AI KR CG

FIRST REPORT, FINAL VERSION

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1. EXECUTIVE SUMMARY

This report contains background, motivation and initial intended direction for the W3C AI KR CG, launched in 2018, together with pointers to published literature, contributions and discussions in relation to the CG core areas of interest (AI KR). It describes possible work ahead including the outline of SLKR (System Level Knowledge Representation) and Neuro Symbolic Integration as the basis for a future possible AI KR specification (see planned actions). The purpose of the report is to summarize the main activities carried out to date by the Chairs, to invite members to contribute, and to elicit expressions of interest from the wider community and given enough support, upgrading the activities to WG (work group).

2. BACKGROUND

The need to start a CG devoted to AI KR was prompted by a worrying trend in IT to devise powerful autonomous systems capable of minimizing or bypassing knowledge altogether, and by the emergence of an incumbent generation of AI applications designed solely to distort and misrepresent knowledge and truth with the explicit aim to manipulate and control public opinion and influence decision making by producing outcomes which are not aligned with legal policies.

Fragmenting and decoupling logic and representation from AI systems has become accepted in ML (Machine Learning) to facilitate certain aspects of data processing.
The acceptance of computation without humans in the loop and explainable, shared KR has been growing in parallel to increased acceptance of the systemic deconstruction of integrity and truth preservation in AI. Breaking up logical constructs by fragmenting them

and/or rendering them irrelevant, unintelligible and inaccessible to humans (including developers. users, observes, experts, analysts and researchers who end up with limited visibility of the whole) contributes to the many concerns for AI: lack of transparency, limited understandability, accountability, fairness, algorithmic bias, misrepresentation, deep fakes, and fundamentally hinders the ability to understand and explain what is going on in the box, at system level and especially system of systems level.

Given the growing importance of AI in mediating all aspects of data, information and operations in science, research and computing, and all spheres of public concern, the importance of KR is now not only relevant to AI, science and engineering, but also to epistemology, education, public awareness and public life. Ultimately KR as applied in AI and IT, as well as in other domains, mirrors the level of awareness and intentions of stakeholders and impacts all categories of users. The way humans as well as machines process, perceive and project knowledge is the result of knowledge representation.

Eventually choices of knowledge representation and encoding in AI contribute to the future or humanity as a whole. It is with these concerns in mind that the CG was initiated and operates.

As of publication date of this report, the AI KR CG counts 70 members, mostly lurking. A [Stakeholder's Survey](#) with some responses so far. To date members have not yet agreed on a shared plan of action nor deliverables for the CG, nonetheless a rich, diverse and even somewhat entertaining AI KR related list of topics has been discussed on the mailing list. [Read it here.](#)

By monitoring relevant published literature useful resources have been identified which can help to answer **at least one of the questions** raised when this CG launched, namely:

Which are the AI KR techniques/resources of interest to this group? There is no reason to limit the focus of this group to a subset of techniques. Whatever KR techniques are adequate to address current AI challenges. Useful starting points can be gathered from published literature See or example:

KR Knowledge Representations in Technical Systems -- A Taxonomy Kristina Scharei, Florian Heidecker, Maarten Bieshaar https://arxiv.org/abs/2001.04835

A mind map of KR

A visualization (Image 1) of the convergence between AI/KR and COGAI (Kotsuba et al) shows the range of COGAI techniques **mapped to KR paradigms This diagram** shows an interesting correspondence between KR and CO GAI.
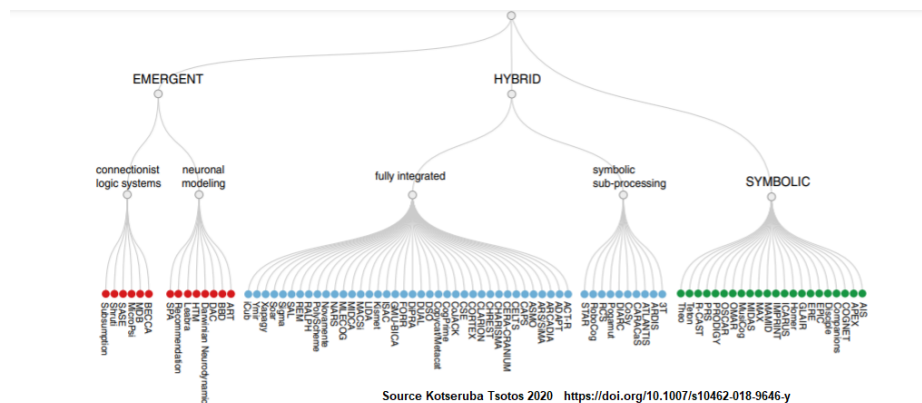

Image 1. Kotsuba et al 2020 (reproduced with permission)

3. PROBLEM STATEMENT

Most of the risks currently associated with AI, as well as general challenges related to belief systems and misinformation in society, can be ascribed to non adequate KR. Despite the wealth of resources, tools, techniques, literature, expertise in AI KR there are huge gaps in the understanding and application of KR to resolve key open AI concerns. Ironically, KR itself can be used (misused?) to misrepresent knowledge such as making false assertions, and to render intelligent systems seemingly perfectly functional while making the underlying data and knowledge unintelligible, opaque thus resulting in systems untrustworthy and ultimately unaccountable. For example, KR can be used to deliberately inject bias into algorithms.

This misuse of KR is a type of Systemic Deviation. [1], one that adequate KR can attempt to identify and resolve. With these considerations in mind, the work carried out within the CG intends to shine some light on the role of KR to address AI risks and open concerns.

4. OPEN QUESTIONS

How can KR be used to address knowledge misrepresentation in AI, from algorithmic bias, to deepfakes, and truth preservation in massively distributed environments? How can KR be used to balance the trend in ML which is attempting to minimize or avoid the role of K (Knowledge) in systems automation? How can KR be used to make explicit the continuum between human evolution, higher cognition, intelligent systems design, automation, decentralization, knowledge sharing and participatory paradigms? Members are welcome to post more questions.

5. CONTRIBUTIONS

Interesting ideas have been highlighted on the public mailing list, including

a) documenting AI/ML initiatives in StratML format. Owen Ambur, active contributor to the CG plans to continue documenting AI/ML initiatives in StratML format and to encourage AI/ML researchers and developers to document their plans and publish their performance reports in StratML
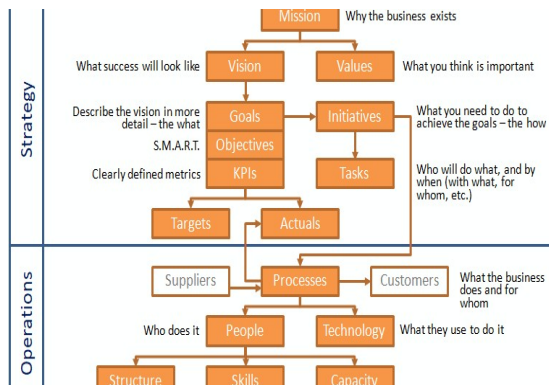

Diagram Courtesy of Chris Fox, https://www.stratnavapp.com/

b) supporting the creation of a catalog of such efforts, to align with efforts at EU or US institutional level to the development of a schema for ethical AI registries to the compilation of shared vocabularies that specify general AI requirements for sharedness, reliability and trustworthiness. Explicitly shared knowledge is a necessary foundation for responsible use of technology, algorithmic awareness and conscious socio technical society. This CG is stressing the

need and importance of the topics summarized briefly in this report and invites members to share their work and thoughts on the topics already discussed and many more ahead. The diagrams below summarize some of the original constructs and arguments relating to discussions (on the mailing list and elsewhere) originating from AI KR CG. These may form the basis or future developments and justification or future standardization efforts
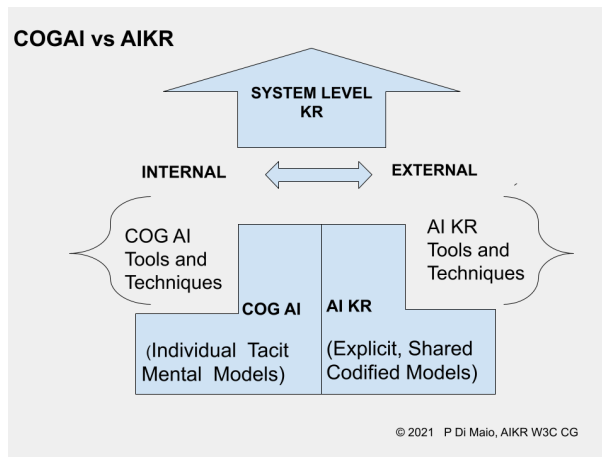

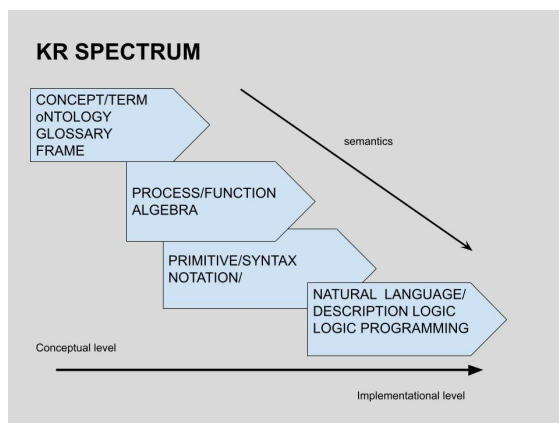**Image 2 -** CogAI vs AI /KR (Internal vs External representation) P Di Maio

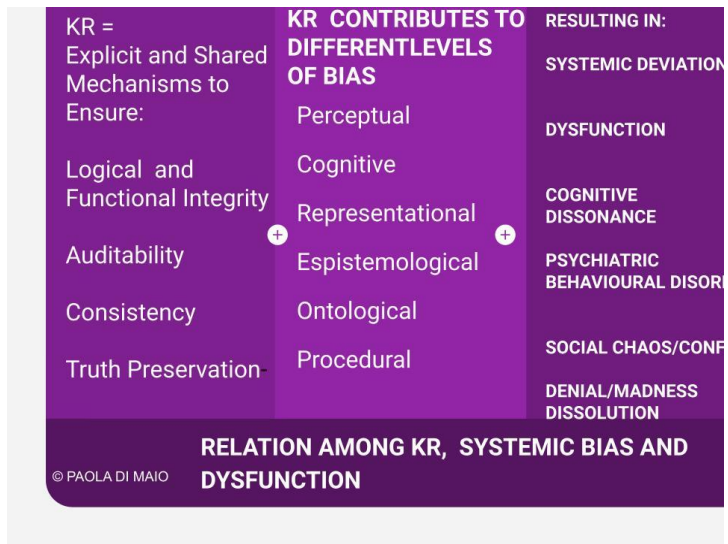
Image 3 - KR as a spectrum - P Di Maio

Image 4 Role of KR in Systemic Bias P Di Maio

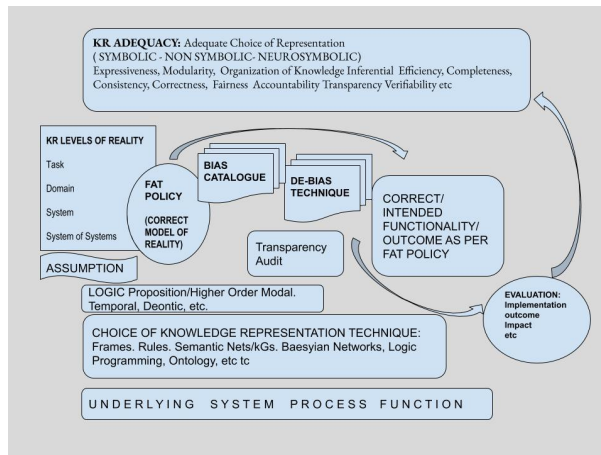# System Level Knowledge Representation (SLKR)

Image 5 SLKR P Di Maio 2021

A SLKR model has been applied to model knowledge complexity in the domains of AI, neuroscience and IOT (internet of things) in peer reviewed publications[2,3,4,5, 7].

Knowledge misrepresentation, especially when it occurs through hidden permutations, is responsible for the likelihood of corruption of logical integrity of intelligent autonomous systems

Considering the complexity and logical fragmentation whereby units of logic, System Level Knowledge Representation (SLRK) can be used as an explicit integrated model aimed at supporting logical integrity throughout the system lifecycle. It has the potential to become part of an open specification, possibly resulting from the CG becoming a WG, if enough members commit to this vision.

Additionally, discussion have been contributed in relation to KR as a diagnostic tool for mental health, KR and gut bacteria etc *check the group's mailing list.

6. PLANNED ACTIONS

- Continue activities and contributions by individual members and update the group's pages
- Propose a draft standard for neural symbolic integration
- Identity enough members to form a WG
- Nominate Richard Lea, Rakuten as co-co-chair (tasked with creating and maintaining AI KR CG online repositories and encouraging Members to support the AI KR transition to WG) [1]
- Start drafting the neurosymbolic KR standard
  (See the abstract on academia[2])
- Start taking notes for the next report
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7. TPAC MEETING NOTES

During TPAC 2021 the AI KR CG held a virtual meeting on 25 October. 9 participants were present on the call, none of whom except Paola, Chair, was a CG member. The outline of this report was presented as the basis for the meeting. Richard Lea expressed interest in contributing as a W3C Member company, Rakuten. It was suggested that the combination of RDF/SHACKL addresses some of the challenges raised by this CG, a demo was invited
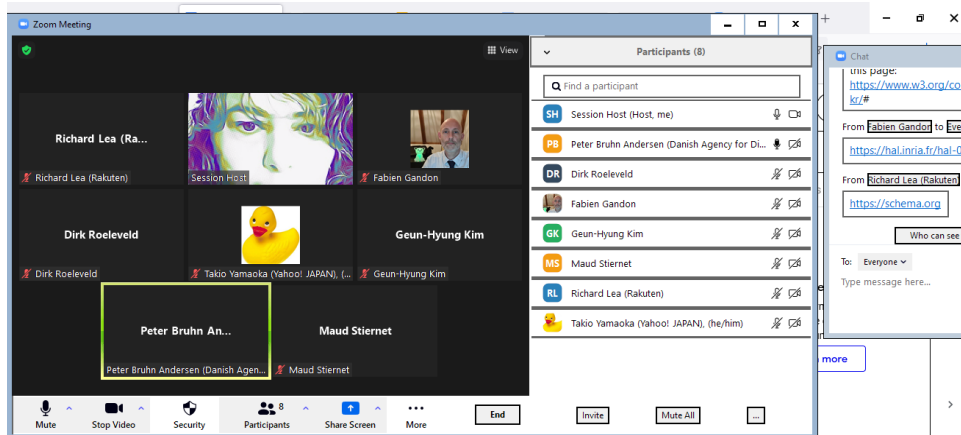
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[1] Note: Richard Lea was nominated co-chair in the spring 2022, before the report was published

[2] **A Metamodel Card for System Level Neuro-symbolic Integration**

Paola Di Maio 2020, Research Notes

Image 6 IScreenshot from ZOOM call @tpac2021

Fabien Gandon during mentioned relevance with this work: ML+SW/KR: Learning and Reasoning for Cultural Metadata Quality : https://hal.archives-ouvertes.fr/hal-03363442/document

ACKNOWLEDGMENTS

Thanks to members and the co-chair for their contribution, and to EUON State of AI[6]report for including a mention to this CG.

REFERENCES

[1] Systemic Deviation, Di Maio, ISSS 2016

[2]System Level Knowledge Analysis and Keyword Extraction in Neuroscience

PDi Mail International Conference on Brain Informatics, 225-2342021

[3] System Level Knowledge Representation for Metacognition in Neuroscience

PD MaioInternational Conference on Brain Informatics, 79-882021

[4] System-level knowledge P Di MaioLeveraging Artificial Intelligence in Global Epidemics, 261

[5] System Level Knowledge Representation for ComplexityP Di Maio

2021 IEEE International Systems Conference (SysCon), 1-6 2021

[6] EUON https://zenodo.org/record/5011179#.YXW3MRwRXjF

[7] System Level Knowledge Representation for Edge Intelligence Paola Di Maio,
22 Published in: Artificial Intelligence for Cloud and Edge Computing, Springer International Publishing

https://www.springerprofessional.de/en/system-level-knowledge-representation-for-edge-intelligence/20029570

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