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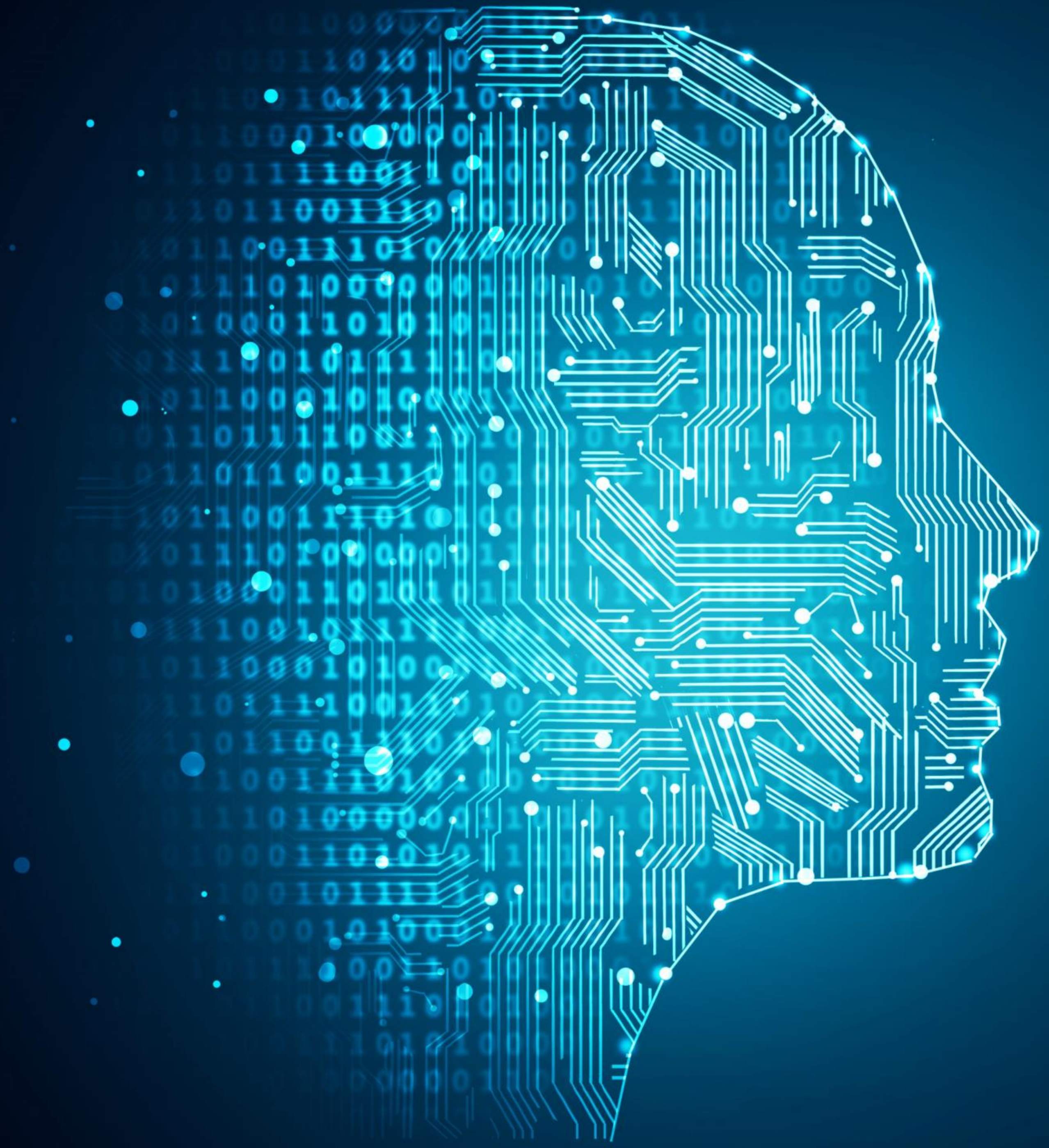

Threat Detection based on Deep Learning at Scale

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Siemens Cyber Defense Center

Cyber Defense Center

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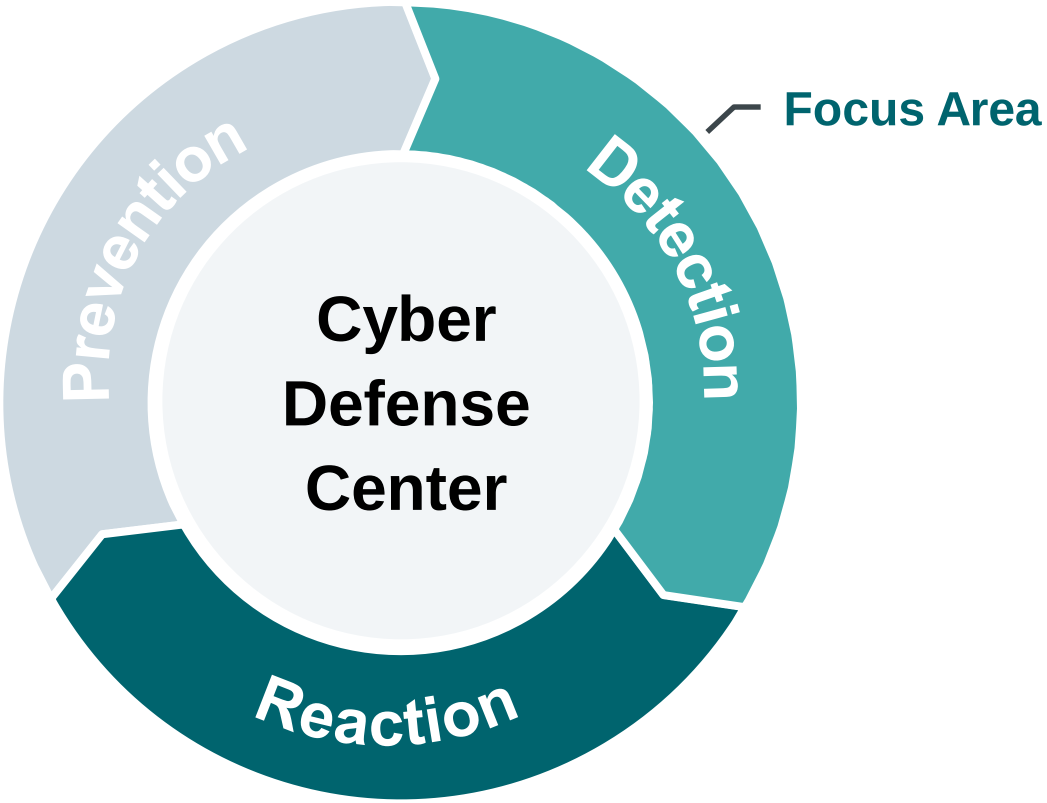
Globally distributed Team

Mission

- Monitoring of Siemens infrastructure worldwide
- Identify and analyze security threats



Cyber Defense Center

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Mission: Threat Detection

Log Collection
(Endpoints, Servers, Proxies, AD, Packet Captures, Sandboxes, Email Servers…)

Store, Enrich, Alert

Analyze, Verify, Hunt

Threat Detection System

Storage

Search Tools

Dashboards

Alert

Decision (TP/FP)

Threat Hunting

Siemens Corporate Network
(500,000+ Hosts, 350,000+ Users)

Hybrid Cloud Solution
(50,000+ Events/Sec)

Security Analysts

Cyber Defense Center

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Main Detection Components

Static Analysis

Dynamic and **Hybrid Analysis**

Key motivation for us:

- **More robust detection:** Learn general malware characteristics
- **Enable novel detection vectors**: E.g., image recognition for phishing detection
- **Automate repetitive tasks**

Exact Matching:
Rulesets, Regexes, Periodic Search Queries, Scripts etc.

Machine Learning, Artificial Intelligence and Deep Learning:
Non-exact Matching, Aggregate/Preselect/Visualize etc.

AI and Deep Learning on the Rise

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High expectations due to success stories

Self-driving Cars

Translation

Cancer Detection

AI and Deep Learning on the Rise

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How about Security?

Dedicated Workshops

Large amount of new Papers

Numerous (Open Source)
Tools and Implementations

AI and Deep Learning on the Rise

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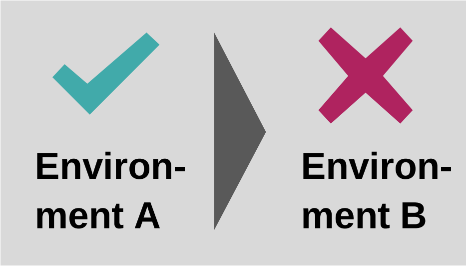
Key Challenges (in Large Environments):

→ Huge gap between research and practice

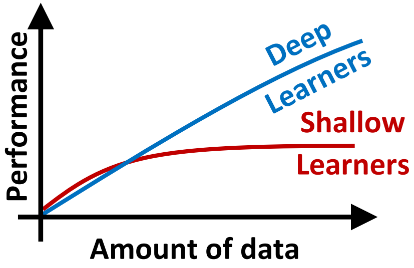


Limited Generalizability

Limited Scalability

Accuracy (TPs, FPs etc)

No Standard Architectures



Not enough (labeled) Data

Technical Challenges

Use Case: DGA Detection

What is a DGA doing?

1 **Malware:** attempt to communicate with Attackers' server

Infected Host

www.IamEvil.com

What is a DGA doing?

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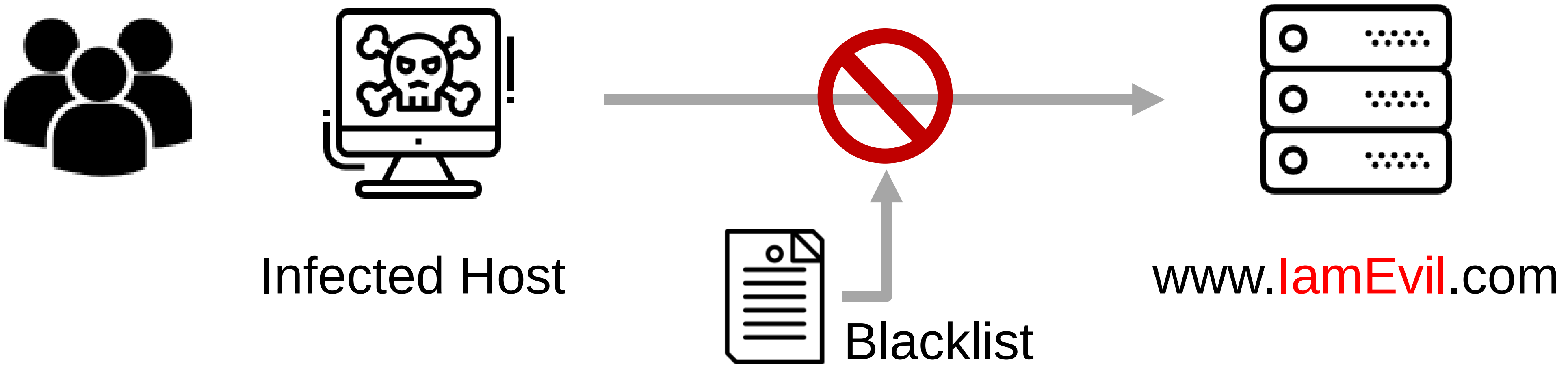
2 **Defenses Up:** blacklist stops the communication



What is a DGA doing?

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3 **DGA in action**

Infected Host

- ⃠ www.IamEvil-0001.com
- ⃠ www.IamEvil-0002.com
- ✓ www.IamEvil-0003.com

What is a DGA doing?

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Simply blocking domains does not scale anymore

A Simple DGA Example

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```python
def generate_domain(year, month, day):
    """Generates a domain name for the given date."""
    domain = ""

    for i in range(16):
        year = ((year ^ 8 * year) >> 11) ^ ((year & 0xFFFFFFF0) << 17)
        month = ((month ^ 4 * month) >> 25) ^ 16 * (month & 0xFFFFFFF8)
        day = ((day ^ (day << 13)) >> 19) ^ ((day & 0xFFFFFFFE) << 12)
        domain += chr(((year ^ month ^ day) % 25) + 97)

    return domain + ".com"
```

[CryptoLocker DGA]

```python
print(generate_domain(2019, 5, 7))
print(generate_domain(2019, 6, 19))
```

```
konsbolyfadifehn.com
myycvfoqtcpbbypd.com
```

Quiz: Can you distinguish Legitimate Domains from Malicious ones?

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edkowalczyk.com

abcdefgtfddf2223.com

xjpakmdcfuqe.nl

b9qmjjys3z.com

watdoejijbijbrand.nl

skhhtcss.edu.hk

reqblcsh.net

blkdmnds.com

oqjiwef12egre6erg6qwefg312qrgqretg132.com

lkckclckl1i1i.com

kdnlrklb.com

cilavocofer.eu

hzmksreiuojy.in

llanfairpwllgwyngyllgogerychwyrndrobwll-llantysiliogogogoch.com

Quiz: Can you distinguish Legitimate Domains from Malicious ones?

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edkowalczyk.com

abcdefgtfddf2223.com

xjpakmdcfuqe.nl

b9qmjjys3z.com

skhhtcss.edu.hk reqblcsh.net

watdoejijbijbrand.nl

blkdmnds.com

oqjiwef12egre6erg6qwefg312qrgqretg132.com

lkckclckl1i1i.com

kdnlrklb.com

cilavocofer.eu

hzmksreiuojy.in

llanfairpwllgwyngyllgogerychwyrndrobwll-llantysiliogogogoch.com

= malicious

Name of a town in Wales

[https://www.youtube.com/watch?v=fHxO0UdpoxM]

Detecting DGAs with Deep Learners

Detecting DGAs with AI

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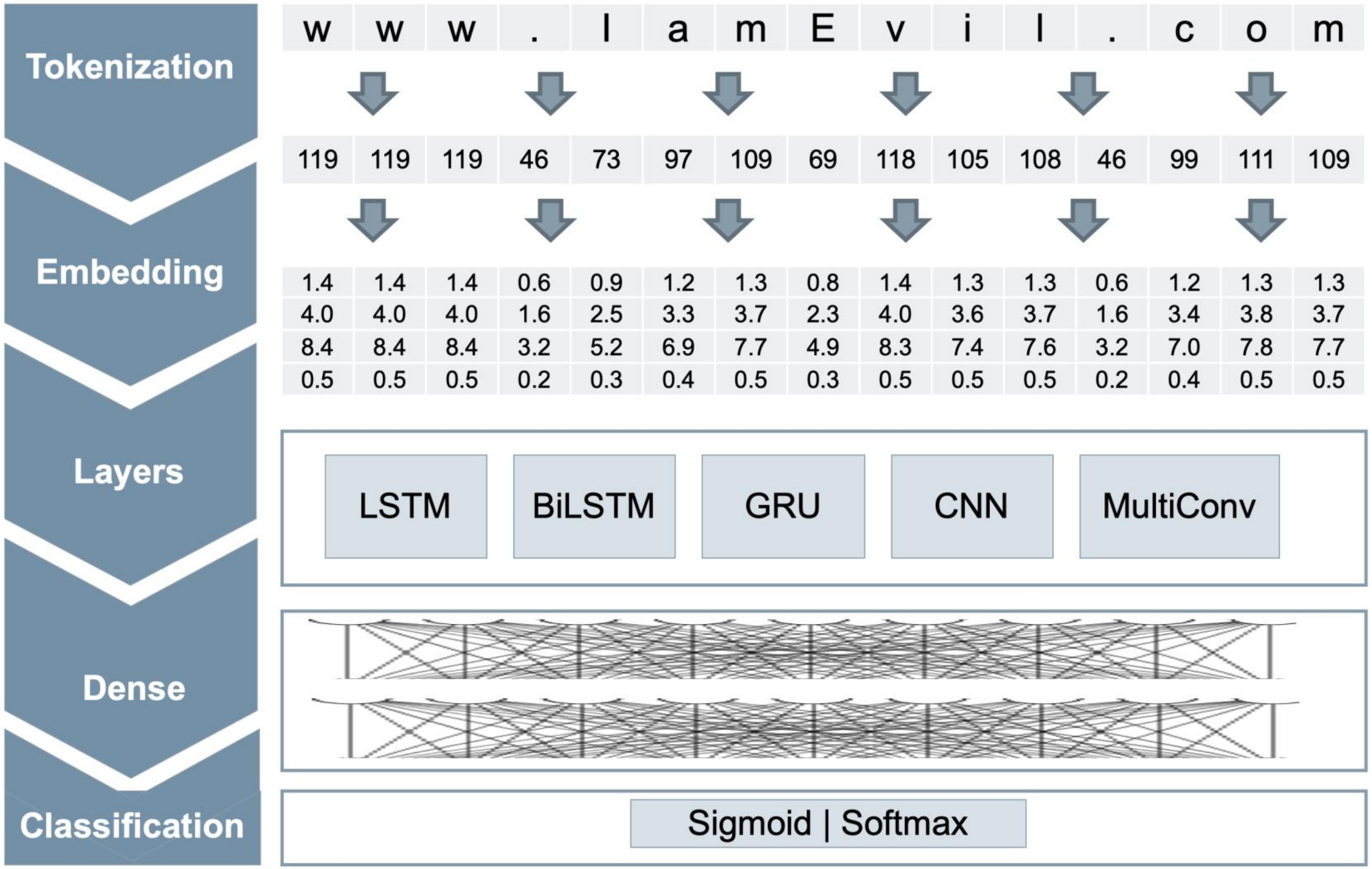


1. Characters are converted to ASCII tokens

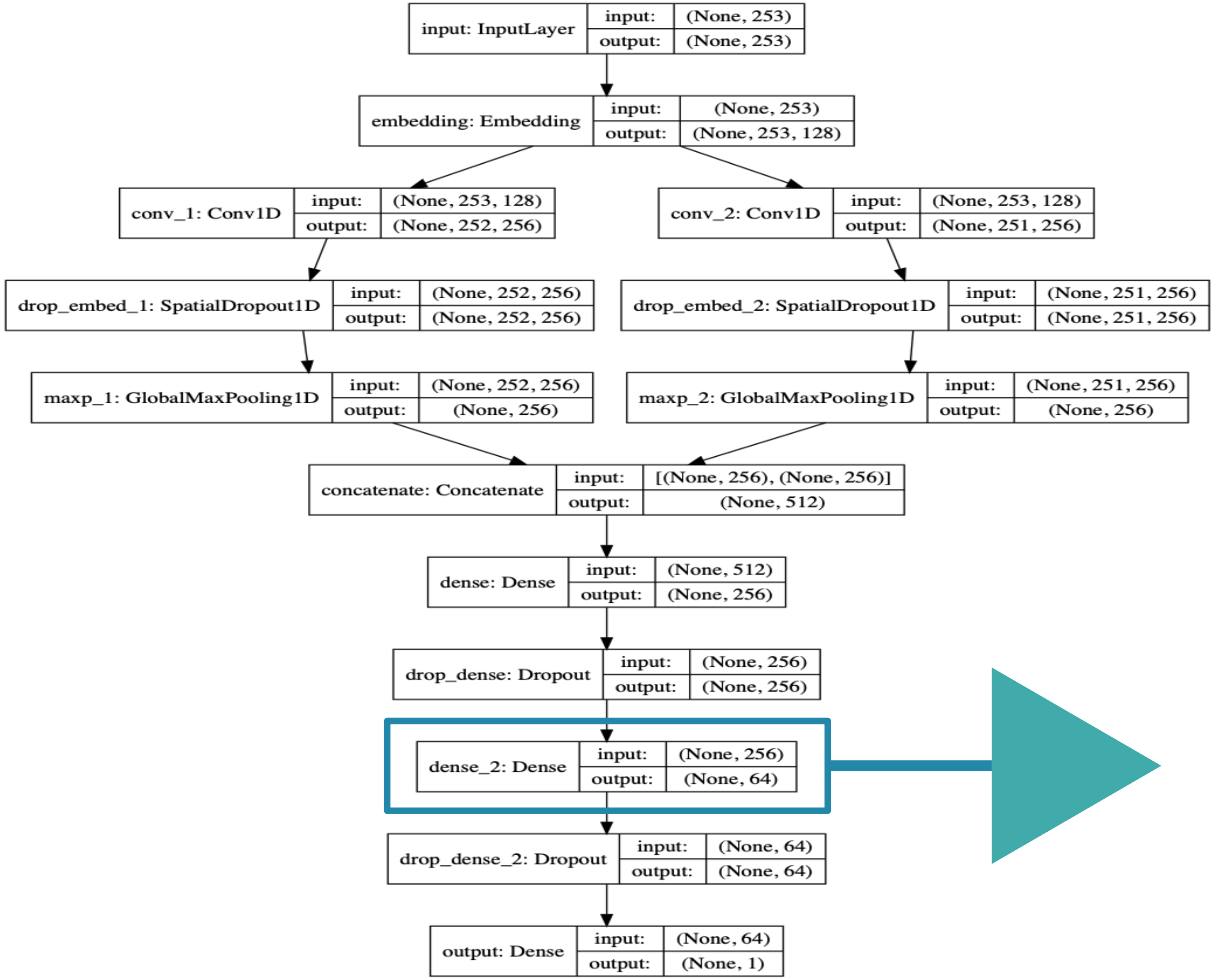
2. Tokens are embedded into multi-dimensional vectors

3. Forward layers or Recurrent layers can be utilized to generate features

4. Fully connected layers can be used to increase the model depth

5. A suspiciousness score is assigned based on the output of sigmoid output neuron or softmax layer

Example CNN Layer with UMAP



domain	label
simonettecaileigh.net	1
kimberleedonaldson.net	1
savingdrivetechnology.com	2
durforcogivprasufor.ru	3
kokkoku-anime.com	normal-traffic
personpermitmountain.com	2

Results

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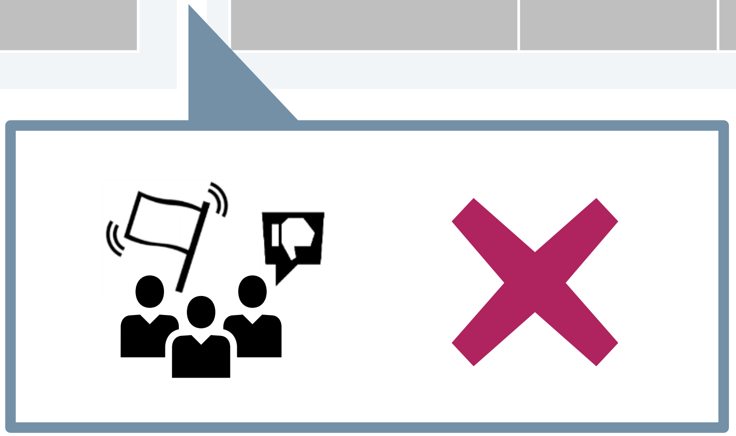
Deep Learning Approach

Accuracy (%)	TPR (%)	**FPR (%)**	TNR (%)	FNR (%)
98.64	98.08	**0.77**	99.23	1.02

Shallow Learner Approach (

Accuracy (%)	TPR (%)	**FPR (%)**	TNR (%)	FNR (%)
84.36	96.78	**31.56**	68.43	3.21



Design Platform and Operationalize

Operational Challenge

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500,000+ Hosts

50,000+ Events per second

6+ TBs of data per day

24/7 Operations

Highly Volatile Loads (20x)

Operationalize Smart!

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500,000+ Hosts

50,000+ Events per second

6+ TBs of data per day

24/7 Operations

Highly Volatile Loads (20x)

Don't burden your team with

Auto Scaling (Elasticity)

Auto Failover

Server Patching

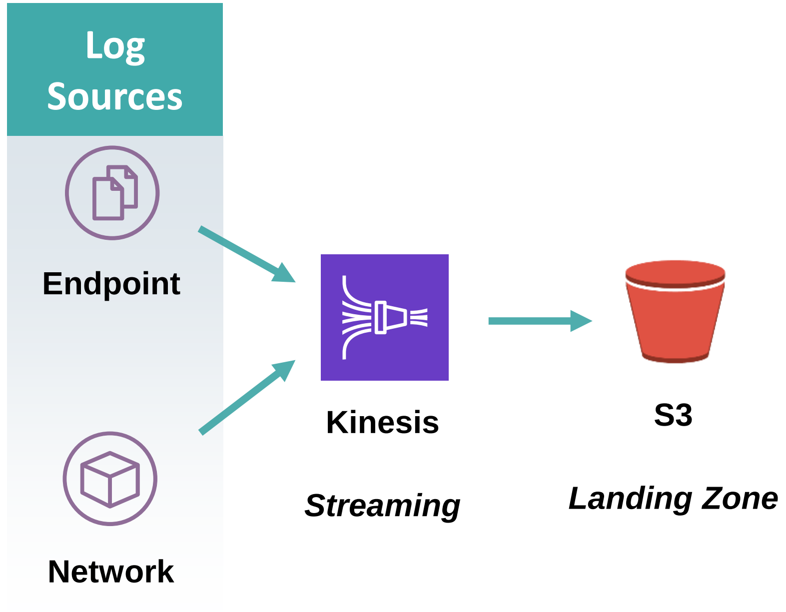
Backups

Go Serverless

Important Pipelines

Ingest and Inference

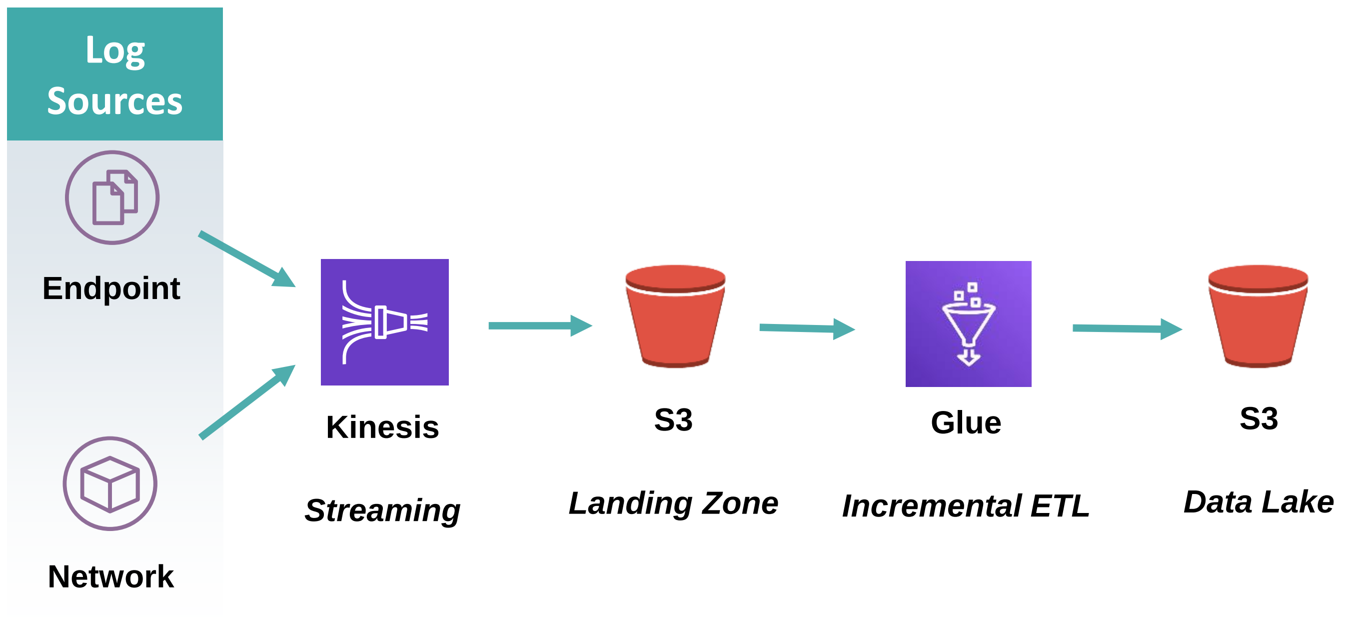
1 Ingest Pipeline: Store AD- Proxy- Email-Logs into the S3



Important Pipelines

Ingest and Inference

2 **ETL: Cleaning and Transforming Data**



Important Pipelines

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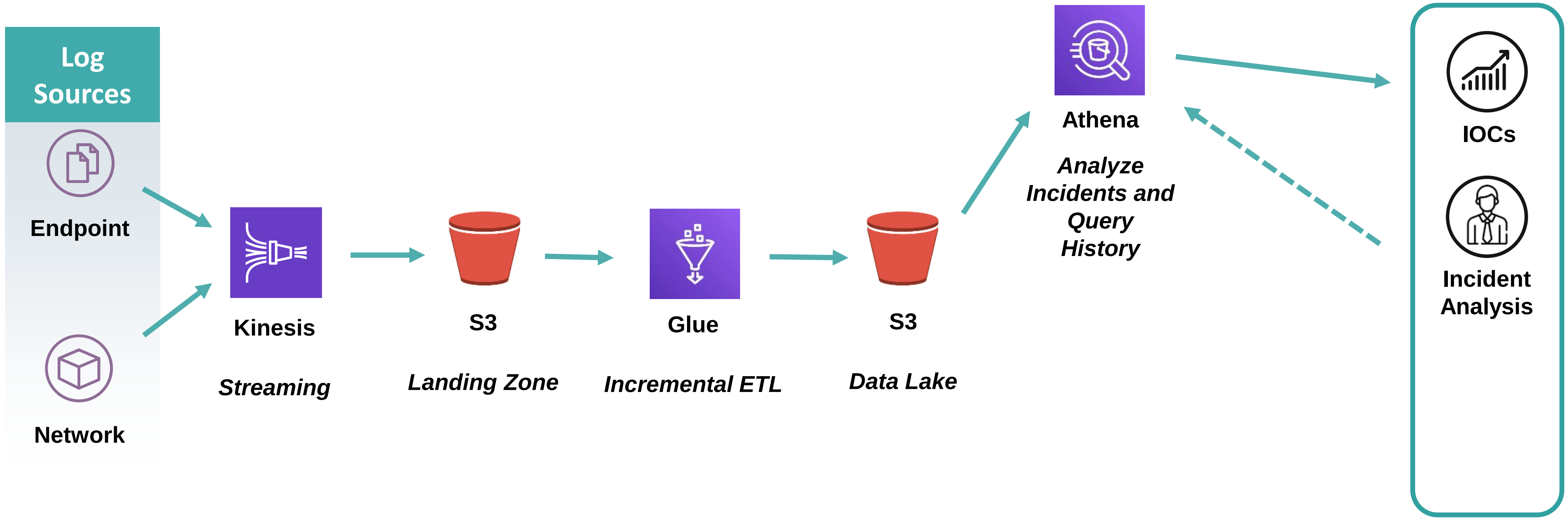
Ingest and Inference

3 Presentation: Create Statistics, Provide Data to Analysts



Important Pipelines

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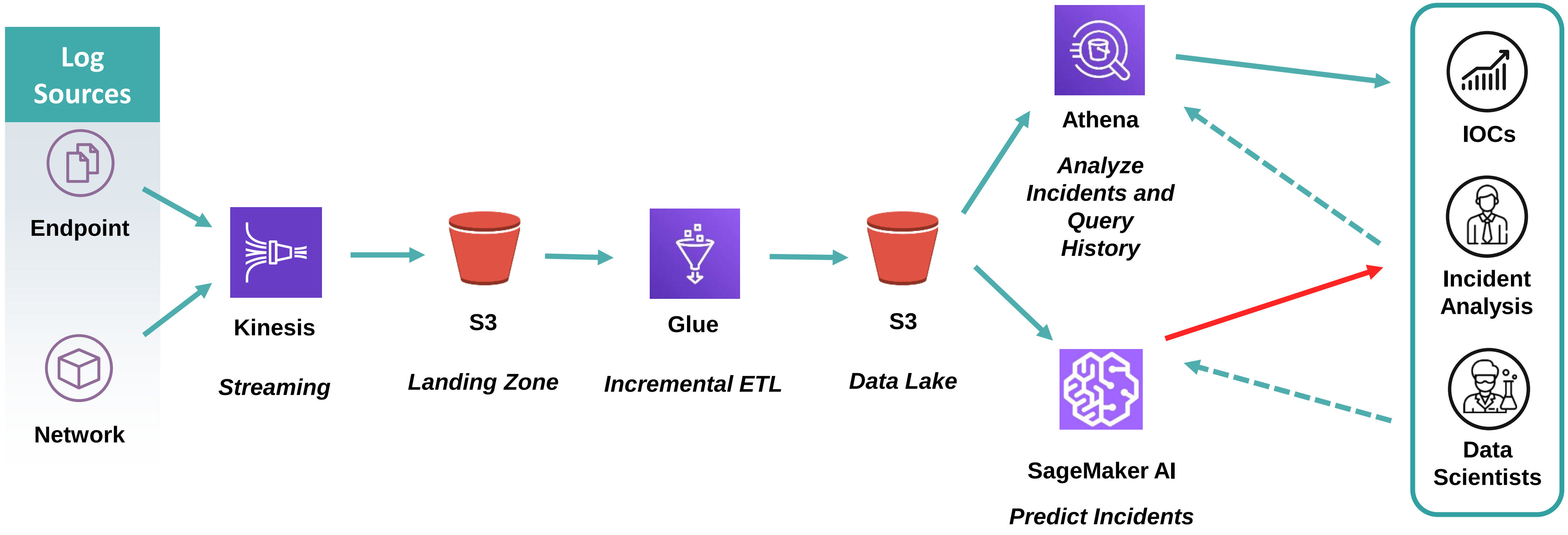
Ingest and Inference

4 **Detection: Real Time Prediction of Threats**



Important Pipelines

Ingest and Inference

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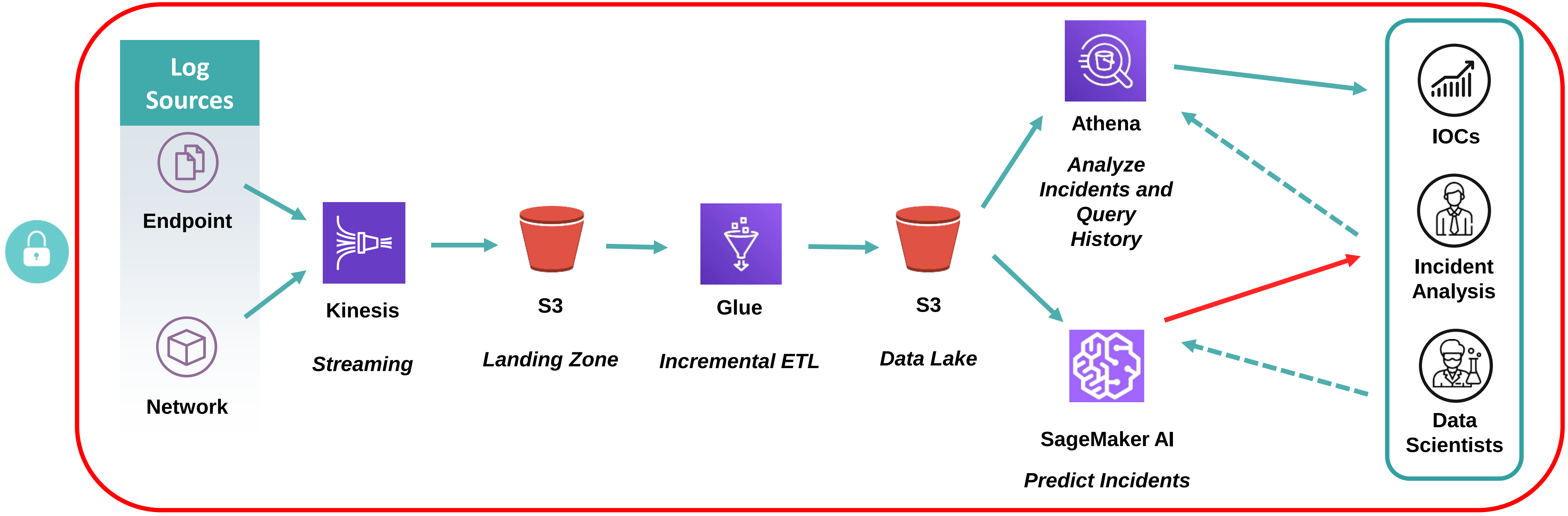
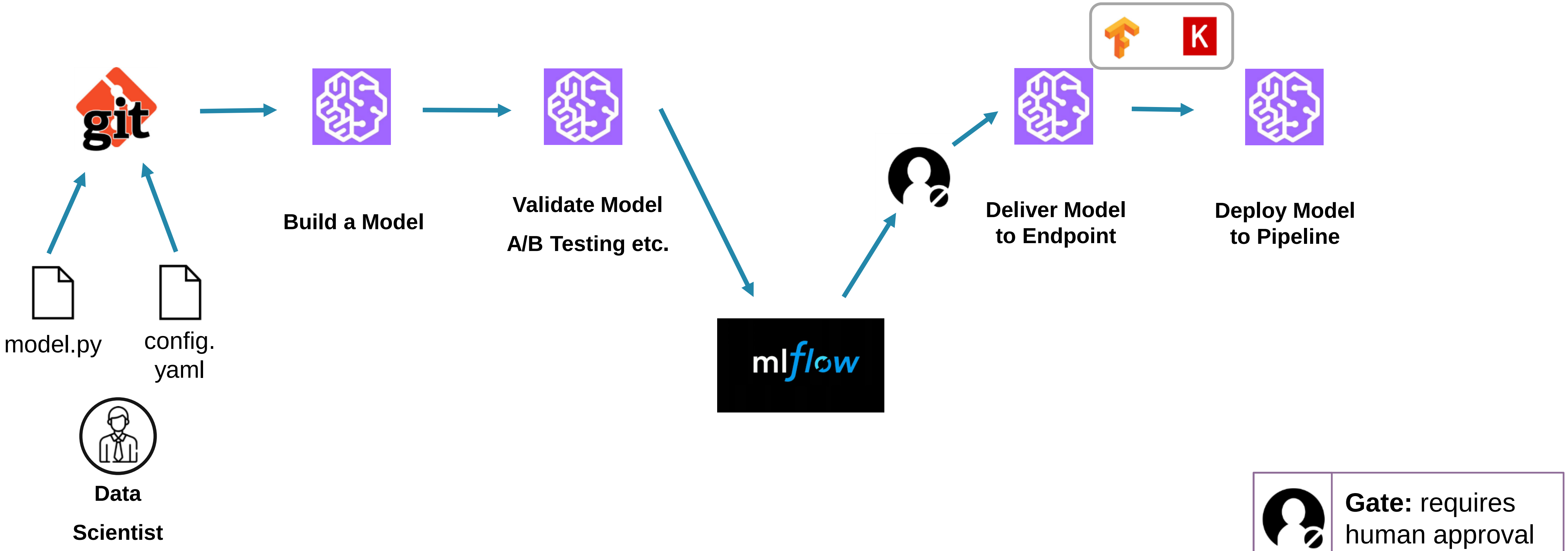
4 Detection: Real Time Prediction of Threats



Important Pipelines

AI Model Generation and Deployment



Important Pipelines

AI Feedback Loop

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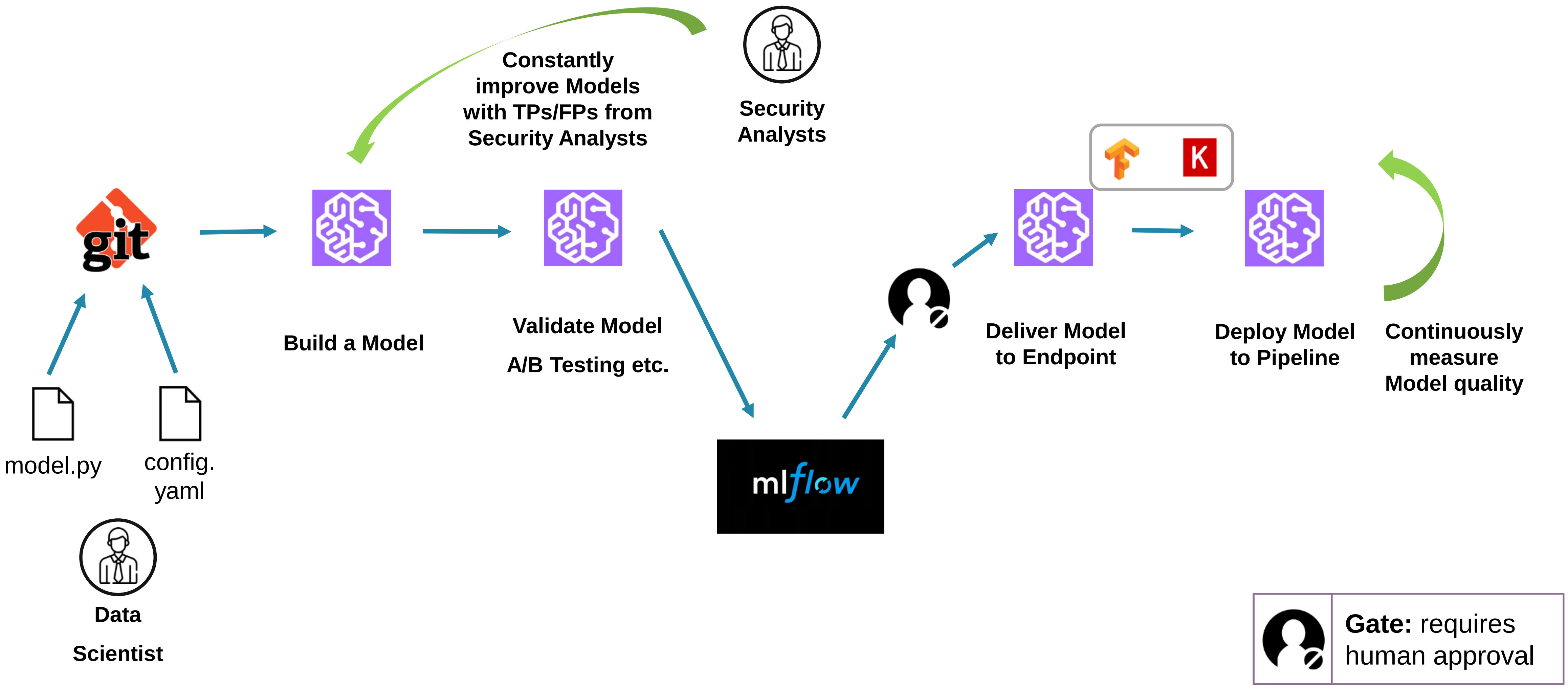

Thank You