Report about the internship done from 28th of January to 11th of March

IN THE LABORATORY :

IMAG LIG

IN GRENOBLE

Exploration of issues about validation on a Cyber Physical system

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SCHEDULE

INTRODUCTION

This is the Pre report about my internship done at the Laboratory of Grenoble **IMAG LIG.** This internship aims to prepare my main internship during this summer in Japan (from May to July).
The Objective of those 2 first months, was to understand what kind of software I'll be developing there, and how to proceed and what kind of support I'll use to test and validate it.

I / Study Case : Recognizing ADLs of One Person Household based on non-intrusive environmental sensing.

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I / Study Case : Recognizing ADLs of One Person Household based on non-intrusive environmental sensing.

1 / Problematic

There is more and more one-person households on earth. According to people who live alone, it is easier to have a tendency to lose control of a healthy lifestyle.
In general the rhythm of life is characterized by simple activities * ADLs * (eating, sleeping, washing, etc ...).

To maintain a good rhythm of life, the person must regularly register a list of his activities. However, it requires strong mind and patience.

We therefore seek to automate these recordings so that the person concerned can consult them without having to constantly think to save them and thus avoid a degradation of his lifestyle.

=> Some research has already be done in this area field , the results were :

- The researchers realized that coupling several types of sensors (video, audio, etc ...) gave a better idea of the activities done by the evaluated person.
- When a video process is used people find it hard to accept the fact that they are "observed" in their "privacy".

=> The Idea : The “SensorBox”

It is an IOT device which regroup different environmental sensor allowing to measure 7 environmental attributes (temperature, humidity, lighting intensity, atmosphere pressure,
sound volume, human motion and vibration) .

2 / Challenge

Most of the research done on ADLs mainly applies to the elderly, people with cancer or ordinary families, but very little for people living alone.
The main characteristic: the person lives alone
Furthermore the system should not be considered intrusive, the resident must be comfortable in the presence of the system.
The purpose of this research is to minimize these limitations of conventional approach while having a good quality of ADL recognition of a person living alone.

3 / Steps

A / Data Collection

During the first few days to permit the system to correctly learn the ADLs from the recovered data the user is asked to register his activities (LifeLogger).
Then the SensorBox integrates the collected data with registered activities to supervise learning

B / Establish Machine learning Recognition Model

=> Analysis Activity-sensitive Environment Sensing Sensors:
For Accurate ADL recognition, it was needed to identify which environmental values were well predicted.
From the 7 attributes, only temperature, humidity, light, sound volume, and motion were kept, because the others seemed irrelevant.

=> Feature Engineering :
First : determine the size of the time-window, because it affect the accuracy. If it’s to large, the window is going to contain different activities. If it’s to small it will not contains sufficient data to predict the ADL.

Finally : for each environment attributes chosen, we determine an aggregation function. It aggregates all data within the same time window, including MAX, MIN AVG, STDEV, and so on.
Depending on the nature of the attribute the one appropriate is chosen.

=> Establish Recognition Model :
We apply machine learning algorithms, in order to construct a predict model for ADL recognition.

C / Evaluation

=> Experiment set-up :
The SensorBox was deployed in an apartment of a single resident. The data were collected during 10 day.

=> Results :
Once the results were retrieved, there were analyzed, especially there accuracy witch is very important to determine if the models were efficient.

=> Discussion :
Once analyzed, the results are discussed, and interpreted.

D / Conclusion

In theory, we propose a new system that automates the recognition of the activities of the daily life of a person living alone.
We need only a single "SensorBox" for an entire apartment, which allows to answer the problem of the price of deployment while remaining as non-intrusive as possible in the life of the person living in this apartment.
To have a good evaluation of the ADL it takes only 10 days of data collection via “LiffeLogger” to have an accuracy of 88%.
In future works we will study this system on various focuses to observe how the learning process varies from one home to another.
We also want to know if taking the 7 types of ADLs is enough to get an idea of the rhythm of life of a person living alone.

4 / What did I learned

To start a project including a machine learning process, there’s some main point to proceed.

First of all it is needed to find a problematic to determine exactly where you’re going to lead our researches.

Secondly, we must search for researches already done in this field, look for what is working and what is needed to be improved (in this case for example one of the problem was the “privacy” issues), and what could be reused. This lead to define the constraints of the project.
Once all those factors are analyzed and the constraint are defined, we need to determine how we’re going to answer the problematic (here the “SensorBox”) .

Thirdly, we can start the experiment :
First of all, some data collections need to be done and analyzed.
Once analyzed, a machine learning model is established based on the data collected.
Next the model need to be test to determine if he is efficient or not.

- -Configure the experiment
- -Collect the results
- -Discus It

Finally Conclude, saying in what way you answer the problematic and where you can lead your next research based on this one.

II / Improving Testability of Software Systems that Include a Learning Feature

1 / Introduction

Today Artificial Intelligence (AI) is becoming increasingly important in computer systems.
From this fact, each App or system will promise more and more a personalized experience for each user.
However security problems are still regularly reported.
In this article we report the lessons learned in an application case consisting of a learning interface.

2 / Machine learning and validation

This section considers the validation of the machine algorithms, the system level and the testability point of view.

A / Algorithms validation

It exist different kind of machine learning (ML). We expect from it to do good predictions, after a learning time.
Firstly, we need to checked the quality of the predictions.
Performance measures are specific to the types of algorithms evaluated.

B / validation of the final software

The validation of a system with a learning system is complicated.
The application of this kind of system is not easy to predict because it varies with respect for the environment.

Even for a specific user his needs may evolve over time. This makes the specification impossible to express precisely. For the same reason it is very difficult to determine the characteristics of the environment of the final system.

For example, to be able to test a smart house that regulates the temperature, it is necessary to be able to change the temperature of this one to check that the system reacts correctly. However, overheating a room in the winter to see if the system cools is unacceptable.

For this reason the final system is usually tested in a simulated environment before deployment. For validation, monitoring is preferred. This consists of observing the output without controlling the inputs.

3 / Case Study

Case of an “intelligent air-conditionner” => It controls a traditional air-conditioner and offers a planning functionality.

4 / Expressing Properties

Expressing the properties.

Our air-conditionner, has to achieve the basic properties expected from it.
=> it should, when it is “On” , heat/cool respectively when the room temperature is below/above the expected one.
=>temperature should be reach on time.
=>spend the less energy as possible to achieve a chosen temperature.

Set the properties.

Once the properties are expressed, we need to set the variable which will express it.

For example :
P , a property stating that the room temperature should be equal to the expected one when the timer is elapsed.

(P) : iAC.timerElapsed ⇒ | env.temp − iAC.requiredTemp | < 0.5

Run the Experiment.

Once variables set, we can run the experiment.

5 / Lessons Learnt

After running the experiment, we analyzed the results and think about which properties are good to keep, which one are good to improved or removed, and maybe others we forget firstly.

6 / What did I learned

Testing an intelligent machine is not something which can be done simply by using one bases (experiment) as references.

From one to another, even if the bases are the same, the environment in which one is going to work, can and most probably will be completely different from another one.

That’s why we need to introduce some Machine-learning in it to let it adapt to an environment. The thing is that it is not simple to test the validity of an IA.

Firstly, some main properties need to be expressed, those ones will be true for any devices wherever the software is deployed.

Secondly those properties will be expressed in variable, which there value will differ from one to another between each deployed software depending one the environment.

Once it is done, we need to test it by experimenting it in different environment and observe how the device deployed will react.
Depending on the result we will improved the properties to perfect it.

III / Partrap

1 / Introduction

Since we talk about analyzing variables, this section is introduced to the Partrap Language, which goal is to help untrained computer engineers in the field of formal methods.

ParTraP is an expressive language that allows you to express properties on parametric event traces.

2 / Use Case

During my classes in distributed system, I was entrust to create a chat server, I reused this software to test the Partrap language.

3 / Traces

The language Partrap take a json file which has traces of a software execution.
For example :

{"id" :"BroadcastS","temps" : 4113218645132,"idMess" : 1, "client" : "a", "message" : "coucou", "listUsers" : ["a"]}

Each traces has an *id*, a *time* , and others attribute that I decide to use.
In this example I decide to put an *idMess* for each message sent, a *client* who send the message, a *message* which is the one sent and a *listusers* which is l=the list of users connected on the server chat.

Among the *id* used there are two of them : *BroadcastS* and *BroadcastR* S for “send” and R for “received”

4 / Partrap Validation

Once the json file is generated, we need to expressed what we want to evaluate.
I decide to evaluate, for example, one properties, which is :
Each time someone send a message, all the users connected on the server, receive it.

Which is traduce in PartTrap Language as :

```
ValidBroadcast: after each BroadcastS b,forall u in b.listUsers, occurrence_of
BroadcastR r where b.message==r.message && u==r.receiver && b.idMess==r.idMess;
```

`ValidBroadcast` is the name of what I'm tests

Here we check that the message is the same and the id too because, if not it is possible that someone or the same person write more than one time the same message so it is important to check that the one sent is the same than the one received.