Can evolutionary computing be applied to dementia care?

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ABSTRACT

In dementia care, caregivers need to respond adequately and in a timely manner to their recipients' needs, which is a challenging problem. As it is difficult to measure the effect of responses with strongly evidenced methods, computational simulation may be a useful means of evaluating the results. This article introduces conceivable cases that may be candidates for simulation.

CCS CONCEPTS

• Human-centered computing → Human computer interaction (HCI) → HCI design and evaluation methods → User studies

KEYWORDS

Dementia care, assistive technologies, multi-objective optimization

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1 INTRODUCTION

Global aging is becoming a serious problem in this century, and societies are facing aging-related issues such as dementia care. According to a report by the World Health Organization, there are approximately 50 million persons with dementia (PWD), and 7.7 million new cases are added each year [1]. As noted in this report, dementia affects PWD, their families, and society. Professional caregivers are one of the key players to reduce the impact in care facilities. They engage in difficult daily activities to deal with the ambiguity arising from the nature of their work. Caregiving is a hybrid collection of simple medical treatments and support of daily activities with appropriate humane interaction. Caregivers' tasks are often not completed quickly and are usually interrupted by unexpected actions of the care recipients.

It is highly necessary to mitigate the burden of caregivers to secure quality care and to provide quality of life to care recipients. Although the significance of the issue is well known, evaluating and implementing effective approaches into actual care facilities can be difficult or impractical. Dementia causes highly diverse behaviors and causes multiple behavioral patterns. Randomized control trials are practically difficult to conduct in the field.

Computational simulations are promising means to evaluate the effect of approaches (therapy, assistive technologies, among others) on PWD and caregivers. This article describes difficulties involving dementia care as examples for multi-objective optimization.

2 DEMENTIA AND CAREGIVING

Dementia is characterized by a decline in memory, language, problem-solving, and other cognitive skills that affect a person's ability to perform everyday activities [2]. The cognitive ability of PWD is predominantly impaired in two ways: memory and higher-brain functions. If a person's memory is impaired, he/she has difficulty remembering recent events (as recent as the last few hours).

This ill-formed behavior results from their environments and personal histories. Wandering around a residence is a typical symptom; to caregivers and family members, this may appear to be aimless wandering. However, this behavior may not be persistent, i.e., a PWD may not constantly wander. Such types of ill-formed behavior are called behavioral and psychological symptoms of dementia (BPSD).

Person-centered care [3] is an approach to care, including dementia care, whereby the person cared for is central. The key idea of person-centered care is to respect "personhood," that is, to understand the individual's needs, considering his or her motivation and background. However, person-centered care provokes conflicts owing to caregivers' needs and the PWD's unexpected behaviors. Caregivers must react immediately to the recipients' dangerous actions (e.g., beginning to show signs of aimless wandering) even if they are assisting others (e.g., eating).

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3 CAREGIVING TASKS AS ISSUES IN MULTIOBJECTIVE OPTIMIZATION

Dementia care with person-centered care often creates a hectic work environment for caregivers. Caregivers must face dilemmas in such workplaces, implying that caregiving potentially represents appropriate examples for multi-objective optimization.

3.1 Decision making in hectic workplaces

Caregivers in a hectic workplace have to cope with difficult decision making in their daily activities. Their daily tasks involve reactive work to elderly actions excepting household duties such as cooking and laundry. Caregivers place themselves in difficult situations regarding decision-making owing to the workplace characteristics. They have to decide what the highest priority task is at any given time. Sometimes, simultaneous actions caused by BPSD occur, and a caregiver must decide which priorities to consider first and how to approach the care recipient and must immediately decide how these factors influence each other.

Every situation poses several local optimal points but there is insufficient time (and/or human resources) to fully assess the situation. Collaborative work accelerates the complexity of the decision-making issue. The combination of caregivers, their abilities, the characteristics of care recipients, and the environment and situation generate massive local optimal points.

The other typical case of decision-making issues is information sharing among staff members. When caregivers attempt to provide quality care based on person-centered care, they need to adequately share information regarding the care recipient. It is, however, difficult to decide the quantity and quality of information, time to convey the information, and the persons who would benefit from the information. As caregiving involves many stakeholders, factors of information sharing interact with each other; thus caregivers inevitably deal with complex decision-making in their work.

3.2 Changing the role

Hectic environments also impose several simultaneous roles on caregivers. For instance, a caregiver cooking in the kitchen must carefully watch care recipients in the dining room. An assistant that is changing a patient's clothes must change his/her role to a transferring assistant if a care recipient requests wheel chair use. Such superficial role changes are a daily occurrence.

Caregivers furthermore confront a deeper role change in their minds, known as role stress [4, 5], which is an additional burden. Caregivers tend to prefer having human-touch opportunities, and person-centeredness facilitates this tendency. They try to talk to care recipients in a friendly manner even if they only have short intervals between duty tasks. In addition, they carefully look after the care recipient regardless of the task, e.g., meal assistance, toiletry assistance, and bathing assistance. However, they cannot fully meet their desires because the nature of caregiving involves responsive work such as a caregiver providing meal assistance for a person with severe dementia who must suspend the activity when another person suddenly stands up and starts walking toward the restroom. Although caregivers aspire to play the role of affectionate assistant for a person, this type of opportunity is actually low in caregiving facilities.

To improve personal care, computational simulation may provide some insight. If an individual person's behavior pattern can be anticipated, simulation using multi-objective optimization may enable caregivers to timely change roles by reducing the need for responsive approaches.

3.3 Assistive technologies in caregiving context

Although assistive technologies have been developed in laboratory contexts, these are promising solutions for the issues mentioned in this article in actual care establishments. Monitoring technologies [6, 7] enable caregivers to observe care recipients even if they are in blind areas. Information sharing technologies [8, 9, 10] provide support to caregivers regarding patients' status and facilitate the involvement of other stakeholders such as family members who need to understand the behavioral changes in the care recipient and how to cope with these [11].

However, the development and deployment of assistive technology is not well-established with regard to care facilities. Caregivers, who are not generally specialists in technology, will have to manage the operation, maintenance, and update of such systems, which will simply place an additional burden on them. Issues such as adding and changing the role to a technology manager will also emerge a month or two after the deployment. Above all, caregivers (and family members as the sponsors) will require information regarding the cost benefit of using technology. Computational simulations represent an opportunity to facilitate the use of technology to assist in solving these complex issues.

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