Why are variables "i" and "j" used for counters?

Asked **14 years, 1 month ago**   Modified **9 years, 8 months ago**

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178

votes

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↺

🔒 **Locked**. This question and its answers are [locked](#) because the question is off-topic but has historical significance. It is not currently accepting new answers or interactions.

I know this might seem like an absolutely silly question to ask, yet I am too curious not to ask...

Why did "i" and "j" become THE variables to use as counters in most control structures?

Although common sense tells me they are just like X, which is used for representing unknown values, I can't help to think that there must be a reason why everyone gets taught the same way over and over again.

Is it because it is actually recommended for best practices, or a convention, or does it have some obscure reason behind it?

Just in case, *I know I can give them whatever name I want and that variables names are not relevant.*

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10 revs, 6 users 35%
Carlos

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17   i=iteration while j=after interation – ajreal Nov 9, 2010 at 19:48

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7   strange 'c' was not choosen? as in the Intel 'cx' counter register. – user295190 Nov 9, 2010 at 23:12 ✎

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12   Cartesian coordinates – Nick Dandoulakis Nov 10, 2010 at 19:33 ✎

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16   Why do actual questions become community wikis just because they're popular? This feels very reminiscent of communism. If somebody invents something really cool, the government steals the invention to share with the community. – orokusaki Dec 8, 2010 at 21:34

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9   Closed wrong way: the answers here are more informative than to the other qn... – Charles Stewart Dec 9, 2010 at 10:07

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23 Answers

Sorted by: Highest score (default)   ⇕

328
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It comes ultimately from mathematics: the summation notation traditionally uses *i* for the first index, *j* for the

second, and so on. Example (from http://en.wikipedia.org/wiki/Summation):

$$\sum_{i=1}^{n} i = \frac{n^2 + n}{2}$$

It's also used that way for collections of things, like if you have a bunch of variables x_1, x_2, ... x_n, then an arbitrary one will be known as x_i.

As for why it's that way, I imagine SLaks is correct and it's because I is the first letter in Index.

Share

answered Nov 9, 2010 at 19:54

community wiki
zwol

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93   @SLott: And why is `i` used in math? – SLaks Nov 9, 2010 at 20:31

---

13   @Slaks: That's a good question. I actually think that "i" might come from integer more than index. I also think it's easy to write on a chalkboard. Back in the 70's we were cautioned to be sure that we wrote our "i" and "j" in a perfectly distinctive manner. Indeed, we were told to draw our "i" exactly like a backwards "j" to be perfectly clear about it. – S.Lott Nov 9, 2010 at 20:38

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26   @S.Lott: I doubt it comes from integer. We use $\mathbb{Z}$ (blackboard bold Z) for the integers because it stands for the German word *Zahlen*, which means *numbers*. Assuming that the

summation notation arose at around the same time, the German-based notation would be expected—and the German word for *index* is *Index*, which also begins with an *i*. And I can't think of many letters which are particularly hard to write on a chalkboard. Well, except ξ :-) – Antal Spector-Zabusky Nov 9, 2010 at 22:52 ✎

14 "This convention exists because this convention has existed before." That's kind of how etymology works: nobody knows why a particular noise had a particular meaning in PIE. It would be nice to explain the mathematical convention, but the question is "why are they used as counters in control structures", so until someone produces an answer that goes back further, this is the best. It does at least speculate why it's used in mathematics. A proper mathematical historian could find out, maybe using a binary chop. Euclid didn't use it, I bet von Neumann did. How about Cauchy? He used indexes a lot – Steve Jessop Nov 9, 2010 at 23:14 ✎

14 I think it was Lagrange who recommended using a,b,c for constants of a function, and x,y,z for variables of a function. i,j,k denote the 'directions' of a vector, and the factors of a formal sum like this can be construed as degrees of freedom [directions, by another name] of the equation. – David Dec 5, 2010 at 19:57

199

votes

🔖

↺

I believe it dates back to Fortran. Variables starting with I through Q were integer by default, the others were real. This meant that `I` was the first integer variable, and `J` the second, etc., so they fell towards use in loops.

Share

answered Nov 9, 2010 at 19:48

53 I think this comes from the way mathematicians seem to like to use i, j, k as handy subscripts for summation and matrix multiplication indices and what-not. I remember reading in an early Fortran II manual something about that. (Yes, Fortran II.) – S.Lott Nov 9, 2010 at 19:51 ✎

5 Yes, FORTRAN originates these conventions. – Jé Queue Nov 10, 2010 at 0:26

9 I was taught `I` through `N` not `Q` . Google seems to mostly agree. (different versions of FORTRAN?) – Hugh Allen Nov 12, 2010 at 14:14

2 And everything else in Fortran was, by default, real. Which leads to the joke "God is real, unless declared integer". – cadolphs Nov 16, 2010 at 19:14

4 @learnvst - because mathematicians had been using i,j for at least a century beforehand. – Martin Beckett Nov 18, 2010 at 17:49

195

votes

🔖

🕓

Mathematicians were using i,j,k to designate integers in algebra (subscripts, series, summations etc) long before (e.g 1836 or 1816) computers were around (this is the origin of the FORTRAN variable type defaults). The habit of using letters from the end of the alphabet (...,x,y,z) for unknown variables and from the beginning (a,b,c...) for constants is generally attributed to Rene Descartes, (see also here) so I assume i,j,k...n (in the middle of the alphabet) for integers is likely due to him too.

answered Jan 18, 2009 at 0:54

timday
24.9k ● 12 ● 87 ● 136

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17   To me, this is clearly the best answer. (Honorable mention for Michael Borgwardt's answer, which also cites mathematical convention but isn't as specific.) I'm sorry yours isn't the accepted one. All I can do is give it my upvote. – John Y Jun 2, 2009 at 2:12

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3   This is exactly the reason that the we need to be able to vote for a community accepted answer (and yeah I know this belongs on uservoice). – Kredns Jun 18, 2009 at 3:31

Heh. I occasionally update the link to an old google book in this answer because google keeps chopping stuff around. By chance, I note the 1816 document now linked includes Charles Babbage (presumably he of difference engine/analytical engine fame) as an author. So arguably it's an example of the first use of an integer variable "i" by a computer programmer :^) – timday Jul 1, 2009 at 12:57

..OK the 1816 link doesn't go to page with "i" used on it, but they're there. – timday Jul 1, 2009 at 13:00

129
votes

i = integer

Comes from Fortran where integer variables had to start with the letters I through N and real variables started with the other letters. Thus I was the first and shortest integer variable name. Fortran was one of the earliest

programming languages in widespread use and the habits developed by programmers using it carried over to other languages.

EDIT: I have no problem with the answer that it derives from mathematics. Undoubtedly that is where the Fortran designers got their inspiration. The fact is, for me anyway, when I started to program in Fortran we used I, J, K, ... for loop counters because they were short and the first legally allowed variable names for integers. As a sophomore in H.S. I had probably heard of Descartes (and a very few others), but made very little connection to mathematics when programming. In fact, the first course I took was called "Fortran for Business" and was taught not by the math faculty, but the business/econ faculty.

For me, at least, the naming of variables had little to do with mathematics, but everything due to the habits I picked up writing Fortran code that I carried into other languages.

Share

edited Jun 18, 2009 at 3:22

community wiki
4 revs
tvanfosson

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4   I'm pretty sure it was FORTRAN. – Cade Roux Jan 17, 2009 at 23:43

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4   Ya, fortran..... It rots the mind. We have a programmer that uses i ii and iii as loop variable names. The other symptom is

6 character variable/function names with no vowels.
– EvilTeach Jan 17, 2009 at 23:54

4 @tvan, I'm pretty sure variables starting with I through N **defaulted** to integer, but you could still declare them real hence the joke "God is real, unless declared integer". +1 anyway, since my recollection from so many years ago may possibly NOT be perfect. – paxdiablo Jan 18, 2009 at 0:06

10 Hey, the FORTRAN guys got it off the mathematicians!
– timday Jan 18, 2009 at 0:10

6 I agree with @timday. Using i as an index of a series has been a practice by mathematicians for at least 2 centuries.
– Scottie T Jun 2, 2009 at 13:06

91

votes

`i` stands for **I**ndex.
`j` comes after `i`.

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answered Nov 9, 2010 at 19:47

community wiki
SLaks

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12 I think he was talking about alphabet, try to use some imagination :) – Jack Nov 9, 2010 at 21:16

33 @Jack: I think @Pete was joking ;-) – Chris Pfohl Nov 9, 2010 at 21:59

13 @Cpfohl: yep, just wanted to be boring :D – Jack Nov 9, 2010 at 22:02

4 @Pete Kirkham: Thank you very much Pete, it was the best laugh I had in the past month. – AMissico Nov 17, 2010 at

@SLaks ... I believe your right it does i=Index which comes from index notation used in Math en.wikipedia.org/wiki/Index_notation or here is a nice reference physics.ucsb.edu/~physCS31/fall2010/index-notation.pdf – John Hartsock Nov 18, 2010 at 2:49 ✎

63

votes

These symbols were used as matrix indexes in mathematics long before electronic computers were invented.

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answered Nov 9, 2010 at 19:52

community wiki
erickson

52

votes

I think it's most likely derived from index (in the mathematical sense) - it's used commonly as an index in sums or other set-based operations, and most likely has been used that way since before there were programming languages.

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edited Jan 17, 2009 at 23:56

answered Jan 17, 2009 at 23:39

Michael Borgwardt
346k ● 80 ● 486 ● 723

Good answer. This (to me) indeed seems like the most probable explanation. – Noldorin Mar 8, 2009 at 23:03

3 Yup. The mathematic notation for a sum like `Y = Σ Xi` precedes every programming language. – Treb Mar 23, 2009 at 0:30

I am thinking of *index* each time I use `i`. But originally I use it mainly because all code I look at elsewhere use it, and *that* may be inherited from Fortran programmers... – awe Sep 10, 2009 at 12:26

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47 votes

There's a preference in maths for using consecutive letters in the alphabet for "anonymous" variables used in a similar way. Hence, not just "i, j, k", but also "f, g, h", "p, q, r", "x, y, z" (rarely with "u, v, w" prepended), and "α, β, γ".

Now "f, g, h" and "x, y, z" are not used freely: the former is for functions, the latter for dimensions. "p, q, r" are also often used for functions.

Then there are other constraints on available sequences: "l" and "o" are avoided, because they look too much like "1" and "0" in many fonts. "t" is often used for time, "d & δ" for differentials, and "a, s, m, v" for the physical measures of acceleration, displacement, mass, and velocity. That leaves not so many gaps of three consecutive letters without unwanted associations in mathematics for indices.

Then, as several others have noticed, conventions from mathematics had a strong influence on early programming

conventions, and "α, β, γ" weren't available in many early character sets.

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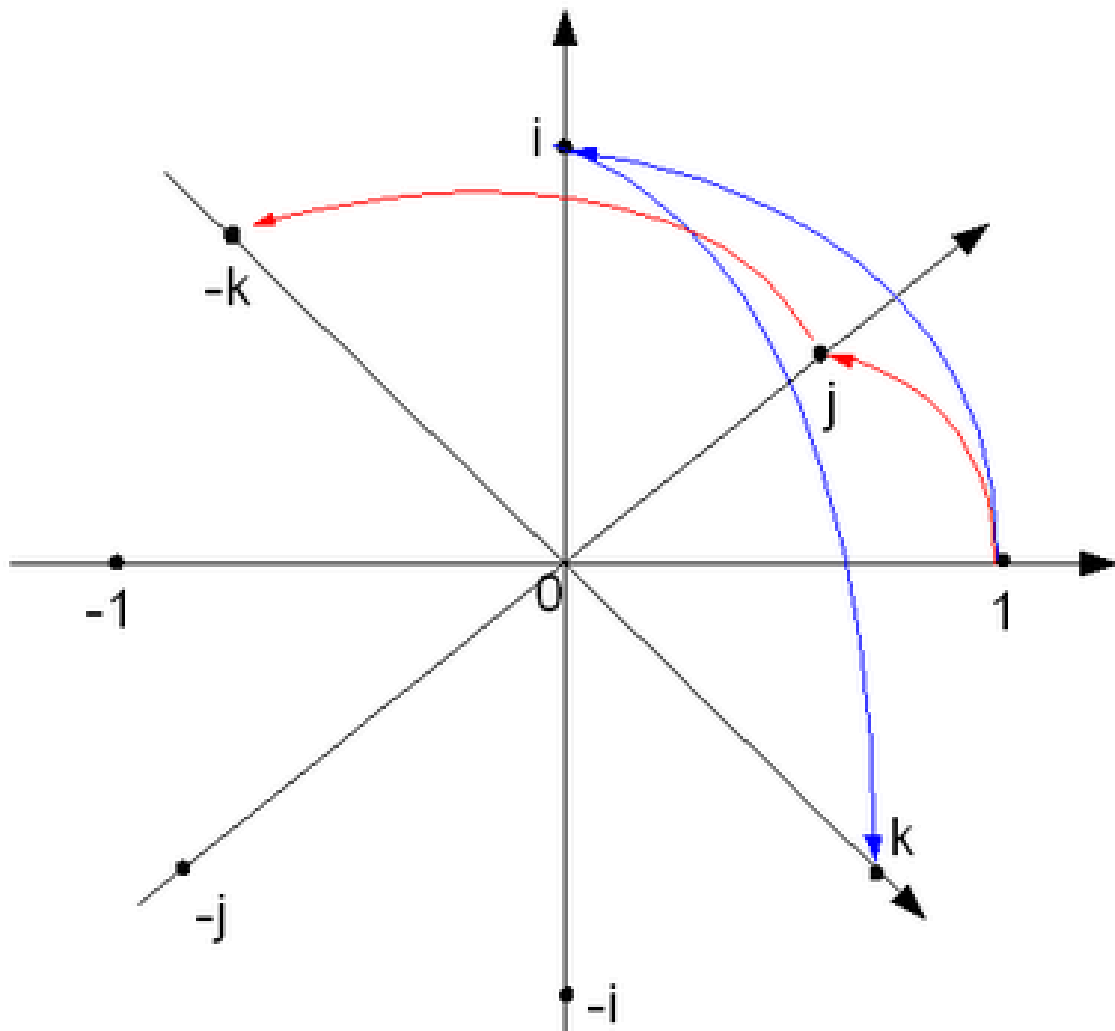
2   Agreed. Although, `a, b, c` is a fairly commonly used sequence despite `a` having multiple meanings... – Stobor Nov 17, 2010 at 5:25

32
votes

I found another possible answer that could be that i, j, and k come from `Hamilton's Quaternions`.

Graphical representation of
quaternion units product as
90°-rotation in 4D-space

$$ij = k$$
$$ji = -k$$
$$ij = -ji$$

Euler picked i for the imaginary unit.

Hamilton needed two more square roots of -1: `ii = jj =`
`kk = ijk = -1`

Hamilton was really influential, and quaternions were the standard way to do 3D analysis before 1900. By then, mathematicians were used to thinking of (ijk) as a matched set. **Vector calculus replaced quaternionic analysis** in the 1890s because it was a *better way* to write Maxwell's equations. But people tended to write vector quantities as like this: `(3i-2j+k)` **instead of** `(3,-2,1)`. So (ijk) became the standard basis vectors in R^3.

Finally, physicists started using group theory to describe symmetries in systems of differential equations. So (ijk) started to connote "vectors that get swapped around by permutation groups," then drifted towards "index-like things that take on all possible values in some specified set," **which** is basically what they mean in a for loop.

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edited Dec 5, 2010 at 17:49

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[4 revs](#)
[Carlos](#)

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11   at last a different approach to the question, interesting point +1 – [Fabian](#) Dec 5, 2010 at 17:20

30

votes

🔖

by discarding (a little biased)

```
a seems an array
b seems another array
c seems a language name
```

```
d seems another language name
e seems exception
f looks bad in combination with "for" (for f, a
pickup?)
g seems g force
h seems height
```

```
i seems an index
j seems i (another index)
```

```
k seems a constant k
l seems a number one (1)
m seems a matrix
n seems a node
o seems an output
p sounds like a pointer
q seems a queue
r seems a return value
s seems a string
t looks like time
u reserved for UVW mapping or electic phase
v reserved for UVW mapping or electic phase or a
vector
w reserved for UVW mapping or electic phase or a
weight
x seems an axis (or an unknown variable)
y seems an axis
z seems a third axis
```

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answered Nov 18, 2010 at 11:58

3   I see n as `number`, usually the number of elements in a set.
    – Tom Leys Dec 5, 2010 at 19:30

6   Oh men, and what XXX seem to be?)) +1 for the creativity ;)
    – Hovhannes Grigoryan Mar 12, 2011 at 13:54 ✏

    Sometimes i'm glad that most of the time i don't have to bother
    with what sorts of mnemonics other people come up with in
    their heads for things like that... – Thies Heidecke May 29, 2011
    at 15:59 ✏

21
votes

🔖

🕘

One sunny afternoon, Archimedes what pondering (*as was
usual for sunny afternoons*) and ran into his buddy
Eratosthenes.

Archimedes said, "Archimedes to Eratosthenes greeting!
I'm trying to come up with a solution to the ratio of several
spherical rigid bodies in equilibrium. I wish to iterate over
these bodies multiple times, but I'm having a frightful time
keeping track of how many iterations I've done!"

Eratosthenes said, "Why Archimedes, you ripe plum of a
kidder, you could merely mark successive rows of lines in
the sand, each keeping track of the number of iterations
you've done within iteration!"

Archimedes cried out to the world that his great friend was
undeniably a shining beacon of intelligence for coming up
with such a simple solution. But Archimedes remarked that
he likes to walk in circles around his sand pit while he
ponders. Thus, there was risk of losing track of which row
was on top, and which was on bottom.

"Perhaps I should mark these rows with a letter of the alphabet just off to the side so that I will always know which row is which! What think you of that?" he asked, then added, "But Eratosthenes... whatever letters shall I use?"

Eratosthenes was sure he didn't know which letters would be best, and said as much to Archimedes. But Archimedes was unsatisfied and continued to prod the poor librarian to choose, at least, the two letters that he would require for his current sphere equilibrium solution.

Eratosthenes, finally tired of the incessant request for two letters, yelled, "I JUST DON'T KNOW!!!"

So Archimedes chose the first two letters in Eratosthenes' exclamatory sentence, and thanked his friend for the contribution.

These symbols were quickly adopted by ancient Greek Java developers, and the rest is, well... history.

Share

answered Nov 18, 2010 at 17:45

community wiki
Brendan

6   ... and had the letter `j` . – Andrew Grimm Nov 22, 2010 at 12:27

> Wow, that nearly reads like a Tortoise and Achilles's story from Hofstadter's G.E.B. – ProfK Dec 5, 2010 at 14:33

---

15 votes

i think it's because a lot of loops use an Int type variable to do the counting, like

```
for (int i = 0; etc
```

and when you type, you actually speak it out in your head (like when you read), so in your mind, you say 'int....'

and when you have to make up a letter right after that 'int....' , you say / type the 'i' because that is the first letter you think of when you've just said 'int'

like you spell a word to kids who start learning reading you spell words for them by using names, like this:

WORD spells William W, Ok O, Ruby R, Done D

So you say Int I, Double d, Float f, string s etc. based on the first letter.

And j is used because when you have done int I, J follows right after it.

Share

answered Nov 17, 2010 at 21:30

community wiki

Michel

1   That's a great way to confuse the crap out of a kid; you really teach yours to spell like that?! – Lightness Races in Orbit Apr 30, 2011 at 12:02

14

votes

I think it's a combination of the other mentioned reasons :

For starters, 'i' was commonly used by mathematicians in their notation, and in the early days of computing with languages that weren't binary (ie had to be parsed and lexed in some fashion), the vast majority of users of computers were also mathematicians (... and scientists and engineers) so the notation fell into use in computer languages for programming loops, and has kind of just stuck around ever since.

Combine this with the fact that screen space in those very early days was *very* limited, as was memory, it made sense to keep shorter variable names.

Share

answered Nov 17, 2010 at 23:36

community wiki
Alex Marshall

13

votes

Possibly historical ?

FORTRAN, aurguably the first high level language, defined i,j,k,l,m as Integer datatypes by default, and loops could only be controlled by integer variable, the convention continues ?

eg:

do 100 i= j,100,5 .... 100 continue ....

FWIW, I usually skip the letter l because it looks too much like the number 1. – Nosredna Feb 2, 2009 at 20:00

13

votes

i = iterator, i = index, i = integer

Which ever you figure "i" stands for it still "fits the bill".

Also, unless you have only a single line of code within that loop, you should probably be naming the iterator/index/integer variable to something more meaningful. Like: employeeIndex

BTW, I usually use "i" in my simple iterator loops; unless of course it contains multiple lines of code.

Share

answered Jun 2, 2009 at 1:24

Chris Pietschmann
29.8k ● 36 ● 123 ● 167

13

votes

i = iota, j = jot; both small changes.

iota is the smallest letter in the greek alphabet; in the English language it's meaning is linked to small changes, as in "not one iota" (from a phrase in the New Testament: "until heaven and earth pass away, not an iota, not a dot, will pass from the Law" (Mt 5:18)).

A counter represents a small change in a value.

And from iota comes jot (iot), which is also a synonym for a small change.

cf. http://en.wikipedia.org/wiki/Iota

13

votes

Well from Mathematics: (for latin letters)

a,b: used as constants or as integers for a rational number

c: a constant

d: derivative

e: Euler's number

f,g,h: functions

i,j,k: are indexes (also unit vectors and the quaternions)

l: generally not used. looks like 1

m,n: are rows and columns of matrices or as integers for rational numbers

o: also not used (unless you're in little o notation)

p,q: often used as primes

r: sometimes a spatial change of variable other times related to prime numbers

s,t: spatial and temporal variables or s is used as a change of variable for t

u,v,w: change of variable

x,y,z: variables

11

votes

Many possible main reasons, I guess:

- mathematicians use `i` and `j` for *Natural Numbers* in formulas (the ones that use *Complex Numbers* rarely, at least), so this carried over to programming

- from *C*, `i` hints to `int`. And if you need another `int` then `i2` is just way too long, so you decide to use `j`.

- there are languages where the first letter decides the type, and `i` is then an `integer`.

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answered Nov 18, 2010 at 12:44

community wiki
towi

10

votes

It comes from Fortran, where i,j,k,l,m,n are implicitly integers.

Share

answered Dec 5, 2010 at 19:32

community wiki
Walter Bright

7

votes

It definitely comes from mathematics, which long preceded computer programming.

So, where did if come from in math? My completely uneducated guess is that it's as one fellow said, mathematicians like to use alphabetic clusters for similar things -- f, g, h for functions; x, y, z for numeric variables; p, q, r for logical variables; u, v, w for other sets of variables, especially in calculus; a, b, c for a lot of things. i, j, k comes in handy for iterative variables, and that about exhausts the possibilities. Why not m, n? Well, they are used for integers, but more often the end points of iterations rather than the iterative variables themselves.

Someone should ask a historian of mathematics.

Share   answered Dec 5, 2010 at 14:10

community wiki
David Lewis

6

votes

Counters are so common in programs, and in the early days of computing, *everything* was at a premium... Programmers naturally tried to conserve pixels, and the 'i' required fewer pixels than any other letter to represent. (Mathematicians, being lazy, picked it for the same reason - as the smallest glyph).
As stated previously, 'j' just naturally followed...

:)

24   In the early days of computing, pixels didn't *exist*. – SLaks Nov 18, 2010 at 2:55

1   @Slaks, that is one winning comment. Just see the grin on my face reading it, and the votes. Nice! – ProfK Dec 5, 2010 at 14:24

"Programmers naturally tried to conserve pixels, and the 'i' required fewer pixels than any other letter to represent." <<< that is hilarious. – ocodo Feb 14, 2011 at 2:05 ✎

1   ...and thus, premature optimization was born! – Gerrat Feb 14, 2011 at 14:53

4

votes

I use it for a number of reasons.

- Usually my loops are int based, so you make a complete triangle on the keyboard typing "int i" with the exception of the space I handle with my thumb. This is a very fast sequence to type.

- The "i" could stand for iterator, integer, increment, or index, each of which makes logical sense.

With my personal uses set aside, the theory of it being derived from FORTRAN is correct, where integer vars used

letters I - N.

answered Jan 17, 2009 at 23:42

user36457

4

votes

I learned FORTRAN on a Control Data Corp. 3100 in 1965. Variables starting with 'I' through 'N' were implied to be integers. Ex: 'IGGY' and 'NORB' were integers, 'XMAX' and 'ALPHA' were floating-point. However, you could override this through explicit declaration.

answered Dec 5, 2010 at 14:44

community wiki
Pierre