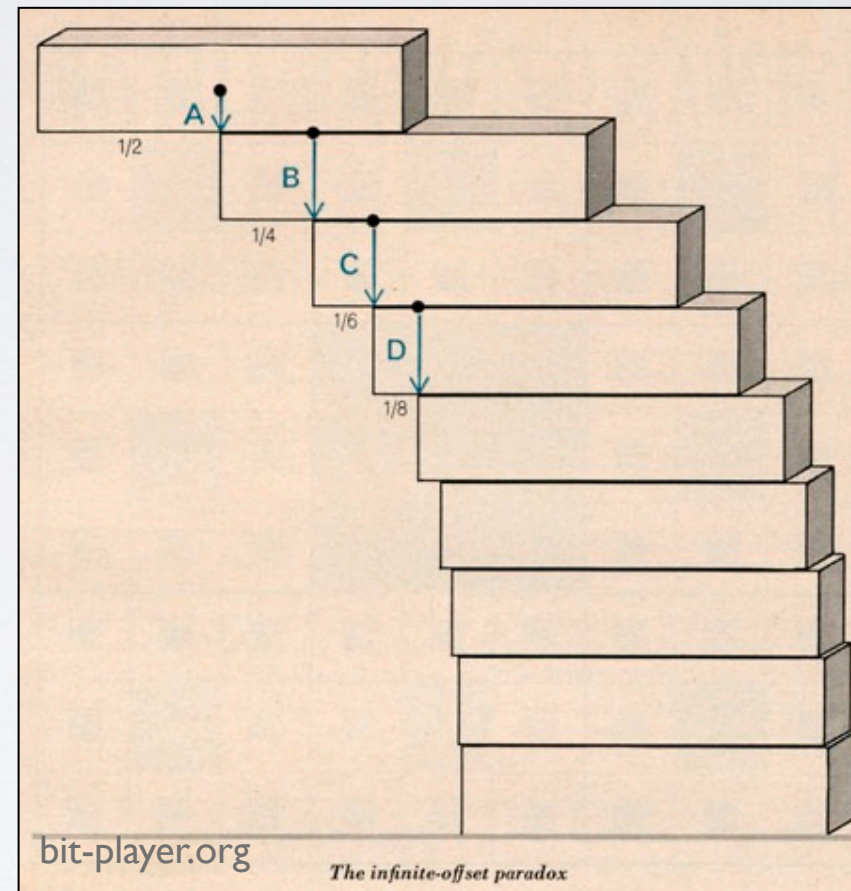
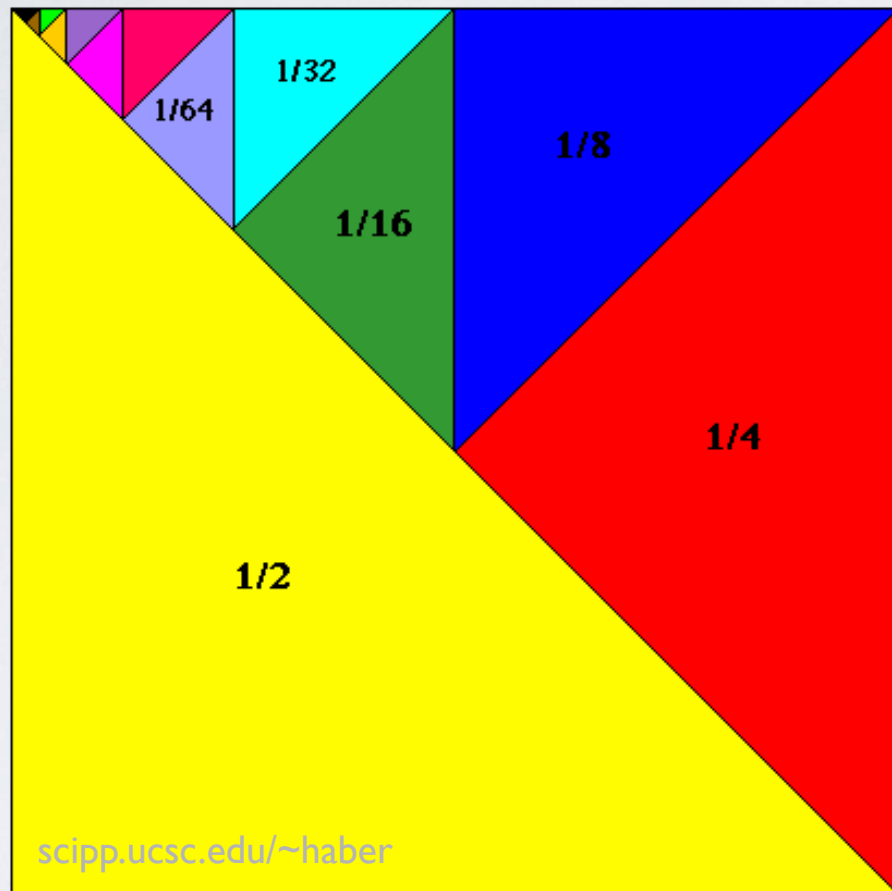


Week 1 - #2

Infinite & Power Series, Complex Numbers (I)



Today: Ch 1-2

Next Class: Ch 2

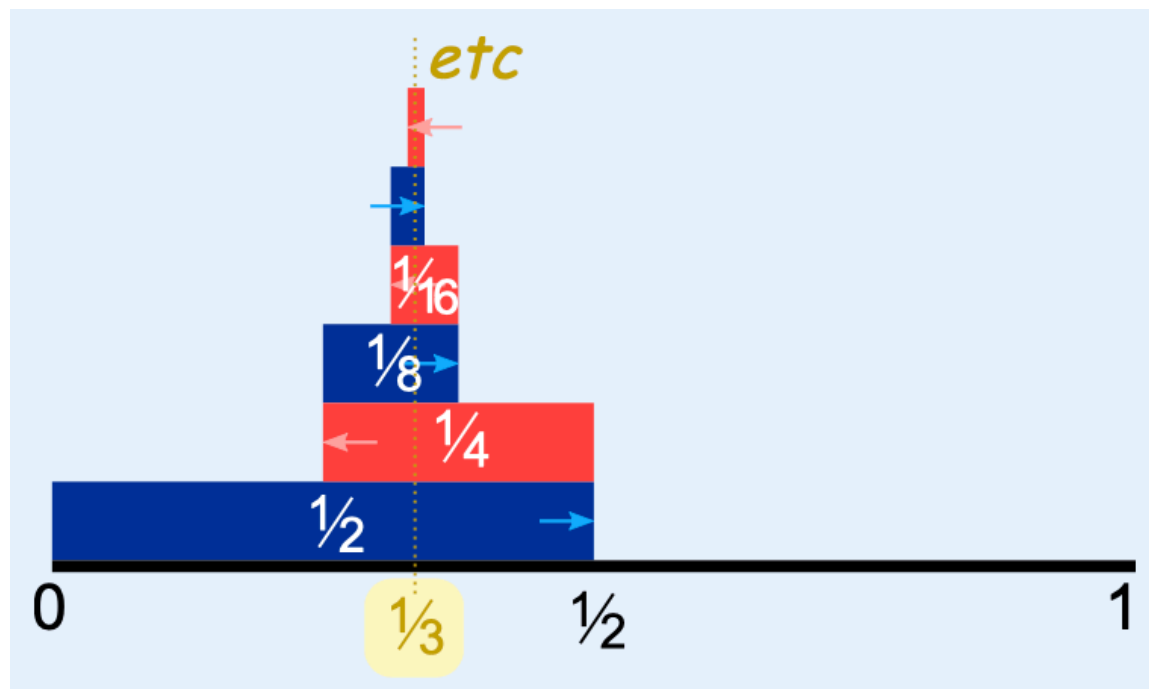
Ji-hoon Kim (Seoul National University)

Rudimentary Mathematical Methods of Physics (Fall 2025): Quiz #1

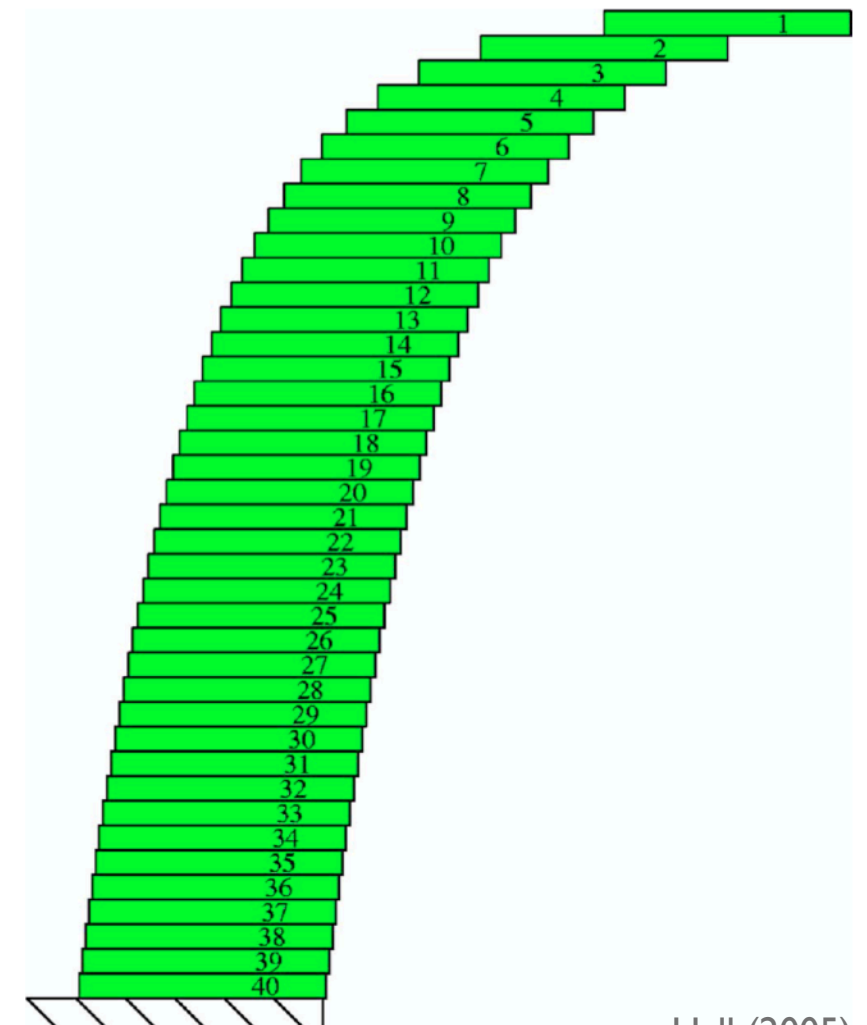
— [open book and open note, **but** no cellphone or laptop, **drop it off as you leave the class**] —

Please write down your name and student ID in the top right corner. (0.0 pt: no paper found with your name / 0.5 pt: paper found with your name and some answers / 1.0 pt: good answers)

1. Boas, Chapter 1, Section 6, Problem 19
2. Boas, Chapter 1, Section 6, Problem 35
3. Imagine you are a tutor for high school math. A student complains that she sees no use of “series” in any aspect of her future life. How would you convince her that it is useful?



mathisfun.com



Hall (2005)

Rudimentary Mathematical Methods of Physics (Fall 2025): Suggested Problems in Chapter 1, Boas, 3rd ed.

The problems I suggest you to take a deeper look into include, but are not limited to, the following.
The class homework assignments will mainly be from this list.

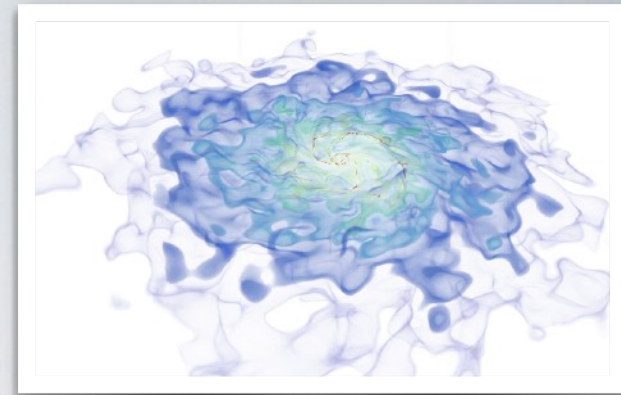
- Section 01: Problems 12, 14, 15
- Section 02: Problems 5, 7, 8, 9
- Section 04: Problems 3, 5, 7
- Section 05: Problems 2
- Section 06: Problems 5, 6, 10, 13, 17, 18, 26, 33, 34
- Section 07: Problems 3, 5, 6, 10
- Section 09: Problems 4, 8, 17, 21, 22(a)(b)
- Section 10: Problems 2, 8, 14, 19, 21
- Section 13: Problems 4, 9, 13, 14, 19, 24, 36
- Section 14: Problems 4, 6
- Section 15: Problems 2, 15, 16, 18, 23, 24(e)(f), 28, 29, 32, 33
- Section 16: Problems 1, 3, 18, 22, 24, 25

Rudimentary Mathematical Methods of Physics (Fall 2025): Suggested Problems in Chapter 2, Boas, 3rd ed.

The problems I suggest you to take a deeper look into include, but are not limited to, the following.
The class homework assignments will mainly be from this list.

- Section 04: Problems 4, 13
- Section 05: Problems 6, 7, 27, 28, 47, 50, 57
- Section 06: Problems 11, 14
- Section 07: Problems 12, 13, 17
- Section 08: Problems 3
- Section 09: Problems 9, 24, 25, 27, 28, 37
- Section 10: Problems 23, 32, 33
- Section 11: Problems 18
- Section 12: Problems 1, 10, 14, 15, 27, 38
- Section 14: Problems 2, 7, 9, 24, 25
- Section 15: Problems 6, 7, 18
- Section 16: Problems 1, 2, 5, 8, 11
- Section 17: Problems 19, 21, 25, 30

48 problems / 337 total



Fun with Stacking Blocks

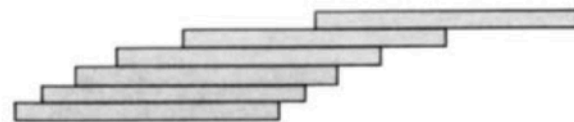
(Example of Diverging Infinite Series)

Fun with Stacking Blocks

- See: Problem 16.1 + “Fun with Stacking Blocks” (Hall, 2005), etc.

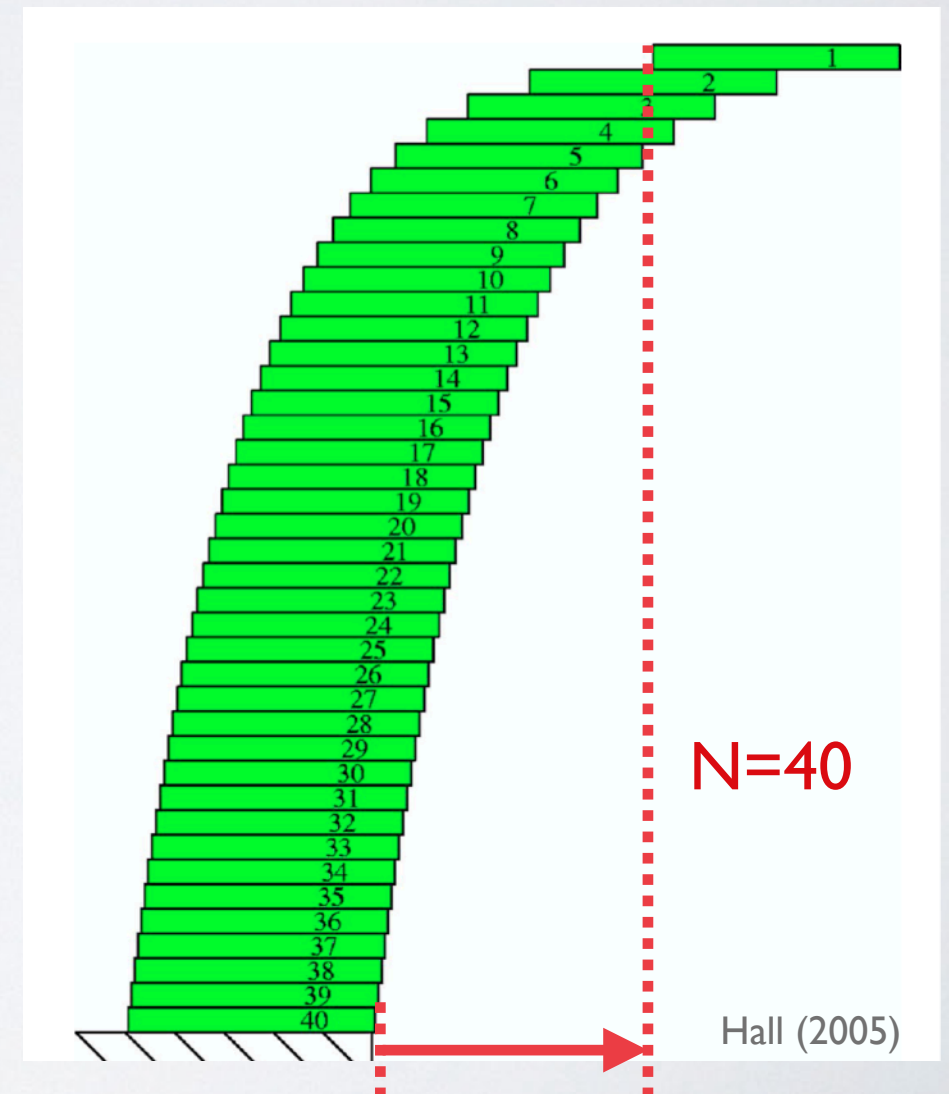
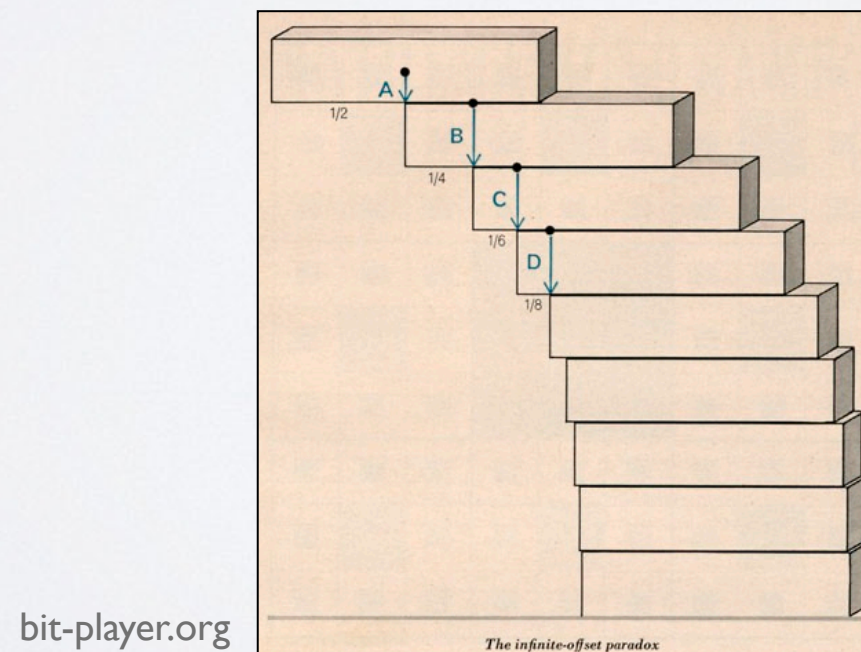
► 16. MISCELLANEOUS PROBLEMS

1. (a) Show that it is possible to stack a pile of identical books so that the top book is as far as you like to the right of the bottom book. Start at the top and each time place the pile already completed on top of another book so that the pile is just at the point of tipping. (In practice, of course, you can't let them overhang quite this much without having the stack topple. Try it with



a deck of cards.) Find the distance from the right-hand end of each book to the right-hand end of the one beneath it. To find a general formula for this distance, consider the three forces acting on book n , and write the equation for the torque about its right-hand end. Show that the sum of these setbacks is a divergent series (proportional to the harmonic series). [See “Leaning Tower of *The Physical Reviews*,” *Am. J. Phys.* **27**, 121–122 (1959).]

Boas, Chapter I

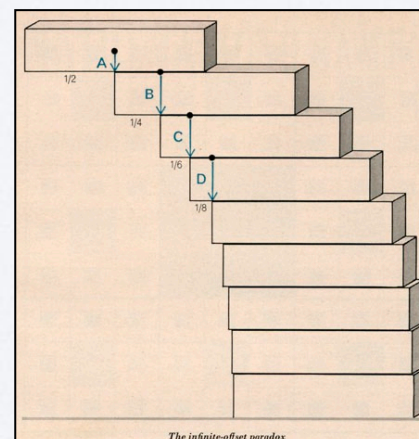


Fun with Stacking Blocks

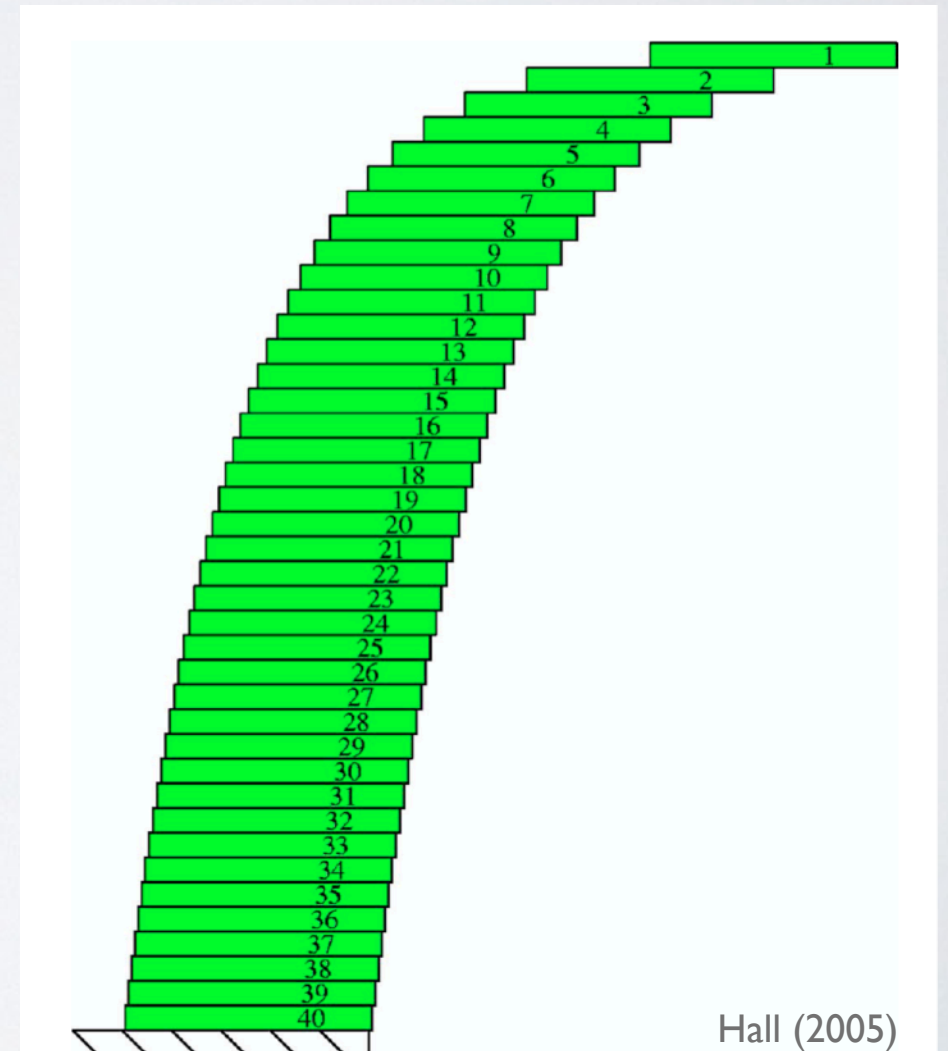
- See: Problem 16.1 + “Fun with Stacking Blocks” (Hall, 2005), etc.



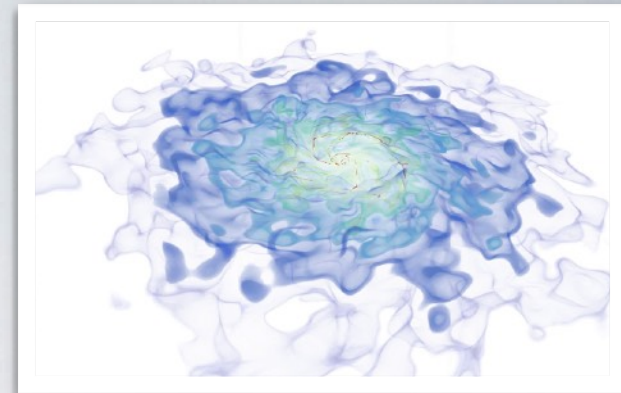
N=13



bit-player.org



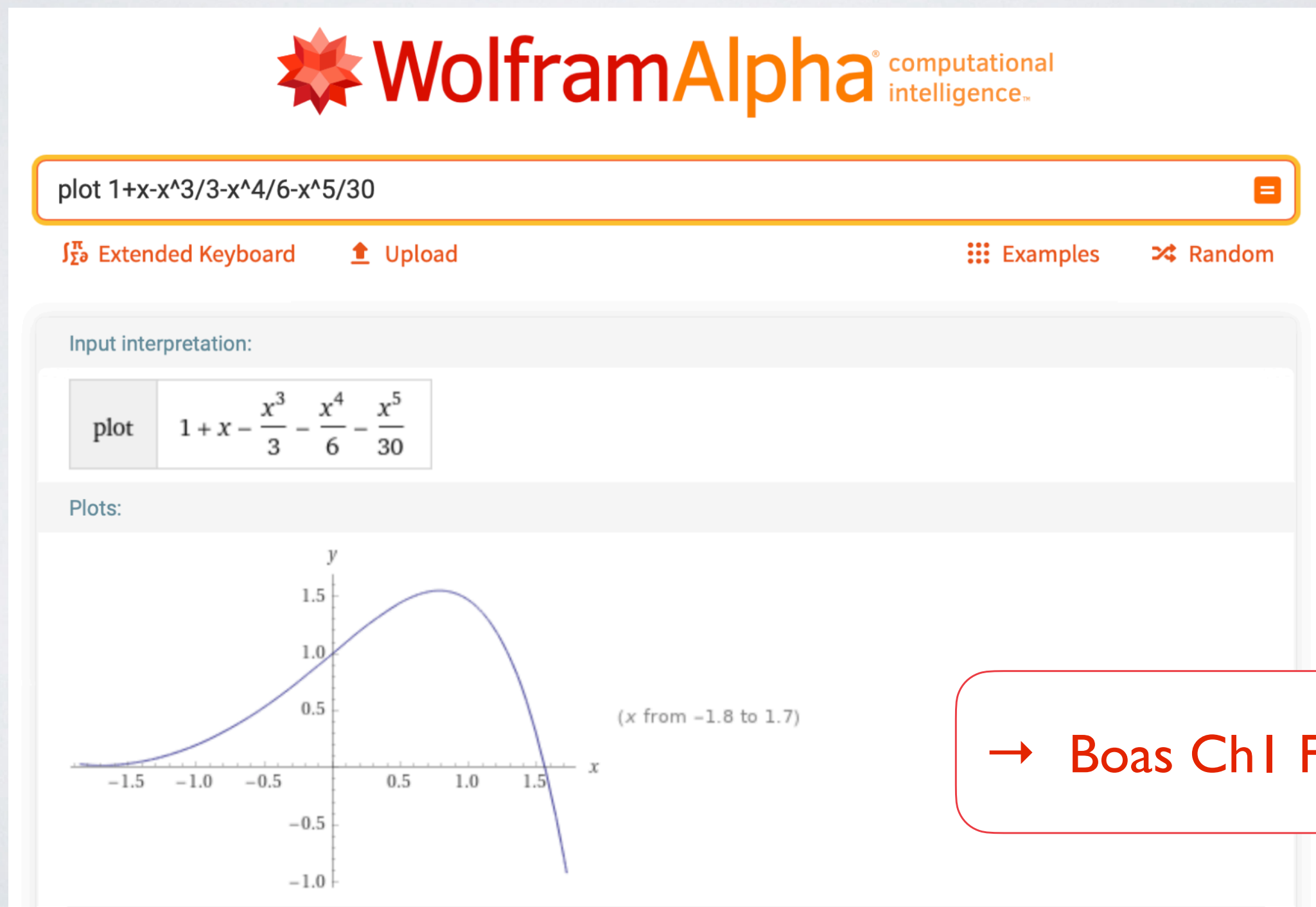
Hall (2005)



Taylor Series Using A Computer

Numerical Problems

- Tools you may want to try for your numerical problems:
Matlab, Mathematica, Mathcad, **Wolfram Alpha**, Python, etc.



Taylor Series Using A Computer



taylor expand $e^x \cos x$

Extended Keyboard

Upload

Examples

Random

Input interpretation:

series

$e^x \cos(x)$

Series expansion at $x = 0$:

[Fewer terms](#)

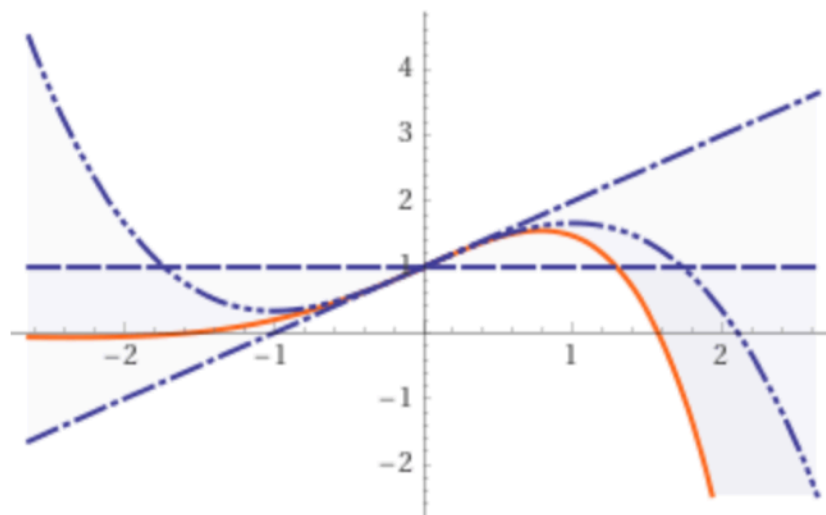
[More terms](#)

$$1 + x - \frac{x^3}{3} - \frac{x^4}{6} - \frac{x^5}{30} + \frac{x^7}{630} + \frac{x^8}{2520} + \frac{x^9}{22680} - \frac{x^{11}}{1247400} + O(x^{12})$$

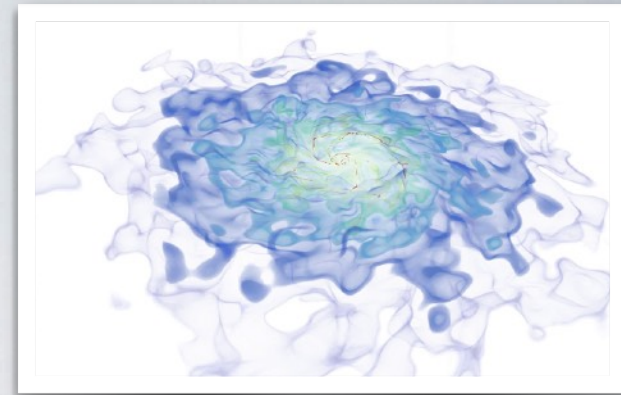
(Taylor series)

(converges everywhere)

Approximations about $x = 0$ up to order 3:



(order n approximation shown with n dots)



Pitfalls of Blind Computation

Pitfalls of Blind Computation

- Inaccurate estimation on Google:

The screenshot shows a Google search interface. The search bar contains the expression $\ln(\sqrt{(1+0.0015)/(1-0.0015)})) - \tan(0.0015)$, which is underlined in red. Below the search bar, navigation links for All, Images, Maps, Videos, Shopping, and More are visible, along with Settings and Tools. The search results indicate "About 602 results (0.47 seconds)". Below this, a calculator interface displays the same expression as $\ln(\sqrt{(1 + 0.0015) / (1 - 0.0015)}) - \tan(0.0015 \text{ radians}) =$. The result shown is $\underline{6.0606901e-16}$, underlined in red. The calculator interface includes buttons for Rad, Deg, x!, (,), %, AC, Inv, sin, ln, 7, 8, 9, ÷, π, cos, log, 4, 5, 6, ×, e, tan, √, 1, 2, 3, −, Ans, EXP, x^y, 0, ., =, and +.

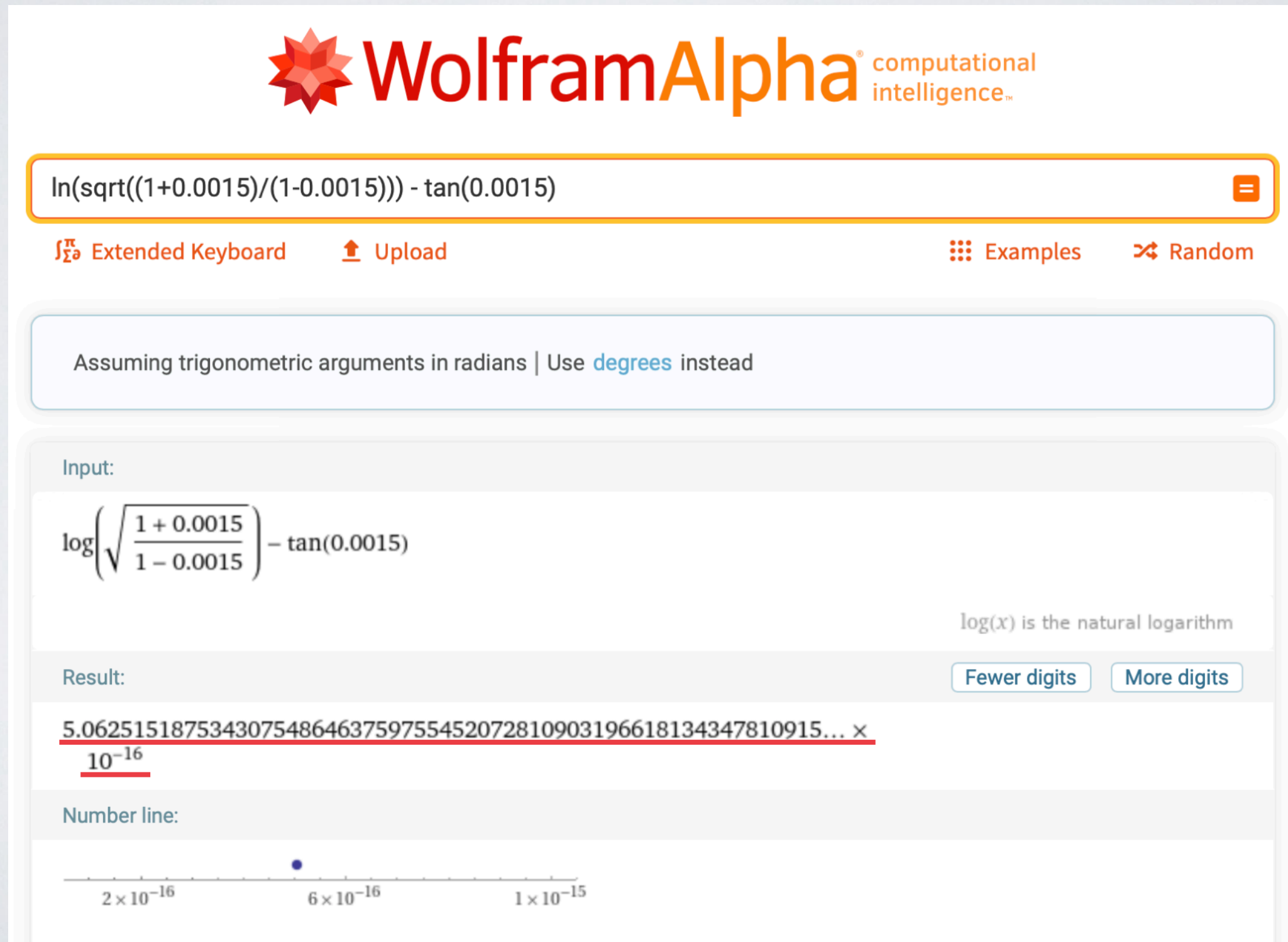
Pitfalls of Blind Computation

- Inaccurate estimation on Python:

```
bash-3.2$ python
Python 2.7.9 (default, Sep  9 2015, 22:07:15)
[GCC 4.2.1 Compatible Apple LLVM 6.1.0 (clang-602.0.53)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> import math
>>> math.log(math.sqrt((1+0.0015)/(1-0.0015))) - math.tan(0.0015)
6.06069014419397e-16
>>> math.log(math.sqrt((1+0.0015)/(1-0.0015)))
0.0015000011250016186
>>> math.tan(0.0015)
0.0015000011250010125
>>>
>>>
```

Pitfalls of Blind Computation

- Accurate estimation on WolframAlpha:



The screenshot shows the WolframAlpha interface. At the top is the logo with a red star and the text "WolframAlpha computational intelligence". Below the logo is a search bar containing the expression $\ln(\sqrt{(1+0.0015)/(1-0.0015)}) - \tan(0.0015)$. To the right of the search bar are links for "Extended Keyboard", "Upload", "Examples", and "Random". Below the search bar is a light blue box with the text "Assuming trigonometric arguments in radians | Use [degrees](#) instead". The main content area is divided into sections: "Input:" showing the expression in a more formal mathematical notation, "Result:" showing a long decimal string followed by $\times 10^{-16}$, and "Number line:" showing a horizontal axis with a point marked at approximately 5.06×10^{-16} .

WolframAlpha[®] computational intelligence[™]

$\ln(\sqrt{(1+0.0015)/(1-0.0015)}) - \tan(0.0015)$

[Extended Keyboard](#) [Upload](#) [Examples](#) [Random](#)

Assuming trigonometric arguments in radians | Use [degrees](#) instead

Input:

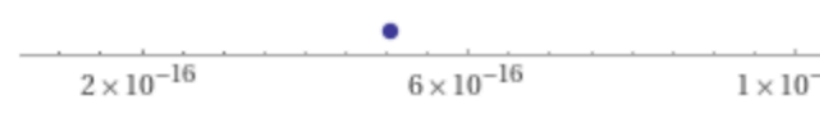
$$\log\left(\sqrt{\frac{1+0.0015}{1-0.0015}}\right) - \tan(0.0015)$$

$\log(x)$ is the natural logarithm

Result: [Fewer digits](#) [More digits](#)

5.0625151875343075486463759755452072810903196618134347810915... $\times 10^{-16}$

Number line:



The number line shows a horizontal axis with tick marks at 2×10^{-16} , 6×10^{-16} , and 1×10^{-15} . A blue dot is placed on the axis between 2×10^{-16} and 6×10^{-16} , representing the computed value.

Pitfalls of Blind Computation

- Accurate estimation on Full Precision Calculator:

Full Precision Calculator

This calculator calculates answers to full* accuracy.
If you want more functions (but not full precision) try the [Scientific Calculator](#)

$$\ln(\sqrt{(1+0.0015)/(1-0.0015)}) - \tan(0.0015 \cdot 180/\pi)$$

0.000000000000000506251518753430754864637597554
5207281090319661813434781091560762983344871629
59393151147072175618546084275046494927908515814
2080150864641203183784359975199564279750604123
6612968728336675572119291634

7	8	9	×	÷
4	5	6	+	-
1	2	3	(	)
0	.	^	←	C

! e pi

History:

$$\ln(\sqrt{(1+0.0015)/(1-0.0015)}) - \tan(0.0015 \cdot 180/\pi) =$$

0.00000000000000050625151875343075486463759755452072810903
1966181343478109156076298334487162959393151147072175618546
0842750464949279085158142080150864641203183784359975199564
2797506041236612968728336675572119291634

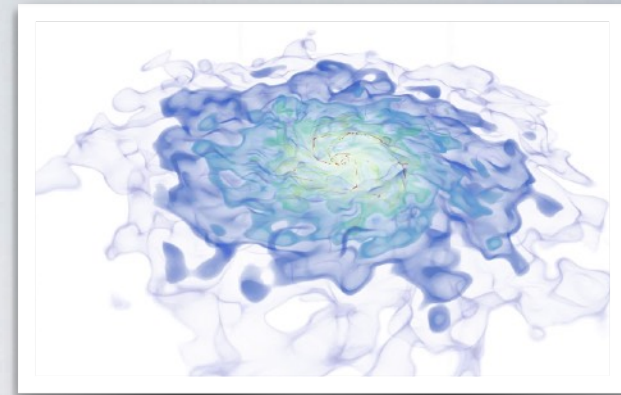
$$\ln(\sqrt{(1+0.0015)/(1-0.0015)}) =$$

0.00150001125001518752440852485777952715102659838705448085
5820599653054716307555148275394381298635589258005404247102

Decimals: 200

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www.mathsisfun.com/calculator-precision.html



Pitfalls of Blind Computation (Another Example: Problem 15.2)

Pitfalls of Blind Computation

- Inaccurate estimation on Google:

The screenshot shows a Google search for the expression $1/\sqrt{1+0.012^4}-\cos(0.012^2)$. The search bar contains the expression, and the results show "About 226,000 results (0.55 seconds)". Below the results, a calculator interface displays the expression $(1 / \sqrt{1 + (0.012^4)}) - \cos(0.012^2 \text{ radians}) =$ and the result 0 . The calculator interface includes buttons for Rad, Deg, x!, (,), %, AC, Inv, sin, ln, 7, 8, 9, ÷, π, cos, log, 4, 5, 6, ×, e, tan, √, 1, 2, 3, −, Ans, EXP, x^y, 0, ., =, and +.

1/sqrt(1+0.012^4)-cos(0.012^2)

Google search results for the expression $1/\sqrt{1+0.012^4}-\cos(0.012^2)$. The results show "About 226,000 results (0.55 seconds)". Below the results, a calculator interface displays the expression $(1 / \sqrt{1 + (0.012^4)}) - \cos(0.012^2 \text{ radians}) =$ and the result 0 .

Rad	Deg	x!	(	)	%	AC
Inv	sin	ln	7	8	9	÷
π	cos	log	4	5	6	×
e	tan	√	1	2	3	−
Ans	EXP	x ^y	0	.	=	+

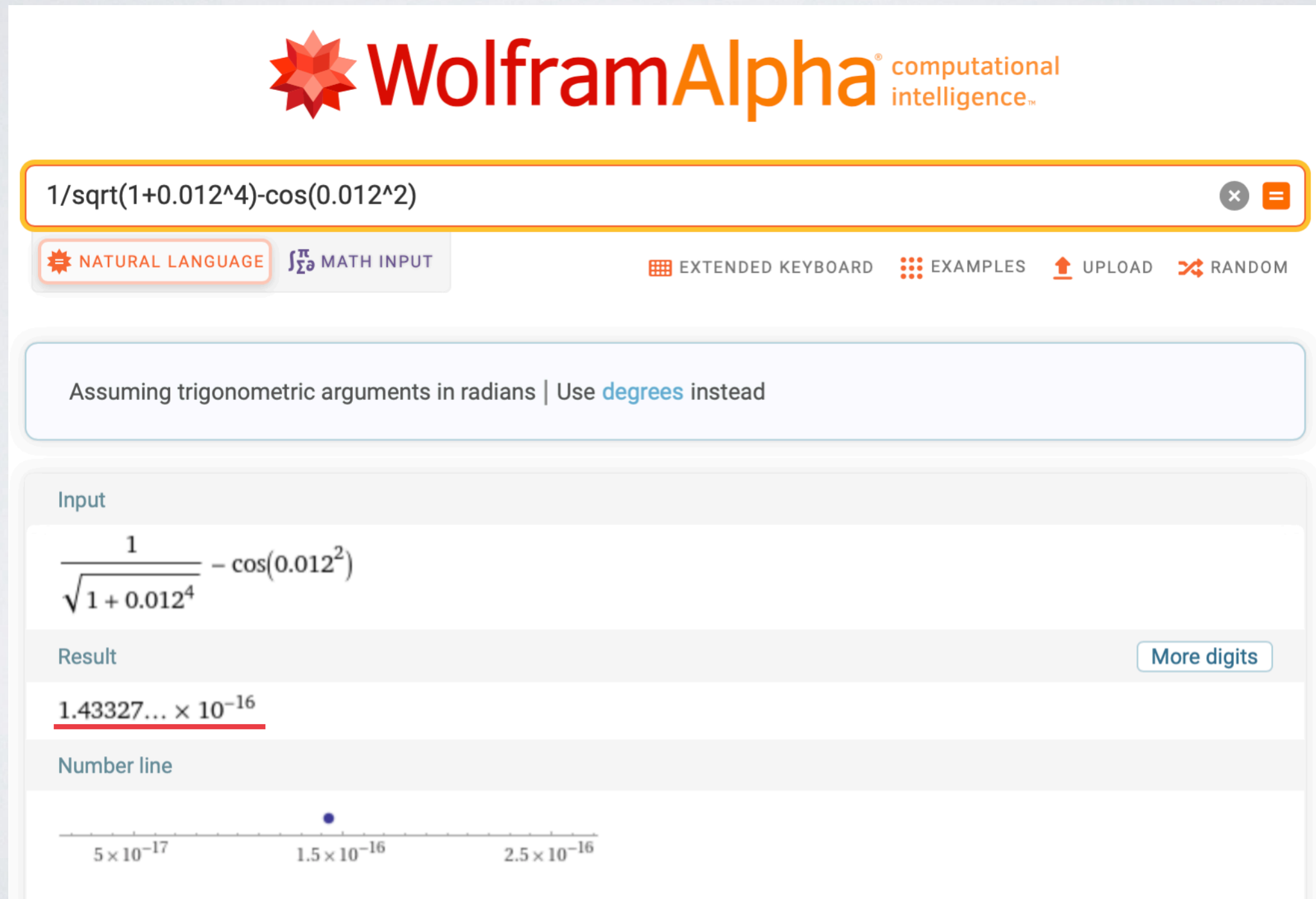
Pitfalls of Blind Computation

- Inaccurate estimation on Python:

```
bash-3.2$ python
Python 2.7.9 (default, Sep  9 2015, 22:07:15)
[GCC 4.2.1 Compatible Apple LLVM 6.1.0 (clang-602.0.53)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> import math
>>> 1/math.sqrt(1+0.012**4) - math.cos(0.012**2)
1.1102230246251565e-16
>>>
```

Pitfalls of Blind Computation

- Accurate estimation on WolframAlpha:



The screenshot shows the WolframAlpha interface. At the top is the logo with the text "WolframAlpha computational intelligence". Below it is a search bar containing the expression $1/\sqrt{1+0.012^4}-\cos(0.012^2)$. Under the search bar are two tabs: "NATURAL LANGUAGE" and "MATH INPUT", with "MATH INPUT" being selected. To the right of the tabs are links for "EXTENDED KEYBOARD", "EXAMPLES", "UPLOAD", and "RANDOM". Below the search bar is a message: "Assuming trigonometric arguments in radians | Use [degrees](#) instead". The main content area shows the input expression in a large font, followed by the result $1.43327... \times 10^{-16}$, which is underlined in red. To the right of the result is a button labeled "More digits". Below the result is a "Number line" visualization showing a horizontal axis with tick marks at 5×10^{-17} , 1.5×10^{-16} , and 2.5×10^{-16} . A blue dot is placed on the axis at the position corresponding to the result, which is slightly to the right of the 1.5×10^{-16} mark.

WolframAlpha[®] computational intelligence™

1/sqrt(1+0.012^4)-cos(0.012^2)

NATURAL LANGUAGE MATH INPUT

EXTENDED KEYBOARD EXAMPLES UPLOAD RANDOM

Assuming trigonometric arguments in radians | Use [degrees](#) instead

Input

$$\frac{1}{\sqrt{1+0.012^4}} - \cos(0.012^2)$$

Result [More digits](#)

1.43327... × 10⁻¹⁶

Number line

5 × 10⁻¹⁷ 1.5 × 10⁻¹⁶ 2.5 × 10⁻¹⁶