

Artificial Intelligence Use in Project Management¹

Issues for Project Managers and Teams to be Aware of, Part 2²

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Introduction

In the technology world today, it is vital for project managers to have a sense of how artificial intelligence (AI) systems work. In particular, project managers must be familiar with the algorithms that drive AI systems. An algorithm is a step-by-step procedure for solving a problem, answering a question, or providing a pathway to a decision (Cormen et al., 2009).

Algorithms are the building blocks of AI systems and fall into two main categories:

Rule-based systems:

Systems that operate using predefined rules are known as rule-based systems. For example, an expert system for project scheduling might follow a set of established rules for allocating resources and setting project deadlines. These rules are normally created by hand and do not change unless a human modifies them.

Machine learning models:

Which use changing and evolving datasets that can be used to predict future data by classifying data (Goodfellow et al., 2016). Basic AI capabilities in regard to AI applications in project management are data analysis, task automation, resource optimization, risk assessment, decision support and others (The Role of Artificial Intelligence in Project Management, 2021). Working in concert with artificial intelligence applications in project management, project managers will learn and continuously improve their cognitive skills to write clear and concise

¹*Editor's note: This series of articles is on the use of artificial intelligence (AI) in the project management field. While the authors recognize the rapidly growing attention on the potential power and impact of AI on project management, they also want to point out some risks of assuming AI and human intelligence are or can be equated. The authors have previously researched and published on topics related to neuro-behavioral issues and cognitive intelligence in project management.*

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prompts for guiding AI outputs. (Pre-train Prompt and Predict: A Systematic Survey of Prompting Methods in Natural Language Processing, 2021).

Models in Machine Learning include:

- **Deep Learning Neural Networks:**
 - Enables project managers to deal with large datasets and can make sense of complex patterns. For example, by analyzing historical data the neural networks can predict project delays by finding patterns that lead to delays.
- **Natural Language Processing (NLP) Models:**
 - Uses algorithms for doing sentiment analysis on stakeholder communications or automating extraction of the information from project documents, thereby enabling targeted communication and reducing chances of critical information being missed.
- **Decision Trees:**
 - Assists in the decision-making process by evaluating the different possible outcomes and suggesting the ones that could be helpful based upon the past data. Decision Trees can be used to identify potential risks and their forecasted impacts on the project.

AI capabilities go beyond what have been traditional software solutions for project management. It is a combination of algorithms, hardware, and software designs that give AI the ability or human-like mental characteristics of an artificial agent, such as a robot. How are these new AI-like robots programmed? Most AI programs are written in a dialect of Lisp called Common Lisp. AI programmers do not write programs that tell the computer what to do. Instead, they write a program that has the capabilities that we now seek in computer tools and systems.

When artificial intelligence (AI) makes a decision or generates a response, it does so for a reason. Understanding these reasons and the factors that influence AI's outputs can be invaluable to users. It provides a level of transparency that is otherwise difficult or impossible to achieve. In this sense, AI is asked to fulfill an expectation that we don't typically have with respect to human brains, which don't always afford us clear insight into why a certain decision was made. Furthermore, AI offers the promise of not just being able to tell us why it made a certain decision, but also doing so in a way that we're likely to understand. But as we'll see, the explanations forthcoming from AI can vary in both their accuracy and their understandability.

Providing information to users in a format that is clear and structured is essential. When it comes to natural language, serving users requires understanding first, and pushing past that requires an AI system that is able to represent its information in the right way. That means using maps, spatial data, and the setup of a location to offer guidance and clear directions to the user. And what about a bit of "physical touch" to help elevate an AI system that is already on the cusp of conversation with a human? The truly meaningful use of AI coordinates all four of these elements.

As it turns out, every aspect of a robot's behavior - its modules, its knowledge resources, its behavior nets (interconnected nodes that determine the robot's actions and responses), even its architectures - can be designed as programming systems.

As algorithms shape the parameters and focus of the databases being queried, project managers and their team members should build and sustain a skill in prompt engineering. Prompt engineering is the craft of writing effective [allows one to acquire information sought] and efficient [allows one to target information and rule out non-productive information] prompts to direct AI systems to generate relevant and targeted results. This ability is significant because the quality and precision of prompts significantly impact the capability of AI algorithms to generate valuable insights.

Why Prompt Engineering Matters:

- Prompt engineering is an important skill for project managers because it enables the following:
 - Guiding AI outputs:
 - Thoughtfully designed prompts help AI systems undertake the task within a set context and requirements, yielding outputs that should be more accurate and germane.
 - Maximizing algorithm efficiency:
 - Distinct, concise prompts to enable algorithms to process data more efficiently, meaning less time and fewer computational resources are needed.
 - Enhancing decision-making:
 - By offering targeted instructions to AI systems, project managers can obtain more reliable data-driven recommendations, leading to better decisions.
 - Why project managers need prompting skills:
 - To use AI in their projects, project managers must understand and apply prompt engineering techniques and be able to explain the process and results to executive and senior management.

Algorithms determine how data is processed, analyzed, and presented. Thus, being able to write precise prompts is a crucial project management capability now and into the future. Prompts which are unfocused, too broadly written, or even too narrowly written can mean that AI-powered tools deliver misleading or nonsensical results—harming rather than helping a project manager and the team. While prompt engineering is an essential skill for project managers using AI, it is equally important to recognize that it is just one of several critical aspects. Data quality, system integration, and continuous learning are also vital to ensure a balanced and effective implementation of AI in project management. By focusing on these key areas, project managers can harness the power of AI to enhance decision-making, improve efficiency, and drive successful project outcomes.

Algorithm insights for Project Managers

For project managers, it's not enough to just understand AI. They also need to know about algorithms—the basic step-by-step building blocks of the type of AI that's increasingly being applied to projects and organizational decisions. After all, it is the algorithms that do the actual work of optimizing tasks, enhancing decision-making, and providing information that can improve overall project efficiency.

And what is an algorithm, exactly? In its most basic form, an algorithm is a set of instructions that define a task; in more elaborate form, it is a step-by-step procedure for solving a problem or query. "If A happens, then B will happen; if C happens, then D likely happened first" is how an algorithm might interpret events.

Algorithms are dedicated problem-solving or decision-enhancing processes that work by utilizing a set of well-defined instructions. In project management, algorithms can be found in scheduling tasks, optimizing the use of resources, and even in some machine learning models that forecast project outcomes or risks. Indeed, algorithms form the backbone of many projects and are increasingly used to enable project managers to be more efficient and effective.

Cormen, Leiserson, Rivest, & Stein (2009) define an algorithm as "a single step in a multi-step process for solving a problem." They go on to say that an algorithm is defined not by its input but by its output: "An algorithm is an instruction that describes a task, paired with an input that provides further context."

Project management can benefit greatly from the many applications that algorithms currently offer, as well as applications under development. Some of these are relatively straightforward, like using datasets to generate meaningful insights with an algorithm. This is pretty much what algorithms were designed to do in the first place. Other applications are a bit more subtle. For instance, project managers can save time by letting an algorithm handle the kind of repetitive tasks that tend to eat up a project team's time. When those tasks are handled by an algorithm, the project team is freed up to focus on more activities leading to meeting the objectives and delivering the benefits of the project.

Having the knowledge of understanding the basics of algorithms, it may potentially be part of a project managers' job descriptions to see to it that their projects' algorithms and AI systems are compliant with security standards of their organization, as well as their customers. This approach entails putting in place strong cybersecurity measures to safeguard data against infringements, unauthorized viewing, business proprietary information moving to outside organizations, and in some instances sequestering data on systems. The security protocols of the project should be monitored and modified regularly. Insecure protocols bring risks and are the fast track to hacking the system.

Algorithms that process personal or sensitive information must comply with data protection regulations. As such, project managers must provide that their data-handling practices follow guidelines such as General Data Protection Regulation (GDPR) and California Consumer

Privacy Act (CCPA). Data protection will require proper data anonymization, obtaining consent from data subjects, and implementing data governance frameworks that oversee data usage and storage.

Biases present in the data used to train algorithms can be unintentionally encoded into the models they produce. Project managers should be mindful of potential biases when working with ML models and take action to identify and minimize them. This approach includes using diverse and representative datasets, conducting bias audits, validating, and verifying data sets, and consistently monitoring the algorithmic decisions for accuracy, completeness, and equity.

Ethical use of algorithms in project management is composed of transparency, accountability, ethical reviews, and fairness. Clear ethical guidelines and codes for the use of AI systems should be established by organizations, enterprise management offices, project managers, or other oversight governance structures and should be understandable by the stakeholders. Issues within ethics comprise exclusionary practices, retaining privacy, and being transparent about how algorithmic determinations are made.

The term "black box" or "opaque algorithm" refers to the naturally intricate and unclear nature of algorithms. That is, they make decisions that are hard for us to understand. Internally, an algorithm is just a set of instructions for solving some problem. If you follow the instructions, you should not make any procedural errors, and you should get the right output. However, it can be difficult to understand exactly why an algorithm is making the decisions it makes, especially when the process happens in a computer.

For example, Alice wants transparency, so managers must record the logic, inputs, and decision-making or results of AI systems. If team members perform the testing and developing stages, it will also improve transparency and trust bounded by continued testing and improvement with the AI systems.

It is important for project managers to understand algorithms in order to appropriately use AI tools and handle the complexities of deployment. By understanding algorithms, providing security and compliance, managing bias, ensuring ethical guidelines are met, and increasing transparency, project managers can maximize the potential of AI in their projects.

The Art and Science of Query Formulation

The process of writing accurate and appropriately worded queries is a crucial component of AI's success. The importance of writing targeted queries is because it is the basis on which algorithms operate. And as a good project manager knows, the ability to express a thought clearly and in a manner to achieve a desired result is not an easy skill to master. With practice, however, writing good queries becomes easier, and the practitioners' intuition about what makes a query achieve the desired output tends to improve over time. As project managers gain more experience, they are also likely to become better at understanding why certain queries work well and then applying those techniques to writing other queries.

Writing requests for AI algorithms should involve several critical elements. First and foremost, they must be clear and free of any kind of ambiguity. These requests are basically queries that the right algorithms can understand and then operate on in such a way that yields the kind of results we're after. They do this in a way that channels the power of the available computing resources to achieve that understanding and solve the problem at hand.

Ensuring that our queries are firmly related to the project's objectives is very important. It's a red flag when queries seem to serve no clear purpose. At times, we might find ourselves chasing relatively meaningless tasks because they were part of the way the team analyzed a problem, not because they offered a plausible way of solving it. To minimize this, it is helpful to keep the project's goals always in mind as we formulate and work with queries.

The query's background, task, and any conditions or circumstances that may be important to grasping its meaning are all part of the essential context. The more you can do to make the context of a query explicit to your algorithm, the better the algorithm is likely to function. Data quality is another critical factor. If the data itself is not of high-quality or is not clean, well-structured, and free of errors, then obviously, whatever comes out of an AI algorithm will reflect those poor data qualities. And we all know what happens when you try to solve a problem using bad data—the problem usually does not go away; it often just changes form and shows up somewhere else in the output or causes issues to arise that can be costly to the project.

And last but not least, bias awareness is something to always keep in mind. Biases can come from anywhere: from the data (which may be biased for any number of reasons), from how the data are structured (again, could be problematic if poorly structured), or even from how a request is worded (could inadvertently introduce bias if not worded properly). Bias that results from the data in open-source can be invisible to the user. One can attempt data integrity reviews and validation and verification; however, in most cases it is not something that can be achieved in an adequate manner since the data is acquired and accumulated outside the organization.

When constructing a query, there is an art and science to the formulation. The following steps and examples are suggestions to help guide the process:

1. Identify the Goal:

- a. Define clearly what you want to achieve with the query.
 - i. Example: "Predict the likelihood of project completion within the deadline, based upon information about the project."

2. Analyze the Request:

- a. Take the top-level request and break it up into smaller components that are actionable.
 - i. For example, the request "Find the major influences on project timelines" can be broken up into the request "Find patterns in historical projects that have similar work scopes."

3. Incorporate Specific Keywords and Phrases:

- a. Include exact wording that is directly relevant to the objective.
 - i. For example, instead of "How can project efficiency be improved?" state "What are the specific key performance indicators that lead to success through project efficiency in historical, similar projects?"

4. Give Contextual Information:

- a. Put the scenario into context to assist the algorithm in understanding the larger picture.
 - i. For example: "Based on the present allocation of resources and project scope, what are the prospective delays?"
 - ii. Example: Start with "What factors affect project success?" and iterate to "How do project team size and budget variances impact project success rates?"

Enhancing query formulation will be an ongoing effort. Here are suggested tactics to improve queries:

- **Feedback Loop:**
 - Use the output from initial queries to refine and enhance subsequent queries.
 - Example: If the initial query "What causes project delays?" returns broad results, refine it to "What are the top three causes of project delays based upon the type of project?"
- **Work with Experts:**
 - Collaborate with data scientists, data analysts, and AI experts to refine queries.
 - For example, consult with a data scientist to get a better grasp on machine learning models in project management tools.
- **Use AI tools that can optimize your query.** For example, you can use Natural Language Processing (NLP) tools to automatically generate/refine your query based on the job or project requirements.
- **Keep learning:**
 - Keep up with the latest advances in AI and query formulation techniques.
 - Example: Attend workshops regularly and read recent research papers on AI query optimization.
 - Join a user group and learn from other users.
- **Experiment and iterate:**
 - Do not worry about experimenting with different formulations and learning from the results. However, be aware of the time and budget being devoted to the queries.
 - Example: Try different phrasing and structure for the same query and see which yields the best results.

Effective query formulation is a key skill in information retrieval. Retrieving information effectively means making queries in natural language that convey the user's information need with high precision. That is; to achieve this precision, the user must compose a query that represents their requirement exactly. The well-formed query is then fed to the matching process, which attempts to identify, among all the documents in the system, those that are most relevant to the user's requirements. There are various techniques that can be used to formulate effective queries, such as rephrasing, paraphrasing, and using natural language processing tools.

Understanding the user's intent and being able to convey it clearly in a query is essential for retrieving informative and relevant results. Additionally, knowing how to refine queries by narrowing or broadening the search criteria can also be helpful in finding more specific or general information, respectively. Overall, effective query formulation is a crucial skill for information professionals to master in order to assist users in efficiently locating the resources they need.

Project managers or a designated team member for AI queries can improve the effectiveness of AI tools and algorithms in a remarkable way—by writing better requests. Writing better requests is an art and a science. It's an art because it requires the project manager to have a good understanding of the request itself—as well as an understanding of what type of response is appropriate. It's also a science because there are methods that can be applied to writing requests that ensure they are clear, direct, and easily understood by the AI tool or algorithm providing the response.

Conclusion

Understanding the algorithmic nature of artificial intelligence (AI) systems has become a critical skill for project managers in today's age of technology. An algorithm is a step-by-step process for solving problems, answering questions, or making decisions (Cormen et al., 2009), and it is the core element of AI systems. The two primary kinds of algorithms are rule-based systems and machine learning models. Rule-based systems follow explicit rules, while machine learning models operate on data to make predictions.

When it comes to project management, algorithms are at the heart of artificial intelligence capabilities, such as data analysis, task automation, resource optimization, risk assessment, and decision support. To effectively harness AI in their projects, project managers need to understand how these algorithms work.

Prompt engineering, the skill of creating well-defined and productive requests, is crucial for project managers. A thoughtfully constructed prompt instructs AI systems to return more precise and applicable outputs, thus granting project optimization and decision-making processes. Prompt engineering speaks directly to algorithms by setting the framework to evaluate and understand data.

There are many things a project manager must consider, for example, security, data compliance, bias, ethics, and algorithmic transparency. Making sure there are robust cybersecurity precautions, processes and procedures in place, and that data protection regulations are strictly adhered to is crucial. In addition, being conscious and actively addressing any identified potential biases that could exist in the data and in algorithmic decision-making helps to promote applicability, fairness, and equity. Lastly, transparent ethical guidelines and transparency in AI operations help to create greater trust and a higher-level of accountability.

Project managers can dramatically increase the power of AI tools by learning to craft queries, understanding the algorithms being used, and what data will be queried. This knowledge helps to optimize the operation of tasks, improve decision-making, and provide more successful AI implementations in project management. The key is to keep learning and working side-by-side with AI experts and other users to stay current, while honing your query skills.

In summary, project managers who comprehend and implement these principles will be ready to hold and lead the power of AI to allow the delivery of more wins and an upper hand in the technology-led ventures scene.

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Ivano di Filippo is a distinguished scientist in Applied Cognitive Neuroscience, focusing on project management and artificial intelligence. He currently leads the Cognitive Readiness Research Program, which is dedicated to advancing the mental preparation of leaders. From 2017 to 2019, Ivano served on the Board of Directors at the Italian Institute of Project Management (ISIPM), where he also holds certification as a Project Manager.

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Darrell Mesa, a Senior Program Planner / Scheduler and a dynamic intrapreneur, with extensive expertise in project management, including program planning, scheduling, and risk management. As a certified Project Management Professional (PMP), he has a demonstrated history of steering large-scale projects to success by applying industry best practices, with special proficiency in Earned Value Management (EVM), Critical Path Schedule Management, and Work Breakdown Structure. His role as a Microsoft Project Practitioner at Denver Corporate Search showcases his ability to develop and update intricate MS Project schedules, adhering to stringent government regulations.

Darrell's professional journey is marked by significant roles that have allowed him to leverage his skills effectively. At Projitz LLC, as a Senior Program Planner / Scheduler, he enhanced project efficiency through meticulous application of Work Breakdown Structure and Critical Path Analysis. As a Senior Integrated Master Scheduler at Highbury Defense Group, he made notable improvements in program efficiencies through the execution of Integrated Master Schedules and the integration of Earned Schedule methodologies. A key achievement in his career was the development of 89 Project E-cademy training courses, which increased team productivity by 10%. In his capacity as a Learning Management Administrator, he demonstrated dedication to knowledge dissemination, using WordPress Tutor LMS to bolster team skills in Project Scheduling using Microsoft Project Professional and Project Web App.

In addition to his corporate roles, he is the founder of Influence IPM LLC, a business focused on Integrated Project Management, where he leverages his vast experience to provide cutting-edge project management solutions. More about his entrepreneurial venture can be found at influenceipm.com. Beyond traditional project management, he is also an active AI Influencer through his YouTube channel ([Restless Minds](#)), where he creates and shares content on AI advancements, fostering a community of tech enthusiasts and professionals keen on the latest in artificial intelligence. Based in Murrieta, California, he is keen on connecting with like-minded professionals and can be reached via email at darrell.mesa@pm-ss.org or through LinkedIn at <https://linkedin.com/in/darrell-mesa-pmp-csm-4bbb8955>.



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