9th International Interdisciplinary Congress on Renewable Energies, Industrial Maintenance, Mechatronics and Informatics

Booklets

RENIECYT
Registro Nacional de Instituciones y Empresas Científicas y Tecnológicas
1702902 CONAHCYT

RENIECYT - LATINDEX - Research Gate - DULCINEA - CLASE - Sudoc - HISPANA - SHERPA UNIVERSIA - Google Scholar DOI - REDIB - Mendeley - DIALNET - ROAD - ORCID - V|LEX

Title: State Estimation of Discrete Event Systems Using Fuzzy Timed Petri Nets

Authors: González-Castolo, Juan Carlos, López-Mellado, Ernesto, Ramos-Cabral, Silvia and Zataraín-Durán, Omar Alí

KZU-7150-2024 0000-0003-2659-0646
LKN-8375-2024 0000-0003-0880-7098
KHV-0681-2024 0000-0003-4204-1700
KRQ-0829-2024 0000-0002-7934-7765

Editorial label ECORFAN: 607-8695
BCIERMMI Control Number: 2024-01
BCIERMMI Classification (2024): 241024-0001
RNA: 03-2010-032610115700-14
Pages: 18

CONAHCYT classification:
Area: Engineering
Field: Engineering
Discipline: Systems engineer
Subdiscipline: System analysis

ECORFAN-México, S.C.
Park Pedregal Business. 3580, Anillo Perif., San Jerónimo Aculco, Álvaro Obregón, 01900 Ciudad de México, CDMX,
Phone: +52 1 55 6159 2296
Skype: ecorfan-mexico.s.c.
E-mail: contacto@ecorfan.org
Facebook: ECORFAN-México S. C.
Twitter: @EcorfanC

www.ecorfan.org

Holdings
Mexico Colombia Guatemala
Bolivia Cameroon Democratic
Spain El Salvador Republic
Ecuador Taiwan of Congo
Peru Paraguay Nicaragua

PRESENTATION CONTENT

Introduction

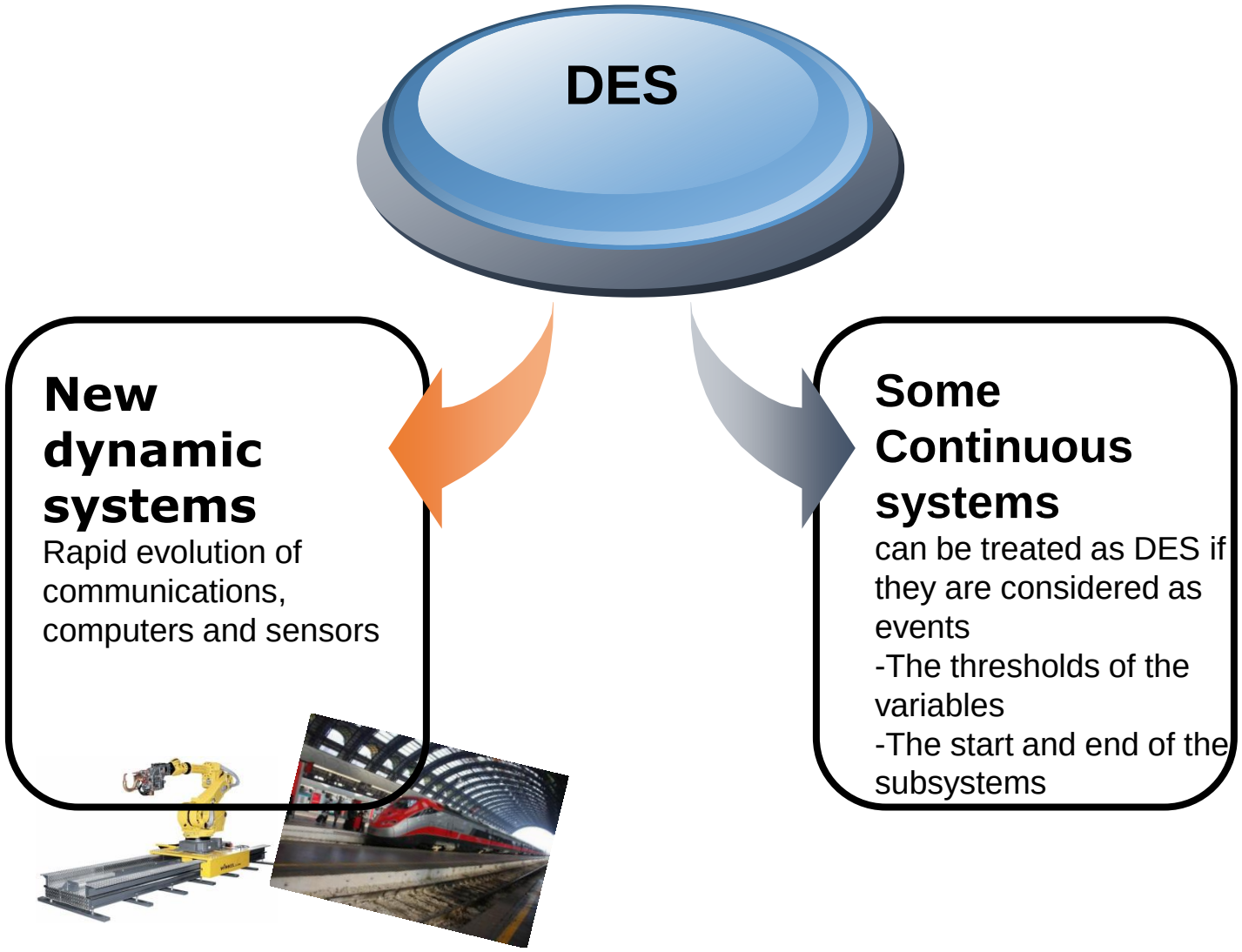
Background

Fuzzy Timed Petri Nets

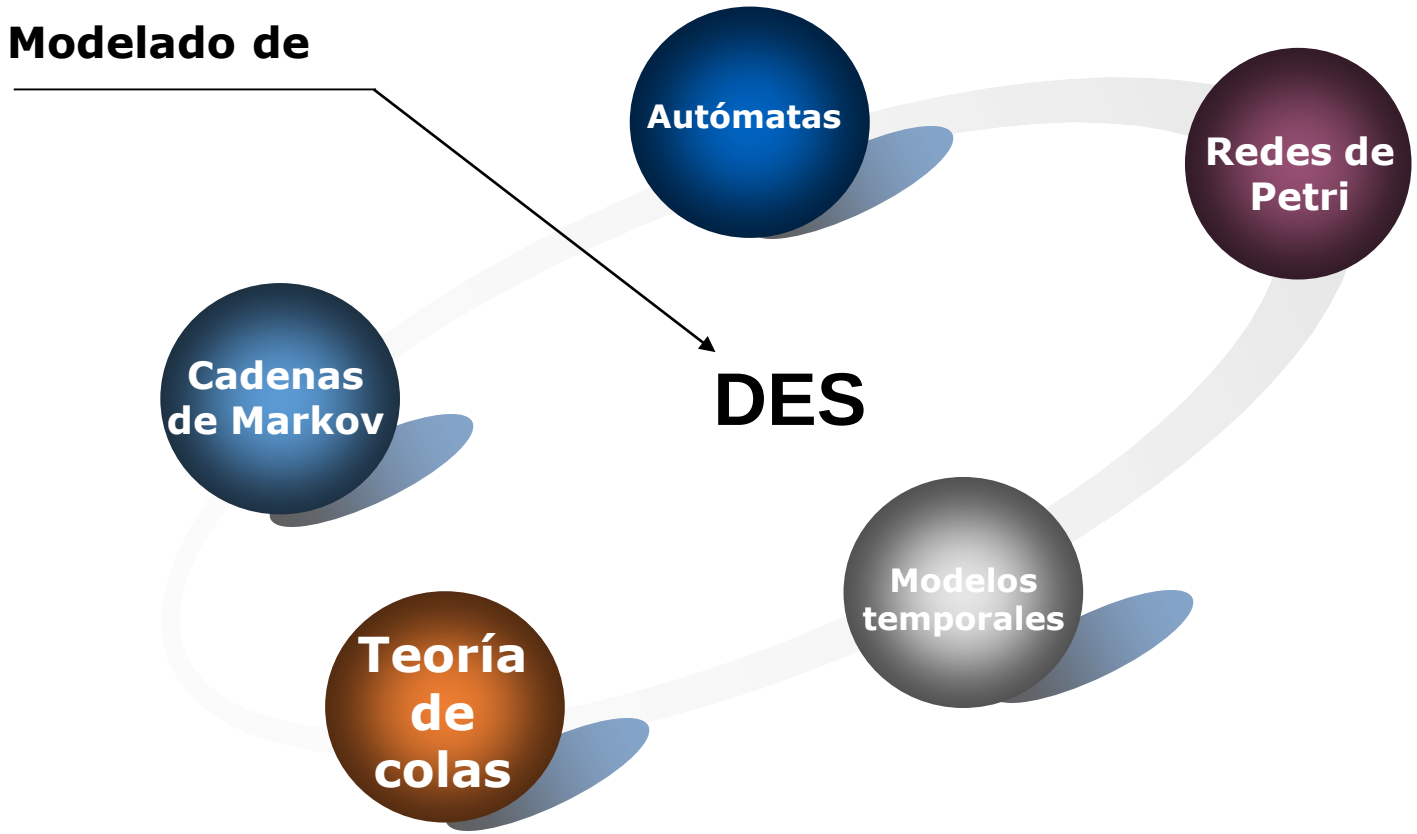
Measurable places in a FTPN

Conclusions

Introduction

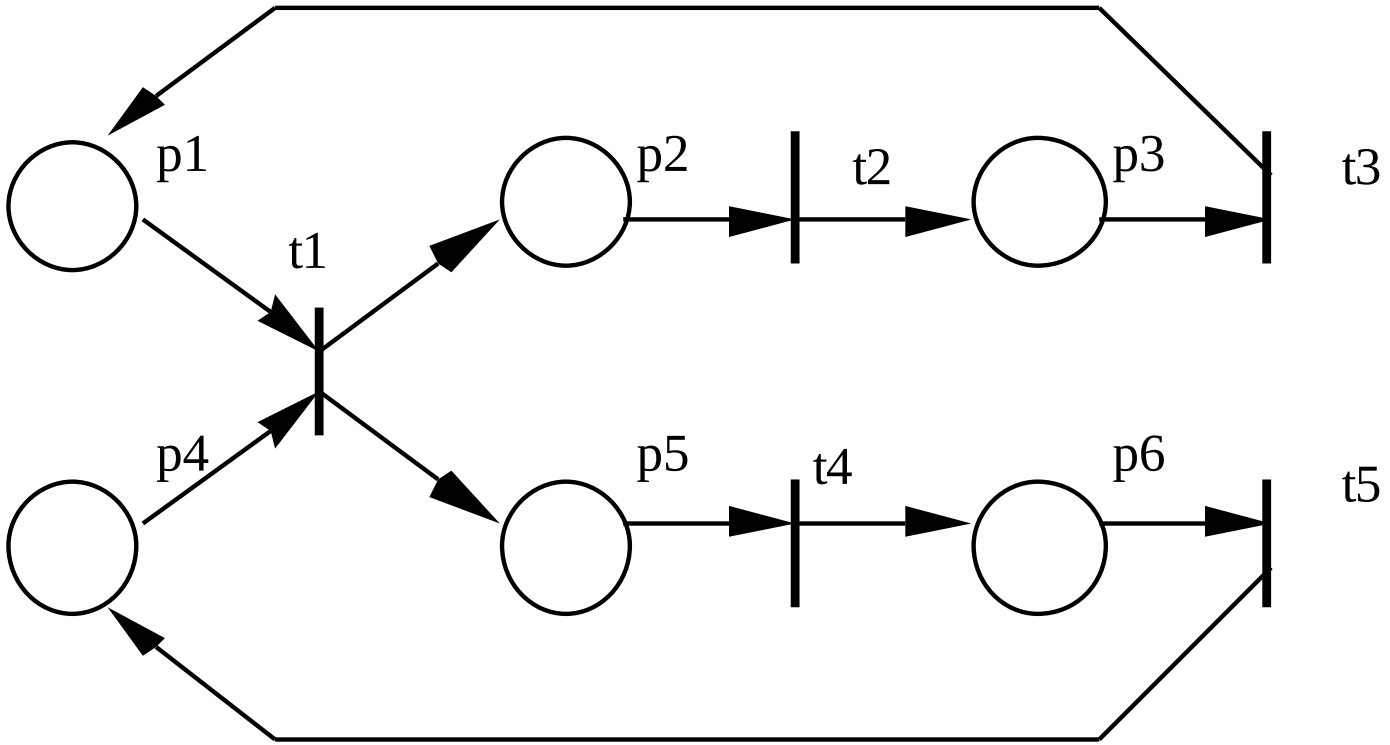


Introduction



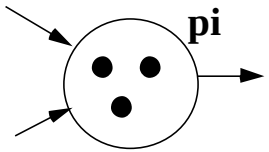
Background: Redes de Petri

Estructura de la PN → **Grafo bipartita**



Background: Redes de Petri

Distribución de marcas o tokens (puntos) dentro de los lugares



Marcado inicial (M_0): Localización inicial de la marca

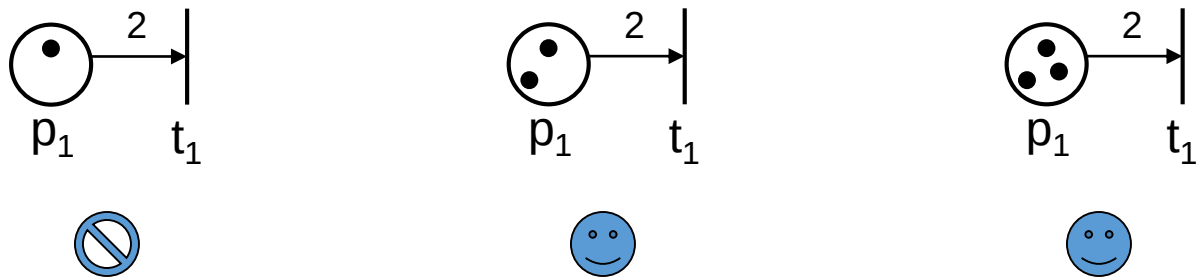
- Lugares de entrada $\bullet t_j$,
- Lugares de salida $t_j \bullet$

Background: Redes de Petri

Evolución del marcado → **regla de transición en dos partes**

Transición habilitada:

- El lugar de entrada debe tener al menos tantas marcas como lo requiera el peso de los arcos de entrada

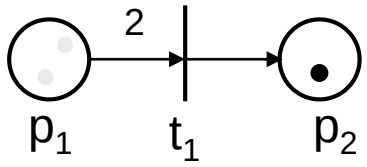


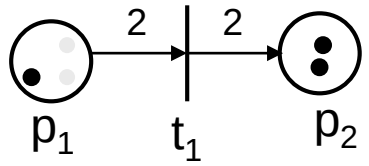
Background: Redes de Petri

Disparo de transición:

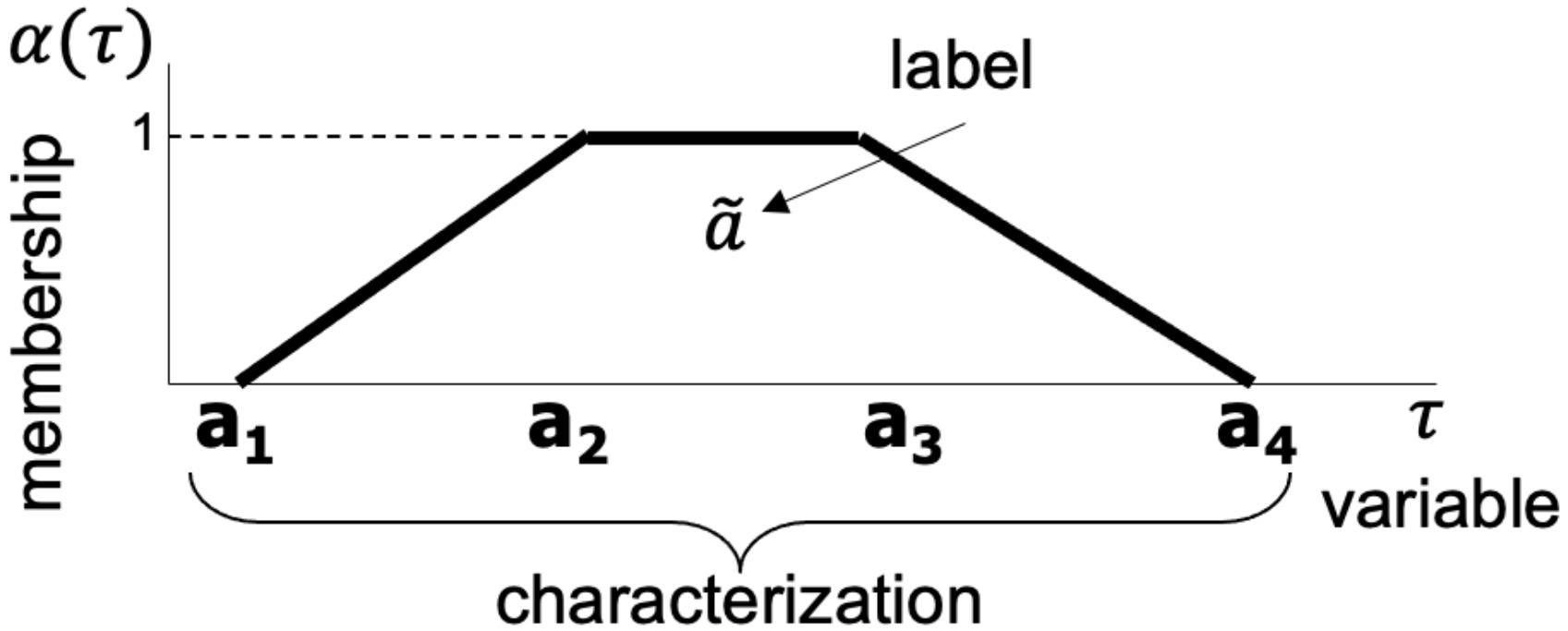
- Remover las marcas de los lugares de entrada según lo indique el peso de los arcos de entrada

- Agregar marcas a los lugares de salida según lo indique el peso de los arcos de salida



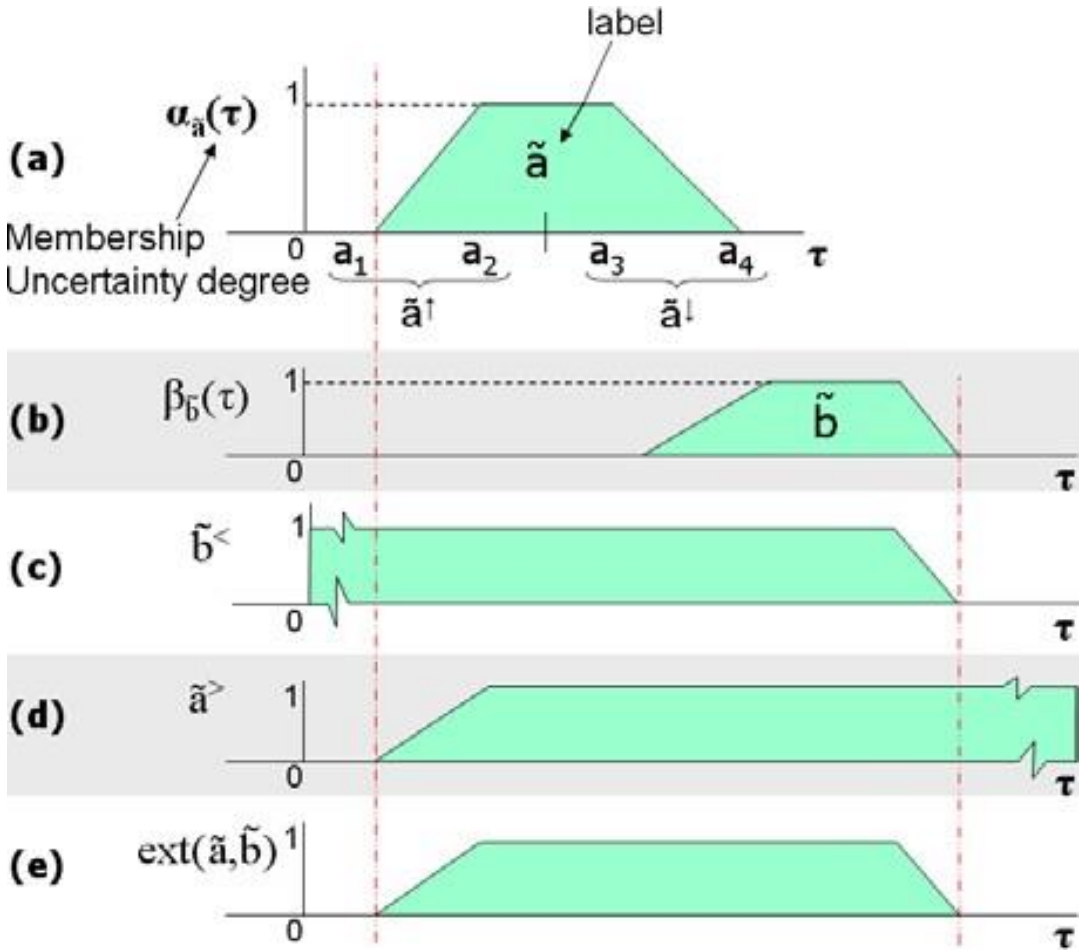


Background: Fuzzy Logic



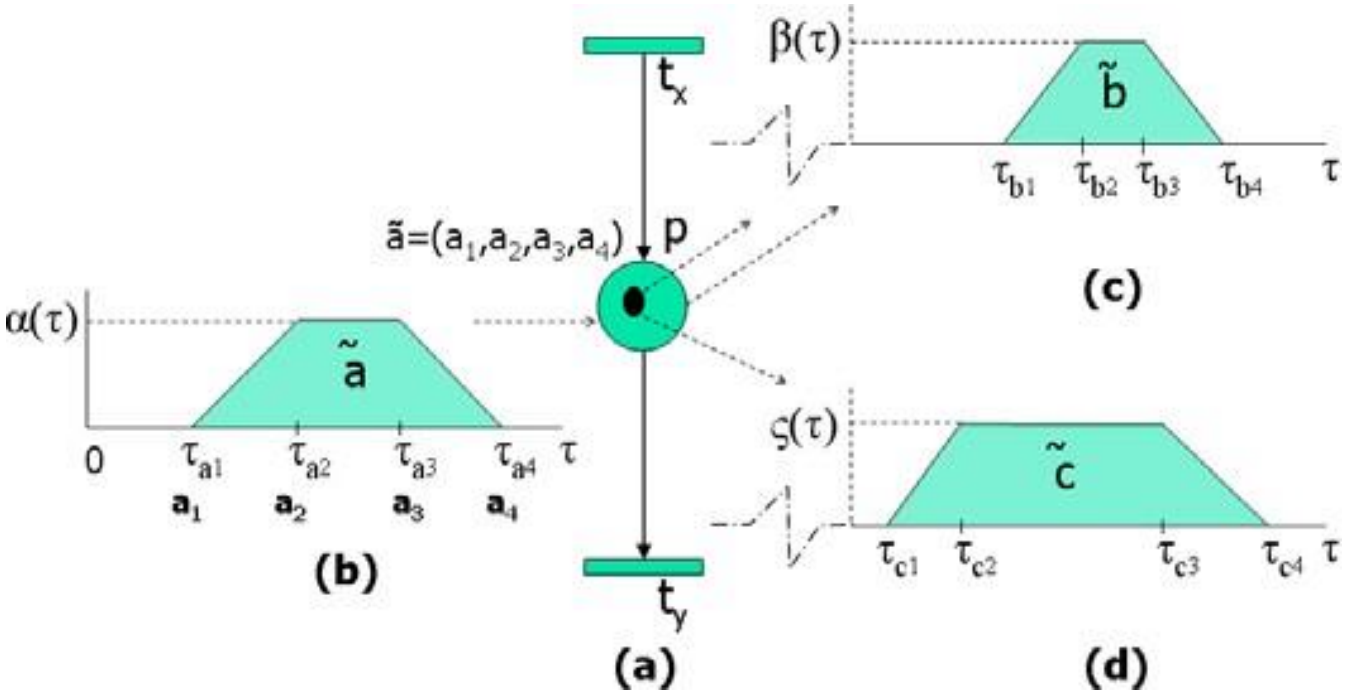
Fuzzy set

Background: Fuzzy Logic



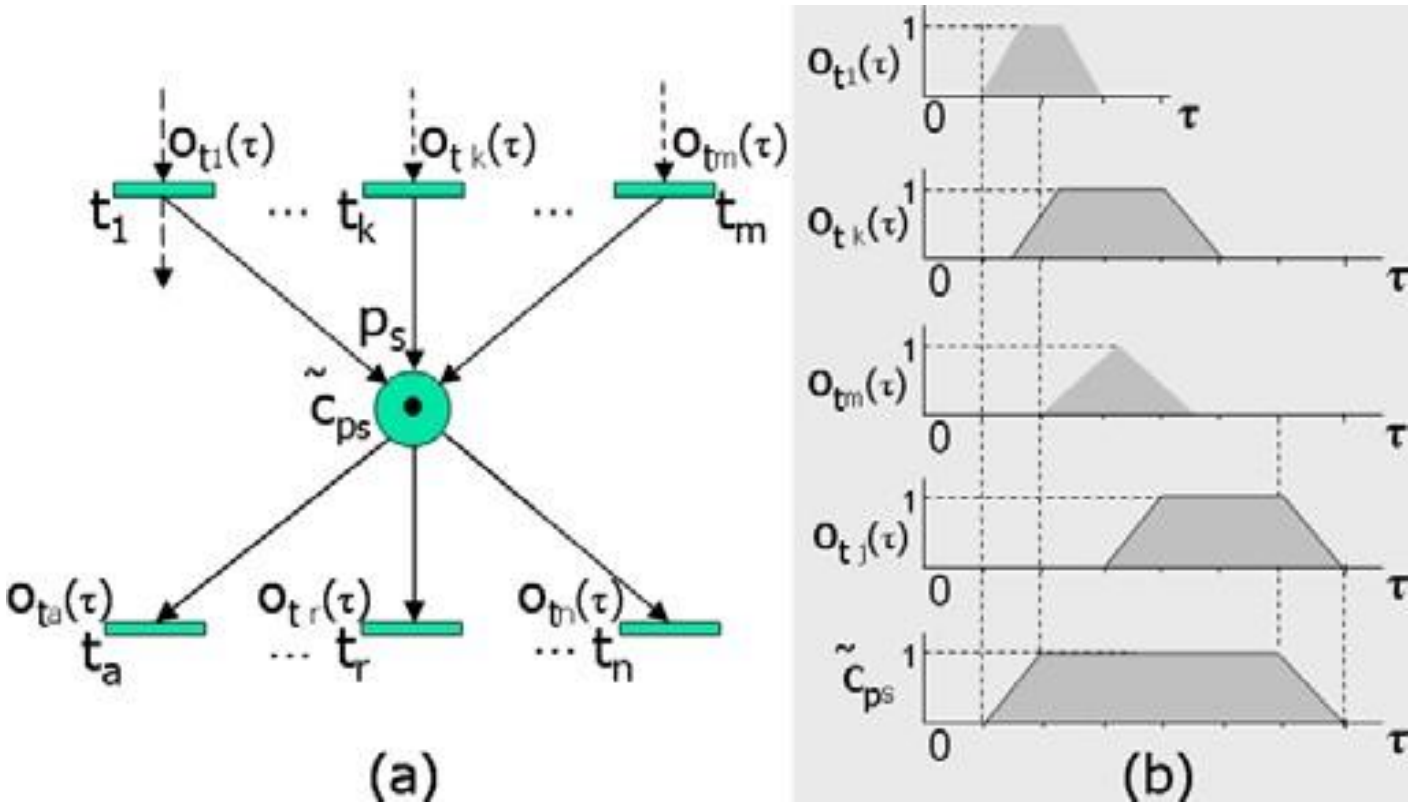
Fuzzy sets and operations

Fuzzy Timed Petri Nets



(a) Fuzzy Petri net, (b) The fuzzy set associated to places. (c) Fuzzy set to place or mark associated. (d) Fuzzy timestamp

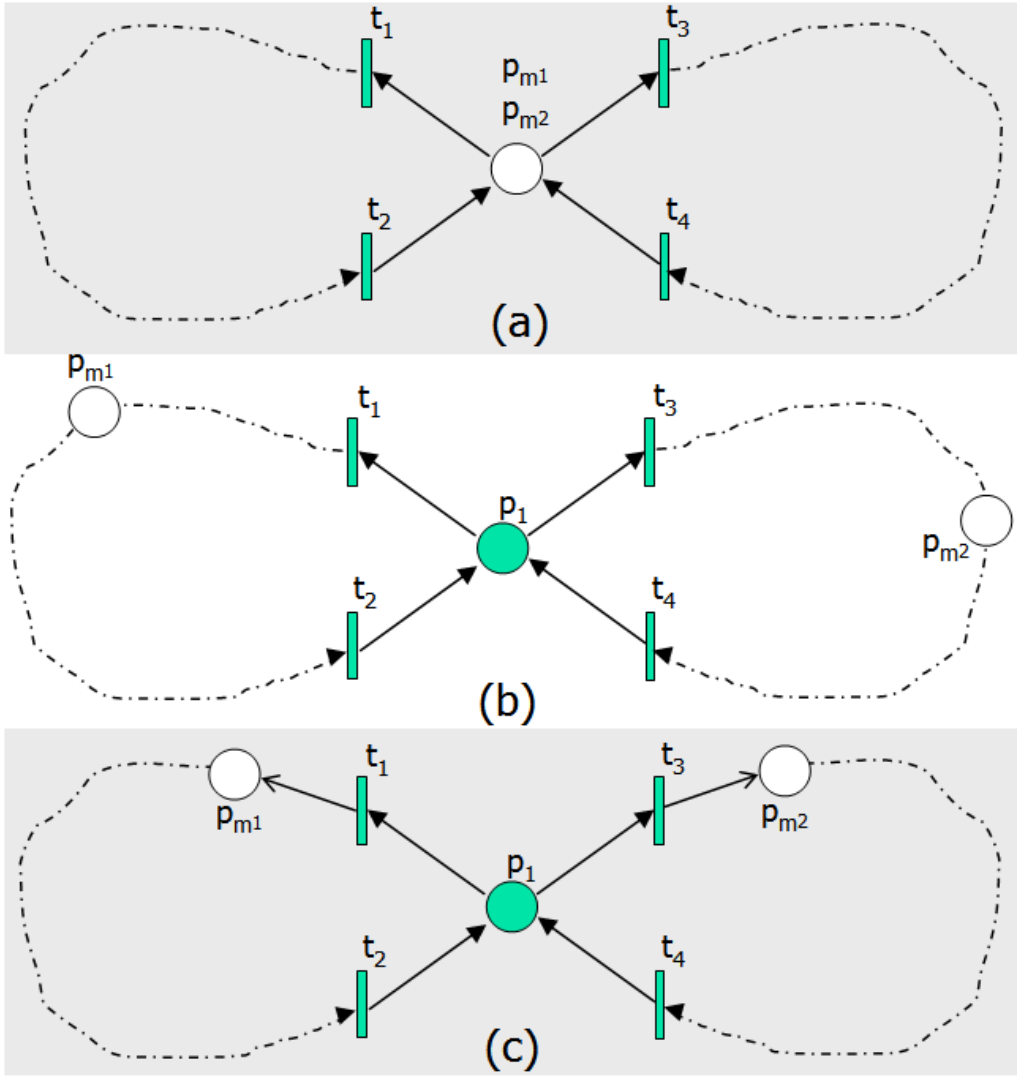
Fuzzy Timed Petri Nets



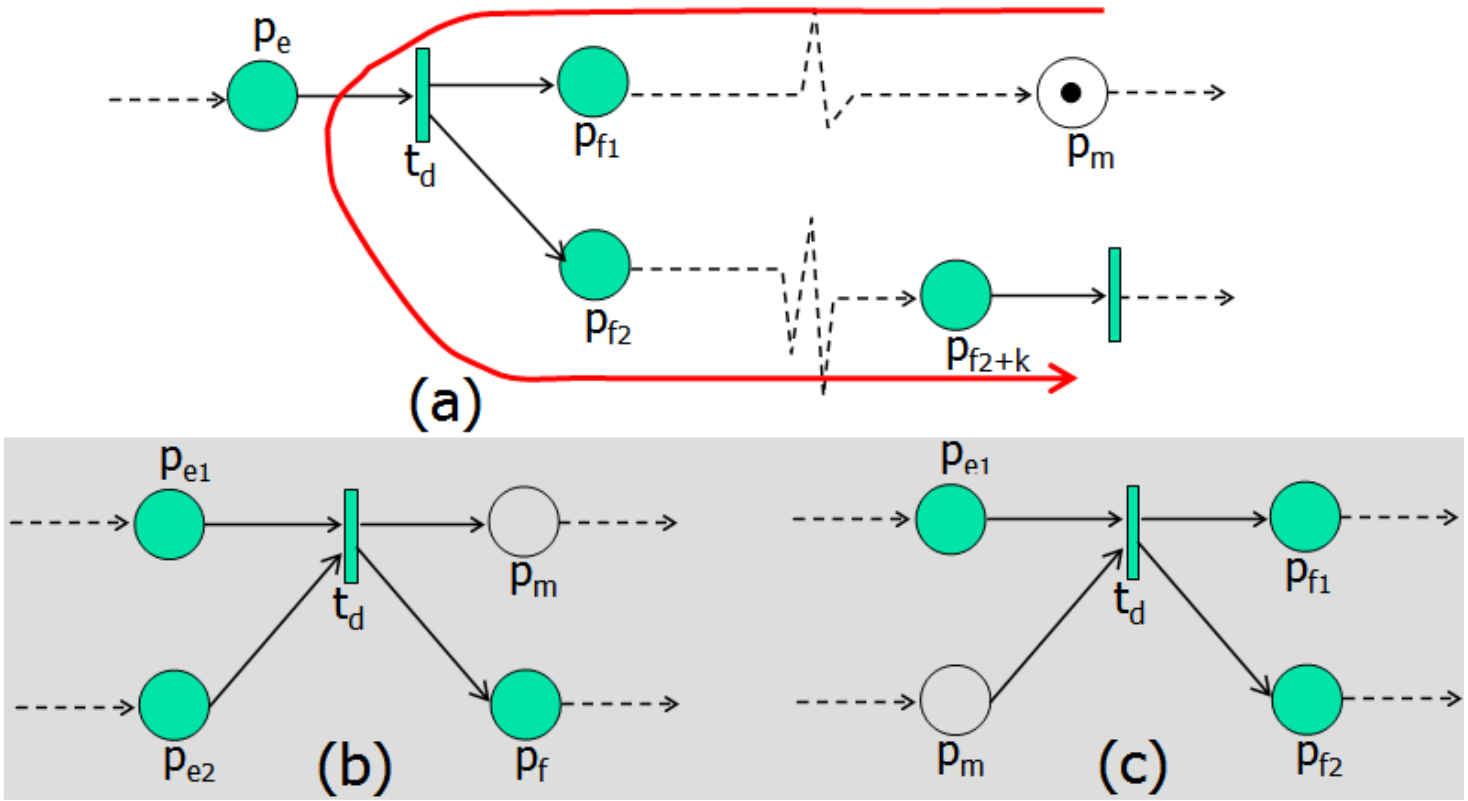
(a) Attribution and selection place. (b) Fuzzy timestamp computing

Measurables Places in a FTPN

Fuzzy marking evolution

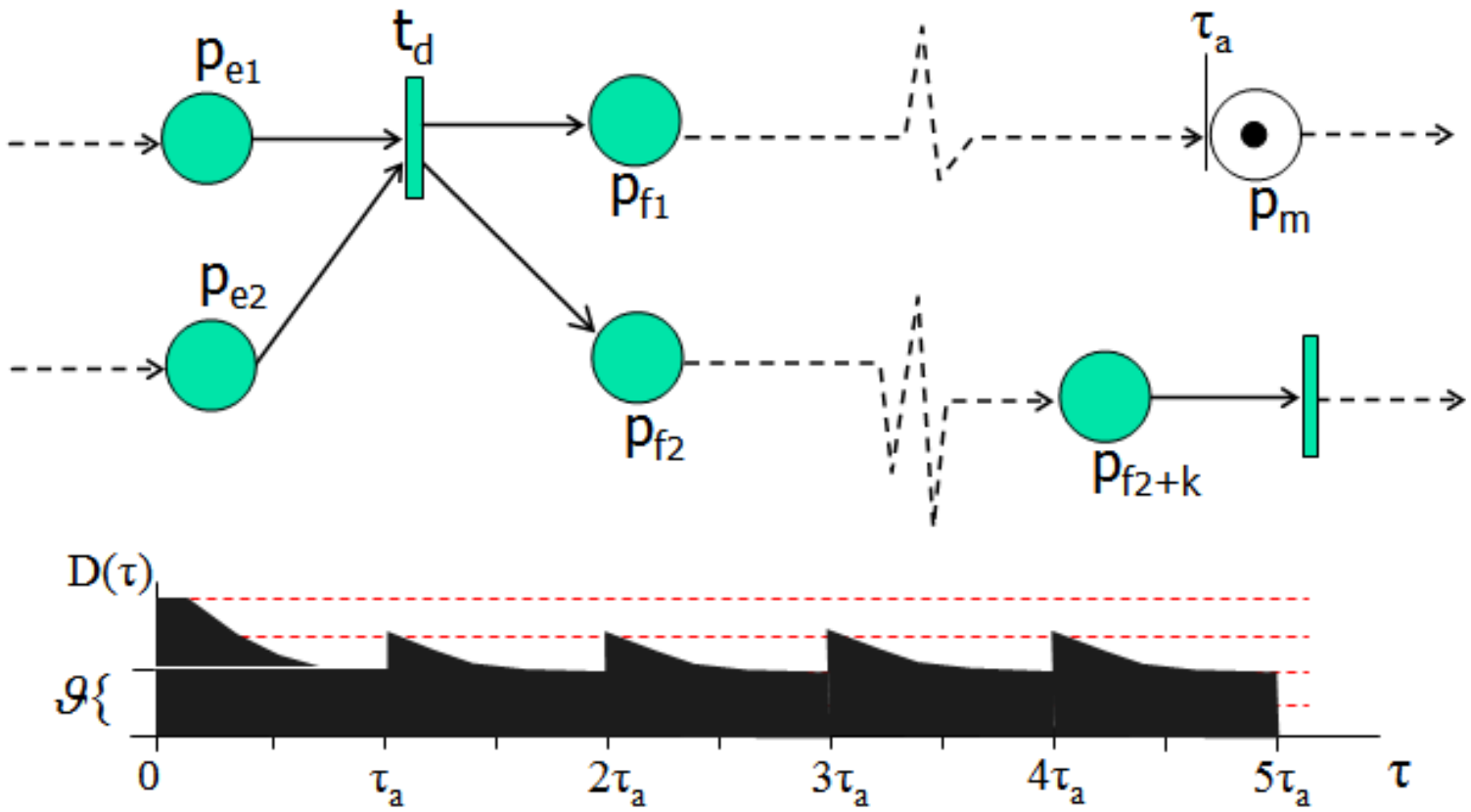


Measurables Places in a FTPN



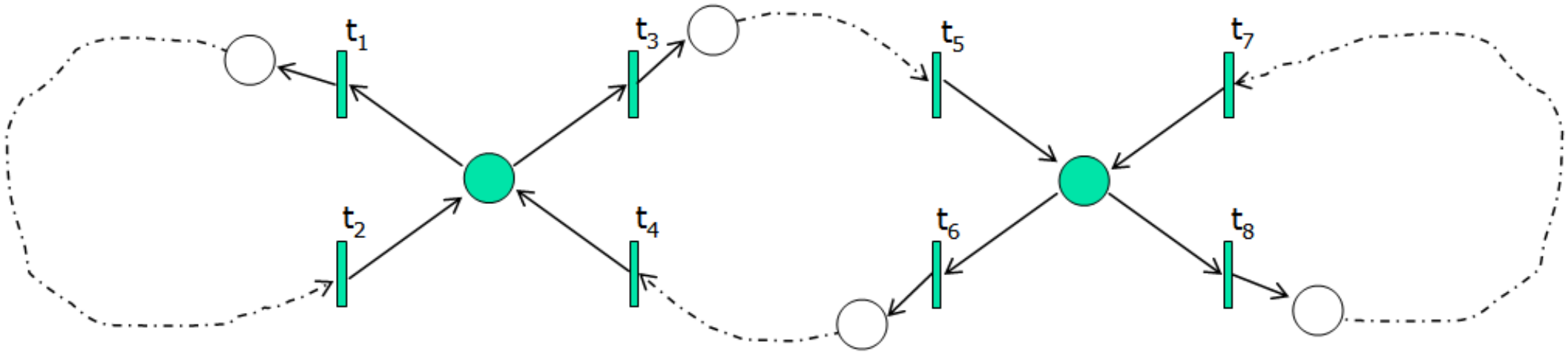
Location of places with associated sensor signals

Measurables Places in a FTPN



Quality of state estimate ϑ

Measurables Places in a FTPN



FTSM with more than one measurable place by t-component

Conclusions

This paper addressed the problem of DES state estimation for which activity durations are poorly known; fuzzy sets represent the uncertainty of the end of activities.

Current research addresses the inclusion of sensors in FTPN to reduce the uncertainty about marking the observed locations to zero and to keep the uncertainty of marking bounded for any evolution of the system.

The inclusion of sensory information in the fuzzy model, called semi-fuzzy in this case, allows to keep the uncertainty in the approximation of marking bounded.

The analysis presented shows that a reduced number of sensors is enough to give this property to the state estimation device.

ECORFAN®

State Estimation of Discrete Event Systems Using Fuzzy Timed Petri Nets

Questions?

jcgcastolo@cucea.udg.mx
silvia.ramos@academicos.udg.mx

References

Andreu , D., Pascal , J., & Valette , R. (1997). Fuzzy Petri net-based programmable logic controller. *IEEE Trans Syst Man Cybern B Cybern*, 952-961. doi:10.1109/3477.650056

Klir, G. J., & Yuan, B. (1995). *Fuzzy Logic. Theory and Applications.*

Murata, T. (1996). Temporal uncertainty and fuzzy-timing high-level Petri nets. *Application and Theory of Petri Nets 1996. ICATPN 1996. Lecture Notes in Computer Science, 1091*, 29-58.

Zadeh, L., & Goguen, J. (1965). Fuzzy sets. *Information and control*, 338–353. doi:10.2307/2272014

González-Castolo, J. C., & López-Mellado, E. (2007). Approximating State of DES Using Fuzzy Timed Petri Nets., (págs. 722-728). doi:10.1109/COASE.2007.4341788

González-Castolo, J. C., & López-Mellado, E. (2007). Marking estimation of fuzzy timed marked graphs. *IEEE International Conference on Systems, Man and Cybernetics*, 1421-1426. doi:10.1109/ICSMC.2007.4413809

González-Castolo, J. C., & López-Mellado, E. (2011). State Estimation of Partially Observable DES Using Fuzzy Timed Petri Nets. *16 th IEEE International Conference on Emerging Technologies and Factory Automaton* (págs. 1-8). Toulouse: EFTA.

González-Castolo, J. C., & López-Mellado, E. (2011). State Uncertainty Analysis of Fuzzy Timed DES. *IEEE Conference on Automation Science and Engineering* (págs. 600-606). Trieste, Italy: CASE.

González-Castolo, J., & López-Mellado, E. (2006). Fuzzy State Estimation of Discrete Event Systems., *4293*. doi:10.1007/11925231_9

Aguayo-Lara, E., Gómez-Gutiérrez, D., Ramírez-Treviño, A., & Ruiz-León, J. (2015). Sensor Placement and Observer Design for Free Choice Continuous Timed Petri Nets. *IEEE Latin America Transactions, 13*(10), 3253-3261. doi:10.1109/TLA.2015.7387229

Anguiano-Gijón, C. A., Chávez, J., Cid-Gaona, A., & Vázquez, C. (2024). Assessment of Petri nets Regulation Control methodologies for automation systems. *Control Engineering Practice, 144*. doi:https://doi.org/10.1016/j.conengprac.2023.105819

Deabes, W., Bouazza, K., & Algthami, W. (2023). Smart Fuzzy Petri Net-Based Temperature Control Framework for Reducing Building Energy Consumption. *Sensors, 23*, 5985. doi:10.3390/s23135985

H., Y., Y., H., K, K., H, H., & S, P. (2024). Minimum Initial Marking Estimation in Labeled Petri Nets With Unobservable Transitions Based on Minimal Explanations. *IEEE Transactions on Systems, Man, and Cybernetics: Systems, 54*(6), 3427-3438. doi:https://10.1109/TSMC.2024.3357742

Hua , S., & Hu-Chen, L. (2023). *Fuzzy Petri Nets for Knowledge Representation, Acquisition and Reasoning* (Vol. 1). Springer. doi:10.1007/978-981-99-5154-3

ECORFAN®