# Fast In-Memory Reasoner for Oracle NoSQL Database EE: Uncover Hidden Relationships that Exist in Your Enterprise Data

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Graph databases and NoSQL databases, two very important topics in Big Data, have gained popularity in recent years due to their unique characteristics in their horizontally scale-out capability and flexible schema or schema-free design. The recent release of OWL-DBC [1], an adaptor between Oracle Spatial and Graph [2] and the TrOWL reasoner [2, 1], has built a tight integration between one of the leading industrial graph databases and the cutting edge, in-memory, semantic reasoner to achieve high quality and efficient semantic reasoning on large scale enterprise data.

In this session we present OWL-NOSQL, which enhances the Oracle NoSQL Database EE [3] with efficient in-memory reasoning capability from TrOWL. With OWL-NOSQL, users are able to manage their enterprise data in the form of RDF Graph stored in Oracle NoSQL Database EE and gain insight into their data through powerful semantic reasoning.

Oracle NoSQL Database EE is a horizontally scaled, key-value database for Web services and cloud. This system uses a simplistic key-value pair data model to achieve efficiency and high scalability. Despite of its simplicity, such a data model can be engineered to represent rather complex knowledge and structures in data, including RDF graphs and OWL ontologies. In fact, key-value pair databases have emerged as one of the promising solutions for semantic exploitation in recent years. Such flexibility enables Oracle NoSQL Database EE to expose its data to external semantic applications, including semantic reasoners, to uncover hidden relationships in the stored data, especially those represent semantic annotations. More concretely, such a semantic extension of Oracle NoSQL Database EE is performed as follows:

1. Exporting RDF data stored in Oracle NoSQL Database EE into an ontology.
2. Performing reasoning using the semantic reasoner TrOWL to uncover hidden relationships in the data.
3. Importing reasoning results into Oracle NoSQL Database EE to persistent the uncovered relationships.

According to our previous experience with OWL-DBC, the most significant performance challenge of such a solution rises from the data transferring be-

[1] http://trowl.eu/owl-dbc/
[2] http://www.oracle.com/technetwork/database/options/spatialandgraph/overview/index.html
[3] http://www.oracle.com/us/products/database/nosql/overview/index.html

tween database and reasoner. To address such an issues and offer faster data exploitation, the following means have been taken:

1. Performing reasoning and data export/import in memory. This minimises the need to perform storage I/O.
2. Enable parallel processing of data. Such parallelisation can be realised on two levels:
   (a) Export, reasoning and import can be performed in parallel to each other. Particularly, modules of exported data can be used by TrOWL for reasoning, while other modules of the data are being exported from Oracle NoSQL Database EE. Once a reasoning result is being computed, it can be directly imported into Oracle NoSQL Database EE, without having to wait for the other reasoning results. Such parallelisation exploits the parallel mechanism between storage, memory and CPU cores.
   (b) Export, reasoning and import individually can be performed in parallel. Particularly, Oracle NoSQL Database EE is capable of exporting and importing data in parallel using multiple threads. TrOWL, on the other hand, is capable of executing reasoning on several mutually independent partitions. On a computer (cluster) with multiple storage I/O bandwidth and multiple CPU cores, such parallelisation can make the best use of all available hardware resources.

With the above solutions, we are able to improve the efficiency of data transferring and reasoning. Together, OWL-NOSQL enhances Oracle NoSQL Database EE with semantic reasoning, offering more flexibility to our clients in terms of data storage, management and exploitation options.

We are optimistic about OWL-NOSQL because many industries have already embraced Semantic Web and NoSQL technologies. In the past decade, we have observed more and more enterprise applications built on top of RDF and OWL standards; and NoSQL technologies at the same time play an ever-increasingly critical role for the management and analysis of Big Data. There clearly is a natural synergy between these two sets of technologies.

## References


1. Ren, Y., Pan, J.Z., Zhao, Y.: Soundness Preserving Approximation for TBox Reasoning. In: the Proc. of the 25th AAAI Conference Conference (AAAI2010) (2010)
2. Thomas, E., Pan, J.Z., Ren, Y.: TrOWL: Tractable OWL 2 Reasoning Infrastructure. In: the Proc. of the Extended Semantic Web Conference (ESWC2010) (2010)