Where Do We Go From Here? Debates on the Future of Robotics Research at ICRA 2019

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> It is better to debate a question without settling it than to settle a question without debating it.
>
> —*Joseph Joubert*

The future and potential impacts of robotics and automation are frequent subjects of debate among practitioners. These discussions have not, however, been a significant and intentional feature of major technical events, occurring instead as outgrowths of panel discussions, during coffee breaks, and online. In this report, we summarize the results of the IEEE International Conference on Robotics and Automation (ICRA) 2019 Debates on the Future of Robotics Research. This experimental workshop brought together prominent researchers and industry leaders to formally debate key issues affecting robotics as an academic discipline and its broader social and economic contexts. Unlike traditional panels, which often arrive at a premature consensus, the debate format was intended to provide a framework for exploring a broader range of ideas and opinions. In addition, the workshop featured a series of "lightning talks" that highlighted submissions from early career researchers.

The workshop format was well-received and generated spirited discussion on a range of topics. The success of the format and high attendance (Figure 1) underscored the community's appetite for self-reflection and its willingness to engage in discussions complementary to the deeper technical topics at ICRA.

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First Debate: The Size and Scope of Robotics Conferences

The first debate (Figure 2) asked participants to resolve whether "ICRA, IROS [the IEEE/RSJ International Conference on Intelligent Robots and Systems], and other major robotics conferences cover too broad a range of topics for meaningful discourse." The "for" side argued that the continued growth of robotics conferences inhibits the creation of a common language, values, and standards of publication among subdisciplines and leads to logistical and structural problems in the peer review process.

The "against" side highlighted the interdisciplinary nature of robotics, noting that many successful ideas, such as learning-based methods, have emerged from cross-pollination between fields. They suggested that large conferences serve as an essential

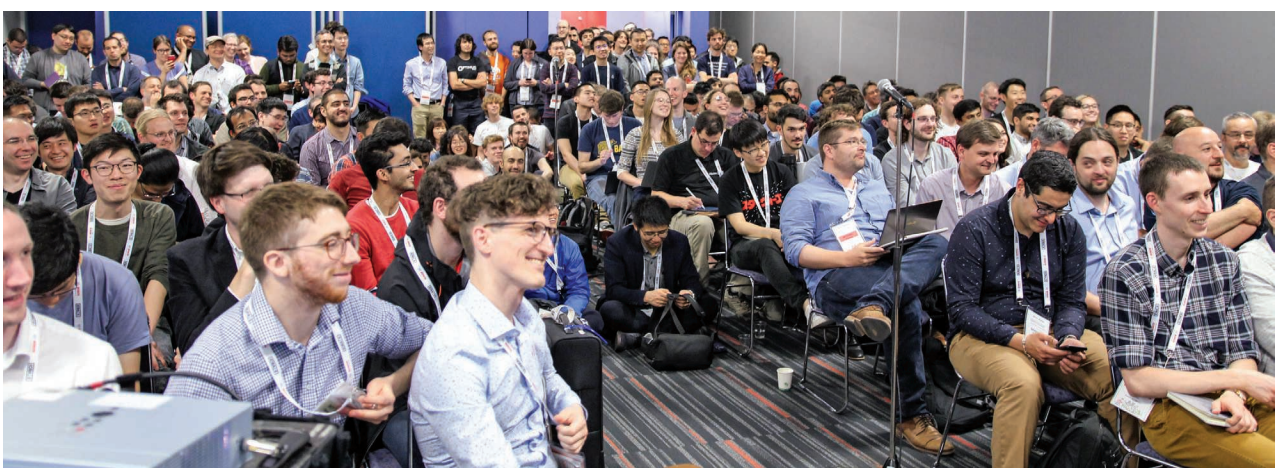

Figure 1. The capacity crowd attending the 2019 ICRA Debates on the Future of Robotics Research workshop. (Source: Olivier Lamarre; used with permission.)

and efficient way to minimize the "mean free path" to serendipitous and meaningful interactions between researchers.

During the discussion period, participants noted that organizers must consider the need for technically deep and rigorous discourse with clear scientific norms and recognize the necessity for a diverse, open, and collegial community to mitigate the risk of insularity and narrow research goals. Other key discussion points included removing the peer review process, the publication pressures experienced by early-career researchers, and different learning and communication styles among attendees. The participants agreed that active experimentation with the conference format is necessary to keep up with the growth of the field.

Second Debate: Deep Learning in Robotics Research

The second debate (Figure 3) focused on whether "the pervasiveness of deep learning (DL) in robotics research is an impediment to gaining scientific insights into robotics problems." Noting that "the dose makes the poison," the "for" side argued that the current high "dosage" of DL in robotics has transformed DL from a useful tool to a distraction and that the relative ease of publishing DL-based papers disincentivizes scientific rigor, stifles research on interpretable models, and "poisons" the field with superficial applications of poorly understood black-box learning.

The "against" side countered that, by limiting inductive bias, DL helps researchers model complex phenomena that are essential to the operation of robotic systems. Arguing that the prevalence of DL in robotics reflects its utility in modeling complex input–output relationships, they proposed that roboticists should double down on DL to challenge long-held structural assumptions, such as the von Neumann computing architecture, and take advantage of existing tools for interpreting deep models.

In discussion, the "for" side cited the "no free lunch" theorem to argue that the lack of inductive bias in DL is an impediment to producing effective models and antithetical to the goals of safety and interpretability. The "against" side responded that effective DL does rely on assumptions about input data and noted that the prevalence of open source tools in the DL community catalyzes reproducible research in robotics.

Third Debate: Regulation and Certification for Robotics

The final debate (Figure 4) considered whether "robotics needs a similar level of regulation and certification as other engineering disciplines (for example, aviation), even if this results in slower technological innovation." The "for" side proposed that robotics produces physical systems capable of harming people and property and so should be regulated like civil engineering, medicine, and warfare. Making analogies to the weak financial regulation that led to the 2008 global recession, the "for"

side argued that unregulated markets will not automatically lead to robotics technologies that minimize social harm and maximize social good.

The "against" side argued that robots and artificial intelligence (AI) are inherently difficult to regulate and certify, as their behavior can evolve over time and is often predicated on unpredictable human interactions. Participants noted that existing certification and regulatory frameworks are

Figure 2. (From left): Hadas Kress-Gazit (for), Jonathan How (for), Peter Corke (against), and Chad Jenkins (against) argue whether major robotics conferences cover too many topics for meaningful discussion to occur. John Leonard moderates. (Source: Olivier Lamarre; used with permission.)

Figure 3. (From left): Oliver Brock (for), Ryan Gariepy (for), Angela Schoellig (against), and Nicholas Roy (against) debate whether pervasive DL in robotics research hinders scientific insights into robotics problems. Michael Milford moderates. (Source: Olivier Lamarre; used with permission.)

Figure 4. (From left): James Mickens (for), Ludovic Righetti (for), Aude Billard (against), and Melonee Wise (against) debate the need for robotics to be regulated and certified. Hallie Siegel moderates. (Source: Olivier Lamarre; used with permission.)

often used as instruments for assessing liability and can be bypassed if businesses judge the benefits of noncompliance to outweigh the potential costs.

The discussion revolved around the inability of existing regulatory processes to identify and mitigate potential harms, the extent to which regulation should preempt emerging technologies and their possible (mis)uses, and the need for technologists to be informed about, and involved in, the development of appropriate standards and policies. The panel broadly agreed that regulation, in some form, is ultimately necessary to ensure that safety and fairness are centered in the design and deployment of AI and robotic systems.

Lightning Talks

The "lightning talks" featured five contributed papers:

- Adam Hall and Emmett Wise (University of Toronto), "Different Degrees of Regulation for Robotics"
- Karime Pereida and Melissa Greeff (University of Toronto), "Bias In, Bias Out—Diversity In, Diversity Out"
- Matthew Robertson (École Polytechnique Fédérale de Lausanne), "Play, Explore, Challenge: A Design Strategy for Innovation"
- Dr. Signe Redfield (U.S. Naval Research Laboratory, Washington, D.C.), "Robotics: An Academic Discipline" (published as a "Comment" in *Nature Machine Intelligence*)
- Stewart Jamieson (Massachusetts Institute of Technology, Cambridge), "The Pervasiveness of Deep Learning in Robotics Research Does Not Impede Scientific Insights Into Robotics Problems."

Future Directions

Based on overwhelmingly positive feedback from community members and participants alike, we believe that structured debate should become a mainstay of academic robotics conferences. To broaden its impact within the robotics community, we hope to see this format extend to many parts of the conference week, including keynote and plenary sessions.