APPENDIX A

How to Architect and Build a Machine Learning Solution

Organizations are looking at technologies like machine learning, IoT, and Big Data to be more relevant in the market and attract customers in the competitive age of technologies, process, and the war of talent. However, the only way to achieve their goals is to provide effective products and respond to market needs in a timely manner. In order to effectively and efficiently take advantage of these technologies, an organization must have a strong foundational infrastructure to store data, execute analytical jobs, and defend its data assets from unforeseen modification or compromise.

Cloud-based infrastructures provide organizations with a flexible platform for data storage, management, and processing. They are also easily scalable (horizontally and vertically) based on need. However, to build a good machine learning solution, the requirements, needs, vision, and practical specific use cases must be clear. A well-designed cloud-based infrastructure can easily add new capabilities.

In the recent times, machine learning implementation has become less expensive through the use of cloud infrastructure. Therefore, chances were high that technology would be misapplied. Cloud providers often highlighted that machine learning would provide companies with huge benefits, but this is a subjective statement and depends on multiple factors. Therefore, making a proper, rational decision is the key. The value and benefit of a machine learning solution will not be realized if it is applied to systems where it is not required. For instance, if it is applied to the system where prediction capabilities are not required at all or appropriate data is not available.

Generally, a machine learning solution should not be implemented to replace existing systems or replace an existing data store. However, to build a machine learning solution, organizations need a solid data strategy, infrastructure, architecture, and workflows. These help ensure the high-quality data availability across organizations (LOB, UNITs), which are linked to rapid analysis and do not expose the organization to risk through data compromise. This also helps them meet compliance challenges.

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Here are the common steps an organization must take before and after kicking off machine learning projects. These must be addressed for an effective and efficient machine learning project implementation:

- Define the scope.
- Review the existing system and data governance structures.
- Revisit security policies and tune them per current needs.
- Generate a map of existing workflow and relationships between applications and data stores.
- Create infrastructure, process, and technology maps and highlight strong and week relations among them.
- Define the business vision for machine learning.
- Determine the suitability of technologies for the solution, define business drivers, call out risks, and establish business cases.
- Define migration strategies for the application, infrastructures, and services.
- Secure the budget and resources.
- Define the operational model.
- Create an implementation roadmap.
- Determine the implementation plan.
- Implement it.
- Evaluate the implementation.
- Incorporate feedback iteratively.
- Modify and fine-tune the strategies based on the analysis of feedback.
- Follow the usual cycle.

The primary value of Big Data and machine learning is to bring flexibility and insight through analysis of complex data sets. Many associated technologies will be part of this suite, including predictive analytics tools, IOT, and cloud technologies, as well as data modeling, data quality, and cognitive computing frameworks. However, the most important step of any analytical workflow is an efficient data process.

The following steps should generally be followed to convert data to insight to its consumption. Following these steps involves confirming that high quality data is considered. Also, these would help data scientists analyze the prepared data in the correct manner.

These steps help to convert raw data to insight:

1. Gather: Gathering data from heterogeneous sources.
2. Discover relationship: Discover the relationship in the existing data set.
3. Organize: Organize and then reorganize the data set for efficient and effective utilization.
4. Analyze: Identify and analyze the relationship.
5. Generate insight: Generate insight after the analysis of data.
6. Report: Report the insight in user understandable format.
7. Consume: Consume the insight for the business purpose.

Architectural Considerations

The technical architecture for a machine learning solution must be built around need and requirements. Therefore, while designing the machine learning solution, the key design considerations must align with these factors:

- Know your need: Identify your need and define the use cases accordingly. This will enable proper prioritization of work, section of technology, scalability considerations, seamless systems, and data integration.
- Define operational strategies: Define the operational strategies beforehand in order to execute the solution effectively.
- Be optimistic about scalability and performance: While creating machine learning solutions, an optimistic approach is required. You have to believe as time passes that your organization will grow and evolve. Therefore, while you are designing the solution or architecture, your platform must be capable of incorporating the growing demand of data and must take care of analysis without much change. It must be able to handle data expansion effortlessly.
- Strong data access and retrieval strategies are key: Easy to understand interfaces, effective tools for storing data, optimized platforms, and excellent handling capabilities of unstructured data are some of the parameters that must be considered during the design. These parameters facilitate efficient and effective ingestion and processing of data.

- Security controls, logging, and auditing: Security is a key consideration for machine learning solutions. Identity management, auditing, and access controls must be designed to cater to the risk levels of the organization and be efficient enough to handle compliance needs. Access control implementation must be consistent between access methods.
- DevOps and Analytics Ops (refer to Chapter 7 for details on these concepts): Incredible operational value comes from storing and processing heterogeneous sources of data in a machine learning solution, especially in the cloud environment. Therefore, it is difficult to manage them manually. Hence, the preferred solution is to automate deployment and recovery. This would lower the operational problem on the IT team when making changes and responding to incidents.
- Be synchronized with advanced capabilities: Implementing advanced capabilities, like APIs, parallelization, and cognitive capabilities is the key to an effective machine learning solution. Therefore, synchronization with the latest advances is a must.

Cloud Adoption of a Machine Learning Solution

When organizations are planning to put their machine learning solution on the cloud, they need to adopt a few specific steps and strategies. In cloud-based environments, ensuring environment availability, reliability, and scalability becomes important. It is more relevant in a Big Data/machine learning scenario because of the real-time demand for insight. Therefore, to provide analytics and machine learning as a service, this is a high priority.

Blueprinting is a very important activity for designing any architecture. Therefore, a brief description it is provided in the next section. However, these are high-level views. If you need more detail, consider dedicated literature for the appropriate setup.

Blueprinting and Machine Learning Projects

Blueprinting an IT project involves the following:

- Brainstorm with business and technology stakeholders to elaborate, align, and document the scope of the stated business problem
- Translate this problem further to high-level requirements.
- Come up with various possible technical solutions (including high-level costs and timelines).
- Align and secure sign-off with the best solution.

Subsequent to this exercise, the budget is secured for the implementation project and a project team is identified and installed. The team refers to the blueprinting documents as high-level requirements that furnish the technical requirements, followed by subsequent SDLC phases.

It is extremely important to spend time in the brainstorming sessions to understand the business problem in detail from the business stakeholders.

The business stakeholders have a tendency to state the problem at a very high level. Create a questionnaire to probe for the necessary details. That questionnaire should cover aspects such as:

- What is/are the base issue(s)?
- How is it impacting the business or performance of duties?
- Are there any financial impacts of this issue?
- Is the stated functionality actually going to solve the base issue or create new ones in the future?
- Has the business tried to solve these issues before?
- If yes, what were the shortcomings of the previous solution?

For a successful blueprinting exercise, it's imperative to include all the relevant stakeholders. Here is a typical list of stakeholders and the area of contribution.

Individuals/Groups	Contribution
Business teams	Sign off on the requirements and the chosen solution.
Architect/Architectural group	Sign off on proposed solution compliance to organization technology architecture.
Designer/design group	Provide input on current state of the system design and contribute to proposed solutions.
Project manager	Manage budget, resourcing, talent, timeliness, and coordination of the project.
Technology manager	Provide roadmap of the technology to the project. Interact with the architect/architecture groups to make sure technical smoothness of the project.
Business analysts	Help to understand current business logic and process and give the current state and data flow.

APPENDIX B

A Holistic Machine Learning and Agile-Based Software Methodology

Workforces in the IT/IS industry are comprised of humans and their complex social, moral, emotional, and spiritual behaviors. When employees come to work, they bring their psychological state of minds with them. This affects their interactions with the stakeholders and other activities at work. Having high-level technical skills do not automatically mean high performance, unless the team members are committed, motivated, and enjoy their work. Therefore, organizations and in turn managers and leaders have to understand the importance of team members' psychology and behavior at the workplace, which includes their stress and conflict-handling skills.

Employee communication and collaboration abilities in the workplace (especially in the IT industry) play a critical role in project success. Alignment of employee values, skills, competencies, and goals with the organization and with clients is important for good results. Also, proper understanding of the philosophy of technical methodologies is one of the factors for achieving excellence in the deliverables.

Many academic studies and professional viewpoints have recognized the significance of managing emotions (emotional intelligence, EI) in the workplace. The ability to navigate and facilitate social relationships (social intelligence, SI) and the ability to apply universal principles to one's values and actions (moral intelligence, MI) toward workplace success and organizational efficiency and effectiveness has gained recognition in professional cycles (for details, refer to Chapter 8).

Several emotional intelligence training programs have been established to tune employees to the organizational culture and vision, but no framework has been developed (so far) to address employees' emotional, social, moral, and spiritual competencies holistically.

The rationale behind this appendix is to underline the importance and application of emotional, social, moral, and spiritual intelligence in the software industry and with technology companies. It also highlights how these competencies can contribute positively toward an organization's quality of service and deliverables, which will ultimately lead to organizational success.

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It also discusses an integrative software development methodology based on holistic intelligence (= IQ+ SQ+ MQ+ EQ+ Social intelligence+ ingredients of positive psychology). Technologies are changing dynamically. Every day, something big is happening in the technical space. But the software methodologies have not changed over the last few decades. They are forced to fit to the existing ones with the small changes to accommodate new generations of technical project demand.

The Goal

This appendix presents a software methodology that's based on the Agile software development principles and psychological concepts. The proposed methodology is effective in designing, executing, and testing highly technical, complex projects, which often need with motivation, focus, and commitment from all levels, starting from programmers to clients to leaders. Big Data and machine learning projects fall under this umbrella (however, they could be applicable to any project). This framework uses integrative and innovative methods and models to diffuse different leadership techniques with information technology (IT) and software development.

Proposed Software Process and Model

Agile is a fundamental change in how people manage projects if it is compared to waterfall techniques. Delivering workable software on time is what actually measures the success of a project. However, software delivery is not enough. The quality of the delivered project, stakeholder satisfaction, and workforce happiness are also very important. If the workforce is happy, they will be more productive, creative, and innovative and therefore be able to create more robust solutions. Existing software methodologies typically cater to the few administrative and technical success factors of software development projects, like timely delivery of workable software and keeping projects within budgets. Often, behavioral and psychological success factors are not being accommodated in the project in any considerable way.

Thus, the overall existing process, including the software methodologies, need to change the fundamental way of thinking. Organizations have to change or fine-tune the old management style by making it more dynamic and customizable, per project need and demand. One standard management style across the organization will not be of much use. Customized and personalized management styles on a project basis are the need of the hour. The behavior of the programmers—their psychology and skills—needs to adjusted or modified based on the need of the project. This can be done by using machine learning, Big Data, and cognitive computing techniques.

The machine learning analytics based software development methodology is capable of bringing dynamism and agility to the development methodology itself with continuous learning and adaptability. The expectation is that the model must learn from the continuous changing behavior of the people who are the part of the project and in turn with the organization. The model can analyze all the data available in the organization in all forms and suggest the appropriate customized software process and methodologies based on the availability of skills, processes, technologies, and people.

This includes charting out the guidelines for planning, developing, and executing in an automated way with no or very little human intervention.

The model will also suggest the appropriate customized software methodology based on the requirements. For example, the machine learning and predictive analytics techniques will enable the model to evaluate and analyze the requirements, including inputs from similar projects that the organization delivered in the past. The model can study the scope of work by using SOW documents, accessibility of the self-components, present talent availability, time to deliver the project, character, and behavioral analysis of the stakeholders/team members, and then determine that the project needs a mix of Agile, waterfall, and Kanban methodologies. Then it would generate customized methodologies with the guidelines for implementation, process, and other action items. It then can predict its success percentage on the solid foundation of data, statistical techniques, and analytics.

Problem State

Most software methodologies are based on mathematical and statistical techniques and not on the people factor. Therefore, several problems occur. Although all methodologies are implemented by humans, they do not consider the psychological state of the human being on work during the overall project lifecycle. It is well known that overall productivity and project success depend heavily on the psychological well-being of the individuals and of the group. For any project to be successful, we have to take into consideration the human factors along with the technical factors.

Solution

Holistic intelligence maps the complete personality of humans. People having holistic intelligence can communicate with the outer world effectively and efficiently, and also with their inner world (their own minds) with confidence. The proposed software development methodology is the integration of holistic intelligence with Agile methodology.

Holistic intelligence is applicable everywhere—during the requirements gathering, design, testing, and implementation phases of software development. It deals with humans and their psychological states and human intervention and involvement exists at all phases of the software development lifecycle. Therefore, to make the methodology more robust and efficient, there is a need for holistic thinking, which includes technical, behavioral, and intellectual skills. Proper application of this proposed methodology will increase the knowledge workers' productivity. For example, in the process of implementing software, the programmers' emotional and social competences become important, because if these competencies are present in the programmers, it will help them better interact with team members, clients, and other stakeholders.

The humans/programmer/knowledge workers are not necessarily equipped with all these competencies. You must be aware of all of their hidden potential at the start of the project. So, once the team is onboarded with the bare minimum qualifications, the desired competencies should be incorporated in the progress of the project. This can be done in an iterative way, whereby the core competencies are cultivated first in the people involved and the rest later… exactly like the Agile methodology.

As projects proceed, training is added to the cycle to improve the holistic intelligence parameters of employees, resulting in more efficient and well-prepared individuals. The training program will be done again in an iterative way: training ➤ evaluation ➤ performance ➤ feedback ➤ more training. That way, the right feedback can correctly assess individuals' progress and competency without having an adverse effect on the project.

Working

This methodology can be technically implemented in multiple ways. One method of applying it is described next.

The Process

When companies or organizations recruit employees, they ask for all the information to determine if the prospective employee is the right person for the job. The information ranges from grades to professional experience. In time-based projects, it is very important to pick the right set of people; hence, this information matters because it provides insight on the person's technical expertise. These information in turn could be mapped to the professional expertise of the resource to the specific needs of machine learning, cognitive computing, and Big Data analytics-based projects.

Also based on these techniques, a model could be created that provides appropriate suggestions based on the project requirements. This "insight" is generated on the basis of information stored in the database that defines an individual's intellectual capability. It also helps an organization pick people who are suitable for projects in the centralized way.

Many organizations have similar databases; however, they do not contain all the behavioral data of an individual. This ranges from individual details scattered at multiple places, including social media and other unstructured data. This need justifies the importance of integrative database or "organizational professional database". The "integrative database" or "organizational performance database" will contain all the content of the employee/ perceptive employee to the extent of behavioral history, personality type, strength and weakness, and emotional and spiritual parameters.

In Agile methodology, when teams develop software, they use pair programming for coding. Pair programming is a software development technique in which two programmers work closely together at one workstation. The driver transcribes code while the navigator analyzes, accesses, and reviews each line of code as it is typed. In this way, while reviewing, the navigator can deliberate the strategic path to the coding work. The navigator also comes up with ideas for improvements and provides insights on future glitches to address. The driver's main responsibilities are to focus on the "tactical" aspects of implementation of the present task. In this process, the driver generally uses the navigator as a safety net and guide.

The integrative database can be helpful in this type of situation, in order to pick the right resources that would play these roles based on the gathered insights on the data stored. Picking the right resources will result in cooperative and more efficient teams, because team members are selected on the basis of behavioral patterns. This is just one example of applying the database to many development methodologies.

Relevance and Future Direction of the Model

No attempts have been made to date to combine social and spiritual intelligence with Agile software development methodologies. These factors (social and spiritual intelligence) help develop one model/framework and innovative methods/calculations, which will provide a new dimension to software development techniques. To improve this methodology, multiple tools need to be developed. A few are mentioned in Figure B-1.

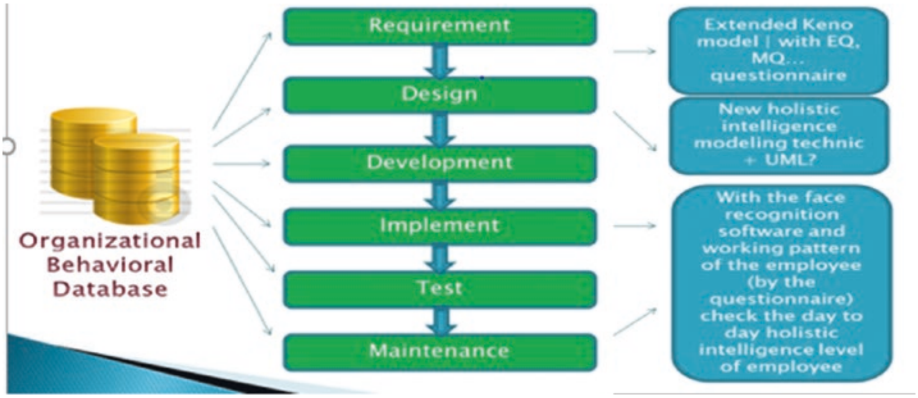

Figure B-1. *Combining social and spiritual intelligence with Agile software development methodologies*

The best way to change problematic behavior is to understand the issues that drive it and then design a plan to combat it. For example, violent conduct may be motivated by distress and anxiety, by cluelessness, or by a wish to govern and control team members. The workplace should be a place of peace and positivity in order to enable quality work and innovation. Teams/individuals are supposed to contribute toward and maintain that peace. One of the prime reasons for emotional imbalance, including aggression, is fear and insecurity.

These toxic behaviors can be controlled if managed with tolerance and reassurance. Unmanaged emotions worsen all types of problems. Therefore, better understanding of emotions and social behavior is required even in the workplace. The better you comprehend how other individuals see the world and what inspires them, the better you will be able to motivate them to perform in helpful ways. The more you identify, analyze, and understand what inspires individuals of different personality types, the better you will be able to shield yourself and inspire them to collaborate with you and provide the work per the requirements. Toxic behaviors generally create problems in software development environments/teams, because ultimately software development is a team activity. Individual-based projects generally fail. The chances of success of team-based projects are high, no matter how complex they are.

This proposed model can be helpful in understanding difficult people and then correcting their behaviors. The goal is to align them with the organization's vision, mission, and propose. Ultimately, this harmony will percolate down to the project level.

APPENDIX C

Data Processing Technologies

Multiple tools and technologies for data processing are described under the Big Data analytics technology stack in Chapter 4. However, many other technologies exist as well, and it is good to know about them for a complete understanding. Covering all the tools is beyond the scope of this book, but the tables in this appendix provide brief explanations of some of them.

Table C-1. *Data Gathering and Processing Tools and Technologies*

Purpose	Tools
Data integration • Enterprise data warehouse • Enterprise reporting	SAP, BDOS Oracle DI, IBM Data Stage, IBM Information Analyzer, Business Glossary, IBM MDM, DB2
Data modeling • MDM data conversion/ migration	Trillium, D3JS, IDL, Riverstand, TIBCO Spotfire, 17 Tableau, SSRS, SSAS, PowerTools
Data profiling • Data quality • Data governance	Erwin, ER/Studio, Visio, DB Designer
Data integration • Enterprise data warehouse • Enterprise reporting	SAP, BDOS Oracle DI, IBM Data Stage, IBM Information Analyzer, Business Glossary, IBM MDM, DB2
Text mining • Data streaming • Complex event processing	SAP MDM, Oracle MDM, 18 Oracle Essbase, 19 IBM, COGNOS, MicroStrategy, SAP BO, Oracle OBIEE
Big Data • Social media	SAP HANA, Oracle Exadata, Oracle Times 10, Terradata, IBM Netezza, HP

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Table C-2. *Analytical Tools and Technologies*

Purpose	Tools
Cluster analysis • Statistical testing, such as t-test, chi-square, and ANOVA • Latent class analysis • Discriminant analysis	SAS, SPSS, R, Python, Knex, Knime, Weka, MiniTab, Mahout, ilog, Matlab, Statistica, Evolve
Descriptive analytics • Univariate analytics • Bivariate analytics • Multivariate analytics	Hadoop, HBase, Hive, Spark, Storm, Splunk, Pig, Oozie
Monte Carlo analysis • Conjoint analysis • Retention analysis • Survey analysis • Lifetime value analysis	MondoDB, CouchDB, Neo4J, Infinitie, MarkLogic, Amazon Dynamo, TITAN
Campaign analysis • Pricing analysis • Survival analysis • Pareto analysis • Quality control analysis	UIMA, Rapid Miner, Tresseract Café, Brandwatch, Crimson Hexagon, Radian6, Symosis, Lithium
Chaid analysis • Regression analysis • Decision trees • Neural network	Apache, Cloudera, 16 Hortonworks, MapR, IBM, Cassandra, Hypertable, Amazon

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