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Trigonometrics in financial applications

*Message #1 Posted by **Valentin Albillo** on 29 June 2003, 9:06 p.m.*

Karl Schneider posted:

"Just curious: Is there any practical application of trigonometric functions for business/finance (excluding calculation of biorythms and constellation positions for making business decisions)?

Of course. There are many practical applications of trigonometric functions for financial purposes, but they tend to be of a sufficiently high level and complexity that the average financial Joe, with his trusty 12C's 99 program steps and not-exactly-very-advanced programming features, won't be able to cut it.

Trigs are used extensively, for instance, to compute the discrete wavelet transforms in financial time series applications (stock price evolution, volatility, ...) as well as in the creation of financial simulation models, where you need to perform a lot of trigonometric decomposition operations to the large matrices that are usually needed to implement the models, among others.

To deal with such advanced financial computations using a handheld, you'd better put aside your cute little 12C and use a really capable machine, such as the vintage Sharp PC-1421 (sold in the US as EL-5510) Business/Financial Computer.

This beautiful, metallic, very slim and light machine is fully alphanumeric, has a complete qwerty keyboard, all financial and statistics functions, a fast 768 Khz 8-bit processor, 4 Kb RAM on board, expandable via RAM/ROM cards, full serial and parallel I/O for connection to a PC or peripherals such as printer and mass storage, and further it's programmable in an enhanced version of BASIC, including two-dimensional string arrays, long variable names, input/output commands, and of course, all financial functions are *integrated as BASIC commands and can be included in complex BASIC programs* ! All this in a beautiful, solid, very small machine.

If you want to see what it looks like, visit these links:

http://www.promsoft.com/calcs/pc1421.htm

http://pocket.free.fr/html/sharp/pc-1421_e.html

http://pocket.free.fr/images/sharp/pc-1421.jpg

So much for HP chauvinism. As they say: "Never send a kid to do a man's job !"

Best regards.

Re: Trigonometrics in financial applications

Message #2 Posted by ***Trent Moseley*** *on 29 June 2003, 11:39 p.m.,*
in response to message #1 by Valentin Albillo

Valentin,

I agree. While it doesn't have nearly all the same functions, my 1986 Sharp PC-1500A looks almost like the one you describe.

tm

Re: Trigonometrics in financial applications

Message #3 Posted by ***Ernie Malaga*** *on 30 June 2003, 12:34 a.m.,*
in response to message #1 by Valentin Albillo

> Quote:
>
> ---
>
> Of course. There are many practical applications of trigonometric functions for financial purposes,
>
> ---

Amazing. I would've sworn that finance had no use for trigonometric functions. Logarithmic ones, yes. How about hyperbolics? So far I haven't learned of a _single_ use for hyperbolic functions in any field.

-Ernie

Hyperbolics everywhere ! (almost)

Message #4 Posted by ***Valentin Albillo*** *on 30 June 2003, 6:38 a.m.,*
in response to message #3 by Ernie Malaga

Ernesto wrote:

"How about hyperbolics? So far I haven't learned of a _single_ use for hyperbolic functions in any field."

They're used *all the time* in some *very* important Civil Engineering fields, a few assorted examples:

- electrical transportation (trains and such, which draw power from a suspended conducting wire). The wire's shape is a curve called catenary, which is a hyperbolic cosine, and thus you need hyperbolics to compute lengths, weights, stress, costs, etc. This also applies to high-voltage power lines and, in general, to any kind of chain, rope or wire suspended from two points that hangs freely under its own weight.

- superstructure engineering (suspension bridges and such), where you need to compute the elastic curve and the deflection, also require hyperbolic cosines in spades.

- architecture, specially traditional japanese architecture and civil engineering, where curves have various important social and philosophical meanings (temples and other relevant buildings). Japanese and oriental architects frequently use the catenary shape (hyperbolic cosine) for the upward-pointing curves in their constructions instead of the less-quickly-raising parabolas.

- aerospatial engineering: engineers (from Boeing, for example) face a problem in applying a surface coating to fighter aircraft. The critical feature is the electrical conductivity at the surface. This physical property determines how an electromagnetic wave will scatter when it hits the aircraft. For some fighter parts, the ideal coating varies along the surface according to the hyperbolic cosine function.

etc, etc. Matter of fact, students of the Civil & Environmental Engineering divisions of most universities are required to be confident with the manipulation of hyperbolic functions and the solution of hyperbolic equations. I guess such an student would find himself as much at a loss using a calculator without hyperbolics as you and me would be using one without division, say.

"There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy."

--From Hamlet, Prince of Denmark - 1601 - Act I. - Scene 5. - Rows: 166-167

:-)

Best regards.

Edited: 30 June 2003, 6:44 a.m.

Re: Hyperbolics everywhere ! (almost)

*Message #5 Posted by **Ellis Easley** on 30 June 2003, 8:43 a.m.,*
in response to message #4 by Valentin Albillo

> Quote:
>
> ---
>
> I guess such an student would find himself as much at a loss using a calculator without hyperbolics as you and me would be using one without division, say.
>
> ---

Except hyperbolic functions are fairly easy to calculate, if you have natural log and exponential functions, I think (I can't find the functions right now! But they are fairly simple).

Re: Hyperbolics everywhere ! (almost)

Message #6 Posted by ***Thibaut.be*** *on 30 June 2003, 9:25 a.m.,*
in response to message #5 by Ellis Easley

These functions were on the cover of the electrical engineering solution book for the 41C. The artwork of this book was so well designed that even if I never had to use them I memorized the formula for ever. They are geniously simple :

sinh x = (e^x - e^-x)/2 cosh x = (e^x + e^-x)/2 tanh x = sinh x / cosh x (who wouldn't have guessed this one ?)

now go on with the properties of sin, cos, tan and see if they apply to hyperbolics...

Things are not what they seem

Message #7 Posted by ***Valentin Albillo*** *on 30 June 2003, 9:51 a.m.,*
in response to message #5 by Ellis Easley

Ellis wrote:

"Except hyperbolic functions are fairly easy to calculate, if you have natural log and exponential functions, I think (I can't find the functions right now! But they are fairly simple)."

Yes, the hyperbolic sine and cosine seem fairly easy, being

sinh(x) = (e^x - e^(-x))/2, cosh(x)) = (e^x + e^(-x))/2

but then the derived and inverse functions begin to *complicate* somewhat:

tanh(x) = (e^x - e^(-x))/(e^x + e^(-x))

arcsinh(x) = ln(x + (x^2 + 1)^(1/2))

arccosh(x) = ln(x + (x^2 - 1)^(1/2))

Not having them built-in means, then, that:

- you must *remember* the above expressions (and the ones for the remaining functions not shown) *flawlessly*, or else you'll have to program them, which requires a programmable calculator which isn't usually admitted in most exams !
- if you can't program them (for above reason or simply you don't have a suitable programmable calculator), you must resort to sheer memory and very precise keypunching. After you've calculated more than a few that way, you'll be craving for a calculator which includes them built-in.
- even if you can use a programmable calculator and/or don't mind frenetic keypunching, there's the *big* problem of *accuracy*. Not all calculators have really accurate versions of e^x and, specially, logarithmic functions, at all. But even if they did, there's the catch that for certain arguments which happen very frequent in real-life applications (such as values near 0 or near 1, depending on the function) there's *a lot of cancellation*, and you'll end up losing most significant digits, and so getting *wildly inaccurate results*. That's why the HP-41C (which didn't have hyperbolic functions) did nevertheless include the two rather exotic functions E^X-1 and LN1+X !!

So, you see, if you need to use hyperbolic functions frequently, you *absolutely* need to have them built-in from the start in your choice calculator. Else you'll lose time, effort, accuracy, or even worse, the possibility of using your carefully programmed versions in an exam.

Best regards.

Edited: 30 June 2003, 10:06 a.m.

Re: Hyperbolics everywhere ! (almost)

*Message #8 Posted by **Ellis Easley** on 30 June 2003, 9:55 a.m.,*
in response to message #5 by Ellis Easley

sinh(X)=((e^X)-(e^-X))/2

cosh(X)=((e^X)+(e^-X))/2

tanh(X)=sinh(X)/cosh(X)

I found these in the HP35 Math Pac. Beyond this, they use formulas with trig functions [including for tanh(X)], which I guess are easier (if trig is available) than sticking with the log formulas.

I wish I could remember where I saw all three functions and inverses using only log and exponential. (I guess I could try to derive them from the three formulas above, but I wouldn't trust me either!)

And don't even get me started ...

*Message #9 Posted by **Valentin Albillo** on 30 June 2003, 10:37 a.m.,*
in response to message #3 by Ernie Malaga

... on *elliptic* sines and cosines ! :-)

They're tremendously useful in many advanced technological fields (design of *optimum* high-pass, low-pass and band-stop filters comes to mind), unlike their hyperbolic cousins there are *no* simple formulas to compute them, yet I know of no calculator or handheld that did ever include them as built-in functions !

And it's a real pity: it would be very elegant and proper for an advanced 21st-century calculator to have all three kinds of trigonometric functions: *circular* [like sin(x)], *hyperbolic* [like sinh(x)], and *elliptic* [like sn(x)] ... :-)

Best regards.

So, now defend Gradians . . .

*Message #10 Posted by **Paul Brogger** on 30 June 2003, 12:57 p.m.,*
in response to message #3 by Ernie Malaga

. . . they alwasys seemed kind of bogus, and were looked-down-upon by my pure-math pro-HP-calculator professor. (But he looked down upon Degrees, too, and wanted to use Radians for everything -- the formulas are so much cleaner.)

So what's GRAD for? Is it a weird decimal hold-over, or is there some intrinsic value there?

(I think I'm ready to admit that "There are things, Horatio . . . ")

No way ...

*Message #11 Posted by **Valentin Albillo** on 30 June 2003, 1:04 p.m.,*
in response to message #10 by Paul Brogger

I've never used gradians in my whole life, and don't feel like starting now. You'll need another paladin to defend that lost cause, methinks ... :-)

Best regards.

Elementary, my dear Watson...

*Message #12 Posted by **Bob** on 30 June 2003, 3:02 p.m.,*
in response to message #10 by Paul Brogger

The Gradian is a measure that is traditionally applied in the field of surveying. (No pun intended) 100 Gradians is equal to 90 degrees so it is more suited for these calculations. As you can tell from the link below, it is seldom seen in pure mathematics.

http://mathworld.wolfram.com/Angle.html

Unless you are a Civil Engineer, a Surveyor, or just interested in finding out, you probably just learned the conversion (or not) and moved on.

There is also an explanation for the use of Radians and Steradians.

I forgot to add...

Message #13 Posted by ***Bob*** *on 30 June 2003, 3:06 p.m.,*
in response to message #12 by Bob

...that it is a pretty cool website too. Check out the "Recreational Mathematics" area.

Re: So, now defend Gradians . . .

Message #14 Posted by ***Tizedes Csaba*** *on 1 July 2003, 11:16 a.m.,*
in response to message #10 by Paul Brogger

I hope it will be post...

----------- Gradians:

It's came from Earth's sizes:

Average Radius of Earth (IAU): R=6371.024km; average circumfence: C=2*R*Pi=40030.3km; 1grad=C/400=100.08km (about 100km) on Earth's surface;

Like nautical mile: 1nmi=1852m=(about)=40030.3km/(360*60); 1nmi=1arcmin on earth surface;

And 1knot=1arcmin on Eart surface/1hour

Csaba

Re: So, now defend Gradians . . .

Message #15 Posted by ***Trent Moseley*** *on 1 July 2003, 4:02 p.m.,* *in response to message #14 by Tizedes Csaba*

I find this info about grads very interesting. As an amateur astronomer the nautical mile/earth circumference relationship is well known (no metrics here). Thanks for your informative post.

tm

Re: Trigonometrics in financial applications

Message #16 Posted by ***Karl Schneider*** *on 30 June 2003, 4:55 a.m.,*
in response to message #1 by Valentin Albillo

Valentin --

Great post! -- exceptionally well-presented and informative.

I have no knowledge about the "discrete wavelet transforms" and "trigonometric decomposition operations" for finance, but they sound similar in principle to Fourier analyses. It would certainly make sense to try to identify all significant periodic components of a stock price, and its relationship to multiple factors.

I surmised in my original post the the 19B/ii had trigs (Luiz confirmed "yes"; interestingly, the predecessor 18C did not.

Great effort!

Karl

Re: Trigonometrics in financial applications

Message #17 Posted by ***unspellable*** *on 30 June 2003, 10:28 a.m.,*
in response to message #16 by Karl Schneider

I have often thought that business, finance, politics, etc. could benifit from the application of a few engineering principles. Especially politics. Unlike the current political scene, when the bridge falls down, everbody knows the engineer screwed up.

Please don't !

Message #18 Posted by ***Thibaut*** *on 30 June 2003, 10:36 a.m.,*
in response to message #17 by unspellable

... they would use the chaos theory at its best !