

ASSIGNMENT COVER SHEET

Module Code: **ITS69404**

Module Name: **Cognitive Computing and applications**

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Assignment No. / Title	Assignment No. 2	
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Declaration *(need to be signed by students. Otherwise, the assignment will not be marked)*

We certify that this assignment is entirely our work, except where we have given fully documented references to the work of others, and that the material contained in this assignment has not previously been submitted for assessment in any other formal course of study.

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Introduction

In the rapidly evolving landscape of the digital era, cognitive systems stand out as pivotal elements, playing a transformative role in enhancing customer service and user experiences. The significance of these systems in processing vast amounts of unstructured data to provide insightful recommendations and solutions cannot be overstated. This report delves into the intricacies of developing the 'HomeOnline' cognitive system, a novel solution aimed at revolutionizing the way customer complaints are recommended and managed. Drawing from the foundational ideas presented in Assignment 1, this evaluation seeks to identify the most suitable enterprise solutions—both hardware and software—to effectively bring the 'HomeOnline' system to fruition.

The overarching objective of this study is twofold: first, to critically examine and identify the functional components inherent in the given scenario, and second, to assess a myriad of enterprise solutions to determine the optimal fit for the proposed system. With a focus on Taylor's Graduate Capabilities (TGCs), particularly 3.1, 3.2, and 3.4, this report presents a thorough analysis, buttressed by a plethora of evidence and references from reputable sources.

In the ever-evolving landscape of online businesses, customer satisfaction stands as the cornerstone of success. In this pursuit of excellence, HomeOnline presents a groundbreaking solution for managing customer complaints, a system meticulously crafted at the intersection of cutting-edge technology and user-centric design. This visionary approach encompasses a multi-layered strategy, seamlessly integrating the prowess of Amazon Web Services (AWS) and IBM Watson. From the user interface to the cloud infrastructure, each layer of HomeOnline's Customer Complaint Management System is fortified with purpose-built solutions, promising not only efficiency and scalability but a transformative experience for both customers and support agents. Let us embark on a journey through the intricacies of this comprehensive solution, where cloud-based innovation converges with cognitive computing, setting the stage for a new paradigm in customer service excellence.

Recommendation of Software and Hardware solutions

User Layer

At the User Layer, HomeOnline can leverage AWS Connect - Amazon's cloud-based contact center service that allows for the creation and management of a customer contact center with minimal effort. AWS Connect provides a set of tools for voice and chat interactions that can be easily scaled as HomeOnline grows. This service simplifies various operations, such as customer call routing, interactive voice responses, and queue management, which greatly enhances customer interaction. The ability to integrate with other AWS services and third-party applications means that AWS Connect can serve as the foundation of HomeOnline's customer service platform, providing a seamless experience for both customers and support agents. In addition to AWS Connect, Amazon Lex offers the capabilities to create advanced conversational interfaces using text and voice. Lex utilizes the same deep learning technologies that power Amazon Alexa, making it highly effective for developing chatbots that can engage customers, answer frequently asked questions, and escalate complex issues to human agents. Integrating Amazon Lex into HomeOnline's complaint management system will enable immediate and automated responses to customer queries, ensuring that users receive prompt and accurate information, which can significantly enhance customer satisfaction and operational efficiency.

Data Collection Layer

For the Data Collection Layer, HomeOnline can utilize AWS Kinesis to handle the ingestion of real-time data streams from various sources such as emails, social media, chat, and phone calls. Kinesis allows for the real-time processing and analysis of this data, which is crucial for a responsive customer complaint management system. By enabling immediate action on incoming data, AWS Kinesis helps HomeOnline quickly address customer complaints, identify and resolve issues as they arise, and potentially even predict issues before they escalate. Simultaneously, Amazon S3 can serve as the central repository for storing the large volumes of collected data. It offers secure, durable, and scalable object storage, ensuring that HomeOnline can retain customer interactions and system logs for the long term. The integration of Amazon S3 with other analytical and machine learning services provided by AWS facilitates the easy utilization of

stored data to gain insights into customer behavior, enhance service offerings, and tailor responses to customer complaints more effectively.

Browser

At the Browser level, HomeOnline can utilize AWS Amplify to streamline the development of the web application that customers interact with. AWS Amplify offers a comprehensive set of tools and services that assist developers in creating secure, scalable, and reliable full-stack applications. It simplifies the process of connecting the application to backend services such as databases, storage, API gateways, and user authentication. This ensures that the web application is not only responsive and user-friendly but also built on AWS's robust infrastructure. To further enhance the user experience, integrating Amazon CloudFront as a CDN service ensures the fast and secure delivery of the web application's content to users regardless of their geographic location. CloudFront works by caching content in multiple locations worldwide, resulting in quick loading times and an improved overall experience for every customer. The use of CloudFront is particularly crucial for HomeOnline's complaint management system as it guarantees quick and uninterrupted access to the service, which is crucial during peak traffic periods when complaint volumes may be high.

Model Layer

IBM Watson's Natural Language Understanding (NLU) is a suite of tools that can extract valuable information from text data. It includes important features such as sentiment analysis, emotion detection, and entity recognition (IBM Corporation, n.d.). This service is recommended for understanding the contextual nuances, sentiment, and emotions expressed in customer complaints across various media sources. Watson Assistant offers a conversational interface or chatbot that allows real-time and personalized interactions with customers, effectively addressing queries and complaints. By adopting Watson Assistant, HomeOnline can have a responsive and customized system to efficiently handle customer inquiries. Moreover, the Watson Text to Speech and Speech to Text features enable the system to convert voice-based complaints into text, facilitating in-depth analysis and transcription of telephone call logs. These capabilities significantly broaden the cognitive system's capabilities, ensuring comprehensive coverage across different channels of customer complaints. IBM Watson NLU provides pre-trained models in more than 20 languages, curated by a dedicated team of experts and evaluated for quality in

each specific language (*Natural Language Understanding - IBM Cloud*, n.d.). These pre-trained models can be used in production environments without concerns about licenses or intellectual property. Additionally, IBM Watson NLU can be enhanced with custom models built on Watson Knowledge Studio, which can identify custom entities and relationships specific to your domain. It supports various languages depending on the features being analyzed, including English, Arabic, Chinese (simplified), Dutch, French, German, Italian, Japanese, Korean, Portuguese, Russian, Spanish, and Swedish - with more to be added. Overall, IBM Watson NLU is a top-notch text analytics service that can be integrated into an existing data pipeline, supporting 13 languages depending on the feature. It utilizes advanced learning techniques to extract meaning and metadata from unstructured data.

Cloud Layer

To create a strong and scalable cloud layer for the Customer Complaint Management System at HomeOnline, we can combine various Amazon Web Services (AWS) to build a unified backend infrastructure.

At the heart of the system, Amazon Elastic Compute Cloud (EC2) would provide the foundation, offering flexible compute capacity in the cloud. This service is crucial for hosting the server components of the system, allowing HomeOnline to adjust and expand virtual servers based on the changing demands of customer complaint traffic. The versatility of EC2 instances is a valuable asset, as it allows HomeOnline to choose the appropriate processing power and memory requirements that best suit the complaint management workload, ensuring efficiency and optimal performance. By integrating AWS Lambda into the system, we can introduce an event-driven, serverless computing model that eliminates the need for server provisioning or management. Lambda automatically scales the application by executing code in response to triggers, with billing based solely on the compute time used. This approach is cost-effective for HomeOnline, enabling them to allocate resources more efficiently towards improving direct customer service rather than managing infrastructure.

Working in collaboration with Lambda, the AWS Serverless Application Model (SAM) offers a streamlined approach for defining and deploying serverless applications. By allowing HomeOnline to easily manage the lifecycle of its serverless applications, AWS SAM ensures

quick deployment and effective management of the services that make up the cloud layer of the complaint management system. Acting as the gateway to the backend, AWS API Gateway is a managed service that empowers developers to create, publish, and manage secure APIs at any scale. It plays a crucial role for HomeOnline by providing a structured way for customer complaint applications to communicate with backend services, facilitating efficient data retrieval and triggering of actions in a secure environment. For containerized microservices, AWS Elastic Container Service (ECS) and AWS Elastic Kubernetes Service (EKS) offer powerful orchestration capabilities, handling the deployment, scaling, and operation of container workloads. By utilizing these services, HomeOnline can achieve a higher level of scalability and reliability, ensuring that each component of the complaint management system can be scaled and maintained independently.

To coordinate and synchronize the various AWS services and Lambda functions, AWS Step Functions would be a strategic addition to the architecture. This service allows HomeOnline to design and execute serverless workflows, ensuring smooth operation of the interconnected cloud services and streamlining the processing of customer complaints from reception to resolution. Lastly, AWS CloudFormation provides a unified solution to define and provision the AWS infrastructure using code, allowing HomeOnline to maintain consistency, repeatability, and version control over the cloud resources. This enables efficient scaling and adaptation of the infrastructure in response to new business requirements or customer service initiatives.

By incorporating these AWS services, HomeOnline can not only achieve scalability and robustness for its Customer Complaint Management System, but also establish a secure, flexible, and cost-effective cloud environment that can adapt to the changing dynamics of customer service management.

Bottom Components

IBM Watson's Language Translator is a tool designed to translate text across different languages, making it easier for the cognitive system to understand complaints in multiple languages from sources like social media and emails (*Watson Language Translator*, n.d.). Its recommendation is crucial to ensure an inclusive understanding and processing of customer complaints expressed in different languages for HomeOnline's customers. The Watson Tone Analyzer plays a vital role in

detecting and interpreting the emotional and linguistic tones in written text. This functionality is essential for understanding the diverse emotional expressions in chat, messages, and social media, enabling an accurate interpretation of customer sentiment (*IBM Documentation*, n.d.). Furthermore, the Watson Natural Language Classifier offers the ability to categorize text into predetermined categories. It can be trained to categorize complaints based on types, risk levels, products, services, or other factors, resulting in a more organized and structured analysis of customer complaints for HomeOnline. IBM Watson NLU provides pre-trained models in over 20 languages, curated by a dedicated team of experts and evaluated for quality in each specific language. These pre-trained models can be used in production environments without any concerns about licenses or intellectual property. Additionally, IBM Watson NLU can be extended with custom models built on Watson Knowledge Studio to identify custom entities and relations specific to your domain. It supports various languages depending on the analyzed features, including English, Arabic, Chinese (simplified), Dutch, French, German, Italian, Japanese, Korean, Portuguese, Russian, Spanish, and Swedish - with more to come. Overall, IBM Watson NLU is a top-tier text analytics service that can be integrated into an existing data pipeline supporting 13 languages, depending on the feature. It utilizes deep learning techniques to extract meaning and metadata from unstructured data. Additionally, IBM Watson Language Translator supports 58 languages and can be customized with glossaries and fine-tuning using parallel data to enhance translation quality.

Database Services

Amazon's range of services provides a complete solution for managing the diverse data requirements associated with customer complaints. Utilizing Amazon RDS (Relational Database Service) is ideal for handling structured data related to customer complaints. This includes transaction details, customer profiles, and employee information. The managed nature of RDS is its main advantage, as it allows HomeOnline to focus on efficient complaint management without the complexities of database maintenance. RDS ensures high availability, scalability, and reliability for structured data storage.

For unstructured or semi-structured data, Amazon DynamoDB, a NoSQL Database Service, is an excellent choice. It's skilled at storing varied information such as sentiment analysis results, social media interactions, and multimedia content. DynamoDB is particularly recommended for

its seamless scalability, low-latency performance, and flexibility. This makes it well-suited to handle the dynamic and evolving nature of data associated with customer complaints.

Lastly, Amazon S3 (Object Storage) is recommended for storing large volumes of unstructured data, like multimedia files, images, and customer communication records. S3 stands out for its cost-effectiveness, durability, and ease of integration with other AWS services, making it a suitable choice for storing unstructured data from various media sources related to customer complaints. This integrated approach using Amazon's services ensures a comprehensive and efficient management of all types of data related to customer complaints.

Integration and Orchestration Services

Incorporating AWS Step Functions and AWS Lambda into the complaint management system offers a robust and efficient approach to handle complex processes. AWS Step Functions are chosen for orchestrating workflows, where they can coordinate the flow of complaint management processes across different AWS services. This ensures a seamless and efficient workflow. The recommendation for Step Functions stems from their ability to streamline and coordinate complex workflows that involve multiple AWS services. This is particularly beneficial for integrating complaint data from various sources and executing different processes in response.

Additionally, implementing AWS Lambda for running backend code significantly enhances the system's responsiveness and efficiency. Lambda can execute backend processes triggered by events, such as processing sentiment analysis results, categorizing complaints, and updating database records. The key advantage of using Lambda is its serverless architecture, which allows HomeOnline to execute code in a scalable and cost-effective manner. This feature is particularly important for efficient backend processing in response to events triggered by various customer interactions. Together, AWS Step Functions and AWS Lambda create a powerful combination, enabling HomeOnline to manage and respond to customer complaints effectively and efficiently.

In summary, HomeOnline's cognitive computing solution for managing customer complaints is supported by a combination of relational and NoSQL databases (Amazon RDS and DynamoDB) to handle structured and unstructured data, respectively. Amazon S3 serves as the object storage

solution for large volumes of unstructured data. AWS Step Functions and Lambda are employed for workflow coordination and backend code execution, ensuring an integrated and efficient complaint management system. The chosen services align with the requirements of handling diverse customer data sources and provide a scalable, reliable, and cost-effective solution.

Cost Estimates

Layer/Service	Metrics	Cost per metrics	Monthly cost per metrics
User Layer			
AWS Connect	2 ports x 730 hours	\$0.66 per hour	\$960
Amazon Lex	17500 Speech intervals 7500 Text requests 5 hours chatbot training time	\$0.0065 per speech \$0.0020 per text \$0.5 per minute	\$150
Data Collection Layer			
AWS Kinesis	620 GB Data-In 620 GB Data-Out	\$0.08 per GB \$0.040 per GB	\$75
Amazon S3	500 TB S3 Intelligent-Tiering 1 TB S3 Glacier Instant Retrieval	\$0.024 per GB \$0.005 per GB	\$12000
Browser Layer			
AWS Amplify	Build and deploy charges Hosting charges	\$0.01 per minute	\$10 \$350
Amazon CloudFront	200 TB Data-Out Operational Support	\$0.085 per GB	\$17000 \$8.5

Model Layer			
IBM Watson NLU	25,000 NLU items	\$0.003/NLU item	\$75
IBM Watson Language Translator	2 million characters	\$0.0025 per character	\$5000
Cloud Layer			
Amazon EC2	1 year Instance Savings Plan	\$0.121 per hour	\$1000
AWS Lambda	Compute Charges (400,000 GB-s)	\$0.00002 per GB	\$100
	Request Charges (1 million requests)	\$0.20 per million requests	\$50
	Ephemeral Storage Charges (512 MB)	\$0.00000003 per GB-second	
AWS API Gateway	Messages (37.5M messages)	\$1.0 per million messages	\$25
	Connectivity (54M minutes)	\$0.25 per million minutes	
AWS Step Functions	State Transitions (900,000)	\$0.000025 per state transition	\$12.6
AWS CloudFormation	Third-Party Handler Operations (15000)	\$0.0009 per handler	\$3.4
	Hook Handler Operations (4500)	\$0.0009 per handler	
Database Services			
Amazon RDS	Enterprise server (730 hours)	\$2.583 per hour	\$1,900
Amazon DynamoDB	Standard-IA Data Storage (100 TB)	\$0.10 per GB	\$12000
Total Cost			\$48106

The cost structure table presented provides a detailed analysis of the estimated costs for building a cognitive system suited to HomeOnline's operational needs. Given that it is one of the largest e-commerce sites selling home goods, HomeOnline's client base and revenue must be

substantial. To put these figures into context, we drew a comparative analysis from IKEA Malaysia, a major e-commerce player that had approximately 34.9 million website visits and MYR 714.4 million in total e-commerce sales the previous year (IKEA Press Release, 2022). The enormity of IKEA's client base may be used to gauge the prospective scale and operating requirements for HomeOnline's customer complaint management system.

The operating profile of HomeOnline is quite similar to that of IKEA, providing a wide range of home goods, including furniture, kitchen appliances, décor, and accessories. We estimated HomeOnline to have 100,000 active users extrapolating from the statistics of IKEA. Industry statistics suggest that a fraction, roughly 24%, of these customers could likely transition into complainants (Shaharudin et al.). Taking these figures into account and matching them to HomeOnline's operational size, we anticipate an expected 10 million visits to the website every month, with 100,000 active users. This estimate works out to about 25,000 expected complaints every month.

Taking these metrics into account, we assembled the cost structure which captures the estimated costs per metric and the total monthly costs for each service within different layers. We obtained the pricing data from the official documentation and websites of the services. For example, the approximate prices for AWS Connect, Amazon Lex, AWS Kinesis, and other services were estimated from AWS's extensive pricing guides and cost calculators. Similar to this, the cost estimates for IBM Watson services like Language Translator and Natural Language Understanding (NLU) were derived from IBM's official pricing documentation.

From the estimations in the table, the total cost per month turns out to be about \$50,000 USD. For a large ecommerce company like HomeOnline which is focused on improving its customer service, this cost structure can be very cost-effective compared to the costs of traditional complaint management systems. Aside from the prices of the services and layers, additional factors that must be considered when developing a customer complaint management system include security and compliance, cost management, user feedback, and scalability. These expenses may be calculated by monitoring the system's requirements once it has been successfully built and deployed in HomeOnline.

Conclusion

HomeOnline's recommendation for a comprehensive Customer Complaint Management System involves the integration of various software and hardware solutions across different layers. At the User Layer, AWS Connect and Amazon Lex enhance customer interactions, providing a seamless experience. For the Data Collection Layer, AWS Kinesis and Amazon S3 handle real-time data streams and storage, enabling agile complaint resolution. AWS Amplify at the Browser level ensures a responsive and secure web application, while IBM Watson's NLU and other tools in the Model Layer enhance text analytics and multilingual support. The Cloud Layer utilizes AWS services like EC2, Lambda, API Gateway, and more for scalability, efficiency, and cost-effectiveness. IBM Watson's Language Translator and Tone Analyzer contribute to multilingual understanding and sentiment analysis. Database services like Amazon RDS, DynamoDB, and S3 manage structured and unstructured data efficiently. AWS Step Functions and Lambda facilitate workflow coordination and backend processing, creating an integrated and efficient complaint management system.

HomeOnline's recommendation for a Customer Complaint Management System presents a robust, scalable, and agile solution that leverages the strengths of Amazon Web Services and IBM Watson. The integration of cloud-based services at different layers ensures a responsive user interface, efficient data collection and analysis, and a dynamic, cost-effective backend infrastructure. The incorporation of IBM Watson's language processing capabilities adds a layer of sophistication, enabling the system to understand nuanced customer expressions across various channels. The use of AWS services, such as EC2, Lambda, and Step Functions, streamlines operations and ensures scalability. Overall, this comprehensive approach addresses the diverse needs of handling customer complaints, providing HomeOnline with a powerful tool to enhance customer satisfaction, streamline complaint resolution, and adapt to evolving business requirements.

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Marking Rubrics

Criteria	Weightage	Outstanding (5)	Mastering (4)	Developing (3)	Beginning (0-2)
Examine the given scenario or case study in identifying the functional components. (TGC 3.1)	5	Deliver compelling content which demonstrates a thorough understanding of the given case study and the functional components necessary in written form.	Deliver a central content which demonstrates a good understanding of the given case study and the functional components necessary in written form.	Deliver basic content which demonstrates a basic understanding of the given case study and the functional components necessary in written form.	Deliver superficial content which demonstrates a lack of understanding of the given case study and the functional components necessary in written form.
Criteria	Weightage	Outstanding (9-10)	Mastering (7-8)	Developing (5-6)	Beginning (0-4)
Ability to assess various enterprise solutions for the functional components necessary for the given case. (TGC 3.2)	10	Demonstrate detailed attention to and successful evaluation of various enterprise solutions to form a cognitive system that is well organized and presented.	Demonstrate competent attention to and successful evaluation of various enterprise solutions to form a cognitive system that is well organized and presented.	Demonstrate adequate attention to and successful evaluation of various enterprise solutions to form a cognitive system that is presented in an organized manner.	Demonstrate little attention to evaluation of various enterprise solutions to form a cognitive system, and poorly organized and presented.
Criteria	Weightage	Outstanding (5)	Mastering (4)	Developing (3)	Beginning (0-2)
Evidence for supporting the proposed enterprise solution. (TGC 3.4)	5	Uses a variety of supporting evidence, making appropriate reference to information or analysis that significantly supports the proposed enterprise solution.	Uses adequate supporting evidence, making appropriate reference to information or analysis that supports the proposed enterprise solution.	Uses adequate, but sometimes irrelevant, supporting evidence, or sometimes inappropriate, reference to information or analysis that supports the proposed enterprise solution.	Uses little or irrelevant supporting evidence, with little reference to information or analysis that supports the proposed enterprise solution.

Contributions

Student Name	Student ID	Contributed Sections/Works
Satoaki Ishihara	0354208	<ul style="list-style-type: none">● Introduction (draft)● Recommendation (User Layer)● Recommendation (Data Collection Layer)● Recommendation (Browser)● Recommendation (Cloud Layer)
Abrar Shah Ahmed	0352859	<ul style="list-style-type: none">● Recommendation (Model Layer)● Recommendation (Bottom Components)
Lubaba Maryam Ahmed	0353506	<ul style="list-style-type: none">● Cost Estimates
Nowreen Zaman Bhuiyan	0341789	<ul style="list-style-type: none">● Recommendation (Model Layer)● Recommendation (Bottom Components)
Mohamed Fahad Farhan	0354487	<ul style="list-style-type: none">● Introduction (Final Draft)● Conclusion