ISSN : 0974 - 7435
Volume 10 Issue 11

2014

BioTechnology
An Indian Journal

FULL PAPER
BTAIJ, 10(11), 2014 [5576-5583]

Research on the probability of extended UML state diagram/random kripke structure semantic

Saidong Lv[1], Zhiping Li[2]*
[1]Institute of Security, Yunnan Normal University, Kunming, Yunnan, (CHINA)
[2]Institute of Information, Yunnan Normal University, Kunming, Yunnan, (CHINA)
E-mail : lsdong_ynnu@sina.com

ABSTRACT

Now probability model probability of detection has been widely used in network protocol, the analysis and verification of safety critical systems. Probabilistic model checking is application-level, however, difficult to understand, and modelers have a certain mathematical basis. Extended UML state diagram, and the detection probability model between syntax and semantics, with implicit mapping relation, so this article puts forward from the extended UML state chart to probability/random Kripke structure between semantic mapping rules and precise definition, and corresponding semantic algorithm is given.

KEYWORDS

UML state diagram; Probability/random kripke structure; Semantics; Algorithm.

INTRODUCTION

UML as a kind of universal modeling language, users can easily be mastered and the use of [1,2]. But for some probability, rate, time related to real-time concurrent systems, such as probability, the probability of Ad Hoc network, non-repudiation protocols queuing network, etc., UML design and validation of incompetence. If given performance analysis in the form of semantic oriented to UML, can be requirements, design stage, the visual design of the system, automatic reasoning and analysis, get the key quantitative performance index of the system properties.

But for some probability, rate, time related to real-time concurrent systems. UML design and validation of incompetence. If given performance analysis in the form of semantic oriented to UML, can be requirements, design stage, the visual design of the system, automatic reasoning and analysis, get the key quantitative performance index of the system properties[3,4].

THEORY OF PROBABILITY/RANDOM KRIPKE STRUCTURE

Probabilistic model checking support three kinds of mathematical models, respectively Discrete-Time Markov Chains, Markov Decision Processes and Continuous-Time Markov Chains.

Discrete '- Time Markov Chains and Markov Decision the Processes are Markov model of Discrete, Kripke structure can be formalized description for probability, Continuous - Time Markov Chains is Continuous Markov model, can be formalized description for random Kripke structure. Formal definition of probability/random Kripke structure are as follows[5-7]:

Definition 1: Kripke structure is formalized probability is defined as the six group , among:

Σ_{pk}, represent the set of finite state.

$I_{pk} \subseteq \Sigma_{pk}$, represent the set of initial state.

E_{pk} represent the set of triggering events.

represent the set of guard condition, guard conditions are about the triggering event, state, and the atomic assertions Boolean expressions.

, is a function that the system state, migration relations between system in the current state, if the external events, and meet certain health conditions, with a certain probability, moved to the following relationship.

, Is a function, a set of input state, return a set of atoms assertions in state in the collection. AP is Atomic Proposition, represent all atomic assertions said system set a domain.

represent the set of state between the probability of migration, the range between 0 and 1.

Definition 2: Random Kripke structure formalize is defined as the six group[8]:

$M_{sk} = (\sum_{sk}, I_{sk}, E_{sk}, G_{sk}, \Delta_{sk}, L_{sk}, R_{sk})$ among:

Σ_{sk}, represent the set of finite state.

The definition of are respectively the definition of in probability of Kripke structure.

$I_{pk} \subseteq \Sigma_{pk}$, represent the set of initial state.

, is a function that the system state relations between migration and the current state of the system, if the external events, and meet certain guard conditions, to a certain ratio, moved to the following relationship.

represent the set of state migration rate.

PROBABILITY/RANDOM KRIPKE SEMANTIC STRUCTURE OF EXTENDED UML

Definition 3: Statte label was formalized definition for a function: $\text{Label}: s \rightarrow 2^{AP}$, and $s \in \Sigma_{sc}$ represent in the UML state diagram, enter a system state name S, return to a state and the corresponding tag set 2^{AP}, label is the system variable to true or false, Σ_{sc} represent the set of state diagram.

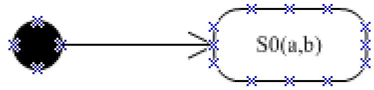

Figure 1 : system init

As shown in Figure 1, the solid circle represent the starting point, the starting point to the initial state. S0 is state name, in the state S0, a, b is the tag name, value is true. Generalization in system processing, will be given a unique number to each state; When the system initialization, each initial values are endowed with true or false.

Rule 1:

$$(\forall s \in \Sigma_{sc}) \Rightarrow ((s \longrightarrow s) \wedge (s \in \Sigma_{pk}) \wedge (\forall n \in \text{Label}(s) \Rightarrow (n \in L_{pk}) \wedge value(n) = true) \wedge \left(\forall m \notin \text{Label}(s) \wedge m \in L_{pk} \Rightarrow (value(n) = false)\right))$$

,represent in the UML state diagram, each state s, are mapped to the probability Kripke structure of a state; Associated with the state S all tags, it is a subset of the probability of Kripke structure, the value is set to true; Label does not belong to the state's system, its value is set to false.

Rule 1 is also suitable for random Kripke structure.

Status and variable initialization PRISM BNF paradigm of statements as shown below:

$$S \longrightarrow S;\ \text{VarInit}|\text{StateInit}$$

$$\text{StateInit} \longrightarrow s: [0 \ldots \text{StateNum}]\text{init StateDefaultNum}$$

$$\text{VarInit} \longrightarrow \text{VarName}; \text{VarType init VarInitVal}$$

In the PRISM, use an enumeration variable, record the serial number of the state. Tags inside the state, the mapping for a bool variable of the PRISM, established according to whether the label in the state, the variable's value is classified as true or false.

By definition 3 rules 1 we can represent the UML state diagram shown in Figure 1, express the probability/random Kripke structure system initialization, the corresponding PRISM code for:

```
s: [0 ... n]init 0;

a bool init true;

b bool init true;
```

Definition 4: Migration is defined as a function: , and among ,, , are the same of definition 1. In the UML state diagram, system S current status, if the external events e, and satisfy the health condition of type g, execute action a, system migration to the following status T.

Figure 2 : migration state

By the mathematical model of definition 1 described can be obtained is showed in Figure 2 UML state diagram can be represented as:

among,

, , , ,

The order of the UML state diagram migration LTS operational semantics is expressed as

Among them: S and T represent state, e represent, e represent external events, [g] represent guard conditions, a represent action.

Rule2:

And

$S_i \to S_i' \wedge S_j \to S_j' \wedge \text{event} \to event' \wedge \text{guard} \to guard' \wedge \text{rate} \to rate' \wedge Label(S_i) = L_1 \wedge Label(S_j) = L_2$

After migration, must satisfy

Rule 2 represent any UML state diagram model, there is always a probability/random mathematical model of Kripke structure and at the same time. Among them, the UML state diagram, events, health conditions, respectively mapped to the corresponding probability Kripke structure elements; UML state diagram, Kripke structure is mapped to the probability of aim-listed probability, or random rate of Kripke structure, semantic changed.

represent after migration, all associated and subsequent stateS_j tags, its value is set to true, otherwise its value is set to false.

As shown in Figure 2, $S_i$system is in a state of the ith number, is the source of order migration state, $S_j$system in the first j of state, is the target state, said the event event, guard said who, in the UML state diagram, "rate" semantic actions, in CTMC model, the semantic changes, are mapped to rate.

Order migration PRISM BNF paradigm of statement as shown below:

$\mathrm{S} \rightarrow \mathrm{S};\mathrm{SeqTrans}|\mathrm{SeqTrans}$

$\mathrm{SeqTrans} \rightarrow [\mathrm{event}](\mathrm{guard}\&\mathrm{s} = \mathrm{source}) \rightarrow \mathrm{rate}: (\mathrm{s}' = \mathrm{target})\mathrm{VarAssignVal}$

$\mathrm{VarAssignVal} \rightarrow \mathrm{VarAssignVal}\&(\mathrm{VName}' = \mathrm{true})|\mathrm{VarAssignVal}\&(\mathrm{VName}' = \mathrm{false})|\varepsilon$

SeqTrans represent order migration, represent the event event, guard represent guard conition, source represent rate ratio, target represent target state, VarAssignVal represent variable assignment.

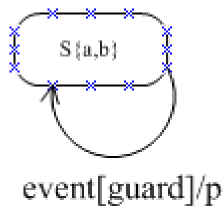

Figure 3 : Internal migration

By defining 4 and migration rules as shown in Figure 3 oder of UML state diagram of the PRISM code for: $[\mathrm{event}](\mathrm{guard}\&\mathrm{s} = \mathrm{i}) \rightarrow \mathrm{rate}: (\mathrm{s}' = \mathrm{j})\&(\mathrm{b}' = \mathrm{true})\&(\mathrm{a}' = \mathrm{false})$; among, $(\mathrm{b}' = \mathrm{true})\&(\mathrm{a}' = \mathrm{false})$ false)represent change in the next state variables that are endowed with the new value.

Definition 5: Internal migration. In definition 4, if the system state of the current state and then the state is the same, order transfer to internal transfer, namely the state transition to itself. It is represented in the UML state diagram, system S current status, in the event of external events, and meet the guard conditions, is to perform an action a, and migrated to their own, called the internal migration. Internal migration PRISM BNF paradigm of clause as follows:

$\mathrm{S} \rightarrow \mathrm{S};\mathrm{InternalTrans}|\mathrm{InternalTrans}$

$\mathrm{InternalTrans} \rightarrow [\mathrm{event}]\mathrm{guard} \rightarrow \mathrm{p}: (\mathrm{s}' = \mathrm{Source})$

About UML state diagram of internal migration, as well as rule 2, the mathematical model from UML state chart to probability/random Kripke structure transformation of the mathematical model. By defining rules of 4 and 2 available as shown in Figure 3.3 the internal migration of UML state diagram of the PRISM code for:

$\mathrm{s}: [\mathrm{Source}, \mathrm{Target}]\mathrm{init}\ \mathrm{Source};$

$\mathrm{a}: \mathrm{bool}\ \mathrm{init}\ \mathrm{true};$

$\mathrm{b}: \mathrm{bool}\ \mathrm{init}\ \mathrm{true};$

$[\mathrm{e}]\mathrm{guard} \longrightarrow \mathrm{p}: (\mathrm{s}' = \mathrm{Source});$

Choose migration including the selection of general choose migration and non-deterministic migration. Generally choose migration refers to the current state of the system, only an external event happens, won't produce conflict; Non-deterministic choice migration refers to the current state of the system, many external events can occur, produce conflict, need to confirm your selection mechanism with a solution.

Definition 6: Select the migration is defined as a function: $S \times e \times [g_i] \times r_i \times T_i, \{1 \ldots n\} \wedge S, T_i \in \Sigma_{sk} \wedge e_i \in E_{sk} \wedge [g_i] \in G_{sk} \wedge r_i \in R_{sk}$represent In the UML state diagram, system S current status, if the external events e_i, and guard condition $[g_i]$ was established, then the system may be in ratio r_i,, migrated to its successive state T_i, this is one for the CTMC model, namely the definition of random Kripke structure.

The choice of UML state diagram migration LTS operational semantics is expressed as:

$$\frac{S, T_i \in \Sigma_{sk} \wedge e_i \in E_{sk} \wedge g_i \in G_{sk} \wedge r_i \in R_{sk} \wedge i \in \{0 \ldots n\} \qquad Label(T_i) = L_{i,} L_{sk} = \sum_{i=1}^{n} L_i \cup Label(S)}{S \xrightarrow{e[g_i]/r_i} T_i, \forall m \in L_i \Rightarrow val(m) \coloneqq true, \forall n \notin L_i \wedge n \in L_{sk} \Rightarrow val(n) \coloneqq false}$$

Select the semantic description of migration is: the system S current status, if the external events e_i, and guard condition $g_i$was established, with ratio r_i, migration to the successor state T_i.

Rule 3:

$$\forall \Sigma_{sc} = \left(\{S, T_i | i \in \{1 \ldots n\}\}, \{S\}, \{e_i | i \in \{1 \ldots n\}\}, \{g_i | i \in \{1 \ldots n\}\}, \{r_i | i \in \{1 \ldots n\}, \{S \times e_i \times g_i \times r_i \times S_j | i \in \{1 \ldots n\}\}\right) \Rightarrow$$
$$\exists M_{sk}\left(\{S', T_i' | i \in \{1 \ldots n\}\}, \{S'\}, \{e_i' | i \in \{1 \ldots n\}\}, \{g_i' | i \in \{1 \ldots n\}\}, \{r_i' | i \in \{1 \ldots n\}, \{S' \times e_i' \times g_i' \times r_i' \times T_j' | i \in \{1 \ldots n\}, \{Label(S) \cup Label(Ti) | \in 1 \ldots n, (ri') | \in 1 \ldots n\},\right.$$

And

$$S \to S' \wedge T_i \to T_i' \wedge e_i \to e_i' \wedge g_i \to g_i' \wedge r_i \to r_i' \wedge \mathrm{Label}(T_i) \to L_i,$$

If the first j a migration is performed, must meet:

$$\forall m \in L_j \Rightarrow val(m) \coloneqq ture, \forall n \notin L_j \wedge n \in L_{sk} \Rightarrow val(n) \coloneqq false$$

Rule 3 represent any choose UML statechart model of migration, there is always a probability/random mathematical model of Kripke structure and at the same time.

$$\forall m \in L_j \Rightarrow val(m) \coloneqq ture, \forall n \notin L_j \wedge n \in L_{sk} \Rightarrow val(n) \coloneqq false$$

Represent after the first j a migration happens, all associated with subsequent state T_j, its value is set to true, otherwise its value is set to false.

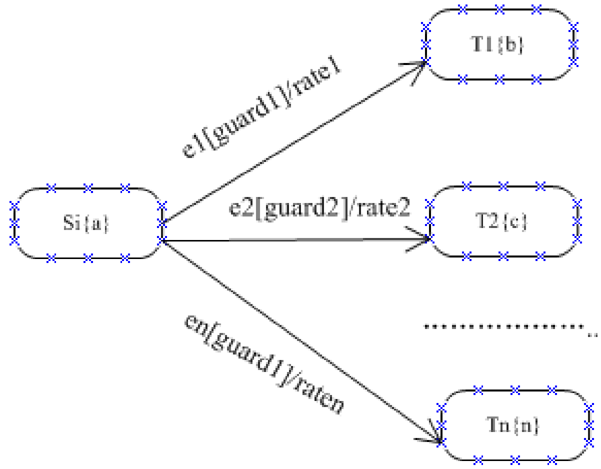

Figure 4 : Choose migration

As shown in Figure 4, the system S current status, if the external events e_j, and meet the guard conditions g_j, with ratio r_j, migration to the successor state T_j.

CONCLUSIONS

In this paper, the UML state diagram given probability/random Kripke form semantics, you can extend the UML state diagram modeling and automatic analysis ability, make the UML state chart to model probability, rate, time related to real-time concurrent systems, such as queuing network, the probability of Ad Hoc networks, such as non-repudiation protocols, under the existing probabilistic model checking tool PRISM support, can be critical for the future system performance indicators, automatic derivation, design, verification and analysis of the real-time concurrent system, play a guiding role.

ACKNOWLEDGEMENT

First we thank the reviewers for their constructive comments in improving the quality for this study. This work was supported by the ministry of education research project in general (NO. 14JDSZ2072), YunNan province education department fund project (NO. 2013 Y435,NO. 2014Y147), Academic education research station in YunNan province, YunNan province high quality basic education resource sharing and interactive service research.

REFERENCES

[1] Yaowen Xia; Research & Application of domain Component reuse based on UML [D]. Yunnun Normal University, **(2007)**.

[2] YaoWen Xia; The Design of Online Examination System Based on UML & Component, Information Technology Applications in Industry, Computer Engineering and Materials Science, **9**, 0847-0851 **(2013)**.

[3] YaoWen Xia; The Study & Application of Infromation System Based on Component Model and UML, Informtion Technology Applications in Industry, Computer Engineering and Materials Science **9**, 0852-0856 **(2013)**.

[4] Feng Xu, Xuan Chen; UML object-oriented modeling foundation. China water conservancy and hydropower press, **(2006)**.

[5] H.Hermanns; Interactive Markov Chains. PhD thesis, University of Numberg, **(2008)**.

[6] Ying Zhou; For model test of UML state machine semantics, Electronic Journals [J], **12**, **(2012)**.

[7] Hai yu Pan; Based on fuzzy logic categories Kripke structure, the relationship between computer science, **5**, **(2013)**.

[8] R.Milner, J.Parrow, D.Walker; A calculus of mobile process (Parts I and II). Information and Computation, **100**, 1-77 **(2012)**.