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hüpoteesist/"geometry.cfg"  
hüpoteesist/"textcomp.cfg"  
hüpoteesist/"bblopts.cfg"  
hüpoteesist/"english.cfg"      hüpoteesist/"riemanni_h__poteesist.aux"
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# Riemanni hüpoteesist

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## Part I hüpotees

$$\begin{aligned} & \exists_{x_1} ( \\ & \zeta(x_1) = 0 \wedge \\ & x_1 \in C \wedge \\ & \neg(Re(x_1) = 1/2) \wedge \\ & \neg(\exists_{x_2} (x_2 \in N \wedge Re(x_1) = -x_2 * 2 \wedge Im(x_1) = 0) \\ & ) \end{aligned}$$

## Part II muud seoud väited

### 1 zetafunktsioonist

#### 1.1 kui reaalsosa suurem kui 1

$$\forall_{x_1} (x_1 \in C \wedge Re(x_1) < 1 \rightarrow \zeta(-x_1) = \sum_{n=1}^{\infty} (n^{x_1}) = \sum_{n=1}^{\infty} (n^{x_1}) = \sum_{n=1}^{\infty} (n^{Re(x_1)+i*Im(x_1)}) = \sum_{n=1}^{\infty} (n^{Re(x_1)} * n^{i*Im(x_1)}) = \sum_{n=1}^{\infty} (n^{Re(x_1)} * (\cos(Im(x_1) * \ln(n)) + i * \sin(Im(x_1) * \ln(n))))$$

#### 1.2 Dirichlet series

avaldis1: Dirichlet\_series\_Wikipediast

$$\forall_{x_1} (x_1 \in C \wedge Re(x_1) > 0 \rightarrow \zeta(x_1) = (x_1 - 1)^{-1} * \sum_{n=1}^{\infty} (\frac{n}{(n+1)^{x_1}} - \frac{n^{-x_1}}{n^{x_1}})$$

lihtsustan seda avaldist:

$$\begin{aligned} & \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\ & \zeta(x_1 + i * x_2) = \end{aligned}$$

$$\begin{aligned} & (x_1 - 1 + i * x_2)^{-1} * \sum_{n=1}^{\infty} (\frac{n}{(n+1)^{x_1+i*x_2}} - \frac{n^{-x_1-i*x_2}}{n^{x_1+i*x_2}}) = \\ & (x_1 - 1 + i * x_2)^{-1} * \sum_{n=1}^{\infty} (\frac{n}{(n+1)^{x_1} * (\cos(x_2 * \ln(n+1)) + i * \sin(x_2 * \ln(n+1)))} - \frac{n^{-x_1-i*x_2}}{n^{x_1} * (\cos(x_2 * \ln(n)) + i * \sin(x_2 * \ln(n)))}) = \end{aligned}$$

$$\begin{aligned} & \frac{x_1 - 1 - i * x_2}{(x_1 - 1)^2 + x_2^2} * \sum_{n=1}^{\infty} (n * (n+1)^{-x_1} * (\cos(x_2 * \ln(n+1)) - i * \sin(x_2 * \ln(n+1))) - (n - x_1 - i * x_2) * n^{-x_1} * (\cos(x_2 * \ln(n)) - i * \sin(x_2 * \ln(n)))) = \\ & \sum_{n=1}^{\infty} (((x_1 - 1) - i * x_2) * (\cos(x_2 * \ln(n+1)) - i * \sin(x_2 * \ln(n+1))) * ((x_1 - 1)^2 + x_2^2)^{-1} * n * (n+1)^{-x_1} - \\ & ((x_1 - 1) - i * x_2) * (\cos(x_2 * \ln(n)) - i * \sin(x_2 * \ln(n))) * ((x_1 - 1)^2 + x_2^2)^{-1} * (n - x_1 - i * x_2) * n^{-x_1}) = \end{aligned}$$

$$\begin{aligned} & \sum_{n=1}^{\infty} (((((x_1 - 1) * \cos(x_2 * \ln(n+1)) - x_2 * \sin(x_2 * \ln(n+1))) - i * ((x_1 - 1) * \sin(x_2 * \ln(n+1)) + x_2 * \cos(x_2 * \ln(n+1)))) * ((x_1 - 1)^2 + x_2^2)^{-1} * n * (n+1)^{-x_1} - \\ & ((n - x_1) * ((x_1 - 1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n)))_2 - x_2 * ((x_1 - 1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n))) - i * \end{aligned}$$

$$((n-x_1) * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n))) + x_2 * (((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n)))))) * ((x_1-1)^2 + x_2^2)^{-1} * n^{-x_1} =$$

$$\begin{aligned} & \sum_{n=1}^{\infty} (((x_1-1) * \cos(x_2 * \ln(n+1)) - x_2 * \sin(x_2 * \ln(n+1))) * ((x_1-1)^2 + x_2^2)^{-1} * n * (n+1)^{-x_1} - ((n-x_1) * ((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n))) - x_2 * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n)))) * ((x_1-1)^2 + x_2^2)^{-1} * n^{-x_1} \\ & - i * (((x_1-1) * \sin(x_2 * \ln(n+1)) + x_2 * \cos(x_2 * \ln(n+1))) * ((x_1-1)^2 + x_2^2)^{-1} * n * (n+1)^{-x_1} + ((n-x_1) * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n))) + x_2 * (((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n)))))) * ((x_1-1)^2 + x_2^2)^{-1} * n^{-x_1})) = \\ & ((x_1-1)^2 + x_2^2)^{-1} * \sum_{n=1}^{\infty} (((x_1-1) * \cos(x_2 * \ln(n+1)) - x_2 * \sin(x_2 * \ln(n+1))) * n * (n+1)^{-x_1} - ((n-x_1) * ((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n))) - x_2 * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n)))) * n^{-x_1} - i * ((x_1-1)^2 + x_2^2)^{-1} * \sum_{n=1}^{\infty} (((x_1-1) * \sin(x_2 * \ln(n+1)) + x_2 * \cos(x_2 * \ln(n+1))) * n * (n+1)^{-x_1} - ((n-x_1) * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n))) + x_2 * (((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n)))) * n^{-x_1})) = \end{aligned}$$

))

järgneva väite nimi on zeta2\_reaalosa\_ja\_imaginaarosa\_eraldatud:

$$\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow$$

$$\begin{aligned} & \zeta(x_1 + i * x_2) = \\ & ((x_1-1)^2 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ( \\ & ((x_1-1) * \cos(x_2 * \ln(n+1)) - x_2 * \sin(x_2 * \ln(n+1))) * n * (n+1)^{-x_1} - \\ & ((n-x_1) * ((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n))) - x_2 * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n)))) * n^{-x_1} \\ & ) \\ & - i * ((x_1-1)^2 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ( \\ & ((x_1-1) * \sin(x_2 * \ln(n+1)) + x_2 * \cos(x_2 * \ln(n+1))) * n * (n+1)^{-x_1} - \\ & ((n-x_1) * ((x_1-1) * \sin(x_2 * \ln(n)) + x_2 * \cos(x_2 * \ln(n))) + x_2 * ((x_1-1) * \cos(x_2 * \ln(n)) - x_2 * \sin(x_2 * \ln(n)))) * n^{-x_1} \\ & ) = \\ & )) \end{aligned}$$

lihtsustan seda väidet edasi

$$\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow$$

$$\zeta(x_1 + i * x_2) =$$

$$\begin{aligned} & (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ( \\ & \sin(x_2 * \ln(n) + 0 * (2\pi)/4) * x_2 * (n-1) * n^{-x_1} - \sin(x_2 * \ln(n+1) + 0 * (2\pi)/4) * x_2 * n * (n+1)^{-x_1} \\ & + \sin(x_2 * \ln(n) + 1 * (2\pi)/4) * (x_1^2 - x_1 - n * x_1 + n + x_2^2) * n^{-x_1} \\ & - \sin(x_2 * \ln(n+1) + 1 * (2\pi)/4) * (1 - x_1) * n * (n+1)^{-x_1} \\ & ) \\ & + i * (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ( \\ & \sin(x_2 * \ln(n) + 1 * (2\pi)/4) * x_2 * (n-1) * n^{-x_1} - \sin(x_2 * \ln(n+1) + 1 * (2\pi)/4) * x_2 * n * (n+1)^{-x_1} \\ & + \sin(x_2 * \ln(n) + 2 * (2\pi)/4) * (x_1^2 - x_1 - n * x_1 + n + x_2^2) * n^{-x_1} \\ & - \sin(x_2 * \ln(n+1) + 2 * (2\pi)/4) * (1 - x_1) * n * (n+1)^{-x_1} \\ & ) \\ & = \end{aligned}$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} (\sum_{n=1}^M ( \\ & + \sin(x_2 * \ln(n) + 1 * (2\pi)/4) * (x_1^2 - x_1 - n * x_1 + n + x_2^2) * n^{-x_1} \\ & - \sin(x_2 * \ln(n+1) + 1 * (2\pi)/4) * (1 - x_1) * n * (n+1)^{-x_1} \\ & ) - \sin(x_2 * \ln(M+1) + 0 * (2\pi)/4) * x_2 * M * (M+1)^{-x_1} * \\ & (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} \\ & + i * \lim_{M \rightarrow \infty} (\sum_{n=1}^M ( \\ & \sin(x_2 * \ln(n) + 2 * (2\pi)/4) * (x_1^2 - x_1 - n * x_1 + n + x_2^2) * n^{-x_1} \\ & - \sin(x_2 * \ln(n+1) + 2 * (2\pi)/4) * (1 - x_1) * n * (n+1)^{-x_1} \\ & ) - \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2 * M * (M+1)^{-x_1} * \\ & (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} = \\ & \lim_{M \rightarrow \infty} (\sum_{n=1}^M ( \\ & + \sin(x_2 * \ln(n) + 1 * (2\pi)/4) * (x_1^2 - 2 * x_1 + x_2^2 + 1) * n^{-x_1} \\ & ) \end{aligned}$$

$$\begin{aligned}
& + \sin(x_2 * \ln(n) + 1 * (2\pi)/4) * (1 - x_1) * (n - 1) * n^{-x_1} - \sin(x_2 * \ln(n + 1) + 1 * (2\pi)/4) * (1 - x_1) * n * (n + 1)^{-x_1} \\
& ) - \sin(x_2 * \ln(M + 1) + 0 * (2\pi)/4) * x_2 * M * (M + 1)^{-x_1} * \\
& (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} \\
& + i * \lim_{M \rightarrow \infty} (\sum_{n=1}^M ( \\
& + \sin(x_2 * \ln(n) + 2 * (2\pi)/4) * (x_1^2 - 2 * x_1 + x_2^2 + 1) * n^{-x_1} \\
& + \sin(x_2 * \ln(n) + 2 * (2\pi)/4) * (1 - x_1) * (n - 1) * n^{-x_1} - \sin(x_2 * \ln(n + 1) + 2 * (2\pi)/4) * (1 - x_1) * n * (n + 1)^{-x_1} \\
& ) - \sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * x_2 * M * (M + 1)^{-x_1} * \\
& (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M + 1) + 0 * (2\pi)/4) * x_2) * M * (M + 1)^{-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& )
\end{aligned}$$

$$\begin{aligned}
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M + 1) + 2 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * x_2) * M * (M + 1)^{-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& =
\end{aligned}$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M + 1) + 0 * (2\pi)/4) * x_2) * M * (M + 1)^{-x_1} * (1 + 1/M) * \\
& ((1 - x_1)^2 + x_2^2)^{-1} \\
& )
\end{aligned}$$

$$\begin{aligned}
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M + 1) + 2 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * x_2) * M * (M + 1)^{-x_1} * (1 + 1/M) * \\
& ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& =
\end{aligned}$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M + 1) + 0 * (2\pi)/4) * x_2) * M^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M + 1) + 2 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M + 1) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) =
\end{aligned}$$

$$\begin{aligned}
& )) \\
& \text{Valem zeta9\_M\_plus\_1e\_ei\_ole:} \\
& \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) =
\end{aligned}$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M) + 1 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M) + 0 * (2\pi)/4) * x_2) * M^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^M (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\
& - (\sin(x_2 * \ln(M) + 2 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(M) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))
\end{aligned}$$

kuivõrd M läheneb lõpmatusele võin igal pool avaldiſes i asemele panna  $\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})$  või

$$\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi/x_2}).$$

$$\forall_{q_1}(\forall_{q_2}(\forall_{x_1}(\forall_{x_2}(x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \zeta(x_1 + i * x_2) =$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})} (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\ & - (\sin(x_2 * \ln(\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})) + 1 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})) + \\ & 0 * (2\pi)/4) * x_2) * \text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) \\ & + i * \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})} (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\ & - (\sin(x_2 * \ln(\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})) + 2 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln(\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})) + \\ & 1 * (2\pi)/4) * x_2) * \text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = \end{aligned}$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})} (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\ & - (\sin(x_2 * \ln((e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})) + 1 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln((e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})) + 0 * (2\pi)/4) * \\ & x_2) * (e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) \\ & + i * \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})} (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\ & - (\sin(x_2 * \ln((e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})) + 2 * (2\pi)/4) * (1 - x_1) + \sin(x_2 * \ln((e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})) + 1 * (2\pi)/4) * \\ & x_2) * (e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})^{1-x_1} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = \end{aligned}$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})} (\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\ & - (\sin((\text{floor}(M) * (x_2/\text{abs}(x_2)) + q_1) * 2\pi + 1 * (2\pi)/4) * (1 - x_1) + \sin((\text{floor}(M) * (x_2/\text{abs}(x_2)) + q_1) * 2\pi + 0 * \\ & (2\pi)/4) * x_2) * (e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi*(1-x_1)}) * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) \\ & + i * \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})} (\sin(x_2 * \ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\ & - (\sin((\text{floor}(M) * (x_2/\text{abs}(x_2)) + q_2) * 2\pi + 2 * (2\pi)/4) * (1 - x_1) + \sin((\text{floor}(M) * (x_2/\text{abs}(x_2)) + q_2) * 2\pi + 1 * \\ & (2\pi)/4) * x_2) * (e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi*(1-x_1)}) * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = \end{aligned}$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})} (\sin(x_2 * \ln(n) + (2\pi) * 1/4) * n^{-x_1}) \\ & - (\sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + \sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) \\ & + i * \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})} (\sin(x_2 * \ln(n) + (2\pi) * 2/4) * n^{-x_1}) \\ & - (\sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = \\ & )))) \end{aligned}$$

Nagu kvantrite abilgi öeldud on kehtib võrrand mistahes  $q_1$  ja  $q_2$  väärtuste puhul, aga kuna pole kindel, et millised väärtused  $q_1$  ja  $q_2$  asemele pannes saab kõige paremal kujul avaldise, siis loon su subsectionionites võrrandist erinevaid variante, kus  $q_1$  ja  $q_2$ 'el on erinevad väärtused.

asendan siinuse selle Tayloriga reaga:

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})} ( \\
& n_0^{-x_1} * \sum_{n_1=0}^{\infty} ((-1)^{n_1} * (x_2 * \ln(n_0))^{2*n_1} * factorial(2 * n_1)^{-1} \\
& ) \\
& - (sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi})} ( \\
& n_0^{-x_1} * \sum_{n_1=0}^{\infty} ((-1)^{n_1} * (x_2 * \ln(n_0))^{2*n_1+1} * factorial(2 * n_1 + 1)^{-1} \\
& ) \\
& - (sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

asendal naturallogaritmi selle maclaurini reaga:

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{\infty} ((\sum_{n_2=0}^{\infty} ((2 * n_2 + 1)^{-1} * (n_0 - 1)^{2*n_2+1} * (n_0 + 1)^{-2*n_2-1}))^{2*n_1} * x_2^{2*n_1} * factorial(2 * \\
& n_1)^{-1} * 2^{2*n_1} * (-1)^{n_1} \\
& ) \\
& - (sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{\infty} ((\sum_{n_2=0}^{\infty} ((2 * n_2 + 1)^{-1} * (n_0 - 1)^{2*n_2+1} * (n_0 + 1)^{-2*n_2-1}))^{2*n_1+1} * x_2^{2*n_1+1} * \\
& factorial(2 * n_1 + 1)^{-1} * 2^{2*n_1+1} * (-1)^{n_1} \\
& ) \\
& - (sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

kasutan multinomial valemit:

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{M-1} (x_2^{2*n_1} * 2^{2*n_1} * (-1)^{n_1} * \sum_{n_2=0}^{(2*n_1+1)^{M-1}} ( \\
& (\sum_{n_3=0}^{M-1} (floor(n_2/(2 * n_1 + 1)^{n_3}) \% (2 * n_1 + 1)) = 2 * n_1) * \\
& \prod_{n_3=0}^{M-1} (factorial(floor(n_2/(2 * n_1 + 1)^{n_3}) \% (2 * n_1 + 1))^{-1} * ((2 * n_3 + 1)^{-1} * (n_0 - 1)^{2*n_3+1} * (n_0 + 1)^{-2*n_3-1})^{floor(n_2/(2 * n_1 + 1)^{n_3}) \% (2 * n_1 + 1)} \\
& )))) \\
& - (sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{M-1} (x_2^{2*n_1+1} * 2^{2*n_1+1} * (-1)^{n_1} * \sum_{n_2=0}^{(2*n_1+2)^{M-1}} ( \\
& (\sum_{n_3=0}^{M-1} (floor(n_2/(2 * n_1 + 2)^{n_3}) \% (2 * n_1 + 2)) = 2 * n_1 + 1) * \\
& \prod_{n_3=0}^{M-1} (factorial(floor(n_2/(2 * n_1 + 2)^{n_3}) \% (2 * n_1 + 2))^{-1} * ((2 * n_3 + 1)^{-1} * (n_0 - 1)^{2*n_3+1} * (n_0 + 1)^{-2*n_3-1})^{floor(n_2/(2 * n_1 + 2)^{n_3}) \% (2 * n_1 + 2)} \\
& )))) \\
& - (sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

lihtsustan teades, et korutamise asemel võib astmd liita.

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{M-1} (x_2^{2*n_1} * 2^{2*n_1} * (-1)^{n_1} * \sum_{n_2=0}^{(2*n_1+1)^{M-1}} ( \\
& (\sum_{n_3=0}^{M-1} ( floor(n_2/(2*n_1+1)^{n_3}) \% (2*n_1+1) ) = 2*n_1) * \\
& (n_0-1) \sum_{n_3=0}^{M-1} ((2*n_3+1)*(floor(n_2/(2*n_1+1)^{n_3}) \% (2*n_1+1))) * \\
& (n_0+1) \sum_{n_3=0}^{M-1} ((2*n_3+1)*(floor(n_2/(2*n_1+1)^{n_3}) \% (2*n_1+1))) * \\
& \Pi_{n_3=0}^{M-1} (factorial( floor(n_2/(2*n_1+1)^{n_3}) \% (2*n_1+1) )^{-1} * (2*n_3+1)^{-floor(n_2/(2*n_1+1)^{n_3}) \% (2*n_1+1)} \\
& )) \\
& ))) \\
& -(\sin((q_1+1/4)*2\pi) * (1-x_1) + \sin((q_1+0/4)*2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{M-1} (x_2^{2*n_1+1} * 2^{2*n_1+1} * (-1)^{n_1} * \sum_{n_2=0}^{(2*n_1+2)^{M-1}} ( \\
& (\sum_{n_3=0}^{M-1} ( floor(n_2/(2*n_1+2)^{n_3}) \% (2*n_1+2) ) = 2*n_1+1) * \\
& (n_0-1) \sum_{n_3=0}^{M-1} ((2*n_3+1)*(floor(n_2/(2*n_1+2)^{n_3}) \% (2*n_1+2))) * \\
& (n_0+1) \sum_{n_3=0}^{M-1} ((2*n_3+1)*(floor(n_2/(2*n_1+2)^{n_3}) \% (2*n_1+2))) * \\
& \Pi_{n_3=0}^{M-1} (factorial( floor(n_2/(2*n_1+2)^{n_3}) \% (2*n_1+2) )^{-1} * (2*n_3+1)^{-floor(n_2/(2*n_1+2)^{n_3}) \% (2*n_1+2)} \\
& )) \\
& ))) \\
& -(\sin((q_2+2/4)*2\pi) * (1-x_1) + \sin((q_2+1/4)*2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

selle asemel et üle erinevate n2'ede ristsummade summeeridaarvutan lihtsalt n2'e ristsumma:

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) \% 2) * \\
& (\sum_{k_2=0}^{M-1} (floor(k_1/(2*M-1)^{k_2}) \% (2*M-1)) < 2*M-1) * \\
& (y*2) \sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) * \\
& (-1) \sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) / 2 * \\
& (x-1) \sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2}) \% (2*M))) * \\
& (x+1) \sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2}) \% (2*M))) * \\
& \Pi_{n_2=0}^{M-1} (factorial(floor(n_1/(2*M)^{n_2}) \% (2*M))^{-1} * (2*n_2+1)^{-floor(n_1/(2*M)^{n_2}) \% (2*M)} \\
& )) \\
& -(\sin((q_1+1/4)*2\pi) * (1-x_1) + \sin((q_1+0/4)*2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) \% 2) * \\
& (\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) < 2*M) * \\
& (x_2*2) \sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) * \\
& (-1) \sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2}) \% (2*M)) + 3) / 2 * \\
& (n_0-1) \sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2}) \% (2*M))) * \\
& )
\end{aligned}$$

$$\begin{aligned}
& (n_0 + 1)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2})\% (2*M)))} * \\
& \Pi_{n_2=0}^{M-1} (factorial(floor(n_1/(2*M)^{n_2})\% (2*M))^{-1} * (2*n_2+1)^{-floor(n_1/(2*M)^{n_2})\% (2*M)}) \\
& )) \\
& - (sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

kuna Mi lähenedes lõpmatusele see avaldis nagu nii koondub ja selle muutuse tegemine ainult lisab liikmeid, mis on absoluutväärtuselt väiksemad kui oleksid liikmed, mis lisanduksid Mi suurendamisel:

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_2=0}^{M-1} ((floor(n_1/(2*M-1)^{n_2})\% (2*M-1)) + 1)\%2) * \\
& (y * 2)^{\sum_{n_2=0}^{M-1} (floor(n_1/(2*M-1)^{n_2})\% (2*M-1))} * \\
& (-1)^{\sum_{n_2=0}^{M-1} (floor(n_1/(2*M-1)^{n_2})\% (2*M-1))/2} * \\
& (n_0 - 1)^{\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M-1)^{n_2})\% (2*M-1)))} * \\
& (n_0 + 1)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M-1)^{n_2})\% (2*M-1)))} * \\
& \Pi_{n_2=0}^{M-1} (factorial(floor(n_1/(2*M-1)^{n_2})\% (2*M-1))^{-1} * (2*n_2+1)^{-floor(n_1/(2*M-1)^{n_2})\% (2*M-1)}) \\
& ))/2 \\
& - (sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=1}^{floor(e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi})} (n_0^{-x_1} * \sum_{n_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2})\% (2*M))\%2) * \\
& (x_2 * 2)^{\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2})\% (2*M))} * \\
& (-1)^{(\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2})\% (2*M))+3)/2} * \\
& (n_0 - 1)^{\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2})\% (2*M)))} * \\
& (n_0 + 1)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2})\% (2*M)))} * \\
& \Pi_{n_2=0}^{M-1} (factorial(floor(n_1/(2*M)^{n_2})\% (2*M))^{-1} * (2*n_2+1)^{-floor(n_1/(2*M)^{n_2})\% (2*M)}) \\
& )) \\
& - (sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

viin  $n_0^{-x_1}$  summa sisse ja panen  $n_0$  summa 0 ist algama.

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=0}^{floor(e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi})-1} (\sum_{n_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_2=0}^{M-1} (1 + floor(n_1/(2*M)^{n_2})\% (2*M))\%2) * \\
& (x_2 * 2)^{\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2})\% (2*M))} * \\
& (-1)^{\sum_{n_2=0}^{M-1} (floor(n_1/(2*M)^{n_2})\% (2*M))/2} * \\
& \sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2})\% (2*M))) \\
& n_0 \\
& (n_0 + 1)^{-x_1} * \\
& (n_0 + 2)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2})\% (2*M)))} * \\
& \Pi_{n_2=0}^{M-1} (factorial(floor(n_1/(2*M)^{n_2})\% (2*M))^{-1} * (2*n_2+1)^{-floor(n_1/(2*M)^{n_2})\% (2*M)}) \\
& )) \\
& - (sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1 - x_1)^2 + x_2^2)^{-1}
\end{aligned}$$



$$\begin{aligned}
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})-1} ( \sum_{n_1=0}^{(2*M)^M-1} ( \\
& (\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))} * \\
& (-1)^{(\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)) + 3)/2} * \\
& \sum_{n_2=0}^{M-1} ((2*n_2+1) * (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))) \\
& n_0 \\
& (n_0+1)^{-x_1} * \\
& (n_0+2)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1) * (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)))} * \\
& \prod_{n_2=0}^{M-1} (\text{factorial}(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))^{-1} * (2*n_2+1)^{-\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)}) \\
& )) \\
& - (\sin((q_2+2/4)*2\pi) * (1-x_1) + \sin((q_2+1/4)*2\pi) * x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

lihtsustan viies n0-summa n1-summa sisse. ja muudan summade indekseid.

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} (\sum_{n_0=0}^{(2*M)^M-1} ( \\
& (\sum_{n_1=0}^{M-1} (1 + \text{floor}(n_0/(2*M)^{n_1}) \% (2*M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_1=0}^{M-1} (\text{floor}(n_0/(2*M)^{n_1}) \% (2*M))} * \\
& (-1)^{\sum_{n_1=0}^{M-1} (\text{floor}(n_0/(2*M)^{n_1}) \% (2*M))/2} * \\
& \sum_{n_1=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi})-1} ( \\
& \sum_{n_2=0}^{M-1} ((2*n_2+1) * (\text{floor}(n_0/(2*M)^{n_2}) \% (2*M))) \\
& n_1 \\
& (n_1+1)^{-x_1} * \\
& (n_1+2)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1) * (\text{floor}(n_0/(2*M)^{n_2}) \% (2*M)))} * \\
& ) \\
& \prod_{n_1=0}^{M-1} (\text{factorial}(\text{floor}(n_0/(2*M)^{n_1}) \% (2*M))^{-1} * (2*n_1+1)^{-\text{floor}(n_0/(2*M)^{n_1}) \% (2*M)}) \\
& ) \\
& - (\sin((q_1+1/4)*2\pi) * (1-x_1) + \sin((q_1+0/4)*2\pi) * x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)+q_1/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=0}^{(2*M)^M-1} ( \\
& (\sum_{n_1=0}^{M-1} (\text{floor}(n_0/(2*M)^{n_1}) \% (2*M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_1=0}^{M-1} (\text{floor}(n_0/(2*M)^{n_1}) \% (2*M))} * \\
& (-1)^{(\sum_{n_1=0}^{M-1} (\text{floor}(n_0/(2*M)^{n_1}) \% (2*M)) + 3)/2} * \\
& \sum_{n_1=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})-1} ( \\
& \sum_{n_2=2}^{M-1} ((2*n_2+1) * (\text{floor}(n_0/(2*M)^{n_2}) \% (2*M))) \\
& n_1 \\
& (n_1+1)^{-x_1} * \\
& (n_1+2)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1) * (\text{floor}(n_0/(2*M)^{n_2}) \% (2*M)))} * \\
& ) \\
& \prod_{n_1=0}^{M-1} (\text{factorial}(\text{floor}(n_0/(2*M)^{n_1}) \% (2*M))^{-1} * (2*n_1+1)^{-\text{floor}(n_0/(2*M)^{n_1}) \% (2*M)}) \\
& ) \\
& - (\sin((q_2+2/4)*2\pi) * (1-x_1) + \sin((q_2+1/4)*2\pi) * x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

lihtsustan n1-summa(vana n0-summa) sees olevat osa: 9

$$\begin{aligned}
& \forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} (\sum_{n_0=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_1=0}^{M-1} (1 + \text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_1=0}^{M-1} (\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M))} * \\
& (-1)^{\sum_{n_1=0}^{M-1} (\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M)) / 2} * \\
& \sum_{n_1=2}^{\text{floor}(e^{(\text{floor}(M) / \text{abs}(x_2) + q_1 / x_2) * 2\pi}) + 1}} ( \\
& (1 - 2 / n_1)^{\sum_{n_2=0}^{M-1} ((2 * n_2 + 1) * (\text{floor}(n_0 / (2 * M)^{n_2}) \% (2 * M)))} * \\
& (n_1 - 1)^{-x_1} * \\
& ) \\
& \prod_{n_1=0}^{M-1} (\text{factorial}(\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M))^{-1} * (2 * n_1 + 1)^{-\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M)}) \\
& ) \\
& - (\sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + \sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(\text{floor}(M) / \text{abs}(x_2) + q_1 / x_2) * 2\pi * (1 - x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n_0=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_1=0}^{M-1} (\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_1=0}^{M-1} (\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M))} * \\
& (-1)^{(\sum_{n_1=0}^{M-1} (\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M)) + 3) / 2} * \\
& \sum_{n_1=2}^{\text{floor}(e^{(\text{floor}(M) / \text{abs}(x_2) + q_2 / x_2) * 2\pi}) + 1}} ( \\
& (1 - 2 / n_1)^{\sum_{n_2=2}^{M-1} ((2 * n_2 + 1) * (\text{floor}(n_0 / (2 * M)^{n_2}) \% (2 * M)))} * \\
& (n_1 - 1)^{-x_1} * \\
& ) \\
& \prod_{n_1=0}^{M-1} (\text{factorial}(\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M))^{-1} * (2 * n_1 + 1)^{-\text{floor}(n_0 / (2 * M)^{n_1}) \% (2 * M)}) \\
& ) \\
& - (\sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(\text{floor}(M) / \text{abs}(x_2) + q_2 / x_2) * 2\pi * (1 - x_1)} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

### 1.2.1 tagumine pool nulliks

$$\begin{aligned}
& \sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + \sin((q_1 + 0/4) * 2\pi) * x_2 = 0 \wedge \\
& \sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2 = 0
\end{aligned}$$

$$\begin{aligned}
& \sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + \sin(q_1 * 2\pi) * x_2 = 0 \wedge \\
& \sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2 = 0
\end{aligned}$$

$$\begin{aligned}
& \exists_k (k \in N \wedge q_1 = k/2 - \arctan((1 - x_1) / x_2) / (2\pi)) \\
& \exists_k (k \in N \wedge q_2 = k/2 + \arctan(x_2 / (1 - x_1)) / (2\pi))
\end{aligned}$$

$$\exists_k (k \in N \wedge q_2 = k/2 - \arctan((1 - x_1) / x_2) / (2\pi) + 1/4)$$

$$\begin{aligned}
& \arctan(x_2 / (1 - x_1)) + \arctan((1 - x_1) / x_2) = 2\pi/4 * \text{sgn}((1 - x_1) * x_2) \\
& \arctan(x_2 / (1 - x_1)) = -\arctan((1 - x_1) / x_2) + 2\pi/4 * \text{sgn}((1 - x_1) * x_2)
\end{aligned}$$

$$\exists_k (k \in N \wedge q_2 = k/2 - \arctan((1 - x_1) / x_2) / (2\pi) + 1/4 * \text{sgn}((1 - x_1) * x_2))$$

$$q_2 = q_1 + 1/4 * \text{sgn}((1 - x_1) * x_2) + k/2$$

$$\begin{aligned}
& q_2 = q_1 + 1/4 \\
& \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} (\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2) + (k/2 - \arctan((1-x_1)/x_2)/(2\pi))/x_2}) * 2\pi)} (\sin((x_2 * \ln(n)/(2\pi) + 1/4) * 2\pi) * n^{-x_1})) \\
& + i * \lim_{M \rightarrow \infty} (-\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2) + (k/2 + \arctan(x_2/(1-x_1))/(2\pi))/x_2}) * 2\pi)} (\sin((x_2 * \ln(n)/(2\pi) * 2\pi) * n^{-x_1})) = \\
& \lim_{M \rightarrow \infty} (\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/\text{abs}(x_2) + k * 2\pi/2 - \arctan((1-x_1)/x_2)/x_2})} (\sin(x_2 * \ln(n) + 2\pi/4) * n^{-x_1})) \\
& + i * \lim_{M \rightarrow \infty} (-\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/\text{abs}(x_2) + k * 2\pi/2 + \arctan(x_2/(1-x_1))/x_2})} (\sin(x_2 * \ln(n)) * n^{-x_1})) = \\
& \lim_{M \rightarrow \infty} (\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/2/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sin(x_2 * \ln(n) + 2\pi/4) * n^{-x_1})) \\
& + i * \lim_{M \rightarrow \infty} (-\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/2/\text{abs}(x_2) + \arctan(x_2/(1-x_1))/x_2})} (\sin(x_2 * \ln(n)) * n^{-x_1})) = \\
& \lim_{M \rightarrow \infty} (\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/2/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sin(x_2 * \ln(n) + 2\pi/4) * n^{-x_1})) \\
& + i * \lim_{M \rightarrow \infty} (-\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/2/\text{abs}(x_2) + (-\arctan((1-x_1)/x_2)/x_2 + 2\pi/4 * \text{sgn}((1-x_1) * x_2)/x_2})} (\sin(x_2 * \ln(n)) * n^{-x_1})) = \\
& \lim_{M \rightarrow \infty} (\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/2/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sin(x_2 * \ln(n) + 2\pi/4) * n^{-x_1})) \\
& + i * \lim_{M \rightarrow \infty} (-\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M) * 2\pi/2/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2 + 2\pi/4 * \text{sgn}((1-x_1) * x_2)/x_2})} (\sin(x_2 * \ln(n)) * n^{-x_1})) = \\
& ))
\end{aligned}$$

Valem zeta13\_tagumine\_pool\_nulliks:

$$\begin{aligned}
& \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} (\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/2 * 2\pi/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sin(x_2 * \ln(n) + 2\pi/4) * n^{-x_1})) \\
& + i * \lim_{M \rightarrow \infty} (-\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/2 + 1/4) * 2\pi/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sin(x_2 * \ln(n)) * n^{-x_1})) \\
& ))
\end{aligned}$$

asendan siinuse ja logaritmi vastavate Tayloriga ridadega.

valem zeta14\_tagumine\_pool\_nulliks\_tayloriga(ei suutnud kontrollida, aga vb sest arvutusvõime piiratuse tõttu ei saanud piidsavaõlt suurt Mi vsalida):

$$\begin{aligned}
& \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) = \\
& \lim_{M \rightarrow \infty} (\sum_{n_0=0}^{\text{floor}(e^{(\text{floor}(M)/2 * 2\pi/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sum_{n_1=0}^{(2 * M)^{M-1}} ( \\
& \sum_{n_2=0}^{M-1} (1 + \text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M))} * \\
& (-1)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M)) / 2} * \\
& \sum_{n_2=0}^{M-1} ((2 * n_2 + 1) * (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M))) \\
& n_0 \\
& (n_0 + 1)^{-x_1} * \\
& (n_0 + 2)^{-\sum_{n_2=0}^{M-1} ((2 * n_2 + 1) * (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M)))} * \\
& \prod_{n_2=0}^{M-1} (\text{factorial}(\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M))^{-1} * (2 * n_2 + 1)^{-\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M)}) \\
& )))
\end{aligned}$$

$$\begin{aligned}
& + i * \lim_{M \rightarrow \infty} (\sum_{n_0=0}^{\text{floor}(e^{(\text{floor}(M)/2 + 1/4) * 2\pi/\text{abs}(x_2) - \arctan((1-x_1)/x_2)/x_2})} (\sum_{n_1=0}^{(2 * M)^{M-1}} ( \\
& \sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M)) \% 2) * \\
& (x_2 * 2)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M))} * \\
& (-1)^{(\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M)) + 1) / 2} * \\
& \sum_{n_2=0}^{M-1} ((2 * n_2 + 1) * (\text{floor}(n_1/(2 * M)^{n_2}) \% (2 * M))) \\
& n_0
\end{aligned}$$

$$\begin{aligned}
& (n_0 + 1)^{-x_1} * \\
& (n_0 + 2)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(floor(n_1/(2*M)^{n_2})\%(2*M)))} * \\
& \Pi_{n_2=0}^{M-1} (factorial(floor(n_1/(2*M)^{n_2})\%(2*M))^{-1} * (2*n_2+1)^{-floor(n_1/(2*M)^{n_2})\%(2*M)}) \\
& ))) \\
& ))
\end{aligned}$$

### 1.2.2 $q_1 = q_2$

$$\forall_{q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M)/abs(x_2)+q/x_2)*2\pi})} (sin(x_2 * ln(n) + (2\pi) * 1/4) * n^{-x_1}) \\
& - (sin((q+1/4) * 2\pi) * (1-x_1) + sin((q+0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q/x_2)*2\pi*(1-x_1)/x_2} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M)/abs(x_2)+q/x_2)*2\pi})} (sin(x_2 * ln(n) + (2\pi) * 2/4) * n^{-x_1}) \\
& - (sin((q+2/4) * 2\pi) * (1-x_1) + sin((q+1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+q/x_2)*2\pi*(1-x_1)/x_2} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& ))))
\end{aligned}$$

$q_1 = 0 \wedge q_2 = 0$  kui valida, et  $q_1 = 0$  ja  $q_2 = 0$ . Valem zeta12:

$$\begin{aligned}
& \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) =
\end{aligned}$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M)*2\pi/abs(x_2))})} (sin(x_2 * ln(n) + 1 * (2\pi)/4) * n^{-x_1}) \\
& - e^{floor(M)*2\pi*(1-x_1)/abs(x_2)} * ((1-x_1)^2 + x_2^2)^{-1} * (1-x_1) \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M)*2\pi/abs(x_2))})} (sin(x_2 * ln(n) + 2 * (2\pi)/4) * n^{-x_1}) \\
& - e^{floor(M)*2\pi*(1-x_1)/abs(x_2)} * ((1-x_1)^2 + x_2^2)^{-1} * x_2 \\
& ) = \\
& ))
\end{aligned}$$

### 1.2.3 $q_1 = 1/8 \wedge q_2 = -1/8$

$$\begin{aligned}
& \forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow \\
& \zeta(x_1 + i * x_2) =
\end{aligned}$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M)/abs(x_2)+1/8/x_2)*2\pi})} (sin((x_2 * ln(n)/(2\pi) + 1/4) * 2\pi) * n^{-x_1}) \\
& - (sin((1/8+1/4) * 2\pi) * (1-x_1) + sin((1/8+0/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)+1/8/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M)/abs(x_2)-1/8/x_2)*2\pi})} (sin((x_2 * ln(n)/(2\pi) + 2/4) * 2\pi) * n^{-x_1}) \\
& - (sin((-1/8+2/4) * 2\pi) * (1-x_1) + sin((-1/8+1/4) * 2\pi) * x_2) * e^{(floor(M)/abs(x_2)-1/8/x_2)*2\pi*(1-x_1)/x_2} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) =
\end{aligned}$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+1/8/x_2)*2\pi})} (\sin((x_2 * \ln(n))/(2\pi) + 1/4) * 2\pi) * n^{-x_1} \\
& - ((1-x_1) + x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)+1/8/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} * 2^{-1/2} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)-1/8/x_2)*2\pi})} (\sin((x_2 * \ln(n))/(2\pi) + 2/4) * 2\pi) * n^{-x_1} \\
& - ((1-x_1) + x_2) * e^{(\text{floor}(M)/\text{abs}(x_2)-1/8/x_2)*2\pi*(1-x_1)} * ((1-x_1)^2 + x_2^2)^{-1} * 2^{-1/2} \\
& ) = \\
& ))
\end{aligned}$$

### 1.2.4 kirjutades siinuse ja koosiinuse summana

**kasutatud valem**  $\sin(x) = \sum_{m=0}^{\infty} (x^{2*m+1} * ((2*m+1)!)^{-1} * (-1)^m)$   
 $\cos(x) = \sum_{m=0}^{\infty} (x^{2*m} * ((2*m)!)^{-1} * (-1)^m)$

**zeta ise**  $\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \rightarrow$   
 $\zeta(x_1 + i * x_2) =$   
 $(x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ($   
 $\sum_{m=0}^{\infty} (\ln(n * (2 * m + 1))) * x_2^{2*m+1} * ((2 * m + 1)!)^{-1} * (-1)^m * x_2 * (n-1) * n^{-x_1} +$   
 $\sum_{m=0}^{\infty} (\ln(n * 2 * m)) * x_2^{2*m} * ((2 * m)!)^{-1} * (-1)^m * (x_1^2 - x_1 - n * x_1 + n + x_2^2) * n^{-x_1} -$   
 $\sum_{m=0}^{\infty} (\ln((n+1) * (2 * m + 1))) * x_2^{2*m+1} * ((2 * m + 1)!)^{-1} * (-1)^m * x_2 * n * (n+1)^{-x_1} -$   
 $\sum_{m=0}^{\infty} (\ln((n+1) * 2 * m)) * x_2^{2*m} * ((2 * m)!)^{-1} * (-1)^m * (1-x_1) * n * (n+1)^{-x_1}$   
 $)$   
 $+ i * (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ($   
 $(\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * x_2 * (n-1) + \sin(x_2 * \ln(n) + 2 * (2\pi)/4) * (x_1^2 - x_1 - n * x_1 + n + x_2^2)) * n^{-x_1} -$   
 $(\sin(x_2 * \ln(n+1) + 1 * (2\pi)/4) * x_2 + \sin(x_2 * \ln(n+1) + 2 * (2\pi)/4) * (1-x_1)) * n * (n+1)^{-x_1}$   
 $)$   
 $=$   
 $(x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} * \sum_{n=1}^{\infty} (\sum_{m=0}^{\infty} (x_2^{2*m} * (-1)^m * ((2 * m)!)^{-1} * ($   
 $\ln(n * (2 * m + 1))) * (2 * m + 1)^{-1} * x_2^2 * (n-1) * n^{-x_1} +$   
 $\ln(n * 2 * m) * (x_1^2 - x_1 - n * x_1 + n + x_2^2) * n^{-x_1} -$   
 $\ln((n+1) * (2 * m + 1))) * (2 * m + 1)^{-1} * x_2^2 * n * (n+1)^{-x_1} -$   
 $\ln((n+1) * 2 * m) * (1-x_1) * n * (n+1)^{-x_1}$   
 $)))$   
 $+ i * (x_1^2 - 2 * x_1 + 1 + x_2^2)^{-1} * \sum_{n=1}^{\infty} ($   
 $(\sin(x_2 * \ln(n) + 1 * (2\pi)/4) * x_2 * (n-1) + \sin(x_2 * \ln(n) + 2 * (2\pi)/4) * (x_1^2 - x_1 - n * x_1 + n + x_2^2)) * n^{-x_1} -$   
 $(\sin(x_2 * \ln(n+1) + 1 * (2\pi)/4) * x_2 + \sin(x_2 * \ln(n+1) + 2 * (2\pi)/4) * (1-x_1)) * n * (n+1)^{-x_1}$   
 $)$   
 $=))$

## 2 zetafunktsiooni nullkohad

on võrdsustan zetafunktsiooni avaldisega, mille mujal tuletasin.

$$\forall_{q_1} (\forall_{q_2} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + (2\pi) * 1/4) * n^{-x_1}) \\
& - (\sin((q_1 + 1/4) * 2\pi) * (1-x_1) + \sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1-x_1)^2 + x_2^2)^{-1} \\
& ) \\
& + i * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_2)*2\pi/x_2})} (\sin(x_2 * \ln(n) + (2\pi) * 2/4) * n^{-x_1}) \\
& )
\end{aligned}$$

$$\begin{aligned}
& -(\sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M) + q_2) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \\
& ))))
\end{aligned}$$

kuna nii reaalsosa kui imaginaarsosa peavad nullid olema, siis võin imaginärsosa suvalise konstandiga läbi korrutada.

$$\forall_{q_1} (\forall_{q_2} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned}
& Q_1 * \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M) + q_1) * 2\pi / x_2})} (\sin(x_2 * \ln(n) + (2\pi) * 1/4) * n^{-x_1}) \\
& - (\sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + \sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M) + q_1) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} = 0 \\
& ) + \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M) + q_2) * 2\pi / x_2})} (\sin(x_2 * \ln(n) + (2\pi) * 2/4) * n^{-x_1}) \\
& - (\sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M) + q_2) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \\
& ))))
\end{aligned}$$

viin konsatndi sulguse sisse.

$$\forall_{q_1} (\forall_{q_2} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& Q_1 * \sum_{n=1}^{floor(e^{(floor(M) + q_1) * 2\pi / x_2})} (\sin(x_2 * \ln(n) + (2\pi) * 1/4) * n^{-x_1}) \\
& - Q_1 * (\sin((q_1 + 1/4) * 2\pi) * (1 - x_1) + \sin((q_1 + 0/4) * 2\pi) * x_2) * e^{(floor(M) + q_1) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} + \\
& \sum_{n=1}^{floor(e^{(floor(M) + q_2) * 2\pi / x_2})} (\sin(x_2 * \ln(n) + (2\pi) * 2/4) * n^{-x_1}) \\
& - (\sin((q_2 + 2/4) * 2\pi) * (1 - x_1) + \sin((q_2 + 1/4) * 2\pi) * x_2) * e^{(floor(M) + q_2) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \\
& ))))
\end{aligned}$$

muudan kirjutat ümber viies ühiseid kordajaid sulguse ette.

$$\forall_{q_1} (\forall_{q_2} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M) + q_1) * 2\pi / x_2})} (Q_1 * \sin(x_2 * \ln(n) + (2\pi) * 1/4) * n^{-x_1} + \sin(x_2 * \ln(n) + (2\pi) * 2/4) * n^{-x_1}) \\
& - ((Q_1 * \sin((q_1 + 1/4) * 2\pi) + \sin((q_2 + 2/4) * 2\pi)) * (1 - x_1) + (Q_1 * \sin((q_1 + 0/4) * 2\pi) + \sin((q_2 + 1/4) * 2\pi)) * \\
& x_2) * e^{(floor(M) + q_1) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} ) = 0 \\
& ))))
\end{aligned}$$

siinuse ja koosinuse summa saab ühiseks siinuseks teha nii, et argumendile on midagi liidetud.

$$\forall_{q_1} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M) + q_1) * 2\pi / x_2})} (\sqrt{Q_1^2 + 1} * -\sin(x_2 * \ln(n) + \arctan(-Q_1)) * n^{-x_1}) \\
& - ((-\sqrt{Q_1^2 + 1} * \sin(q_1 * 2\pi + \arctan(-Q_1))) * (1 - x_1) + \sqrt{Q_1^2 + 1} * \sin(q_1 * 2\pi + \arctan(1/Q_1)) * x_2) \\
& e^{(floor(M) + q_1) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} ) = 0 \\
& )))
\end{aligned}$$

$\arctan(-x) = \arctan(x)$

$$\forall_{q_1} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{floor(e^{(floor(M) + q_1) * 2\pi / x_2})} (-\sin(x_2 * \ln(n) - \arctan(Q_1)) * n^{-x_1}) \\
& - (-\sin(q_1 * 2\pi - \arctan(Q_1)) * (1 - x_1) + \sin(q_1 * 2\pi + \arctan(1/Q_1)) * x_2) \\
& e^{(floor(M) + q_1) * 2\pi * (1 - x_1) / x_2} * ((1 - x_1)^2 + x_2^2)^{-1} ) = 0 \\
& )))
\end{aligned}$$

$$\arctan(1/x) = -\arctan(x) + \operatorname{sgn}(x) * 2\pi/4$$

$$\forall_{q_1} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (-\sin(x_2 * \ln(n) - \arctan(Q_1)) * n^{-x_1}) \\ & - (-\sin(q_1 * 2\pi - \arctan(Q_1)) * (1 - x_1) + \sin(q_1 * 2\pi - \arctan(Q_1) + \operatorname{sgn}(Q_1) * 2\pi/4) * x_2) \\ & e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = 0 \\ & ))) \end{aligned}$$

korrutan -1ega läbi

$$\forall_{q_1} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - \arctan(Q_1)) * n^{-x_1}) \\ & - (\sin(q_1 * 2\pi - \arctan(Q_1)) * (1 - x_1) - \sin(q_1 * 2\pi - \arctan(Q_1) + \operatorname{sgn}(Q_1) * 2\pi/4) * x_2) \\ & e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = 0 \\ & ))) \end{aligned}$$

2pi/4 lahutamise on sama kui 2pi/4 lahutamise ja siis -1'ega läbi korrutamine

$$\forall_{q_1} (\forall_{Q_1} (\forall_{x_1} (\forall_{x_2} (x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow$$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - \arctan(Q_1)) * n^{-x_1}) \\ & - (\sin(q_1 * 2\pi - \arctan(Q_1)) * (1 - x_1) - \sin(q_1 * 2\pi - \arctan(Q_1) + 2\pi/4) * \operatorname{sgn}(Q_1) * x_2) \\ & e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = 0 \\ & ))) \end{aligned}$$

kui  $Q_1$  on positiivne, siis  $\operatorname{sgn}(Q_1)=1$ , kui negatiivne, siis  $\operatorname{sgn}(Q_1)=-1$

$$\forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$\begin{aligned} & Q_1 > 0 \text{ and } ( \\ & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - \arctan(Q_1)) * n^{-x_1}) \\ & - (\sin(q_1 * 2\pi - \arctan(Q_1)) * (1 - x_1) - \sin(q_1 * 2\pi - \arctan(Q_1) + 2\pi/4) * x_2) \\ & e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = 0 \\ & \vee \end{aligned}$$

$$\begin{aligned} & Q_1 < 0 \wedge ( \\ & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - \arctan(Q_1)) * n^{-x_1}) \\ & - (\sin(q_1 * 2\pi - \arctan(Q_1)) * (1 - x_1) + \sin(q_1 * 2\pi - \arctan(Q_1) + 2\pi/4) * x_2) \\ & e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = 0 \\ & ) \end{aligned}$$

)))

$\arctan(Q_1)$  võtab väärtuseid  $-2\pi/4$  kuni  $2\pi/4$

$$\forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$(Q_1 > -2\pi/4 \wedge Q_1 < 0) \wedge ($$

$$\begin{aligned} & \lim_{M \rightarrow \infty} ( \\ & \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - Q_1) * n^{-x_1}) \\ & - (\sin(q_1 * 2\pi - Q_1) * (1 - x_1) - \sin(q_1 * 2\pi - Q_1 + 2\pi/4) * x_2) \\ & e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\ & ) = 0 \vee \end{aligned}$$

$$\begin{aligned}
& (Q_1 > 0 \wedge Q_1 < 2\pi/4) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi - Q_1) * (1 - x_1) + \sin(q_1 * 2\pi - Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \\
& )
\end{aligned}$$

))))

Ühes kohas  $Q_1$  asemele samanimeline muutuja  $-Q_1$ . Teises kohas  $Q_1$  asemele samanimeline muutuja  $2\pi/2 - Q_1$ .

$$\begin{aligned}
& \forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ( \\
& (Q_1 > 0 \wedge Q_1 < 2\pi/4) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \vee \\
& )
\end{aligned}$$

$$\begin{aligned}
& (Q_1 > 2\pi/4 \wedge Q_1 < 2\pi/2) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) - 2\pi/2 + Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi - 2\pi/2 + Q_1) * (1 - x_1) + \sin(q_1 * 2\pi - 2\pi/2 + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \\
& )
\end{aligned}$$

))))

arvestan, et  $\sin(x-2\pi/2)=-\sin(x)$

$$\begin{aligned}
& \forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ( \\
& (Q_1 > 0 \wedge Q_1 < 2\pi/4) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \vee \\
& )
\end{aligned}$$

$$\begin{aligned}
& (Q_1 > 2\pi/4 \wedge Q_1 < 2\pi/2) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (-\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (-\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1} \\
& ) = 0 \\
& )
\end{aligned}$$

))))

Arvestan, et  $0*(-1)=0$  ja  $\sin(x+2\pi/2)=-\sin(x)$ . Muutuja  $Q_1$  asemele muutuja  $Q_1-2\pi/2$ .

$$\begin{aligned}
& \forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ( \\
& (Q_1 > 0 \wedge Q_1 < 2\pi/4) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1})
\end{aligned}$$



$$\begin{aligned}
& -(\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2 * ((1-x_1)^2 + x_2^2)^{-1}} \\
& ) = 0 \\
& \vee
\end{aligned}$$

$$\begin{aligned}
& (Q_1 > 2\pi/4 \wedge Q_1 < 2\pi/2) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (-\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (-\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2 * ((1-x_1)^2 + x_2^2)^{-1}} \\
& ) = 0 \\
& \vee
\end{aligned}$$

$$\begin{aligned}
& (Q_1 > 2\pi/2 \wedge Q_1 < 2\pi * 3/4) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2 * ((1-x_1)^2 + x_2^2)^{-1}} \\
& ) = 0 \\
& \vee
\end{aligned}$$

$$\begin{aligned}
& (Q_1 > 2\pi * 3/4 \wedge Q_1 < 2\pi) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (-\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (-\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2 * ((1-x_1)^2 + x_2^2)^{-1}} \\
& ) = 0
\end{aligned}$$

)

))))

korrtutan osad osad -lega läbi. ja panaen osad kokku.

$$\begin{aligned}
& \forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ( \\
& (Q_1 > 0 \wedge Q_1 < 2\pi/4 \vee Q_1 > 2\pi/2 \wedge Q_1 < 2\pi * 3/4) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2 * ((1-x_1)^2 + x_2^2)^{-1}} \\
& ) = 0 \\
& \vee
\end{aligned}$$

$$\begin{aligned}
& (Q_1 > 2\pi/4 \wedge Q_1 < 2\pi/2 \vee Q_1 > 2\pi * 3/4 \wedge Q_1 < 2\pi) \wedge ( \\
& \lim_{M \rightarrow \infty} ( \\
& \sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1}) \\
& - (\sin(q_1 * 2\pi + Q_1) * (1 - x_1) + \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * x_2) \\
& e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2 * ((1-x_1)^2 + x_2^2)^{-1}} \\
& ) = 0
\end{aligned}$$

)

))))

üheks oskas kokku.

$$\forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$\lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1) * n^{-x_1})$$

$$- (\sin(q_1 * 2\pi + Q_1) * (1 - x_1) - \sin(q_1 * 2\pi + Q_1 + 2\pi/4) * \text{sgn}(Q_1 \% (2\pi/2) - 2\pi/4) * x_2)$$

$$e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

$$) = 0$$

$$)$$

$$)))$$

muutuja Q\_1 asemele Q\_1/(2\pi)

$$\forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$\lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1 * 2\pi) * n^{-x_1})$$

$$- (\sin((q_1 + Q_1) * 2\pi) * (1 - x_1) - \sin((q_1 + Q_1 + 1/4) * 2\pi) * ((\text{floor}(Q_1 * 4) \% 2) * 2 - 1) * x_2)$$

$$e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

$$) = 0$$

$$)$$

$$)))$$

kuna Q\_1'ele 2\pi liites...

$$\forall_{q_1} (\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (q_1 \in R \wedge Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$\lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1 * 2\pi) * n^{-x_1})$$

$$- (\sin((q_1 + Q_1) * 2\pi) * (1 - x_1) - \sin((q_1 + Q_1 + 1/4) * 2\pi) * ((\text{floor}(Q_1 * 4) \% 2) * 2 - 1) * x_2)$$

$$e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

$$) = 0$$

$$\wedge \lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1 * 2\pi) * n^{-x_1})$$

$$- (\sin((q_1 + Q_1) * 2\pi) * (1 - x_1) + \sin((q_1 + Q_1 + 1/4) * 2\pi) * ((\text{floor}(Q_1 * 4) \% 2) * 2 - 1) * x_2)$$

$$e^{(\text{floor}(M)+q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

$$) = 0$$

$$)$$

$$)))$$

et see mõlemal juhul 0 oleks sin((q\_1+Q\_1+1/4)\*2\pi)=0 seega q\_1=-1/4-Q\_1 või q\_1=1/4-Q\_1

$$\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$\lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)-1/4-Q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1 * 2\pi) * n^{-x_1})$$

$$+ (1 - x_1) * e^{(\text{floor}(M)-1/4-Q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

$$) = 0$$

$$\vee \lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)+1/4-Q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1 * 2\pi) * n^{-x_1})$$

$$- (1 - x_1) * e^{(\text{floor}(M)+1/4-Q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

$$) = 0$$

$$)$$

$$)))$$

samahästi võib m'i 2 korda aeglasemalt suurendada.

$$\forall_{x_1} (\forall_{x_2} (\forall_{Q_1} (Q_1 \in R \wedge x_1 \in R \wedge x_2 \in R \wedge x_1 > 0 \wedge \zeta(x_1 + i * x_2) = 0 \rightarrow ($$

$$\lim_{M \rightarrow \infty} ($$

$$\sum_{n=1}^{\text{floor}(e^{(\text{floor}(M)/2+1/4-Q_1)*2\pi/x_2})} (\sin(x_2 * \ln(n) + Q_1 * 2\pi) * n^{-x_1})$$

$$- (1 - x_1) * ((\text{floor}(M) \% 2) * 2 - 1) * e^{(\text{floor}(M)/2+1/4-Q_1)*2\pi*(1-x_1)/x_2} * ((1 - x_1)^2 + x_2^2)^{-1}$$

) = 0

)  
)))

### 3 muu

#### 3.0.1 c

$$\begin{aligned}
& \lim_{M \rightarrow \infty} (M * (M+1)^{-x_1} - M^{1-x_1}) = \\
& \lim_{M \rightarrow \infty} (M * (M+1)^{-x_1} - M * (M+1)^{-x_1} * (M+1)/M) = \\
& \lim_{M \rightarrow \infty} (M * (M+1)^{-x_1} - M * (M+1)^{-x_1} * (1+1/M)) = \\
& \lim_{M \rightarrow \infty} (M * (M+1)^{-x_1} * (1 - (1+1/M))) = \\
& \lim_{M \rightarrow \infty} (M * (M+1)^{-x_1} * (-1/M)) = \\
& \lim_{M \rightarrow \infty} (-(M+1)^{-x_1}) = \\
& \lim_{M \rightarrow \infty} \left( \frac{-1}{(M+1)^{x_1}} \right) =
\end{aligned}$$

$x_1 > 0 \rightarrow \text{return}(0)$

$x_1 \leq 0 \rightarrow \text{return}(\infty)$

#### 3.0.2 b

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& (\sin(x_2 * \ln(M+1) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2) * M * (M+1)^{-x_1} * (x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} - \\
& (\sin(x_2 * \ln(M+1) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} * (x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} \\
& ) = \\
& \lim_{M \rightarrow \infty} ((\sin(x_2 * \ln(M+1) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2) * \\
& (M * (M+1)^{-x_1} - M^{1-x_1}) \\
& ) = \\
& x_1 > 0 \rightarrow \text{return}(0) \\
& x_1 \leq 0 \rightarrow \text{return}(\infty)
\end{aligned}$$

#### 3.0.3 a

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& (\sin(x_2 * \ln(M+1) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2) * M * (M+1)^{-x_1} * (x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} - \\
& x_2^2 + 1)^{-1} - \\
& (\sin(x_2 * \ln(M) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} * (x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} \\
& ) = \\
& \lim_{M \rightarrow \infty} ( \\
& (\sin(x_2 * \ln(M+1) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2) * M * (M+1)^{-x_1} - \\
& (\sin(x_2 * \ln(M) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} \\
& ) =
\end{aligned}$$

#### 3.0.4 d

$$\begin{aligned}
& \lim_{M \rightarrow \infty} ( \\
& (\sin(x_2 * \ln(M+1) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M+1) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} * (x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} - \\
& (\sin(x_2 * \ln(M) + 2 * (2\pi)/4) * (1-x_1) + \sin(x_2 * \ln(M) + 1 * (2\pi)/4) * x_2) * M^{1-x_1} * (x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} \\
& ) =
\end{aligned}$$

$$(x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} * \lim_{M \rightarrow \infty} (M^{1-x_1} * ( (1-x_1) * (\sin(x_2 * \ln(M+1)) + 2 * (2\pi)/4) - \sin(x_2 * \ln(M)) + 2 * (2\pi)/4) + x_2 * (\sin(x_2 * \ln(M+1)) + 1 * (2\pi)/4) - \sin(x_2 * \ln(M)) + 1 * (2\pi)/4) )) =$$

$$(x_1^2 - 2 * x_1 + x_2^2 + 1)^{-1} * \lim_{M \rightarrow \infty} (M^{1-x_1} * ( (\cos(x_2 * \ln(M+1))) - \cos(x_2 * \ln(M))) * x_2 - (\sin(x_2 * \ln(M+1))) - \sin(x_2 * \ln(M))) * (1-x_1)))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ( \text{abs}((\cos(x_2 * \ln(M+1))) - \cos(x_2 * \ln(M))) * x_2) + \text{abs}((\sin(x_2 * \ln(M+1))) - \sin(x_2 * \ln(M))) * (1-x_1)))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ( \text{abs}((x_2 * \ln(M+1)) - x_2 * \ln(M)) * x_2) + \text{abs}((x_2 * \ln(M+1)) - x_2 * \ln(M)) * (1-x_1)))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ( \text{abs}((\ln(M+1)) - \ln(M)) * x_2^2) + \text{abs}((\ln(M+1)) - \ln(M)) * (1-x_1) * x_2))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ( (\ln(M+1)) - \ln(M)) * x_2^2 + (\ln(M+1)) - \ln(M)) * \text{abs}((1-x_1) * x_2))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ( (\ln(M+1)) - \ln(M)) * (\text{abs}(x_2) * (\text{abs}(x_2) + \text{abs}(1-x_1))))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ((\ln(M+1)) - \ln(M)) * (\text{abs}(x_2) * (\text{abs}(x_2) + \text{abs}(1-x_1))))$$

$$\lim_{M \rightarrow \infty} (M^{1-x_1} * ((\ln(M+1)) - \ln(M)))$$

$$\lim_{M \rightarrow \infty} (M^{-x_1} * ((\ln(M+1)) - \ln(M)) * M)$$

$$\lim_{M \rightarrow \infty} (M^{-x_1})$$

$$x_1 > 0 \rightarrow \text{return } 0$$

### 3.0.5 f

$$\ln(M) * x_2 = (k * 2\pi) / 2$$

$$M = e^{(k * 2\pi) / (2 * x_2)} = e^{\frac{k * 2\pi}{2 * x_2}}$$

$$k = 2 * \ln(M) * x_2 / (2\pi) = \frac{2 * \ln(M) * x_2}{2\pi}$$

$$x_2 = k * 2\pi / \ln(M) / 2 = \frac{k * 2\pi}{\ln(M) * 2}$$

asendus

$$M_{uus} = e^{(\text{floor}(M) + q) * 2\pi / x_2} = e^{\frac{\text{floor}(M) * 2\pi}{x_2}} = e^{(\text{floor}(M) * 2\pi + \alpha) / x_2}$$

asendus2

$$\ln(M) * x_2 = (k * 2\pi) + \alpha$$

$$M = e^{(k * 2\pi + \alpha) / (x_2)} = e^{\frac{k * 2\pi + \alpha}{x_2}}$$

$$k = (\ln(M) * x_2 - \alpha) / (2\pi) = \frac{\ln(M) * x_2 - \alpha}{2\pi}$$

$$x_2 = ((k * 2\pi) + \alpha) / \ln(M)$$

$$q = \alpha / 2\pi$$

### 3.0.6 g

$$\sin(\ln(x)) =$$

$$\forall_x (x > -1 \wedge x < 1 \rightarrow$$

$$\ln(x+1) = \sum_{n=1}^{\infty} ((-1)^{n+1} * n^{-1} * x^n)$$

)

muutuja vahetus x-1

$$\forall_x (x > 0 \wedge x < 2 \rightarrow$$

$$\ln(x) = \sum_{n=1}^{\infty} ((-1)^{n+1} * n^{-1} * (x-1)^n)$$

)

mv 1/x

$$\forall_x (x > 1/2 \rightarrow$$

$$\ln(1/x) = \sum_{n=1}^{\infty} ((-1)^{n+1} * n^{-1} * (1/x - 1)^n)$$

)

mv summas

$$\forall_x (x > 1/2 \rightarrow$$

$$\ln(1/x) = \sum_{n=1}^{\infty} ((-1)^{n+1} * n^{-1} * (1/x - 1)^n)$$

)

..

### 3.0.7 ln maclaurin

<https://math.stackexchange.com/questions/585154/taylor-series-for-logx>

valem ln\_maclaurin:

$$\forall_x (x > 0 \rightarrow$$

$$\ln(x) = 2 * \sum_{k=0}^{\infty} ((2 * k + 1)^{-1} * (x - 1)^{2 * k + 1} * (x + 1)^{-2 * k - 1})$$

)

### 3.0.8 sin(ln(x)) maclaurin

sin:

$$\forall_x (x \in R \rightarrow$$

$$\sin(x) = \sum_{k=0}^{\infty} ((-1)^k * x^{2 * k + 1} * \Gamma(2 * k + 2)^{-1})$$

)

sin(y\*ln(x)): Valem sin\_y\_ln\_x\_maclaurin\_3:

$$\forall_x (x > 0 \rightarrow$$

$$\sin(y * \ln(x)) = \sum_{k_1=0}^{\infty} ((\sum_{k_2=0}^{\infty} ((2 * k_2 + 1)^{-1} * (x - 1)^{2 * k_2 + 1} * (x + 1)^{-2 * k_2 - 1}))^{2 * k_1 + 1} * y^{2 * k_1 + 1} * factorial(2 * k_1 + 1)^{-1} * 2^{2 * k_1 + 1} * (-1)^{k_1})$$

)

kasutan Multinomial theoreemi. Siin on eeldatud, et True'ga korrutamise on nagu 1ega korrutamise ja Falsega korrutamise on nagu 0'iga korrutamise. Valem sin\_y\_ln\_x\_multinomial\_1:

$$\forall_x (x > 0 \rightarrow$$

$$\sin(y * \ln(x)) = \lim_{M \rightarrow \infty} (\sum_{k_1=0}^{M-1} (\sum_{k_2=0}^{(2 * k_1 + 2)^{M-1}} ($$

$$\begin{aligned}
& (\sum_{k_3=0}^{M-1} (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)) = 2*k_1+1) * \\
& \Pi_{k_3=0}^{M-1} (\text{factorial}(\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2))^{-1} * ((2*k_3+1)^{-1} * (x-1)^{2*k_3+1} * (x+1)^{-2*k_3-1})^{\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)} \\
& ) * y^{2*k_1+1} * 2^{2*k_1+1} * (-1)^{k_1}) \\
& )
\end{aligned}$$

elementide korrutamise asemel võib nende astemed liita:

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \sin(y * \ln(x)) = \\
& \lim_{M \rightarrow \infty} (\sum_{k_1=0}^{M-1} (\sum_{k_2=0}^{(2*k_1+2)^{M-1}} ( \\
& (\sum_{k_3=0}^{M-1} (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)) = 2*k_1+1) * \\
& \Pi_{k_3=0}^{M-1} (\text{factorial}(\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2))^{-1} * (2*k_3+1)^{-\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)} * ((x-1)/(x+1))^{\sum_{k_3=0}^{M-1} ((2*k_3+1) * (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)))} * y^{2*k_1+1} * 2^{2*k_1+1} * (-1)^{k_1}) \\
& ) \\
& )
\end{aligned}$$

lihtsustan. Valem sin\_y\_ln\_x\_multinomial:

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \sin(y * \ln(x)) = \\
& \lim_{M \rightarrow \infty} (\sum_{k_1=0}^{M-1} (y^{2*k_1+1} * 2^{2*k_1+1} * (-1)^{k_1} * \sum_{k_2=0}^{(2*k_1+2)^{M-1}} ( \\
& (\sum_{k_3=0}^{M-1} (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)) = 2*k_1+1) * \\
& (x-1)^{\sum_{k_3=0}^{M-1} ((2*k_3+1) * (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)))} * \\
& (x+1)^{-\sum_{k_3=0}^{M-1} ((2*k_3+1) * (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)))} * \\
& \Pi_{k_3=0}^{M-1} (\text{factorial}(\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2))^{-1} * (2*k_3+1)^{-\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)} \\
& )))) \\
& )
\end{aligned}$$

viin teguri sulgude sisse::

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \sin(y * \ln(x)) = \\
& \lim_{M \rightarrow \infty} (\sum_{k_1=0}^{M-1} (\sum_{k_2=0}^{(2*k_1+2)^{M-1}} ( \\
& (\sum_{k_3=0}^{M-1} (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)) = 2*k_1+1) * \\
& y^{2*k_1+1} * 2^{2*k_1+1} * (-1)^{k_1} * \\
& (x-1)^{\sum_{k_3=0}^{M-1} ((2*k_3+1) * (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)))} * \\
& (x+1)^{-\sum_{k_3=0}^{M-1} ((2*k_3+1) * (\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)))} * \\
& \Pi_{k_3=0}^{M-1} (\text{factorial}(\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2))^{-1} * (2*k_3+1)^{-\text{floor}(k_2/(2*k_1+2)^{k_3}) \% (2*k_1+2)} \\
& )))) \\
& )
\end{aligned}$$

selle asemel et üle eri n2'e ristsummade summeerida arvutan lihtsalt n2'e ristsumma. Valem sin\_y\_ln\_x\_multinomial\_2:

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \sin(y * \ln(x)) = \\
& - \lim_{M \rightarrow \infty} (\sum_{k_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{k_2=0}^{M-1} (\text{floor}(k_1/(2*M)^{k_2}) \% (2*M)) \% 2) * \\
& (\sum_{k_2=0}^{M-1} (\text{floor}(k_1/(2*M)^{k_2}) \% (2*M)) < 2*M) * \\
& (y * 2)^{\sum_{k_2=0}^{M-1} (\text{floor}(k_1/(2*M)^{k_2}) \% (2*M))} * \\
& (-1)^{(\sum_{k_2=0}^{M-1} (\text{floor}(k_1/(2*M)^{k_2}) \% (2*M)) - 1) / 2} * \\
& (x-1)^{\sum_{k_2=0}^{M-1} ((2*k_2+1) * (\text{floor}(k_1/(2*M)^{k_2}) \% (2*M)))} * \\
& (x+1)^{-\sum_{k_2=0}^{M-1} ((2*k_2+1) * (\text{floor}(k_1/(2*M)^{k_2}) \% (2*M)))} * \\
& \Pi_{k_2=0}^{M-1} (\text{factorial}(\text{floor}(k_1/(2*M)^{k_2}) \% (2*M))^{-1} * (2*k_2+1)^{-\text{floor}(k_1/(2*M)^{k_2}) \% (2*M)} \\
& )) \\
& )
\end{aligned}$$

kuna Mi lähenedes lõpmatusle see avaldis nagu nii koondub ja selle muutuse tegemine ainult lisab liikmeid, mis on absoluutväärtuselt väiksemad kui oleksid liikmed, mis lisanduksid Mi suurendamisel. Valem sin\_y\_ln\_x\_multinomial\_4:

$$\forall_x (x > 0 \rightarrow \sin(y * \ln(x)) =$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} \left( \sum_{k_1=0}^{(2*M)^{M-1}} \right. \\
& \left( \sum_{k_2=0}^{M-1} ( \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M)) \% 2 \right) * \\
& (y * 2)^{\sum_{k_2=0}^{M-1} ( \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M))} * \\
& (-1)^{\sum_{k_2=0}^{M-1} ( \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M)) + 3} / 2 * \\
& (x - 1)^{\sum_{k_2=0}^{M-1} ((2 * k_2 + 1) * ( \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M)))} * \\
& (x + 1)^{-\sum_{k_2=0}^{M-1} ((2 * k_2 + 1) * ( \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M)))} * \\
& \prod_{k_2=0}^{M-1} ( \text{factorial}( \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M)) )^{-1} * (2 * k_2 + 1)^{- \text{floor}(k_1 / (2 * M)^{k_2}) \% (2 * M)} \\
& \left. \right) \\
& )
\end{aligned}$$

kasutan multimomial astendajategenereerimiseks teist valemit  $v[A] = \sum_{k_4=0}^{\infty} (k_2 / 2^{k_4 * M + A} \% 2)$ . Ehk biti indexi jääk määrab, et mitmenda astendaja bit see on.

### 3.0.9 cos(ln(x)) maclaurin

cos:

$$\begin{aligned}
& \forall_x (x \in R \rightarrow \\
& \cos(x) = \sum_{k=0}^{\infty} ((-1)^k * x^{2*k} * \text{factorial}(2 * k)^{-1}) \\
& )
\end{aligned}$$

cos(y\*ln(x)):

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \\
& \sin(y * \ln(x)) = \sum_{k_1=0}^{\infty} ((-1)^{k_1} * (2 * \sum_{k_2=0}^{\infty} ((2 * k_2 + 1)^{-1} * (x - 1)^{2*k_2+1} * (x + 1)^{-2*k_2-1}))^{2*k_1} * y^{2*k_1} * \Gamma(2 * k_1 + 1)^{-1}) \\
& )
\end{aligned}$$

Valem cos\_y\_ln\_x\_multinomial:

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \cos(y * \ln(x)) = \\
& \lim_{M \rightarrow \infty} \left( \sum_{k_1=0}^{M-1} (y^{2*k_1} * 2^{2*k_1} * (-1)^{k_1} * \sum_{k_2=0}^{(2*k_1+1)^{M-1}} \right. \\
& \left( \sum_{k_3=0}^{M-1} ( \text{floor}(k_2 / (2 * k_1 + 1)^{k_3}) \% (2 * k_1 + 1) ) = 2 * k_1 \right) * \\
& (x - 1)^{\sum_{k_3=0}^{M-1} ((2 * k_3 + 1) * ( \text{floor}(k_2 / (2 * k_1 + 1)^{k_3}) \% (2 * k_1 + 1)))} * \\
& (x + 1)^{-\sum_{k_3=0}^{M-1} ((2 * k_3 + 1) * ( \text{floor}(k_2 / (2 * k_1 + 1)^{k_3}) \% (2 * k_1 + 1)))} * \\
& \prod_{k_3=0}^{M-1} ( \text{factorial}( \text{floor}(k_2 / (2 * k_1 + 1)^{k_3}) \% (2 * k_1 + 1) ) )^{-1} * (2 * k_3 + 1)^{- \text{floor}(k_2 / (2 * k_1 + 1)^{k_3}) \% (2 * k_1 + 1)} \\
& \left. \right) \\
& )
\end{aligned}$$

Valem cos\_y\_ln\_x\_multinomial\_2:

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \sin(y * \ln(x)) = \\
& \lim_{M \rightarrow \infty} \left( \sum_{k_1=0}^{(2*M)^{M-1}} \right. \\
& \left( \sum_{k_2=0}^{M-1} (( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)) + 1) \% 2 \right) * \\
& \left( \sum_{k_2=0}^{M-1} ( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)) < 2 * M - 1 \right) * \\
& (y * 2)^{\sum_{k_2=0}^{M-1} ( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1))} * \\
& (-1)^{\sum_{k_2=0}^{M-1} ( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)) / 2} * \\
& (x - 1)^{\sum_{k_2=0}^{M-1} ((2 * k_2 + 1) * ( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)))} * \\
& (x + 1)^{-\sum_{k_2=0}^{M-1} ((2 * k_2 + 1) * ( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)))} * \\
& \prod_{k_2=0}^{M-1} ( \text{factorial}( \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)) )^{-1} * (2 * k_2 + 1)^{- \text{floor}(k_1 / (2 * M - 1)^{k_2}) \% (2 * M - 1)} \\
& \left. \right) / 2 \\
& )
\end{aligned}$$

veel üks valem:

$$\begin{aligned}
& \forall_x (x > 0 \rightarrow \cos(y * \ln(x)) = \\
& \lim_{M \rightarrow \infty} \left( \sum_{n_1=0}^{(2*M)^{M-1}} \right. \\
& \left( \sum_{n_2=0}^{M-1} ( \text{floor}(n_1 / (2 * M)^{n_2}) \% (2 * M)) \% 2 \right) *
\end{aligned}$$

$$\begin{aligned}
& (\sum_{k_2=0}^{M-1} (\text{floor}(k_1/(2*M-1)^{k_2}) \% (2*M-1)) < 2*M-1) * \\
& (y*2)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))} * \\
& (-1)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))/2} * \\
& (x-1)^{\sum_{n_2=0}^{M-1} ((2*n_2+1)*(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)))} * \\
& (x+1)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)))} * \\
& \Pi_{n_2=0}^{M-1} (\text{factorial}(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))^{-1} * (2*n_2+1)^{-\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)}) \\
& )) \\
& )
\end{aligned}$$

Valem cos\_y\_ln\_x\_multinomial\_4\_2:

$$\forall_x (x > 0 \rightarrow \cos(y * \ln(x)) =$$

$$\begin{aligned}
& \lim_{M \rightarrow \infty} (\sum_{n_1=0}^{(2*M)^{M-1}} ( \\
& (\sum_{n_2=0}^{M-1} (1 + \text{floor}(n_1/(2*M)^{n_2}) \% (2*M)) \% 2) * \\
& (y*2)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))} * \\
& (-1)^{\sum_{n_2=0}^{M-1} (\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))/2} * \\
& (x-1)^{\sum_{n_2=0}^{M-1} ((2*n_2+1)*(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)))} * \\
& (x+1)^{-\sum_{n_2=0}^{M-1} ((2*n_2+1)*(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)))} * \\
& \Pi_{n_2=0}^{M-1} (\text{factorial}(\text{floor}(n_1/(2*M)^{n_2}) \% (2*M))^{-1} * (2*n_2+1)^{-\text{floor}(n_1/(2*M)^{n_2}) \% (2*M)}) \\
& )) \\
& )
\end{aligned}$$

### 3.0.10 sisemine summa

$$A = \sum_{n_2=0}^{M-1} ((2*n_2+1) * (\text{floor}(n_0/(2*M)^{n_2}) \% (2*M)))$$

$$\begin{aligned}
& - \\
& \sum_{n_1=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})-1} ( \\
& n_1^A * \\
& (n_1+1)^{-x_1} * \\
& (n_1+2)^{-A} * \\
& )
\end{aligned}$$

kasutan binomial valem:  $\forall_n (\forall_a (\forall_b ((a+b)^n = \sum_{k=0}^{\infty} (\text{faktorial}(n) * \text{faktorial}(k)^{-1} * \text{faktorial}(n-k)^{-1} * a^k * b^{n-k}))$

saadud tulemus:

$$\begin{aligned}
& \sum_{n_1=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})-1} ( \\
& \sum_{k=0}^{\infty} (\text{faktorial}(-x_1) * \text{faktorial}(k)^{-1} * \text{faktorial}(-x_1-k)^{-1} * n_1^{k+A}) * \\
& \sum_{k=0}^{\infty} (\text{faktorial}(-A) * \text{faktorial}(k)^{-1} * \text{faktorial}(-A-k)^{-1} * n_1^k * 2^{-A-k}) * \\
& )
\end{aligned}$$

panen 1 summa 2 sisse:

$$\begin{aligned}
& \sum_{n_1=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})-1} ( \\
& \sum_{k_1=0}^{\infty} (\sum_{k_2=0}^{\infty} (\text{faktorial}(-x_1) * \text{faktorial}(k_1)^{-1} * \text{faktorial}(-x_1-k_1)^{-1} * n_1^{k_1+A} * \text{faktorial}(-A) * \text{faktorial}(k_2)^{-1} * \\
& \text{faktorial}(-A-k_2)^{-1} * n_1^{k_2} * 2^{-A-k_2})) * \\
& )
\end{aligned}$$

lihtsustan seest ja viin n1 summa sisse:

$$\begin{aligned}
& \sum_{k_1=0}^{\infty} (\sum_{k_2=0}^{\infty} (\text{faktorial}(-x_1) * \text{faktorial}(k_1)^{-1} * \text{faktorial}(-x_1-k_1)^{-1} * \text{faktorial}(-A) * \text{faktorial}(k_2)^{-1} * \text{faktorial}(-A- \\
& k_2)^{-1} * 2^{-A-k_2} * \\
& \sum_{n_1=0}^{\text{floor}(e^{(\text{floor}(M)/\text{abs}(x_2)+q_2/x_2)*2\pi})-1} (n_1^{k_1+k_2+A})
\end{aligned}$$



))  
kasutan