NAME : Antoine Marot
COUNTRY : France

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Towards an AI assistant for power grid operators

From the beginning, power grids have been complex artificial systems. As of today, complexity keeps rising at a time of energy transition given the advent of intermittent renewable energies over a more and more interconnected European grid. Operators are facing ageing grids, with slower grid asset developments due to decreasing social acceptability. Operators hence need to operate a system closer to its limits while dealing with greater uncertainty and increasing grid automation [1] inducing complex cyber-physical dynamics [2]. Given technology advances such as with AI, there could eventually be a temptation to develop a fully autonomous grid to cope with that complexity. But it falls short for such large critical system operations. Indeed, coordination, responsibility, accountability, and explainability are a must when operating such a system and can only be reasonably achieved by humans today: human operators remain key players [3] as with flight pilots.

When possibly transitioning to automation, ”Ironies or myth of automation” [4,5] warn that operators should ultimately be more skilled than less skilled to deal with the most difficult new and complex situations. Amongst many short-comings mentioned in [6], over-reliance and deskilling are one of the most damaging for control rooms. As of today, operators have a deep knowledge of their grid area, both in terms of infrastructure and electrical phenomena. Adding an automatic system could lead operators to rely too heavily on the system, progressively losing their expertise, with potentially catastrophic consequences when it fails. Overconfidence should not be a trade-off with over-reliance, and operators should have the opportunity to keep developing their skills and cognitive strategies through regular training and manual problem-solving.

Latest developments of AI, and particularly in Machine Learning (ML), yet enable deeper and more practical large-scale real-time information processing, such as in computer vision [7], image understanding [8], natural language processing [9], and recommendations [10]. This shows a potential shift towards even more advanced Human Machine Interaction (HMI), through the concept of assistants. Assistants were found useful to both improve single-user performance and group collaboration on a common task [11], help chess players develop their playing skills [12], or help programmers write code [13]. In power grids, the notion of an AI assistant was used

lately in [14,15] and listed as an opportunity to tackle climate change [16]. Nevertheless, eventual assistant pitfalls should be closely investigated, analogous to previously mentioned “ironies of automation“ [4].

Other industries such as in Warehouse Logistics with Amazon, Data-center cooling or balloon network management with Google, or huge scientific machine operations with LHC have already used AI extensively in their operations and offers different examples to reflect on. With Amazon, there is a target for full automation and replacing human operators in warehouse. The developed assistants use today [17] give orders to human operators through earpods, somewhat automating the humans. The human acceptance is low with high turnover. This would not apply in power system context as responsibility and experience is of utmost importance. For data-center cooling [18], the assistant showed as daily recommendations by email which could be considered or not by humans. This was more acceptable even if it was limited in terms of interactions which could have improved the usability. Considering the stratospheric balloon management system [19], we are looking forward to seeing if for a brand new and more autonomous system, human operators are still needed, and if the case, how a related assistant is accepted by new operators. Finally, a successful and useful example building on AI and to learn lessons from comes with LHC operations and large experiments [20]: humans could rely on vital assistance functions with AI to explore new physics and acceptance was high in that case.

To make things clearer regarding the overall concept of an AI assistant, we explain how it articulates with assistance functions and is distinct from a completely autonomous system. Assistance functions help users with domain-specific tasks, for example, by alerting when relevant information arrives, or monitoring user context and warning him about unforeseen risks. Situation awareness [22,3,21] offers, in that sense, advanced assistance functions. Transportation sector evokes those functions through different autonomy levels [23,24,25], that we can reflect on. We here focus on the Grades of Automation (GoA) definition from the International Association of Public Transport [26,24].

GoA1 and GoA2 offer assistance functions as discussed previously, but without much consideration for HMI. GoA3 and GoA4 are targeting autonomy through automation. It highlights that many fields such as autonomous driving [23] aim at fully autonomous systems. They diverge from our goal of augmenting operators through an assistant. While being conceptually closer to GoA2, an assistant move away from the usual automation typical of system engineering, to be rather operator centric.

An assistant is yet another level whose goal is to offer the right balance between user control and autonomy [27] for enhanced decision-making. It certainly has assistance functions at its core, but most importantly also engages actively with the user. It offers a unified interface and allows for dynamic bidirectional interaction with the user to cooperate efficiently on task completion and with others. It is essential to keep in mind that, in this paradigm, the responsibility of system management still ultimately falls on the operators of critical systems. While some tasks could eventually be automated away, it is paramount to avoid pitfalls such as operator deskilling, often due to the “out-of-the-loop” effect [3]. Assistants should rather let operators remain in

control, which will require more than automation supervision [28], and help reinforce their expertise. Finally, unlike GoA framework, getting a teamwork perspective is important, by taking into consideration the interactions between control room operators, to foster proper coordination and to allow for observability, predictability and directability as in Human-Centered AI [29].

While the Assistant framework should be generic with high interoperability, its instancitation will probably build up incrementally over more and more diverse tasks, possibly starting with congestion management as in and continuously integrating new AI capabilities relevant to humans and teams.