APPLIED COGNITIVE COMPUTING: ENHANCING BUSINESS PROCESSES WITH COGNITIVE COMPONENTS TO BETTER MANAGE COMPLEXITY

Vlad Zamfirescu[1] and Natalia Bob[2]
[1) 2)] The Bucharest University of Economic Studies, Romania
E-mail: vlad.zamfirescu@hotmail.com; E-mail: natalia.bob@aol.com

Abstract
As businesses evolve and depart from their initial business model, decision-makers start focusing more on optimizing resource utilization to improve the results obtained from the underlying business processes that support their operations. Moreover, when integrating innovative technologies as part of the supporting IT architecture, business process architects are often faced with a challenge when it comes to analyzing the integration costs and benefits associated with these implementations. In our paper, we introduce the Contextual Blocks Framework as an approach to designing and analyzing the performance of IT business processes. Furthermore, we propose an enhanced version of the Contextual Blocks Framework through the implementation of a cognitive computing gateway to improve the interaction between decision-makers and business processes.

Keywords: cognitive computing, business process innovation, business process optimization

JEL Classification: O31, O32, M15

Introduction

Data is at the core of any informed decision, whether at the management or individual contributor level. Throughout its lifetime, a business will undergo multiple transformations and gradually increase its maturity level. The more a business departs from its initial startup context, the more it will focus on restructuring and redefining its business processes to accommodate business model iterations and external pressures. Moreover, decision-makers will increasingly allocate more resources towards innovating the business model and restructuring the underlying technological infrastructure to accommodate these iterations. Furthermore, the activity of a company also tends to evolve throughout this process, as businesses start optimizing resource utilization and try maximizing the performance of business process components (Bulllinger *et al.*, 2016). Business Intelligence (BI) can be leveraged to collect performance data and monitor the evolution of business processes. By defining a series of performance variables for a business process, companies can quantify the efficiency of each individual component, as well as identify interaction patterns. The implementation of such a framework can be used as a decision support system that provides involved entities with a mechanism to make data-driven, informed decisions. Moreover, as business processes and practices mature, BI solutions and methodologies need to efficiently scale to provide insights on big volumes of data. Considering the speed of data volume increase, BI solutions evolved to better serve larger scopes of analytics. Business Analytics aim to expand the area of BI and further improve the performance of analytical components (Mwilu, Comyn-Wattiau & Prat, 2016). Even though there is a significant cost associated with the implementation of business analytics solutions (Kitsios & Kamariotou, 2016), they are gradually becoming a vital component of the decision-making process.

1. Business Process Analytics

Traditionally, BI and analytics solutions had been deployed on-premises. Thus, apart from the knowledge and skill development cost, an implementation also required a significant financial effort. However, with the advent of Information Technology (IT) and Information Systems (IS), businesses started exploring recent solutions to identify more efficient implementation and deployment mechanisms (Mwilu, Comyn-Wattiau & Prat, 2016). To maintain their competitive advantage, companies should closely monitor and invest in IT innovation to identify better solutions to existing implementations of business models and underlying processes. Apart from adopting innovative technologies, decision-makers should model strategic objectives and build them upon the capabilities encompassed by the supporting IT and IS infrastructure. Thus, prior to selecting the appropriate technological resources required by a business model, organizations should invest in researching the complexity of their core business processes and identify any existing or potential performance gaps. Decision-makers should select the IT&S infrastructure solution that supports their strategic objectives and allows the scaling of business processes through subsequent business model iterations (Kitsios & Kamariotou, 2016). Due to its potential, cloud computing distinguished itself from traditional implementation models by eliminating the infrastructure layer from the pool of components that were previously managed by the same organizations that benefitted from the solution. Cloud computing allows companies to focus only on the actual business analytics solution and its features, as the underlying infrastructure is managed by the cloud provider. One of the main concerns regarding this approach is that of information security. Thus, some organizations might decide to opt for a traditional on-premises implementation to mitigate this risk. However, a hybrid implementation model, where the core business data is managed locally by the organization and the 3rd party business analytics cloud infrastructure is used only for processing data through a secure pipeline. This approach satisfies the security concern, but it often has a higher implementation cost associated with it (Singh, Jeong & Park, 2016). Depending on the level of maturity of a business, multiple approaches are available when analyzing potential business analytics implementation frameworks. Regardless of the approach used by an organization to implement a business analytics solution, it is recommended to first design and map their business process collection to the underlying IT infrastructure. To address this need, we propose the *Contextual Block Framework* for designing, analyzing and integrating the IT business processes of an organization.

2. Business Process Architecture - The Contextual Blocks Framework

To analyze and quantify the complexity of core IT business processes, we introduce the Contextual Blocks Framework for designing and analyzing business processes. The proposed framework allows business process architects to identify performance gaps during the design phase, as well as after the business process implementation. Apart from the business process structure and performance, our framework also allows the analysis of interaction patterns and inter-process dependencies across an organization's business process collection. In the Contextual Blocks Framework, individual business process fragments are considered *contextual blocks* that spawn their own isolated context, and the transitions between contextual blocks are envisioned as *context links* that can impact the output of an individual block and shape the evolution of the business process. Figure no. 1 depicts a business process architecture designed using the Contextual Blocks Framework.

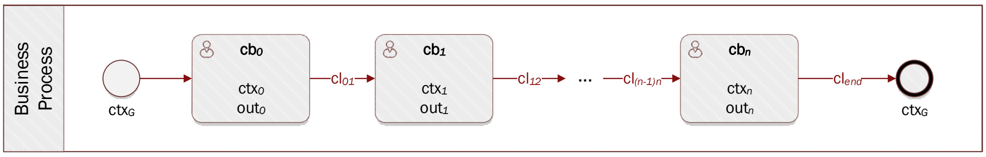

Figure no. 1: Business Process Architecture Illustrated Using the Contextual Blocks Framework

Prior to providing any input for the business process, a global context object (ctx_G) is defined as part of the business process architecture, which is used to track the execution state. It is a dynamic object that not only updates the latest state of the process, but also keeps track of all intermediary results to be able to analyze the performance of each contextual block and provide information regarding interaction patterns at the end of a business process execution. The core component of each contextual block (cb_n) is the isolated local scope (ctx_n) that is responsible for building the state of the business logic implemented as part of that component and pass it as a parameter for the next block through a context link ($cl_{(n-1)n}$). The notation used to illustrate context links contains two integers: the first one (*n-1*) represents the source contextual block and the second one (*n*) refers to the target contextual block that will use the context link as a parameter to implement its business logic. Apart from the execution state, the output of a contextual block (out_n) is also passed on through the context link. To signal that the business process execution completed, the *end contextual link* (cl_{end}) is mapped to the global context object. Thus, the performance and complexity of a business process can be analyzed by looking at individual contextual blocks, segments of multiple blocks or the entire execution sequence. Figure no. 2 presents the structure of a global context object at the end of a business process execution.

```
ctxG = {
  cblocks: {
       cb0: {cb0 business logic attributes},
       ...
       cbn: {cbn business logic attributes}
  },

  clinks: {
       cl01: {cl01 contextual attributes},
       ...
       clend: {clend contextual attributes}
  },
  // additional business process attributes
  // and parameter values which are
  // part of the global context object
}
```

Figure no. 2: Global Context Object Structure for a Business Process Execution

Due to its structure, the global context object can be used to store the statistics of each business process execution in a database to provide decision-makers with a mechanism that allows them to modify the characteristics of contextual blocks of past executions to run simulations on actual data to identify performance bottlenecks and optimize interaction patterns. Even though the Contextual Blocks Framework provides flexibility in terms of business process complexity management and analysis, it still requires decision-makers to familiarize themselves with the specifics of the process they are triggering. Therefore, for business processes to produce the results that satisfy the inquiries of decision-makers, the latter need to gain the knowledge required to interact with the process and go through each subsequent step of an execution path. To better match the user interaction patterns to business process executions, we enhance the Contextual Blocks Framework with cognitive computing components that aim to reduce the knowledge and skills development costs associated with understanding and leveraging a business process.

3. Cognitive Enhancement of Business Process Architectures

Cognitive computing is an emerging paradigm that builds upon the advancement in understanding cognition as a component of cognitive science and translating it into computational intelligence that can be replicated using IT infrastructure resources. One of the main characteristics of cognitive computing elements is that they are usually deployed as standalone computational modules that are often configured to act as a natural interface that aims to improve the interaction between users and business processes. Moreover, by integrating them with an organization's business process collection, operations can be automatized and improved as the analysis of the increasing volume of performance data can provide new perspectives into the evolution of business processes (Orii *et al*., 2016). Thus, by actively monitoring the execution of business processes and the relations between the underlying components, cognitive computing modules optimize the execution paths to maximize the business process results. Moreover, through cognitive engineering (Konar & Jain, 2005), business process architects can model IT integration layers that encompass learning components and provide complexity management through automation (Ciftcioglu & Bittermann, 2015). To optimize the performance of business processes, we introduce an enhanced version of the Contextual Blocks Framework that enriches the standard version of the framework through the addition of a cognitive computing layer (Figure no. 3).

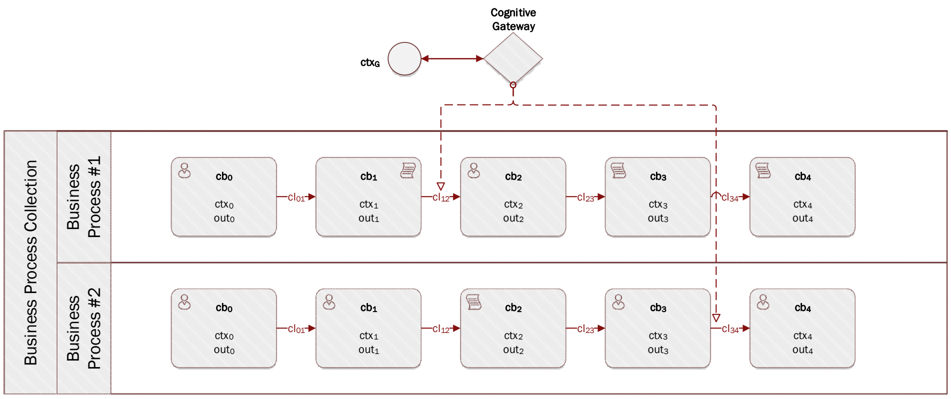

Figure no. 3: Cognitive Enhancement of the Contextual Blocks Framework for Business Process Optimization

The purpose of the cognitive module is to optimize the interaction patterns by dynamically building the global context object (ctx_G) and determine the best execution path for the provided input parameters. Thus, the cognitive computing component serves as a routing gateway that oversees the collection of IT business processes and, through continuous learning iterations, it maps the intent of business users to the appropriate business process or group of business processes. Moreover, as the global context object is managed by the cognitive gateway, decision-makers no longer need to limit their interaction to a single, specific process, but benefit from the entire business process collection scope. For example, let's consider a team that is asked to implement a cloud platform microservice architecture as a common self-service analytics module for decision-makers. The main purpose of the platform will be to act as a data discovery engine that connects multiple data sources across the organization and provides business users with the ability to access the collection of existing IT business processes. One common approach is to build an access point to each business process from a common front-end gateway, thus allowing business users to interact with individual processes. Even if they would build an integration middleware to provide access to all existing IT business processes through a common platform, they would still limit the interaction to the context of each process. However, in the Enhanced Contextual Blocks Framework approach, a natural language classifier cognitive component can be implemented to act as a shared global context on top of the existing business process collection. This approach eliminates the boundaries previously set on a singular business process instance and, through the shared global context object, dynamically detects the intent of the platform user and maps it to the appropriate business process execution path. Another advantage of this architecture is the inter-process communication that can be established through the shared global context object. As in the standard Contextual Blocks Framework, this object is used to build the business process output, as well as store all intermediary states for further analyses. However, in the enhanced version of the framework, the cognitive computing gateway transcends the boundary between business processes and maps the request of decision-makers to the appropriate contextual block, regardless of its encompassing business process or location on the execution path. This can be done by implementing a natural language processing engine such as IBM's Watson Conversation Service[*] as part of the cognitive computing gateway. The enriched architecture illustrated by the Enhanced Contextual Blocks Framework can provide insights into performance bottlenecks, as well as highlight efficient execution paths by mixing contextual blocks spanning across multiple IT business processes through dynamic context link building. Furthermore, the experience of decision-makers is improved by providing them with a mechanism that simulates natural conversations through cognitive computing, while also reducing the knowledge costs associated with the understanding of IT business processes.

Conclusions

Through the *Contextual Blocks Framework* that we introduced in this paper we are attempting to provide a methodology that empowers business process architects and decision-makers to collaborate more efficiently in innovating an organization's business model. Furthermore, through the enhanced version of the Contextual Blocks Framework,

[*] Conversation | IBM Watson Developer Cloud - https://www.ibm.com/watson/developercloud/conversation.html

we illustrated a mechanism through which companies can incorporate cognitive computing technologies in their business model. At its core, the *Enhanced Contextual Blocks Framework* aims to improve the alignment between the functional definition of business process architectures and the actual implementation. Thus, this methodology can be leveraged to potentially increase the alignment between decision-makers and business process architects.

References

Bullinger, H. J., Nägele, R., Rueger and M., Fischer, D., 2016. Business Model Innovation: From Technology Market to Market Success. *2016 Portland International Conference on Management of Engineering and Technology (PICMET)*, Honolulu, HI, pp. 1264-1270.

Ciftcioglu, Ö. and Bittermann, M. S., 2015. Architectural Design by Cognitive Computing. *2015 IEEE Congress on Evolutionary Computation (CEC)*, Sendai, pp. 2295-2302.

Kitsios, F. and Kamariotou, M., 2016. The Impact of Information Technology and the Alignment Between Business and Service Innovation Strategy on Service Innovation Performance. *2016 International Conference on Industrial Engineering, Management Science and Application (ICIMSA)*, Jeju, pp. 1-5.

Konar, A. and Jain, L., 2005. *Cognitive Engineering – A Distributed Approach to Machine Intelligence*. London: Springer Verlag London Limited.

Mwilu, O. S., Comyn-Wattiau, I. and Prat, N., 2016. Design Science Research Contribution to Business Intelligence in the Cloud – A Systematic Literature Review. *Future Generation Computer Systems*, 63, 108-122.

Ogiela, L.and Ogiela, M. R., 2014. Cognitive Systems for Intelligent Business Information Management in Cognitive Economy. *International Journal of Information Management*, 34, pp. 751-760.

Orii, Y. *et al.*, 2016. Advanced Interconnect Technologies in the Era of Cognitive Computing. *2016 Pan Pacific Microelectronics Symposium (Pan Pacific)*, Big Island, HI, pp. 1-6.

Singh, S., Jeong, Y. S. and Park, J. H., 2016. A Survey on Cloud Computing Security: Issues, Threats, and Solutions. *Journal of Network and Computer Applications*, 75, pp. 200-222.