perfSONAR Network Analytics

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#52 LHCOPN-LHCONE Meeting
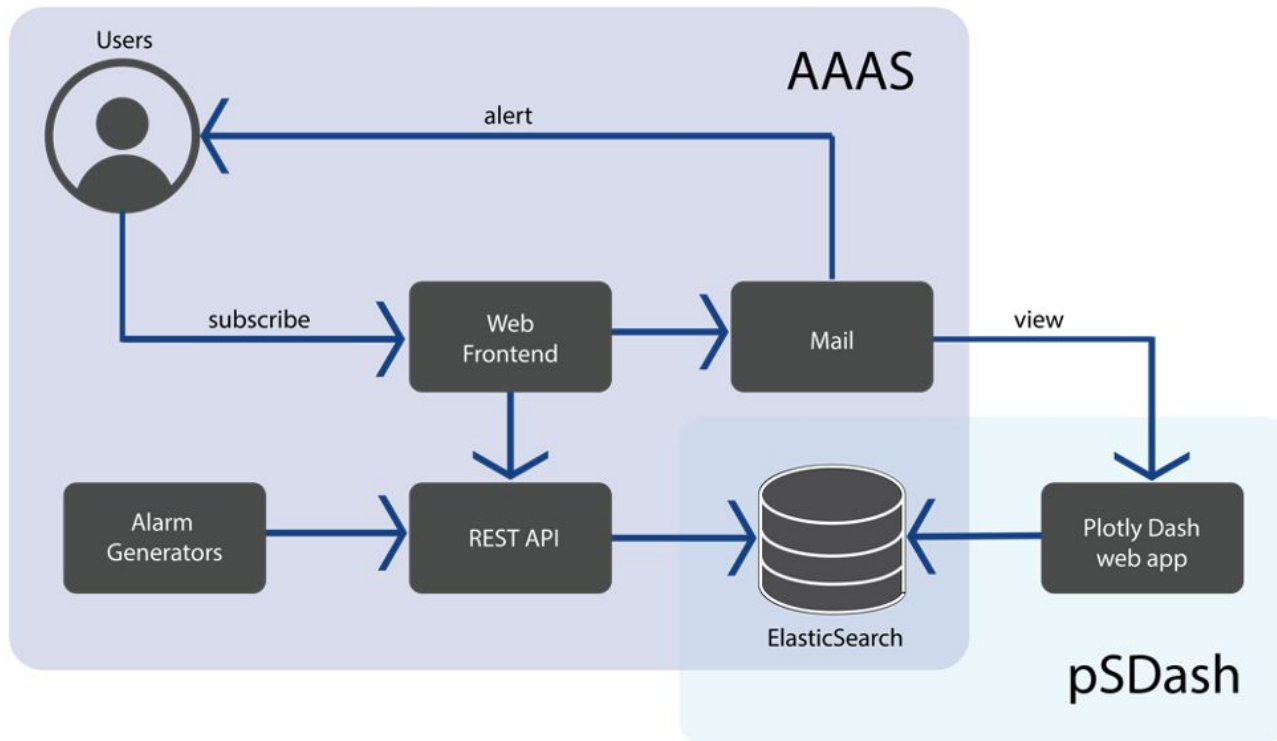IHEP Beijing CN
9 - 12 Oct 2024

Status and Plans

pS platform
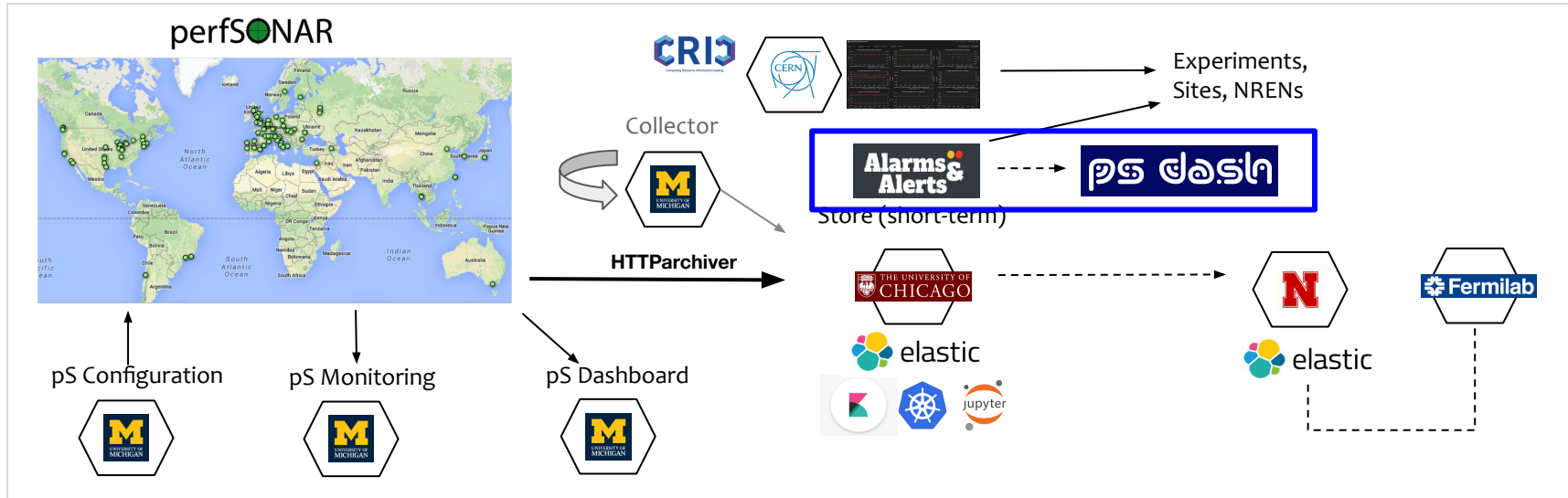
Analytics Tools

Covered in this presentation

- Alarms and Alerts
- pSDash
- ML implementation (in progress)

Alarming & Alerting Service: https://psa.osg-htc.org/
The perfSONAR Dashboard application: https://ps-dash.uc.ssl-hep.org/

How to subscribe for email alerts

Hover over an alarm to see details

Track a specific site or a host

Sat, 05 Oct 2024 03:02:07   Networking/Perfsonar/firewall issue   Firewall issue
tags: GSI-LCG2-LHCONE
Site: GSI-LCG2-LHCONE, perfsonar node: dclxdlperfsonar2.gsi.de seems to have a firewall issue. Packet loss is 100% from at least 10 hosts. Affected sites: ['CERN-PROD-LHCOPNE', 'NLT1-SARA-LHCOPNE', 'PRAGUELCG2-LHCONE', 'PIC-LHCOPNE', 'IN2P3-CC-LHCOPNE']. More infromation could be found in pSDash:
https://ps-dash.uc.ssl-hep.org/loss-delay/bdf4ce3c56b604ace5944490946673b1e218b376fb15b4230afaf9aa

What you'll receive

In the past 12 hours, path between 12 pairs diverged and went through ASN 174 owned by COGENT-174, US. The change affected the following sites ['SPRACE-REDNESP', 'CA-WATERLOO-T2-LHCONE', 'UKI-LT2-QMUL', 'RRC-KI-T1-LHCOPNE', 'CERN-PROD-LHCOPNE', 'DESY-ZN-LHCONE', 'INFN-T1-LHCOPNE', 'MWT2_IU', 'UKI-SOUTHGRID-RALPP-LHCONE', 'JP-KEK-CRC-02', 'CBPF-LHCONE', 'PIC-LHCOPNE', 'IN2P3-CC-LHCOPNE']. The code can be found on pS-Dash: https://ps-dash.uc.ssl-hep.org/paths/c648363dca4131c09b9daee028215540ac6bc3bc8329c175961b74aa

Tue, 02 Jul 2024 04:08:11   Networking/Sites/bandwidth decreased   bandwidth decreased
tags: JINR-LCG2-LHCONE, UKI-SOUTHGRID-RALPP-LHCONE
Bandwidth decreased for the ipv6 links between sites JINR-LCG2-LHCONE and UKI-SOUTHGRID-RALPP-LHCONE. Current throughput is 17 MB, dropped by -98% with respect to the 21-day-average. More infromation could be found in pS-Dash:
https://ps-dash.uc.ssl-hep.org/throughput/7cedc9ccf2c135d32acae685b34d714837fc6e3579b9143a452b3b4f

Understanding the paths (via pSDash)

BASELINE PATH

Taken in 98% of time   Always reaches destination: NO

9264   291   229

ALTERNATIVE PATHS

Taken in 1.0% of time   Always reaches destination: YES

291   229

Taken in 0.0% of time   Always reaches destination: NO

9264   291

Taken in 0.0% of time   Always reaches destination: YES

9264   2907   101   237   229

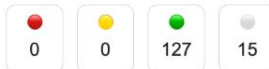Taken in 0.0% of time   Always reaches destination: NO

9264   7660   101   237

TW-ASGC → AGLT2_UM

The plot shows the AS numbers for every hop and the frequency of their occurences at each position (source and destination not included).
The dark blue values of 1 mean the ASN was always used at that position; Close to 0, means the ASN rarely appeared; OFF indicates the device did not respond at the time of the traceroute test; 0 is when there was a responce, but the ASN was unknown.

ps dash   **SITES OVERVIEW**   **SEARCH ALARMS**   **EXPLORE PATHS**   **MAJOR ALARMS**

Site Status Dashboard

Summary

🔴	🟡	🟢	⚪
0	0	127	15

Highest number of alarms from site
GSI-LCG2-LHCONE (DE): 26

Highest number of alarms from country
United Kingdom: 83

SITE	STATUS	NETWORK	INFRASTRUCTURE	OTHER	URL
filter data...					
INFN-CATANIA	🟢	0	0	0	See latest alarms
RRC-KI	🟢	0	0	0	See latest alarms
RO-NIPNE-LHCONE	🟢	0	0	0	See latest alarms
RO-16-UAIC	🟢	0	0	0	See latest alarms
RO-14-ITIM	🟢	0	0	0	See latest alarms
RO-11-NIPNE	🟢	0	0	0	See latest alarms
RO-07-NIPNE	🟢	0	0	0	See latest alarms
RO-03-UPB	🟢	0	0	0	See latest alarms
RO-02-NIPNE	🟢	0	0	0	See latest alarms
RAL-LCG2-ECHO	🟢	0	0	0	See latest alarms
RAL-LCG2	🟢	0	0	0	See latest alarms
PURDUE-LHCONE	🟢	0	0	0	See latest alarms
PURDUE	🟢	0	0	0	See latest alarms
PRAGUELCG2	🟢	0	0	0	See latest alarms
PIC	🟢	0	0	0	See latest alarms
OU_OCHEP_SWT2	🟢	0	0	0	See latest alarms

« ‹ 1 / 9 › »

How was the status determined?

Types of alarms

INFRASTRUCTURE

bandwidth decreased on multiple sites
path changed between sites
unresolvable hosts
no tests for a host

NETWORK

destination cannot be reached
source cannot reach any destination
bad owd measurements
large clock correction
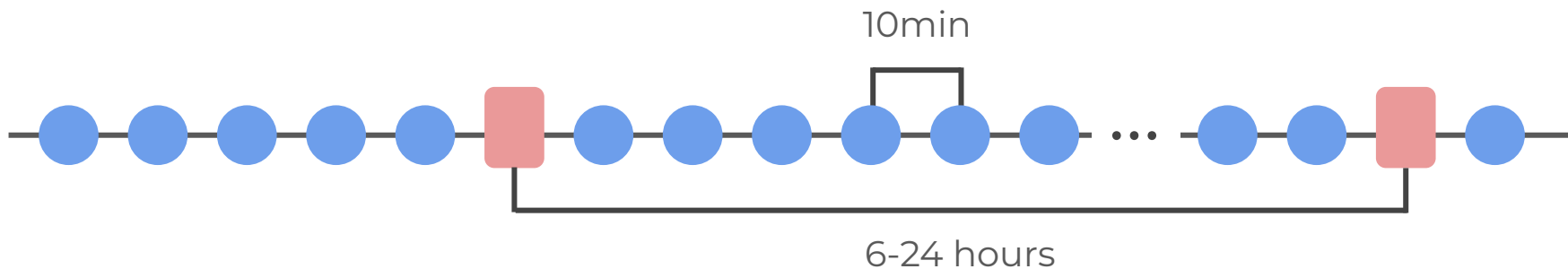complete packet loss
firewall issue

Other

bandwidth increased
bandwidth decreased (on a single pair)
high packet loss

The goal is to
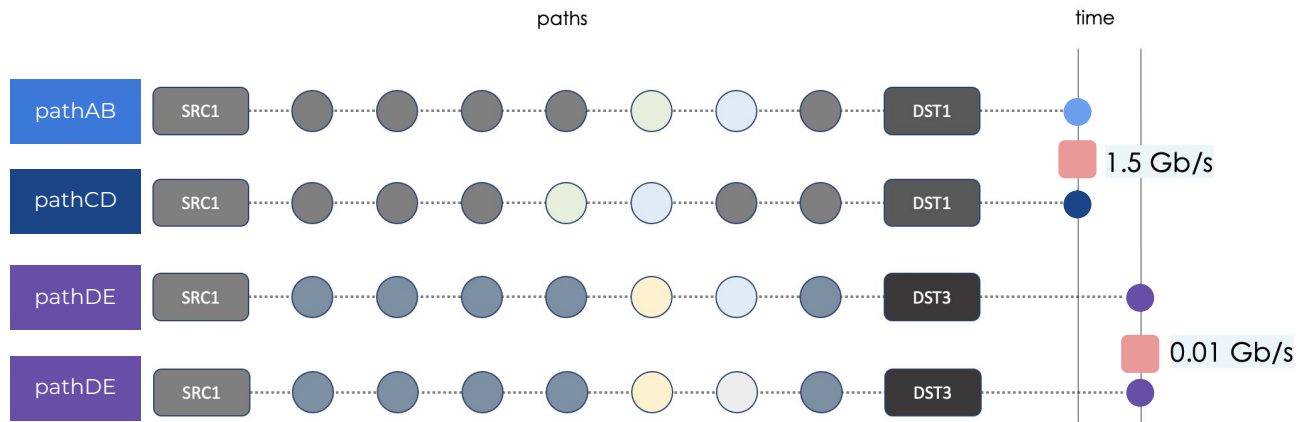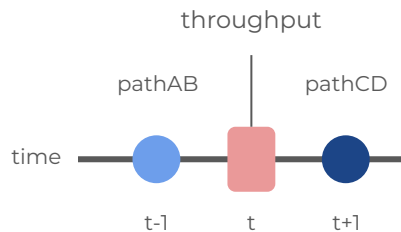**proactively discover network issues**

How to combine pS tests?

Tests' rate of execution varies by type

10min

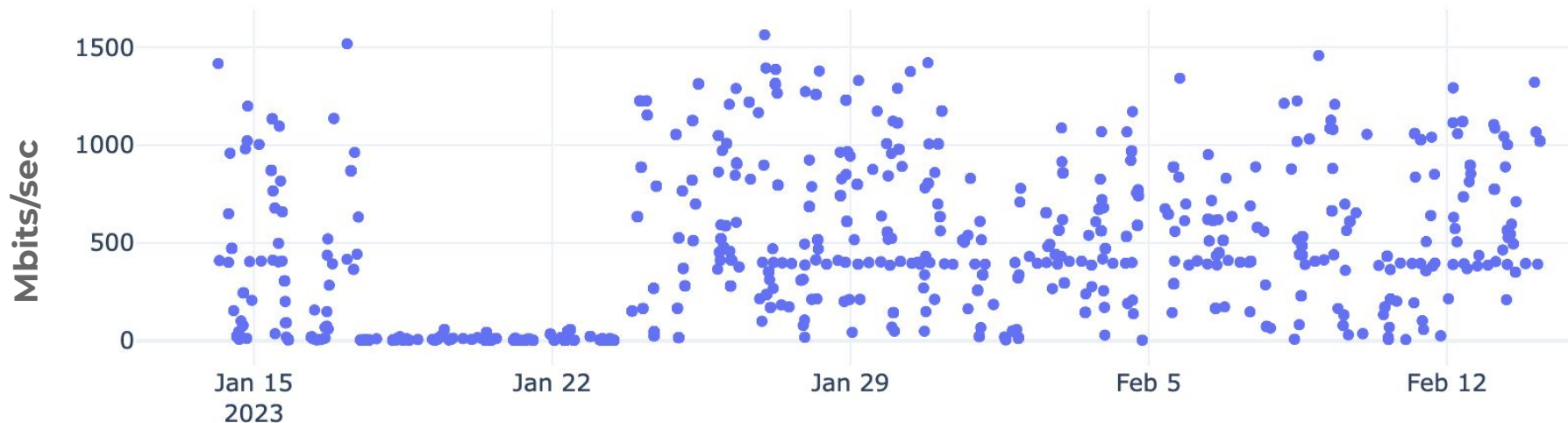6-24 hours

🟥 traceroute test every 10 min

🔵 throughput test every 6-24 hours

Correlate network tests
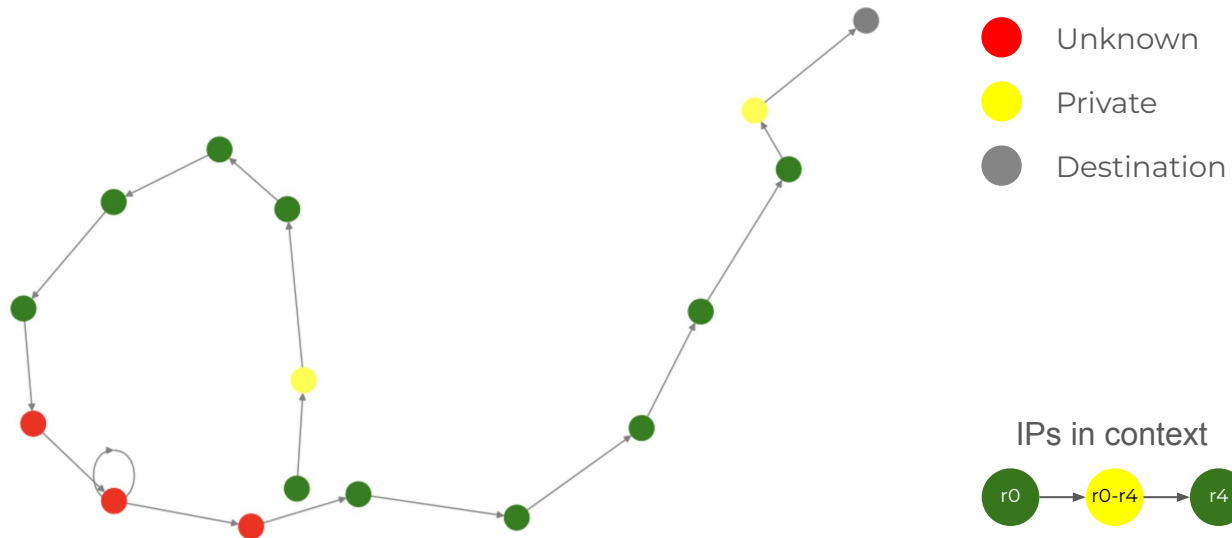
Trends on routers

2001:630:0:9011::189

Each **point** represents the throughput values collected when the node was on the path
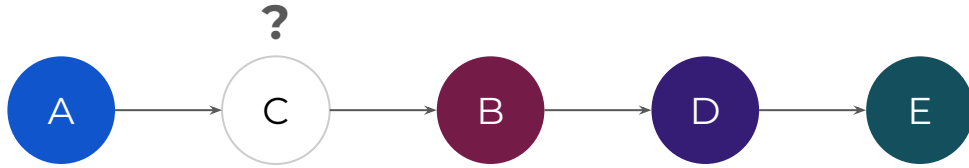
Challenges

- 50% of the paths are incomplete

- some addresses are private

Path from JINR-T1-LHCOPNE to BEIJING-LCG2

Unknown
Private
Destination

IPs in context

r0 → r0-r4 → r4

To build **reliable topology** models for identifying weak points on the network, we need to **reconstruct the paths**

What is the most probable C, given it's between A and B?

```
Possible intermediates:
r237 P(AtoC)= 0.008  and  P(CtoB)= 0.038
r265 P(AtoC)= 0.056  and  P(CtoB)= 0.009
r536 P(AtoC)= 0.176  and  P(CtoB)= 0.551
r792 P(AtoC)= 0.072  and  P(CtoB)= 0.008
r838 P(AtoC)= 0.008  and  P(CtoB)= 0.01
The most probable intermediate router between r792 and r237 is r536
with a probability of 0.097
```

There are multiple possibilities for C. What is the correct node that lies between A and B depends more on the surrounding nodes rather than on highest probability value
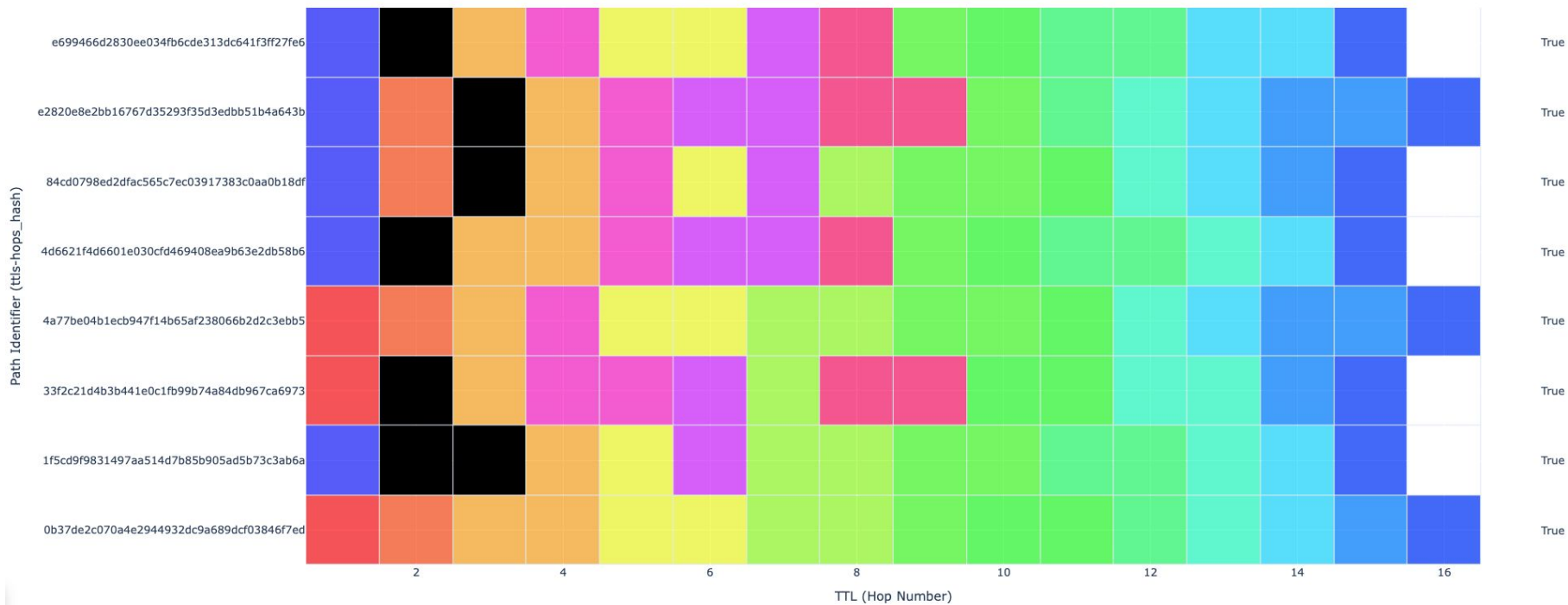
Site to site path signature

Path signature between UKI-NORTHGRID-MAN-HEP and JINR-LCG2
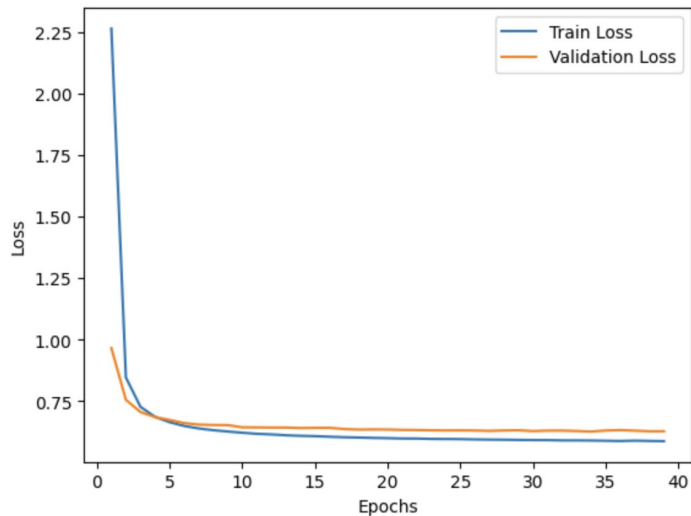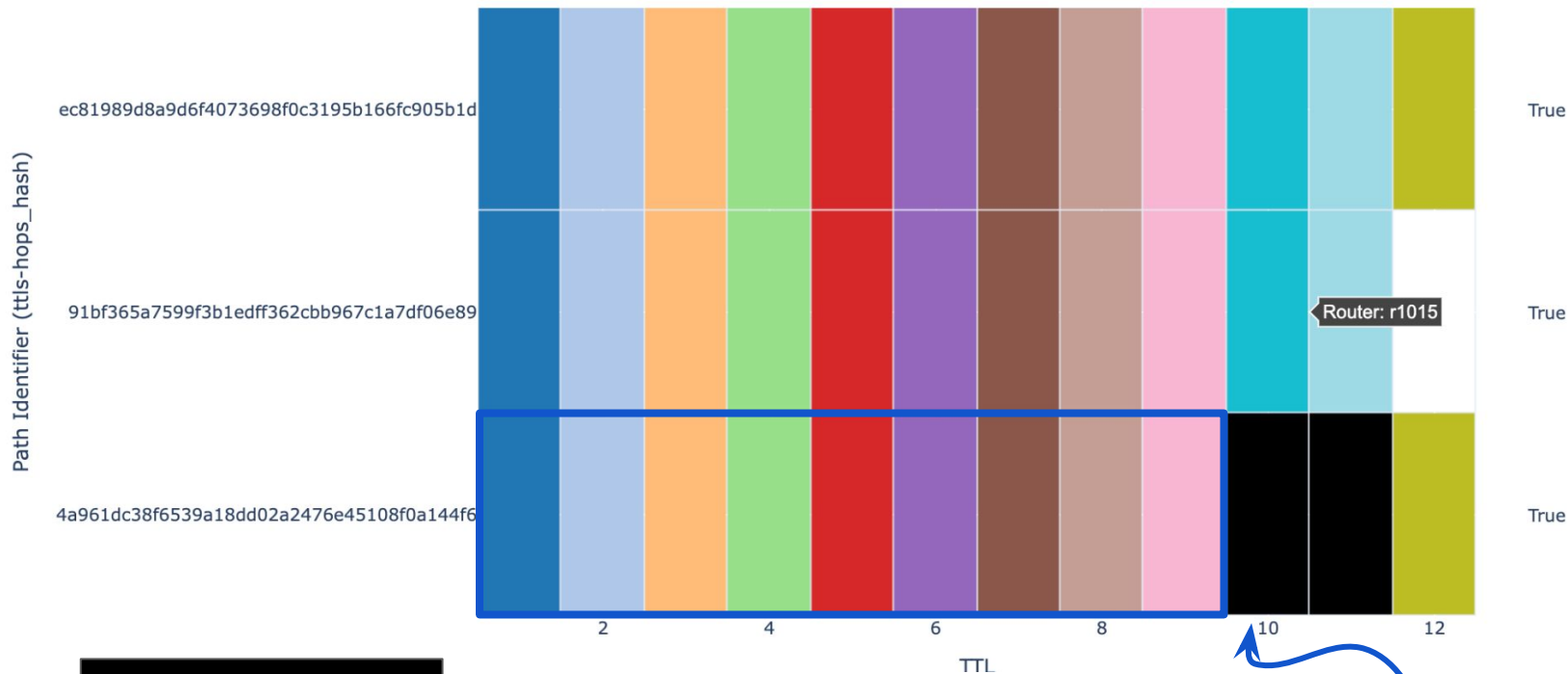
Path reconstruction via ML

- Transformer model
- Pays attention to the nodes preceding the one in question
- Currently excludes unknown nodes as targets

The model performs well and converges quickly

Path signature between UKI-LT2-IC-HEP and T2_US_WISCONSIN

Corner cases

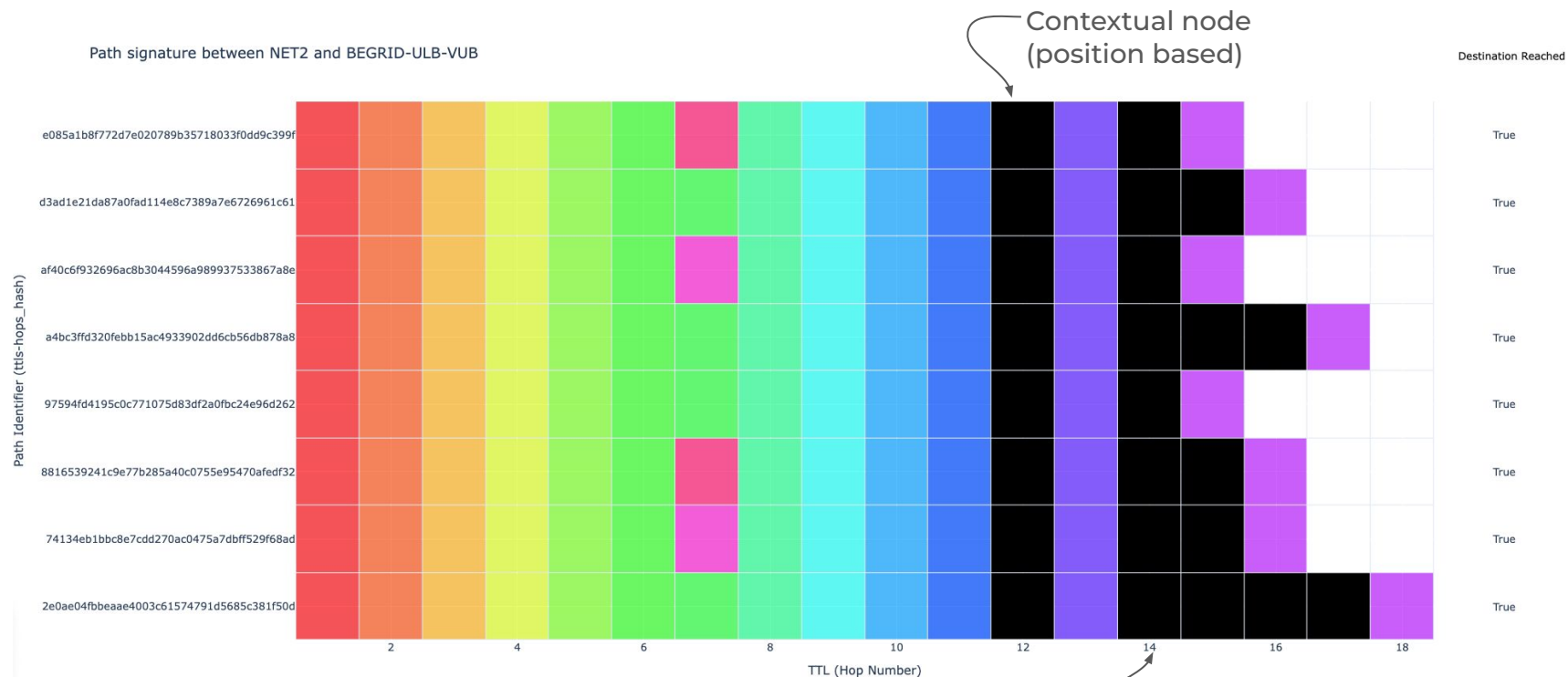
Path signature between NET2 and BEGRID-ULB-VUB

Contextual node (position based)

Destination Reached

Path Identifier (ttls-hops_hash)

e085a1b8f772d7e020789b35718033f0dd9c399f — True
d3ad1e21da87a0fad114e8c7389a7e6726961c61 — True
af40c6f932696ac8b3044596a989937533867a8e — True
a4bc3ffd320febb15ac4933902dd6cb56db878a8 — True
97594fd4195c0c771075d83df2a0fbc24e96d262 — True
8816539241c9e77b285a40c0755e95470afedf32 — True
74134eb1bbc8e7cdd270ac0475a7dbff529f68ad — True
2e0ae04fbbeaae4003c61574791d5685c381f50d — True

TTL (Hop Number)

Unknown IP

Each color is a different IP

Contextual node or retrying until it gets to the final node?

Next steps

Include the **corner cases** by:
- Creating "confidence score" to be used into the loss function
- Collapsing the multiple consecutive unknown nodes into a single one

Implement another sequence model to compare the results

Once the **topology** is **fixed**, we can proceed by building more **complex models** that incorporate other metrics such as **loss, bandwidth** or **file transfer** statistics

Acknowledgements

We would like to thank the **WLCG**, **HEPiX**, **perfSONAR** and **OSG** organizations for their work on the topics presented.

Thank you!

Any questions?

Contact us @ **net-discuss@umich.edu**

Backup slides

Get your site name
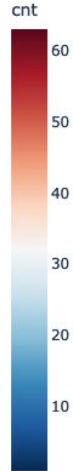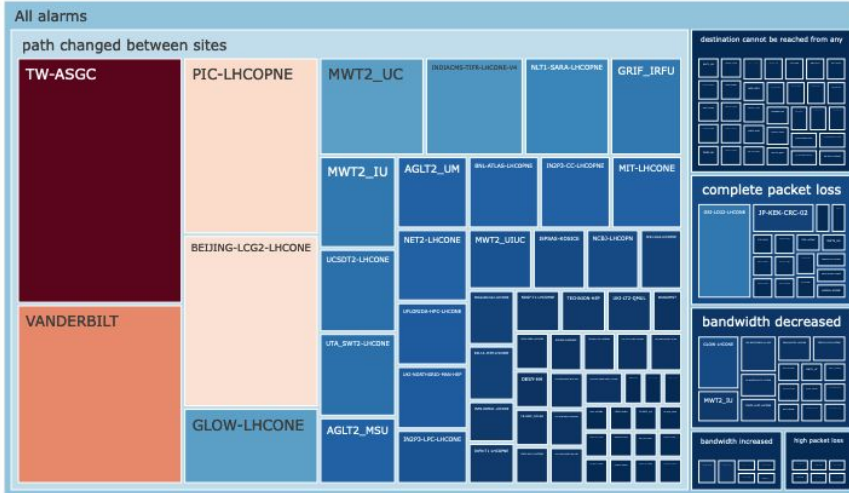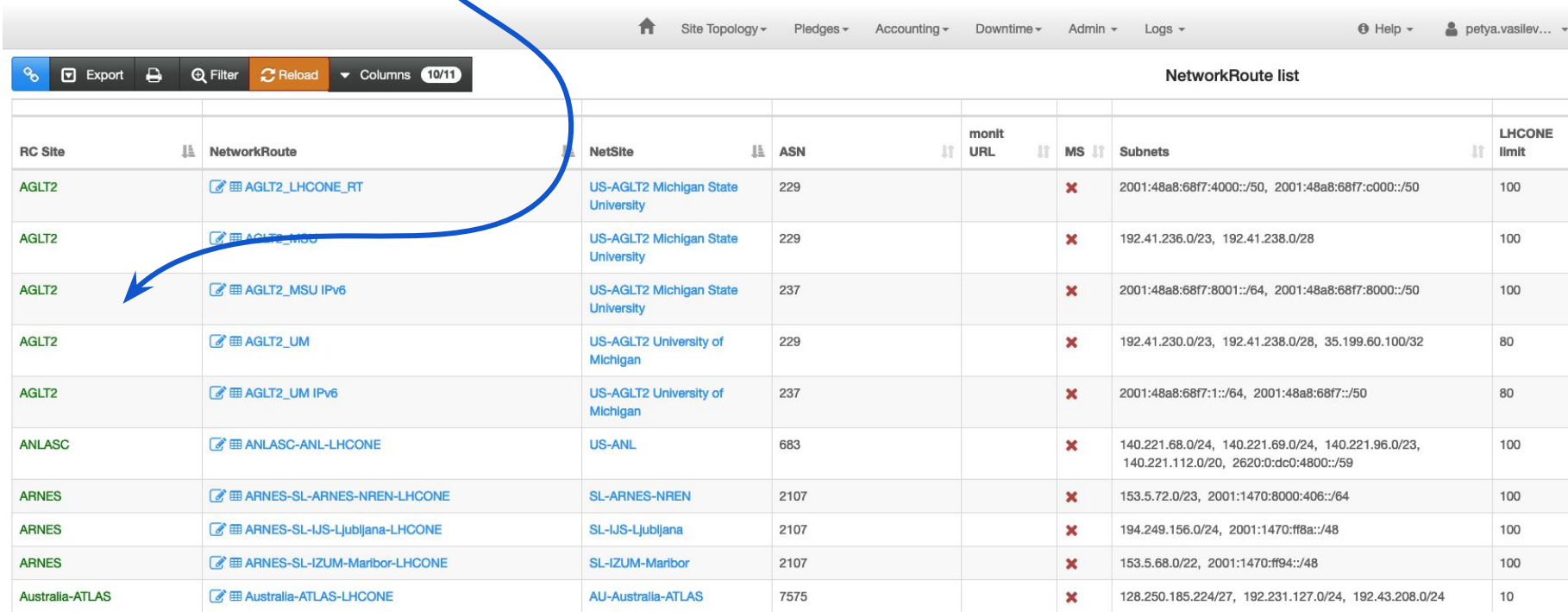
from pSDash: https://ps-dash.uc.ssl-hep.org/search-alarms

Get your site name

from CRIC: https://wlcg-cric.cern.ch/core/networkroute/list/

NetworkRoute list

RC Site	NetworkRoute	NetSite	ASN	monit URL	MS	Subnets	LHCONE limit
AGLT2	✎ ⊞ AGLT2_LHCONE_RT	US-AGLT2 Michigan State University	229		✖	2001:48a8:68f7:4000::/50, 2001:48a8:68f7:c000::/50	100
AGLT2	✎ ⊞ AGLT2_MSU	US-AGLT2 Michigan State University	229		✖	192.41.236.0/23, 192.41.238.0/28	100
AGLT2	✎ ⊞ AGLT2_MSU IPv6	US-AGLT2 Michigan State University	237		✖	2001:48a8:68f7:8001::/64, 2001:48a8:68f7:8000::/50	100
AGLT2	✎ ⊞ AGLT2_UM	US-AGLT2 University of Michigan	229		✖	192.41.230.0/23, 192.41.238.0/28, 35.199.60.100/32	80
AGLT2	✎ ⊞ AGLT2_UM IPv6	US-AGLT2 University of Michigan	237		✖	2001:48a8:68f7:1::/64, 2001:48a8:68f7::/50	80
ANLASC	✎ ⊞ ANLASC-ANL-LHCONE	US-ANL	683		✖	140.221.68.0/24, 140.221.69.0/24, 140.221.96.0/23, 140.221.112.0/20, 2620:0:dc0:4800::/59	100
ARNES	✎ ⊞ ARNES-SL-ARNES-NREN-LHCONE	SL-ARNES-NREN	2107		✖	153.5.72.0/23, 2001:1470:8000:406::/64	100
ARNES	✎ ⊞ ARNES-SL-IJS-Ljubljana-LHCONE	SL-IJS-Ljubljana	2107		✖	194.249.156.0/24, 2001:1470:ff8a::/48	100
ARNES	✎ ⊞ ARNES-SL-IZUM-Maribor-LHCONE	SL-IZUM-Maribor	2107		✖	153.5.68.0/22, 2001:1470:ff94::/48	100
Australia-ATLAS	✎ ⊞ Australia-ATLAS-LHCONE	AU-Australia-ATLAS	7575		✖	128.250.185.224/27, 192.231.127.0/24, 192.43.208.0/24	10

Site Topology ▾   Pledges ▾   Accounting ▾   Downtime ▾   Admin ▾   Logs ▾   ℹ Help ▾   👤 petya.vasilev... ▾

🔗 ⊡ Export 🖶   🔍 Filter ⟳ Reload   ▾ Columns 10/11

Transformer model: Preprocessing example

unknown

| r1 | r2 | ⬛ | r10 | r11 |

| r1 | r2 | r2-r10 | r10 | r11 |

Give contextual ID
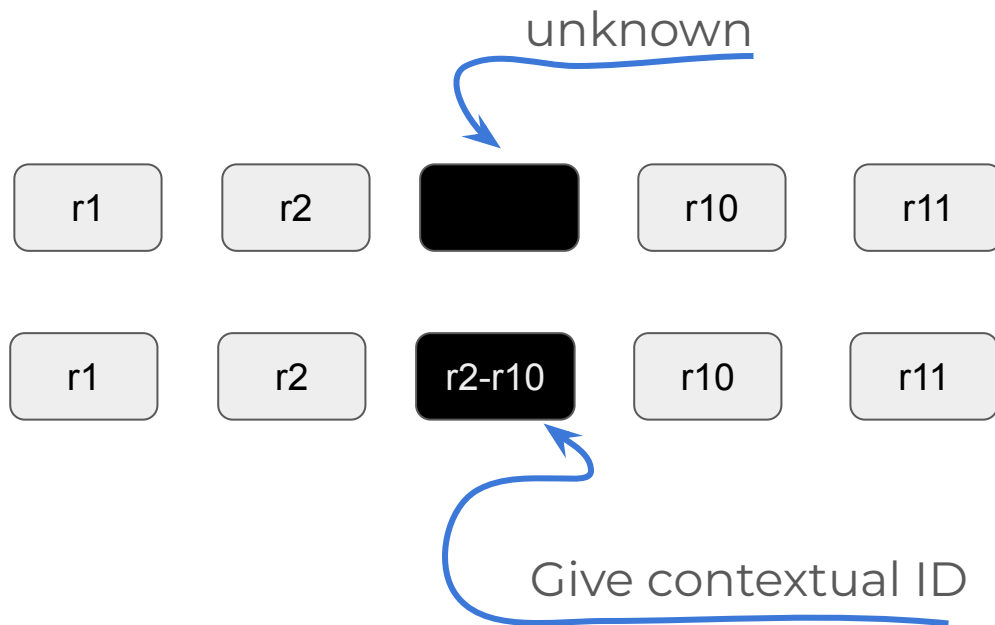
The dataset

path | r1 | r2 | **r2-r10** | r10 | r11 |

Input

r1				
r1	r2			
r1	r2	r2-r10		
r1	r2	r2-r10	r10	

Target

| r2 |
| r2-r10 |
| r10 |
| r11 |

Skip unknown
nodes as targets