

Data Science and Artificial Intelligence in Project Management: The Past, Present and Future

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Abstract: The contemporary landscape of Project Management is continually morphing as a response to the changing demands as well as the availability of developing technology. This article discusses and uncovers the current state of Data Science and Artificial Intelligence in relation to the Project Management sector. Drawing from this context, the possible future applications and uses are then delineated. Several trends are identified, and the overall findings are synthesized to provide a realistic impression of what the future topography of Project Management holds. The increasingly sophisticated applications of technology have been found to assist in streamlining the current industry-standard procedures.

Keywords: Data Science; Artificial Intelligence; and Project Management

Introduction

Although Data Science and Artificial Intelligence have existed since the 1950s, both fields have only very recently experienced a surge in popularity as a result of the expansion in the capabilities of technology. In extension to this, the distinction between Data Science and Artificial Intelligence predominantly lies within the differences in application – the former exists as a process whereas the latter concerns itself with the ability to utilize datasets to inform decision-making processes (Russell & Norvig, 2016). Deep Learning and Machine Learning are both subsets of Artificial Intelligence, with the former being more complex than the latter (Goodfellow et al., 2016).

As the applications and uses of Data Science processes become increasingly widespread, the roles of various types of data scientists are becoming fostered. Humans are gradually integrating into higher-level roles as technology embodies simpler and mundane tasks. This calls for a wide range of functions which are rendered necessary for each step and type of data application process. Types of roles include statisticians, spatial data scientists, business analytic practitioners, software programming analysts, actuarial scientists among others. A wide range of corresponding prerequisite skills relevant to these roles include statistics, calculus and algebra, software engineering and data intuition in addition to others. The increased connectivity throughout the world has also resulted in a heightened level of available data, which in turn creates an enriching environment for the development of Data Science and Artificial Intelligence. Artificial Intelligence, which manifests itself in the applications of Data Science, is becoming more prevalent as current research expands the boundaries and limits including the capacities they can be used for. One example includes the determination of how Artificial Intelligence and Natural Language Processing can be applied to collaborative and semi-structured websites such as Wikipedia to gain knowledge and information (Hovy et al., 2013). With this type of development becoming more widespread, it has been predicted that there is a 50% probability that Artificial Intelligence will exceed human abilities within as little as 45 years (Grace et al., 2018).

Also, recently there has been an increased level and prevalence of Artificial Intelligence throughout multiple industries (Wang, 2019). This growing popularity is most specific to the project management industry and has been due to the multiple benefits present in its applications. Some of these benefits include, and are associated with; support, accuracy, insight and strategy, elimination of information bias, use of emotional intelligence as well as creativity (Munir, 2019). Constituting an important application of Data Science, Artificial Intelligence converses closely with statistics and incorporates the ability to utilize critical thinking in decision-making processes by asking the right questions and applying the appropriate methods of delivery (Rose, 2016).

As time progresses, the applications of Artificial Intelligence are developing and becoming more refined and sophisticated. Initial undertakings of research on the applications of Artificial Intelligence were mainly concerned with project information, project tasks, critical path method and program evaluation and review technique (Foster, 1988; Levitt et al., 1988). However, its definition has since evolved to include and incorporate automation. This article

sets out to determine the existing research on the synergy between Artificial Intelligence and Data Science with project management and possible directions for future development.

Existing Applications of Data Science and Artificial Intelligence in Project Management

Data Science forms the foundation on which Artificial Intelligence processes are based. Existing techniques and applications from Data Science (such as data preparation, exploration, analysis and so on) in project management are mostly generalized in nature. The increased connectivity throughout the world has resulted in the augmentation and prevalence of data information (Nellutla, 2018). With all of this data available, regulation and management of private and intrusive information poses a perceptible challenge. With specific reference to the field of project management, this data information has been examined through two predominant modes - the first being social network analysis (Uddin, 2017) and the second being text analysis (Williams et al., 2014). Applications of Data Science often extend into the realm of Artificial Intelligence in which current applications include processes to save project cost and time. Other contemporary applications include the use of Artificial Intelligence to gauge and pinpoint the specific strengths of employees and to align these strengths to improve projects and to assist with management (Nellutla, 2018). The three most common data analysis techniques that are commonly applied to assist project managers in making informed decisions are statistical analysis (e.g., regression, analysis of variance and covariance, scatter plots, pareto charts and t-test), time series analysis (e.g., single-equation regression and multi-equation simulation) and probabilistic models (e.g., event history analysis, Markov chains and Systems dynamics modelling) (Nayab, 2019)

Artificial intelligence predominantly incorporates the application of Data Science techniques to improve project processes. Broadly, Artificial Intelligence in project management can be summarised and categorized into the following four types which are dependent on context and process (Wang, 2019): integration and automation; chatbot assistance; machine-learning based; and autonomous management of projects. Out of the above, machine-learning based project management has been proposed to be most beneficial (Wang, 2019). Knowledge and understanding of Artificial Intelligence are in process of growth and due to this, there exists a wide range of varying propositions on the applications and sophistication of techniques in delivery. With respect to output and processes, there exists a wide range of relevant languages, tools and techniques.

Artificial Intelligence currently possesses an extensive range of applications in projects. These applications include processes to reduce risks, to assist in the daily tracking of projects, to identify anomalies, outliers or correlations within projects. Robotic Process Automation is also an Artificial Intelligence application gradually gaining traction within the management of projects (Branscombe, 2018). By considering the applications of Artificial Intelligence and Data Science within the delivery stage of projects, it is evident that a gamut of existing software are applicable and employed in process. It can be determined that different software are suited to and correspond to different stages of projects. Examples of current software incorporated

into project management practice include Chatbots, Strategies, Zivebox, Rescoper, Clickup, Polydone as well as Clarizen (Munir, 2019). Other software cited comprise of Slack or JIRA (Schmelzer, 2019). The processes involved in Artificial Intelligence furthermore include machine-learning models, various algorithms (Pedroso, 2017) as well as several different languages such as command line, Git version control, SQL and database concepts, R and Python (Joachims, 1998).

Depending on the desired output information, input data and requirements of the automation processes, different undertakings of Data Science methods and technology will be required. One instance includes the use of Natural Language Processing such as Red-Amber-Green to determine project attributes. This process involves machine-learning as well as networks and incorporates the loading of text data into .csv format, use of a deep-learning library such as *fastai*, and subsequently the generation of output in Red-Amber-Green coding that is relevant to different attributes and stages of the underlying project (Goodfellow et al., 2016). In other instances, such as with the prediction of schedules and timelines, different processes will be required. One such example is the use of Monte Carlo simulation with the processes of decision trees, bagging, random forest, boosting and support vector machines for forecasting project duration (Wauters & Vanhoucke, 2016). Through feeding into the system precedent projects, the different pronumerals may be determined and ultimately used simultaneously with various earned value management and earned schedule measures to predict project duration.

Another representative case of the dynamic application of Artificial Intelligence and Data Science integrates project delivery into the process of project monitoring. The collection of data at various stages of a project can be used to calibrate and assist in the management of projects. The application follows a series of steps (Grabis et al., 2019). At the initiation stage, information in relation to planning needs to be collected in accordance with each of the allocated RASCI roles (Wysocki et al., 1996). Subsequent to this, data throughout the project process can be gathered and represented through weekly reports, change requests among other plans. Thirdly, information on the production process can be collected through acceptance from customer, support, invoicing as well as change orders. The project process integrates various data analysis methods and techniques (including Bayesian network graphs, and vector models) to represent and analyze the complexity of the collected project data from the previous (Grabis et al., 2019).

Some processes are furthermore applied for project planning. Due to the requirements of output, the automation processes applied herein are even more sophisticated. For instance, machine-learning algorithms including *k*-Nearest Neighbours algorithm, Distance-Weighted Nearest algorithm, Feature-Weighted Nearest algorithm are to be used together with Regression models such as Logistics Regression, Cost Function and Stochastic Gradient Descent within a hybrid model (Pedroso, 2017). Such processes require further tweaking and input with feature selection as well as weighting.

Future prospect of Data Science and Artificial Intelligence in Project Management

With the applications of Data Science and Artificial Intelligence increasing in many industries, its impact will also significantly alter the landscape of projects. Current applications already include the estimation and prediction of project time and cost, project network variance analysis (Bayesian network) as well as artificial neural networks for analyzing large-scale networks. These applications within projects have progressively developed since the early 20th century and will continue to be developed in the coming years (Choudhury & Uddin, 2018).

As Data Science becomes more quotidian and prevalent, its methods and techniques will also become conventional. The future of Data Science is very optimistic. It is anticipated that, with the prevalence of data, an environment which fosters the development and growth of this field will be inevitable (Nellutla, 2018; Sanchez et al., 2019). Similar to other sectors, a large volume of data on projects and the management of projects is continuously being collected on a regular basis. In the near future, this project data will be as large as what is currently designated by the term “Big Data”. The Big Data revolution permeates through many different sectors including banking, technology and so on. Specifically, the aspects in which Data Science and Big Data impact on project management can be analyzed and determined in two ways: the first being the context in the “broader eco-system” in which the project is situated; and the second being the intrinsic events and happenings of the project. A protraction of this means that Big Data can be utilized to develop the protocols in which projects are situated as well as the project events intrinsically. The availability of this large volume of project data will enable Big data analytics to shape the future of project management delivery in many ways, including planning and delivery, and project team, quality, risk and knowledge management as well as resource management (Ram, 2017; Whyte et al., 2016).

Improvements on the applications of Artificial Intelligence will also invariably evolve. Applications within projects such as in estimation, resource management and other automation processes are also projected to be developed. For instance, automated data analysis systems can be used to adapt to organizational environments promoting this fluidity within project contexts (Williams et al., 2014). With similarity to other industries, Artificial Intelligence can eventually replace the requirement and need for humans within project processes (Grace et al., 2018).

Other roles which currently require humans will also inevitably be replaced by Artificial Intelligence as they exceed human capabilities. Research has predicted that this will occur within the next couple of decades (Grace et al., 2018). The detailed breakdown of this research has communicated the social consequences and impact that self-driving technology may cause as they eventually replace human jobs. These predictions have also classified the progressive abilities of Artificial Intelligence as they eventually develop and replace jobs of increasing complexity and complication (Grace et al., 2018). From this, it can be deduced that the increasingly complex aspects of projects will gradually be replaced by Artificial Intelligence.

Conclusion

Throughout various applications, it is evident that Artificial Intelligence in project management aims to simplify and generate efficiency in project processes. Generally beneficial, its applications and processes can range in sophistication and include those of risk management, estimation, resource management, KPIs, prediction and experimentation. Various data scientist roles will inevitably be introduced especially during the process of technology development. These higher-level roles will eventually replace more traditional roles as they become fulfilled by technology.

The present state of Data Science and current applications of Artificial Intelligence remain preliminary with great room for development. With the increase and prevalence of data, it is very possible that the processes and techniques of Data Science as well as corresponding Artificial Intelligence applications will experience significant expansion in the near future. Currently, there already exists centralized systems within industry firms which aim to determine relevant Artificial Intelligence processes (Srinidhi, 2019). With Data Science, Artificial Intelligence and Project Management becoming progressively amalgamated, it is inevitable that they will increasingly converse with one another to produce more efficient processes in project delivery. Research within this growing field will greatly assist in its development.

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