OVERCOMING THE CHALLENGES OF BLENDING HARDWARE VERIFICATION EXPERTISE WITH AI AND MACHINE LEARNING

SOHIL SRI MANI YESHWANTH GRANDHI

AGENDA FOR TODAY

- The Verification Challenge: The core problems we all face.
- The AI Promise & The Pitfalls: A realistic look at new technology.
- A Practical Framework: When to use ML vs. LLMs.
- Case Study 1 (ML): Predictive Test Selection in CI/CD.
- Case Study 2 (LLM): Intelligent Log Analysis for Debug.
- Building Your Hybrid Strategy: Actionable best practices.

THE VERIFICATION CHALLENGE: DROWNING IN COMPLEXITY

- The fundamental challenge in verification is that complexity grows exponentially, but our resources do not.

Common Pain Points We All Experience:

- Endless Regression Cycles
- The Debugging Haystack
- Coverage vs Reality

THE AI PROMISE & THE COMMON PITFALLS

- AI offers a path to work smarter, but it's crucial to avoid common mistakes.
- **The Promise** 🧠
  - **Prediction**
  - **Optimization**
  - **Insight**
- **The Pitfalls (Frequent Mistakes in Adoption)** 🚧
  - **"Magic Wand" Thinking**
  - **Wrong Tool for the Job**
  - **Garbage In, Garbage Out**

A PRACTICAL FRAMEWORK: WHEN TO USE ML VS. LLMS

Tool Type	Machine Learning (ML)	Large Language Models (LLMs)
Core Strength	**The Predictor & Classifier**	**The Parser & Generator**
Best For	Structured, numerical data (test results, code metrics, performance stats)	Unstructured text data (logs, specs, code comments, bug reports)
Key Use Cases	Predictive Test Selection Performance Trend Analysis Bug Triage Classification	Log Parsing & Summarization Generating Coverage Models from Specs Automating Documentation

CASE STUDY 1: COMPILER PERFORMANCE REGRESSION ANALYSIS WITH ML

- In a large compiler project like **LLVM**, a code change passes all functional tests but introduces a subtle 2% performance *degradation* on a critical customer benchmark. This is a massive problem, but how do you detect it reliably?
- Legacy Approach: Static Thresholding
- SOTA (ML) Approach: Time-Series Anomaly Detection

CASE STUDY 2: INTELLIGENT LOG ANALYSIS WITH LLMS

- **Problem:** A complex simulation using an open-source HDL tool like **Verilator** fails, producing a 100MB log file with interleaved messages from dozens of modules.
- **Legacy Approach**
- **LLM Approach**

BUILDING YOUR HYBRID STRATEGY: BEST PRACTICES

- How do you start integrating these powerful tools effectively?
  - Start Small, Solve a Real Problem
  - Augment, Don't Replace
  - Build a Solid Data Foundation
  - Keep Humans in the Loop

CONCLUSION & KEY TAKEAWAYS

- The verification crisis is a data problem, and AI provides a new set of tools to tackle it.
- Be Strategic
- The Goal is Augmentation
- Start Now, Start Small

QUESTIONS?