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Social Terrain Modeling: A four-stage framework for Army research

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CONCEPT PAPER

In the near future, the Army mission will no longer be confined to on-the-ground operations but will extend across a multi-domain battlespace that is comprised of physical, computational, and social terrains. While analyzing and understanding the role of the physical terrain in the Army mission is a well-established area of research at Army Research Laboratory (ARL), computational and social terrains are novel constructs that have emerged from the explosion of information technology and global connectivity in the past several decades. As such, the Army is in need of new tools and capabilities for navigating these terrains in order to maintain superiority in multi-domain command and control (C2) of the future.

To begin addressing the above challenge, ARL formed a new research team called Social Terrain Modeling (STM). The goal of the team is to develop technology that illuminates, evaluates, and exploits the social terrain in the same ways that existing technologies utilize the physical terrain to ensure a tactical advantage. The framework of STM is to treat the social terrain as conceptually analogous to a physical terrain, and thus focus research efforts in four progressive stages that mirror those found in technology research for physical terrains. Figure 1 shows the four stages of the STM framework.

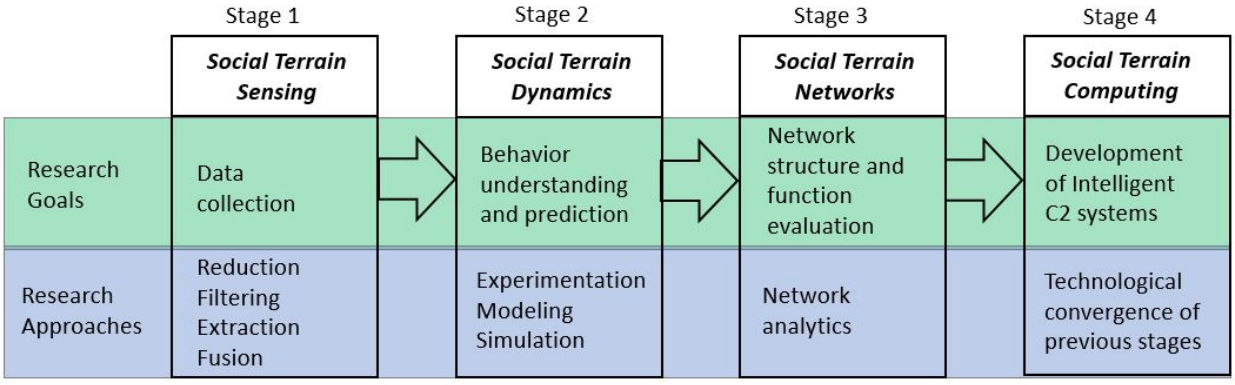

Figure 1. Four-stage Social Terrain Modeling (STM) research framework.

The first stage is the development of *social terrain sensing* technology that gathers and processes mission critical measurements and data about the social terrain. Social sensing technologies mirror the functionality of technologies like RADAR, atmospheric sensors, and laser range finders that provide information about the physical environment. In the social domain however, sensing technologies take the form of machine learning algorithms, dimensionality reduction techniques, and statistical analyses or models that extract information from social media platforms, big data

repositories, and human behavioral research. Social sensing is valuable for its ability to provide a visualization of the social terrain to Soldiers and Commanders, but also because it provides information about the social terrain that is critical for the remaining research efforts in STM.

The second stage of research utilizes information about the social terrain obtained from social sensing technology to construct models of *social terrain dynamics*. Similar to meteorological or spatial models of physical environments, models of social terrain dynamics capture important relationships between social agents, groups, and communities. As such, they can be used to make future predictions about the local and global behavior of these entities. Social terrain dynamics also provides a means of modeling the impact of Army operations on the social terrain which is critical for evaluating operational outcomes in the field.

The third stage of STM research is *social terrain networks* which is critical for evaluating and directing the sensing and dynamics models of the preceding stages. The outcome of the first two research directions is information about, and complex models of a variety of social entities whose actions are highly relevant for Army operations. These social entities are linked by directed lines of influence and communication that can be understood in terms of social networks. Whether they are observed in the wild (such as on a social media platform) or the product of design (such as in heterogeneous human-agent teams), understanding the interconnected behavior of these social entities in relation to the Army mission requires advanced network analysis techniques. Such techniques provide information about the behavior and performance of networked entities at the many different levels required in multi-domain battlespaces.

The final stage of STM research is the development of *social terrain computing* tools that leverage the three previous stages to produce intelligent operational systems. It is readily evident that current robotic, tele-operative, and command and control systems depend critically on physical sensor data and physical dynamics models. However, engagement in a multi-domain battle space means that such platforms will soon be equally dependent on the data and dynamics of the social terrain. Social terrain computing provides algorithms and methodologies for Army systems and platforms to intelligently navigate, exploit, and control the social terrain. The development of these computational capabilities is essential for command and control of heterogeneous teams of humans, computational agents, and robotic platforms.

In summary, the research of the Social Terrain Modeling team at ARL follows a familiar research framework, built around the needs of Soldiers who must successfully navigate and utilize their environment. In the past, these environments have primarily consisted of physical terrains. However, the terrain of the future is not just physical, it is also social. Nonetheless, successfully navigating and utilizing this new social terrain to support the Army mission requires the same crucial capabilities: sensing of the terrain, measuring and modeling of the dynamics, evaluating the influence and communication between entities, and developing computational technologies to exploit the data and models. Together, the four research directions of the STM team form a progressive staircase leading to a better equipped and more capable Army of the future.