Use of AI for Log Analysis in CI/CD Pipelines

Bachelor Thesis - Defence

Maid Ališić

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FH Oberösterreich · Campus Hagenberg

Supervisor: FH-Prof. Dipl.-Ing. Dr. Stefan Wagner

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Research questions

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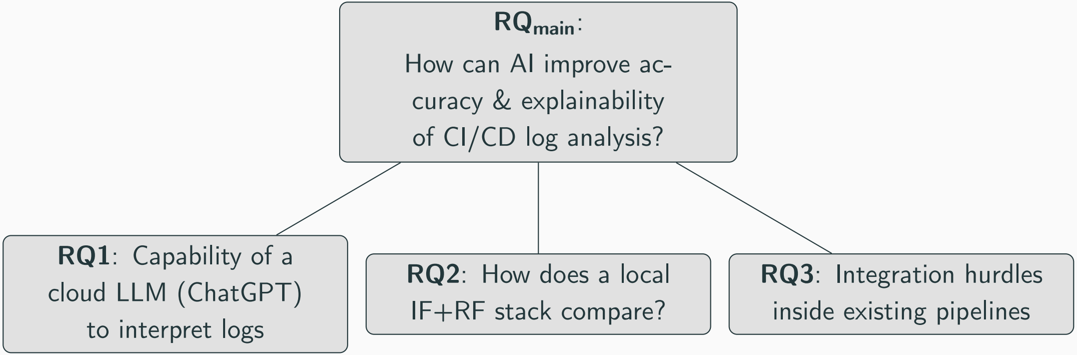

$\mathbf{RQ}_{\mathbf{main}}$: How can AI improve accuracy & explainability of CI/CD log analysis?

RQ1: Capability of a cloud LLM (ChatGPT) to interpret logs

RQ2: How does a local IF+RF stack compare?

RQ3: Integration hurdles inside existing pipelines

Problem context

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- Logs may expose customer IDs, therefore they must remain on-premises (no cloud export).

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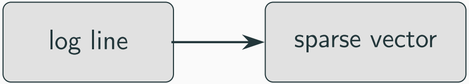
2. **Concept drift** - each merge may rename tests or switches.
3. **Latency pressure** - analysis must finish before runner teardown.
4. **Alert fatigue** - regex rule sets grow without bound.

Method

Vectorisation pipeline ①

1. **Normalise** - strip timestamps, colours, IDs.



Vectorisation pipeline ①

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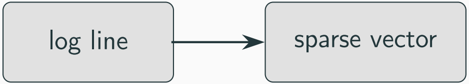

log line

sparse vector

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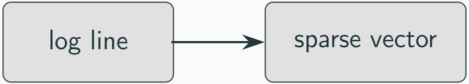

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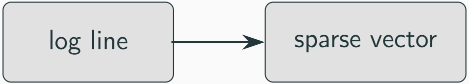
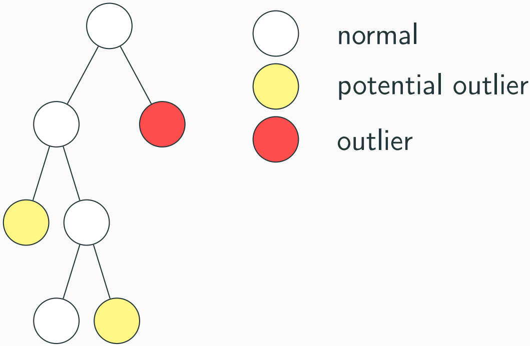


Isolation Forest ② - intuition

- Random binary partitioning isolates unusual lines in fewer splits.



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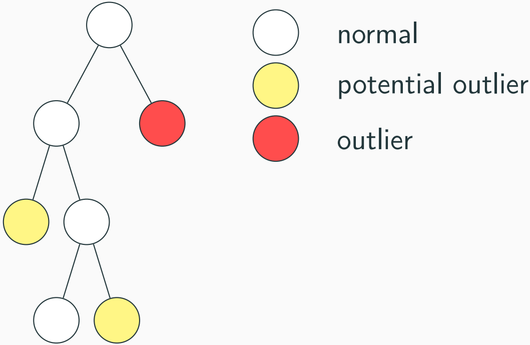
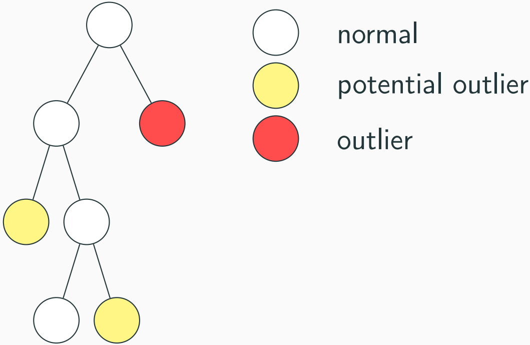


Isolation Forest ② - intuition

- Random binary partitioning isolates unusual lines in fewer splits.
- Score $s(x) = 2^{-h(x)/c(n)} \in [0,1]$ if high → outlier.
- CPU-only: $\approx 30\,\mu s$ per line.



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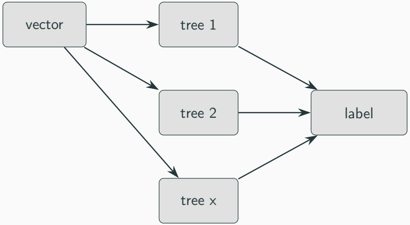

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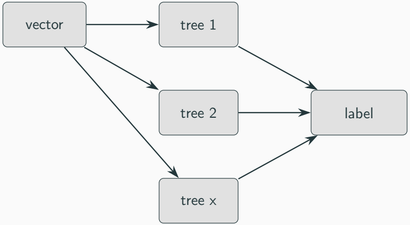

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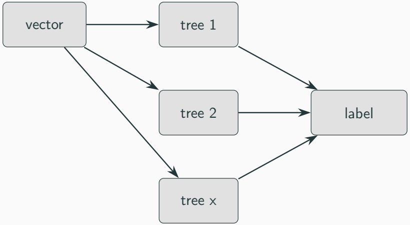
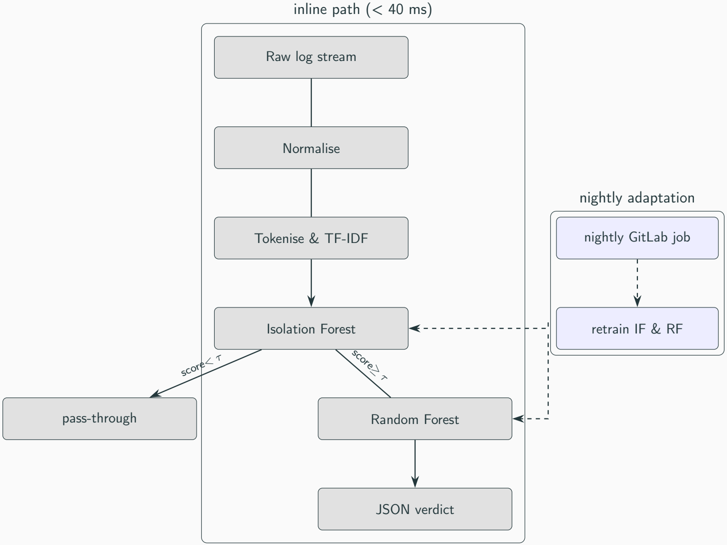
- Nightly retrain < 90 s; warm-start handles drift.



Architecture

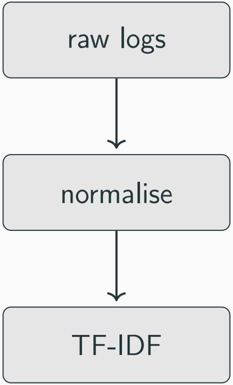
End-to-end pipeline ($<$ 40 ms inline)



Data & evaluation

Datasets & metrics

- 117 k *macOS* logs + 655 k *OpenSSH* logs



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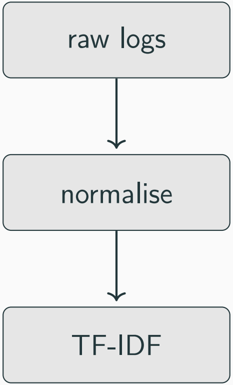

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normalise

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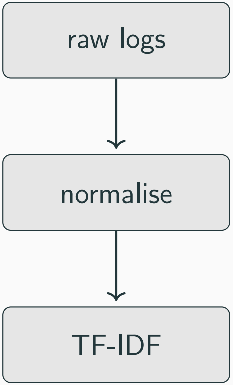

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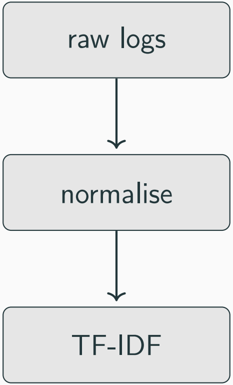
- Split 70 / 15 / 15 % (training / validation / testing)
- Metrics: Precision, Recall and F_1



Results

Headline numbers

	Precision	Recall	F_1
Detection (Isolation Forest)	0.91	0.88	0.89
Classification (Random Forest)	0.99	0.99	0.99
Regex Baseline	0.286	0.286	0.286

$$F_1 = 2 \cdot \frac{P \cdot R}{P + R}$$

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- **GDPR compliant**: logs never leave the VPN.

Wrap-up

Take-away

Light-weight on-prem ML matches AIOps SaaS

without latency, cost or privacy pain.

Questions welcome - thank you!