SolAegis: Actionable personalized heat warning monitoring with dynamic knowledge graphs

Laura Spies in MA Digital Health | Hasso Platner Institute, Potsdam, Germany

Abstract

This is a research proposal for using dynamic knowledge graphs (DKGs) to create actionable insights, interventions and evaluation with respect to heat warning monitoring. In Europe, current climate projections suggest that until 2100 the probability of heat events will more than double and that they could last 30% longer, leading to an increase in inter alia heat related mortality, heat strokes or dehydration[1] . With the increasing accessibility of healthcare multimodal data, connected health concepts can create data quality driven measures in time for actionable and explainable resource allocation and personalized prevention measures.

Climate Anomalies

Insight A: Increasing temp. anomaly in Europe (°C) avg. over the summer [2]

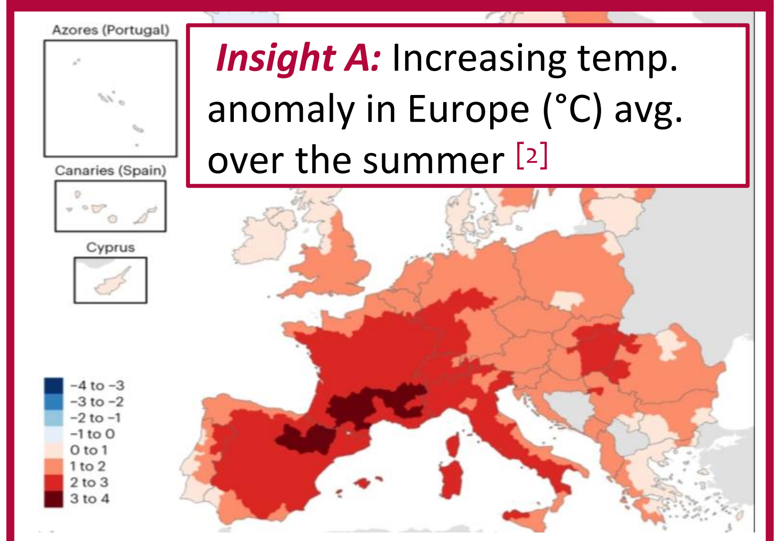


Figure 1: Weather anomaly (Figure from Ballester, J. *et al.*)

Weekly Heat-related Mortality

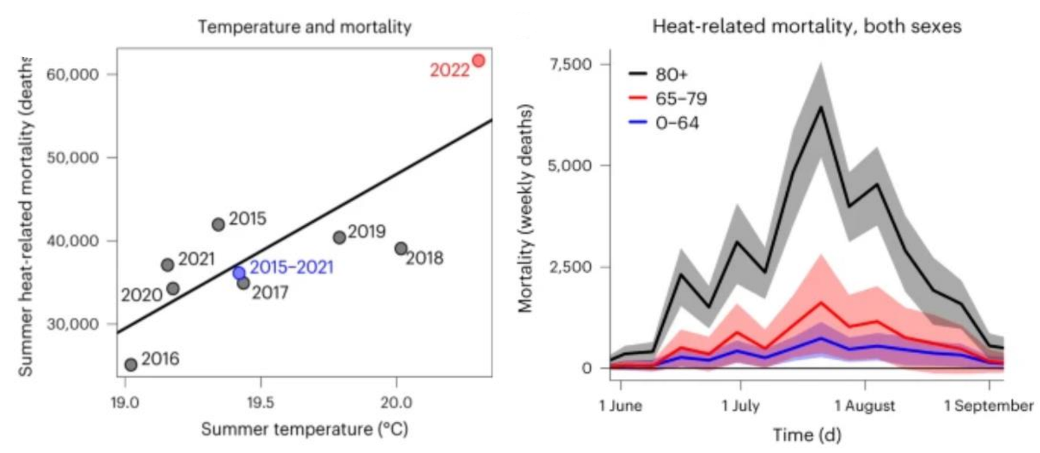


Figure 2: Weekly heat related mortality in Europe (Figure from Ballester, J. *et al.*)

Climate Change might lead to more heat related mortality & morbidity [1]

› 2022 Europe 61,672 est. deaths [95% CI 37,643-86,807] [2]

› 2022 Germany 8,173 deaths [95% CI 5,374-11,018] [2]

Operational Architecture of KGs

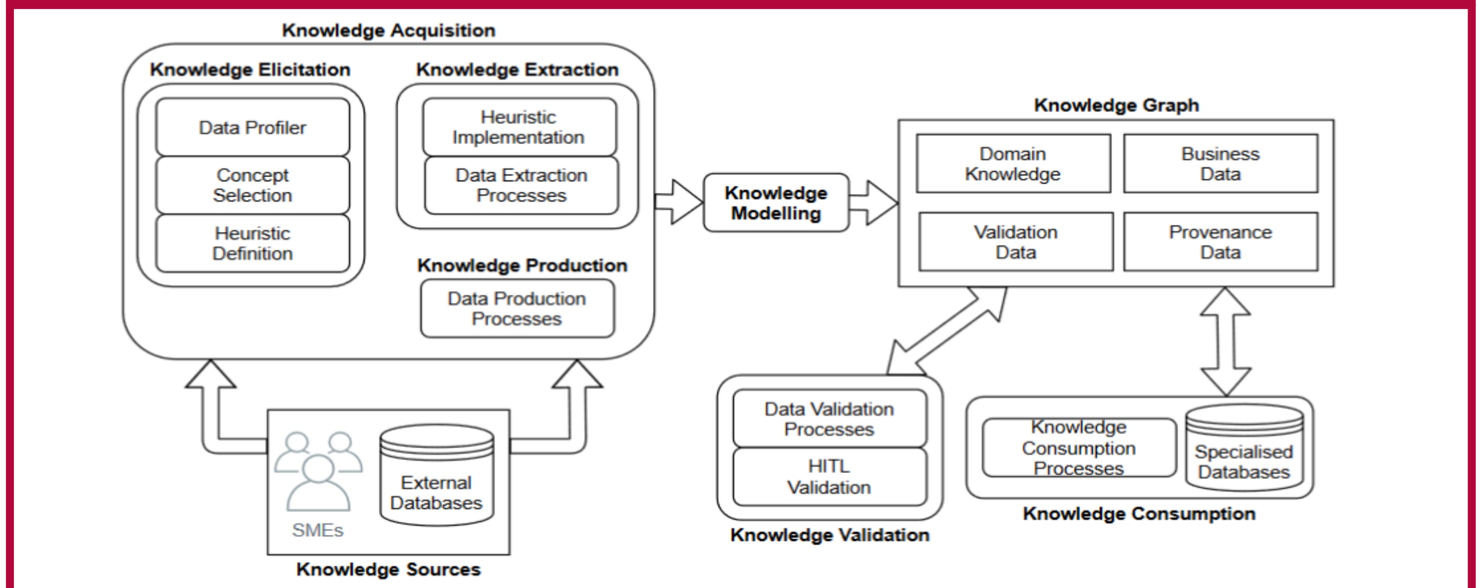


Figure 3: Operational architecture of knowledge graphs (Figure from Sesboüé et al.)[3]

Insight B: Current designs do not use multimodal sensor data for personalized interventions, which dynamic KG architecture could account for

Deep Temporal Reasoning for DKGs

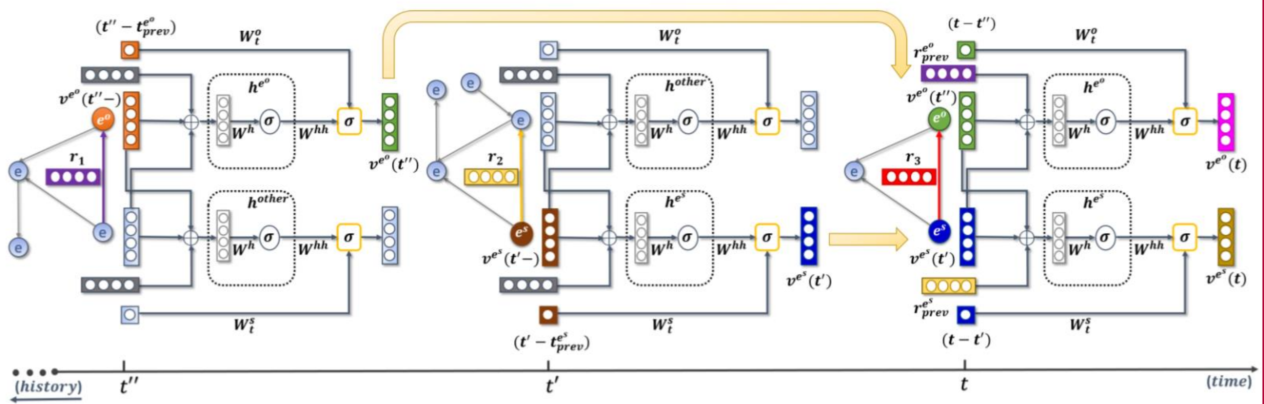


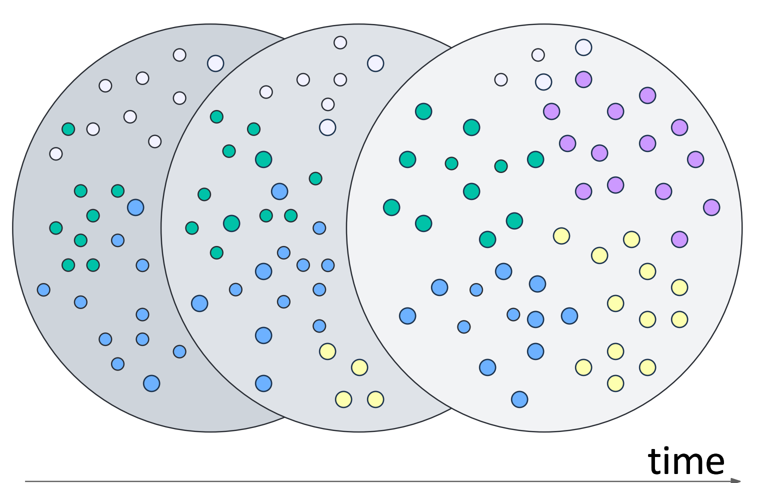
Figure 4: Dynamic Learning with Deep Temporal Reasoning (Figure from Trivedi et al.) [4]

» Sliding window approach for a low computational power initiation of the monitoring system, based on target groups

» Initial parameters will be set through systematic analysis of age, sex, weather conditions and ICD codes for heat-related health factors and included in an updated DKG

» Dynamic update, tested on different machine learning (ML) approaches for different risk and protection groups, and evaluation of quality based on effectiveness of results

Multi layered Quality Circles for DKGs



» Analyzing outcome changes based on ML approaches, multimodal data and target groups

» Evaluating results based on quality circles of outcome assessment

Figure 5: Iterating through knowledge graph layers for evaluation (own Figure c. Chen et al.) [5]

Indictors are …

» less emergencies vs control group

» usage of software, responsiveness to alarms

» less heat related morbidity

» precision action plan for different target groups

Personalized Protection Measures

Implementation:	**Research Question:**
A. Provide DKG networks with explainable results	→ How to implement actionable DKGs architectures?
B. Include quality data based on correlated impact	→ How to include quality circles for outcomes of KGs?
C. Comparing different ML approach layers	→ How to measure ML impact on different target groups?
D. Retaining a high computational efficiency	→ How to achieve lower computational cost?

Artifacts

Code

KG[6]

HPI Hasso Plattner Institut
Digital Engineering · Universität Potsdam

Laura Spies
Digital Health
Hasso Plattner Institute

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2 : Heat-related mortality in Europe during the summer of 2022. 2023. Ballester et al. Nat Med 29, 1857–1866.
3 : An Operational Architecture for Knowledge Graph-Based Systems. 2022. Sesboüé et al. Procedia Comput. Sci. 207. 1667-1676.
4 : Know-Evolve: Deep Temporal Reasoning for Dynamic Knowledge Graphs. 2017. Trivedi et al. ICML 2017. Sydney.
5 : A Practical Framework for Evaluating the Quality of Knowledge Graph. 2019. Chen et al. In: Zhu et al. (eds) Knowledge Graph and Semantic Computing: Knowledge Computing and Language Understanding. Springer. Singapore.
6 : Knowledge Graphs. 2021. Hogan et al. ACM Comput. Surv. 54. 1557-7341.