Domain Specific Language for Modeling Waste Management Systems

In order to develop sustainable waste management systems with considering life cycle perspective, scientists and domain experts in environmental science require readily applicable tools for modeling and evaluating the life cycle impacts of the waste management systems. Practice has proved that modeling these systems with general-purpose tools is a cumbersome task. On one hand, the scientists have to spend considerable amount of time to understand these tools in order to develop their models. On another hand, integrated assessments are becoming gradually common in environmental management and therefore scientists are also faced with the problem of integrating models across scales and domains, which is not a straightforward process.

Domain-Specific Languages (DSLs) are languages which are specialized for a specific application domain and they promise to increase developer productivity by raising the level of abstraction. They allow domain experts, who are non-programmers, to directly encode their domain knowledge about what a system under development should do. In this thesis, we utilize domain-specific languages, on the basis of the flow-based programming (FBP) paradigm, to model and evaluate environmental technologies i.e. solid waste management systems. Flow-based programming is used to support concurrent execution of the processes, and provides a model-integration language for composing processes from homogeneous or heterogeneous domains. And a domain-specific language is used to define atomic processes and domain-specific validation rules for composite processes. We call these DSLs, which are based on FBP paradigm, domain-specific flow based languages and we provide a formal framework to develop them. To this end, we advocate aspect-oriented concepts to FBP to separate cross-cutting concerns, by providing an extension called AOFBP. Afterwards, we propose the framework based on this extension, and we use a formal language called ForSpec, which is an extension of FORMULA, to formally specify the structural and behavioral semantics of the sub-languages proposed in this framework. Finally, we propose a domain specific language for modeling of waste-management systems on the basis of our framework. We evaluate the language by providing a set of case studies. The contributions of this thesis are; addressing separation of concerns in Flow-based programming and providing the formal specification of its syntax and semantics; a formal language and framework to specify domain-specific flow based languages; design and develop domain specific languages for waste management modeling; and finally our work also can be considered as another case study for structural and behavioral semantics specifications in ForSpec and FORMULA.