

Research Challenges in Coupling Artificial Intelligence and Network Management

draft-francois-nmrg-ai-challenges-02

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Summary

- Call for adoption
 - Based on draft-francois-nmrg-ai-challenges-01
 - Ended February first
- Thanks for all the feedback received
 - Positive feedback/support: 20+
 - Neutral: 1 (with detailed comments)
 - Detailed comments: Qin, José, Toerless, José
- New version: draft-francois-nmrg-ai-challenges-02

Minor changes between v1 and v2

- Overall Editorial pass, list of acronyms updated
- Distinction AI / ML clarified in “*1. Introduction*”
- Section “*4. Difficult problems in network management*” revised to ensure each problem is mapped to the characteristics defined as a preamble of the section, e.g. “C6: Solutions MUST be cost-effective”
- Clarification of the classification of subchallenges in section 6 according to global in section 5: text added with explicit cross-references
- 4 external references added to illustrate problems or existing solutions

Change #1: Distributed AI

- New full section to provide answers to different received comments

- AI for NM or NM for AI, both can (co-)exist and this is reflected in distinct subsections

6.4.	Distributed AI	17
6.4.1.	Network management for efficient distributed AI	17
6.4.2.	Distributed AI for network management	18

- 6.4.1 ~ Network is distributed by nature so it is an enabler of distributed AI

- Coupling of the AI app and network management plane (need for interfaces)
- Federated learning example added to illustrate

- 6.4.2 ~ Higher level of coupling

- Location of AI within the network varies according to use cases (no unique answer)
- Co-location of AI processes and network elements (traffic, configurations)
- Local scope to (part of) the problem can avoid additional delay and privacy concerns

...While the network can be adapted or eventually adapt itself to the AI distributed applications, AI applications could also adapt themselves to the underlying network conditions. It paves the way to research on methods to support AI application aware-network management or network-aware AI applications or a mix of both.

...deployment of AI-based solutions for NM can also take into account various network attributes [...]. In that case, management of computational and network resources is even more coupled since the network is both part of the AI pipeline resources and the managed object through AI.

Change #2: added text explaining the relationship between AI-based NM and Digital Twins

- Difference between AI-based NM and Network Digital Twins
 - Using a DT and AI-based management techniques are unrelated
 - DT are not necessarily based on AI
 - Reflected in the “explainability” section

It should be noted that Digital Twins are not considered per se an AI approach; they merely serve to provide a digital representation of a network [...] That being said, it is conceivable that AI-based management applications can be combined and operate in conjunction with Digital Twin technology

Change #3: AI-based products and algorithms in production systems

- Lack of generalization ability of ML algorithms and its impact on ML-based NM solutions
 - Content added to highlight possible solutions: data representativeness, new AI architecture (e.g. GNNs), transfer Learning...
- Lack of discussion on interoperability issues
 - Need for interfaces (with AI meta framework allowing changing algorithms/models)
 - Share commonalities with distributed AI when coupled with NM

One approach is training on diverse data that represents large parts of the expected problem [...] Another approach is to leverage AI designs or architectures that facilitate generalization. [...] GNNs are a rather novel type of neural network able to operate and generalize over graphs. Indeed, networks are fundamentally represented as graphs: topology, routing, etc.

...there are also challenges in terms of interoperability between different AI approaches and different deployment environments [...] This shares some with problems described in Section 6.4 and particularly emphasizes the need for network environments to provide interfaces and descriptions suitable for AI solutions to be properly instantiated and configured [...] These meta-frameworks provide a higher level of abstraction and often allow seamless deployment across different environments

Other comments

- Discussion on specific AI/ML methods
 - Avoid too low level technical details in the document
 - This document must help both people from AI with a little understanding of network AND people from networking with a little understanding on AI
- More details about solutions for the different challenges
 - Challenge-solution mapping is currently one of the challenge (6.1)
 - This document focuses on challenges but not on solutions, it would be impossible to be exhaustive (only illustrative examples with references)
 - How to address properly the different (sub-)challenges) should be done in other documents (drafts, papers...)
- Feedback from the operators
 - We encourage them to give their perspectives on the current document
 - The authors and contributors to this document include several users, in addition to academics and vendors

Next step

- Outcome of the call for adoption
 - Very positive (reminding that this document was first revised as separate shared document , not as a draft → so many previous versions exist before official v2)
 - “Official answer” by the chairs not sent yet
- Next steps
 - Our views: a well supported document with many contributors that can be a basis for future contributions and that is perfectly aligned with global trends in the area of NM from scientific and technological perspectives
 - → we should not wait too long to progress
 - Have this document rapidly adopted as RG document
 - Periodic updates to continue towards informational RFC publication