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A Community-Consensus Approach to Knowledge Interoperability within Heterogeneous Earth System Science based Observational Systems

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Within complex domains - such as Earth System Science - knowledge is constantly evolving. Observational systems used to observe Earth's complex processes are often built in isolation, and data representations are not adequately designed for secondary use and higher order knowledge generation. Cross-community sharing of computable information is therefore difficult to achieve. Barriers to interoperability of information means that specialists cannot fully exploit the data that may be available.

Much of the work done to date within the Information Science community has been to enable interoperability through standardisation, particularly at the syntactic level. The Open Geospatial Consortium's (OGC) Observations & Measurements (O&M) standard [1] is a good example of the ongoing work towards enabling interoperability among observational systems. However, standards have a codifying and constraining effect on information. Object-oriented approaches commonly employed assume a static understanding of entities or classes of information. Therefore, these design methodologies cannot represent the true nature of knowledge within an evolving domain. Standards such as O&M avoid over constraining information objects by allowing variability. Where variability exists, interoperability is often compromised for individual use-cases.

The Health domain also faces similar challenges to representing complex and evolving domain concepts. Within complex domains two categories or levels of domain concepts exist. Those concepts that remain stable over a long period of time, and those concepts that are prone to change, as the domain knowledge evolves. Health informaticians have developed a sophisticated two-level systems design approach for electronic health documentation over many years, and with the use of archetypes, have shown how knowledge interoperability among heterogeneous systems can be achieved [2]. The authors are currently engaged in translating two-level modelling approaches to geo-observational based systems [3][4]. A key differentiator of two-level modelling compared to other approaches is that it allows domain experts to be the primary drivers of digital artefacts, while also ensuring that technical validity is maintained in one highly accessible and integrated process; leading to a managed and interoperable extensibility mechanism to standards such as O&M. This presentation will highlight this ongoing work and demonstrate the tools under development to allow domain practitioners to define and manage a set of Earth System Science community defined archetypes to enable interoperability, beyond the syntactic level of observational systems.

[1] S. Cox, "Observations and measurements," Open Geospatial Consortium Best Practices Document. Open Geospatial Consortium, 2006.

[2] T. Beale, "Archetypes: Constraint-based domain models for future-proof information systems," in OOPSLA 2002 Workshop on Behavioral Semantics, 2002.

[3] P. Stacey, D. Berry, "Applying two-level modelling to remote sensor systems design to enable future knowledge generation," in IEEE YP Conference in Remote Sensing Abstracts, Barcelona, 2015.

[4] P. Stacey, D. Berry, "Design and Implementation of an Archetype Based Interoperable Knowledge Eco-System for Data Buoys" [in press] to appear in proceedings of IEEE/MTS Oceans conference, Aberdeen, June 2017.