




Using AI/ML to Improve DV Productivity

DVClub Bristol

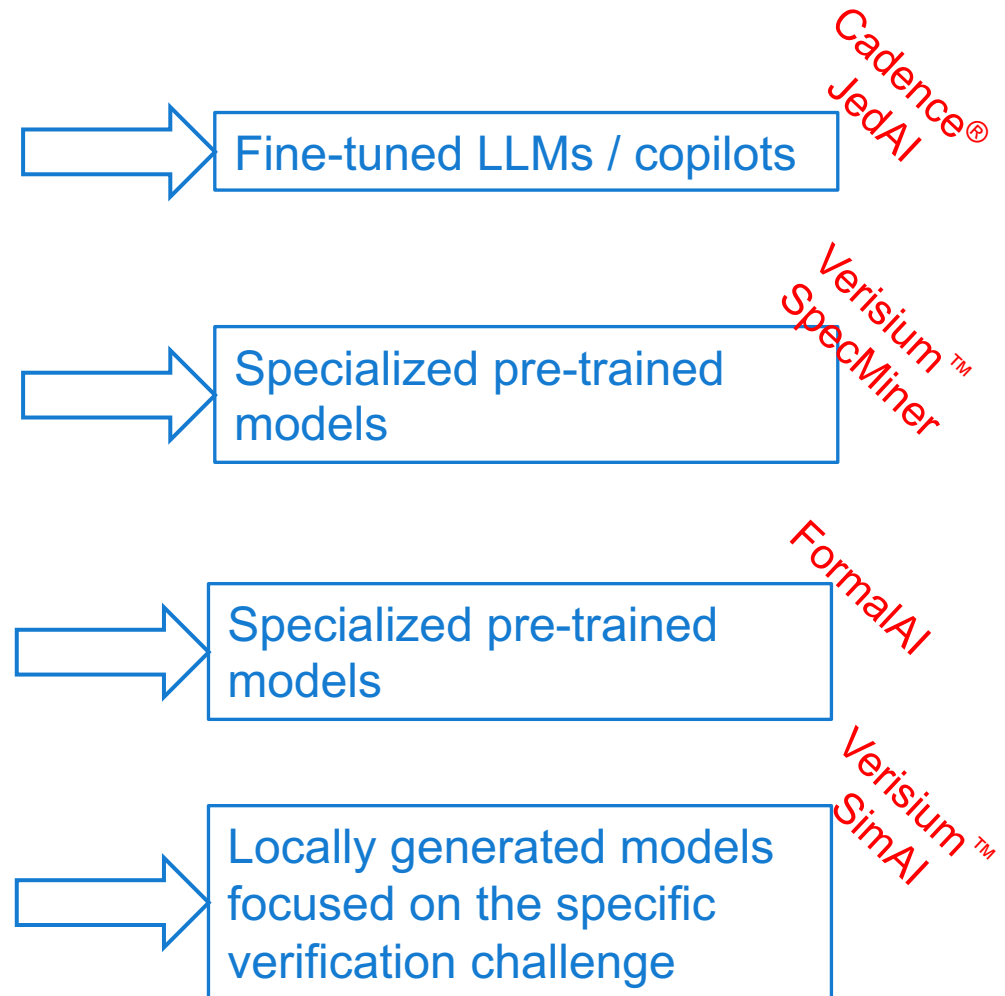
Steve Hobbs

April 9, 2025

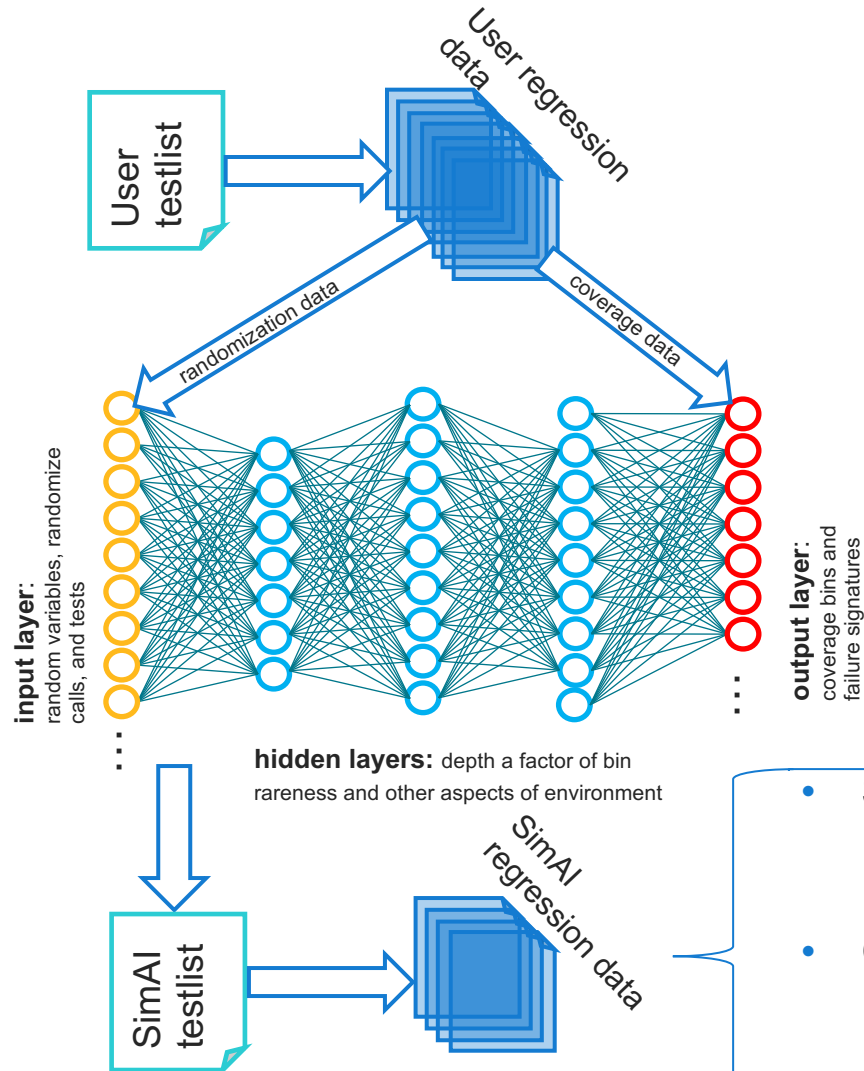
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Where Does AI/ML Fit with Hardware Design and Verification

- Development
 - Spec to RTL, testplan, verification environment
 - Model creation: Constraints, assertions, coverage
- Debug
 - Bug isolation
 - Failure triage
- Tool efficiency
 - Solving high-complexity algorithms such as formal, convergence, etc
- Verification efficiency
 - Compute reduction with improved quality
 - Bug exposure
 - Coverage closure



What Verisium SimAI Does



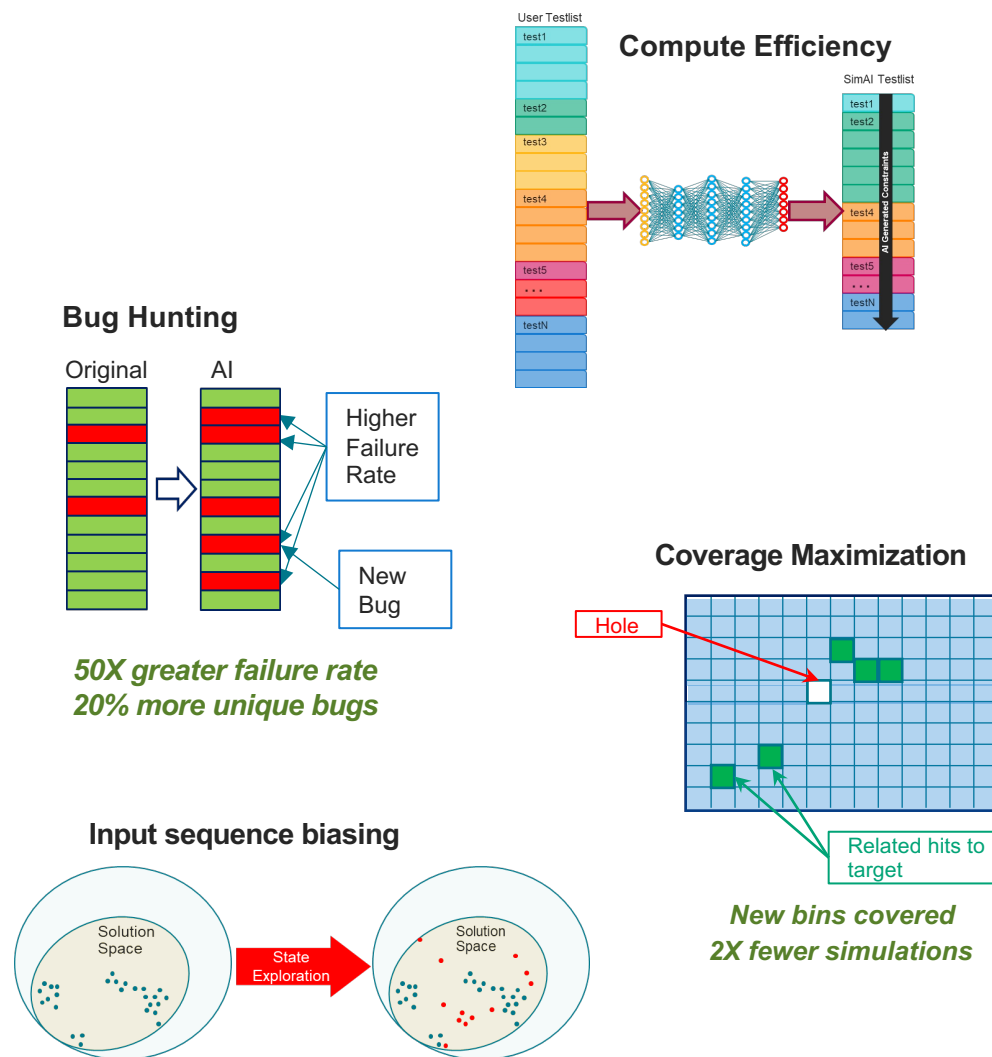
- Uses regression data
 - Randomization activity for each run
 - Coverage data for each run
- Can use one session or many sessions

- Builds a machine learning model with
 - Tests and random data as the input layer
 - Coverage bins and failure signatures as the output layer

- Synthesizes regression instructions with
 - Which tests to run
 - Applying a runtime constraint suggestion for each run
- Goal can be
 - Regression efficiency
 - Bug hunting
 - Coverage maximization

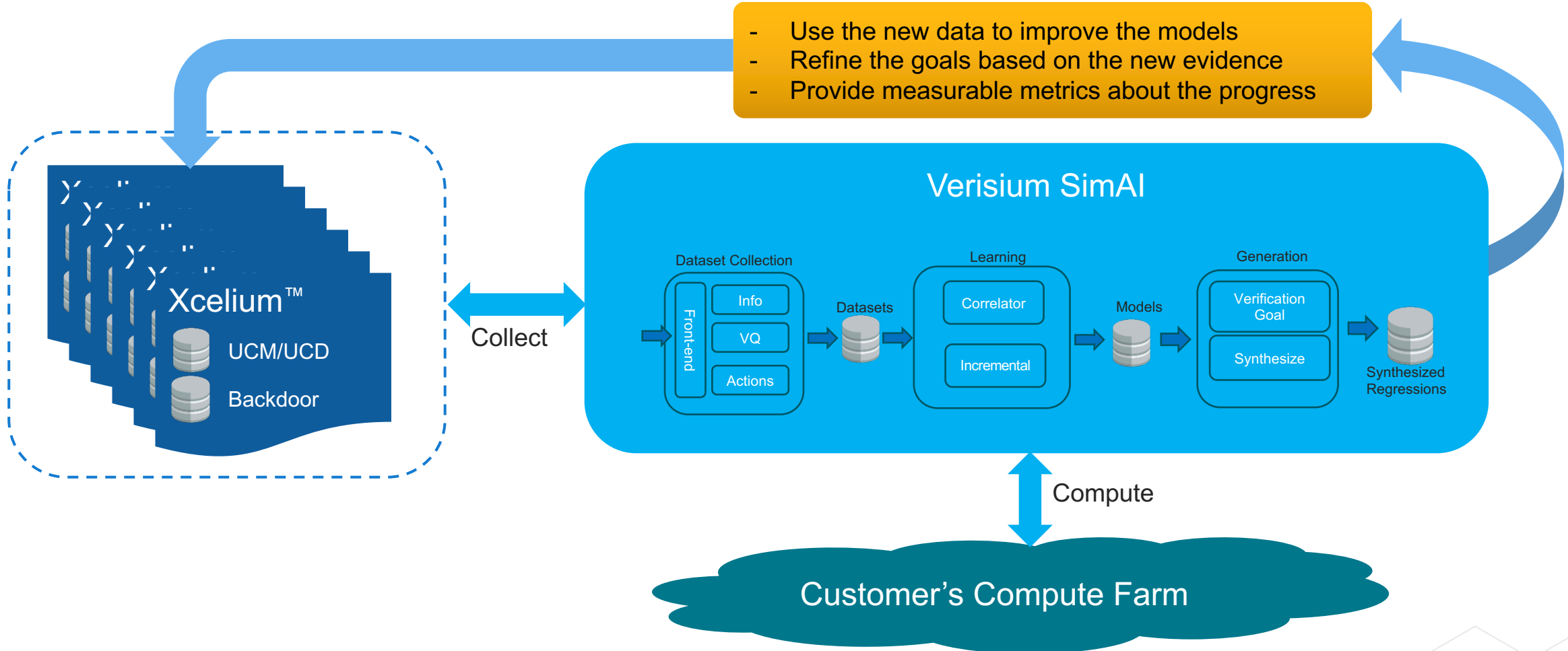
How Verisium SimAI Has Evolved

- Started with goal of replicating the coverage of a random regression with minimal seeds
- Expand the range of problems Verisium™ SimAI can attack and its usage throughout the design/verification cycle
 - Bug Hunting*: Stress hard-to-reach scenarios, either rare coverage bins or rare failure signatures
 - Coverage Maximization*: Target unhit bins by means of structural information of the coverage space, with special emphasis on cross-coverage
 - Bias of Input Sequences*: Ensure the randomization space is fully explored, with particular emphasis on the cross-combination of relevant random variables
- Handling new goals and dealing with extremely complex environments lead to architectural changes
 - Iterative (reinforcement) learning
 - Scalability improvements



How Verisium SimAI Works

- Verisium™ SimAI takes the data from regressions with many simulation runs and synthesizes a new regression targeted to verification goal
- Uses an iterative framework to update runs with new instructions



Challenges

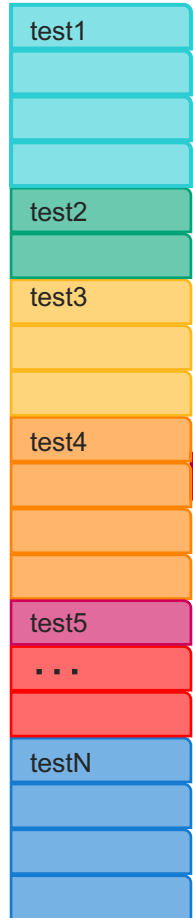
- Size of problem
 - Tens of thousands to hundreds of thousands of simulation runs
 - Tens of thousands to hundreds of thousands of random variables
 - Millions of coverage bins
 - Not large in the sense of what LLMs train on, but a large amount of data to build a local ML model.
- Other concerns
 - Off-the-shelf big data tools don't apply
 - Customers have tight requirements on CPU and memory usage
- Solutions
 - Create custom ML algorithms (similar to but different from off-the-shelf solutions)
 - Parallelize everything (collecting data, building models, synthesizing regressions)
 - Optimize Python libraries for heavy operations (like matrix manipulation) – two orders of magnitude reduction in memory
 - Optimize data being stored and worked on



Verisium SimAI for Performance

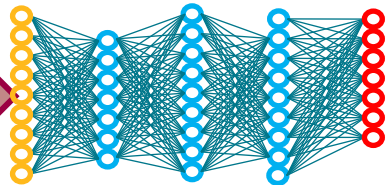
Generate efficient sets of focused runs

User Testlist



- Take one or more sessions as input
 - Focuses on all targets, bins and failures, or
 - Focus on specific areas

ML Model

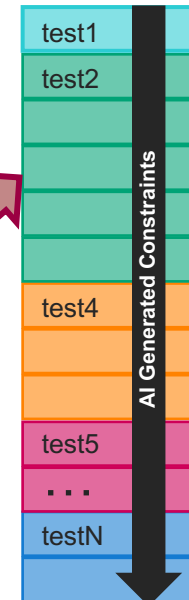


Regression Synthesis

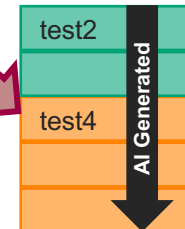


- Used for
 - Nightly runs using weekend regression as input
 - High churn target areas
 - General stressing of target area

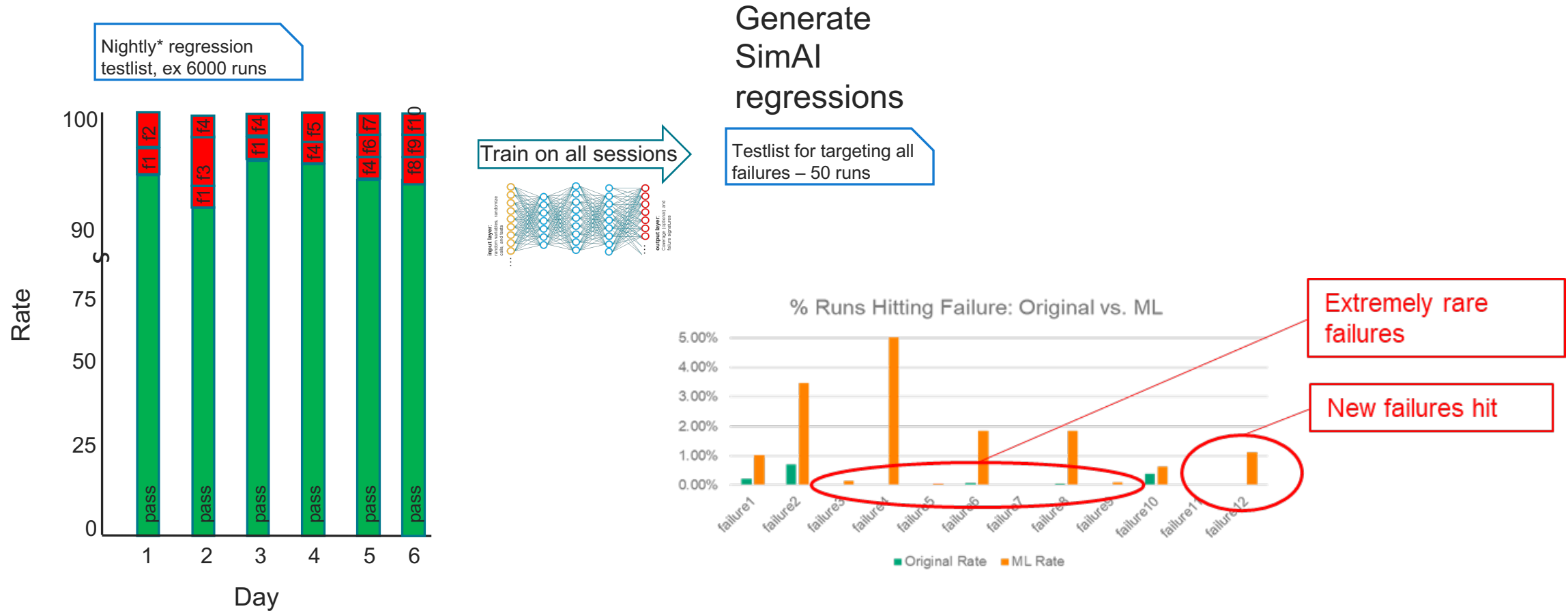
Verisium™ SimAI
Testlists



- Prunes tests that don't aid in achieving goal
- Adds more runs of most relevant test
- Adds run specific constraint instructions to focus runs



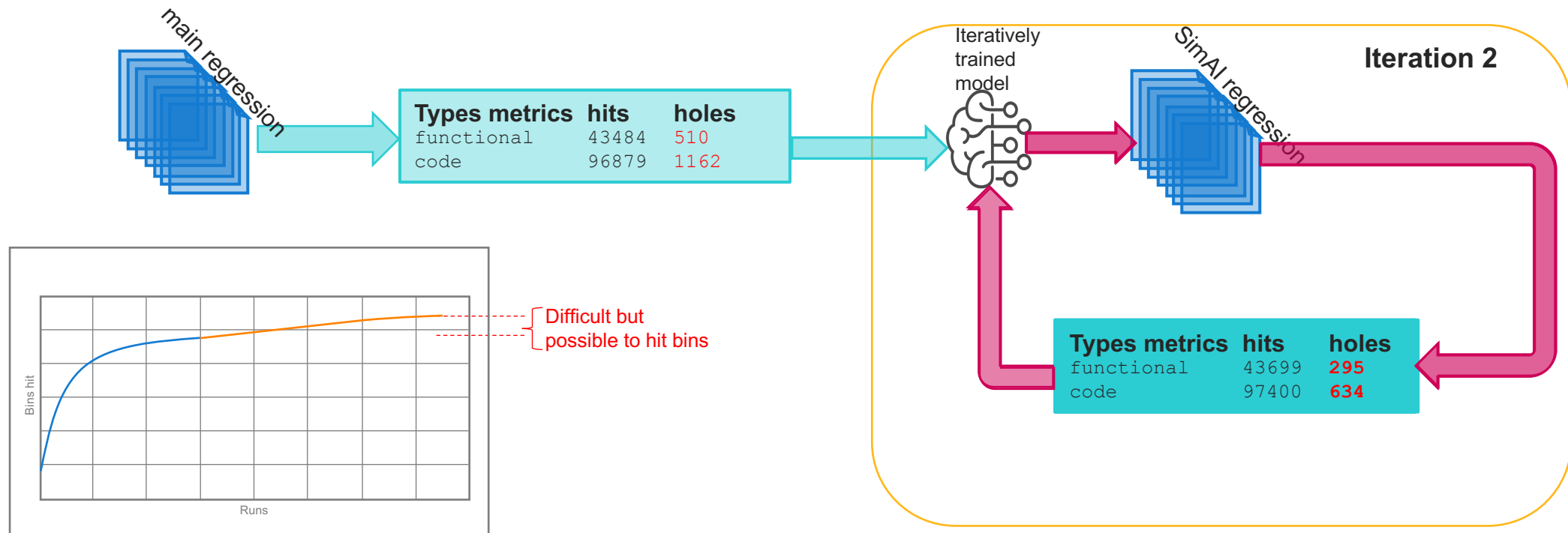
Example Using Verisium SimAI to Stress Failure Area



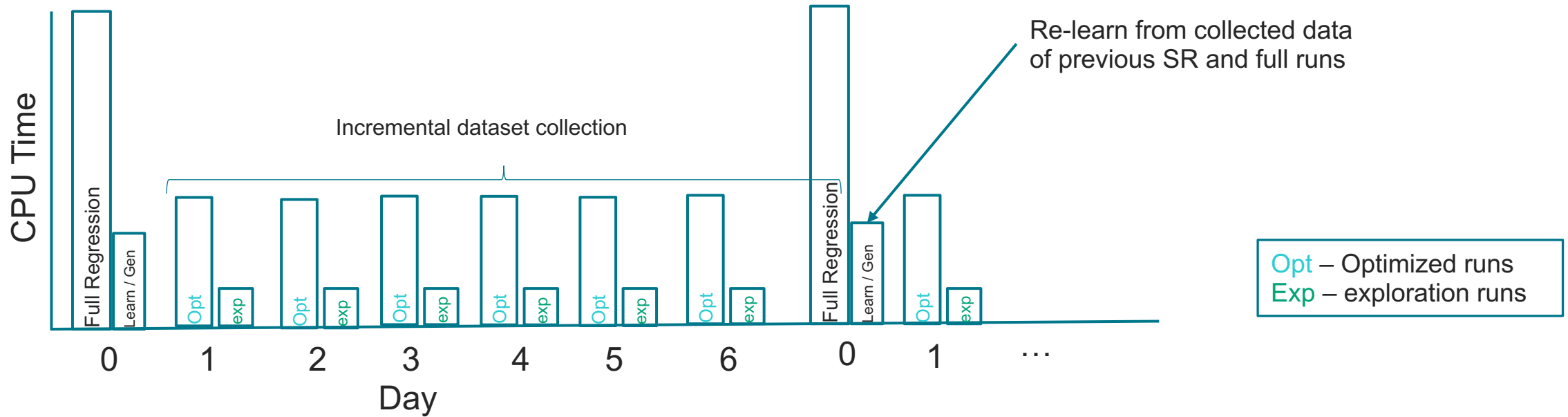
- Verisium™ SimAI regressions typically 30% of the original run count
- 1st Verisium SimAI regression CPU time 30%-50% of original regression, including training and generation
 - Increasing efficiency as training amortized across further regressions

Example of Verisium SimAI for Coverage Maximization

- When regression is largely saturated
 - Use Verisium™ SimAI to explicitly try to hit uncovered bins
 - Each iteration learns what worked and what didn't
 - Can be used for bug hunting, using holes as interesting targets



Verisium SimAI in Project Use



- Early project
 - More full regressions, possibly daily – use optimization and exploration runs or other augmentation runs to generate more scenarios targeted to corner cases or other important areas, target difficult failure signatures to improve coverage of an error condition
- Middle project
 - Optimization and exploration runs become daily regression with periodic runs of full regression
 - Fill out CPU budget with bug-hunting runs
- Late project
 - Optimization and exploration runs become primary regression with some augmentation from original regression
 - Increase bug hunting
 - Use ML to help hit particularly difficult bins and fill out cross-coverage bins or other bins that require large numbers of runs to hit



Any Questions?



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