

CoherentPaaS

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Cultivate Resilient Smart Objects
for Sustainable City Applications

The IoT Challenge @NTUA

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The Scenario (1/3)



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- ❑ Scenario A was chosen to be implemented.
- ❑ In this scenario we offer services to people who are hearing impaired. More specifically, our application receives and analyzes audio signals in the users' environment and, according to their origin, it notifies them via twitter posts.
- ❑ A microphone setup is required in order to actually implement this application in the real world. Initially, we used formatted wav audio files which simulate the real world.

The Scenario (2/3)



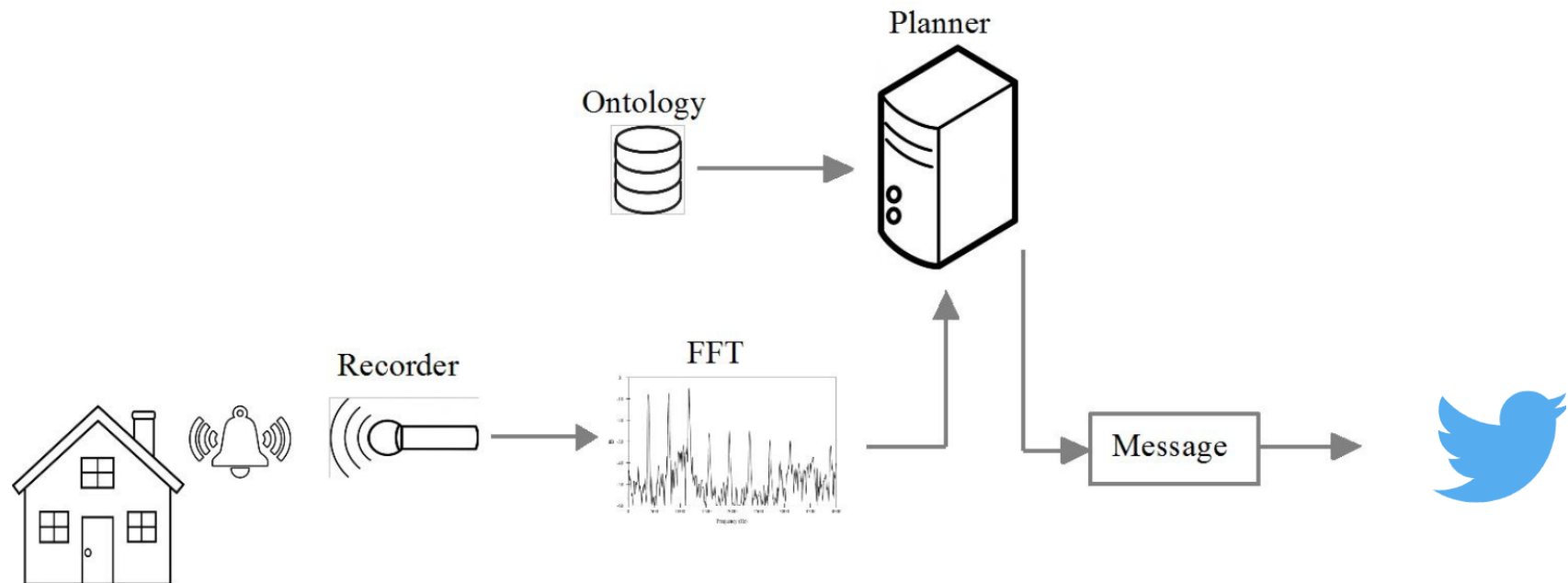
- ❑ More specifically, our application receives a **.wav file** (the path) as input and then it forwards it as input into a **python script**. Given the **five dominant frequencies** that the script returns to us, we form the **.json file**, which represents the **http post request** to the **Planner**. Thereafter, the Planner returns the most similar sound after comparison them with our predefined **knowledge base** using Case-based reasoning.
- ❑ The result is a .json file which we parse in order to acquire the solution attributes (**Sound Category**).
- ❑ Finally using a branch (**switch node**) we create and send the proper message as a tweet to the end-user.

The Scenario (3/3)



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- The diagrammatic description of our application.



The Procedure followed



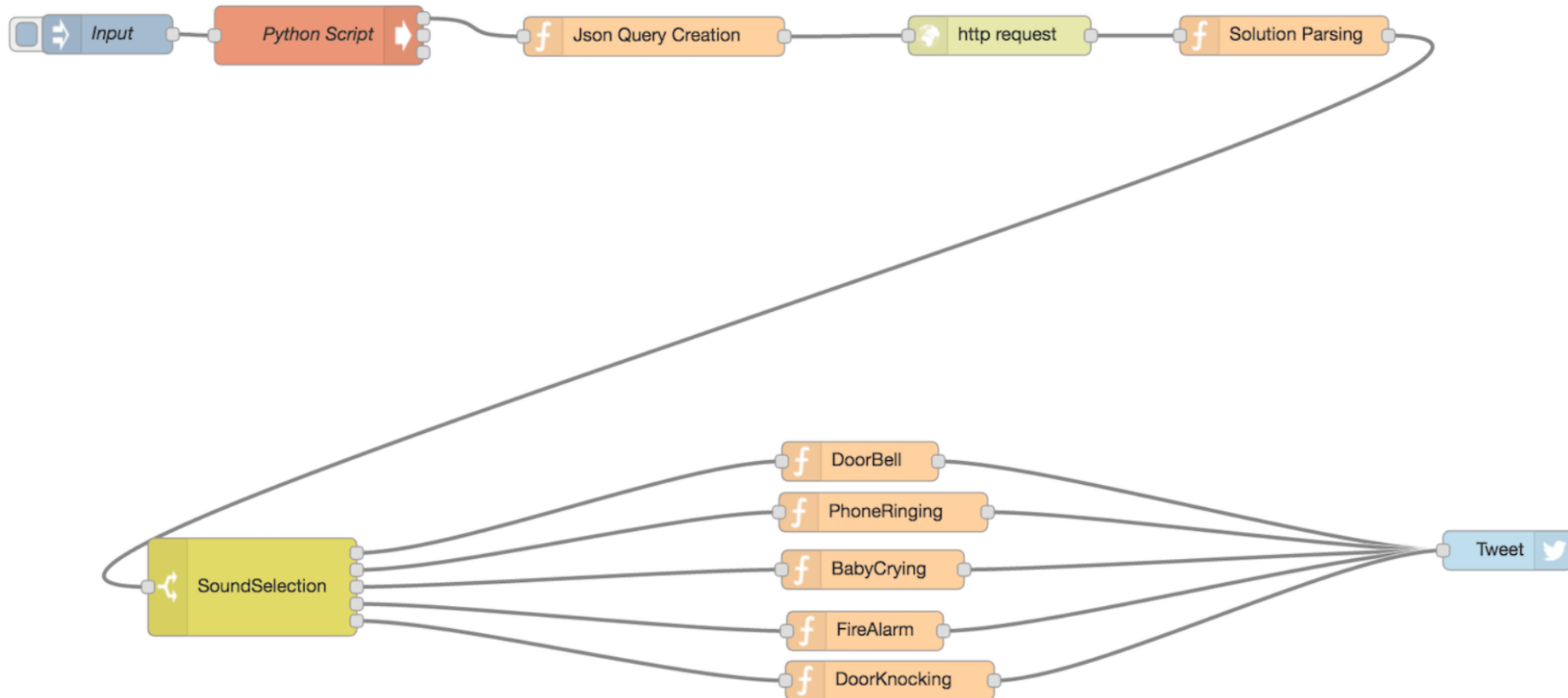
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- ❑ We used the Python programming language to analyze the sound signals. Originally, the script normalizes and isolates the sound on one channel and then it performs **Fast Fourier Transformation (FFT)**. Thus, having the frequency spectrum of the sound, we adjust it to real frequencies using the sampling frequency f_s of the signal. Finally, we keep the five most **dominant frequencies** of the spectrum.
- ❑ We used the Planner that was given to reason on the knowledge base (in which we initially stored the dominant-harmonic frequencies for each sound category extracted from test sounds) in order to give adequate results through Case-based reasoning.
- ❑ The knowledge base was created using the **Protege tool** and stored in **RDF / XML file** format as an ontology.
- ❑ The synthesis of the above as a web service, as well as the **twitter post** was implemented via **Node-RED**.

Node-RED flow



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The final Results



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- ❑ In the final stage , our application can differentiate audio signals between telephone audio, doorbell , fire-alarm , knocking-door and crying baby. Then it forms the appropriate twitter-post in order to inform the end-user. The mentioned posts are the following:
 - “Please answer your phone! Your phone is ringing.”
 - “Please open your door! The bell is ringing.”
 - “Attention! A fire-alarm is ringing.”
 - “Please open your door! Someone is knocking.”
 - “Take care of your baby! It's crying.”
- ❑ Note : To check the correctness of our application , initially, some .wav files were used as examples from the internet.

Problems to deal with (1/3)

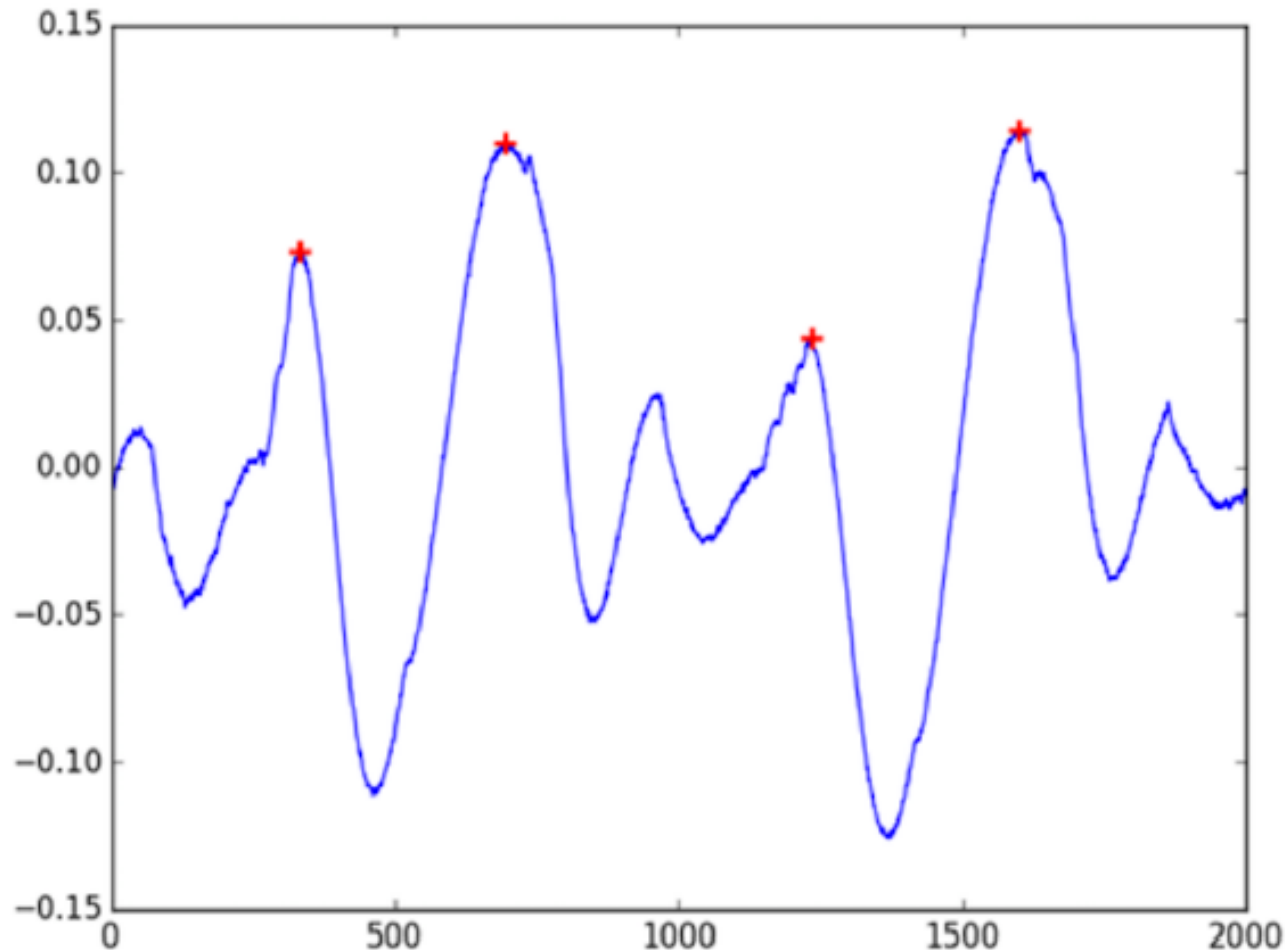


- ❑ We had to isolate the multichannel sounds in monaural by getting the first track and normalizing it.
- ❑ At first, our python script was able to analyze and process 8-bit resolution .wav files. We faced this problem by storing 8bit samples as unsigned ints while the others (16-24bit) as signed ones.
- ❑ Our script can read only uncompressed wav files.
- ❑ The main problem that we faced was the isolation of the five dominant frequencies. Taking the top five from the FFT list wasn't adequate because in most cases we didn't exploit peaks from all over the spectrum but we got frequencies that were extremely close to a peak. For this purpose we used a converted to python MATLAB script, specifically the findpeaks MATLAB function. In addition, to get even better results we set a considerably high limit to the amplitude difference of the peaks and gradually reduced that limit until we got the desired peaks.
- ❑ In order to make posts in Twitter that are unique when they are consecutive (Twitter demands it!) we used the current date and time as a uniqueness factor.

Problems to deal with (2/3)



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Problems to deal with (3/3)



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- Another problem is that a small number of sounds that have complex spectrums such as baby-crying, phone-ringing may not give the expected results. This fact shows us that there is space for further sound processing. For example, we could enhance our knowledge base with more samples for each category of sound and also more characteristic frequencies for each sound.
- In addition, we could dynamically adjust the weights of the dominant frequencies concerning the amplitude of each one of them. For example, for signals which are composed by few dominant frequencies (first and second harmonic) we would choose higher weights for these two frequencies (for instance 0.5 and 0.4). On the other hand, for those which are composed by a larger amount of high dominant frequencies (scattered in the whole spectrum) we would evenly allocate the weights.

Real World Testing



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- ❑ In order to test our application's effectiveness in real world circumstances, we recorded real sounds from our environment (such as doorbells, phone ringtones and alarms).
- ❑ We recorded these sounds with our mobile phones using an android app (Smart Voice Recorder).
- ❑ Giving these signals as input to our application, we observed that the results that were produced were the expected ones for all of the sounds!

Feedback



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□ Planner:

- Easy to set up and easy to use
- Trustworthy and fast results
- Transferable code
- Recommendation: An easy-to-use interface for inserting the data and building fast and automatically our knowledge base could be developed.

- **Node-RED:** Proven to be a very useful and easy to use tool which helped us to synthesize our application as a web-service and much more.



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Thank you!

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