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Predicting Trust in Automated Systems: Validation of the Trust of Automated Systems Test (TOAST)

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Executive Summary

The number of people using autonomous systems for everyday tasks has increased steadily since the 1960s and has dramatically increased since the invention of smart devices that can be controlled via smartphone. Within the defense community, automated systems are currently used to perform search and rescue missions and to assume control of aircraft to avoid ground collision. Until recently, researchers have been able to gain insights on trust levels only by observing a human's reliance on the system. So it was apparent that researchers needed a method of quantifying how much an individual trusts the automated system they are using.

We developed the Trust of Automated Systems Test (TOAST scale) to serve as a validated scale capable of measuring how much an individual trusts a system.

"Trust is a psychological state in which a person makes themselves vulnerable because they are confident that" the automated system is capable and reliable enough to complete the task (Nave 2015). This definition of trust, adapted to fit in the autonomy context, indicates that understanding the capabilities, limitations, and performance of a system is required for trust.

Humans inherently base their trust in automated systems on the amount of risk associated with failing a task. The fundamental differences in potential failure penalties and failure frequencies between automated systems require researchers to view trust on a scale dependent on an expected penalty score according to the system's accuracy level. A lack of either of these things should correlate with a person over-trusting or under-trusting the system.

Given the case in which the researchers have a complete understanding of the autonomous system and all plausible situations while the participants do not, it should be possible for the researchers to estimate the levels of trust. To address this, the nine item TOAST scale has two main categories of questions: Understanding and Performance, with four and five questions, respectively. So far, this scale has been initially validated to detect differences in trust among military-affiliated operators, and current research is focused on extending this validation to civilians.

Additional TOAST details and information about other scales for test and evaluation are available at https://testscience.org/validated-scales-repository/.

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Caitlan Fealing

April 27, 2022

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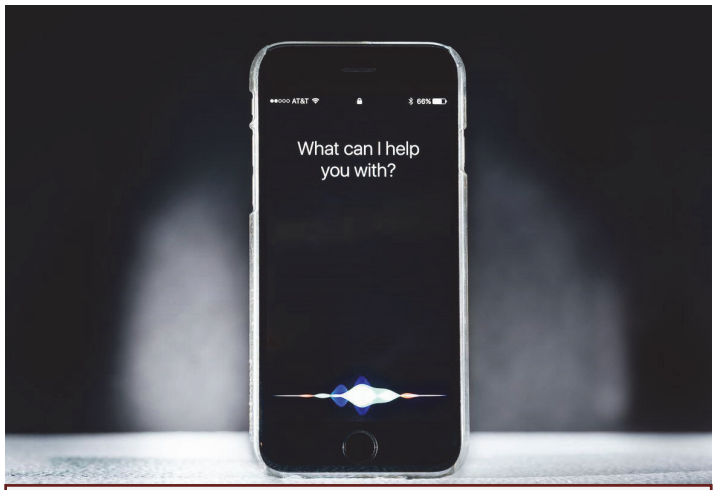
Trust is a key determinant of whether people will rely on automated systems

It is important to have a standard trust of autonomy scale so systems can be compared to one another

Trust of autonomous systems is a psychological state in which a person makes themselves vulnerable because they are confident that the automated system is capable and reliable enough to complete the task.[1]

[1]Nave, 2015; Button, 2017; Hoff, 2015; Lyons, 2016

Trust is dependent on risk level and cannot be adequately measured by observing reliance



Apple's Siri

Tesla's Autopilot

Less risk, low penalty

More risk, high penalty

- Sometimes the outcome is less risky, indicating less penalty for failure, but other times, failure can be catastrophic

- "Trust guides reliance when complexity and unanticipated situations make a complete understanding of the automation impractical."[2]

[2]Lee, 2004

The TOAST scale enables researchers to estimate levels of users' trust

TOAST decomposes trust into understanding and performance

TOAST Questions	
Understanding	**Performance**
• I understand what the system should do • I understand the system's limitations • I understand the system's capabilities • I understand how the system executes tasks Wojton, 2020	• The system helps me achieve my goals • The system performs consistently • The system performs the way it should • I feel comfortable relying on the information that the system provided • I am rarely surprised by how the system responds

Understanding a well-performing autonomous system is the key to the most effective human-machine teams

Key benefits of studying trust of autonomous systems are:

1. Better predictions of how people will accept new autonomous systems
2. An emphasis on creating more human-compatible systems for combat scenarios

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14. ABSTRACT
Within the defense community, automated systems are currently used to perform search and rescue missions and to assume control of aircraft to avoid ground collision. Until recently, researchers have only been able to gain insights on trust levels by observing a human's reliance on the system, so it was apparent that researchers needed a validated method of quantifying how much an individual trusts the automated system they are using. IDA researchers developed the Trust of Automated Systems Test (TOAST scale) to serve as a validated scale capable of measuring how much an individual trusts a system. This presentation will outline the nine item TOAST scale's understanding and performance elements, and how it can effectively be used in a defense setting. We believe that this scale should be used to evaluate the trust level of any human using any system, including predicting when operators will misuse or disuse complex, automated and autonomous systems.

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