Hey, Lumi!

Using Natural Language for Intent-based Network Management

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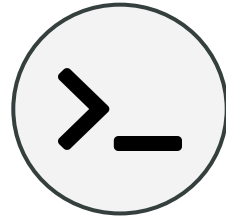
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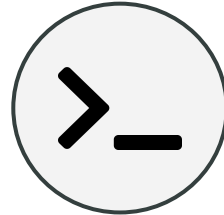
"Rate limit employees streaming traffic"

https://pixy.org/530787/

How to deploy network policies?

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Higher-level

SDN

NETCONF

OPENCONFIG

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Higher-level

PGA   JANUS   COCOON   NetKAT   Merlin   ○○○

SDN   NETCONF   OPENCONFIG

>_
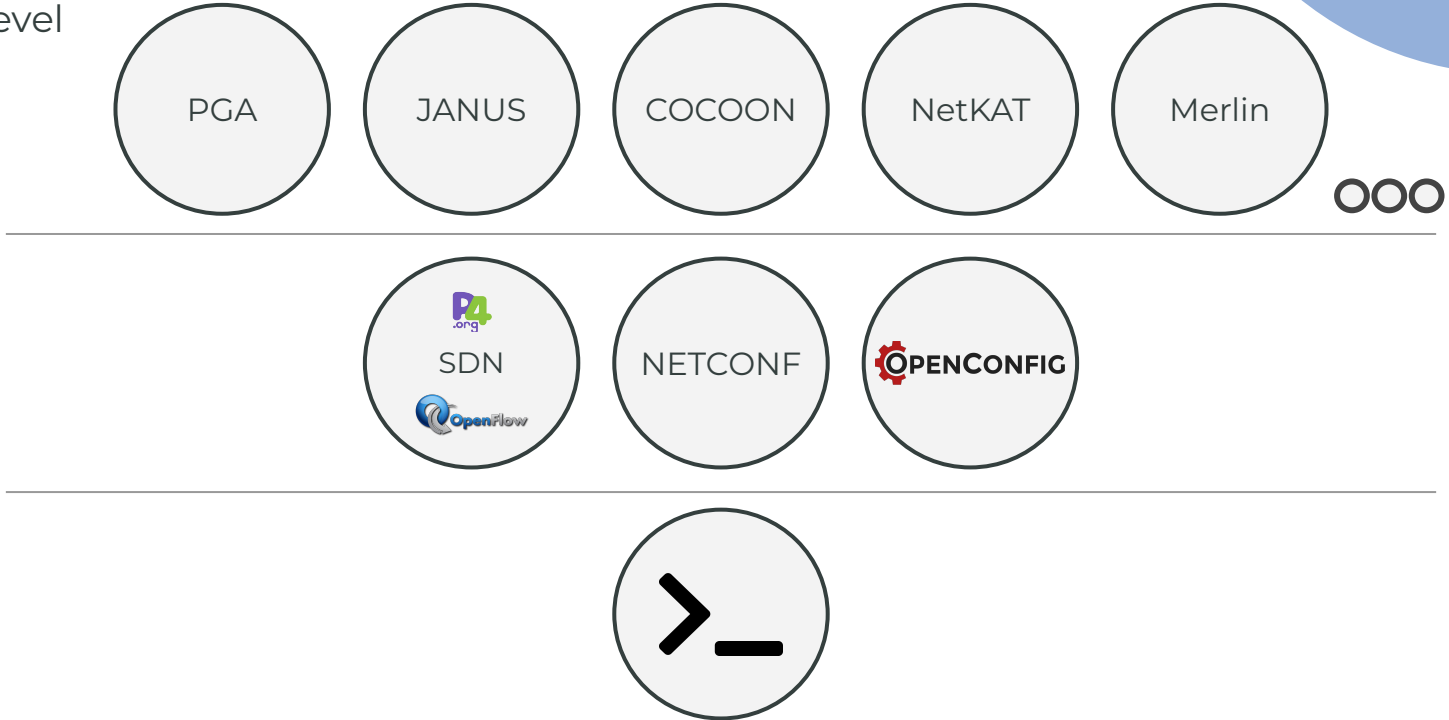
What if we use natural language?

Lumi

1. Allows network operators to express their high-level intents in **Natural Language**

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4. Evaluated using **real-world intents** from US University network policies, and a **User Study**

Lumi

Supported policies

ACL

QoS

Middlebox chaining

Temporal behavior

Related work

	Network Configuration	Learns through Feedback
Net2Text — Query-Guided Network Captioning	—	—
Hey network, can you understand me?	✓	—
Lumi	✓	✓

Lumi in a Nutshell

"Hey, Lumi! Inspect traffic for the dorm."

Client

Config

Network

Lumi in a Nutshell

"Hey, Lumi! Inspect traffic for the dorm."

Client → Lumi → Config → Network

Information Extraction

Tagged Entities:
{
  middlebox: ['**dpi**'],
  target: ['**dorm**']
}

Intent Assembly

Nile intent:
define intent id:
for endpoint('**dorm**')
add middlebox('**dpi**')

Intent Confirmation

"Is this right?"
define intent id:
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Intent Deployment

Merlin program:
[x :
(ipDst =**10.1.2.0/24**)
-> .* **dpi** .*
]

Information Extraction

Named Entity Recognition

① Intent text — Inspect — traffic — for — the — dorm

② Word Embedding — word2vec · word2vec · word2vec · word2vec · word2vec

③ Left-to-right LSTM — $LSTM_L$ ... Right-to-left LSTM — $LSTM_R$

④ Concatenation

⑤ CRF Layer — B-MB ↔ O ↔ O ↔ B-TGT ↔ I-TGT

⑥ Build Dictionary — { middlebox: ['dpi'], target: ['dorm'] }

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Intent Assembly
Network Intent Language (Nile)

High legibility

High expressivity

Intent Assembly
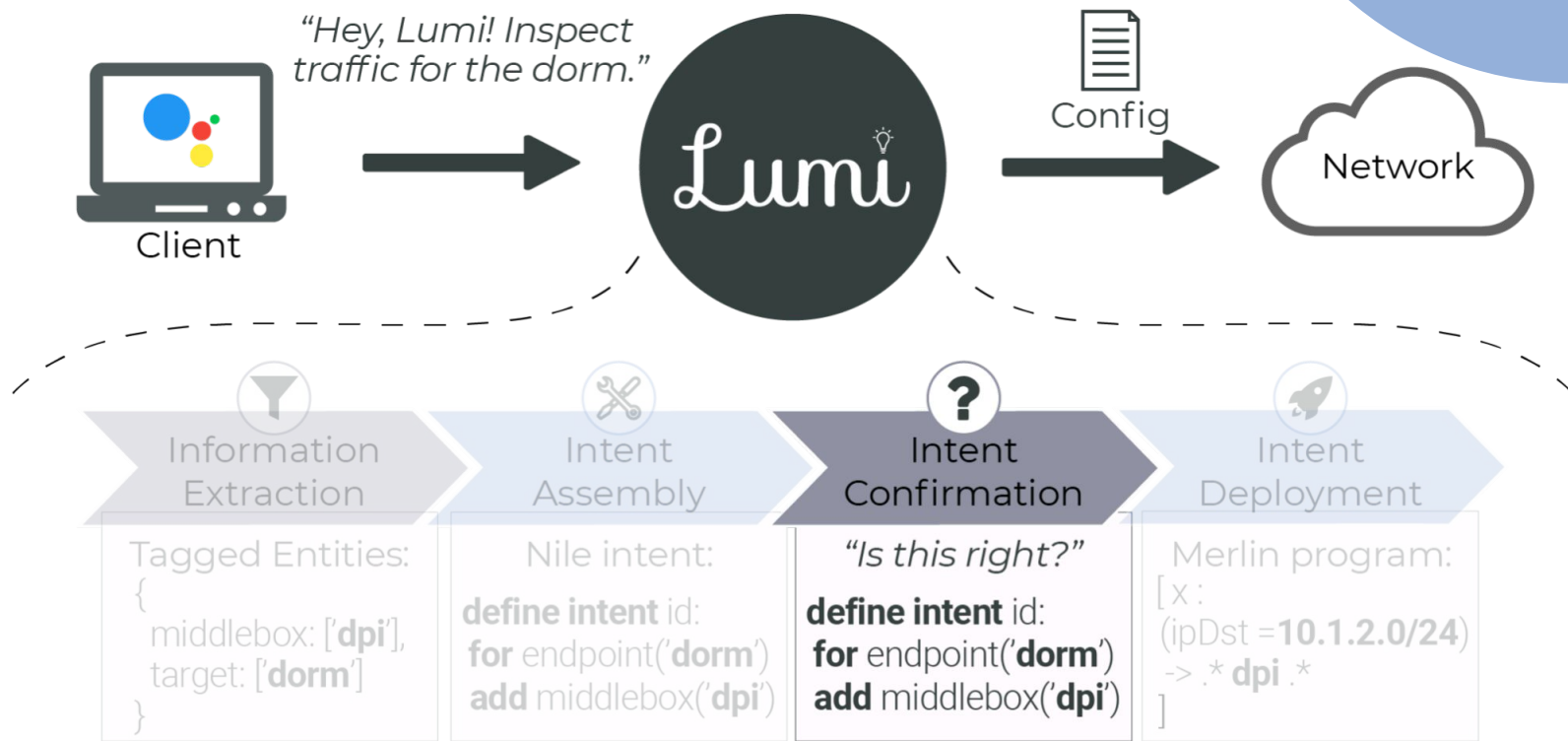Network Intent Language (Nile)

High legibility

High expressivity

"Add a firewall and intrusion detection from gateway to backend for client B with at least 100 mbps of bandwidth, and allow HTTPS only."

```
define intent intentId:
    from      endpoint("gateway")
    to        endpoint("backend")
    for       group("B")
    add       middlebox("firewall"), middlebox("ids")
    set       bandwidth("min", "100", "mbps")
    allow     protocol("https")
```
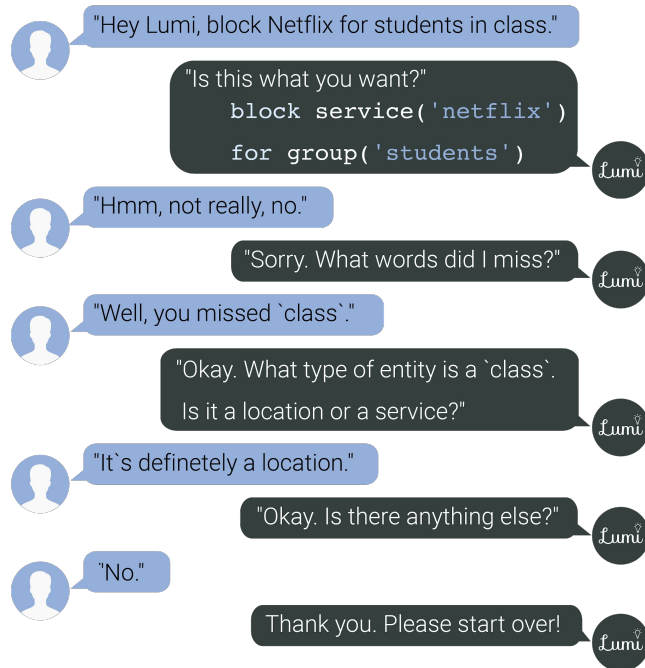
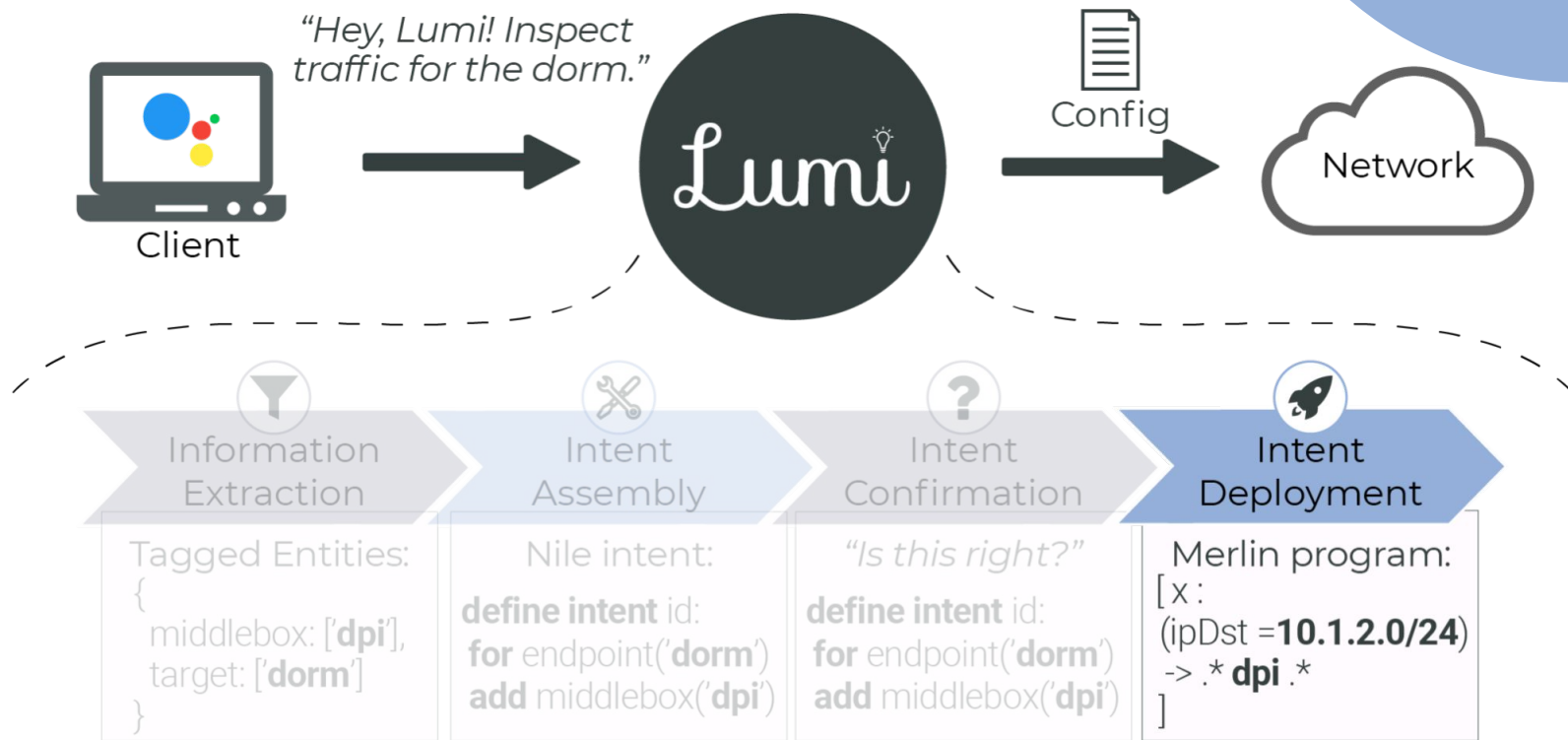# Lumi in a Nutshell

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Intent Confirmation

- Machine learning is always prone to mistakes

- Training data is hard to come by

  - **Use operator knowledge!**

- Iterate to extract key-value pairs

  - **Re-train NER model each time**

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User Study

User Study

Completely anonymous and entirely online

- Subjects were put in the shoes of a **campus network operator**

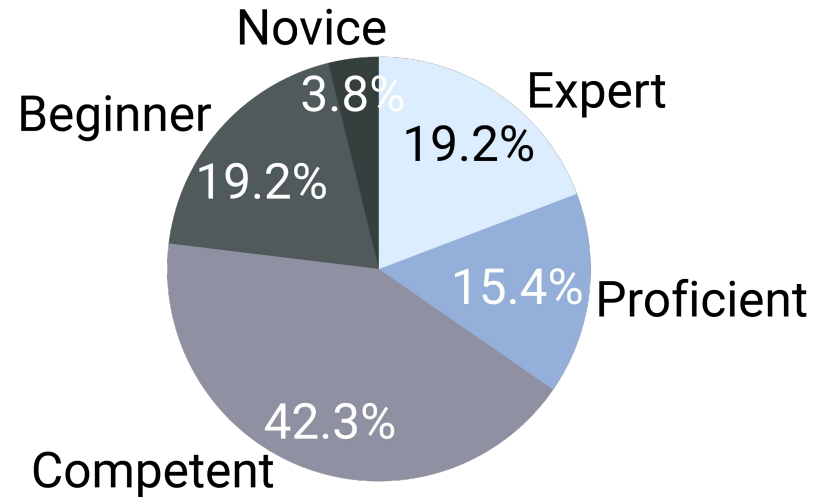- Asked to complete **5 tasks** using our developed Lumi prototype
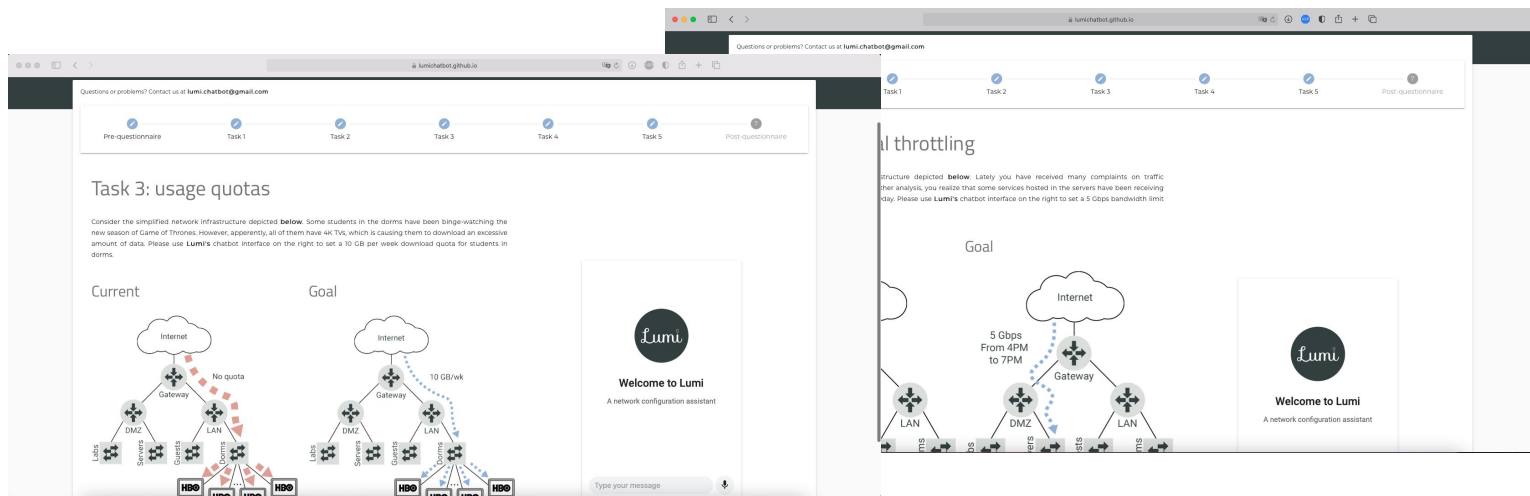
User Study
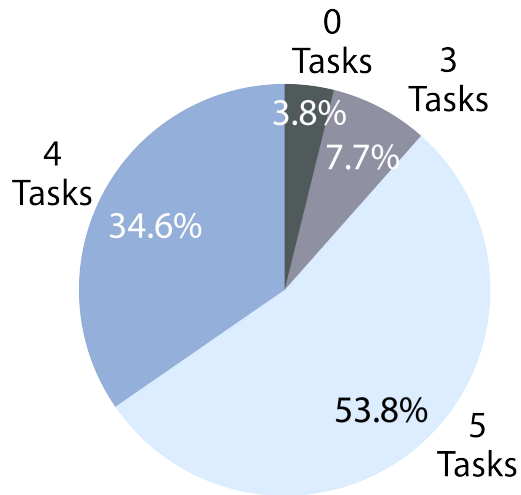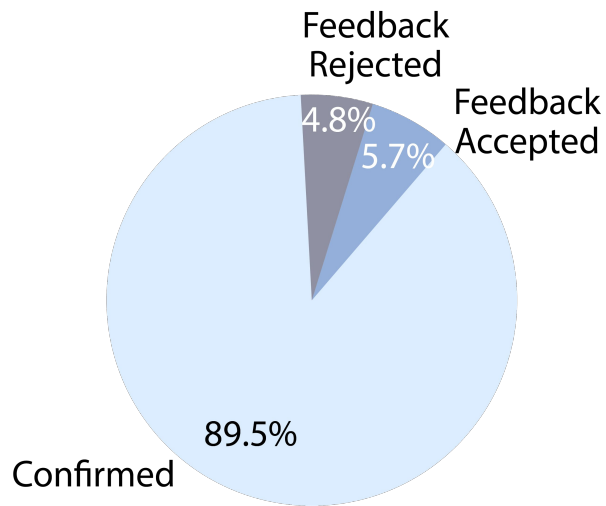
Subjects Profiling

- **26 Participants**
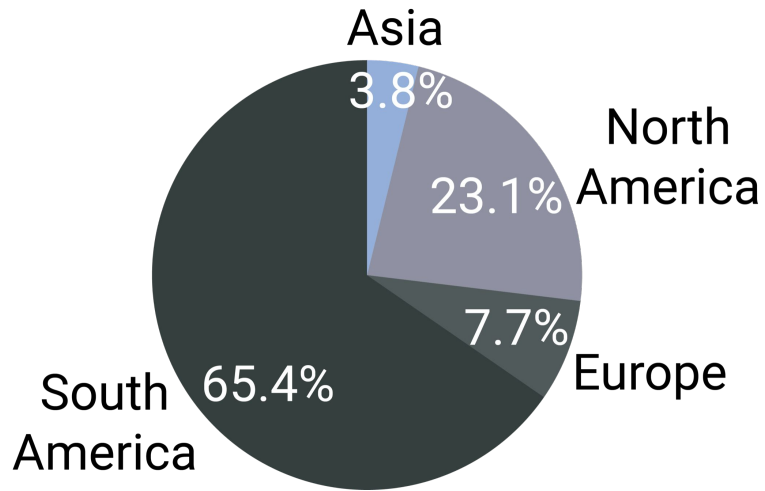
Region

Expertise

User Study

Information Extraction and Feedback

# of Tasks Completed

Impact of Feedback

Summary

Lumi

- End-to-end system to allow using **natural language** for network management
- Uses **Nile** as an abstraction layer for intent confirmation.
- **Learns over time** through operator feedback.

What's next:

- Make Lumi production-ready
- Support for more features for use case scenarios other than Campus Networks

Thank you!
Questions?

Arthur Jacobs
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Lumi

http://lumichatbot.github.io