Finding the Critical MAS(S): Resources and Representations Needed for Weaving a Web that Hosts Linked Multi-Agent Systems

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A small but viral first hMAS. Linked Multi-Agent Systems (MAS) is a vision where MAS are linked through their resources and representations on the Web to allow us to turn the Web into an architecture supporting a network of interoperable MAS. One of the hardest tasks for Tim Berners-Lee in the early 90s was to make people imagine a world with a fully deploy Web and that we have the same cold-start problem with the Agents on the Web [A]. I still believe this to be a strategic question in 2023. In Hypermedia Multi-Agent Systems (hMAS), agents operate on an homogeneous hypermedia fabric that interconnects heterogeneous resources. The Web is the distributed hypermedia that has become the primary software architecture for applications on the Internet but not for Multi-Agent Systems, at least not yet. We are getting closer but we are not there and, in my opinion, a key step is to identify at least one use case that, not only could demonstrate hMAS but, more importantly, that has the potential to reach a critical mass of usage, the tipping point of a network effect like it was the case in the past successes of the Web [B].

The right metadata soil for growing hMAS. A lot of effort has been invested in knowledge acquisition and knowledge publication. We participated to that effort, with methods to index (IndeGx) [M], visualize (Kartographi) and annotate (Metadatamatic) linked data(sets)[N]. But for a first viral hMAS to happen we need the right breeding ground, we need to target metadata that have an impact on targeted adopters, largest users' community, etc. Moreover, with native mechanisms such as conneg (content negotiation over HTTP) the Web can do much more and support adaptative knowledge exchange of customized representations for human and software agents. The Web has the potential to support profile-based knowledge negotiation for AI methods to obtain or contribute the type of knowledge they can process. Such an open negotiation could also be a key enabler for forward compatibility in open hMAS.

The position of hMAS in the effort of (re)decentralization. Even more than AI, it is distributed AI that has a rendezvous with the Web [AA]. By nature, the distributed artificial intelligence paradigm of MAS can participate to the (re-)decentralization of applications and their architectures in general, and on the Web in particular with hMAS. This requires positioning hMAS w.r.t. other initiatives like SOLID. Decentralization in general, has to consider many fronts (architecture, applications, data, schemata) at the same time and hMAS, in particular, will have to consider all of them too.

Extend and make easier the existing solutions. hMAS must be conceived as an extension of the Web and not as another Web or as a Web apart. The futures of the Web must be suited both for "software- and human-agents" [O] and it may reopen the discussion on the relation between humans and agents in MAS both conceptually and practically. This may also echo discussions on other current trends in computer science such as the topic of digital twins (for artefacts, for users, etc.). Finally I would like to conclude on a "meta-risk": In the history of computer science, we have many examples of a language, an architecture or a tool being reinvented because the previous ones had become too complex for

newcomers, for simple use cases, etc. In what we will propose we must thrive to avoid the Déjà Vu of a technology stack that becomes too complex with an adoption cost too high and making the bed for the temptation to create something initially seemingly simpler on the side but that will end up being the first layer of a new technology stack continuing the cycle of reinventing languages, architectures, formats, etc. again and again.

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