Problem 50

The prime 41, can be written as the sum of six consecutive primes:
41 = 2 + 3 + 5 + 7 + 11 + 13

This is the longest sum of consecutive primes that adds to a prime below one-hundred.

The longest sum of consecutive primes below one-thousand that adds to a prime, contains 21 terms, and is equal to 953.

Which prime, below one-million, can be written as the sum of the most consecutive primes?

Solution

We know that we're looking for more than 21 terms, so we'll only bother looking for primes which can fit in a 21-term sum. We split up the lists of n successive primes into {2,3,5},{3,5,7},   [this is working with n=3] and sum them, selecting those totals which are prime and less than a million. We then ask "which n gives us just one prime answer?" because we are asked to find the unique such prime. We find the largest such n:

In[39]:=
```
Select[Range[22, 1000],
  1 == Length@With[{primes = Prime[Range[PrimePi[1 000 000/#] + #]]},
     Select[Total /@ Partition[primes, #, 1], PrimeQ[#] && # < 1 000 000 &]] &]
```

Out[39]=
```
{60, 64, 96, 100, 102, 108, 114, 122, 124, 130, 132, 146, 152, 158, 162, 178, 192,
 198, 204, 206, 208, 214, 216, 296, 308, 326, 328, 330, 332, 334, 342, 350, 356,
 358, 426, 446, 458, 460, 464, 480, 484, 488, 512, 519, 530, 535, 536, 543}
```

So 543 is the longest string of consecutive primes we can have.

In[36]:=
```
With[{primes = Prime[Range[PrimePi[1 000 000/#] + #]]},
   Select[Total /@ Partition[primes, #, 1], PrimeQ[#] && # < 1 000 000 &]] &[543]
```

Out[36]=
```
{997 651}
```