eGuardian Angel

Socialising health burden through different network topologies: A simulation study

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Introduction: Guardian Angel
Social Innovation: eGuardian Angel

— Community Building: Socialising Health Burden
Literature and Related Work

  – Provide borderless support networks
  – Reduce stigma of disease

– Social Contagion [Christakis and Fowler, 2013]
  – Ability for one individual to influence the health behaviours of one or many others in a social network
  – Indirect influence

– Homophily [Mcpherson, 2001]
  – Social networks develop between individuals with similar diseases or traits
  – Homophilous ties are durable and resilient

  – Patient centred to include them in their own decision making and reduce data fragmentation
  – Contact with other patients with similar diseases, cultures, economic backgrounds, symptoms, etc.
Aim

- Gain understanding into how different social network topologies can affect the distribution of benefit from a social messaging health intervention for specific chronic disease
  - Agent-based model simulation used to identify the network that minimises disparity between agents in the network
eGuardian Angel (agents)

- Social innovation for individuals with chronic disease, who’s social connections assist them in keeping motivated to reach health goals

- Guardian
  - Provide motivation, support, advice to ‘child’
  - Help achieving diet, exercise, physical activity, and health related goals

- Child
  - Provides feedback to guardian if they are positively affected by their message
Parameters

— Motivation
  — From others
    • Complete exercises, maintain weight, medication adherence
    • Based on theories of social contagion, dynamic network theory and goal pursuit [4,8,9]
  — From external sources (environment)
    • Family, other health interventions, financial incentive

— Positivity
  — Reflects mood, attitudes, and emotion toward a situation
  — Theoretical measure of how much influence a guardian has on their child

— Goal: Improve group level motivation and positivity and display the lowest variation between individual nodes
  — Provide greatest benefit to all
Simulation Design (Diffusion Model)

Environment: Normal distribution $\mathcal{N}(m(t - 1), 5)$

Motivating Message: $m(t) = m(t - 1) + \left( \frac{\text{Message Factor} \, p_g(t-1)}{\text{number of children}} \right)$

Transfer: $p(t) = p(t - 1) \cdot \left( \frac{\text{Transfer Factor} \, p(t-1)}{p(t-1)} + 1 \right)$

Feedback: $m(t) = m(t - 1) + \left( \frac{p_c(t) - p_c(t-1)}{\text{number of guardians}} \right) \cdot \text{Feedback Factor}$
Simulation Tool

Simulation

- NetLogo [7]
  - Agent-based programming language and modelling environment
  - Agents interact depending on defined formulas and variables
    - Functions based on the theoretical concepts of social contagion, homophily, and social network dynamics.
- Cost effective
- Test before full scale implementation
- Identify emergent properties (expected or not)
Network Topologies

Simulated Networks (N-K Landscape)

- Random: User connected to at least one other at random
- Paired: Two users mutually connected to each other
- Ring: Users connected in series in a closed loop
- Small World: n of connections rewired from ring topology
- Example N = 8, K=2 influence Matrix
Results: Social Dynamics (20 agents)
Results: Variability

- Lowest standard deviation: Ring network
- Paired, Random, and Small World networks had higher standard deviation
  - Less interconnectivity, unequal distribution of edges

![Graph showing standard deviation of motivation over time for different network topologies. BUD: Paired network, RING: Ring network, RAND: Random network, Small-World: Small world network.](image)
Discussion

- Ring network most successfully socialises the burden of disease
  - Indirect connections with all other nodes chain effect of influence
  - Nodes with inherently higher motivation were able to help others to benefit
  - Increasing disorder from the ring network increases the disparity between individuals in the network
Limitations & Conclusion

- Transfer functions based on theory & limited knowledge
  - Limited empirical evidence due to difficulties quantifying social contagion principles
  - The model can’t be empirically validated - networks can only be used in comparison with each other
    - useful for displaying trends and emerging patterns based on theories of social influence and mood contagion

- Future research
  - Clinical trial for Guardian Angel intervention
  - Managing Network sustainability
  - Network evolution

- Conclusion
  - Add to current literature to correctly implement alternative and effective healthcare solutions for the future
  - Network topology must be considered when implementing a social network based intervention
  - Social “role” can be considered as part of the intervention in social networks
References


