

Sina Baghal

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Cognichip

Formal Verification Modeling

- Developing formal verification models for automated Clock Domain Crossing (CDC) checks and static analysis, including constant propagation.

SystemVerilog AutoCompletion (LLM post-training)

- Developed autocompletion model for SystemVerilog using T5 encoder-decoder.
- Extended tokenizer with 16 SV-specific tokens and trained custom embeddings via gradient hooks.
- Monkey-patched attention layers for xformers/FlexAttention to achieve $O(N)$ memory.
- Implemented Group-Robust Sampling inspired by Group DRO for balanced rare construct representation.
- Achieved 0.85 BLEU, 0.92 accuracy score on 500K SV files with near-zero latency on a modern laptop.

Masked Diffusion for Spec-to-RTL Generation

- Built 141M-parameter masked diffusion model for generating SystemVerilog from natural language specs.
- 18-layer transformer encoder with Flash Attention, handling spec + DUT pairs.

Supporting Projects

RTL Knowledge Module

- Built a local, searchable corpus of RTL/FPGA/ASIC resources with hybrid BM25 + FAISS search.
- Integrated LLM grounding layer to reduce hallucinations on hardware design questions.

Spec2RTL

- Zero-shot feature extraction from RTL specs.
- Two-stage pipeline: bi-encoder retrieves candidates from $\sim 13K$ hypothesis fragments (extracted from RTLBank, LLM-paraphrased), then cross-encoder (NLI) classifies.
- Achieved 92.4% F1 on FIFO feature detection.

Entropy-Guided Tokenization

- Alternative to BPE using per-byte conditional entropy from a causal byte-level LM.
- Captures semantic units like `always @(posedge clk) begin` as single tokens.
- Achieved $4.6\times$ sequence length reduction on 177K SV design AST JSONs.



Open Source Projects

Solvable Sokoban Without a Solver via Diffusion

Trained a masked diffusion model on Sokoban puzzles that inherits solvability which it was never trained on.

GPU-Accelerated CFR for Pasur

PyTorch framework for solving Pasur via Counterfactual Regret Minimization. Efficient memory management for game trees with $> 10^9$ nodes.

VAE for Heston Volatility Surfaces

Variational Autoencoder for generating Heston volatility surfaces for exotic derivative pricing.

Deep Smoothing for Implied Volatility

Deep learning for smooth, arbitrage-free implied volatility surfaces using feed-forward networks + CVX.



PhD Project

Termination Criterion for SGD

Early stopping criterion for binary classification via stochastic stability analysis, OPT2020, NeurIPS.

Experience

 Senior Applied Scientist Cognichip, Toronto · AI model development for hardware design automation.	Nov '25 – Present
 Data Scientist III TD Bank, Toronto · AI model development for banking.	Jun '23 – Nov '25
 Consultant, Quantitative Risk Solutions CIBC, Toronto · Risk modeling.	Aug '22 – Jun '23
 Machine Learning Researcher (Intern) Huawei, Montreal · Research on neural network quantization.	Feb '22 – Aug '22
 Postdoctoral Research Fellow University of Waterloo, Waterloo · Research on graph neural networks	May '21 – Feb '22
 Mathematical Olympiad Coach Young Scholars Club, Tehran · Creative problem solving.	Sep '06 – May '16

Education

 PhD, Mathematics University of Waterloo · GPA: 93.88/100	May '16 – May '21
 MSc, Mathematics Sharif University of Technology · GPA: 18.76/20	Sep '10 – Sep '12
 BSc, Mathematics Sharif University of Technology · GPA: 17.41/20	Sep '06 – Sep '10

Honors & Awards

Silver Medal, Mathematical Olympiad Young Scholar Club – Awarded annually to 40 out of 320,000 competing students	'05
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