Mnemosyne:
A Functional Language for Systems Programming
CMPSC600 Senior Thesis Proposal

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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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  - **It focuses on** immutability, purity, and function composition

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- ▶ **Functional programming** models computation as the evaluation of functions [12, 26]
  - ▶ **It focuses on** immutability, purity, and function composition
  - ▶ **Advantages:** expressiveness [10, 12], modularity [10, 12], safety

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- **Mnemosyne is inspired by:**
    - **Lisp**'s syntax and homoiconicity [23, 25].
    - **Haskell and ML**'s type system [9, 11, 14] and pattern matching [11, 14, 16, 18]
    - **Rust**'s memory management [2]

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- **Systems programming** is the implementation of software that provide services to other software [20, 21].
- High quality systems are necessary for high quality applications.
- But there are some significant challenges in this field [2, 21]

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- ▶ Almost all systems programming today is done in C [7, 21]
- ▶ **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, 21]
  - ▶ C manages memory manually (`malloc()`/`free()`) [8, 15, 21]

What is Mnemosyne?

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- ▶ **Manual memory management leads to errors** such as buffer overflows, memory leaks, and null pointer dereferences [7, 21]
- ▶ **What if there was another way?**

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- Mnemosyne manages memory automatically at compile time
- **How?**

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- Mnemosyne manages memory automatically at compile time
- **How?**
  - Stack allocation [3, 6, 19]
  - Ownership analysis [19]
  - Controlled mutability [19]

Methods

Manganese, the Mnemosyne compiler, is implemented in Rust

- **Combinator parsing** [4, 5, 13, 24] using `combine` and `combine-language`
- **Analysis** including type checking and lifetime analysis [19, 22]
- **Code generation** using `librustc-llvm` [17]

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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