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SECTION 2. Applied mathematics. Mathematical modeling.

ON SOME PROPERTIES OF THREE CONSECUTIVE NUMBERS

Abstract: The article considers the sequence of three natural numbers, properties and regularities for generalization to n dimensional case extent in the calculation of the coefficient of proportionality for equality. The convergence coefficient during the growth of the initial point of reference and extent.

Key words: sequence, integer, convergence

Language: Russian

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О НЕКОТОРЫХ СВОЙСТВАХ ТРЕХ ПОСЛЕДОВАТЕЛЬНЫХ ЧИСЕЛ

Аннотация: В статье рассматриваются последовательность из трех натуральных чисел, ее свойства и закономерности для обобщения на n мерный случай степени, при вычислении коэффициента пропорциональности для равенства. Показана сходимость коэффициента при росте начальной точки отсчета и степени.

Ключевые слова: последовательность, натуральное число, сходимость.

Введение

Рассмотрим выражение состоящее из трех последовательных чисел $31+33=2*32$. Очевидно, что при изменении начальной точки отсчета этих последовательных чисел само выражение всегда остается верным, т.е.:

$$1+3=2*2$$

$$10+12=2*11$$

$$4444+4446=2*4445$$

и т.д.

При рассмотрении выражения $\sqrt{1} + \sqrt{3} < 2\sqrt{2}$ очевидно получим знак меньше

```
evalf(sqrt(1)+sqrt(3));  
2.732050808
```

```
evalf(2*sqrt(2));  
2.828427124
```

При рассмотрении выражения $\sqrt[3]{1} + \sqrt[3]{3} < 2\sqrt[3]{2}$ знак меньше сохранится

```
evalf(1^(1/3)+3^(1/3));  
2.442249570
```

```
evalf(2*(2^(1/3)));  
2.519842100
```

Увеличим промежуток

```
for i from 1 to 50 do  
evalf(1^(1/i)+3^(1/i))<evalf(2*(2^(1/i)));  
od;
```

| | |
|------|---------------------------|
| i=1 | 4=4 |
| i=2 | 2.732050808 < 2.828427124 |
| i=3 | 2.442249570 < 2.519842100 |
| i=4 | 2.316074013 < 2.378414230 |
| i=5 | 2.245730940 < 2.297396710 |
| i=6 | 2.200936955 < 2.244924096 |
| i=7 | 2.169930813 < 2.208179028 |
| i=8 | 2.147202690 < 2.181015466 |
| i=9 | 2.129830964 < 2.160119478 |
| i=10 | 2.116123174 < 2.143546926 |
| ... | ... |
| i=50 | 2.022215413 < 2.027918960 |

Обобщим данное выражение и напишем общую формулу

$$\sqrt[n]{x+1} + \sqrt[n]{x+3} = k_n \sqrt[n]{x+2}$$

где

x - начальная точка отсчета,

n - порядок,



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k_n - коэффициент пропорциональности.

Тогда выражая коэффициент пропорциональности получим:

$$k_n = \frac{\sqrt[n]{x+1} + \sqrt[n]{x+3}}{\sqrt[n]{x+2}}$$

или

$$k_n = \sqrt[n]{\frac{x+1}{x+2}} + \sqrt[n]{\frac{x+3}{x+2}}$$

Материалы и методы

Выразим данный коэффициент k_n на Maple и построим график функции k_n .

```
> restart;
n:=100;
k:=x->((x+1)^(1/n)+(x+3)^(1/n))/((x+2)^(1/n));
evalf(k(500));
s:=taylor(k(x), x=0,5);
```

$$k = x \rightarrow \frac{(x+1)^{\left(\frac{1}{n}\right)} + (x+3)^{\left(\frac{1}{n}\right)}}{(x+2)^{\left(\frac{1}{n}\right)}} \quad n=100$$

1.999999961

Разлагая в ряд Тейлора, получим

$$s := \frac{1}{2} \left(1 + 3^{1/100} \right)^{\frac{99}{2}} + \left(-\frac{1}{400} \left(1 + 3^{1/100} \right)^{\frac{99}{2}} + \frac{1}{2} \right) x +$$

$$\left(-\frac{1}{400} + \frac{101}{160000} \left(1 + 3^{1/100} \right)^{\frac{99}{2}} + \frac{1}{2} \left(-\frac{11}{20000} 3^{1/100} - \frac{99}{20000} \right)^{\frac{99}{2}} \right) x^2 + \left(\frac{101}{160000} \right)$$

$$-\frac{1}{400} \left(-\frac{11}{20000} 3^{1/100} - \frac{99}{20000} \right)^{\frac{99}{2}} - \frac{6767}{32000000} \left(1 + 3^{1/100} \right)^{\frac{99}{2}}$$

$$+ \frac{1}{2} \left(\frac{2189}{18000000} 3^{1/100} + \frac{6567}{2000000} \right)^{\frac{99}{2}} x^3 + \left(\frac{1}{2} \left(-\frac{1963533}{800000000} - \frac{654511}{21600000000} 3^{1/100} \right)^{\frac{99}{2}} \right)$$

$$-\frac{6767}{32000000} + \frac{2036867}{25600000000} \left(1 + 3^{1/100} \right)^{\frac{99}{2}} + \frac{101}{160000} \left(-\frac{11}{20000} 3^{1/100} - \frac{99}{20000} \right)^{\frac{99}{2}}$$

$$-\frac{1}{400} \left(\frac{2189}{18000000} 3^{1/100} + \frac{6567}{2000000} \right)^{\frac{99}{2}} x^4 + O(x^5)$$

$$\%1 := \left(\frac{1}{300} 3^{1/100} + \frac{1}{100} \right)^{\frac{99}{2}}$$

```
> s:=evalf(simplify(s));
s:=1.997155378+.003292024341 x-.003013022780 x^2+.002582355946 x^3-.002179512808 x^4+O(x^5)
```

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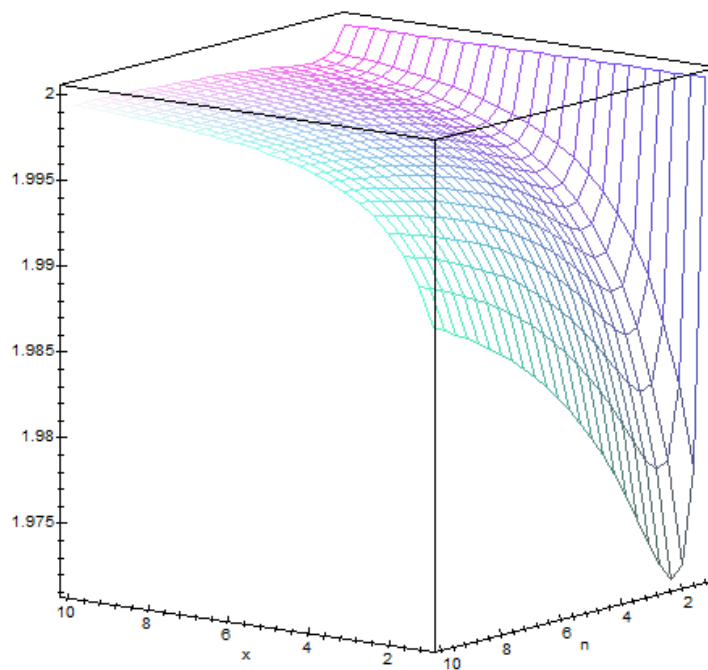
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```
restart;  
k:=(x,n)->((x+1)^(1/n)+(x+3)^(1/n))/((x+2)^(1/n));  
evalf(k(10,10));
```

$$k := (x, n) \rightarrow \frac{(x+1)^{\left(\frac{1}{n}\right)} + (x+3)^{\left(\frac{1}{n}\right)}}{(x+2)^{\left(\frac{1}{n}\right)}}$$

1.999372998

```
plot3d(k(x,n),x=1..10,n=1..10);
```

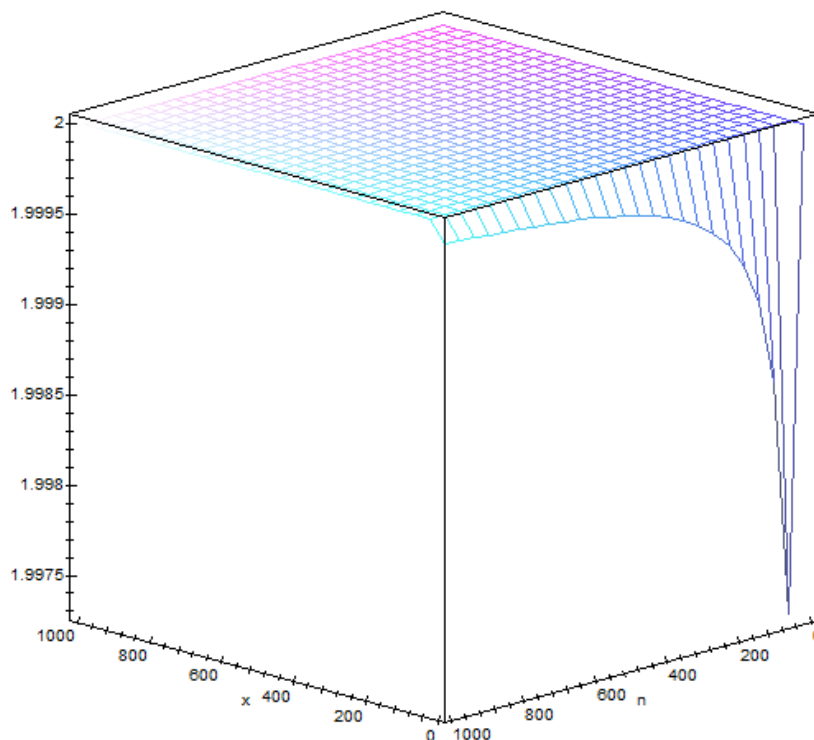


При возрастании x или n будем отмечать сходимость выражения к числу 2.

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```
plot3d(k(x,n), x=1..1000, n=1..1000);
```



Если вместо корня использовать степень, получим

```
restart;  
k:=(x,n)->((x+1)^n+(x+3)^n)/((x+2)^n);  
evalf(k(10,10));
```

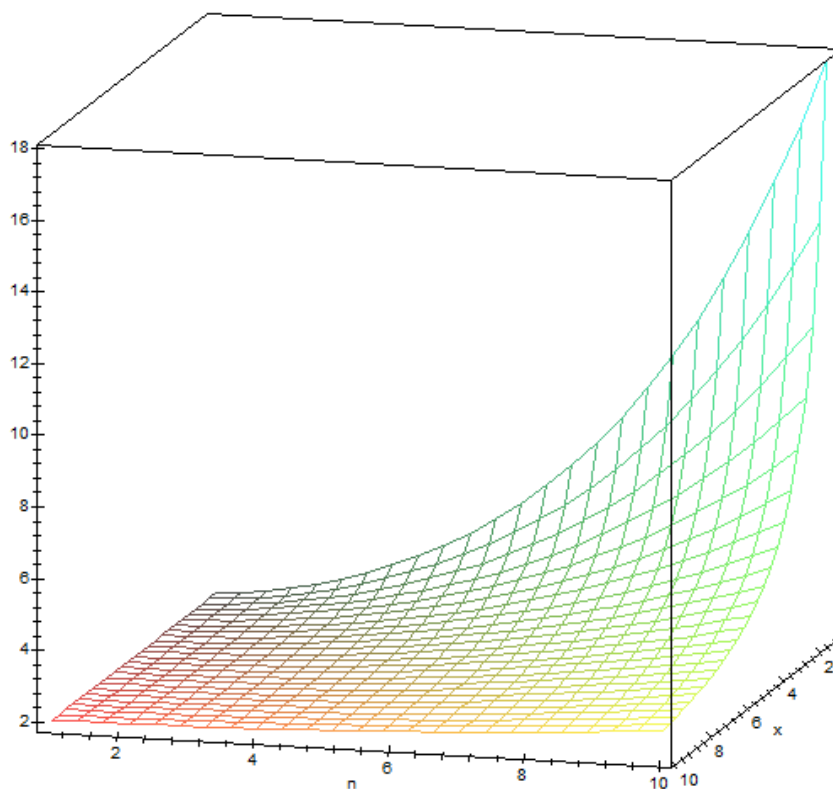
$$k(x, n) \rightarrow \frac{(x+1)^n + (x+3)^n}{(x+2)^n}$$

2.645395496

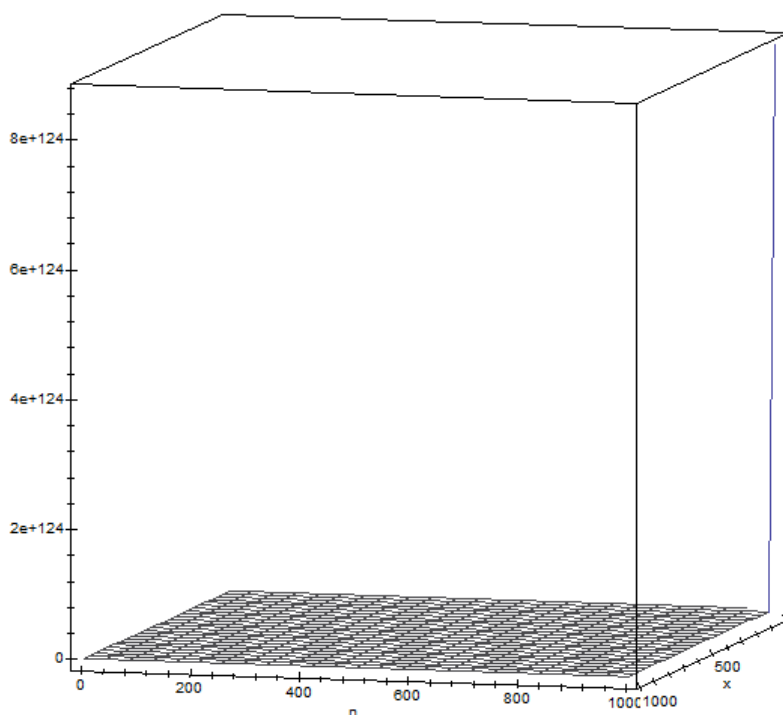
```
plot3d(k(x,n), x=1..10, n=1..10);
```

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```
plot3d(k(x,n), x=1..1000, n=1..1000);
```



Impact Factor:

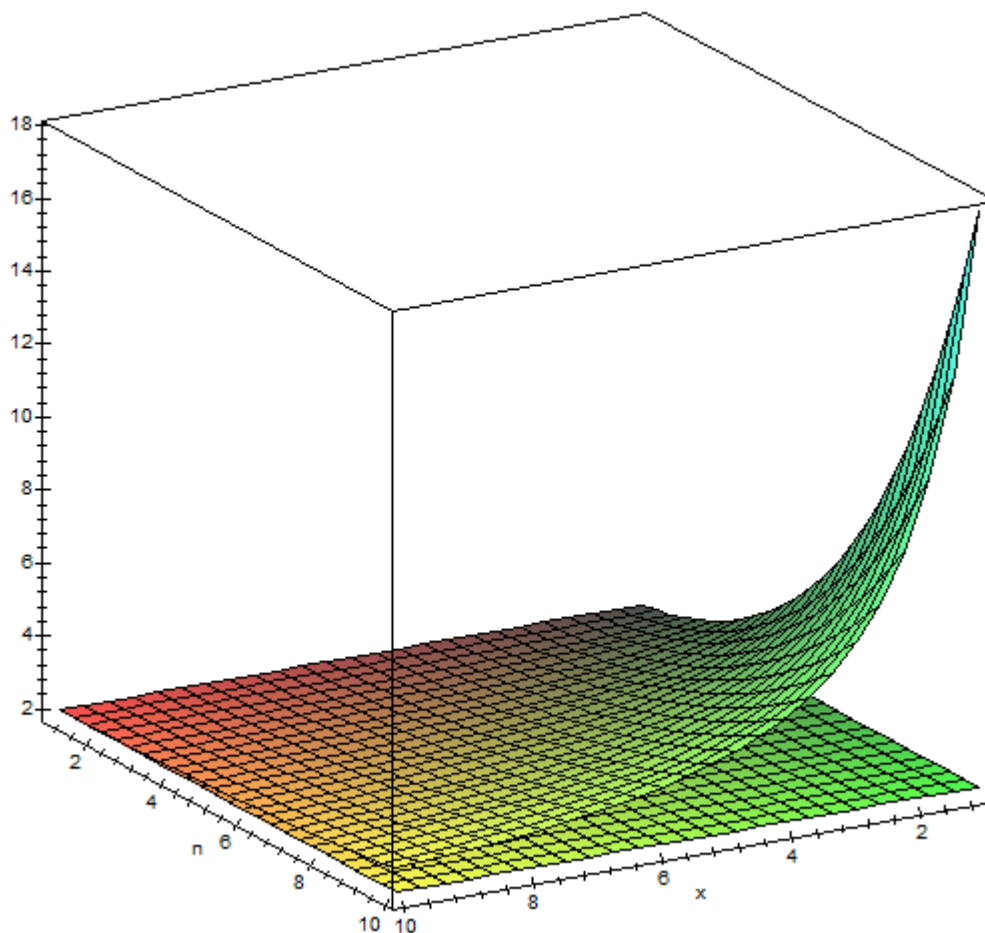
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```
restart;
k:=(x,n)->((x+1)^(n)+(x+3)^(n))/((x+2)^(n));
k2:=(x,n)->((x+1)^(1/n)+(x+3)^(1/n))/((x+2)^(1/n));
```

$$k = (x, n) \rightarrow \frac{(x+1)^n + (x+3)^n}{(x+2)^n}$$

$$k2 = (x, n) \rightarrow \frac{(x+1)^{\left(\frac{1}{n}\right)} + (x+3)^{\left(\frac{1}{n}\right)}}{(x+2)^{\left(\frac{1}{n}\right)}}$$

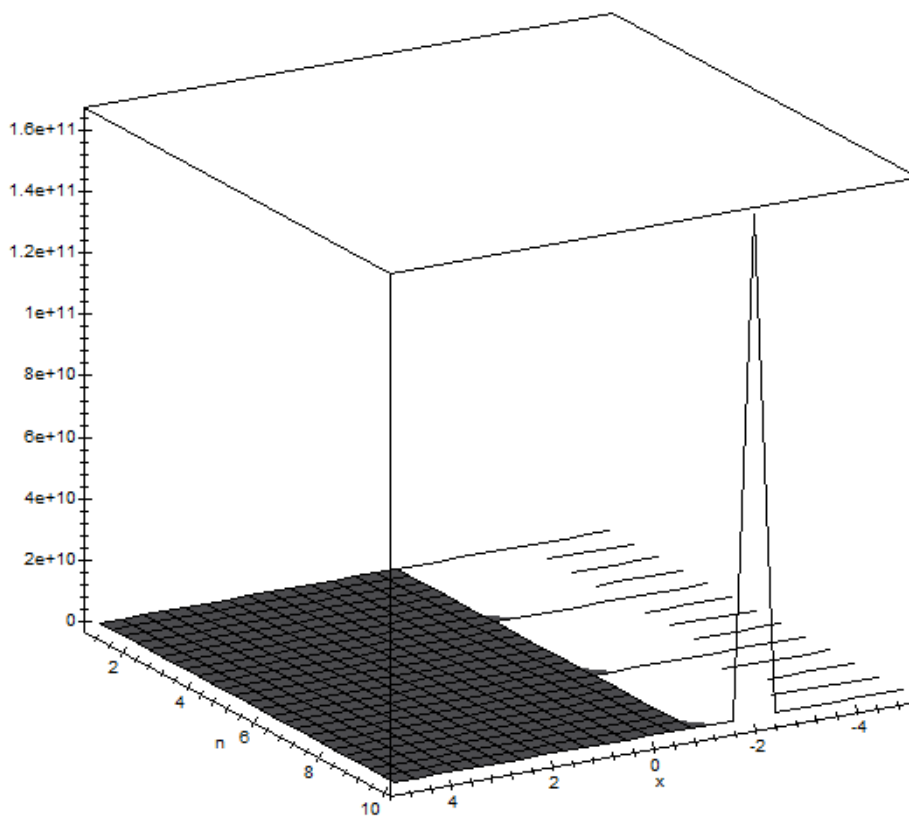
```
plot3d({k(x,n),k2(x,n)},x=1..10,n=1..10,axes=boxed,orientation=[60,70]);
```



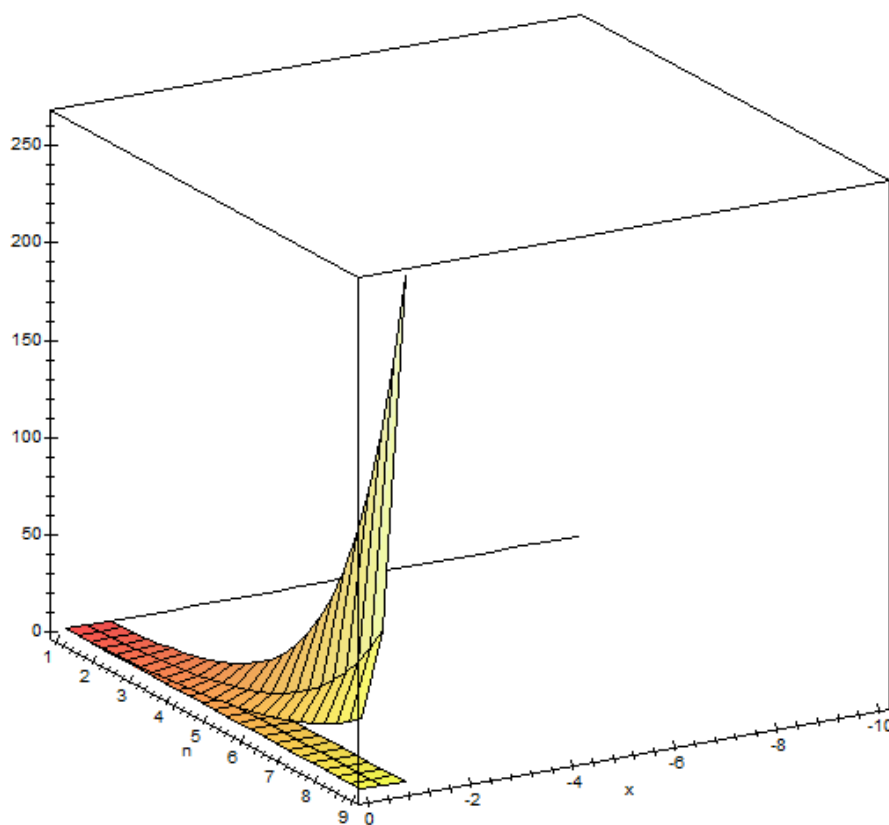
```
plot3d({k(x,n),k2(x,n)},x=-5..5,n=1..10,axes=boxed,orientation=[60,70]);
```

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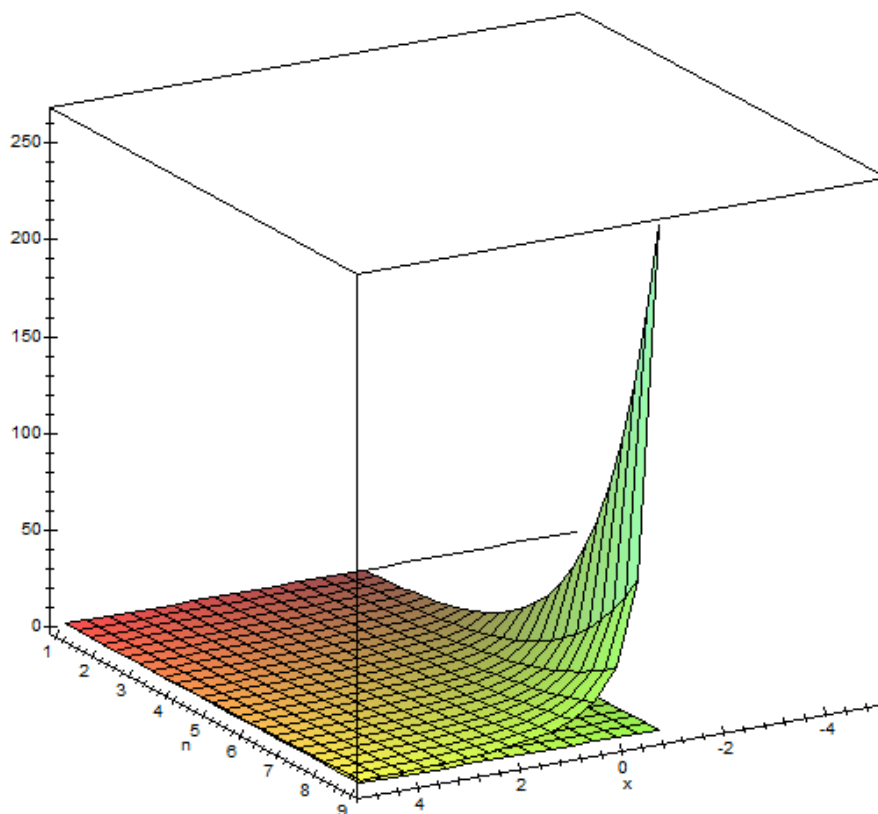
```
plot3d({k(x,n),k2(x,n)},x=-10..0,n=1..9,axes=boxed,orientation=[60,70]);
```



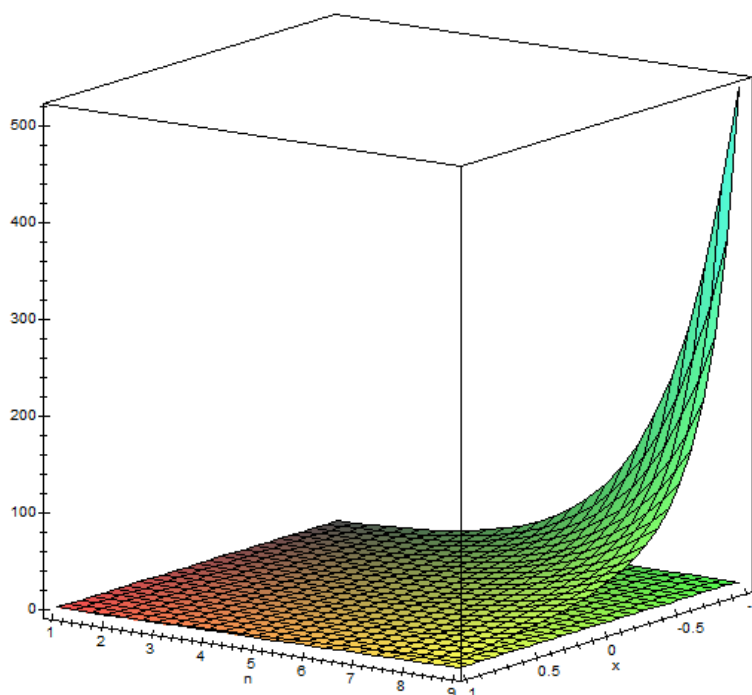
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```
plot3d({k(x,n),k2(x,n)},x=-5..5,n=1..9,axes=boxed,orientation=[60,70]);
```



```
plot3d({k(x,n),k2(x,n)},x=-1..1,n=1..9,axes=boxed,orientation=[60,70]);
```



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Заклучение

Отметим, что первоначально задача ставилась как попытка доказать отсутствие зависимости между коэффициентов k_n и начальной точкой x . Очевидно, что при $\kappa_1 = 2$ какая-либо зависимость отсутствует.

При $n \neq 1$ показана сходимость коэффициента к 2, при росте начальной точки отсчета и степени для $x \geq -1$.

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