

Academic Year 2020-2021

Master's Degree Thesis

# Conversational Agents for Creating Personalization Rules in the IoT

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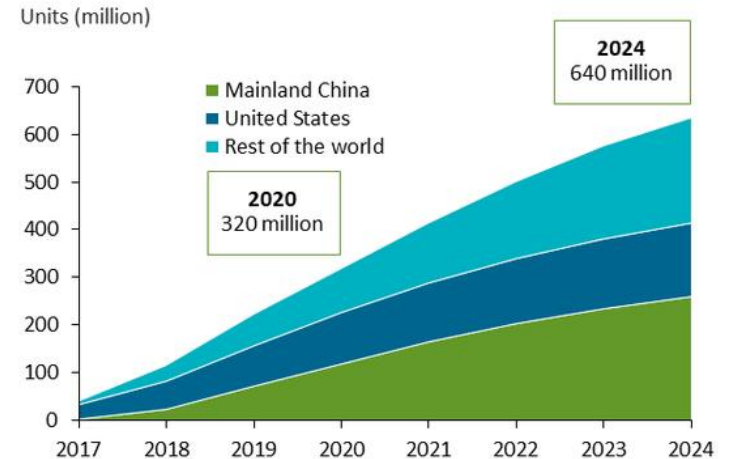
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# INTRODUCTION

The global smart speaker installed base is expected to reach 640 million by 2024. More and more of these devices, such as Google Home or Amazon Echo, are enriching the Internet of Things (IoT) ecosystem in our homes.

The Intelligent Personal Assistants (IPAs) included in the smart speakers allow users to directly control other IoT devices.

Smart speaker installed base forecasts by country



Source: <https://www.canalys.com/newsroom/canalys-global-smart-speaker-market-2021-forecast>



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# INTRODUCTION



Node-RED

  
zapier

- Software tools, such as IFTTT, Node-Red, IPA's mobile apps provide advanced features like the possibility to set up some **personalization rules** in the form of **trigger-action: if something happens, then do something else**.
- The solutions currently on the market are characterized by **medium-high complexity**. This excludes less technical people in the smart home customization process.



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# THESIS GOALS

- If a non-technical user would be **willing to create personalization rules just by talking to a smart speaker.**
- What are **natural formalisms to compose rules by voice**, and if the trigger-action paradigm is good or not.
- Which **characteristics should have an IPA to be suitable for the rule creation process.**



# INTERVIEWS

## Participants

Participant	Age Range	Job	Smart speaker owner
P1	23-27	Speech therapist	✓
P2	18-22	Student	✓
P3	48-52	Housewife	✓
P4	23-27	Health technician	✗
P5	23-27	Student	✗
P6	43-47	Health workers	✗
P7	23-27	Math teacher	✓

- A heterogeneous group of 7 non-technical participants ranging from 18 to 52 years, with a mix of occupations and educational backgrounds.
- The decision was limited to users with a medium-high interest in home automation.

## Study sections

- Background interview
- Imagination exercise



# INTERVIEWS

## Results

- The results indicate that users be inclined to compose personalization rules by conversing with a smart speaker.
- Users vocally composed rules with a **trigger-action formalism**.

### IF > THEN

- Participants preferred to have an **explicit acknowledgment** that the IPAs correctly understood their rule formulation.



# DESIGN & IMPLEMENTATION

## TWO CONVERSATIONAL AGENTS

1 A fully voice-user interface.

2 A multimodal interface that combines the vocal interaction with an active part of the user who should physically interact with the home device.

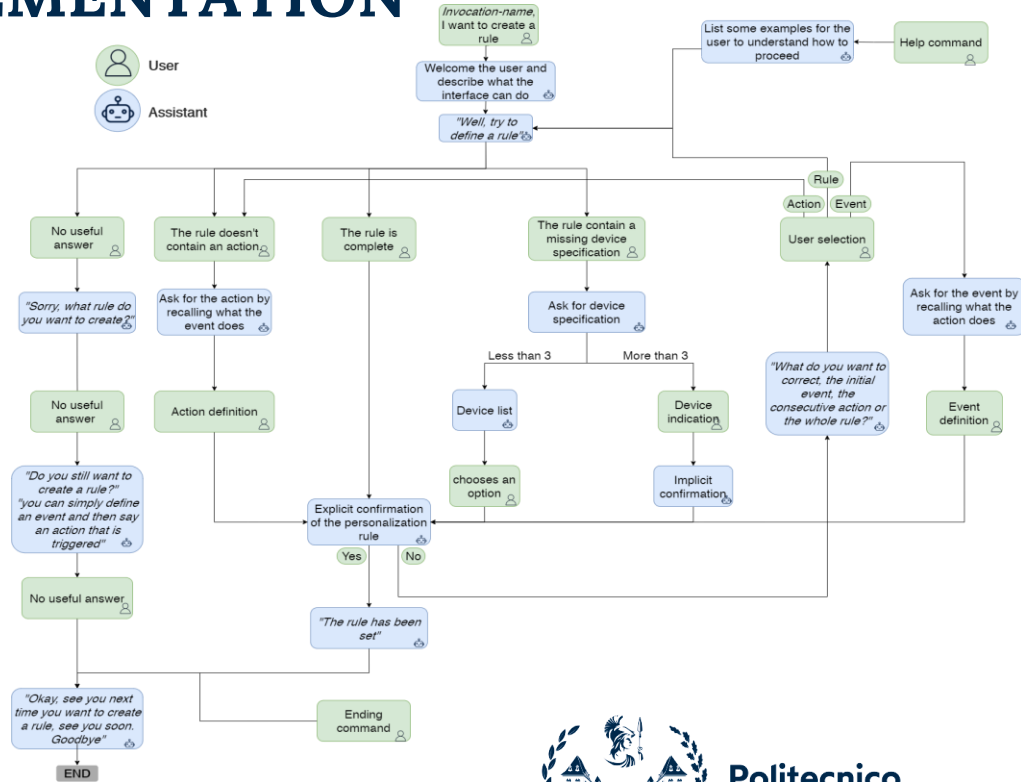




# DESIGN & IMPLEMENTATION

## Main conversational components

- WELCOME
- HELP
- RULE CREATION
- MISSING RULE DETAILS
- CONFIRMATIONS
- CORRECTIONS

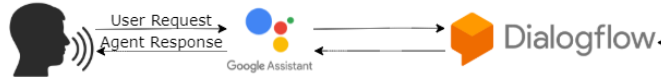


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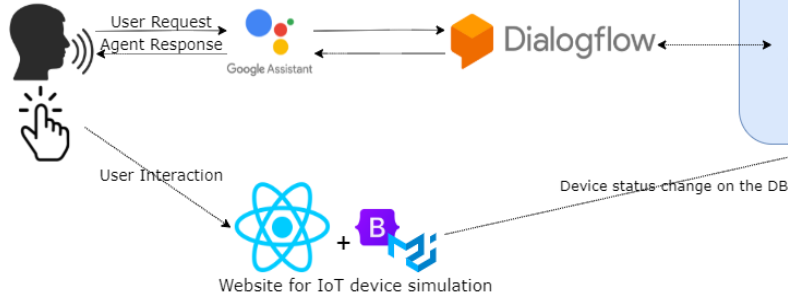


# DESIGN & IMPLEMENTATION

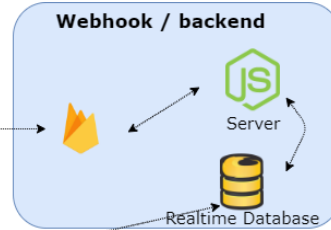
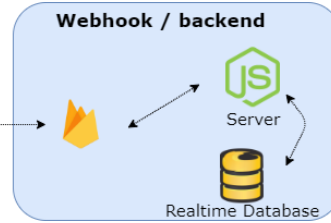
## Prototype architectures



High-level architecture of the full-vocal prototype



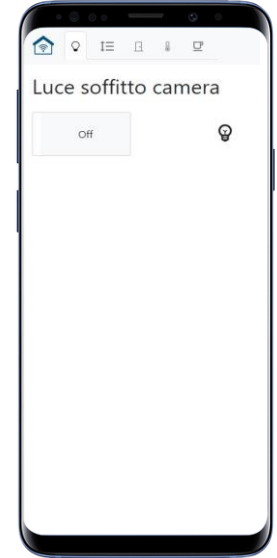
High-level architecture of the multimodal prototype



## Interfaces



Sample dialog from the Google Action of full-vocal prototype



Bedroom light switch simulation



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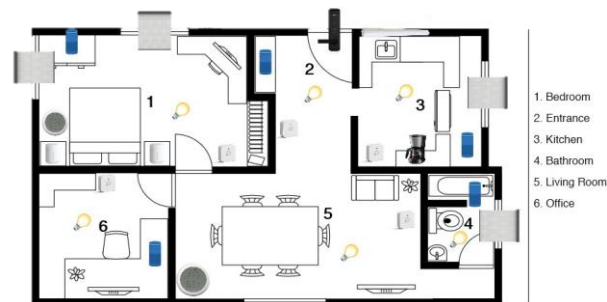
# EVALUATION

## Test participants

Participant	Age Range	Job Sector	Familiarity with Voice Assistants
P1	48-52	Health and Social care	X
P2	53-57	Health and Social care	✓
P3	23-27	Health and Social care	✓
P4	23-27	Health and Social care	✓
P5	53-57	Housewife	✓
P6	53-57	Engineering and manufacturing	✓
P7	23-27	Health and Social care	X
P8	23-27	Teacher training and education	X
P9	23-27	Teacher training and education	X
P10	23-27	Health and Social care	X

## Within-subject design

## Smart home simulation



## Six tasks: each task represents a real situation to solve through the creation of a rule.



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# EVALUATION

## Usability test results

### Evaluation metrics

- Time on Task
- Task completion
- Error Metrics
- Subjective Measures
- System Usability Scale

Avg	Task 1		Task 2		Task 3		Task 4		Task 5		Task 6	
	Pr1	Pr2	Pr1	Pr2	Pr1	Pr2	Pr1	Pr2	Pr1	Pr2	Pr1	Pr2
	40s	56s	39s	58s	37s	48s	30s	71s	41s	54s	33s	59s

### Task execution times

Prototype	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Total
Pr1	100%	40%	80%	50%	100%	90%	76.7%
Pr2	100%	100%	90%	90%	100%	100%	96.7%

### Task completions

- The average times of tasks have been longer with Pr2 than Pr1.

- Task 2 and Task 4 were problematic with Pr1.





# EVALUATION

## Usability of conversational agents

- SUS scores determine a “good” usability
- Failures in the completions did not affect the perceived usability.

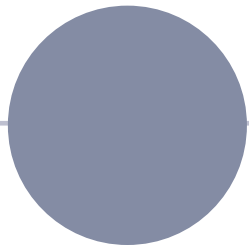
SUS score		
	Pr1	Pr2
Avg	71.5	73.3



# CONCLUSIONS & FUTURE WORKS

- The creation of personalization rules can be natural and effective via voice.
- Smart speakers are generally considered simple entertainment items. Novel approaches to creating even complex scenarios can have a certain impact on the home environment possibilities of personalization.
- Future work could expand the functionality of the developed voice applications by allowing users to configure even more complex rules.
- Further reasoning in the study context could consider other novel approaches for smart homes personalization through conversation.





**Thanks for  
the attention!**

*Questions?*



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