Maintaining Reliability with Canary Testing

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Outline

- What is canary testing?
- Why it is useful?
- How to evaluate canaries?
- Pitfalls in the evaluation process
- Where do I begin?

Dickerson's Hierarchy of Service Reliability

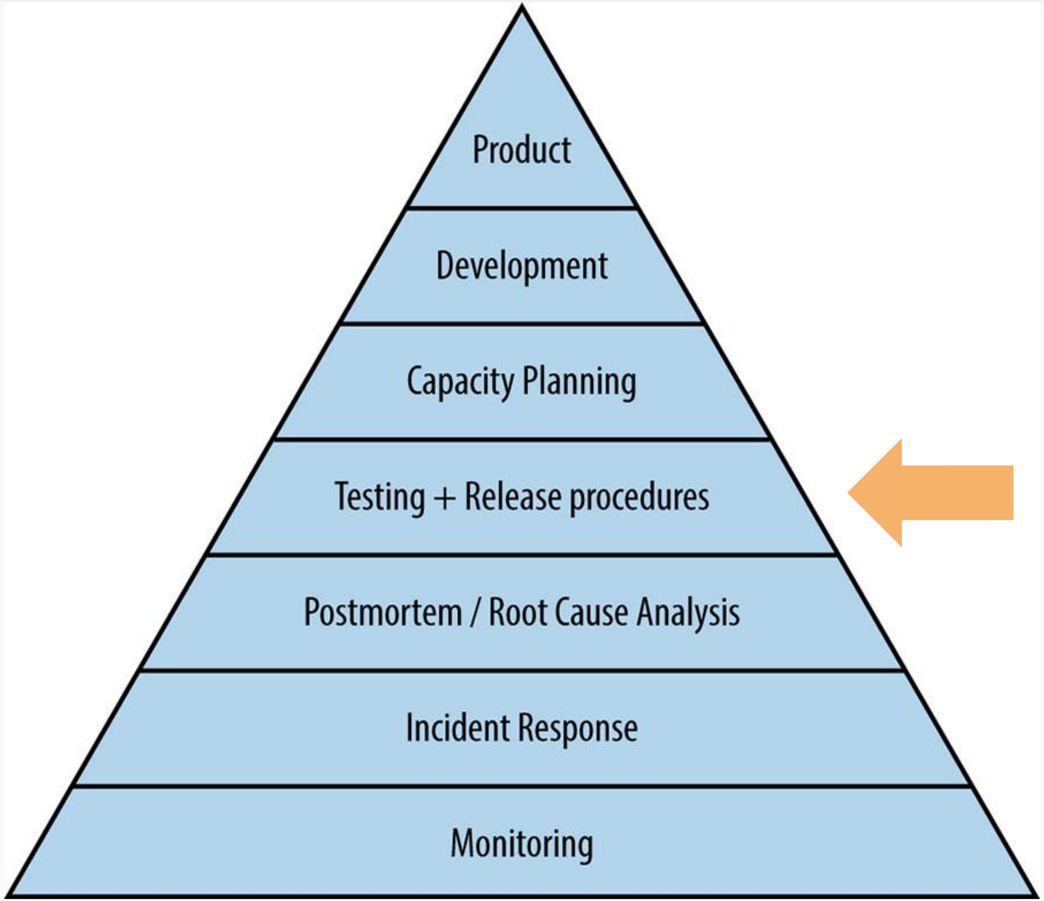


Image source:
Site Reliability Engineering:
How Google Runs Production Systems

Pre-Production Testing

- Unit Tests
- Integration Tests
- Acceptance Tests
- Stress Tests
- ...

Comfort zone

Production testing

- Feature Flagging
- Chaos Engineering
- Blue/Green Deployment
- **Canary Testing**
- ...

Where magic happens

Canary in the coal mine

Historically used to detect gas in coal mines.

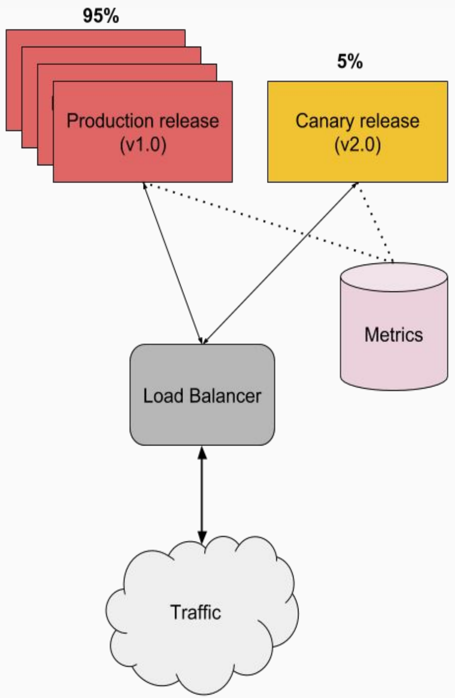
The idea first proposed by John Scott Haldane, in 1913 or later.[1]

Image from: http://coachellavalleyweekly.com/canary-in-a-coal-mine/

[1]: "JS Haldane, JBS Haldane, L Hill, and A Siebe: A brief resume of their lives". *South Pacific Underwater Medicine Society Journal*. **29**(3). ISSN 0813-1988. OCLC 16986801. Retrieved 2008-07-12.

Canary Testing

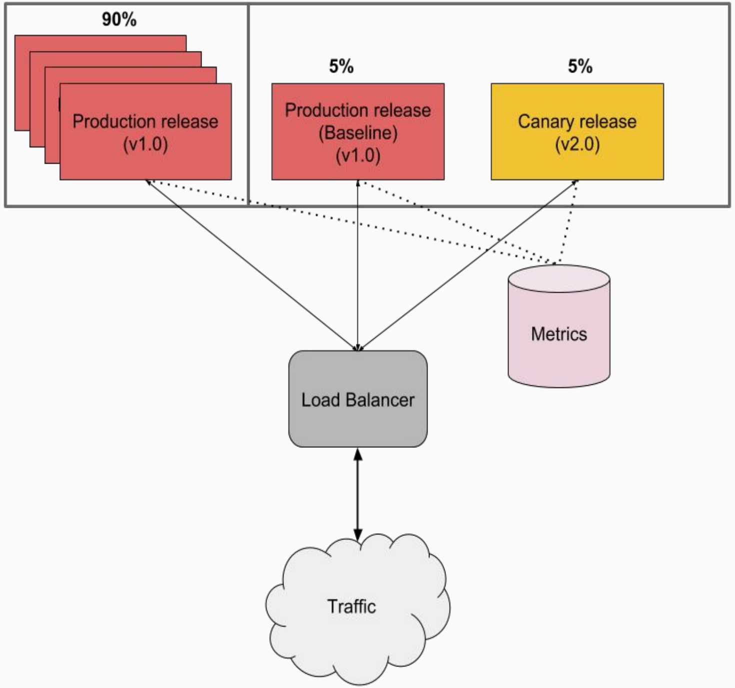
- New releases are deployed incrementally to a small subset of users.
- Stages
  1. Release
     a. Gather data
  2. Evaluate canary
     a. Compare metrics
  3. Verdict
     a. Proceed to rollout on success
     b. Proceed to rollback on bad behaviour



Traffic distribution

- **It depends!**
- Gradual releases (i.e., 5% increase every 3 hours)
- We need representative comparisons

Rule of thumb: Have a large set of production servers serving traffic normally, and have a small subset for production release baseline and canary.



Sampling

- Internal users (dogfooding)
- Random users
- Sophisticated user selection (i.e., country, activity)
- Combination of the above

Benefits

- Early warning system
- Reduces the risk
- Reliable software releases

Downsides

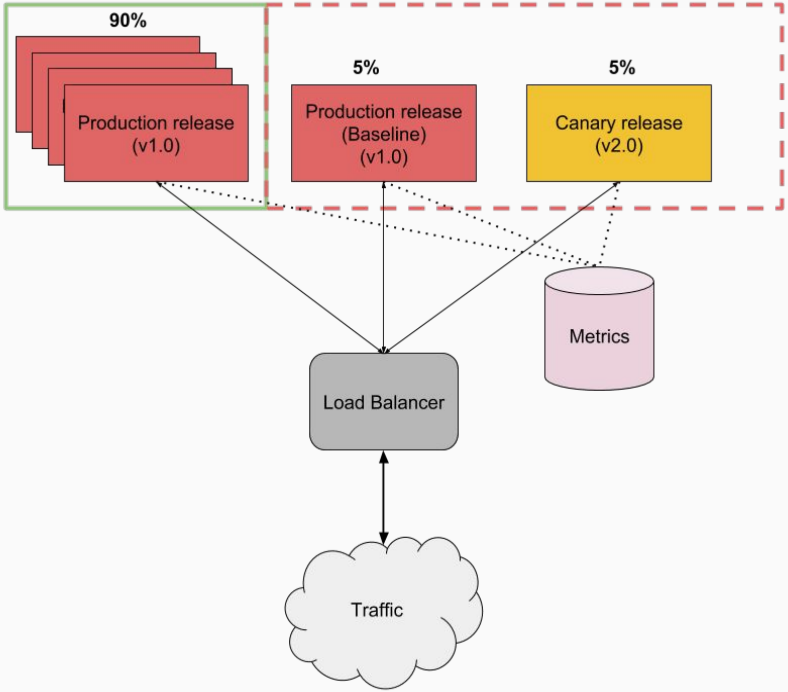
- Not the easiest task to put into practice initially
- Quite a few considerations before rolling out
- Requires time investment to implement properly

Pitfalls in Canary Releases

- Database changes
- Configuration changes
- Distributed monoliths
- Complexity in managing multiple versions

Canary Evaluation

- Identifies the reliability of the canary by comparing critical metrics for the specific release



Canary Evaluation Prerequisites

- Reproducible builds
- Instrumentation (for metrics)
- Have a rollback plan

Measure the impact

- Manually
  - Checking dashboards, graphs and logs
- Semi-automatic
  - Implementing supporting tools that are incorporated in rollout tools
- Automatic
  - Automated evaluation integrated as a service or in the CI pipeline
  - Bonus points: Automated rollback

Measure the impact (cont.)

Manual

- Operational toil for SREs
- Not reliable
- Bias
- Hard to declutter noise and outliers

Semi-Automatic

- It might still require some operational work
- Easier to implement
- Good for ad-hoc solutions

Automatic

- Requires time investment in the beginning
- Reduces the amount of operational work
- Increases productivity for developers and SREs
- Can be generalised for many services

What to measure

- Health checks during deployment (short circuit)
- Incoming network connections (short circuit)
- Success rate (HTTP 2xx)
- Error rate (HTTP 5xx)
- Latency distribution (90p, 95p, 99p)
- Load Average
- CPU utilization
- Memory leaks
- Quality

Considerations

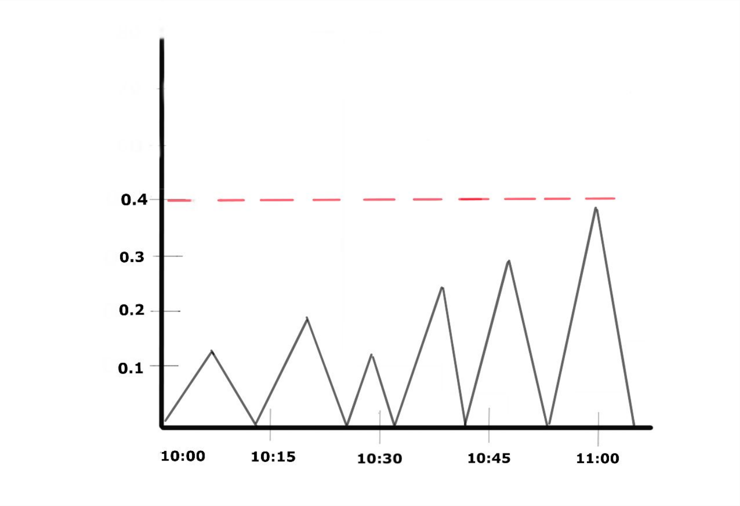
- Velocity for new releases
- Canary lifespan
- Amount of traffic
- New hardware
- Time (day vs night)
- Caches (cold vs hot)
- Different regions (eu-west vs us-west)
- Seasonality
- Diversity of metrics

Potential Issues

- Heterogeneous comparisons
- Overfitting
- False positives/negatives
- Trust

Overfitting

- Hand-tuning thresholds based on bounds observed in dashboard graphs is a bad idea
- Have adequate historical data
- Need to generalise
- Need to find better ways to classify

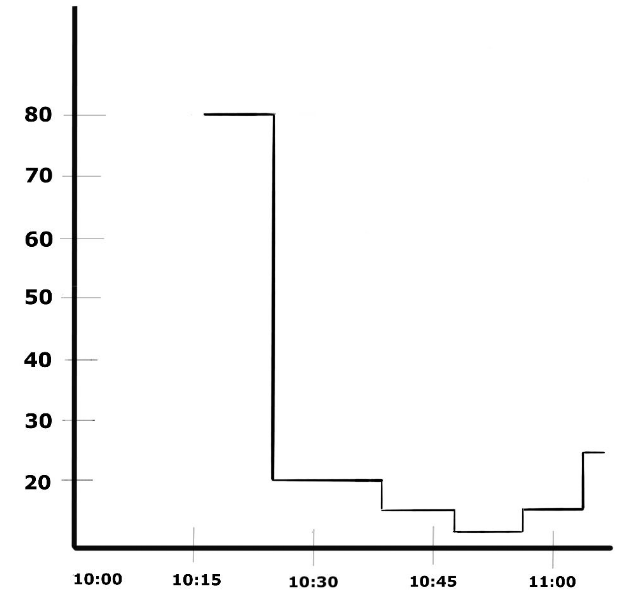


False Positives/Negatives

- Have adequate historical data from your baseline
    - Don’t just look look in the past 1 or 2 weeks.
- Think about your models.
    - What metrics are really meaningful to compare?
- Beware of outliers
- Reconsider importance of your comparisons
    - Error rate vs Systems metrics vs Latency

Caches

- Warmup caches if necessary.
- Wait for certain amount of time before start comparing.



Seasonality

- Christmas holidays, New Year’s Eve, Black Friday or any other public event will affect your metrics
- High variance.
- Difficult problem. Requires thorough investigation.
- Start with moving averages.
- Investigate different anomaly detection algorithms.
  - Example: Anomaly Detection algorithm by Twitter for big events and public holidays.

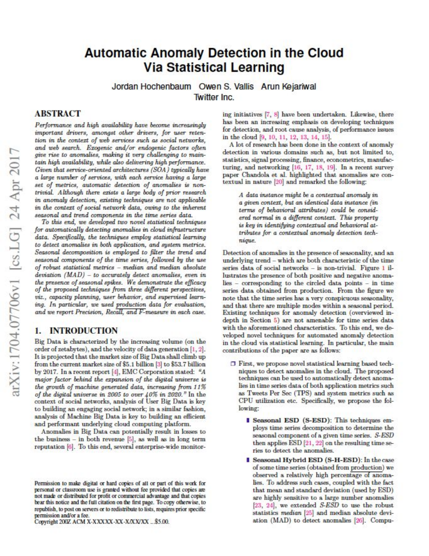
Latency

- User perception of our product changes based on the timeliness of the response
- Factors that affect latency:
  - Network congestion
  - Memory overcommitment
  - Swapping
  - Garbage Collection pauses
  - Reindexing
  - Context Switching
  - ...
- Averages vs Percentiles
  - Averages are misleading, they hide outliers
  - We are interested in the “long tail”
  - Percentiles enable us to understand the distribution
- The bell curve is not representative

Latency (cont.)

- Catch: Canary has an average latency of **70ms**.
  - Reality: 99p: 99% of values are less than 800ms, 1% >=800 ms latency.
- Catch: Canary latency **should not** exceed **10% above the average.**
  - Reality: When the amount of traffic is pretty low, or if we have heavy outliers, we will have false positives.
- Catch: Canary latency **should not** be **more than two standard deviations**.
  - Reality: In high variance (i.e., during peak season), it will give false positives.

Anomaly Detection in Time Series



Shipmon, D.T., Gurevitch, J.M., Piselli, P.M. and Edwards, S.T., 2017. Time Series Anomaly Detection; Detection of anomalous drops with limited features and sparse examples in noisy highly periodic data. arXiv preprint arXiv:1708.03665.

Hochenbaum, J., Vallis, O.S. and Kejariwal, A., 2017. Automatic anomaly detection in the cloud via statistical learning. arXiv preprint arXiv:1704.07706.

Verdict

1. How much deviation is tolerable?
2. Evaluation:
    a. Pass or Fail
    b. Cumulative Score with thresholds
    c. Both a. and b.

Image by StockMonkeys.com. (CC BY 2.0)

Build Trust

- Start small.
- Accept the fact that you will have false positives.
- Don’t overdo it with the comparisons. (less is more)
- Have a pair of eyes in verification initially.
- Experiment with different models.
- Iterate often to improve the accuracy.
- Don’t neglect your SLOs

Getting Started

- Metrics collection:
  - Stackdriver
  - Prometheus and Influxdb
- Evaluation:
  - Spinnaker with Kayenta
  - Kapacitor (Influxdb)
  - Kubervisor

Summary

- Canary testing
  - is important to maintain the reliability levels
  - can be applied to any size of infrastructure
- Never neglect the evaluation stage. Many factors to consider!
- Keep a minimal amount of metrics comparisons per evaluation
  - Not all metrics are important
- Start small, then, iterate for better accuracy

Further Reading

- Testing Microservices, the sane way
- How release canaries can save your bacon - CRE life lessons
- Canary Analysis Service
- Automated Canary Analysis at Netflix with Kayenta
- Canarying Well: Lessons Learned from Canarying Large Populations
- Introducing practical and robust anomaly detection in a time series
- "How NOT to Measure Latency" by Gil Tene

Thank you!

@dastergon

https://dastergon.gr

https://speakerdeck.com/dastergon

https://github.com/dastergon/awesome-sre

Real World SRE by Nat Welch (Packt Publishing)