# Computational Social Systems

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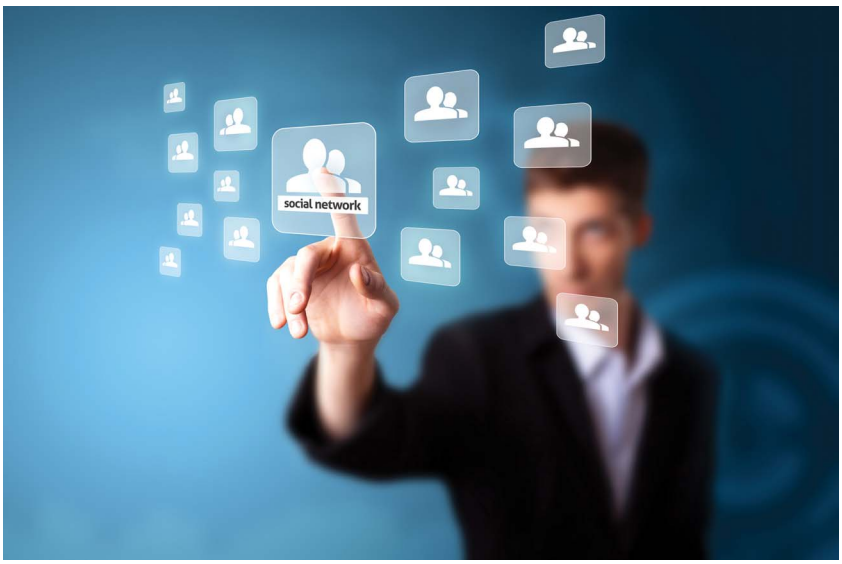


The last 50 years has been a particularly rich time in the development of technology that has affected societal interaction, and which is leading to changes in society's fundamental underpinnings and how we interact with each other. We have seen the advent of the Internet, wireless communications, GPS, mobile applications technology, as well as cloud computing. In addition, there have been major advances in computer architecture and computing power, as well as the development of a number of other critical technologies (such as social media).

This underlying technological infrastructure has provided the means to research and develop new methods, models, and analyses for a wide variety of phenomena spanning the physical, biological, and social sciences. The blending of approaches from engineering and these scientific disciplines has resulted in significant insights and knowledge, particularly, in computational physics, biology, medicine, and chemistry.

## I. COMPUTATIONAL SOCIAL SYSTEMS

Turning our attention to the area of computational social systems, it is fair to say that this has been a relatively new field that has only recently gained traction as a research field spanning engineering, computing, and the sciences, including most importantly social sciences. The inclusion of social knowledge into modeling, simulation, and analyses can be seen from the advancements in social networks analysis, network science, data mining, and other areas [3]. Furthermore, the richness of social information can be especially seen in the last few years with the advent of social media technologies, Web 2.0/3.0, mobile app technology, and cloud computing. Without a doubt, this is one of the most exciting emerging fields, and the underlying technology has engaged the public's interest and imagination, especially through the day-to-day use of social media. Researchers are focused on a wide variety of topics including (to name a few) modeling financial markets, understanding disease spread, determining the effects of catastrophes and crises, uncovering covert activities, evaluating political stability, predicting elections, and determining the nature of "viral" media. Clearly, interest in such work can be found among various groups spanning corporations, governments, health organizations, defense, advertising/marketing firms, and many others [1], [2].

However, this field is still in its nascent phase due to a variety of issues. This includes the fact that in the social science field, there is a wealth of disciplines (e.g., economics, anthropology, sociology, psychology, political science) with theories, data, and statistical analyses which have yet to be more fully explored and/or incorporated effectively into areas such as computational representations, modeling, simulation, and/or analyses. In fact, a number of current computational approaches suffer from an oversimplification of human behavior, be it at the individual/group/organization/nation-state. Moreover, there has been little in the way of determining

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whether the simplifying assumptions match reality. This is due in part to the lack of standardized data sets for modeling and analyses. As such, while these approaches may provide initial insights into gross likely outcomes, further investigation is required in modeling and understanding in-depth human behavior beyond aggregate behavior. This stems in part due to the complex, adaptive, and dynamic nature of human behavior and the multiscale information needs for effective modeling and/or analyses. Also, behavior is based on social and cultural attitudes that are particularly difficult to incorporate. Furthermore, different from other, more classical computational fields (e.g., physics), determining how and when to represent such socio, cultural, or behavioral theories from the social sciences (especially such as anthropolgy or sociology) computationally has been problematic.

## II. THE FUTURE

The next 50 years should see ongoing advancements in computational social systems research. Incorporation of social science theories and methodologies should continue to be an area of worthwhile investigation. Of particular importance is the determination of which social theories/data are relevant to the scenario being modeled, simulated, and/or analyzed. At issue is the fact that a number of social theories are not readily convertible into a general computational representation. Without a doubt, there is a high-activation barrier in understanding between computational science/engineering and the social sciences. This needs to be scaled in order to more fully actualize capabilities and advance research.

Data in this field are both overly rich and overly poor. On the one hand, there is the potential to obtain data on behavior, cultural ideology, and social interactions that can be tagged with temporal and geospatial information. On the other hand, there are scenarios in which, due to the dynamic, emerging situation, reliable information may not be readily obtainable (this can be seen during natural disasters, such as those that occurred during Hurricane Katrina, or during times of rapid political and social change that have occurred through different parts of the world, such as the Arab Spring). As such, work needs to be done to determine the appropriate use of information based on its reliability, timeliness, and/or completeness.

Much focus on computational social or cultural modeling is not only on average behavior but also on outlier behavior. This requires the need for specificity in a domain that is ever adaptive and changing within a multiscale environment. Also, dynamism, cultural view, and attitudes shape behavior and are a critical part of effective computational social systems. All these topics are areas of worthwhile research and development.

There are and will continue to be a multitude of approaches developed in computational social systems. While some have already focused on creating a simple model fusion, this is unlikely to be productive and research must be done to determine how to move beyond this to true integration of models. Determining how to span and incorporate the spectrum of approaches in a principled manner will become one of the critical problems for the field, and critical work must be done in this arena.

This is but a small list of areas requiring further work. The field is currently at a truly fascinating and exciting time of development. The potential is clear but the building blocks are still being constructed and the next 50 years should see a wealth of new and hopefully unexpected research, results, and capabilities in computational social systems. ■

## REFERENCES

[1] National Research Council, *Applications of Social Networks Analysis for Building Community Disaster Resilience: Workshop Summary.* Washington, DC: National Academies Press, 2009.

[2] National Research Council, *Sociocultural Data to Accomplish Department of Defense Missions: Towards a Unified Social Framework.* Washington, DC: National Academies Press, 2011.

[3] D. Lazer, A. Pentland, L. Adamic, S. Aral, A.-L. Barabási, D. Brewer, N. Christakis, N. Contractor, J. Fowler, M. Gutmann, T. Jebara, G. King, M. Macy, D. Roy, and M. Van Alstyne, "Computational social science," *Science*, vol. 323, no. 5915, pp. 721–723, Feb. 6, 2009.