AMERICAN STATISTICAL ASSOCIATION
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March 25, 2021

Dr. Bindu Nair
Director of Basic Research
Department of Defense

Dear Dr. Nair,

We write to request a discussion with you about engaging the statistical community in Department of Defense (DOD) basic research work. As the "science of learning from data, and of measuring, controlling, and communicating uncertainty,"[1] we believe more engagement of statisticians in DOD research will result in more robust science because of the importance of the statistical perspective; the benefit of multidisciplinary collaboration; and the fundamental role of statistics in artificial intelligence (AI), machine learning, and data science.

While the American Statistical Association (ASA) routinely advocates for the engagement of statisticians by research organizations—and encourages statisticians to engage with the various research organizations and in multidisciplinary research—reports that the Army Research Office (ARO) is cutting its program for supporting 6.1 statistics research at the end of this fiscal year are the impetus for this letter. If true, we understand none of the DOD branch research funding units—the ARO along with Air Force Office of Scientific Research and Office of Naval Research—would have programs explicitly devoted to funding statistics research. While we understand statisticians could still seek DOD 6.1 funding through other programs, we would appreciate the opportunity to discuss with you how DOD might benefit from more explicit support of statistics and engagement of statisticians.

Statistics has long been fundamental to DOD research and is more so now with the DOD work to become more data-driven as reflected, for example, through the DOD releasing a data strategy[2] and its engagement over the past decade of data science, machine learning, and AI. Not only is statistics foundational to these areas, as noted above, each

[1] "Why Statistics?", Marie Davidian and Thomas Louis, *Science*, **336,** April 6, 2012, p. 12.
[2] https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF

suffers without the high-level engagement of statisticians. For example, because machine learning methods tend to be algorithmic, they often do not adequately quantify uncertainty of the predictions they produce. Furthermore, because these algorithms act as black box models, they may not provide insight into the physical processes driving the outcomes.

The department is moving toward wide-scale AI adoption. Enabling adoption requires new research on assuring AI. Similar to concepts of quality assurance, where statisticians developed much of the fundamental research, statisticians are uniquely qualified to study and develop the fundamental field of research to enable AI adaption. AI assurance involves quantifying capabilities and associate risks across critical domains, including algorithm predictive performance, reliability, fairness, explainability, and security. Data quality, model performance, and environmental factors that may change over time affect the ability of AI to deliver consistent results. Statisticians can drive fundamental change and accelerate progress in this domain.

Statisticians have expertise in both developing models that use data to inform underlying processes and account for and describe uncertainty in estimates and predictions, and the discipline is integrating this expertise into the field of data science and its methods. The ASA and Computing Research Association statements on data science also emphasize the important role of statistics in data science.[3,4]

Emphasizing the importance of statistics to DOD, an ASA Section on Defense and National Security self-formed in 2004 and is a vibrant forum of 300 people. The section recently highlighted how statisticians have developed powerful analysis tools that help keep our nation safe.[5] The tools cover a range of topics, including attack prevention, cyber defense, biosurveillance, military research, and military force structure. Also, in 2018, the publication *CHANCE* devoted a special issue to how statistics is playing a key role in addressing various issues.[6] (We will have copies mailed to you.) An article by Laura Freeman and Catherine Warner, for example, titled, "Informing the Warfighter—Why Statistical Methods Matter in Defense Testing" (enclosed), explains how data and statistics are key to assessing the wide range of military systems in both developmental and operational testing.

To drill down on an example of ARO-funded statistical research benefitting the Army and DOD, consider the work of Georgia Tech Professors Chien-Fu Jeff Wu and Roshan Joseph Vengazhiyil that started in 2005 with the award, "Adaptive Designs for Sensitivity

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[3] ASA Statement on the Role of Statistics in Data Science, http://magazine.amstat.org/blog/2015/10/01/asa-statement-on-the-role-of-statistics-in-data-science/, 2015.
[4] Computing Research and the Emerging Field of Data Science, http://cra.org/data-science/, 2016.
[5] https://www.amstat.org/asa/files/pdfs/StatSig/StatSigNationalSecurity.pdf
[6] https://amstat.tandfonline.com/toc/ucha20/31/2?nav=tocList

Experiments and Related Problems." That and related work allowed statisticians and other researchers in the United States Army Combat Capabilities Development Command (CCDC) Armaments Center to develop a comprehensive suite of tools in R software that resulted in 3pod, an application that employs sequential sensitivity tests to estimate the probability a projectile will perforate a surface as a function of factors such as velocity and angle. That team also made implementation of 3pod sensitivity testing available to analysts and engineers across the Joint Services, NASA, Department of Energy, Missile Defense Agency, other government agencies, and medical industry.

The CCDC team has also used the Wu/Joseph sensitivity test algorithm for verification testing of munitions, developing and testing novel energetic formulations, and studying the lethality of munitions and the survivability of soldier-protective armor and equipment. In addition, they have consulted with US Air Force development teams to apply the test algorithm to one of their premier weapon systems, which resulted in marked improvements to the system's performance and reliability.

The Wu/Joseph work as developed and applied by the CCDC team is one example in which statistics research has helped solve critical problems for the Army and Joint Services. Advances in modeling and simulation (M&S) by the CCDC statistics group is another example of the fundamental importance of statistics to DOD. The M&S work, which introduces probabilistic analysis and uncertainty quantification, helps "reduce test costs, make design and manufacture more robust, develop resilient and reliable armament systems, and improve the transition of science and technology initiatives to program managers," according to an article in the Army publication *The Picatinny Voice*.[7] CCDC lead statistician Douglas Ray[8] further explained the major advance: "We can transition into a test phase from modeling and simulation quicker, strengthen predictions, and get better information about the system's capabilities."

We would be pleased to discuss with you the myriad ways statistics can benefit your DOD research. Thank you for your consideration.

Sincerely,

Kathy Ensor, 2022 ASA President

Lance Waller, Chair, ASA Committee on Funded Research

[7] "Picatinny statistics group pioneers new mathematical method to aid weapon modeling and simulation," Cassandra Mainiero, Picatinny Voice, August 2016. Also online: https://www.army.mil/article/174276/picatinny_statistics_group_pioneers_new_mathematical_method_to_aid_weapon_modeling_and_simulation.

[8] See also, "A framework for probabilistic model-based engineering and data synthesis," Douglas Ray & Jose Ramirez-Marquez, *Reliability Engineering and System Safety*, **193**, January 2020. https://doi.org/10.1016/j.ress.2019.106679.