MyrrorBot: a Digital Assistant Based on Holistic User Models for Personalized Access to Online Services (*)

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Personal Digital Assistants (PDAs)

Contents analysis

Speech Recognition

**Smart Services**

Recommendation

Meta Layer of Intelligence

HUM (**holistic user modeling)** is a comprehensive representation of the user, which is based on seven different facets, that is to say, *demographics data, interests, physical states, psychological traits, behaviors, social connections, affects and knowledge and skills*. Ina ddition we decided to collect when possibile also user's health data.

Myrror: a platform for querable holistic user modeling *
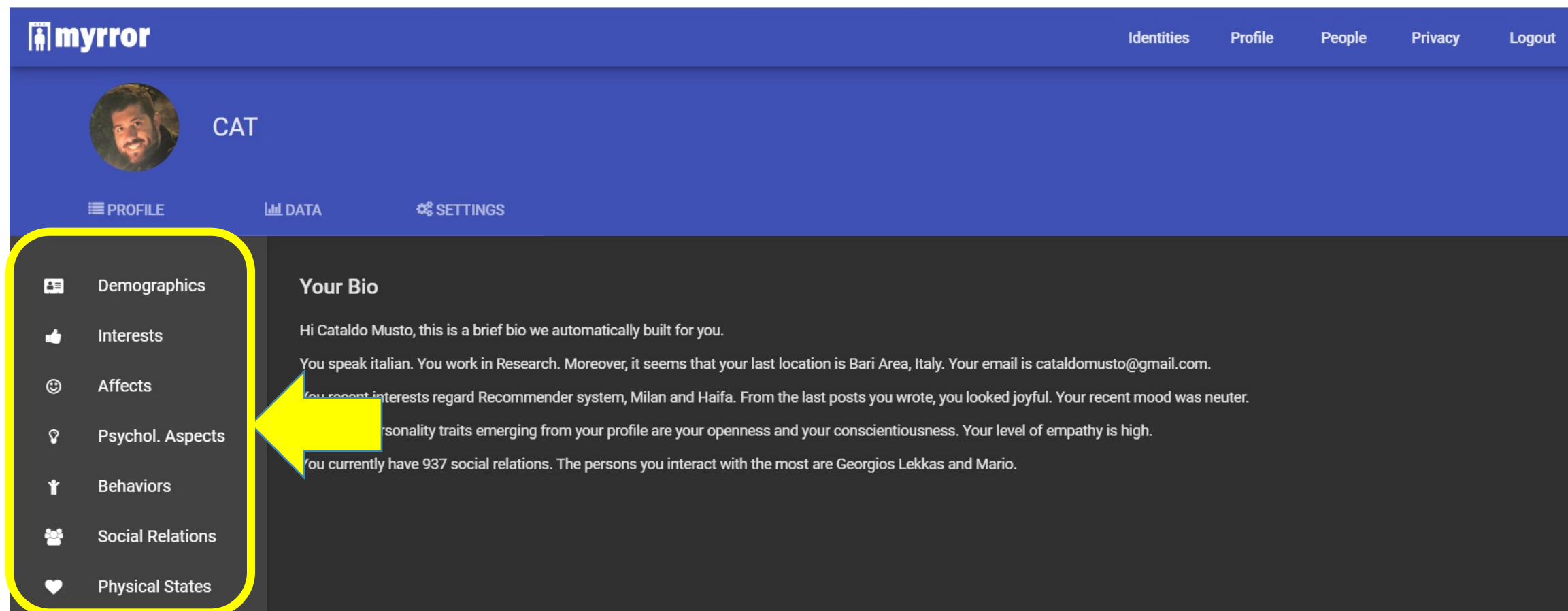
This characteristic, inspired by the popular paradigm of Quantified Self and fostered by recent regulations as the European GDPR, is supposed to make the personalization process more *transparent.*

(*) Musto, C., Polignano, M., Semeraro, G. *et al.* **MYRROR: a platform for holistic user modeling.** *User Modeling and User-Adapted Interaction* (2020).

Contribution

Personalization

We propose a a strategy to provide **personalized** access to the online services available in a PDA
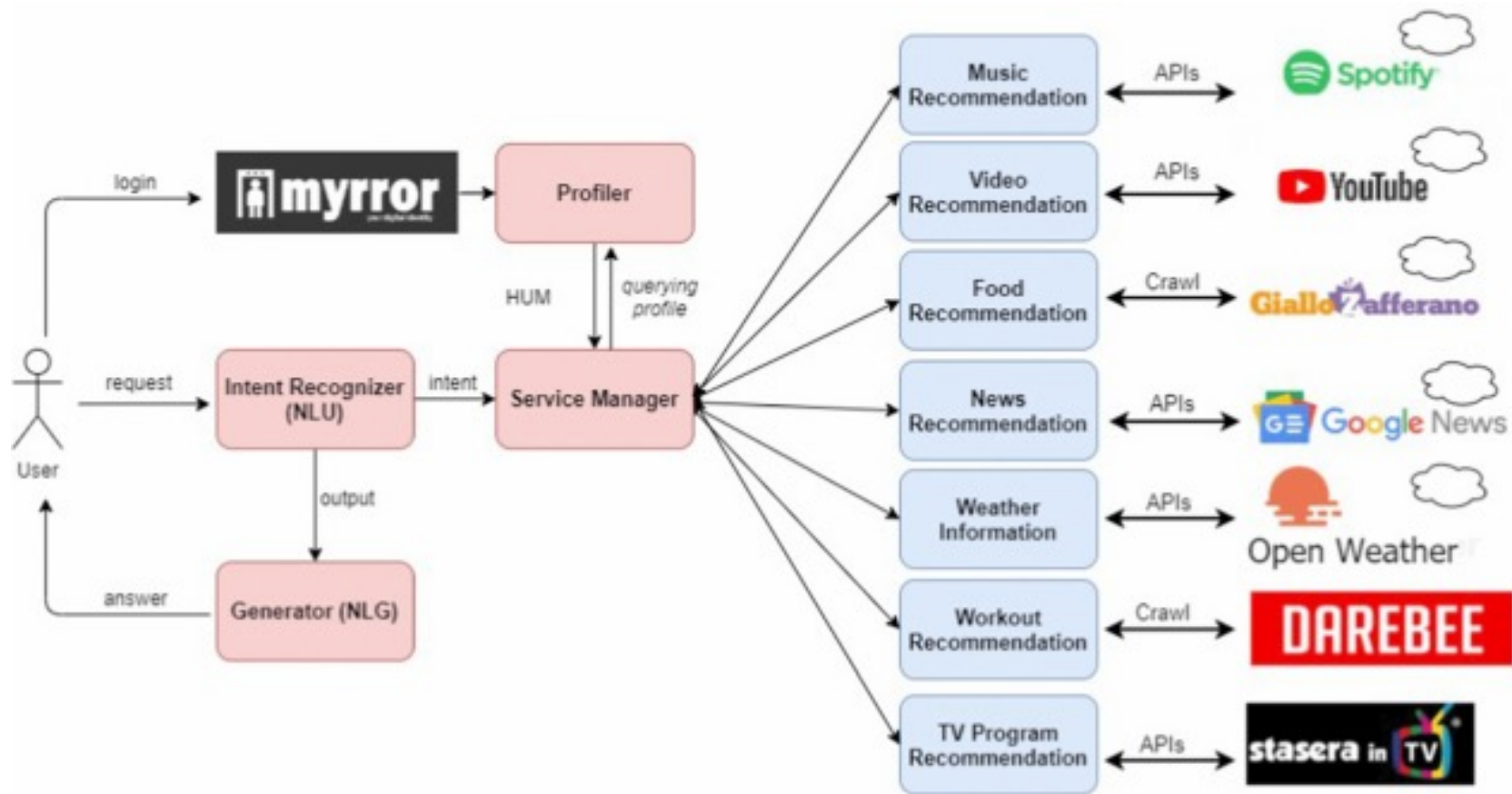
Conversational agent

We validate our approach by designing a modular PDA that allows the users to interact with such personalized services and to query their own profiles.

Queryable user model

This can be useful to increase users' self-knowledge and self-awareness and to make personalization process more transparent

User Study

We investigated both qualitative (users' acceptance of the system, usability) as well as quantitative (time required to complete basic tasks, effectiveness of the personalization strategy) aspects of the system.
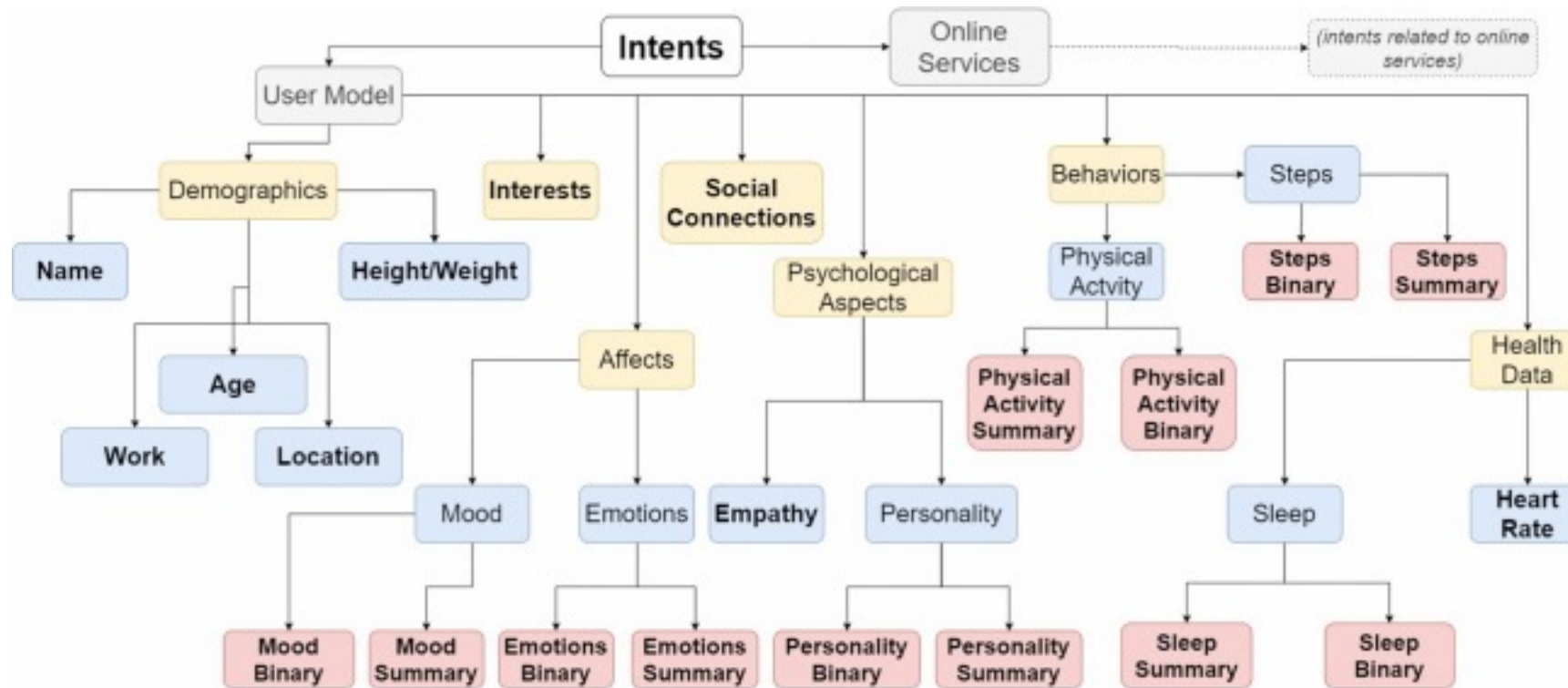
Architecture of Myrrorbot

MyrrorBot is a conversational agent built on top of Myrror, based on HUMs able to answer to natural-language requests concerning the information encoded in the user profile.
It can provide personalized services Alexa-like (Music, News, Recipes, etc.)

INTENT RECOGNIZER

Every time a user interacts with PDA is asking to fulfill a particular information need. Each information need can be expressed through several utterances, thus it is necessary to implement a component whose goal is to:
(i)   understand the *meaning* of each request expressed by the user;
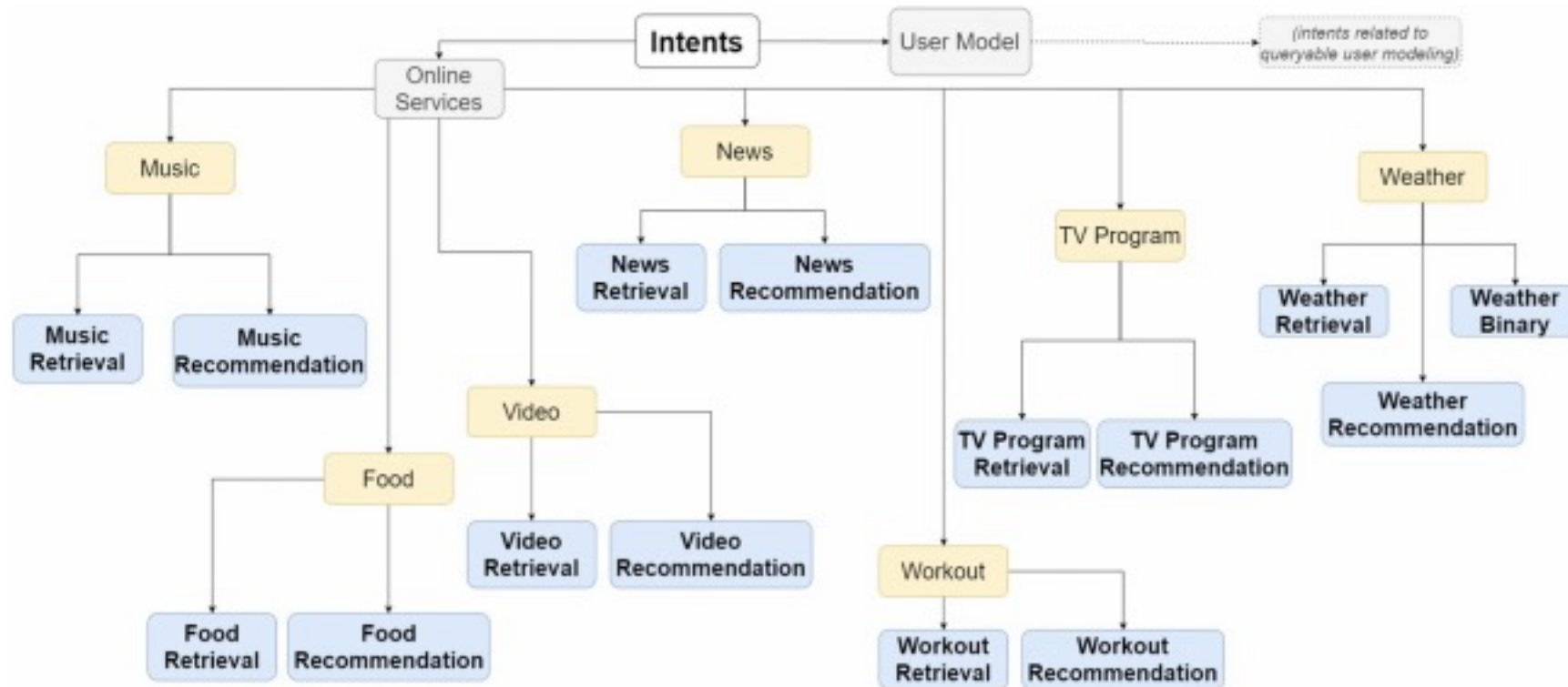(ii) forward such information to the module that dispatches the request to the correct service.
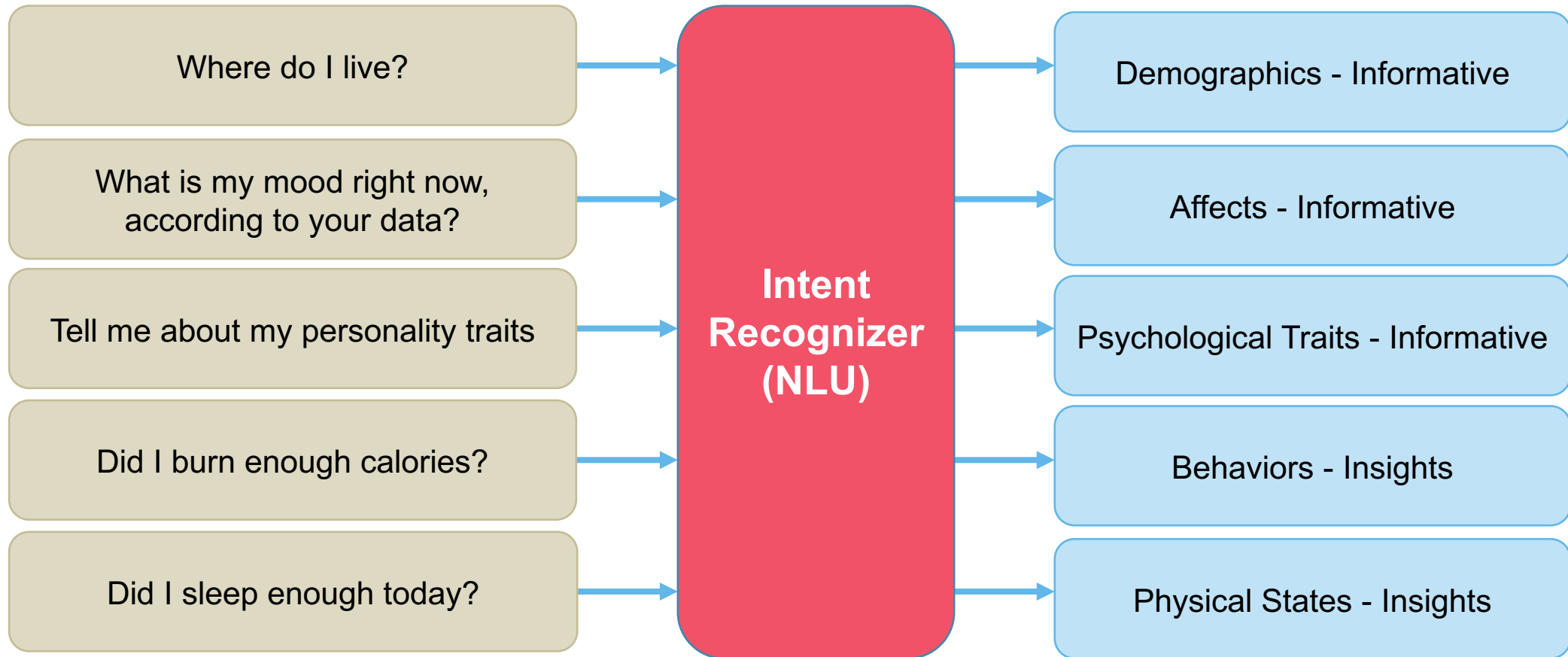
Intent Recognizer

Every time a user interacts with PDA is asking to fulfill a particular information need. Each information need can be expressed through several utterances, thus it is necessary to implement a component whose goal is to:
(i)   understand the *meaning* of each request expressed by the user;
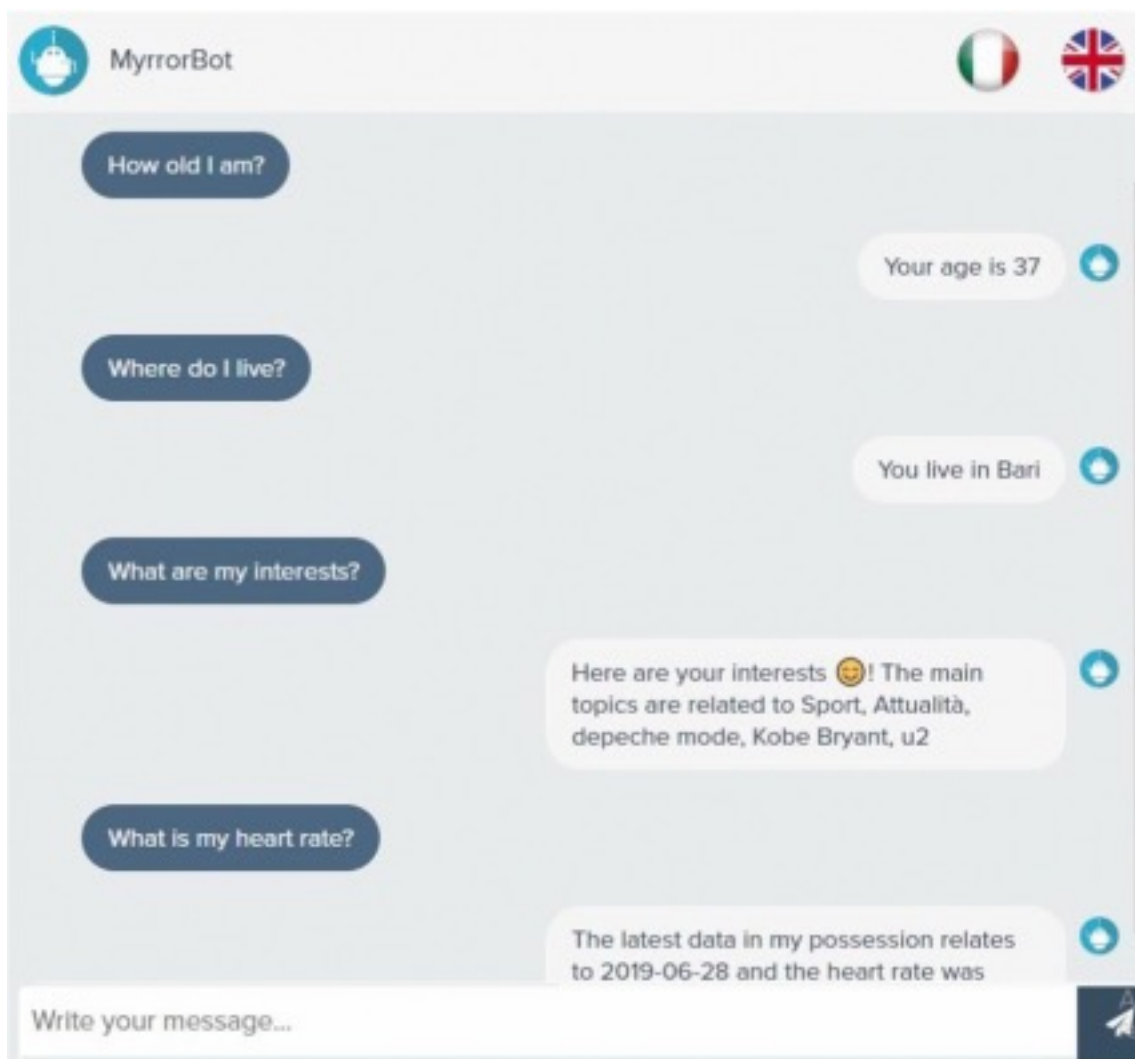(ii) forward such information to the module that dispatches the request to the correct service.

INTENT RECOGNIZER @WORK

Where do I live?		Demographics - Informative
What is my mood right now, according to your data?		Affects - Informative
Tell me about my personality traits	**Intent Recognizer (NLU)**	Psychological Traits - Informative
Did I burn enough calories?		Behaviors - Insights
Did I sleep enough today?		Physical States - Insights

MyrrorBot: Generator

The Generator module **produces a natural language answer** that fulfill user's information need.

We have split the answers into **services-related** and **user model-related** answers. Of course, user model-related intents are available only for the users who have an active Myrror profile.

In particular, each answer is based on a template that consists of a *fixed* part, which is the same for all the users, and a *dynamic* part, which depends on the output of the services.
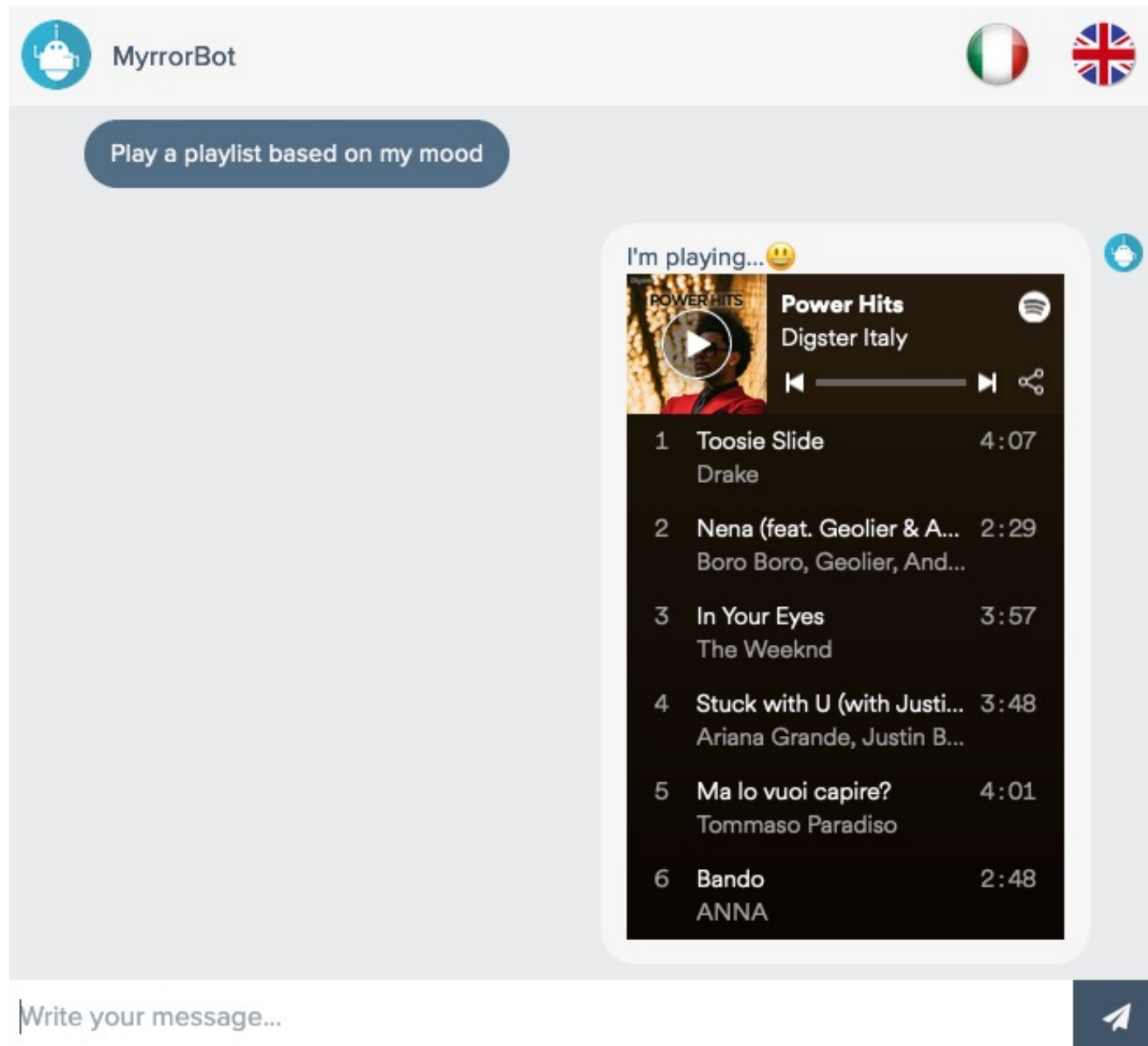
MyrrorBot

Music Service

1. strategy based on user preferences
2. strategy based on user's characteristics
3. strategy based on user's emotional state

	Physical activity	
Age range	Limited	Frequent
≤ 20	Pop/Rap	Punk/Metal
$20 < x < 50$	Relax/Romantic/Blues	Electronic/Summer/Rock
≥ 50	Classic/Jazz	Aged/Folk

MyrrorBot

Food Service

Logged users will receive personalized recipes that will take advantage of the information that is available in HUMs such as *height, weight, mood, amount of sleep, and amount of physical activities*.
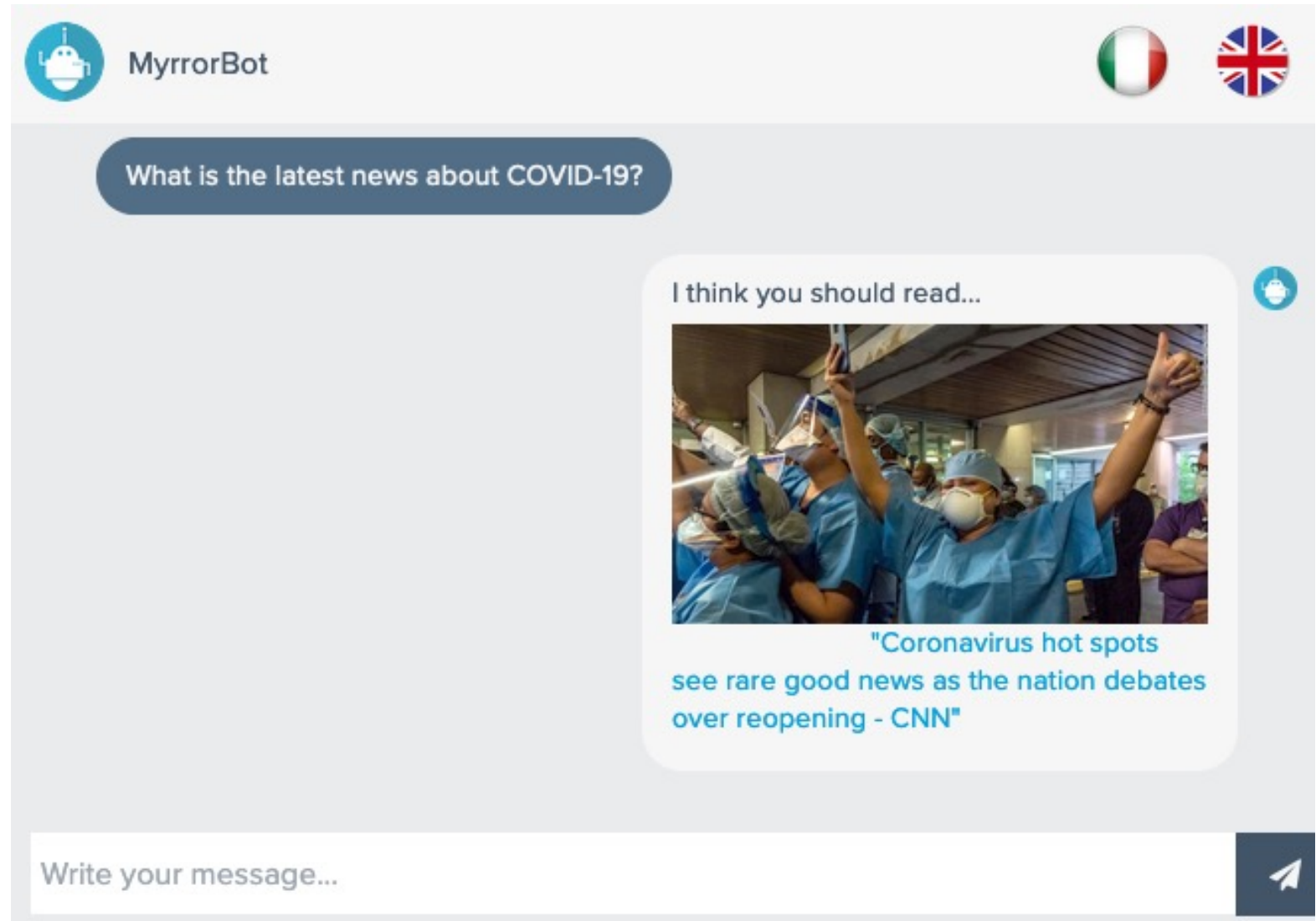
MyrrorBot

News Service

The user can request the latest news about a particular category (e.g., Business, Health, Entertainment, Technology, Science, Sports) or about a particular topic (e.g., news discussing "Coronavirus").
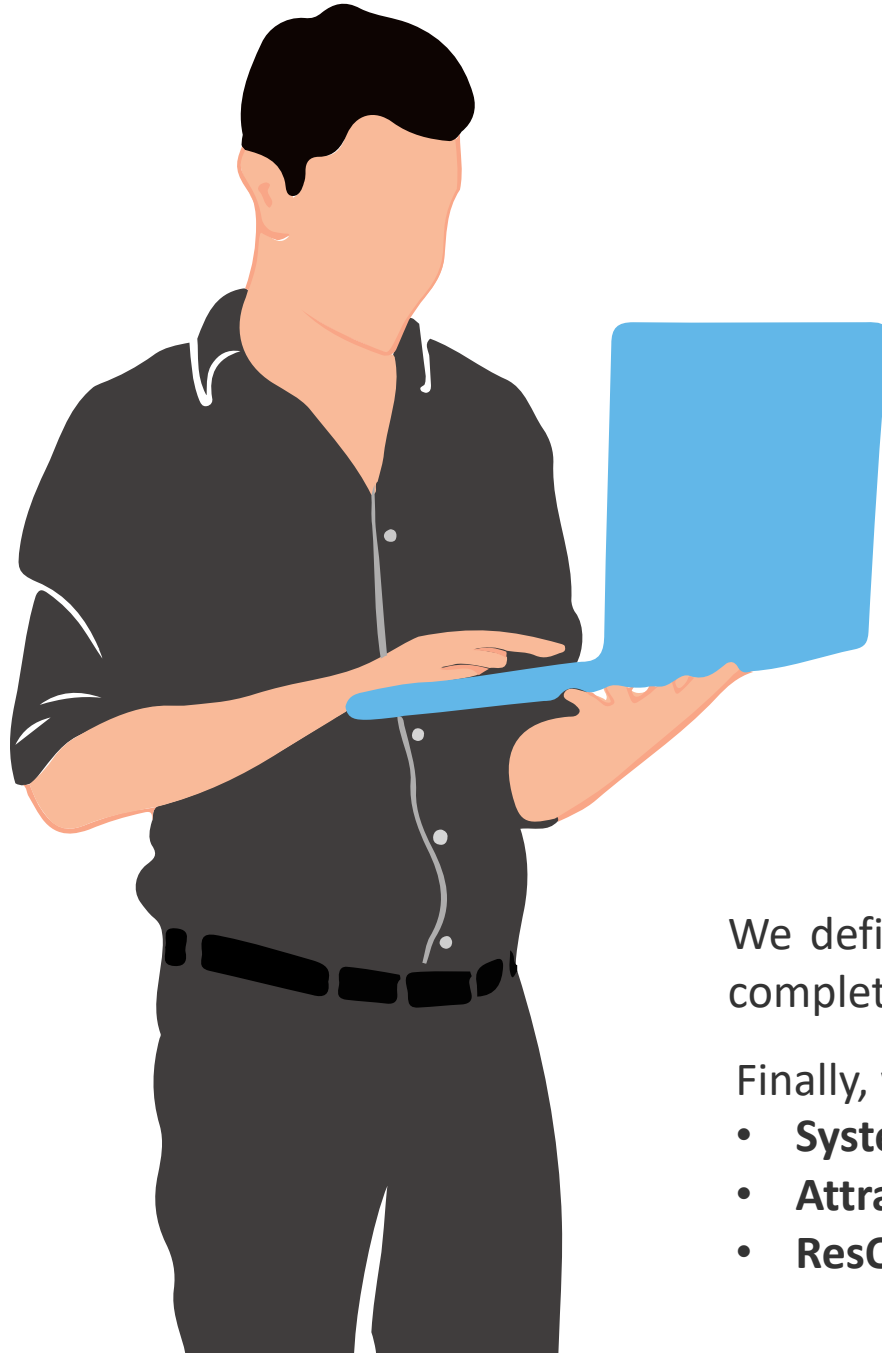
MyrrorBot

Workout Service

10 different training programs are currently available in MYRRORBOT: *cardio, high intensity (hi-it), combat, strength, wellness, stretching, yoga*, and exercises focused on *abdomens, upper body, and lower body parts*.

EXPERIMENTAL EVALUATION

We carried out a **user study (N=76)** and we investigate:

1. How effective is MYRRORBOT at supporting the users in their daily tasks or at accessing personal information stored in their profiles? *(Research Question 1)*

2. How accurate and satisfying are the recommendations based on HUMs, which are available in MYRRORBOT *(Research Question 2)*

3. What is the opinion of users regarding the overall usability and ease of use of the system? *(Research Question 3)*

We defined a set of 24 tasks to be carried out, and we asked the participants to complete them by using MYRRORBOT.

Finally, we asked the users to fill in three post-usage questionnaires.
- **System Usability Scale**
- **AttrakDiff**
- **ResQUE**

EXPERIMENTAL RESULTS

Service	Task	Baseline	MyrrorBot	Gap
Music	*Find a song by U2*	11.95	**10.52**	-11.96% $p < 0.001$
	Find a playlist for a party	16.37	**11.55**	-29.44% $p < 0.001$
Video	*Search for a video about Juventus*	14.66	**12.64**	-12.06% $p < 0.001$
News	*Search for an article about technology*	16.68	**12.17**	-27.03% $p < 0.001$
Food	Search for a lactose-free recipe	17.14	**13.22**	-22.87% $p < 0.001$
	Search for a second course with chicken	21.32	**13.75**	-35.51% $p < 0.001$
Weather	Ask for the weather in Bari	13.41	**12.61**	-5.96% $p > 0.05$
Workout	*Search for a Yoga training*	12.79	**7.76**	-39.32% $p > 0.001$
TV-Program	*Search for a TV Program for tonight*	10.20	**9.32**	-8.62% $p > 0.05$

We can state that the highest gaps are noted for tasks related to *complex information needs*, such as searching a particular playlist, searching for a particular recipe and search for a specific training.

EXPERIMENTAL RESULTS

Percentage of Positive Feedbacks: HUM-based Recommendations vs. Guest

Task	HUM	Guest
Music Recommendation	**84.2%**	65.7%
Video Recommendation	**73.6%**	60.5%
News Recommendation	**81.5%**	68.4%
Food Recommendation	**77.6%**	71.0%
Weather Information	**100%**	61.8%
Workout Recommendation	**92.1%**	63.1%
TV-Program Recommendation	**89.4%**	86.8%

Question	HUM	Guest
"The items recommended to me match my interests"	**81.5%**	63.1%
"The recommender systems helped me discover new products"	**68.4%**	60.5%
"I understood why the items were recommended to me"	**78.9%**	71.0%
"Overall, I am satisfied with the recommender"	**94.7%**	68.4%
"I will use this recommender again"	**77.6%**	60.5%

Scores represented the sum of "Agree" and "Completely Agree" answers to the questions.

It should be pointed out that the gaps are particularly large when the recommendation strategy is based on a richer set of personal information, as it happens for *workout* recommendation and *music* recommendation.

Experimental Results

Usability Evaluation of the System Inspired by SUS

Metrics	Question	MyrrorBot			Myrror			Gap
		% Comp. Agree	% Agree	% Others	% Comp. Agree	% Agree	% Others	
Learning Curve	*"I became familiar with the system very quickly."*	**51.3%**	38.2%	10.5%	35.9%	**44.2%**	19.9%	**+9.4%**
Interaction	*"It was easy to communicate with the system and to formulate my requests."*	40.8%	**48.7%**	11.8%	29.4%	**43.1%**	27,5%	**+15.7%**
Accuracy	*"The system provided me with the answers I needed."*	**55.3%**	35.5%	9.2%	**55.0%**	31.9%	13.1%	**+3.9%**
Daily Use	*"I would use the system for my daily tasks."*	28.9%	**40.8%**	29.2%	25.4%	**40.1%**	34.5%	**+5.3%**
Switching	*"I would use the system instead of a web platform"*	**40.8%**	**40.8%**	18.4%	n.a.			

"Agree" and "Completely Agree" count the answers equal to 4 and 5 of 5. "Others" aggregates the remaining answers. Gap refers to the difference of the sums of "Completely Agree" and "Agree" answers between MyrrorBot and Myrror.

The users were in general very satisfied with their experience with the new natural language interface, since almost 90% of the participants stated that they received the answers they were looking for.

Conclusion and Future Work

- In this article, we presented MYRRORBOT, a personal digital assistant that provides users with personalized access to online services. The architecture we propose is based on an *intent recognizer* that exploits Google DialogFlow to automatically interpret users' requests.

- The experiments showed a significant gap in *task completion time* and *recommendation accuracy* when natural language interfaces and holistic user models were adopted, and this finally confirmed the effectiveness of the proposed method.

As future work, we will first extend the set of the available services to support the users in a broader range of tasks. We will also improve the architecture of the system by including a dialog state tracker that keeps track of the requests of the user during a single session, to make the interaction even more effective and satisfying.

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https://github.com/orgs/swapUniba