

Evolving Employee Behavior Profiles by Fuzzy Petri Nets

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Abstract— Detecting the new evolved behavior of an employee in an organization is a challenge due to difficulties in measuring the features evolving in it. It needs either strong evidence by modeling of human behavior as human resource of an organization or quantifying the features by a meaningful survey. Integrating the fuzzy logic and petri-net gives as an opportunity for designing a reliable system for this purpose. Here firstly the imprecisions in measuring human behavior attributes are associated with the membership function or characteristics function of fuzzy logic. Secondly the rules generated or mapped from the fuzzy features to the crisp output are modeled by colored petri-net. In this paper we address the problem of implementing such a petri-net based recommending system for human resource. As proof of concept we considered a group of IT employees and conducted collection of data for this research. The obtained model is validated with the human resource management.

Keywords— human behavior, verification, validation, high-level fuzzy Petri nets, forward chain inference.

I. INTRODUCTION

The complexity analysis of human behavior models requires specific flexible fast reasoning and modeling methods. The field of expert system seems very appropriate for designing and implementing a knowledge base pertaining to human behavioral studies. As the class of fuzzy petri-net [2, 3, 4] are very interesting tools, for characterizing the imprecise knowledge inherently prevailed in this studies of human behavior especially in human resource context. We consider design and development of rule base system as associations anticipate from the laborers to require their obligations as an aftereffect of competitions, high desires of the customers and quality-based progressions have raised [5]. Inside the times, organizations attempt and rent those that experience properly with troubles and underline on their convictions.

There are several rationales behind which to base a computational paradigm for expert systems on Petri net theory.

- Petri nets achieve the structuring of knowledge within rule bases, which can express the relationships among rules and help experts construct and modify rule bases.

- The Petri net's graphic nature provides the visualization of the dynamic behavior of rule-based reasoning.
- Petri nets make it easier to design an efficient reasoning algorithm.
- The Petri net's analytic capability provides a basis for developing a knowledge verification technique.
- The underlying relationship of concurrency among rules activation can be modeled by Petri nets, which is an important aspect where real-time performance is crucial.

To model fuzzy rule-based reasoning through the use of Fuzzy Petri nets, several important issues need to be addressed.

- Is partial matching considered?
- Does the Petri net's firing rule that tokens will be removed from the input places of a transition after the transition fired remain unchanged? It should be noted that the firing rule in Petri nets is a basis for controlling the evolution of markings in the execution process. To modify the firing rule is to change the evolution of markings.
- Is the proposed algorithm consistent with the rule-based reasoning?
- Is the proposed algorithm consistent with the execution of Petri nets?

The organization of this paper is as follows. In section II Fuzzy petri-net terms and methods are described. In section III design of survey based experiment is carried out. In IV is render to introduction part of the proposed methodology. In section V is acceptance process. Section VI is conclusion and remark.

II. FUZZY PETRI NETS

A. Fuzzy Petri Nets-a short Introduction

Petri nets range unit a graphical and numerical displaying instrument relevant to a few frameworks. {they region unit they're} a guaranteeing apparatus for depicting and figuring out data science frameworks that are characterized as being harmonizing, offbeat, appropriated, parallel, nondeterministic, or arbitrary [6]. However the tokens of spot hubs region unit singularly in addition to entire number; the terminating of move hubs has no limit; the load perform for info and yield is

prohibited to positive number. It's light to clarify the framework holding harum-scarum conduct. Hence, some agent have given a few harum-scarum Petri web displays and made it settle sensible hindrance. The predominating harum-scarum Petri nets territory unit a great deal of non-deterministic or confined to demonstrating a clear truly issues. The past isn't advantageous for examination and likewise the harum-scarum Petri nets that meet normal detriment is troublesome to unwind elective one. In this way, a manifestation of most recent harum-scarum Petri nets is given. Fundamental plans and phrasings of Petri nets that we have a tendency to use throughout this paper will be seen by References.

A soft Petri web model (FPN) may well be utilized to talk to a soft guideline based mostly framework. A FPN could be a steered chart holding 2 types of hubs: places and moves, wherever rounds speak to places and bars speak to moves. each spot speaks to a precursor or succeeding and probably} possibly hold a token connected with a truth degree between zero and one that represents the live of trust within the legitimacy of the precursor or sequent. Each move chatting with a typical is connected with sureness part esteem between zero and one. The conviction part speaks to the {standard} of the boldness within the standard [2, 3, 4]. The connections from spots to moves and therefore the alternative method around area unit spoken to by guided bends.

FPN = (P, T, D, I, O, μ , α , β), where

P = {p1, p2, ..., pn} is a finite set of places,

T = {t1, t2, ..., tm} is a finite set of transitions,

D = {d1, d2, ..., dn} is a finite set of propositions,

$P \cap T \cap D = \emptyset, |P| = |D|$

The monitoring fuzzy Petri net – is defined as being the FPN = < P, T, D, I, O, f, F, S, R, a, b, l >, with:

P = { p1 , p2 ,pn } - the finite set of places modeling possible faults, identified at the discrete event system level. Two types of faults characterize this fault set: basic faults and derived faults. The considered faults can be as well transient that persistent;

T = { t1 , t2 ,tn } - the finite set of transitions, representing the fault evolution, corresponding to the set of logical fuzzy rules R. Every transition is associated to a fuzzy rule;

D = { d1 , d2 ,dn } - the finite set of logical propositions that defines the rule basis R; I : T @ P - the input function of places;

O : P @ T - the output function of places;

f : T @ F - the function that associates to the every rule modeled by a transition, a function F describing the credibility degree $\mu = F(t)$ of the rule. The instant t corresponds to the detection of a fault symptom in the surveyed discrete event system;

S = { s1 , s2 , ,sl } - the set of fuzzy symptoms (signals) received by the monitoring system from the surveyed discrete event system;

R = { r1 , r2 , ,rl } - the set of fuzzy recovery information (signals) emitted by the monitoring system. These signals will be used by the recovery tool;

a : P @ [0,1] - the function giving a fuzzy value aj of credibility for each place pi corresponding to the logic proposition di OED. This parameter represents the possibility of apparition of the corresponding fault;

b : P @ D - the bi-jjective function that associates a logic proposition di to each place pi OEP;

l : P @ [0,1] - the function that associates an acceptance/permisiveness warning threshold li of the fault corresponding to each pi OEP of the critical path of the fault tree. These thresholds represent the starting point of all recovery policy. M0 - the basic faults places initial marking. Every token of the marking M0 is associated to the fuzzy number 1 that means the certainty of the basic fault occurrence.

By convention, places associated to the basic faults are not represented in the global model of the MFPN. Each transition of the MFPN represents a fuzzy logic elementary proposition: di @ dj. The transition is associated to a function F(t) describing the degree of credibility of the corresponding proposition at the time t (firing possibility at time t).

B. Mapping the Rule Base to FPN

Throughout this mapping technique, all principle is spoken to as a move with its relating sureness variable and each precursor is displayed by a data place and therefore the consequents are incontestable by out spots with scrutiny truth degrees. During this displaying a move here a suggestion is scaptured to be abandoning if all its enter spots have a truth degree resembling or over a predefined **limit esteem**. As drawn in Fig.1, within the wake of terminating the principle, the yield spots can have a truth degree resembling the information place truth degree increased by the move assurance variable.

Fuzzy Petri nets (Fpns) [7, 10] are utilized for learning illustration what is more thinking within the section of imprecise info and learning bases. Machine taking in with down like AND-OR neurons [9] and with downlike Petri nets are projected by Pedrycz. In, whereas displaying a specific psychological feature structure, Pedrycz analyzed the extent of the model in down like example distinguishment.

The projected model of downlinked Petri internet embodies downlike OR AND neurons spoke to by spots and moves of the system. Regularly, a collection of moves emulated by a collection of spots constitutes a layer. An l-layered downlike Petri internet on these lines holds l - 1 layers of moves emulated by spots, and an additional embody layer comprising of spots simply. The spots within the last layer are known as closing spots. Such a system has 2 figural profits. To start out with, it will speak to inaccurate learning like normal Fpns. Second, the system may well be ready with a collection of input-output examples (as in an exceedingly food forward neural net). Such a system, once utilized for article distinguishment from downlike characteristics, offers the profits of each inaccurate thinking and machine taking in on a standard.

III. FRAME WORK FOR THE HRBM

HRBM exists with the parameter for the purpose of fine tuning the employee behaviors. The primary performance indicators most of the time are not direct.

Hence the researcher extracts them by conducting a meaningful survey carefully. Here we design the questionnaire exhaustively covering the related properties correlated to the performance of individual behavior of an

employee. We consider 15 such properties and designed with two level of extraction as shown in the following section.

IV. The proposed methodology

A. The reasoning processes in this framework are constructed systematically by considering the influencing properties appropriately.

Any supervisor's nature is to localize the employee's momentary behavior and take decisions. But here we try to include research of the properties to be included. For this purpose forward chain verification by inference is done by fuzzy petri-net representing the rule base covering all the properties.

B. The Input Properties.

The values of the internal properties may get values in the qualitative scale starting from very-low (vl), low (l), medium (m), high(h), very-high(vh).

I; 1

1. My chief takes a particular investment in helping me to excel at my employment.
2. I am ready to contact Senior Management as required.
3. The organization is decently overseen.

I; 2

4. My Manager agents work viably.
5. My Manager sets a great sample.
6. My Supervisor tries to take in new things.

I; 3

7. The gatherings that I have with my associates and chiefs help me to accomplish my employment.
8. I accept that all the divisions in the organization communicate and cooperate to attain a basic objective.
9. The individuals I work with coordinate to accomplish the work.

I; 4

10. I accept that remunerates are given decently where I work.
11. I feel preference is not an issue in my area of expertise.
12. The association values differences.

I; 5

13. I can get the data I have to do my employment.
14. I have an agreeable thought of my occupation obligations.
15. My abilities and capabilities are used successfully by the organization.

I; 6

16. I am considered responsible for attaining particular effects.
17. I know how company measures its execution.
18. My Department has particular execution measures .

I; 7

19. Issues are tackled at the main driver, not exactly at the indication level
20. We cooperate to tackle issues
21. Portray an issue you were as of late asked to understand. What did you do? What options did you think about?

I; 8

22. I feel I am some piece of the group
23. Pioneers push collaboration
24. Data is uninhibitedly imparted around all group member.

I; 9

25. How might you rate the medicine of {company} representatives?
26. How might you rate your Business Manager/process Owner's medicine of company representatives?
27. How might you rate your Process Owner / Business Manager giving you the instructing important to help you help at a more elevated amount?

I; 10

28. Company is a great Company to work for.
29. Company is inventive in creating better approaches to serve our clients.
30. Generally speaking, I feel the association is fruitful.

I; 11

31. I earnestly look for sentiment from associates and clients about my work.
32. I feel answerable for accomplishing effects.
33. I feel that my prescriptions are invited and esteemed by our administration.

I; 12

34. Organization distinguishes and rewards inventive representatives.
35. Q Project Manager energizes inventive thoughts.
36. Have you ever recommended new thoughts to your administrator? What were effects?

I; 13

37. Do you like cooperation?
38. Do you like autonomously?
39. Do parts openly impart their estimations, thoughts, solid emotions, contradictions and issues with one another?

I; 14

40. I appropriate great reaction from clients
41. Chiefs are concentrated on enhancing client administration
42. Administration is responsive and helps clients

I; 15

43. Our most excellent quality is our workforce
44. We support and prize imagination
45. We encourage a society based on trust .

C. The Internal Properties.

The inside properties of the framework are made on the groundwork of some arrangement of the info properties.

- The input properties Q1, Q2, and Q3 from an internal properties called “The Administration”
- The input properties Q4, to Q6 form an internal property called “Chief”.
- The input properties Q7, to Q9 form an internal property called “Cooperation”.
- The input properties Q10, to Q12 form an internal property called “Fairness”.
- The input properties Q13, to Q15 form an internal property called “Assets”.
- The input properties Q16, to Q18 form an internal property called “Execution”.
- The input properties Q19, to Q21 form an internal property called “Critical thinking”.
- The input properties Q22, to Q24 form an internal property called “Cooperation (team work)”.
- The input properties Q25, to Q27 form an internal property called “Administration (Leadership)”.
- The input properties Q28, to Q30 form an internal property called “About the company”.
- The input properties Q31, to Q33 form an internal property called “Individual experience”.
- The input properties Q34, to Q36 form an internal property called “Improvement”.
- The input properties Q37, to Q39 form an internal property called “Interpersonal”.
- The input properties Q40, to Q42 form an internal property called “Client Service”.
- The input properties Q43, to Q45 form an internal property called “Required Knowledge vital arrangement”.

As it were, we have a harum-scarum derivation in two levels: Level one should derive the inner properties; level two should conclude the prof's rank dependent upon the interior and info properties,

Table 1: Sample set of 10 employees' responses for the survey questionnaire.

1) Level 1:

If Q1, to Q3 isthen “The Administration is.....

If Q4, to Q6 isthen “Chief” is

If Q7, to Q9 isthen “Cooperation” is

If Q10, to Q12 isthen “Fairness” is

If Q13, to Q15 isthen “Assets” is

If Q16, to Q18 isthen “Execution” is

If Q19, to Q21 isthen “Critical thinking” is

If Q22, to Q24 isthen “Cooperation” is

If Q25, to Q27 isthen “Admin (Leadership)” is ...

If Q28, to Q30 isthen “About Company” is

If Q31 to Q33 isthen “Individual Exp.” Is

If Q34 to Q36 isthen “Improvements” is

If Q37 to Q39 is then “Interpersonal” is.....

If Q40 to Q42 isthen “Client Service” is.....

If Q43 to Q45 isthen “knowledge vital” is....

We label the above combinations as I1, I2..... I15.

2) Level 2:

The table 1 shows the response from the sample of employees based on the values very low (vl) to very high (vh) in each category. This is not complete for all possible combination of values.

An example principle base for the above careful investigation could be displayed as a human conduct model HRBM (*Human Resource Behavior Model*) as the accompanying structure indicated in Fig. 1.

The blanks in the level 1 rule are filled with a linguistic value: very low, low, medium, high, and very high.

--HRBM= (EMP-HR, IPS, InPS, OPS, RS);

--HRBM.IPS= {“Q1, Q2, Q3, Q4, Q5, Q6, Q7 to Q45”};

--HRBM. InPS= {Internal properties};

--HRBM.OPS= {KEEP, CHANGE, FIRE};

--HRBM. RS= {“R1, R2R15”}

R1 = Q1 (vh) ^ Q2 (h) ^ Q3 (vh) ^ “Administration (vh)

R2 = Q4 (h) ^ Q5 (h) ^ Q6 (m) ^ “Chief (h)”.

R3 = Q7 (m) ^ Q8 (h) ^ Q9 (h) ^ “Cooperation (h)

R4 = Q10 (m) ^ Q11 (h) ^ Q12 (m) ^ “Fairness (m)”

R5= Q13 (l) ^ Q14 (m) ^ Q15 (l) ^ “Assets (m)”

R6 = Q16 (vh) ^ Q17 (m) to Q18(h) ^ “Execu (h)”

R7 = Q19 (l) ^ Q20 (VL) ^ Q21 (l) ^ “Critical thinking (vl) “

R8= Q22 (l) ^ Q23 (h) ^ Q24 (h) ^ “Cooperation (m)”

R9 = Q25 (m) ^ Q26 (h) ^ Q27 (vh) ^ “Admin (Leader) (h)”

R10 = Q28 (h) ^ Q29 (vh) ^ Q30 (vh) ^ “About Company (vh)

R11 = Q31 (l) ^ Q 32(m) ^ Q33 (m) ^ “Exp (m)”

R12 = Q 34(m) ^ Q 35(h) ^ Q36 (h) ^ “Imp (h)”

R13 = Q37 (vh) ^ Q38 (VL) ^ Q39 (h) ^ IntPers (h)

R 14 = Q40 (h) ^ Q 41 (vh) ^ Q42 (h) ^ CusSer (h)

R 15 = Q43 (vh) ^ Q44 (m) ^ Q45 (Vh) ^ Know (l)

3) Level 3:

--HRBM = {Individual experience (vh) ^ Leadership (h) then become Administrator}

--HRBM = {Cooperation (h), ^ Assets (vh) then become Chief}

--HRBM = {Team work (vh) ^ Execution (m) then become Admin [Leader]}

--HRBM = {Knowledge (m) ^ Performance (vh) then
become *Innovative*}

Table no.1 Employees' responses for the survey
questionnaire.

In the above structure, human conduct model (HRBM)

Employees Questions	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Q1	VH	H	L	M	VL	H	VL	H	VL	VL
Q2	H	H	M	VL	L	H	M	L	L	M
Q3	VH	VH	L	M	VL	VH	VL	H	VL	VL
Q4	H	M	VL	VH	M	H	VL	M	M	VH
Q5	H	M	VL	M	VH	VH	VL	H	VH	VL
Q6	M	H	L	VL	VH	M	M	M	VH	M
Q7	M	M	H	L	L	M	H	M	L	VL
Q8	H	H	M	L	VL	VH	L	VH	VL	M
Q9	H	M	M	VL	H	M	M	H	H	VL
Q10	M	H	L	VH	VL	M	VL	M	VL	L
Q11	H	M	L	VL	VH	H	L	H	VH	VL
Q12	M	H	VH	L	VL	M	M	H	VL	VL
Q13	L	VL	L	M	VH	L	L	L	VH	M
Q14	M	L	VL	H	VH	M	VL	L	VH	H
Q15	L	VL	VL	H	H	L	VL	VL	H	H
Q16	VH	H	L	M	VL	VH	L	M	VL	M
Q17	M	VH	H	L	VL	M	H	VH	VL	L
Q18	H	M	H	VH	VL	H	H	M	VL	VH
Q19	L	VL	M	L	H	L	M	VL	H	L
Q20	VL	L	M	H	VH	VL	M	L	VH	H
Q21	L	VL	L	VH	VH	L	L	L	VH	VH
Q22	L	M	H	VH	H	L	H	M	H	VH
Q23	H	L	M	L	VL	H	M	VL	VL	L
Q24	H	L	H	M	VL	H	H	L	VL	M
Q25	M	VH	L	VH	L	M	VL	H	L	VL
Q26	H	M	VL	M	M	H	L	VH	VL	M
Q27	VH	H	VL	H	M	VH	VL	M	M	H
Q28	H	VH	L	M	VH	H	L	VH	H	L
Q29	VH	H	VL	H	H	VH	VH	H	M	H
Q30	VH	H	M	VH	H	VH	M	H	VH	VH
Q31	L	M	M	VL	L	M	L	M	L	VL
Q32	M	M	L	VL	M	L	L	M	M	M
Q33	M	L	L	M	L	M	VL	L	L	M
Q34	M	L	H	M	M	H	VH	L	M	M
Q35	H	M	VH	L	VL	H	VH	M	VL	M
Q36	H	L	H	M	L	M	M	L	L	L
Q37	VH	VL	VL	VH	VH	VH	VL	VL	VH	VL
Q38	VL	VH	VH	VL	H	VL	VH	VH	H	VH
Q39	H	VL	L	M	VH	VH	L	H	M	M
Q40	H	VH	H	H	M	H	VH	H	H	H
Q41	VH	H	VH	M	M	H	M	VH	VH	M
Q42	H	VH	H	M	L	M	H	H	L	M
Q43	VH	M	M	VL	L	M	M	M	M	VL
Q44	M	H	M	L	M	VH	VH	H	L	L
Q45	VH	H	M	VL	L	VH	M	VH	VL	VL
	Better	Good	Medium	Low	V Low	Better	Medium	Good	V Low	Low

--HRBM = {Client services (vl) ^ Individual exp. (vl) then
Change Department}

is presented inside a 5-tuple comprising of the data property set (IPS), inward property set (Inps); yield property set (OPS) and tenet set (RS). Q1 to Q45 represent Question 1 to Question 45 as info properties. Admin, chief, Cooperation,

Fairness, etc. and pop separately remained for the force of educating, consistency, conduct, magnetism and ubiquity as inner properties. Terms vl, l, m, h and vh individually speak to the etymological qualities: quite low, low, medium, high and quite high. In the guidelines, the second component demonstrates the precursors, the third component indicates the ensuing and the last number demonstrates the sureness variable committed to the standard. For instance Rule 1 is as accompanies.

---HRBM.R1= (Rule1, Q1 (vh) \wedge Q2 (h) \wedge Q3 (vh), Admin (vh); Then the Administration power is very high.

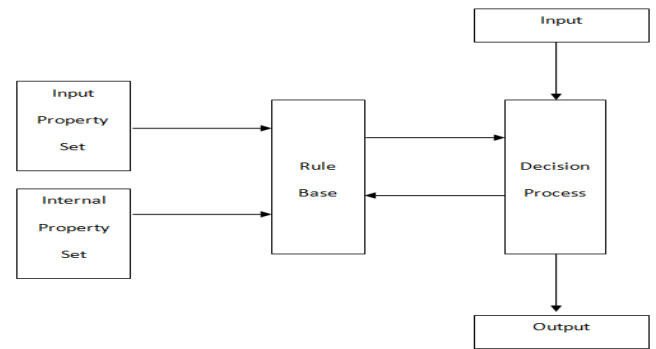
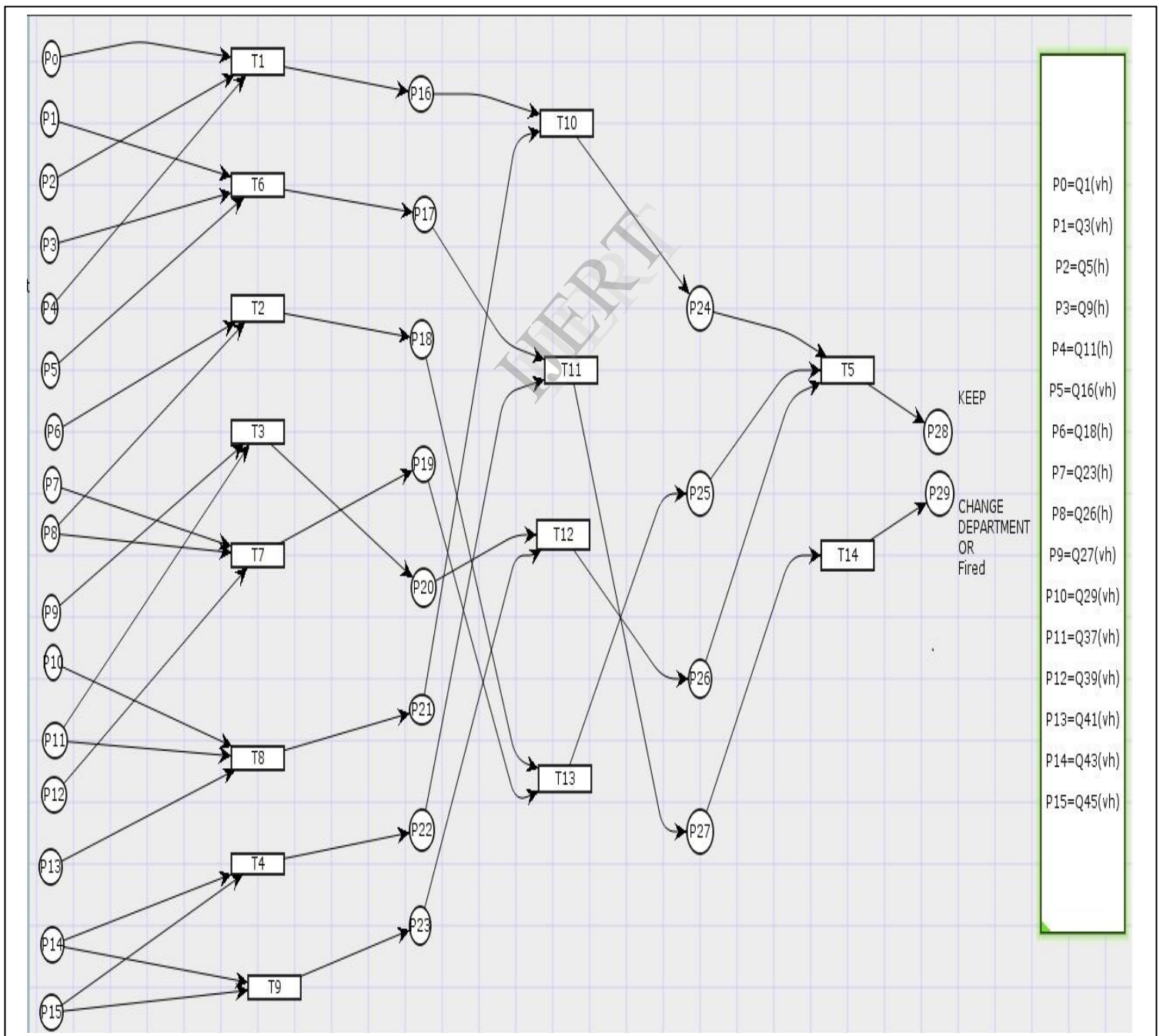


Figure 1. The decision model

The fuzzy Petri net model is shown in Figure whose behavior is to simulate the decision model in figure 2 [8].

Fig. 2 Fuzzy Petri-net model



The corresponding architecture for the high level Petri web model is portrayed in Fig. 2. The places P0 to P15 considered TRUE antecedents. During this marking transitions T1, T2, T3, T4, T6, T7, T8 and T9 enabled. Once firing these transitions, within the second step, places P16 to P23 stuffed and also the corresponding values within the node vector measure. During this marking transitions T1, T2, T3, T4, T6, T7, T8 and T9 enabled. Once firing these transitions, within the second step, places P16 to P23 are stuffed on the ultimate step by firing T5 and T14 (the enabled transitions), the places P28 and P29 will be stuffed up to indicate the ultimate output.

V. ACCEPTANCE PROCESS

Static acceptance includes recognizing the semantic inadequacy [9]. In the static approval running or thinking the FPN is not required. In this stage just the spots are sought and their properties are recorded and contrasted and the referent. Assuming that the amount of sought data properties is less than the normal ones, the principle base may miss precursors, if the amount of looked yield properties is less than the normal ones, the guideline base may miss consequents and if the amount of sought inner properties is less than the normal ones, the standard base may miss predecessors or consequents.

HRBM= (EMP-HR, IPS, InPS, OPS, RS);

--HRBM.IPS= {"Q1, Q2, Q3, Q4, Q5, Q6, Q7 to Q45"};

--HRBM. InPS= {Internal properties};

--HRBM.OPS= {KEEP, CHANGE, FIRE};

--HRBM. RS= {"R1, R2R15"};

R1 = Q1 (vh) ^ Q2 (h) ^ Q3 (vh) ^ "Administration (vh)"

R2 = Q4 (h) ^ Q5 (h) ^ Q6 (h), ^ "Chief (h)".

R3 = Q7 (m) ^ Q8 (h) ^ Q9 (h) ^ "Cooperation (h)

R4 = Q10 (m) ^ Q11 (h) ^ Q12 (m) ^ "Fairness (m)"

R5= Q13 (l) ^ Q14 (m) ^ Q15 (l) ^ "Assets(m)"

R6 = Q16 (vh) ^ Q17 (m) to Q18(h) ^ "Execu (h)"

R7 = Q19 (l) ^ Q20 (vl) ^ Q21 (l) ^ "Critical thinking (vl)"

R8= Q22 (l) ^ Q23 (h) ^ Q24 (h) ^ "Cooperation (m)"

R9= Q25 (m) ^ Q26 (h) ^ Q27 (vh) ^ "Admin (Leadership (h))"

R10 = Q28 (h) ^ Q29 (vh) ^ Q30 (vh) ^ "About Company (vh)"

R11 = Q31 (l) ^ Q 32(m) ^ Q33 (m) ^ "Exp (l)"

R12 = Q34 (m) ^ Q 35(h) ^ Q36 (h) ^ "Imp (h)"

R13 = Q37 (vh) ^ Q38 (vh) ^ Q39 (h) ^ "IntP (vh)"

R14 = Q40 (h) ^ Q41 (m) ^ Q42 (vh) ^ CliSer (vh)

R15 = Q43 (m) ^ Q44 (m) ^ Q45 (m) ^ Knowld (m)

- HRBM = {Individual experience (vh) ^ Leadership (h) then become Administrator}
- HRBM = {cooperation (h), ^ assets (vh) then become Chief}

- HRBM={team work (vh) ^ execution (m) then become Admin [Leader]}
- HRBM = {knowledge (m) ^ preformation (vh) then become Innovative}
- HRBM = {client services (vl) ^ individual exp. (vl)then Change Department}

VI. CONCLUSION AND REMARKS

Human behavior is dynamic in nature. It varies from person to person. With the implication of questionnaire we tend to determine the personality according to the situation and calibrate the employee behavior and decide upon which is suitable for organization. This helps us to gain better output and better selection of employees by human resource. In order to increase the performance, competitive environment must be created to analyze and know the talents of the employee. Expert system implemented here is an example for measuring and monitoring by primary key indicators as reflected in the list of internal properties. This can be expanded further by including more properties and validating the same.

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