Analyzing the Communication Clusters in Datacenters

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General context

- A lot of attention on optimizing datacenter traffic.
- Most papers today focus on sparsity, skeweness\(^1\), and locality\(^2\).
- Traffic optimization done through black-box models.
- We focus on finding explainable patterns in datacenter traffic.

Our contribution

- Systematic and efficient approach to identify dense clusters
- Analyse quality and stability of found clusters

\(^1\) ProjecToR Dataset.  

Finding high quality traffic cluster

Experiments

Overview

High level overview of our approach

Step 1: Partition timesteps

Step 2: Thresholding

Step 3: Bicluster detection

Step 4: Cluster analysis

traffic trace containing all communications

<sender, receiver, #bytes, time>

<rack1, rack2, 50, T1>
<rack3, rack21, 3, T2>
<rack31, rack22, 201, T3>
<rack7, rack91, 109, T4>
<rack1, rack3, 73, T4>
<rack15, rack3, 393, T4>

real-valued traffic matrices

Boolean matrices

clustered Boolean matrices

quality and similarity of communication clusters over time
Cluster analysis

Metrics

- Cluster quality
## Cluster analysis

### Metrics

- Cluster quality: Recall and Precision
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Cluster analysis

Metrics

- Cluster quality: Recall and Precision

Examples of low recall and low precision clusters.
Cluster analysis

Metrics

- Cluster quality: Recall and Precision
- Stability of clusters overtime
Cluster analysis

Metrics

- Cluster quality: Recall and Precision
- Stability of clusters overtime
- Actual traffic inside biclustering
Case study: Altoona datacenter

Used a real-world dataset containing actual packet traces (Web, Database, and Hadoop) released by Facebook.

- Traffic over a 150 minutes (2.5 hours) time frame
- Focus on the steady-state behavior
- Partition the 150 minutes of traffic into disjoint time intervals of 1, 5, and 15 minutes
Clustering reveals Web servers structure

- Rack–rack Web cluster communication
- \( p = 70\% \), 1 minute interval
Cluster reveals Web servers structure

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High quality clusters recovered for the Web server

15 min, $p = 70\%$

5 min, $p = 70\%$

1 min, $p = 50\%$
Hadoop: a very dense matrix trace.

Hadoop cluster: 5 min, $p = 30\%$. 
Key takeaways

- Find high-quality clusters
- Small clusters are responsible for a significant amount of network traffic
- These clusters are stable over time
- Our methodology only requires a list of endpoint pairs which cause a lot of traffic.