

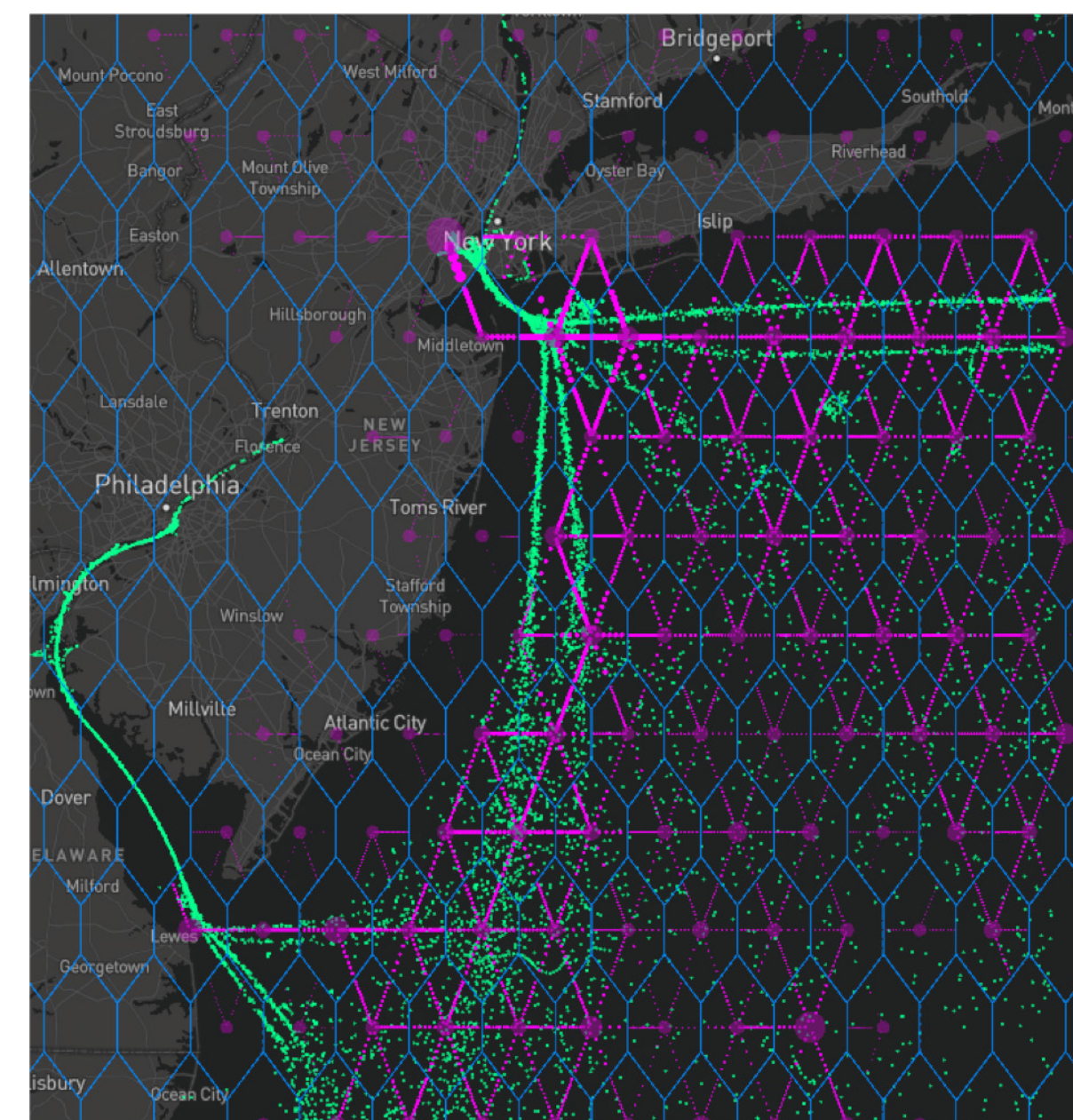
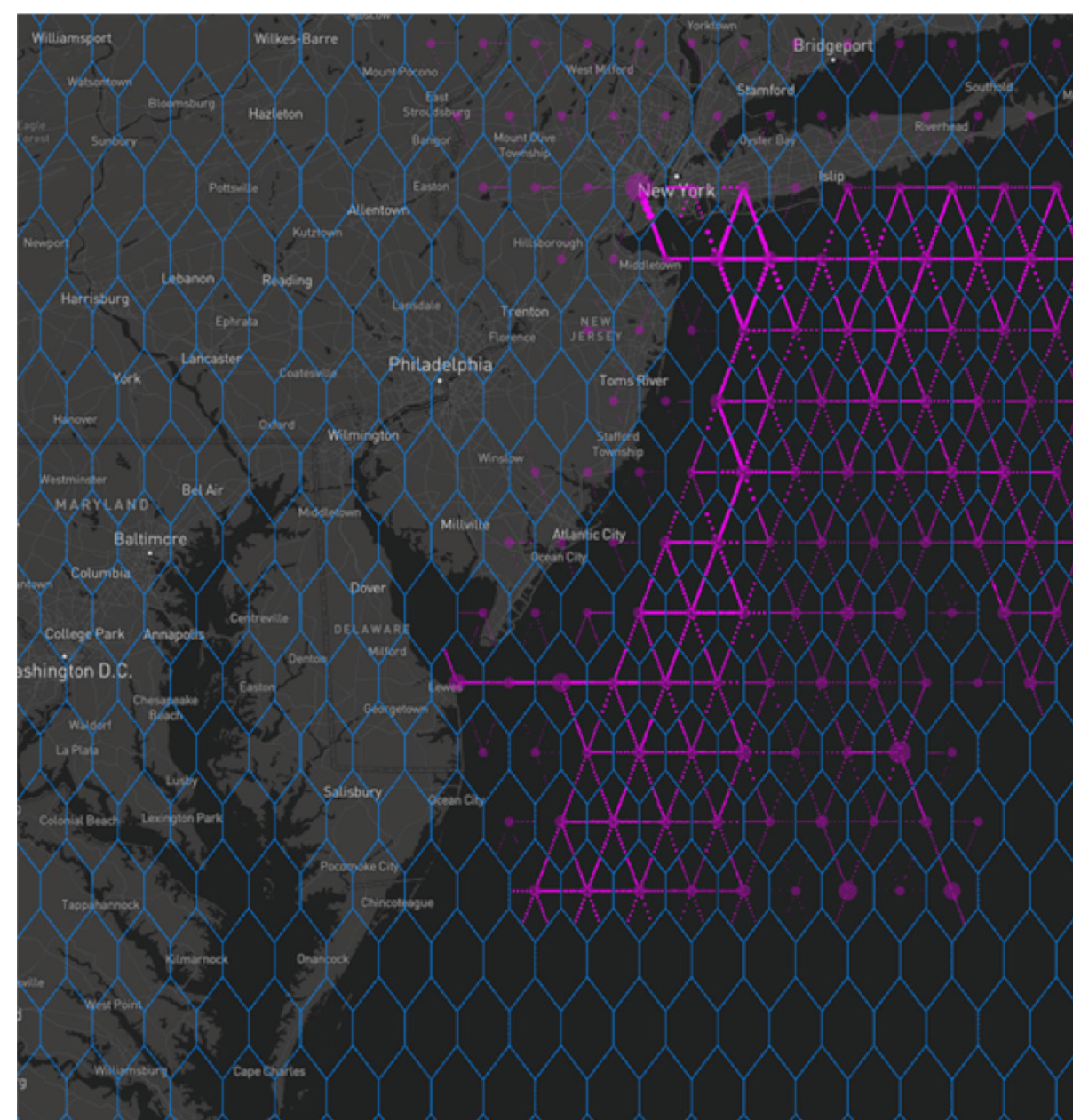
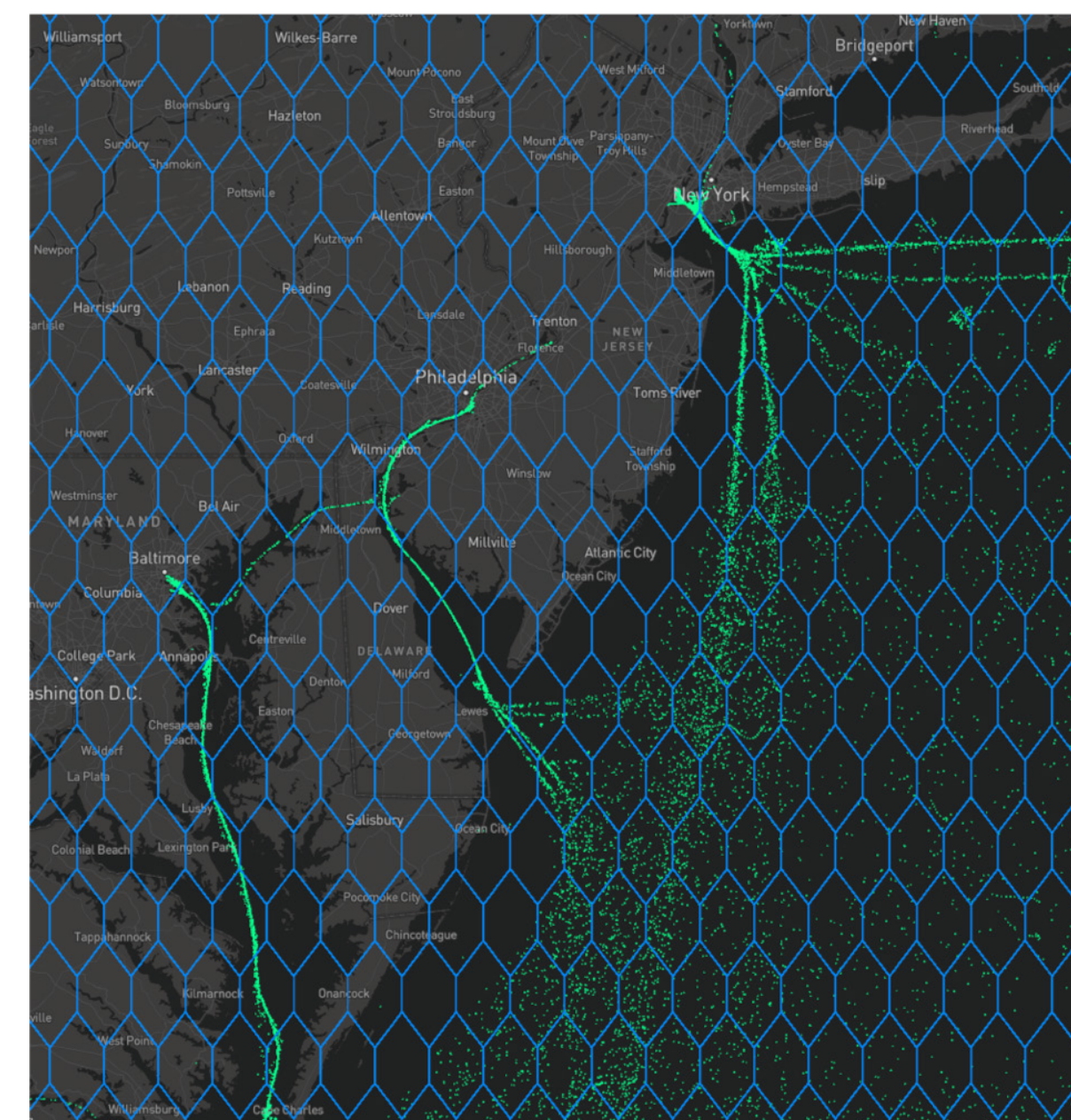
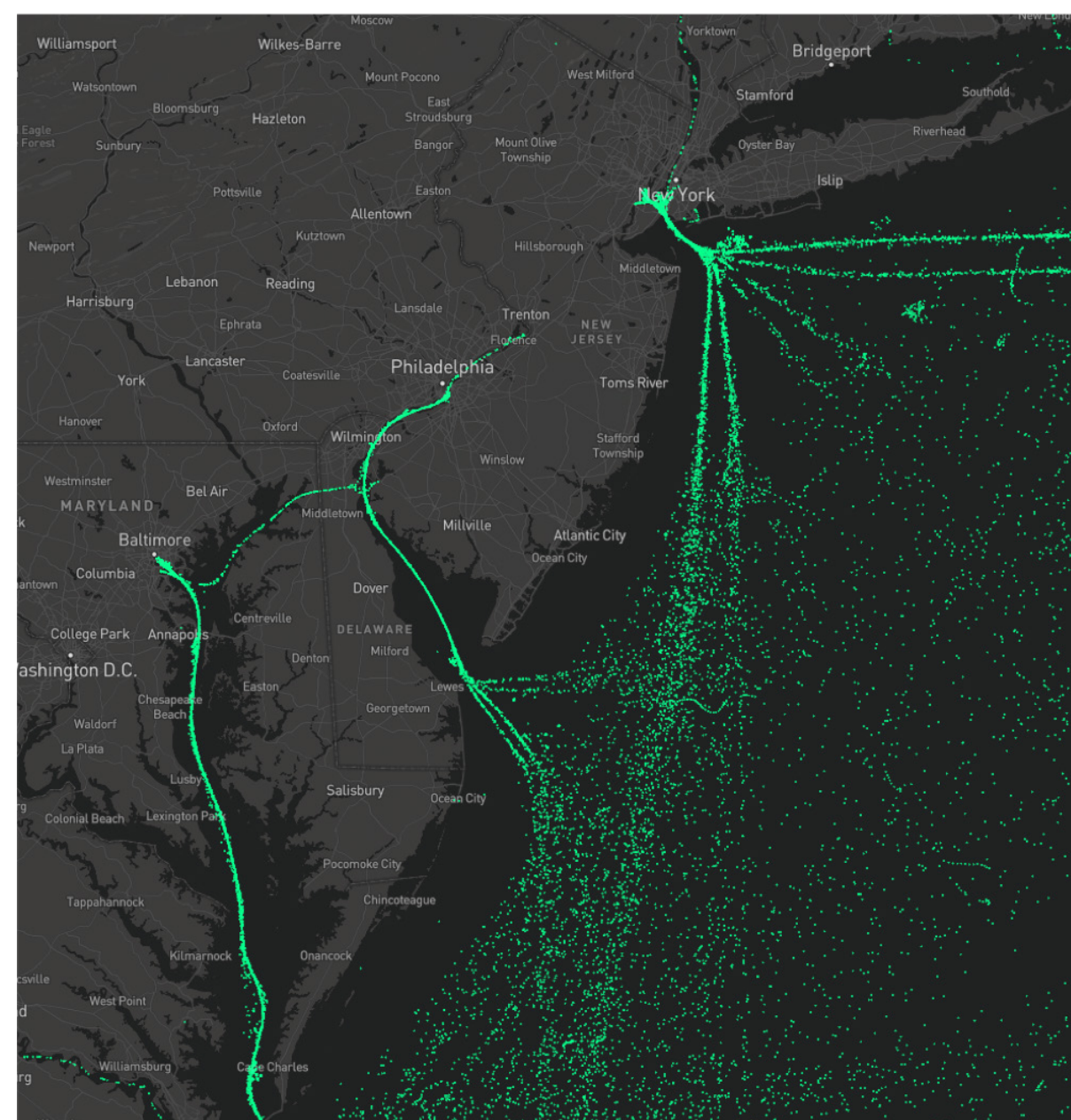
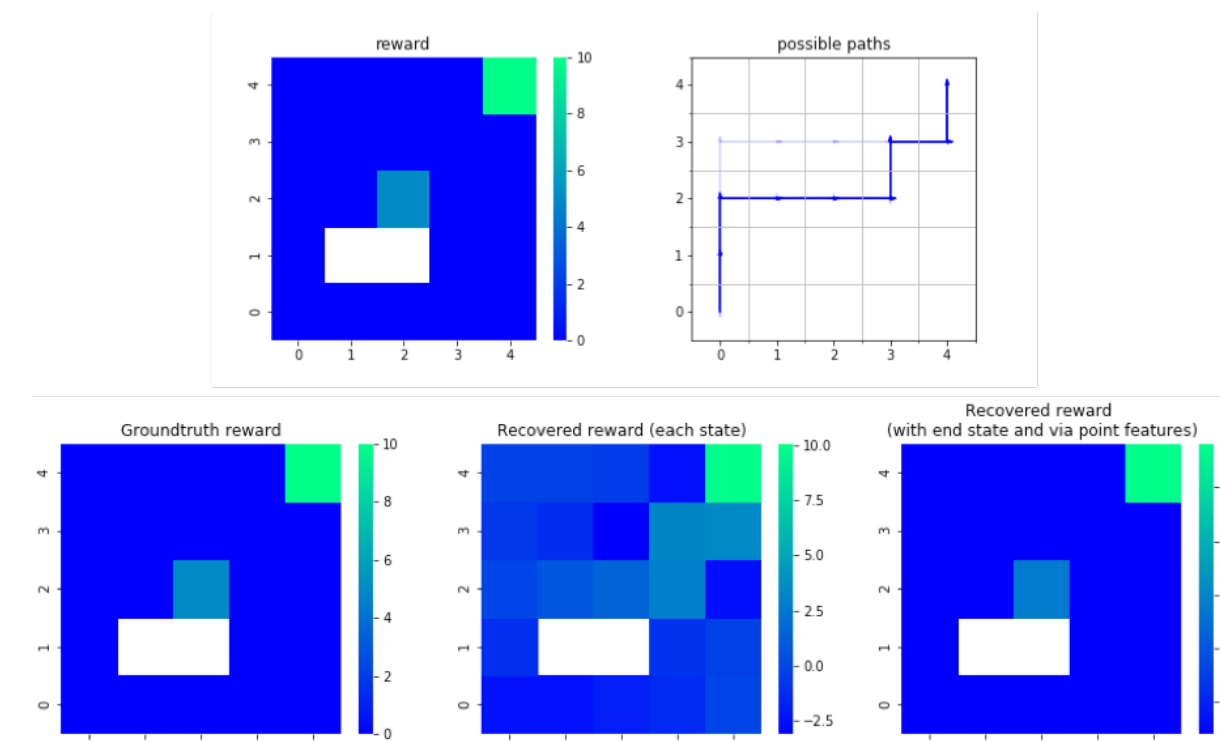
Modeling and Explaining Sequential Behavior

A Series of Unlikely Events and What Will the Robot Do Next?

Understanding sequential behavior is crucial to many defense-related tasks. Why did a drone make a sudden movement away from its destination? Why did a rover choose a certain path? Does a patrolling soldier's route indicate the presence of danger? Two SEI projects offer novel solutions toward modeling and explaining sequential behavior.

Identifying Unlikely Events

Current methods for identifying unlikely or anomalous events require labeled data about what constitutes an unlikely event and the time of human operators to verify predictions. We are using inverse reinforcement learning, an approach based in machine learning, which learns a statistical model of routine and anomalous actions that are taken from each state.



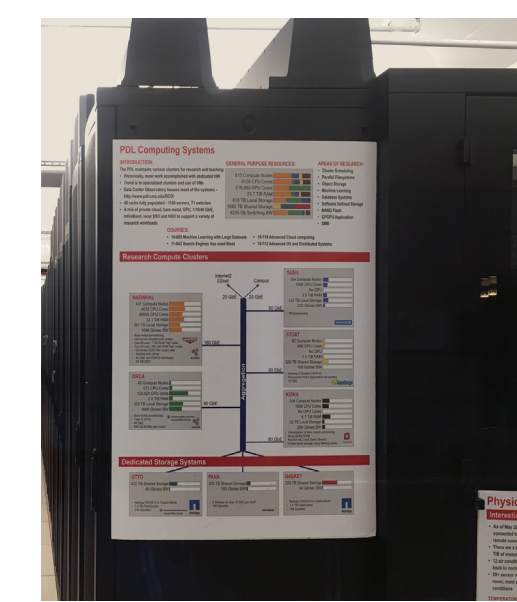
Modeling Ship Paths

Using publicly available Automatic Identification System (AIS) data collected by the U.S. Coast Guard, we use inverse reinforcement learning to model trajectories of marine vessels into New York Harbor. We can use these models to predict where vessels are going, find anomalous behavior, and potentially classify vessel type based on trajectory.



Future Work

In a collaboration with the Carnegie Mellon University Parallel Data Laboratory, we will use inverse reinforcement learning to model behavior of supercomputer users. This collaboration extends our work beyond predicting movements in the physical world and into domains such as cybersecurity, social networks, and more.



Prior Work: Explaining Robot Behavior

For human soldiers working with robot counterparts, being able to predict robot behavior ensures trust and supports human-machine teaming. Our "What Will the Robot Do Next" project has developed algorithms for robots to proactively adapt their behavior to enable users to predict what the robot will do next.



In an ongoing experiment, we are working to predict what people will focus on while performing a dual task: playing a simple video game and observing a Cozmo robot. We will collect dual task data from participants to compare to our predictive models.

Copyright 2018 Carnegie Mellon University. All Rights Reserved.

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

The view, opinions, and/or findings contained in this material are those of the author(s) and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

NO WARRANTY. THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

[DISTRIBUTION STATEMENT A] This material has been approved for public release and unlimited distribution.

Please see Copyright notice for non-US Government use and distribution.

Internal use:* Permission to reproduce this material and to prepare derivative works from this material for internal use is granted, provided the copyright and "No Warranty" statements are included with all reproductions and derivative works.

External use:* This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other external and/or commercial use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

* These restrictions do not apply to U.S. government entities.

Carnegie Mellon® is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

DM18-1142