# LFortran: A Modern Interactive LLVM-based Fortran Compiler

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# Introduction

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- **LFortran** is a modern, open-source interactive Fortran compiler built on top of **LLVM**.
- Designed for **high-performance computing (HPC)** and **scientific applications**.
- Provides **fast compilation** and enables both interactive exploration (like Python or Julia) and compilation to optimized binaries.
- Licensed under **BSD** and actively developed by an open community.
- Main repository: github.com/lfortran/lfortran

# Motivation and Goals

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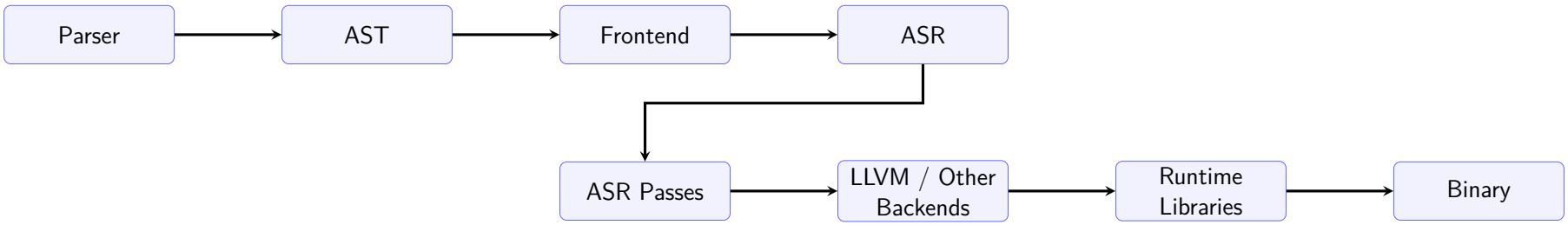
- Modernize Fortran to fit todays developer workflows.
- Enable fast experimentation through **interactive execution** and seamless integration with **Jupyter notebooks**.
- Provide a robust compiler infrastructure for HPC and scientific computing.
- Achieve cross-platform execution on CPUs, GPUs, and WebAssembly.
- Foster an open, sustainable ecosystem around **Fortran tooling**.

# Architecture Overview

# Architecture Overview

- Built upon the **LLVM** compiler infrastructure.
- Modular design allows multiple backends:
  - **LLVM** (primary backend)
  - Experimental: C, C++, Julia, MLIR, and WebAssembly
- Frontend designed for extensibility and modern Fortran standards.
- Integrates with **Fortran Package Manager (FPM)** and **stdlib**.
- The compilation pipeline proceeds through multiple representations as shown below.

# LFortran Compilation Pipeline




*AST: Abstract Syntax Tree, ASR: Abstract Semantic Representation*

# Key Features

# Feature Highlights

- **Interactive JIT execution** for exploratory programming.
- Supports both **monolithic** and **separate compilation**.
- Support for **OpenMP pragmas** and **Do Concurrent**.
- Early **GPU offloading** support (NVIDIA architectures).
- **WebAssembly backend** for browser-based execution.
- Partial support for compilation of **FPM** and the growing **stdlib**.

# Recent Milestones

# Recent Milestones (2023–2025)

- Reached 8/10 of the beta milestone (compile 10 production codes).
- Successfully compiled major scientific codes:
  - Minpack (Legacy & Modern)
  - fastGPT
  - dftatom
  - SciPy (60%)
  - stdlib
  - SNAP
  - PRIMA
  - POT3D
- Introduced **Fortran on Web** (May 2024).

# Demonstration

# Try LFortran Online

- Experience LFortran directly in your browser.
  - Uses the experimental WebAssembly (WASM) backend instead of LLVM.
- WebAssembly-based online IDE: dev.lfortran.org
- No installation required: run, edit, and compile interactively.
- Ideal for teaching, prototyping, and quick validation of Fortran code.

# Community and Ecosystem

# Community and Ecosystem

- Active, open-source development on GitHub:
  - ∼335 Pull Requests per month*
  - ∼390 total commits commits per month*
  - Total PRs; GitHub: 4733, GitLab: 1838
  - 118 total contributors
  - 7-10 active contributors monthly
- Integration with key Fortran projects:
  - Fortran Package Manager (FPM)
  - Fortran Standard Library (stdlib)
  - SciPy and other scientific frameworks
- Open to contributors in compiler development, testing, and documentation.
- Expanding collaboration with HPC researchers and Fortran developers worldwide.

*Averages calculated over the last 6 months.

# Roadmap

# Roadmap to Beta and Beyond

- **Beta goal:** compile 10 production codes (currently 8/10 achieved).
- Upcoming priorities:
  - Complete object-oriented feature support.
  - Enhanced GPU offloading (NVIDIA & AMD).
  - Improved diagnostics and error handling.
  - Expanded FPM and stdlib compatibility.
  - Stable WebAssembly and browser toolchain.

# Conclusion

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- LFortran modernizes Fortran for contemporary HPC and scientific workloads.
- Combines interactivity, modular design, and multi-backend flexibility.
- Active community driving rapid innovation.
- Goal: a production-ready, portable, and open Fortran compiler ecosystem.

**Learn more:** lfortran.org

# Thank you!

*Questions?*
github.com/lfortran/lfortran