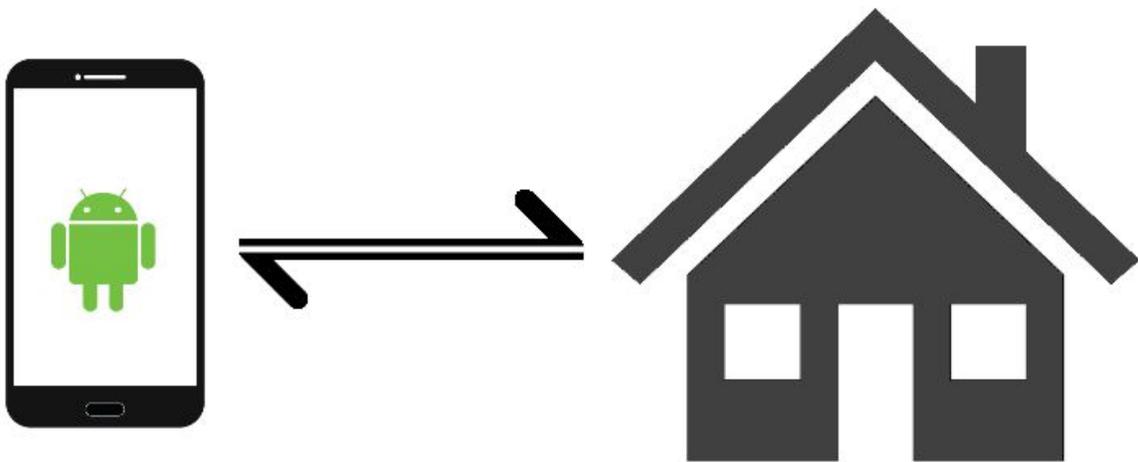


Using Smartphones as Semantic Sensors in Smart Home Applications



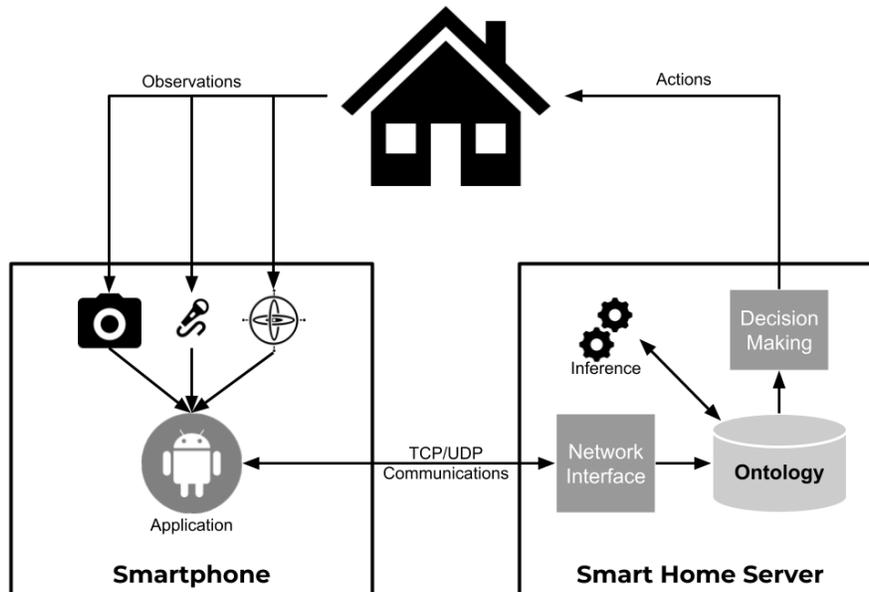
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Objective

The aim of this lab is to use your own smartphone as a source of information for smart home applications. The objective is to design an Android application that acquires data from embedded sensor and communicates with a “Smart Home Server” that maintains a context ontology and performs decision making.



Note: This lab was designed for Android devices, however, you are free to use the technology that suits you. You can also rely on the Android emulator, yet sensor data simulation may be limited.

Material

- A (Android) Smartphone
- USB connector to your phone
- Local WiFi network

Documentation

- Java specification: <https://docs.oracle.com/javase/7/docs/api/overview-summary.html>
- Jena documentation: <https://jena.apache.org/documentation/ontology/>
- Android getting started: <https://developer.android.com/guide/>
- Android reference: <https://developer.android.com/reference/>

Outline

I - Setting up

II - Sensor Data Acquisition

III - WiFi Communications

IV - Semantic Analysis and Action

V - Further work

I - Setting up

Objective: Prepare the development environment, set up a first application and test it on your phone

Don't hesitate to refer to <https://developer.android.com/training/basics/firstapp/> that was widely used for preparing this section.

Install Android Studio

Download and install Android Studio on your system: <https://developer.android.com/studio/>
Be aware that this process can be long and memory consuming. Don't hesitate to prepare the next steps (in particular the section IV about the ontology).

Prepare your Phone

In order to test your application on your phone, you need to enable on-device developer options: <https://developer.android.com/studio/debug/dev-options>

1. Go to **Settings**
2. Select **System** (Android 8.0 and higher)
3. Select **About phone**.
4. Tap **Build number** 7 times.
5. Return to the previous screen to find **Developer options** near the bottom
6. When you'll plug the phone while Android Studio is active, you should an authorization message on your phone.

Several options and tools are available for developer, feel free to explore and use them !

Create an Application

In Android Studio:

1. Create a new project: **File > New Project**
 - a. Select a Name and a Company Domain that suit you
2. In the **Target Android Devices**, select the lower version that match your phone
3. Create and empty activity

Deploy the Application on your Phone

Connect your phone to your computer.

II - Sensor Data Acquisition

Objective: Gather data from a sensor of the smartphone

Smartphone have multiple sensors, such as cameras, microphones and motion sensors. They can be used to acquire precious data about the environment that are essential in smart home applications. There are many information that can be gathered, you can try out applications, such as [Sensor Multitool](#) or [Phybox](#) to get an idea of all the possibilities. **Among these sensors/data, select one you want to focus on** (example: detecting the motion of the user), then, use the Android reference and tutorial to acquire and display sensor data on your phone.

Useful Links about Sensor Data

<https://developer.android.com/guide/topics/sensors/>

<https://developer.android.com/reference/android/hardware/SensorManager>

<http://velmm.com/detect-noise-in-android-example/> (old example)

III - Wifi Communications

Objective: Communicates the acquired sensor data to the smart home server

Adapt your application and create a Java program with a client/server architecture (TCP or UDP). You're free to determine which device is server and which is the client. If you are not familiar with network programming, you can rely on tutorials and examples, including: <https://github.com/CatalinPrata/funcodetuts/tree/master/AndroidTCPClient>

IV - Semantic analysis and action

Objective: Design a context ontology, integrate sensor data, apply reasoning and act accordingly

Scenario

The first step is to design a very simple scenario of smart home application based on the sensor data obtained by the smartphone. Let us consider the case of a motion detected by the smartphone. A scenario could consist of the detection of the user being late to work: *if the phone is not moving while the user's agenda asserts he/she has a meeting soon, the smartphone should notify him/her to prevent a delay.*

You are free to design any scenario that uses the data you acquired and you think can be useful at home. Basically, your scenario should consider the acquisition of a context data (from the smartphone), its (with other data) use toward the detection of an event or activity of the user, and the action taken in accordance.

You can associate with other groups to interact with their works: why not switch a light control by Arduino if the user is standing still at night (thus probably sleeping) ? Or trigger a phone alarm if another movement was detected in the house ?

Ontology Creation

In order to store the context data about the environment, we will rely on a dedicated Ontology.

With Protégé¹, design a context ontology that carries the following information:

- Individuals (example: Pierre, Maeva, Nono...)
- Rooms (example: living room, kitchen)
- Sensors
- Context data (example: luminosity, temperature, location, movement, etc...)
 - Relation towards entities
- User habit and/or agenda (example: working at 5)
- Anything you think is important to store

The structure and the general design remain to your concern. Don't forget that you will use it after, thus, think about your needs and use the scenario to warrant your design choices.

Java integration with Jena

Based on the previous sections, create a program that:

1. Obtain the sensor data from the smartphone and insert it in the ontology

¹ <https://protege.stanford.edu/>

2. Apply rules to reason on the ontology
 - a. Design and insert rules that match the scenario
3. Communicates with the smartphone (or any device !) for interaction with the user or the environment

And test it out. If the system behave and react as expected through your test, congratulation, you now have a simple smart home application running. :)

V - Further work

Objective: Improve your work on multiple axis and make the application (more) usable.

Improvements

In the case you finished this lab early, don't worry, this was just the beginning. For now, you just did a very simple scenario with a few case. The next step is to create a real and complete application. Based on what you learnt, you have to slightly improve the system following multiple axis:

- Design the application as a background service
- Acquire multiple sensor data on the application
- Provide restful API
- Share and interact with other groups
- Consider and propose a (or more) complete and realistic scenario (not only a single use case !)
- Improve the context ontology and its rules accordingly

In this step, you are (more) autonomous in your directions, choices and implementation. Have fun. ;)

Projects

The work performed in this lab can be used for bigger scale projects. Here are some features that can be addressed as part of project, each of them having its problematics and challenges:

- Freedomotic integration
 - Freedomotic is a framework allowing to create, test and manage smart space
 - Website: <http://freedomotic.com/>
 - Integrate your service in Freedomotic
- Connection to the network (and Internet)
 - Make the sensor data accessible over the network (REST Api)
 - Be aware of privacy and security issues
- Uncertainty management
 - Some sensor are not accurate, impacting the reasoning
 - Modeling and solving uncertain is a strong issue
- Any awesome idea you may have :)