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# Using the Continuos Extrapolation Functions of Measurement Data on Prediction of the Sportmen Performances

Mariana R. Milici[1], L. Dan Milici[2], Mihai Crețu[3], Radu Pentiuc[4]

[1] *University of Suceava, Universitatii Street, 13, Suceava – 720229, Romania, mami@eed.usv.ro*
[2] *University of Suceava, Universitatii Street, 13, Suceava – 720229, Romania, dam@eed.usv.ro*
[3] *"Gh. Asachi" University of Iasi, Bd. Profesor Dimitrie Mangeron, nr. 51-53,, Iasi - 700050, Romania*
[4] *University of Suceava, Universitatii Street, 13, Suceava – 720229, Romania, radup@eed.usv.ro*

***Abstract-*** The sportsmen performances are evaluated through periodical tests. Based upon these tests we can draw conclusions referring to the way in which the sportsman answered to a certain training program, to the parameters which can be increased, to the accumulated tiredness level. To extrapolate these data in the sight to aim at the next evolution of the sportsman and to predict some next performances it must to find an evolution law for values controlled periodically till a certain moment. This prediction can be made for one or more tests, at the middle of the training period, so that the evolution from the second part or from the end of this period could be instituted, in order to prepare the new training program.

## I. Introduction

There are more approaches concerning the using of the informatics on sport domain, in the important fields of it, the most important being the analysis of training and competition. The biomechanical analysis instruments, data bases for documentation concerning the training and competition and the video techniques plays an essential part on the systems for studying of the sportsmen as part of teams, on individual sports and on sportive subjects.

Studying the specialty literature it was observed that in actual epoch, the sportive training process is based on the well organized activities, planned and lead by laws, principles and rules subordinated to biological, psychical and social sides, where are especially observed the progress of the motive aptitudes simultaneous with that intellectual and affective. This process must organized and planned with more attention during the period in which appears a series of biological, physical and psycho-motive changes in the sportsman body.

From the bibliographical analysis process it was constituted an ample supply concerning the organization and evolution of the sportive training at the high performance level, especially at the senior sportsmen. We consider that in the junior stage doesn't lent a sufficient attention for implementation of some methodologies based on informational technique and on the mathematical methods. The application of mathematical methods and of the computing techniques can contribute to training forecasting and to establish the selection, planning and psycho-motive training way, so to make the sportive performances obtaining to be efficient.

The scientific and technological evolution at an unimaginable pace, in the last ten-year period, the coming into being of extremely sophisticated devices changed the sports domain, holding out large variety and high quality ways. If till no long ago the sportsmen training had on the base the experience of a technical team more or less capable, today the computer became a necessity that plays a decisive part in some sports directions.

## II. Continuos extrapolation functions on prediction of the sportmen performances

Because in the large majority of cases the tests direct to a real function of real variable, the approximation of this characteristic, in the specified cases, consists in the approximation of a real function, approximation named interpolation too. The approximation of the certain real function is made by simple and easy utilized functions, especially through implementation of the computing of the values of this function. Because the real function set is a linear dimensional infinite space, while the function sets in which we look for the approximation are dimensional finite spaces, in actual fact, the abstract problem that stand on the base of approximation techniques consists in replacing of one element from an dimensional infinite space by representatives of one dimensional finite space. To can specify the "approximation" notion and to can appreciate the error made through the above specified replacing, the using of "norm" mathematical concept is needed.

## A. Mathematical methods for functions approximation

Because in the large majority of cases the tests direct to a real function of real variable, the approximation of this characteristic, in the specified cases, consists in the approximation of a real function, approximation named interpolation too. The approximation of the certain real function is made by simple and easy utilized functions, especially through implementation of the computing of the values of this function. Because the real function set is a linear dimensional infinite space, while the function sets in which we look for the approximation are dimensional finite spaces, in actual fact, the abstract problem that stand on the base of approximation techniques consists in replacing of one element from an dimensional infinite space by representatives of one dimensional finite space. To can specify the "approximation" notion and to can appreciate the error made through the above specified replacing, the using of "norm" mathematical concept is needed.
Considering a real linear space *X*, we define on it the norm symbolical noted by:
$\| \| : X \to \Re$, having the properties (that satisfy the axioms):

$$\begin{aligned} &a)\|f\| \geq 0, \forall f \in X \\ &b)\|f\| = 0 \Rightarrow f = 0 \\ &c)\|\alpha f\| = |\alpha| \cdot \|f\|, \forall \alpha \in R, \forall f \in X \\ &d)\|f + g\| \leq \|f\| + \|g\|, \forall f, g \in X \end{aligned} \tag{1}$$

If on the linear space *X* it was defined the norm $\| \|$, *X* is a normalized linear space. On these terms we could specify the "approximation" of one function from normalized linear space *X*, defining what means a best approximation.
Considering the dimensional infinite functions space *X*, normalized by $\| \|$ and $X_m$ a linear subspace of *X*, dimensional finite with $dim\ (X_m) = m$, we define the notion of approximation of one function $f \in X$ by function $g_m \in X_m$ considering $\|f-g_m\|$ as a measure of the error that is made if instead of the function *f* is used the function $g_m$. It is naturally on these terms to say that $g_m$ is the best approximation of *f* if:

$$\|f - \overline{g}_m\| = \inf_{g_m \in X_m} \|f - g_m\| = \alpha_m \tag{2}$$

In many cases, in the function approximation theory is sufficient a hypothesis flimsier than the existence of one norm on the space *X* namely is sufficient the existence of one semi-norm on *X* that is a function noted also $\| \| : X \to \Re$, but satisfying only the axioms *a*, *b* and *d* from [1.1]. The existence and oneness of a best approximation is assured by the next theorems which will be enounced without demonstration.
Generally, when we know data on certain moments of time, we can find a continuous function that approximates the evolution of these data. Now there are known several kinds of approximation functions able to approximate data that have a certain evolution.

## 2. Optimal approximation of data obtained after sportsmen testing

The models used on sports are divided in two basic categories: in the firs are included the models which characterize the structure of the contest activity namely those that hint at various aspects of the sportive training, the morpho-functional models, that reflect the morphological particularities of the human body, therefore assuring the reaching after the level requested by the sportive performance. In the second category are included models which reflect the continuity and the dynamics of the sportive performance establishing and of the short, medium, long and very long time plane planning and the models of various training exercises with the foresight of their complexity.
The sportsmen performances are evaluated through periodical tests. Based upon these tests we can draw conclusions referring to the way in which the sportsman answered to a certain training program, to the parameters which can be increased, to the accumulated tiredness level. To extrapolate these data in the sight to aim at the next evolution of the sportsman and to predict some next performances it must to find an evolution law for values controlled periodically till a certain moment. This prediction can be

made for one or more tests, at the middle of the training period, so that the evolution from the second part or from the end of this period could be instituted, in order to prepare the new training program.
The extrapolation is very frequent used as a method to model and to obtained expertise data; therefore it will have in the future a more and more wide applicability on sports result forecasting. The forecasting applicability expectation will be closer by reality if it will be used prompter, more efficient and if it will use the informational technology possibilities, with the help of that will be processed and analyzed the sportive results obtained during a training macro-cycle or more macro-cycles even an Olympic cycle.
Knowing that the evolution of the human performances is made through leaps (discontinuous functions, with variable level thresholds that appear at different moments of time for the same sportsman and with variation difficult analyzed from a person to another), the time periods for which it is made the approximation must be longer than the time between two performance leaps of the tested sportsman, but at the same time must not include more than three evolution bearing because the prediction for a too longer time can't be made. Because the evolution step functions can not be approximated it is tried the approximation used continuous functions that coincide with the evolution functions at the edges of the approximation interval and in another maximum two points choosen into this interval (figure 1).

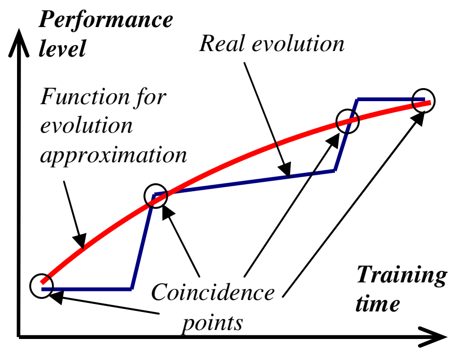

Figure 1.

Concerning the characteristics of the age of 14 - 16, the literature presents following aspects:
- height – the girl's growing speed decrease progressive;
- weight – continues to be increasing;
- the step growing speed changes, the bust having an increasing;
- the definitive body proportions are established;
- increase the thorax dimensions, the shoulders remain smaller;
- simultaneous with superior members the inferior members grow also, the span exceed the height with 2-3 cm;
- the locomotory system becomes more vigorous, the bone growing less as length and more as width;
- increase the muscle volume and force;
- the psychical functions becomes more active.

At the and of this period of high endocrine storm, the differences between sexes are installed oneself.
Based on the data sets drawn during the training period (months: September 2006, December 2006 and January 2006) for 12 swimming-girls with age between 14 and 16 years, it was evaluated the exponential approximation functions described into previous paragraphs. In the table 1 there are shown the functions used at data extrapolation.

Tabel 1. Psycho-motive tests

| *Surname and first name* | *Minimum speed controlling capability* | *Keeping the swimming speed with the feet* | *Maintaining on an established direction* | *Paddle step length testing* |
|---|---|---|---|---|
| A.A. | $0,1709\cdot e^{-0,1858\cdot x}$ | $0,0191\cdot e^{0,078\cdot x}$ | $9,7478\cdot e^{0,0045\cdot x}$ | $1,1283\cdot e^{0,0362\cdot x}$ |
| A.R. | $0,1538\cdot e^{-0,065\cdot x}$ | $0,0111\cdot e^{0,533\cdot x}$ | $9,8713\cdot e^{0,0038\cdot x}$ | $1,1968\cdot e^{0,0399\cdot x}$ |
| C.N. | $0,1951\cdot e^{-0,1233\cdot x}$ | $0,0111\cdot e^{0,533\cdot x}$ | $9,7966\cdot e^{-0,0036\cdot x}$ | $1,3158\cdot e^{0,031\cdot x}$ |
| B.R. | $0,1054\cdot e^{-0,00008\cdot x}$ | $0,0289\cdot e^{0,1554\cdot x}$ | $9,6982\cdot e^{0,0048\cdot x}$ | $1,0721\cdot e^{0,0446\cdot x}$ |
| S.D. | $0,134\cdot e^{-0,0769\cdot x}$ | $0,0265\cdot e^{-0,1625\cdot x}$ | $9,8059\cdot e^{0,0041\cdot x}$ | $1,1923\cdot e^{0,0132\cdot x}$ |
| V.E. | $0,1586\cdot e^{-0,1776\cdot x}$ | $0,512\cdot e^{-0,1154\cdot x}$ | $9,7079\cdot e^{0,0045\cdot x}$ | $1,0802\cdot e^{0,0484\cdot x}$ |
| R.S. | $0,1141\cdot e^{-0,0319\cdot x}$ | $0,0581\cdot e^{-0,053\cdot x}$ | $9,8227\cdot e^{0,0029\cdot x}$ | $1,2824\cdot e^{0,017\cdot x}$ |
| G.B. | $0,1167\cdot e^{-0,014\cdot x}$ | $0,0415\cdot e^{-0,1554\cdot x}$ | $9,8882\cdot e^{0,0037\cdot x}$ | $1,3126\cdot e^{0,014\cdot x}$ |
| S.B. | $0,1595\cdot e^{-0,1192\cdot x}$ | $0,0368\cdot e^{-0,172\cdot x}$ | $9,8277\cdot e^{0,0034\cdot x}$ | $1,1344\cdot e^{0,0272\cdot x}$ |
| C.V. | $0,1631\cdot e^{-0,1872\cdot x}$ | $0,0472\cdot e^{-0,0903\cdot x}$ | $10,043\cdot e^{0,0011\cdot x}$ | $1,0754\cdot e^{0,0221\cdot x}$ |
| S.A. | $0,142\cdot e^{-0,1035\cdot x}$ | $0,0881\cdot e^{-0,2113\cdot x}$ | $9,8321\cdot e^{0,0055\cdot x}$ | $1,1258\cdot e^{0,0234\cdot x}$ |
| T.A. | $0,1106\cdot e^{-0,0767\cdot x}$ | $0,0552\cdot e^{-0,0068\cdot x}$ | $10,098\cdot e^{-0,0094\cdot x}$ | $1,1283\cdot e^{0,0362\cdot x}$ |

Table 2 shows the taken and approximated data and the obtained errors. In figure 2 there are graphical representations achieved based on the data taken on sportsmen and the achieved extrapolations, using previously presented functions, in order to observe the way in which the extrapolation function overlaps the real graphic. With more intense colour was represented the curve given by extrapolation. We can observe from the overlapping of these two curves that the approximation error is small, it decreasing for approximated value on the eighth moth from the beginning of the training program.

Tabel 2. Maintaining on an established direction

| MAINTAINING ON AN ESTABLISHED DIRECTION [m] | | | | | PREDICTION |
|---|---|---|---|---|---|
| PERIOD | | sep.05 | dec.05 | jan.06 | may.06 |
| SURNAME AND FIRST NAME | AGE | 0 | 3 | 4 | 8 |
| A.A. | 14 | 9,75 | 9,87 | 9,93 | 10,11 |
| A.R. | 15 | 9,88 | 9,95 | 10,05 | 10,18 |
| C.N. | 14 | 9,8 | 9,89 | 9,95 | 10,08 |
| B.R. | 14 | 9,7 | 9,83 | 9,89 | 10,08 |
| S.D. | 16 | 9,81 | 9,91 | 9,98 | 10,13 |
| V.E. | 15 | 9,72 | 9,79 | 9,92 | 10,06 |
| R.S. | 15 | 9,82 | 9,92 | 9,93 | 10,05 |
| G.B. | 16 | 9,9 | 9,95 | 10,07 | 10,19 |
| S.B. | 16 | 9,83 | 9,92 | 9,97 | 10,10 |
| C.V. | 15 | 10,05 | 9,98 | 10,02 | 10,13 |
| S.A. | 14 | 9,64 | 9,76 | 9,87 | 10,07 |
| T.A. | 14 | 10,12 | 9,73 | 9,79 | 9,37 |
| AVERAGE | 14,83 | 9,84 | 9,88 | 9,95 | 10,0449 |

*The Matorin test* is a psycho-motive test in which is evaluated the general co-ordination and consists in accomplishing of one jump with vertical detachment from the spot followed instantaneous by a rotation as ample as possible around of longitudinal axle of body. A 30-40 cm long line is drawn on the ground on which is putted the sportsman-subject, with the soles fixed on a side and the other side of the line. The measurement is made with a ruler and a compass (protractor) with the help of which could be recorded the values in degree, accomplished in both senses, after the jump with left and right rotation. The estimation and qualitative evaluation scale wil be: $180^0 – 270^0$ suficient mark (S), $270^0$ - $360^0$ good mark (G), over $360^0$ very good mark (VG).

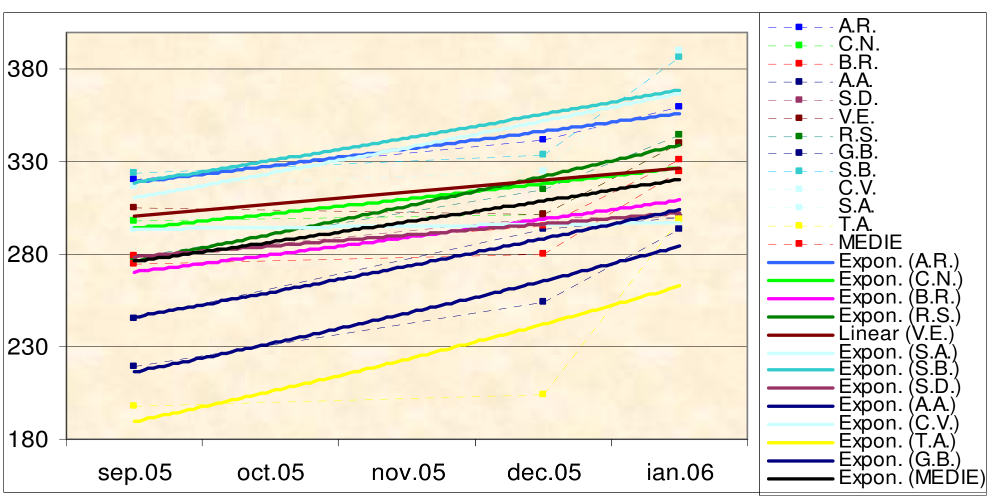


Figura 2. Testul Matorin dreapta

From the graphical representations we can observe that at the initial stage the sports-girls' results are closer by forecasted data, and at the intermediary stage exists a dispersion greater than the foreseen data. This can be explained by that the swimming-girls executed a considerable volume of general and specific physical training by land, and the volume of training by water was directed to executing of some tasks of aerobic nature. At the same time the forming by steps with different periods can direct to obtaining different errors confronted by intermediary values. At the final stage, the real results overlap the forecasting results for the majority of the sports-girls, where the approximations are minim. Thus, we can see that the accomplishing of the computing, by this mathematical model, is correct.

In actual fact, the approximation correctness is then also verified through experimental determinations, at which will be also taken into account the unavoidable errors of testing methods. As we presented, in these situations, the approximation function can be chosen, being more methods and techniques to determinate the static transfer function. The method choosing depends on both user experience and computing technique which he disposes of. In the exceptional cases in which we know also the function derivatives in nodes we can use another methods also, and the case of the function of more variable should be approach eventual in case in which we take into account more quantities that represent errors sources. Considering therefore that the mathematical function that express the characteristic is an approximation function, we putt naturally the problem of the precision with which we make this approximation, therefore of approximation error.

We propose, for determination of the optimal approximation method, to use relative error in the respect of previous definition, in computing considering the real value of the measured quantity as being the value of the evaluated quantity, it being measured into a certain number of points $n$ with the help of some precision methods, and the measured value, in the respect of the previous definition, being the value computed in the respective input points using the approximation points determined through the previous presented methods. This methodology is in actual fact the same with that used to establish the precision class of the measurement devices, corresponding to the metrological norms.

## II. Conclusions

On the base of the above presented, we can make important conclusions concerning of the value exploration and the prediction of some performances of tested sports-girls:

- from the achieved graphics, where we represented the linear and exponential interpolated characteristics for each sports-girls, we observe the satisfactory way in which the exponential function approximates the obtained data;
- the grouping of the initial and final values within the framework of tests divide them into three categories: test at which the obtained initial values are compact, the final values being dispersed (example: the tests for evaluation of the anaerobic speed), tests at which the obtained value, after a training period, are more grouped, then we obtain a homogeneity of the group (example: the establishing of the capacity to control de minimum speed, the test for heart frequency) and test that lead to a changing of the sports-girls values but with the keeping of the difference between them.

The result at the psycho-motive tests are characterized by a constant evolution of the sportsmen but with a different slope. There are also detached cases in which we can observe regress at some test, non-evolution or evolution in significant leaps.

From the experiments and the tests made by authors, which numbered a very important volume of results and which include the previous representations, we can make the following conclusions concerning to the extrapolation error, using the exponential functions:

- the evaluation using exponential functions is made for training periods big enough, so that to include at least a discreet period of individual evolution, in other words to approximate the leap evolution for a certain test;
- the evaluation of the sportsmen which are trained for high performance (at the representative teams level) will be not made using extrapolation functions, because the person evolution cannot keep a certain shape of the function from one person to another or from one test to another, in these cases the evolution having on the base functions with discontinuities and leaps;
- the human nature offers a no-uniform growing not only from person to person (reason for that it was determined one approximation function specific to each sports-girls) but for the same person also, at the different time intervals and for different training programs. From this reason there was obtained, in dispersed cases, great approximation errors, either negative (in case in which the dynamic was more then great in the first part of the training period) or positive (for the case of the sports-girls which, in the first part, have not performances great alike that in the second part of the training);
- we can observe a approximation by missing for some events (speed crossing, floatings) – that means a sub-estimation by extrapolation, or approximation by addition at another events as long jump and high jump, performed by predictive overestimation. From here results the evolution characteristic of some sportive performances during the training period.

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