



Logging requirement for continuous auditing of responsible machine learning-based applications



POLYTECHNIQUE
MONTREAL

UNIVERSITÉ
D'INGÉNIERIE

GIGL, Polytechnique Montréal

By Patrick Loic Foalem, Leuson Da Silva, Foutse Khomh, Heng Li, Ettore Merlo



OUTLINE

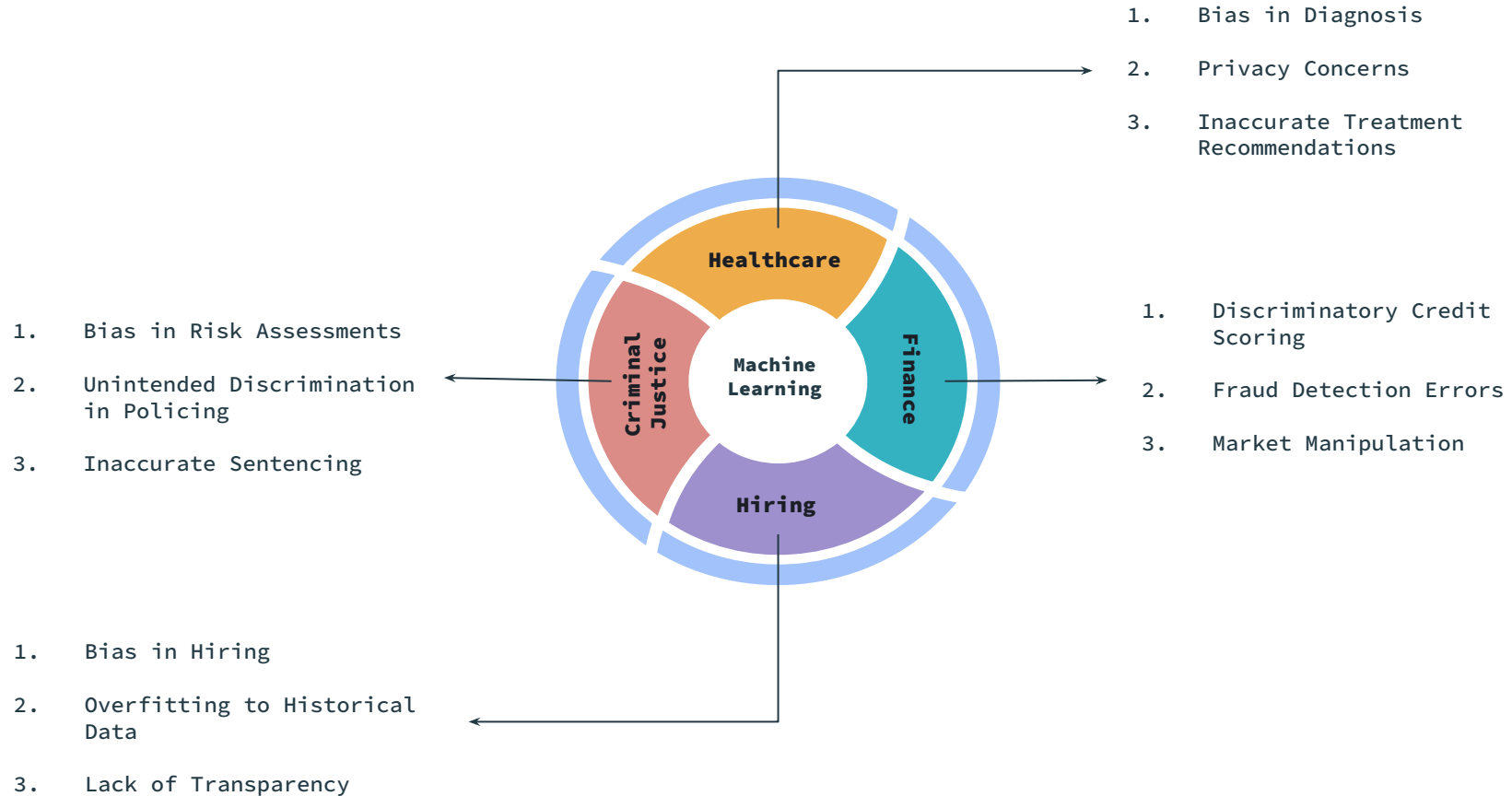
- ❖ MOTIVATION
- ❖ RELATED WORKS, GAP, AND CONTRIBUTIONS
- ❖ STUDY DESIGN
- ❖ RESULTS, FINDINGS, AND RECOMMENDATIONS
- ❖ CONCLUSION

1. MOTIVATION

High-stakes AI.
Real impact.
No room for error.



Why is Responsible AI Auditing Crucial for ML Applications?



What is Responsible AI?

Human Agency and Oversight

AI systems should serve people, respecting human dignity and autonomy. They should be developed to ensure that humans can oversee and control their use.

Technical Robustness and Safety

AI systems must be robust and resilient to technical issues, errors, and malicious interference. They should be designed to prevent harm and minimize risks to safety and reliability.

Privacy and Data Governance

AI systems should comply with data protection laws and ensure the privacy of individuals. They should handle data with integrity, ensuring high standards of data quality, and protect user privacy.



Transparency

AI systems should be transparent, with clear information about their capabilities, limitations, and design. This includes making human users aware when interacting with AI and ensuring interpretability.

Diversity, Non-discrimination and Fairness

AI systems must be developed to avoid discrimination and bias. They should be inclusive, promoting equal access, gender equality, and cultural diversity, and avoiding any discriminatory impacts.

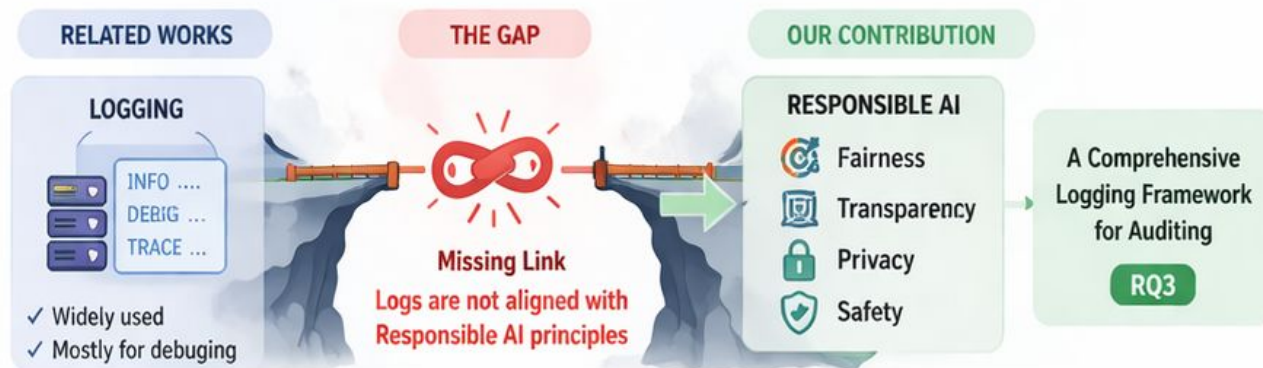
Societal and Environmental Well-being

AI systems should be used to benefit society and promote sustainable development. Their design and use must consider their long-term social and environmental impact, ensuring that they contribute positively to humanity.

Thanks to *Philipp et al*, *COMPL-AI Framework: A Technical Interpretation and LLM Benchmarking Suite for EU AI Act*, DOI: <https://arxiv.org/abs/2410.07959>

2. RELATED WORKS, GAP, AND CONTRIBUTIONS

We connect the dots between logging and responsible AI.



What Do We Already Know About Logging and Responsible AI?



Responsible AI Research

- Strong focus on core principles
- Extensive development of metrics
- Availability of dedicated tools and libraries
- Emphasis on model evaluation and post-hoc analysis
- Limited integration into system-level practices

- *Closing gap [Schiff et al.]*
- *Responsible AI catalogue [Lu et al.]*
- *Fairness tools [Nguyen et al.]*
- *Explainability [arya et al.]*

Logging in Machine Learning.

- Model performance monitoring (accuracy, loss, RMSE)
- Experiment tracking & reproducibility
- Model and data management
- Visualization & dashboarding
- Limited support for responsible AI auditing

- *Logging in ML [Foale et al.]*
- *Logging in DL [Chen et al.]*

Logging in Traditional Systems.

- Debugging & failure diagnosis
- System monitoring & observability
- Security & compliance auditing
- Guiding logging decisions
- Anomaly detection in Logs

- *Anomaly detection [Wu et al.]*
- *Logging decision Li et al.]*
- *Logging practice [Gu et al.] [Zeng et al.]*
- *Logging audit [reuben et al.]*

Research Gap



Research objectives



Investigating Logging Practices in ML Applications.



Identifying Key Responsible AI Metrics.




Proposing a Comprehensive Logging Framework for Responsible AI.

Three research questions.

 ★ **RQ1:** What responsible AI principles are considered by ML practitioners?

 ★ **RQ2:** What runtime information of the ML applications is logged to support responsible AI auditing?

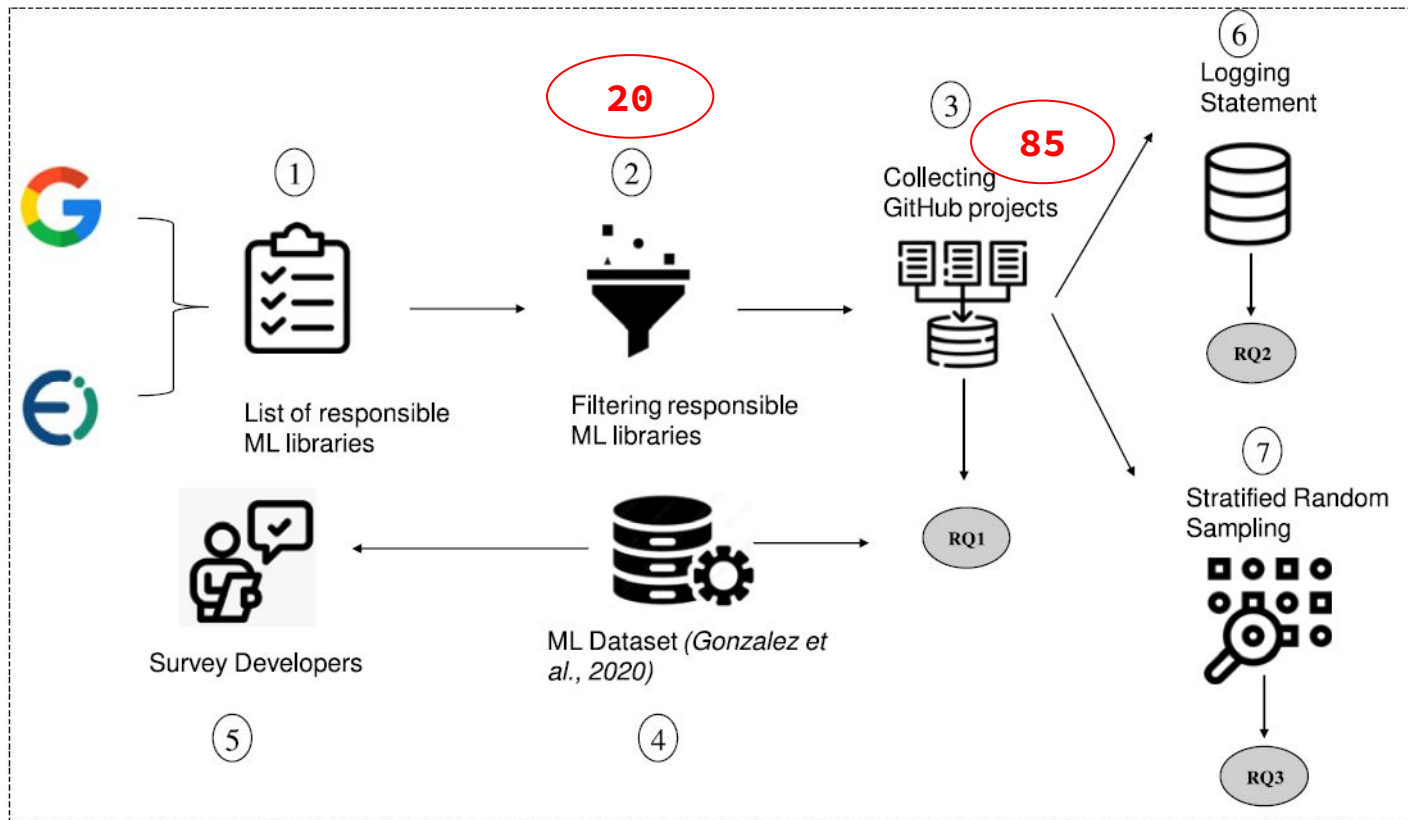
 ★ **RQ3:** What specific logging requirements and information are essential for effective auditing of responsible AI principles?

3. STUDY DESIGN

A large-scale, multi-method study for reliable insights.



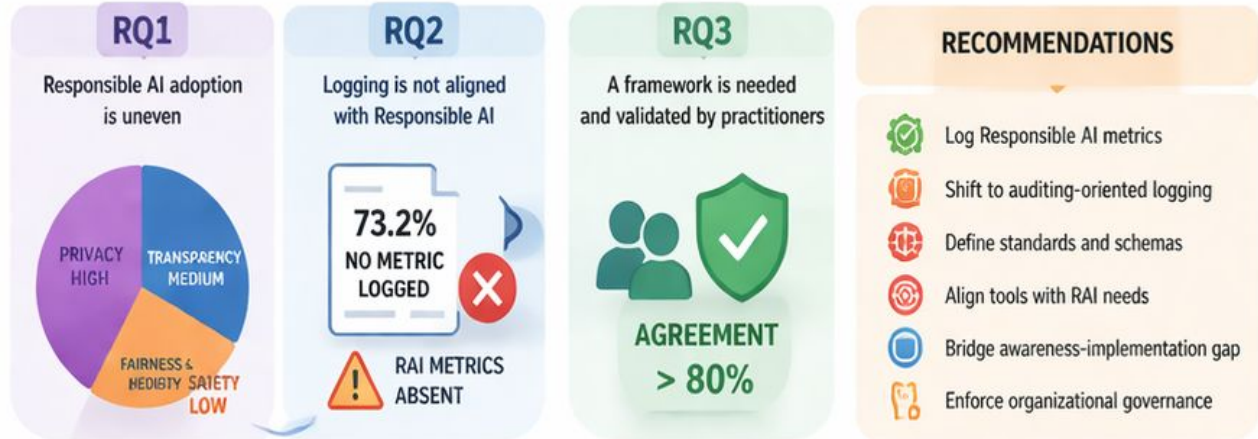
Study design



**Replication package
Try it out!**

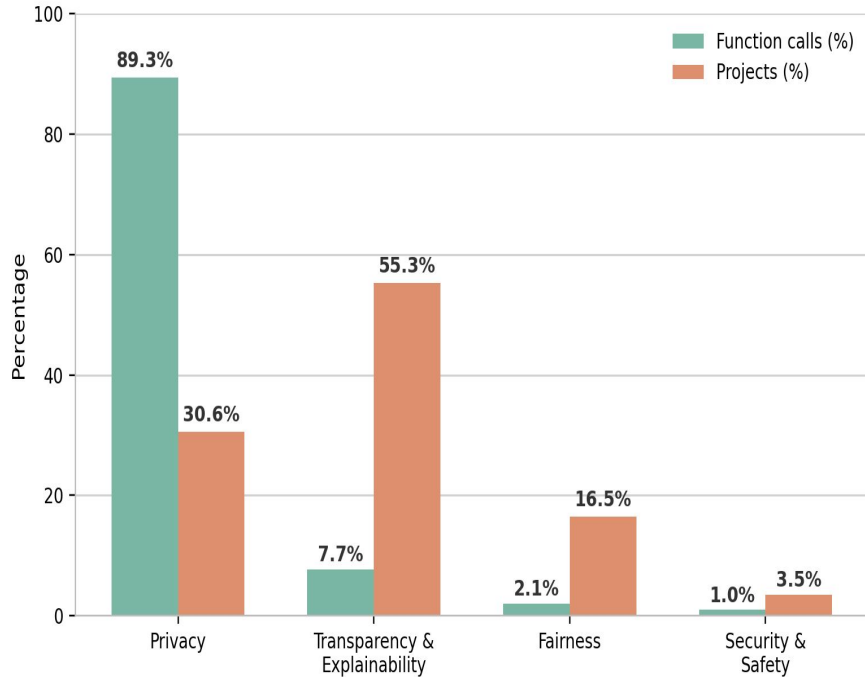
4. RESULTS, FINDINGS, AND RECOMMENDATIONS

What we discovered, what it means, and what to do next.

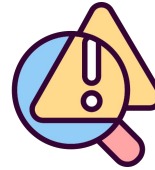


RQ1: What responsible AI principles are considered by ML practitioners?

Result (1): Responsible AI Adoption Is Uneven Across ML Projects



- ❖ **Privacy dominates implementation** in terms of function calls.
- ❖ **Transparency & explainability appears in more projects** than privacy.
- ❖ **Fairness and security remain marginal**, confirming uneven adoption.



8.1% of 382 issues



40.9% of 22 practitioners

Fig. 1: Responsible AI principles considered in practice.

RQ1: What responsible AI principles are considered by ML practitioners?

Result (2): Most ML Projects Consider Only One Responsible AI Principle

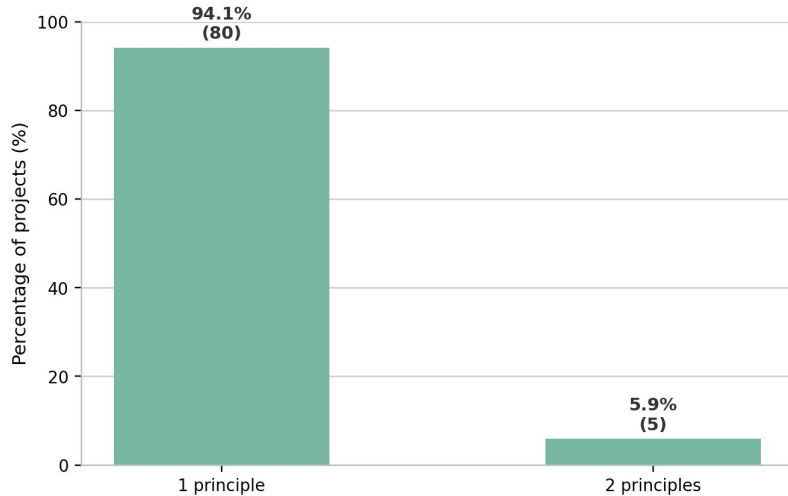
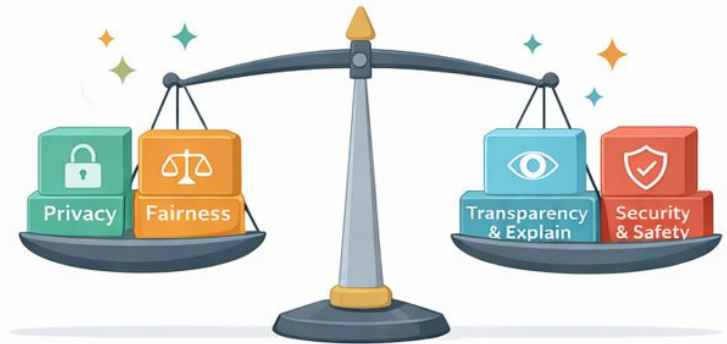


Fig. 2: Number of responsible principles considered in ML project.

Findings:

- Privacy dominates implementation (~90%).
- Fairness & security are rarely implemented (<3%).
- 94.1% of projects consider only one principle
- Perception-implementation gap exists



RQ2: What runtime information of the ML applications is logged to support responsible AI auditing?

Result (1): Hybrid logging libraries in ML.

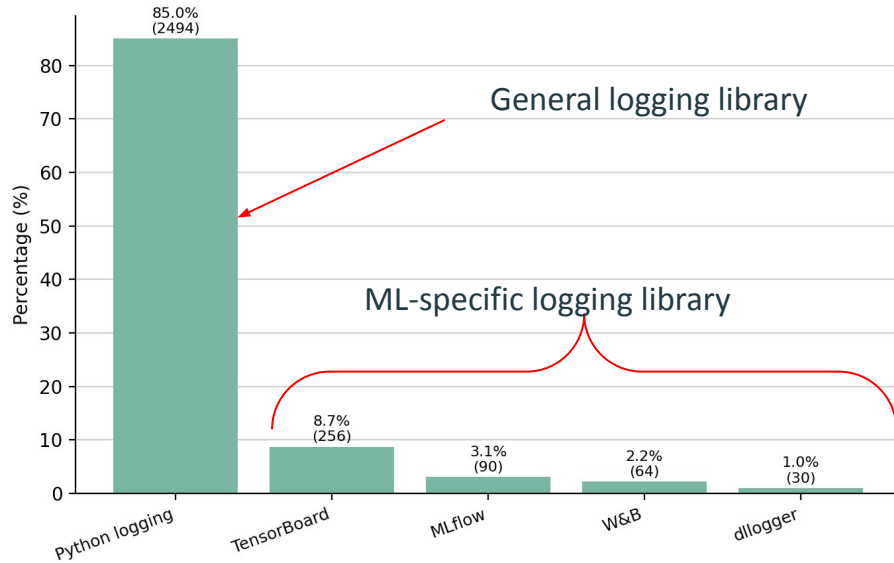
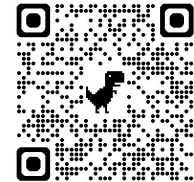


Fig. 3: Logging libraries used in ML project.

- General-purpose logging dominates
- ML-specific tools are secondary



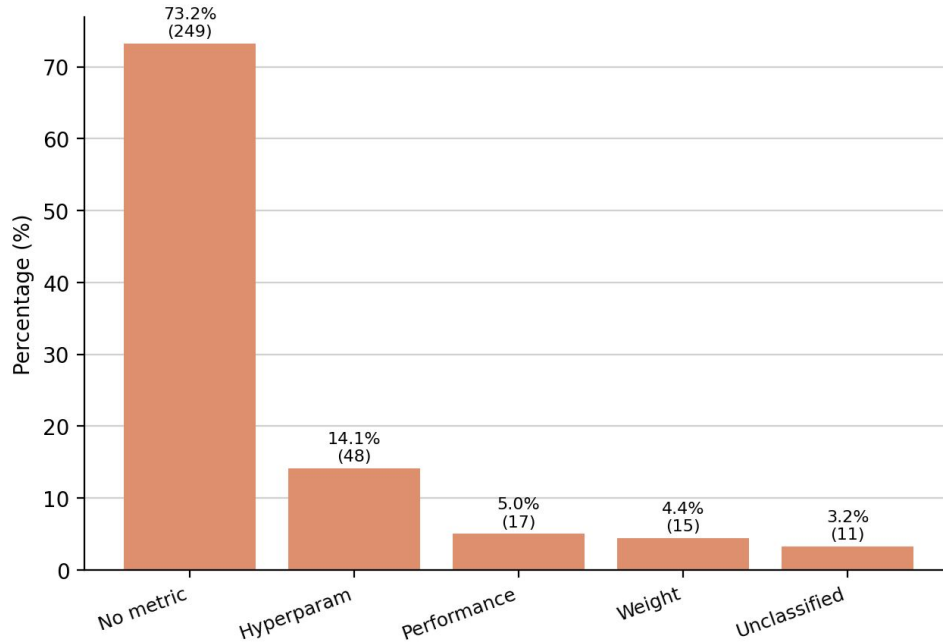
Logging in ML [Foalem et al.]



Logging in DL [Chen et al.]

RQ2: What runtime information of the ML applications is logged to support responsible AI auditing?

Result (2): Responsible AI metrics are largely NOT logged



- 73.2% of logs contain NO metric
- Limited ML-specific metrics
- Responsible AI metrics are absent

**Zero logging
statement
related to RAIP**

Fig. 4: Logging statement content.

RQ2: What runtime information of the ML applications is logged to support responsible AI auditing?

Result (3): Responsible AI is not operationalized in logging practices

Do your current logging practices support responsible AI principles?



RQ3: What specific logging requirements and information are essential for effective auditing of responsible AI principles?

Result (1): A Logging Framework for Responsible AI Auditing

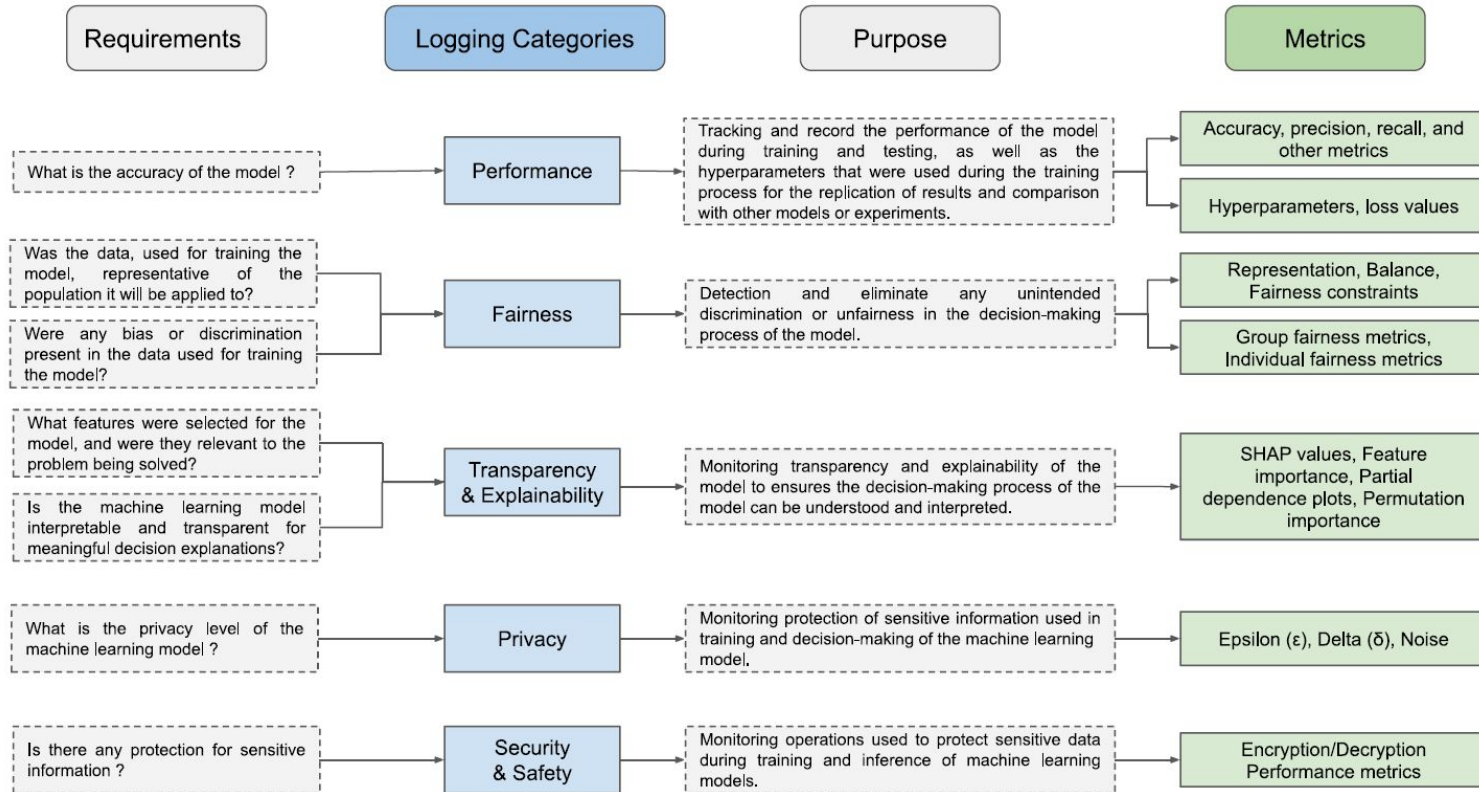


Fig. 5: Logging Framework for responsible ML applications.

RQ3: What specific logging requirements and information are essential for effective auditing of responsible AI principles?

Result (2): Practitioner Validation of the Framework

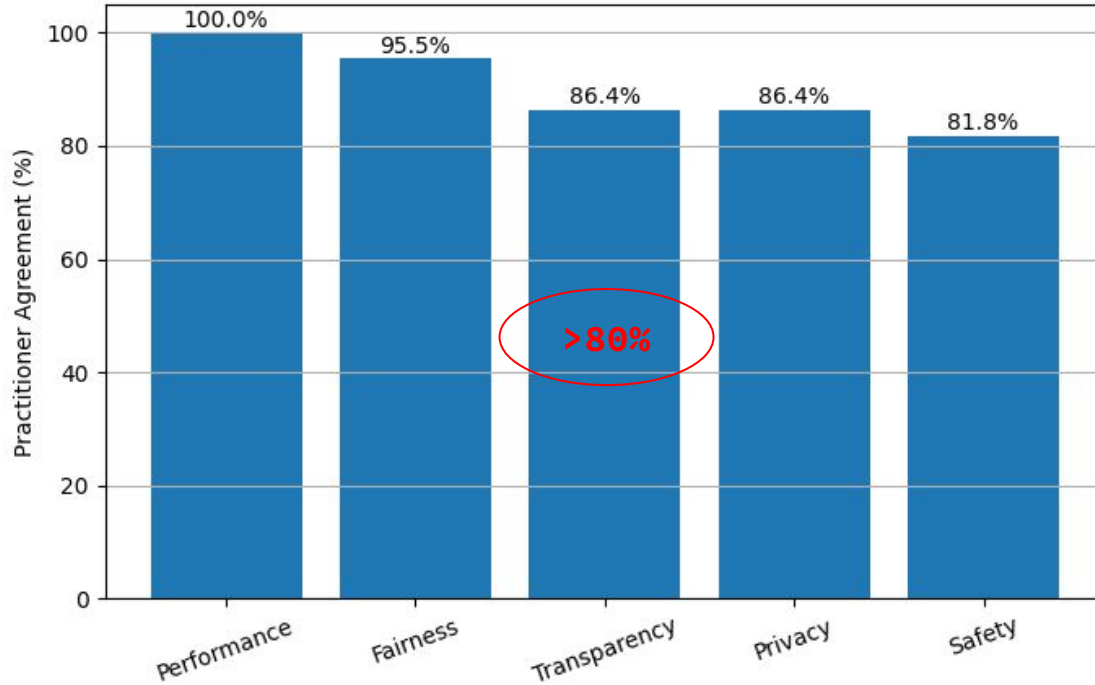


Fig. 5: Logging framework for responsible ML applications.

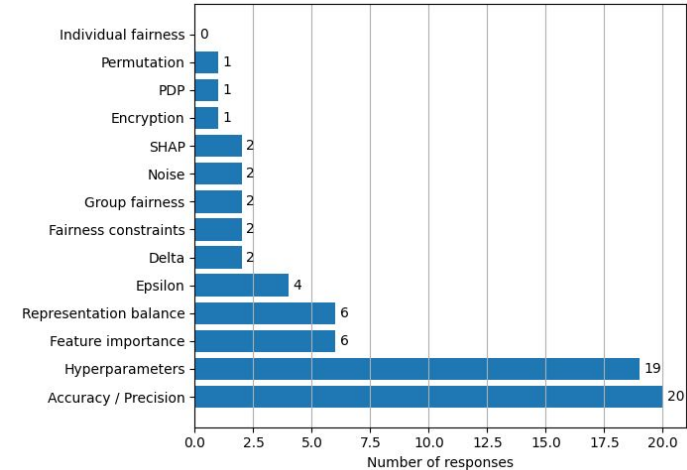


Fig. 6: Practitioners overview on different logging metrics.

Our recommendations

Recommendations for Responsible AI Logging

01 → Log Responsible AI metrics



02 → Shift from debugging → **auditing** logging



03 → Define logging standards



04 → Enhance ML tools



05 → Translate awareness into practice

06 → **Establish** governance for Responsible AI logging



CONCLUSIONS



Patrick-loic.foalem@polymtl.ca



- Recommendations for Responsible AI Logging**
- 01 → Log Responsible AI metrics
 - 02 → Shift from debugging → auditing logging
 - 03 → Define logging standards
 - 04 → Enhance ML tools
 - 05 → Translate awareness into practice
 - 06 → Establish governance for Responsible AI logging