

Computational Synthesis and Creative Systems

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Creativity has become the motto of the modern world: everyone, every institution, and every company is exhorted to create, to innovate, to think out of the box. This calls for the design of a new class of technology, aimed at assisting humans in tasks that are deemed creative.

Developing a machine capable of synthesizing completely novel instances from a certain domain of interest is a formidable challenge for computer science, with potentially ground-breaking applications in fields such as biotechnology, design, and art. Creativity and originality are major requirements, as is the ability to interact with humans in a virtuous loop of recommendation and feedback. The problem calls for an interdisciplinary perspective, combining fields such as machine learning, artificial intelligence, engineering, design, and experimental psychology. Related questions and challenges include the design of systems that effectively explore large instance spaces; evaluating automatic generation systems, notably in creative domains; designing systems that foster creativity in humans; formalizing (aspects of) the notions of creativity and originality; designing productive collaboration scenarios between humans and machines for creative tasks; and understanding the dynamics of creative collective systems.

This book series intends to publish monographs, textbooks and edited books with a strong technical content, and focuses on approaches to computational synthesis that contribute not only to specific problem areas, but more generally introduce new problems, new data, or new well-defined challenges to computer science.

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Artificial Intelligence and the Arts

Computational Creativity, Artistic Behavior,
and Tools for Creatives



Springer

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ISSN 2509-6575 ISSN 2509-6583 (electronic)
Computational Synthesis and Creative Systems
ISBN 978-3-030-59474-9 ISBN 978-3-030-59475-6 (eBook)
<https://doi.org/10.1007/978-3-030-59475-6>

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

This book is dedicated to our parents for their unconditional
love, support and encouragement.

Preface

Be kind, resourceful, beautiful, friendly, have initiative, have a sense of humour, tell right from wrong, make mistakes, fall in love, enjoy strawberries and cream, make someone fall in love with it, learn from experience, use words properly, be the subject of its own thought, have as much diversity of behaviour as a man, do something really new. Alan Turing [1]

When people think about Artificial Intelligence, they tend to think about logic, reasoning, problem solving, natural language processing, image recognition, autonomous driving, rational thought and, most likely, machines plotting to kill us, enslave us, or take our jobs.

These associations and fears are justifiable. Artificial Intelligence research has focused, and to a large extent still does focus, on these areas of research; and the eventual rise of intelligent machines poses obvious risks. Nevertheless, this perspective reflects a rather limited view of Intelligence and of Artificial Intelligence research.

We posit that emotions, creativity, aesthetics, artistic behavior, divergent thoughts and curiosity are a fundamental part of the human experience. Furthermore, we consider them to be hallmarks of Human Intelligence and, possibly, a prerequisite or unavoidable consequence of Human-level Intelligence. As such, in our view, a system that lacks such abilities is likely to have considerable shortcomings and show a limited form of intelligence.

Although, we do not defend the imitation of Human Intelligence as the ultimate goal for Artificial Intelligence research, we consider that the previously mentioned characteristics are instrumental for the development of Human-Centered Artificial Intelligence systems able to relate, communicate, and understand human motivations, desires and needs.

For these reasons we are interested in the study and development of computational creativity and more specifically, in the development of systems that exhibit artistic behavior or that can improve humans' creative and artistic abilities.

We live in a wonderful world where Artificial Intelligence boldly goes where no machine has gone before, every single day. Major companies such as Google, Amazon or Tesla make spectacular advances in AI, while small companies create applied AI products for aesthetics prediction like PhotoLike.com.

In recent years, the growth of the scientific community devoted to Computational Creativity and the developments in the field of Machine Learning – along with increasing computational power – has given rise to several novel possibilities for the application of Artificial Intelligence, most notably of Artificial Neural Networks, to fields like music, art, sound, architecture, and design. In fact, although techniques and applications such as deep learning, generative adversarial neural networks, variational auto-encoders, style transfer, deep fakes, deep dreams, etc., are currently widespread, they were implausible a few years ago.

This book is aimed at a wide audience including researchers, artists, experts and, generally speaking, all those who are interested in exploring the relationship between Artificial Intelligence and the arts, design and music, independently of their background or approach, and it endorses an all encompassing view of intelligence, which is, by no means, limited to anthropocentric approaches.

We strived to reach these goals by putting together a comprehensive set of chapters that synthesizes the current trends in the field, reflects upon it, and identifies the core challenges and opportunities that lie ahead, while also presenting novel contributions and applications that advance the state-of-the-art. The book is divided into five sections: Visual Arts, Music, 3D, Other Art Forms, and Artistic Perspectives.

In the opening section, Visual Arts, Gary Greenfield focuses on visual art based on swarming techniques, and virtual and physical robotics, as well as neural networks and deep learning; Colin G. Johnson addresses various aesthetic theories highlighting a number of areas that have been neglected by computer system builders and that could be considered future opportunities within the area; and Florian Uhde focuses on the transfer of artistic style, highlighting recent technologies and offering information on various approaches.

In the section on Music: Geraint A. Wiggins deals with the topic of musical composition from the perspective of Artificial Intelligence in a philosophical way; Maximos Kaliakatsos-Papakostas shows us a first step towards new methodologies of music generation that combine the strengths of other previously researched approaches; and James McDermott focuses on the training variational autoencoder neural networks in an unsupervised way using MIDI drum loops.

For the section on 3D Tom De Smedt, Ludivine Lechat, Ben Burtenshaw and Lucas Nijs provide their views on the research that the Experimental Media Research Group (EMRG) of the St. Lucas School of Arts in Antwerp has carried out over the past 15 years in relation to computer graphics and Artificial Intelligence; and Jonathan Eisenmann discusses the challenges and practical strategies for integrating machine learning into design software through

a case study, in which the software (Adobe Dimension) configures a 3D environment.

The section on Other Art Forms, starts with Pablo Gervás' review of computational approaches for the creation of narratives, comparing them with existing models of human performance in similar tasks. Michael Cook addresses the automated game design system ANGELINA. Antonio Liapis analyzes the prism of the six facets of creativity involved in the gaming experience, highlighting important examples of human creativity in commercial games and how Artificial Intelligence has been applied to generate content for each of these facets.

In the last section of the book, Artistic Perspectives, Alan Dorin presents a comparison between the collective and subconscious design of flowers, made by bees, and the human design process using computers. Miguel Carvalhais, on the other hand, focuses on the processes to achieve closure through a procedural reading in computational artworks that centre their aesthetic experiences on procedurality rather than form. Jon McCormack concludes the book by presenting new methods for hybrid design relationships between living organisms, human designers and programmable machines.

We hope that the book presents a fair and open-minded view of the area and puts forward two core propositions:

- Creative artistic behavior is one of the key challenges, possibly the ultimate challenge, of Artificial Intelligence research;
- Computer-Assisted Creativity and Human-Centered Artificial Intelligence systems are the driving forces for research in this area.

Considering current developments in the field of Artificial Intelligence, and the dangers they pose to democracy and even human rights, we take this opportunity to defend the assertion that Artificial Intelligence should contribute to strengthen social ties, promote consensus, encourage solidarity. AI developments should be guided by principles of social responsibility, promoting inclusion and equality. Thus, we need Artificial Intelligence systems that are able to actively collaborate with human beings, understand our motivations, and counterbalance our faults, ultimately making us better humans. And for all of that, we need creative Artificial Intelligence.

Acknowledgement. This book would have never been possible without the continuous support and dedication of many.

We take this opportunity to thank the authors for their willingness to participate in this project and for their contributions and patience. Likewise, we would also like to thank the reviewers for their dedication, expertise and feedback, for assisting the authors in further improving their chapters, and Iria Santos who provided invaluable help in the proofreading and editing tasks. We also express our gratitude towards Springer's editorial staff, especially Ronan Nugent, for their encouragement and support.

The research in this area of knowledge has been nurtured throughout the years by a large and varied group of researchers that have become part of our family and

enriched our lives. As such, we take this opportunity to thank and acknowledge the work done by the evoMUSART, evo* and Computational Creativity communities who created an environment that allowed this area to flourish.

A final word of thanks goes to our research groups and colleagues for being there whenever we needed them.

Coimbra, A Coruña, Richmond
October 2020

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