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Generation of real time fuzzy rule sets by Coloured Petri nets

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Abstract: Petri Nets is a graphical and mathematical modeling tool. CPN Tools is a tool, which is used for the purpose of editing, simulating, and analyzing Coloured Petri nets. The tool includes incremental syntax checking and code generation, which takes place while a Petri net is constructed. A simulator handles the untimed and timed nets well. Full and partial state spaces can be generated and analyzed, and a standard state space report contains information, such as boundedness properties and liveness properties. CPN plays a major role in the human-computer interaction. This paper provides information to the readers about the construction of CPN by using CPN tools and also carrying out the simulation of the same.
Keywords: Petri Nets, Colored Petri Nets, CPN Tool interface, churn modeling.

I. INTRODUCTION

CPN is a graphical language which is helpful in constructing model of concurrent system and also analyzing their properties. The CPN is useful in modeling non deterministic and stochastic process. It also provide modeling frame work which is suitable for simulating distributed and concurrent process with both synchronous and asynchronous communication[6].CPN model is an executable representation of the system, which consist of state of system ,events or transitions which allow the system to change its state. It is possible to examine and explore various scenarios and behavior of the system with the help of simulation of a CPN model.CPN is the combination of graphical component of ordinary Petri nets and high level programming language. This allows them to use it widely in modeling of complex system. The Petri nets provides foundation for modeling concurrency and synchronization, whereas the high level programming language .It also plays role for the definition of data types and the manipulation of data values .Both timed and untimed model can be created with the help of CPN .The untimed models usually validate logical correction of the system, whereas timed model evaluate the performance, Time plays a role in analysis of performance on concurrent system. CP-nets have been developed by the CPN group at Aarhus University, Denmark since 1979.The first version was part of the PhD thesis of Kurt Jensen and was published in 1981.

II. CPN TOOLS INTERFACE

CPN tools interface requires a keyboard and pointing device. The below figure :1 represent the CPN tools interface .The left column is called the INDEX .The Index contains list of objects and tools which are required for the construction of a Petri net model. The Binders at the top left and top right contains sheets of the same page showing different views .The bottom binders has six sheets which are represented by tables. The interface does not have menu bars or pull down menus, instead they have scrollbars or dialog boxes. They use a combination of traditional recent and noval interactions techniques.

A. Formal Definition of CPN Tool

A Coloured Petri Net is a nine-tuple

CPN = (P, T, A, S, V, C, G, E, I).

P: Set of places.

T: Set of transitions.

A: Set of arcs.

S: Set of colour sets.

V: Set of variables.

C: Colour set function (assigns colour sets to places).

G: Guard function (assigns guards to transitions).

E: Arc expression function (assigns arc expressions to arcs)

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I: Initialisation function (assigns initial markings to places).

III.   BASIC ELEMENTS OF PETRI NETS AND COLORED PETRI NETS

A.   Places, Transitions and Arcs

Petri nets is a bi-partite graph consisting of [3] places, transitions and arcs where places are denoted by rings and transitions are denoted by rectangle. Each place represent an antecedent or consequent and may or may not contain a token associated with a truth degree between zero and one that represents the live of trust within the legitimacy of the antecedent or consequent. Places and transitions are connected by directed arcs (Edges).Arc exists only between a place and a transition or vice versa.

B.   Token and the Firing Rule

Token circulate in the system between places. A transition is fired whenever there at least one token in all its input places. When an enabled transition is fired, its input arc weights are subtracted from the input place markings and its output arc weights are added to the output place markings. For example the below figure: 2.1 and 2.2 illustrate that before and after firing of transition.

Figure 2.1 Before Firing of T1   Figure 2.2 After Firing of T1
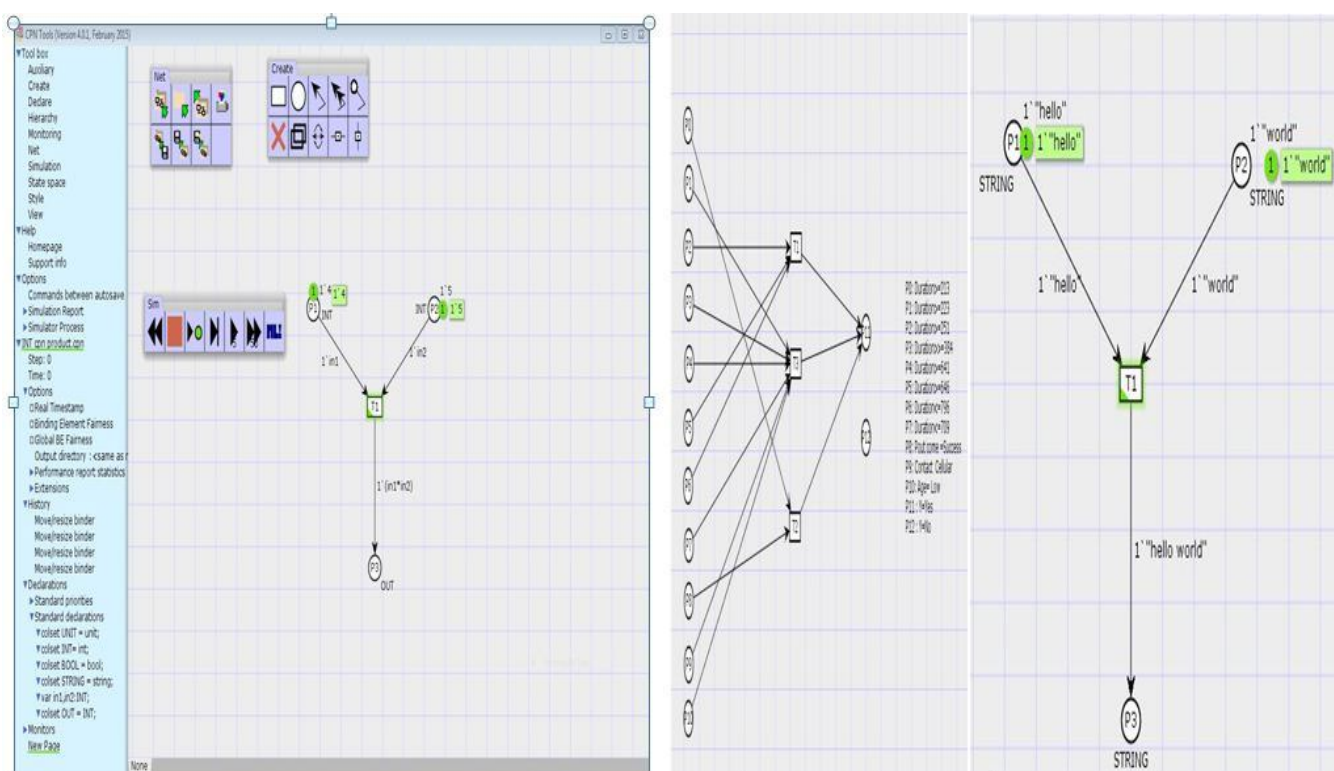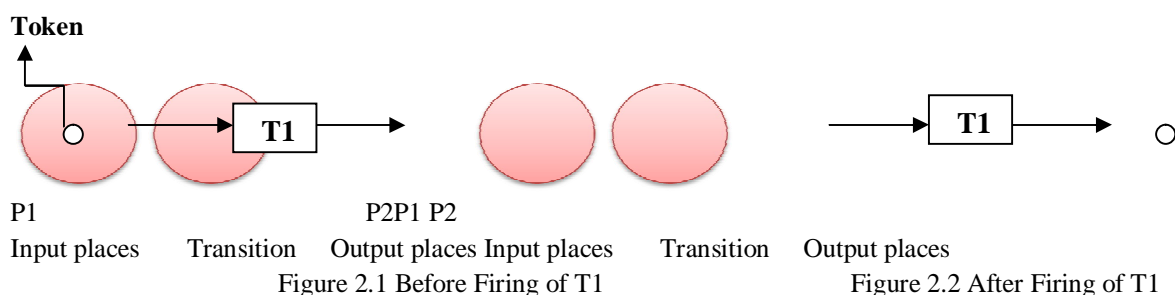

Figure: 1 The CPN Tools interface

Petri Nets [5] provide a framework for modeling distributed and concurrent systems with synchronous and asynchronous communications and resource sharing. The flexible nature of Petri Nets serves as role in modeling a variety of systems and situations. Figure: 3 show some useful net configurations.

IV.   TOOLS FOR EDITING CP-NET

There are various way to perform a particular task, because editing CP net in CPN tools is easy fast and flexible .There are various tools used for the construction of colored Petri Nets .The main basic tools are as follows.

Create Tools are used to create CP net elements .These net elements are constructed by using palettes, tool glasses and marking menus. These net elements can be positioned anywhere within the sheet itself. Inscriptions can be added to the net elements by clicking on the net element.

Style Tools are used to change the style of any net element. Every element has default style which signifies size, line and fills colors. This can be changed by using style tools

View Tools are useful in viewing zoom in and out of a page. This tool can be used as on alternative for the conventional zoom in and out using positive device.

Hierarchy Tools are useful in creating hierarchical CP nets. These tools are useful for both top down and bottom up structuring of the net. This tool are helpful in assigning an existing page as a subpage to a substitution transition, for turning a transition into a substitution transition and automatically creating a new page with interface places, for assigning port types to places, and for creating fusion sets.

Net Tools are used for opening and saving nets, and for adding new pages to obtainable nets. Individual pages from CP-nets can be saved as summarize postscript files using the print tool.
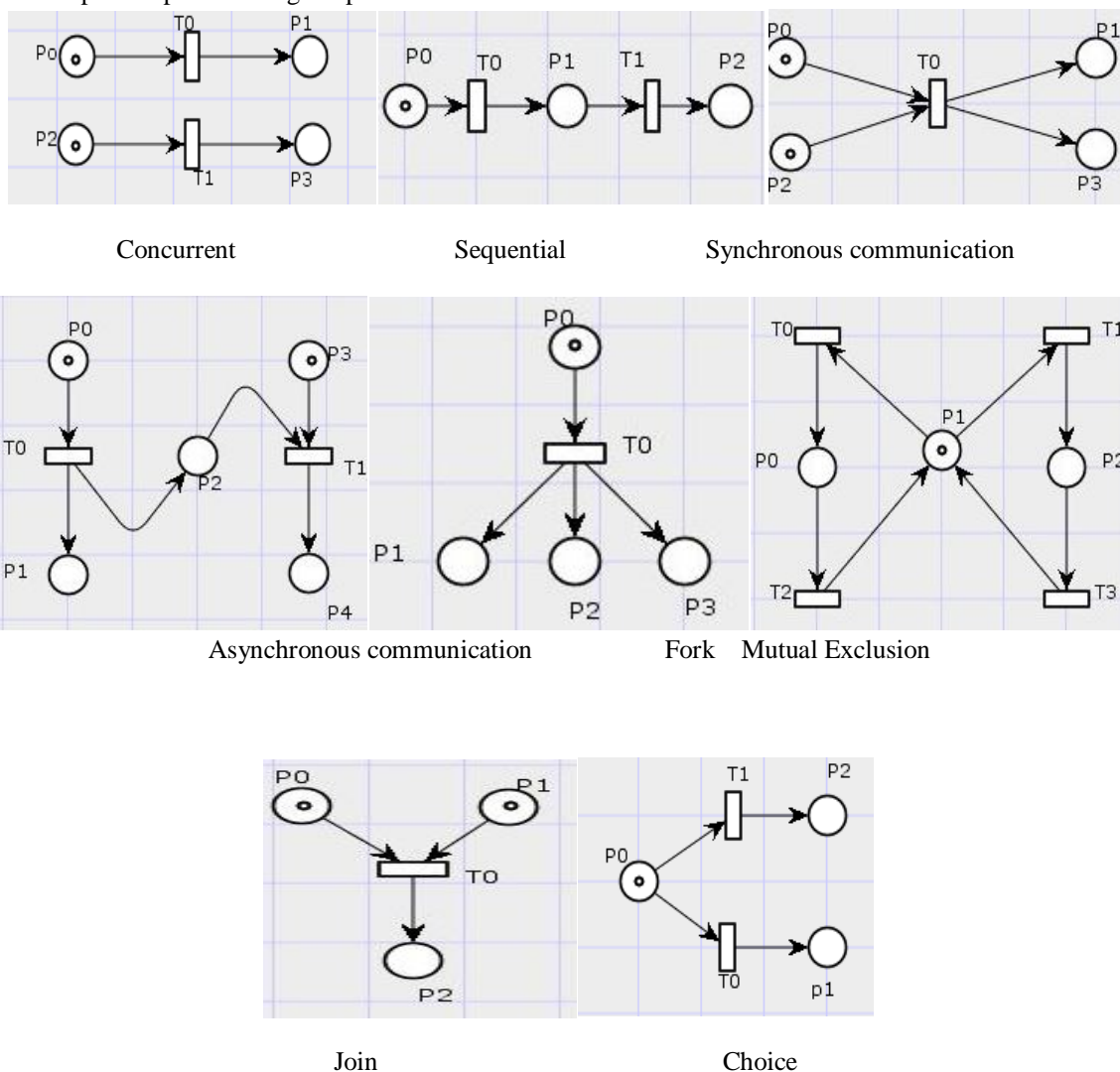

| Concurrent | Sequential | Synchronous communication |

Asynchronous communication   Fork   Mutual Exclusion

Join   Choice

Figure: 3 Useful net configurations

History gives [1]an overview of many of the operations that are implemented during the construction of the CP net. During the use of CPN Tools, the history is automatically updated. History having open and close operations for nets, sheets, binders and also provide create and delete operations pages, net elements.

Help [1]gives access to number of web pages that are related to CPN Tools .Selecting the help entry from a marking menu opens the help Page for that particular object.

V. EXECUTION OF RULES IN CPN MODEL

A system whose base is represented as a set of rules and facts is called a Rule based systems. Rules are represented in the following form IF < antecedent > THEN < consequent >

A. Example for the CPN Model of Tele communication

Let us start our simple example concerning churn modeling in telecommunications, which is a simplified version of an example given in [2,7].

The condition attributes describing client profile are: In – incoming calls, Out – outgoing calls within the same operator, Change – outgoing calls to other mobile operator, the decision attribute describing the consequence is Churn.

According to [2,5]: "One of the main problem that have to be solved by marketing departments of wireless operatorsis to find the way of convincing current clients that they continue to use the services. In solving this problems can help churn modeling. Churn model in telecommunications industry predicts customers who are going to leave the cur-rent operator".

An example of decision rules is given below

R1: if (In, high) then (Churn, no)

R2: if (In, low) and (Change, low) then (Churn, no)

R3: if (Change, high) then (Churn, yes)

R4: if (In, med.) and (Out, low) then (Churn, yes)

For instance Rule 2 is as follows:

Rule 2 determines the following decision rule:"if the number of incoming calls is high and the number of outgoing calls to other mobile operator is low then there is no churn".
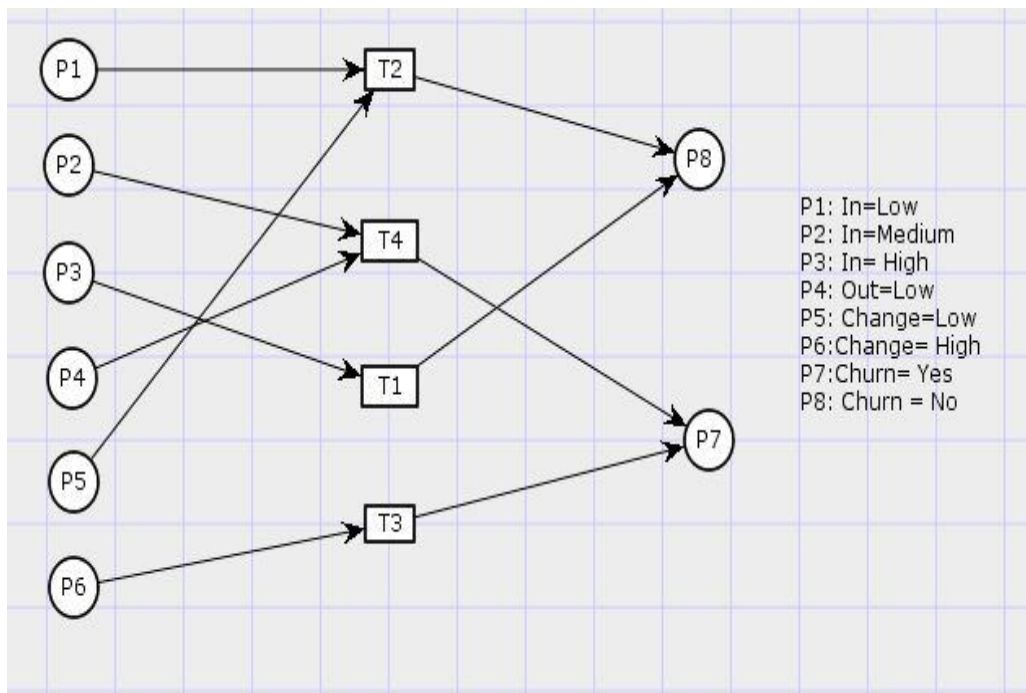

Figure: 4 CPN Tool Snap shot for Churn Modeling in Telecommunication

The corresponding Petri net model is illustrated in Fig. 4. In the Petri net model, according to the proportions dedicated to each place, transitions 1 to 4 respectively represent rules 1 to 4 in the introduced rule base above and firing each transition means the corresponding rule is fulfilled

VI. CONCLUSION

The idea of presenting this paper is to give the users a clear view of the concepts construction and their execution of CPN model. It is also gives the users a view about the flexibility and important features of the CPN.

VII. ACKNOWLEDGMENT

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