

Development of Voice Commands in Digital Signage for Improved Indoor Navigation Using Google Assistant SDK

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The Problem

- Indoor navigation is not easy, especially in a new place
- Traditionally maps are not interactive
- Current digital signs are more dynamic, but often fail to provide custom information or do so in a nonintuitive way
- Many digital signs are large and expensive



Image source: *Kriesten objekt design GmbH* on Wikimedia

The Proposed Solution

- The Smart Sign is a small digital sign that is voice-forward
- It uses a small microphone and a Wi-Fi connection to accept and process verbal requests
- It uses voice input and natural language processing to allow users to find information faster than a sign with only a touchscreen
- The Smart Sign extends the Google Assistant to provide natural user-to-device communication



Constraints

- Portability: the Smart Sign must be easy to install in any indoor location
- Affordability: the Smart Sign must not be cost-prohibitive to buyers
- Ease of use: the Smart Sign must be intuitive to interact with and encourage user interaction
- Ease of development: the Smart Sign software must be easy to modify such that its maps and other information can be easily updated

Design

- The device used for development is the Android Things Pico Pro Maker kit – a development board designed by Google (cost: about 200 USD).
- Primary hardware of the device:
 - Pico i.MX7 development board with:
 - Two ARM® Cortex®-A7 cores (up to 1.2 GHz)
 - An ARM® Cortex®-M4 core
 - 5-inch touch display
 - Wi-Fi antenna
 - USB-C power cable
- Software:
 - Android 8.1 operating system
 - Allows for development of a UI that is easy to use and familiar to Android users
 - Able to receive Android version updates
 - The Smart Sign app was written in Java
- For portability, a case was 3D printed that could fully contain the device



The Smart Sign with microphone



User Interface

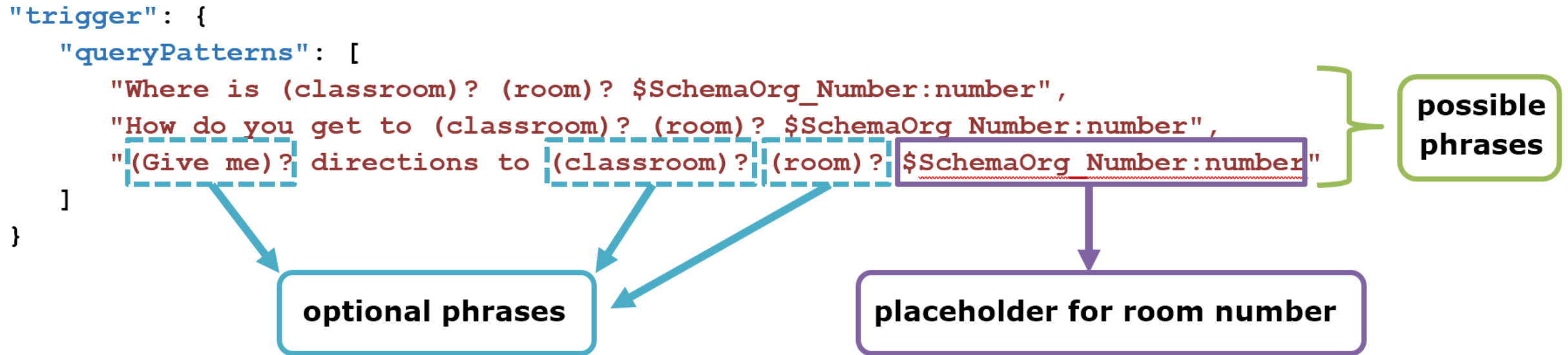
- Simple and intuitive
- An idle state provides the user with general information about the time, location, and weather
- From the idle state the user can press a button to ask the Google Assistant a question
- Users can ask:
 - A question developed specifically for the Smart Sign
 - “Where is room 337?”
 - A question already understood by the Google Assistant
 - “What is the current temperature?”

Custom Commands

- In order for the Smart Sign to be able to give custom directions to the user, custom commands had to be written for the Google Assistant
- Can include questions like “Where is room ____?”
- Allow for the Smart Sign to be adapted to virtually any situation
- Enable the Smart Sign to respond to users in a much more familiar way – conversation.
- Custom commands are defined and written in a JSON file that is included in the app

Writing Custom Commands:

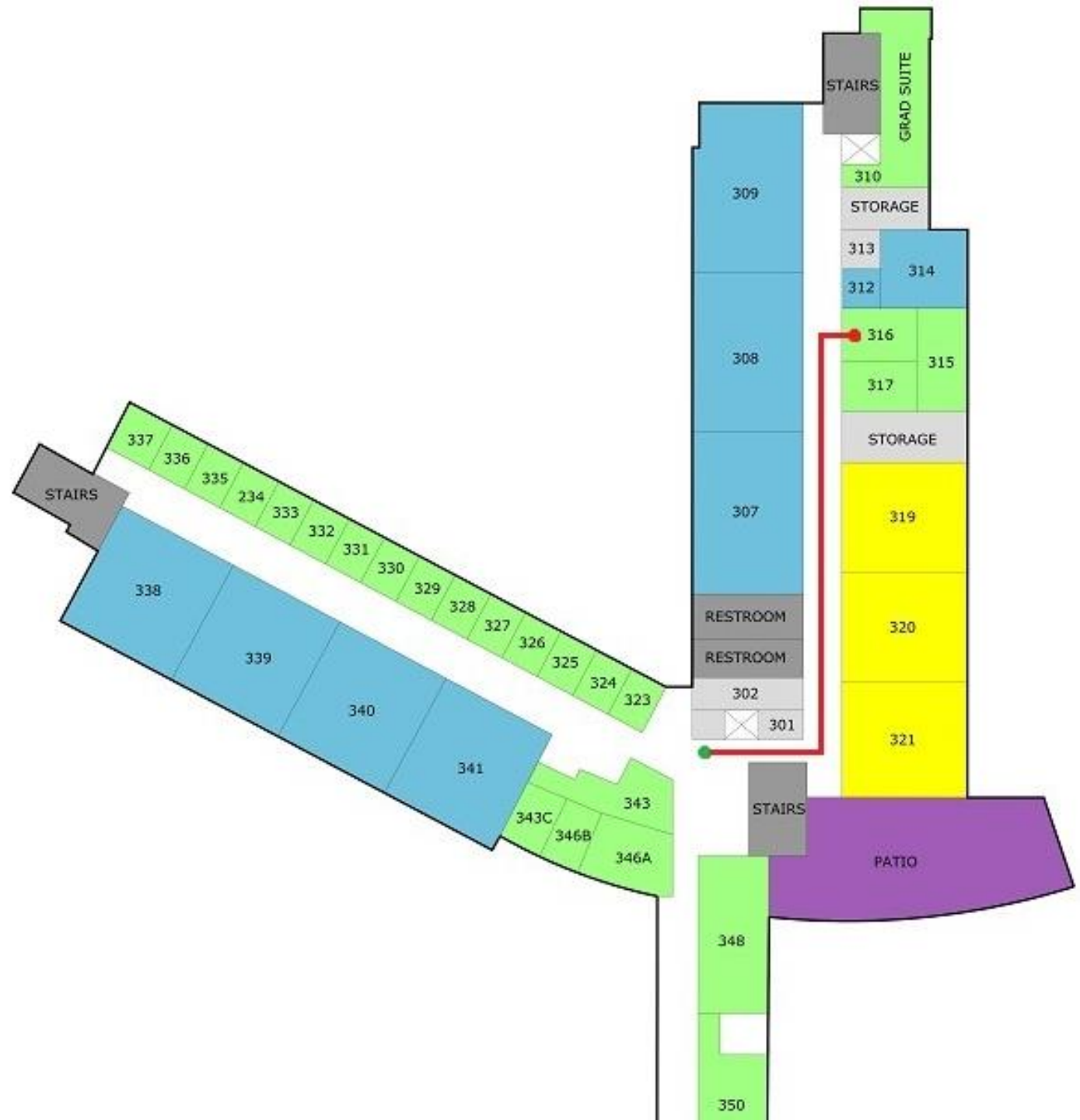
A sample from actions.json



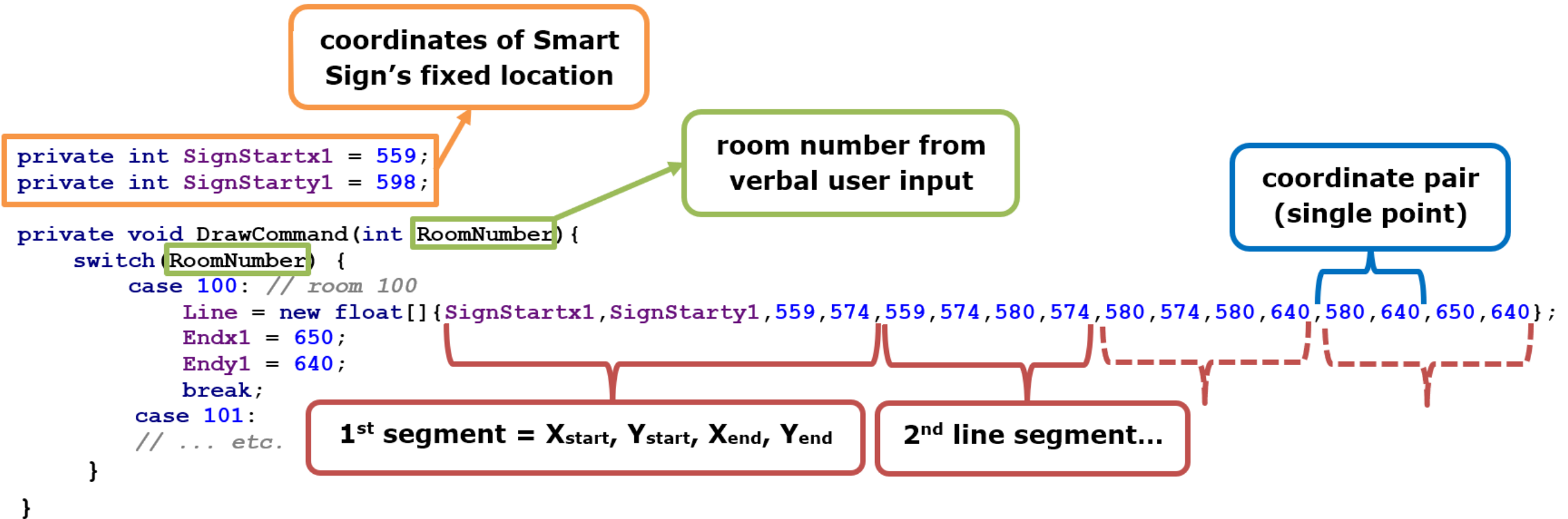
Giving Directions

- Directions are drawn over a map of the building
- Directions consist of:
 - Green circle at current location
 - Red circle at destination
 - Polylines representing the optimal route
- The endpoints of each polyline and locations of each circle are represented as coordinate pairs corresponding to the pixels in the image of the floor map.
- Directions are currently preprogrammed for each room
 - This could be eventually implemented into a mapping algorithm so that polyline parameters do not have to be written manually

Navigation View



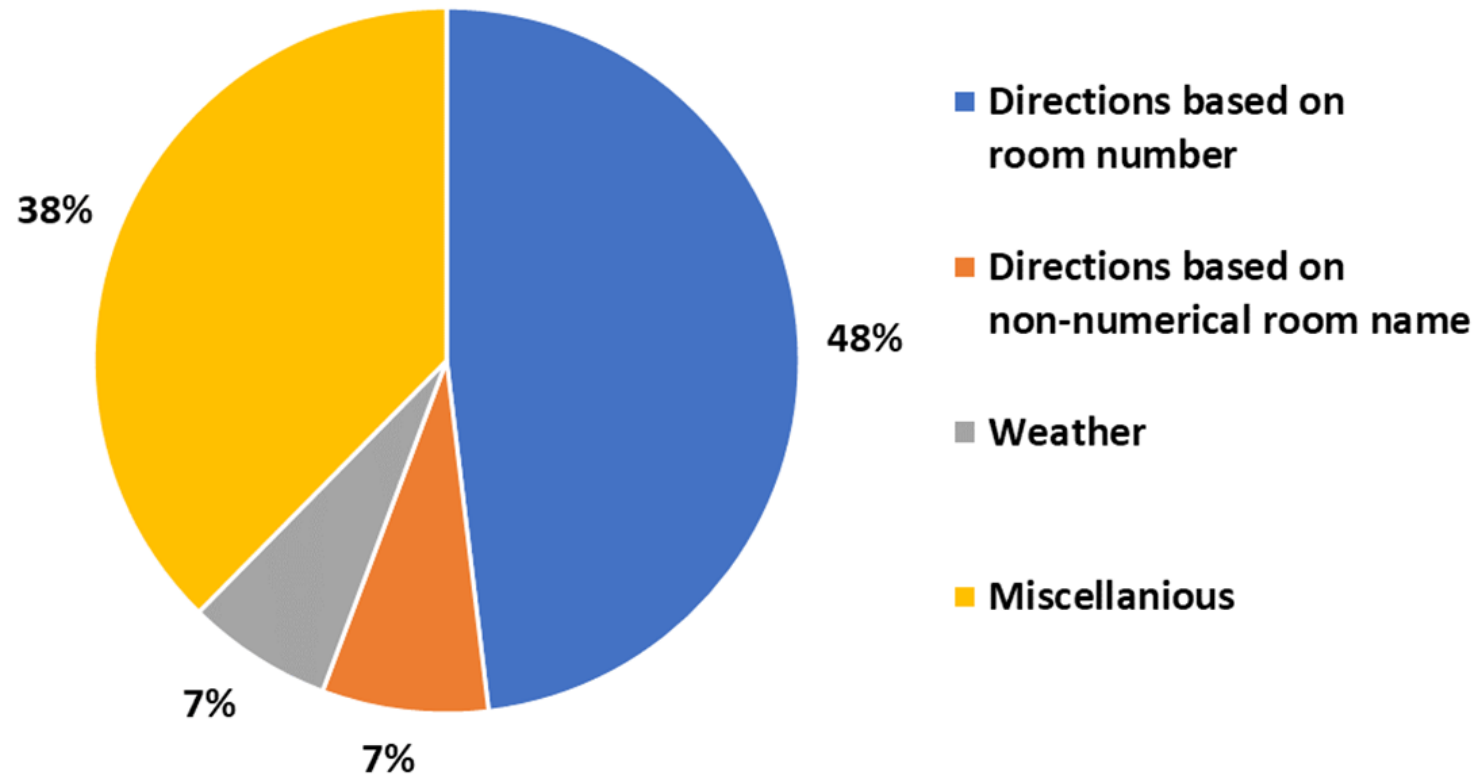
Mapping Function: A sample from NavigationPath.java



Internal Testing

- The Smart Sign was available for alpha testing for about one week in Rowan University's Engineering Hall
- During that time, over 200 queries were processed
- These queries were viewed using the "My Activity" webpage of the Google account that the Smart Sign was signed in to
- The results of the testing gave insight into features that needed to be added to the Smart Sign

Query Categories During Testing



Internal Testing: Conclusions

- The Smart Sign showed to be effective at pointing users to their desired location
- Users liked the Smart Sign's ability to receive quick and succinct directions, while the integration of the Google Assistant allowed users to ask questions that they are accustomed to using with other digital assistants
- Sometimes the Smart Sign had trouble understanding users' requests
 - This was mainly attributed to the poor quality of the microphone used
- Support for non-numerical room names needed to be added
 - (This was completed after testing)
- Further work must be done to improve the quality and versatility of the Smart Sign

Future Work

1. Expand the library of custom commands
 - Will help the Smart Sign to better understand more types of requests
 - Include ability to recognize non-numerical room names (e.g. “office”)
 - This feature was recently added
2. Implement server-side integration of the code
 - Will allow for the application to be modified remotely, further expanding the ease of development
3. Add features to the idle state of the application
 - Announcements
 - Current calendar events in the building
 - Suggestions on how to use the Smart Sign.
 - Advertisements can be incorporated to help the owner of the Smart Sign offset its cost

References

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Thank You

The code for the Smart Sign is open-source and can be found at
<https://github.com/RowanPWLab/smart-signs>