Ilia Zaichuk

Software Engineer, Formal Verification

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Experience

2018–2024 **Proof Engineer**, *Digamma.ai*

Focus: Formal verification of safety-critical software systems.

- **HELIX Formally Verified Compiler:**
  - Developed novel techniques to formally verify compilation from purely functional to imperative paradigms.
  - Formally verified compilation of abstract numerical (real, natural numbers) to binary values (float, int).
  - Utilized tools like Gappa to reason about numerical stability, absense of overflow errors.
  - Contributed to proving semantically-preserving compilation of code deep-embedded in Rocq to LLVM IR using the novel approach of giving LLVM semantics via interaction trees (ITrees).
- Worked on **ASN.1** serialization, formal verification of C libraries (asn1c) using CompCert & VST.
- Contributed to formal verification of safety-critical components in **Coreboot** open-source firmware.
- Managed and administered company's Drone CI server and related tasks.

Publications

Preprint, 2026 **HELIX: Verified compilation of cyber-physical control systems to LLVM IR**, *Co-author*, Manuscript under review. End-to-end verified code generation for high-assurance numerical computing, formalized in Rocq, compiling high-level mathematical specifications through HELIX intermediate languages down to LLVM IR.

ICFP'21 **Modular, compositional, and executable formal semantics for LLVM IR**, *Co-author*, A novel formal semantics, mechanized in Rocq, for a large, sequential subset of the LLVM IR.

VSTTE'20 **Verified Translation Between Purely Functional and Imperative Domain Specific Languages in HELIX**, *Co-author*, Formally verified semantic preservation when translating between functional and imperative paradigms in the HELIX verified compiler. A novel contribution to the field with no established prior approaches.

Skills

Verification **Rocq, VST/CompCert, F*, floating-point representations, numerical stability, compiler design**

Languages **Haskell, OCaml, Python, Go, C**

IT Admin **Linux, shell scripting, Docker, libvirt, networking, git**

Projects

2020 **float-cohorts**, a formally verified library in Rocq for precise manipulation of floating-point numbers with support for arbitrary formats in a unified representation.

2023–2024 **LEG-16**, a Turing-complete processor from NAND gates in a videogame, with custom assembly and ASICs, documented on YouTube (globally ranked 69th for efficiency).

2025–Present **Theseus**, a file server in Go built around URL permanence: stateless design, storage backend agnostic, permanent and ephemeral storage tiers, and security-depth implementation (Argon2id auth, sandboxed file I/O, tar bomb protection, CSP headers).

Awards

Jan 2019 **POPL'19 Student Research Competition, 3rd place**, *ACM*, Formal verification of floating-point number conversion between ASN.1 BER and IEEE 754 binary encodings.

Education

2016–2021 **Bachelor of Computer Science**
Taras Shevchenko National University of Kyiv