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Health monitoring system in a smart home

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ABSTRACT : Care has evolved in a very important way in the last decade by diversifying modes and practices, which has led to an advent in smart health. However, projects that address health in smart homes are still in the experimental stage with mixed and unpromising results, as they are still confronted with the reality of sharing patient data with third parties. The purpose of this work is to predict the health status of one or more individuals living in a smart home using machine learning algorithms ⁽¹⁾ and relying on data collected through the sensors installed in the smart home. and this to prevent domestic accidents.

Keyword : smart health, Prediction, KNN, Linear Regression, smart home, iot, sensor, machine learning.

1 INTRODUCTION

A "smart home"⁽²⁾ is a residence with technological functions that monitor the well-being and activities of their residents to improve the quality of life, increase their independence and prevent emergencies. This type of computer applications targeting the elderly, people with disabilities or the general population is increasingly being researched around the world.

This article presents a solution based on the collection of data from connected objects present in a smart home, and the application of machine learning algorithms. All this to allow prediction on the health status of the inhabitants of the smart home.

2 TOWARDS THE OBSERVATION OF HEALTH IN THE SMART HOME

In general, we will gather in the smart home a sensor-based dataset that reflects activity performance or an individual's ability to perform an activity, all of which will be an input to our machine learning algorithm.

The major problem that arises is the protection of privacy because it is very likely that surveillance is video, in this case there is a violation of the privacy of individuals.

We will try to prove the relationship between learning and prediction by using data collected in a smart home. The goal is to monitor the health of the occupants of the smart home and avoid accidents.

We will apply different learning algorithms to intelligent home device data to get the best prediction

possible. Finally, we evaluate the performance of the learning algorithm for anomaly prediction using data collected and daily activities in a smart home.

3 RELATED WORK

There are a few smart home projects that have been initiated, including the ones at Georgia Tech ⁽³⁾, University of Colorado at Boulder ⁽⁴⁾, and industry labs such as Intel Research ⁽⁵⁾, Microsoft research ⁽⁶⁾, and so forth, located across the globe, which work towards a similar goal to make resident's lead a better life with maximum comfort, minimum cost and maximum security.

As smart environment technologies mature, the application of these technologies to health assistance becomes more prevalent. For instance, the goal of the Computer-Supported Coordinated Care (CSCC) project at Intel Research ⁽⁵⁾ is to identify the characteristics and needs of the care networks for elders who wish to remain at home ("age in place"). They also address the needs of those with common chronic conditions like cancer and cardiovascular disease, with a focus on wellness, including nutrition, physical fitness, and mental health. In a three- phase study, they developed an empirical approach focused on the wide range of people involved with home elder care ⁽⁵⁾.

The Place Lab developed by the MIT House_n Consortium and Technology processing company (TIAX, LLC) ⁽⁷⁾ currently are researching methods to validate performance of the activities of daily life and biometric monitoring. The rich sensing infrastructure of the Place Lab is being used to develop techniques to recognize patterns of sleeping, eating, socializing, recreation, and so forth. Particularly for the elderly, changes in baseline activities of daily living are believed to be important early indicators of emerging health problems – often preceding indications from biometric monitoring ⁽⁷⁾. Their work on recognition of Activities of Daily Living (ADL) in the home setting using ubiquitous sensors is useful for health monitoring and could potentially be enhanced when applied with pattern classification and context-based AI algorithms.

The MavHome project performed anomaly detection on health datasets to check for outliers and drifts in smart homes (⁸).

4 SMART HOME CONFIGURATION

There are various ways to deal with human action acknowledgment. Some of them include the examination of complex sensor flag, for example, video from cameras in PC vision and sound from amplifiers in sound-related scene investigation. Movement acknowledgment from these sensors is testing not just in light of the intricacy in breaking down the sign (highlight extraction) and the multifaceted nature engaged with the example acknowledgment and AI calculations utilized (particularly for ongoing execution). Moreover, cameras and mouthpieces are normally seen as obtrusive by individuals and they don't need them introduced in their homes. The target of this trial is to break down human exercises as an arrangement of double sensor initiations by introducing sensors that sense when ordinary items are being moved or utilized.

In this experience, somewhere in the range of 77 and 84 sensor information gathering sheets furnished with reed switch sensors where introduced in two single-individual lofts gathering information about human action for about fourteen days. The sensors were introduced in regular articles, for example, drawers, iceboxes, compartments, and so on to record opening-shutting occasions (enactment deactivation occasions) as the subject did ordinary exercises.

fig 1 : Sensor installation examples

fig 2 : Sensor installation location

Activity	Subject 1	Subject 2
Preparing dinner	8	14
Preparing lunch	17	20
Listening to music	-	18
Taking medication	-	14
Toileting	85	40
Preparing breakfast	14	18
Washing dishes	7	21
Preparing a snack	14	16
Watching TV	-	15
Bathing	18	-
Going out to work	12	-
Dressing	24	-
Grooming	37	-
Preparing a beverage	15	-
Doing laundry	19	-
cleaning	8	-

fig 3 : Activities labeled for this experiment

5 DATASET

5.1 Sensors

Le titre des sous-sections est en 10pt, gras avec des espacements avant et après de 6 pt

File containing the sensor information in the following forma:

SENSOR_ID,LOCATION,OBJECT

example:

100,Bathroom,Toilet Flush

101,Bathroom,Light switch
104,Foyer,Light switch
... ..

5.2 Activities

Is the file containing all the activities analyzed in the following format:

Heading,Category,Subcategory,Code

example:

Employment related,Employment work at home,Work at home,1
Employment related,Travel employment,Going out to work,5
Personal needs,Eating,Eating,10
Personal needs,Personal hygiene,Toileting,15.

5.3 Daily activities

Is the data of the activities in the following format:

ACTIVITY_LABEL,DATE,START_TIME,END_TIME SENSOR1_ID, SENSOR2_ID, SENSOR1_OBJECT,SENSOR2_OBJECT, SENSOR1_ACTIVATION_TIME,SENSOR2_ACTIVATION_TIME, SENSOR1_DEACTIVATION_TIME,SENSOR2_DEACTIVATION_TIME,

where date is in the mm/dd/yyyy format, time is in the hh:mm:ss format.

NOTE: ACTIVITY_LABEL = Subcategory example: Toileting,17:30:36,17:46:41 100,68 Toilet Flush,Sink faucet - hot 17:39:37,17:39:46 18:10:57,17:39:52 Send any

5.4 Objectifs

We perform two essential tests to assess learning classifier's presentation. The real objective is structuring a prescient wellbeing-based framework which is client driven and adjusts to various people. The principal try predicts wellbeing essential sign qualities, which can be utilized to improve the present condition of workmanship medicinal services checking frameworks. In this paper, we consider how different learning calculations chip away at the wellbeing related information gathered from an occupant in a smart home.

6 APPLICATION MACHINE LEARNING

6.1 Linear Regression

6.1.1 Definition

Linear regression is a basic and commonly used type of predictive analysis. The overall idea of regression is to examine two things: (1) does a set of predictor variables do a good job in predicting an outcome (dependent) variable? (2) Which variables in particular are significant predictors of the outcome variable, and in what way do they—indicated by the magnitude and sign of the beta estimates—impact the outcome variable? These regression estimates are used to explain the relationship between one dependent variable and one or more independent variables. The simplest form of the regression equation with one dependent and one independent variable is defined by the formula $y = c + b \cdot x$, where y = estimated dependent variable score, c = constant, b = regression coefficient, and x = score on the independent variable.

6.1.2 How does it work

Regression uses the historical relationship between an independent and a dependent variable to predict the future values of the dependent variable. Businesses use regression to predict such things as future sales, stock prices, currency exchange rates, and productivity gains resulting from a training program.

6.2 KNN (K Nearest Neighbors)

6.2.1 Definition

K nearest neighbors is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure (e.g., distance functions). KNN has been used in statistical estimation and pattern recognition already in the beginning of 1970's as a non-parametric technique.

6.2.2 How does it work

A case is classified by a majority vote of its neighbors, with the case being assigned to the class most common amongst its K nearest neighbors measured by a distance function.

If $K = 1$, then the case is simply assigned to the class of its nearest neighbor.

6.3 Learning our model

we will go through our model to detect occurrences between the activity reference and our dataset for person 1 (P1) and person 2 (P2).

The first test focuses on the examination of forecasts. The selection and preparation of the classifier implies a remarkable job of improving forecasts. In this step, we take the preparation information to prepare the learning calculation, then we execute the test information to examine the accuracy of the expectations.

	L.R	KNN
P1	13,02	52,5
P2	26,41	50,09
Average	19,71	51,29

Table 1: Algorithm result of prediction

After a series of launches of our two algorithms we could minimize the prediction error and now our model can be used with the test data.

We run both algorithms to compare classifiers whose performance is better. The performance of all classifiers used for this experiment is shown in Table 1.

We observe that the prediction accuracy of a classifier was considered to be the average prediction accuracy of all the prediction accuracies obtained when each algorithm was run on the individual datasets collected from the smart home via the sensors. iot et al.

After comparing the performance of various classifiers to datasets from the time series dataset collected from residents in the smart home.

We find that the K-NN algorithm stands out and works much better than the L.R algorithm. The latter does not work well because we try to predict the numerical value itself. L.R

This classifier allows for locally weighted learning. It can perform a classification (for example, using a naive Bayes) or a regression (for example, using a linear regression). The learner must implement the weighted instance manager for classification. But overall, its performance is not satisfactory.

The overall prediction was small since it was the average of the two precision predictions for each algorithm on a small data set, because there are not many data parameters on which the prediction was made.

Finally, we perform the classification using the K-NN classifier. The nearest neighbor K classifier normalizes the attributes and selects the appropriate K value based on cross-validation and distance weighting and gives better results than previous classifiers. We find that K-NN has a precision of 51% and is more efficient than the other classifier tested.

Currently, with limited data collected from two residents in an intelligent environment, this is considered an acceptable performance relative to the limited clas-

ses in the form of vital health data available for this experiment.

The prediction experiment here attempts to predict the value of the vital sign at a later time from the previous instants. The main objective of this forecast is not to predict a single day in the future, but at a certain time of the chosen time, as this would help to give an insight into the numerical trend of vital signs of health and would help to take precautions.

7 CONCLUSION

The above analyses when displayed would increase the value of a home human services framework. The main model enables the shrewd gadgets to go above and beyond with expectation capacities and thusly would assist inhabitants with watching their imperative signs after some time and play it safe to keep away from basic medical problems.

Intelligent homecare benefits the occupant just as the parental figure. Such astute gadgets would free human work from every minute of every day observing, decreasing work costs and improve effectiveness. They likewise help in checking the imperative signs and would alert when changes in the examples are watched. Presently with prescient abilities they advance a stage and examine the patterns and examples after some time and help get ready for any surprising occasion.

This experiment demonstrates the potential of data mining applications in smart home research. We compared different learning algorithms and also found how K-NN outperforms the other classifiers with an overall accuracy of 51% for the prediction of health sign values.

Our experimentation in trying to predict the behavior of people in a normal state, future work will be focused on the behavior abnormal, which means that the person is sick.

Lastly, if we run our two algorithms and especially the KNN, we can predict the abnormal behavior, ie the days when people will be sick.

The smart home should facilitate the early diagnosis of diseases and health problems among users. Another benefit of this experiment would be to evaluate and determine why vital signs are measured and the factors that affect them, to identify ranges of normal values for different individuals and to adapt to the vital signs of each individual.

Once the predictive system is in place, the remote assistance process is reduced, and early precautions can be taken to avoid extremes and minimize costs. Such devices, when in place in smart environments, would

push telecom-based home health services into the age of the ubiquitous intelligent computing environment..

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