Request for Information (RFI)
DARPA-SN-15-71
New Capabilities for Experimental Falsifiability in Social, Behavioral and Economic Sciences

Responses Accepted: Until 4:00 PM (Eastern) on October 16, 2015
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URL: http://www.darpa.mil/work-with-us/opportunities

The Defense Advanced Research Projects Agency (DARPA) Defense Sciences Office (DSO) is requesting information on and suggestions for research to develop novel methods, including new tools, platforms, techniques, and/or approaches, that could contribute to the development of unprecedented capabilities for testing the experimental falsifiability of (i.e., disconfirming) models, theories, and hypotheses in social, behavioral and economic (SBE) sciences. DARPA/DSO is interested in methods that ultimately advance efforts to test different theories and models at new scales to identify reliable and robust "first principles" of emergent behaviors and state transitions in different kinds of human social systems. Being able to identify any such first principles could significantly improve our understanding of the properties of resilient and adaptive social systems, i.e., systems that are likely to promote cooperation and coordination over conflict, and that are most effective at solving problems or distributing scarce resources. This understanding could also foster the creation of methods for optimizing effective human-machine systems, and/or methods for structuring and enhancing teams and organizations to lead to greater creativity, innovation, and productivity.

For the purposes of this RFI, "experimental falsifiability" is meant to highlight DARPA's interest in advanced capabilities that allow the SBE community to conduct experimental research at new scales, testing and predicting outcomes for different theories and models of causal processes that involve multiple variables at different levels of analyses (e.g., in different parts of the world and among different groups of people), in order to get a deeper, more predictive understanding of first principles underlying the wide variation in emergence of, and transition to, different states of human social systems. If successful, these capabilities will combine the strengths of two general research approaches in SBE, namely the correlational approach (usually associated with observational, longitudinal, descriptive and/or Big Data research) and the causational approach (usually associated with laboratory experimentation and/or modeling and simulation research). At the same time, these capabilities should seek to overcome some of the challenges of replication, reproducibility, and generalizability found in those two approaches – challenges that have contributed to the significant gap between SBE theories and models and the actual patterns of emergent behavior of social systems as documented in the real world.

It is expected that new experimental falsifiability capabilities will leverage recent and anticipated advances in sensors, computing, trans-media platforms, pervasive gaming design and deployment, modeling, data analysis, data security and sharing, data ownership and personally identifiable information (PII) protection, and dynamic visualization tools. Consequently, DARPA/DSO expects that that these capabilities would necessarily require a cross- or trans-disciplinary research effort involving the following Technical Areas (TAs):
        TA 1: Predictive Modeling and Hypothesis Generation

TA 2: Innovative Experimental Methods
TA 3: Analysis and Interpretation

Each TA is detailed below; however, responses need not be exclusively focused on a specific TA and may address any and all parts of this RFI. Furthermore, DARPA/DSO is also interested in receiving relevant responses that may demonstrate or identify fundamental limitations to these TAs, although responses should provide strong evidence for asserting those limitations. Respondents may also suggest ideas they believe are under-investigated and under-invested but could enable the desired transformative research capability envisioned in this RFI. Speculative concepts with insight into practical application are encouraged, especially where they represent a potential revolutionary advance over current capabilities. Responses that build upon speculative knowledge should explicitly state assumptions and presumed technological or methodological developments.

TA 1: Predictive Modeling and Hypothesis Generation
There is a growing awareness in many research communities of a wide range of potential biases in published literature, which are likely to be (negatively) impacting the ability to (1) formulate hypotheses or design models with predictive accuracy and (2) determine the most appropriate follow-on experimental questions or designs to (dis)confirm promising theories about first principles. Further, current approaches to modeling and hypothesis generation tend not to make predictions about the many-to-many nature of human social systems, where many different variables can shape many different kinds of social behaviors and state transitions. DARPA/DSO is therefore requesting information on innovative approaches to predictive modeling and hypothesis generation that may be able to (among other things):
   - Rapidly combine, incorporate and model data/results from both quantitative and qualitative research (e.g., combining automated event-coding with fresh approaches to incorporating ethnographic data) to make generalizable and falsifiable predictions of different kinds of emergent behaviors and state transitions in a wide range of social structures;
   - Generate falsifiable hypotheses and predictive models based on – or leveraging – insights, data and/or first principles from other disciplines (e.g., biology, chemistry, meteorology, zoology);
   - Make specific predictions of the effect sizes of one or more independent variables on one or more dependent variables, which are weighted for potential biases in the literature (e.g., small-study effects, selection models, excess significance, publication and potential file-drawer bias);
   - Produce falsifiable hypotheses regarding multi-layer causal processes of emergent – and shifting – behavior and relationships (e.g., cooperation, coordination, competition, or conflict) in different social systems, which may appear or disappear over time;
   - Identify specific theories, hypotheses, assumptions and/or models that are best candidates for "proof of principle" research using ground-breaking methods for experimental falsifiability.

DARPA/DSO is explicitly not interested in responses that are focused solely on modeling for modeling's sake, or that seek primarily to develop techniques for elaborating current models or bibliometric approaches that cannot generate empirically falsifiable hypotheses for experimental research at scale.

TA 2: Innovative Experimental Methods

Historically, the SBE community has generally been limited in its capability to conduct large-scale, replicable experimental research protocols that address questions of external, internal, and construct validity. With the advent of modern, pervasive communication tools, games, trans-media platforms, and affordable sensors, as well as greater connectivity and more computational power, there may be opportunities to overcome those limitations. DARPA/DSO is therefore soliciting input on novel experimental methods to conduct replicable, transparent and generalizable research on emergence and state transitions in human social systems. Such methods may include (but need not be limited to):

- Trans-media platforms, such as alternate or augmented reality, for conducting longitudinal geographically distributed studies that can engage sufficient numbers of participants to test multi-level hypotheses with sufficient power and diversity to characterize – and explain – variability;
- Designing and deploying studies that are narrative- or game-based that allow for the operationalization of a wide – and potentially varying – number of independent and dependent variables related to emergence and state transitions while increasing (and quantifying) participant engagement;
- Tools for enhancing informed consent processes, to include increased agility, updating, and interpretability of informed consent for experimental designs or approaches, potentially during the same study or cohort;
- Tools for allowing participants to feasibly own their experimental data, thereby allowing participants to choose whether to grant permission to researchers to use or re-use their data on a case-by-case basis;
- New apps or sensors – or new uses of extant apps or sensors – for capturing relevant behaviors (and/or other signals, e.g., physiology) as well as the context of those behaviors at new population and/or geographical scales, frequencies, fidelity, and/or over different time periods;
- Original or under-utilized platforms or tools to facilitate, enhance and/or lower the barriers to experimental replication (e.g., increase feasibility of, and time to, replication of any given experiment).

DARPA/DSO is explicitly not interested in responses that focus on platforms or studies that (1) cannot be reasonably scaled up due to cost, logistics, or facility-specificity (e.g., immersive training simulation platforms), or (2) cannot reasonably or ethically be adopted for experimental purposes.

TA 3: Analysis and Interpretation

In light of several widely recognized "crises" in reproducibility in a number of disciplines, there is increased appreciation for the importance – and challenges – of experimentally validating results and claims of accurate predictions of theories or models. Falsifiability is a key part of determining the reliability and generalizability of findings that can help identify first principles. One particular challenge to falsifiability is the increasing complexity of datasets and the appropriate analyses required to interpret them, which can be applied inconsistently in ways that limit their utility and/or their credibility for transformative social science research. Further, while there are a number of recommended "best practices" for promoting reproducibility in research, these are often unevenly adopted. DARPA/DSO is therefore seeking information on

new or under-utilized methods that may enhance the ability to evaluate the accuracy of predictions of specific theories or models, in part by facilitating the reproducibility, replication, falsifiability and – ultimately – interpretation of experimental results from studies dealing with complex, emergent human social behaviors. Such methods might include (but need not be limited to):

- Analytic methods for multi-modal, variable time-series datasets (potentially collected with quasi-experimental designs and approaches and large numbers of co-variates with non-linear relationships), as well as approaches for dealing with missing data in these datasets;
- Ways of quantifying different kinds of uncertainty in complex, multi-modal datasets related to research on emergence and state transitions in human social systems;
- Capabilities or approaches for pre-registering, comparing and quantitatively ranking a wide range of different models and social science theories that make different predictions for the same experimental question or design (e.g., Brier scoring and other methods for measuring accuracy and/or amount of surprising/novel information, quantifying return on investment, use of forecasting tools, incentive prizes, etc.);
- Visualization tools or approaches to communicating data or research related to emergence or state transition in human social systems, which will allow non-expert audiences to more accurately interpret results;
- Capabilities for protecting participant PII and other potentially sensitive data while enhancing data sharing to more effectively ascertain the reproducibility of results.

SUBMISSION FORMAT
As stated above, responses may address any part of this RFI. Respondents to this RFI are encouraged to be as succinct as possible, while also providing actionable insight. Responses are limited to 9 total pages (cover page + 7 page technical description + 1 page bibliography/references), unless respondents wish to include a one-page overview slide in Microsoft (MS) PowerPoint that graphically depicts the main ideas of the response for ease of communication, in which case responses are limited to 10 total pages (cover page + 7 page technical description + 1 page bibliography/references + 1 graphic overview page).

Format specifications for responses include 12-point font, single-spaced, single-sided, 8.5 by 11 inches paper, with 1-inch margins in MS Word or Adobe PDF format (and, as applicable, PowerPoint). Each submission must include a cover page which provides the following information:

   a. Title
   b. Organization
   c. Technical point of contact name, telephone number, and email address

SUBMISSION INSTRUCTIONS AND CONTACT INFORMATION
All responses to this RFI must be emailed to DARPA-SN-15-71@darpa.mil. Responses will be accepted any time from the publication of this RFI until 4:00 PM (Eastern) on October 16, 2015. Early responses are encouraged.

All technical and administrative correspondence and questions regarding this RFI should also be sent to the same email address. Emails sent directly to the Program Manager may result in delayed/no response.

DISCLAIMERS AND IMPORTANT NOTES

This is an RFI issued solely for information and new program planning purposes; it does not constitute a formal solicitation for proposals. In accordance with FAR 15.201(e), responses to this notice are not offers and cannot be accepted by the Government to form a binding contract. Submission is voluntary and is not required to propose to a subsequent Broad Agency Announcement (BAA) (if any) or other research solicitation (if any) on this topic. DARPA will NOT provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that DARPA is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI.

NO CLASSIFIED INFORMATION SHOULD BE INCLUDED IN THE RFI RESPONSE. Respondents are responsible for clearly identifying proprietary information. Responses containing proprietary information must have each page containing such information clearly marked with a label such as "Proprietary" or "Company Proprietary." DARPA will disclose submission contents only for the purpose of review.