ELECTRONCS AND ELECTRICAL ENGINEERING
ISSN 1392 – 1215 *2009. No. 7(95)*
ELEKTRONIKA IR ELEKTROTECHNIKA

MEDICINE TECHNOLOGY
T 115
MEDICINOS TECHNOLOGIJA

Analysis Methods for Computerized Forecasting in the Athletes' Sportive Performances for Term of the Competitional Period

E. Rață, L. D. Milici
„Stefan cel Mare" University of Suceava,
13, University Street, 720229, Suceava, Romania, phone: +40722537125; e-mail: dam@eed.usv.ro

Introduction

Beginning from the history of sports performance forecasting technology, men were always fascinated of the possible evolution of records and of the performance marginal limit.

The sportsmen future always interested the trainer. To achieve the objectives, permanent and well directed plans were needed, in a manner of speaking, well based, forecasted, assumptions.

The Physical Education and Sports from Romania Encyclopedia, Volume 4, explains the sportive forecast as foresighting, anticipation of sports phenomenon developement or evolution on the whole, as regards the developement dynamic tendencies, the spreading of a sport and pretypifying the results trajectory, records and classifications, in the imediate or future perspective.

The forecast is a component for any managerial thinking, especially in performance sports, where the contests objective is anticipated, determining the preparation strategy. Forecasting on sport using the computing technique represents a complex process whose goal is to obtain competition performances. Using the computer on forecasting can create the possibility to obtain in short time great quantities of information, proving itself extremely important to estimate the most important parameters concerning somatically, functional, motive, psycho-motive, and psychological aspects, specific to the respective event.

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.

On this direction are available methods, algorithms and instruments came from informatics, very different as form and quality, which was improved significant during the last years concerning the technical possibilities, the importance of the applications and the ease with which these can be used. Using of these in practical is still scanty, from reasons generated by financial problems, by the absence of specialized personnel, by the insufficient knowledge of the possibilities to use these, and also by the reasons which stick by those acceptances.

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.

The large majority of specialists on sport domain, after the undertaken studies, proposed varied solutions to improve this process and promoted modern methods and means. In this way, came into being some installations, equipments and computerized technologies that more contributed to the improvement of the training process development. The computing technique also integrated itself into the selection process and into sportsmen training. Through this it is used multiple programs for physical effort planning and for refreshment. The informational system can forecast next results that will be obtained by the sportsmen.

This paper represents a computerized method of analyzing and forecasting of sports performances of athletes in the competition season. There are analyzed the most frequently utilized functions of approximation and the way that these allow the most accurate evaluation. It is established, using real data and error estimation, that the exponential function is the one indicated in these types of evaluations and conclusions are made over the errors obtained for each interpolation method used.

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.

Approximation of data obtained after athlets testing of the competitonal period

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.

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.

To realise the complexe forecast it is required the summing and processing of information over all the base aspects of training and competition processes.

The contest is actually a comparison between the athletes performance potential and the actual result. From a different point of view, the contest is a control method, of establishing the training efficiency on longer or shorter periods.

The contests can be divided in two categories:

- *preparation contests* (very important training means) in which can be set objectives of performance, of place. These are means of verification and control of the preparation, in which it may take part in the basic trials and other trials too. These contests do not influence the normal training ("Bistritei Cup", National University Championship – Bacău 2009", Suceava District Athletics Championship – 2009", " Dorin Melinte Memorial - Bacău 2009")

- *objective contests* are those which modify the training in the fore coming days. It should be remembered that in these contests are usually programmed elimination trials, an athlete having to rum two or three times in it's event, over a two to four days time. From here, the process of training has as purpose the best training of the athlete over this kind of a contest (The National Indoor Championship for Youth and Seniors – Bucharest 2009). In the context of those earlier mentioned it was interesting to see the approach of implementation of the computerized forecasting method in the competition period of the middle-distance racing athlete subjected to this research.

The athlete began training and taking part in competitons in an organised way since 2003, after which previously sporadically trained. In 2009 she realized a personal record 92.08.73) at the National Indoor Championship for Youth and Seniors– Bucharest, in the 800 meters event.

The result obtained stimulates the activity of training for the athlete, of moral-volitive features to participate at the Inter-University Competition – the 25th edition, in Belgrade – 04-09 July 2009.

Mathematical methods for aproximation of the sportive performances

Sport represents one of the most dynamic social activities that have for an object the human being perfection. Rom this reason appears as justified the specialist's care to effect periodically forecast analyses with the purpose of discovering the evolution tendencies. We refer, in the main, to the performance sports whose special role amplified continuously, phenomenon that determine some specialist to affirm that the apogee will be followed by a crisis or an imminent decline.

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.

The results obtained in the competition period by the athlete, on which the study was realized, are presented in Table 1.

Starting from these results the method proposes to examine the results the athlete will obtain in the main event of the season. To forecast these values the approximation of evolution graphics of competition results was utilized, using four types of functions: logarithmic, exponential, 2nd degree polynomial and 3rd degree polynomial. Table number two presents the mathematical functions obtained for the two trials, in which $\boldsymbol{y}$ is the athletes evaluated performance and $\boldsymbol{x}$ is the time since the competition period began.

Table 3 presents numerical values obtained after realizing the forecast using the functions in Table 2. In the last column is presented the real performance of the athlete. In Fig. 1 are presented the graphics of approximation of the values, through the four functions proposed.

Table 1 The sports performances that stood at the base of the approximation functions determination.

Competition	*"Bistritei Cup"*	*"National University Championship – Bacău 2009"*	*"Suceava District Athletics Championship – 2009",*	*"Dorin Melinte Memorial - Bacău 2009"*	*National Indoor Championship for Youth and Seniors – Bucharest - 2009*
Number of days since the competition period began	1	7	12	21	27
800 m	2:21:37	2:17:36	2:17:10	2:12:43	?
1500 m	4:47:19	4:49:03	4:46:10	4:45:14	?

Table 2. Approximation functions obtained after the extrapolation of the values from Table 1

Type of approximation function	*Logarithmic Approximation*	*Exponential Approximation*	*2nd degree polynomial Approximation*	*3rd degree polynomial Approximation*
800 m	$y = -0.002 \cdot \ln(x) + 0.0987$	$y = 0.0984 \cdot e^{-0.003 \cdot x}$	$y = 2 \cdot 10^{-6} \cdot x^2 - 0.003 \cdot x + 0.0985$	$y = -3 \cdot 10^{-6} \cdot x^3 + 9 \cdot 10^{-5} \cdot x^2 - 0.0011 \cdot x + 0.0993$
1500 m	$y = -4 \cdot 10^{-4} \cdot \ln(x) + 0.2$	$y = 0.2003 \cdot e^{-5 \cdot 10^{-4} \cdot x}$	$y = -7 \cdot 10^{-6} \cdot x^2 + 6 \cdot 10^{-5} \cdot x + 0.1998$	$y = 4 \cdot 10^{-6} \cdot x^3 + 0.0001 \cdot x^2 + 0.001 \cdot x + 0.1986$

Table 3. Numerical values obtained through the functions presented in Table 2.

Type of approximation function	*Logarithmic Approximation*	*Exponential Approximation*	*2nd degree polynomial Approximation*	*3rd degree polynomial Approximation*	*National Indoor Championship for Youth and Seniors – Bucharest - 2009*
800 m	2:12:38	2:10:40	2:12:17	0:06:15	**2:12:38**
1500 m	4:46:06	4:44:34	4:42:42	6:29:57	**4:46:06**

Table 4. Errors obtained in the forecast.

Errors (%)	*Logarithmic Approximation*		*Exponential Approximation*		*2nd degree polynomial Approximation*		*3rd degree polynomial Approximation*		*National Indoor Championship for Youth and Seniors – Bucharest - 2009*
800 m	2:12:38	2.65	**2:10:40**	**1.13**	2:12:17	2.37	0:06:15	-95.16	**2:12:38**
1500 m	4:46:06	0.39	**4:44:34**	**-0.15**	4:42:42	-0.8	6:29:57	36.83	**4:46:06**

Error analysis and conclusions

After the forecast realized using numerical computing methods and comparison of resulted values with the real data, obtained by the athlete in the competition period, the relative errors resulted, presented in Table 4. After evaluating the errors we ascertain that the best forecasting method is the one based on the exponential approximation.

Approximation of the exponential curves In case of some exponential curves the approximation by polynomial functions is made with high errors, reason for that there was tried other approximation methods satisfactory from the point of view of error, being obtained for these curves through using of one approximation function as the form:

$$y(x) = \sum_{i=1}^{m} c_i \cdot e^{-\lambda_i \cdot x} \quad (1)$$

with the condition $m \leq n$, therefore the number of sum terms smaller than the number of interpolation nodes.

From the analysis of the proposed method and the evaluation of the results in the case of the realized evaluation we get the next conclusions:

- The positive error obtained with the computerized forecasting method presented shows a steady evolution to better results over the competition activity and assures great chances so that the actual results would be superior to the results numerically evaluated;
- The polynomial and logarithmical approximations lead to greater errors in the trials in which the athlete excels. Obtaining smaller errors (under 2%) for the approximations, using polynomial or logarithmical methods is a clue that the athlete does not have steady results and a corresponding evolution in the competing activity in this trial;
- It is not recommended the approximation through 3rd degree or higher polynomial approximation methods because these lead to great errors when evaluating the competing time;
- The smallest errors are registered in the case of approximation with the exponential method, this being recommended also for the evaluation of performances of athletes in the training periods too.

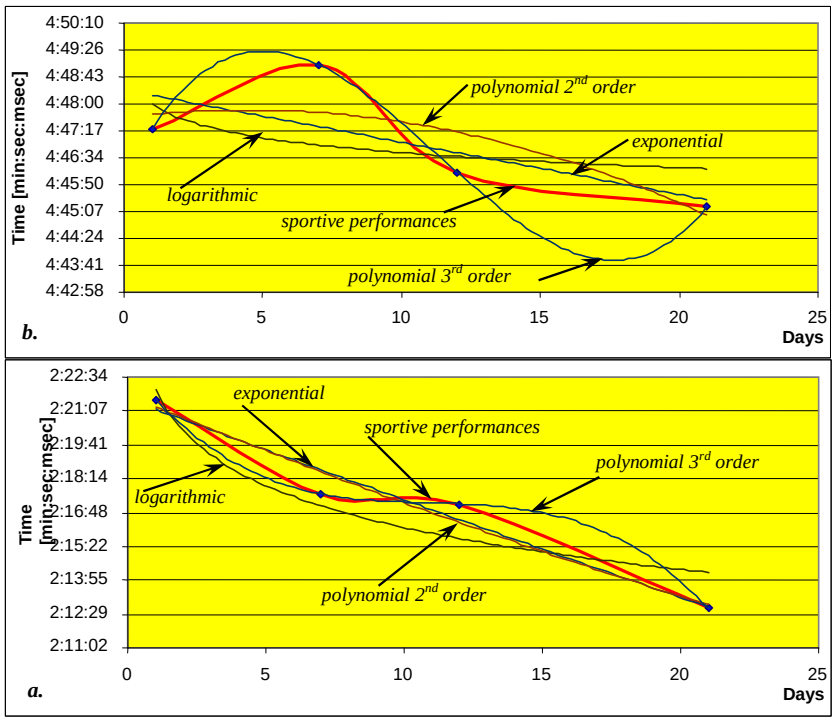

Fig. 1. Graphic representation of approximation functions for: a) 800 meters and b) 1500 meters trials

- 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, tests at which the obtained value, after a training period, are more grouped, then we obtain a homogeneity of the group and test that lead to a changing of the sports-girls values but with the keeping of the difference between them.

References

1. **Alexe N.** The Theory and methodic of modern sports training. – Bucharest: Romania de maine Foundation Publishing House, 1999.
2. **Baladin V. J., Bludov I. M, Plahtienco V. A.** Forecast in sports. – Moscow. – 1986.
3. **Bompa O. T.** The theory and methodology of training. – Bucharest: EX PUNTO Publishing House, 2002.
4. **Demidovitch B., Maron I.** Elements de calcul munerique. – MIR Publishing House. – 1973.
5. **Havlicek I.** Forecast validity of mothric attributes from the point of view of multilateral athletic capacity // Sports for children and juniors – CCEFS XXVIII. – Bucharest. – 1976.
6. **Ilioi C.** Numerical analyze, Approximation techniques. – "Al. I. Cuza" University, Iaşi. – 1983.
7. **Răduţ C.** The forecast and the sports performance pattern // EFS Magasine. – Bucharest. – 1989. – No. 4.
8. **Zaporojanov V. A.** Forecasting and modelling in sports. – 1987.
9. **Milici D., Pentiuc Ş. G., Milici M.** Mathematical Analysis Applied for of Heart Signals // IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems. – Dortmund, Germany. – 2007. – P. 304–307.

Received 2009 04 18

E. Raţă, L. D. Milici. Analysis Methods for Computerized Forecasting in the Athletes' Sportive Performances for Term of the Competitional Period // Electronics and Electrical Engineering. – Kaunas: Technologija, 2009. – No. 7(95). – P. 99–102.

A computerized method of analyzing and forecasting of sports performances of athletes in the competition season is presented. There are analyzed the most frequently utilized functions of approximation and the way that these allow the most accurate evaluation. It is established, using real data and error estimation, that the exponential function is the one indicated in these types of evaluations and conclusions are made over the errors obtained for each interpolation method used. Ill. 1, bibl. 9 (in English; summaries in English, Russian and Lithuanian).

Е. Рата, Л. Д. Милици. Компьютеризованный метод анализа прогноза состояния здоровья спортсменов // Электроника и электротехника. – Каунас: Технология, 2009. – № 7(95). – P. 99–102.

Описывается компьютеризованный метод анализа и прогноза спортивных результатов. Проанализированы наиболее часто используемые функции аппроксимации и их точность. Используя реальные данные и оценку ошибки установлено, что экспонентная функция найболее точно аппроксимирует указанные данные. Ил. 1, библ. 9 (на английском языке; рефераты на английском, русском и литовском яз.).

E. Rata, L. D. Milici. Atletų sportinės būklės sezono metu prognozei naudojamų kompiuterizuotų metodų analizė // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2009. – No. 7(95). – P. 99–102.

Pateiktas kompiuterizuotas metodas, skirtas atletų sportiniams rezultatams varžybų sezono metu analizuoti ir prognozuoti. Analizuojamos dažniausiai taikomos aproksimavimo funkcijos ir tiriamas jų tikslumas. Naudojant realius duomenis ir klaidos įvertinimo rezultatus nustatyta, kad eksponentinė funkcija yra tiksliausia. Išvadose aptariamos paklaidos, gautos taikant skirtingus interpoliavimo metodus. Il. 1, bibl. 9 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).