

# Mnemosyne: A Functional Language for Systems Programming

## CMPSC600 Senior Thesis Proposal

Hawk Weisman

Department of Computer Science  
Allegheny College

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# Proposal

To implement and evaluate a prototype compiler for the Mnemosyne programming language.

- ▶ Mnemosyne is a functional language for systems programming, with compile-time automatic memory management.
- ▶ But what does that mean?

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- ▶ **Functional programming** models computation as the evaluation of functions [11, 25]
  - ▶ **It focuses on** immutability, purity, and function composition
  - ▶ **Advantages:** expressiveness [10, 11], modularity [10, 11], safety

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- ▶ **Mnemosyne is inspired by:**
  - ▶ **Lisp**'s syntax and homoiconicity [22, 24].
  - ▶ **Haskell and ML**'s type system [9, 13] and pattern matching [13, 15, 17]
  - ▶ **Rust**'s memory management [2]

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- ▶ **Systems programming** is the implementation of software that provide services to other software [19, 20].
- ▶ High quality systems are necessary for high quality applications.
- ▶ But there are some significant challenges in this field [2, 20]

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- ▶ Almost all systems programming today is done in C [7, 20]
- ▶ **Why?** C manages memory at compile-time
  - ▶ Most languages use through garbage collection (GC) [1]
  - ▶ GC is unsuitable for most low-level systems [7, 8, 20]
  - ▶ C manages memory manually (`malloc()`/`free()`) [8, 14, 20]

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- ▶ **Manual memory management leads to errors** such as buffer overflows, memory leaks, and null pointer dereferences [7, 20]
- ▶ **What if there was another way?**

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- ▶ **How?**

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- ▶ Mnemosyne manages memory automatically at compile time
- ▶ **How?**
  - ▶ Stack allocation [3, 6, 18]
  - ▶ Ownership analysis [18]
  - ▶ Controlled mutability [18]



# Methods

Manganese, the Mnemosyne compiler, is implemented in Rust

- ▶ **Combinator parsing** [4, 5, 12, 23] using `combine` and `combine-language`
- ▶ **Analysis** including type checking and lifetime analysis [18, 21]
- ▶ **Code generation** using `librustc-llvm` [16]

# Methods

Assessing Mnemosyne's correctness

- ▶ **Unit and integration testing** to validate the compiler implementation
- ▶ **Demonstration** by implementing example code, including parts of the prelude
- ▶ **Benchmarking** compiled Mnemosyne binaries

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