# Change Point Detection of Internet Traffic Anomalies via Singular Values of the Laplacian Matrix

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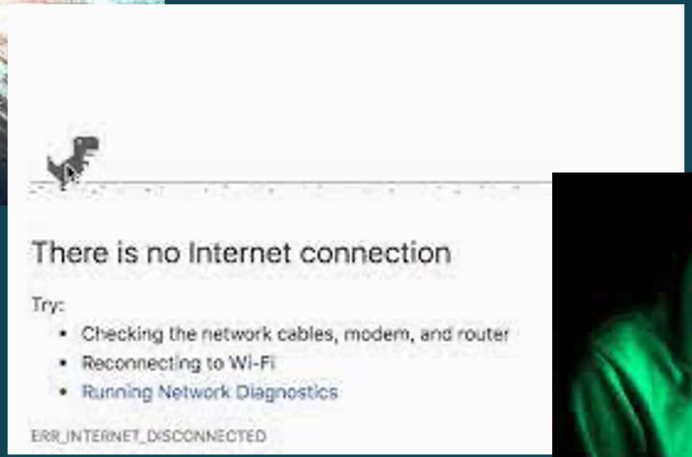
# What are internet traffic anomalies?



University of Maryland, Baltimore

Midland University

University of California

University of Hawaii

Ohio Valley University

M.I.T.

University of Colorado

Lincoln College

University of Miami

University of Washington

Pennsylvania State University

Howard University

Grand Valley State University

North Carolina A&T State University

Stanford University School of Medicine

Des Moines Public School District

Yeshiva University

## Why the new perspective?

- Looking to save time, storage and money
- Application of “conductence”

Pre-Process
Singular Values of Laplacian Matrix
Time Series
Change Point Detection

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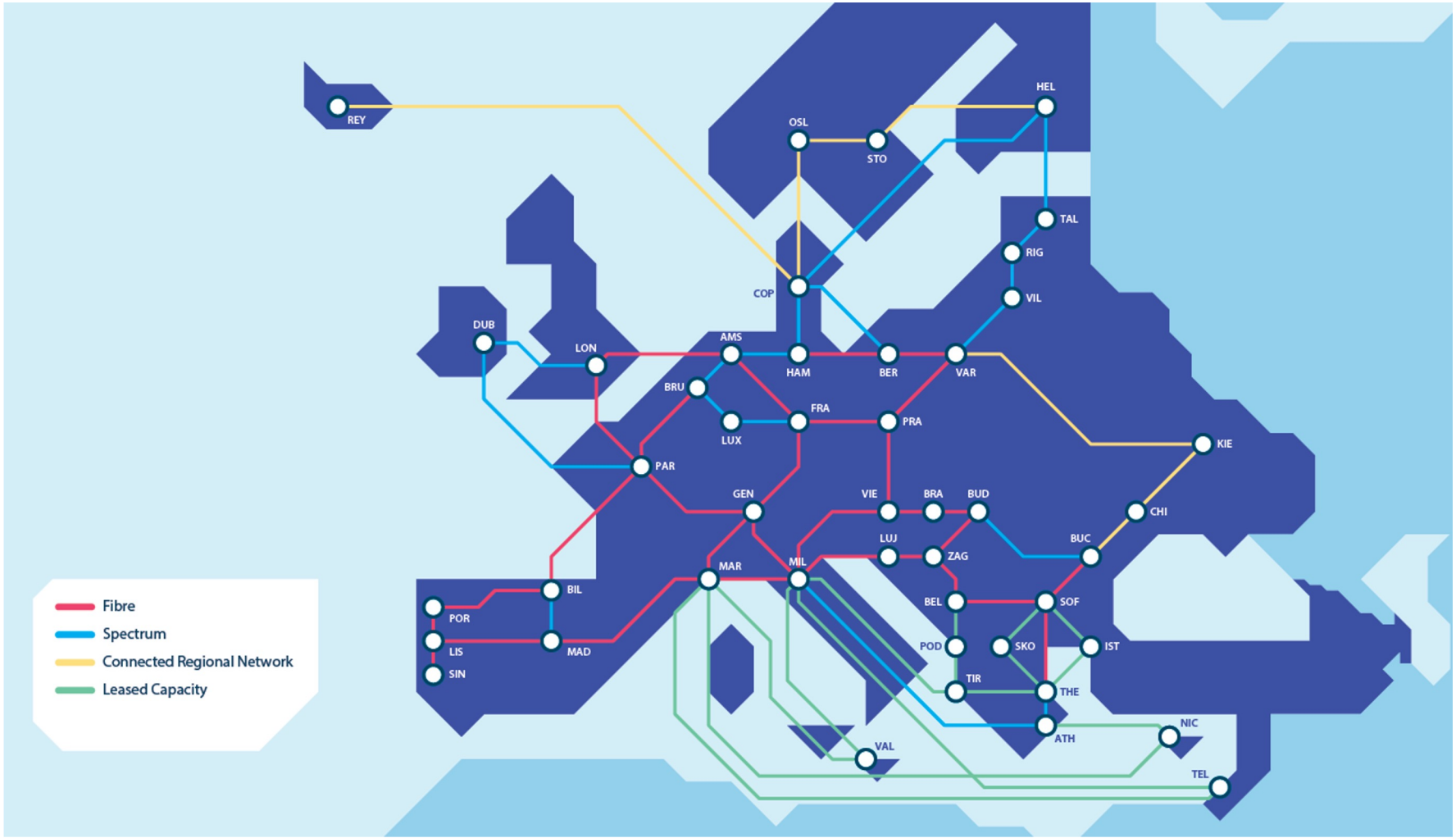
# Where did the data come from?


REY
OSL
STO
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TAL
RIG
VIL
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DUB
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HAM
BER
VAR
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FRA
PRA
LUX
KIE
PAR
GEN
VIE
BRA
BUD
CHI
LUJ
BUC
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MAR
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POR
LIS
SIN
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POD
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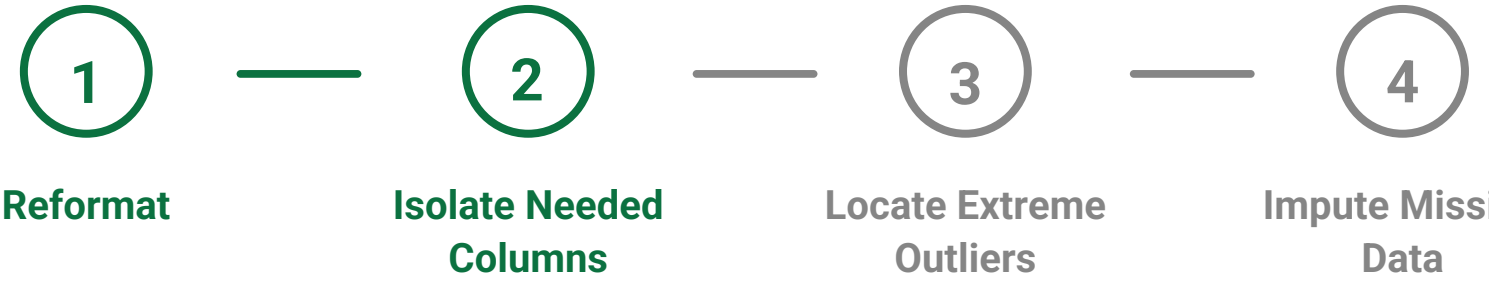
TIR
THE
ATH
NIC
VAL
TEL
Fibre
Spectrum
Connected Regional Network
Leased Capacity


1
2
3
4
Reformat
Isolate Needed Columns
Locate Extreme Outliers
Impute Missing Data

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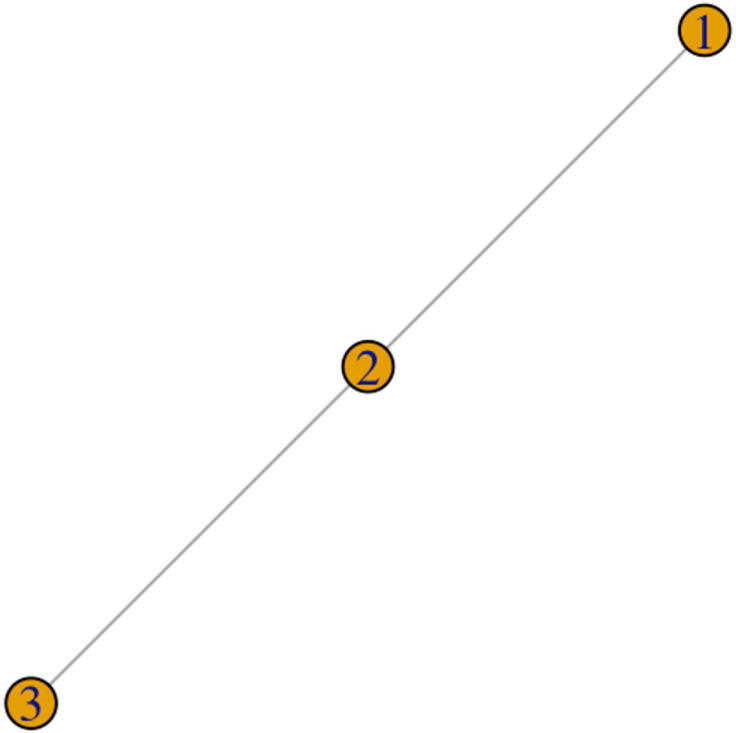
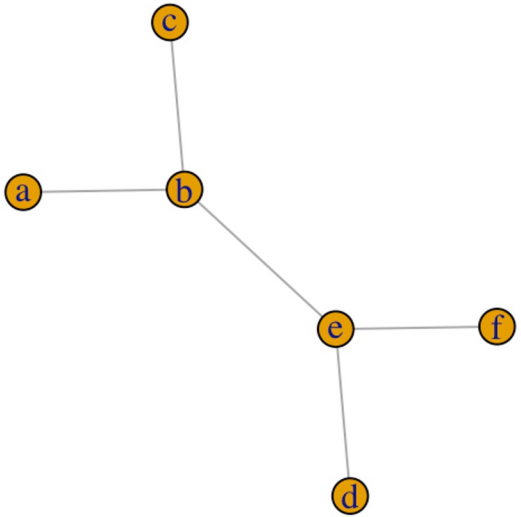
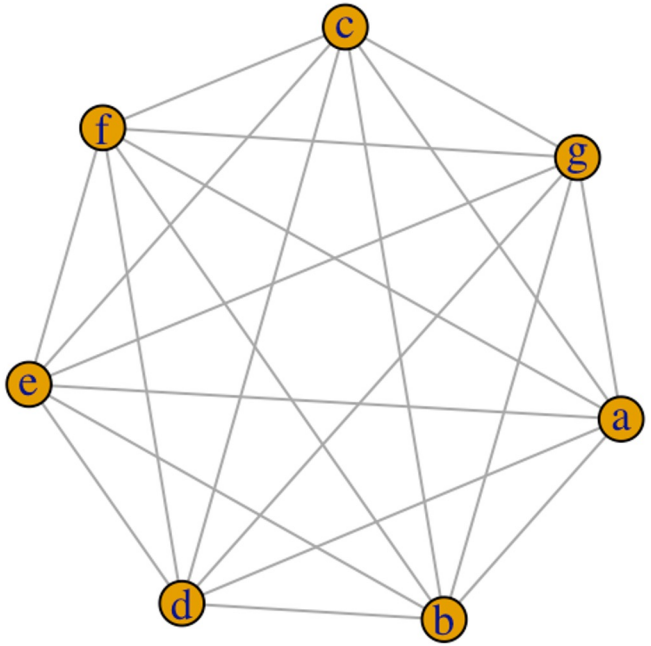
# Laplacian Matrix




$$\begin{pmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{pmatrix}$$

# Singular Value of Laplacian Matrix



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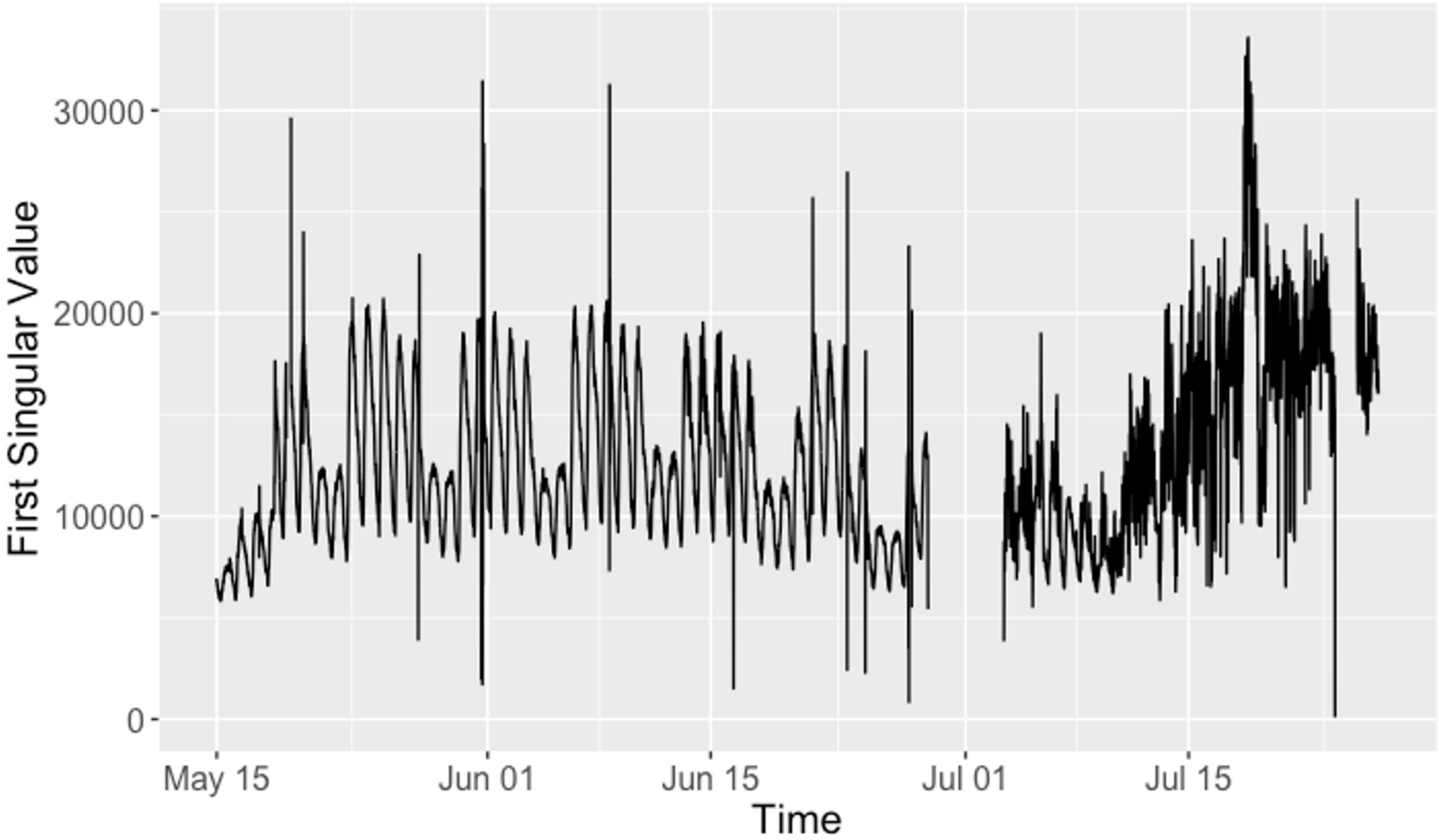
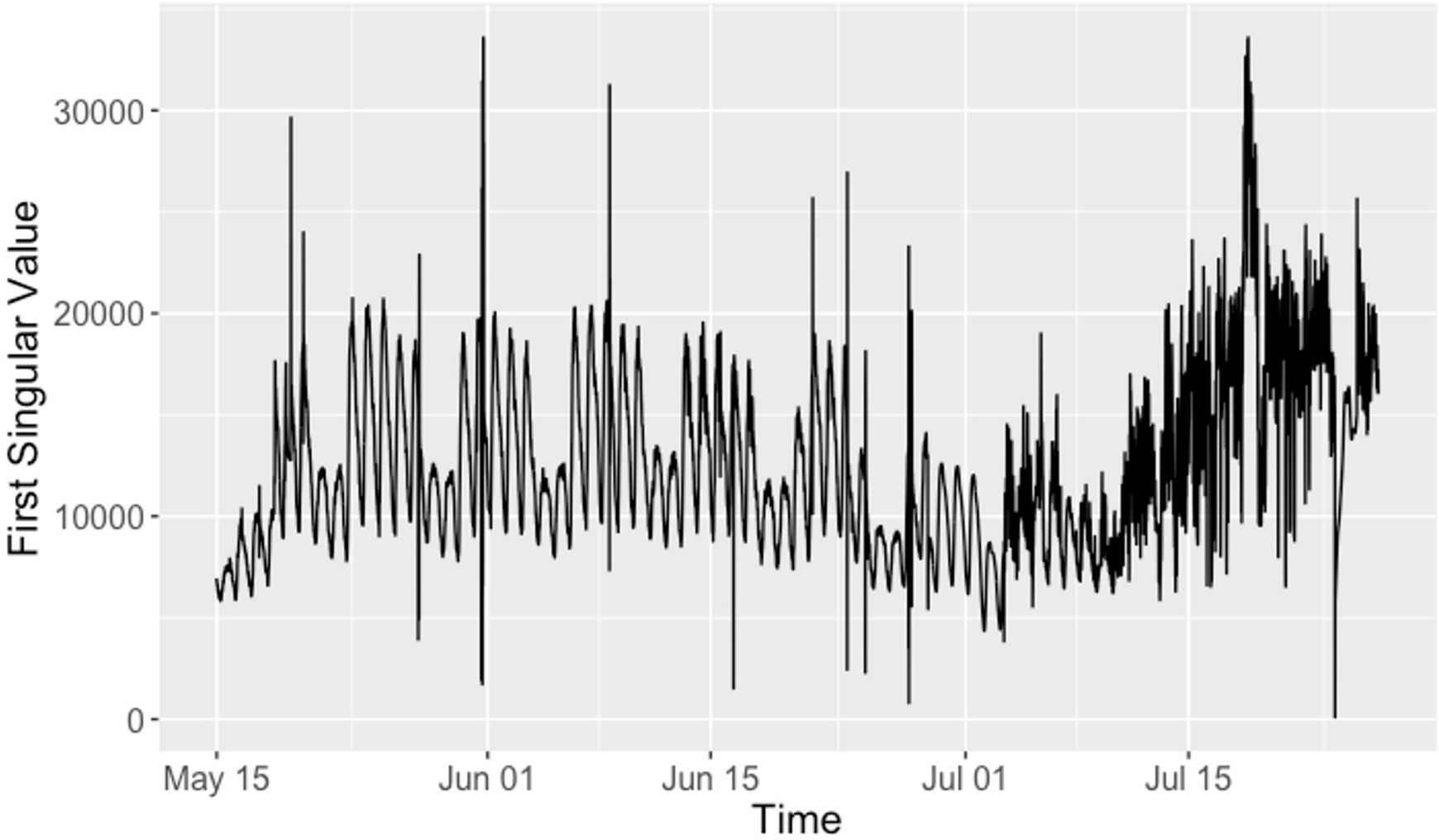

First Singular Value
30000
20000
10000
0
May 15
Jun 01
Jun 15
Jul 01
Jul 15
Time


First Singular Value
30000
20000
10000
0
May 15
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Jul 15
Time

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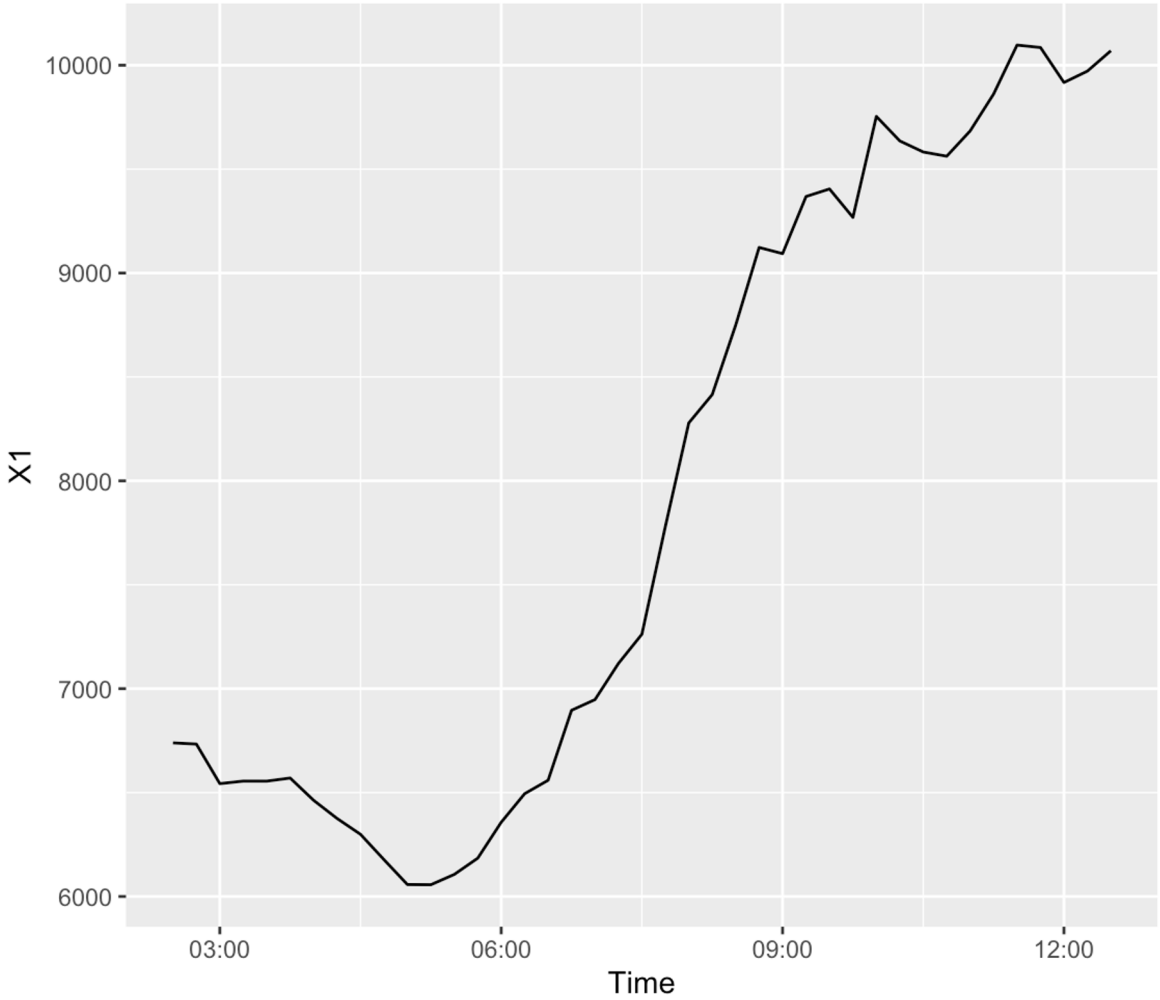
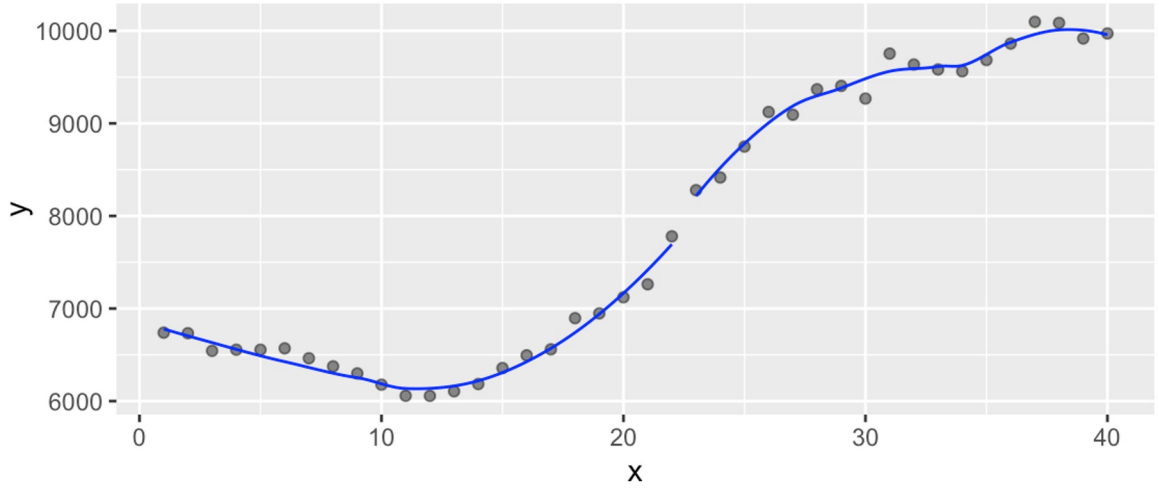
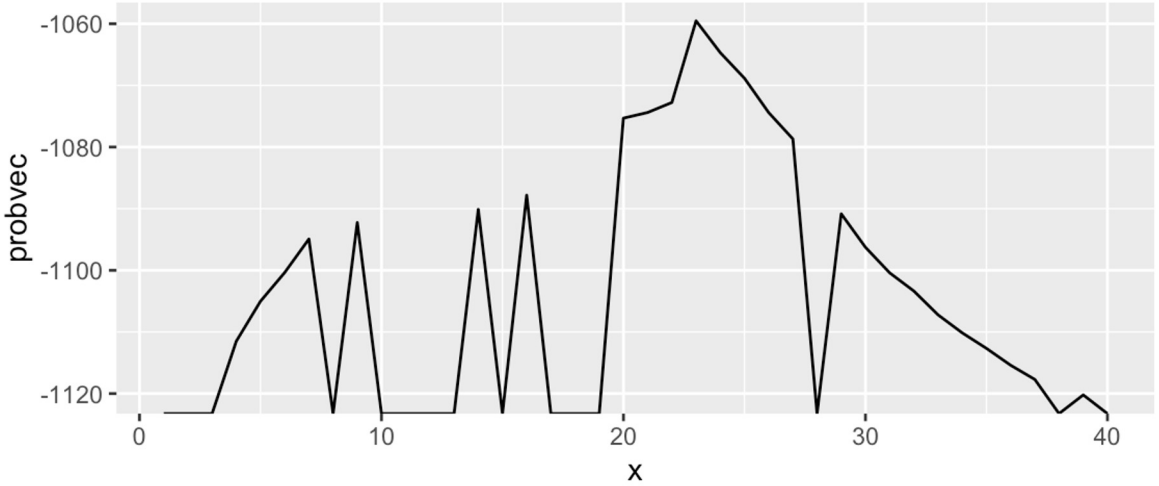

10000
9000
8000
7000
6000
X1
03:00
06:00
09:00
12:00
Time




```
$value
[1] 79.89921

$index
[1] 22 23 24 25
```

## What did we find?

- Clear patterns of seasonality
- More avenues to explore

## What's next?

- Exploring different methods for computing the eigenvalues of the Laplacian and comparing it to the singular values

- Applying our change point detection algorithms to new data sets, such as the Facebook social network

## Take Home Messages

- Accurately and efficiently detecting anomalies in network traffic is essential for effective network management.
- Our approach using singular values of the Laplacian and change point detection has shown promising results and offers a new perspective on this problem.
- We believe that continued research in this area has the potential to greatly improve the automation of network management tasks.

# Change Point Detection of Internet Traffic Anomalies via Singular Values of the Laplacian Matrix

Thank you!

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