

# ICRAMCS 2026

THE EIGHTH EDITION OF THE INTERNATIONAL CONFERENCE ON  
RESEARCH IN APPLIED MATHEMATICS AND COMPUTER SCIENCE  
April 23-24-25, 2026 | Marrakech, Morocco



## Structural Refinement of Markov Chains: Hidden Intermediate States and Stochastic Factorization

### Communication Info

#### Authors:

Chaimaa RIAHI<sup>1</sup>  
Youssef EL FOUTAEYNI<sup>2</sup>

<sup>1</sup> University Hassan 2,  
Casablanca, Morocco

<sup>2</sup> University Cadi Ayyad,  
Marrakech, Morocco

#### Keywords:

- (1) Markov chains
- (2) State space refinement
- (3) Hidden intermediate states
- (4) Stochastic matrix factorization

### Abstract

Markov chain models are widely used in applied mathematics to describe stochastic dynamics in biological, ecological, and economic systems. Previous studies on temperature-dependent profit estimation [1], multi-species bioeconomic equilibria [2], and wind-driven exploitation [3] suggest that observable transitions may conceal latent intermediate mechanisms.

Motivated by this, we introduce a structural framework for refining finite Markov chains, where each transition is represented as a collection of hidden intermediate states. This yields a refined state space allowing stochastic factorization through latent layers.

We explore theoretical questions on the existence, minimal representation, and structural constraints of such refinements, emphasizing their impact on spectral properties, stability, and convergence [4,5]. This approach provides a foundation for modeling coarse-grained stochastic systems and interpreting latent transition dynamics.

© ICRAMCS 2026 Proceedings ISSN: 2605-7700

### References

- [1] Riahi, C., Agmour, I., & El Foutayeni, Y. (2023). Impact of temperature on profit estimation of two fishermen exploiting three competing species using Markov chain. *Advanced Mathematical Models & Applications*, 8(1), 65-82.
- [2] Riahi, C., El Foutayeni, Y., Guerbaz, R. (2019). Modélisation bioéconomique des équilibres Multi-espèces avec interactions éco-systémiques et de marché. *ICRAMCS*, 144. [<https://icramcs2019.sciencesconf.org>]
- [3] Riahi, C., Agmour, I., El Foutayeni, Y., Achtaich, N. (2024). Impact of wind speed on profit maximization in dual-fishermen exploitation of tritrophic prey-predator fish populations. *Communications in Mathematical Biology and Neuroscience*, 2024 (2024), Article ID 7.
- [4] Delbianco, F., Fioriti, A. & Tohmé, F. Markov chains, eigenvalues and the stability of economic growth processes. *Empir Econ* 64, 1347–1373 (2023). <https://doi.org/10.1007/s00181-022-02276-8>