ICOMP
Instituto de Computação

SPHERE
Research Group

UNIVERSIDADE FEDERAL DO AMAZONAS
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UFAM

SE4AI: Structured AI/ML Enabled **Software Development Process**

ICSE Companion '26 -
Doctoral Symposium

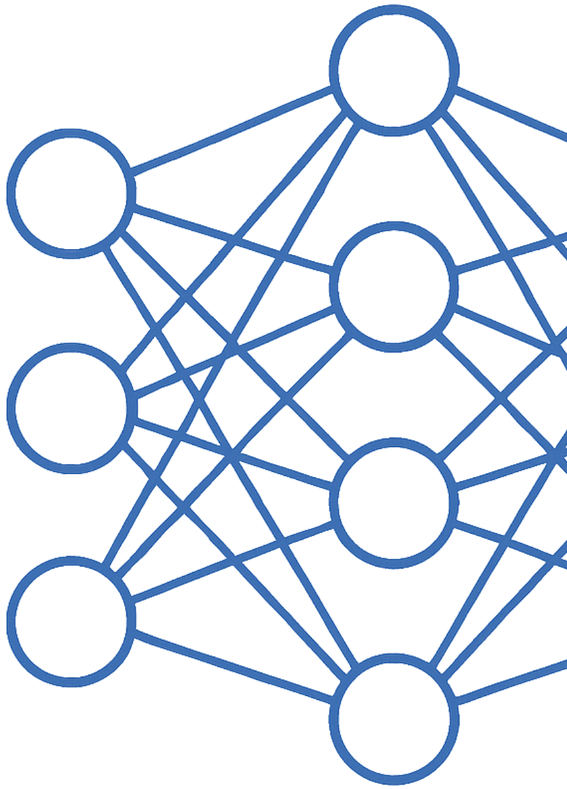
Abril 2026

felpsmanzoni.github.io/
projects/research/se4ai_icse_2026

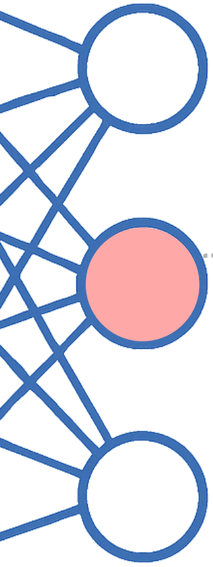
Background

As **early as 2025**, AI has **shifted from** a **research focus to widespread implementation**, with roughly **77%** of electronic devices containing some form of AI [1]:

- Over **70,000 AI startups** are operating globally;
- **88%** of organizations report **regular AI use** in at least one business function, with **23%** scaling **agentic AI systems;**
- Also, AI is increasingly being **present at everyday tasks**, objects and activities with **Waymo** providing **150,000 rides a week.**



[1] *https://hai.stanford.edu/ai-index/2025-ai-index-report*



Issues on output

However, **roughly 80% of these projects fail** to deliver sufficient **quality** and deliver **planned requirements**.

Derived from input

Mainly issues are related to poor **data quality**, **leadership & definition**, and due to the **"PoC trap" [2].**

Pain points

While **AI research is migrating to AI development** in industry and real world, the research area **have not prepared** grounds for a **structured development process** that enables **quality deliverables**, where applied DevOps are still [3]:

- Ad Hoc oriented;
- Fragmented;
- Poorly aligned with SE practices;

[2] *https://www.pertamapartners.com/insights/ai-project-failure-statistics-2026*
[3] *Nascimento et al. (2020), Lorenzoni et al. (2021)*

Motivation

Literature and **Industry** cases show that still today AI development and projects **suffers with** [3]:

- Misaligned requirements;
- Poor data readiness;
- **Poorly aligned with SE practices;**
- Rework due to model mismatch;
- Integration failures;
- **Lack of quality assurance;**

Main concept

Mainly, literature have shown that traditional SE practices and processes cannot fix these issues

Reasoning

AI/ML projects differ very much from Traditional Software development, mainly in data and infrastructure needs

[3] *Nascimento et al. (2020), Lorenzoni et al. (2021)*

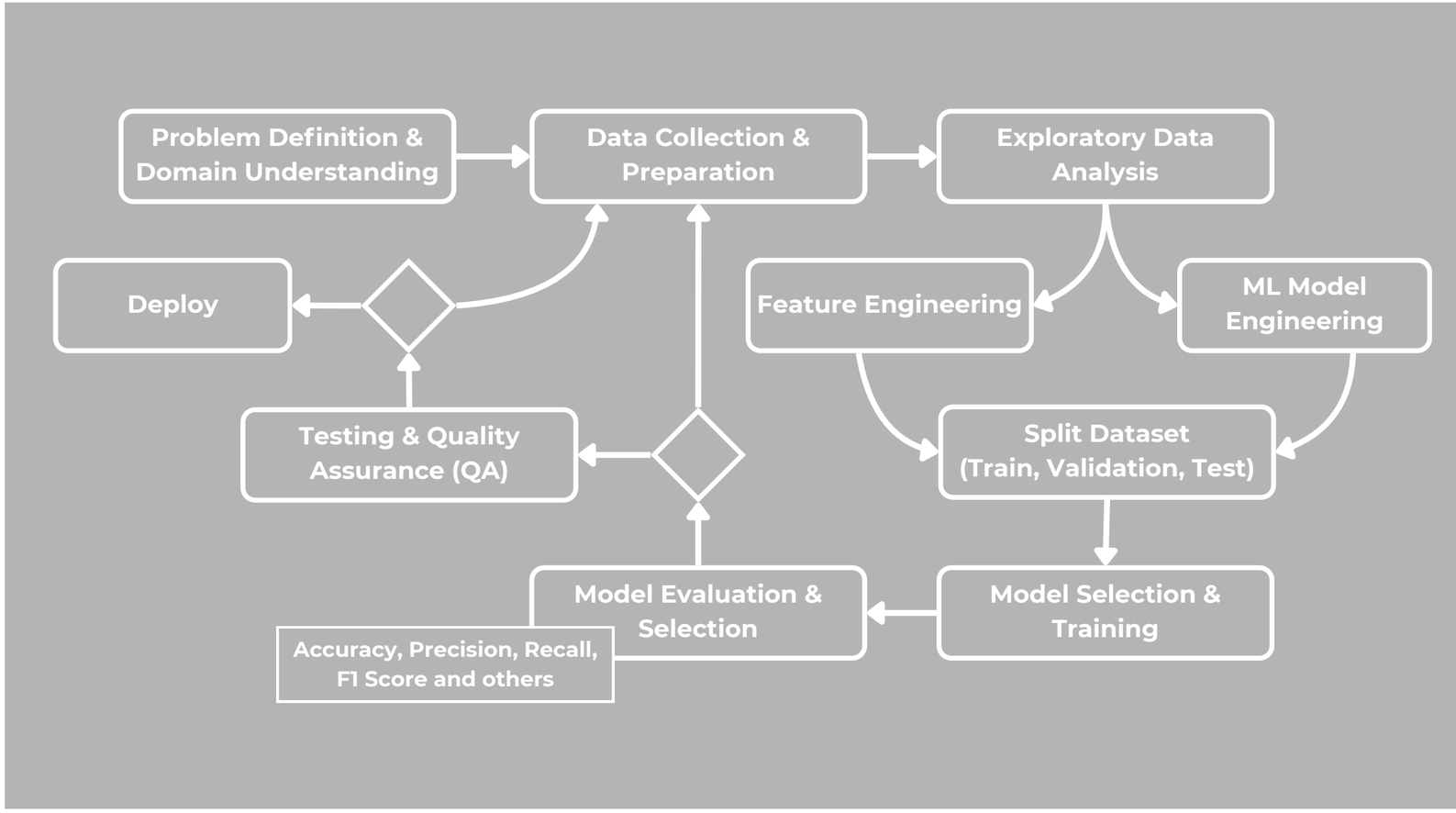
No process that

- Covers the full AI/ML lifecycle;
- Integrates data + model + software;
- Ensures quality accross stages;
- Supports planning and estimation;

Also, current solutions are **fragmented, phase-specific** and **not actionable end-to-end**

Problem

This brings us to the **current problem** where **no integrated SE process exists** that covers all needed aspects of AI development



Research Hypothesis

"A structured and empirically grounded software development process life cycle that can measurably improve the quality, predictability, and alignment of AI/ML-enabled software systems."

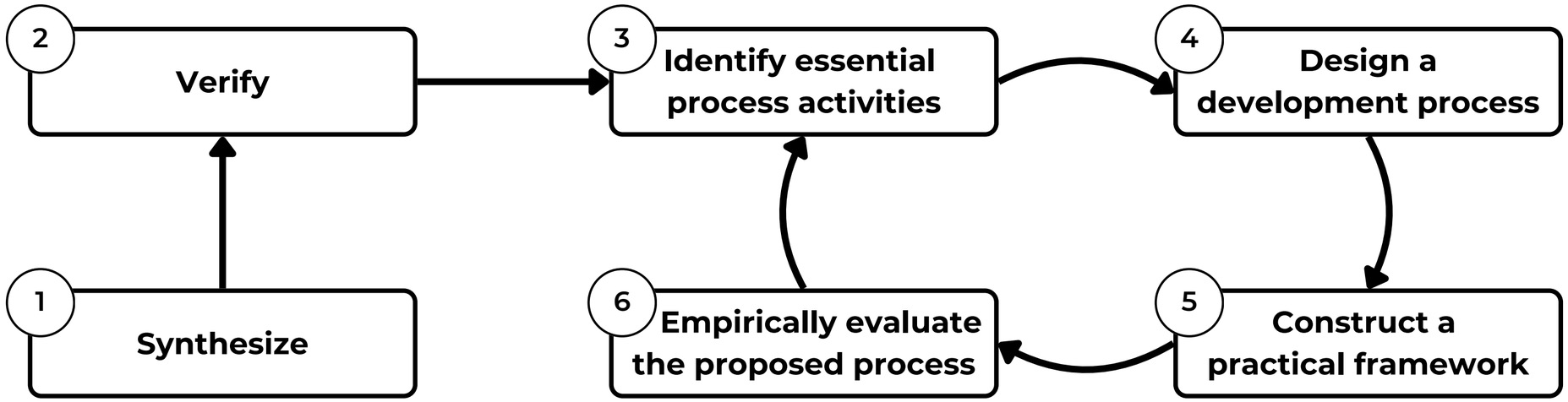
This hypothesis considers that this process enables to

- **Impove AI/ML software quality generally;**
- **Improve the predictability of the system outcome;**
- **Improve the system allignment to the expected outcome and real world;**

for a given AI/ML-enabled software system.

Research Objectives

Following a **DSR approach** and **evidence-based cycle**, the objectives can be synthesized through a cyclic flow where some objectives can be repeated untill process maturity is satisfied.



Core **Contribution**

GOAL: To allign and embed AI/ML with Software Engineering practices

Process V0

Embeding the **Continuous Quality Assurance, Iterative experimentation & System-level validations** into the development process

Process V1

Integration of **Data Lifecycle, Model Lifecycle & Software Lifecycle** into the development process

Process V2

Tailorize and adapt **testing practices, SE practices and principles** and **embed** tailored SE concepts **into development process**

Methodology

The research **contributions** will be mainly **achieved** through some **methodology pillars:**

- **Sistematic Literature Review**
- **Survey** - Practices and Principles in the wild
- Grounded Theory - industry data
  - **Feasibility studies**
  - **Observation studies**
  - **Case studies** (industry)

Envidence-based process evolution and real-world content gathering for grounded theory.

Expected **Impacts**

Scientific

- End-to-end AI/ML SE process
- Structured lifecycle definition
- QA integration across stages

Industrial

- Better project estimation
- Reduced rework
- Improved system alignment
- Cross-team coordination

Current status

- ✓ Initial process (industry-driven)
- ✓ Early evidence paper

ICEIS 26'

Next steps

Practices and principles in the wild - **Survey**

Answer it now!

Thank you!

Support this research!

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