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(Un-)Natural language processing

Defensive AI in practice

Mages Monkeys Bananas Leopards

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CrowdSec TLDR

- French Startup founded in 2020
- Team of ~35 people distributed over Europe
- Been there for a bit more than 2 years
- We produce an open source IDPS/WAF

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Security software TLDR

Lightweight agent that reads your logs/traffic

Logs/traffic are matched with rulesets/signatures

Detected intruders are sent to remediation

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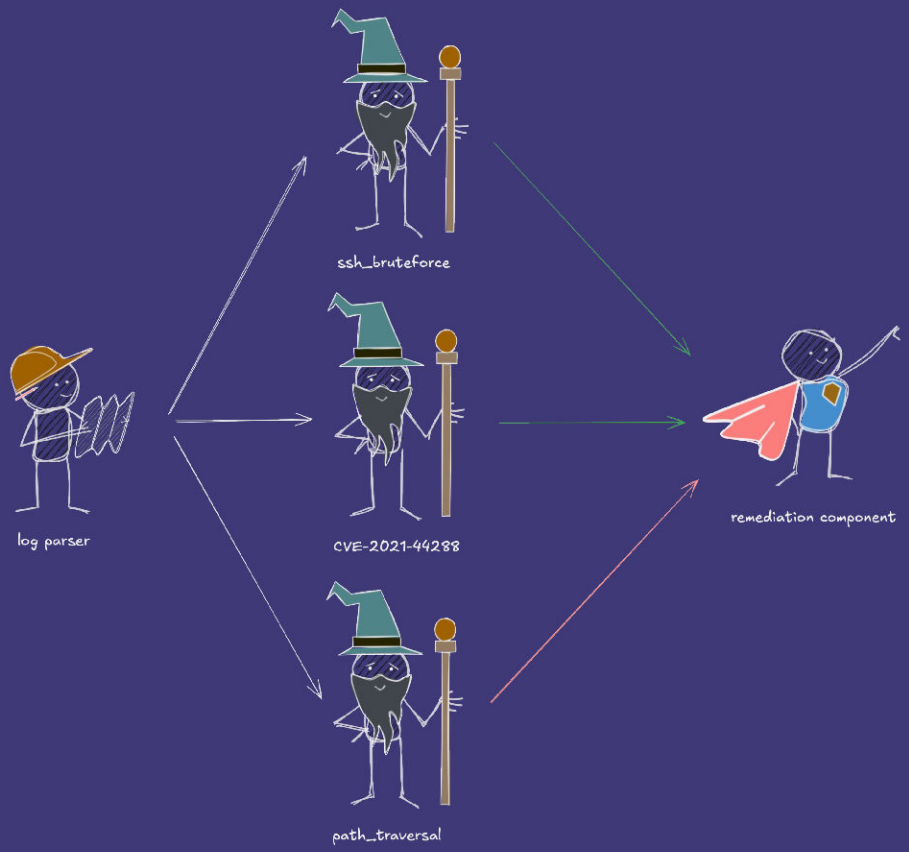
ssh_bruteforce
log parser
CVE-2021-44228
remediation component
path_traversal

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but...

Who teaches the mages to read?

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The Update Problem

For a security tool to be effective, the detection signatures need to be updated continually and in a timely manner.

This incurs a cost both on our side and on the customer side.

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On the other hand:

/blog/the-new-air-jordan-is-here
/store/home
/store/search?query=air%20jorden
/store/search?query=air%20jordan
/store/search?_jinjadbg=.forName(“java.lang.Runtime
/cart?product_id=374987&quantity=12
/checkout

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!!!

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Conclusion

If you had a monkey that would read all your logs, it could detect attacks by simply reporting anything that looks abnormal!

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If you had a monkey that would read all your logs, it could detect attacks by simply reporting anything that looks abnormal!

=> This is a good usecase for AI

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The Plan

Create a generic outlier detection algorithm to act as a first line of defense against novel threats.

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Questions going into the project

- Does this famed AI monkey even exist?
- Can we transfer monkeys or do we have to train one per customer?
- Are these monkeys cost effective?

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The trick

URIs have a known structure which we can use to turn a URI into something that looks like a sentence.

Afterwards we simply copy-paste the tricks we learned from natural language processing.

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Example

“/store/search?query=air%20jordan”

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Example

“/store/search?query=air%20jordan”

=> split on /, ?, = (url structure)

“store search query air%20jordan”

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Example

“/store/search?query=air%20jordan”

=> split on /, ?, = (url structure)

“store search query air%20jordan”

=> split on “%20” (url encoding)

“store search query air jordan”

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The method

Based on “sec2vec” paper by Gniewkowski et al.

Basically a two step process:

- Turn URI into a vector (embedding)
- Run a second ML model to classify embeddings into good and bad

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Sec2Vec pipeline

URI -> English sentence (base transform)

English -> sequence of numbers (tokenizer)

seq. of numbers -> vector (embedding)

vector -> label (classifier)

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Results

Sec2Vec actually works!*

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Results

Sec2Vec actually works!*

* on research data

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The data problem

Due to various constraints (legal, privacy etc.) the logs publicly available to researchers are terrible

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The data problem

Due to various constraints (legal, privacy etc.) the logs publicly available to researchers are terrible

In fact, this year there was a paper on how bad they generalize to real logs

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Trading NDAs for bananas

To fix the issue with the synthetic research dataset we reached out to our users and customers to send us their logs

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Benefits on better data

Models trained on our dataset performed significantly better, dropping about 9/10 attacks used by a common vulnerability scanner

The new models also generalized better to new url structures, i.e. one model could serve multiple users

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Conclusions

- Researchers have pretty good ideas
- Researchers have pretty bad data
- With better data, language models have serious potential in network defense

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Bonus Chapter: Performance

To illustrate the trade-offs faced by security teams, consider a standard website service with some form of security software attached

We can differentiate between two modes of security operations: in-band and out-of-band

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In-band system

User sees content only after they pass security

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Out-of-band system

User can connect before the security system cleared them

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If out-of-band is so insecure...

Why would anyone use an out-of-band security solution?

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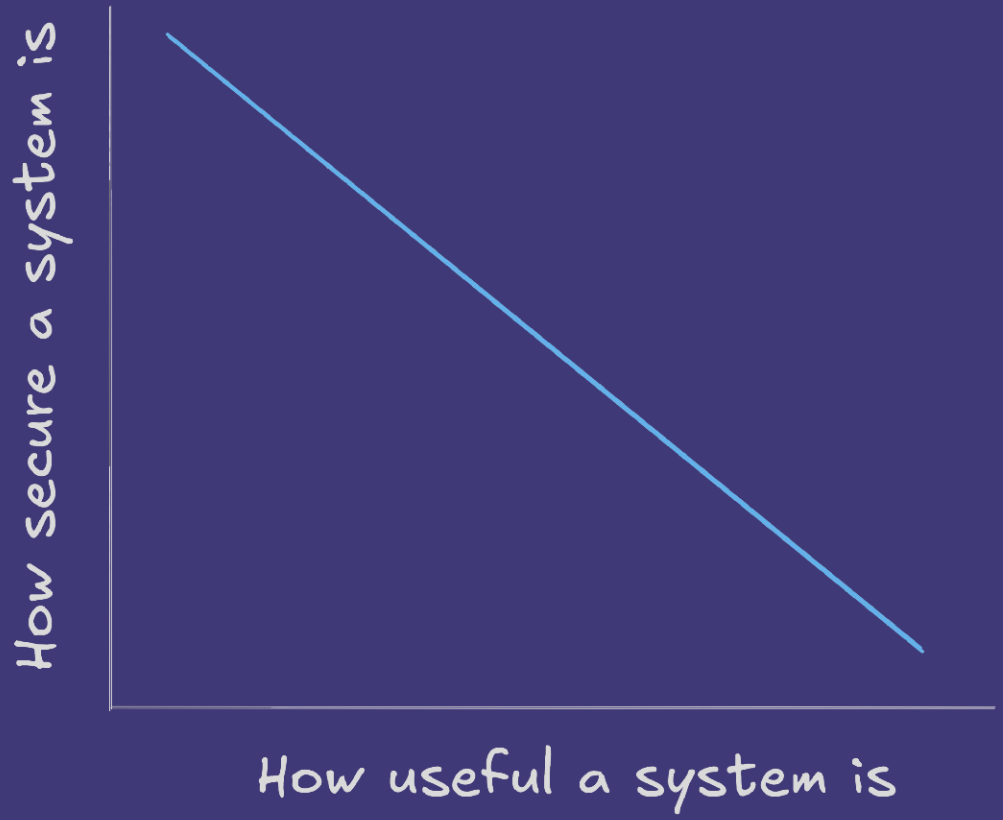
The security tradeoff



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Performance considerations

In an in-band system, a user will see higher time-to-first-byte, an important business objective

In an out-of-band system, an attacker might get in before the security system has time to respond

Such competing objectives we also have to worry about with the ML models

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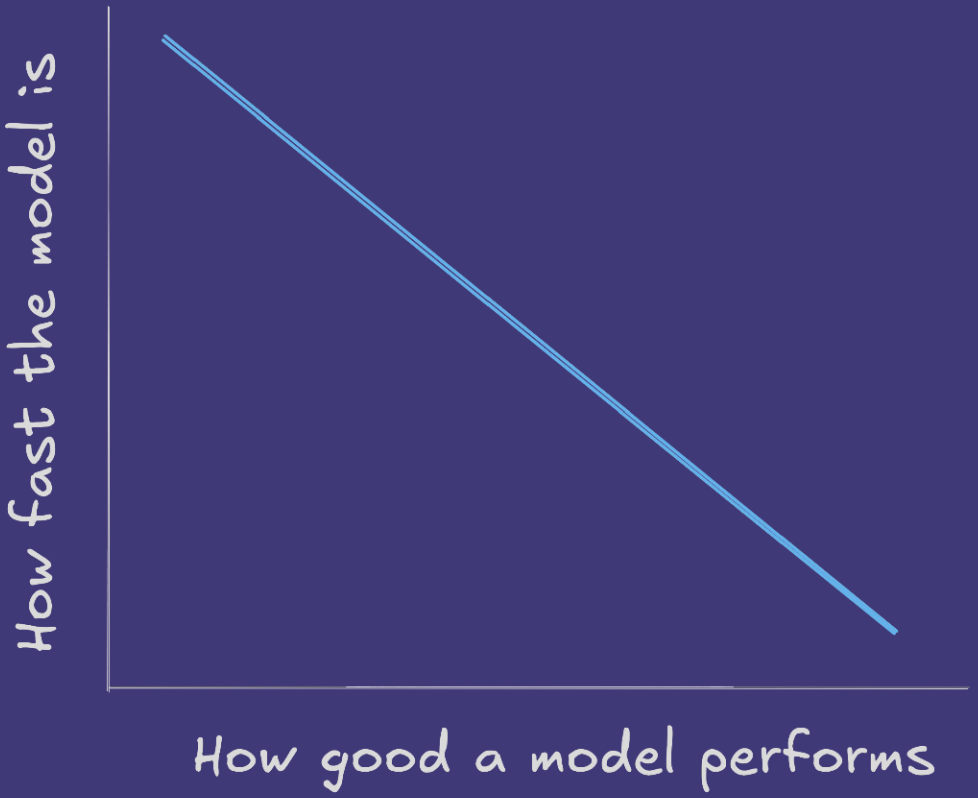
The Deep Learning tradeoff



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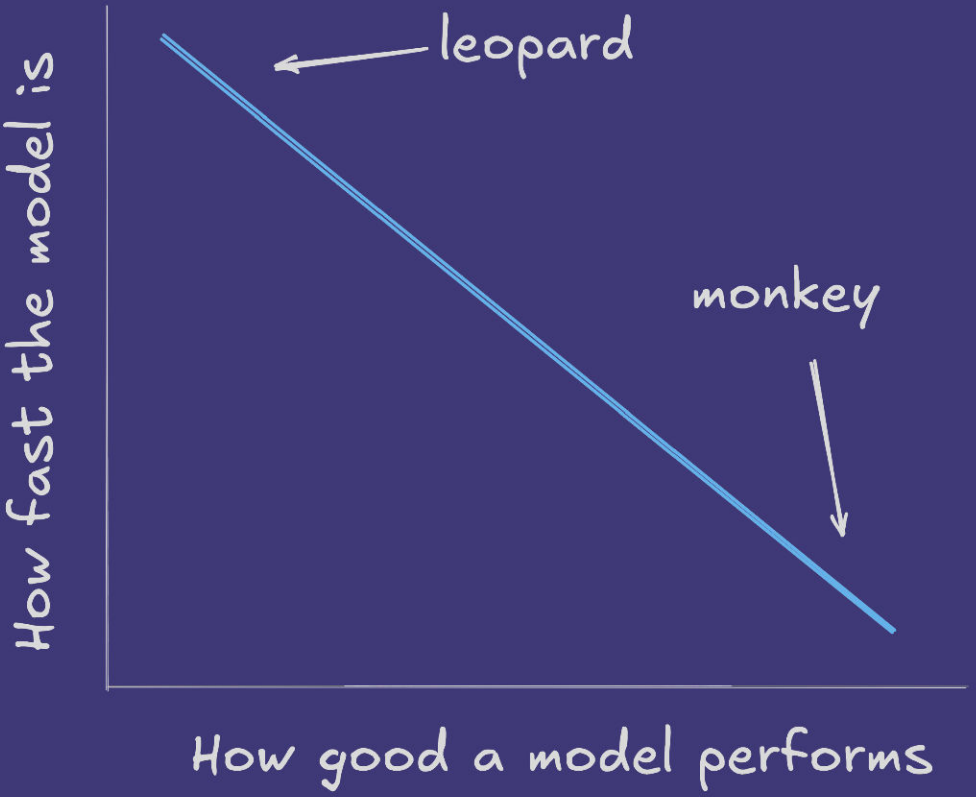
The monkey leopard tradeoff



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Performance considerations

Big ML models (monkeys) require specialized hardware to run fast which an is unnecessary cost factor for a webserver

There are optimizations that can be done, such as quantization or decreasing model size (leopards) but these come at an effectiveness cost

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Conclusions

- Researchers have pretty good ideas
- Researchers have pretty bad data
- With better data, language models have serious potential in network defense
- Feasibility of running big ML models still an open question

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Answers coming out of the project

- Does this famed AI monkey even exist?
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Answers coming out of the project

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Answers coming out of the project

- Does this famed AI monkey even exist?

=> Yes

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=> Yes, if we feed them enough bananas

- Are these monkeys cost effective?

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Answers coming out of the project

- Does this famed AI monkey even exist?

=> Yes

- Can we transfer monkeys or do we have to train one per customer?

=> Yes, if we feed them enough bananas

- Are these monkeys cost effective?

=> No, but we can train leopards instead

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Next steps

We are open-sourcing the models and the plugin to run sec2vec within the crowdsec software soon-ish (Q4/Q1)

Repo:
github.com/crowdsecurity/crowdsec

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