Research Proposal: Participatory Modeling for Societal Complexity in Healthcare

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Introduction

The increasing complexity of healthcare systems, especially in addressing aging-related challenges, necessitates innovative approaches for developing sustainable and effective policies. **In silico models**—computational simulations of real-world phenomena—offer an unparalleled opportunity to understand, predict, and optimize healthcare processes. However, the successful deployment of such models requires an in-depth understanding of **societal complexity**, encompassing stakeholder dynamics, institutional constraints, and incentive structures.

This research aims to bridge the gap between advanced computational modeling and its real-world application by leveraging **participatory modeling** approaches. These approaches bring together diverse stakeholders to collaboratively develop models that reflect societal and systemic nuances, ensuring both accuracy and usability.

Research Objectives

1. **Develop a Participatory Modeling Framework**
   Create a research protocol that captures the agency complexities, structural hindrances, and incentive dynamics in healthcare systems, with a focus on adopting in silico models at the hospital level.
2. **Model the Societal Complexity of In Silico Model Deployment**
   Design a **System Dynamics Model (SDM)** to simulate interactions between stakeholders, such as clinicians, hospital administrators, and policymakers. The model will explore:
   - Barriers to model adoption.
   - Strategies for incentivizing uptake.
   - Policy implications for healthcare delivery optimization.
3. **Validate Participatory Methods and Policies**
   Develop actionable policies through participatory workshops and validate the outcomes with real-world stakeholders and data.
4. **Impact Evaluation**
   Measure the effectiveness of participatory modeling in driving the adoption and success of in silico models within healthcare organizations.

Research Methodology

1. **Literature Review**
   Conduct a systematic review of participatory modeling and in silico applications in healthcare to identify best practices and gaps in current approaches.
2. **Stakeholder Engagement**
   - Collaborate with clinicians, administrators, and patients to co-develop models.
   - Utilize workshops, interviews, and surveys to gather qualitative data.
3. **Model Development**
   - Use **System Dynamics Modeling (SDM)** to represent societal and organizational complexities.
   - Integrate Hidden Markov Models (HMMs) to capture uncertainties in stakeholder behavior and decision-making.
4. **Validation and Refinement**
   - Perform validation against real-world case studies at Karolinska University Hospital.
   - Iterate the model based on stakeholder feedback and data analysis.
5. **Policy Recommendations**
   - Propose evidence-based policies for facilitating in silico model adoption.
   - Evaluate recommendations during the planned secondment at VU Amsterdam.

Year Planning

Year 1: Foundations and Exploration

- Conduct a comprehensive literature review on participatory modeling and in silico models.
- Engage with initial stakeholders to map societal and organizational complexities.
- Develop a preliminary framework for participatory modeling.
- Begin technical modeling work, focusing on System Dynamics Modeling (SDM) as a foundational approach.

Year 2: Model Development and Stakeholder Engagement

- Finalize the initial System Dynamics Model based on stakeholder feedback.
- Incorporate Hidden Markov Models (HMMs) to address behavioral uncertainties.
- Conduct participatory workshops with stakeholders to refine and validate the models.
- Planned secondment to VU Amsterdam (August, 6 months): Focus on institutional dynamics in healthcare organizations and refine participatory methods.

Year 3: Validation and Policy Development

- Apply models to case studies, particularly at Karolinska University Hospital (April, 4 months).
- Test and validate policy recommendations with real-world stakeholders.
- Refine models and outputs based on validation results.

Year 4: Dissemination and Finalization

- Publish findings in peer-reviewed journals and present at international conferences.
- Finalize a robust participatory modeling protocol and validated policies for in silico model adoption.
- Complete and defend the doctoral thesis.

Expected Outcomes

- A robust participatory modeling framework tailored to healthcare contexts.
- Insights into stakeholder dynamics and barriers to in silico model adoption.
- Actionable policies for hospital-level deployment of in silico models.
- Contributions to the broader academic discourse on participatory modeling and healthcare optimization.

Significance

This research aligns with the objectives of the **InSilicoHealth doctoral network** by addressing challenges in deploying in silico models for healthy aging. By incorporating societal complexity through participatory methods, the project seeks to ensure that these models are not only technically sound but also socially viable and impactful. This work has the potential to revolutionize how healthcare organizations adopt computational tools to enhance patient outcomes and operational efficiency.

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17th November 2024