# There Is No Largest Prime Number

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# Outline

# 1. Motivation

## 1.1 The Basic Problem That We Studied

# What Are Prime Numbers?

## Definition

A prime number is a number that has exactly two divisors.

## Definition

- 2 is prime (two divisors: 1 and 2).
- 3 is prime (two divisors: 1 and 3).
- 4 is not prime (three divisors: 1, 2, and 4).

## Theorem

There is no largest prime number.

**Proof**

1. Suppose $p$ were the largest prime number.

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3. Then $q + 1$ is not divisible by any of them.

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**Proof**

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2. Let $q$ be the product of the first $p$ numbers.
3. Then $q + 1$ is not divisible by any of them.
4. But $q + 1$ is greater than 1, thus divisible by some prime number not in the first $p$ numbers.

The proof used *reductio ad absurdum*.

# What's Still To Do?

- Answered Questions
  - How many primes are there?
- Open Questions
  - Is every even number the sum of two primes?

# An Algorithm For Finding Prime Numbers.

## Finding Prime Numbers

```
int main (void)
{
  std::vector<bool> is_prime (100, true);
  for (int i = 2; i < 100; i++)
    if (is_prime[i])
    {
      std::cout << i << " ";
      for (int j = i; j < 100; is_prime [j] = false, j+=i);
    }
  return 0;
}
```

# An Algorithm For Finding Prime Numbers.

## Finding Prime Numbers

```
int main (void)
{
  std::vector<bool> is_prime (100, true);
  for (int i = 2; i < 100; i++)
    if (is_prime[i])
    {
      std::cout << i << "␣";
      for (int j = i; j < 100; is_prime [j] = false, j+=i);
    }
  return 0;
}
```

Note the use of `std::`.