Intent Sets - Architectural Choices for Building Practical Chatbots

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Introduction – What is a Chatbot?

• A colloquial term used to refer to a conversational software component
• Interacts with the user, either through voice or text, using some Natural Language like English
• Often added to an existing system, to provide a conversational querying interface over some data
• There are commercial platforms which can aid in designing, implementing and deploying these chatbots
• Examples: Google Dialogflow, IBM Watson Assistant, Amazon Lex
QBE vs Conversational Interface

**QBE Interface**

**Team Stats**
- **Batting Stats**
  - Who scored more than 0 runs and 0 or 0.
  - With average greater than 0 and 0 or 0.
  - With strike rate greater than 0 and 0 or 0.
  - Scored more than 50 centuries in any/all of the following formats: Tests, ODI, T20.

**Player Stats**
- **Bowling Stats**
  - Fielding Stats

**Match Stats**
- Result: Sachin Tendulkar (India) - Centuries: 51
  - [1 row(s) matched your query]
Elements of a Chatbot's definition

- Almost all platforms today seek 4 elements to build a chatbot
- **Intents**
  - Broad categories of queries the chatbot will be serving
- **Entities**
  - Real-world actors which will appear in queries
- **Sample Queries**
  - Examples of possible queries that the chatbot will receive
- **Fulfilments**
  - Background business logic to be invoked to process a query
Sample Formulations

•  *Query* - "What's the price for a large double-cheese Margherita?"

• Sample Formulation 1:
  •  Intents: garlic_bread_query | pizza_query | choco_lava_cake_query
  •  Entities: Product_Type: *Margherita*, Product_Size: *Large*,
               Additional_Req: "double-cheese"

• Sample Formulation 2:
  •  Intents: small-sized_order | medium-sized_order | large-sized_order
  •  Entities: Product_Name: *Pizza*, Product_Type: *Margherita*,
               Additional_Req: "double-cheese"
Intent Sets - Definition

An Intent Set is a collection of Intents and their associated Parameters, which can collectively cover all possible queries that a chatbot may encounter.
Intent Sets – Example

Which batsman has scored more than 50 centuries?

Two Intent Sets to parse this query

\( IS_1 \)

\( IS_2 \)

Sachin Tendulkar | India | 51

Sachin Tendulkar from India scored 51 centuries in Test matches!!
Intent Sets – Properties

• *If the platform maps every query to the correct Intent, and parses all the Parameter values correctly, then the response produced by any Intent Set for a given chatbot is exactly the same.*

• *An Intent Set divides the real-world into a finite number of disjoint scenarios, the union of which, constitutes all possibilities that the chatbot can handle.*
Experiments – Overview

• We built a chatbot, called *Cricket Novice* using three different platforms – Google Dialogflow, IBM Watson Assistant and Amazon Lex.

• The chatbot could answer some queries about the game of Cricket, such as how the game is played, the formats, team composition etc.

• In addition, we choose 35 rows of statistics about individual performances from ESPNCricinfo Statsguru, for which Cricket Novice acts like a conversational querying interface.

• In total, we created 25 Intents with a static, descriptive response, and some other Intents to cater to the tabular data.
Experiments – Setup

• To handle the tabular data, we created two Intent Sets
• We choose a fixed set of 105 Sample Queries, to be used for training chatbots with both Intent Sets
• These queries were divided into three groups, and the chatbot was trained in three passes, in a cumulative fashion
• We choose a fixed set of 20 Queries, not used during the training, to test the response of the chatbot
• We defined a metric called **Utility Score** which measured the accuracy of the chatbot after each pass
• In a fourth pass, we also provided some **Negative Examples** to the chatbot, to cover out-of-scope queries and improve accuracy
Some of the stats known to the Cricket Novice. The shaded columns are used by the bot to stitch a response.

<table>
<thead>
<tr>
<th>Match Type</th>
<th>Stat Span</th>
<th>Stat Type₁</th>
<th>Stat Type₂</th>
<th>Stat</th>
<th>Player</th>
<th>Team</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>test</td>
<td>innings</td>
<td>highest</td>
<td>batting</td>
<td>runs</td>
<td>Brian Lara</td>
<td>West Indies</td>
<td>scored 400* runs</td>
</tr>
<tr>
<td>odi</td>
<td>career</td>
<td>highest</td>
<td>bowling</td>
<td>wickets</td>
<td>Muttiah Muralitharan</td>
<td>Sri Lanka</td>
<td>took 534 wickets</td>
</tr>
<tr>
<td>odi</td>
<td>career</td>
<td>lowest</td>
<td>bowling</td>
<td>strike rate</td>
<td>Rashid Khan</td>
<td>Afghanistan</td>
<td>bowled 2623 deliveries</td>
</tr>
<tr>
<td>test</td>
<td>career</td>
<td>highest</td>
<td>batting</td>
<td>average</td>
<td>Sir Donald Bradman</td>
<td>Pakistan</td>
<td>had an average of 99.94</td>
</tr>
<tr>
<td>t20</td>
<td>innings</td>
<td>highest</td>
<td>batting</td>
<td>strike rate</td>
<td>Dwayne Smith</td>
<td>West Indies</td>
<td>had a strike rate of 414.28</td>
</tr>
<tr>
<td>t20</td>
<td>career</td>
<td>highest</td>
<td>batting</td>
<td>centuries</td>
<td>Rohit Sharma</td>
<td>India</td>
<td>scored 4 centuries</td>
</tr>
<tr>
<td>t20</td>
<td>career</td>
<td>lowest</td>
<td>bowling</td>
<td>average</td>
<td>Rashid Khan</td>
<td>Afghanistan</td>
<td>has an average of 12.4</td>
</tr>
<tr>
<td>t20</td>
<td>career</td>
<td>lowest</td>
<td>bowling</td>
<td>economy rate</td>
<td>Daniel Vettori</td>
<td>New Zealand</td>
<td>had economy rate of 5.7</td>
</tr>
<tr>
<td>test</td>
<td>innings</td>
<td>best</td>
<td>bowling</td>
<td>figures</td>
<td>Jim Laker</td>
<td>England</td>
<td>had figures of 51.2-23-10-53</td>
</tr>
<tr>
<td>test</td>
<td>career</td>
<td>highest</td>
<td>batting</td>
<td>centuries</td>
<td>Sachin Tendulkar</td>
<td>India</td>
<td>scored 51 centuries</td>
</tr>
<tr>
<td>test</td>
<td>career</td>
<td>highest</td>
<td>batting</td>
<td>double centuries</td>
<td>Sir Donald Bradman</td>
<td>Australia</td>
<td>scored 12 double centuries</td>
</tr>
</tbody>
</table>
Statistical Intents for Cricket Novice. The Descriptive and default Intents were common.
Experiments – Observations

Utility Scores for Dialogflow

Utility Scores for Watson Assistant

Utility Scores for Lex
Conclusion

• Picking an Intent Set for a chatbot is a Principle Design Decision
  • Picking one Intent Set over another can produce chatbots with widely varying behaviours

• Some Intent Set may be a better choice on one platform, but may not do well on another platform
  • Since platforms do not disclose the background process used to build a chatbot, it cannot be predicted beforehand
Thanks for your time!

• A version of Cricket Novice chatbot -
  https://bot.dialogflow.com/aca181a6-0769-41f6-a4ed-bcd945380ef2
• Questions?