Spiral primes

Problem 58 (http://projecteuler.net/problem=058)

Starting with 1 and spiralling anticlockwise in the following way, a square spiral with side length 7 is formed.

```
37 36 35 34 33 32 31
38 17 16 15 14 13 30
39 18  5  4  3 12 29
40 19  6  1  2 11 28
41 20  7  8  9 10 27
42 21 22 23 24 25 26
43 44 45 46 47 48 49
```

It is interesting to note that the odd squares lie along the bottom right diagonal, but what is more interesting is that 8 out of the 13 numbers lying along both diagonals are prime; that is, a ratio of 8/13 ≈ 62%.

If one complete new layer is wrapped around the spiral above, a square spiral with side length 9 will be formed. If this process is continued, what is the side length of the square spiral for which the ratio of primes along both diagonals first falls below 10%?

Solution

In [1]:

```
def prime(m=0):
    if m > 2:
        yield 2
    if m > 3:
        yield 3
    p, n, q = 5, 3, 9
    while (not m) or (p < m):
        if  all(p % x for x in range(3, n+1, 2)):
            yield p
        p += 2
        while p>q:
            q += n
            n += 1
            q += n

ptable = list(prime(30000))

def isprime(n):
    if n <= ptable[-1]:
        return n in ptable
    q = int(n ** 0.5) + 1
    for x in ptable:
        if n % x == 0:
            return False
        if x > q:
            return True
    if q>ptable[-1]:
        for x in range(ptable[-1],q,2):
            if n % x == 0:
                return False
    return True

def spiral(x=None):
    n = z = 1
    yield z
    while (x is None) or (n < x):
        n += 1
        for _ in range(4):
            z += n
            yield z
        n += 1

sp = spiral()
next(sp)
size, dt, pt = 1, 1, 0
while True:
    for _ in range(3):
        x = next(sp)
        if isprime(x):
            pt += 1
    x = next(sp)
    dt += 4
    size += 2
    if pt / dt < 0.1:
        print(size)
        break
```

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```