

Euler Method

Saswata Ghosh

Roll No: MA24M022

M.Tech, IMSC, IIT Madras

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Introduction

In this report, we study the numerical solution of an ordinary differential equation (ODE) using Euler's method and compare it with the exact analytical solution. Euler's method is one of the simplest and most widely used techniques for numerically approximating solutions to differential equations, particularly when an exact solution is difficult or impossible to obtain.

To demonstrate this, we solve a first-order ODE by two approaches: first, by deriving its exact solution analytically, and second, by implementing Euler's method using the Rust programming language. Rust is chosen for its high performance, memory safety, and growing relevance in scientific computing.

The objective of this study is to visualize and analyze the difference between the exact and numerical solutions, evaluate the accuracy of Euler's method, and observe how the error behaves with respect to step size and interval.

Euler's Method: Overview

Euler's method is one of the simplest numerical techniques used to approximate solutions to ordinary differential equations (ODEs), particularly initial value problems. It works by using the slope (derivative) at a point to estimate the value of the function at the next point.

Given a first-order ODE:

$$\frac{dy}{dt} = f(t, y), \quad y(t_0) = y_0$$

Euler's method approximates the solution using the iterative formula:

$$y_{n+1} = y_n + h \cdot f(t_n, y_n)$$

where: - y_n is the current approximation, - $f(t_n, y_n)$ is the derivative evaluated at the current point, - h is the step size, and - $t_{n+1} = t_n + h$

Choosing the Step Size:

To compute the step size h , we first define the interval over which we want to solve the differential equation. Suppose we are solving over the interval $[a, b]$, and we divide it into n equal steps. Then the step size is given by:

$$h = \frac{b - a}{n}$$

For example, if we want to approximate the solution from $t = 0$ to $t = 5$ using 100 steps, then:

$$h = \frac{5 - 0}{100} = 0.05$$

A smaller value of h generally yields more accurate results but increases the computational cost. The trade-off between accuracy and efficiency is a key consideration in choosing the step size.

Problem Statement

The objective of this project is to numerically solve an initial value problem (IVP) using Euler's method, implemented in the Rust programming language. The differential equation under consideration is:

$$\frac{dy}{dt} = \cos(t) - y, \quad \text{with initial condition } y(0) = 1$$

The solution is to be approximated over the interval $0 \leq t \leq 5$ using Euler's method with $n = 20$ uniform steps. The step size h is computed using:

$$h = \frac{5 - 0}{20} = 0.25$$

The primary goal is to implement this numerical method in Rust and submit the code via a GitHub repository.

Optional Challenge:

To further evaluate the accuracy of the Euler method, an optional extension is provided. You are encouraged to:

- Increase the number of steps to $n = 100$ or $n = 1000$
- Derive the analytical (exact) solution of the differential equation
- Compare the numerical and analytical results by computing the point-wise error

Exact Solution of the Differential Equation

We are given the first-order linear ordinary differential equation (ODE):

$$\frac{dy}{dt} = \cos(t) - y, \quad y(0) = 1$$

This can be rewritten in standard linear form:

$$\frac{dy}{dt} + y = \cos(t)$$

To solve this analytically, we use the method of integrating factors. The integrating factor $\mu(t)$ is given by:

$$\mu(t) = e^{\int 1 dt} = e^t$$

Multiplying both sides of the ODE by the integrating factor:

$$e^t \frac{dy}{dt} + e^t y = e^t \cos(t)$$

This simplifies to:

$$\frac{d}{dt}(e^t y) = e^t \cos(t)$$

We now integrate both sides:

$$\int \frac{d}{dt}(e^t y) dt = \int e^t \cos(t) dt$$

The left-hand side simplifies directly to $e^t y$. The right-hand side requires integration by parts or a known standard result:

$$\int e^t \cos(t) dt = \frac{1}{2} e^t (\sin(t) + \cos(t)) + C$$

Thus, we have:

$$e^t y = \frac{1}{2} e^t (\sin(t) + \cos(t)) + C$$

Dividing both sides by e^t , we get the general solution:

$$y(t) = \frac{1}{2} (\sin(t) + \cos(t)) + C e^{-t}$$

To find the constant C , we apply the initial condition $y(0) = 1$:

$$1 = \frac{1}{2} (\sin(0) + \cos(0)) + C e^0 \Rightarrow 1 = \frac{1}{2} (0 + 1) + C \Rightarrow 1 = \frac{1}{2} + C \Rightarrow C = \frac{1}{2}$$

Therefore, the exact solution is:

$$y(t) = \frac{1}{2} (\sin(t) + \cos(t)) + \frac{1}{2} e^{-t}$$

This exact solution will be used to compare with the Euler approximation, and to calculate the error at each point.

Numerical and Analytical Comparison Using Python

To gain an initial understanding of the behavior of Euler’s method and its accuracy, the problem was first implemented and solved using Python. The objective was to numerically solve the differential equation

$$\frac{dy}{dt} = \cos(t) - y, \quad y(0) = 1$$

using Euler’s method and compare it with the exact (analytical) solution.

Step 1: Euler Method with $n = 20$

Initially, the solution was computed using a coarse discretization with $n = 20$ steps over the interval $[0, 5]$. The step size was calculated as:

$$h = \frac{5 - 0}{20} = 0.25$$

Using this configuration, both the Euler solution and the analytical solution were plotted on the same graph. A third plot was included to show the pointwise absolute error between the numerical and exact solutions. As expected, the Euler approximation showed noticeable deviation from the true solution, and the error curve reflected significant inaccuracies, especially as t increased.

Step 2: Euler Method with $n = 1000$

To observe how the error behaves with finer step sizes, the number of steps was increased to $n = 1000$, resulting in a much smaller step size of:

$$h = \frac{5}{1000} = 0.005$$

With this finer discretization, the Euler solution closely matched the exact solution throughout the interval. The error graph showed a substantial reduction in deviation—dropping to values very close to zero. This visually and numerically confirmed that Euler’s method becomes significantly more accurate as the step size decreases.

Visualization and Insights

All three plots—(1) the Euler solution, (2) the exact solution, and (3) the error—were generated using Python’s ‘matplotlib’ library. These plots clearly demonstrated:

- Euler’s method provides a good approximation to the exact solution when a sufficiently small step size is used.
- For $n = 20$, the numerical error is significant and increases over time.
- For $n = 1000$, the error is minimal and tends toward zero, confirming the convergence of Euler’s method to the exact solution as the step size decreases.

This experiment served to validate both the theoretical and practical aspects of Euler’s method and highlighted the importance of choosing an appropriate step size in numerical simulations.

Why Rust? An Introduction to the Language

Rust is a modern systems programming language designed with performance, reliability, and safety in mind. Developed by Mozilla and backed by a growing open-source community, Rust offers memory safety without the need for a garbage collector, making it both efficient and robust for building high-performance applications.

Unlike traditional systems programming languages like C or C++, Rust prevents entire classes of bugs at compile time, particularly those related to memory access (such as null pointer dereferencing or buffer overflows). It achieves this through a powerful ownership and borrowing model, which ensures safe memory management and concurrency by design.

Why Use Rust for Numerical Computation?

Rust is increasingly gaining traction in the scientific computing and data science communities for several reasons:

- **High Performance:** Rust compiles to highly optimized native code, making it ideal for performance-critical numerical tasks.
- **Memory Safety:** Rust's strict compile-time checks eliminate common bugs without sacrificing control over low-level memory layout.
- **Concurrency:** Rust allows safe multithreading and parallelism, which is crucial for large-scale numerical simulations.
- **Growing Ecosystem:** Libraries like `ndarray`, `nalgebra`, `plotters`, and `csv` make Rust increasingly suitable for mathematical, data processing, and visualization tasks.
- **Tooling:** Rust offers excellent compiler diagnostics, package management through `Cargo`, and unit testing support out of the box.

Given these advantages, Rust was chosen for this project not only as a challenge but also to demonstrate how well it performs in numerically solving differential equations such as the one tackled using Euler's method.

Furthermore, implementing a classic numerical technique like Euler's method in Rust provides a valuable opportunity to bridge mathematical modeling with systems-level programming, enabling robust and efficient scientific computing pipelines.

Rust Implementation with Euler Method and Analytical Solution

After experimenting with the Euler method and exact solution in Python, the same problem was solved using Rust to take advantage of its performance, type safety, and low-level memory control. For this part of the project, the number

of steps was increased to $n = 1000$, allowing a finer discretization and more accurate approximation.

Euler Method with $n = 1000$

Euler's method was implemented in Rust using a fixed step size:

$$h = \frac{5 - 0}{1000} = 0.005$$

The differential equation:

$$\frac{dy}{dt} = \cos(t) - y, \quad y(0) = 1$$

was solved numerically over the interval $[0, 5]$ using this fine step size. At each step, the new value of y was calculated using the Euler update formula, and the time t was incremented accordingly.

Analytical Solution

The exact (analytical) solution of the ODE was also calculated for comparison. At each step, the exact value of $y(t)$ was computed based on the derived formula:

$$y(t) = \frac{1}{2}(\sin(t) + \cos(t)) + \frac{1}{2}e^{-t}$$

Data Export and Visualization

To analyze and visualize the results:

- A CSV file was generated containing four columns: Step Number, Exact Solution, Euler Solution, and Absolute Error.
- This file allows for further analysis in external tools like Python, Excel, or R.
- A plot was generated using a Rust-compatible plotting library or exported data. The graph clearly shows the Euler solution and the exact solution overlapping almost perfectly due to the small step size.

Observations

With $n = 1000$, the numerical approximation from Euler's method is nearly indistinguishable from the analytical solution. The absolute error at each step was very small, approaching zero. This demonstrates the convergence of the Euler method as the step size decreases and validates the correctness of the Rust implementation.

Overall, the Rust-based implementation proved to be accurate, efficient, and suitable for scientific computing tasks such as solving ordinary differential equations and generating structured output for further analysis.

You can find the complete source code on [GitHub](#).

t	solution		
	euler_y	exact_y	error
0	0	1	1
0	0	1	0
0.005		1	0.999999979192708 2.0807291667424E-08
0.01	0.99999993750013		0.99999983375 1.03750130153735E-07
0.015	0.999999687814713		0.999999439609375 2.48205337838314E-07
0.02	0.999999126886186		0.999998673333333 4.53552853052486E-07
0.025	0.999998131285088		0.999997412109374 7.19175714314346E-07
0.03	0.999996578210041		0.999995533749996 1.04446004545178E-06
0.035	0.999994345487736		0.999992916692696 1.42879504028137E-06
0.04	0.999991311572915		0.999989439999968 1.8715729470653E-06
0.045	0.999987355548355		0.999984983359301 2.37218905363434E-06
0.05	0.999982357124852		0.999979427083179 2.93004167306599E-06
0.055	0.999976196641203		0.999972652109075 3.54453212791928E-06
0.06	0.999968755064185		0.999964539999449 4.21506473613498E-06
0.065	0.99995991398854		0.999954972941744 4.94104679638063E-06
0.07	0.999949555636954		0.99994383374838 5.72188857339562E-06
0.075	0.999937562860035		0.999931005856751 6.55700328400233E-06
0.08	0.999923819136296		0.999916373329214 7.44580708222919E-06
0.085	0.999908208572128		0.999899820853082 8.38771904598801E-06
0.09	0.999890615901779		0.999881233740617 9.38216116186386E-06
0.095	0.99987092648733		0.999860497929017 1.04285583125696E-05
0.1	0.999849026318669		0.999837499980407 1.1526338262513E-05
0.105	0.999824802013466		0.999812127081823 1.26749316432528E-05
0.11	0.999798140817141		0.9997842670452 1.38737719411752E-05
0.115	0.999768930602839		0.999753808307355 1.51222954835051E-05
0.12	0.999737059871396		0.999720639929972 1.64199414242061E-05
0.125	0.999702417751308		0.999684651599576 1.77661517321015E-05
0.13	0.999664893998698		0.999645733627522 1.91603711761079E-05
0.135	0.999624378997279		0.999603776949965 2.06020473133561E-05
0.14	0.999580763758315		0.99955867312784 2.20906304754243E-05
0.145	0.999533939920587		0.999510314346831 2.36255737555702E-05
0.15	0.999483799750346		0.99945859341735 2.5206332996075E-05
0.155	0.999430236141274		0.999403403774498 2.68323667758086E-05
0.16	0.999373142614439		0.999344639478042 2.85031363970178E-05
0.165	0.999312413318245		0.999282195212372 3.02181058727813E-05
0.17	0.999247943028386		0.99921596628647 3.19767419154626E-05
0.175	0.999179627147792		0.999145848633869 3.37785139230551E-05
0.18	0.999107361706577		0.999071738812609 3.56228939683012E-05
0.185	0.999031043361985		0.998993534005199 3.75093567857032E-05
0.19	0.998950569398326		0.998911132018567 3.94373797595327E-05
0.195	0.998865837726921		0.998824431284009 4.1406442911951E-05
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0.205	0.99868319604081		0.998637730417849 4.54656229612604E-05
0.21	0.998585084983204		0.998537530270218 4.75547129861198E-05
0.215	0.998482314131908		0.998432631342486 4.96827894226337E-05
0.22	0.998374784532283		0.998322935186977 5.18493453064428E-05
0.225	0.998262397856275		0.998208343980033 5.40538762417997E-05
0.23	0.998145056402338		0.998088760521949 5.62958803894675E-05
0.235	0.998022663095353		0.997964088236898 5.85748584556178E-05
0.24	0.99789512148654		0.997834231172859 6.08903136808392E-05
0.245	0.997762335753367		0.997699094001538 6.32417518293682E-05
0.25	0.997624210699464		0.997558582018286 6.562868117721E-05
0.255	0.997480651754519		0.997412601142017 6.80506125021463E-05

solution

0.26	0.99733156497419	0.997261057915117	0.0000705070590723
0.265	0.997176857039991	0.997103859503355	7.29975366360325E-05
0.27	0.997016435259198	0.996940913695787	7.55215634105078E-05
0.275	0.996850207564731	0.99677212890466	7.8078660071812E-05
0.28	0.996678082515049	0.996597414165305	8.0668349743851E-05
0.285	0.996499969294028	0.996416679136039	8.32901579886913E-05
0.29	0.996315777710845	0.996229834098049	8.59436127954583E-05
0.295	0.996125418199854	0.996036789955283	8.86282445707876E-05
0.3	0.99592880182046	0.995837458234332	9.13435861278344E-05
0.305	0.995725840256985	0.995631751084308	9.40891726772808E-05
0.31	0.995516445818539	0.995419581276723	0.0000968645418158998
0.315	0.995300531438875	0.995200862205357	9.96692335183402E-05
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0.325	0.994848797713282	0.994743432956945	0.000105364756337267
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0.35	0.993599389970473	0.993479305010772	0.000120084959700617
0.355	0.993328256584857	0.993205148631853	0.000123107953004076
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0.365	0.992764082625689	0.992634853259782	0.000129229365907313
0.37	0.992470881018384	0.992338554104176	0.000132326914208281
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0.39	0.99122212739946	0.99107717473932	0.000144952660140474
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0.4	0.990551092073256	0.990399691173587	0.000151400899668808
0.405	0.990203641582904	0.990048984197515	0.000154657385389667
0.41	0.989848135360819	0.989690200468674	0.000157934892144995
0.415	0.989484498798098	0.989323265792621	0.00016123300547688
0.42	0.98911265790658	0.988948106593468	0.00016455131311266
0.425	0.988732539318609	0.988564649913653	0.000167889404955934
0.43	0.988344070286786	0.988172823413706	0.000171246873079789
0.435	0.987947178683726	0.98777255537201	0.000174623311716804
0.44	0.987541793001804	0.987363774684552	0.000178018317252393
0.445	0.987127842352895	0.98694641086468	0.000181431488215367
0.45	0.986705256468111	0.98652039404284	0.000184862425271159
0.455	0.986273965697534	0.986085654966321	0.000188310731212948
0.46	0.985833901009939	0.985642124998985	0.000191776010953992
0.465	0.985384993992517	0.985189736120998	0.000195257871519416
0.47	0.984927176850588	0.984728420928549	0.00019875592203944
0.475	0.984460382407312	0.984258112633572	0.00020226977374016
0.48	0.983984544103391	0.983778745063454	0.000205799039937449
0.485	0.983499595996771	0.983290252660743	0.000209343336027734
0.49	0.98300547276233	0.982792570482848	0.000212902279481786
0.495	0.982502109691569	0.982285634201732	0.000216475489836387
0.5	0.981989442692292	0.981769380103605	0.000220062588687231
0.505	0.981467408288282	0.981243745088601	0.000223663199681257
0.51	0.980935943618972	0.980708666670462	0.000227276948509436
0.515	0.980394986439106	0.980164082976206	0.00023090346289989
0.52	0.9798444751184	0.979609932745791	0.000234542372609892

solution

0.525	0.979284348641197	0.979046155331777	0.000238193309419654
0.53	0.978714546606106	0.978472690698982	0.000241855907123889
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0.54	0.977545677325894	0.977296462695463	0.000249214630430816
0.545	0.976946492346084	0.976693582312447	0.000252910033636811
0.55	0.976337396338256	0.976080780685326	0.000256615652930448
0.555	0.975718331966862	0.975458000834784	0.000260331132077907
0.56	0.975089242508377	0.974825186391557	0.000264056116820011
0.565	0.974450071850902	0.974182281596038	0.000267790254864009
0.57	0.973800764493765	0.973529231297887	0.000271533195877249
0.575	0.973141265547107	0.972865980955626	0.000275284591480962
0.58	0.972471520731475	0.972192476636231	0.000279044095243597
0.585	0.971791476377393	0.97150866501472	0.000282811362673829
0.59	0.971101079424942	0.970814493373727	0.000286586051214566
0.595	0.970400277423318	0.970109909603082	0.000290367820235615
0.6	0.969689018530399	0.96939486219937	0.000294156331029027
0.605	0.968967251512296	0.968669300265495	0.000297951246800765
0.61	0.968234925742896	0.96793317351023	0.000301752232665486
0.615	0.967491991203409	0.967186432247768	0.000305558955640661
0.62	0.966738398481896	0.966429027397257	0.000309371084639132
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0.7050000000000001	0.952251670416449	0.951876977776905	0.000374692639543928
0.7100000000000001	0.951298469823177	0.950919922236505	0.000378547586672329
0.7150000000000001	0.950333786854014	0.949951384852512	0.000382402001501525
0.7200000000000001	0.949357584125802	0.94897132853617	0.000386255589631679
0.7250000000000001	0.948369824850877	0.947979716792439	0.000390108058438421
0.7300000000000001	0.947370472836453	0.946976513719385	0.000393959117068299
0.7350000000000001	0.946359492483995	0.945961684007563	0.00039780847643256
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0.7500000000000001	0.943256434313507	0.942847090819085	0.000409343494422565
0.7550000000000001	0.942198596486309	0.94178541328534	0.000413183200968836
0.7600000000000001	0.941128961219791	0.940711941430683	0.000417019789107909
0.7650000000000001	0.940047496467396	0.93962664348716	0.000420852980235753
0.7700000000000001	0.938954170772242	0.938529488274764	0.00042468249747829
0.7750000000000001	0.937848953266436	0.93742044520075	0.000428508065685507
0.7800000000000001	0.936731813670383	0.936299484258956	0.000432329411427679
0.7850000000000001	0.935602722292093	0.935166576029102	0.000436146262990267

solution

0.7900000000000001	0.934461650026468	0.9340216916761	0.000439958350368475
0.7950000000000001	0.933308568354597	0.932864802949334	0.000443765405262808
0.8000000000000001	0.932143449343029	0.931695882181955	0.000447567161074636
0.8050000000000001	0.93096626564305	0.930514902290149	0.000451363352900525
0.8100000000000001	0.929776990489944	0.929321836772415	0.000455153717528689
0.8150000000000001	0.928575597702253	0.928116659708819	0.000458937993433661
0.8200000000000001	0.927362061681025	0.926899345760254	0.000462715920771295
0.8250000000000001	0.926136357409058	0.925669870167684	0.000466487241374658
0.8300000000000001	0.924898460450132	0.924428208751383	0.000470251698749702
0.8350000000000001	0.923648346948238	0.923174337910168	0.000474009038069934
0.8400000000000001	0.922385993626796	0.921908234620623	0.000477759006172529
0.8450000000000001	0.921111377787869	0.920629876436315	0.000481501351553559
0.8500000000000001	0.919824477311364	0.919339241487001	0.000485235824363106
0.8550000000000001	0.918525270654232	0.91803630847783	0.000488962176401819
0.8600000000000001	0.917213736849655	0.916721056688539	0.000492680161115922
0.8650000000000001	0.915889855506227	0.915393465972634	0.000496389533592545
0.8700000000000001	0.914553606807128	0.914053516756572	0.000500090050555957
0.8750000000000001	0.913204971509293	0.91270119003893	0.000503781470362563
0.8800000000000001	0.911843930942563	0.911336467389565	0.000507463552997689
0.8850000000000001	0.910470467008843	0.909959330948773	0.000511136060069806
0.8900000000000001	0.909084562181241	0.908569763426433	0.000514798754807866
0.8950000000000001	0.907686199503203	0.907167748101147	0.000518451402055864
0.9000000000000001	0.906275362587643	0.905753268819373	0.000522093768269283
0.9050000000000001	0.904852035616058	0.904326309994547	0.000525725621510653
0.9100000000000001	0.903416203337644	0.902886856606199	0.000529346731445668
0.9150000000000001	0.9019678510684	0.901434894199062	0.000532956869338741
0.9200000000000001	0.900506964690221	0.899970408882171	0.000536555808049233
0.9250000000000001	0.899033530649987	0.89849338732796	0.000540143322027231
0.9300000000000001	0.897547535958647	0.897003816771338	0.000543719187309333
0.9350000000000001	0.896048968190291	0.895501685008775	0.000547283181515201
0.9400000000000001	0.89453781548121	0.893986980397367	0.000550835083842904
0.9450000000000001	0.893014066528959	0.892459691853894	0.00055437467506525
0.9500000000000001	0.891477710591405	0.890919808853879	0.000557901737526234
0.9550000000000001	0.889928737485768	0.889367321430632	0.000561416055136155
0.9600000000000001	0.888367137587652	0.887802220174283	0.000564917413368504
0.9650000000000001	0.886792901830076	0.88622449623082	0.000568405599256083
0.9700000000000001	0.885206021702488	0.884634141301101	0.000571880401386782
0.9750000000000001	0.883606489249777	0.883031147639878	0.000575341609899582
0.9800000000000001	0.881994297071275	0.881415508054793	0.000578789016481784
0.9850000000000001	0.88036943831975	0.879787215905386	0.000582222414363898
0.9900000000000001	0.878731906700393	0.878146265102077	0.000585641598316755
0.9950000000000001	0.877081696469799	0.876492650105152	0.000589046364647183
1	0.875418802434934	0.874826365923739	0.000592436511195227
1.005	0.8737432199521	0.873147408114771	0.000595811837329152
1.01	0.87205494492589	0.871455772781947	0.000599172143943005
1.015	0.870353973808132	0.869751456574681	0.000602517233451505
1.02	0.868640303596833	0.868034456687045	0.000605846909788155
1.025	0.866913931835108	0.866304770856707	0.000609160978400136
1.03	0.865174856610099	0.864562397363853	0.000612459246245756
1.035	0.863423076551898	0.862807335030108	0.000615741521789781
1.04	0.86165859083245	0.861039583217449	0.00061900761500111
1.045	0.859881399164451	0.859259141827103	0.000622257337348109
1.05	0.858091501800245	0.85746601129845	0.0006254905017955

solution

1.055	0.856288899530703	0.855660192607901	0.000628706922801481
1.06	0.854473593684099	0.853841687267786	0.000631906416312944
1.065	0.852645586124981	0.852010497325218	0.000635088799763151
1.07	0.850804879253029	0.850166625360962	0.000638253892067286
1.075	0.848951476001906	0.848310074488286	0.000641401513620354
1.08	0.847085379838106	0.846440848351814	0.000644531486292066
1.085	0.845206594759784	0.844558951126359	0.000647643633424733
1.09	0.843315125295591	0.842664387515761	0.00065073777982938
1.095	0.841410976503489	0.840757162751707	0.000653813751782417
1.1	0.839494153969569	0.838837282592547	0.000656871377021862
1.105	0.837564663806849	0.836904753322104	0.000659910484745008
1.11	0.835622512654076	0.834959581748472	0.000662930905603876
1.115	0.833667707674515	0.833001775202812	0.000665932471702657
1.12	0.831700256554723	0.831031341538129	0.000668915016594274
1.125	0.829720167503333	0.829048289128056	0.000671878375277046
1.13	0.82772744924981	0.827052626865619	0.000674822384191032
1.135	0.825722111043212	0.825044364161996	0.000677746881215802
1.14	0.823704162650939	0.823023510945274	0.000680651705665669
1.145	0.821673614357476	0.820990077659189	0.000683536698287579
1.15	0.819630476963125	0.818944075261867	0.00068640170125811
1.155	0.81757476178273	0.816885515224551	0.000689246558178813
1.16	0.815506480644398	0.814814409530324	0.000692071114074433
1.165	0.813425645888208	0.812730770672818	0.000694875215389246
1.17	0.81133227036491	0.810634611654927	0.000697658709983617
1.175	0.809226367434627	0.808525945987496	0.000700421447131228
1.18	0.807107950965534	0.806404787688018	0.000703163277515628
1.185	0.80497703533254	0.804271151279314	0.000705884053226802
1.19	0.802833635415963	0.802125051788203	0.000708583627759607
1.195	0.800677766600186	0.799966504744178	0.000711261856008227
1.2	0.798509444772318	0.797795526178053	0.000713918594265173
1.205	0.796328686320839	0.795612132620623	0.000716553700216616
1.21	0.794135508134244	0.793416341101304	0.000719167032940726
1.215	0.79192992759967	0.791208169146766	0.000721758452903565
1.22	0.789711962601523	0.788987634779566	0.000724327821956305
1.225	0.787481631520095	0.786754756516763	0.000726875003332239
1.23	0.785238953230175	0.784509553368532	0.000729399861643665
1.235	0.782983947099647	0.782252044836768	0.000731902262879003
1.24	0.780716632988084	0.779982250913685	0.000734382074399353
1.245	0.778437031245338	0.777700192080402	0.000736839164936276
1.25	0.776145162710112	0.775405889305525	0.000739273404587681
1.255	0.773841048708538	0.773099364043722	0.000741684664815945
1.26	0.771524711052734	0.77078063823429	0.000744072818443797
1.265	0.769196172039362	0.768449734299709	0.000746437739652439
1.27	0.766855454448176	0.766106675144198	0.000748779303977654
1.274999999999999	0.764502581540561	0.763751484152254	0.000751097388307587
1.279999999999999	0.762137577058069	0.76138418518719	0.000753391870879305
1.284999999999999	0.759760465220939	0.759004802589663	0.000755662631275467
1.289999999999999	0.757371270726616	0.756613361176194	0.000757909550422431
1.294999999999999	0.754970018748266	0.75420988623768	0.000760132510586487
1.299999999999999	0.752556734933271	0.751794403537899	0.000762331395371518
1.304999999999999	0.750131445401727	0.749366939312012	0.0007645060897149
1.309999999999999	0.747694176744935	0.746927520265048	0.000766656479886607
1.314999999999999	0.745244956023873	0.744476173570389	0.000768782453483996

solution

1.3199999999999999	0.742783810767678	0.742012926868247	0.000770883899430364
1.3249999999999999	0.740310768972101	0.739537808264129	0.00077296070797217
1.3299999999999999	0.737825859097974	0.737050846327299	0.000775012770674932
1.3349999999999999	0.735329110069653	0.734552070089231	0.000777039980421446
1.3399999999999999	0.732820551273464	0.732041509042056	0.000779042231408345
1.3449999999999999	0.730300212556139	0.729519193136996	0.000781019419143214
1.3499999999999999	0.727768124223242	0.7269851527828	0.000782971440442482
1.3549999999999999	0.725224317037591	0.724439418844164	0.000784898193427308
1.3599999999999999	0.722668822217671	0.721882022640149	0.000786799577521702
1.3649999999999999	0.72010167143604	0.719312995942591	0.000788675493448965
1.3699999999999999	0.717522896817727	0.716732370974498	0.000790525843229584
1.3749999999999999	0.714932530938626	0.714140180408448	0.000792350530177899
1.3799999999999999	0.712330606823878	0.711536457364979	0.000794149458898996
1.3849999999999999	0.709717157946248	0.708921235410961	0.000795922535286597
1.3899999999999999	0.707092218224496	0.706294548557976	0.000797669666519507
1.3949999999999999	0.704455822021738	0.703656431260679	0.000799390761059282
1.3999999999999999	0.701808004143805	0.701006918415158	0.000801085728647344
1.4049999999999999	0.699148799837588	0.698346045357286	0.000802754480301537
1.4099999999999999	0.696478244789378	0.695673847861064	0.000804396928314022
1.4149999999999999	0.693796375123205	0.692990362136957	0.000806012986248383
1.4199999999999999	0.691103227399162	0.690295624830225	0.000807602568936527
1.4249999999999999	0.688398838611725	0.687589673019249	0.00080916559247568
1.4299999999999999	0.685683246188065	0.684872544213839	0.000810701974226058
1.4349999999999999	0.682956487986359	0.682144276353551	0.000812211632808091
1.4399999999999999	0.680218602294081	0.679404907805982	0.000813694488099093
1.4449999999999999	0.677469627826301	0.676654477365071	0.000815150461230596
1.4499999999999999	0.674709603723968	0.673893024249381	0.000816579474586243
1.4549999999999999	0.671938569552185	0.671120588100387	0.000817981451797678
1.4599999999999999	0.669156565298485	0.668337208980742	0.000819356317742881
1.4649999999999999	0.666363631371093	0.66554292737255	0.000820703998543171
1.4699999999999999	0.663559808597183	0.662737784175624	0.000822024421559875
1.4749999999999999	0.660745138221132	0.65992182070574	0.000823317515391775
1.4799999999999999	0.657919661902759	0.657095078692887	0.000824583209872665
1.4849999999999999	0.655083421715567	0.654257600279499	0.000825821436068241
1.4899999999999999	0.65223646014497	0.651409428018697	0.000827032126273219
1.4949999999999999	0.649378820086519	0.648550604872511	0.000828215214008887
1.4999999999999999	0.646510544844119	0.645681174210099	0.000829370634019555
1.5049999999999999	0.643631678128237	0.642801179805966	0.000830498322271223
1.5099999999999999	0.640742264054109	0.639910665838162	0.000831598215947027
1.5149999999999999	0.637842347139935	0.63700967688649	0.000832670253445356
1.5199999999999999	0.634931972305072	0.634098257930695	0.000833714374377625
1.5249999999999999	0.632011184868215	0.631176454348651	0.000834730519564064
1.5299999999999999	0.629080030545576	0.628244311914543	0.000835718631032378
1.5349999999999999	0.626138555449056	0.625301876797042	0.000836678652013756
1.5399999999999999	0.623186806084409	0.622349195557468	0.000837610526940757
1.5449999999999999	0.620224829349399	0.619386315147955	0.00083851420144454
1.5499999999999999	0.617252672531954	0.616413282909603	0.000839389622351527
1.5549999999999999	0.61427038330831	0.613430146570629	0.000840236737681299
1.5599999999999999	0.611278009741149	0.610436954244506	0.000841055496643262
1.5649999999999999	0.608275600277735	0.607433754428101	0.000841845849634315
1.5699999999999999	0.605263203748037	0.604420595999801	0.000842607748235413
1.5749999999999999	0.60224086936285	0.601397528217641	0.000843341145209231
1.5799999999999999	0.599208646711912	0.598364600717415	0.000844045994497722

solution

1.58499999999999	0.596166585762009	0.595321863510791	0.000844722251218233
1.58999999999999	0.593114736855075	0.592269366983413	0.000845369871661617
1.59499999999999	0.590053150706291	0.589207161893002	0.000845988813289234
1.59999999999999	0.586981878402173	0.586135299367443	0.000846579034729955
1.60499999999999	0.583900971398656	0.583053830902879	0.000847140495777499
1.60999999999999	0.580810481519169	0.579962808361781	0.00084767315738743
1.61499999999999	0.577710460952708	0.576862283971033	0.00084817698167472
1.61999999999999	0.574600962251903	0.573752310319992	0.000848651931910527
1.62499999999999	0.571482038331072	0.570632940358553	0.00084909797251953
1.62999999999999	0.568353742464282	0.567504227395205	0.000849515069077378
1.63499999999999	0.56521612828339	0.564366225095083	0.000849903188307244
1.63999999999999	0.562069249776088	0.56121898747801	0.000850262298077831
1.64499999999999	0.558913161283937	0.558062568916538	0.000850592367399483
1.64999999999999	0.5557479175004	0.554897024133978	0.000850893366422523
1.65499999999999	0.552573573468865	0.551722408202431	0.000851165266433585
1.65999999999999	0.549390184580661	0.548538776540808	0.000851408039853174
1.66499999999999	0.546197806573075	0.545346184912843	0.000851621660232449
1.66999999999999	0.542996495527359	0.542144689425108	0.000851806102250885
1.67499999999999	0.539786307866729	0.538934346525016	0.00085196134171317
1.67999999999999	0.536567300354363	0.535715212998816	0.000852087355546205
1.68499999999999	0.533339530091392	0.532487345969595	0.000852184121796551
1.68999999999999	0.530103054514884	0.529250802895257	0.00085225161962732
1.69499999999999	0.526857931395827	0.526005641566511	0.000852289829315289
1.69999999999999	0.523604218837097	0.522751920104849	0.00085229873224868
1.70499999999999	0.520341975271434	0.519489696960511	0.000852278310922938
1.70999999999999	0.517071259459401	0.516219030910461	0.000852228548939737
1.71499999999999	0.513792130487342	0.512939981056339	0.000852149431002203
1.71999999999999	0.510504647765338	0.509652606822425	0.000852040942913246
1.72499999999999	0.507208871025155	0.506356967953583	0.000851903071572457
1.72999999999999	0.503904860318181	0.503053124513208	0.000851735804972886
1.73499999999999	0.500592676013369	0.499741136881171	0.000851539132198376
1.73999999999999	0.497272378795167	0.496421065751747	0.000851313043420732
1.74499999999998	0.493944029661446	0.49309297213155	0.000851057529896726
1.74999999999998	0.49060768992142	0.489756917337455	0.000850772583965209
1.75499999999998	0.487263421193566	0.486412962994522	0.000850458199044057
1.75999999999998	0.483911285403533	0.483061171033905	0.000850114369627675
1.76499999999998	0.480551344782051	0.479701603690767	0.000849741091283496
1.76999999999998	0.477183661862833	0.476334323502184	0.000849338360649488
1.77499999999998	0.473808299480473	0.472959393305042	0.000848906175431208
1.77999999999998	0.470425320768338	0.469576876233939	0.00084844453439864
1.78499999999998	0.467034789156452	0.466186835719069	0.000847953437383364
1.78999999999998	0.463636768369387	0.462789335484111	0.000847432885275556
1.79499999999998	0.460231322424133	0.459384439544112	0.000846882880021382
1.79999999999998	0.456818515627978	0.455972212203359	0.000846303424619443
1.80499999999998	0.453398412576373	0.452552718053254	0.000845694523118334
1.80999999999998	0.449971078150797	0.449126021970184	0.000845056180613424
1.81499999999998	0.44653657751662	0.445692189113376	0.000844388403244023
1.81999999999998	0.443094976120953	0.442251284922763	0.000843691198190111
1.82499999999998	0.439646339690504	0.438803375116835	0.000842964573669891
1.82999999999998	0.436190734229422	0.435348525690486	0.000842208538936129
1.83499999999998	0.432728226017137	0.431886802912863	0.000841423104273875
1.83999999999998	0.429258881606203	0.428418273325206	0.000840608280996968
1.84499999999998	0.425782767820127	0.424943003738682	0.000839764081445149

solution

1.84999999999998	0.422299951751201	0.42146106123222	0.00083889051898095
1.85499999999998	0.418810500758322	0.417972513150335	0.000837987607987145
1.85999999999998	0.415314482464821	0.414477427100958	0.000837055363863026
1.86499999999998	0.411811964756272	0.41097587095325	0.00083609380302202
1.86999999999998	0.408303015778308	0.40746791283542	0.000835102942888188
1.87499999999998	0.40478770393443	0.403953621132537	0.000834082801893454
1.87999999999998	0.40126609788381	0.400433064484336	0.000833033399474548
1.88499999999998	0.397738266539092	0.396906311783022	0.000831954756069731
1.88999999999998	0.394204279064188	0.393373432171072	0.000830846893115966
1.89499999999998	0.390664204872073	0.389834495039027	0.000829709833045866
1.89999999999998	0.387118113622571	0.386289570023286	0.00082854359928447
1.90499999999998	0.38356607522014	0.382738727003894	0.000827348216245971
1.90999999999998	0.380008159811659	0.379182036102327	0.000826123709331383
1.91499999999998	0.376444437784196	0.375619567679272	0.000824870104924713
1.91999999999998	0.372874979762792	0.372051392332402	0.000823587430390071
1.92499999999998	0.369299856608224	0.368477580894155	0.000822275714068677
1.92999999999998	0.365719139414774	0.364898204429499	0.000820934985275634
1.93499999999998	0.362132899507996	0.361313334233699	0.000819565274296885
1.93999999999998	0.358541208442468	0.357723041830082	0.000818166612386206
1.94499999999998	0.354944137999557	0.354127398967795	0.000816739031761771
1.94999999999998	0.351341760185165	0.350526477619562	0.000815282565603315
1.95499999999998	0.347734147227483	0.346920349979435	0.000813797248048587
1.95999999999998	0.344121371574735	0.343309088460544	0.000812283114190959
1.96499999999998	0.34050350589292	0.339692765692845	0.000810740200075266
1.96999999999998	0.336880623063557	0.336071454520862	0.000809168542695582
1.97499999999998	0.333252796181416	0.332445228001424	0.000807568179991336
1.97999999999998	0.329620098552253	0.328814159401408	0.000805939150844648
1.98499999999998	0.325982603690542	0.325178322195465	0.000804281495076775
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1.99999999999998	0.315042073937873	0.314242936757591	0.000799137180281628
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2.00999999999998	0.307725758223956	0.306930192947942	0.000795565276013821
2.01499999999998	0.304061035172345	0.303267298423381	0.00079373674896388
2.01999999999998	0.300392035142313	0.29960015524224	0.000791879900073178
2.02499999999998	0.29671883323601	0.295928838459448	0.000789994776561831
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2.05999999999998	0.270895114871057	0.270119103491612	0.000776011379444497
2.06499999999998	0.267191023728064	0.266417121860617	0.000773901867446969
2.06999999999998	0.263483414819097	0.262711650272715	0.000771764546382336
2.07499999999998	0.259772365024208	0.259002765551781	0.000769599472426719
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2.08499999999998	0.252340251119905	0.251575064824975	0.000765186294930054
2.08999999999998	0.248619341586666	0.247856403278551	0.00076293830811483
2.09499999999998	0.244895300315202	0.244134637513349	0.000760662801853468
2.09999999999998	0.241168204987692	0.240409845151016	0.00075835983667577
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2.12999999999998	0.218745867087595	0.218001898181535	0.000743968906060433
2.13499999999998	0.214999581064043	0.214258105568865	0.000741475495177779
2.13999999999998	0.211250867769794	0.210511912629474	0.000738955140319159
2.14499999999998	0.207499806183947	0.206763398274308	0.000736407909639275
2.14999999999998	0.203746475418002	0.20301264154588	0.000733833872122502
2.15499999999998	0.199990954713511	0.199259721615931	0.000731233097580247
2.15999999999998	0.196233323439732	0.195504717783084	0.00072860565664723
2.16499999999998	0.19247366109128	0.191747709470502	0.000725951620777654
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2.18499999999998	0.177416295098894	0.17670122411337	0.000715070985524396
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2.19999999999998	0.166105857347516	0.165399222463308	0.000706634884208107
2.20499999999998	0.162332822474502	0.161629051716059	0.000703770758442718
2.20999999999998	0.158558477231219	0.157857596514068	0.000700880717150437
2.21499999999998	0.154782902236392	0.154084937396599	0.000697964839792786
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2.23499999999997	0.139669920547039	0.138983875960828	0.00068604458621066
2.23999999999997	0.135889409473188	0.135206408725516	0.000683000747671997
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2.24999999999997	0.128326236489959	0.127649399363543	0.000676837126416141
2.25499999999997	0.124543737193895	0.123870019679727	0.000673717514168726
2.25999999999997	0.120760737906209	0.120090165090464	0.000670572815745243
2.26499999999997	0.116977320133708	0.116309917015447	0.000667403118260926
2.26999999999997	0.113193565459003	0.112529356949426	0.000664208509576769
2.27499999999997	0.109409555538141	0.108748566459845	0.000660989078295593
2.27999999999997	0.105625372098236	0.104967627184477	0.000657744913758904
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2.28999999999997	0.0980568119109082	0.0974056291649534	0.000651182745954826
2.29499999999997	0.0942725989517628	0.0936247340267331	0.000647864925029745
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2.30499999999997	0.0867047172387704	0.0860635609683469	0.000641156270423493
2.30999999999997	0.0829212126357153	0.0822834470122983	0.000637765623416997
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2.31999999999997	0.0753554867257861	0.0747245745637507	0.000630912162035355
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2.40999999999997	0.00744478626120732	0.00687976129859504	0.000565024962612279
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2.51999999999997	-0.0746060256579308	-0.0750808904131146	0.000474864755183754
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2.53499999999997	-0.0856692798420421	-0.0861310896765343	0.000461809834492247
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2.54499999999997	-0.0930243414081366	-0.0934773519477155	0.000453010539578871
2.54999999999997	-0.0966954934641913	-0.0971440759213026	0.000448582457111296
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2.79999999999996	-0.273006127140505	-0.273212063943743	0.000205936803237494
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2.90999999999996	-0.344560558965304	-0.344649197086422	8.86381211182563E-05
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2.92999999999996	-0.357074855866767	-0.357141666325433	6.68104586661888E-05
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2.95999999999996	-0.375537235513838	-0.375571063983499	3.38284696611013E-05
2.96499999999996	-0.378577335901439	-0.378605641276964	2.83053755251173E-05
2.96999999999996	-0.381606689202783	-0.381629464437385	2.27752346018684E-05
2.97499999999996	-0.384625226097558	-0.384642464298313	1.72382007545546E-05
2.97999999999996	-0.387632877503796	-0.387644571931817	1.1694428020792E-05
2.98499999999996	-0.390629574579757	-0.390635718650366	6.14407060850475E-06
2.98999999999996	-0.393615248725814	-0.393615836008705	5.87282891706398E-07
2.99499999999996	-0.396589831586322	-0.396584855805727	4.97578059421855E-06
2.99999999999996	-0.399553255051489	-0.399542710086332	1.05449651560119E-05
3.00499999999996	-0.402505451259233	-0.402489331143286	1.61201159474267E-05
3.00999999999996	-0.405446352597039	-0.405424651519065	2.17010779733906E-05
3.01499999999996	-0.408375891703798	-0.408348604007704	2.72876960938917E-05
3.01999999999996	-0.411294001471652	-0.411261121656623	3.28798150289189E-05
3.02499999999996	-0.414200615047823	-0.414162137768461	3.84772793618482E-05
3.02999999999996	-0.417095665836439	-0.417051585902895	4.40799335444941E-05
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3.04999999999996	-0.428558918291147	-0.428492378957717	6.65393334291498E-05
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3.05999999999996	-0.434219455487107	-0.43414165936787	7.7796119236806E-05
3.06499999999996	-0.437031724038252	-0.43694829330142	8.34307368320353E-05
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3.07499999999996	-0.442619938669537	-0.442525227030377	9.47116391594172E-05
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3.09499999999996	-0.453649290021877	-0.453531974295772	0.000117315726105405
3.09999999999996	-0.456375617365088	-0.456252642723192	0.000122974641896423
3.10499999999996	-0.459089415029629	-0.458960778628247	0.000128636401382387
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3.12999999999996	-0.472468289731927	-0.472311307377469	0.000156982354458435
3.13499999999996	-0.475105612312987	-0.474942954437479	0.000162657875507621
3.13999999999996	-0.477729975594112	-0.47756164045452	0.000168335139592357
3.14499999999996	-0.48034131937478	-0.480167305385475	0.000174013989304889
3.14999999999996	-0.48293958375291	-0.482759889485702	0.000179694267207708
3.15499999999996	-0.485524709126502	-0.485339333310664	0.000185375815837607
3.15999999999996	-0.488096636195257	-0.487905577717547	0.00019105847770956
3.16499999999995	-0.490655305962193	-0.490458563866872	0.000196742095321611
3.16999999999995	-0.493200659735258	-0.492998233224099	0.000202426511158704

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3.17499999999995	-0.495732639128922	-0.495524527561225	0.000208111567696789
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3.18499999999995	-0.500756242778111	-0.50053675980535	0.000219482972760976
3.18999999999995	-0.503247751809493	-0.50302258280326	0.000225169006233039
3.19499999999995	-0.505725656016332	-0.505494800966026	0.000230855050305956
3.19999999999995	-0.508189898569435	-0.507953357621961	0.000236540947474384
3.20499999999995	-0.510640422955562	-0.510398196415312	0.000242226540249857
3.20999999999995	-0.513077172978959	-0.512829261307795	0.000247911671164447
3.21499999999995	-0.515500092762897	-0.515246496580123	0.000253596182774429
3.21999999999995	-0.517909126751193	-0.517649846833527	0.000259279917665722
3.22499999999995	-0.520304219709721	-0.520039256991264	0.000264962718456663
3.22999999999995	-0.522685316727927	-0.522414672300123	0.000270644427803779
3.23499999999995	-0.525052363220317	-0.524776038331913	0.000276324888404123
3.23999999999995	-0.527405304927955	-0.527123300984954	0.000282003943001152
3.24499999999995	-0.529744087919934	-0.529456406485547	0.00028768143438751
3.24999999999995	-0.532068658594855	-0.531775301389445	0.000293357205410683
3.25499999999995	-0.534378963682284	-0.534079932583308	0.000299031098975333
3.25999999999995	-0.536674950244207	-0.536370247286158	0.000304702958049297
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3.26999999999995	-0.541223757710244	-0.540907717765314	0.000316039944930568
3.27499999999995	-0.54347647441339	-0.543154769654369	0.000321704759021713
3.27999999999995	-0.545714664191939	-0.545387297280741	0.000327366911197946
3.28499999999995	-0.547938275791466	-0.547605249546666	0.00033302624480025
3.28999999999995	-0.550147258298504	-0.549808575695247	0.000338682603256757
3.29499999999995	-0.552341561141923	-0.551997225311836	0.000344335830087306
3.29999999999995	-0.554521134094323	-0.554171148325416	0.000349985768906991
3.30499999999995	-0.556685927273395	-0.556330295009966	0.000355632263429717
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3.31499999999995	-0.560970976515984	-0.560604062221018	0.000366914294965937
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3.32499999999995	-0.565196316764716	-0.564818136088158	0.000378180676557593
3.32999999999995	-0.567286475015804	-0.56690266740672	0.00038380760908463
3.33499999999995	-0.569361561522416	-0.568972131360495	0.0003894301619215
3.33999999999995	-0.571421528855559	-0.571026480675965	0.000395048179593571
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3.34999999999995	-0.575495918065437	-0.575089648077225	0.000406269988212804
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3.35999999999995	-0.579509270351373	-0.579091798557506	0.000417471793866531
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3.37499999999995	-0.585414054322534	-0.584979820034882	0.000434234287652102
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3.41999999999995	-0.602287490094891	-0.601803296722183	0.000484193372707553
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3.43999999999995	-0.609376000878102	-0.608869782852669	0.000506218025432603
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3.45499999999995	-0.614524199765883	-0.614001544232792	0.000522655533090943
3.45999999999995	-0.616208021782812	-0.615679903314032	0.000528118468779315
3.46499999999995	-0.617875657721615	-0.617342084685706	0.000533573035909063
3.46999999999995	-0.61952706979603	-0.61898805071228	0.000539019083749426
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3.47999999999995	-0.622781073138038	-0.622231188118213	0.000549885019825225
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3.51999999999995	-0.63514084237459	-0.634547864360339	0.000592978014250956
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3.59999999999995	-0.656654706916792	-0.65597756859084	0.000677138325951954
3.60499999999995	-0.657855225463879	-0.657172927133484	0.000682298330394793
3.60999999999995	-0.65903862240596	-0.658351176701058	0.00068744570490209
3.61499999999995	-0.660204871534466	-0.659512291227331	0.000692580307134705
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solution

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3.71999999999994	-0.680692948395695	-0.679895740098729	0.000797208296965613
3.72499999999994	-0.681476155658586	-0.680674129024368	0.000802026634218134
3.72999999999994	-0.682241727332641	-0.681434898304722	0.000806829027919953
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3.74499999999994	-0.684432469497389	-0.683611330278239	0.000821139219149725
3.74999999999994	-0.685127341625178	-0.68430146511294	0.0008258765122382
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3.75999999999994	-0.686463935723645	-0.685628634569872	0.000835301153773727
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3.76999999999994	-0.687729571692743	-0.686884913360664	0.000844658332079029
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3.84499999999994	-0.694950734222136	-0.694038151015768	0.000912583206367779
3.84999999999994	-0.695289193945024	-0.694372229882145	0.000916964062878445
3.85499999999994	-0.695609743270986	-0.69468841748553	0.000921325785456451
3.85999999999994	-0.695912376827323	-0.694986708574576	0.000925668252747425
3.86499999999994	-0.696197089676023	-0.695267098332117	0.000929991343906367
3.86999999999994	-0.696463877313952	-0.695529582375351	0.000934294938601532
3.87499999999994	-0.696712735673032	-0.695774156756015	0.000938578917016986
3.87999999999994	-0.696943661120407	-0.696000817960551	0.0009428431598556
3.88499999999994	-0.697156650458601	-0.696209562910259	0.000947087548342052
3.88999999999994	-0.697351700925662	-0.696400388961436	0.000951311964226043
3.89499999999994	-0.697528810195295	-0.696573293905509	0.000955516289785741
3.89999999999994	-0.697687976376982	-0.696728275969153	0.000959700407829223
3.90499999999994	-0.697829198016098	-0.696865333814399	0.000963864201698805
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3.92999999999994	-0.698266117685141	-0.697281743421989	0.000984374263152454
3.93499999999994	-0.698299665942694	-0.697311252250267	0.000988413692426859
3.93999999999994	-0.698315271687189	-0.697322839691074	0.000992431996114096
3.94499999999994	-0.698312936953771	-0.69731650789184	0.000996429061930981
3.94999999999994	-0.698292664213971	-0.697292259435817	0.00100040477815422
3.95499999999994	-0.698254456375704	-0.697250097342081	0.00100435903362306
3.95999999999994	-0.698198316783254	-0.697190025065513	0.00100829171774153
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solution

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3.98999999999994	-0.697485154645149	-0.696453725942492	0.00103142870265704
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