

Towards a Digital Biomarker Ontology (DBO): A Heart Failure Health Markers Application

Introduction

- ▶ Remote patient monitoring generates heterogeneous sensor data across different devices and time periods, stored in silos.
- ▶ We explore how the SAREF ontology [1], based on the SSN Ontology, can be reused to model health data.
- ▶ We also reuse the appropriate concepts from other ontologies or taxonomies including FOAF, SNOMED-CT, LOINC, QUDT and BMONT.
- ▶ We demonstrate this through a protocol adherence use case in *The Box* program [2], where patients are monitored with three devices: blood pressure cuff, smartwatch, and scale.

Ontology Modularisation

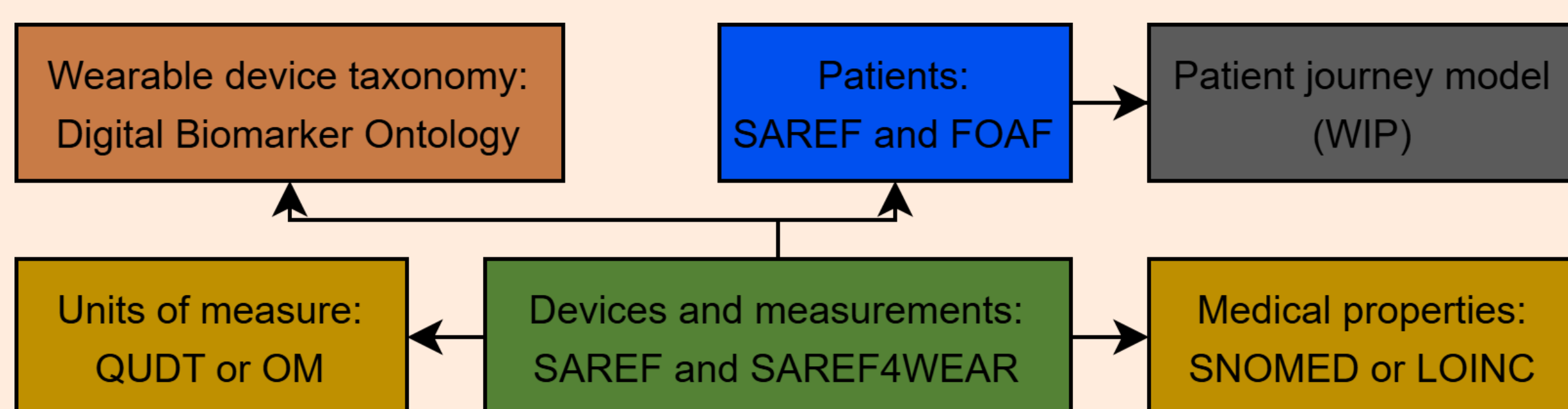


Figure: Overview of the various existing ontologies reused

Ontology Overview

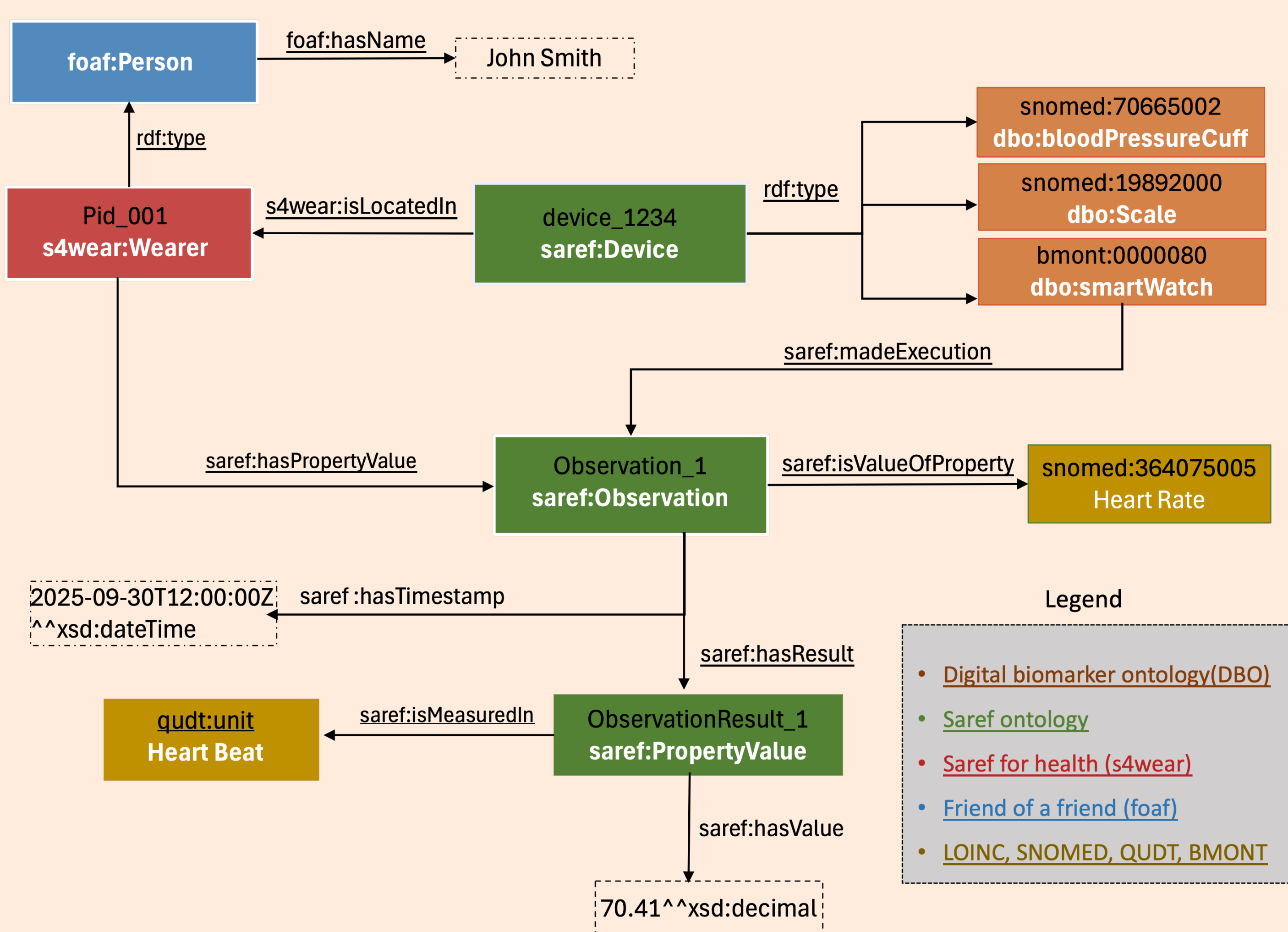


Figure: Example patient observation

References

- [1] Raúl García-Castro, et al. The ETSI SAREF ontology for smart applications: a long path of development and evolution. *Energy Smart Appliances: Applications, Methodologies, and Challenges*, pages 183–215, 2023.
- [2] N.E. van Hattem, et al. Effectiveness of remote monitoring for patients with a high risk of cardiovascular disease: a 12-month matched cohort study in primary care. *European Heart Journal - Digital Health*, 7(2), 2026.

Competency Question Selection

- ▶ Atomic level:
 - Which wearable or sensor made this measurement?
- ▶ Connectivity level:
 - How many measurements were made between two consecutive hospital visits?
 - How many measurements did the patient take per week on average?
- ▶ Use case level:
 - How consistent were patients in following the measurement protocol?

Adherence Monitoring: Query Design and Result

1. Find all enrolled patients
`?wearer a s4wear:Wearer`
2. Link to their measurement results
`?wearer saref:hasPropertyValue ?result`
3. Find the observation that produced each result
`?obs saref:hasResult ?result`
4. Identify which device made the observation
`?device saref:madeExecution ?obs ; a ?devType`
5. Check the count of all devices in protocol
`FILTER (?devType IN (dbo:BP, dbo:Watch, dbo:Scale))`
6. Calculate per week device usage
`BIND (FLOOR((?ts - ?firstTs) / 604800) AS ?week)
FILTER(?week >= 0 && ?week < 11)`

Subject id	Weekly Measurement Adherence											Adherence (%)
	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	
pid_001	3	3	3	3	3	0	3	3	3	2	3	87.9%
pid_002	2	2	1	2	2	1	2	2	2	2	2	60.6%
pid_003	2	2	3	3	2	3	2	3	3	3	2	84.8%
pid_004	3	3	3	2	2	3	2	2	1	1	1	69.7%
pid_005	1	2	1	1	0	1	1	2	1	1	0	33.3%
pid_006	3	3	3	3	2	3	3	3	3	3	3	96.9%

Legend: 0 devices (red), 1 device (orange), 2 devices (blue), 3 devices (adherent) (green)

Conclusion and Future Work

- ▶ Extend use case coverage to clinical measurements and patient journey
- ▶ Synthetic knowledge graph generation to enable exploration
- ▶ Empirical comparison of ontology and relational database workflows
- ▶ Extensions and additional ontology or taxonomy alignments for other use cases

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