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Smart Health: Automated Nutrition Monitoring Management System in the IoT

Arindam Pal,
Assistant Professor, MahadevanandaMahavidyalaya, Kolkata-700120
arinpal@yahoo.com

The purpose of nutrition watching and analysis is to work out and live the number of progress created for the nutrition intervention and whether or not the nutrition connected goals/expected outcomes square measure being met. The aim is to market additional uniformity among the bioscience profession in assessing the effectiveness of nutrition intervention. This condition results in the requirement of an automatic watching of the food we have a tendency to consume specially for the infants in day care centers and aged individuals reception. This downside may be overcome by Internet of Things (IoT) primarily based automatic nutrition and health care watching system. to handle this challenge, this paper presents a brand new Internet of Things (IoT) primarily based fully automated nutrition watching system, known as Smart-Health, to advance the state-of-art in good attention. Smart-Health is prototyped as a shopper physical science product that consists of WiFi enabled sensors for food nutrition quantification, and a wise phone application that collects nutritionary facts of the food ingredients.

Index Terms—Internet of Things (IoT), Consumer Electronics, Smart Healthcare, Smart Home, Food Monitoring, Nutrition Monitoring.

I. INTRODUCTION

New technologies have influenced several components of our existence. Today's attention system has additionally recognized the benefits of Information and Communication Technology (ICT) to enhance the standard of attention, turning ancient into sensible attention. in step with Blue Stream practice, "smart attention is outlined by the technology that results in higher diagnostic tools, higher treatment for patients, and devices that improve the standard of life for anyone and everybody." The key conception of sensible health includes eHealth and mHealth services, electronic record management, sensible home services and intelligent and connected medical devices.

As mentioned higher than, one in every of the key ideas for rising today's attention is eHealth, i.e. the usage of ICT in care. this can be additionally however the globe Health Organization defines the term: "eHealth is that the use of Information and communication technology (ICT) for health. Examples embrace treating patients, conducting analysis, educating the health men, pursuit diseases and observance public health.

"The European Union extends this definition by adding that eHealth "can profit the complete community by rising access to worry and quality of care and by creating the health sector additional economical. This includes data and information sharing between patients and health service suppliers, hospitals, health professionals and health data network; electronic health records; telemedicine services; transportable patient-monitoring devices, operating theatre programming package, robotized surgery and blue-sky analysis on the virtual physiological human." The goal of the EU regarding eHealth is improvement of EU residents' health by exploitation eHealth tools that offer instrumental data between countries once required. to ensure this improvement, the EU desires

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to reinforce these eHealth tools and build them simpler, easy and wide accepted by patients and professionals. Moreover, the EU aims at increasing the standard of attention and facultative higher access to attention by creating eHealth a part of health policy.The term mHealth is brief for mobile health. These terms have been outlined by the United Nations agency as "a part of eHealth". Since there's no standardized definition of mHealth, the worldwide Observatory of eHealth (GOe) has determined mHealth as "medical and public health follow supported by mobile devices, like mobile phones, patient observance devices, personal digital assistants (PDAs), and different wireless devices." Mobile phones and different devices area unit accustomed support patients and improve attention. Besides exploitation mobile phones to form calls and sent text messages, mHealth additionally includes additional complicated options and applications like general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), GPS and Bluetooth technology.

2. Latest trends in medical observance devices and wearable health technology

Wearable technology in attention includes electronic devices that customers will wear, like Fitbits and smartwatches, and area unit designed to gather the information of users' personal health and exercise.

Growing demand for wearables has generated a booming market, and currently insurers and corporations area unit seeing however provision wearable health technology to their shoppers and workers is helpful.

Do you're employed within the attention industry? corporate executive Intelligence publishes many insights, charts, and forecasts on the Digital Health trade with the Digital Health informing.

Wearable fitness technology has weaved itself into society in order that work Bits and smartwatches area unit seen as mainstream; and therefore the way forward for wearable devices shows no sign of fastness down.Piloted by the increasing demand of shoppers to watch their own health and keep track of their own important signs, use of wearable technology has quite tripled within the last four years. in step with analysis from corporate executive Intelligence, quite eightieth of shoppers area unit willing to wear fitness technology.

3. Benefits of technology in healthcare:

Improving patient care and experiences-

Using technology to live and capture information across the entire system of patient care provides health organizations a big-picture read of however they are playacting. Technology additionally helps to modify that mensuration thus organizations will endlessly review their results, spot problems that require to be fastened and uncover ways that to boost care and also the patient expertise.

Real-time data exchange-

From clinicians to patients to payers, many alternative teams have to be compelled to be ready to access health records for various reasons. historically, organizations have had to take care of totally different records for every cluster. However with new technology that creates it easier for digital

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patient records to be standardized and hold on firmly, a lot of organizations square measure desegregation their information so licensed folks will access the records they have at the time they have them.

5. Cloud computing in aid

When most of the people consider cloud technology, they consider the cloud as an area to store information. Nevertheless cloud environments do over passive information storage. Cloud environments supply ways that for aid organizations to create and customise applications which will modify however information moves through their data technology systems. Hybrid cloud environments above all, supply security measures which will facilitate organizations maintain compliance with HIPAA and different rules whereas giving them the flexibleness they have to manoeuvre information around to wherever it must go. This flexibility additionally provides aid suppliers with a lot of choices for change existing gift systems and workflows. Cloud adoption exposes opportunities for organizations to use AI and machine learning tools too, which may facilitate uncover hidden patterns and insights that improve however care is delivered.

6. however can we apply aid technology?

From huge diagnostic imaging scanners to small wearable sensors, technology is Associate in Nursing integral a part of fashionable aid. Additionally to new treatments and medical procedures, technology has improved several aid business processes additionally. many folks have come back to fancy the conveniences of programming appointments on-line, accessing check results and records with simply a couple of clicks, or causing inquiries to their suppliers through email or text.

Here square measure simply a couple of samples of the square measureas during which aid technology innovations are supporting subsequent wave of advances in healthcare:

Disease diagnosing and treatment:

Using AI to method information, like medical pictures, and develop unwellness models will probably facilitate clinicians create diagnoses with a lot of exactness. for instance, recent work from IBM analysis has shown that AI are often wont to acknowledge and interpret brain activity patterns in MRIs to trace the progression of neurodegenerative sicknesses, like monogenic disease.

Medical imaging:

Computers and AI models square measure notably valuable in medical imaging as a result of they'll facilitate flip footage into numbers and notice trends. These innovations will facilitate radiologists and different clinicians manage the unbelievably giant volume of pictures they need to review by distinctive high-value findings and conveyance anomalies to their attention.

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Healthcare operations:

Many hospitals and aid systems square measure beginning to rest on enhancements they've seen with electronic medical records and realize different ways that to consistently improve their operations. Cloud technology, analytics and mobile technology square measure simply a couple of the technologies organizations square measure mistreatment to optimize their digital infrastructure.

Clinical research:

Life sciences organizations square measure mistreatment technology to rework however clinical trials square measure being performed. Sensible devices, telehealth visits and sensors square measure being employed to support redistributed trials that create information assortment a lot of economical and convenient for the people that participate.

Redefining Healthcare:

The proliferation of healthcare-specific IoT merchandise exposes Brobdingnagian opportunities. and also the Brobdingnagian quantity of information generated by these connected devices hold the potential to rework aid.

IoT contains a four-step design that square measure essentially stages during a method (See Figure below). All four stages square measure connected during a manner that information is captured or processed at one stage and yields the worth to subsequent stage. Integrated values within the method brings intuitions and deliver dynamic business prospects.

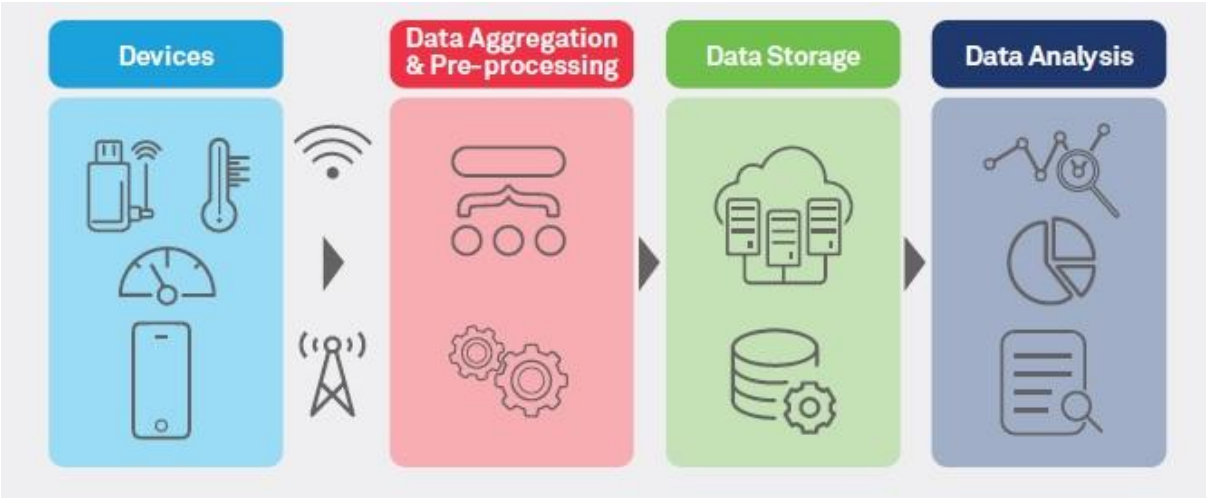
Step 1: initiative consists of readying of interconnected devices that features sensors, actuators, monitors, detectors, camera systems etc. These devices collect the information.

Step 2: typically, information received from sensors and different devices square measure in analog type, which require to be collective and born-again to the digital type for more processing.

Step 3: Once the information is digitized and collective, this is often pre-processed, standardized and emotional to the information center or Cloud.

Step 4: Final information is managed and analyzed at the desired level. Advanced Analytics, applied to the current information, brings unjust business insights for effective decision-making.

IoT is redefining aid by making certain higher care, improved treatment outcomes and reduced prices for patients, and higher processes and workflows, improved performance and patient expertise for aid suppliers.



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II. PROPOSE SYSTEM

Reviewing the varied systems, it's doable to develop another low value easy system thus on accurately live the calorie and biological process level at intervals the food. The diagram of the projected system is as shown at intervals the figure. Users have to be compelled to take the image of the food before and when the meal for the correct mensuration of calories. the next step of the system is segmentation, every image goes to be analyzed to extract numerous segments of the food image portion. Out of various tools offered for segmentation, color and texture segmentation tools are used for the effective mensuration. Numerous food options as well as size, shape, color and texture are progressing to be extracted and sent to the classification step wherever, exploitation the Support Vector Machine. Therefore exploitation the higher than steps, some of food is recognised. Finally, by estimating the globe of the food portion and exploitation some biological process tables, the calorie price of the food goes to be extracted. Diagram of system Nutrition is also a significant demand for the great health of a population and it is the tip results of the operation of a complicated set of things cutting across a spread of economic sectors. The terms watching and police investigation are sometimes used as synonyms in nutrition assessment. However, it is vital to understand the excellence between these a pair of terms. "Monitoring" refers to the gathering, analysis and feedback of quantitatively precise measures from a relatively big sample of a population – at the national and state levels – essentially for the wants of following time trends and understanding population sub-group variations in diet, organic process standing and nutrition connected unhealthy risks. The neural Network consists of various layers and therefore the output of a layer is that the input of consequent layer. The most objective of the complete application is {create| to form|to create} the director manual input from the user and make use of correct information collections with cheap IoT devices. To depict the practicability and viability of the projected approach to create it helpful in real time a system example of the model is meant.

Knowledge representation:

The first step is to outline information structures to represent the tiniest items of a doable resolution. Here it's required to represent the Person and diagnosing categories. A deftemplate is sort of a category declaration in Java, whereas category objects have member variables, deftemplate have slots. as an example, the person model has slots named sex, age, mass, height and articulatioradiocarpea as is show within the following script:

```
(deftemplate result-bmi
 "Result BMI to diagnose Person nutrition status"
 (slot bmi-person
 (allowed-values
Very-severely-underweight Severely-underweight Moderately
Underweight Underweight Normal-healthy-weight Overweight
 Moderately-obese-Class-I Severely-obese-Class-II Very-severely
obese-Class-III))
```

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(slot bmi-msg (type STRING)))

The program in Java uses these templates to create facts for each of the possible combinations. For example:

private void DefPerson (String sex, double age, double mass, double height, double wrist) { try { Fact myFact = new Fact("person", engine);

myFact.setSlotValue

("sex", new Value(sex, RU.SYMBOL));

("age", new Value(age, RU.FLOAT));

("mass ", new Value(mass, RU.FLOAT));

("height ", new Value(height, RU.FLOAT));

("wrist ", new Value(wrist, RU.FLOAT));

engine.assertFact(myFact); }

catch (JessException e) { result = "(7.1):" + e.toString(); }}

The baseline characteristics of the sample originally eligible for inclusion within the analysis square measure bestowed in following Table; no statistically vital variations across the randomized organic process study arms were ascertained. The adolescents were, on average, fourteen years previous and had completed a bit over five years of schooling, that is a smaller amount than the expected six to seven grades of schooling to be completed by age fourteen in Syllet. Though a large share (approximately eighty %) of ladies were at school at baseline, their ability to browse easy sentences in Urdu/English or an area language, complete grade-appropriate skill evaluations and perform well on psychological feature exams counsel deficiencies within the acquisition of educational and different skills. Finally, the info indicate that tierce of ladies don't co-reside with their mothers, with a touch over simple fraction having mothers that square measure deceased. Fathers' co-residence is even less common, with over not living with their fathers and nearly 1 / 3 having deceased fathers.

Nutrition	Food Group	Recommended %
Carbohydrates	Cereals and grains, etc.	53%
Vitaminsand Minerals	Various fruits and vegetables	13%
Meat Protein	Fish, meat and eggs	12%
Milk Proteins	Dairy products	15%
Fat and Sugar	Fatty foods, sugary sweets etc.	7%

Children Diet Chart

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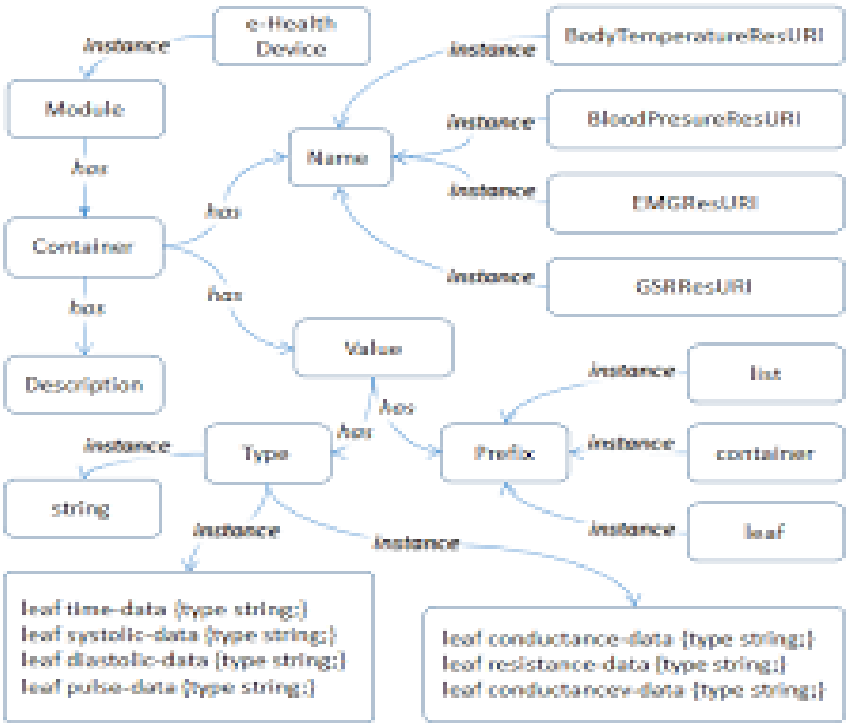
Designing and Implementation:



Dataset:

Summary of findings:

• A nutrition transition is occurring—stunting has declined however remains high (27%), overweight is increasing (currently 7%), and thin (thinness) has remained consistent, around twelve-tone system throughout recent years. stunt flying and thin are each highest in Sylhet. thin is higher in adolescent boys (22%) than women (17%), a minimum of in rural areas.

• Anaemia and substance deficiencies are common in adolescents, notably antiophthalmic factor, zinc, and iodine, and different deficiencies like metallic element are possible common, since dietary intakes are so much below needs.

• Each boys and women are susceptible to deficiency disease to variable degrees betting on the indicator.

• Quite 1/2 females 10-49 years have inadequately numerous diets, and there are robust variations by universe, significantly by wealth quintile. Adolescent women and ladies with low wealth, WHO are food insecure and sleep in rangpur lime, Barisal, or Rajshahi, are additional possible to own inadequately numerous diets, particularly throughout the season.

• Adolescent women 10-16 years ar a minimum of doubly as possible as boys 10-16 years to travel to sleep hungry, skip meals, and take smaller meals, and one-and-a-half times additional possible to eat solely rice, as cope ways throughout food insecurity.

• Early wedding has declined however remains high—59% of ever-married girls 20-24 years were

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married by age eighteen. Age initially wedding is lowest in rangpur lime and highest in Sylhet.

• Gymnasium enrollment is low—only forty third of adolescents 11-17 years ar listed in Gymnasium. Gymnasium group action is lowest in Sylhet.

• There are massive variations in deficiency disease and its determinants by subpopulations, wherever national-level information usually masks massive disparities.

• Interventions are required that range foods high in micronutrients (especially animal-source foods) and/or fiber, as well as vegetables, legumes, fish and shellfish, eggs, meats (particularly organ meats), and milk and its merchandise, which aim to cut back consumption of energy-dense, nutrient-poor foods, like refined flours, sugar, vegetable oils, and ultra-processed foods.

• {college|lyceum|lycee|Gymnasium|middleschool|school} feeding programs that embody conditional money transfers and/or give net food rations might incentivize school enrollment, delay wedding, increase academic attainment, improve consumption of wholesome foods, and permit targeting of the poorest households.

• Up coverage of element salt ought to be a priority—only fifty eight of households have adequately element salt.

• Population-weighted, across the country representative biological process and dietary information on adolescent boys and women is lacking and may be reported by disaggregated subpopulations to supply higher programmatic steerage.

The dataset used in this study is the monitoring data on the nutritional in 2017 with a total of 853 toddlers. Monitoring data on thenutritional status of toddlers has three categories, namely the category of body weightaccording to age (BB/U), height for age (TB/U), and body weight for height (BB/TB).The BB/U category has 4 classification labels namely Best, Good, Bad and Worst. TheTB/U category has 4 classification labels namely High, Normal, Short, and Very Short.While the BB/TB category has 4 classification labels namely Fat, Normal, Thin, andVeryThin (Tablebelow).

CategoriesandLabels

No	Category	Label
1	BB/U	Best, Good, Bad, Worst
2	TB/U	High,Normal,Short,VeryShort
3	BB/TB	Fat,Normal,Thin,VeryThin

DataSelection:

In thedataset, thereare19 attributes, including name, dateof birth, gender M/F,body weight, PB/TB, measured position, age, age calculation process, conversion ofTB/PB, age family, code, code1, code2, nutritional standards Poor BB/U, NutritionalStandardsGoodBB/U,ShortPB/UorTB/UStandards,NormalPB/UorTB/UStandards, Weight Standards BB/TB or BB/TB, and Normal Standards of BB/TB orBB/TB.Atthedataselectionstage,theattributesusedfortheclassificationweredetermined (feature

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selection). In the selection of attributes, the attributes of GenderM/F, Body Weight, PB/TB and Age were selected. These attributes were selected basedon recommendations from the health center. The results of the attribute selection areshownin Table.

Attributesusedbyeachcategory

No	Category	Attribute	Label
1	BB/U	Gender M/F,BodyWeight, Age	Best, Good, Bad, Worst
2	TB/U	Gender M/F, PB/TB,Age	High,Normal,Short,VeryShort
3	BB/TB	GenderM/F,BodyWeight, Age	PB/TB,Fat,Normal,Thin,VeryThin

ModelingC4.5DecisionTree:

Every fold is modeled using the C4.5 decision tree method, so that there are*n*models for each *n*folds. The C4.5 decision tree method classifies the data by lookingfor the value of Entropy, Information Gain, Split Info and Gain Ratio. Tree formationbegins with finding the highest Gain Ratio value to become the root node, then for leafnodesit iscarried outrecursively untiladecisiontreeisformed.

Thefollowingisanexample ofa tree formationstep:

1. Prepare the data that will be used for the formation of the C4.5 decision tree model.In this example, 9 data on children under five are used for the classification of theBB/ Ucategory with theattributesused according toTable Dataset.
2. Separating data into training data such as Table 4 and testing data as in Table Data Training witha total of 3 folds.

Gender M/F	Body Weight	Age	BB/U
1	8	9	Good
1	7.8	8	Good
1	10.1	8	Good
2	6.1	6	Good
2	4.6	6	Worst
2	10	44	Worst
2	7.3	27	Worst
2	8.9	17	Worst
1	8.1	26	Worst

TableDataset

Gender M/F	Body Weight	Age	BB/U
1	8	9	Good
1	7.8	8	Good
1	10.1	8	Good
2	6.1	6	Good
2	4.6	6	Worst
2	10	44	Worst

Table DataTraining

Table DataTesting

Gender M/F	Body Weight	Age	BB/U
2	7.3	27	Worst
2	8.9	17	Worst
1	8.1	26	Worst

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3. Calculatingentropyusingformula(1),informationgainusingformula(2),splitinfo using formula (3), and calculating the gain ratio using formula (4) for eachattribute.Theentropy isformulatedas

$$\text{Entropy}(S)=\sum_{i=1}^{n} -p_i * \log_2 p_i. \quad (1)$$

Descriptionofformula(1)follows:$S$is theset ofcases,$n$isthe number ofpartitions$S$and$p_i$istheproportion of$S_i$to$S$. Thegain isformulated as

$$\text{Gain}(S,A)=\text{Entropy}(S)-\sum_{i=1}^{n} \frac{|S_i|}{|S|} * \text{Entropy}(S_i). \quad (2)$$

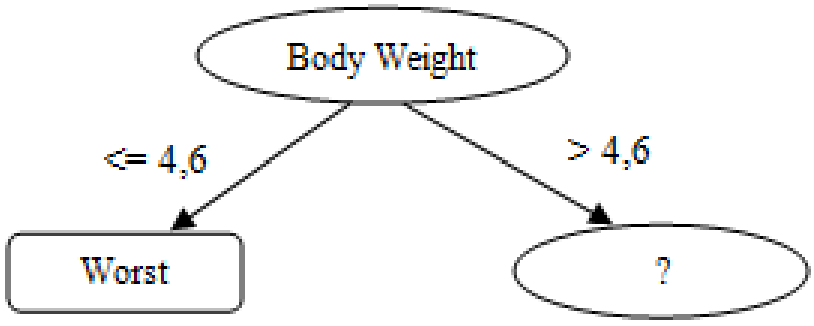
Description of formula (2) follows: $S$is Sample, $A$is attribute, $n$is the number ofpartitions of the attribute set A, $|S_i|$ is the number of samples on the partition, and $|S|$isthenumber of samplesin$S$.Nowweformulatethe Split Info as

$$\text{SplitInfo}(S,A)=-\sum_{i=1}^{v} \frac{|S_i|}{|S|} \times \log_2\left(\frac{|S_i|}{|S|}\right). \quad (3)$$

Description of formula (3) follows: $v$is the subset resulting from solving usingattribute$A$whichhasasmanyas$v$values. Then,wehave theGain Ratioas

$$\text{GainRatio}(S,A)=\frac{\text{Gain}(S,A)}{\text{SplitInfo}(S,A)}. \quad (4)$$

Next, look for the root node candidates by looking for the highest information gainvalue for each attribute. Determine the root node by finding the highest gain ratiovalueforeachcandidate.Thehighest gainratiovalue isfoundintheweightattribute with a variable value of 4.6,thus the root node of the tree is Weight B.with a value of 4.6. The decision tree formed from the calculation is shown inFigure Root Node.



FigureRootNode

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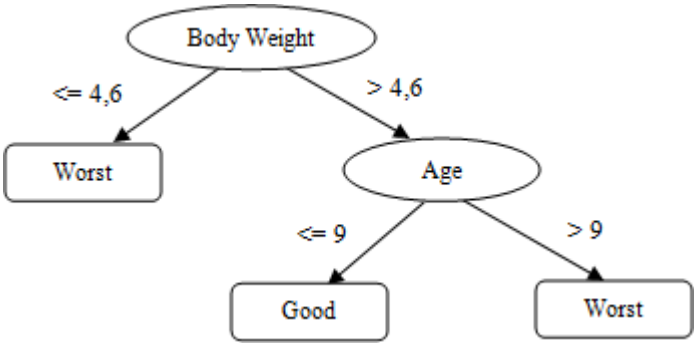
4. After getting the root node, then we do a leaf node search. Data with a weight valueof 4.6 aredeleted /removed fromthe datasetbeforesearching for leaf nodes

Table.Thedatasettableatnode2

Gender M/F	Body Weight	Age	BB/U
1	8	9	Good
1	7.8	8	Good
1	10.1	8	Good
2	6.1	6	Good
2	4.6	6	Worst
2	10	44	Worst

After it has been removed, it is followed by looking for leaf nodes, and searchingfor the highest information gain value. The highest information gain value is in theAge attribute with a value of 9, thus the leaf node is Age, if the age is below 9 thenthe classification label is Good and if it is above 9 then the classification label isWorst.Theresulting treeisshown inFigureLeaf Node.



FigureLeafNode

Evaluation:

Several experiments were carried out to evaluate this system. Each experiment wascarried out by dividing the data into 3, 5, 7 and 9 folds. Each experiment was carried outfor each category, namely the categories BB/U, TB/U and BB/TB. The experiments areshownin Table C4.5decisiontreeexperiment.

Table

Experiment	Numberof Folds
1st	*3-folds*
2nd	*5-folds*
3rd	*7-folds*

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4th *9-folds*

Result of general characteristic:

A total of 254 child included in this work. This sample consisted five category of age. Age 0(below 1 year) had 91.53% poor nutritional state, while 8.47% people had normal nutritional status. Age of 1 year child had 57.53% poor nutritional status. Age of 2 years child had poor nutritional status 66.22%. Age of 3 years child had poor nutritional status 61.90%. Age of 4 years had poor nutritional status 81.48%. Gender of Male had 90.90% of malnutrition. Gender of Female had 97% of malnutrition. Religion of Hindu had 75.22% of poor nutritional status. Religion of Christian had 59.09% of poor nutritional status. Religion of Muslim had 30% of poor nutritional status. Mothers Education of Non-Education had 82.98% of poor nutritional status. Mothers Education of Secondary had 69.94% of poor nutritional status. Mothers Education of Primary had 69.04% of poor nutritional status. Mothers Education of Higher had 52.39% of poor nutritional status. Wealth Index of poor had 86.27% of poor nutritional status. Wealth Index of Middle had 75.31% of poor nutritional status. Wealth Index of rich had 61.47% of poor nutritional status.

Algorithm:

Nutritional Balance Network Algorithm for building a multilayer perceptron neural network using Stochastic Gradient Descent

1: Initialize the input layer (Type of Meal).

2: Initialize the connection weights W with small random numbers.

3: Randomize the order of input training examples for hidden layer (Weight of the meal, time at which the meal was consumer and intended nutritional goal) X.

4: while Not converged do

5: for layer l1 to lp−1 do

6: Feed Forward Network: Compute output of each hidden layer by using the weights and bias for each meal.

7: Back Propagation Network: Update the weights w p mn and biases b p m computed based on gradient descent.

8: Compute the output layer, nutritional balance of the meal based on the hidden layers.

9: end for

10: end while

11: Return Nutritional balance network.

```
void setup() {

Serial.begin(9600); //Baud rate

}

void loop() {

  float sensor_volt; //Define variable for sensor voltage

  float RS_weights; //Define variable for weights
```

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```
  float time; //Define variable for time
  float sensorValue; //Define variable for analog readings
  for (int x = 0 ; x < 500 ; x++) //Start for loop
  {
sensorValue = sensorValue + analogRead(A0); //Add analog values of sensor 500 times
  }
sensorValue = sensorValue / 500.0; //Take average of readings
sensor_volt = sensorValue * (5.0 / 1023.0); //Convert average to voltage
RS_weights = ((5.0 * 10.0) / sensor_volt) - 10.0; //Calculate RS in weights
time = RS_weight / 4.6; //Calculate time
Serial.print("time = "); //Display "time"
Serial.println(time); //Display value of time
  delay(1000); //Wait 1 second
}
{ "kioskId":
"6947FA34B86", "userId":
"", "scanId":
"djklfj4980985fdsl", "date":
"13/09/2017", "time":
"15:30", "items":
[ { "sensorId":
"6874AB159", "sensorType":
"scale", "metric":"weight" "value":
182.5, "unit":"g" },
{ "sensorId":
"C456D3450", "sensorType":
"composition", "metric":
"calories" "value":397.5, "unit":"kJ"}] }
```

Fig. representing the data being uploaded to the Engine.

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The various steps involved in building the CNN model is summarized as follows.

Step 1: The initial setup which comprises of importing the necessary packages namely Sequential, Convolution2D, MaxPooling2D, Flatten and Dense.

Step 2: The neural network is initialized using an object.

Step 3: The convolutional layers are added specifying the filter size, shape, dimensions and the activation function.

Step 4: Pooling is performed for feature map size reduction without losing the important image characteristics.

Step 5: Flattening is done by collecting all the pooled feature maps and putting them into a single vector.

Step 6: The full connection is created using the number of hidden layer nodes, relu function for hidden layer, softmax function for multiple outcomes and the output probabilities are randomly generated.

Step 7: The CNN model is compiled and image augmentation is done to train and test the model.

Step 8: The model is tested with unseen (new) image and the output is evaluated in terms of classification accuracy and Mean Square Error (MSE).

CONCLUSIONS:

An autonomous nutrition monitoring system is presented in this work. The implemented design is cost efficient with high accuracy in diet monitoring. The algorithm for nutrient feature extraction based on a Bayesian network and an algorithm based on a 5 layer perceptron neural network for determining the nutritional balance after each meal. As future research, Smart-Log will be integrated with physiological monitoring mechanisms to keep track of user activities for accurate automated prediction of diet for adults.

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