

An Investigation Into the Use of Haskell for Dynamic Programming

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Abstract Over the last decade the speed of computers has increased by many orders of magnitude but the speed of the typical programmer has not. In many cases it is far more important to quickly produce correct and robust code than to optimise code for performance, and as computers continue to become more powerful, while humans will essentially remain the same this is ultimately going to become the norm. We argue that prototyping new heuristics and algorithms for combinatorial optimisation is one area where speed of development of correct code is already more important than absolute performance.

As an example, there was a high profile case recently[1] in which a software bug has caused erroneous results to be published, and to possibly influence European policy¹. Amongst other things, a cause of error was a range-indexing mistake in the spreadsheet which caused several countries to be excluded from the analysis.

Consider the simplified example of summing a collection of numbers: in a high level programming language like Haskell one passes the name of a collection of numbers (whether an array, a list or otherwise) to the *sum* function which will, behind the scenes and opaque to the user, index each element and add them together thus completely eliminating that class of errors. In most spreadsheet software however one has to manually select the cells (e.g. “C3:C100”)² which is error-prone as well as being non-trivial to later expand to include additional data.

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¹ www.bbc.co.uk/news/magazine-22223190

² While named ranges do exist they still have to be manually specified which just pushes the problem elsewhere.

TODO: talk about reasoning about code

We use Haskell to implement standard dynamic programming algorithms, including bounded and unbounded knapsack, and column generation. Then we compare with implementations in Java and C in terms of speed, conciseness, modularity, as well as ease of parallelisation, refactoring, debugging and reasoning. To make the comparisons fair we keep the structure of the code similar across languages, except when taking advantage of specific language features (e.g., pointers, objects or laziness). The implementations are idiomatic and representative of an 'average' user, without non-portable micro-optimisations. In particular, standard libraries are used throughout for data structures, mathematics and floating-point arithmetic with as little as possible implemented by hand.

Our preliminary results (unbounded knapsack in C and Haskell) show that while the C code is about four times faster, using Haskell for prototyping indeed offers significant advantages in terms of speed of development and eliminating certain classes of errors, without incurring a performance penalty that is unacceptable for a prototype. TODO: extend this, talk a little more about results

TODO: Graph of results here? gcc -O2 vs ghc-O2 vs ghc -O2 -llvm vs clang -O2

Keywords Haskell · C · Java · Functional Programming · Dynamic Programming · Language Comparison

References

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