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TECHNICAL CONTRIBUTION

Education in Artificial Intelligence K-12

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In recent years, Artificial Intelligence (AI) has gained increased attention by the public, showed significant influence across various sectors and fields, and became a major topic of intense discussion. AI already affects various areas of life. The rapidity with which AI is impacting our everyday life as well as our working world poses a tremendous challenge for our economy, society and educational system. Sound knowledge about AI, its principles and concepts, the ability to apply AI techniques and methods, coupled with the ability to analyze their risks and long-term benefits, are becoming 21st century key skills. Such skills are the basis for creating career opportunities and fostering a broad common understanding of AI applications and products. As a consequence, this also enables people to better estimate potential opportunities and possible risks of those upcoming technologies. Thus, literacy in AI—similar to reading and math—is needed. Access to basic AI understanding, education and tools will also reduce the danger of social or economic exclusion of certain groups of people, especially women and minorities. Moreover, it will allow an open, broad and informed discussion about AI within the population and with policy makers. In this context it is essential to introduce fundamental concepts and techniques of AI from an early age.

Teaching fundamental AI concepts and techniques has traditionally been done at the university level. Education in AI at the K-12 level is still quite rare. However, in recent years numerous initiatives, projects, resources and tools have emerged that support the mission of K-12 AI education. The field of AI K-12 education is a vibrant and interesting one and shows quite divers faces in terms of formal versus informal education, time period of the intervention as well as tools and teaching paradigms used.

The main goal of this special issue is to allow researchers and practitioners active in the field of K-12 AI education to present fundamental concepts, curricula, tools, and projects related to this new kind of education. The special issue should allow the interested reader to get an overview of the current directions and activities in this area around the globe.

The technical contributions in this special issue can be categorized into three areas. The first area focuses on a more fundamental view on AI K-12 education. The contribution of Kim et al. analyses the pedagogical, content related, and technological competences a teacher would need in order to allow good teaching of AI to young people. Using the Technological Pedagogical Content Knowledge (TPACK) framework, AI K-12 curricula of different countries are analyzed. Eguchi et al. aim at the important question of how relevant the cultural context is for a fruitful K-12 education in AI. By analyzing the K-12 AI curriculum from Japan, areas and topics sensitive to the cultural context are identified and suitable responses are developed. The second area of this special issue covers examples for smaller, closed activities that can be used in K-12 AI education. In Fernandez-Martinez et al. concepts for AI courses suitable for high schools using short paper & pencil or programming activities are presented. The proposed courses were held in a high school and the impact to the learners' attitude on AI was investigated. The contribution of Henry et al. aims at the question of how gamification can be used to foster a critical view of

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the learners on AI systems. Students play different roles in the development cycle of an AI system and learn different perspectives on the system. The approach was evaluated with learners from a middle school and also from an elementary school. The approach by Shamir et al. aims at familiarizing young learners in elementary school with the concept of neural networks. While still teaching the fundamental aspects of neural networks such as training and prediction, the focus lays on how the complex context can be simplified and abstracted. In Alexandre et al. it is investigated how Massive Open Online Courses (MOOCs) can be used to develop a critical but still connected attitude towards AI. Given the concept of the activity a much broader audience than for instance in schools can be reached. The activities presented in Kahn et al. follow the idea of Constructivism and provide motivating mini-projects in the areas of fundamental topics of AI. The projects are half-way done in order to give the learners enough guidance while still stimulating, motivating and challenging them. The last area of the special issue covers projects with a longer time frame and a bigger scale. The project reported in Chklovski et al. focuses on the development of an understanding of the technology and the potential of AI in under-resourced communities. The key idea to address this issue is to motivate learners and their parents around the globe to solve real-word problems in their communities using AI techniques. Learners and their guardians are supported by mentors and motivated by a world-wide competition setting. The initiative was able to reach several thousands of students. Results from the two editions in 2018 and 2019 are reported. The contribution of Kandlhofer et al. reports results of a project in Hungary and Austria with the aim to institutionalize, enlarge and professionalize AI education in schools. In order to reach this goal a training and certification program for AI and Robotics for teachers and learners had been developed. The key idea for scalability and sustainability of the project is the train-the-trainer concept where well educated and certified teachers act as multipliers in schools. Results from the ramp-up phase of the training and certification system are reported. The special issue is rounded up by a set of interviews. Experts and policy makers have been asked about their view on AI K-12 education as well as their assessment of opportunities, risks and challenges. In order to get a more complete picture, experts from different areas of the world (The Americas, Europe, Asia) and different backgrounds (researcher, policy maker, practitioner) had been selected for the interviews.

1 Content

1.1 Technical Contributions

- Seonghun Kim, Yeonju Jang, Seongyune Choi, Woojin Kim, Heeseok Jung, Soohwan Kim, Hyeoncheol Kim: Analyzing Teacher Competency with TPACK for K-12 AI Education.
- Amy Eguchi, Hiroyuki Okada, Yumiko Muto: Contextualizing AI Education for K-12 Students to Enhance Their Learning of AI Literacy through Culturally Responsive Approaches.

1.2 Projects

- Carmen Ferandez-Martınez, Isidoro Hernan-Losada, Alberto Fernandez: Early Introduction of AI in Spanish Middle Schools.
- Julie Henry, Alyson Hernalesteen, Anne-Sophie Collard: Teaching Artificial Intelligence to K-12 through a Role-playing Game Questioning the Intelligence Concept.
- Gilad Shamir, Ilya Levin: Neural network construction practices in elementary school.
- Frederic Alexandre, Jade Becker, Marie-Helene Comte, Aurelie Lagarrigue, Romain Liblau, Margarida Romero, Thierry Vieville: Why, What and How to help each Citizen to Understand Artificial Intelligence?
- Ken Kahn, Niall Winters: Learning by enhancing half-baked AI projects.

1.3 Research Projects

- Tara Chklovski, Richard Jung, Rebecca Anderson, Kathryn Young: Comparing Two Years of Empowering Families to Solve Real-World Problems with AI.
- Martin Kandlhofer, Gerald Steinbauer, Julia Lassnig, Manuel Menzinger, Wilfried Baumann, Margit Ehardt-Schmiederer, Ronald Bieber, Thomas Winkler, Sandra Plomer, Inge Strobl-Zuchtriegl, Marlene Miglbauer, Aron Ballagi, Claudiu Pozna, Gabor Miltenyi, Istvan Alfoldi, Imre Szalay: EDLRIS: A European Driving License for Robots and Intelligent Systems.

1.4 Interviews

Fredrik Heintz: Three Interviews about K-12 AI Education in America, Europe, and Singapore.

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