Enhancing the Capability of N-Dimension Self-Organizing Petrinet using Neuro-Genetic Approach

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***Abstract*— The paper highlight intelligent Urban Traffic control using Neuro-Genetic Petrinet. The combination of genetic algorithm provides dynamic change of weight for faster learning and converging of Neuro-Petrinet.**

***Keywords*— Neuro Petrinet, Urban Traffic Systems, Genetic Algorithm.**

I. Introduction

The previous models like developed for vehicular studies only considered a limited macro mobility, involving restricted vehicle movements, while little or no attention was paid to micro - mobility and its interaction. The research community could not provide the realistic environment[6] for modeling Urban Traffic which could simulate close to real time situations. Our papers extend the concept of Li, M and Change works of August oriented urban Traffic simulation using interaction agent in controlling and management of urban traffic systems. We use the concept of Neuro Genetic Networks on self organizing Petrinet to simulate the traffic condition.

II. Literature SURVEY

The dynamics of Urban traffic System[4] was observed by Tzes, Kim and Mc Shane[8] which explains about the timing plans of the traffic controlling junctions. While an example of coloured petrinet modeling of traffic light was proposed by Jenson [5]. Later on Darbari[2] and Medhavi also developed Traffic light control by Petrinet.

A. Petrinet

Most recently List and Cetin [7] discussed the use of PNs in modeling traffic signal controls and perform a structural analysis of the control PN model by P-invariants, demonstrating how such a model enforces traffic operations safety.

List and Cetin [7] proposed different colour scheme to each vehicle entering the system, they modelled it by defining appropriate subnets modeling links at the intersections.

III. Basics of Petrinet Model application in Urban Traffic Modeling

To start with , we described a simple pattern of PN using event relationship diagram. It shows that event e1 can cause event e2 within a time period [I1, I2] where T represents Transition.

Figure 1 : Simple Petrinet Representation

A. Dynamics of Producer

Consumer Petrinet with the algorithm for Dynamic Producer-Consumer given as:

Step 1 : Initialise each of the Producers- Consumer situation (x). set the pattern rate as 'r'.

Step 2 : Set the control centre such that :

$$X_i : = S_i :$$

Step 3 : Let the Token release rate be given as 1/N, where N is defined as the number of producer - consumer initial states.

Step 4 : The release of Token are updated as :

x : (producer - old) = x; (producer - new state) + r

Step 5 : Stop when system has transferred all the tokens and traffic reaches a balancing state.

Assuming the initializing condition to be Xi and after successive training it reaches to 9. The stabilising condition is reached after 'n' iteration given as :

$\{x; = t\ (x_1\ldots.. x_n\} \mid I \in \{ 1\ldots..n\}$

if there are N - dimensional node the equation will become.

$x_i = t\,(x_1\ldots..\ x_n)$

.

..

$x_n = t_n\,(x_1\ldots..\ x_n)$

x_i represents the recursion variables and $t(x_1\ldots.\ x_n)$ shows the process terms with possible occurrence of the recursion variables.

IV. N- Dimensional self Organised Petrinet model of Urban Traffic System

Let '0' and '1' be defined as Low and High learning rate of the grid network of petrinet showing the simulation of Traffic in a mesh network.

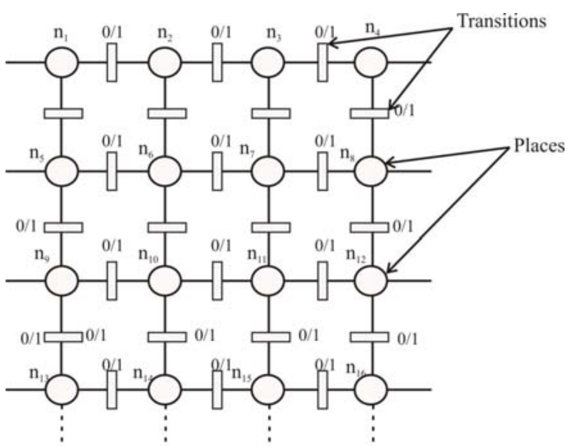

Figure 2 : Process Representation of Petrinet with 0/1 Learning rate in N-Dimensions.

We can define the movement of tokens and 0/1 learning rate by a single recursive equation as:

$$Si = in\ (0)\ (X \parallel out\ (0)) + in(1)\ (X\ \parallel out\ (1)) \qquad (1)$$

The process graph of Neural Petrinet Framework represents bisimilar relationship in Recursive mode. The Recursion can be is achieved by using Genetic Algorithm[1] with learning rate of modes $[n_1\ldots.n_n]$ with a particular time frame.

Let the total function be defined as:

$$n_t = \int (n_{t-1},\ n_{t-2},\ n_{t-3},\ \ldots..\ n_{t-M}) \qquad (2)$$

Which predicts the current value of node n^{th} from past input conditions.

The Nodes which will learn first will survive and based on them the traffic control network will converge. The Fitness[3] value (F.V.) is defined as :

$$\left[F.V. = \frac{1}{N}\sum_{i=1}^{N}\left(f(n_t) - \hat{f}(n_t)\right)^2\right] \qquad (3)$$

Where:

$\hat{f}(n_t)$ is the value of the function represented by GP individual (Geno-type).The algorithm for Procedure Trained Node selection by Genetic Algorithm[9,10] :

BEGIN

Set the values to initial trained conditions.

Generate as many nodes as possible;

Evaluate each node in the set of Nodes selected;

WHILE termination NOT coverage DO

BEGIN

Select the Cube of Nodes with faster learning rates;

Generate offspring cube of Nodes by applying crossover and mutation on the selected cube or nearest neighbour cube;

Evaluate the equilibrium condition;

Generate new nodes to be trained further in combination with older node cube;

END

Return the best trained Cube Node from the Mesh;

END

The first phase of the Algorithm deals with controlling parameters, such the population of Cube (P) and Offspring (O), the maximum number of crossover probability and mutations are set. The offspring Cube of Node is then evaluated and traffic is stabilized accordingly completing one cycle of operations. After several iterations the entire control Network converges to optimal solutions

V. Conclusions

The paper represents the dynamic control strategy of Urban Traffic System by combining Neuro-genetic approach on Petrints. The use of genetic learning method performs rule discovery of larger system with rules fed into a conventional system. The main idea to use genetic algorithms with neural network is to use a genetic algorithm to search for the appropriate weight change in neural network which optimizes the learning rate of the entire network.

A good Genetic Algorithm can significantly reduce neuro-Petrinet in aligning with the traffic conditions, which other wise is a very complex issue.

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