

ASSIGNMENT COVER SHEET

Module Code: **ITS69404**

Module Name: **Cognitive Computing and applications**

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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 modern digital era, e-commerce platforms have profoundly transformed the way consumers shop, turning the conventional brick-and-mortar experience into a virtual interaction. HomeOnline, emerging as a pivotal contender in this domain, has significantly revolutionised the online shopping landscape in Malaysia. With its vast array of household products and an unwavering commitment to offering unparalleled online shopping experiences, HomeOnline has solidified its position as a go-to destination for a myriad of consumers.

Online shopping is not merely transactional – it's an experience. An experience that commences from the first click on the website, meandering through product selections, and culminating in post-purchase interactions. Over the years, with technology's advancement, this experience has evolved, integrating interactive interfaces, chatbots, personalised recommendations, and real-time customer support, making it more immersive and user-centric.

Customers are no longer just passive consumers in this hyperconnected day. They serve as reviewers, influencers, and brand advocates. Their voice, as expressed in comments, reviews, and complaints, is quite powerful. When recognized and taken into consideration, this input may inspire advancements, promote trust, and strengthen customer loyalty.

There is intense competition in the e-commerce space, with a number of platforms fighting for customers' attention. Market leaders stand out from the competition not simply by their wide selection of products or competitive pricing, but also by the holistic user experiences they provide. Effectively handling and resolving client complaints in this situation isn't only a service need; it's also a tactical instrument that can give an advantage.

Problem Statements

The manual system in place to handle client complaints has shown signs of pressure as HomeOnline expands its operations. Longer response times, inconsistent complaint handling, and sporadic neglect of urgent concerns are some symptoms of these strains. Although complaints are recorded and tracked using digital means, the absence of automation and cognitive comprehension during the resolution process leads to bottlenecks. In essence, a system that can handle the rising number and complexity of complaints is required due to the user base expansion and operational scale.

This proposal's main goal is to replace the current manual method with a cognitive computing-based system that can handle consumer complaints automatically, quickly, and efficiently to enhance the efficiency of customer complaint dealing. The intended method aims to manage complaints while also comprehending the subtleties, feelings, and emotions that underlie them. Such a system will not only increase the effectiveness of the complaint management procedure, but it will also give the business useful information about areas where it can improve. It's a move in the direction of developing a platform that is more customer-centric, where input is not just handled but also used for ongoing improvement.

Multiple results are envisaged from the use of cognitive computing systems:

- **Operational Efficiency:** Automated, quicker classification and resolution of complaints, minimising manual intervention.
- **Improved Customer Satisfaction:** Complaints may be resolved more effectively and personally if the root causes are recognized and addressed.
- **Important Insights:** The data gathered and evaluated will offer significant insights into problems with products and services, prospective areas for development, and customer behaviour patterns.
- **Customer Retention:** HomeOnline's reputation as a customer-centric platform in the e-commerce industry is cemented by offering rapid and efficient complaint handling.

The advantages go beyond simple complaint handling. Through this project, HomeOnline reaffirms its dedication to improving the whole customer experience, which is unquestionably the key to long-term success and customer loyalty.

Related Works

1. IBM Watson - utilised by Regions Bank

Various sectors have made substantial use of IBM's Watson for customer service. Because of its NLP skills, it can classify complaints, comprehend consumer sentiment, and even automate first answers. Watson was integrated by Regions Bank to support bank staff in responding to consumer inquiries and to guarantee that correct and consistent information is given. Watson's NLP capacity helps to comprehend client problems and direct users to appropriate solutions.

2. Ada and Zendesk - utilised by Telus

Ada is an AI-driven chatbot that has been integrated with Zendesk to improve the customer assistance capabilities of the platform. Through machine learning, the system gains knowledge from previous encounters to handle complaints and inquiries more quickly. A telecoms firm named Telus used Ada to automate 50% of their customer interactions and provide immediate customer care.

3. eBay ShopBot - utilised by eBay

It functions as a virtual shopping assistant, helping consumers through the product search and purchasing processes while providing a personalised and interactive shopping experience. It streamlines the online buying trip by learning about the user's interests and making targeted suggestions, offering product descriptions, and delivering auction notifications, eventually assisting consumers in finding the things they are seeking on eBay.

4. Woebot - launched by Woebot Health

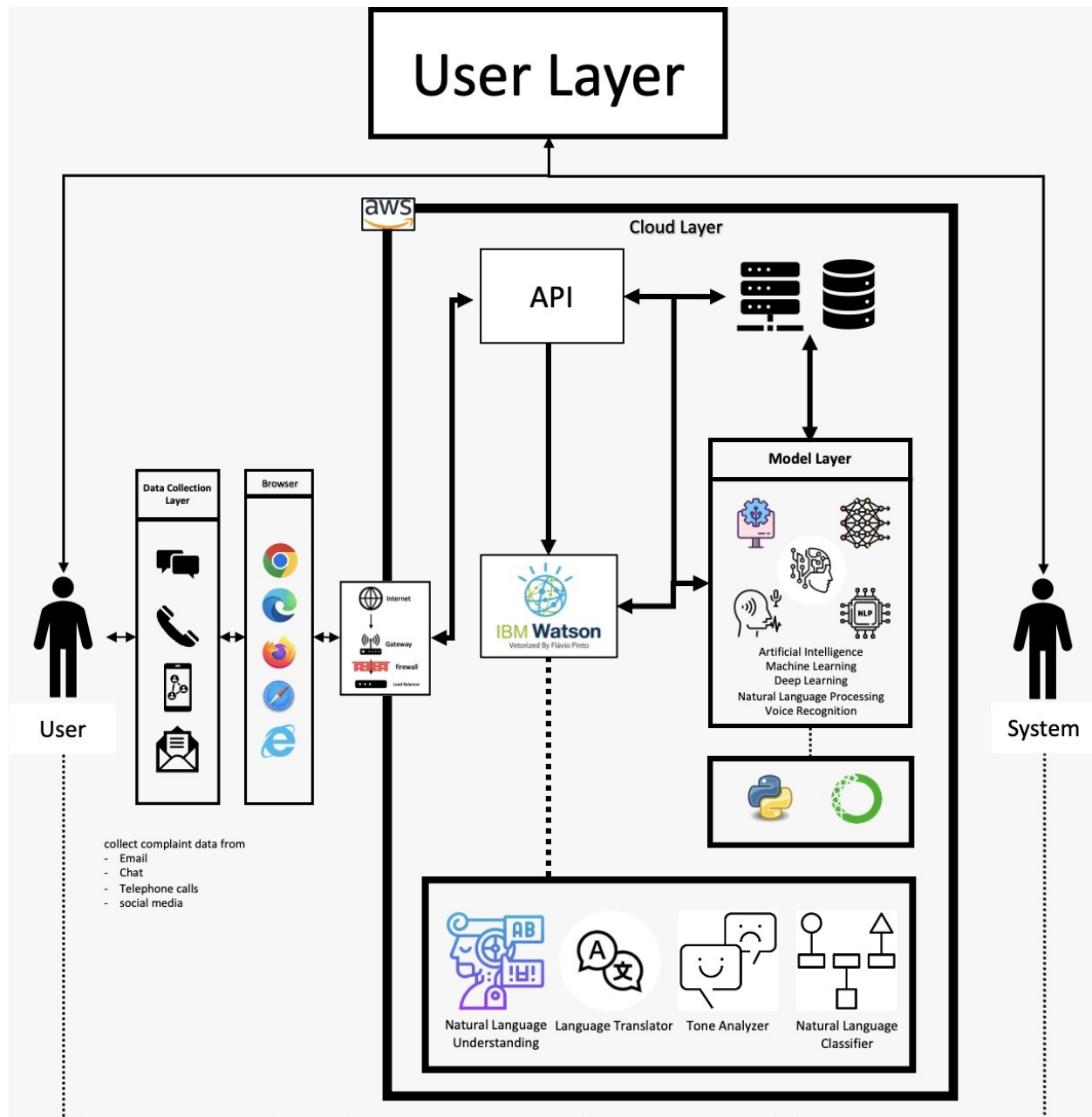
It is a smartphone application that provides consumers with a handy and accessible mental health solution. It provides a secure environment for users to share their feelings, get evidence-based advice, and develop emotional resilience. Woebot, which is available on iOS and Android platforms, can assess users' emotional and mental health using standardised questionnaires and self-report measurements. It is capable of detecting mood

swings and emotional discomfort. Woebot is available 24 hours a day, seven days a week, and offers emotional support and therapeutic treatments. Users can monitor their emotional development throughout time.

5. Duolingo Chatbots - used on Duolingo

Chatbots from Duolingo are an interactive tool for language learners that allows them to practise speaking, listening, and comprehending a new language in real-world circumstances. These chatbots supplement Duolingo's courses with gamification aspects such as earning points and incentives for finishing lessons. Users may practise speaking using Voice Recognition, listening with audio-based questions, and writing in the language of their choice. Users may practise in numerous settings and questions, which adds fun and drive to the learning process.

Proposed System



Overview:

Our aim for the system is to replace the manual management process of HomeOnline's customer complaint system with an automated cognitive system that will promote customer satisfaction by resolving complaints in a timely, efficient, and accurate manner, and providing a personalised experience.

Features:

The proposed system is a cloud based platform implementing various AI and NLP techniques to automate the complaint management process. Unstructured data through various media such as emails, messages and social media is gathered containing customer's complaints, feedback, and conversations with customer care agents. Such data can be valuable for meaningful insights such as emotions and sentiments of the customers, determining the underlying and specific causes of customers' issues and identifying developing issues (Zaki et al., 2021).

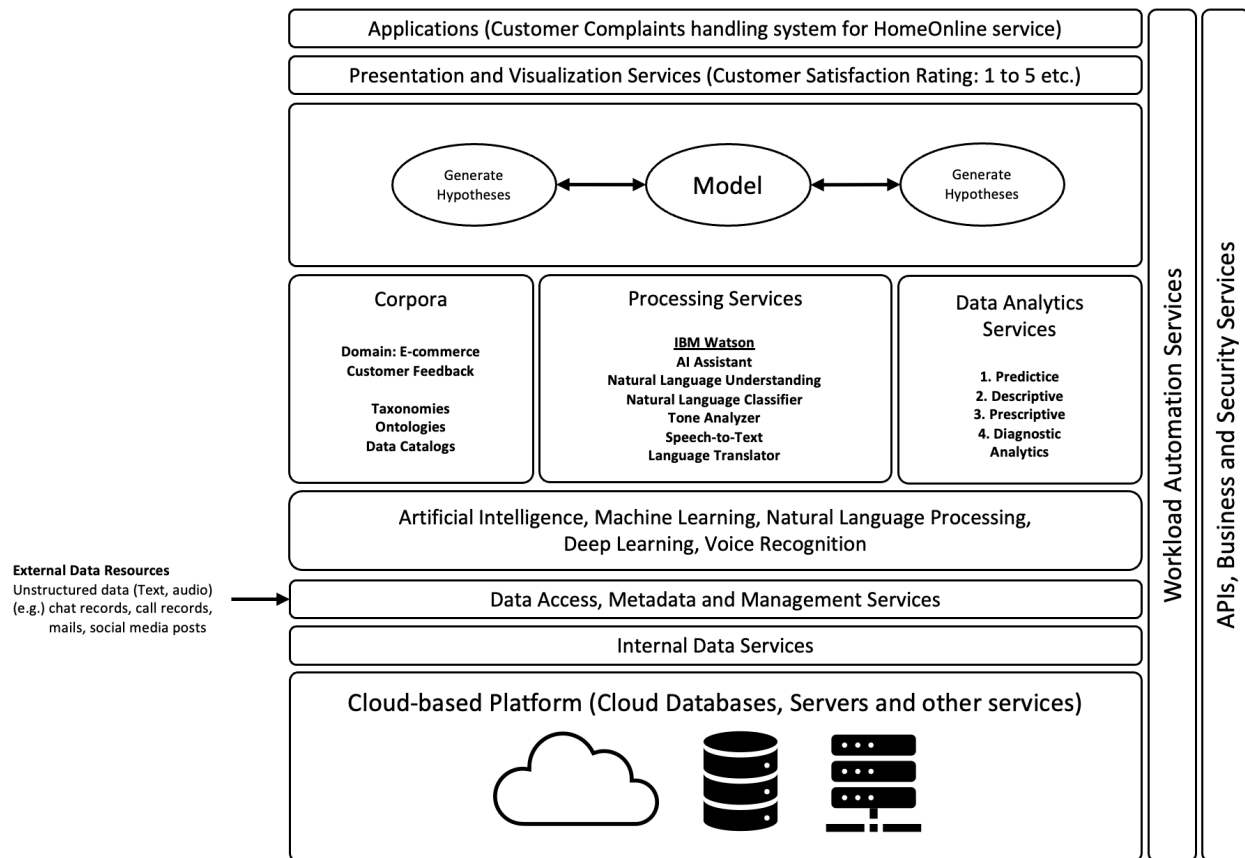
The cognitive system is developed employing the models utilising various techniques such as Natural Language Understanding, Language Translator, Tone Analyzer and Natural Language Classifier. The cloud service chosen was IBM Watson, due to its capabilities of extracting emotions and objectives from customers' interactions and responding in a human-like, natural manner (Adam et al., 2020). The architecture has a layered framework for seamless and real-time communication with customers.

Customers submit feedback and complaints through various media, and the system subsequently classifies the submission based on various criteria, such as type of complaint, urgency of customer's issues, emotions and language used by the customer, etc. The system then provides the customer with a solution in accordance with the classification. The customer may be provided with an automated suggestion, routed to a customer care agent, or notified that the problem is being resolved. Customers are provided with real-time updates on the status of their complaint and are able to provide feedback for the system. Several other features are implemented to ensure optimum user experience.

Benefits:

Implementing a cognitive complaint management system in place of HomeOnline's present manual method can result in a variety of enhancements that will significantly improve its customers' user experience. Customers will be able to obtain replies in real-time, resulting in fewer delays, a higher number of addressed complaints, and lower expenses associated with the management process (Harbola, 2021). Since HomeOnline places a high priority on customer satisfaction, the system can guarantee that clients have a constantly improving experience as it is able to continually learn from experience and get better over time.

Design or Architecture



The above figure represents the general architecture of HomeOnline's cognitive system for customer complaint handling.

1. Applications (Customer Complaints Handling System for HomeOnline service)

The applications layer represents the primary user interface and functionality of the system. In the context of the HomeOnline service, it encapsulates the following core components.

Key components:

- **User Interface (UI)**: This is where customers initiate and track their complaints. Designed to be user-friendly, the interface should incorporate intuitive forms for complaint submission, a dashboard for complaint status tracking, and avenues for direct communication with support if needed.

- Automated Response System: Upon complaint submission, customers may receive automated initial feedback or suggestions. This system uses previous data and the AI backend to guide customers immediately, potentially resolving minor issues without further intervention.
- Complaint Tracking: Once a complaint is submitted, users can track the progress of their complaint resolution in real-time, giving them transparency and assurance about the process. Each complaint will have stages like 'Received', 'In Process', 'Resolved', or 'Requires Further Attention'.
- Feedback Mechanism: After the resolution of each complaint, customers can provide feedback about their experience. This is crucial for continuous improvement of the service and understanding user satisfaction levels.

2. Presentation and Visualization Services

This layer serves two main functions – first, to provide users (customers) with a clear representation of their interaction outcomes, and second, to give administrators and decision-makers insights into the performance of the system.

Key components:

- Customer Satisfaction Rating: By providing a simple scale (e.g., 1 to 5), users can easily communicate their satisfaction levels post-interaction. This serves as immediate feedback, giving the system a sense of the effectiveness of the complaint resolution.
- Graphical Dashboards: For administrators, dashboards with graphical presentations of various metrics like the number of complaints received, average resolution time, and satisfaction scores offer a snapshot of system performance. These can be tailored for daily, weekly, or monthly views.
- Detailed Analytics: Beneath the surface-level graphics, this layer can provide in-depth data analyses. For instance, administrators could drill down to see which types of complaints are most common, which ones take the longest to resolve, or which ones have the lowest satisfaction scores.

- Sentiment Analysis: By leveraging NLP, the system can gauge the overall sentiment of the feedback received. This can be visualised in the form of word clouds, sentiment score graphs, or other visual representations to quickly understand customer emotions and sentiments.
- Trend Predictions: Based on historical data, the visualisation layer can also provide predictions on potential future trends, like an anticipated increase in complaints during sale seasons or after a new product launch.

3. Generate Hypotheses, Model, Generate Hypotheses:

A. Generate Hypotheses:

This is the preliminary step, where the system formulates assumptions based on the current data. Given the context of customer complaints, hypotheses can be shaped around potential causes of complaints, correlations between product categories and customer dissatisfaction, seasonal trends, etc.

Key components:

- **Preliminary Data Scan**: Before generating hypotheses, the system will perform a cursory scan of the data to determine any evident patterns or anomalies.
- **Expert Input**: Human expertise isn't entirely sidelined. Subject matter experts from HomeOnline can suggest potential problem areas they've noticed, prompting the system to formulate hypotheses around these areas.
- **Pattern Recognition**: Using basic AI techniques, the system will identify recurring patterns, which can then be shaped into hypotheses.

B. Model:

After formulating the hypothesis, the system moves to the modelling phase, where it tests the hypotheses using machine learning, deep learning, or other appropriate models. This is where the 'meat' of cognitive computing work happens.

Key components:

- **Model Selection:** Depending on the hypothesis, the system might select different modelling techniques. For example, a time series model might be chosen for seasonal complaint trends, while a neural network might be used to identify patterns in textual complaints.
- **Training:** Using historical data, the system will 'train' the model, adjusting parameters to optimise accuracy and reliability.
- **Validation:** After training, the model is validated using a separate dataset (not used in training). This step ensures the model's predictions are robust and not just fitted to the training data.
- **Feedback Loop:** This is vital. The outcomes from the model are fed back to refine the hypotheses. For instance, if a hypothesis is disproven, it can be discarded or redefined.

C. Score Hypotheses:

Scoring revolves around assigning a quantitative value or a "score" to each hypothesis based on its likelihood or the confidence of the model in the hypothesis after testing.

Key components:

- **Confidence Scoring:** Each hypothesis, once tested by the model, receives a confidence score. This score denotes how probable it is that this hypothesis holds true based on the data.
- **Ranking & Prioritization:** Hypotheses are ranked based on their scores. Those with higher confidence scores get prioritised, meaning the system perceives them as more likely explanations or areas to address first.
- **Decision Points:** A threshold might be set, such that hypotheses with scores beyond this point are accepted for further action, while others might be discarded or sent back for refinement.

- Feedback Incorporation: If certain hypotheses consistently score low, it might lead to their refinement or even replacement with new ones in subsequent iterations. Conversely, high-scoring hypotheses can provide insights for immediate action or deeper exploration.

4. Corpora:

The corpora layer, as the name suggests, is the repository of language data and related resources that the system uses to understand and process natural language inputs.

Key Components:

- Domain-Specificity: The corpus is tailored for the e-commerce industry, with a particular focus on customer feedback. This ensures the system can understand industry jargon, slang, abbreviations, and other specialised language nuances.
- Taxonomies and Ontologies: Taxonomies define the classification of complaints, while ontologies provide relationships and meanings. For instance, a taxonomy may categorise complaints as "delivery-related", "product quality", or "customer service", while an ontology might reveal that 'broken' and 'damaged' in product feedback relate to quality issues.
- Data Catalogues: These are organised collections of complaint data, perhaps sorted by date, product category, or severity, helping the system quickly locate and reference relevant data.

5. Processing Services:

This layer comprises various cognitive computing tools and services that parse and understand the data from the corpora.

Key Components:

- IBM Watson Suite: Leveraging the suite of tools provided by IBM Watson ensures a robust foundation for processing.
- AI Assistant: Offers real-time responses based on learned patterns and data.

- NLU (Natural Language Understanding) and NLC (Natural Language Classifier): These services process the natural language input, extracting entities, concepts, emotions, and sentiments, and classify them accordingly.
- Tone Analyzer: Discerns emotional undertones in feedback, such as frustration or satisfaction.
- Speech-to-Text: Converts verbal complaints, like those from call logs, into textual data for further processing.
- Language Translator: Translates non-English complaints, ensuring inclusivity and comprehensive coverage.

6. Data Analytics Services:

This layer transforms raw, processed data into actionable insights for HomeOnline.

Key Components:

- Predictive Analysis: Predicts future trends in complaints based on past and current data. For example, it could highlight potential spikes in delivery-related complaints during festive seasons, prompting preemptive measures.
- Descriptive Analysis: Offers a comprehensive view of the complaint landscape. It can highlight which products get the most complaints or which regions face frequent delivery issues.
- Prescriptive Analysis: Goes beyond highlighting problems by suggesting solutions. If product quality complaints are on the rise, prescriptive analysis might suggest increased quality checks or vendor reviews.
- Diagnostic Analysis: Digs deep into the causes of specific issues. If there's a sudden rise in delivery-related complaints in a particular region, diagnostic analysis could pinpoint issues like logistic partner problems or local disruptions.

7. Data Access, Metadata, and Management Services:

This layer integrates various technologies to enhance the system's cognitive abilities. Machine Learning helps in making data-driven decisions, NLP ensures smooth language processing, Deep Learning aids in complex pattern recognition, and Voice Recognition facilitates processing of audio feedback.

Key Components:

- Data Access: This layer emphasises ensuring that data is not only stored but is also retrievable efficiently. With vast amounts of data being processed daily from various customer feedback channels, it's crucial to have a system that can quickly access the right data without causing delays.
- Metadata Management: Metadata, or data about data, plays a crucial role in understanding the context of the data. It can provide information about when a particular piece of feedback was given, through which channel, or even which version of the platform the customer was using. Proper metadata ensures that the system can provide more contextual responses or solutions.
- Data Security and Privacy: Given the personal nature of some feedback, it's paramount to have stringent security measures in place. This means ensuring data encryption, access controls, and compliance with data protection regulations.
- External Data Resources: The architecture integrates external sources of unstructured data, which include:
 - Text: This includes written complaints from emails, chatbots, social media platforms, and more.
 - Audio: This consists of voice-based feedback, possibly from customer service phone calls or voice messages.

8. Cloud-based Platform:

Here, the system connects to external data resources like chat records, call logs, emails, and social media posts, extracting unstructured data in the form of text or audio. This layer ensures seamless integration and access to these data points, aiding in comprehensive feedback analysis.

Key Components:

- Cloud Databases: Utilising cloud databases ensures scalability. As HomeOnline grows and the volume of feedback increases, cloud databases can scale without significant infrastructure changes.
- Servers and Other Services: The cloud-based platform ensures high availability. If one server faces issues, another can take over, ensuring that the complaints system is always operational. This is vital for a 24/7 online shopping platform like HomeOnline.
 - AWS (Amazon Web Services): AWS is chosen for its wide array of services, reliability, and extensive documentation. Specific services from AWS that could be instrumental include:
 - Amazon RDS: A managed relational database service that makes it easier to set up, operate, and scale databases in the cloud.
 - Amazon S3: Useful for storing vast amounts of unstructured data like audio files, chat logs, and more.
- Amazon Comprehend: A natural language processing (NLP) service that can be used to find insights and relationships in the text.
- Cost Efficiency: Using a cloud platform like AWS means HomeOnline only pays for what it uses, rather than investing heavily in on-premise infrastructure.
- Flexibility and Integration: AWS, with its vast suite of tools, offers flexibility. As new tools or technologies emerge in the future, integrating them into the existing system would be more seamless.

9. Internal Data Services:

This pertains to the internal databases and data storage solutions. It stores historical data, system configurations, and other essential data required for the smooth functioning of the system.

Key Components:

- Centralised Repository: This layer is responsible for keeping a comprehensive database of all internal company data related to products, customer transactions, previous complaints, and their resolutions. It acts as the core data storage that the system refers to when processing complaints.
- Data Integrity and Consistency: Maintaining data quality is crucial. Internal Data Services ensures that the data stored is free from inaccuracies and inconsistencies, making the decision-making process based on this data more reliable.
- Data Lifecycle Management: As data accumulates over time, it's vital to manage its lifecycle. This means periodically archiving old data, ensuring recent and relevant data is easily accessible, and purging data that is no longer needed.
- Data Relationship Mapping: For a system to understand the context better, the relationships between different sets of data (like a product and its common complaints) are mapped and maintained.
- Access Control: Not every piece of data should be accessible by all parts of the system. Appropriate permissions and access controls ensure that sensitive data is protected and only accessible by authorised processes or users.

10. Cloud-based Platform (Enhanced Explanation):

The entire system operates on a cloud platform, utilising resources like cloud databases, servers, and other services. AWS, a robust and scalable cloud solution, will provide the necessary infrastructure, ensuring high uptime, redundancy, and global accessibility.

Key Components:

- Scalability: Cloud platforms are inherently designed to grow (or shrink) according to the needs of the service. For HomeOnline, as their user base expands and the volume of data inflow increases, the cloud platform can scale resources dynamically without manual intervention.
- High Availability and Disaster Recovery: Cloud platforms, especially services like AWS, ensure that applications are available most of the time. They provide redundancy – if one

server or even an entire data centre goes down, another takes over, ensuring uninterrupted service. They also offer robust backup and recovery solutions.

- Security Protocols: Cloud platforms come equipped with a suite of security protocols, ensuring data remains protected from potential threats. AWS, for instance, provides services like AWS Shield (for DDoS protection) and AWS Key Management Service (for creating and controlling cryptographic keys).
- Microservices and Containerization: AWS and other cloud providers support a microservices architecture and containerization (like Docker). This allows the system components to operate independently, making updates and maintenance smoother without affecting the entire system.
- Integration Capabilities: Given the plethora of tools and services available in cloud platforms, integrating new technologies, tools, or processes is straightforward. This means as technology evolves or HomeOnline's needs change, the system can adapt quickly.
- Monitoring and Optimization: Services like Amazon CloudWatch allow for real-time monitoring of resources, ensuring everything is running optimally. This ensures any potential hitches are detected and rectified before they escalate.

11. Workload Automation Services (Vertical Layer):

This ensures that tasks are scheduled, automated, and load-balanced. It manages the computational resources, ensuring the system operates optimally even under high load.

Key Components:

- Task Scheduling: At the core of workload automation is the ability to schedule tasks. This ensures that specific processes, such as data analysis or predictive modelling, occur at predetermined times or upon particular triggers, optimising system efficiency.
- Dynamic Resource Allocation: As system demand fluctuates (e.g., during peak shopping hours or sales events), workload automation dynamically allocates more resources to handle the increased load, ensuring the system remains responsive and efficient.

- Parallel Processing: To enhance performance, especially for computationally intensive tasks, the system can execute multiple operations concurrently, significantly speeding up data processing and decision-making.
- Dependency Management: Some tasks or processes may be dependent on others. Workload automation can ensure that these tasks execute in the right sequence, ensuring data consistency and system stability.
- Error Handling and Recovery: Should an error or system failure occur, workload automation services can restart processes, reroute tasks, or even initiate backup systems to ensure continuity.

12. APIs, Businesses, and Security Services (Vertical Layer):

This vertical layer facilitates external integrations via APIs, connects to other business services, and ensures that the entire system is secure. It manages user authentications, data encryption, and all security-related aspects, ensuring that customer data remains confidential and the system is immune to potential cyber threats.

Key Components:

- API Management: With a system as complex as HomeOnline's complaint handling platform, numerous APIs (Application Programming Interfaces) are likely in use. API management ensures these interfaces are available, efficient, and updated, allowing seamless integration between different system components.
- Standardised Communication: APIs ensure that different software components, possibly developed using different technologies, can communicate effectively. They translate requests and responses into a standard format, ensuring smooth data flow.
- Security Protocols: Any interface exposed, like APIs, can be a potential security risk. This layer ensures robust security measures, including encryption, authentication, and authorization. Tools like OAuth or JWT (JSON Web Tokens) can be employed to ensure that only authenticated entities can access the services.

- Business Logic Implementation: This is where the core processes and decision-making algorithms of the platform reside. It contains the logic for categorising complaints, predicting outcomes, and more.
- Rate Limiting and Throttling: Especially vital for APIs, these measures ensure that no single user or process overwhelms the system with too many requests. This is essential for both system performance and security.
- Monitoring and Logging: Continuous monitoring of API calls and business processes is crucial for both troubleshooting and security. Logs can provide a detailed history of activities, helping trace any issues or breaches.

Methodology



Data collection is the first step of any cognitive computing endeavour. A wide range of sources collect raw data at this early stage. This means Home Online would be collecting data from services such as email, chat, phone logs and Social Media. Ensuring that the data collected are fully representative of the customer base is a key requirement. Ethical considerations, such as the need to obtain user approval and protect personal data privacy, are equally important.

Data preparation, also called data preprocessing, is the most important stage in analysis. It means that the unprocessed data are cleaned and organised in a way which allows easy analysis. Abnormalities and inconsistencies are removed or corrected, and complaints are structured on the basis of severity or related products. Conversion, which enables your data to be converted into an appropriate format for analysis such as tokenization of text in the natural language processing process or recalculation of categorical data, is a final step.

With the data set and prepped, the next stage is to dive into the depth of analysis. NLP techniques like these have become essential to the examination of sentiment, emotions and overarching context in view of the linguistic character of complaints. In addition to the area of NLP, it is also possible to look for patterns or anomalies in complaint data by way of conventional Statistical Methodologies.

Now the main focus is to make educated business decisions based on knowledge gained through rigorous data analysis. This is a team effort, which often brings together both engineering and business experts. Depending on the frequency or seriousness of these cases, some problems might be seen as more serious than others. Decisions should always be made with regard to HomeOnline's most important objectives, which are improving customer satisfaction, enhancing operational efficiency and encouraging business growth.

The deployment phase, where analytical models and tools can be applied in realistic applications, is at the end of the methodology's journey. It involves integrating the new cognitive system into Home Online's existing digital infrastructure to enable real time access to data and timely

delivery of information. In order to maintain its pace and relevance in a constantly evolving customer market, the system must also have mechanisms which allow it to continuously improve based on new data and feedback.

Technology

1. Natural Language Processing (NLP)

Natural Language Processing (NLP) is a crucial technique in customer service and complaint management, as it understands, interprets, and generates human language. Complaints, regardless of their language, are a form of natural language, and understanding them requires a system that can parse, interpret, and potentially respond in kind. NLP, an interdisciplinary domain that fuses linguistics and computational techniques, is ideally positioned for this challenge. Given the global nature of e-commerce and varied linguistic backgrounds of consumers, NLP becomes indispensable in bridging the language gap and ensuring consistent service quality across demographics.

Users often follow a specific pattern or structure in their complaints, with components like greetings, gratitude expressions, and detailed descriptions. NLP can effectively identify, segregate, and interpret these elements, setting a polite tone for automated responses and matching concluding gratitude expressions with cordial closing remarks. Beyond the overt content of a complaint, NLP can discern the underlying sentiment or emotion, enabling the system to prioritise and address complaints appropriately.

Modern NLP tools support multiple languages, making them invaluable for global platforms like HomeOnline, catering to a diverse audience. Pre-trained models have shown remarkable efficacy in understanding multiple languages. NLP models, especially those based on machine learning, can learn and adapt over time, making the system more human-like and empathetic, enhancing the overall user experience.

2. Sentiment Analysis

The method of determining whether a block of text is good, negative, or neutral is known as sentiment analysis. Sentiment analysis seeks to understand public sentiment in order to analyse it for commercial purposes. It emphasises emotions, such as happiness, sadness, and anger, in addition to polarity (positive, negative, and neutral). It makes use of a variety of Natural Language Processing techniques, including Automatic, Hybrid, and Rule-based.

3. Lexical Analysis

Lexical analysis is a crucial aspect of Natural Language Processing (NLP) and is often compared to deciphering the DNA of a language. It involves identifying distinct units of meaning in a sentence, such as words or phrases, and deconstructing textual data from its highest-level structures to its most fundamental components. A robust lexicon is essential for the efficacy of lexical analysis, as it helps ascertain the meaning of words within specific contexts. Lexical analysis also plays a role in segmentation, breaking down larger textual chunks into smaller, more manageable units. For example, a document can be segmented into paragraphs, paragraphs into sentences, and sentences into words or tokens. This segmentation becomes even more critical in languages without clear word boundaries, such as Chinese. In summary, lexical analysis is a vital tool in understanding textual data and enhancing NLP.

4. Syntactic Analysis

Syntactic analysis is a method that goes beyond lexical analysis by examining the structure of sentences and their relationships between words. It is the scaffolding that holds the language together, offering structure and form. Syntactic analysis uses established grammatical rules to decipher the legitimacy and meaning of sentences, avoiding ambiguities or misunderstandings. For example, the sentence "The dog chased the cat" uses words "dog," "chased," and "cat" to clarify their relationship.

One advanced technique in syntactic analysis is the construction of parsing trees, which visually represent the hierarchical structure of sentences, showcasing dependencies and relationships between words. For example, in the sentence "The cat sat on the mat," a parsing tree would visually represent the primary action, "sat" as the primary action, "cat" as the doer, and "mat" as the location.

5. Language Modelling

For the suggested cognitive system to comprehend the context as well as the significance of the complaints, a pre-trained language model(a model that has been already trained on a massive text dataset. In this case, the text dataset would be composed of past customer complaints.) will be used. Therefore, the system could understand texts written in both formal and informal ways, and processing can be performed more efficiently.

Tools

1. IBM Watson

IBM Watson, a renowned AI and machine learning suite, offers a diverse range of tools tailored for tasks such as language processing, understanding sentiments, and conversational AI. In the context of HomeOnline:

- Watson Assistant: Will drive the initial interface where customers lodge their complaints, guiding them with intelligent prompts and ensuring the right information is captured.
- Watson Natural Language Understanding (NLU): Will be used for extracting entities, concepts, and emotions from customer complaints. This aids in classifying complaints and extracting pertinent information.
- Watson Tone Analyzer: Provides insights about the emotional tone behind the complaints, helping in prioritising grievances that convey high distress or dissatisfaction.

2. Cloud-based platform

A cloud-based platform such as AWS or Azure, GCP will be used to host the cognitive computing system. This is pivotal for the system's scalability, reliability, and overall performance.

In the HomeOnline customer complaint handling system, AWS would be utilised as mentioned in the Proposed System and Design or Architecture section. Below are the vast user base of HomeOnline based on the condition:

- Distributed Computing: Utilising services like AWS Lambda can ensure that processing can happen concurrently, handling multiple complaints in real time.
- Data Storage: Services like Amazon S3 can be used to store complaint data, logs, and model artefacts.
- Database Services: Amazon RDS oDatabase can store structured data related to complaints, user details, and resolution metrics.

3. Natural language processing (NLP) libraries and frameworks

NLP libraries and frameworks such as spaCy and TensorFlow will be used to extract relevant information from customer complaints and identify the emotional tone of customer complaints.

- spaCy: Renowned for its efficient and accurate linguistic annotations. It can be used for tokenization, part-of-speech tagging, and entity recognition in complaints.
- TensorFlow: A flexible tool that not only aids in NLP tasks but is also pivotal in developing and training machine learning models, especially deep learning models which can be efficient for text classification and sentiment prediction.

4. Sentiment analysis libraries and frameworks

Sentiment analysis libraries and frameworks such as TextBlob and VADER will be used to identify the emotional tone of customer complaints.

- TextBlob: A Python library that provides a simple API for common NLP tasks. It's especially effective for rudimentary sentiment analysis, giving polarity and subjectivity scores for texts.
- VADER (Valence Aware Dictionary and sEntiment Reasoner): A lexicon and rule-based sentiment analysis tool that is specifically attuned to sentiments expressed in social media. It provides positive, neutral, negative, and compound sentiment scores, making it a good choice for analysing the nuanced sentiments in complaints.

5. Machine learning libraries and frameworks

Machine learning libraries and frameworks such as scikit-learn and TensorFlow will be used to train the system to categorise complaints and predict customer churn.

- scikit-learn: A comprehensive machine learning library in Python, it offers a wide array of algorithms for classification, regression, and clustering. It could be used for tasks like categorising complaints into different buckets (e.g., shipping issues, product dissatisfaction, payment troubles).

- TensorFlow: Beyond its NLP capabilities, TensorFlow's deep learning models can be utilised to predict metrics like customer churn or the likelihood of a complaint being escalated, based on historical data.

Conclusion

E-commerce systems like HomeOnline have the enormous burden of guaranteeing smooth customer experiences in today's changing digital environment. The effective processing, comprehension, and resolution of the increasing number of customer complaints was the main problem for HomeOnline, as described throughout this study. This is relevant to both the platform's operational effectiveness and, more crucially, the perception, trust, and loyalty it develops among its sizable user base.

We explored current systems, pointing out their flaws and highlighting the requirement for a cutting-edge, cognitive computing-based solution. Our study of previous works gave us knowledge about the advantages and disadvantages of similar projects, which helped us develop our proposal for a cutting-edge system design that makes use of modern technology. The system at the centre of the concept is layered and elaborately structured, with each layer performing a vital task from the collection of initial data to the display of the ultimate resolution. Furthermore, cutting-edge developments in the areas of artificial intelligence, machine learning, and natural language processing have influenced the technique and tools chosen.

The suggested solution, which embraces IBM Watson and other cutting-edge technology together with strong cloud platforms and specialised libraries, offers not just automation but also a comprehension of customer concerns on a human level. Predictive analytics, sentiment analysis, and identification of linguistic inflections are crucial aspects that set HomeOnline apart in Malaysia's cutthroat e-commerce business.

In summary, this report's goal is to emphasise a paradigm change rather than only offer a solution. From considering complaints as just operational difficulties to accepting them as priceless input, promoting ongoing development and cultivating true client connections. By following the suggested approach, HomeOnline will further solidify its position as a platform that is genuinely focused on its consumers by listening to, comprehending, and evolving with them.

References

- Andrian, B., Simanungkalit, T. and Budi, I. (2022). *Sentiment Analysis on Customer Satisfaction of Digital Banking in Indonesia*. [online] researchgate.net. Available at: https://www.researchgate.net/publication/359684655_Sentiment_Analysis_on_Customer_Satisfaction_of_Digital_Banking_in_Indonesia. [Accessed 25 Sep. 2023].
- Banga, D. and Peddireddy, K. (2023). Artificial Intelligence for Customer Complaint Management. *International Journal of Computer Trends and Technology*, [online] 71(3), pp.1–6. Available at: <https://ijcttjournal.org/2023/Volume-71%20Issue-3/IJCTT-V71I3P101.pdf> [Accessed 25 Sep. 2023].
- Hare, J. (2016). *What is metadata and why is it as important as the data itself?* [online] Opendatasoft. Available at: <https://www.opendatasoft.com/en/blog/what-is-metadata-and-why-is-it-important-data/>. [Accessed 4 Oct. 2023].
- International Business Machines (IBM) Corporation (2015). *IBM Cognitive – Cognitive Customer Service and Support*. [online] www.ibm.com. Available at: <https://www.ibm.com/watson/advantage-reports/cognitive-business-lessons/customer-service.html>. [Accessed 2 Oct. 2023].
- International Business Machines (IBM) Corporation (2019). *Regions Bank Taps IBM's AI to Power Next Generation Customer Service*. [online] IBM Newsroom. Available at: <https://newsroom.ibm.com/2019-04-25-Regions-Bank-Taps-IBMs-AI-to-Power-Next-Generation-Customer-Service>. [Accessed 30 Sep. 2023].
- Lu, Y., Srivastava, M., Kramer, J., Elfardy, H., Kahn, A., Wang, S. and Bhardwaj, V. (2019). *Goal-Oriented End-to-End Conversational Models with Profile Features in a Real-World Setting*. [online] pp.48–55. Available at: <https://assets.amazon.science/47/03/e0d14dc34d3eb6e0d4ec282067bd/goal-oriented-end-to-end-chatbots-with-profile-features-in-a-real-world-setting.pdf>. [Accessed 2 Oct. 2023].

Kriss, P. (2014). *The Value of Customer Experience, Quantified*. [online] Harvard Business Review. Available at: <https://hbr.org/2014/08/the-value-of-customer-experience-quantified>. [Accessed 22 Sep. 2023].

Pitman, J. (2022). *Local Consumer Review Survey | Online Reviews Statistics & Trends*. [online] BrightLocal. Available at: <https://www.brightlocal.com/research/local-consumer-review-survey/>. [Accessed 21 Sep. 2023].

PR Newswire (2018). *Ada and Zendesk Unite to Improve Chatbot Experience for Customer Service*. [online] www.prnewswire.com. Available at: <https://www.prnewswire.com/news-releases/ada-and-zendesk-unite-to-improve-chatbot-experience-for-customer-service-300686172.html>. [Accessed 1 Oct. 2023].

Puthiyamadam, T. and Reyes, J. (2018). *Experience is everything: Here's how to get it right*. [online] PWC. Available at: <https://www.pwc.com/us/en/advisory-services/publications/consumer-intelligence-series/pwc-consumer-intelligence-series-customer-experience.pdf>. [Accessed 21 Sep. 2023].

OptiSol (2022). *5 Phases of Natural Language Processing - NLP Development Company | New York*. [online] OptiSol. Available at: <https://www.optisolbusiness.com/insight/the-5-phases-of-natural-language-processing>. [Accessed 1 Oct. 2023].

Orza, P. (2023). *How to Use AI for Customer Complaint Analysis*. [online] levity.ai. Available at: <https://levity.ai/blog/ai-for-customer-complaint-analysis>. [Accessed 3 Oct. 2023].

Wells, D. (2019). *What Is a Data Catalog? - Alation*. [online] Alation. Available at: <https://www.alation.com/blog/what-is-a-data-catalog/>. [Accessed 4 Oct. 2023].

Contributions

Student Name	Student ID	Contributed Sections/Works
Satoaki Ishihara	0354208	<ul style="list-style-type: none">● Introduction● Problem Statements● Design or Architecture● Methodology● Tools● References
Abrar Shah Ahmed	0352859	<ul style="list-style-type: none">● Introduction● Related Works● Design or Architecture
Lubaba Muryam Ahmed	0353506	<ul style="list-style-type: none">● Introduction● Problem Statements● Related Works● Proposed System
Nowreen Zaman Bhuiyan	0341789	<ul style="list-style-type: none">● Introduction● Problem Statements● Related Works● Proposed System
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Marking Rubric

Criteria	Weightage	Outstanding (5)	Mastering (4)	Developing (3)	Beginning (0-2)
Identify the problem related to the chosen potential application with appropriate introduction. (TGC 2a.1)	5	Identify the problem critically with an insightful problem statement listing substantial relevant background details.	Identify the problem with a well-defined problem statement listing major relevant background details.	Identify the problem with a moderately detailed problem statement listing some relevant background details.	Identify the problem listing few relevant background details in a superficial way.
Criteria	Weightage	Outstanding (9-10)	Mastering (7-8)	Developing (5-6)	Beginning (0-4)
Identifying and proposing the relevant technology, methods, models, framework, and tools in an organized manner. (TGC 2a.2)	10	Explore from multiple perspectives demonstrating rigour consistently throughout the process of identifying and proposing the relevant technology with reasoning that is well thought-out and the presentation is well organized.	Explore from multiple perspectives throughout the process of identifying and proposing the relevant technology with basic reasoning and organized.	Explore from only a few perspectives of identifying and proposing the relevant technology with simplistic reasoning and organization.	Lack or no attempt to explore in identifying and proposing the relevant technology and lack any reasoning or organization.
Criteria	Weightage	Outstanding (5)	Mastering (4)	Developing (3)	Beginning (0-2)
Creative thinking. (TGC 2b.2)	5	Extend a novel or unique idea, or product to create new knowledge or knowledge that crosses boundaries.	Create a novel or unique idea, product, or system.	Experiment with creating a novel, unique idea, product, or system.	Reformulate a collection of available ideas.