International Journal of Modern Engineering Research (IJMER)
www.ijmer.com Vol.2, Issue.2, Mar-Apr 2012 pp-001-005 ISSN: 2249-6645

Data Mining for Prediction of Clothing Insulation

M.Martin Jeyasingh[1], Kumaravel Appavoo[2], P.Sakthivel[3]

[1]Research Scholar, [2]Dean& Professor,
[1&2]Bharath Institute of Higher Education and Research,Chennai-73,Tamilnadu, India.
[3]Associate Professor, [3]Anna University,Chennai-25,Tamilnadu,India.

ABSTRACT

Owing to difficulties of gathering large volumes of textile domain data in a context of less mining research, predicting the characteristics of garments becomes an important open problem which receives more and more attention from the textiles research community. In this research work, the field of Data mining attempts to predict clothing insulation factors with the goal of understanding the computational character of learning. Characteristics of clothing learning is being investigated as a technique for making the selection and usage of training data and their outcomes. It is observed from the results obtained by experimentation that the Linear Regression is quiet appealing because of effectiveness in terms of high prediction rate and Linear Regression is able to discover the clothing insulation performance in a most efficient manner in comparison to all other leaning algorithms experimented. Data mining Classifiers has showed spectacular success in reducing classification error from learned classifiers like Linear regression, LeastMedSq and AdditiveRegression functions have been analyzed for improving the predictive power of classifier learning systems.

Keywords : **- Classifiers, Clothing Insulation, Data Mining, Garment layers, Linear Regression, Manikins**

I. INTRODUCTION

Just as the diet is critical to survival , so too is the clothing. It is used to protect the wearer from the most extreme conditions. Clothing is all the more important for people who travel or live in a variety of conditions and temperatures. One never wants to be in a position of being inadequately protected!

There are three essential layers in the modern clothing system. The inner-most layer is "moisture control." The key to warmth and comfort is to have a dry layer next to your skin — this is absolutely essential. This first layer is made of a fabric which carries away or "wicks," the perspiration from the body, keeping the wearer dry. The second layer is the "temperature control" layer. This layer is for comfort and warmth and is where insulation is the key factor. Different thicknesses of polar fleece, which keeps the wearer warm, breathes, and dries quickly, are used most often in this layer. Finally, the third layer is for "element protection." This outer layer protects the wearer from wind, precipitation, and extreme temperature [1].

Industry standards are often rules of thumb, developed over many years, that offset many conflicting goals: what people will pay , manufacturing cost, local climate, traditional building practices, and varying standards of comfort. Both heat transfer and layer analysis may be performed in large industrial applications, but in household situations (appliances and building insulation), air tightness is the key in reducing heat transfer due to air leakage (forced or natural convection). Once air tightness is achieved, it has often been sufficient to choose the thickness of the insulating layer based on rules of thumb. Diminishing returns are achieved with each successive doubling of the insulating layer. It can be shown that for some systems, there is a minimum insulation thickness required for an improvement to be realized.

The type of clothing worn by people directly affects the heat loss from the human body to the environment. Clothing blocks conduction losses by trapping still air within fabric structures and between garment layers. Clothing also reduces radiant heat loss since each fabric layer serves as a thermal radiation barrier. Clothing impedes evaporative heat loss by restricting the evaporation of sweat that may be produced by the body. Dry or sensible heat loss refers to the first three types of heat loss; latent heat loss refers to the evaporative form. Only dry heat loss is addressed in this clothing study[1]. This research work explores and studies the Clothing insulation in various stages and uses the clothing dataset to find the prediction of accuracy in clothing insulation with the help of data mining techniques. Besides storing information concerning the properties of datasets, this database must also store information about the performance of base classifiers on the selected datasets. Data quality is an important aspect in clothing learning as in any machine learning task.

II. METHODS AND DATA DESCRIPTION

A. Description of Dataset

Data processing : The data types like nominal(text), numeric or mixed attributes and classes ,and the missing data has been filled with meaningful assumptions in the database. Specification of database with description and table structure as shown in Table 1.

B. Description of Data Mining

Data mining is the process of extracting patterns from data and it is becoming an increasingly important tool to transform these data into information. It is commonly used in a wide range of profiling practices, such as sales marketing, surveillance and scientific discovery [6].

B.1.The Function of Data Mining

The primary function of data mining is to assist in the analysis of collections of observations of behaviour Knowledge Discovery in Databases is used to describe the process of finding interesting, useful data [3]. Data mining commonly involves five classes of tasks:

- Classification: to arrange the data into predefined groups. Common algorithm include Decision Tree Learning, Nearest neighbour, naive Bayesian classification and Neural network.
- Clustering: to classify the groups while the groups are not predefined. The algorithm should try to group similar items together.
- Regression: to find a function which models the data with the least error.
- Association rule learning: to searches for relationships between variables.
- Predictive analytic: to exploit patterns found in historical and transaction data to identify risks and opportunities, and analyse current and historical facts to make predictions about future events[4].

B.2. The Application of Data Mining

Data mining can be used to uncover patterns. The increasing power of computer technology has increased data collection and storage. Automatic data processing has been aided by computer science, such as neural networks, clustering, genetic algorithms, decision trees and support vector machines. Data mining is the process of applying these methods to the intention of uncovering hidden patterns [5]. It has been used for many years by businesses, scientists to sift through volumes of data. The application of data mining in fashion product development for detection analysis, forecasting by using classification and prediction methods by algorithms as shown in Fig. 1.

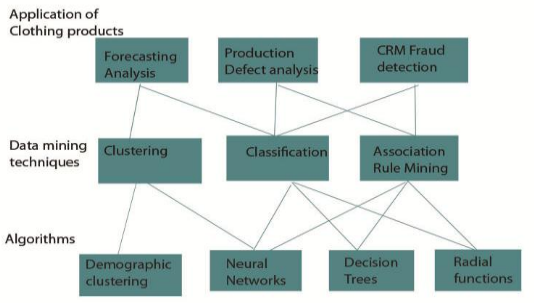

Fig. 1 Application of data mining in fashion Products

B.3. Steps of Data Mining

Data Mining process involved in various steps as follows:

- Data Integration: First of all the data are collected and integrated from all the different sources.
- Data Selection: We may not all the data we have collected in the first step.
- Data Cleaning: The data we have collected are not clean and may contain errors, missing values, noisy or inconsistent data.
- Data Transformation: The data even after cleaning are not ready for mining as we need to transform them into forms appropriate for mining. The techniques used to accomplish this are smoothing, aggregation, normalization etc.
- Data Mining: Now we are ready to apply data mining
- techniques on the data to discover the interesting patterns.
- Pattern Evaluation and Knowledge Presentation: This step involves visualization, transformation, removing redundant patterns etc. from the patterns we generated.
- Decisions / Use of Discovered Knowledge: This step helps user to make use of the knowledge acquired to take better decisions[9].

TABLE 1. SPECIFICATION OF DATABASE

Field No.	**Field Name**	**Description**	**Data Type**
1	Garment Code	To refer the garment type according to their category	Numeric
2	Design Description	The type of garment (eg. Shirts, Trousers, Sweatersetc)	Nominal (Text)
3	Fabric type	the particular garment construction style features	Nominal (Text)
4	Garment Weight	weight of the garment which is used as an predictor of insulation. The present study garment weight ranged from 0.03 to 1.54 kg.	Numeric
5	Body Surface Area	The amount of body surface area covered by garments which is given in (%) for clothing insulation, It is also used as a predictor of the insulation.	Numeric
6	Fcl	Clothing area factor – the increased surface area for heat loss, and the number of fabric layers in the garment (e.g., pockets, lining)	Numeric
7	I T	Total insulation (Total thermal insulation of clothing plus air layer, clo) IT =(k (Ts – Ta) As) / Q	Numeric
8	I cle	Effective clothing & insulation Icle = IT – Ia	Numeric
9	Icl	Basic or intrinsic clothing insulation(amount of body surface area)Icl = IT – (Ia/Fcl)	Numeric

III.CLOTHING INSULATION

A. Factors for Clothing Insulation

Dependent upon specific clothing design the insulation will be provided by individual garments , which in turn, affects the amount of body surface area covered by the garment, and the fit (loose or tight), the increased surface area for heat loss (i.e.,Fcl), and the number of fabric layers in the garment (e.g., pockets, lining). Garment insulation is also related to characteristics of fabric—particularly the thermal resistance or thickness of the fabric. In addition to other fabric properties such as stiffness can affect the increase in surface area for heat loss, and extensibility can change garment fit (i.e., skin contact vs. air gap).

The insulation provided by a clothing system is usually expressed in clo units, with 1 clo = 0.155 m2 K/V [2].The insulation provided by clothing ensembles is related to the characteristics of the component garments including their insulation values, the amount of body surface area covered by clothing, the distribution of the insulation over the body (i.e., number of fabric layers on different parts of the body), looseness or tightness of fit, and the increased surface area for heat loss. Several of these factors can be varied for a given ensemble by changing the way the garments are worn on the body (i.e., degree of garment closure, sequence of garment layering) [1].

B. Heated Manikins

Electrically-heated manikin in an environmental chamber is always recommended method measuring for clothing insulation. The manikin is a constant temperature method of. It would be heated internally to simulate the skin temperature distribution of a human being. The amount of power that it takes to keep the manikin's average skin temperature at the proper level (i.e. approximately 33°C) in a cooler environment is recorded. The power level will vary in proportion to the amount of insulation provided by the clothing worn by the manikin. Manikins in use today are designed primarily for treasuring the resistance to dry heat transfer. However, some researchers have determined the resistance to evaporative heat transfer provided by clothing using a "sweating" manikin [7].

C. Selection of Garments

A variety of garment designs were made into summer and winter seasons using different fabrics. The designs were selected by considering the following

- variation in the amount of body surface area covered,
- longevity of style with regard to fashion obsolescence,
- looseness or tightness of fit, and
- fabric overlap.

Nightwear (i.e.,robes, nightgowns, and pajamas), common work garments, (i.e., coveralls and overalls), and special garments (i.e., sweatshirt and sweatpants) also were representative knits for these garments are not available in the fabric market. Sweater design comparisons for sleeve length were made by shortening the sleeves of additional long-sleeve sweaters that were purchased. The undergarments were also purchased ready-made because it would be difficult if not impossible to construct representative items in a clothing laboratory (e.g., bra), and these items were inexpensive and readily available in retail outlets. Miscellaneous garments were purchased readymade because they were not directly compared to one another. Clothing items for the head and hands were not included because these garments cover only a small amount of body included since clo values for these types of garments are not listed in the dataset. Some of the garments such as long trousers were constructed into summer (cool) and winter (warm) seasons. Others are worn only during one season (e.g., short shorts), or they are worn all year round with no seasonal fabric variation (e.g., sweatshirt).These types of garments were constructed or purchased in only one characteristic fabric. According to the seasons different types of garments would be used by consumers , this analysis examined by Clothing merchandisers. The sweaters were purchased ready-made because surface area and are rarely worn by people in indoor environments[1].

D. Measurement of the Body Surface Area

The manikin's surface will be modified so that the body surface area covered by a garment could be determined from photographs. A stylus was used to etch the manikin's surface into a grid of small areas, most of which measured 3 x 3 cm. The body was also divided in to a grid of small areas, most of which measured 3 x 3 cm. The body was also divided into 17 major segments as shown in Fig 2. The location and surface area of each square and segment was recorded. White tape was then used to cover the markings etched into the anodized copper to make them more visible Fig 3.

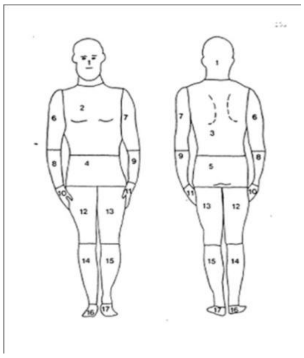

Fig. 2. Segments of manikin[1]

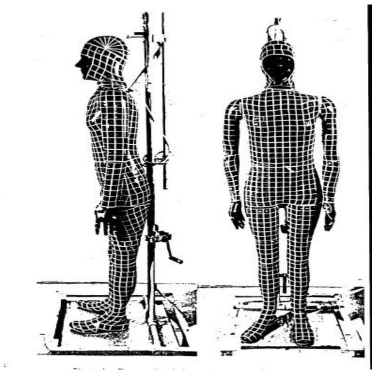

Fig. 3.Anodized copper manikin[1]

IV. EXPERIMENT AND RESULTS

A. Distribution of Classes

The main reason to use this dataset is that the relevant data that can easily be shared with other researchers, allowing all kinds of techniques to be easily compared in the same baseline. The data-set might have been criticized for its potential problems, but the fact is that it is the most widespread dataset that is used by many researchers and it is among the few comprehensive datasets that can be shared in clothing insulation. Like the test dataset, 302 different types of garments that are broadly categorized in nine groups of Shirts, Sweaters, Sleepwear, Dresses, Robes, Skirts, Suit Jackets and Vests ,Trousers and Coveralls , Underwear/Footwear. The Distribution of Classes in the actual training data for classifiers evaluation and the occurrences as given in Table II. The percentage of Garment Design Categories using Pie chart as shown in Fig.4.

The clothing information in the original Database files were summarized into associations. Therefore, each instance of data consists of garment features and each instance of them can be directly mapped and discussed in classifiers algorithms. Due to the huge number of audit data records in the original database, 302 instances have been extracted as datasets for this experiments.

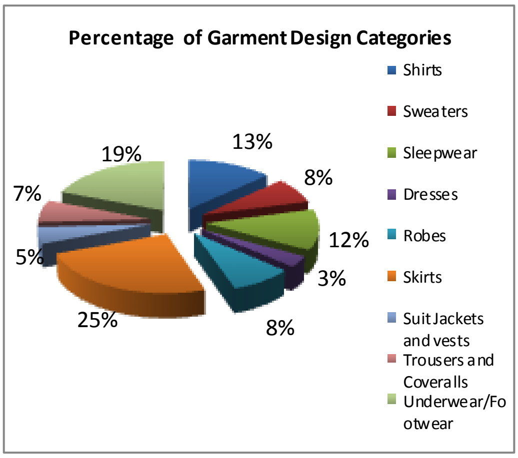

Fig. 4 Percentage of Garment Design Category

TABLE II. DISTRIBUTION OF CLASSES IN THE ACTUAL TRAINING SET

Garment Design Category (Class)	No. of Records	Percentage of Class Occurrences (%)
Shirts	40	13
Sweaters	23	8
Sleepwear	37	12
Dresses	10	3
Robes	25	8
Skirts	74	25
Suit Jackets and vests	15	5
Trousers and Coveralls	20	7
Underwear/Footwear	58	19
Total	302	100

B. Data Mining Process

For the experimental setup the collected data preprocessed for data cleaning, transformation, pattern evaluation and knowledge discovery using the data mining software called weka 3.6.4 which has been implemented in Java with latest windows 7 operating system, These dataset has been applied and then evaluated for accuracy by using 10-fold CrossValidation strategy[8]. The predicted result values of various classifiers with prediction accuracy as given Table III.

TABLE III. DATA MINING CLASSIFIERSWITH PREDICTION ACCURACY

Functions	Correlation coefficient	Mean absolute error	Root mean squared error
Linear Regression	0.9663	0.0094	0.0545
Leastmedsq	0.8936	0.0437	0.1059
Multilayerperceptran	0.9984	0.0024	0.012
RBFNetwok	0.5566	0.1288	0.1745
Additive Regression	0.9676	0.0422	0.0548

C. Regression Analysis

This comprehensive dataset to develop equations for predicting clothing insulation. Consequently, regression analyses were conducted using data collected. The garment data set are representative of the types of clothing worn by a people in indoor environments. Therefore, the regression equations reported here should be applicable to most types of clothing. When a particular equation does not work well for certain types of clothing (i.e., as evidenced by a few data points located way of the regression line on the graph), the exceptions will be noted and explained. Removal of any data has not done from garment set because of an effort to strengthen or improve the predictive ability of an equation. A number of variables that could be related to garment insulation were used to develop a series of linear and quadratic regression equations. The equations were developed with the Y intercept equal to zero (or whatever the origin should theoretically be) and with the actual Y intercept based on the data set. Both types of equations were developed so that trade-offs in the simplicity and, accuracy of the equations could be evaluated. Surprisingly, none of the quadratic forms of the equations offered any significant improvement in predictability over the linear equations with a Y intercept.

D. Experimental Outcomes

This section presents experimental results using data mining function classifiers LeastMedSq, Linear Regression with different base classifiers along with the results obtained from various existing algorithms. Data mining classification result for current regression equations as given in Table IV. and comparisons of existing dataset regression measures are shown in Table V. Performance of classifier instances with highest prediction accuracy as correlation coefficient and mean absolute error as shown in Fig. 5.

TABLE IV. DATA MINING CLASSIFICATION RESULT OF CURRENT EQUATIONS

Method	**Equation**	**Slope**	**Intercept**
Linear Regression	Fcl= 0.448*Icl+1.01	0.448	1.01
Linear Regression When y intercept 1.00	Fcl= 0.458*Icl+1.00	0.458	1.00

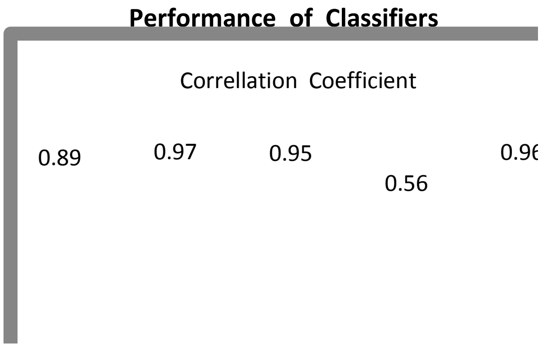

Fig.5.Performance of Classifiers with Prediction Errors

TABLE V. COMPARISON OF RESULT MEASURES WITH EXISTING REGRESSION EQUATIONS

Method	**Equation**	**Slope**	**Intercept**
LeastMedSq	Fcl= 0.584*Icl+0.981	0.584	0.981
Linear Regression	Fcl= 0.480*Icl+1.002	0.480	1.002

V. CONCLUSION AND DISCUSSION

It is observed from the results obtained by experimentation is that the Linear Regression is quiet effective in terms of high prediction performance rate. Linear Regressions able to discover the clothing insulation performance in a most efficient manner in comparison to all other leaning algorithms discussed in this work. Thus resulting effects on clothing insulation is derived with remarkable prediction accuracy by using the data mining classification technique. More work is needed to relate manikin data on clothing insulation to human subject data for thermal comfort, particularly in factory environments. Clothing insulation has been done on stitched garments with manikin or human subjects the same could be applied in simulated computer model with changes in clothing system by using various design software's. Classifiers have shown comparable performance in reducing classification error from selected classifiers. Therefore this study reinforces that, Data mining is the perfect and prevailing technological tool to implement the clothing insulation factors to reveal the prediction rapidly for the accurate result that would facilitate to make the precise clothing products in the apparel sector.

REFERENCES

[1] Elizabeth A.,McCullough and Byron W.Jones.,A Comprehensive database For Estimating Clothing Insulation, 32-5620,1984.

[2] M. KantardzicData Mining:Concepts, Models, Methods and algorithms. John Wiley & Sons, pp.62-81,2003,

[3] Jiao Licheng and Liu Fang,bData Mining and Knowledgediscovery. Xian University of Electric Technology Publishing, pp.25-7.,2006.

[4] L. Devroye, L. Györfi and G. Lugosi, A Probabilistic Theory of pattern Recognition. Springer- Verlag,: pp.112-149,1996.

[5] Liang Xun,DataMining:Algorithms and Application. Beijing university Press: pp.22-42,2006.

[6] http://dataminingwarehousing.blogspot.com/2008/10/data-mining.

[7] McCullough, E.A.; Arpin, E.J.; Jones, B.; Konz, S.A.; andRohles, F.E., Jr.Heat transfer characteristics of clothing worn in hot industrialenvironmnts ASHRAE Transactions,Vol.88,Part 1,pp1077-1094,1982.

[8] H.Dai, R.Srikant, and C.Zhang (Eds.) Evaluating the Replicabilityof Significance Tests for comparing learning algorithms, PAKDD 2004,LNAI 3056,pp. 3-12 2004