AN ABSTRACT OF THE THESIS OF

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Title: The Ownership Monad

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The Ownership Monad

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Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Michael McGirr, Author

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Chapter 1: Introduction

1.1 Introduction

This paper presents a library for Haskell that implements an *ownership-style* set of rules for resource-aware programming. This ownership system introduces a set of rules that govern how, when, and by whom a resource within what is called an Owned reference (an *ORef*) can be used. While the restrictions this implementation imposes may seem to increase the complexity of writing programs, the resulting guaranties that adhering to these rules facilitates offers significant improvements in specific areas.

Adding a way to keep track of resources in a pure language like Haskell may at the onset seem unnecessary since in a pure language, by definition, the data making up the resources bound to variables are immutable. Because of this there is inherent changing state. Haskell's purity allows for referential transparency where values and variables can be thought of as being interchangeable in the sense that under any context evaluating an expression will always lead to the same result. This is a very desirable property that Haskell's purity grants and it allows for a greater ability to reason about the behavior of a program.

Unfortunately even in a pure language like Haskell, this property breaks down in the context of concurrency. Concurrency introduces a changing state as separate threads interleave actions. Under some circumstances this can make a program in Haskell look and act as though it were an imperative language.

Concurrent Haskell programs can still fall prey to the same fundamental problems that other impure languages can, namely deadlock and starvation. This paper will demonstrate what some of these problems look like using basic concurrency tools available in Haskell such as shared state with MVars and message passing with channels. It will then demonstrate and explain the benefits of tracking resource usage with a set of rules similar to affine types. The contribution that tracking resources while they are being used and sent between threads will be shown.

1.2 Additional contributions

While this library does not do so - by tracking resources with the ownership system it becomes in theory possible to reason about the memory usage over the lifetime of a program using the type system of the language. This method makes it possible to do a form of automatic deterministic destruction instead of the typical garbage collection approaches. This paper will show where in an example program this could occur.

1.3 Background

Approaching resource usage with this style of implementation is not a new concept. Restricting all entities to following the rules specified under a affine type system discipline is applied under the Ownership System in the Rust programming language.

Idris, which treats Uniqueness Types as a subkind of regular Types, shows the other way of approaching this and the benefits and tradeoffs of doing so. By allowing non-unique types to exist and be used along side Unique Types, Idris offers a degree of flexibility with it's approach to Uniqueness Typing that is not present with ours.

Chapter 2: The Ownership Monad

2.1 Move Semantics

2.2 ORef's

ORef's section