2A7 - Applying Machine Learning to Back End IC Design, 2018
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Project Definition

- Relationship of Back-End IC tool “knobs” to design outcomes is complex, leads to uncertain schedules and high design costs
- Our goal is to train computer models that can
  - predict outcomes with reasonable accuracy
  - show us the settings to minimize iterations
  - be generalized to many designs
  - gradually improves with more training data

Results and Significance

- Accuracy varies with clock-period constraint. Unconstrained region is the most accurate.
- Overall 45nm accuracy: 0.5/2.5/1.1 ns RMSE (best/worst/avg design) in unconstrained region. Goal is < 0.5 ns on every design.
- Half of the designs are under 500 cells. More large designs are needed to avoid overfitting and achieve our goals.

Progress

- Focused on questions of defining “reasonable accuracy” and how to generalize the model
- Assembled a training library of 32 designs with number of cells ranging from 64 to 8,875
- Linear Regression used to predict routed delay from synthesis results, varying clock-period constraint and one other knob
- Expanded modeling approach to include Multivariate Adaptive Regression Splines (MARS)

Future Outlook

- Continue to expand training library
- Begin mining the data-sets to find good model parameters
  - Will explore Variance Inflation Factor (VIF) to avoid multicollinear parameters
- Explore adaptive sampling methods to determine constraint-regions and accelerate data collection
Accuracy varies with clock-period constraint region

- Unconstrained – most predictability
- Multiple constraints (area & delay) – gradual change in outcomes
- Tight constraint – least predictability

**Pareto-optimal outcomes found in all regions**
- Simple algorithms developed to determine the region
- More work needed to develop efficient sampling methods to determine the statistics in each region
Simple linear prediction of routed delay using synthesized delay used as first attempt
- Good match - ISCAS89_s38584
  0.50 ns RMSE in unconstrained region (0.10 ns output StDev)
- Worst match – AES
  2.50 ns RMSE in unconstrained region (0.46 ns output StDev)
- Overall: 1.1 ns RMSE (2.4 ns output StDev)
- Two more variables + MARS yields similar results
- Likely that we simply haven’t found the right variables