Assignment 2: Building a chatbot app

COS60016: Programming for Development

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Creating and building a chatbot – justifying the approach

Amazon Lex is a web service that allows for the construction of conversation interfaces (Mishra, 2019). The concept is to create a ‘friendly’ user-experience whilst fielding a wide range of questions from users and processing the information to fulfil particular goals, known as **intents**. Within each intent, a number of **slots** provide a framework of information in a JSON element. After the customer’s query directs the Lex engine to select a particular intent, a range of queries from the bot are answered by the user, and the JSON file is adjusted each time until it contains a complete set of information for that particular intent.

Numerous challenges were encountered and overcome during development of the Lex bot for this assignment. Despite the recent launch of a Version 2 for Amazon Lex, Version 1 was used for this assignment. This was due to its more streamlined implementation with Amazon Lambda. Also, of the few bot examples given in the Lex documentation (Amazon Web Services, 2022), the *Book Trip* blueprint provided a similar structure to that required of in this assignment. From this starting point, significant changes were made to create a unique bot that met the specific requirements of this assignment:

- 3 intents – BookFlight, BookCar and BookHotel
- 5 slots per intent
- at least 4 utterances for each intent

At first, I created detailed **Slot Types** to validate inputs – many of these were deactivated when I linked the Lambda function for validation. Also, it was important to ensure that all mentions of any slots were accurately and consistently typed, and that small changes made in one area were reflected throughout the Lex bot. This process also included the creation of a new slot (BookFlight), a process that both mirrored the other slots and yet carried unique features. I nicknamed my bot “Jarvis” to give it a name and therefore a ‘friendly’ face for user engagement (Kull, et al., 2021). Eventually, I recreated the bot from scratch so that I could ensure that it was correctly configured. Continuous testing was carried out during development as detailed in the next section.

Amazon Lambda is another aspect of the Amazon Web Service family, a **Function as a Service** platform that deploys functions within a lightweight virtual machine, or container and can be used for improvement of functionality both within the AWS suite and beyond (Chapin & Roberts, 2020). In addition to the conversational flow generated by the Lex bot, Lambda can be used for initialisation of a JSON element, validation of each query and final fulfilment upon customer confirmation of all input data – all with the effect of improving the Lex bot’s functionality.

Nicknamed “JarvisValidation”, the Lambda function was the most intensively developed aspect of this assignment. Starting with the BookTrip blueprint, significant changes were made to achieve the specific goals of the assignment. Firstly, non-essential elements were removed from the code, such as “GeneratePrice” and its related elements. Also, a new method and validation function for “BookFlight” were added – the significant testing process to ensure correct integration of all intents is detailed in the next section, with examples of code provided in Appendix 1.

Testing the chatbot – test-driven development and reflective practice

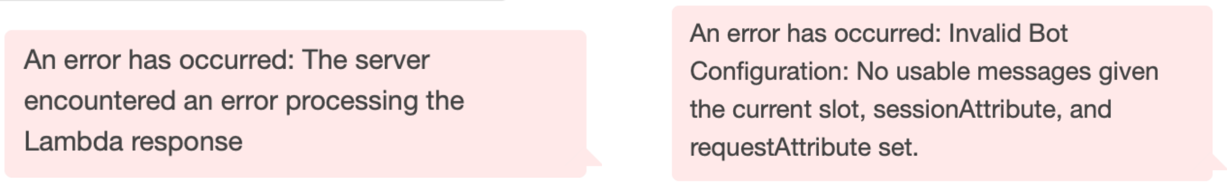
Test-driven development is a double edged sword (Janzen & Saiedian, 2008). Whilst consistent testing can lead to polished code with minimal errors, it depends on the tools that you use for testing. A prime example of this is the JSON file used for testing in Amazon Lambda. This represents the input data for a test user, based on the details of informational flow in the Lambda console (Amazon Web Services, 2022). Initially, I had not understood how this system worked, although I had encountered many of these concepts before. As such, I received a Key Error when I tested initially, since the dictionary did not match my Lambda function at all (Hansen, 2022). This taught me the importance of having a good test to use, and not simply relying on inbuilt systems or templates. Understanding is key to effective test-driven development.

In their recent book, "Programming AWS Lambda", Chapin and Roberts had this to say regarding testing:

> *"A good test suite, like the solid foundation of a house, provides a known baseline of system behavior on top of which we can build confidently…*
>
> *When integrated into a development workflow, that same test suite also encourages good practices by making it easier to maintain existing tests and add new ones."*
>
> (Chapin & Roberts, 2020) - highlights added

Throughout the development process, it was essential to not just solve a problem, but to understand it, and properly fix errors. The initial KeyErrors and syntax errors were simple to solve, as they were easily traced to a known source. As my familiarity with the code grew, so too did my understanding of the need for specific JSON input and the role of key/value pairs in handling incoming data from the Lex bot and producing a response (Moisi, 2018). As it represented a single test case, it was important not to rely solely on the JSON test input, although it did provide initial screening before testing conversational flow.

As well as solving specific errors in the Lambda function, it also became clear that the Lex bot sometimes contained inconsistencies with the Lambda function. This required a detailed analysis of the bot for errors. One method I discovered for troubleshooting the Lex bot occurred somewhat by accident. Whilst analysing the differences between Version 1 and Version 2 of the Lex console, I discovered that error checking in Version 2 is far superior. If I had an error that I could not find a solution to, I was able to migrate it to the Version 2 console and use the error checking there to find the errors. Whilst this was not an ideal fix, it did help me on at least two occasions. My very last error in this assignment was an incorrectly labelled slot in my confirmation response for BookFlight – a simple error that took much troubleshooting to find (*see Figure 1 below*).



```
An error has occurred: The server encountered an error processing the Lambda response
```

```
An error has occurred: Invalid Bot Configuration: No usable messages given the current slot, sessionAttribute, and requestAttribute set.
```

Figure 1: Two common error messages produced during testing of conversational flow in the Lex bot. The right hand error message was particularly hard to find.

In considering the improvements I would make to this assignment, I would first suggest optimisation in the Lex bot's responses with further Lambda improvements (Amazon Web Services, 2022), and a handoff point for human assistance with difficult queries (Mamgain, 2022). Also, I discovered CloudWatch logs as a useful tool in the final stages of development, as well as in reviewing the development process. Fully searchable logs of events provided an abundant source of data for evaluating the development process. The table below shows the range of errors encountered in development of this project based on this data:

Table 1: Errors encountered during Lambda testing; Type and amount based on CloudWatch Log

Key Errors	Syntax Errors	Value Errors	Name Errors	Exceptions
5	14	1	12	4

Despite the challenges encountered during this assignment, especially in grasping a holistic system and the specificities of its data handling, it became clear that test-driven development was essential for this task. The immediate feedback provided by the aforementioned testing methods shaped any further development. As such, it was important to understand and modify testing procedures to steer the development process towards a successful product.

The GitHub repository for this assignment can be found here.

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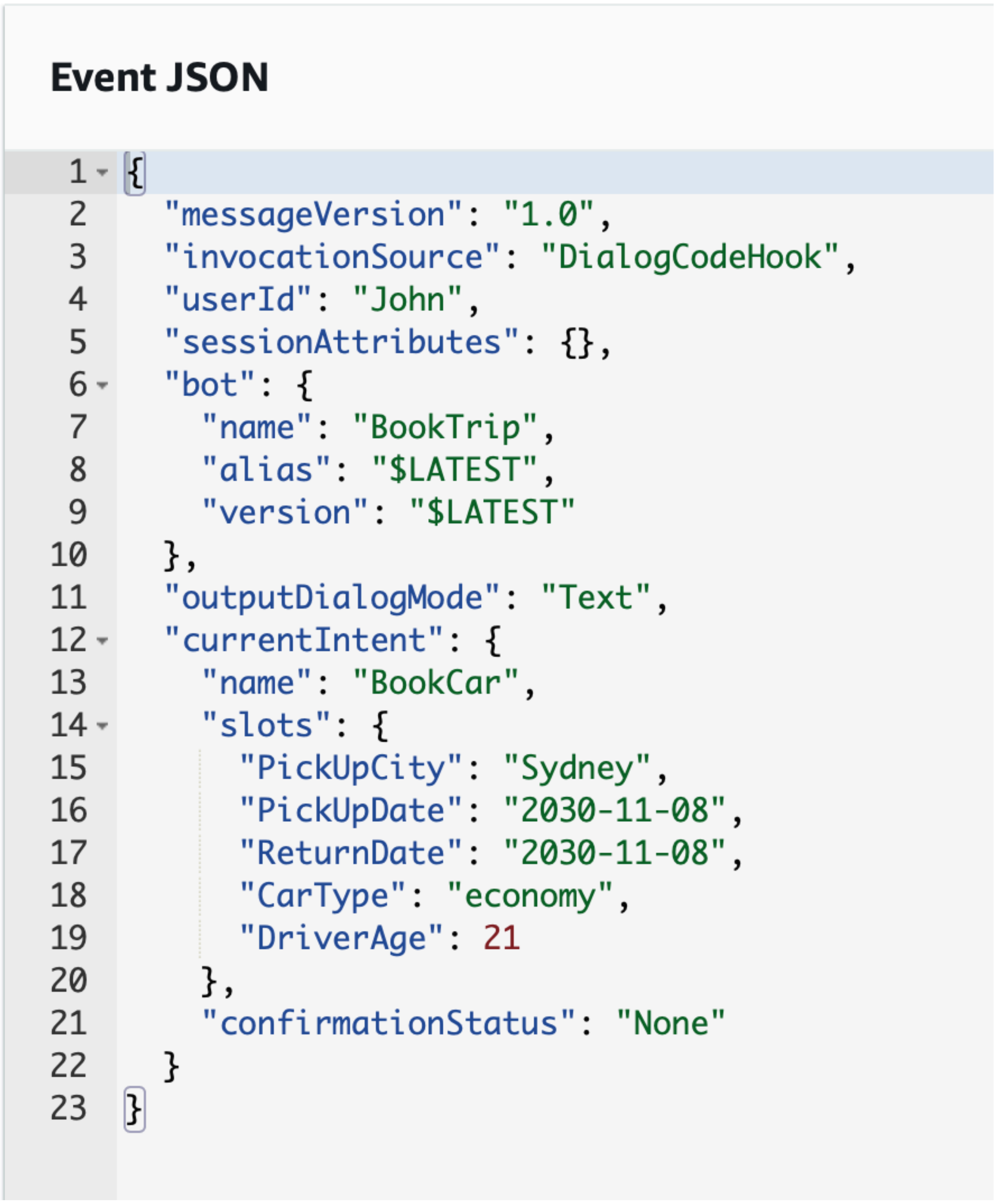
Appendix 1

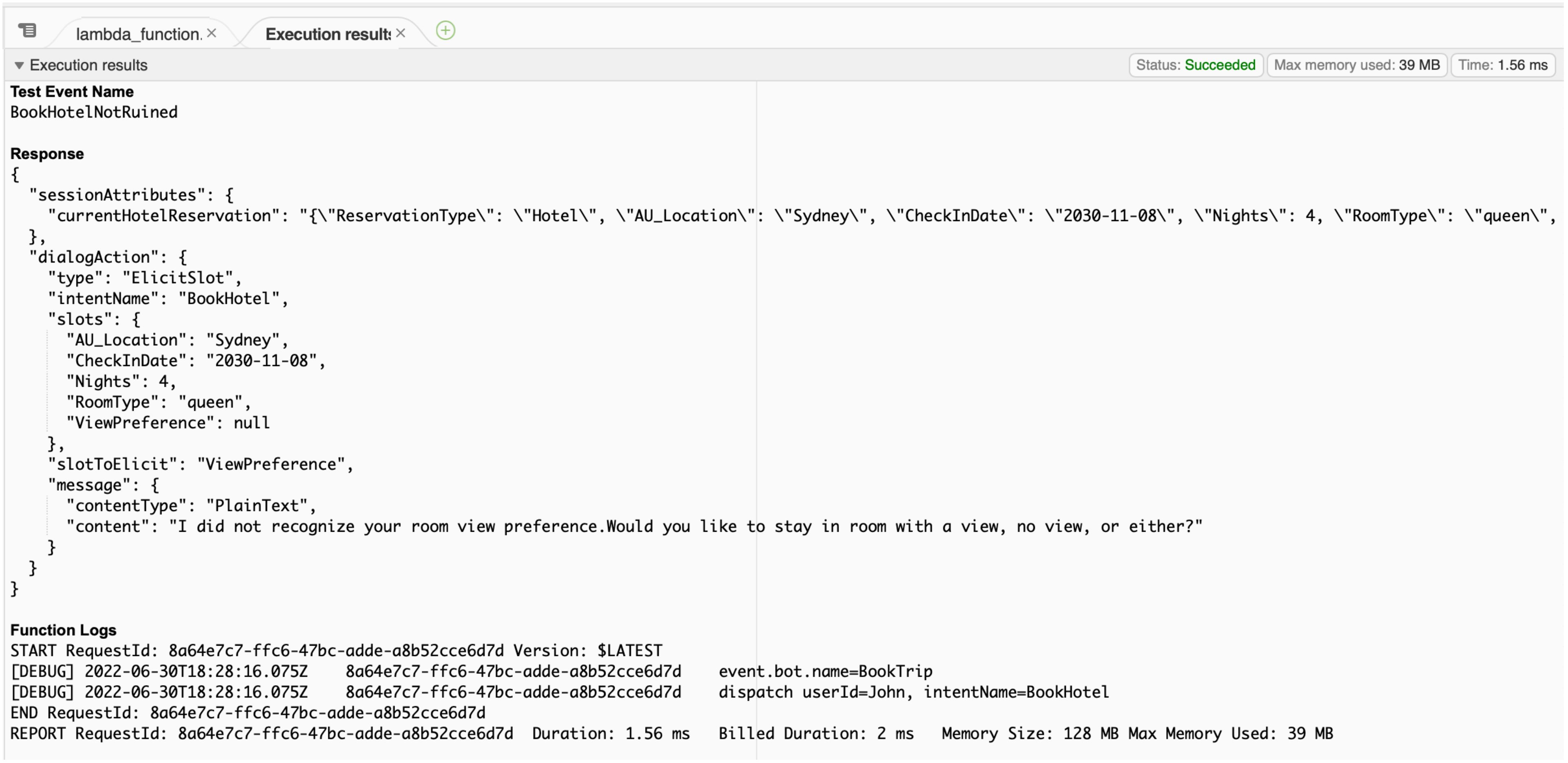
Event JSON – BookCar

All information has been inputted as it would be expected to come from the user.


Event JSON

```
{
  "messageVersion": "1.0",
  "invocationSource": "DialogCodeHook",
  "userId": "John",
  "sessionAttributes": {},
  "bot": {
    "name": "BookTrip",
    "alias": "$LATEST",
    "version": "$LATEST"
  },
  "outputDialogMode": "Text",
  "currentIntent": {
    "name": "BookCar",
    "slots": {
      "PickUpCity": "Sydney",
      "PickUpDate": "2030-11-08",
      "ReturnDate": "2030-11-08",
      "CarType": "economy",
      "DriverAge": 21
    },
    "confirmationStatus": "None"
  }
}
```

A successful test using the above JSON input:



lambda_function. Execution result:

Execution results

Status: Succeeded | Max memory used: 39 MB | Time: 1.56 ms

Test Event Name
BookHotelNotRuined

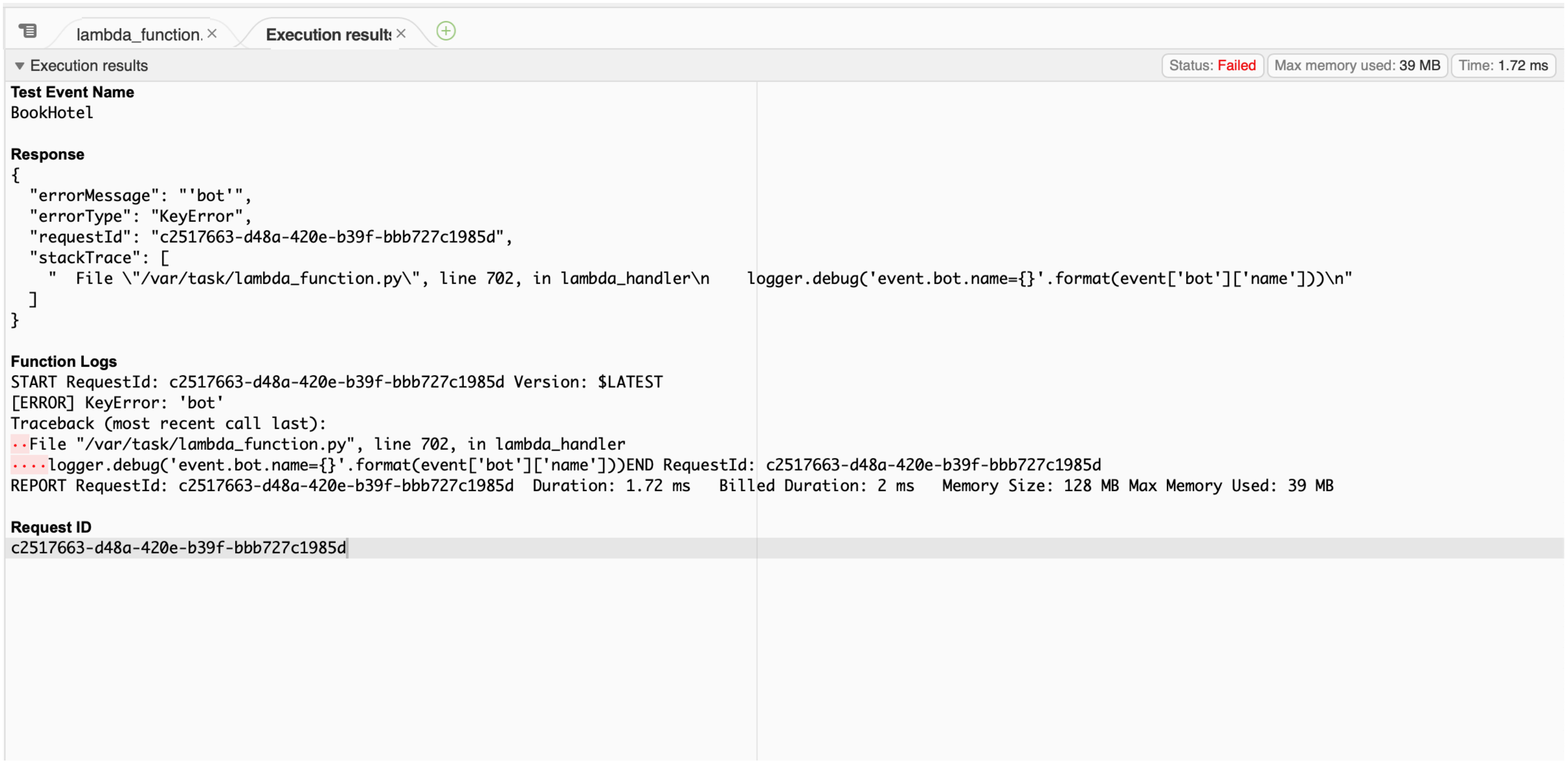
Response

```
{
  "sessionAttributes": {
    "currentHotelReservation": "{\"ReservationType\": \"Hotel\", \"AU_Location\": \"Sydney\", \"CheckInDate\": \"2030-11-08\", \"Nights\": 4, \"RoomType\": \"queen\",
  },
  "dialogAction": {
    "type": "ElicitSlot",
    "intentName": "BookHotel",
    "slots": {
      "AU_Location": "Sydney",
      "CheckInDate": "2030-11-08",
      "Nights": 4,
      "RoomType": "queen",
      "ViewPreference": null
    },
    "slotToElicit": "ViewPreference",
    "message": {
      "contentType": "PlainText",
      "content": "I did not recognize your room view preference.Would you like to stay in room with a view, no view, or either?"
    }
  }
}
```

Function Logs

```
START RequestId: 8a64e7c7-ffc6-47bc-adde-a8b52cce6d7d Version: $LATEST
[DEBUG] 2022-06-30T18:28:16.075Z    8a64e7c7-ffc6-47bc-adde-a8b52cce6d7d    event.bot.name=BookTrip
[DEBUG] 2022-06-30T18:28:16.075Z    8a64e7c7-ffc6-47bc-adde-a8b52cce6d7d    dispatch userId=John, intentName=BookHotel
END RequestId: 8a64e7c7-ffc6-47bc-adde-a8b52cce6d7d
REPORT RequestId: 8a64e7c7-ffc6-47bc-adde-a8b52cce6d7d  Duration: 1.56 ms   Billed Duration: 2 ms   Memory Size: 128 MB Max Memory Used: 39 MB
```

An unsuccessful test message due to incorrect test JSON configuration:



Test Event Name

BookHotel

Response

```
{
  "errorMessage": "'bot'",
  "errorType": "KeyError",
  "requestId": "c2517663-d48a-420e-b39f-bbb727c1985d",
  "stackTrace": [
    "  File \"/var/task/lambda_function.py\", line 702, in lambda_handler\n    logger.debug('event.bot.name={}'.format(event['bot']['name']))\n"
  ]
}
```

Function Logs

```
START RequestId: c2517663-d48a-420e-b39f-bbb727c1985d Version: $LATEST
[ERROR] KeyError: 'bot'
Traceback (most recent call last):
  File "/var/task/lambda_function.py", line 702, in lambda_handler
    logger.debug('event.bot.name={}'.format(event['bot']['name']))END RequestId: c2517663-d48a-420e-b39f-bbb727c1985d
REPORT RequestId: c2517663-d48a-420e-b39f-bbb727c1985d  Duration: 1.72 ms   Billed Duration: 2 ms   Memory Size: 128 MB Max Memory Used: 39 MB
```

Request ID

c2517663-d48a-420e-b39f-bbb727c1985d