

# Undergraduate Thesis Prospectus

Improving Practices for Generalization in Machine Learning Models  
(tentative technical research project in Computer Science)

Automation in Caregiving: Technology and Residential Care for the Aged in the  
United States  
(sociotechnical research project)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guideline for Thesis-Related Assignments.

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## **General research problem**

*How can practices in technological development better account for the variety of use cases in which they will be applied?*

Designing technology for use cases is applicable across disciplines and is essential for developing useful and usable tools. This involves both an understanding of users' needs as well as technical expertise. Considering use cases is crucial to users' experience with a tool and are specifically important in software design. They are built on how users are expected to use a tool and aid choices in development. Across domains, this concept describes how users interact with systems. The emergence of machine learning analysis in medical imaging is one area where use cases are being considered. Differences in image quality and equipment can significantly impact model performance with serious consequences (Saw & Ng, 2022). Physicians and designers are considering how healthcare providers can assess model reliability across settings. Desire lines in urban planning are examples of poor use case design. These form when pedestrians prefer walking along unmarked paths where constructed paths are missing or inefficient (Saxena et al, 2020). While marked paths may plot a safer route, they ignore users prioritizing travel time. Insights into user needs and use cases are critical in designing effective tools.

## **Improving Practices for Generalization in Machine Learning Models**

*How can the generalization of machine learning models to real world applications be improved?*

In my upcoming Computer Science technical research project, I intend to choose the proposal option. I tentatively plan to explore current and potential methods for designing user and use case conscious machine learning models.

## **Automation in Caregiving: Technology and Residential Care for the Aged in the United States**

*In U.S. residential care facilities for the aged, how have professional caregivers, corporations, insurers, patients, and patient advocates competed to determine the place of automation in caregiving?*

In residential care facilities, automation can improve patients' independence and quality of life, but pose dangers in healthcare. Patients, caregivers, and physicians may also refuse to use devices that frustrate them or are difficult to use. A disconnect among device manufacturers and the needs of caregivers and patients exacerbates the problem (Freedman et al, 2005). Many patients are optimistic about automation, but concerned with its potential to reduce the human element of caregiving (Greenhalgh et al, 2013). Device manufacturers and caregivers must manage the potential of automation to improve care quality with solely increasing the patient-caregiver ratio. An aging U.S. population and a shift towards technology in the patient-physician relationship magnifies the need for responsible implementation of technology in caregiving (CHWS, 2006).

The physician-patient relationship is integral to patient health. Stronger patient relationships also reduce healthcare provider burnout and stress (Haverfield et al, 2020). Automation which reduces human involvement in treatment may lack these benefits and inadvertently lead to less effective treatment. Telehealth visits exemplify how technology can be used to supplement healthcare relationships without removing interpersonal relationships. Despite limitations for physical examinations, these visits increase healthcare accessibility to patients. Popularized during the COVID-19 pandemic, care providers quickly adopted this method for routine visits. Kemp (2021) found that providers frequently cite equipment and

internet connection issues posing a barrier to building patient relationships in telehealth visits, and propose a focus on equipment and specialized training for providers. Learnability and ease of use in telehealth and caregiving technology design may reduce the need for training. Kohn and Verhoek-Oftedahl (2011) describe prevalence of patient abuse by caregivers and how the demographic's vulnerability and low visibility exacerbates risk. They recognize managing patient-caregiver relationships and caregiver emotional health is overlooked and may reduce incidence. Introducing automation into caregiving can pose new risks from technology companies, and could enable caregiver neglect through reliance on automation systems.

Patients are both optimistic and concerned about the benefits of automated systems and their effect on interpersonal caregiving (Greenhalgh et al, 2013). Greenhalgh (2013) surveyed patients' opinions on assistive technologies. One patient explains, "I'm scared of them [doctors] closing a drawer and forgetting me," prioritizing the human aspect of caregiving. Another patient describes a walking aid, "This got me out and gave me fun, it gave me confidence ... it's the most important thing to me because that gets me out." The design of some devices, such as emergency alarms and telehealth equipment, dissuaded some patients surveyed. The interest group AARP advocates for Americans over 50, listing health and quality of living as primary concerns and promotes wearable health technologies (Collier, 2019). The group promotes automated caregiving technologies for telehealth visits, remote vitals monitoring, and at-home treatments (Oldenburg, 2022). Research from the advocacy recognizes the need for human centered design and ethical data use in devices (Keenan, 2022).

Physicians and professional caregivers aim to improve healthcare quality and accessibility, but are wary of irresponsible automation (Volpato et al, 2021). Healthcare providers express concern that poor remote monitoring devices may enable misinformed decisions and

harm patient trust (Volpato et al, 2021). Physicians recognize capacity strain from the aging U.S. population will require automation to treat more patients without reducing quality; “With our aging baby boomers, we’re going to run out of space... If we can do it safely, and with high quality to provide the best experience, it’s how the medical community and the future of healthcare survive in this country” (Oldenburg, 2022). The National Alliance for Caregiving (NAC) provides resources and advocacy for U.S. caregivers. The NAC recognizes the potential benefit of automation in bettering caregiving quality, but recommends more insight into caregiver needs (Adler & Mehta, 2014). They emphasize that technology alone is not a solution and effective support systems for caregivers are needed.

The Medical Device Manufacturers Association lobbies for device manufacturers and those with a financial interest in the industry. It promotes relaxing regulations on use and payment collection for telehealth and remote monitoring devices for patient care (MDMA, 2020). The group broadly advocates for wider use and increased profitability of automated healthcare devices. Their stated mission is “to ensure that patients have access to the latest advancements in medical technology,” through advocating for device manufacturer compensation (MDMA, 2020).

Further research would analyze how remote monitoring devices have evolved and identify industry trends. Characterizing device manufacturers’ attitudes towards interpersonal caregiving through design should also be explored.

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