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A MODELLING BASE TO SUPPORT LONG-TERM CARE COMPARATIVE STUDIES BY AN AGENT-BASED SIMULATION APPROACH

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ABSTRACT

This work aims to construct a modelling base to enable the deployment of an agent-based simulation approach in comparing and evaluating long-term care (LTC) models. By leveraging advanced simulation approaches with latest empirical data, this modelling base can be used to investigate the key question that to what extent the varied LTC design may influence LTC system outcomes, in terms of equity and efficiency, if they are instituted in different population structures. A method to construct the modelling base composed by individuals, households, and service providers of approximated target distributions is proposed. Global standardized datasets on healthcare issues of the aging population are analyzed and converted into computational agents equipped with attributes and behavioral rules. Optimization methods are integrated to tune the joint-distribution of individual attributes and household structures. Different LTC models can be implemented computationally on this modelling base for future LTC comparative studies.

1 INTRODUCTION

Rapid aging is creating global challenges on healthcare systems, and concerted efforts have been made to develop long-term care (LTC) systems to deal with the escalating care demands (UNESCAP 2015). A few developed countries have adopted LTC models, such as the Netherlands and Japan, while developing countries, such as China, just started to pilot LTC models in recent years. Although such systems have been proved to be beneficial to the welfare of the elderly, different design features (e.g., eligibility rules and services covered) have substantial varied impacts. It is thus critical to understand how these variations may influence equity in access and efficiency in resource allocation, if instituted in different social contexts.
In such investigation, both endogenous (population structure, etc.) and exogenous (care patterns, financing mechanisms, etc.) factors are necessary (Wittenberg et al. 2002). These factors intertwine in a dynamic manner leading to unexpected impacts against equity and efficiency, which are difficult to examine by conventional approaches. In contrast, an agent-based simulation approach can capture the heterogeneity of individuals and their dynamic responses to a changing environment to offer new perspectives. Therefore, with the recognition of such system complexities, there is an emerging interest in deploying agent-based simulation approaches in LTC studies (Braithwaite 2018).

2 METHOD

Against this background, this work aims to construct a modelling base, as illustrated in Figure 1, to enable the deployment of an agent-based simulation approach in comparing and evaluating LTC models. We first merge and cluster sectional datasets from standardized global aging datasets, such as China Health and Retirement Longitudinal Study (CHARLS 2011) and Japan Study on Aging and Retirement (JSTAR 2007; 2009; 2011), to computerize and generate nation-wide individual and household records with attributes on health issues and living arrangement of the elderly (Chang and Deguchi 2018). We then propose a revised combinatorial optimization method integrated with an efficient optimization method DX-NEX (Fukushima et al. 2011) to build artificial populations mirroring particular local-wise population structures using above

disaggregated records. The resulted distribution of LTC-relevant attributes including individual details, household structures and service providers at aggregated level approximates to that of a target population. Finally, we formalize and code three major LTC financing models, Long-term Care Nursing Insurance, a means-tested model and Social Health Insurance, in terms of eligibility regulations, covered services, and cost charging structures into the above artificial population. Agents' care-seeking behaviors, left as future works, can be informed from extant theoretical frameworks such as Andersen's (1995) health care utilization model, and calibrated against relevant datasets if available. Above modules are coded in the programming language Java, and can be used for future simulation works.

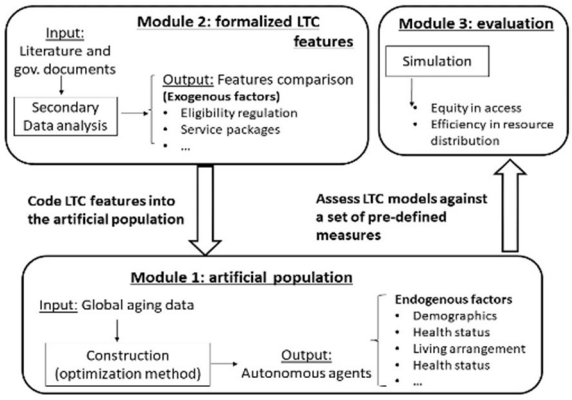

Figure 1: A modelling base to support LTC comparative studies by an agent-based simulation approach.

3 SUMMARY AND LIMITATIONS

This work is among the first in developing a modelling base to enable agent-based simulation approaches for LTC comparative studies. However, the design and validation of future agents' care-seeking behavioral models, and the evaluation of LTC comparisons will be application-dependent and thus subject to particular LTC models and social contexts. As future works, this modelling base can be used to compare diverse LTC models as alternatives when imported into different social contexts. It will eventually help answer the key question - to what extent the varied LTC design may influence LTC outcomes, in terms of equity in access and efficiency in resource distribution, if they are instituted in different population structures.

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