Shiv Kiran Bagathi

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Shiv-Kiran

Research Interests

Programming Languages, Compiler Optimization, Agentic AI, SysML, LLMs.

Education

2024
2020

Indian Institute of Technology Bombay (IIT Bombay)
Bachelor of Technology (Honors) in Computer Science and Engineering ***(GPA: 8.93/10.0)***
Advanced Coursework: Advanced Machine Learning, Advanced Compilers, Program Analysis, Code Optimization for OO Languages, Operating Systems, Game Theory & Mechanism Design, Blockchains & Smart Contracts, Applied Algorithms, Foundations of Intelligent Agents, Speech & NLP.

Publications

Bagathi, S. K. (First Author), Thakur, M., et al. **"ScalaF: Functional Refactoring Suggestions for Scala."**
The Scala Workshop 2025 (co-located with SPLASH/ICFP). Paper Link

Research Experience

May 2024
Aug 2023

Undergraduate Researcher: ScalaF Functional Refactoring Suggestions for Scala
Advisor: Prof. Manas Thakur. *IIT Bombay, CompL Lab*

- Engineered **ScalaF**, a static analysis engine using **Scalameta** to detect imperative anti-patterns; implemented custom AST traversal algorithms to compute purity/effect summaries and escape analysis for safe refactoring.
- Designed a **semantics-preserving transformation pipeline** that synthesizes functional constructs via quasiquote-based AST reconstruction, enforcing correctness through structural effect guards.
- Developed parallelization logic to identify associative, side-effect-free regions, automatically exposing mappings to parallel primitives to enable deterministic concurrency.
- Architected a **VS Code extension** backed by an LSP-style service, optimizing the analysis engine for real-time feedback ($<$3s latency on 5k LoC) while exposing a **modular API** for user-defined refactoring rules.

May 2024
Jan 2024

B.Tech Thesis: Ransomware Early Detection using RL
Advisor: Prof. Virendra Singh. *IIT Bombay, CADSL Lab*

- Developed a novel Early Preemptive Malware Detector using Reinforcement Learning (RL), framing the **API call sequence analysis** as an optimal stopping problem.
- Demonstrated significant efficiency: achieved a **30% quicker detection** than deterministic baselines and utilized only **10% average API calls** compared to full sandbox, with **no significant loss in accuracy**.
- Designed the high-dimensional state space using contextual Indicators of Compromise (IOC) and leveraged **RNN/Bi-LSTM** to encode API history for the PPO agent.
- Optimized the **Proximal Policy Optimization (PPO)** agent's learning through a formalized reward function designed to strictly penalize delayed or false-negative detections.

Selected Academic Work

May 2024

Optimization of Intermediate Java Code (Soot Framework) Prof. Manas Thakur
Implemented Variable Type Analysis to construct the call graph and enable Method Inlining at monomorphic callsites. Applied **Scalar Replacement** to non-escaping objects and designed custom dead code elimination using Intra-Procedural points-to-information and Liveness Analysis, yielding a **50% runtime reduction**.

Apr 2023

C Compiler with Optimization and x86 Assembly Generation Prof. Amitabha Sanyal
Architected a compiler using **Lex/Yacc** and **3-Address Code (3AC) IR** to decouple front-end analysis from backend generation. Implemented the **Sethi-Ullman algorithm** for efficient x86 assembly, and **validated correctness** across **100+ test programs** covering control-flow and pointers.

May 2023

Diffusion Models for Counterfactual Generation Prof. Sunita Sarawagi
Designed a diffusion model **conditioned on a Structural Causal Model (SCM)** for counterfactual generation, incorporating a **Half U-Net** backbone and an SCM-driven regularization term to enforce causal consistency. Achieved a **95% counterfactual validity rate**, outperforming Causal VAE baselines.

Nov 2022

xv6 OS Kernel Enhancement (Systems Programming) Prof. Purushottam Kulkarni

Extended the xv6 kernel with **lazy page allocation** integrated into the page-fault handler (reducing initial physical allocation by **>60%**), implemented a **lottery scheduler** (yielding **40% lower average process wait time**), and optimized the filesystem I/O pipeline via buffer-cache batching. Changes **validated on QEMU** with **50+ unit and system tests.**

Nov 2022

Image Captioning using Attention-based Transformers Prof. Pushpak Bhattacharya

Enhanced the "Show, Attend and Tell" framework by integrating a **Transformer decoder** with **masked multi-head attention**. Built a **modular encoder–decoder architecture** enabling rapid experimentation and extensible visual encoders (e.g., EfficientNet). Leveraged **transfer learning** to achieve a competitive **BLEU-4 score of 27.5** on Flickr8k, surpassing LSTM+Attention baselines.

Key Projects

- **RefractorIQ — Code Deduplication & Dependency Analyzer**: Built a Tree-sitter multi-language AST pipeline with canonical tokens and **SimHash+LSH** for scalable clone detection; added dependency toggling and graph visualizations.
- **Speech-driven Customer Service Assistant**: Developed an end-to-end **STT** → **RAG** → **TTS** assistant with low-latency dialogue; integrated a **G2P-based phoneme-aware generator** using constrained decoding for higher-quality TTS.
- **MCP Server for Browser Automation**: Implemented **Model Context Protocol** server enabling NL browser control with Playwright-backed action planning and capability-scoped safe DOM operations.
- **Multithreaded Go Chess Engine + Gemma3**: Designed a multithreaded Go engine for parallel move evaluation and fine-tuned **Gemma3** on FEN/game-history data to generate legal moves and reasoning; added a rule-based validator.
- **Anonymous Web Platform**: Built a privacy-focused platform using ephemeral fingerprints, entropy-throttled identifiers, and zero-knowledge–style session tokens for identity-free authentication.

Work Experience

Present
July 2024

Software Development Engineer *JLR TBSI, Bangalore*

- Developed high-precision localization pipelines using **Factor Graph Optimization** (GNSS+IMU)
- Architected the underlying event-driven architecture to a **controlled polling mechanism**, optimizing instruction cache locality to enforce deterministic performance critical for **safety-critical** ECUs.
- Designed a scalable **Software-in-the-Loop (SIL)** framework for reproducible sensor/vehicle traces and regression testing across releases.

June 2023
May 2023

Research Intern — Frontend Hosting & Micro-Frontends *D. E. Shaw India*

Evaluated and prototyped **Module Federation + Monorepo** hosting architecture, reducing bundle and integration overhead via code-splitting and host/remote composition.

Apr 2022
Jan 2022

Computer Vision Intern *Assert SecureTech, Mumbai*

Built annotation + preprocessing pipeline (9k+ images) and trained landmark-based **face recognition** models for production attendance systems.

Voluntary Work & Teaching

- **Teaching Assistant, CS 101** : Assisted instruction for **1200+ students**, led a **30-student** lab batch.
- **Alumni Mentorship, IIT Bombay** : Guided 20 mentees on transitioning into academic/industry roles.
- **Teaching Underprivileged Students** : Conducted weekly sessions in math and basic computer literacy.
- **Swachh Bharat Abhiyan** : Community cleanliness drives under the Govt. of India's initiative.
- **Beti Bachao Beti Padhao** : Awareness and education-support campaigns for girl child welfare.
- **COVID-19 Relief Drives** : Contributed to NGO-led food and medicine distribution efforts.
- **Karunashraya CSR Volunteering** : Prepared and served meals for students across **50 government schools**.

Awards & Extracurricular

- **AIR 45, JEE Advanced (2020)** : Secured All India Rank 45 among 1.5 million candidates.
- **KVPY Fellow (AIR 130)** : Awarded the prestigious fellowship by Govt. of India.
- **Olympiad Qualifications** : Qualified for INPhO, INChO, NSEJS, and IMO stages.
- **Creator Kudos, JLR TBSI** : Awarded to **top 1% employees** for exceptional technical impact and performance.
- **Tennis (NSO)** : Year-long NSO training and selected for state-level tournament representation.
- **Fit India Campaign** : Completed the national "300 km in 30 days" walking challenge.