Providing Engineering Services With Smart Objects: An Active Big Data Approach

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ABSTRACT

The world of data has been evolving due to the expansion of operations and the complexity of the data processed by systems. Big Data is no longer numbers and characters but are now unstructured data types collected by a variety of devices. Recent work has postulated that the Big Data evolutionary process is making a conceptual leap to incorporate intelligence. This challenges system engineers with new issues as they envision and create service systems to process and incorporate these new data sets and structures. This article proposes that Big Data has not yet made a complete evolutionary leap, but rather that a new class of data—a higher level of abstraction—is needed to integrate this “intelligence” concept. This article examines previous definitions of Smart Data, offers a new conceptualization for smart objects (SO), examines the smart data concept, and identifies issues and challenges of understanding smart objects as a new data managed software paradigm. It concludes that smart objects incorporate new features and have different properties from passive and inert Big Data.

KEYWORDS

Big Data, Intelligence, Services, Smart Data, Smart Objects, Software Paradigm

INTRODUCTION

The expansion of the Big Data concept has affected the changing and evolving nature of data. Big Data has matured as a critical component of the Information Systems, Computer Science, Information Processing, and Data Analytics disciplines. Research has focused for a number of years on characterizing Big Data with five Vs: volume, velocity, variety, veracity, and value as originally described by Kaisler, Armour, Espinosa, and Money (2013). These characteristics are recognized and discussed in the information systems research literature (Goes, 2014) as being valuable to the information systems field. The Vs aid researchers and practitioners in framing approaches for improving systems by focusing research on how to addressing the challenges and difficulties associated

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with Big Data. They improve our understanding of Big Data and clarify the issues, methodological concerns, and complex research problems facing practitioners and users of Big Data.

The descriptive characterization of Big Data offered in 2013 was the authors’ proposed approach to the problem of communicating about the state of Big Data’s five Vs. The paper advances our understanding of the different ways researchers and practitioners approach and operationalize the Vs used to describe Big Data. Further, it clarifies how the VS could be addressed from a research perspective (at that time, 2012-13). The operationalization components of the Vs evolved from the authors’ appreciation and understanding of how the simple idea of Big Data morphed to mean different things over time. It first referred only to a volume of data that could not be efficiently processed using the available system methods, tools, and technologies. But this original pragmatic definition offered little insight into the solutions to the problems associated with collecting, handling and processing Big Data. It was incapable of dealing with data growth because the growth never stopped, or even slowed. As new expanded storage methods and processing performance improved, data accessibility exploded (again and again) because if data could be more easily accessed, more could and would be collected. Researchers could simply not keep up with growing data volumes, but researchers and users wanted to communicate about what they were doing about the “growth of data” and share solution attempts, successes, and failures. A second issue (beyond ever-expanding volumes) also became important because data definitions which first focused on structured data needed to address massive amounts of unstructured text and imagery. The explosion of these data was not accompanied by a corresponding new storage medium. Almost 20 years ago, Laney (2001) described the Big Data occupying this environment with 3 Vs (volume, variety, and velocity) and helped initiate the direction of research in the field toward an analysis of attributes and characteristics that if better managed could deliver greater value to the users of Big Data. Big Data, throughout this period, is viewed as being inert. The three, and subsequent five Vs thus describe Big Data using passive attributes that are only derived or changed through manipulation by external events and procedures.

Big Data (without a widely accepted definition, not well understood, and not clearly characterized) was being noticed in many areas because it was associated with potential business and process value. For example, Big Data was recognized as a national challenge and priority along with healthcare and national security in 2010 by the American Institute of Physics (2010). Two years later the National Science Foundation led a large multi-agency effort and research program to develop new Big Data tools and techniques, and advance the technological understanding of the massive amounts of information and knowledge available from Big Data. The goals of this effort were to apply the Big Data findings and tools to health, energy, defense, education and researcher goals (Mervis, 2012).

This paper now posits that the proposed characteristics of “inert” Big Data as viewed in 2013 must again evolve and possibly incorporate new Big Data characteristics. The concept of Smart Data, as proposed in this paper, imbues Big Data with additional attributes (beyond the 5 Vs) and characteristics through the application of analytics.

Our research and observations of the growing Big Data field suggest that not all data are passive or inactive. Other authors, as discussed in Espinosa, Kaisler, Armour, and Money (2019), have recognized that data do not always behave as passive groups of characters and numbers. These data present new challenges to system engineers and designers, and require that researchers extend their work to understand these new data structures and characteristics.

Such capabilities would (if well understood) have several advantages from a service-oriented perspective and for the development of applications and services across the Web. Business services and business processes would likely be re-engineered and formal operations would be conducted in very different ways. For example, many file openings and search steps (for documents or service) in a filing system (local or remote) would be unnecessary. Data might literally place itself in the proper place at the proper time if it “knew” when it was needed.

To discuss these new types of data (and their behaviors) and distinguish them from the standard, passive view of data, we introduce a new concept, smart objects (SO), focused on data with intelligent
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