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DOI: 10.12762/2020.AL15-00

Artificial Intelligence and Decision Making

Artificial Intelligence (AI) is currently an inescapable keyword in computer science given its predicted huge contribution to the global economy [1] or to the whole society [2, 3], as argued in many recent white papers or reports. Its techniques are expected to provide efficient ways to deal with heterogeneous and voluminous numerical environments and data, help or even improve decision making, and automate complex functions. The aeronautics, spatial and defense domain (ASD) is impacted by this evolution [4].

AI is a research field with a complex history and numerous areas. It is customary to divide these into two trends:

- Formal and logical, which rely on models, knowledge representation and solvers;
- Empirical, which rely on data, statistical estimation and inference.

Although this last trend mainly drives what is sometimes referred to as the third wave of AI, with Machine Learning playing the key role of a general design principle, it cannot fully solve all problems: data can be rare and costly in the ASD domain, where the requirements of reliability and predictability are often very high.

The present issue of the Aerospace Lab journal contains several examples of AI research, from rather specific studies to more general position papers or surveys, which exemplifies these two traditions and, eventually, their possible combination.

With regard to the representation and use of knowledge, the contribution "*Semantic Mediation for Dynamic Fusion of Observations and Sensor Data*" addresses the problem of fusing sensor data and natural language messages generated by humans for entity tracking and identification in dynamic environments. The framework relies on a generic ontology, which provides a uniform vocabulary for data from human observations and sensor outputs, with different levels of granularity. Specifically, a semantic mediation layer is used to fuse information from both sensors and humans.

"*A survey on chronicles and other behavior detection techniques*" is a survey of information extraction from data flows. It treats this area from a logical perspective and describes logical approaches from information flow processing, knowledge representation and reasoning perspectives. It describes event calculus, Etalis system, chronicle and SQL-based approaches, together with their specific operators for combining and detecting events.

Making plans is a typical intelligent activity often addressed using formal AI methods. The paper "*Collaborative Common Path Planning in Large Graphs*" studies the two-agent collaborative path planning problem, where the agents are incentivized to move together along the same path as much as possible by scaling down the duet cost function when they move together. It proposes A*-based algorithms and provides heuristics to guide the search. The paper presents an assessment of the algorithms on grids of different sizes and with different cost reductions. Another article: "*Planning for space telescopes: survey, case studies and lessons learnt*" presents the application of AI planning and scheduling techniques for optimizing the operations of satellites whose mission is to observe celestial objects. Several mission-planning tools are presented and three case studies are tackled using a constraint-based optimization and operations research approach. Future work directions are highlighted: development of generic mission-planning tools, management of uncertain events and definition of a centralized mission-planning concept for several telescopes.

The Multi-agent architecture is a traditional model of formal AI methods. Considering a class of linear multi-agent s*ystems, "Robust consensus seeking via a multi-player nonzero-sum differen*tial *game*" studies the problem of consensus seeking in the presence of an exogenous signal, possibly representing a disturbance. It formulates the robust consensus-seeking problem as a nonzero-sum differential game, characterizes solutions, and presents simulations of examples to illustrate the resulting performances: one example concerns consensus among agents described by single-integrator dynamics and the other concerns formation flight of unmanned aerial vehicles. A multi-agent approach is also used to coherently manage embedded sensors in the *article "RAMSES: a multi-agent architecture to design a multi-sensor system deployed on the next generation of airborne* platform". This paper focuses in particular on multi-sensor systems embedded in remote piloted aircraft systems and proposes a scenario related to those systems.

The Machine Learning dimension of AI is discussed in three articles: "*Challenges in certification of computer vision based systems for civil aeronautics*" addresses the problem for modern computer vision techniques to comply with current certification standards. By describing two prototypical pipelines, for visual odometry and for scene understanding, it outlines the challenges faced when applying current certification guidelines to non-deterministic systems and machine-learning-based algorithms. The article "*Scaling up information extraction from scientific data with deep learning*" focuses on applications of Deep Learning (DL) for real life use cases where the size of the experimental data is an obstacle for understanding a physical phenomenon and showing how such techniques allow experimental work to get rid of uninteresting, repetitive and time-consuming tasks. Finally, the article "*Recent examples of deep learning contributions for earth observation issues*" focuses on the impact on Earth Observation (EO) practices of using learning methods for remote sensing image analysis. It presents DL particularities and challenges for analyzing EO data, highlights differences between EO and computer vision problematics and covers the main modalities of EO sensor data and the principal aspects of EO image processing: co-registration, image enhancement, classification, object detection, parameter retrieval and multi-temporal analysis ■

References

[1] *Artificial Intelligence the Next Digital Frontier?* McKinsey and Company Global Institute, 2017.

[2] *White Paper on Artificial Intelligence: a European Approach to Excellence and Trust.* 2020.

[3] C. VILLANI - *For a Meaningful Artificial Intelligence: Towards a French and European Strategy*. Conseil national du numérique, 2018.

[4] *Artificial Intelligence Roadmap. A Human-Centric Approach to AI in Aviation.* European Union Aviation Safety Agency, 2020.

AUTHORS

Stéphane Herbin received an engineering degree from the *Ecole Supérieure d'Electricité* (Supélec), the M. Sc. degree in Electrical Engineering from the University of Illinois at Urbana-Champaign, and the PhD degree in applied mathematics from the *Ecole Normale Supérieure de Cachan*. He was employed by Aérospatiale Matra Missiles (now MBDA) from 1998 to 2000. He joined ONERA in 2000, and has been working since then in the Information Processing and Modelling Department. His research adresses mainly the design of models and algorithms for data interpretation with a focus on images and videos.

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