Collective Methodologies for Efficient High-Level Synthesis

Aggelos Ferikoglou, Sotirios Xydis, and Dimitrios Soudris

Microprocessors and Digital Systems Laboratory, ECE, National Technical University of Athens, Greece

*{**aferikoglou**, sxydis, dsoudris}@microlab.ntua.gr*

PhD Thesis Motivation

High-Level Synthesis (HLS) democratized **Field Programmable Gate Arrays (FGPAs)**

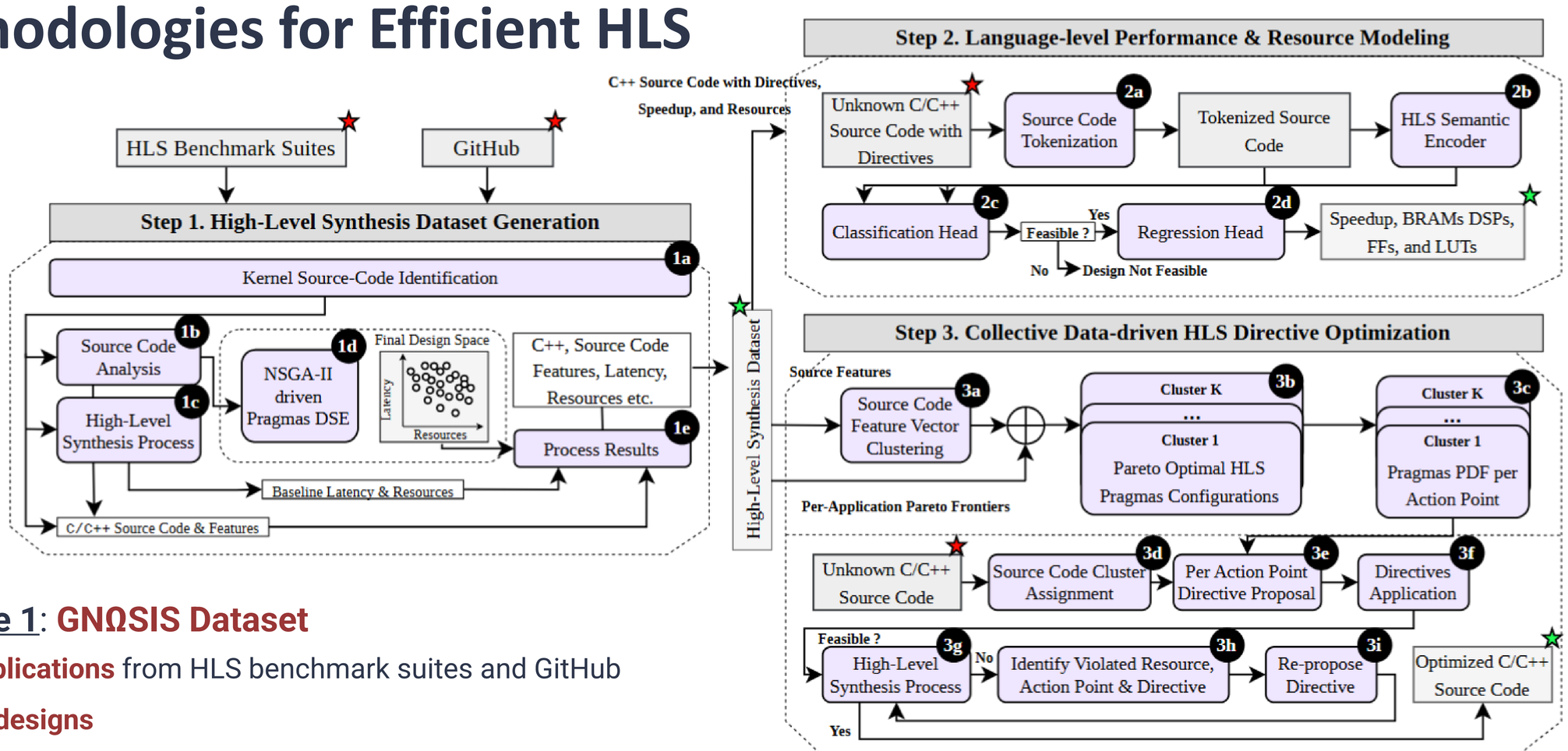
- Enables the **use of high-level programming languages**
- Guides HW compilation through **directives**

Selecting the appropriate HLS directives is **challenging**

- Vast **design space of optimization**
- Correlation between **HLS directives** and the **underlying FPGA**
- Lack of tools that **quickly and automatically** assist in achieving optimal designs

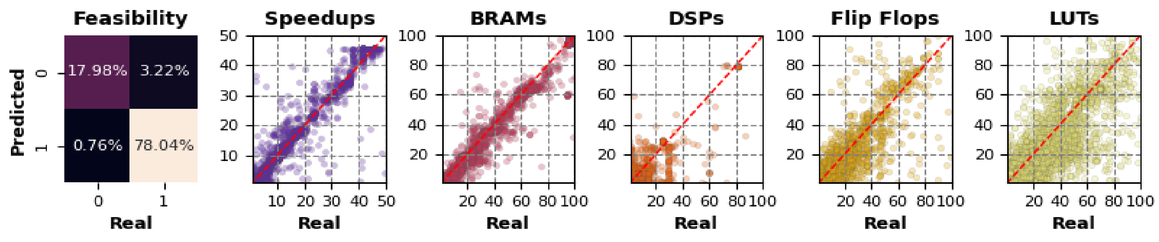
Need for methodologies that simplify the HW development process to support the HLS adoption

Methodologies for Efficient HLS



Outcome 1: GNΩSIS Dataset

- >**55 applications** from HLS benchmark suites and GitHub
- >**219K designs**
- Targeted **UltraScale+ ZCU104** and **Alveo U200** @**100**, **200**, and **300 MHz**

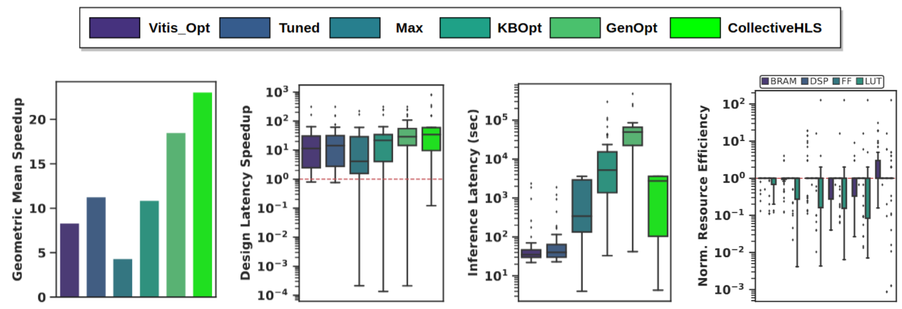


Outcome 2: Language-level Performance and Resource Model

- ~**96% accuracy** for feasibility classification
- R2 scores of **0.95** and **0.91** for performance and resource estimation

Outcome 3: Data-driven HLS Directive Optimization

- Geometric mean speedup **23.1x higher** over kernel without HLS directives
- Maintains **100% synthesizability** and **96.6% feasibility**
- Optimization time **14.6x faster on average** compared to SotA



[1] *Ferikoglou, Aggelos, et al. "CollectiveHLS: Ultrafast Knowledge-Based HLS Design Optimization." IEEE Embedded Systems Letters 16.2 (2023): 235-238.*

[2] *Ferikoglou, Aggelos, et al. "Data-driven HLS optimization for reconfigurable accelerators." Proceedings of the 61st ACM/IEEE Design Automation Conference. 2024.*

[3] *Ferikoglou, Aggelos, et al. "CollectiveHLS: A Collaborative Approach to High-Level Synthesis Design Optimization." ACM Transactions on Reconfigurable Technology and Systems 18.1 (2024): 1-32.*

[4] *Masouros, Dimosthenis, et al. "Late Breaking Results: Language-level QoR modeling for High-Level Synthesis." Proceedings of the 61st ACM/IEEE Design Automation Conference. 2024.*

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