

---

# **Technologien für die intelligente Automation**

Technologies for Intelligent Automation

Band 3

Ziel der Buchreihe ist die Publikation neuer Ansätze in der Automation auf wissenschaftlichem Niveau, Themen, die heute und in Zukunft entscheidend sind, für die deutsche und internationale Industrie und Forschung. Initiativen wie Industrie 4.0, Industrial Internet oder Cyber-physical Systems machen dies deutlich. Die Anwendbarkeit und der industrielle Nutzen als durchgehendes Leitmotiv der Veröffentlichungen stehen dabei im Vordergrund. Durch diese Verankerung in der Praxis wird sowohl die Verständlichkeit als auch die Relevanz der Beiträge für die Industrie und für die angewandte Forschung gesichert. Diese Buchreihe möchte Lesern eine Orientierung für die neuen Technologien und deren Anwendungen geben und so zur erfolgreichen Umsetzung der Initiativen beitragen.

**Herausgegeben von**

inIT – Institut für industrielle Informationstechnik  
Hochschule Ostwestfalen-Lippe  
Lemgo, Germany

---

Jürgen Beyerer · Oliver Niggemann  
Christian Kühnert  
(Eds.)

# Machine Learning for Cyber Physical Systems

Selected papers from the International  
Conference ML4CPS 2016

*Editors*

Jürgen Beyerer  
Karlsruhe, Germany

Christian Kühnert  
Karlsruhe, Germany

Oliver Niggemann  
Lemgo, Germany

Technologien für die intelligente Automation

ISBN 978-3-662-53805-0

ISBN 978-3-662-53806-7 (eBook)

DOI 10.1007/978-3-662-53806-7

Library of Congress Control Number: 2016955525

Springer Vieweg

© Springer-Verlag GmbH Germany 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer Vieweg imprint is published by Springer Nature

The registered company is Springer-Verlag GmbH Germany

The registered company address is: Heidelberger Platz 3, 14197 Berlin, Germany

## Preface

Cyber Physical Systems are characterized by their ability to adapt and to learn. They analyze their environment, learn patterns, and they are able to generate predictions. Typical applications are condition monitoring, predictive maintenance, image processing and diagnosis. Machine Learning is the key technology for these developments.

The second conference on Machine Learning for Cyber-Physical-Systems and Industry 4.0 - ML4CPS - was held at the Fraunhofer IOSB in Karlsruhe, on September 29<sup>th</sup> 2016. The aim of the conference is to provide a forum to present new approaches, discuss experiences and to develop visions in the area of data analysis for cyber-physical systems. This book provides the proceedings of all contributions presented at the ML4CPS 2016.

The editors would like to thank all contributors that led to a pleasant and rewarding conference. Additionally, the editors would like to thank all reviewers for sharing their time and expertise with the authors. It is hoped that these proceedings will form a valuable addition to the scientific and developmental knowledge in the research fields of machine learning, information fusion, system technologies and industry 4.0.

*Prof. Dr.-Ing. Jürgen Beyerer*

*Dr.-Ing. Christian Kühnert*

*Prof. Dr.-Ing. Oliver Niggemann*

# Table of Contents

	Page
A Concept for the Application of Reinforcement Learning in the Optimization of CAM-Generated Tool Paths . . . . .	1
<i>Caren Dripke, Sara Höhr, Akos Csiszar, Alexander Verl</i>	
Semantic Stream Processing in Dynamic Environments Using Dynamic Stream Selection . . . . .	9
<i>Michael Jacoby and Till Riedel</i>	
Dynamic Bayesian Network-Based Anomaly Detection for In-Process Visual Inspection of Laser Surface Heat Treatment . . . . .	17
<i>Alberto Ogbechie, Javier Díaz-Rozo, Pedro Larrañaga, Concha Bielza</i>	
A Modular Architecture for Smart Data Analysis using AutomationML, OPC-UA and Data-driven Algorithms . . . . .	25
<i>Christian Kühnert, Miriam Schleipen, Michael Okon, Robert Henßen, Tino Bischoff</i>	
Cloud-based event detection platform for water distribution networks using machine-learning algorithms . . . . .	35
<i>Thomas Bernard, Marc Baruthio, Claude Steinmetz, Jean-Marc Weber</i>	
A Generic Data Fusion and Analysis Platform for Cyber-Physical Systems .	45
<i>Christian Kühnert, Idel Montalvo Arango</i>	
Agent Swarm Optimization: Exploding the search space . . . . .	55
<i>Idel Montalvo Arango, Joaquín Izquierdo Sebastián</i>	
Anomaly Detection in Industrial Networks using Machine Learning . . . . .	65
<i>Ankush Meshram, Christian Haas</i>	