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How Machine Learning Can Improve Budget Forecasting for State Governments

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Introduction

As the size and complexity of government programs rapidly evolve and grow, it becomes increasingly difficult for organizations to effectively manage and accurately project their budgets. The emergence of big data and technological innovation in cloud storage and processing allows state governments to position themselves towards more robust data collection and processing. This can then be translated into advanced analytics and modeling to make data-driven decisions in complex environments and quickly reappropriate resources in near real time.

Machine learning (ML) can help states achieve priorities such as equitable fund distribution, better financial stewardship, and faster monitoring and analysis. It can enhance budget modeling by providing more accurate, efficient, and accessible methods for forecasting and decision-making. The ability to analyze and learn from substantial amounts of data can help governments better predict financial outcomes and optimize their spending.

A vital component of an effective ML implementation for budgets is assuring the technology is accessible for governments and non-technical audiences. An ML implementation for budgeting serves as a tool to enhance, not replace, the current budget forecasting process. Equipping budget officers with usable ML tools and capabilities empowers them to improve the budgeting process by allowing them to focus their time on evaluating the impact of budget decisions on policy goals and strategic initiatives.

By implementing ML, organizations can realize the benefits of an automated budget forecasting model that can gather

data, process it, and update budget projections quickly. This provides greater flexibility to re-allocate resources, as needed, and mitigates the risk of error by reducing the need for manual analysis.

Accurate, efficient and flexible budget modeling with ML

Documenting and recording information consume almost half a billion federal government person hours per year at a cost of over $16 billion in wages[1]. The use of ML in budget modeling allows for the automation of complex calculations and predictions, reducing the need for manual input and analysis. This can lead to more accurate and reliable budget predictions, enabling organizations to make more informed financial decisions, and freeing up millions of labor hours per year. That time can be refocused on more critical tasks such as interpretations and policymaking. ML helps government do the work that needs to be done so humans can focus on the work that matters.

With more robust data and greater modeling efficiency, program and budget managers can rerun budget forecasts instantly and reallocate their resources more quickly and dynamically to areas of need. This allows programs to promote equity by allocating resources to traditionally underserved communities with greater precision. Integrating external data models and analytical tools can provide program managers with a fuller picture of the prevailing conditions and help them better prepare and budget for future events. It also improves the accuracy of their forecasts overall as they consider not only the current or past program performance, but also potential future hurdles such as emerging health crises that may require additional funds or attention.

One of the key advantages of using ML in budget modeling is the ability to handle substantial amounts of data. ML algorithms can analyze and process copious amounts of data quickly and accurately, making it possible to identify patterns and trends that would be difficult or impossible to detect through manual analysis.

Traditional budgeting methods often rely on historical data and manual inputs, which can lead to errors and biases. ML, on the other hand, can analyze vast amounts of data and identify patterns that would be difficult for humans to detect. This can lead to more accurate predictions of future financial outcomes, which can help organizations make more informed decisions about spending and budget allocation. Furthermore, ML models can also be used for identifying and mitigating fraud in the budgeting process.

By analyzing data and identifying patterns, ML can help organizations identify areas where they may be overspending or under-utilizing resources. This can lead to more efficient allocation of resources, which can help organizations save money and improve their bottom line. For example, the US Department of Agriculture (USDA) Office of the Chief Financial Officer sought to take a proactive and data-driven approach to monitoring unliquidated obligations for fiscal year 2018. Deloitte helped the USDA develop dashboards and robotic process automations that gave USDA a strategic view of its operations. The automation process notified analysts when unliquidated obligations were flagged as being at high risk of resulting funds loss. This provided greater transparency and reduced the time analysts spent extracting and analyzing data.
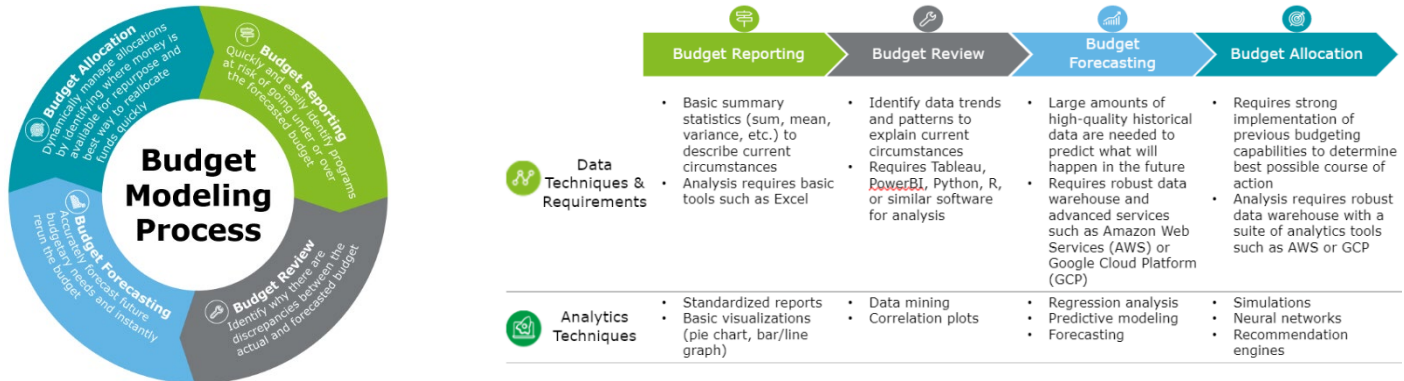
ML can help organizations with budget modeling by providing faster analysis and monitoring. With traditional budgeting methods, organizations often must wait for regular reports or updates to get an idea of how they are performing financially. Significant variation in the number of budget-allocated dollars also makes it difficult for traditional budgeting methods to accurately plan future budgets. ML models can process data in near real-time to make predictions which allows organizations to make quick, informed decisions about spending and budget allocation.

Another advantage of using ML in budget modeling is adapting to data changes. ML algorithms can be trained to detect and respond to changes in the data, making them more flexible and responsive to changing conditions. This can help organizations to better anticipate and respond to regulatory and legislative changes, population changes, major world events or changes in the market, allowing them to make more informed financial decisions and granting greater resiliency to the budget-making process in unprecedented times.

In addition to improving accuracy and efficiency, ML can improve budget modeling flexibility. ML algorithms can be used to create a range of different models, each tailored to specific needs and goals. This allows organizations to create customized budget models, making it easier to adapt to legislative or market changes. While a specific program's budget may have historically followed predictable trends, a flexible model adapts even if external events change the program's landscape drastically.
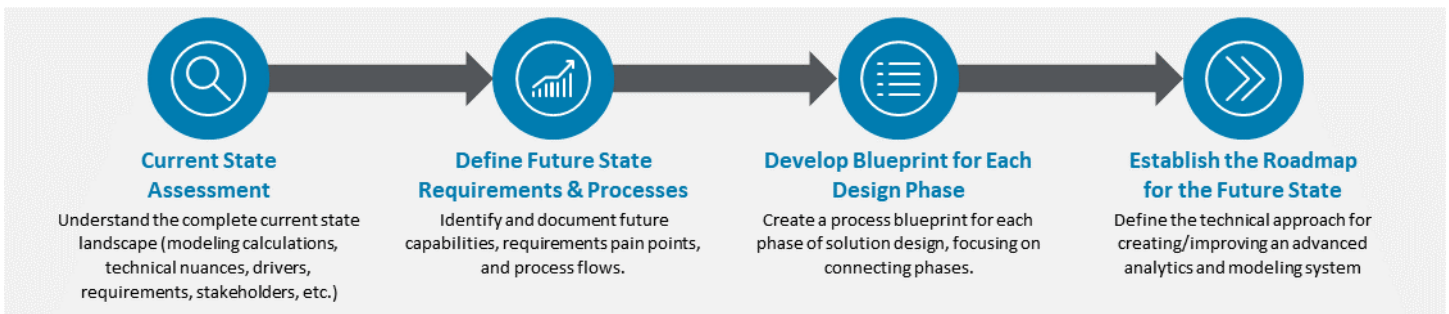
Maturing budget modeling capabilities

Implementing data analytics and modeling solutions enables advanced budgeting capabilities that can be divided into four categories: budget reporting, review, forecasting, and allocation. Effectively utilizing each segment of the cyclical budgetary process leads to more accurate budgets and allows government agencies to make strategic, data-driven decisions.

	Budget Reporting	Budget Review	Budget Forecasting	Budget Allocation
Data Techniques & Requirements	• Basic summary statistics (sum, mean, variance, etc.) to describe current circumstances • Analysis requires basic tools such as Excel	• Identify data trends and patterns to explain current circumstances • Requires Tableau, PowerBI, Python, R, or similar software for analysis	• Large amounts of high-quality historical data are needed to predict what will happen in the future • Requires robust data warehouse and advanced services such as Amazon Web Services (AWS) or Google Cloud Platform (GCP)	• Requires strong implementation of previous budgeting capabilities to determine best possible course of action • Analysis requires robust data warehouse with a suite of analytics tools such as AWS or GCP
Analytics Techniques	• Standardized reports • Basic visualizations (pie chart, bar/line graph)	• Data mining • Correlation plots	• Regression analysis • Predictive modeling • Forecasting	• Simulations • Neural networks • Recommendation engines

Roadmap to advanced analytics and ML

The path to building out an end-to-end ML budget forecasting process begins with developing a roadmap to advanced modeling. Steps include the following:

Current State Assessment
Understand the complete current state landscape (modeling calculations, technical nuances, drivers, requirements, stakeholders, etc.)

Define Future State Requirements & Processes
Identify and document future capabilities, requirements pain points, and process flows.

Develop Blueprint for Each Design Phase
Create a process blueprint for each phase of solution design, focusing on connecting phases.

Establish the Roadmap for the Future State
Define the technical approach for creating/improving an advanced analytics and modeling system

Current state assessment
- Assess the current budget forecasting processes used by the government agency, including data sources, methods, and tools used.
- Identify areas where ML can be used to improve forecasting accuracy and efficiency.

Define future state requirements & processes
- Identify specific requirements for the future state of budget forecasting, such as increased accuracy, automation, and scalability.
- Define the processes and workflows that will be used to implement ML in budget forecasting.

Develop blueprint for each design phase
- Identify the resources and expertise needed to complete each design phase below.
  - Data collection and preparation
  - Model selection and training
  - Deployment
  - Monitoring and maintenance

Establish the roadmap for the future state
- Establish a roadmap that outlines the steps needed to achieve the future state of budget forecasting, including timelines, milestones, and key performance indicators.
- Identify the stakeholders and teams responsible for each step and establish a plan for communicating progress and addressing any issues that arise.
- Develop a governance and compliance plan that outlines the policies and procedures for achieving ML-based budget forecasting solutions that are compliant with all relevant laws, regulations, and best practices.
- Test the ML-based budget forecasting solution in a controlled environment and evaluate its performance against the established key performance indicators. Use the results to make improvements and iterate on the solution as needed.

Roadmap implementation in action

While working with a large Federal intelligence agency, Deloitte conducted a thorough analysis of the current budget forecasting process to identify areas of improvement. The current state assessment revealed analysts spent many hours entering data and manipulating spreadsheets to create a consolidated view of the agency's spending.

The agency implemented Deloitte's integrated budget system that links requirement planning, budget formulation, and execution tracking. This leading-practice Planning Analytics platform interfaced with the agency's accounting system which effectively eliminated additional data entry, resulting in improved accuracy and completeness. The agency can now track spending against the budget in near-real time and reduced its annual actual execution reconciliation process from three weeks to one day.

Once data automation is established, Deloitte can develop a new budget forecasting model incorporating advanced techniques such as neural networks and time series models. Deloitte can provide training and support to agency staff to facilitate effective use of the new ML model. This can range from training and occasional support to an embedded analytics team dedicated to providing ongoing analysis and guidance on how to interpret the results of the forecast and how to use the model for decision-making.

Given our unique mix of experience supporting over 300 ecosystem and alliance organizations in public and private sectors, combined with over 27,000 global analytics and Artificial Intelligence (AI) practitioners around the world, Deloitte can seamlessly implement a ML budget forecasting process. This can help government agencies improve the accuracy and efficiency of their budget forecasting process, allowing them to make more informed decisions and better allocate resources.

Conclusion

ML has the potential to revolutionize budget forecasting. By providing more accurate and detailed near real-time predictions, it can help organizations make better decisions and course correct with funding allocations to avoid prolonged misallocations resulting in costly mistakes. Additionally, by automating time-consuming elements of the forecasting process and reducing the need for manual input, ML can save time and reduce the risk of human error.

The success of ML in budget forecasting depends on the quality of the data and the algorithms used. Organizations should invest in high-quality data and work with experienced data scientists to assure their ML models are robust and accurate. Additionally, they should be prepared to continuously update and improve their models as new data becomes available. With the right data and insights, budget organizations can leverage the power of ML to adapt to a rapidly evolving landscape.

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Endnotes

[1] Deloitte University Press, "How much time and money can AI save government?", May 2023, https://www2.deloitte.com/content/dam/insights/us/articles/3834_How-much-time-and-money-can-AI-save-government/DUP_How-much-time-and-money-can-AI-save-government.pdf