ANALYSIS OF APPROXIMATE NUMERICAL SEQUENCES AND THEIR APPLICATIONS

Sayliyeva Gulrukh Rustam kizi
Bukhara State University,
teacher of the faculty of physics and mathematics
Zikirova Munisa Husenovna
Bukhara State University,
student of the faculty of physics and mathematics

Anotation. In this article, numerical sequences, their convergence and deviability, methods of checking numerical sequences for convergence, applications of converging numerical sequences are studied.

Keywords: converging numerical sequence, limit of numerical sequence, decreasing numerical sequence, limit of function, limit of functional sequence.

АНАЛИЗ ПРИБЛИЖЕННЫХ ЧИСЛЕННЫХ ПОСЛЕДОВАТЕЛЬНОСТЕЙ И ИХ ПРИЛОЖЕНИЯ

Сайлиева Гульрух Рустам кызи
Бухарский государственный университет,
преподаватель физико-математического факультета
Зикирова Муниса Хусеновна
Студент Бухарского государственного университета,
физико-математический факультет

Абстракт. В данной статье изучаются числовые последовательности, их сходимость и девиантность, методы проверки числовых последовательностей на сходимость, приложения сходящихся числовых последовательностей.

Ключевые слова: сходящаяся числовая последовательность, предел числовой последовательности, убывающая числовая последовательность, предел функции, предел функциональной последовательности.

YAQINLASHUVCHI SONLI KETMA-KETLIKLAR TAHLILI VA ULARNING TADBIQLARI

Annotatsiya. Ushbu maqolada sonli ketma-ketliklar, ularning yaqinlashuvchanligi va uzoqlashuvchanligi, sonli ketma-ketliklarni yaqinlashuvchanlikka tekshirish usullari, yaqinlashuvchi sonli ketma-ketliklarning tadbiqlari o‘rganilgan.

Kalit so‘zlar: yaqinlashuvchi sonli ketma-ketlik, sonli ketma-ketlikning limiti, uzoqlashuvchi sonli ketma-ketlik, funksiyaning limiti, funksional ketma-ketlik limiti.

In this article, numerical sequences, their convergence and divergence, and their applications, which are considered important concepts for almost all areas of mathematics, are studied. It is known that the numerical sequence is also a special case of reflection, in which we match the set of natural numbers to the set of real numbers [1-8].

Let's assume that each n number in the natural sequence of numbers $1,2,\ldots,n,\ldots$ is assigned a real number x_n based on a certain law, then this numbered

$$x_1\ , x_2,\ldots, x_n, \ldots \qquad (1)$$

a set of real numbers is called a sequence or sequence. x_n numbers are elements or terms of (1). The sum, difference, multiplication, and division of arbitrary sequences $\{x_n\}$ and $\{y_n\}$ are again considered numerical sequences and are expressed as follows:

$$\{x_n + y_n\}, \{x_n - y_n\}, \{x_n y_n\}, \{x_n / y_n\} \text{ when } y_n \neq 0 \text{ for } \forall\, n \in N.$$

For a given numerical sequence, its boundedness is one of the important properties [9-12]. Suppose that such a real number M (number of m) is found and

$x_n \leq M$ $(x_n \geq m)$ then the sequence $\{x_n\}$ is said to be bounded from above (below). In this case, the number M is called the upper limit of the sequence x_n (the number m is the lower limit). Even if an arbitrary positive number B is taken, if there is an element x_n of the sequence $\{x_n\}$ that satisfies the inequality $|\{x_n\}| > B$, then the sequence $\{x_n\}$ is called an unbounded sequence. For example, if we look at sequences with number

$$\{x_n\} = (-n)^3, \{y_n\} = 2n, \{t_n\} = \frac{1}{n+1}$$

$\{x_n\}$ is bounded from above by -1 and not bounded from below; $\{y_n\}$ is bounded from below by 2 and not bounded from above; and $\{t_n\}$ is bounded by 1/2 from above and 0 from below.

Now we consider the convergence and divergence properties for numerical sequences. There are several equivalent definitions of the convergence of a numerical sequence [13-17]. In general, by the converging numerical sequence, we mean that all subsequent terms of the sequence, starting from one term, are located around a point. This point is considered the limit of a numerical sequence, and even if we look at the arbitrary neighborhood of the limit point, the next infinite term of this sequence, starting from some term, will definitely be located in this neighborhood. To check if a given sequence $\{x_n\}$ converges to a number a by definition

For $\forall\varepsilon > 0$, we need to find a number $\exists\, n_0(\varepsilon) \in N$, for all $n > n_0(\varepsilon)$, the inequality $|x_n - a| < \varepsilon$ must be satisfied. If we can find a number dependent on ε satisfying this inequality, $\{x_n\}$ all the points after the n_0-numbered term of the sequence are located around the point a. In this case, the given number a is called the limit of the sequence $\{x_n\}$ and is expressed as $\lim\limits_{n\to\infty} x_n = a$.

Example 1. General phrase

$$x_n = \frac{2n^2 + 3n + 1}{2n^2 + 3n + 1}$$

prove by definition that the limit of the sequence $\{x_n\}$ is $a = \frac{1}{2}$.

Solving. To solve this problem, we need to show that even if we take

$\forall\varepsilon > 0$, for the sequence $\{x_n\}$ there are infinitely many terms satisfying the inequality $|x_n - a| < \varepsilon$. In this case, the main question to be found is to determine from which element of the sequence $\{x_n\}$ all subsequent elements are located around the point a [18-24]. To answer this question

$$|x_n - a| < \varepsilon \qquad (2)$$

we solve the inequality and determine the number n_0 depending on ε

$$\left|\frac{2n^2 + 3n + 1}{4n^2 - 5n + 6} - \frac{1}{2}\right| = \frac{11n - 4}{2(4n^2 - 5n + 6)} \qquad (3)$$

We evaluate expression (3) to form inequality (2).

$$\frac{11n - 4}{2(4n^2 - 5n + 6)} < \frac{11}{4n - 5} = \varepsilon$$

As a result, the relation $n < \frac{1}{4}\left(\frac{11}{\varepsilon} + 5\right)$ will appear, since $n_0(\varepsilon)$ is a natural number representing the number, we can choose it as follows:

$$n_0(\varepsilon) = \left[\frac{1}{4}\left(\frac{11}{\varepsilon} + 5\right)\right] + 1$$

Thus, we created a number depending on ε that satisfies relation (2). Let's check the result for a deeper understanding. Let's take a positive small quantity as ε and determine the number $n_0(\varepsilon)$ according to it. Let $\varepsilon = \frac{1}{5}$, in this case n_0 =16, and for $\forall n$ >16 terms of the given sequence $\{x_n\}$

$$\left|\frac{2n^2 + 3n + 1}{4n^2 - 5n + 6} - \frac{1}{2}\right| < \frac{1}{5}$$

the inequality holds. The application of converging sequences is important for many fields. In particular, the methods used in determining the limit of a function, checking the continuity of a function, convergence of functional sequences, convergence of functional series, solutions of a linear integral equation are among these.

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