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Clinical Image-Based Procedures, Distributed and Collaborative Learning, Artificial Intelligence for Combating COVID-19 and Secure and Privacy-Preserving Machine Learning

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and First Workshop and Tutorial, PPML 2021
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CLIP Preface

The 10th International Workshop on Clinical Image-Based Procedures: Towards Holistic Patient Models for Personalised Healthcare (CLIP) was held on September 27, 2021, in conjunction with the 24th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2021). As with the previous edition, CLIP 2021 was held virtually to keep all participants safe from the current COVID-19 pandemic while facilitating researchers to participate in spite of the strict traveling rules.

Following the long tradition of CLIP on translational research, the goal of the works presented in this workshop is to bring basic research methods closer to the clinical practice. One of the key aspects that is gaining relevance regarding the applicability of basic research methods in clinical practice is the creation of Holistic Patient Models as an important step towards personalized healthcare. As a matter of fact, the clinical picture of a patient does not uniquely consist of medical images, instead a combination of medical image data of multiple modalities with other patient data, e.g. omics, demographics, or electronic health records, is desirable. Since 2019 CLIP has put a special emphasis on this area of research.

As in the previous CLIP workshops that have taken place every year since 2012, all submitted papers were peer reviewed by at least two experts. CLIP 2021 received 13 submissions and nine of them were accepted for publication. All accepted papers were presented by their authors during the workshop and the attendees chose with their votes the recipient of the Best Paper Award of CLIP 2021. In addition to the oral presentations provided by the authors of the accepted papers, all attendees of CLIP 2021 had the opportunity to enjoy high-quality keynotes followed by avid discussions in which all attendees were involved. We would like to thank our invited speakers for their interesting talks and discussions. Furthermore, we would like to take this opportunity to thank our Program Committee members, authors, and attendees who helped CLIP 2021 to be a great success.

September 2021

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DCL Preface

Machine learning approaches have demonstrated the capability of revolutionizing almost every application and every industry through the use of large amounts of data to capture and recognize patterns. A central topic in recent scientific debates has been how data is obtained and how it can be used without compromising user privacy. Industrial exploitation of machine learning and deep learning (DL) approaches has, on the one hand, highlighted the need to capture user data from the field of application in order to yield a continuous improvement of the model, and on the other hand it has exposed a few shortcomings of current methods when it comes to privacy.

Innovation in the way data is captured, used, and managed, as well as how privacy and security of this data can be ensured, is a priority for the whole research community. Most current methods rely on centralized data stores, which contain sensitive information and are often out of the direct control of users. In sensitive contexts, such as healthcare, where privacy takes priority over functionality, approaches that require centralized data lakes containing user data are far from ideal, and may result in severe limitations in what kinds of models can be developed and what applications can be served.

Other issues that result in privacy concerns are more intimately connected with the mathematical framework of machine learning approaches and, in particular, DL methods. It has been shown that DL models tend to memorize parts of the training data and, potentially, sensitive information within their parameters. Recent research is actively seeking ways to reduce issues caused by this phenomenon. Even though these topics extend beyond distributed and collaborative learning methods, they are still intimately connected to them.

The second MICCAI workshop on Distributed and Collaborative Learning (DCL 2021) aimed at creating a scientific discussion focusing on the comparison, evaluation, and discussion of methodological advancement and practical ideas about machine learning applied to problems where data cannot be stored in centralized databases; where information privacy is a priority; where it is necessary to deliver strong guarantees on the amount and nature of private information that may be revealed by the model as a result of training; and where it's necessary to orchestrate, manage, and direct clusters of nodes participating in the spotential conflicts of interest and recent ame learning task.

During the second edition of DCL, eight papers were submitted for consideration and, after peer review, four full papers were accepted for presentation. Each paper was rigorously reviewed by at least three reviewers in a double-blind review process. The papers were assigned to reviewers taking into account (and avoiding) potential conflicts of interest and recent work collaborations between peers. Reviewers were selected from among the most prominent experts in the field from all over the world.

Once the reviews were obtained, the area chairs formulated final decisions over acceptance, conditional acceptance, or rejection of each manuscript. These decisions

were always taken according to the reviews and could not be appealed. In the case of conditional acceptance, authors had to make substantial changes and improvements to their paper according to reviewer feedback. The nature of these changes aimed to increase the scientific validity as well as the clarity of the manuscripts.

Additionally, the workshop organizing committee granted the Best Paper Award to the best submission presented at DCL 2021. The Best Paper Award was assigned as a result of a secret voting procedure where each member of the committee indicated two papers worthy of consideration for the award. The paper collecting the majority of votes was then chosen by the committee.

The double-blind review process with three independent reviewers selected for each paper, united with the mechanism of conditional acceptance, as well as the selection and decision process through meta-reviewers, ensured the scientific validity and the high quality of the works presented at the second edition of DCL, making our contribution very valuable to the MICCAI community, and in particular to researchers working on distributed and collaborative learning.

We would therefore like to thank the authors for their contributions, and the reviewers for their dedication and fairness when judging the works of their peers.

August 2021

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LL-COVID-19 Preface

During the global COVID-19 pandemic we observed a global pressure on the healthcare systems that drove increased leverage of lung medical imaging for diagnosis, prognosis, and treatment selection. This resulted in a surge of publications exploring, from one side, clinical use of medical imaging by the COVID-19 patients' carers, and AI models analyzing lung medical images developed by the AI community, on the other side. Unfortunately, the publications demonstrating the use of AI models in clinical practice were rather limited. We performed a thorough review of all relevant publications in 2020 [1] and identified numerous trends and insights that may help in accelerating the translation of AI technology in clinical practice in pandemic times. Aiming to continue and expand the discussion, the LL-COVID-19 MICCAI 2021 workshop was devoted to the lessons learned from this accelerated process and in paving the way for further AI adoption, in particular focusing on three main areas, namely (1) data definition, (2) data availability, and (3) research translation, as we reason and describe in detail in the first paper of the volume.

The program of the LL-COVID-19 MICCAI workshop was designed to facilitate discussion between the AI community and medical experts. To this end, in each of our three sessions we included (1) presentations of peer-reviewed papers, (2) presentations from invited speakers to cover domains and expertise not covered by the accepted papers, and (3) panel discussions with all presenters and additional invited panelists to expand the expertise, demographics, and modalities.

To select the peer-reviewed papers we leveraged the CMT tool. We applied a double-blind review process and had each submitted paper reviewed by three independent reviewers. The invited speakers were selected based on their contributions to the COVID-19 publications, as identified in the publications review process we performed. The panelists were selected mostly based on geographic and modalities coverage. The invited speakers and additional panelists are listed on the organization page.

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Colin Campas	NVIDIA, USA
Holger Roth	NVIDIA, USA
Dorit Shaham	Hadassah Medical Center, Israel
Bram van Ginneken	Radboud University Medical Center, The Netherlands

Invited Panelists

Itamar Ofer	World Hospital at Home Community and Congress, Israel
Bishesh Khanal	NAAMII, Nepal
Orest Boyko	Indiana University Health, USA

Reference

1. Born, J., et al.: On the role of artificial intelligence in medical Imaging of COVID-19. Patterns, **2**(6), 1–18 (2021)

PPML Preface

Any handling of medical data, be it in the setting of research or for clinical patient care, by definition involves an interaction with privacy-sensitive attributes inherent to this data. Both the development of novel AI techniques and their validation and future application in healthcare will rely on training and testing of algorithms on large, multi-institutional data sets. This is crucial both for reasons of data representativeness and for fairness and unbiasedness. It becomes apparent that the aforementioned privacy constraints directly contradict the common paradigm of centralized data pooling enabled through data sharing agreements and *carte blanche* institutional review board approval. They infringe on data ownership, preclude the enforcement of granular data governance by creating identical copies of datasets and leave data vulnerable to theft or inappropriate handling. Data trusts provide only limited relief, as they still rely on data centralization. Instead, future-proof solutions based around technical means of privacy enforcement on the patient level and decentralized data utilization without direct data access are required. Privacy-preserving machine learning techniques provide concrete solutions: they enable the security, privacy, and verification of algorithms and data and allow the enforcement of data flow governance, i.e. the compliance of information flow to, for example, contractually agreed norms.

Concrete technical implementations of such systems rely on a novel and expanding set of technical implementations. The remote execution of data processing workflows is typically realized through techniques such as federated learning, in which data processing algorithms, such as deep neural networks, are dispatched to the site where the data resides and are returned to a central server after the data has been processed. Notably this step does not entail transmitting any of the actual patient data. Even in the remote execution setting, however, algorithms trained on sensitive datasets are potentially themselves a source of sensitive information. Reverse engineering of such models can relieve such information to malicious third parties. Objective privacy guarantees are provided by the conceptual and technical framework of differential privacy, which allows the quantification of individual privacy and the fine-grained regulation of the interaction between the dataset and the algorithm or the dataset and the data scientist through privacy budgets.

Our aim with the MICCAI 2021 PPML workshop was to empower the medical imaging community to explore these and other techniques (such as cryptography and verification). It is our conviction that research progress in our field will benefit from their application and their development in concrete research settings, as well as their eventual translation to clinical patient care.

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