A Survey on Term Rewriting for Code Optimization

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1 Introduction

As a means of attempting to popularize the sheer vastness and absurdity of infinity with regards to information, society has often perpetuated the proverb of monkeys on a typewriter; an infinite number of typewriter-equipped monkeys with an infinite amount of time would eventually produce the complete works of Shakespeare. While the broad sentiment conveyed through this statement can serve as an interesting thought experiment for the masses, computer scientists often have to deal with very real consequences of seemingly infinite swaths of data and computation on finite resources. Indeed, with the advent of generative AI models and the internet, collecting and distilling temporarily useful information from universal entropy has become a more pressing and arduous task than ever before.

Since computers are precise, powerful machines limited in expressivity only by their need for extremely simple instructions, the subfield of compilers and programming languages is especially concerned with efficient, effective, and provable methods of translation. Term rewriting is one such method that enables compilers to convert very high level language into fast, low-level executable information.

In this paper, we explore concepts and ideas surrounding the topic of simple term rewriting, delving into the inner-workings, benefits, and limitations of such a system. Later, we will abstract some components of the simple term rewriting for improved expressivity, control, modularity, and overall usefulness in the context of code optimization.

2 Term Rewriting

2.1 The Art of Translation

2.2 A (Simple) Term Rewriting System

2.3 Termination

2.3.1 Reduction Orders

2.3.2 Simplification Orders

2.4 Confluence

2.5 A Complete Algorithm

2.6 Limitations

3 An Improved Term Rewriting System for Code Optimization

3.1 Rewriting Strategies

3.2 Code Optimization with Rewriting Strategies

4 Conclusion

References

[1] F. Baader and T. Nipkow. *Term Rewriting and All That*. Term Rewriting and All that. Cambridge University Press, 1998. ISBN: 9780521779203. URL: https://books.google.ca/books?id=N7BvXVUCQk8C.

[2] Bruno Buchberger. "Mathematica as a rewrite language". In: *Proceedings of the 2nd Fuji International Workshop on Functional and Logic Programming*. World Scientific. 1996, pp. 1–13.

[3] Thomas J. Watson IBM Research Center, F.E. Allen, and J. Cocke. *A Catalogue of Optimizing Transformations*. IBM Thomas J. Watson Research Center, 1971. URL: https://books.google.ca/books?id=oeXaZwEACAAJ.

[4] J. Cooke. *Constructing Correct Software: The Basics*. Formal Approaches to Computing and Inf. Springer, 1998. ISBN: 9783540761563. URL: https://books.google.ca/books?id=N3whAQAAIAAJ.

[5] Albert Graf. *The Pure Manual*. 2020. URL: https://agraef.github.io/pure-docs/pure.html?highlight=term%20rewriting (visited on 03/14/2025).

[6] Zach Kimberg. *Catln Language Summary*. 2025. URL: https://catln.dev/ (visited on 03/14/2025).

[7] Mircea Marin and Florina Piroi. "Rule-Based Programming with Mathematica Mircea Marin". In: (May 2004).

[8] Jeremy Miller. *Introduction to Term Rewriting with Meander*. 2023. URL: https://jimmyhmiller.github.io/meander-rewriting (visited on 03/14/2025).

[9] *Strategic Rewriting*. 2023. URL: https://spoofax.dev/background/stratego/strategic-rewriting/strategic-rewriting/ (visited on 03/14/2025).

[10] Eelco Visser, Zine-el-Abidine Benaissa, and Andrew Tolmach. "Building program optimizers with rewriting strategies". In: *SIGPLAN Not.* 34.1 (Sept. 1998), pp. 13–26. ISSN: 0362-1340. DOI: 10.1145/291251.289425. URL: https://doi.org/10.1145/291251.289425.