

Cloud Computing: How Cloud Computing is Revolutionizing IT

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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ABSTRACT

Accenture Federal Services (AFS), an IT service management company, wanted to reduce the cost and usage of the cloud by creating an efficient system. To analyze the current usage, minimize waste, and create a plan of action for the future. I collected data that would enable us to forecast the future cost and usage. This was done through tools such as AWS, Redshift, and Jupyter Notebook. Results showed many customer accounts have high amounts of unneeded cloud usage especially overnight and during holidays. To minimize these factors, we created a system that automatically shut off cloud usage when it was not needed. While the predictive forecast was a key tool it was not as accurate as intended which created a focus point to improve upon before launching for customer use.

1. INTRODUCTION

The efficient and effective use of computing resources has become a significant factor as the world continues to rely on technology. Cloud computing has become vital in allowing businesses to optimize resources while reducing costs. However, security concerns, scalability, and the effects of downtime are issues that loom over cloud computing [3]. During my internship, I was tasked with tackling the task of optimizing cloud resources to minimize the cost for our customers.

Cloud computing technology has transformed the business world by using online hosted servers to store and access data. The cloud also allows users to have access to the internet from anywhere. It offers many perks such as ease of access, flexibility, and minimized maintenance spending [4]. It allows businesses to no longer rely on expensive hardware and software. The cloud contributes to the growing need for remote work and collaboration as files and applications can easily be accessed and shared.

2. RELATED WORKS

To ensure efficient cloud usage, resources have been created to provide guidance on cloud cost management. For example, VMware [5] provides an overview of the variety of factors that impact cloud costs and techniques to minimize them. A technique my project used was power scheduling, in which a schedule automatically shuts down non-essential instances overnight, during weekends, or holidays.

Prophet is a forecasting tool developed by Facebook used due to its accuracy and ease of access. The tool takes in a set of data and creates a forecast of the future data that it predicts based on past patterns. Facebook [1] provides guidance on using the forecasting tool in a step-by-step tutorial. My project used Prophet to create a model of accounts to see where excessive spending occurred. This revealed problems such as incurring cloud

overnight and during holiday periods when they were not needed.

Neenan [2] provides tips on how to optimize cloud costs, such as using cost monitoring tools. My project implemented this method by creating a user interface enabling customers to monitor their spending patterns. This is similar to the previously mentioned forecasts as it enables users to gain insights into their current and future spending.

These resources provide guidance and techniques for managing the costs of cloud computing. This is critical for businesses to use cloud computing efficiently and effectively.

3. PROJECT DESIGN

The project design included multiple phases such as planning, a review of the system architecture, client and system requirements, and key components including specifications, challenges, and solutions.

3.1 Planning

The first step was to define the requirements of the cloud optimization system. We identified the need to analyze customer accounts in Amazon Web Services (AWS) and determine if they were using resources efficiently. We also needed to identify if there was an opportunity to reduce costs while optimizing usage. These were then broken down into sprints to meet specific goals by a deadline. These sprints then allowed for tasks to be split among the group to focus on different aspects of the project. Finally, there would be a testing aspect that would check for software accuracy and allow for user feedback to create a final product.

3.2 Review of System Architecture

The system architecture was mostly comprised of the cloud computing infrastructure and software tools used to create the product. This

consisted of AWS and Azure as cloud computing platforms as they provide scalable resources when working with large amounts of data. The software tools, such as Python, Jupyter Notebook, and Facebook Prophet, were utilized as tools to collect data on account usage, costs, and creating future forecasts for customers.

3.3 Requirements

The requirements were focused on fulfilling clients' needs while under limitations from a technological standpoint.

3.3.1 Client Needs

The client's goal was to minimize cloud computing cost and maximize efficient usage. This would consist of optimizing inefficient user usage such as overnight and holiday usage. This required a system that would analyze usage patterns and provide recommendations based on user usage.

3.3.2 System Limitations

The software had to be capable of working with large amounts of data and to be able to consistently analyze customer accounts. This is where cloud computing played a significant role as it can be used as a capable tool. The software also needed to be able to provide insight to customers. This would require training and support as it is essential to give customers a functioning and reliable product.

3.4 Key Components

Key components included specifications to identify the different components of the project, challenges faced, and solutions to the challenges.

3.4.1 Specifications

The overall system includes data collection, analysis, and recommendations. The data collection involved gathering information about usage and cost from customer accounts in the cloud. This was from the database that

stored all this data using Redshift, a specialized data warehouse hosted by AWS.

The analysis component of the system involves using Facebook Prophet. This takes advantage of machine learning to optimize the cloud usage. Facebook Prophet required previous data to find patterns to create future forecasts. It also required other parameters such as the timeline of the forecast requested as it would have an impact on the result.

The recommendation aspect involved a presentation to the customer of the analysis. A key aspect was to make the analysis clear to the customer. Customers would typically receive a graph that was both labeled and color coded to easily understand what they were shown. This would normally be a line graph showing the original data and future forecast. The recommendations would then be shown in a separate report that broke down cloud usage based on hours of the day, days of the week and month, and holidays.

3.4.2 Challenges

The main challenge was making sure the forecast was accurate. It was critical to make sure that the recommendations we were giving customers were reliable to avoid making incorrect assumptions.

Another issue we ran into was accounting for unexpected factors and random spikes in the data. A spike occurs when there is a large, unexpected change in the data, positive or negative. Therefore, the forecast will not always be accurate as it works better with consistent data.

We originally noticed that only about 70% of the forecast fell within the eventual data. This could mean the forecast was either overpredicting or underpredicting. It was important to use this as a learning point with our forecasts as we knew what factors

impacted the forecast the most. Therefore, future forecasts of cloud usage became more accurate allowing customers to make informed decisions.

Our next issue involved creating an automated system that would enable customers to decide when their servers were to shut down. There were a lot of necessary questions to answer, and the answers would most likely have to come from the customers as the product is ultimately created for them.

3.4.3 Solutions

To create more accurate forecasts another algorithm was implemented to work with Facebook Prophet. We found that the spikes were having a large impact as the forecast would overcompensate for them. To avoid these spikes, the forecast would then count them as an outlier. Rather than working with averages it would expect a similar spike only if it was repeated over time rather than expecting it if it was only a single occurrence. We saw our forecasts fall within about 90% of the eventual data showing a massive improvement.

As for our forecasting system, we used customer feedback to make necessary adjustments. Our team was able to understand the preferences of the customers so that they could tailor their expectations. The system then went through testing to refine and polish it before it was launched.

4. ANTICIPATED RESULTS

The customers were able to see the forecasts on their home dashboard and could tinker with dates and what data was being forecasted. They were able to select a variety of data such as specific products, hours of the day, specific days of the week or month, and even could create a custom filter. It essentially allowed the user to filter out specific data points from the database that could then be forecasted back to

them. Giving this freedom to the customer allows for greater customization and personalization of their experience. This will lead to higher satisfaction and foster a sense of ownership as they have better control. Making the customer feel heard can result in increased engagement and trust creating a positive relationship.

After consulting with the forecasting system, the customers were able to set specific times for the server to turn on, run, and shut down. For example, most customers shut their servers down overnight and during holidays as they noticed the cost was not worth the minimal usage. They could also set their servers to run during the day when they were more likely to have a high demand. Overall, the system gave the customer control over their server usage, allowing them to optimize their usage while reducing the cost. This resulted in a more efficient system as customers can save money while still getting the server capacity needed.

Overall, the system provides numerous benefits for customers such as cost savings, optimized usage, flexibility, and convenience. It provides visibility and control over their usage which is critical for a business as they rely heavily on their servers.

5. CONCLUSION

Working on this project demonstrated the powers of cloud computing, especially within the business world. This project assisted many customers navigate the cloud efficiently. The product has already had a large impact on customers while not being a fully finished product. With the rapid transition towards cloud-based platforms, it has become crucial to understand how to minimize expenses. The product's ability to give insight, predictive analysis, and recommendations makes it a key component for any business that relies on the cloud. There are various benefits including minimizing expenses, increasing productivity

and usage, and creating a positive customer experience. This tool could help transcend cloud computing and give a business an edge within the industry.

Working with the cloud give me first-hand experience that provided valuable skills. Experience with the cloud required me to properly understand the advantages it has to offer. The project involved analyzing data to identify trends with the assistance of programming languages. I was able to exercise and enhance my programming skills through the project. Additionally, working on this project required communication skills to work within a team and present to higher-up staffers. To navigate around challenges, I had to develop problem-solving and critical thinking skills. The project provided me with an opportunity to gain and develop technical and personal skills that are valuable in today's world.

6. FUTURE WORK

While the product has been very effective there is still room for growth. A few of the next steps include increasing accuracy, more user capabilities, and more insight with the user interface. A goal throughout the project was to reduce any possible error and to maximize the accuracy. There are still some factors that could be accounted for especially with the user's help. For example, there were spikes in the data that made it difficult to create predictions but if the user anticipates spikes during certain times of the year and communicates that with the system this would create a more efficient system. As for user capabilities, it would be ideal to give users more filtering options to gain insight on their cloud usage. This would give more opportunities to the customer to maximize their cloud efficiency. Some options could include removing specific data points and adding custom data points to create a mock forecast. Giving the customer as much control

over their forecasts would increase their satisfaction with the product. While the user interface of the forecast does share information about the customer's account it would be ideal to add more features. These features would focus on creating a more appealing visual that can help the user understand what the forecast is displaying and recommending. It is critical to make figures easy to read while giving out as much information as possible. Functionality is the priority and since this has been achieved it would be best to shift the focus on polishing the product.

7. UVA EVALUATION

A variety of courses at UVA prepared me for this project. For example, there was mostly a focus on Python and basic programming learned in courses such as CS 1110 and CS 2110. These courses taught the foundation of programming to start with. I also appreciated working on creating a website using CSS and HTML as it prepared me for user interfaces. Learning about the different data structures and algorithms in CS 4102 was extremely helpful as it is critical to know when to use different algorithms.

I noticed that there is not as much of a focus on Python or Java in the later courses as it is usually C, C++, or x86. Students might benefit working with Python and Java more as they are primarily used in the work force. Some courses also felt a bit repetitive, specifically ones that I did not think would be as beneficial. Students might benefit on mastering their skills within more relevant topics.

8. ACKNOWLEDGMENTS

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