Staying CALM Beyond Deterministic Queries

Tim Baccaert
Vrije Universiteit Brussel

Abstract

Programming asynchronous distributed systems is a challenging task in which consistency is often achieved by use of expensive coordination protocols like Paxos and 2PC. The CALM theorem, first conjectured by Hellerstein [4], is one of the first results to challenge this practice by stating that a problem can have a consistent, coordination-free distributed implementation if (and only if) the problem is monotonic. This result was proven for queries [2] and shown to extend beyond monotonic (yet monotonic-like) queries for data systems having specific knowledge about the partitioning of data over the network [1].

In this presentation, we present an extension of the latter results in several ways [3]. We consider problems that can be modeled as (non-deterministic) mappings from distributed instances to distributed instances, enabling CALM-style arguments for problems involving data placement and choice. Furthermore, our extended model generalizes the CALM-theorem towards arbitrary system configurations, allowing us to reason about the expressiveness of any particular distributed system and thereby revealing a nuanced gradient of problems with increasing coordination-needs. Finally, we apply our model to identify certain polynomial time computable queries that are not (feasibly) coordination-free, in response to a recent question raised by Hellerstein and Alvaro [5].

References

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