

Founding Editors

Gerhard Goos

Karlsruhe Institute of Technology, Karlsruhe, Germany

Juris Hartmanis

Cornell University, Ithaca, NY, USA


Editorial Board Members

Elisa Bertino

Purdue University, West Lafayette, IN, USA

Wen Gao

Peking University, Beijing, China

Bernhard Steffen 

TU Dortmund University, Dortmund, Germany

Gerhard Woeginger 

RWTH Aachen, Aachen, Germany

Moti Yung

Columbia University, New York, NY, USA

More information about this subseries at <http://www.springer.com/series/7412>

Sandy Engelhardt · Ilkay Oksuz · Dajiang Zhu ·
Yixuan Yuan · Anirban Mukhopadhyay ·
Nicholas Heller · Sharon Xiaolei Huang ·
Hien Nguyen · Raphael Sznitman ·
Yuan Xue (Eds.)

Deep Generative Models, and Data Augmentation, Labelling, and Imperfections


First Workshop, DGM4MICCAI 2021
and First Workshop, DALI 2021
Held in Conjunction with MICCAI 2021
Strasbourg, France, October 1, 2021
Proceedings


Editors


Sandy Engelhardt 
Universitätsklinikum Heidelberg
Heidelberg, Germany


Ilkay Oksuz 
Istanbul Technical University
Istanbul, Turkey

Dajiang Zhu
The University of Texas at Arlington
Arlington, TX, USA


Yixuan Yuan 
University of Hong Kong
Hong Kong, Hong Kong


Anirban Mukhopadhyay 
TU Darmstadt
Darmstadt, Germany

Nicholas Heller 
University of Minnesota
Minneapolis, MN, USA

Sharon Xiaolei Huang 
Pennsylvania State University
University Park, PA, USA

Hien Nguyen 
University of Houston
Houston, TX, USA

Raphael Sznitman 
University of Bern
Bern, Switzerland

Yuan Xue 
Johns Hopkins University
Baltimore, MD, USA

ISSN 0302-9743

ISSN 1611-3349 (electronic)

Lecture Notes in Computer Science

ISBN 978-3-030-88209-9

ISBN 978-3-030-88210-5 (eBook)

<https://doi.org/10.1007/978-3-030-88210-5>

LNCS Sublibrary: SL6 – Image Processing, Computer Vision, Pattern Recognition, and Graphics

© Springer Nature Switzerland AG 2021

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, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

DGM4MICCAI 2021 Preface

It was our genuine honor and great pleasure to hold the inaugural Workshop on Deep Generative Models for Medical Image Computing and Computer Assisted Intervention (DGM4MICCAI 2021), a satellite event at the 24th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2021). In addition to the workshop, we organized an associated challenge the AdaptOR: Deep Generative Model Challenge for Domain Adaptation in Surgery.

DGM4MICCAI was a single-track, half-day workshop consisting of high-quality, previously unpublished papers, presented orally (virtually), intended to act as a forum for computer scientists, engineers, clinicians and industrial practitioners to present their recent algorithmic developments, new results, and promising future directions in deep generative models. Deep generative models such as generative adversarial networks (GANs) and variational auto-encoders (VAEs), are currently receiving widespread attention from not only the computer vision and machine learning communities but also the MIC and CAI community. These models combine the advanced deep neural networks with classical density estimation (either explicit or implicit) for achieving state-of-the-art results. The AdaptOR challenge formulated a domain adaptation problem “from simulation to surgery”, which was a clinically relevant technical problem due to data availability and data privacy concerns. As such, DGM4MICCAI provided an all-round experience for deep discussion, idea exchange, practical understanding, and community building around this popular research direction.

This year’s DGM4MICCAI was held on October 1, 2021, virtually in Strasbourg, France. There was a very positive response to the call for papers for DGM4MICCAI 2021. We received 15 workshop papers and 2 challenge papers. Each paper was reviewed by at least two reviewers and we ended up with 10 accepted papers for the workshop and 2 for the AdaptOR challenge. The accepted papers present fresh ideas on broad topics ranging from methodology (image-to-image translation, synthesis) to applications (segmentation, classification).

The high quality of the scientific program of DGM4MICCAI 2021 was due first to the authors who submitted excellent contributions and second to the dedicated collaboration of the international Program Committee and the other researchers who reviewed the papers. We would like to thank all the authors for submitting their valuable contributions and for sharing their recent research activities.

We are particularly indebted to the Program Committee members and to all the external reviewers for their precious evaluations, which permitted us to set up this proceedings. We were also very pleased to benefit from the keynote lectures of the invited speakers: Andreas Maier, FAU Nürnberg, Germany, and Stefanie Speidel, NCT Dresden, Germany. We would like to express our sincere gratitude to these renowned experts for

making the inaugural workshop a successful platform to rally deep generative models research within the MICCAI context.

August 2021

Sandy Engelhardt
Ilkay Oksuz
Dajiang Zhu
Yixuan Yuan
Anirban Mukhopadhyay

DGM4MICCAI 2021 Organization

Organizing Committee

Sandy Engelhardt	University Hospital Heidelberg, Germany
Ilkay Oksuz	Istanbul Technical University, Turkey
Dajiang Zhu	University of Texas at Arlington, USA
Yixuan Yuan	City University of Hong Kong, China
Anirban Mukhopadhyay	Technische Universität Darmstadt, Germany

Program Committee

Li Wang	University of Texas at Arlington, USA
Tong Zhang	Peng Cheng Laboratory, China
Ping Lu	University of Oxford, UK
Roxane Licandro	Medical University of Vienna, Austria
Chen Qin	University of Edinburgh, UK
Veronika Zimmer	TU Muenchen, Germany
Dwarikanath Mahapatra	Inception Institute of AI, UAE
Michael Sdika	CREATIS Lyon, France
Jelmer Wolterink	University of Twente, The Netherlands
Alejandro Granados	King's College London, UK
Liang Zhan	University of Pittsburgh, USA
Jinglei Lv	University of Sydney, Australia

Student Organizers

Lalith Sharan	University Hospital Heidelberg, Germany
Henry Krumb	Technische Universität Darmstadt, Germany
Moritz Fuchs	Technische Universität Darmstadt, Germany
Caner Özer	Istanbul Technical University, Turkey
Chen Zhen	City University of Hong Kong, China
Guo Xiaoqing	City University of Hong Kong, China

Additional Reviewers

Chen Chen
Shuo Wang
Matthias Perkonigg
Martin Menten
Alberto Gomez
Yanfu Zhang
Mariano Cabezas
Haoteng Tang
Jorge Cardoso

DALI 2021 Preface

This volume contains the proceedings of the 1st International Workshop on Data Augmentation, Labeling, and Imperfections (DALI 2021) which was held on October 1, 2021, in conjunction with the 24th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2021). This event was originally planned for Strasbourg, France, but was ultimately held virtually due to the COVID-19 pandemic. While this is the first workshop under the “DALI” name, it is the result of a joining of forces between previous MICCAI workshops on Large Scale Annotation of Biomedical data and Expert Label Synthesis (LABELS 2016–2020) and on Medical Image Learning with Less Labels and Imperfect Data (MIL3ID 2019–2020).

Obtaining the huge amounts of labeled data that modern image analysis methods require is especially challenging in the medical imaging domain. Medical imaging data is heterogeneous and constantly evolving, and expert annotations can be prohibitively expensive and highly variable. Hard clinical outcomes such as survival are exciting targets for prediction but can be exceptionally difficult to collect. These challenges are especially acute in rare conditions, some of which stand to benefit the most from medical image analysis research. In light of this, DALI aims to bring together researchers in the MICCAI community who are interested in the rigorous study of medical data as it relates to machine learning systems.

This year’s DALI workshop received 32 paper submissions from authors all over the world. Each paper was reviewed by at least three peer-experts, and in the end, 15 high-quality papers were selected for publication. The workshop day included presentations for each of these 15 papers as well as longer-form invited talks from Margrit Betke of Boston University, Ekin Dogus Cubuk of Google Brain, Jerry Prince of Johns Hopkins University, Adrian Dalca of Massachusetts Institute of Technology, and Stephen Wong of Weill Cornell Medical College.

No scientific program would be successful without a monumental effort on the part of its peer reviewers. We are deeply grateful to the more than 30 scientists who volunteered a substantial amount of their time to provide valuable feedback to the authors and to help our editorial team make final decisions. We would also like to thank Histosonics Inc. for its generous financial support of the DALI workshop.

August 2021

Nicholas Heller
Sharon Xiaolei Huang
Hien V. Nguyen

DALI 2021 Organization

Organizing Committee

Nicholas Heller	University of Minnesota, USA
Sharon Xiaolei Huang	Pennsylvania State University, USA
Hien V. Nguyen	University of Houston, USA

Editorial Chairs

Raphael Sznitman	University of Bern, Switzerland
Yuan Xue	Johns Hopkins University, USA

Award Committee

Dimitris N. Metaxas	Rutgers University, USA
Diana Mateus	Centrale Nantes, France

Advisory Board

Stephen Wong	Houston Methodist Hospital, USA
Jens Rittscher	University of Oxford, UK
Margrit Betke	Boston University, USA
Emanuele Trucco	University of Dundee, Scotland

Program Committee

Alison C. Leslie	University of Minnesota, USA
Amelia Jiménez-Sánchez	Pompeu Fabra University, Spain
Anjali Balagopal	UT Southwestern, USA
Brett Norling	University of Minnesota, USA
Chandra Kambhampettu	University of Delaware, USA
Chao Chen	Stony Brook University, USA
Christoph M. Friedrich	Dortmund University of Applied Sciences and Arts, Germany
Devante F. Delbrune	University of Minnesota, USA
Edward Kim	Drexel University, USA
Emanuele Trucco	University of Dundee, UK
Filipe Condessa	Instituto Superior Tecnico, Portugal/Carnegie Mellon University, USA

Haomiao Ni	Pennsylvania State University, USA
Hui Qu	Adobe Inc., USA
Jiarong Ye	Pennsylvania State University, USA
Jue Jiang	Memorial Sloan Kettering Cancer Center, USA
Kelvin Wong	Houston Methodist Hospital Research Institute, USA
Li Xiao	Chinese Academy of Science, China
Michael Goetz	German Cancer Research Center (DFKZ), Germany
Nicha Dvornek	Yale University, USA
Niklas E. P. Damberg	University of Minnesota, USA
Pengyu Yuan	University of Houston, USA
Pietro Antonio Cicalese	University of Houston, USA
Rafat Solaiman	University of Minnesota Medical School, USA
Samira Zare	University of Houston, USA
Ti Bai	UT Southwestern, USA
Weidong Cai	University of Sydney, Australia
Wen Hui Lei	University of Electronic Science and Technology of China, China
Xiao Liang	UT Southwestern, USA
Xiaoxiao Li	Princeton University, USA
Xiaoyang Li	Adobe Research, USA

Contents

Image-to-Image Translation, Synthesis

Frequency-Supervised MR-to-CT Image Synthesis	3
<i>Zenglin Shi, Pascal Mettes, Guoyan Zheng, and Cees Snoek</i>	
Ultrasound Variational Style Transfer to Generate Images Beyond the Observed Domain	14
<i>Alex Ling Yu Hung and John Galeotti</i>	
3D-StyleGAN: A Style-Based Generative Adversarial Network for Generative Modeling of Three-Dimensional Medical Images	24
<i>Sungmin Hong, Razvan Marinescu, Adrian V. Dalca, Anna K. Bonkhoff, Martin Bretzner, Natalia S. Rost, and Polina Golland</i>	
Bridging the Gap Between Paired and Unpaired Medical Image Translation	35
<i>Pauliina Paavilainen, Saad Ullah Akram, and Juho Kannala</i>	
Conditional Generation of Medical Images via Disentangled Adversarial Inference	45
<i>Mohammad Havaei, Ximeng Mao, Yiping Wang, and Qicheng Lao</i>	
CT-SGAN: Computed Tomography Synthesis GAN	67
<i>Ahmad Pesaranghader, Yiping Wang, and Mohammad Havaei</i>	

Applications and Evaluation

Hierarchical Probabilistic Ultrasound Image Inpainting via Variational Inference	83
<i>Alex Ling Yu Hung, Zhiqing Sun, Wanwen Chen, and John Galeotti</i>	
CaCL: Class-Aware Codebook Learning for Weakly Supervised Segmentation on Diffuse Image Patterns	93
<i>Ruining Deng, Quan Liu, Shunxing Bao, Aadarsh Jha, Catie Chang, Bryan A. Millis, Matthew J. Tyska, and Yuankai Huo</i>	
BrainNetGAN: Data Augmentation of Brain Connectivity Using Generative Adversarial Network for Dementia Classification	103
<i>Chao Li, Yiran Wei, Xi Chen, and Carola-Bibiane Schönlieb</i>	

Evaluating GANs in Medical Imaging	112
<i>Lorenzo Tronchin, Rosa Sicilia, Ermanno Cordelli, Sara Ramella, and Paolo Soda</i>	
AdaptOR Challenge	
Improved Heatmap-Based Landmark Detection	125
<i>Huifeng Yao, Ziyu Guo, Yatao Zhang, and Xiaomeng Li</i>	
Cross-Domain Landmarks Detection in Mitral Regurgitation	134
<i>Jiacheng Wang, Haojie Wang, Ruochen Mu, and Liansheng Wang</i>	
DALI 2021	
Scalable Semi-supervised Landmark Localization for X-ray Images Using Few-Shot Deep Adaptive Graph	145
<i>Xiao-Yun Zhou, Bolin Lai, Weijian Li, Yirui Wang, Kang Zheng, Fakai Wang, Chihung Lin, Le Lu, Lingyun Huang, Mei Han, Guotong Xie, Jing Xiao, Kuo Chang-Fu, Adam Harrison, and Shun Miao</i>	
Semi-supervised Surgical Tool Detection Based on Highly Confident Pseudo Labeling and Strong Augmentation Driven Consistency	154
<i>Wenjing Jiang, Tong Xia, Zhiqiong Wang, and Fucang Jia</i>	
One-Shot Learning for Landmarks Detection	163
<i>Zihao Wang, Clair Vandersteen, Charles Raffaelli, Nicolas Guevara, François Patou, and Hervé Delingette</i>	
Compound Figure Separation of Biomedical Images with Side Loss	173
<i>Tianyuan Yao, Chang Qu, Quan Liu, Ruining Deng, Yuanhan Tian, Jiachen Xu, Aadarsh Jha, Shunxing Bao, Mengyang Zhao, Agnes B. Fogo, Bennett A. Landman, Catie Chang, Haichun Yang, and Yuankai Huo</i>	
Data Augmentation with Variational Autoencoders and Manifold Sampling	184
<i>Clément Chadebec and Stéphanie Allasonnière</i>	
Medical Image Segmentation with Imperfect 3D Bounding Boxes	193
<i>Ekaterina Redekop and Alexey Chernyavskiy</i>	
Automated Iterative Label Transfer Improves Segmentation of Noisy Cells in Adaptive Optics Retinal Images	201
<i>Jianfei Liu, Nancy Aguilera, Tao Liu, and Johnny Tam</i>	

How Few Annotations are Needed for Segmentation Using a Multi-planar U-Net?	209
<i>William Michael Laprade, Mathias Perslev, and Jon Sporring</i>	
FS-Net: A New Paradigm of Data Expansion for Medical Image Segmentation	217
<i>Xutao Guo, Yanwu Yang, and Ting Ma</i>	
An Efficient Data Strategy for the Detection of Brain Aneurysms from MRA with Deep Learning	226
<i>Youssef Assis, Liang Liao, Fabien Pierre, René Anxionnat, and Erwan Kerrien</i>	
Evaluation of Active Learning Techniques on Medical Image Classification with Unbalanced Data Distributions	235
<i>Quok Zong Chong, William J. Knottenbelt, and Kanwal K. Bhatia</i>	
Zero-Shot Domain Adaptation in CT Segmentation by Filtered Back Projection Augmentation	243
<i>Talgat Saparov, Anvar Kurmukov, Boris Shirokikh, and Mikhail Belyaev</i>	
Label Noise in Segmentation Networks: Mitigation Must Deal with Bias	251
<i>Eugene Vorontsov and Samuel Kadoury</i>	
DeepMCAT: Large-Scale Deep Clustering for Medical Image Categorization	259
<i>Turkay Kart, Wenjia Bai, Ben Glocker, and Daniel Rueckert</i>	
MetaHistoSeg: A Python Framework for Meta Learning in Histopathology Image Segmentation	268
<i>Zheng Yuan, Andre Esteva, and Ran Xu</i>	
Author Index	277