University of Waterloo
Faculty of Engineering
Department of Electrical and Computer Engineering

Artificial Intelligence (AI) Technologies Analysis for Enterprise Applications

Microsoft Canada Inc.
Mississauga, Ontario, Canada

Prepared by
Youjing Li
20602178
y864li@uwaterloo.ca
4B Electrical Engineering

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740 Karlsfeld Road
Waterloo, Ontario, Canada
N2T 2W4

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Vincent Gaudet, Chair
Electrical and Computer Engineering
University of Waterloo
Waterloo, Ontario
N2L 3G1

Dear Sir,

This report, entitled "Artificial Intelligence (AI) Technologies Analysis for Enterprise Applications", was prepared as my 4B Work Report for Microsoft Canada Inc. This report is intended for the WKRPT 401 course and was written during my work term at Microsoft Canada, where I worked for the Azure Business Group.

Microsoft Azure is one of the top public cloud providers. As the cloud industry booms, Microsoft Azure quickly becomes one of Microsoft's most profitable products. As a result, Microsoft Canada decided to establish the Azure Business Group to focus on developing product marketing strategies for the Canadian market.

The Azure Business Group defines the unique messaging and positioning of cloud products. This term, the focus of my work has been on evangelizing Azure AI(Artificial Intelligence) capabilities. This report analyzes different types of AI technologies available and their applications in solving industry problems.

I would like to thank my supervisor Ahmed Adel and mentor Iman Abudagga for guidance and support throughout my internship. I hereby confirm that I have received no further help other than what is mentioned above in writing this report. I also confirm this report has not been previously submitted for academic credit at this or any other academic institution.

Sincerely,

Youjing Li
ID 20602178

Contributions

The Azure Business Group I worked for was relatively small for the company. My immediate team consisted of ten full time employees and myself. The larger group this team belonged to, Marketing & Operations Team, was composed of hundreds of engineers and marketers working on different Microsoft products. I was the only person working on my specific project, other than some review process.

The team's main goal was to develop and evolve market segmentation for each product offering. Azure products are categorized into many different applications and some of the most popular fields are Apps, Infrastructure, Data, and AI. The team is responsible for the high-level thinking, planning, and research of Azure products before they go to the market. Each product is assigned to a Product Marketing Manager who manages the positioning, training, and marketing required for their own products. These goals are often accomplished by launching programs and events that engage with potential customers and partners. To gain a better understanding of Azure products and market demand, more research is needed to collect industry use cases and to translate customer needs into Azure capabilities.

As a Product Marketing Manager focused on AI products, my tasks were to explore the existing AI technologies and to identify industry problems that require AI solutions. To achieve my goals, I first had to understand the fundamentals of cloud architecture and learn about different products that Azure offers. Azure is a public cloud computing platform that offers a range of cloud services to solve business challenges such as storage, compute, and analytics. Since Azure is open to the public, there is a big online community and abundant resources which I can learn from. Microsoft offers free training and courses to its employees to explore various functionalities of Azure products. I took the course titled "Azure Fundamentals" to gain the basic understanding of the cloud platform. After establishing the basic knowledge, I compared the different AI technologies available and selected the best solutions to advocate for cross-industry applications. Throughout the term, I took note of various customer challenges by attending conferences, meetings, and workshops and communicated potential solutions based on in-depth research of AI enterprise applications. The solutions I proposed include appropriate usages of AI and their roles in solving industry problems. Future work involves inclusion of services from Azure Apps and Infrastructure to enhance maintenance work once the solutions are in production.

The relationship between this report and my job is that the report investigates into the different AI technologies available and explains their industry connections in detail. My team is exploring different capabilities of AI and aligning these functionalities with customer use cases; as a result,

my research helps to centralize AI use cases and evangelizing goals. I was the only person assigned to analyze the different AI technologies available, so all the use cases were collected and summarized by me with weekly team meetings to discuss about customer needs and potential solutions. The project was carried out with engineering analysis and insight in which I gained an in-depth understanding of Azure Cognitive Services and Azure Machine Learning Service applications. The technical skills that I possessed were made stronger by hands-on software engineering practices of testing high-level APIs, architecting AI solutions, and translating customer needs to engineering requirements. My analytical and presentation skills were also enriched through analyzing customer data and presenting results.

In the broader scheme of things, the work that I performed helped Microsoft Canada Inc. in deciding on an optimal AI evangelizing strategy that could be used to land AI businesses with customers of different backgrounds. The connection between AI technologies and businesses were clearer with the addition of research findings. Market compete situations and customer use cases were collected to detect reoccurring patterns and to draw conclusions. In addition, the findings are also used by the Product Development Team to make product design decisions. Product Managers are using the data to plan product roadmaps. For example, decisions were made to prioritize the development of handwriting recognition in order to secure the high number of customers requesting the feature.

Summary

The main purpose of the report is to identify the best implementations of AI technologies that helps Azure to stand out among competitors and to meet enterprise demand. The goal of the project is to propose AI evangelizing strategies based on customer use cases and market compete situations. The AI solutions introduced in this report are chatbot and recommendation systems. Chatbots leverage Azure's Language services while providing real-time operations management. On the other hand, recommendation APIs are built on top of Azure Machine Learning and provides predictive analytics. Alternatives are also discussed and compared throughout the report.

The major points covered in this report are as follows. The first section (1.0 Introduction) discusses the problem and the objective of this report. The next section further expands on the project goals and an overview of the whole report. Section 3.0 and Section 4.0 cover the basic background information on technical material necessary for understanding emerging AI technologies on Microsoft Azure. The fifth section outlines the differences among popular public cloud vendors and the sixth discusses about customer demand based on AI use cases collected across different industries. Based on the analysis and comparisons, we land on the best solutions to highlight to meet market demand and enterprise needs. The conclusions and recommendations come next, followed by a glossary to define technical acronyms used in this report.

The major conclusions in this report are that the chosen AI solutions have many benefits over Azure's competitors. These solutions, chatbots and recommendation APIs, can be built to leverage Azure's outstanding services, Azure Cognitive Services and Azure Machine Learning.

The major recommendations in this report are that monitoring strategies should be introduced along with the CI/CD solution, with some minor suggestions for future reference.

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1 Introduction

The Azure Business Group at Microsoft Canada Inc. develops and evolves market segmentation for Azure products by organizing programs and events that engage with targeted audiences. As the team grows and evolves, the work complexity builds and the demand for visibility into customer use cases increases. Therefore, it was decided to allocate resources to investigate into the market compete situation and industry use cases to determine customer demand and to identify business opportunities.

This report is concerned with the investigated methods for integrating Azure Cognitive Services and Azure Machine Learning Service in order to establish reliable AI solutions for enterprise applications.

2 Description of Microsoft AI Offerings

This report will be concerned with Cognitive Services and Machine Learning Service solutions that are currently being offered on Microsoft's cloud platform, Azure. The solutions involve integration of multiple AI technologies. Figure 1 shows a visualization of the available AI offerings.
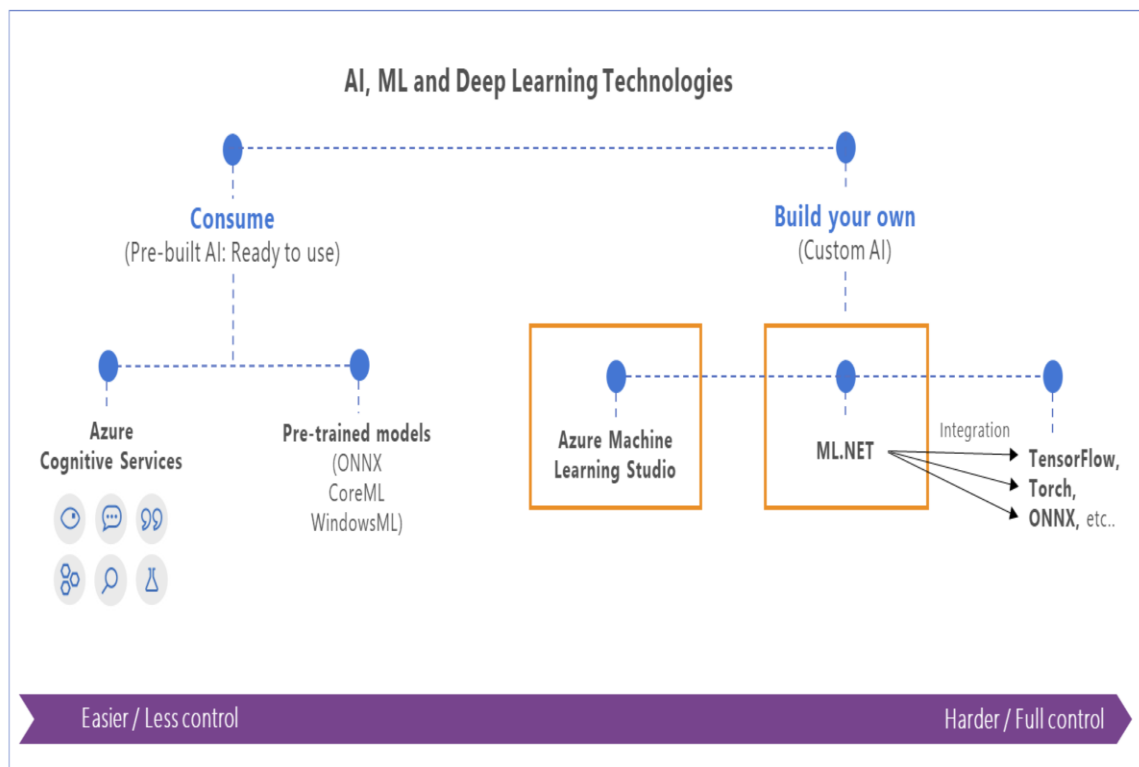

Figure 1. Classification of AI technologies [1].

Figure 1 demonstrates different ways to apply AI into products, either through the ready-to-use Cognitive Services or the comprehensive set of tools available in Azure Machine Learning [1]. Both the pre-built and custom AI technologies are investigated and compared to ensure maximum visibility into potential enterprise applications.

2.1 Scope

The purpose of this report is to determine the best uses of AI technologies that helps Azure to stand out among competitors and to meet customer demand. This will derive maximum value from existing AI products. Results from comparisons of various AI technologies will be analyzed to make a recommendation as to the best services to highlight. Market compete situation is also evaluated by comparing leading cloud vendors such as Microsoft, Google, Amazon and IBM. Lastly, AI use cases are accessed across different industries to land a conclusion on the best AI technologies to satisfy both market need and consumer demand.

2.2 Outline

The balance of this report is divided into three main sections. The first section, on various AI technologies, compares the different pre-built and custom services available on Azure. Next, we go over the market compete situation as well as industry demand for AI solutions. Lastly, we land on a few solutions that can best leverage Azure capabilities and ensure maximum public acceptance. Following these are conclusions that summarize the decisions made to determine the best impletions of AI technologies and a recommendation as to the best practices to improve reliability and scalability of the proposed solutions.

3 Pre-built AI

Azure Cognitive Services is a collection of pre-trained AI models that can be used to enable bots, apps, and websites to speak, see, hear and understand user requests in a way that mimics human actions [2]. Table 1 identifies some of the popular Cognitive Service resources and put them under specialized product categories.

Table 1. Azure's Cognitive Services comparison [2].

Category	Purpose	Capabilities
Speech	Convert speech into text and text into natural-sounding speech. Translate from one language to another and enable speaker verification and recognition.	- Speaker Recognition [PREVIEW] - Speech to Text - Text to Speech
Vision	Recognize, identify, caption, index, and moderate your pictures, videos, and digital ink content.	- Form Recognizer [PREVIEW] - Face Detection - Video Indexer
Language	Allow your apps to process natural language with pre-built scripts, evaluate sentiment and learn how to recognize what users want.	- Language Detection - Text Analytics - QnA Maker
Decision	Build apps that surface recommendations for informed and efficient decision-making.	- Anomaly Detector [PREVIEW] - Content Moderator - Personalizer
Search	Add Bing Search APIs to your apps and harness the ability to comb billions of webpages, images, videos, and news with a single API call.	- Bing Video Search - Bing Image Search - Bing Entity Search

The capabilities offered by these services allow developers to create AI-powered projects without having to build intelligent algorithms from scratch. Practical usages of these services are investigated to show how businesses can integrate Azure Cognitive Services in their own processes, services, or products.

3.1 Speech

Azure's Speech services provide multi-language translations of speech. Customers can turn speech into text, convert text into speech, and translate languages in real time [3]. The new service that is preview, Speaker Recognition, can identify and verify voice owners by processing audio files [4].

3.2 Vision

Other than speech and text, people communicate through other methods—vision. With the advancement in Azure Vision services, customers can analyze content from images, videos, writings, and forms. The Face Detection service can identify people, emotions, and similarities from images; the Video Indexer service take this capability to video content by detecting objects, landmarks, and activities from moving pixels. Lastly, with the new addition of Form Recognizer service, content from both digital and paper forms of communication can be extracted [3].

3.3 Language

With the abilities to gather information from all types of communication channels—speech, vision, or text—Azure Cognitive Services take data processing to the next level by developing language understanding capabilities. The data collected are analyzed, evaluated, translated, or even used to create knowledge base.

To best leverage these data, we have the Language Detection service to detect and translate information, the Text Analytics service to identify sentiment and highlight key phrases, and QnA Maker service to generate a question and answer bank from the data [4].

3.4 Decision

To gain more insights and to filter unwanted information, services under the Decision category can be applied. Personalizer uses reinforcement learning to prioritize relevant content; Content Moderator filters potentially undesirable information; Anomaly Detector automatically applies best-fitting detection models on time-series data to identify problems early on [4].

3.5 Search

Azure's Search services allow users to search through various data formats such as image, video, and text. To optimize the searching experience, specialized contents are differentiated from one another. As a result, many services like Bing Video Search, Bing Image Search, and Bing Entity Search are created [2].

4 Custom AI

Other than the pre-built AI services, Azure also provides end-to-end lifecycle support for building and deploying AI algorithms. As shown in Figure 1, Custom AI is an umbrella term used to

describe all the products and services available to solve issues such as data processing, model training, and model evaluation throughout training and deployment of machine learning models. Table 2 summarizes the Azure products available that fall under Custom AI. Each of them with a unique purpose to simplify the building and deployment process of AI algorithms, specifically Machine Learning.

Table 2. Azure Machine Learning products comparison [5].

Product	Purpose	Capabilities
Azure Machine Learning service	A managed cloud service for machine learning.	To manage, train, and deploy models in Azure using Python, Azure CLI, and Azure portal.
Azure Machin Learning Studio	A drag-and-drop visual interface for machine learning.	To build, test, and deploy models using preconfigured algorithms.
Azure Databricks	Apache Spark-based analytics platform with an integrated notebook interface that works with Azure Active Directory.	To build and deploy models and data workflows with big data technologies.
Azure Data Science Virtual Machine	A virtual machine with pre-installed data science tools.	To build machine learning solutions in a pre-configured data science environment.
SQL Server Machine Learning Services	Integrated with Microsoft SQL Server, this scalable analytics server supports the Python and R language.	To build and develop models in an on-premises SQL server that scales to match the SQL Server engine.

4.1 Azure Machine Learning service

Customers can use Azure Machine Learning service to build their own machine learning models much easier and faster. The service allows users to build solutions using popular open-source frameworks like TensorFlow, PyTorch, and Scikit-learn, and deploy them to the cloud [3]. The added benefit of cloud allows customers to scale up, automate, and containerize their solutions, leading to better results with reduced time and costs [5].

4.2 Azure Machine Learning Studio

While Azure Machine Learning service is a cloud-based service, Azure Machine Learning Studio is a drag-and drop tool where customers can use to develop machine learning components [6]. Figure 2 shows a high-level overview of how Machine Learning Studio helps to connect machine different components together.
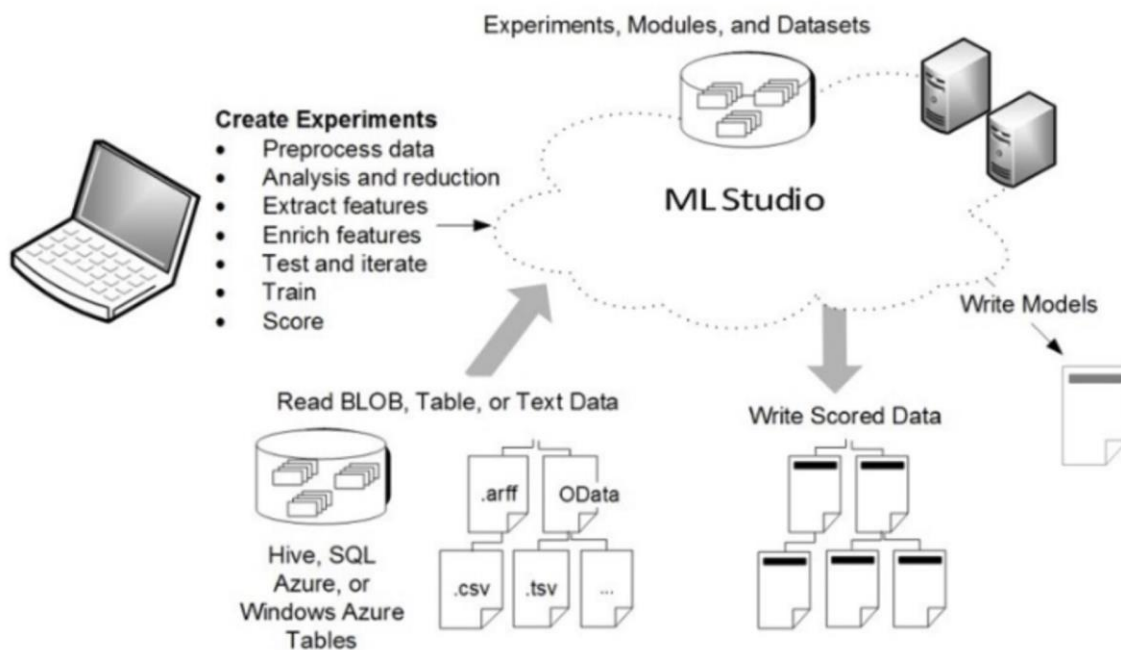

Figure 2. Machine Learning Studio capabilities [6].

From users' perspectives, they can easily access Machine Learning Studio on their laptop to create machine learning experiments. These experiments can also be published as web services to be used by others [6].

4.3 Azure Databricks

Azure Databricks is a collaboration platform designed for data scientists. The added benefits include easier job scheduling, granular security control, and seamless integration with both Azure and Spark. Spark clusters can be edited and controlled easily without having to worry about data losses [5].

4.4 Azure Data Science Virtual Machine

Azure Data Science Virtual Machine is a pre-configured data science environment to save the trouble of installing and configuring tools. With Azure Data Science Virtual Machine, customers can immediately start working on developing intelligent applications any time and any where [7].

4.5 SQL Server Machine Learning Services

SQL Server Machine Learning Services is a feature in SQL Server that supports scale up and high performance of Python and R code. With Machine Learning Services, customers can build and train intelligent models within SQL Server [8]. Python and R components and packages are available to support processes like data manipulation, transformation, and visualization.

5 Marketing Competitor Analysis

In addition to Microsoft, there are other public cloud providers like Amazon, Google and IBM, each with their own weaknesses and strengths that make them ideal for different use cases. To gain a better market understanding, AI capabilities offered by these leading companies are compared. By looking at both pre-built and custom AI technologies, Microsoft seems to offer a lot more services and products compared to its competitors.

5.1 Cognitive Services Competitive Analysis

In terms of pre-built AI technologies, Microsoft offers a wide range of Cognitive Services (see Section 3). Among all the service categories, Speech and Language stand out the most among competitors. Figure 3 lists all the Speech and Language understanding capabilities developed by Amazon, Microsoft, Google, and IBM. It is evident from Figure 3 that Microsoft offers the most features when compared to its competitors.

	Amazon	Microsoft	Google	IBM
Speech Recognition (Speech into Text)	✓	✓	✓	✓
Text into Speech Conversion	✓	✓	✓	✓
Entities Extraction	✓	✓	✓	✓
Key Phrase Extraction	✓	✓	✓	✓
Language Recognition	100+ languages	120 languages	120+ languages	60+ languages
Topics Extraction	✓	✓	✓	✓
Spell Check	✗	✓	✗	✗
Autocompletion	✗	✓	✗	✗
Voice Verification	✓	✓	✗	✗
Intention Analysis	✓	✓	✓	✓
Metadata Extraction	✗	✗	✗	✓
Relations Analysis	✗	✓	✗	✓
Sentiment Analysis	✓	✓	✓	✓
Personality Analysis	✗	✗	✗	✓
Syntax Analysis	✗	✓	✓	✓
Tagging Parts of Speech	✗	✓	✓	✗
Filtering Inappropriate Content	✗	✓	✓	✗
Low-quality Audio Handling	✓	✓	✓	✓
Translation	6 languages	60+ languages	100+ languages	21 languages
Chatbot Toolset	✓	✓	✓	✓

Figure 3. Speech and language processing APIs comparison [9].

The comparison in Figure 3 shows Microsoft Azure's advancement in developing speech and language processing APIs. Compared to Amazon and IBM, Microsoft offers a wider range of selections both in languages and features. Although Google covers more languages for language translation and detection services, Microsoft competes by providing additional features like Spell Check, Autocompletion, and Voice Verification, and Relations Analysis.

5.2 Machine Learning Competitive Analysis

For custom AI capabilities, we draw our attention to machine learning tools. Figure 4 presents an overview of the main machine-learning-as-a-service platforms offered by industry leaders in cloud computing. From Figure 4, we see that Microsoft provides the most out-of-box algorithms as part of its machine learning services.

	Amazon	Microsoft	Google	IBM
Automated and semi-automated ML services				
	Amazon ML	Microsoft Azure ML Studio	Cloud AutoML	IBM Watson ML Model Builder
Classification	✓	✓	✓	✓
Regression	✓	✓	✓	✓
Clustering	✓	✓	✗	✗
Anomaly detection	✗	✓	✗	✗
Recommendation	✗	✓	✓	✗
Ranking	✗	✓	✗	✗
Platforms for custom modeling				
	Amazon SageMaker	Azure ML Services	Google ML Engine	IBM Watson ML Studio
Built-in algorithms	✓	✗	✓	✓
Supported frameworks	TensorFlow, MXNet, Keras, Gluon, Pytorch, Caffe2, Chainer, Torch	TensorFlow, scikit-learn, Microsoft Cognitive Toolkit, Spark ML	TensorFlow, scikit-learn, XGBoost, Keras	TensorFlow, Spark MLlib, scikit-learn, XGBoost, PyTorch, IBM SPSS, PMML

Figure 4. Machine Learning services comparison [9].

6 Customer Demand Analysis

Consideration for multiple industries ensures success when it comes to scaling of AI solutions. As AI gains public awareness, more businesses are interested in integrating AI in their products or services. Figure 5 provides an overview of the top three AI uses cases demanded by each industry.

% of respondents

- ● Highest scoring answer
- ● Second-highest scoring answer
- ● Third-highest scoring answer

	Financial services	Government/ Public sector	Healthcare & life sciences	Manufacturing	Retail
Predictive analytics	30	22		28	33
Real-time operations management	26	22		26	22
Risk management and analytics		22	23		
Customer services					31
R&D				30	
Fraud detection	25				
Social engagement			21		
Knowledge creation			21		

Figure 5. AI use cases by industry [10].

By looking at the varying industry demand, we see the overlapping need for predictive analytics and real-time operations management across government, manufacturing, retail, and financial services sectors.

7 Enterprise Solution Analysis

From marketing competitor analysis (see Section 5), we identified Azure's strongest areas—Vision, Language, and Machine Learning services. In addition, we concluded that use cases like predictive analytics and real-time operations management have the most cross-industry demand

(see Section 6). Leveraging both Azure's strengths and industry demand, out-of-box AI solutions for chatbots and recommendations are architected. While all chatbots and recommendations are different, there are common workflows and technologies that can be applied and extended to different problems.

7.1 Chatbot Solution

The conversational bot is an AI technology that integrates Azure Cognitive Services to ensure efficient execution of routine tasks, providing top to bottom visibility of activities as they happen. A reference implementation for chatbots is shown in Figure 6. The solution can be applied to any industry that requires frontline staff for customer services.
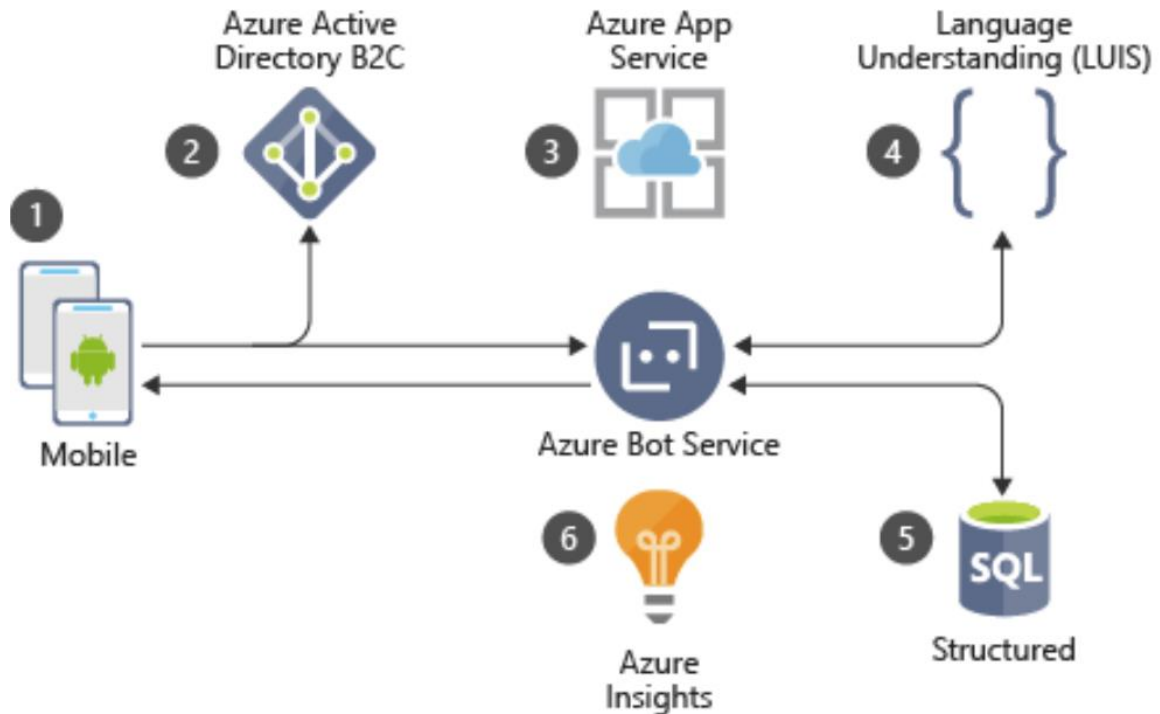

Figure 6. Conversational bot system architecture [11].

The solution used six different components to draft a sample interaction. As the customer accesses the chatbot service with a mobile or web application, Bot Service and Active Directory are activated to enable bot and authentication logics. Through the Azure Bot Service, Language Understanding service is used to understand user requests and structured data are pulled from databases to answer requests [11]. The addition of Azure Insights and Azure App service serve to enhance solution reliability by providing performance monitoring and app management for bots.

7.2 Recommendation Solution

Businesses can also leverage Azure Machine Learning to automate product recommendations for their customers. Industries from retail to financial services to manufacturing can benefit from the solution. The reference architecture shown in Figure 7 demonstrates the data flow to leverage Azure machine Learning Service for predictive analytics.
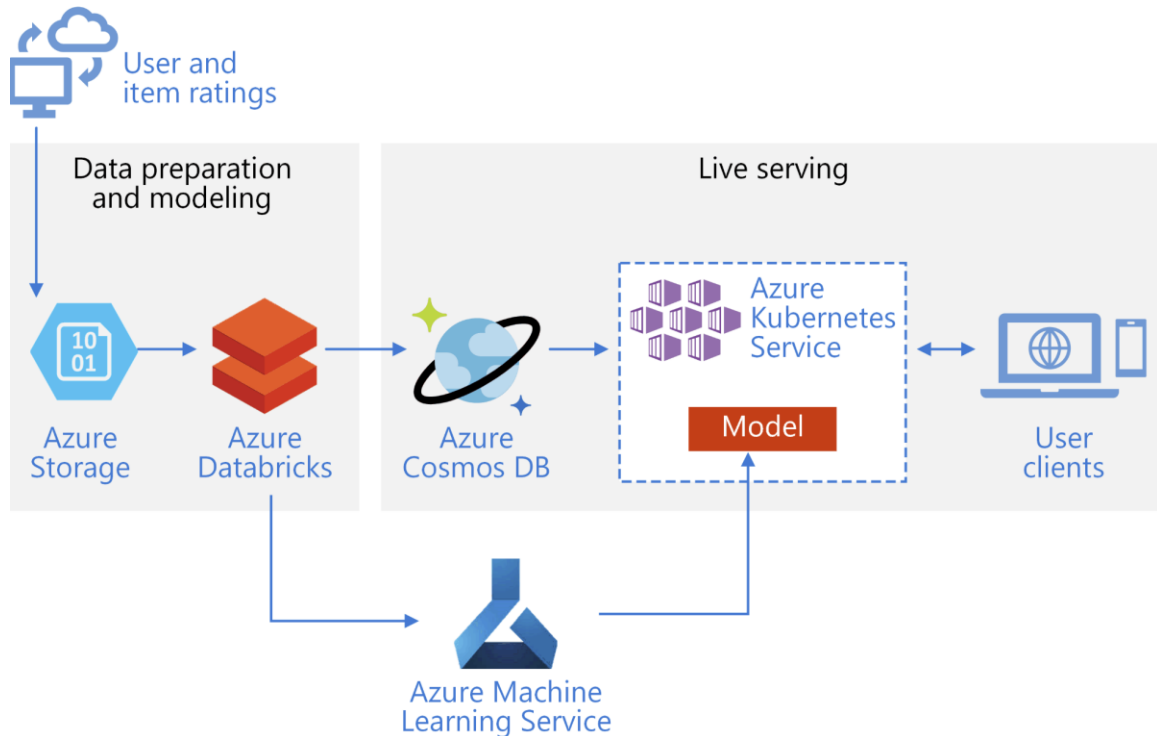

Figure 7. Real-time recommendation API architecture [12].

The recommendation model is trained using Azure Databricks and deployed as an API through Azure Machine Learning, Azure Cosmos DB, and Azure Kubernetes Service [12]. The architecture provides a generalized view of recommendation engine scenario that can be applied to many different use cases, including generating recommendations for movies, news, or services.

8 Conclusions

From the analysis in the report body, it is concluded that AI technologies like conversational bots (See Section 7.1) and recommendation APIs (see Section 7.2) can best meet customer needs and market demand. The result is concluded through a series of analysis on Azure offerings, market competitions, and customer demand.

Azure offers many AI products and services under Azure Cognitive Services (Section 3) and Azure Machine Learning (Section 4). Through analysis of market competitorss (Section 5), we find that Azure stands out among its competitors through its advancement in Speech and Language services as well as Machine Learning services. Furthermore, AI solutions related to operations optimization and predictive analytics appear to be the most requested use cases across all industries (Section 6).

To leverage language processing APIs, chatbots can be implemented to provide real-time operations management (Section 7.1). The solution automates routine work for frontline staff while improving efficiency and consistency. In addition, the control and visibility that come with chatbot solutions provide managers with more business insights.

Furthermore, the solution to predictive analytics is discussed in Section 7.2. Recommendation systems can be built using Azure Machine Learning services. The recommendations can be personalized to specific customer or industry. Some sample use cases include recommendations for movies, news, or consumer products.

9 Recommendations

Based on the analysis and conclusions in this report, it is recommended that chatbot and recommendation solutions be advocated to make the greatest impact—resonating with customers and standing out among competitors. Although the solutions identified satisfy the criteria of leveraging existing AI technologies, future work is required to improve user experience by incorporating services from Azure Apps and Infrastructure.

In addition to AI technologies, it is also recommended to expand on the subsystem for logging and monitoring. At the enterprise level, it can be difficult to gain visibility in application performance due to the great number of client interactions. As a result, tools like Application Insights and Power BI can be used to collect metrics and derive insights from bots and recommendation systems [13]. These dashboards can serve multiple purposes including monitoring, diagnosis, and analytics.

As the AI solutions mature, it is also desirable to use a CI/CD solution to enable continuous deployment to automate code changes deployment. This is a good practice to avoid conflicts when building fixes and testing new features. Azure DevOps can be used to configure continuous deployment for our AI applications—bot and recommendation systems. With simple set up, the new commits and changes from GitHub will be automatically deployed to Azure solutions [14].

Glossary

AI: Artificial Intelligence (AI) is the development of machines to learn from experience, and to perform human-like tasks like speech recognition, visual perception, and language translations.

ML: Machine Learning (ML) is an application of AI that allow machines to learn and improve from experience without constant supervision.

Azure: Azure is an open and flexible cloud computing platform, created by Microsoft.

API: An application programming interface (API) is a set of functions and procedures to access web-based software applications and tools.

SharePoint: A web-based collaborative platform used by organizations to create websites.

DataBricks: A cloud platform popular for massive scale data science and data engineering.

Spark: A unified analytics engine used for big data processing, created by DataBricks.

Python: A popular programming language to use with machine learning APIs.

R: A popular programming language to use for statistical analysis.

VM: A virtual machine(VM) is a software program or operating system that provides functions of a physical computer.

Azure Cosmos DB: database service offered by Microsoft Azure.

Azure Kubernetes Service: container management service offered by Microsoft Azure.

CI/CD solution: Continuous integration, delivery, and deployment (CI/CD) solves problems with new code integrations.

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