# MODELLING AND REASONING OF LARGE SCALE FUZZY PETRI NET USING INFERENCE PATH AND BIDIRECTIONAL METHODS

ZHOU KAIQING

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Faculty of Computing
Universiti Teknologi Malaysia

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*To*

*all my family members*

*who support me spiritually throughout my life*

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# ABSTRACT

The state explosion problem has limited further research of Fuzzy Petri Net (FPN). With the rising scale of FPN, the algorithm complexity for related applications using FPN has also rapidly increased. To overcome this challenge, this research proposed three algorithms, which are transformation algorithm, decomposition algorithm and bidirectional reasoning algorithm to solve the state explosion problems of knowledge-based system (KBS) modelling and reasoning using FPN. Based on the goal of this research, the entire research is separated into two tasks, which are KBS modelling and reasoning using FPN. In modelling, a transformation algorithm has been proposed while in reasoning, decomposition and bidirectional reasoning algorithms have been proposed. In transformation, the algorithm is proposed to generate an equivalent large-scale FPN for the corresponding large-size KBS using a novel representation method of Fuzzy Production Rule (FPR). In decomposition, the algorithm is proposed to separate a large-scale FPN into a group of sub-FPNs by using a presented index function and incidence matrix. In bidirectional reasoning, the algorithm for optimal path is proposed to implement inference operations. Experimental results show that all proposed algorithms have successfully accomplished the requirements of each link of KBS modelling and reasoning using large-scale FPN. First, the proposed transformation algorithm owns ability to generate the corresponding FPN for the large-size KBS automatically. Second, the proposed decomposition owns ability to divide a large-scale FPN into a group of sub-FPNs based on the inner-reasoning-path. Lastly, the proposed bidirectional reasoning algorithm owns ability to implement inference for the goal output place in an optimal reasoning path by removal of irrelevant places and transitions. These results indicate that all proposed algorithms have ability to overcome the state explosion problem of FPN.

# ABSTRAK

Masalah ledakan keadaan telah merghadkan kajian lanjutan ke atas Rangkaian Petri Kabur (FPN). Dengan penambahan skala FPN, kerumitan algoritma terhadap aplikasi yang berkaitan dengan FPN juga telah bertambah. Bagi menangani cabaran ini, kajian ini mencadangkan tiga algoritma iaitu algoritma transformasi, algoritma penghuraian dan algoritma penaakulan dwiarah bagi menyelesaikan isu ledakan keadaan terhadap pemodelan dan penaakulan sistem berasaskan pengetahuan (KBS) menggunakan FPN. Berdasarkan matlamat kajian ini, kajian dibahagikan kepada dua bahagian iaitu pemodelan dan penaakulan KBS dengan FPN. Dalam pemodelan, satu algoritma transformasi telah dicadangkan manakala dalam penaakulan, algoritma penghuraian dan dwiarah telah dicadangkan. Dalam transformasi, algoritma dicadangkan untuk menjana kesepadanan FPN berskala besar bersesuaian dengan KBS berskala besar menggunakan kaedah perwakilan baru bagi Peraturan Penghasilan Kabur (FPR). Dalam penghuraian, algoritma dicadangkan untuk mengasingkan FPN berskala besar menjadi kumpulan sub-FPN menggunakan fungsi indeks dan matriks insiden. Dalam penaakulan, algoritma dwiarah bagi laluan optimum dicadangkan untuk melaksanakan operasi inferens. Keputusan eksperimen menunjukkan semua algoritma yang dicadangkan berjaya melaksanakan keperluan bagi setiap sambungan pemodelan dan penaakulan KBS FPN berskala besar. Pertama, algoritma transformasi yang dicadangkan mampu menjana kesepadanan FPN untuk KBS berskala besar secara automatik. Kedua, algoritma penghuraian yang dicadangkan mampu membahagikan FPN berskala besar kepada sub-FPN berdasarkan laluan-penaakulan-dalaman. Akhirnya, algoritma penaakulan dwiarah yang dicadangkan mampu melaksanakan inferens bermatlamat tempat output dalam laluan penaakulan optimum secara penyingkiran tempat dan peralihan yang tidak relevan. Keputusan ini menunjukkan semua algoritma yang dicadangkan mampu menangani masalah ledakan keadaan FPN.