Random Test Stimuli Generation Based on a Probabilistic Grammar

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Abstract

In our research, we are focusing on universal test stimuli generation for any system. Under the concept of stimulus generation we understand generating randomly constructed input test data that determine the behavior of the system. In the case of a processor, the input stimulus is a program which determines its computing operation. In the case of a robot controller, input stimulus is a maze that the robot goes through. This random stimulus creates new circumstances which the system must solve. The architecture of the universal stimuli generation which we have defined is based on two input structures (*Format* and *Constrains*) that describe a test stimulus (see Fig. 1).

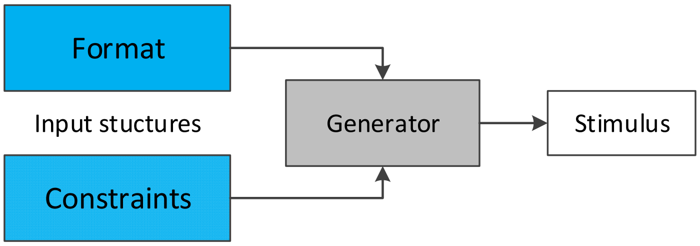

Fig. 1: The architecture of the universal test stimuli generation.

We benefit from the grammar systems which allow us to formally define the format of the stimuli and generate any language through the application of rewrite rules. This language forms desired stimuli for the given system.

The idea is based on the use of a probabilistic context-free grammar with our extension. An innovation that we bring to this grammar is the dynamic change of probabilities during the generation of the language through a special constraint definition. The definition formulates the new grammar system which carries signs of a context sensitivity.

The common probabilistic context-free grammar *G* is the quintuplet:

G = (N,T,R,S,P); where

N is a finite set of non-terminal symbols.
T is a finite set of terminal symbols, applies $N \cap T = 0$.
R is a finite set of rewrite rules with form $A \rightarrow \alpha$, where $A \in N$ and $\alpha \in (N \cup T)^*$.
S is starting non-terminal.
P is a finite set of probabilities for rewrite rules.

The rewriting rules must be clearly identifiable by an identifier. Furthermore, we defined extension in the form of constraints for this grammar definition. Constraints represent restrictions and limitations for derivation of rewrite rules and their application will change defined probabilities for specific rules. The constraint *CONS* is defined as the quintuplet:

CONS = (R_S,R_D,P,[R_E],[C]); where

R_S	is the identifier of the rule which calls this constraint.
R_D	is the identifier of the rule for which the probability is changed.
P	is the new probability value.
R_E	(optional) is the identifier of the rule, the application of which causes the abolition of the constraint.
C	(optional) is the count of derivations of R_E rule before abolishing the constraint.

The task of the constraint is to set the probabilities during the generation process so that the result is a valid stimulus. After the application of the R_S rule, the algorithm will call all the constraints that have defined this identifier and the value of the *P* probability will be set for the rule with the R_D identifier. In the case that the R_E parameter is not defined, the probability is permanently set. In the case that the R_E identifier is specified, the value of the probability will be set until *C* derivations of the R_E rule will not be done. If the *C* parameter is not defined, the default value for *C* is set to one.

The application of the approach was performed to the RISC processor where the stimuli represented the programs consisting of assembly instructions.

Paper origin

The original paper has been accepted and presented at International Conference on Field Programmable Technology in Xi'an: China [1].

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References

[1] Čekan, O.; Podivínský, J.; Kotásek, Z.: Random Stimuli Generation Based on a Stochastic Context-Free Grammar. In: Proceedings of the 2016 International Conference on Field Programmable Technology. Xi'an: IEEE Computer Society, 2016, s. 291-292. ISBN 978-1-5090-5602-6.