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IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.

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The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

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John MacIntyre · Ilias Maglogiannis ·
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Artificial Intelligence Applications and Innovations

15th IFIP WG 12.5 International Conference, AIAI 2019
Hersonissos, Crete, Greece, May 24–26, 2019
Proceedings

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Preface

AIAI 2019

According to Professor Klaus Schwab (founder and executive chairman of the World Economic Forum), we are living in the era of a great revolution that is rapidly bringing huge changes and challenges in our daily lives. This is the Fourth Industrial Revolution, which has a big impact on all disciplines, even in the way that we communicate and interact with each other. Artificial intelligence (AI) is a major and significant part of the Fourth Industrial Revolution. Its rapid technical breakthroughs are enabling superhuman performance by machines in a real-time mode. Machine vision (e.g., face recognition) or language translators and assistants like Siri and Alexa are characteristic examples. AI is promising a brave new world where business and economies will expand their productivity and innovation. Machine learning and deep learning are part of our usual common interactions on our mobile phones and on social media. Numerous applications of AI are used in almost all domains from cybersecurity to financial and medical cases. However, historic challenges for the future of mankind are being faced. Potential unethical use of AI may violate democratic human rights and may alter the character of Western societies.

The 15th Artificial Intelligence Applications and Innovations (AIAI) conference offered insight into all timely challenges related to technical, legal, and ethical aspects of intelligent systems and their applications. New algorithms and potential prototypes employed in diverse domains were introduced.

AIAI is a mature international scientific conference held in Europe and is well established in the scientific area of AI. Its history is long and very successful, following and spreading the evolution of intelligent systems.

The first event was organized in Toulouse France in 2004. Since then, it has had a continuous and dynamic presence as a major global, but mainly European scientific event. More specifically, it has been organized in China, Greece, Cyprus, Australia, and France. It has always been technically supported by the International Federation for Information Processing (IFIP) and more specifically by the Working Group 12.5, which is interested in AI applications.

Following a long-standing tradition, this Springer volume belongs to the IFIP AICT Springer Series and it contains the papers that were accepted to be presented orally at the AIAI 2019 conference. An additional volume comprises the papers that were accepted and presented at the workshops and were held as parallel events.

The diverse nature of papers presented demonstrates the vitality of AI algorithms and approaches. It certainly proves the very wide range of AI applications as well.

The event was held during May 24–26, 2019, in the Aldemar Knossos Royal five-star Hotel in Crete, Greece.

The response of the international scientific community to the AIAI 2019 call for papers was more than satisfactory, with 101 papers initially submitted. All papers were peer reviewed by at least two independent academic referees. Where needed, a third referee was consulted to resolve any potential conflicts. A total of 49 papers (48.5% of the submitted manuscripts) were accepted to be published as full papers (12 pages long) in the proceedings. Owing to the high quality of the submissions, the Program Committee decided that it should accept six more papers to be published as short ones (10 pages long).

Three scientific workshops on timely AI subjects were organized under the framework of AIAI 2019.

- The 8th Mining Humanistic Data Workshop (MHDW 2019) organized by the University of Patras and Ionion University, Greece
- The 4th Workshop on 5G-Putting Intelligence to the Network Edge (5G-PINE 2019) organized by the research team of the Hellenic Telecommunications Organization (OTE) in cooperation with 22 major partner companies
- The First Workshop on Emerging Trends in AI (ETAI 2019)
Sponsored by the Springer journal *Neural Computing and Applications*
(open workshop without submission of papers)

We are grateful to Professor John MacIntyre from the University of Sunderland, UK, for organizing this workshop and, moreover, for his continuous support of the AIAI and EANN conferences.

We wish to thank Professor Andrew Starr for his contribution to this very interesting workshop.

AI is in a new “boom” period, with exponential growth in commercialization of research and development, products being introduced into the market with embedded AI as well as “intelligent systems” of various types. Projections for commercial revenue from AI show exponential growth; such is the ubiquitous nature of AI in the modern world that members of the public are interacting with intelligent systems or agents every day – even though they often are not aware of it!

This workshop, led by Professor John MacIntyre, considered emerging themes in AI, covering not only the technical aspects of where AI is going, but the wider question of ethics, and the potential for future regulatory frameworks for the development, implementation, and operation of intelligent systems and their role in our society.

The workshop format included three short presentations by the keynote speakers, followed by an interactive panel Q&A session where the panel members and audience engaged in a lively debate on the topics discussed!

The subjects of their presentations were the following:

- John MacIntyre: “The Future of AI – Existential Threat or New Revolution?”
- Andrew Starr: “Practical AI for Practical Problems”

This was an open workshop without submission of papers.

Four keynote speakers were invited to give lectures on timely aspects of AI. The following talks were given:

1. Professor Plamen Angelov, University of Lancaster, UK: “Empirical Approach: How to Get Fast, Interpretable Deep Learning”
2. Dr. Evangelos Eleftheriou, IBM Fellow, Cloud and Computing Infrastructure, Zurich Research Laboratory Switzerland. subject: “In-Memory Computing: Accelerating AI Applications”
3. Dr. John Oommen: Carleton University, Ottawa, Canada: “The Power of Pursuit. Learning Paradigm in the Partitioning of Data”
4. Professor Panagiotis Papapetrou, Stockholm University: “Learning from Electronic Health Records: From temporal Abstraction to Timeseries Interpretability”

A tutorial was hosted on the topic: “Automated Machine Learning for Bioinformatics and Computational Biology.”

The tutorial (3 hours) was given by Professor Ioannis Tsamdinou (Computer Science Department of University of Crete, co-founder of Gnosis Data Analysis PC, a University spin-off company, and Affiliated Faculty at IACM-FORTH) and Professor Vincenzo Lagani (Ilia State University, Tbilisi, Georgia and Gnosis Data Analysis PC co-founder).

Numerous bioinformaticians, computational biologists, and life scientists in general are applying supervised learning techniques and feature selection in their research work. The tutorial was addressed to this audience intending to shield them against methodological pitfalls, inform them about new methodologies and tools emerging in the field of Auto-ML, and increase their productivity.

The accepted papers of the 15th AIAI conference are related to the following thematic topics:

- Deep learning ANN
- Genetic algorithms - optimization
- Constraints modeling
- ANN training algorithms
- Social media intelligent modeling
- Text mining/machine translation
- Fuzzy modeling
- Biomedical and bioinformatics algorithms and systems
- Feature selection
- Emotion recognition
- Hybrid intelligent models
- Classification-pattern recognition
- Intelligent security modeling
- Complex stochastic games
- Unsupervised machine learning
- ANN in industry
- Intelligent clustering
- Convolutional and recurrent ANN

Recommender systems
Intelligent telecommunications modeling
Intelligent hybrid systems using internet of things

The authors of submitted papers came from 23 different countries from all over the globe, namely: Austria, Brazil, Canada, Colombia, Czech Republic, Finland, France, Germany, Greece, The Netherlands, Hungary, India, Italy, Japan, P.R. China, Peru, Poland, Portugal, Spain, Sweden, Tunisia, the UK, and the USA.

May 2019

John MacIntyre
Ilias Maglogiannis
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Abstracts of Invited Talks

Learning from Electronic Health Records: From Temporal Abstractions to Time Series Interpretability

Panagiotis Papapetrou

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Abstract. The first part of the talk will focus on data mining methods for learning from Electronic Health Records (EHRs), which are typically perceived as big and complex patient data sources. On them, scientists strive to perform predictions on patients' progress, to understand and predict response to therapy, to detect adverse drug effects, and many other learning tasks. Medical researchers are also interested in learning from cohorts of population-based studies and of experiments. Learning tasks include the identification of disease predictors that can lead to new diagnostic tests and the acquisition of insights on interventions. The talk will elaborate on data sources, methods, and case studies in medical mining.

The second part of the talk will tackle the issue of interpretability and explainability of opaque machine learning models, with focus on time series classification. Time series classification has received great attention over the past decade with a wide range of methods focusing on predictive performance by exploiting various types of temporal features. Nonetheless, little emphasis has been placed on interpretability and explainability. This talk will formulate the novel problem of explainable time series tweaking, where, given a time series and an opaque classifier that provides a particular classification decision for the time series, the objective is to find the minimum number of changes to be performed to the given time series so that the classifier changes its decision to another class. Moreover, it will be shown that the problem is NP-hard. Two instantiations of the problem will be presented. The classifier under investigation will be the random shapelet forest classifier. Moreover, two algorithmic solutions for the two problem instantiations will be presented along with simple optimizations, as well as a baseline solution using the nearest neighbor classifier.

Empirical Approach: How to Get Fast, Interpretable Deep Learning

Plamen Angelov

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Abstract. We are witnessing an explosion of data (streams) being generated and growing exponentially. Nowadays we carry in our pockets Gigabytes of data in the form of USB flash memory sticks, smartphones, smartwatches etc. Extracting useful information and knowledge from these big data streams is of immense importance for the society, economy and science. Deep Learning quickly become a synonymous of a powerful method to enable items and processes with elements of AI in the sense that it makes possible human like performance in recognizing images and speech. However, the currently used methods for deep learning which are based on neural networks (recurrent, belief, etc.) is opaque (not transparent), requires huge amount of training data and computing power (hours of training using GPUs), is offline and its online versions based on reinforcement learning has no proven convergence, does not guarantee same result for the same input (lacks repeatability).

The speaker recently introduced a new concept of empirical approach to machine learning and fuzzy sets and systems, had proven convergence for a class of such models and used the link between neural networks and fuzzy systems (neuro-fuzzy systems are known to have a duality from the radial basis functions (RBF) networks and fuzzy rule based models and having the key property of universal approximation proven for both).

In this talk he will present in a systematic way the basics of the newly introduced Empirical Approach to Machine Learning, Fuzzy Sets and Systems and its applications to problems like anomaly detection, clustering, classification, prediction and control. The major advantages of this new paradigm are the liberation from the restrictive and often unrealistic assumptions and requirements concerning the nature of the data (random, deterministic, fuzzy), the need to formulate and assume a priori the type of distribution models, membership functions, the independence of the individual data observations, their large (theoretically infinite) number, etc.

From a pragmatic point of view, this direct approach from data (streams) to complex, layered model representation is automated fully and leads to very efficient model structures. In addition, the proposed new concept learns in a way similar to the way people learn – it can start from a single example. The reason why the proposed new approach makes this possible is because it is prototype based and non-parametric.

“In-memory Computing”: Accelerating AI Applications

Evangelos Eleftheriou

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Abstract. In today’s computing systems based on the conventional von Neumann architecture, there are distinct memory and processing units. Performing computations results in a significant amount of data being moved back and forth between the physically separated memory and processing units. This costs time and energy, and constitutes an inherent performance bottleneck. It is becoming increasingly clear that for application areas such as AI (and indeed cognitive computing in general), we need to transition to computing architectures in which memory and logic coexist in some form. Brain-inspired neuromorphic computing and the fascinating new area of in-memory computing or computational memory are two key non-von Neumann approaches being researched. A critical requirement in these novel computing paradigms is a very-high-density, low-power, variable-state, programmable and non-volatile nanoscale memory device. There are many examples of such nanoscale memory devices in which the information is stored either as charge or as resistance. However, one particular example is phase-change-memory (PCM) devices, which are very well suited to address this need, owing to their multi-level storage capability and potential scalability.

In in-memory computing, the physics of the nanoscale memory devices, as well as the organization of such devices in cross-bar arrays, are exploited to perform certain computational tasks within the memory unit. I will present how computational memories accelerate AI applications and will show small- and large-scale experimental demonstrations that perform high-level computational primitives, such as ultra-low-power inference engines, optimization solvers including compressed sensing and sparse coding, linear solvers and temporal correlation detection. Moreover, I will discuss the efficacy of this approach to efficiently address not only inferencing but also training of deep neural networks. The results show that this co-existence of computation and storage at the nanometer scale could be the enabler for new, ultra-dense, low-power, and massively parallel computing systems. Thus, by augmenting conventional computing systems, in-memory computing could help achieve orders of magnitude improvement in performance and efficiency.

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