Techniques for CAD Tool Parameter Auto-tuning in Physical Synthesis: A Survey

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Jan, 2022

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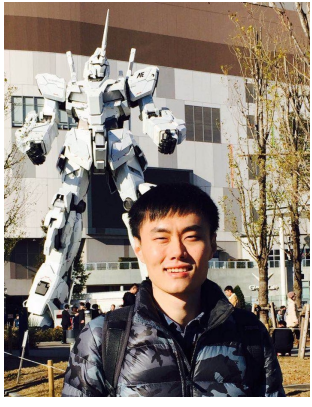
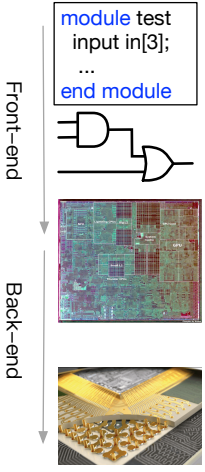
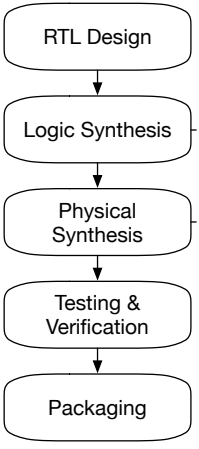


Backgrounds

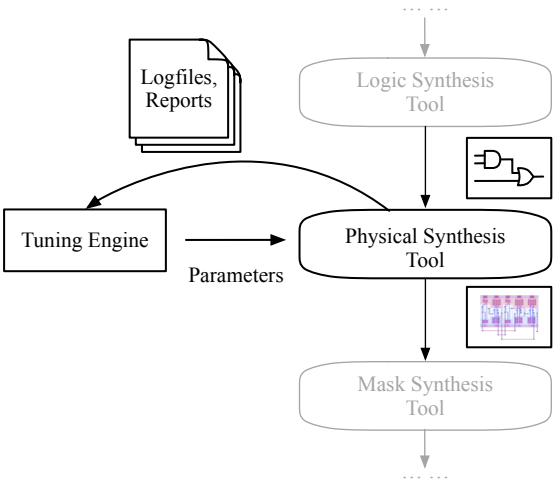




Tool Parameter Tuning

1. EDA tools have been developed to aid and speed the closure of IC design.
2. Numerous tunable parameters with different data types are exposed as hints for human and impact the QoR of the tool outcome.
3. How to find optimal parameter configurations?

What is Physical Design Tool Parameter Tuning?

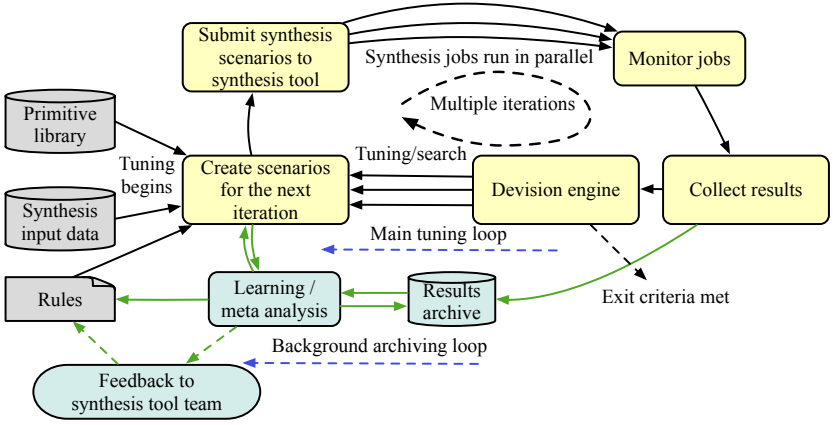


The overview of the parameter tuning of a physical design tool

Current Status & Challenges in Tool Parameter Tuning Issue

1. Oceans of values of design parameters need to be determined or tuned
2. Multiple quality-of-result (QoR) metrics (e.g., area, power, and delay) to be optimized
3. "Black-box" parameter-to-performance mappings: **no** explicit function expressions
4. Time-consuming EDA tool evaluation
5. Existing methods: Heuristic Method-based, Machine Learning-based

Heuristic-based Work: SynTunSys (STS)[1][2]

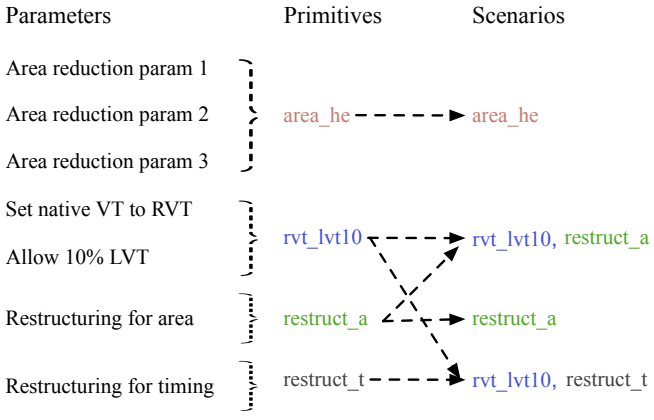


The framework of the SynTunSys.

[1] J. Kwon et al., "Scalable auto-tuning of synthesis parameters for optimizing high-performance processors," ISLPED, 2016.

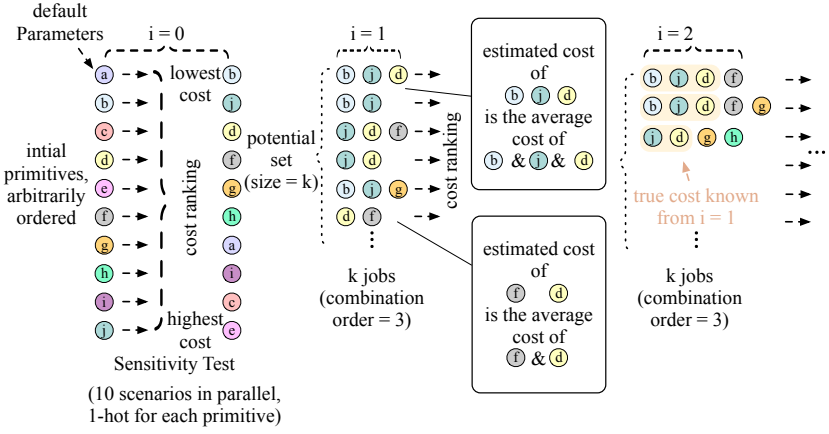
[2] M. Ziegler et al., "A synthesis-parameter tuning system for autonomous design-space exploratio" DATE, 2016.

Heuristic-based Work: SynTunSys (STS)



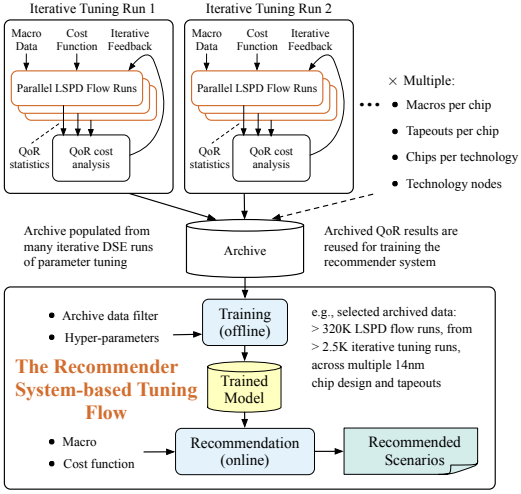
The illustration of the interaction of parameters, primitives, and scenarios in the SynTunSys.

Heuristic-based Work: SynTunSys (STS)



The learning decision algorithm of the SynTunSys.

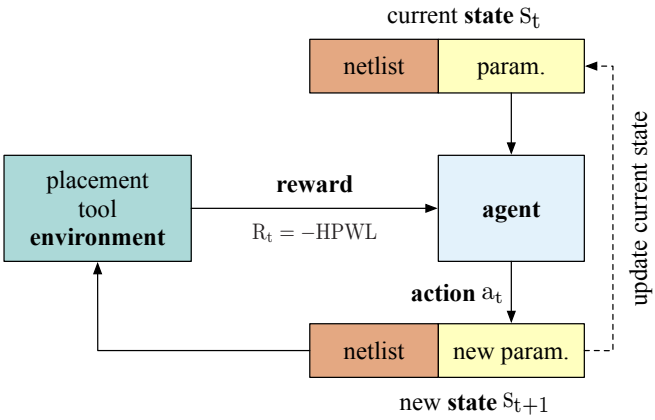
Machine learning-based Works: (I)



The associated tuning framework in DAC'19[1].

[1] J. Kwon et al., "A learning-based recommender system for autotuning design flows of industrial high-performance processors," DAC, 2019.

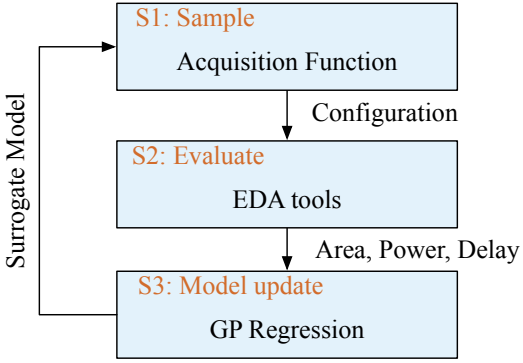
Machine learning-based Works: (II)



Deep reinforcement learning-based parameter tuning of a placement tool[1].

[1] A. Agnesina et al., "VLSI placement parameter optimization using deep reinforcement learning," ICCAD, 2020.

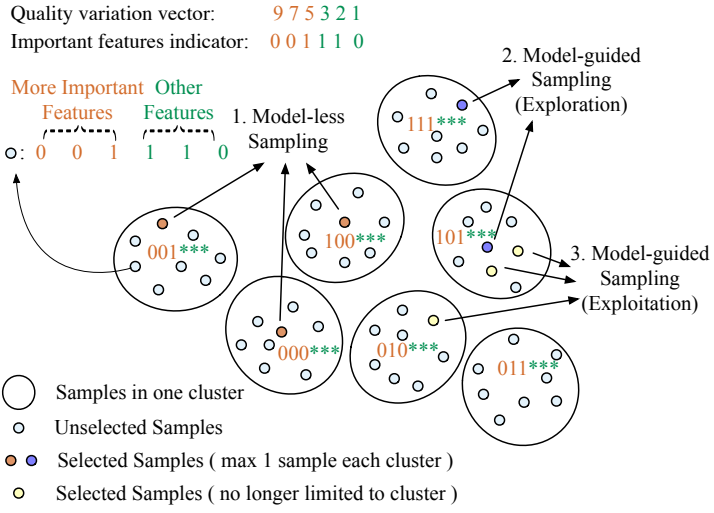
Machine learning-based Works: (III)



The diagram of the workflow proposed in MLCAD'19[1].

[1] Y. Ma et al., "CAD tool design space exploration via Bayesian optimization," MLCAD, 2019.

Machine learning-based Works: (IV)



An example of sampling by clustering in ASPDAC'20[1].

[1] Z. Xie et al., "FIST: A feature-importance sampling and tree-based method for automatic design flow parameter tuning," ASPDAC, 2020.

Conclusion & Future Directions

- A survey of recent line of arts in tool parameter tuning
- Parameter space auto-pruning
- Rethinking Gaussian process in iterative refinement tuning frameworks like Bayesian optimization
- Collectively considering parameter auto-tuning of multiple tools exploited in the whole design flow
- ... ...

THANK YOU!