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# What is the most efficient algorithm to find the Pisano period for a given integer (even for large integers)?















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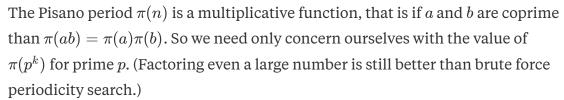
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### 1 Answer



Mark Gritter, Stanford CS PhD dropout





It is hypothesized that  $\pi(p^k) = p^{k-1}\pi(p)$  and since no counterexamples are known to exist, you might as well use that in your algorithm.

So, how to calculate  $\pi(p)$  efficiently? There are two special cases and two general cases

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$$\pi(2^k)=3\cdot 2^{k-1}$$

$$\pi(5^k) = 4 \cdot 5^k$$

If 
$$p \equiv 1$$
 or  $p \equiv 9 \pmod{10}$  then  $\pi(p) \mid p-1$ 

If  $p \equiv 3$  or  $p \equiv 7 \pmod{10}$  then  $\pi(p) \mid 2(p+1)$ , and by an odd divisor too.

The last two statements give us a relatively small number of cases to try (after factoring p-1 or 2(p+1).) Now use your favorite formula to calculate large values of the Fibonacci numbers  $F(x) \mod p$ . See Michal Forišek's answer to What's a fast algorithm to find the remainder of the division of a huge Fibonacci number by some big integer? To test a candidate period R, calculate  $F(R) \mod p$  and  $F(R+1) \mod p$ . If these are equal to F(0) = 0 and F(1) = 1, then  $\pi(p) \mid R$ .

It might be that p-1 or 2(p+1) have a lot of divisors, but we don't need to try them all. Suppose  $q^k \mid R$  for some prime q. Then test R/q. If that doesn't produce a cycle, then  $\pi(p)$  must have factor  $q^k$ , and we can leave it in and go on to other factors. Otherwise, we can use R/q as our new starting point and repeat the process. Thus we have to do a number of checks proportional to  $\Omega(2(p+1))$ , not d(2(p+1)).

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