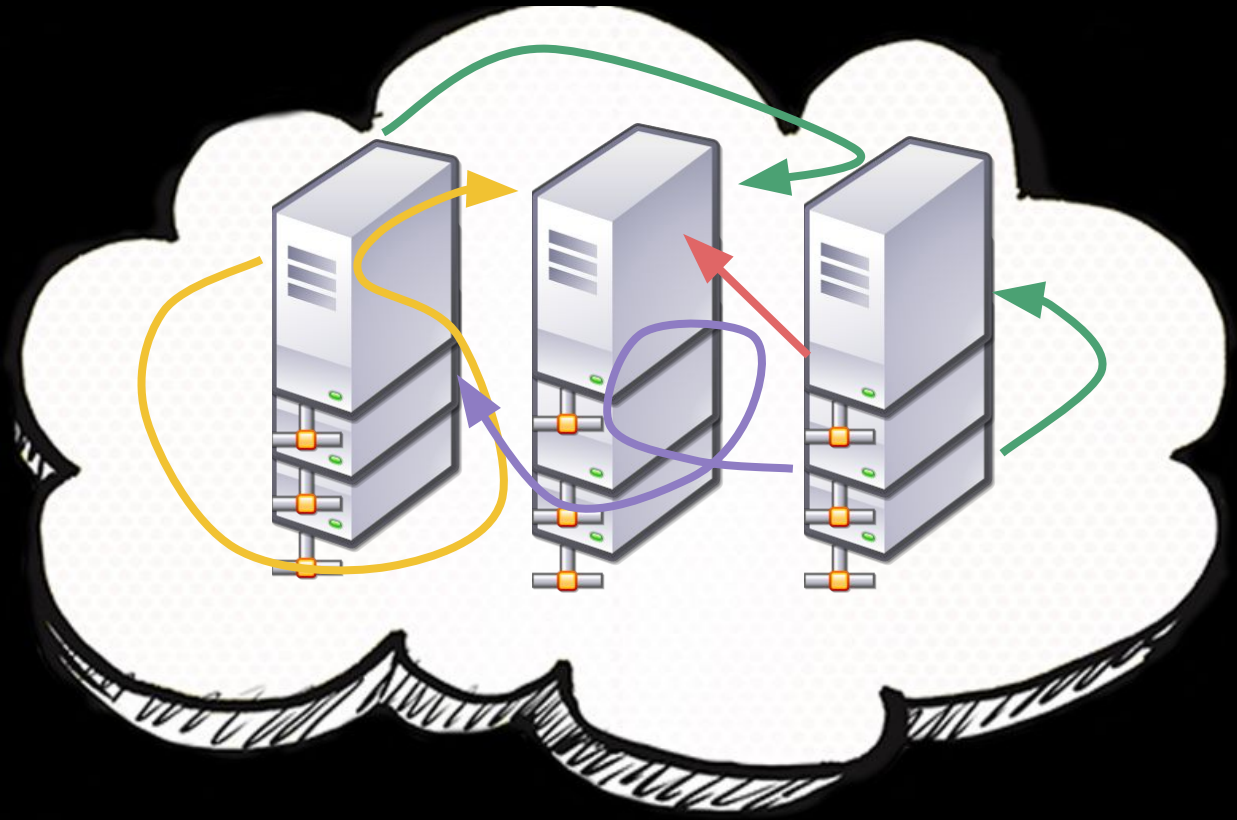
You

→ Time

Unique challenges in debugging distributed systems

Where is the problem?
It could be in ...

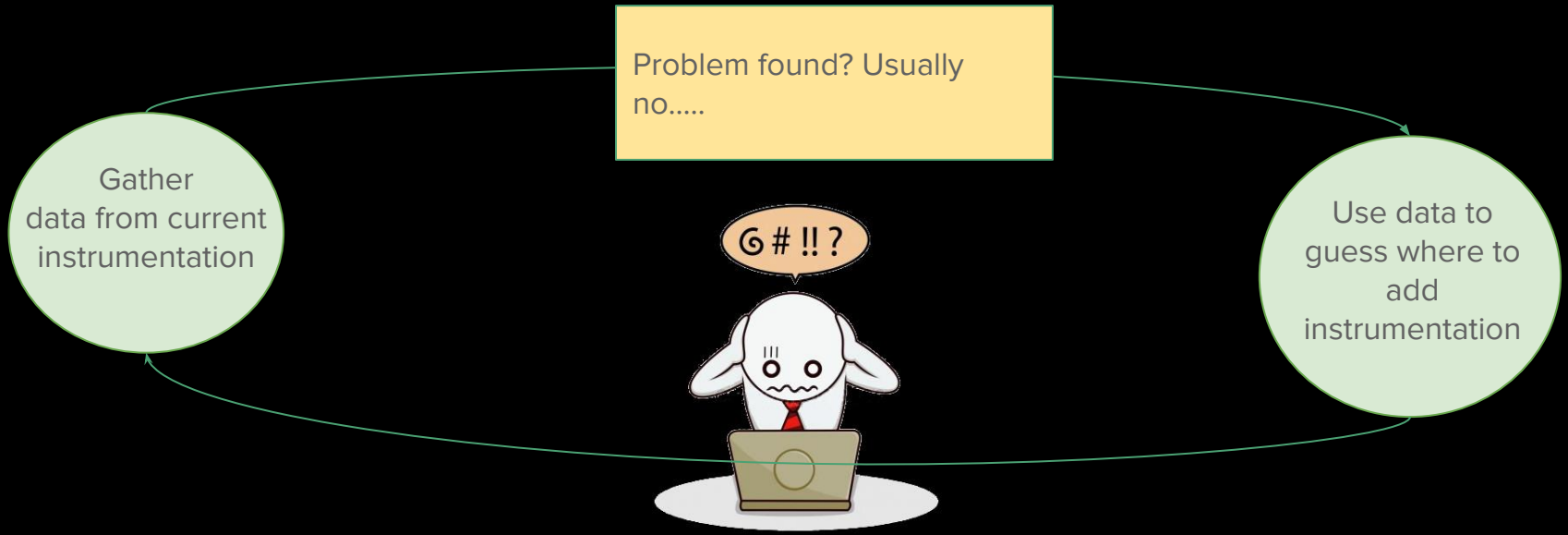
- One of many components
- One of several stack levels
- Inter-component interactions



Adventure 1: Painful Debugging Cycle

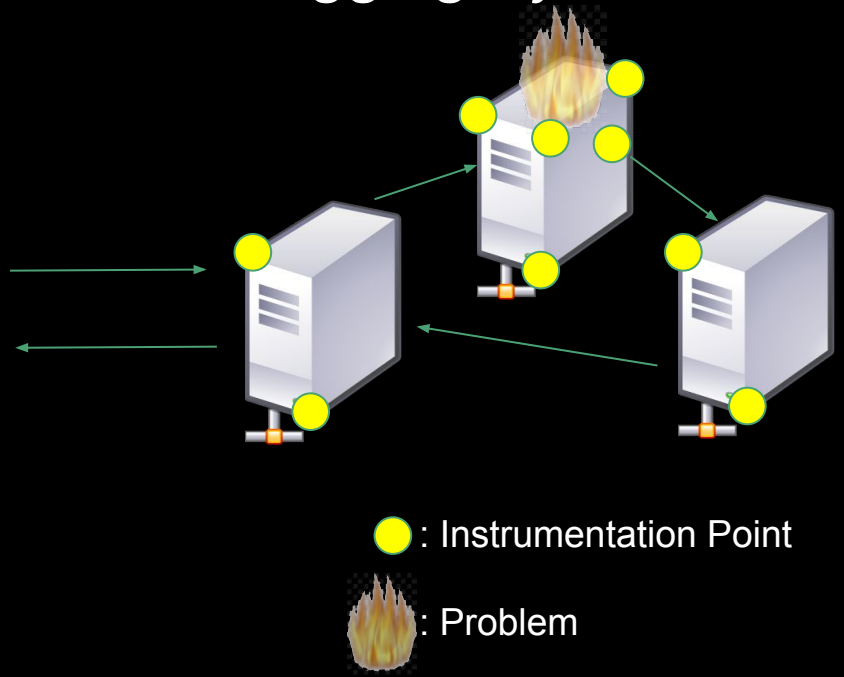
The instrumentation in your system does not give enough information about the root cause of the problem. You can add instrumentation.

Where do you add instrumentation?



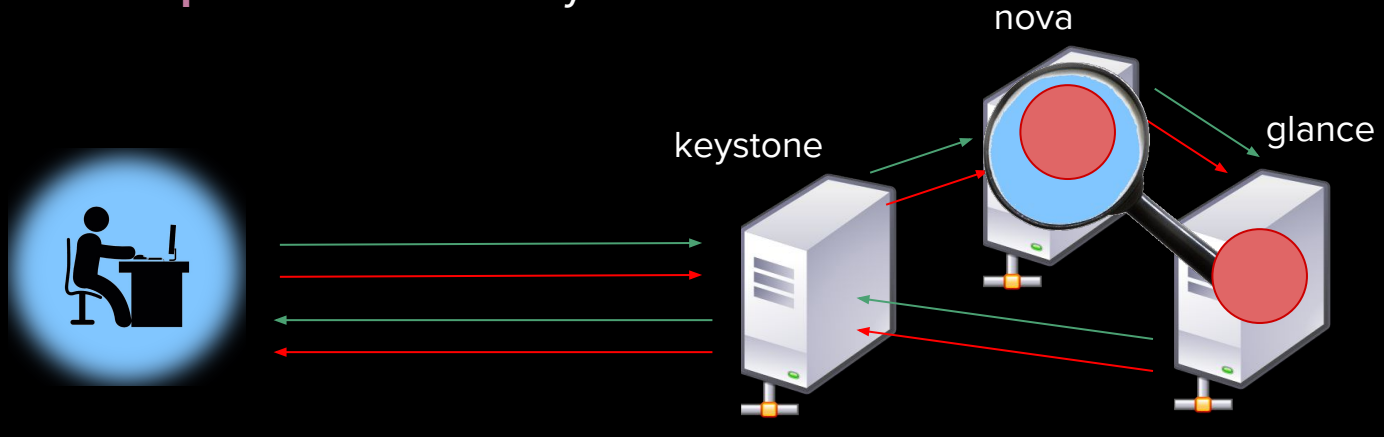
Adventure 2: Using Pythia to Automate Debugging Cycle

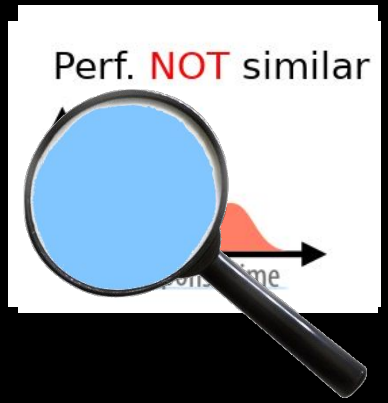
- Before the engineer, Pythia investigates the traces
  - Locates problematic areas
- Enables instrumentation that would help locate problems
  - Disables “boring” instrumentation
- Repeats the cycle
  - Enables deeper instrumentation that is closer to the problem
- Engineer only inspects lean traces that include information about the potential problem
  - *Only* need to fix the problem
  - Skipped the painful cycle



Pythia's key insight: Performance variations

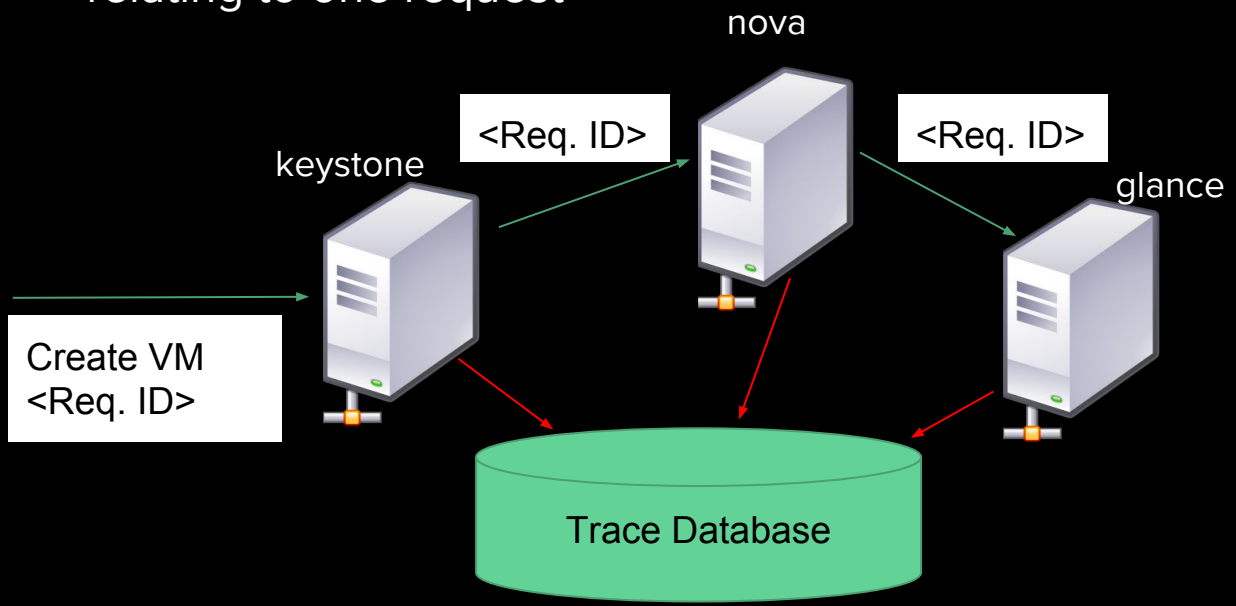
- **High perf. variation** among workflows expected to perform similarly
  - Indicative of problems!
- **Localizes perf. variation** to identify where additional instrumentation needed
- Enables **necessary instrumentation** points in system
- **Repeats** as necessary



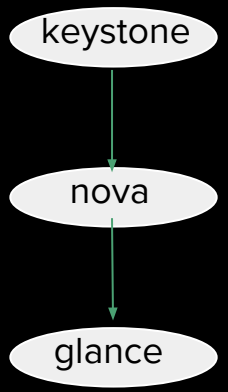


Pythia's key enabling technology: end-to-end tracing

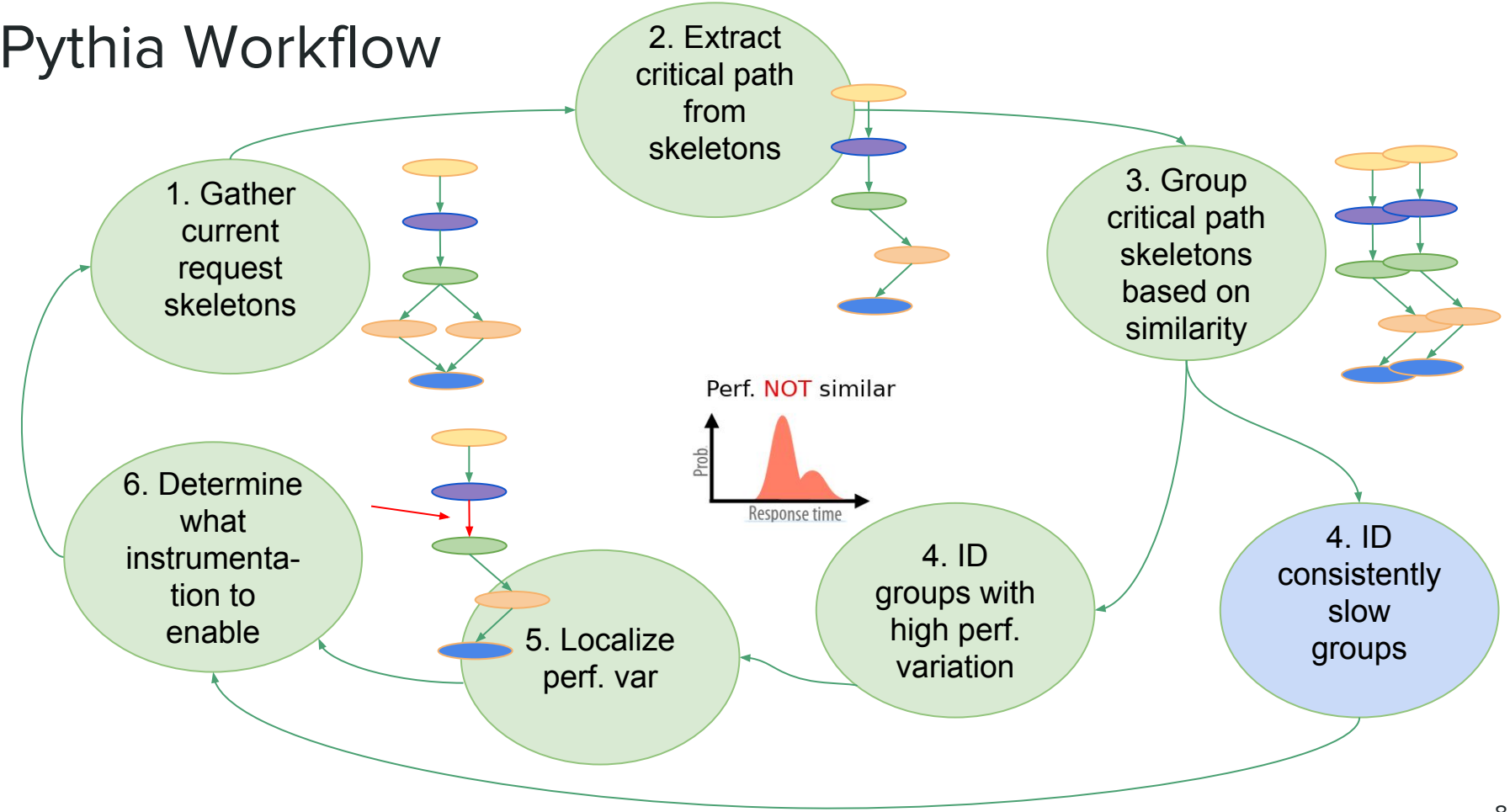
- Captures request workflows by sending metadata with workflows
- Tags enabled instrumentation points with workflow metadata
- Re-constructs workflow as trace by stitching together instrumentation data relating to one request



Reconstructed workflow
For <Req. ID>



Pythia Workflow



Pythia's current status

- Exploring applicability to OpenStack and eventually Ceph
- Augmenting OpenStack's tracing system to support Pythia
- Prototype codebase identifies & localizes high perf. Variation
- Initial testing on simple OpenStack problems

Some research questions

- Are there other metrics that can predict where instrumentation may be needed?
- What is the minimum level of instrumentation for Pythia to begin its analysis?
  - What are the stopping conditions for the analysis cycle?
- What is the relationship between the search strategies used for enabling instrumentation and Pythia's output?