

On the role of cross-disciplinary research and SSE in addressing the challenges of digital society

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ABSTRACT

Today we live in a world that ...

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous;
D.2.8 [Software Engineering]: Metrics—*complexity measures, performance measures*

General Terms

Theory

Keywords

Social Software Engineering (SSE), Cross-Disciplinary Research (CDR), challenges, digital society

1. INTRODUCTION

The ongoing, extremely rapid digitalization of society, i.e. the increasing use of digital technologies is changing every aspect of society. Infrastructures, numerous online artefacts, and a fast-growing amount of data generated by people, transaction systems, sensors, etc. is changing the way we work, study, associate, and live our everyday lives. This creates opportunities for positive social and business development where new knowledge can lead to efficiency and higher quality in many processes in our society. For example big data has been pointed out by World Economic Forum [7] as an opportunity for third world development, creating new opportunities in areas like health, education, and finance.

The digital technology is already playing an important role in meeting a number of existing global challenges, and its contribution is expected to grow further. For example digitalization will play an important role in helping us meet environmental challenges - providing data describing the state of the environment, climate, resources, including water and precious metals, enabling smarter and efficient resource management. With digitalization the society will also move towards more circular business models of service delivery

rather than goods, thus mitigating the current wasteful use of scarce resources.

However, the explosive expansion of digital technologies and data being collected either actively by consent or passively via sensors poses a number of challenges [10]. If treated right, data access and management can contribute to the empowerment of marginalized groups; if treated wrong it will contribute to a digital divide, compromising security, innovation, and openness.

In this paper we contend that Cross-Disciplinary Research (CDR) and Social Software Engineering (SSE) have an important role to play in addressing the challenges of digital society. We list some of the important challenges society is likely to be confronted with as we move further on the path of digitalization followed by discussion over how cross-disciplinary research and SSE can help us attend to these challenges.

2. CHALLENGES OF DIGITAL SOCIETY

The rapid digitalization of society on one hand is creating number of opportunities, but on other also raises a number of challenges for society to deal with, these could be categorized broadly into:

- technological,
- legislative,
- organizational, and
- ethical.

Some of the challenges of increasing use of digital technology within our society is projected to have far reaching implications, Dirk Helbing [5], provide some examples:

- **Problems with big data analytics:** major challenges highlighted include security, cyber crime, possibility of cyber wars, mis-belief on ability of big data effectiveness, and privacy.
- **Problems with artificial and super-intelligence:** with exponential rise of computing power and predictions of reaching “singularity”¹ within foreseeable future - problems of over-fitting leading to incorrect knowledge or predictions can lead to serious consequences. Also deep concerns are raised for scenarios

¹Singularity refers to time at which artificial intelligence reaches the level comparable to human brain

when such artificial and super-intelligence is infected with viruses or hijacked by people/group striving for power.

- **Problems with manipulative (“persuasive”) technologies:** society wide experimentation with manipulative technologies can undermine the principle of “wisdom of crowds” further undermining the basis of democracy and financial markets. Further issues such as “filter bubble”, behaviour manipulation leading to collapse of diversity can be the undesirable outcomes of widespread use of persuasive technologies.

Increasing collection of personal and user generated data is already raised concerns of privacy and security [9]. An increasing use of robotics and artificial intelligence is likely to bring disruptive changes to the labour market; It is not far-fetched to imagine that routine jobs will disappear and more complex jobs in future will demand more complex competencies. Such scenarios raises vital questions, for e.g. - How can we avoid mass unemployment? How will education systems cope with the demands for new competencies?

An increasing use of robots and sensors, an increasing collection and use of data to provide services, will need new systems of rules and regulations both at work places, in traffic, health services, education, homes, and on the consumer market. How can old systems of rules and regulations be adapted to support innovation and development of new solutions? How can new systems be developed to protect citizens from negative effects?

We argue for the need to formulate such questions & critique that contribute to a deeper understanding of the challenges in order to avoid risks and hazards for individuals, groups, and society at large. Such global and local events as financial crises [8], spread of diseases [7], or failures of newly formed businesses [3] can be identified, predicted, and potentially prevented or mitigated if sufficient quantity of high quality data is available along with the competence on how to use it [1].

3. CDR, SSE, AND THE CHALLENGES OF DIGITAL SOCIETY

3.1 Cross-Disciplinary Research

To meet the challenges of digitalization we need innovations, legislation and strategies to support us in building an inclusive digital society. To understand the complexities of global challenges of digitalization of society, formulate and implement effective solutions would need a multidisciplinary focus, engaging computer scientists, information systems, social scientists, and expertise from humanities.

The goal of such CDR would be to combine these disciplines to support the development of an inclusive digital society and prevent the devastating consequences by conducting research and education projects in collaboration between individuals, businesses, researchers, and non-governmental organizations. The projects will cut across disciplines in order to address the challenges and include the different types of actors (e.g. researchers, individuals, companies) in order to maximize the impact of the results on the society.

The value of CDR aimed at understanding and addressing challenges of digital society would contribute with innovative, reflective and actionable input to societal challenges we face today as well as ones we are likely to face in future. A possible way of structuring such CDR is represented in Figure 1, with cross-cutting themes such as data handling, openness & quality, legislation, organization and ethics, and crowd-sourcing [6] and citizen science [2]. These themes intersect with focus areas such as finance and consumer behavior, smart and safe mobility, digital innovation and personalized and remote healthcare.

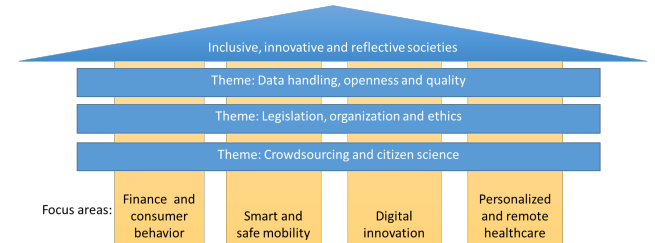


Figure 1: (I’ll Change this Picture!)An example of themes and application for CDR supporting digital transformation

3.2 Social Software Engineering

Hammouda et al. [4] defined SSE as “the application of processes, methods, and tools to enable community-driven creation, management, deployment, and use of software in online environments”. The social software engineering is frequently characterized for software/systems build with emphasis on the social side and usually are:

- **Community-centered:** the community rather than the individual is at the centre of software/system design,
- **Collaboration/collectiveness:** importance is given to either use collaborative nature of individuals to build the system and/or on how the software/system will be used,
- **Companionship/relationship:** the software/system is targeted explicitly towards social relationships,
- **Human/social activities:** the main or one of the main goals of developing a given software/system is to address social problems, and
- **Social inclusion:** the software/system is based on the principle of inclusion that enforces trust in communities and not build just to maximize profit for certain individual/organization.

The principles of SSE not only are useful for developing software and systems based on software that can benefit society, but they also provide a framework similar to Free/Libre and Open Source Software (FLOSS) that promote an open, collaborative, and inclusive system to solve problems society face.

3.3 The role of CDR and SSE

In order to illustrate how CDR and SSE may contribute towards addressing the challenge we provide a number of typical application scenarios:

- **Finance and consumer behavior:** Indebtedness and a large repayment burden coupled with low savings rates constitute a source of potential future insolvency, which will have detrimental effects on consumption as well as being an important precursor of financial crises. Utilizing CDR and applying principles of SSE will provide the possibility to collect data through crowd-sourcing, virtual communities, social networking services, and web-based economic experiments and surveys. Analytical applications designed to support interactive data visualization will be useful for identifying new patterns in consumer behavior and support decision making,
- **Smart and safe mobility:** Future metropolitan mobility solutions will include smart vehicles to assist human actors. How shall such systems for transportation be organized? Who shall own and run them? How can digital information infrastructure and associated services contribute to sustainable expansion of passenger and freight transport? The tool-set from SSE and more emphasis on cross-disciplinary work such as human-machine interface will promote generation of knowledge on how to capture, aggregate, process, and predict the data that is required to realize mobility and transportation solutions that are smart and safe,
- **Personalized and remote healthcare:** The spread of health-apps and others that are collecting activity data in wide variety of settings such as the home, workplace, sidewalk, jogging trail etc. can be understood as an example of how person-centered medical information is no longer bound to or developed in medical institutions, but have expanded into society at large. Such initiatives are particularly important in order to provide healthcare services in developing countries. SSE principles can help us to use such data for expansion of public utility (e.g. health) rather than use of such technologies and data for profit maximization,
- **Innovation and entrepreneurship:** Digital innovation and entrepreneurship are fundamental drivers in the digital society generating a multitude of technologies and services that we use extensively. Generative capacity is a vital component in processes of open innovation, and it is generativity rather than openness in it self that seem to drive innovation. In addition, CDR will assist us in addressing the important question i.e. how we affect technology and how technology affects us.

4. IMPACTS

4.1 Scientific impacts

The scientific impact of endeavours to identify and attempt to resolve serious issues surrounding highly digitalized society will naturally strengthen our knowledge and understanding of complex systems. It will also enhance our ability to deal with problems that warrant solutions involving cross-disciplinary themes (e.g. Data handling, openness and quality or Legislation, organization and ethics).

Research into the societal issues in digital environment would also require a great deal of interaction between research and education offering an opportunity for greater collaboration

between academia, industry, and society for orchestrating close collaboration between researchers, students, and practitioners to help address challenges in practice and advance new theories. The proposed research by the virtue of its nature is also likely to promote collaboration of several research centers beyond the current collaborative landscape to access expertise from different areas needed to tackle global multi-dimensional challenges.

Our efforts to understand the deeper issues surrounding the digitalized society will lead us into more and better comprehension on human nature itself, how societies should be organized and what matters to us. The attempts to solve the associated challenges using CDR and SSE principles among others will bring us closer to each other and advance our competence in dealing with large and complex problems.

4.2 Impacts on Education

The digitalization itself and proposed research agenda will also impact on the content and delivery of education:

- Greater collaboration across international researchers on issues around digitalization of society, would lead to better use of digital technologies in- & out-side of classroom,
- The new awareness and knowledge created on the associated issues is likely to be combined into new courses and programmes that would be used to educate the next generation on such important issues,
- These new courses and programmes will also equip the succeeding generation(s) with skills that would be needed for new types of jobs as well as equipping them to use the digital technology to solve further societal problems,
- As the society and our education system get more digitalized, the understanding we will draw from CDR and SSE will also help us optimize the online education systems to meet the goals of society. For example moving further in direction where the educational resources are more open, free, and distributed on principles of inclusion (e.g. licensing under creative commons).

4.3 Impacts on Society

There are substantial positive benefits for society from being more digitalized. If we are able to tackle the challenges that arise from this transformation, then the adverse effects can be controlled. By analysing and preparing upfront for challenges from diverse perspective and building the digital technological solutions following characteristics based on SSE - the society would maximize the benefits of novel ICT applications enhancing further the interaction between individuals, businesses, and other organizations.

The CDR, education and community created with the spirit to remove informational and technological barriers will contribute towards developing an ecosystem that will help society make progress on multitude of significant issues such as:

1. a sustainable financial system,
2. safe mobility solutions,
3. more efficient health care, and

4. better commercialization of new ideas.

And solutions that better address these issues will have broader impact on society. The knowledge, awareness and community created around these issues will empower:

- **Citizens:** enhanced understanding of consumer behaviour when utilized in right manner will lead to development of methods and tools to empower citizens to manage and achieve their long term goals (e.g. health, savings, enriched relationships, happiness etc.).
- **Businesses:** with our improved understanding of challenges we face and data that will be more open and public - businesses can leverage their resources to provide better solutions to the problems through innovation and more collaboration as that would also lead them to make more profit.
- **Policy makers:** collection and analysis of open data and collaboration between researchers from different fields will highlight which policies lead to meaningful results thus guiding our policy makers. As many governments already support number of initiatives aimed at digital transformation of society, CDR and principles of SSE can help highlight further the challenges the society is likely to face and also provide possible effective solutions helping to frame policies aimed at maximizing social welfare.

5. CONCLUSIONS

The human society in a short span of time has seen many transformations, for example agriculture and industrial revolution that transformed the society in number of ways....

6. ACKNOWLEDGMENTS

The work presented here has been in part funded by Vinnova and Volvo Cars jointly under the FFI programme (VISEE, Project No: DIARIENR: 2011-04438). We also extend our sincere thanks to all participants of UGOT proposal "Digital Society Center (DigSoc)" at University of Gothenburg for their inputs and discussions.

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