SYNOPSYS®

AI: Trailblazing the Future: Innovative Chip Design in the era of Pervasive AI

Sudipto Kundu

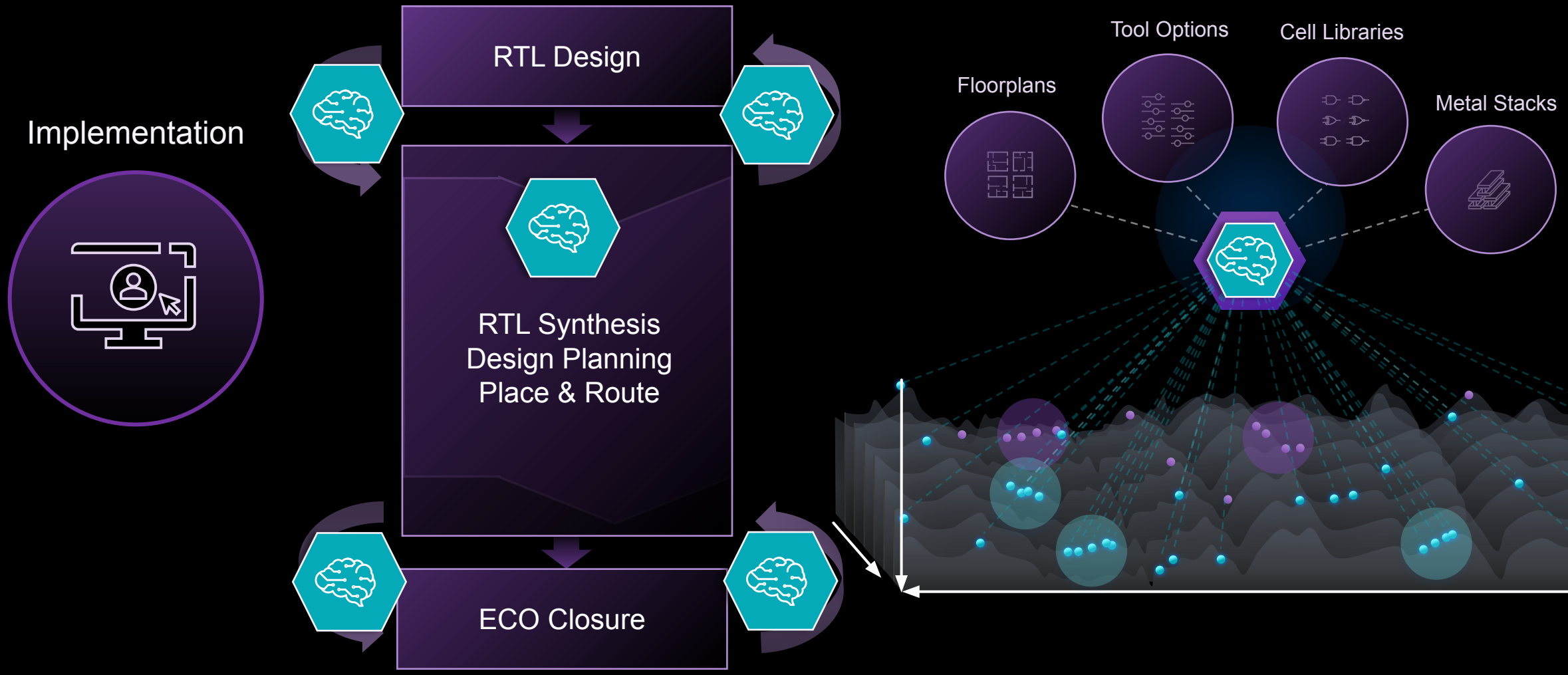
R&D Scientist, Technology Product Group

Mar, 2025

The Fourth Industrial Revolution – Powered by Silicon

Complexity of Chip Design growing exponentially

EDA Workflow Offers Opportunities for AI



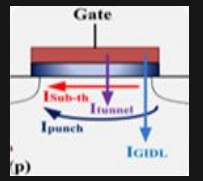
Chip Design Workflows Have Large Search Spaces

- Architectural Design
- Structural Design
- Logic Design
- Layout Design

- System Architecture
- Design Capture
- Verification
- Implementation
- Signoff
- Test & Silicon Lifecycle Mgmt.
- Silicon Manufacturing

Performance
- Frequency, WNS, TNS,…
- CTS latency,…

Area
- Die area, std cell area,..
- Area by cell VT,…



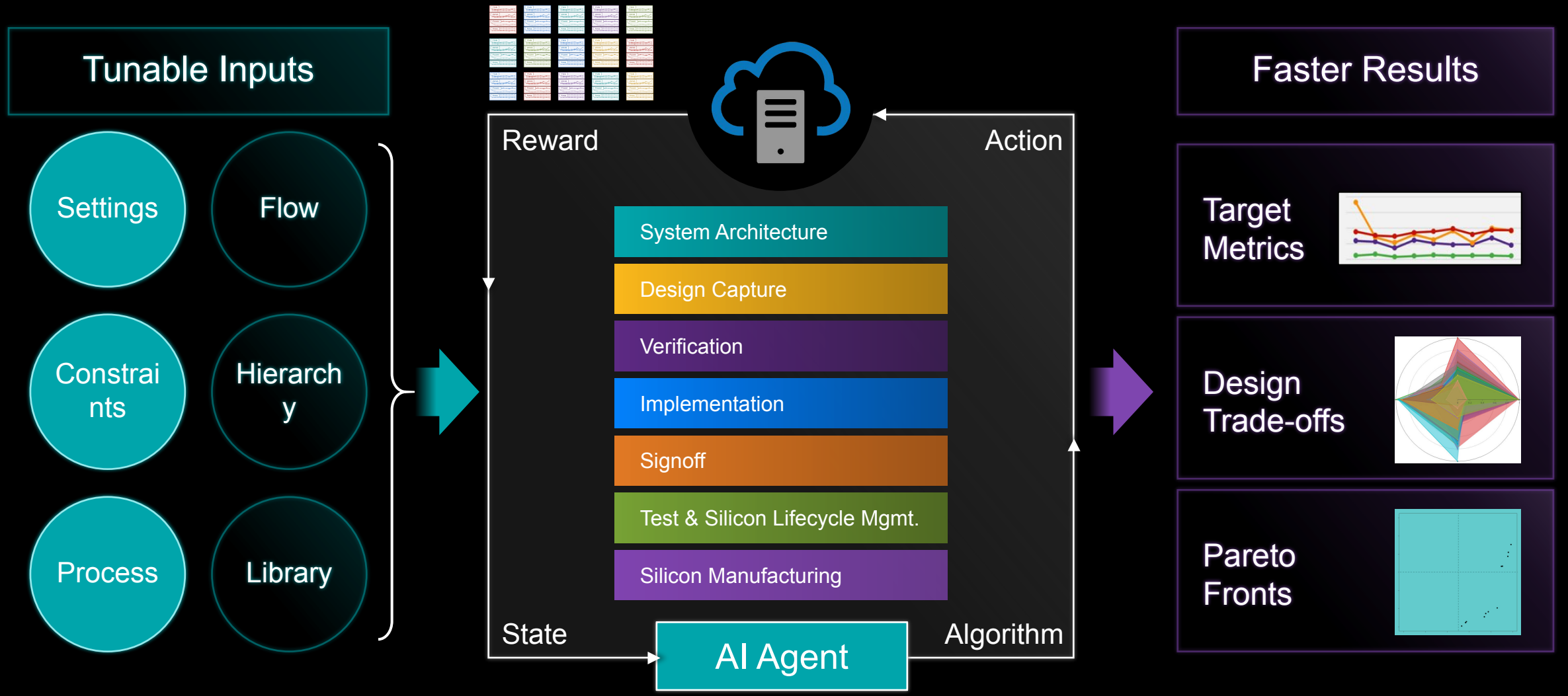
Power Leakage
- Leakage
- Leakage by cell type, by VT,…

Source : SV SNUG '23 Proceedings

Example : 10^{25} for latest Arm CPU

Can AI Help?

Digital Implementation: Applying AI to Navigate Chip Design Solution Space



What’s next in AI for EDA ?

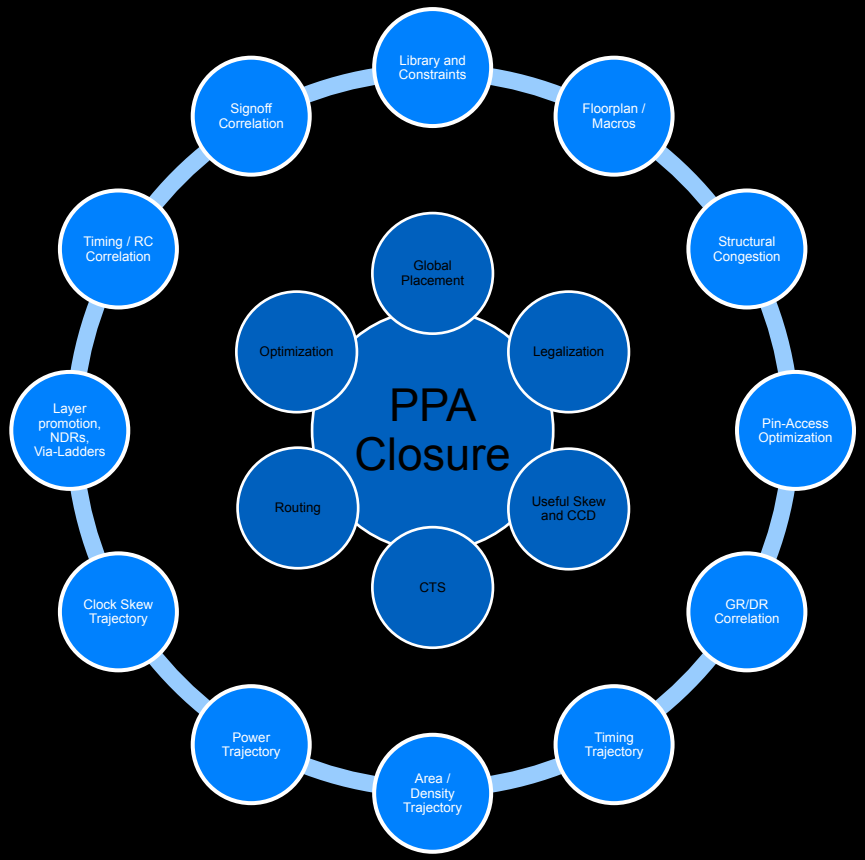
EDA R&D perspective

- Design Learning Driven Auto-Convergence
  - Graduate from point AI/ML applications
  - EDA tools become a fully learning-driven system to drive end-end convergence

- Auto-convergence to target different user personas
  - “Virtual” designers
  - “Green” designers
  - “Expert” designers

AI inside Physical Design Subsystems

EDA R&D perspective



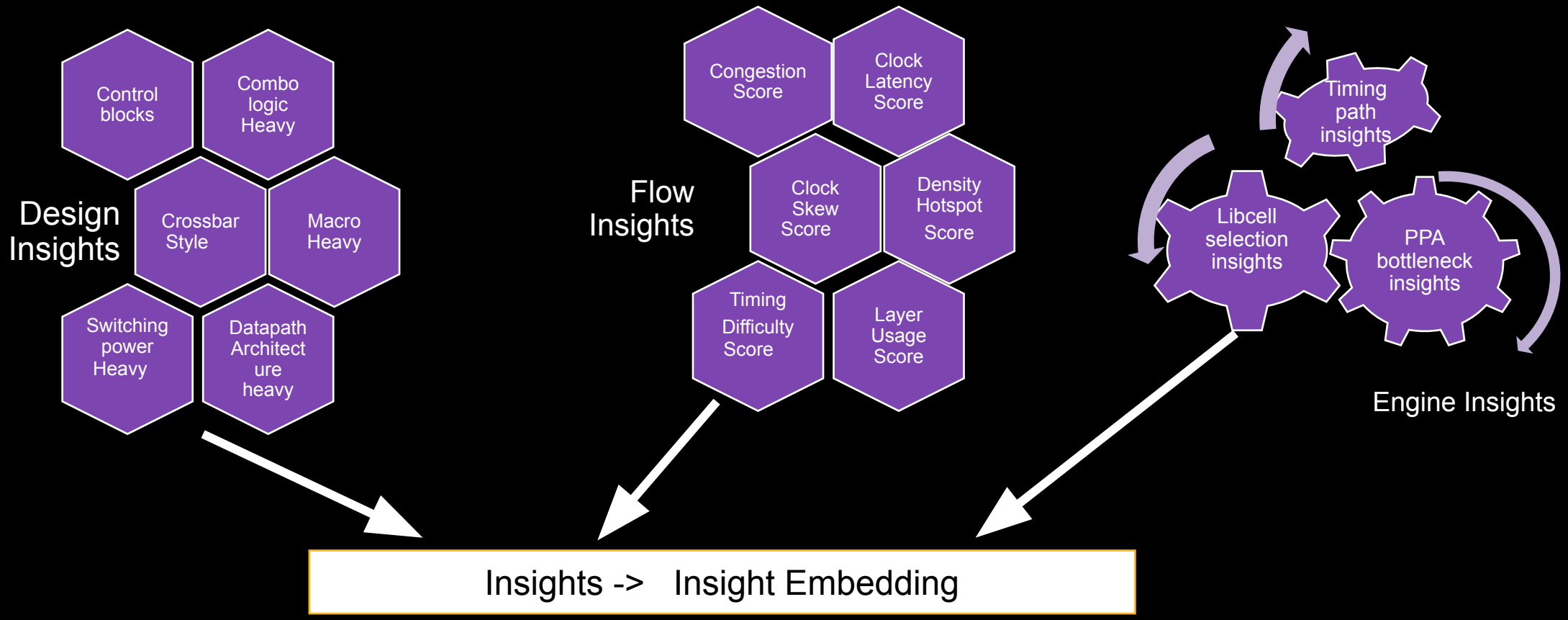
- Complex workflow with many subsystems
  - Same engine runs multiple times.
  - Opportunity to learn from initial invocation
  - Learning from one subsystem pass down to next subsystem.
  - Auto discovery of trend and patterns
  - Self recovery of PPA trajectory anomalies

- Pilot Learning using small sample execution
  - Formulate small problem and build knowledge Model
  - Example-I : Fast solver iteration in placement
  - Example-2: Fast netlist optimization on top timing paths
  - Leverage ML models for parameter optimization within the flow

Deep Insights – Catalysts for AI in EDA

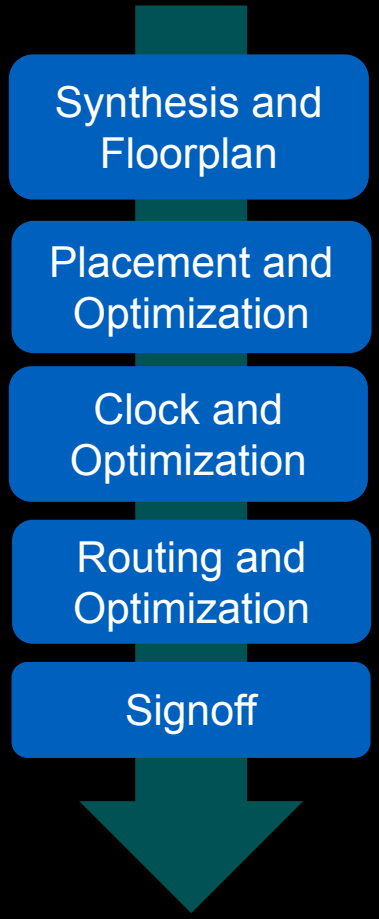
EDA R&D perspective

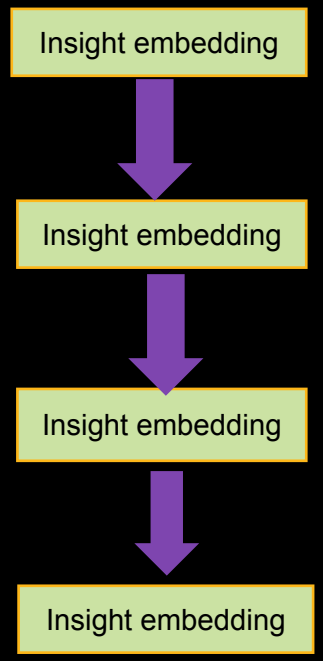
- Build deep netlist insights to drive AI recommendation

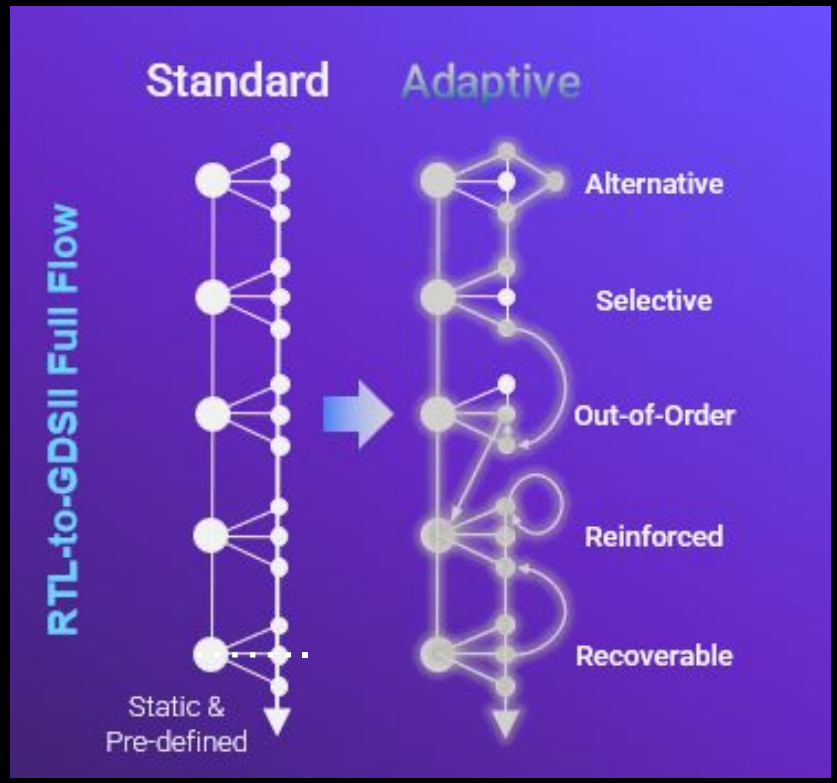


Design Insight based Physical Design Flow

Transitioning from Black Box AI



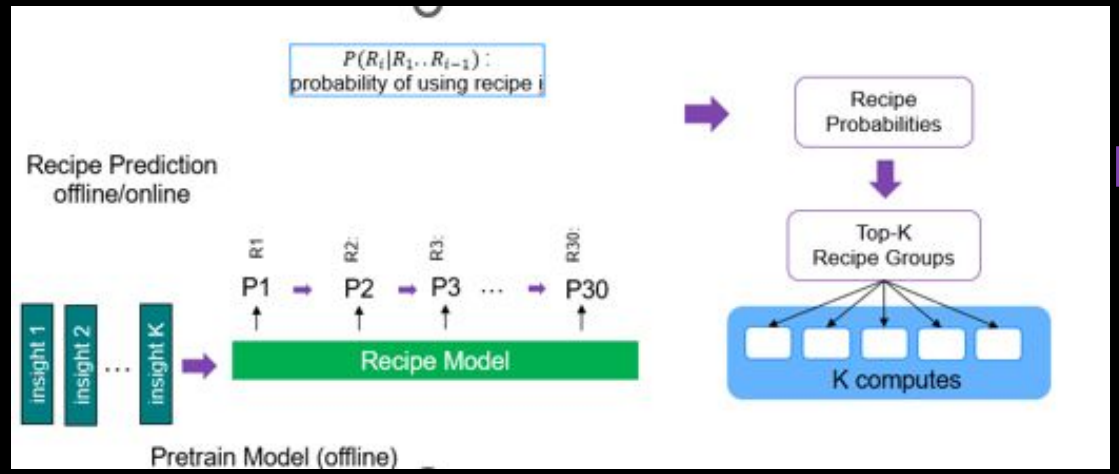


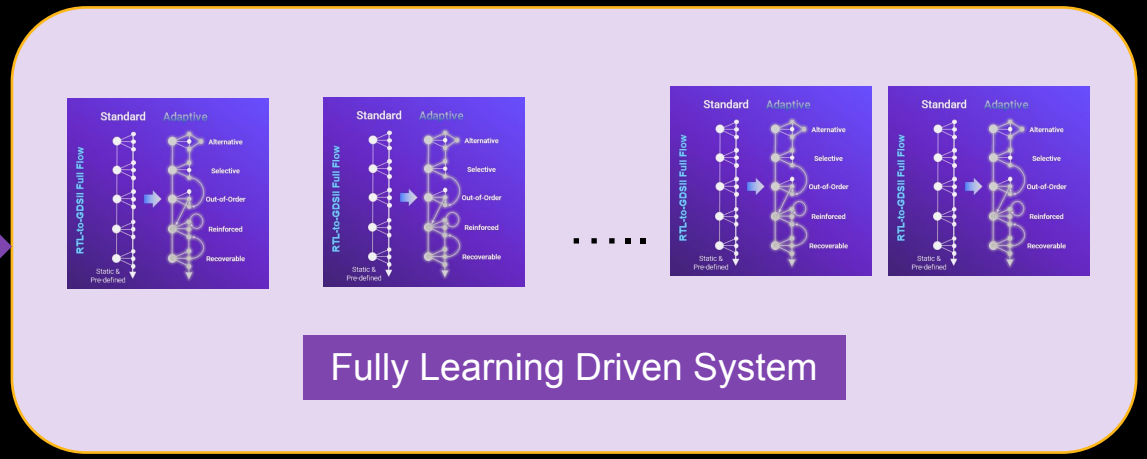


Insight Embedding -> Action Prediction

Design Insight Assisted Solution Space Navigation

- Train offline AI models for Top K recipe group prediction
  - ❖ Driven by insight embeddings.
- Given apriori run with insights -
  - ❖ predict group of recipes for exploration.





Experimental Result

Total-Power Benefit

Design	Default Baseline	Human Baseline	Offline Prediction	Improvement (Δ%)
D1 (3nm)	49.67	47.08	42.93	13.57%
D2 (3nm)	55.45	53.04	49.18	11.31%
D3 (2nm)	2076.16	2065.07	2058.80	0.84%
D4 (2nm)	437.36	431.08	428.54	2.02%
D5 (5nm)	71.12	68.62	64.81	8.87%

- Insight Inspired Recipe model shows superior PPA over manually tuned baseline

Summary

Key Takeaways

- AI everywhere : Within a single run, across parallel runs
- Learning driven subsystems generate deep design, flow and engine insights.
- Pilot learning within run using small samples within subsystem domain.
- Insights inspired AI models to generate action recommendation within run and across runs.

AI,
The Only Way Forward

SYNOPSYS®

Thank you