

Parallel agent-based simulation of South Korean population dynamics

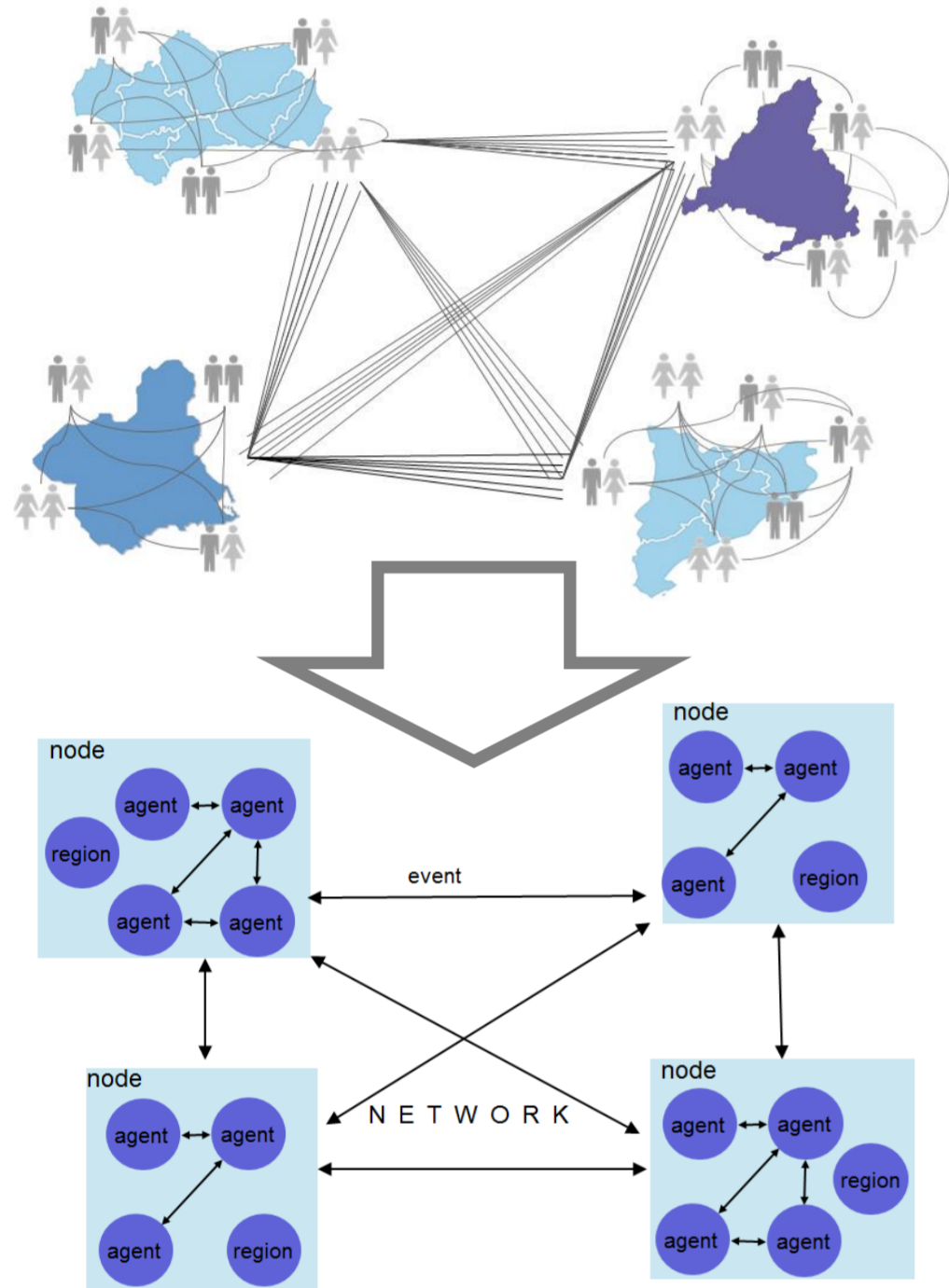
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Parallel Simulation for Demographics

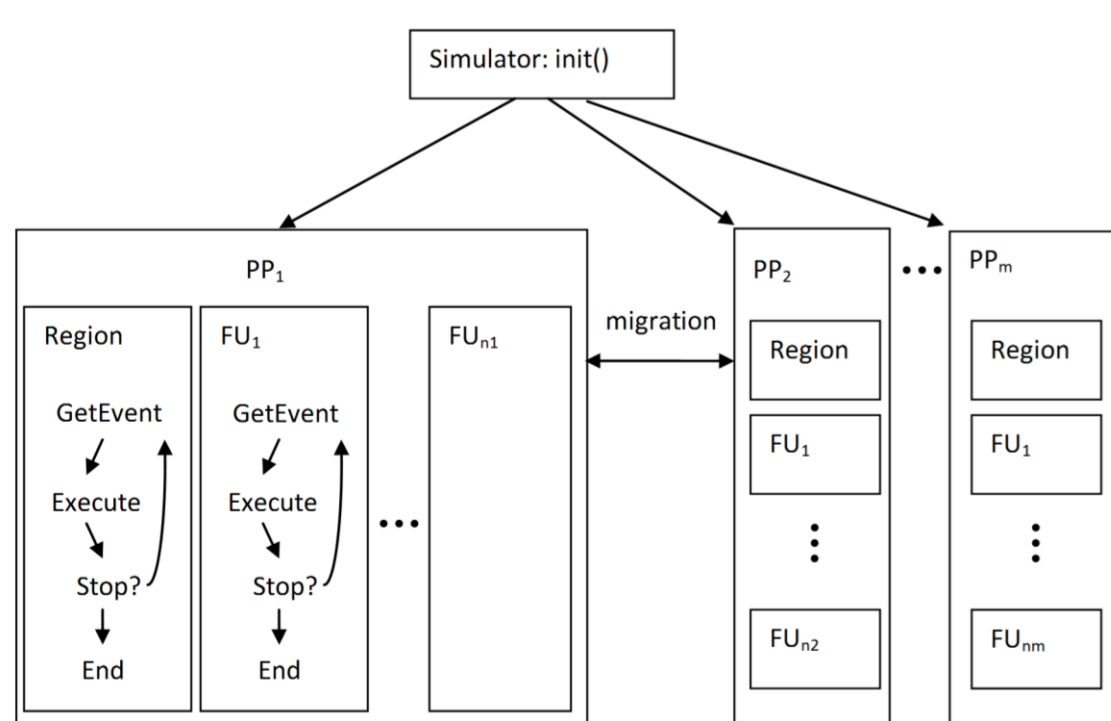
Agent-based modeling and simulation is a promising methodology that can be used in the study of population dynamics. Two of the main obstacles hindering the use of agent-based simulation in practice are its scalability and ease-of-use.

We developed **Yades (Yet Another Demographic Simulator)** platform to design specify agent-based demographic models and run them in parallel environments.



Yades architecture

Yades simulation library [1] is implemented using **μsik** [3], a parallel discrete-event simulation library that supports both lookahead-based conservative synchronization protocol and state rollback-based optimistic synchronization protocol. Logical processes (LPs) communicate through events with the standardized communications protocol Message Passing Interface (MPI).



Yades framework

Web-based user interface:

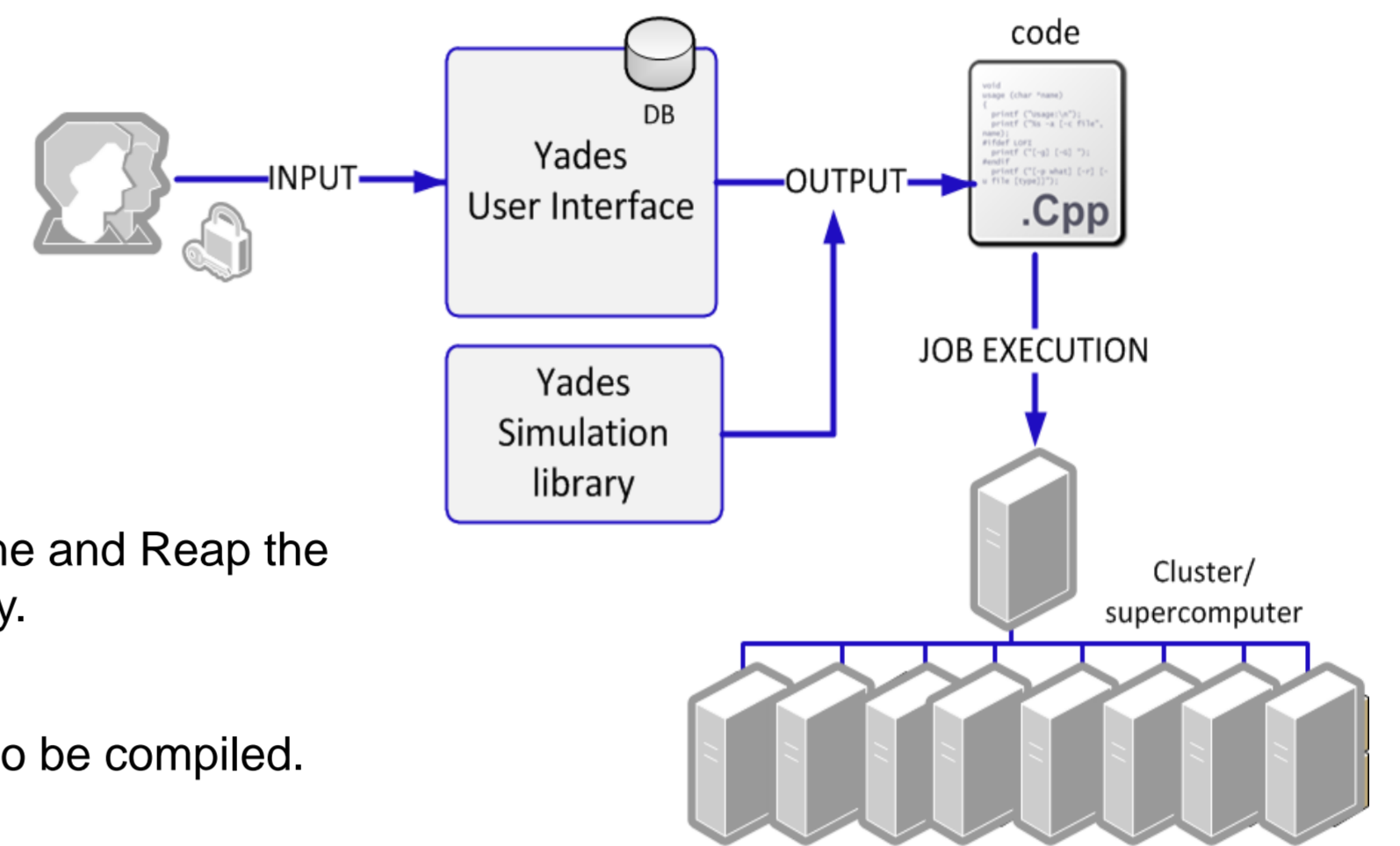
Specify demographic model components in a number of representations familiar to demographers (i.e., regression and statistical distribution functions).

Demographic simulation library

Uses a scalable parallel discrete-event simulation engine and Reap the performance offered by parallel computers transparently.

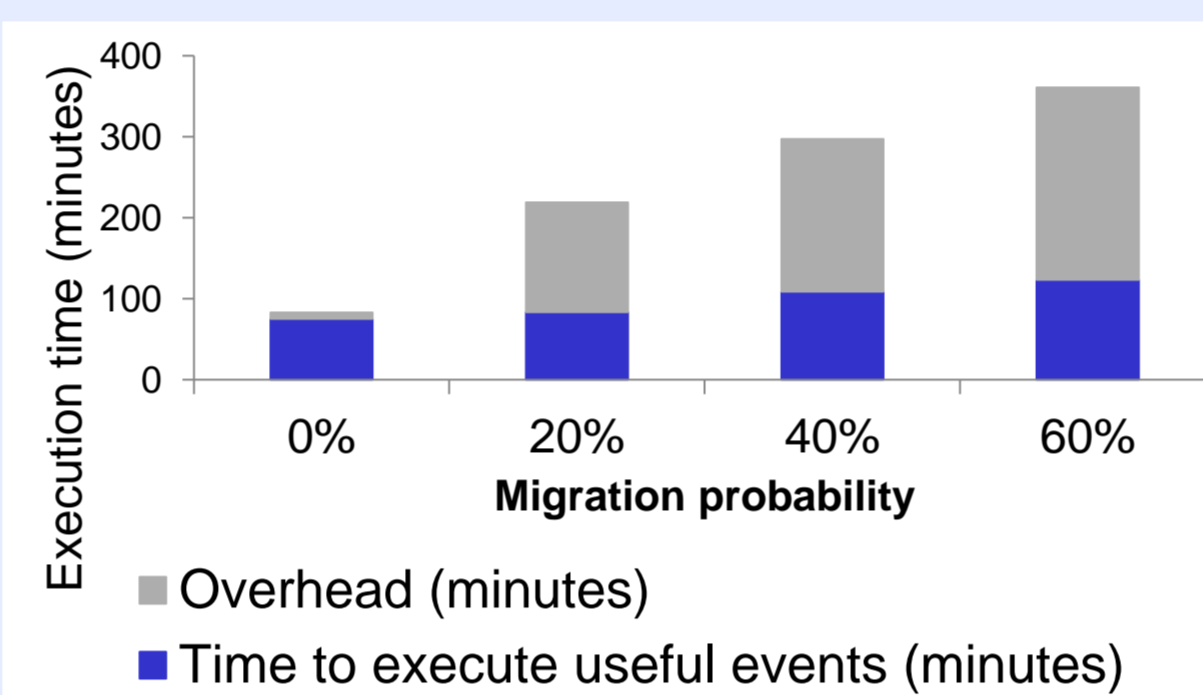
Simulation code generator

Translate input data to corresponding C++ code ready to be compiled.

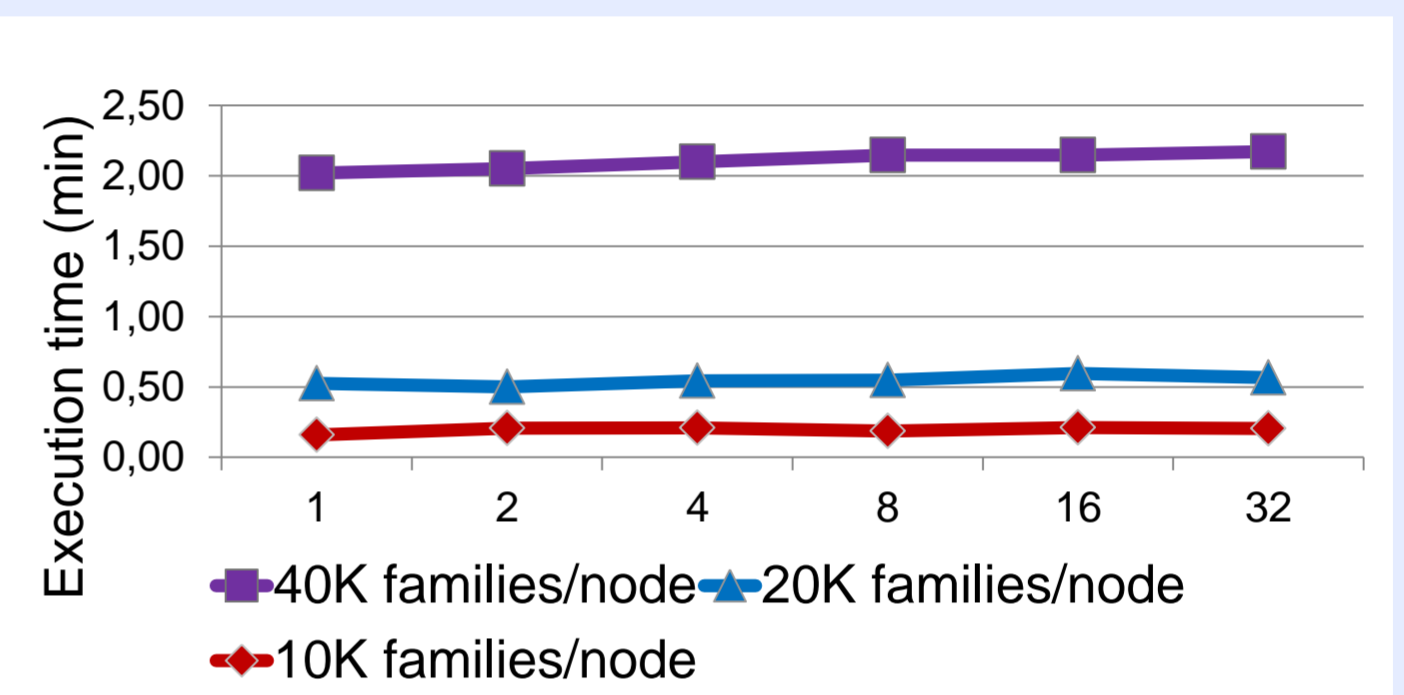


Yades performance [2]

Effect of migration in performance



Weak scaling



Simulating 100 years of South Korean demographics

OECD country with the highest unprecedented growth.

Highly urbanized society (65.4%). Seoul concentrates 25% of the total population. By 2050, Korea could be the oldest country on earth [4].

Simulation from 1990-2090. 17 regions, 445K families, 956K individuals

The model include: fertility, mortality, marital status, economic status, and domestic migrations (no immigrations) Data relied on micro-census provided by the Korean National Statistics Office (1990-2013).

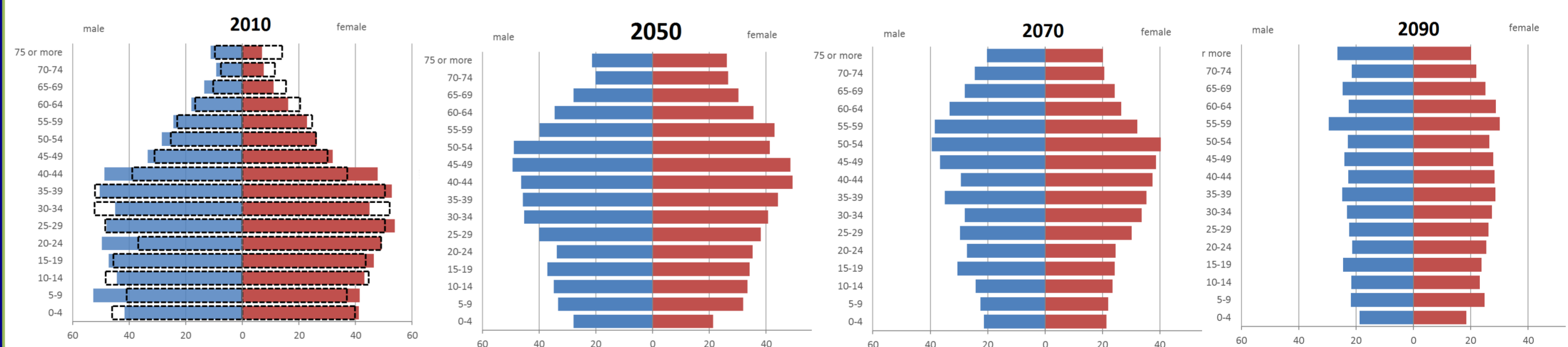
Results obtained

Our model predicted 96% of domestic migrations in 1990-2013.

There are several observed differences in some age groups possibly due to not including immigrant arrivals.

Our results show a collapse of South Korean population similar to the UN forecast studies [5].

Simulations were run in 15 nodes, with an average execution time of 17.6 min and 11.13GB memory used.



Literature cited

- [1] Onggo, B.S.S. 2008. "Parallel discrete-event simulation of population dynamics". In *Proceedings of the 2008 Winter Simulation Conference*, S. J. Mason, R. R. Hill, L. Mönch, O. Rose, T. Jefferson, J. W. Fowler (Eds.), 1047–1054. IEEE Computer Society Press: Piscataway, NJ.
- [2] Onggo, B.S.S., Montañola-Sales, C. and Casanovas-Garcia J. 2010. "Performance Analysis of Parallel Demographic Simulation". In *Proceedings of the 24th European Simulation and Modelling Conference*, 142-148. Eurosis-ETI: Belgium.
- [3] Perumalla, K.S. 2005. μ sik – a micro-kernel for parallel/distributed simulation systems. In *Proceedings of the 19th Workshop on Principles of Advanced and Distributed Simulation*, 59-68. ACM Press: New York, NY.
- [4] Howe N., Jackson R., Nakashima K.. The aging of Korea. Demographics and retirement policy in the land of the morning calm. Technical report, Global Aging Initiative, Center for Strategic and International Studies, April 2007.
- [5] United Nations. Dept. of Economic. Replacement migration: is it a solution to declining and ageing populations?, volume 206. United Nations Publications, 2001.



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