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PROJECTION MODELING PROGRAMS OF ECONOMIC FACTORS, EFFECTIVELY CONSIDERING MUTUAL INFLUENCE OF ELEMENTS OF A DYNAMIC RANGE.

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Algorithms for linear and quadratic prediction were presented in [1]. An example of the application of discrete linear prediction to the competitiveness of agricultural enterprises with the number of indicators k = 24 is considered. According to the annual statistics for 2012-2016 for all indicators k = 24, a sample implementation representing the relative errors of the actual data to the prognostic values was formed.

Based on the nature of the prediction model being studied, the distribution of the relative error of the actual value to the prognostic one can only be said to belong to a certain family of distributions. We modify the task [1] under the priority direction of modern Kazakhstan studies, one of which is the competitiveness of agricultural enterprises. To increase the efficiency of production of agroindustrial complex, a comprehensive approach to this task is needed.

1 Discrete quadratic prediction

Here are three ways of simple discrete linear prediction. Let t_{n-1}, t_{n-2}, t_{n-3},..., t_{n-l},... - decreasing sequence of time units t_{i+1}-t_i= t_i-t_{i-1}, and are determined respectively at each time point of the vector b_{n-1}, b_{n-2}, b_{n-3},..., b_{n-l},..., where $b_j=(b_{j,1},...,b_{j,k})$ is a k-dimensional vector indicator of the economic state in t_j moment of time.

We denote by $\mathbf{h}(t)=(h_1(t), h_2(t),..., h_q(t))^T$ - vector-column of cosmic indicators at time point t. Suppose that $q\geq n$.

We introduce a rectangular matrix X, consisting of k rows and q columns where

$$\begin{cases} \mathbf{X}\cdots\mathbf{h}(t_{n-k}) = \mathbf{b}_{n-k}, \\ k=1,...,l. \end{cases} \tag{1}$$

Equation (1) is algebraic. This system always has a solution (possibly infinitely many) for reasonably larger q.

It is possible to slightly modify the next linear prediction of several more parameters into the vector $\mathbf{b}(i)$. The reason for adding such parameters is when the more accurate prediction depends on these parameters (see [1]). For this reason, we now consider the case where the prediction $\mathbf{b}_{n-i}$ is sought as a polynomial not higher than the second power of the vector $\mathbf{b}(i+1)$. This task is based on quadratic prediction. We define the vector $\mathbf{b}(i)$ as follows:

$$\mathbf{b}(i) = \left(b_{n-i,1},...,b_{n-i,k}, b_{n-i-1,1},...,b_{n-i-1,k},...,b_{n-i-l+1,1},...,b_{n-i-1+1,k}, a_{kl+1,i},...,a_{C_{kl}^2+kl,i}\right)$$

Where numbers $a_{kl+1,i},...,a_{C_{kl}^2+kl,i}$ are defined as all possible $\mathbf{b}(i+1)$ $\mathbf{b}_{n-i}$. $\mathbf{b}(i)$ two products from the collection: $\{b_{n-i,1},...,b_{n-i,k}, b_{n-i-1,1},...,b_{n-i-1,k},...,b_{n-i-l+1,1},...,b_{n-i-1+1,k}\}$ The length of the vector b (i) is

$$C_{kl}^2 + 2kl ,$$

where

$$C_p^q = \frac{p!}{q!(p-q)!} .$$

For example, for i = 3 and k = l = 2, we have

$$\mathbf{b}_2 = \begin{pmatrix} b_{2,1} \\ b_{2,2} \end{pmatrix}, \mathbf{b}_1 = \begin{pmatrix} b_{1,1} \\ b_{1,2} \end{pmatrix}$$

and

$$\mathbf{b}(3) = \left(b_{2,1}, b_{2,2}, b_{1,1}, b_{1,2}, (b_{2,1})^2, (b_{2,2})^2, (b_{1,1})^2, (b_{1,2})^2, b_{2,1}b_{2,2}, b_{2,1}b_{1,1}, b_{2,1}b_{1,2}, b_{2,2}b_{1,1}, b_{2,2}b_{1,2}, b_{1,1}b_{1,2}\right).$$

The length of this vector is

$$C_{2\cdot 2}^2 + 2\cdot 2\cdot 2 = 14.$$

For the future it will be convenient to assume that the squares in the vector $\mathbf{b}(i)$

$$\left\{(b_{n-i,1})^2, ..., (b_{n-i-1+1,k})^2\right\}$$

are in the vector b (i) immediately after the element $b_{n-i-l+1,k}$, as in the example considered for i = 3 and k = l = 2, and then all the other elements in a certain sequence. Next, we look for a matrix X having k rows and

$$C_{kl}^2 + 2kl$$

columns from the system

$$\begin{cases} \mathbf{b}_{n-i} = \mathbf{X}\cdot\mathbf{b}(i+1), \\ i = 1, ..., C_{kl}^2 + 2kl. \end{cases} \quad (2)$$

It would be possible to solve system (2) in the same way as was the case with linear prediction, but it is possible to represent system (2) in a different form, which will be useful in questions of parallelization (see [1]). For this we denote by $\mathbf{x}^j$ (j=1,...,k)- a vector composed of the j-th row of the matrix X:

$$\mathbf{x}^j = \left(x_{j,1}, ..., x_{j,C_{kl}^2+2kl}\right)$$

Then system (2) can be rewritten in the following form

$$\begin{cases} \mathbf{B}_j\mathbf{x}^j = g_j, \\ j = 1, ..., k. \end{cases}$$

where $\mathbf{B}_j$- square matrix of $C_{kl}^2 + 2kl$ order.

2 Comparative statistical analysis of linear and quadratic predictions

Here is considered the statistics Gross output of products (services) of agriculture, forestry and fisheries of the Republic of Kazakhstan from 2012-2016 where indicators are k = 24. Table 1 presents statistical data for the annual average.

Table 1 - Gross output of products (services) of agriculture, forestry and fisheries in the Republic of Kazakhstan from 2012-2016.

	2012	2013	2014	2015	2016
Index №1	2,22	2,37	2,53	2,68	2,84
Index №2	1,15	1,15	1,15	1,14	1,14
Index №3	2,15	2,16	2,18	2,19	2,21
Index №4	2,88	2,92	2,97	3,01	3,06
Index №5	2,87	2,87	2,87	2,87	2,87
Index №6	3,9	3,93	3,97	4	4,03
Index №7	2,03	2,03	2,03	2,03	2,03
Index №8	2,63	2,56	2,49	2,42	2,34
Index №9	5,31	5,35	5,38	5,41	5,45
Index №10	5,83	5,85	5,88	5,9	5,93

Index №11	3,26	3,22	3,18	3,15	3,11
Index №12	6,12	6,08	6,05	6,01	5,98
Index №13	7,67	7,76	7,84	7,93	8,01
Index №14	7,6	7,75	7,89	8,04	8,18
Index №15	7,61	7,58	7,56	7,53	7,51
Index №16	8,74	8,75	8,76	8,77	8,78
Index №17	8,02	8,03	8,05	8,06	8,07
Index №18	8,83	8,83	8,83	8,83	8,83
Index №19	10,74	10,6	10,45	10,31	10,16
Index №20	7,79	7,72	7,65	7,58	7,51
Index №21	10,95	10,79	10,64	10,48	10,33
Index №22	11,4	11,4	11,4	11,4	11,4
Index №23	12,9	12,96	13,02	13,07	13,13
Index №24	10,53	10,45	10,37	10,29	10,21

The information was taken from the archive blocks of the sale of valuable papers (see http://stat.gov.kz/faces/wcnav_externalId/homeNumbersAgriculture?_afrLoop=7038825192132302#%40%3F_afrLoop%3D7038825192132302%26_adf.ctrl-state%3D8sgxgly1i_50).

When considering the linear prediction algorithm, we have statistical data errors to linear prognostic values for 24 indicators, which are presented in Table 2.

Table 2 - Errors of statistical data to the forecast values of gross output of products (services) of agriculture, forestry and fisheries in the Republic of Kazakhstan from 2012-2016 for 24 indicators

	2012	2013	2014	2015	2016
Index №1	0,55	0,96	0,97	1,39	1,45
Index №2	0	0	0	0,88	0,88
Index №3	0,47	0,93	1,84	2,28	3,17
Index №4	0,34	0,32	0,63	0,6	0,88
Index №5	0	0	0	0	0
Index №6	0,77	1,53	2,52	3,25	3,97
Index №7	0	0	0	0	0
Index №8	0,36	0,34	0,32	0,28	0,64
Index №9	0,57	1,31	1,86	2,4	3,12
Index №10	0,51	0,86	1,36	1,7	2,19
Index №11	1,23	2,49	3,77	4,76	6,11
Index №12	0,17	0,18	0,35	0,36	0,55
Index №13	0,14	0,15	0,29	0,3	0,45
Index №14	0,14	0,16	0,31	0,34	0,5
Index №15	0,11	0,17	0,08	0,12	0,03
Index №16	0,11	0,23	0,34	0,46	0,57
Index №17	0,12	0,25	0,5	0,62	0,74
Index №18	0	0	0	0	0
Index №19	0,08	0,07	0,15	0,13	0,2
Index №20	0,12	0,24	0,37	0,49	0,61
Index №21	0,01	0,12	0,23	0,26	0,4

Index №22	0	0	0	0	0
Index №23	0	0,01	0,01	0,1	0,11
Index №24	0,09	0,08	0,07	0,6	0,004

Similarly, when considering the statistical data of the values of the gross output of agricultural, forestry and fisheries in the Republic of Kazakhstan, we have actual data errors to the quadratic prognostic values of the gross output of agricultural, forestry and fisheries in the Republic of Kazakhstan from 2012-2016 to 24 indicators, which are presented in Table 3.

Table 3 - Errors of actual data to the forecast values of gross output of products (services) of agriculture, forestry and fisheries in the Republic of Kazakhstan from 2012-2016 for 24 indicators

	2012	2013	2014	2015	2016
Index №1	0,45	0,23	0,67	1,23	1,05
Index №2	0,21	0,25	0,32	1,23	0,18
Index №3	0,21	0,36	0,23	2,23	2,63
Index №4	0,01	0,12	0,63	0,32	1,23
Index №5	0,06	0,13	0,53	0,23	0,23
Index №6	0,07	0,23	1,53	3,25	2,13
Index №7	0,12	0,32	0,23	1,23	0,23
Index №8	0,26	0,33	1,02	0,63	0,32
Index №9	0,05	0,21	0,26	2,3	2,36
Index №10	0,15	0,56	0,65	2,3	2,23
Index №11	1,13	1,16	0,77	2,32	2,36
Index №12	0,1	0,19	0,15	0,36	0,96
Index №13	0,12	0,16	0,19	0,52	0,89
Index №14	0,12	0,27	0,13	0,23	0,86
Index №15	0,01	0,36	0,02	0,32	0,45
Index №16	0,45	0,26	0,13	0	0
Index №17	0,52	0,36	0,63	0,12	0,85
Index №18	0,23	0,23	0,23	0	0,23
Index №19	0,56	0,17	0,12	0,21	0,32
Index №20	0,13	0,16	0,06	0,32	0,23
Index №21	0,05	0,13	0,05	0,36	0,23
Index №22	0,23	0,23	0,23	0,02	0,36
Index №23	0,36	0,23	0,12	0,02	0,23
Index №24	0,19	0,15	0,02	0,04	0,56

Therefore, when comparing tables 2 and 3, we have the following. When considering linear prediction using statistical processing (see, for example, [1]), the mean sample error is 0.66795, the mean sample variance is 1.098785 and the maximum value is 6.11. When considering quadratic prediction using statistical processing, the mean sample error is 0.520167, the average sample variance is 0.434561 and the maximum value is 3.25.

Thus, the latest facts of statistical processing indicate the advantage of quadratic prediction.

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THE SET OF UNBIASED ESTIMATORS FOR DISCRETE DISTRIBUTION OF SUMS OF RANDOM VARIABLES

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Multivariate model, as a reflection of the current reality, are essential to the description of many phenomena and situations encountered in daily life. In recent years, there were developed a considerable amount of probabilistic models [1-2]. Nevertheless, there are still many unresolved problems, when possible to observe only the sum of the components, which can not be detected by observation [3-5]. To date, probabilistic models describing such situations were not considered. Extremely relevant example of application of such a model is the advertising industry, where it is necessary to link the distribution of consumer interests with appropriate advertisements in various sources. Similar problems are very common in meteorology and other fields. In this article we present statistical evaluation of the distribution of the sum of random values $L_1, \dots, L_d$, where $L_1, \dots, L_d$ are not observable and observable only their sum. Thus, the results of the proposed work can solve many of these problems.

Suppose that an urn contains balls and each ball in the urn marked some value L_α. Also assume that the number of possible L_α there is d.

Let the elements of the vector p = ($p_1, \dots, p_d$) determine the probability of retrieving the ball boxes labeled respective values of $L_1, \dots, L_d$, and $\sum_{\alpha=1}^{d} p_\alpha = 1$.

Produces a sequence of extraction of n balls from the urn with the return, and it is not known exactly which balls were removed from the box. We only know the value of u, which represents the sum of the values of the n taken out of the urn balls. To study this situation requires the construction of a probability distribution u.

Assume that V_u is the number of possible combinations $r_{1v_u}L_1, \dots, r_{d\,v_u}L_d$, which together formed u, where $r_{1v_u}, \dots, r_{dv_u}$ determine the possible number of balls are removed, that bear the $L_1, \dots, L_d$. In other words, in [1] that is, the number of partitions V_u u on the part of $L_1, \dots, L_d$.

The probability that the random variable U takes the value u, there

$$P(U=u) = \sum_{v_u}^{V_u} n! \prod_{\alpha=1}^{d} \frac{p_\alpha^{r_{\alpha v_u}}}{r_{\alpha v_u}!}. \qquad (1)$$

Theorem. A function that is defined in (1) is a probability distribution.

Let $\mathbf{X} = (X_1, ..., X_k)$ represents a sampling volume of distribution n (1) and $\mathbf{x} = (x_1, ..., x_k)$ is the observed value of $\mathbf{X}$, where the elements x_i $(i = 1, ..., k)$ represent the sum of the values of the n balls consistently taken out of the urn with replacement. For each $i = 1, ..., k$ we define the number of partitions of V_i $\underline{x_i}$ values at $L_1, \dots, L_d$.

Vectors $\mathbf{r}_{1i}=(r_{11i}, \dots, r_{d1i})$, …, $\mathbf{r}_{Vi}=(r_{1Vi}, \dots, r_{dVi})$, defining these partitions, when $v_i=1, ..., V_i$, are solutions of the following system of equations