# ETSI TR 103 875-2 V1.1.1 (2023-03)

TECHNICAL REPORT

**User Centric approach in Digital Ecosystem;**
**The Smart Interface;**
**Part 2: Smart Identity: A Proof of Concept**

Reference

DTR/USER-0053

Keywords

cybersecurity, interface, QoS, user

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# Foreword

This Technical Report (TR) has been produced by ETSI Special Commitee User Group (USER).

The present document is part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.1].

# Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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# Introduction

The present document is associated with a demo of the Smart Identity Proof of Concept (see annex A).

# 1 Scope

The present document demonstrates the feasibility of the Smart Identity as it is defined in ETSI TR 103 875-1 [i.1].

It defines, for a specific use case (e-health), the Smart Identity (ID) and provides an associated Proof of Concept (PoC).

# 2 References

## 2.1 Normative references

Normative references are not applicable in the present document.

## 2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 103 875-1: "User Centric Approach in Digital Ecosystem; The Smart Interface; Part 1: Smart Identity: user digital clone".

[i.2] Workbook N°1: "Digital identities". Personal Information Values and Policies Chair. Mines Telecom Institut.

[i.3] IEEE 802.11™: "IEEE Standard for Information Technology -- Telecommunications and Information Exchange between Systems -- Local and Metropolitan Area Networks -- Specific Requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the following terms apply:

**deep learning:** type of artificial intelligence where the machine is able to learn by itself (unlike execute rules predetermined)

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI Artificial Intelligence
API Application Programming Interface

| | |
|---|---|
| DB | Database |
| DNA | DeoxyriboNucleic Acid |
| IBAN | International Bank Account Number |
| ID | Identity |
| ML | Model Language |
| PoC | Proof of Concept |
| UML | Unified Modeling Language |
| XNLI | Cross-lingual Natural Language Inference |

# 4 Smart Identity: from definition to PoC design

## 4.1 Identity definition

The notion of identity is complex and polysemous. A definition is available in [i.2].

It depends on the point of view to consider what an individual can be, and on the use that the Smart ID want to make of this identity.

It is possible to identify 3 domains of identification which are cumulative:

1) Civil and legal identity

   This identity traditionally and mainly consists of the following elements:

   - surname, first name, gender, nationality, filiation (relationships), date and place of birth.

   This identity is deemed to be stable throughout life.

2) Biological identity: Height, weight, eye color, retina, fingerprint, DNA

   Some attributes of this identity can be used to formally identify a person, in addition to the civil identity.

3) Social and personal identity

   It is made up of many sociological and psychological elements: place of residence, profession, standard of living, hobbies, tastes, friends, beliefs, commitments, etc.

   It is built, it evolves and is enriched during life, it is never fixed.

These are identities that can be described as objective or suffered (civil, legal, biological). But there are also subjective and desired identities, corresponding to the way an individual decides for themselves how they intend to present themselves to others. It is a kind of narrative identity. Social networks and the use of pseudonyms and avatars in cyberspace are a tangible manifestation of this. It can be noted in this regard that in the digital world it is possible to have several identities.

The Smart ID is created with:

- The attributes of the objective identity of the person.
- The available resources (equipment, services).

It considers the sequence of the user roles in space-time: objectives, activities, tasks, schedule.

It takes care of the information used to make awareness choices.

More simply, the Smart ID is thus the representation of a person:

- What the user is
- What the user has
- What the user is doing

- What is the user's knowledge

## 4.2 From Identity to User Profile

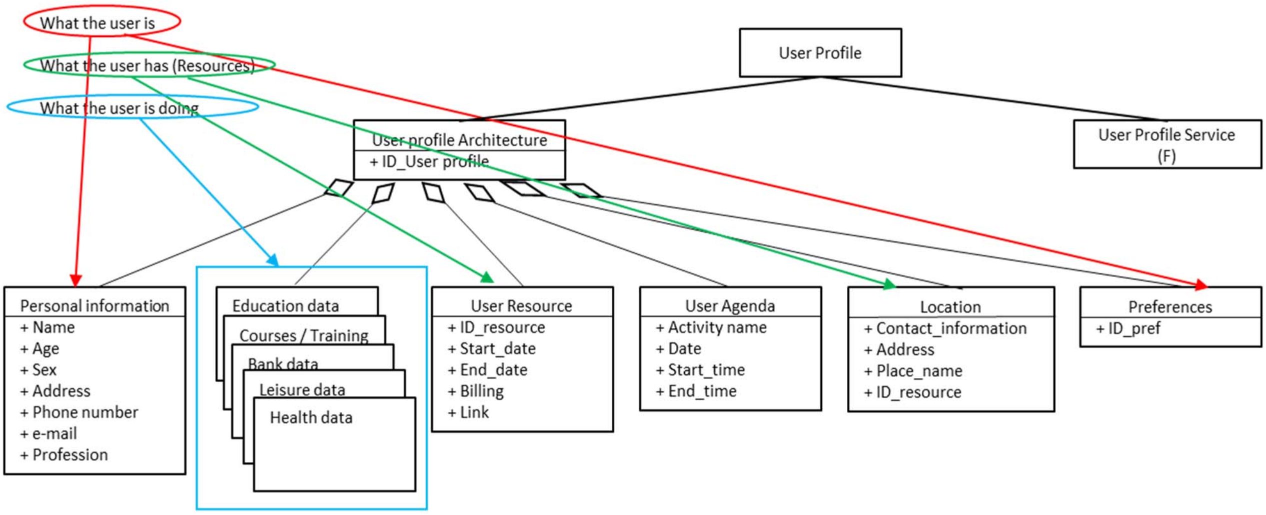


**Figure 1: Relationship between Identity definition and user profile model**

The "user profile" is therefore the informational representation of the user's identity (figure 1) in the digital ecosystem, including:

- Personal information:
  - Legal identity
  - Identifications
  - Roles (worker, patient, parent, benevolent, etc.)
- User centric characteristics that impact configurations:
  Actions according to:
  - Preferences
  - Space-time (agenda)
  - Location
- The resource description according to the location:
  - Internal resources (equipment, network, services)
  - External resources (equipment, network, services)

More precisely the personal sheet/template (figure 2) identity can be as following:

| PERSONAL INFORMATION |
|---|
| Social ID |
| Social ID |
| Last Name |
| First name(s) |
| |
| Gender |
| Date of birth |
| Country of birth |
| City of birth |
| Country of birth |
| Nationality (s) |
| Profession |
| Personal contact information |
| Address |
| Postcode |
| Town or city |
| Country |
| Mobile phone (s)/landline (s) |
| E-mail address (es) |
| Professional contact information |
| Business address |
| Postcode |
| Town or city |
| Country |
| Mobile phone(s)/landline(s) |
| E-mail address(es) |
| Other |
| Residence permit |
| Visa |
| Passport |
| Identity Card |
| Licences (e.g. Driving licence) |

**Figure 2: Personal information template**

Moreover, with the evolution of paradigms, the **relationship** between the user and the system is now an **N to N** relationship meaning that the user has N profiles according to the role (figure 3).

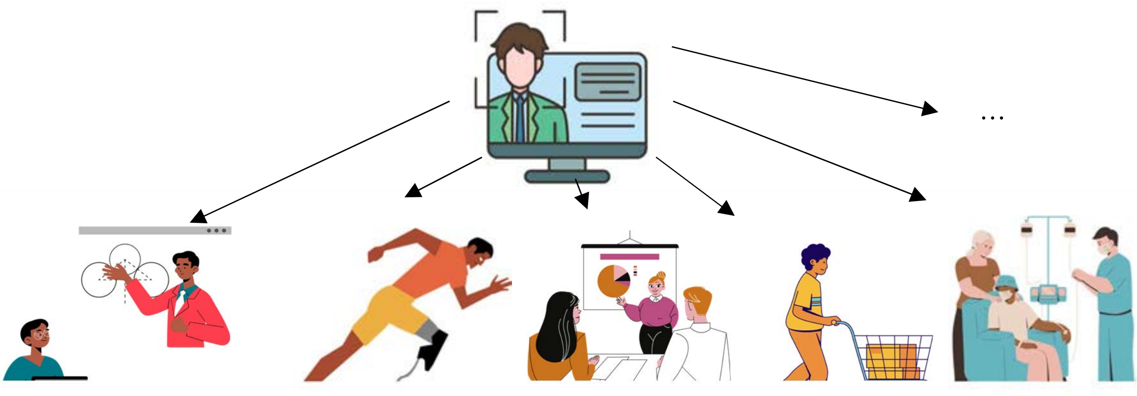


**Figure 3: N user potentials roles**

The instantiation of the User Profile model will give the complete picture of the user according to their roles in space-time, preferences, and location.

## 4.3 Knowledge base for Smart Identity: Potential profile

The user identity also takes care of "what the user knows".

This is why the knowledge base also includes the characteristics of the different fields of activity known to the user. This is why, it will be said that he acts in all awareness.

What user knows: potential profile (information allowing choice to be made awareness).

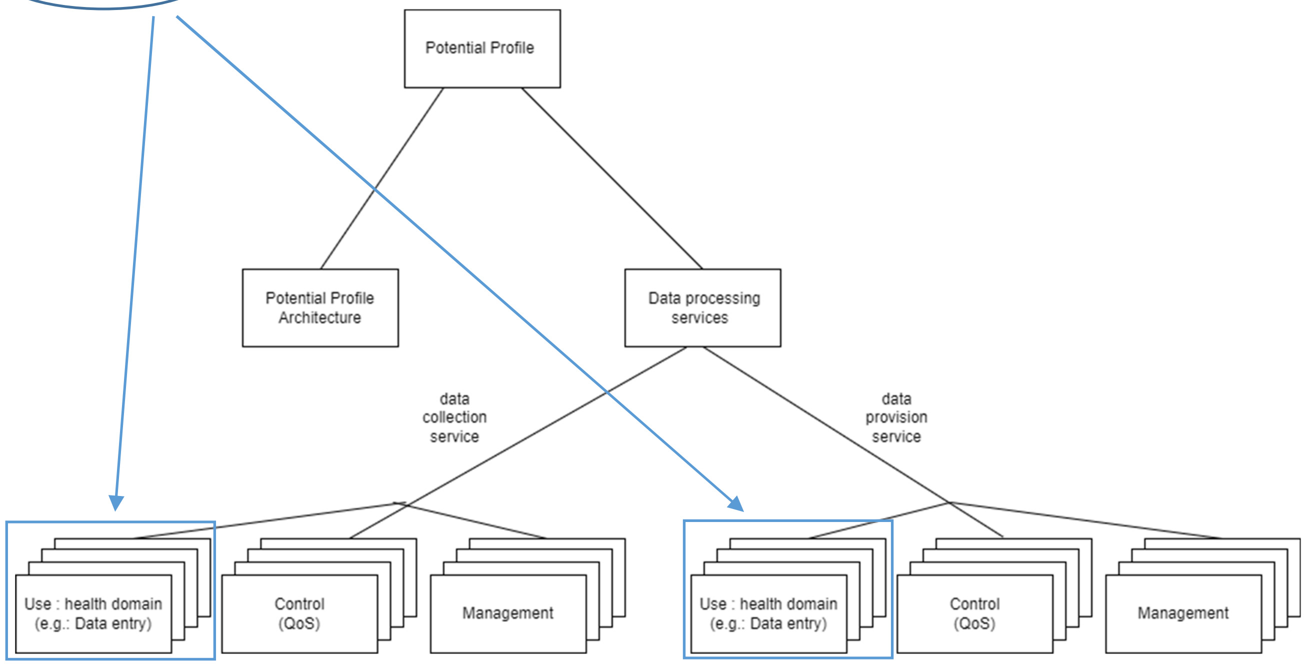


**Figure 4: Knowledge base**

Like any entity, the Potential Profile has an architecture and a service interface.

The first service consists of data collection (instantiation of the Potential Profile model) to store architecture information. The architecture of the Potential Profile enriches the architecture of the User Profile by informing all the areas relating to a temporal action.

The second service will be all the processing on data analysis in order to have additional decision-making information.

Each role played by the user requires data from each of the domains. That is, for each action the Smart ID needs cross-sectional data (figure 4). For example, when the user has a medical appointment, the profile will need the health domain and the finance domain, as with all actions that require payment.

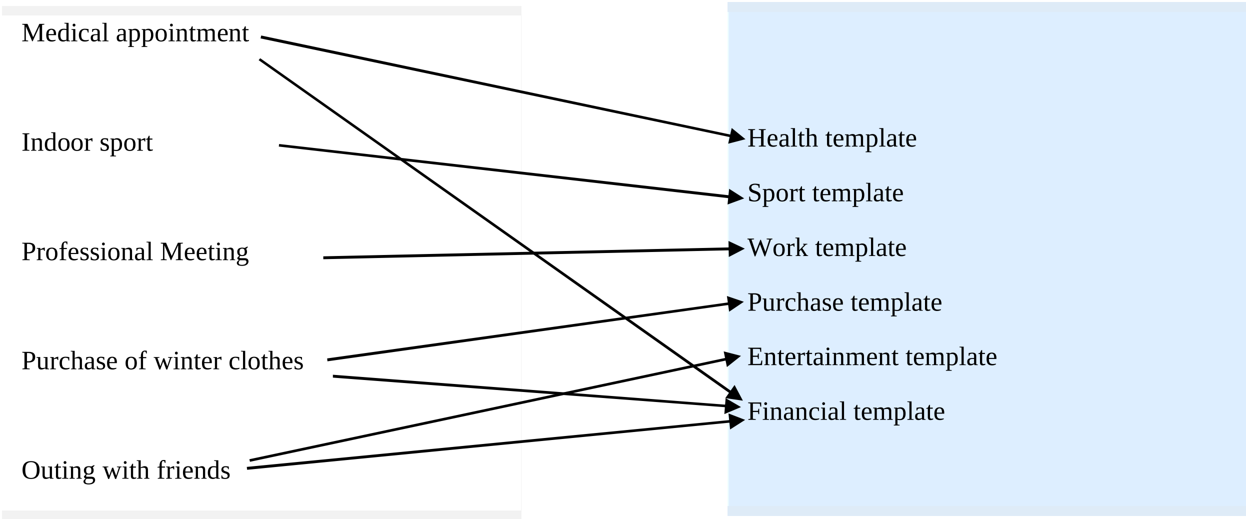


**Figure 5: Example of transversal data**

For the PoC it will need templates corresponding to the most common roles, that is to say the basic roles (figure 5) involved in areas such as health, work, finance, travel, etc.

| HEALTH TEMPLATE |
|---|
| Social security number<br>Mutual insurance (personal, professional, etc.)<br>Health information<br>General information<br>Weight<br>Height<br>Health parameters<br>Temperature<br>Pulse/heart rate<br>Oxygen saturation<br>Respiratory rate<br>Blood pressure<br>Medical record<br>Blood type<br>Rhesus<br>Vaccination booklet<br>Vaccination certificates (covid-19)<br>Current treatment(s)<br>Allergies<br>Last tests<br>Latest prescriptions<br>Medical appointments (past and future)<br>Doctor notes<br>Emergency contacts |

| TEMPLATE SPORT (well-being) |
|---|
| Membership card<br>Information<br>User behaviours<br>Time spent sleeping/in bed<br>Inactivity time<br>Number of steps<br>Distance (walking and running)<br>Stages climbed<br>Stability of walking<br>Other<br>Calories<br>Information sheet<br>Type of subscription (classic, premium)<br>Duration of subscription<br>Wellness goal(s) |

| TEMPLATE TRAVEL |
|---|
| Information<br>Tickets/tickets for transport<br>Ticketing<br>Flight/train/bus tickets<br>Advantage/discount card<br>Carpooling information<br>Name and contact of the driver<br>Departure time<br>Meeting point (departure)<br>Arrival point<br>Stay<br>Hotel/accommodation reservation |

| TEMPLATE WORK |
|---|
| Registration number<br>Access badge<br>Tickets/restaurant card<br>Professional file<br>Job function<br>Office<br>Department/service<br>Other<br>Employment contract/internship agreement<br>Pay slips |

| TEMPLATE EDUCATION |
|---|
| Personnel number<br>Student number<br>Education card<br>Student information<br>Education<br>Timetable<br>Teaching units<br>Documents<br>Graduations |

| TEMPLATE SHOPPING/PURCHASES |
|---|
| Information<br>Item preferences<br>Product size<br>Customer record by supplier<br>Customer number<br>Membership/loyalty card<br>Username<br>Gift card<br>Discount coupons<br>Ordering<br>Points<br>My addresses (delivery and billing)<br>My payment methods (credit card, multiple payments, etc.) |

| TEMPLATE DOMOTIC |
|---|
| Access card/key<br>Charges<br>Energy supplier<br>Hot and cold water<br>Heating<br>Maintenance costs<br>Green space<br>Common areas<br>Household waste collection tax<br>Connected house<br>Management of: security, access, lighting, temperature, fans, objects, etc.<br>Other<br>Lease agreement/certificate of residence |

| TEMPLATE FINANCIAL |
|---|
| **Bank information/current account** |
| **IBAN** |
| **Authorized overdraft** |
| **Bank card** |
| **Cheques** |
| **Transfers & direct debits** |
| **Savings (passbook)** |
| **Insurance** |
| **Home insurance** |
| **Life insurance** |
| **Loan(s)** |
| **Sponsorship** |
| **Other** |
| **Bank documents** |

**Figure 6: Common knowledge templates**

# 4.4 PoC Design

## 4.4.1 Data Collection

Data collection consists of filling in the Potential Profile, which includes User Profile data, data on the various user domain interest, and data from the services requested (e.g. weather, etc.), as well as data processing contributions.

## 4.4.2 SmartID: active profile

The intelligent user profiling process, after the collection of the user data, begins with the consideration of their user centric parameters (space-time, space-place and preferences), which constitute the system input data allowing the obtaining the active profile.

Then an identification of the activity and a classification in relation to the different domain will be made using artificial intelligence algorithms during the data processing phase. There will then follow a selection of templates that may correspond to the areas of user action during this time slot. For example, a medical appointment might require the health, finance, and travel templates.

The preferences will make it possible to finalize the personalization of the active profile (figure 7) and to select the user's preferred resources (equipment, networks, services) according to user location.

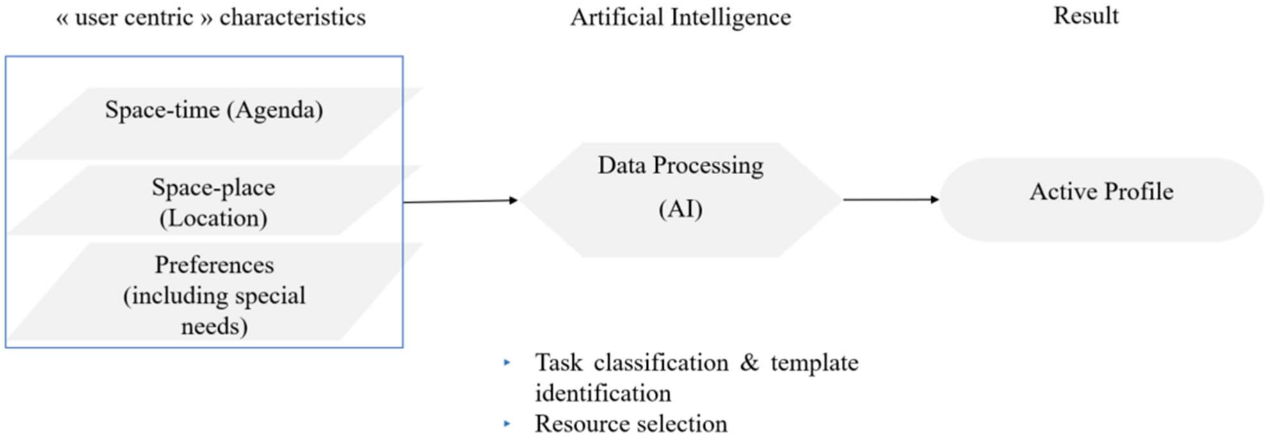


**Figure 7: Smart user profiling process and active profile procurement**

# 5 Data collection

## 5.1 User Profile service: data collection process

The dataset included a set of information allowing AI (deep learning) models to understand the challenge of Smart ID and to become familiar with user-centric characteristics.

Given that the objective is to have independent data of application services, a dataset using a relational database could not meet these linkage requirements.

The approach was to create a dataset written in Python® and containing key information, including the task, internal resources (equipment, networks, and services) by location, external resources and templates.

## 5.2 Knowledge base tools

The tools used to create the dataset to build and train Artificial Intelligence models are as follows:

Jupyter® Notebooks implementation is used, allowing to write programs in different languages.

"Python®" is a Programming language used for the dataset.

"Pandas™" is the Python® library to create datasets as dataframes.

## 5.3 Knowledge base

Figure 8 shows the draft of our dataset used to build and train the built deep learning models.

| | task | location | internal equipment | internal networks | internal services | external equipment | external networks | external services | information | templates |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | medical appointment booking | office | smartphone or computer | 802.11 | | equipment participating in the session | internet | web, health platform services | health insurance | health |
| 1 | book medical appointment | house | smartphone or computer | 802.11 | | equipment participating in the session | internet | web, health platform services | health insurance | health |
| 2 | medical appointment booking | outside | smartphone | 3GPP | | equipment participating in the session | internet | web, health platform services | health insurance | health |
| 3 | Go to doctor | outside | smartphone | 3GPP | set location | equipment participating in the session | internet | weather, get location | travel ticket | displacement |
| 4 | Consultation by doctor | at destination | smartphone | | | | | | health insurance, mutuals | health |
| 5 | Teleconsultation | house | smartphone or computer | 802.11 | Consultation reminder notification | equipment participating in the session | internet | health platform services | health insurance, mutuals | health |
| 6 | Consultation fee payment | house | smartphone | 802.11 | notification for payment validation | equipment participating in the session | internet | banking services | credit card | finance |
| 7 | Consultation fee payment | at destination | smartphone | | | | | banking services | credit card, health insurance, mutual funds | finance |

**Figure 8: Draft dataset used for Smart ID**

# 6 Data processing

## 6.1 Shaping the problem

Before using Artificial Intelligence algorithms, it is necessary to transform the input textual data (user-centric characteristics) into number vectors of the same size (embeddings) so that they can be understood by neural networks.

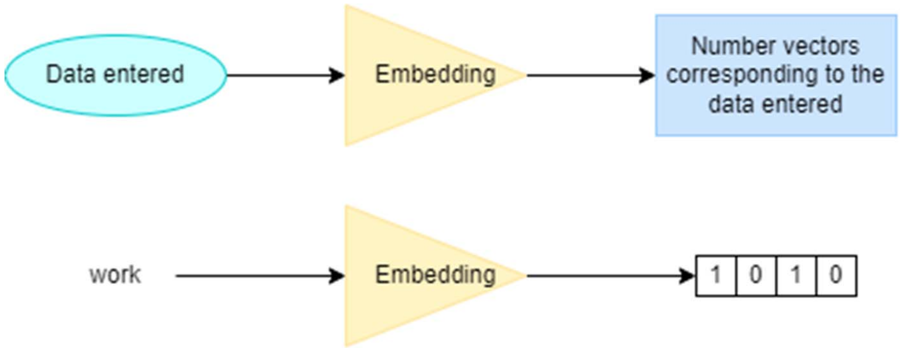


**Figure 9: Embedding generation**

The steps generally performed for this processing of textual data are as follows:

1) "Lowercase", to put all the characters of the sentences in lower case.

2) Remove punctuation, numbers, and special characters.

3) Remove phrases in English (or French, depending on the problem to be solved).

4) "Tokenization" to reduce the size of vocabulary needed to encode a message.

## 6.2 Resolution tools

For the Smart ID, the **Transformers** model and its **AutoTokenizer** library were used to pre-process the data presented in clause 6.1.

```
from transformers import AutoTokenizer,
```

**Figure 10: Line of code used to pre-process data**

# 7 PoC: use case presentation

## 7.1 User Story

As an example, the use case for the PoC is to consider the Provisional Agenda and Location of September 19, 2022, as presented in figure 11.

| | SCHEDULE | LOCATION |
|---|---|---|
| 15h - 17h | Team Meeting | **Office** |
| 17h15 - 18h | **(Travel)** | |
| 18h - 18h30 | **Preparation for the gym** | **House** |
| 18h45 - 20h | **Sports session** | **Nearest gym** |
| 20h15 - 21h | **Dinner** | **House** |
| 21h - 22h | **Purchase of autumn / winter clothes** | **Online** |
| 22h | **Rest** | |

**Figure 11: Day Program of September 19, 2022**

## 7.2 Potential Profile data

In the following example, it is 6 p.m. and the user has just returned home. Users would like to go for a workout and need to know if the weather allows them to go out, but also to find a gym close to their home.

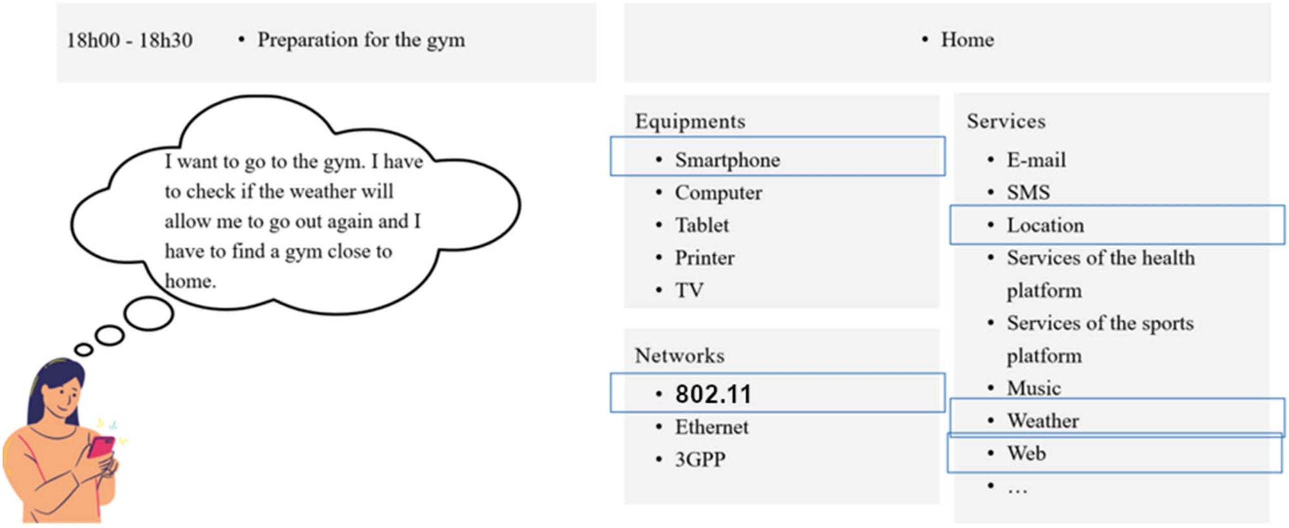


**Figure 12: Available Resources for the specific use case**

The resources available in the user's environment are shown in figure 12.

## 7.3 Active profile

To perform the tasks presented in clause 7.2, the user needs a terminal, network access and services.

Since the users are at home, they will choose:

1) the Smartphone as a terminal for mobility concerns;

2) Wi-Fi® (IEEE 802.11™ [i.3]), to save mobile data and to respect the environment;

3) weather, location, and web services.

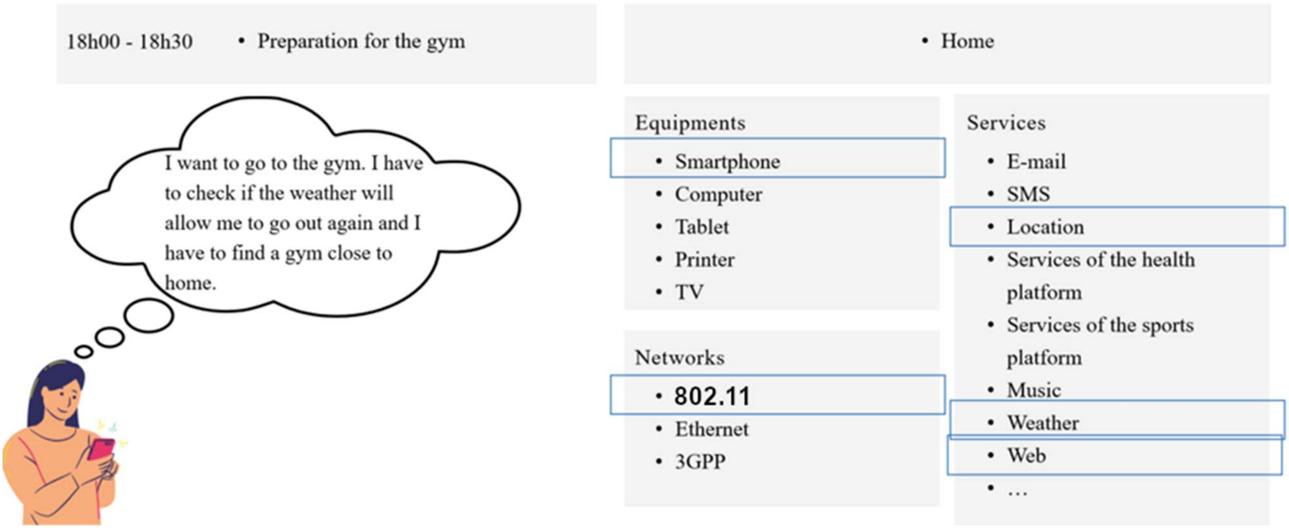


**Figure 13: Active user profile from 6 p.m. to 6:30 p.m.**

The active profile of the user from 6 p.m. to 6:30 p.m. at home is shown in figure 13.

# 8 PoC: realization (results)

## 8.1 Platform description

### 8.1.1 Activity diagram

The activity diagram is the representation of the behaviour of the system in the form of flows or sequences of activities.

Figure 14 shows the operations performed to process user data and build AI models relevant to Smart ID.

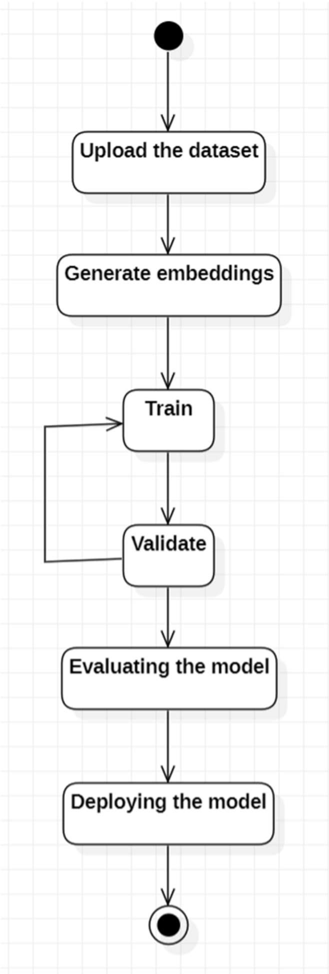


**Figure 14: Choosing the right AI model for Smart ID**

### 8.1.2 UML diagram of components

Figure 15 shows the UML diagram of the components of the Smart ID system. The data entered as text correspond to the tasks in the user's agenda. These are classified by the text classification component that will output the percentages of the different domains to which the task can belong to facilitate the choice of "templates".

Next, the semantic similarity component will browse the dataset to find an existing task that can be like the one the user wants to perform. The output of the semantic similarity component is therefore the set of textual data that are like the input data.

Finally, the prediction component will determine the resources required by the user to perform this task.

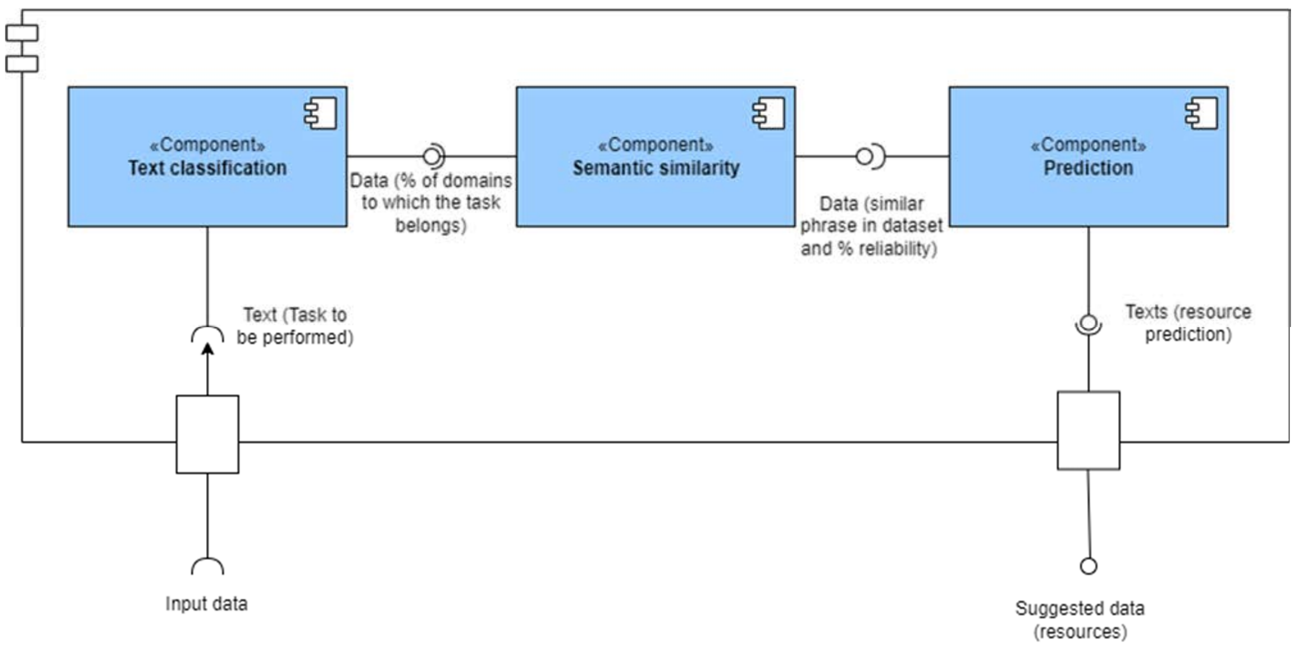


**Figure 15: UML diagram of system components**

## 8.2 Models building

### 8.2.1 Operating principle of Transformers

The Transformer is a deep learning model that uses attention by differentially weighting the importance of each part of the input data to increase its training speed.

The Transformer consists of two main components, namely: the encoder and the decoder and the connections between them (figure 16).

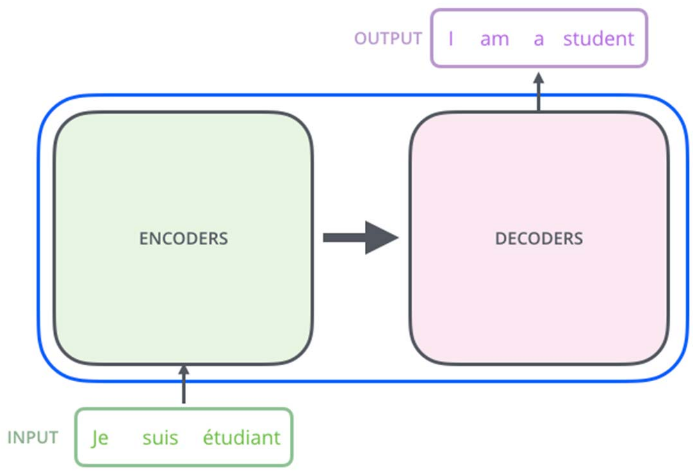


**Figure 16: Components of a transformer**

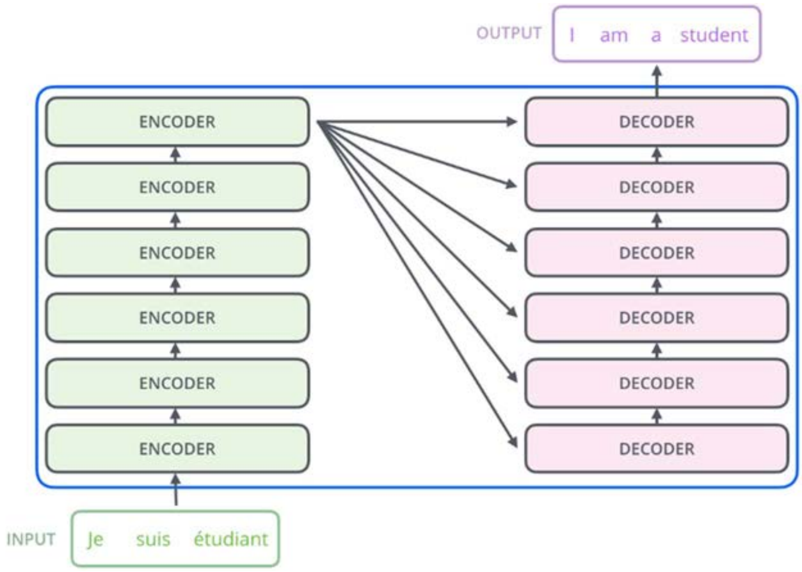


**Figure 17: Encoders - Decoders**

The **encoding** component is generally composed of six (6) encoders stacked on top of each other (figure 17).

The **decoding** component is composed of decoders stacked on top of each other of the same number as the encoding component.

The overall architecture of the transformer is shown in figure 18.

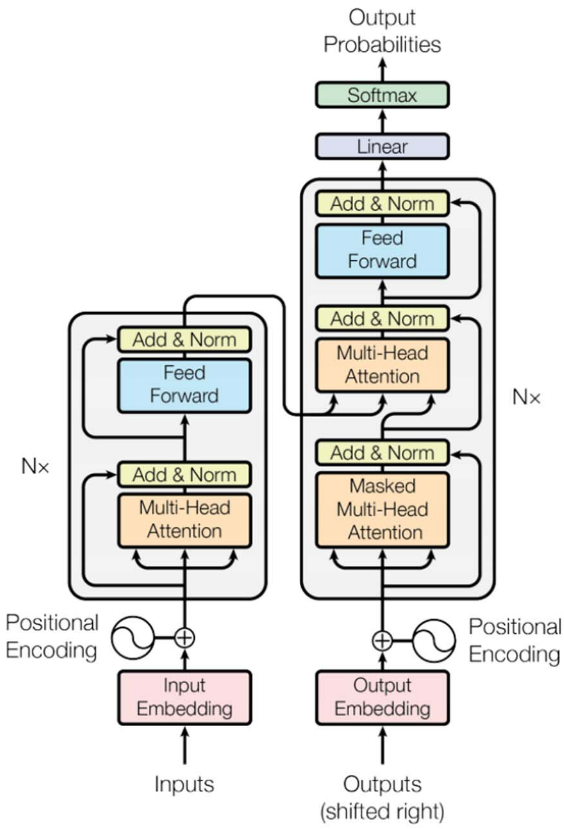


**Figure 18: Global transformer architecture**

In accordance with the overall architecture of the transformer (figure 18), there are three (3) attention mechanisms:

1) Self-Attention in the encoder
It is a layer that helps the encoder look at other words in the input phrase when encoding a specific word.

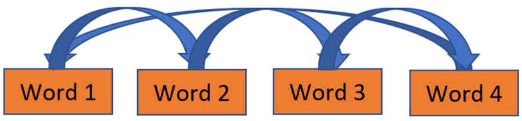


**Figure 19: Self-Attention Mechanism**

2) Self-attention with all previously generated elements in the input of the decoder (at the level of "Encoder-decoder Attention") to help the decoder focus on the relevant parts of the input sentence.

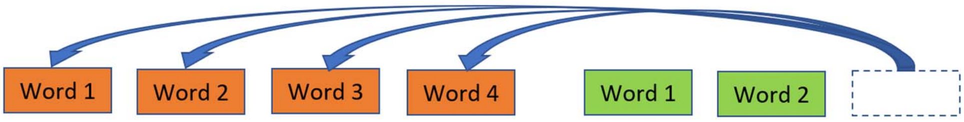


**Figure 20: Mechanism of "Encoder-Decoder Attention"**

3) "Masked" Attention between the element generated by the decoder and all the elements of the encoder. This mechanism can be used for text generation or simultaneous translation and is autoregressive.

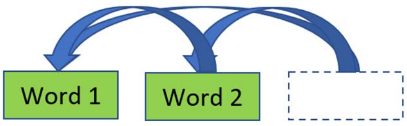


**Figure 21: "Masked Attention" mechanism**

## 8.2.2 Model used for Smart-ID

For the creation of AI models for Smart ID, a pre-trained neural network model based on Transformers was used. It is called **CamemBERT™.**

The Camembert™-Base-XNLI zero-stroke pre-trained transfer learning algorithm was used because classical machine learning algorithms did not give accurate results during training on the dataset.

**Camembert™-base-XNLI** is a transformer-based natural language processing model written in Python®. It was trained on XNLI (Multilingual Natural Language Inference) which was published by Facebook™. It is mainly used to determine the probability of a corpus of text belonging to a predefined class.

## 8.2.3 Similarity calculation

To obtain the similarity score between two (2) sentences, the system takes as input:

1) the reference phrase from the dataset;

2) the candidate phrase to be challenger (entered by the user).

Embeddings (number vector) are generated from this textual data and these will be used to calculate the cosine similarity (cosine similarity per word pair + linear regression) between sentences.

## 8.3 Choice of tools and technologies

To implement the Camembert™-Base-XNLI algorithm for data entry and resource prediction, the tools used are listed in table 1.

**Table 1**

| Tools/Technologies | Version | Role |
|---|---|---|
| Python® | 3.7 | The most widely used programming language for data analysis, ML and AI in general.<br>It is platform independent. |
| Transformers | 4.24.0 | Library for downloading and training pre-trained natural language processing models. |
| Tensorflow®-Text | 2.9.0 | It is a library of TensorFlow® to perform operations on texts for pre-processing. |
| Pandas™ | 1.3.5 | For managing datasets using dataframes |
| Google Colab® | 1.0.0 | A cloud service offered by Google®, based on Jupyter® Notebook and allowing to train ML models directly online, without the need to install anything. |

For a better visualization of the results of the main model, web interfaces have been developed with the Gradio API version 3.12.1. Gradio allows for deploying locally to test models.

## 8.4 Results

### 8.4.1 First Model Use Scenario

Before running the model corresponding to the first component of the Smart ID, the **pipeline** library was imported to link to the camemBERT™ pre-trained model. Then a classifier based on this model was defined.

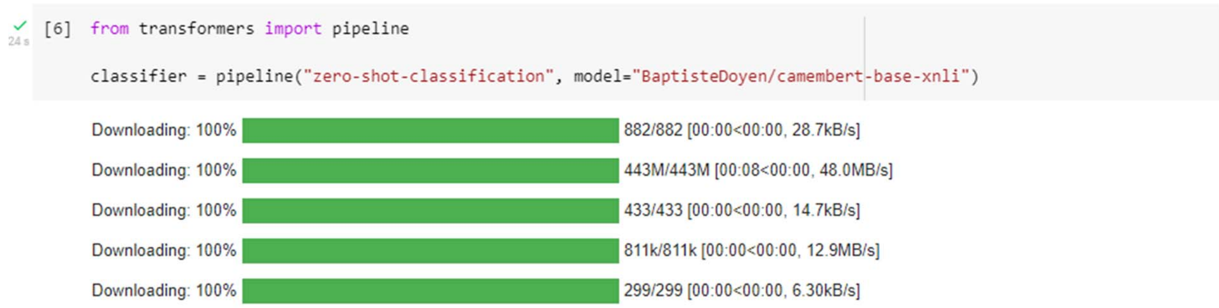


**Figure 22: Task classifier definition**

To test Model 1, the Gradio interface developed for this purpose is run. Then simply fill in the task to be executed as well as the templates that constitute here the candidate classes.

The behaviour of Model 1 is shown in figure 23.

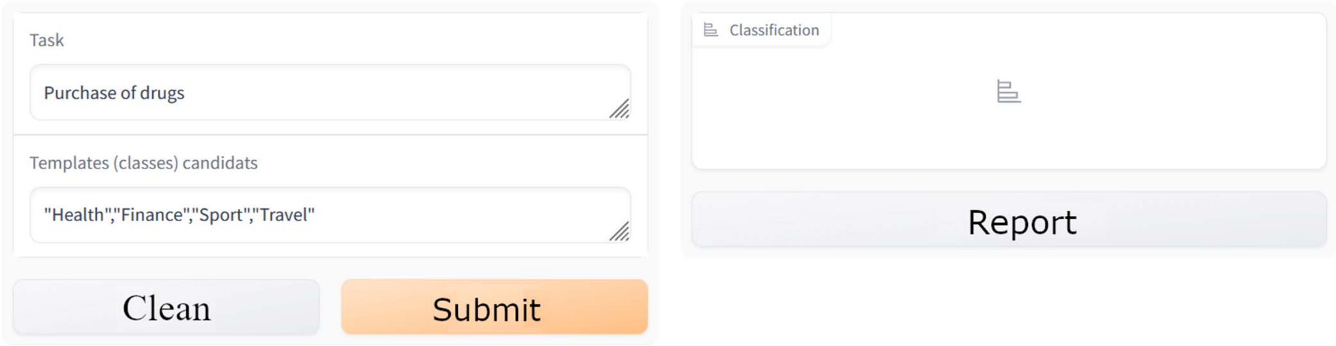


**Figure 23: Entering the task to classify in relation to the different templates**

Figure 24 shows the result after clicking "**submit**". Model 1 is therefore able to classify a given task in relation to domains, giving the probabilities that it belongs to one class rather than another.

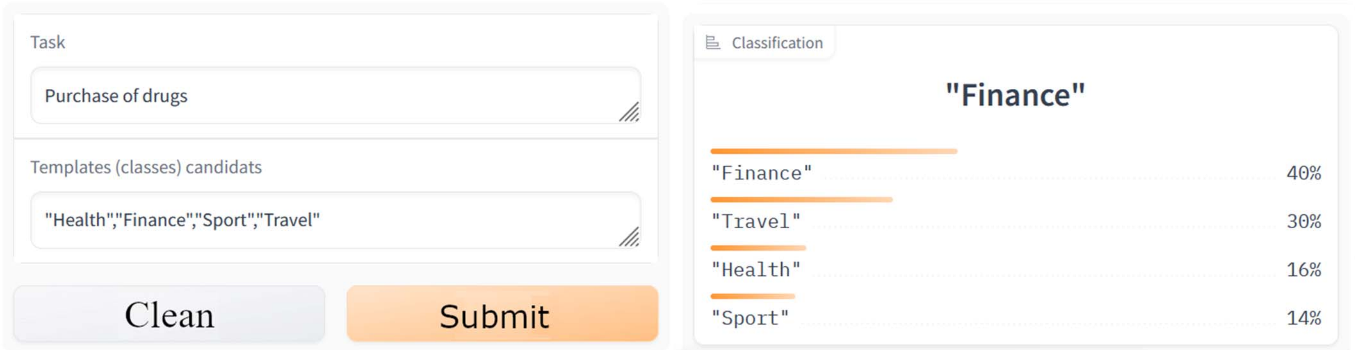


**Figure 24: Result of Model 1**

## 8.4.2 Second Model Use Scenario

### 8.4.2.1 Similarity between sentences

For model 2, it is first necessary do the embedding (see figure 25) with the AutoTokenizer library of the Transformers library so that the model can understand and process the candidate task that will be entered.

```
[9]  #Importation de la bibliothèque permettant de faire le pré-traitement des données

     from transformers import AutoTokenizer, AutoModelForSequenceClassification

[10] # Génération des embeddings et importation du modèle pré-entraîné

     nli_model = AutoModelForSequenceClassification.from_pretrained("BaptisteDoyen/camembert-base-xnli")
     tokenizer = AutoTokenizer.from_pretrained("BaptisteDoyen/camembert-base-xnli")
```

**Figure 25: Embeddings**

```
det_tache("Book a slot with the doctor", df)

(52.55739688873291, 'medical appointment booking')
```

**Figure 26: Result**

This component gives the result of the similarity calculation between the candidate sentence (task to be performed) and the reference phrase (task that is in the dataset), as well as the sentence that it considers to be reference.

Figure 26 shows the result of the template for the "book a slot with doctor" task.

Score: 52,56 %

Reference phrase: Medical appointment booking.

### 8.4.2.2 Resource Prediction

The resource prediction model considers the task at hand, the calculation of similarity between sentences, as well as the location to propose internal and external resources (equipment, networks, services) that may be useful.

Here is the behaviour of Model 2.

```
det_ressources1("Composition of the training program", "house")

['smartphone',
 '802.11',
 'set location',
 'equipment participating in the session',
 'internet',
 'web, get location, weather']
```

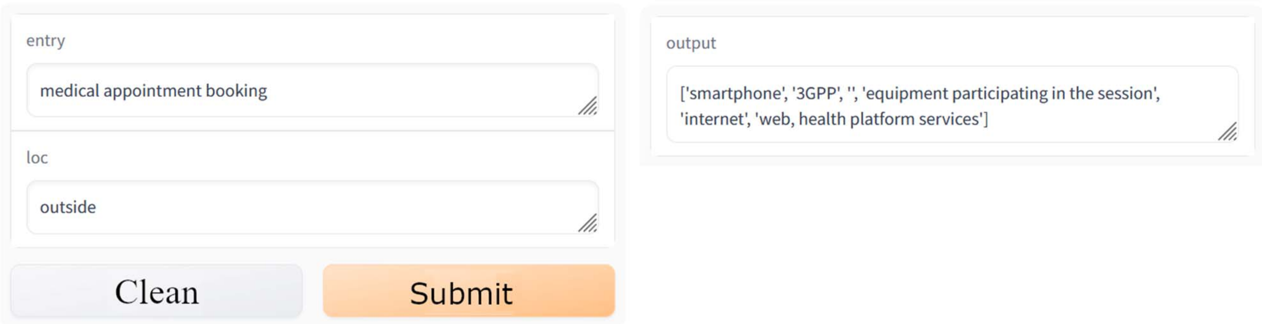


**Figure 27: Proposal of internal and external resources for the entered task**

# Annex A: Code file for Proof of Concept

The Smart Identity Proof of Concept is run in the Google® Colaboratory notebook (https://colab.research.google.com/).

The code file for the present document is available on the ETSI Forge repository, at the following link:

- https://forge.etsi.org/rep/user/tr-103-875-2/smartid-poc/-/tree/v1.1.1

The *POC_SmartID_v3.ipynb* file is to be uploaded to Google® Colaboratory and the PoC is executed from there.

# Annex B: Change History

| Date | Version | Information about changes |
|---|---|---|
| 01-2023 | V0.0.5 | Final draft for Approval |
| 03-2023 | V1.1.1 | First published version |
| | | |
| | | |

# History

| Document history | | |
|---|---|---|
| V1.1.1 | March 2023 | Publication |
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