An Inductive Method and Database in Energy Management

Geo V. Kunev[1]

Abstract – **Most of human activities are related to consumption of energy. The sources of energy are electric current, gas, oil, etc. The consumers of energy can be industry, house heating, etc. The main goal of Energy management is to achieve the balance between sources and energy consumers, providing the desired quality and minimum of charges. An application of inductive approach in form of classifying algorithm and developing of appropriate database for estimation of buildings thermo-isolation with use of infrared thermography is given.**

Keywords – **Infrared thermography, Energy management**

I. Introduction

The tasks of Energy management can be supported in different wais – from home energy budget calculations, through the computer based office systems, to using the most advanced methods of applied mathematics, and - in this case – using of inductive approach in form of Databases and Data mining techniques [4] to made statistical estimations and decisions on buildings thermo isolation quality.

II. An Unified Classification Method

Today's approach in searching complex estimations, based on databases, is Data mining, or KDD. It uses most sophisticated statistical and other methods for machine learning and estimating of different cases and factors. The used method is some unification of different statistical methods for classification, accenting on the same calculating formulas and procedures [1]. It combines the most frequently used statistical approaches – the Bayes probability, and geometry interpretation (Fig.1).

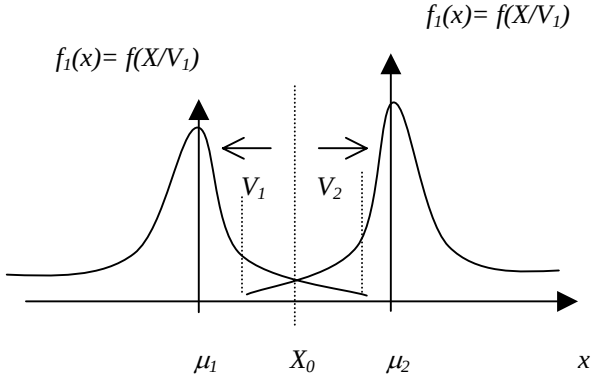

Fig. 1. Two classes classification

In the simplest case, we have two classes V_1 and V_2 and we need to find the boundary line and value X_0 , which divides the classes. We can use estimation:

$$X \in V_1, \text{ if } X<X_0 = \frac{\mu_1 + \mu_2}{2}; \quad X \in V_2, \text{ if } X>X_0 \qquad (1)$$

In the Bayes interpretation, the classification can be done, knowing aposteriori probabilities:

$$X \in V_1, \text{ if } P_i f(X/V_i) > P_j f(X/V_j); \ (i,j_{i\neq j}=1,2) \qquad (2)$$

where P_i и P_j – are apriory probabilities for V_1 и V_2. classes' appearance.

Except some cases [5]: (3)

$$X \in V_1, \text{ if } \frac{X^2}{2}\left(\frac{1}{\sigma_2^2}-\frac{1}{\sigma_1^2}\right)+X\left(\frac{\mu_1}{\sigma_1^2}-\frac{\mu_2}{\sigma_2^2}\right)+\left(\frac{\mu_2^2}{2\sigma_2^2}-\frac{\mu_1^2}{2\sigma_1^2}\right)>\ln\frac{P_2}{P_1}$$

If $\sigma_1=\sigma_2=\sigma$, *.and* $P_1=P_2$, we have a minimax strategy.

III. Infrared Thermography

To estimate the thermo isolation quality of buildings, we use the modern infrared thermography technology [2]. This way, we can directly view the outer walls thermo-conditions, and make digital comparison with the example image (Fig.2).

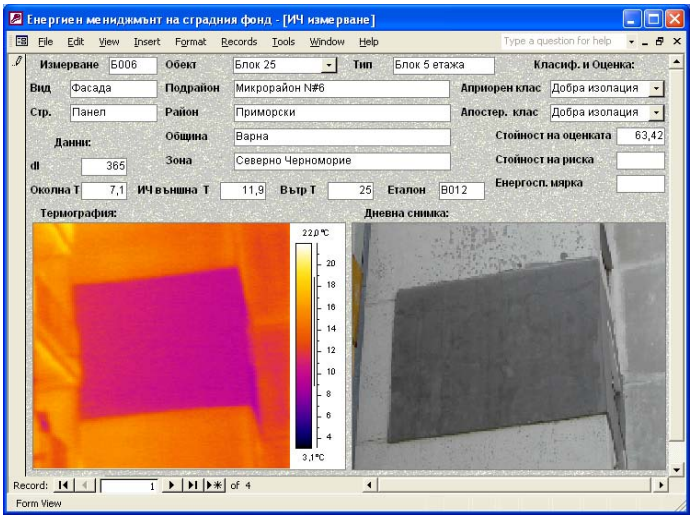

Fig. 2. Using infrared thermography

[1]Geo Kunev is with the Faculty of Computer Sciences, TU Varna, Studentska 1, 9000 Varna, Bulgaria, E-mail: geo_qnew@hotmail.com

The images are of two types – IR (infrared), and daylight (Fig.2). The estimating procedure is based on:
1. Digital distance to the example image,
2. Average outer walls temperature,
3. Ambient temperature,
4. Average inner walls temperature

The inductive method was verified in the form of MatLab programs, experimenting with two and more a priory classes and different number of classification factors. The most effective variant is described here (in brief):

```
l12=load('12'); l22=load('22');
mean_1=mean(l12); mean_2=mean(l22);
cov_1=cov(l12); cov_2=cov(l22);
s1=size(l12); s2=size(l22);
cov_pretegl=(cov_1.*s1(1)+cov_2.*s2(1))./(s1(1)+s2(1));
A=inv(cov_pretegl)*(mean_1-mean_2)'
B=1/2.*(mean_1+mean_2)*A
lt1=load('12tst');
lt2=lt1*A-B;
lt3=(lt1*A-B)*[1 1];
for i=1:size(lt2);
  if(lt3(i,1)>0) lt3(i,2)=1;
  else lt3(i,2)=2;
  end
end
lt3
```

IV. Developing Databases

The task of inductive estimating needs many data, to provide the process of training the system. So, a database was developed to hold data and images (Fig.3). Except the above mentioned data, we need some more data:
1. Types of buildings,
2. Types of construction,
3. Areas,
4. Zones,
5. Other.

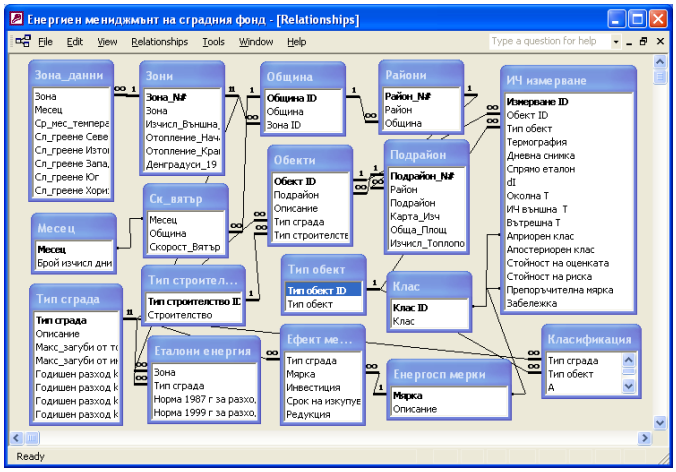

Fig. 3. Energy management database

The same database is used to support the estimation of common buildings heat consumption of the city of Varna [3], and to advance the appropriate strategy (Fig.4.)

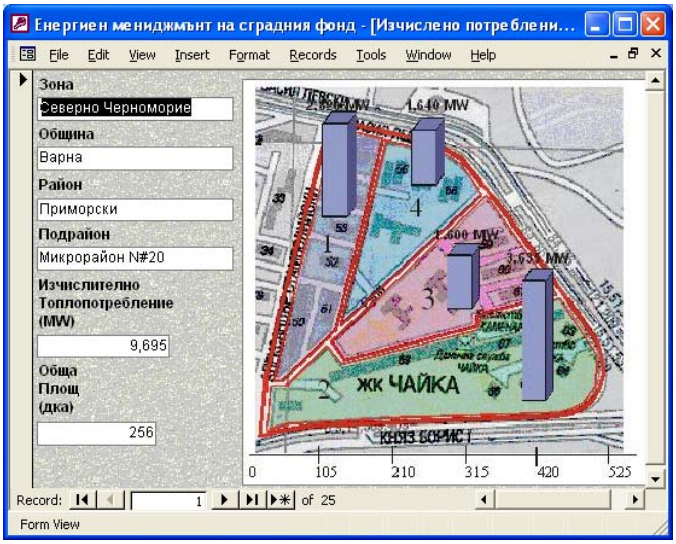

Fig. 4. Heat consumption estimation of Varna city

The used method and the developed database prototype demonstrate the power of combining the latest IT technology in form of databases and data mining techniques with classical thermo-analysis tools, as Ashrae [6].

V. Conclusion

Usage of unified inductive method for estimation offers relatively easy way to estimate the thermo isolation of buildings, but we need first to have data to provide the system training. The developing of inductive databases [4], enabling both data and knowledge support, is a way to achieve better effectiveness.

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