Studying Systems as Artifacts

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Today's Menu

1. Goal
2. Recipe
3. First Steps
4. Recent Results
5. Promising Direction

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Goal

Imperfect Systems

- We build imperfect systems
- We will **always** build imperfect systems
- These imperfections are expensive

Vision Statement

We require generic techniques to **measure** and **analyze** systems s.t. we can detect, isolate, fix, mask, or mitigate imperfections.

(2)

Recipe

System Design Cycle

build

measure

$$f(t;\lambda) = \lambda e^{-\lambda t}$$

```
R12-M1-N3-C:J11-U11 2005-06-03-23.06.32.246746 R12-M1-N3-
C:J11-U11 RAS KERNEL INFO CE sym 7, at 0x03ffa060, mask 0x04
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and corrected
R33-M1-L0-U22-C 2005-06-03-23.10.14.414021 R33-M1-L0-U22-C
RAS LINKCARD INFO MidplaneSwitchController performing bit
sparing on R33-M1-L0-U22-C bit 3
R23-M1-N8-I:J18-U11 2005-06-04-00.24.32.398284 R23-M1-N8-
I:J18-U11 RAS APP FATAL ciod: failed to read message prefix
on control stream (CioStream socket to 172.16.96.116:33399
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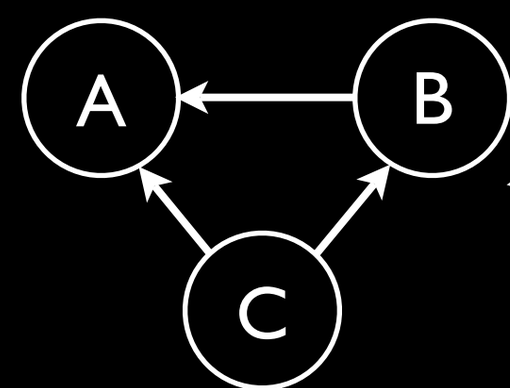

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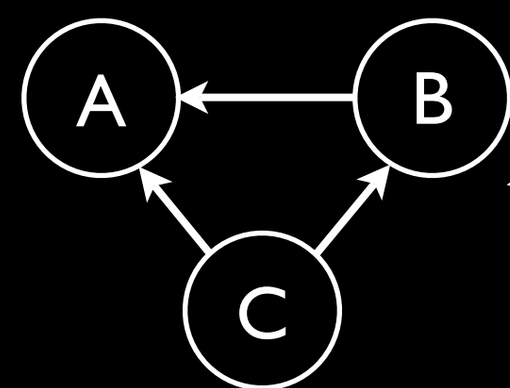

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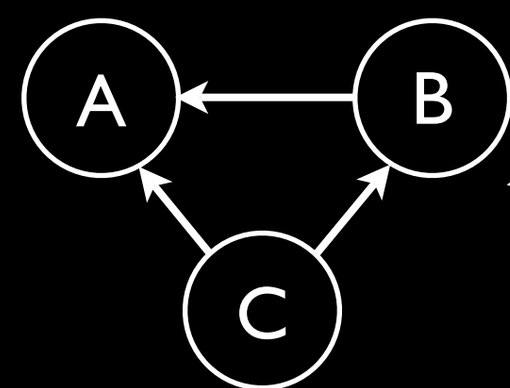

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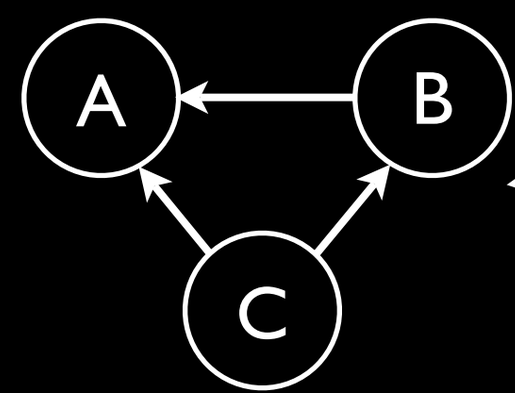

improve

analyze

Recipe

1. Measure
2. Analyze
3. Improve
4. Generalize

Why HPC?

- Canary in the coal mine
- Twin studies
  - Controls an important variable
  - Expectation of similarity

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First Steps

My First Steps

- If we could predict failures...
  - System management [KDD 03]
  - Job scheduling [IPDPS 04]
  - QoS [DSN 05]
  - Checkpointing [IPDPS 06][ICS 06]

Dubious Predicates

- If failures are predictable,
- If failures are not i.i.d.,
- If failures are evident in logs,
- then...

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Recent Results

Real Systems

- Collected and released a data set
  - Five major supercomputers
  - 750+ million CPU hours
- Initial analysis [DSN 07]

Bad News

- Logs are huge, unstructured, time-varying, incomplete, redundant, erroneous, and ambiguous

```
NULL RAS BGLMASTER FAILURE ciodb
exited normally with exit code 0
```

Good News

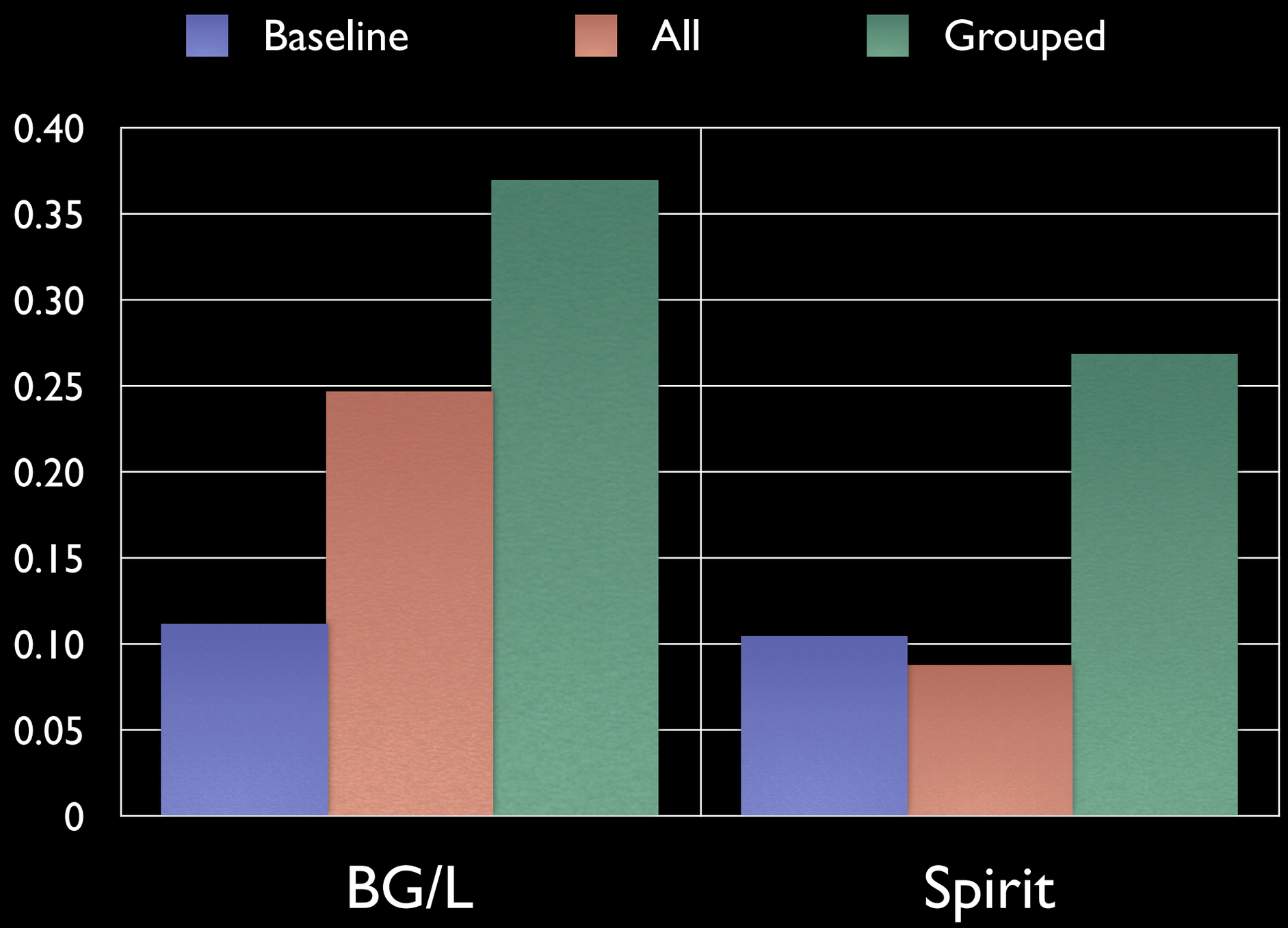
- Logs are rich with information
- Failures not i.i.d.
- Evidence of predictability

Related Studies

- Schroeder and Gibson [DSN 06]
- Liang et al [DSN 06]
- Stearley [ICCC 04]

Alert Detection

- Alert detection [Resilience 08] [ICDM 08]
- Production impact
- Similarity is valuable



Area Under the P-R Curve

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Promising Direction

Key Questions

- If I perturb X, what will happen?
- Why did that happen?

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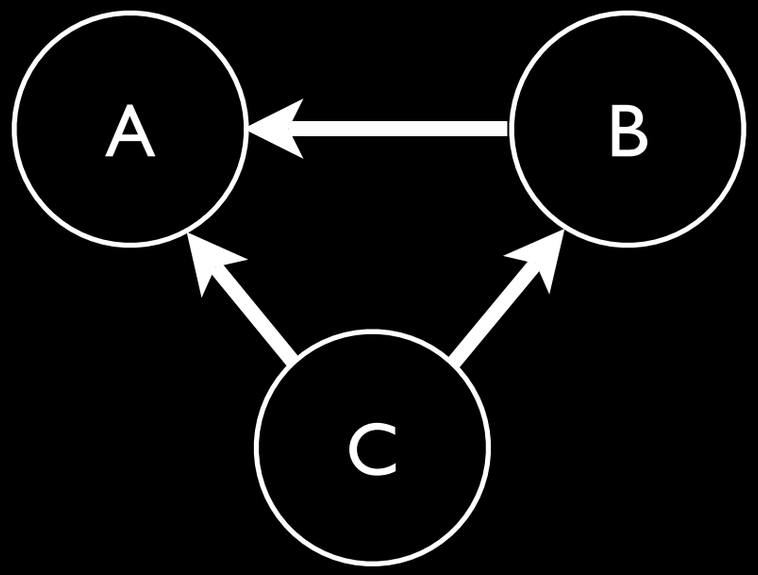
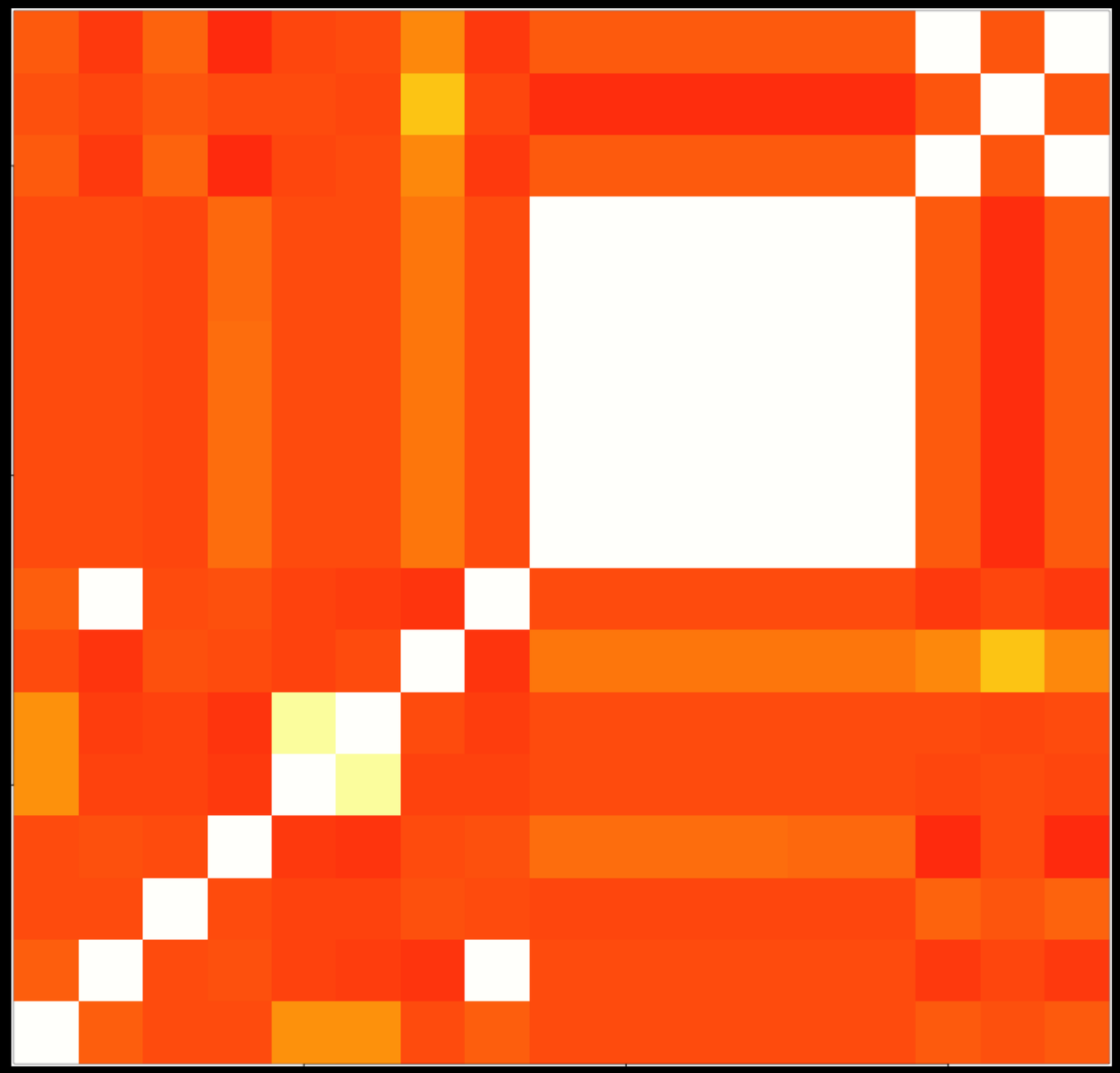


Correlated Anomalies

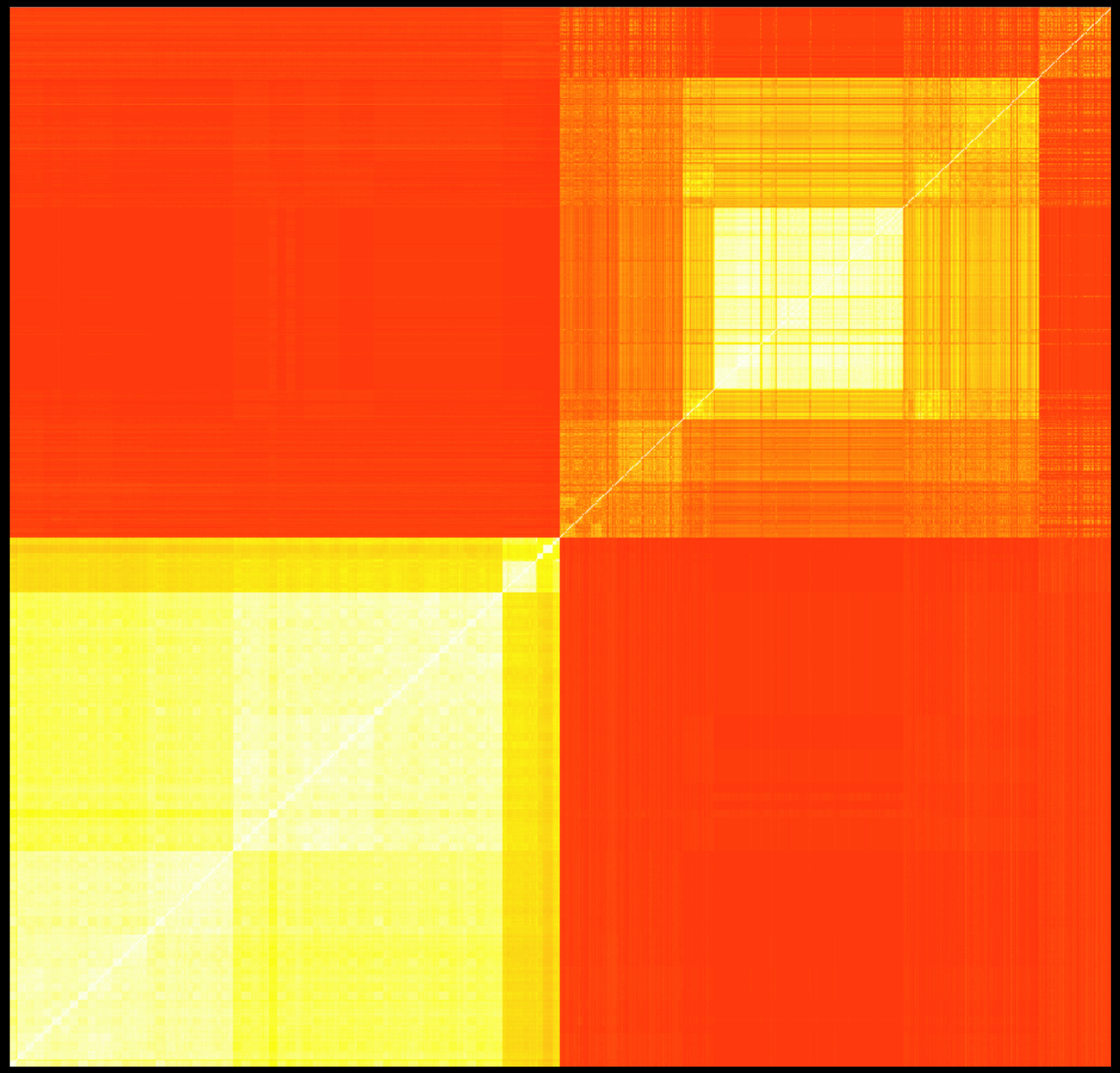
1. Identify anomalies
2. Correlate in time/space
3. Infer dependencies



Correlation Map

Early Results

- Grand Challenge
  - Built model from race logs
  - Found a tough bug
- Syzygy
  - Community intrusion detection
  - Asymptotically perfect



BG/L Correlations

Contributions

- System management techniques
- System logs
- Current direction
  - Correlated anomalies
  - Dependency graphs

Fin

You have reached the end of the presentation. Please turn back.