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Improving Decision Making using Semantic Technology

ESWC21 PhD Symposium

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With inputs from Anna Fensel

Outline

1) *Introduction Decision Making*
2) *Motivation*
3) *Research Question*
4) *Contributions*
5) *Evaluation Plan*

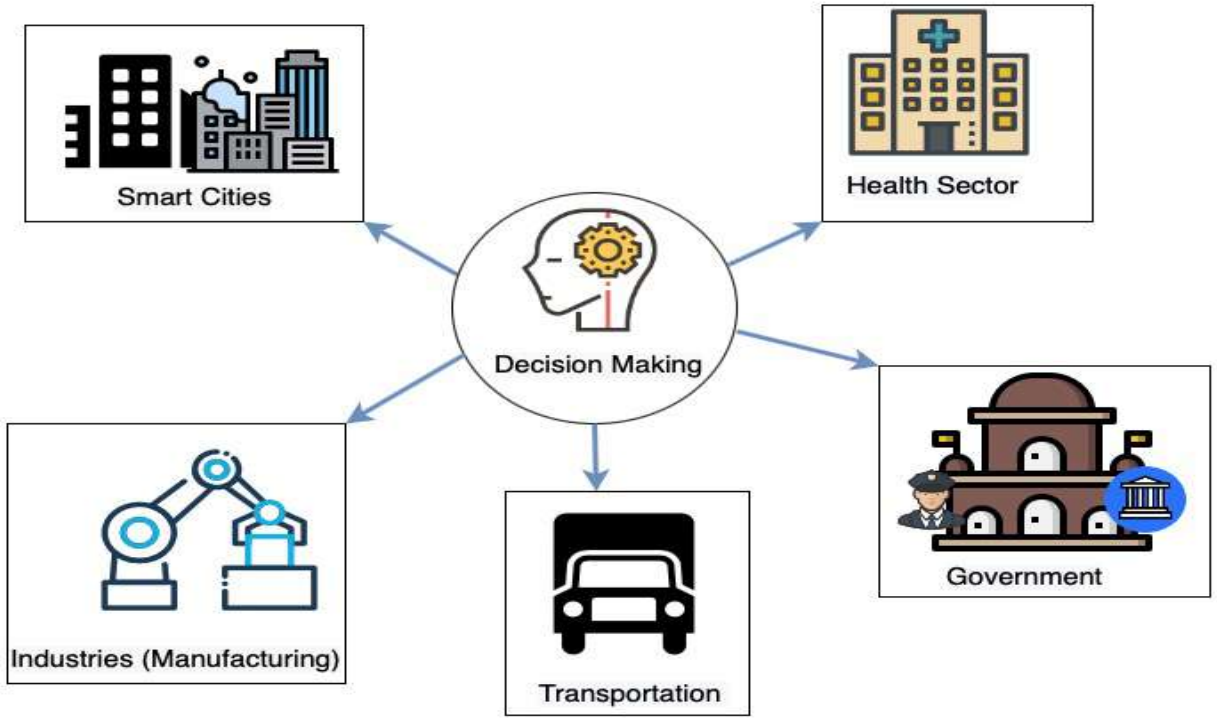
Acknowledgements

- "**smashHit**: Smart Dispatcher for Secure and Controlled Sharing of Distributed Personal and Industrial Data", EU Horizon 2020 funded project, duration: 2020-2022,
- https://www.smashhit.eu

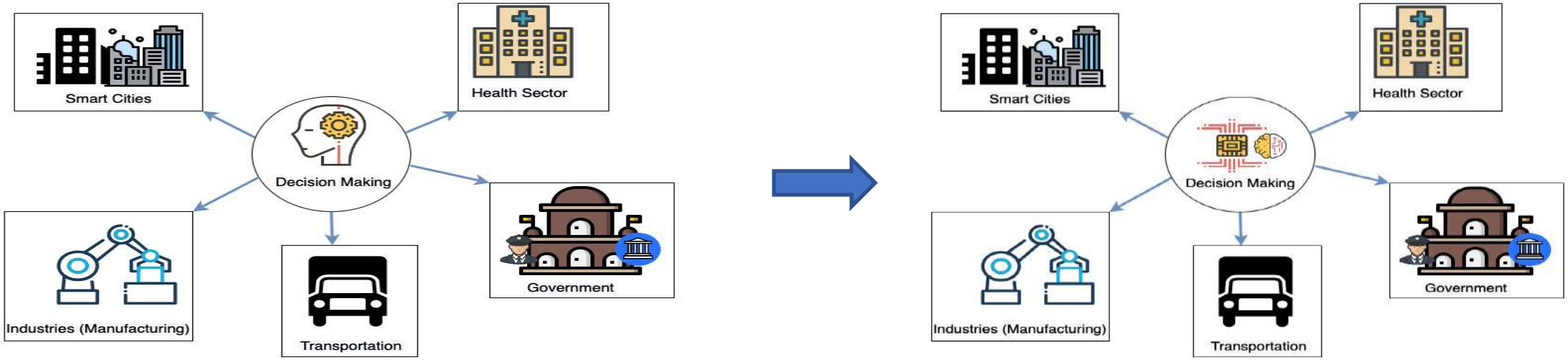
- "**KI-Net**: Building Blocks for AI-based Optimization in Industrial Production", Interreg funded project, duration: 2020-2022,
  - https://www.scch.at/de/das-projekte-details/KI-Net

1. Introduction to Decision Making

- *Decision making is defined as a mental process, which involves judging multiple options or alternatives, in order to select one, so as to best fulfil the aims or goals of the decision-maker* [1].



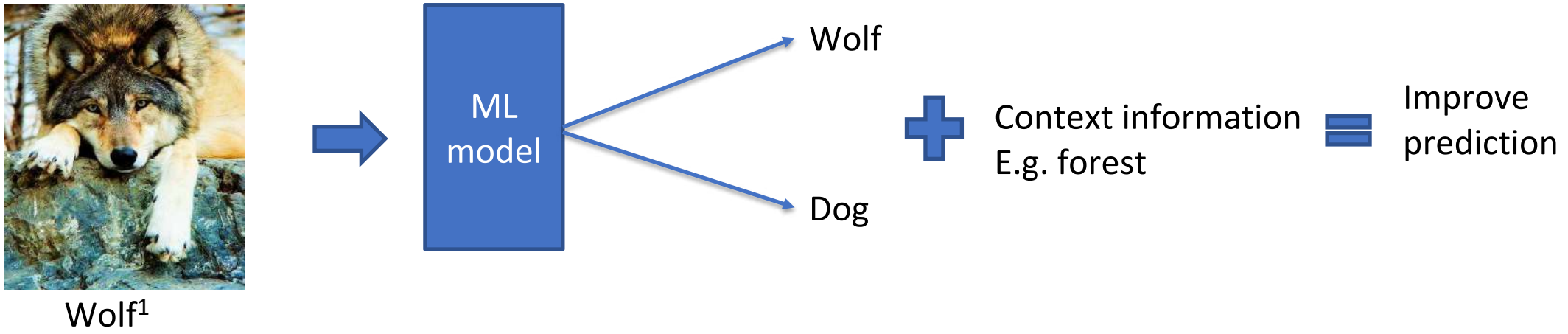
1. Introduction to Decision Making



- The main aim of this research is to improve machine-based automated decision making in a heterogeneous and distributed environment.
- Machine-based automated decision making in a heterogeneous and distributed environment refers to using a machine to decide in a distributed environment, such as smart cities, with complete or minimal human intervention.

2. Motivation

- Machine learning (ML) based systems have limited **explainability**, **interpretability** and are potentially biased in nature [2, 3, 4] and lack context.
  - E.g. Blacks were penalised more severely than nonblacks, even when the nonblacks had more severe crimes [4].



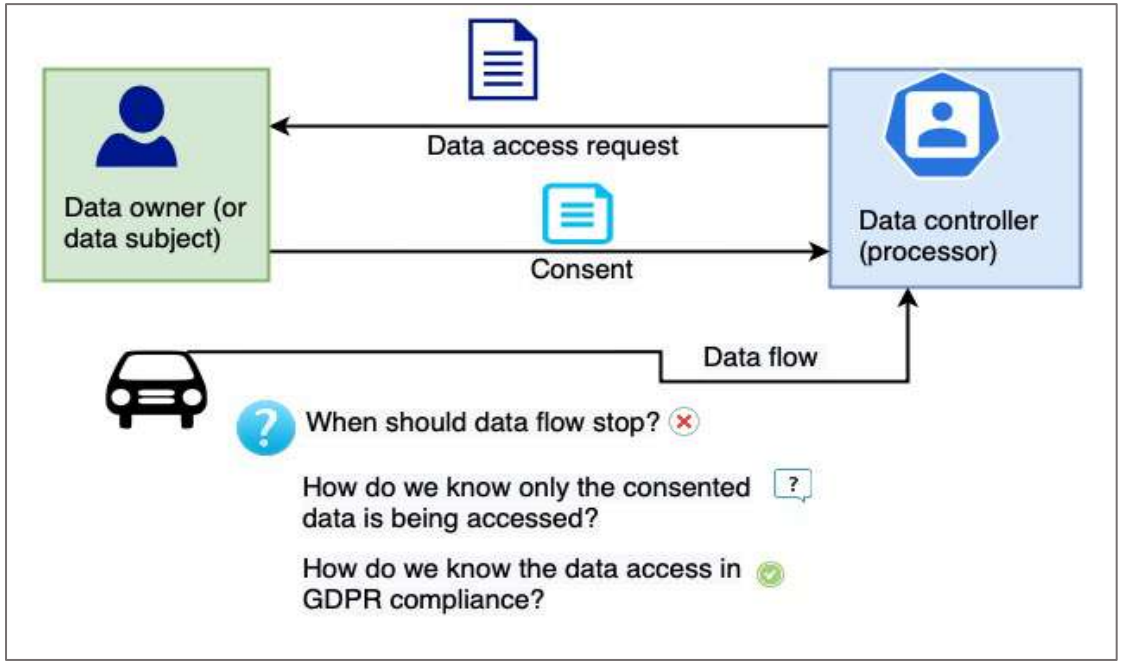
Wolf[1]

- Semantic Web technologies can help ML missing semantics (or contextual information), can make ML and further can make ML interpretable and explainable [5, 6, 7].

1. https://www.fanpop.com/clubs/wolves/images/36658427/title/big-beautiful-wolf-photo

2. Motivation

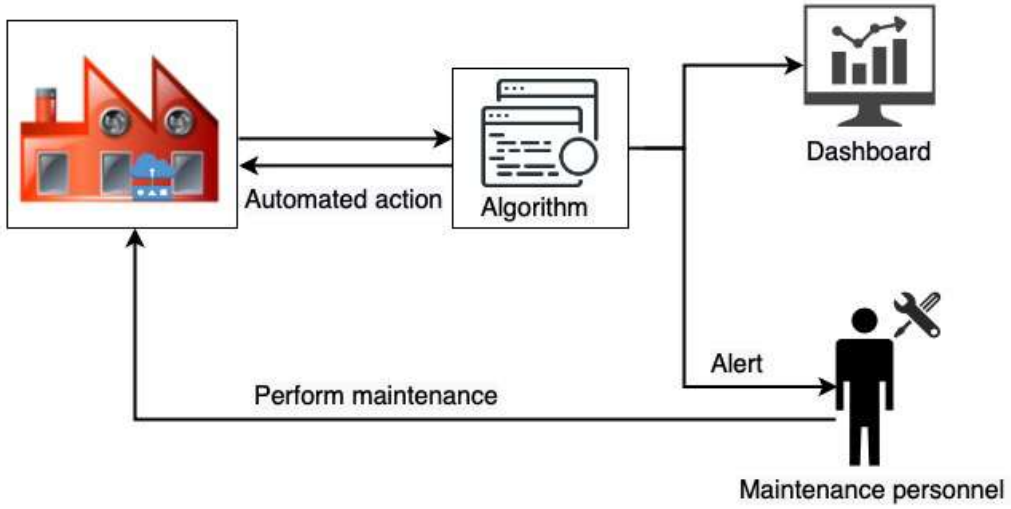
- According to the World Economic Forum data is a new asset in this modern time[2].
- The consequences can be both positive and negative based on how data is used.
  - E.g. The use of voter data in a political campaign to manipulate voters can endanger fundamental rights and undermine democracy [8].
- GDPR (General Data Protection Regulation)[3] was implemented on May 25, 2018 and provides data owner control over their data.
- GDPR has introduced six legal bases; **consent**, contract, legal obligations, vital interests of the data subject, public interest and legitimate interest.
- We need a compliance verifier.



2. http://www3.weforum.org/docs/WEF_ITTC_PersonalDataNewAsset_Report_2011.pdf
3. General Data Protection Regulation (GDPR), available at https://eur-lex.europa.eu/eli/reg/2016/679/oj

2. Motivation

- There is a growing use of connected things in healthcare, industry such as manufacturing and other mission-critical systems.
- The deployed systems in domains such as healthcare needs to be fail safe because failure can reduce productivity, increase downtime and even cost human lives.
- Maintenance yields 15 to 60% of total manufacturing operating costs [9].
- Market value of USD 21.20 Billion by 2027[4].



4. https://www.reportsanddata.com/report-detail/predictive-maintenance-market

Challenges

Knowledge representation and processing at scale, integration with techniques like modern ML methods, and data complexity [10].

Integration of reasoning techniques, such as embedding-based reasoning, logic-based and neural network-based reasoning techniques [11].

3. Main Research Question

RQ: To what extent we can leverage Semantic Web technologies to improve and automate decision making in a distributed and heterogeneous environment?

- *To what extent can we improve decision making by combining a knowledge-driven approach with a data-driven approach where knowledge is represented using Semantic Web technologies in the form of knowledge graphs?*
- *To what extent can we support the required decision while also dealing with complex interactions and maintaining the necessary scalability in dynamic and heterogeneous environments such as smart cities and manufacturing?*

4. Contributions

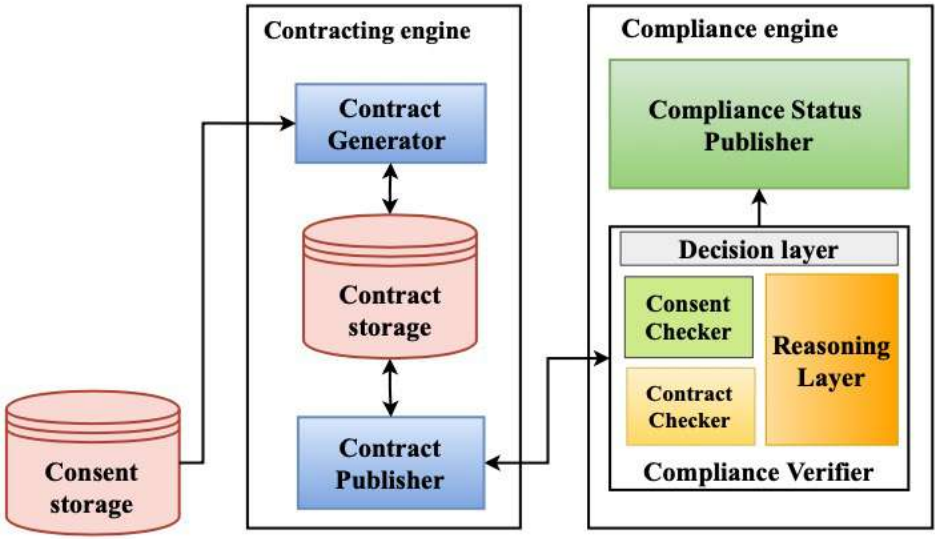
Development of an automatic contracting tool for GDPR compliance verification in smashHit[5].

Predictive maintenance prototype in KI-NET[6].

5. https://smashhit.eu
6. https://scch.at/en/das-projects-details/ki-net

4.1 Automatic Contracting Tool

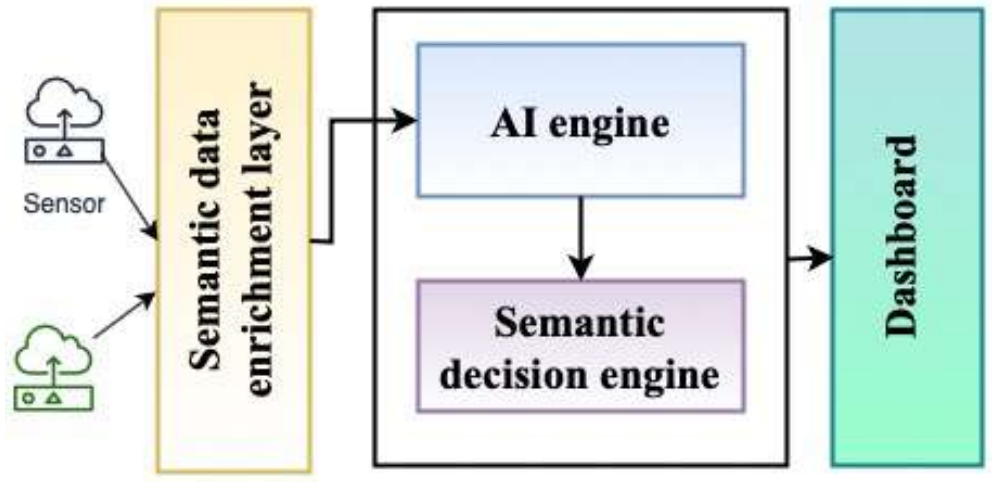
- The automatic contracting tool will be in charge of making (or supporting) the following decisions:
- Whether data exchange should be permitted?
- Performing verification to determine whether there is a breach of contract or a broken consent chain.
- Checking updated consent information to make a further decision, such as limiting data access to the data processor.
- Mahindrakar et al. [12], D'Aniello et al. [13], Panasiuk et al. [14] will be reused.



Automatic contracting tool architecture

4.2 Predictive Maintenance Prototype

- The predictive maintenance prototype would assist in the following decisions:
- Decision when to perform maintenance?
- Decision about the type of action required, such as automatic or manual control action.
- Performing the appropriate automatic control action or selecting the best possible solution and presenting it to the user (or operator) in the case of manual control action.
- Zhou et al [15], D'Aniello et al. [13], Panigutti et al. [16] will be reused.



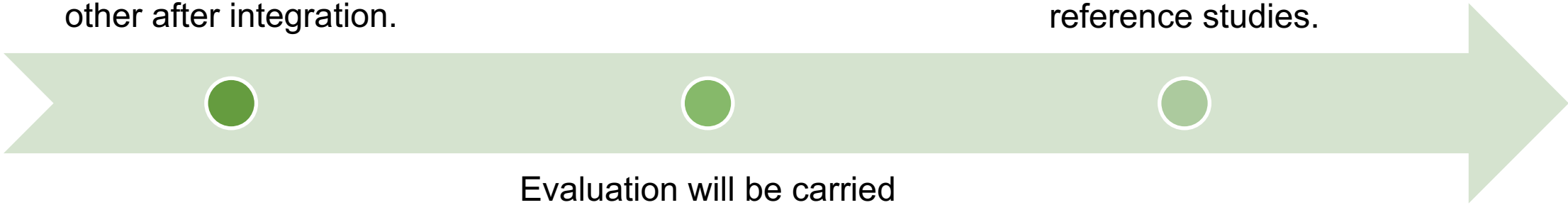
Predictive maintenance prototype architecture

5. Evaluation Plan

Two-stage evaluation, one before integrating and the other after integration.

Evaluation will be carried out using metrics such as accuracy, Precision at N (Prec@N).

Mahindrakar et al. [12], Sun et al. [17] , and Wang et al.[18] will be used as a reference studies.



Thank you for your attention!

Questions?

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