"For the Record" - Update #3 (December 21, 2022)

Andrew B. Kahng
CSE and ECE Departments, UC San Diego
abk@eng.ucsd.edu

To my colleagues in EDA and IC design:

Again with thanks to many for discussions and expressions of interest, here is a third update to follow up on "For the Record" and the previous updates #1 and #2.

Students at UCSD have continued to make progress. Updates continue to be added in our repo, with narrative details here.

Algorithms and Methodology.

- **Synopsys Physical Synthesis.** We have added a Design Compiler-Topological (DCT) physical synthesis based flow. See here.
  - **We thank Synopsys for granting permission to share DCT runscripts.**
  - Circuit Training (CT) achieves similar results with input placements from either physical synthesis tool (Synopsys DCT, Cadence Genus iSpatial). See here.
- **Simulated Annealing.** Simulated annealing for macro placement, as described in the Nature paper and in "Stronger Baselines", has been implemented in our open-source code (SA-UCSD). See here and the discussion of SA-UCSD as a baseline, below.[1]
  - **Force-directed placement.** Circuit Training's force-directed placement, which is a key element of the Nature / Stronger Baselines annealing approach, has been closely reproduced in our open-source code. See here.

Baselines.

- **Human Macro Placements.** Additional human macro placement solutions have been contributed: (i) MemPool Group in NG45 and GF12 enablements, from UCSD + ETH Zurich; and (ii) BlackParrot in NG45 enablement, from IBM Research.
  - The human solutions have smaller wirelength, with better or similar congestion, compared to Circuit Training solutions.
- **Simulated Annealing as a Baseline.** Table 1 metrics for the SA-UCSD macro placement of Ariane133-NG45-68%-1.3ns (respectively, BlackParrot-NG45-68%-1.3ns) are here (respectively, here).
  - Simulated Annealing (SA-UCSD) achieves significantly smaller wirelength, with similar power and timing, compared to Circuit Training solutions.
- **RePlAce and ICCAD04 testcases.** We run RePlAce + NTUPlace3 to generate macro placements for the ICCAD04 testcases studied in Stronger Baselines. Details are here.
  - RePlAce results for the 17 ibm* testcases that have macros are here. These results are similar to the RePlAce results reported in Stronger Baselines.
  - We evaluate proxy cost and HPWL of both RePlAce and SA-UCSD, for the ibm01 and ibm10 testcases. RePlAce outperforms SA-UCSD:[2]

        - Proxy costs for ibm01: 1.176 (RePlAce) vs. 1.845 (SA-UCSD)
        - Proxy costs for ibm10: 1.700 (RePlAce) vs. 2.319 (SA-UCSD)
    - The SA-UCSD HPWL outcome is similar to the HPWL outcome reported in Stronger Baselines (SA-SB):
        - HPWL for ibm01: 2.646e6 (SA-UCSD) vs. 2.585e6 (SA-SB)
        - HPWL for ibm10: 40.273e6 (SA-UCSD) vs. 42.314e6 (SA-SB)
- **NVIDIA Research AutoDMP as a Baseline. We thank NVIDIA Research for access to AutoDMP**, an autotuned DREAMPlace-based macro placer that will be reported at ISPD-2023.[3] Our initial results for AutoDMP (Ariane and BlackParrot) are here.
    - For testcases studied so far, AutoDMP generally outperforms other methods, with quality of results similar to that of Cadence CMP.

Ongoing Efforts.

- With respect to the Stronger Baselines work, we have reproduced RePlAce results and are completing reproduction of SA results. The next step will be to reproduce the results reported for Circuit Training on the ICCAD04 testcases.
- We thank members of the research community who have contributed additional questions for study and additional baselines for comparison. We are also grateful to Google Brain engineers who continue to help our efforts to reproduce in open source the methods reported in Nature.
- An invited talk summarizing this effort will be presented at ISPD-2023.

As always, the community's participation and support – along with open technical dialogue – is warmly invited. All tools and most experiments have been open-sourced, and replication and sharing of results would be very welcome.

Thank you and best wishes to all (including for the season and the coming new year!).

NOTES

- **[1]** SA-UCSD includes mirroring of macros in its move set, following the descriptions of SA given in Nature and in Stronger Baselines. The Nature paper describes a post-RL fine-tuning step with SA ("as we do not currently perform macro mirroring in RL") which achieves an average of 1.07% wirelength improvement.
- **[2] Proxy cost of a flat placement.** RL-based macro placement in Nature optimizes proxy cost. But, Stronger Baselines reports HPWL and a congestion metric. To bridge this discrepancy, this flow evaluates a flat mixed-size placement according to the proxy cost in the Nature paper.
- **[3]** AutoDMP uses MOTPE (multi-objective tree-structured Parzen estimator) to perform hyperparameter tuning of DREAMPlace. It is not an RL-based approach.