Application-Specific Instruction Generation for Configurable Processor Architectures

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Developing domain-specific architectures is a highly relevant area of research that has gained a lot of traction with the rise of machine learning. In the field of reconfigurable computing, various configurable processor architectures have emerged, providing the ability to adapt their instruction set to a specific application or domain of applications. Targeting performance optimization and power efficiency in combination with increased design productivity, these architectures are promising candidates for a wide range of application scenarios.

One of the key issues developers of such application-specific instruction set processors (ASIPs) face until today is the selection of the best candidates for processor extensions. In this context, the authors introduce an elegant and exact theoretical formulation as a basis for the automatic generation of custom instructions. They show that the instruction generation for ASIPs is closely related to the classical minimum-area technology mapping problem, which has been extensively studied in the logic synthesis domain. In their approach, the ASIP compilation problem is solved in three steps: After enumerating all candidate patterns for the given data flow graph, instructions are selected based on their occurrence, speedup, and area cost. In the final application mapping step, the data flow graph is mapped onto the extended instruction set to minimize the overall latency. In addition to their theoretical contributions, the authors demonstrate the efficiency of their approach, using real-world benchmarks running on a soft-core processor.

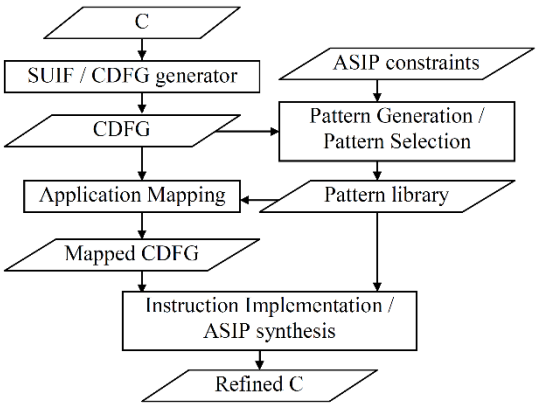

Figure 3. Proposed ASIP compilation flow.

Being one of the early attempts to automatically generate instruction set extensions, the paper demonstrates the feasibility and benefits of ASIPs based on reconfigurable architectures. About 300 citations show the high relevance of the work for the community. Until now, the results are used as a basis for comparisons on a theoretical level as well as for practical applications.

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