

Case Discussion (Robot Waitering)

Syntax Analysis

Divya Kundra and Ashish Sureka, *An Experience Report on Teaching Compiler Design Concepts using Case-Based and Project-Based Learning Approaches*, International Conference on Technology for Education (T4E 2016)

GOLEMS is Humanoid Robotics Lab at Georgia Institute of Technology. The lab works towards developing robots having human and even super human capabilities. The current task of GOLEMS lab is to build and demonstrate a robot waitering the tables. In this scenario, customers order drinks and the robot serves a predefined liquid in glasses from a stash of cans the robot is carrying around. The robot would do the human interactions, just like a waiter would come, serve each patron and then collect the bill from each patron, thus the robot should serve all patrons and collect the bills at the end. The developers at GOLEMS lab have found a new way to represent and verify the controlling mechanisms of robots using Context Free Grammars. The production rules of the grammar represent a task decomposition of robot behavior. The name that they have given to the grammars controlling robots is Motion Grammar. They plan to model the behavior of the robot in uncertain environments with this grammar. Context-free grammars can model robot behavior, providing advantages in hierarchical task decomposition, verification, and supervisory control. The lab has several reasons to use context free grammar over regular language. The developers at the lab have found out that they we can describe a broader class of system behavior using the Context-Free language class than with regular languages. The Context-Free set provides more descriptive power while maintaining the efficiency and verifiability of Regular languages. Additionally Context-Free Grammars provide a natural representation for hierarchies in the system. For example to build the grammar for a robot that does loading and unloading task is as shown in Fig.1. The associated parse tree is also shown. In production (1), the system will repeatedly perform [load] operations until receiving a [full] token from production (2). Then the system will perform [unload] operations of the same number as the prior [load] operations.

This simple use of memory is possible with Context- Free systems.

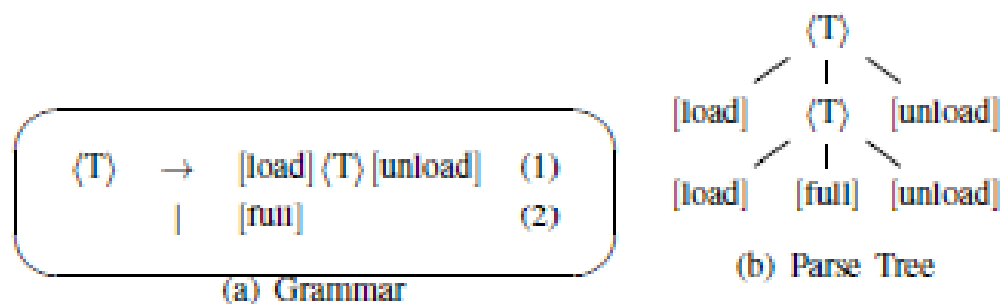


Fig. 1 : CFG and parse tree for loading and unloading task

To directly use the grammar for robot control, it must be translated to machine code, i.e, a computer program; which is the parser generation. Since the model is of a Context free grammar, the developers should decide on the terminal symbols. The productions of the grammar form top-down task decomposition, defining an online control policy for the robot. During operation, selected productions will execute the semantic rules associated with productions to compute input commands for the robot. Thus, controlling the robot will correspond to parsing sensor readings online according to the rules of the grammar. The critical difference between program translation and online control of the robot is time. In program translation, tokens come from a static file available a priori. In robot control, tokens come from sensor readings in real-time. While a compiler need only give its output at the end of the file or statement, a robot must continually respond to its environment.

The precise requirement of the system is that robot's work should start with serving. When serving, the robot should pour cans of soda into glasses as long as there are nonempty cans remaining. When pouring, the robot should keep pouring until either the glass is full or the can is empty. If the glass becomes full, the robot should serve the glass and then charge for the glass once we're done serving. Further, whenever pouring is completed, the can must be placed down again. This requires memory. The developers observed the fact that a finite automata cannot model this task for arbitrary number of customers. However, memory in the form of a context-free stack compactly represents the task. There will be involved other conditions also whose care needs to be done such as ensuring that the robot pours no more drinks after charging for the order (ensuring safety of the cash-register). Identify other conditions also whose care will need to be taken while designing the system. Suggest a suitable Motion Grammar for the required system.