<div align="right">ALGORITHM 28</div>

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CALCULATING THE MEASURE OF ECONOMIC MATURITY

1. Procedure declaration. Procedure *Mrgos* calculates for every object P_i of the set $Z = \{P_1, P_2, ..., P_n\}$, where $P_i = (x_{i1}, x_{i2}, ..., x_{im})$, the measure of economic maturity d_i. The method used is that of [1].

Data:

m — number of features characterizing an object,

n — number of objects,

$x[1:n, 1:m]$ — data matrix,

$B[1:m]$ — Boolean array; $B[j]$ is **true** if feature j is a stimulant and is **false** if feature j is a distimulant.

Results:

$d[1:n]$ — measures of economic maturity of the objects of set Z.

2. Method used. Following [1], the measure of economic maturity of object P_i is defined as

$$d_i = 1 - \frac{d_{i0}}{c},$$

where

$$d_{i0} = \sqrt{\sum_{j=1}^{m} (y_{ij} - y_{0j})^2}, \quad c = \bar{d} + 2\sqrt{\sum_{i=1}^{n} (d_{i0} - \bar{d})^2/n}, \quad \bar{d} = \sum_{i=1}^{n} d_{i0}/n.$$

The quantities y_{ij} $(i = 1, 2, ..., n; j = 1, 2, ..., m)$ are calculated from the formulae

$$y_{ij} = \begin{cases} x_{ij} - \bar{x}_j & \text{if } s_j = 0, \\ \dfrac{x_{ij} - \bar{x}_j}{s_j} & \text{if } s_j > 0, \end{cases}$$

where

$$\bar{x}_j = \frac{1}{n} \sum_{i=1}^{n} x_{ij}, \quad s_j = \sqrt{\sum_{i=1}^{n} (x_{ij} - \bar{x}_j)^2/n}.$$

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procedure Mrgos(m,n,x,B,d);
value m,n;
integer m,n;
Boolean array B;
array d,x;
begin
  integer i,j;
  real r,r1,S,V;
  Boolean R;
  for j:=1 step 1 until n do
  d[j]:=.0;
  for i:=1 step 1 until m do
  begin
    S:=r:=x[1,i];
    V:=r×r;
    R:=B[i];
    for j:=2 step 1 until n do
    begin
      r1:=x[j,i];
      S:=S+r1;
      V:=V+r1×r1;
      if r1>r≡R
        then r:=r1
    end j;
    S:=S/n;
    V:=V/n-S×S;
    V:=if V>.0 then 1.0/V else 1.0;
    for j:=1 step 1 until n do
    begin
      r1:=x[j,i]-r;
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d[i]:=d[j]+r1×r1×V

   end j

   end i;

S:=V:=.0;

for j:=1 step 1 until n do

   begin

      d[j]:=r:=sqrt(d[j]);

      S:=S+r;

      V:=V+r×r

   end j;

S:=S/n;

S:=1.0/(S+2.0×sqrt(V/n-S×S));

for i:=1 step 1 until n do

   d[i]:=1.0-S×d[i]

end Mrgos
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The quantities y_{0j} $(j = 1, 2, \ldots, m)$ are defined as follows:

$$y_{0j} = \begin{cases} \max_{1 \leqslant i \leqslant n} y_{ij} & \text{if feature } j \text{ is a stimulant,} \\ \min_{1 \leqslant i \leqslant n} y_{ij} & \text{if feature } j \text{ is a distimulant.} \end{cases}$$

3. Verification. Procedure *Mrgos* has been verified on many examples and correct results have been obtained after translation on the Odra 1204 computer.

Reference

[1] Z. Hellwig, *Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju i strukturę wykwalifikowanych kadr*, Przegl. Statyst. 15 (1968), p. 307-327.

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MIARY ROZWOJU GOSPODARCZEGO

STRESZCZENIE

Procedura *Mrgos* oblicza dla każdego obiektu P_i zbioru $Z = \{P_1, P_2, \ldots, P_n\}$, gdzie $P_i = (x_{i1}, x_{i2}, \ldots, x_{im})$, miary rozwoju gospodarczego d_i, metodą opisaną w [1].

Dane:

    m — liczba cech,

    n — liczba punktów,

$x[1:n, 1:m]$ — macierz danych,

$B[1:m]$ — tablica boolowska o wartościach

$$B[j] = \begin{cases} \textbf{true,} & \text{gdy } j\text{-ta cecha jest stymulantą,} \\ \textbf{false,} & \text{gdy } j\text{-ta cecha jest destymulantą.} \end{cases}$$

Wyniki:

$d[1:n]$ — miary rozwoju gospodarczego obiektów zbioru Z.

Obliczenia, wykonane na maszynie cyfrowej Odra 1204, wykazały poprawność procedury.