1. Output from program

Result:

Approach1:

```java
//Approach 1 Only consider half of num
if(num == 1) return false;
for(int i = 2; i < num / 2 + 1; i++){
    if(num % i == 0) return false;
}
return true;
```

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
1229 primes in 1 - 10000, it takes 0.012s to find them all.
2262 primes in 1 - 20000, it takes 0.036s to find them all.
3245 primes in 1 - 30000, it takes 0.083s to find them all.
4203 primes in 1 - 40000, it takes 0.128s to find them all.
5133 primes in 1 - 50000, it takes 0.19s to find them all.
6057 primes in 1 - 60000, it takes 0.256s to find them all.
6935 primes in 1 - 70000, it takes 0.343s to find them all.
7837 primes in 1 - 80000, it takes 0.434s to find them all.
8713 primes in 1 - 90000, it takes 0.548s to find them all.
9592 primes in 1 - 100000, it takes 0.657s to find them all.
```

Approach2:

```java
//Approach 2: Only consider number smaller than sqrt(num)

if(num == 1) return false;
if(num == 2) return true;
for(int i = 2; i < Math.sqrt((double)num) + 1; i++){
    if(num % i == 0) return false;
}
return true;
```

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ javac TimeFindPrimeNum.java
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
1229 primes in 1 - 10000, it takes 0.003s to find them all.
2262 primes in 1 - 20000, it takes 0.005s to find them all.
3245 primes in 1 - 30000, it takes 0.006s to find them all.
4203 primes in 1 - 40000, it takes 0.007s to find them all.
5133 primes in 1 - 50000, it takes 0.009s to find them all.
6057 primes in 1 - 60000, it takes 0.011s to find them all.
6935 primes in 1 - 70000, it takes 0.017s to find them all.
7837 primes in 1 - 80000, it takes 0.015s to find them all.
8713 primes in 1 - 90000, it takes 0.019s to find them all.
9592 primes in 1 - 100000, it takes 0.021s to find them all.
```

Approach3:

```
//Approach 3: Only consider 2 and odd number smaller than sqrt(num)

if(num == 1) return false;
if(num == 2) return true;
for(int i = 2; i < Math.sqrt((double)num) + 1; i++){
    if(i != 2 && i % 2 == 0) continue;
    if(num % i == 0) return false;
}
return true;
```

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
1229 primes in 1 - 10000, it takes 0.004s to find them all.
2262 primes in 1 - 20000, it takes 0.004s to find them all.
3245 primes in 1 - 30000, it takes 0.006s to find them all.
4203 primes in 1 - 40000, it takes 0.005s to find them all.
5133 primes in 1 - 50000, it takes 0.014s to find them all.
6057 primes in 1 - 60000, it takes 0.015s to find them all.
6935 primes in 1 - 70000, it takes 0.016s to find them all.
7837 primes in 1 - 80000, it takes 0.017s to find them all.
8713 primes in 1 - 90000, it takes 0.014s to find them all.
9592 primes in 1 - 100000, it takes 0.015s to find them all.
```

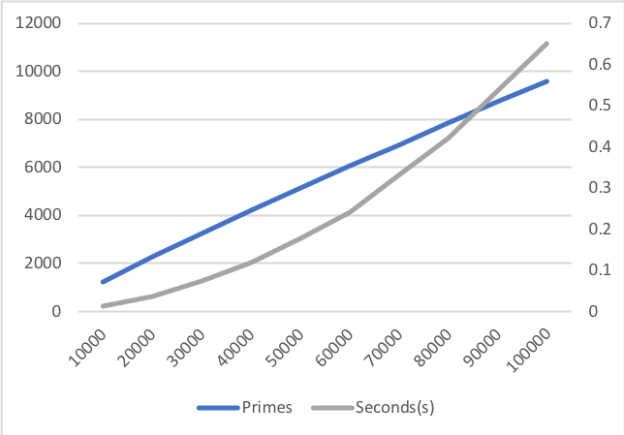
Approach4:

```
//Approach 4: Only consider prime number smaller than sqrt(num), use Arraylist to store prime numbers

if(num == 1) return false;
if(num == 2) {
    list.add(2);
    return true;
}
double max = Math.sqrt((double)num) + 1;
for(int i = 0; i < list.size() && (int)list.get(i) < max; i++){
    int j = (int) list.get(i);
    if(num % j == 0) return false;
}
return true;
```

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
1229 primes in 1 - 10000, it takes 0.006s to find them all.
2262 primes in 1 - 20000, it takes 0.005s to find them all.
3245 primes in 1 - 30000, it takes 0.007s to find them all.
4203 primes in 1 - 40000, it takes 0.005s to find them all.
5133 primes in 1 - 50000, it takes 0.008s to find them all.
6057 primes in 1 - 60000, it takes 0.006s to find them all.
6935 primes in 1 - 70000, it takes 0.01s to find them all.
7837 primes in 1 - 80000, it takes 0.007s to find them all.
8713 primes in 1 - 90000, it takes 0.01s to find them all.
9592 primes in 1 - 100000, it takes 0.01s to find them all.
```

2. Plot（Approach 1）



3. When counting 100000-1000000, there are dramatic difference between different algorithms.

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
9592 primes in 1 - 100000, it takes 0.682s to find them all.
17984 primes in 1 - 200000, it takes 2.716s to find them all.
25997 primes in 1 - 300000, it takes 5.346s to find them all.
33860 primes in 1 - 400000, it takes 9.448s to find them all.
41538 primes in 1 - 500000, it takes 14.372s to find them all.
49098 primes in 1 - 600000, it takes 20.268s to find them all.
56543 primes in 1 - 700000, it takes 27.07s to find them all.
63951 primes in 1 - 800000, it takes 34.653s to find them all.
71274 primes in 1 - 900000, it takes 43.816s to find them all.
78498 primes in 1 - 1000000, it takes 57.166s to find them all.
```

(1)

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
9592 primes in 1 - 100000, it takes 0.026s to find them all.
17984 primes in 1 - 200000, it takes 0.049s to find them all.
25997 primes in 1 - 300000, it takes 0.074s to find them all.
33860 primes in 1 - 400000, it takes 0.08s to find them all.
41538 primes in 1 - 500000, it takes 0.104s to find them all.
49098 primes in 1 - 600000, it takes 0.136s to find them all.
56543 primes in 1 - 700000, it takes 0.173s to find them all.
63951 primes in 1 - 800000, it takes 0.2s to find them all.
71274 primes in 1 - 900000, it takes 0.231s to find them all.
78498 primes in 1 - 1000000, it takes 0.269s to find them all.
```

(2)

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
9592 primes in 1 - 100000, it takes 0.02s to find them all.
17984 primes in 1 - 200000, it takes 0.038s to find them all.
25997 primes in 1 - 300000, it takes 0.074s to find them all.
33860 primes in 1 - 400000, it takes 0.084s to find them all.
41538 primes in 1 - 500000, it takes 0.11s to find them all.
49098 primes in 1 - 600000, it takes 0.146s to find them all.
56543 primes in 1 - 700000, it takes 0.183s to find them all.
63951 primes in 1 - 800000, it takes 0.204s to find them all.
71274 primes in 1 - 900000, it takes 0.22s to find them all.
78498 primes in 1 - 1000000, it takes 0.258s to find them all.
```

(3)

```
chengaoxiangdeMacBook-Pro:HW1_Gaoxiang Chen chengaoxiang$ java TimeFindPrimeNum
9592 primes in 1 - 100000, it takes 0.019s to find them all.
17984 primes in 1 - 200000, it takes 0.037s to find them all.
25997 primes in 1 - 300000, it takes 0.023s to find them all.
33860 primes in 1 - 400000, it takes 0.032s to find them all.
41538 primes in 1 - 500000, it takes 0.035s to find them all.
49098 primes in 1 - 600000, it takes 0.043s to find them all.
56543 primes in 1 - 700000, it takes 0.051s to find them all.
63951 primes in 1 - 800000, it takes 0.072s to find them all.
71274 primes in 1 - 900000, it takes 0.064s to find them all.
78498 primes in 1 - 1000000, it takes 0.073s to find them all.
```

(4)