

# Patterns in pi, copyright law, and philosophy

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- *From:* [shepherdmoon@xxxxxxxxxx](mailto:shepherdmoon@xxxxxxxxxx)
  - *Date:* Sun, 25 Jan 2009 16:14:21 -0800 (PST)
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Hello,

The subject of the post is absurdly grandiose, of course. But I found this interesting link while playing around with searching for number patterns in pi:

<http://www.dubliish.com/articles/31.html>

I saw three general topics discussed a lot. And, although I did not read all of them in their entirety, I also think a fourth topic is of interest.

The best thing about the link is the comments section, which has some fascinating back-and-forth discussion about the following topics:

1. Whether the offset of a string found in pi can be used as a form on compression.
2. Whether the fact that a given string is found in pi negates copyright law.
3. Whether pi itself can appear "in" pi.
4. (my own musings, not necessarily in the comments): What are the implications for ideas of free will and creativity if it can be demonstrated that any human writing, which can be defined as a finite string of encoded numbers, already exists in pi?

I am not trained in math, so please excuse (or correct) any mistakes on my part. But I noticed that the comment section above has what I think are some pretty convincing answers to the above questions. Specifically,

1. Sounds like this can be done trivially but is not in any way practical. For example, this comment:

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Anonymous Coward @ 2006-05-25 22:51:37

Finding long continuous sequences in PI that exactly match the byte values in, say, a 6 MB MP3 is intractable. In fact, for anything but trivial sequences (such as your INFO example), the problem is intractable.

You could provide a bunch of offsets, however, say one for every longword in the data. But this definitely isn't compression; the bits representing the offsets will very likely be as large, if not larger, than the original data.

You are essentially describing a one-time pad, except that it won't work for encryption purposes because everyone knows the codebook.

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2. I think not. Most of the comments at this link that respond in the negative gave answers I found more convincing than those who answered in the affirmative. For the negative:

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Dan @ 2006-05-27 05:40:21

First of all, copyrighted materials are not 'plagiarized from Pi' because any given number of the size of, say, a 250kb picture has certainly not been discovered yet. So, unless you can prove that the creators of the material had the knowledge that the particular string of digits in question already existed within Pi, they have done nothing wrong.

Furthermore, suppose I took all of the bits of an mp3 and mixed them up so that the file could no longer be used to hear the song. If you downloaded this new file, would you be infringing on a copyright? No, because the owner of the song does not lose any money by you having it – you still have to purchase a CD if you actually want to listen to the song. It is only when you acquire the information to de-scramble the file does the copyright holder lose business. (If this were not true, then most novels wouldn't be legal – I'm sure you often can rearrange the letters of one novel to make another, albeit shorter, copyrighted story).

By this logic, simply downloading Pi would not be illegal – only when you acquire the offset(s) would you be breaking the law. And judging by how difficult it is even to find a 1000 digit number in Pi, I suspect that most offsets would be extremely large. This means that it would not be reasonable to argue that you stumbled upon that information by chance – you had to have knowingly and proactively searched for it. Thus, you had acted upon an intent to acquire copyrighted material illegally, and could be prosecuted.

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3. It sounds like pi itself cannot appear "in" pi – aside from the degenerate case one wry commenter presented ("at offset 0"), but that doesn't mean that a given string of finite length cannot be found. I found this comment to be really good at pointing out why a previous comment was wrong on this and other points.

I also think that it doesn't make sense to claim that one cannot

copyright works because their encoded versions exist in pi. After all, until one has the entire work in hand, one doesn't know the starting offset of the pi-encoded version. Getting the work "in hand" – that is, writing it or stealing it – is the whole point, after which finding it in pi – even if it takes an astounding amount of time to find it – is relatively beside the point.

Also, I wonder if one can simply take the length of the given work, then calculate how many digits of pi one would need to raise the probability of finding the string to something reasonable ( $> 0.5$ ). All you can say is, yes, chances are that given a search of these  $n$  digits of pi, you are more likely than not to find the work. But that does nothing to negate the hard work of, say, Shakespeare, of kindly preparing the actual string that you need to feed to the search function.

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truth machine @ 2006-05-27 13:05:29

"We would need a very very very long binary expansion of pi and some kick-ass interface for searching for a file"

No, we would only need to be able calculate it — and, as is noted above, the hexadecimal expansion of pi has the advantage of being calculable from any starting point, so no significant amount of processing power is required. OTOH, downloading the start and end positions of an arbitrary item would generally require longer than the life of the universe and more storage than there is matter.

"This thought pops up with astounding regularity on the net. Without fail, the same logical error is made every time"

The thought pops up frequently because there's a nearly inexhaustible supply of sloppy thinkers — and the same logical error is made every time because anyone recognizing the error immediately dismisses the thought.

"An infinite series of numbers is not an exhaustive set of numbers. Another way to say that is just because there are an infinite number of digits in Pi does not mean that any particular combination of numbers must exist. You might be able to find your phone number or social security number quite easily, but good luck finding any series of numbers that represents a program, music, or anything else. Not that it is impossible, it is just very very improbable."

Too bad you have no idea what you're talking about. The digits of pi aren't just "an infinite series of numbers", they are the decimal expansion of a transcendental number. While it's not proven that every finite string of digits occurs within the decimal expansion of pi, it is very very likely, not "very very improbable", that any specific finite string does appear. The vast majority of mathematicians

believes this to be the case, as there is absolutely no reason to expect otherwise, and it is known that the first 30 million digits of pi are very uniformly distributed.

"To further explain why Pi is not an exhaustive set, let's assume that all number sequences exist in Pi. That statement means that I should be able to find a series of 100 fives, or 1000 fives, or a billion billion billion fives, and even an infinite number of fives. Any number of fives (or any other number) is a valid series of numbers, so it would have to be found if our assumption were true."

This does not "further explain why Pi is not an exhaustive set" — it is to be expected that all of those different sequences occurs at some point in the \*infinite\* string of digits of the decimal expansion of pi. If pi contains all strings of digits, then they all occur; if it does not, then one or more may not occur. Rather than "explain why Pi is not an exhaustive set", you have offered a simple case of *petitio principii*.

To see why it is almost certainly true that all these sequences occur, imagine breaking up the decimal expansion of pi into blocks of a billion billion billion digits. There  $10^{27}$  different such blocks, but an infinity of such blocks in the expansion, and we have no reason to expect any of these blocks to occur any more than any other; we certainly don't have any reason to expect any of them to never occur — and that's the case for the block of all 5's. So not only should we expect such a sequence to occur, but we should expect it to occur infinitely many times.

"It also would mean that I should be able to find all the numbers for e (Euler's number) as well. Since e is a non-repeating, non-terminating number like Pi, its number sequence cannot be found within Pi."

Um, do you know of any images, music, etc. of infinite length? e and other infinite sequences are irrelevant. But we should expect any finite subsequence of the decimal expansion of e to occur within the decimal expansion of pi. Certainly you have offered no reason not to expect that, and there is every reason to expect that, as the digits of pi show no statistical patterns and there is no known reason why there would be any.

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4. I don't think there are serious implications for creativity if any given finite string can be found in pi. Given what I think about item 3 above, I still think the whole point is knowing what string to look for, which presupposes someone's having independently created or "discovered" it. Regarding free will, however, I'm less certain. It would seem strange if it has been proven that any given finite string will appear in pi given enough digits, and it does seem a lot more uncanny than arguing that the keys of a keyboard can be worked into

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any written work. It's the consecutive nature of the pi strings that seems unsettling. But perhaps there already is a philosophical answer to this question?

Thanks for any feedback or advice on the above.

Shepherdmoon