Letter to the Editor

Editor:

I enjoyed reading Tom Dietterich's excellent article, based on his AAAI-2016 presidential address, entitled "Steps Toward Robust Intelligence" in the fall 2017 issue of *AI Magazine*. I think it is a very valuable thing that these addresses are published in *AI Magazine,* especially for those of us who missed hearing it in person. This letter is a footnote about robust (that is, artificial) intelligence.

As I remember, it was Michael Pazzani and I who coined the term *robust intelligence* when we were working up a new National program solicitation (NSF 05-551) in 2004. At that point, Pazzani and I were both serving as rotators at the National Science Foundation: he as division director of the Division of Information and Intelligent Systems (IIS) and I as a program director under him. With this solicitation, my official title became "Program Director for Robust Intelligence." We, together with other members of the RI Cluster, developed the RI material for the solicitation. (I eventually became the inaugural cluster lead.) RI continues to be one of the three core program areas in the IIS solicitation (NSF 17-572).

We were trying to encourage RI research directed at some of the issues that Dietterich is also concerned about. Some of these things like speech understanding, as Dietterich points out, have become great successes for the field. Others still elude us.

I thought your readers might enjoy seeing excerpts from that ancient program solicitation, appended below.

Capsule version:

> Robust Intelligence: systems with robust and flexible intelligence, capable of perceiving, reasoning, learning, and interacting with their environment.

The longer version from the section on RI:

> Robust Intelligence involves the theory, design, and implementation of general, integrated, intelligent perception and reasoning capabilities that are not constrained to address only a single problem in isolation or in one particular context. Systems exhibiting Robust Intelligence will be able to respond intelligently in novel situations, and to gaps, conflicts, and ambiguities in their knowledge and capabilities. Inspired by the flexibility and generality of intelligence in people and animals, Robust Intelligent systems will be able to autonomously assess their environment, construct plans to achieve general goals, learn transferable lessons from their experiences, and communicate their knowledge, conclusions and reasoning to others.
>
> Robust Intelligence is resourceful, innovative and flexible in reasoning and in representing knowledge and experiences. Systems exhibiting Robust Intelligence are capable of harnessing past experiences to solve new problems and to meet new expectations. They are able to use a variety of reasoning approaches, such as analogical, statistical and logical inference, to deal with open-ended and changing concepts and environments and to integrate possibly heterogeneous knowledge and reasoning methodologies in complementary and supplementary ways. They are able to learn new representations. Not only are they able to improve things they are currently tasked with, but they are also, and perhaps even more importantly, able to anticipate and propose new ones. They are able to reason, act, and learn about their tasks, users, environments, and themselves so that they can evolve and grow in capability and robustness.
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> While not every project funded will develop complete integrated solutions, projects that focus on advancing a single aspect of intelligence (e.g., representation, learning, reasoning, perception, understanding, communication) must lead towards the more general goal of robust intelligence.
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> Robust intelligence topics include, but are not limited to:
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> Integrated or hybrid architectures that integrate learning, memory and problem solving or combine deductive, probabilistic, analogical, symbolic or sub-symbolic reasoning.
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> Emergence of complex intelligence from simple components including multi-agent systems and cooperation among multiple robots.
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> Computational models of human cognition, perception, and communication for commonsense or specialized domains such as medicine or mathematics, or for specialized tasks such as spatial cognition or decision-making.
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> Knowledge representation for common sense or scientific domains, including distributed representation of knowledge (e.g., semantic web).
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> Robotics for unstructured environments with novel approaches to sensing, perception, and actuation, including autonomous manipulation.
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> Scene understanding and the recognition, classification, and identification of objects, people, events, and activities from 2D and 3D images or video.
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> Models of image formation and of the statistics of natural images.
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> Understanding text, speech, and other communicative forms, as well as their underlying meaning, intent, and realization, including semantic interpretation, cognitively and neuro-linguistically informed approaches.
>
> Generating text, speech or multimodal communication to convey meaning and intent.

The full RI solicitation from 2004 is archived at www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf05551

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