

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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- ▶ **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

What is Mnemosyne?

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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].

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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 garbage collection (GC) [1]
 - ▶ GC is unsuitable for most low-level systems [7, 8, 21]
 - ▶ C manages memory manually (`malloc()`/`free()`) [8, 15, 21]

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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]

Mnemosyne Syntax

A brief example:

```
(def factorial (fn ( -> int int )  
  ((factorial 0) 1)  
  ((factorial n) ( * n (factorial (- n 1)) )  
)))
```


Mnemosyne Syntax

Using syntactic sugar...

```
def factorial (fn { int -> int }  
  (factorial 0) 1  
  (factorial n) {  
    n * factorial({n - 1})  
  })
```

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

Questions?

For more information:

- ▶ **Sample Mnemosyne code** if there's time
- ▶ **Complete source code:**
`https://github.com/hawkw/mnemosyne`

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