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Representation of Fuzzy IF-THEN rules by Petri Nets

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Research report No. 84

2005

Submitted/to appear:

ASIS 2005

Supported by:

project 1M0572 of the MŠMT ČR

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Abstract: This article is about visualization of modelling steering and decisional processes described by fuzzy IF-THEN rules modified by Petri Nets.

Keywords: Petri Nets, Fuzzy logic, IF THEN rules.

1 Introduction

Not only in area of information technologies we meet more and more with the necessity of process modeling and activity running. For creation of models exist a lot of various devices and tools. We are going to intent on modeling by Petri Nets extended about fuzzy approach for expressing the input and output values.

2 Classical Petri Nets

Classical Petri Nets are defined as a structure $N = (S, T, F)$, where S means set of places, T is set of transitions and F is $F \subseteq (S \times T) \cup (T \times S)$, where $(\forall\, t \in T)(\exists\, p, q \in S)(p, t), (t, q) \in F$. Graphical representation is set up by following symbols:

- Places – rings
- Transitions – rectangle
- Relations – pointers between transitions and places or places and transitions

We won't describe any more into details the idea and properties of basic Petri Nets and for deeper a understanding of this problem we recommend literature. [1].

During process simulation by Petri Nets we have to time to time illustrate the status which we are not sure whether will happen or not. In classical Petri Nets there is token placed if the expression is true (1) or not if it is false (0). Let's now try too create such a Petri Net which will work with vague values ("a lot, "big", ...). We will use tools of fuzzy logic for work with such values especially fuzzy IF THEN rules [2], [3].

Token will be bearer of fuzzy sets in our case, edges will be evaluated by language expression from IF THEN rules and own transition represent basically fuzzy relation according to the IF THEN rule. Creation of that relation is depend on the chosen inferentional method. For more implementation we refer to software LFLC 2000 developed UVAFM [4].

Let's take the following as an example of correspondence between IF THEN rules and Petri Nets:

3 Example of simple model

Let's introduce simple model of weather behaviour in dependency on various factors. We will set up temperature of the air, pressure and cloudy weather at the entry statuses of

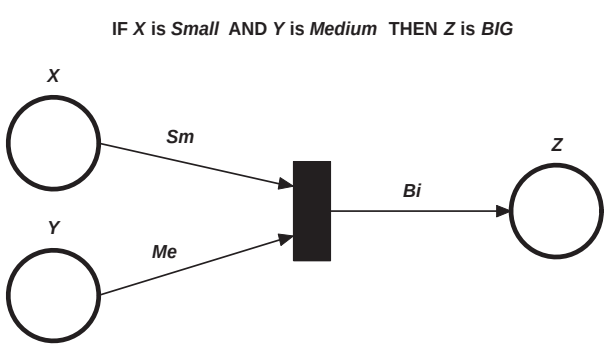

Fig. 1: Modeling of simple IF-THEN rule

Petri Nets. According to these values we will finally receive forecast of nice weather, rain and storm[1].

We will create a model according to our expert knowledge which consists of following observation:

1. When the temperature is high, cloudy a lot and low pressure then storm will be.
2. When the temperature is high, not too cloudy weather and high pressure then will be nice weather.
3. When the temperature is medium, and cloudy a lot that means it will be rainy.

We will model dependencies by Petri Nets according to the rules as visible on figures Fig.2 – Fig.4.

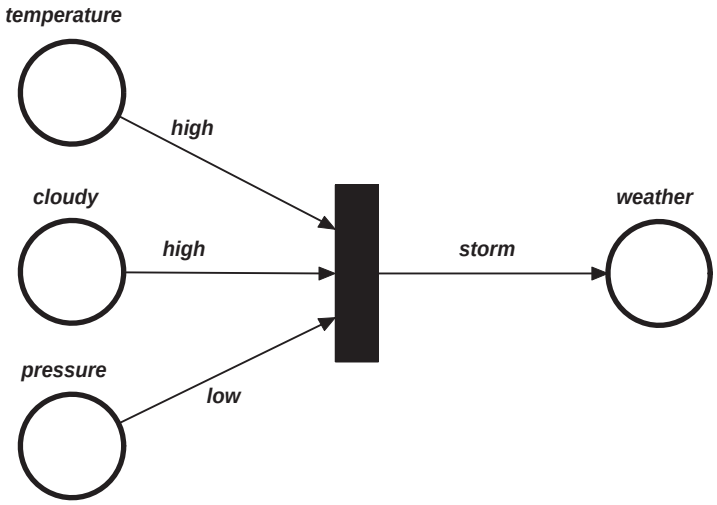

Fig. 2: Rule 1

[1] In this case there is an universum of output variable discreet fuzzy set containing three items.

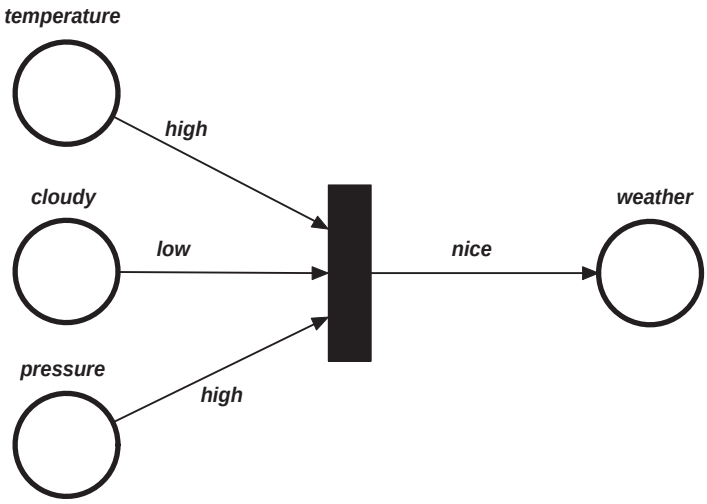

Fig. 3: Rule 2

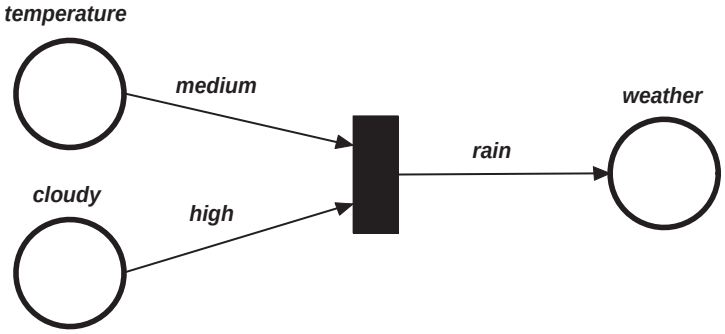

Fig. 4: Rule 3

Now we can simply join all free rules into only Petri Net the way is illustrated on the figure5. Such a connection is quite synoptic but if we would like to find out the level of membership of all items of the final fuzzy set we would have to repeatedly proceed all possible transitions Petri Nets and find out maximum of levels individual items of output universum.

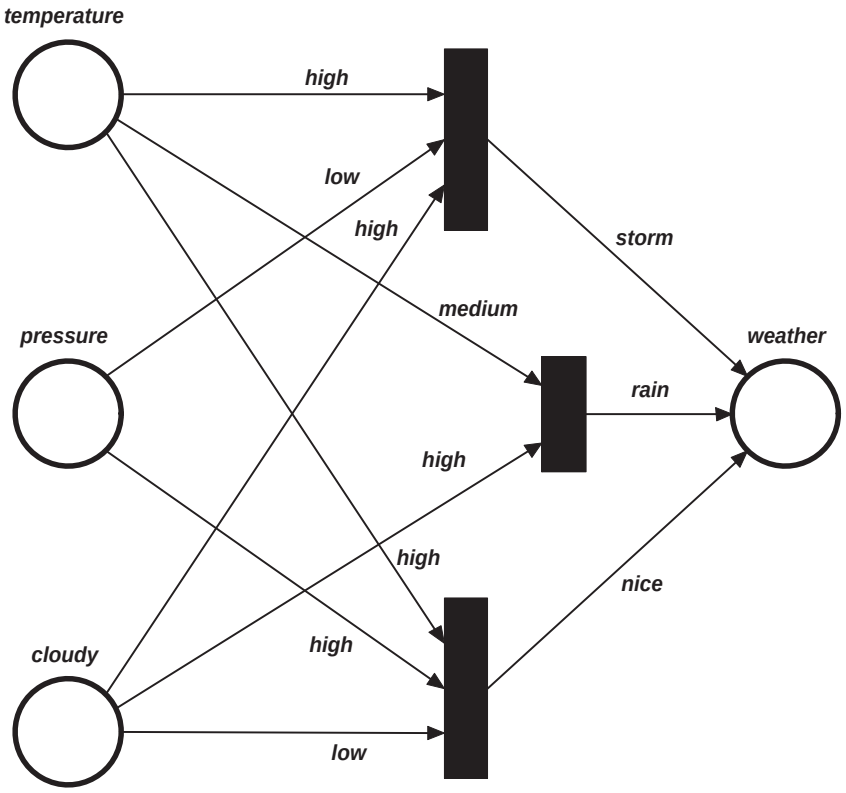

Fig. 5: Simple connection of rules

This defect we can simply solve by modification of Petri Nets into final version as it is shown on the figure 6, The last transition will provide conjunction of output fuzzy sets from individual IF-THEN rules. After the transition of tokens through the Petri Net will the place marked by symbol of weather contain final fuzzy set and according to the level of membership we can conclude the credibility of what the weather will be like.

4 Conclusion and evaluation

We see the main usage of our approach in facilitating the layout of fuzzy IF-THEN rules and making them more synoptic. These rules can be linked to each other. Currently we work on such a simulator of Petri Nets thereby will be created tool for layout and editing fuzzy IF-THEN rules but especially tool for their tuning and program realization.

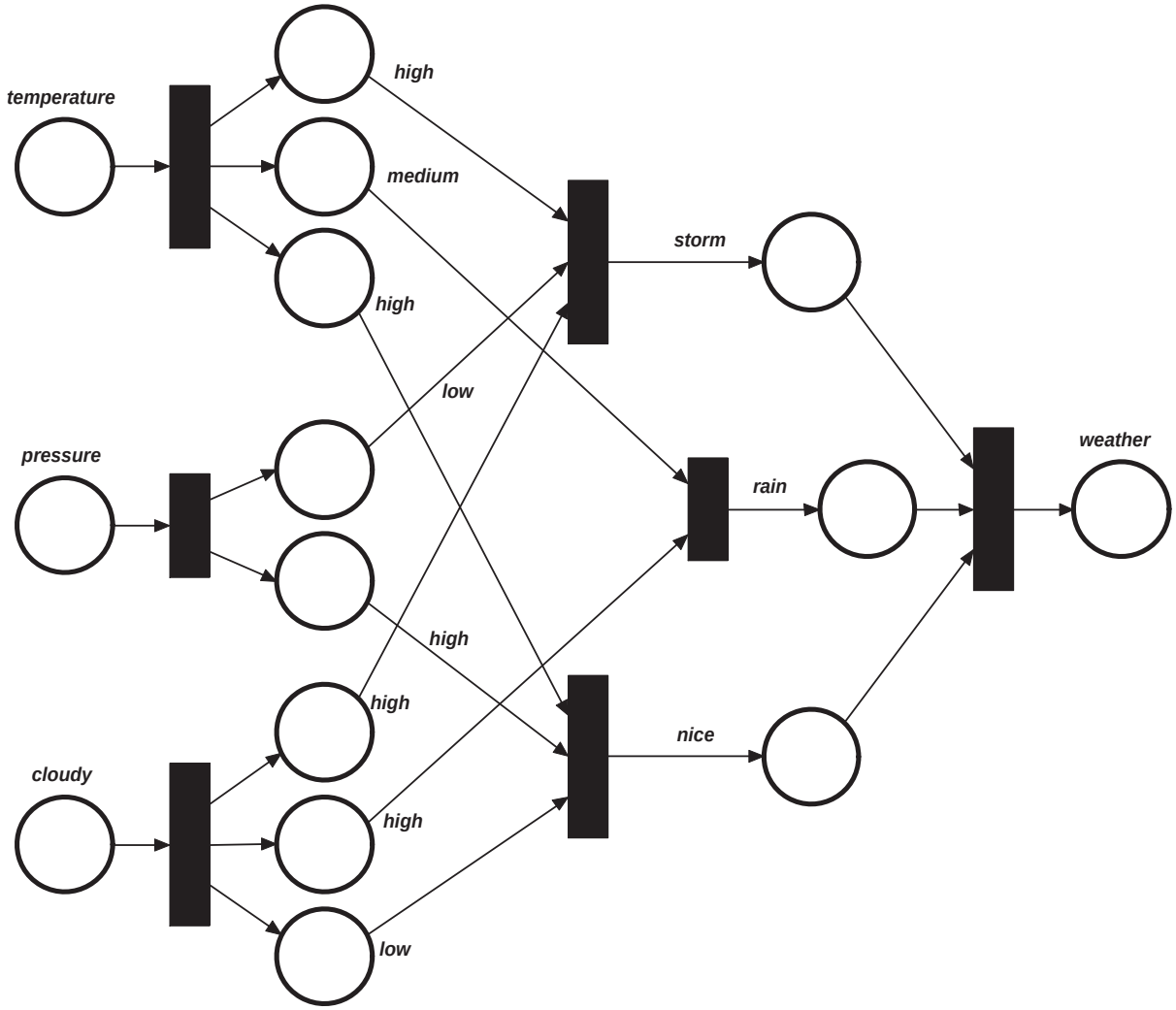

Fig. 6: Final version of the model

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This work has been supported by project 1M0572 of the MŠMT ČR.