Trolloc: A trolling dynamic memory allocator

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1 Abstract

Worldwide trends in the software development sphere have indicated a desire for consistently broken software. Current methods of constructing bad software include the use of LLMs or JavaScript. These do not result in the kind of critical and discreet bugs that give software engineering its lifeforce. To fill this void, this paper introduces *Trolloc*, a trolling memory allocator. *Trolloc* is an explicitly-linked, first-fit memory allocator using a stack-based heap and type system crimes, written in Rust. The allocator implements a so-called *trolling algorithm*, which randomly selects zero or one allocated block(s) from the user's heap to deallocate each time that an allocation is requested. Roughly a quarter of iterations of the reference test applications resulted in premature program termination via OS signals. Other test applications outright refused to allocate any memory or instead decided not to terminate at all. Future work could include application-specific trolling allocators, collected garbage programming languages, or dysfunctional desktop applications.

2 Introduction

In recent years, a trend has emerged of programmers wanting to ensure that their code does not work. This is exemplified by the mass adoption of tools such as LLMs in software development circles. However, the problem with using LLMs as a source for software bugs is that these bugs can be identified at a glance via minimal code review in the brief part of the software life cycle between the "copy" and "paste" operations. Another indication of growing distrust in reliable software is the ever-expanding list of JavaScript frameworks. The number of lines of JavaScript in a product has been shown to directly correlate with the number of hours developers spent wishing they were not working on said product [6]. Still, the solution for all bugs created by the use of JavaScript is very straightforward: developers must simply use a real programming language.

The bugs created by LLM hallucinations and JavaScript's "type" "system" do not result in an enriching debugging experience like bugs hallmarked by more inconsistency and unpredictability. To create persistent, enigmatic, and challenging software bugs, programmers need to embed code flaws into core parts of their programs, deep behind the curtains of abstraction layers. One example of such critical program infrastructure is dynamic memory allocation.

Many computer programs rely on dynamic memory allocation for a large portion of their functionality. Outside of systems programming, dynamic memory allocation is often abstracted away from the programmer, and so it is unlikely to be identified as the source of a software bug quickly. Furthermore, Google, Microsoft, and Mozilla all report a majority of the severe software bugs in their products are related to memory safety [7]. Clearly, memory unsafety is a prime target for introducing the kinds of high-quality software bugs that today's programmers yearn for. To address this need, this paper introduces *Trolloc* [5], a dynamic memory allocator that does a little trolling.

3 Design and Implementation

Due to the significantly unsafe practices that must be used in the implementation of *Trolloc*, the tech stack used for its implementation should ideally include a permissive compiler, lax type system, and only loosely enforced safety rules. For this reason, the reference implementation of *Trolloc* uses the Rust programming language. The reference implementation of *Trolloc* includes an allocator library as well as a test program and unit tests to verify that any software using the allocator fails catastrophically. The allocator library implements the `GlobalAlloc` trait [4] from Rust's standard library, which allows it to be used as the standard allocator for a Rust program. The test program leverages this and uses the allocator for several heap-allocated strings and vectors, which frequently fails.

Trolloc is a dynamic memory allocator with a focus on inconsistency, unsafety, confusion, and frustration. At its core, the allocator is implemented similarly to many general-purpose heap allocators. *Trolloc* is a linked list allocator, maintaining a list of explicitly linked free blocks within a fixed-size, stack-allocated heap. Free blocks are searched using a first-fit algorithm, which leads to a probably-acceptable amount of internal fragmentation. Allocator bookkeeping data is stored at the start of the heap, further limiting the available heap space for users. The allocator implements common optimizations such as free block coalescence, block splitting, and using an entire 8-bit boolean in block metadata to mark whether or not the block is free even though a single bit would suffice.

In order to induce software failures, *Trolloc* implements an unprompted, non-deterministic, invisible deallocation algorithm. During operational allocation requests, *Trolloc* heuristically determines whether now would be a good time to mark a random block in the heap as no longer in use. This process is seamless and does not require the programmer to explicitly free any blocks. Each time an allocation request is processed, the allocator generates a random seed by placing a marker variable at the start of the function's stack frame and reinterpreting its location as an integer. This value's randomness is determined by the target system's address space layout randomization [1], which is assumed, but not verified, to be active. This address is fed into the *wyrand* non-cryptographic pseudo-random number generation algorithm [12] as a seed. The resultant pseudo-random number has a random bit, also identified by the random number, queried. If the random bit is set then *Trolloc* proceeds with deallocating the heap block indexed by the random number. *Trolloc* does not verify that this block actually ends up being freed, that the original allocation request succeeds, or that any portion of this process does not result in catastrophic program failure. The trolling algorithm is shown below in Listing 1.

Listing 1: Trolling algorithm with egregious kerning.

```
random_number := Wyrand (marker_address xor block_address) ;
random_index := random_number Mod num_alloced_blocks ;
random_bit := (random_number Mod size_of_usize) − 1 ;
If ((random_index and (1 << random_bit)) >> random_bit) = 1
Then
    random_block := GetBlockByIndex (random_index)
    Deallocate (random_block) ;
```

Trolloc introduces additional layers of frustration to debugging by misusing the type system in its implementation programming language, often incorrectly. Rather than using any of the tools provided by the Rust standard library, the reference *Trolloc* implementation forces data to be represented as if it were a C struct, then reinterprets data into misaligned and invalid pointers using unsafe casts. This method of representing data internally was chosen for no good reason.

Understanding the remaining features of *Trolloc*'s design is left as an exercise to the reader. Readers are encouraged to contact the author if they can figure out what any of the code is actually doing, as this would help in improving the reliability of *Trolloc*'s unreliability.

4 Results

The reference implementation was tested on a variety of example programs. The outcome of these programs depended primarily on the number of independent allocations that a given program performed. Fewer allocations provide for fewer opportunities for the trolling algorithm to run. For programs with only a few small allocations, the program would encounter an error roughly every 25 out of 100 iterations. The precise errors that occurred also varied: most of the time the program would panic due to a buffer overrun or access violation. Infrequently, test programs would lock up, ostensibly due to an infinite recursion. Investigating the cause of this recursion using debuggers, such as GDB [3] and LLDB [11], indicates that Rust's default panic handler dynamically allocates memory. Since *Trolloc* is configured as the global default allocator for the test programs, this means that the panic handlers allocate memory using *Trolloc*. However, the panic handler is only handling a panic because *Trolloc* was trolling the test program, so when the panic handler goes to allocate memory, it gets trolled, which causes a panic, which must be handled by the panic handler, which must allocate memory, which gets trolled, which causes a panic. Since selective serotonin reuptake inhibitors have a limited efficacy when administered to Rust programs, there is no FDA-approved method to get the program to stop panicking, and so this process continues *ad infinitum*.

Test programs that attempt to make many small allocations tend to fail fast. Repeated allocations of just a few bytes consume the entirety of the available pseudo-heap quickly, and then any slightly larger allocation has nowhere to fit because of a significant amount of external fragmentation. These test programs usually fail due to a memory allocation failing long before they get the chance to use a block that has been freed by way of trolling.

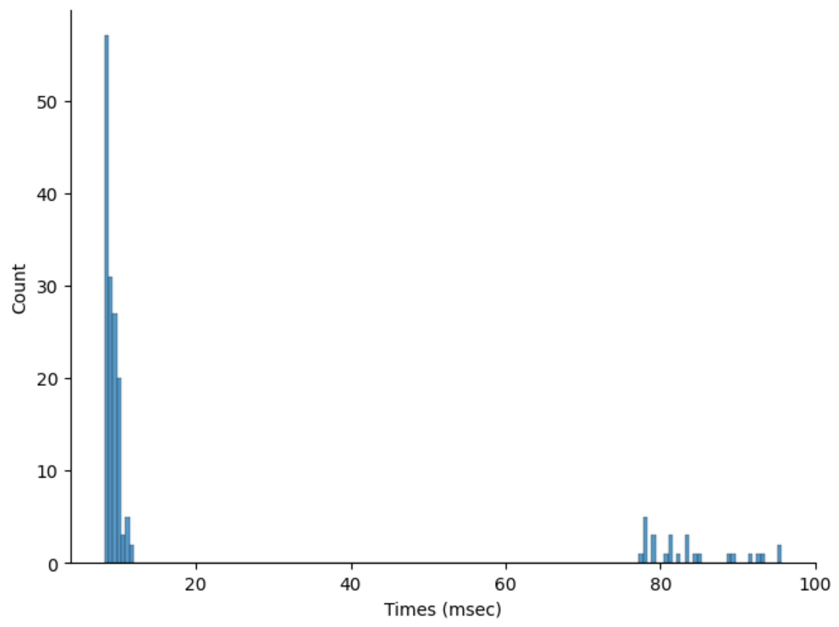
The most current test program, as of writing, was benchmarked using hyperfine [10]. Over 171 test iterations, the total runtime of the program averaged about 20 milliseconds, with most runtimes being closer to 10. The distribution of these results is available in Figure 1 (made with seaborn [13]). These results indicate that the test program is small, and say absolutely nothing whatsoever about the speed of the *Trolloc* library's internal procedures.

Finally, the *Trolloc* test program was tested with Valgrind [8], which is a command-line tool that can be used to check for memory leaks in a program. Consistently, even in situations where the test programs resulted in a panic, the programs did not leak any memory. This is probably because *Trolloc*'s pseudo-heap is actually located on the stack, so there is nothing to leak. In fact, any program that uses *Trolloc* and terminates is provably free of memory leaks.

Theorem 4.1. *Any program which uses Trolloc and terminates does not leak any memory.*

Proof. Every program which terminates does not leak memory. [2] □

Figure 1: Distribution of test program runtimes.



This fact leads to an important conclusion: programmers can use *Trolloc* in their programs and expect significant memory-related bugs, but no memory leaks, sometimes. On the rare occasion in which a program using *Trolloc* results in an infinite loop, the programmer can eliminate the leaked memory by restarting their computer. Furthermore, the programmer can avoid this situation altogether by constructing a Turing Machine to verify that their program halts before attempting to run it.

5 Conclusions

Trolloc contributes a basis for expansion in the burgeoning field of program inadequacy proliferation. There is significant opportunity for other researchers of the subject of memory unsafety to build off of this work with better developed and possibly even functional memory mismanagement systems. Future works might include application-specific allocators that use the proposed trolling algorithm, expansions upon the explicitly-linked allocator using a modified trolling algorithm, or even a collected garbage programming language that uses a trolling allocator to back its garbage production. Brave, bored, or unemployed programmers might even find value in attempting to create complex applications using *Trolloc* or a trolling memory allocator of their own creation. Basically, the author of this paper does not ever intend to touch this monstrosity again, and encourages intrepid researchers to create more interesting and frightening reminders of mortality in the form of programs that wontonly disregard all herefore agreed upon mores and norms. In an ideal world, one in which friction can be ignored and assumptions can be made for sake of contradiction, such "software" will soon permeate the fabrics of humanity's most critical infrastructure.

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