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BOOK REVIEW

Patricia Vargas, Ezequiel Di Paolo, Inman Harvey, and Phil Husbands (eds), The Horizons of Evolutionary Robotics, The MIT Press, 2014, ISBN: 978-0-262-02676-5, Hardcover book, 302 pages

Joel Lehman[1]

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"The Horizons of Evolutionary Robotics" surveys the current state of research in the field of evolutionary robotics (ER). Each chapter in the collection is written by well-known researchers who take on a distinct sub-area or perspective, generally striking a balance between big picture ideas and in-depth reviews of particular experiments.

As a curated portrait of where evolutionary robotics is and has been, it is suitable for new and established researchers, as well as for those outside evolutionary robotics curious about its current status. For beginning Ph.D. students, it can aid developing a broad intuition for what has been thoroughly explored and where gaps in knowledge still exist. It can help inform established researchers of developments across the broad field (see also a recent survey paper [1]). For those outside evolutionary robotics, the book offers an up-to-date introduction to major ideas and interfaces with other fields.

The nearest point of comparison is the evolutionary robotics textbook, "Evolutionary Robotics: The Biology, Intelligence, and Technology of Self-Organizing Machines," MIT Press, 2000 written by Stefano Nolfi and Dario Floreano (both of whom also contribute to this volume). While both books include an overview of evolutionary robotics, Nolfi and Floreano's hefty textbook is more comprehensive. In contrast, "The Horizons of Evolutionary Robotics" is more up to date, and is also easier to browse because its chapters are independent. Thus for a complete sense of evolutionary robotics this collection well-complements Nolfi and Floreano's textbook.

✉ Joel Lehman
lehman.154@gmail.com

[1] IT University of Copenhagen, Copenhagen, Denmark

The twelve chapters cover a diverse set of topics and perspectives, including the intersection of evolutionary robotics and neuroscience (chapter 2), practical considerations for designing effective evolutionary robotics experiments (chapter 4), and a provocative concluding essay on classical Artificial Intelligence's (AI) failure to embrace "mindless intelligence" (chapter 12). Because chapters are written independently, writing quality and ease of reading vary. However, as a whole quality is high and all chapters are readily comprehensible. At times the analysis of particular experiments from authors' lab seems too detailed and narrow; a higher-level approach might have been more useful towards the book's aspiration as an expansive survey. Although these 12 chapters cover much ground, there remain some gaps, e.g. not much is included about generative encodings or open-ended evolution.

As a representative sample of the book, I touch briefly on the chapters mentioned above. Other chapters are similar in structure but focus on different topics, such as swarm robotics, analyzing neural network dynamics, and the evolution of various classes of behavior (e.g. higher-order cognition, communication, cooperation, spatial cognition, and locomotion).

In the second chapter, Phil Husbands et al. describe connections between evolutionary robotics and neuroscience. In particular, how it can help answer questions in neuroscience, and how knowledge from neuroscience can enable more effective evolutionary robotics models. Similar to many of the other chapters, the authors begin with a high-level review of intersections between neuroscience and evolutionary robotics before drilling into their own research in detail. The chapter is well-researched and interesting, and highlights one aspect of the intellectual richness of evolutionary robotics that results from its extreme multi-disciplinarity. Note that the well-written chapter by Josh Bongard can be seen in a similar light, showcasing how evolutionary robotics (in particular the evolution of robot morphologies) interfaces with and aids understanding in evolutionary developmental biology (evo-devo), robotics, and the study of animal behaviour.

Chapter 4 reviews practical engineering knowledge for designing effective evolutionary robotics experiments, the kind of information that is important yet rarely published. Thus Chapter 4 is of particular relevance to new researchers. Inman Harvey and Ezequiel Di Paolo describe a series of "travel tips" to enable evolution to find fruitful paths through a search space. Such tips range from how to scale the parameters and mutations of an encoding, to how incremental evolution can best be applied to decompose a complex problem into a curriculum of tractable subproblems. The penultimate chapter (written by Eric Vaughan plus Harvey and Di Paolo) demonstrates the logical conclusion of this approach, in which a complex set of human-engineered scaffoldings enables evolving an omni-directional walking behavior for a biped robot.

The concluding chapter is an iconoclastic and wide-ranging reflection by Jordan Pollack, focused on a perceived short-sightedness of more traditional AI research. Related to Rodney Brook's "Intelligence without Representation," Pollack reviews research threads that feature processes that lack cognition yet appear intelligent, touching on philosophical aspects of AI's quest and the nature of thought. Whether

or not you agree with Pollack's analysis, the chapter is compelling, entertaining, and challenges common preconceptions.

While at times "The Horizons of Evolutionary Robotics" delves too deeply into intricacies of the authors' particular experiments, it is certainly a valuable and well-researched volume of recent developments across evolutionary robotics. The chapters have been written by foundational researchers, who provide insights into what they believe are the most interesting issues and developments for the future of this rich and ambitious field.

Reference

1. S. Doncieux et al., Evolutionary robotics: what, why, and where to. Front. Robot. AI **2**, 4 (2015)