CS 112

How to approach programming problems:

The BigInt

Spring 2021

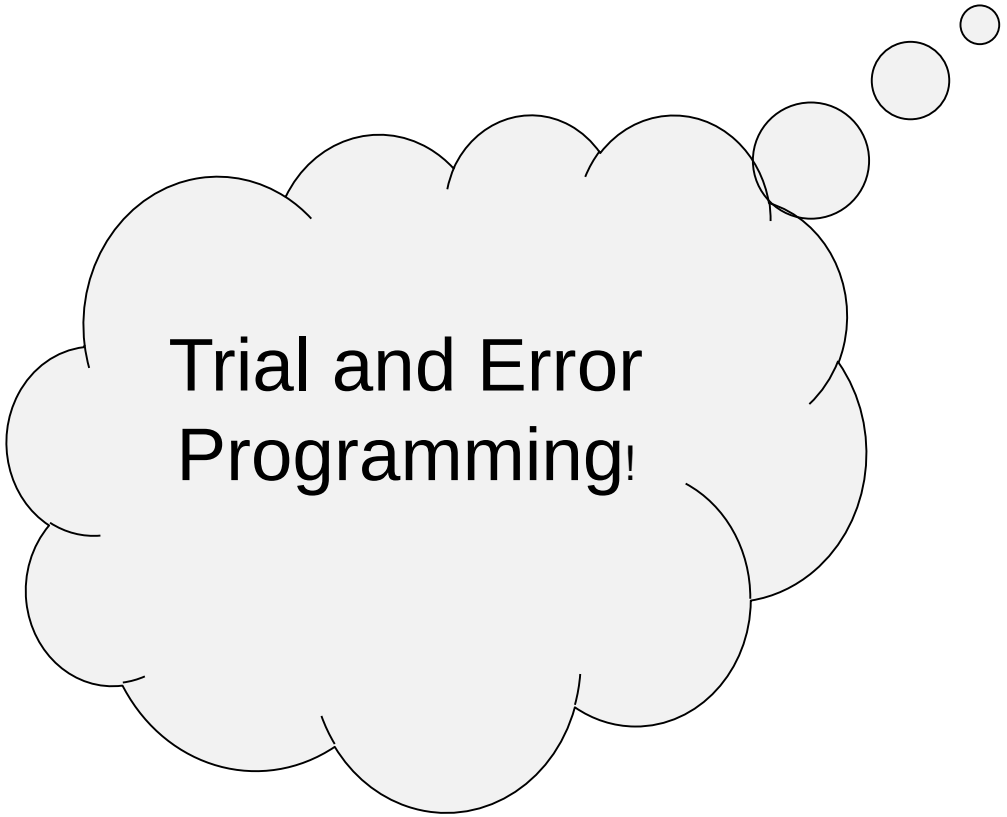
Christine Papadakis-Kanaris

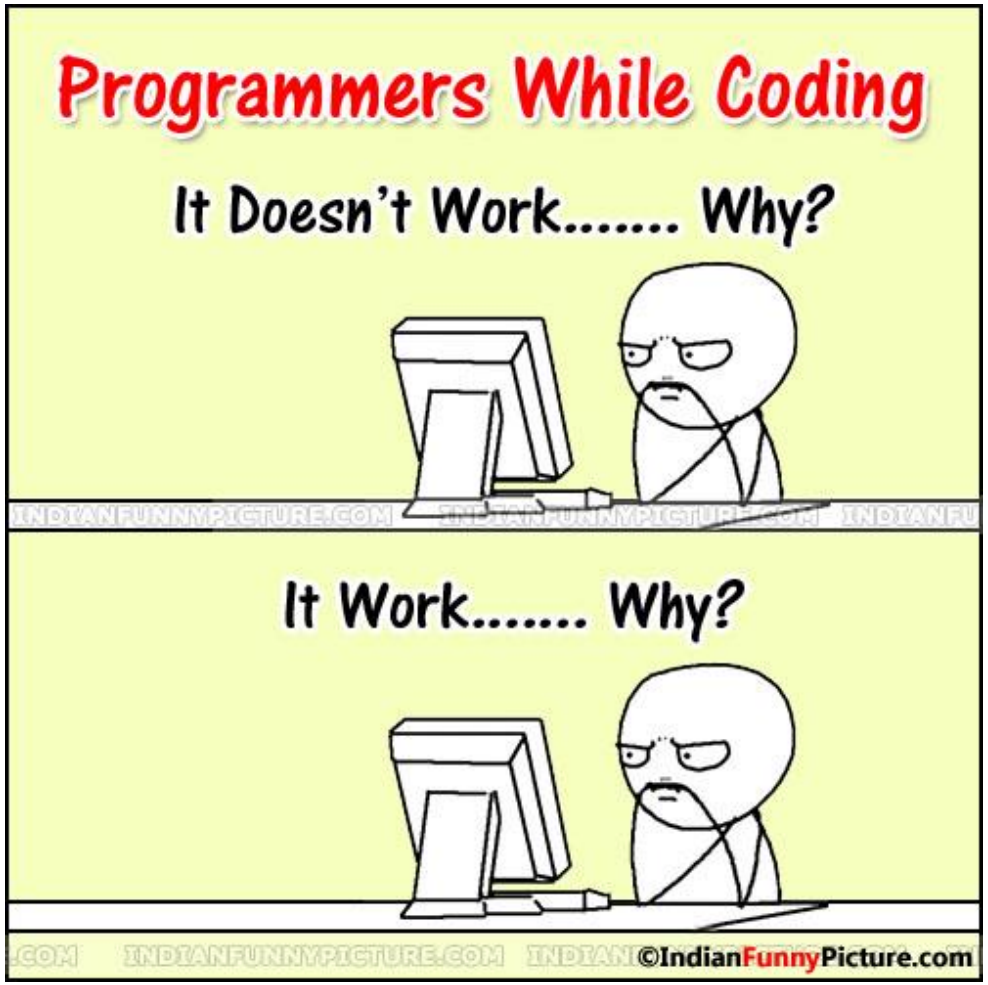
How to Approach Programming Problems

What not to do:

How to Approach Programming Problems

What not to do:





How to Approach Programming Problems

What to do:

#1
Understand the Problem!

How to Approach Programming Problems

What to do:

How to Approach Programming Problems

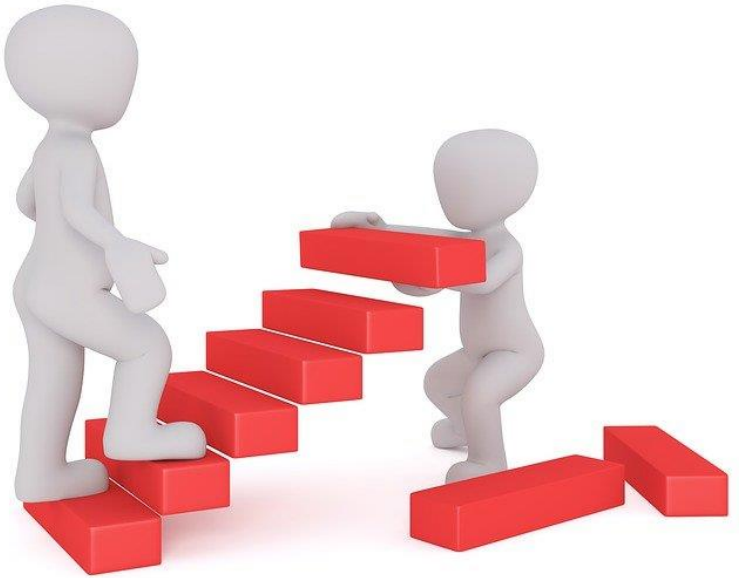
What to do:

#2
Form the solution

How to Approach Programming Problems

What to do:

#2
Identify the BASIC steps



Understanding BigInt

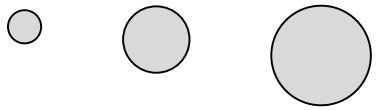
- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.

- How can we represent very large integers in Java?

Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- How can we represent very large integers in Java?
- How is it that Python does not have this issue?

```
number = 5
number = 50000
number = 500000000000
```



The variable `number` does not contain the assigned value, but a reference to an object that represents that value.

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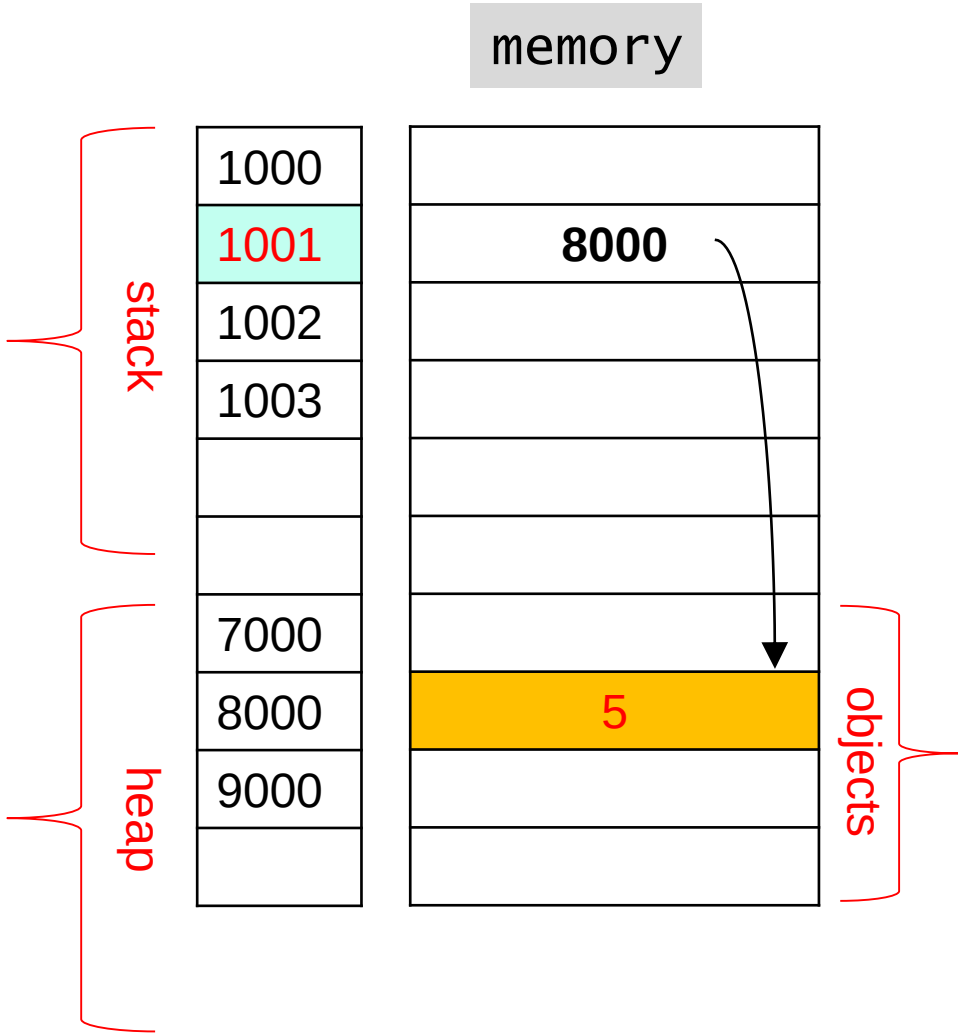
```
number = 5
number = 50000
number = 500000000000
```

mapping

number	1001



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```

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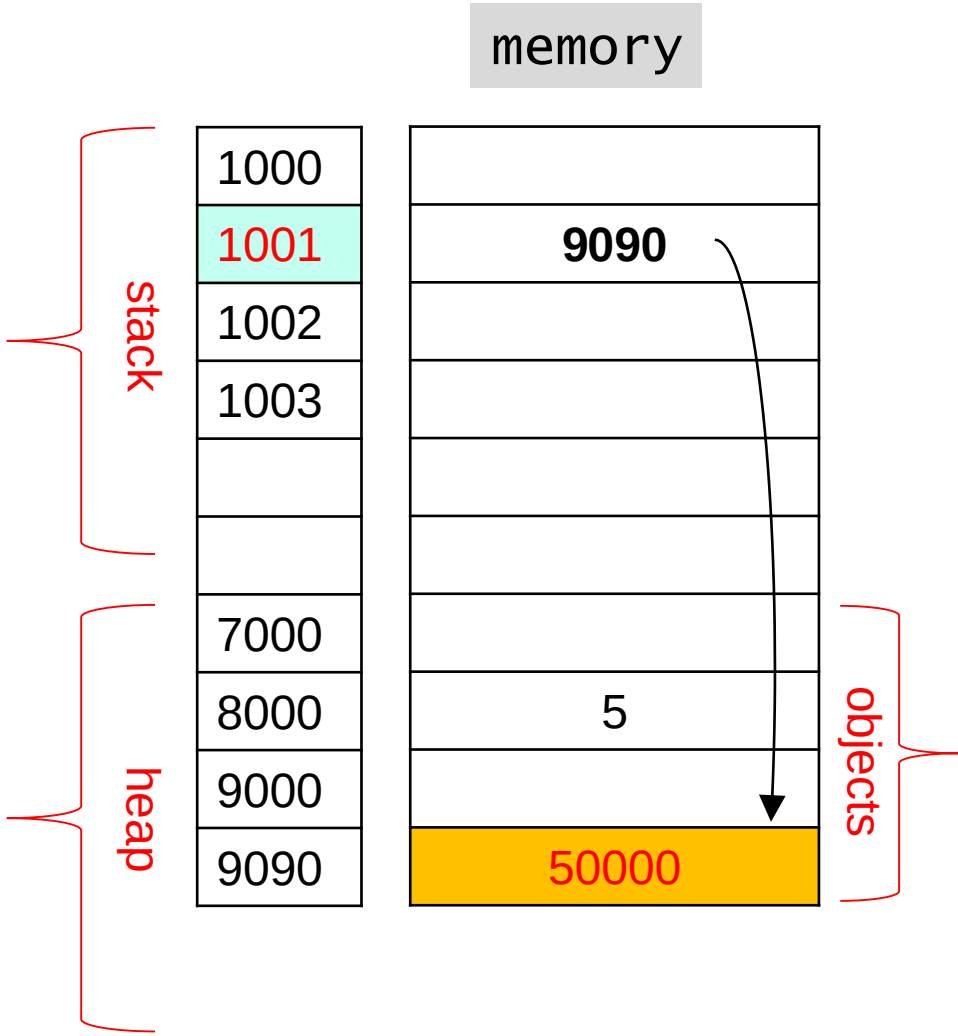
number	1001



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```
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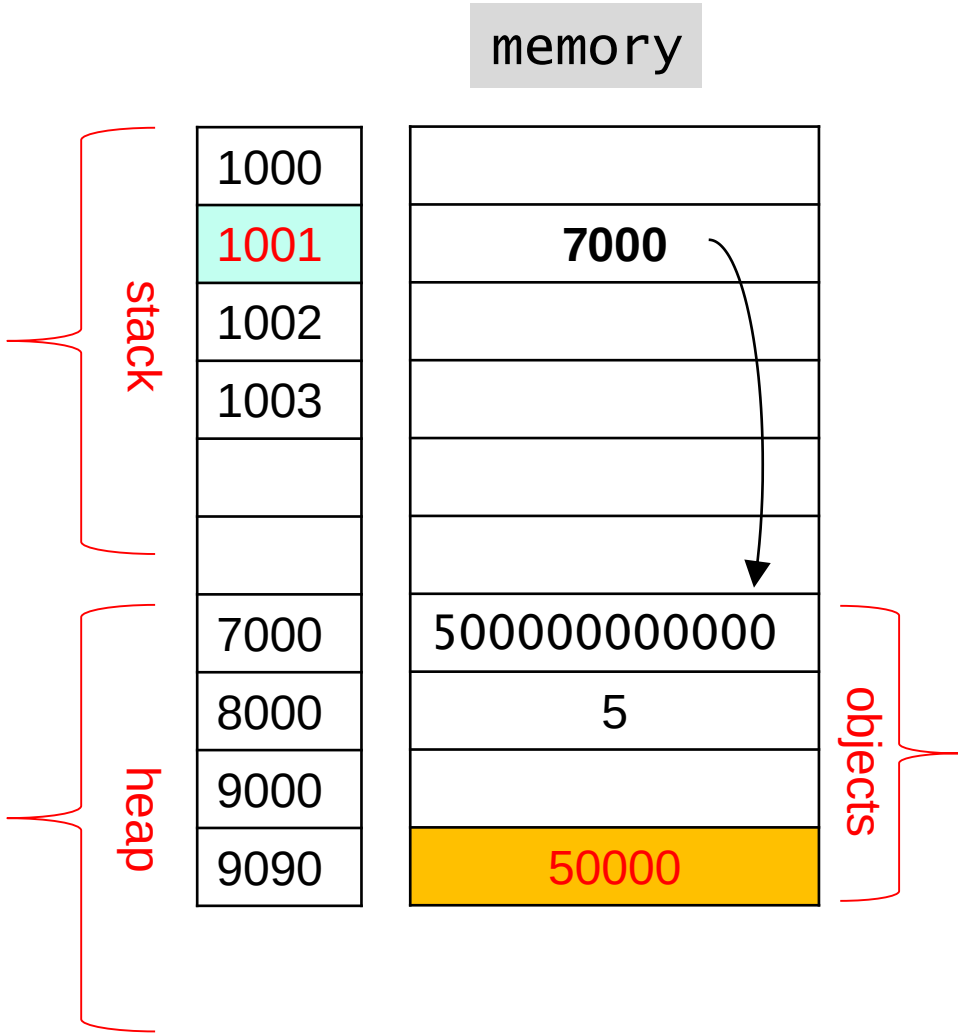
number = 50000000000
```

mapping

number	1001



Understanding BigInt

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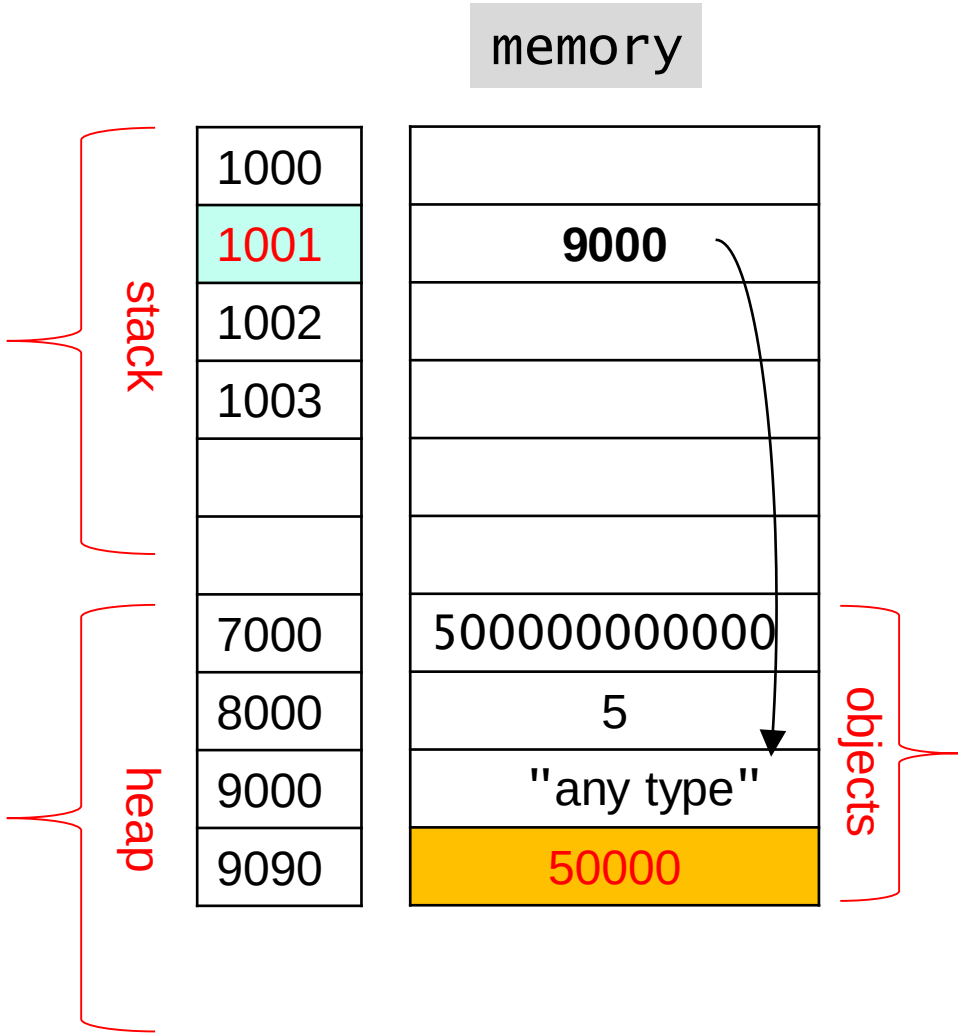
- How can we represent very large integers in Java?
- How is it that Python does not have this issue?

```
number = 5
number = 50000
number = "any type"
```

mapping

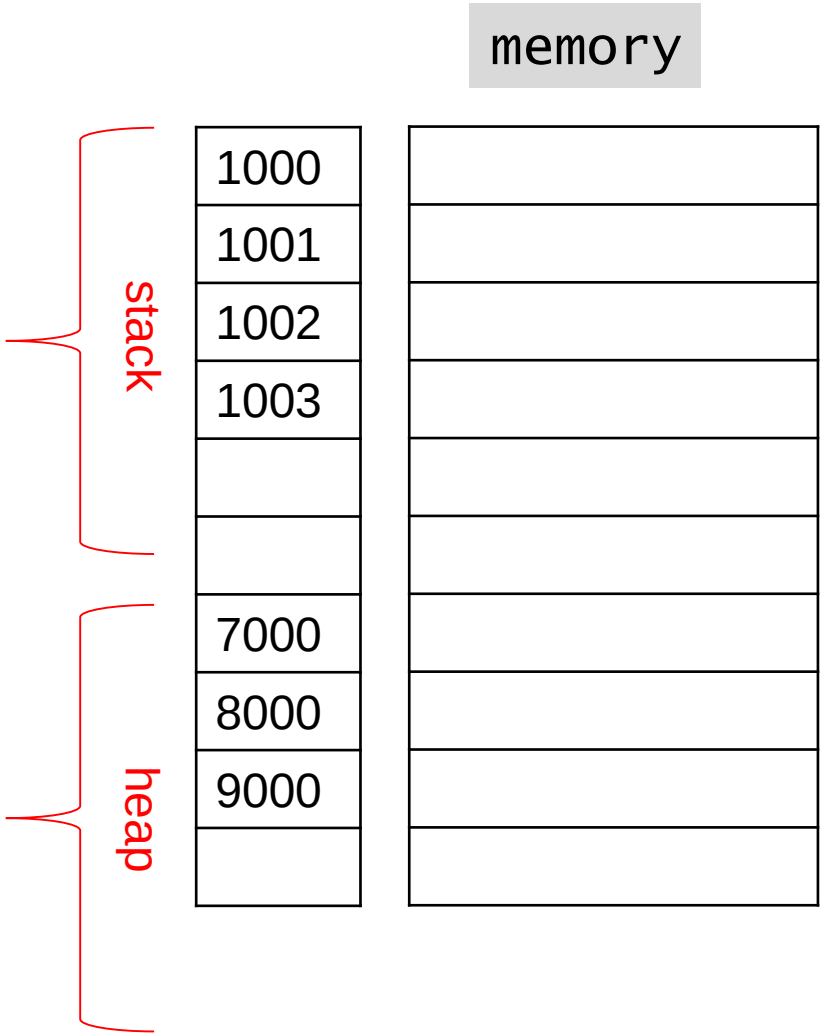
number	1001



Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- How can we represent very large integers in Java?
- Java is a strongly typed compiled language.

```
int number = 5;
number = 50000;
number = 500000000000;
```



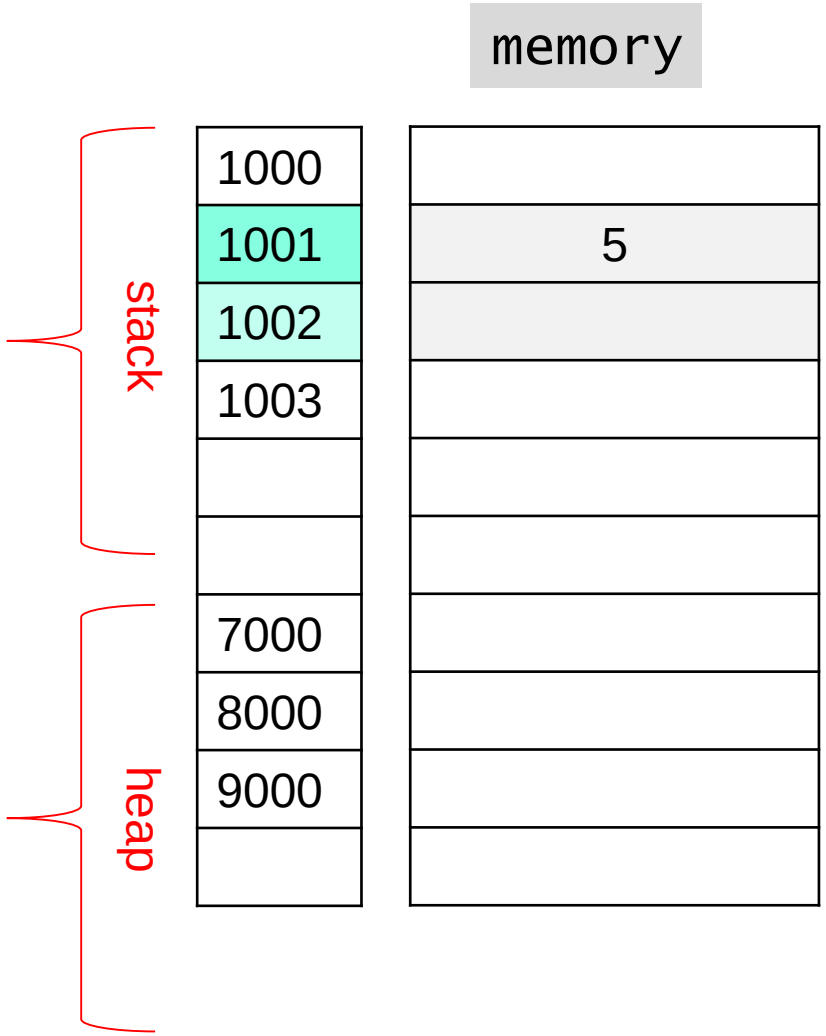
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- How can we represent very large integers in Java?
- Java is a strongly typed compiled language.

```
int number = 5; // assume 2 bytes per integer
number = 50000;
number = 500000000000;
```

mapping

number	1001



Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- How can we represent very large integers in Java?
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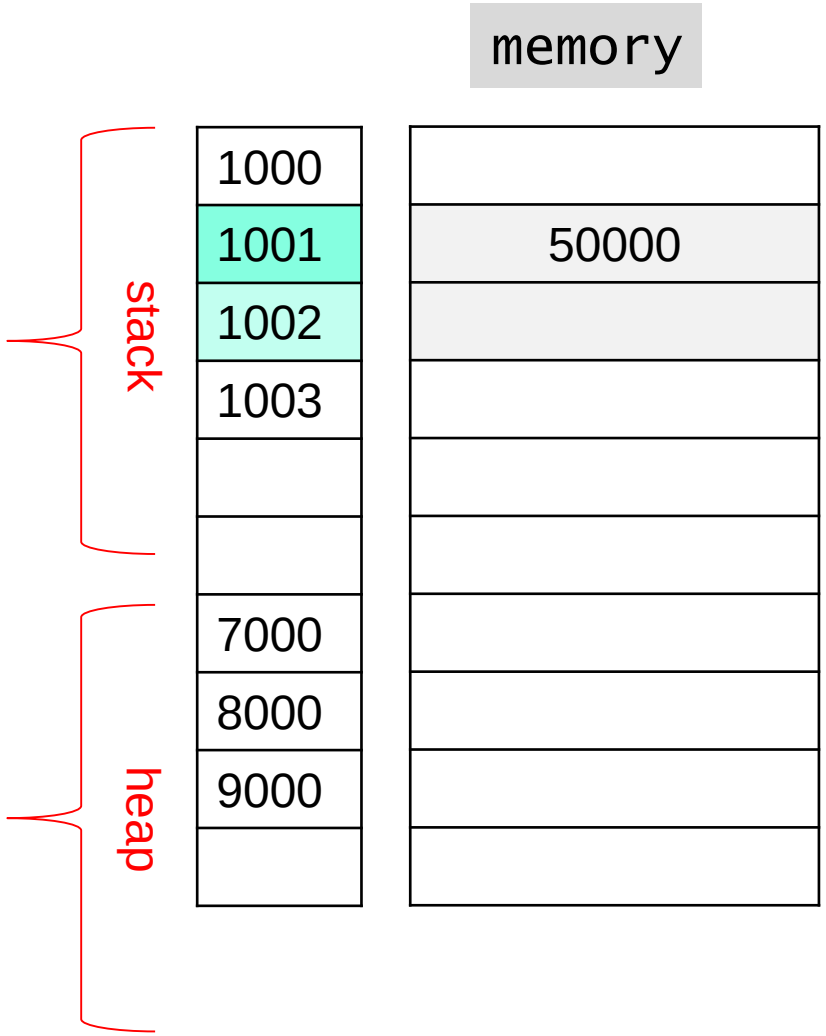
```
int number = 5; // assume 2 bytes per integer
number = 50000;
number = 500000000000;
```

mapping

number	1001



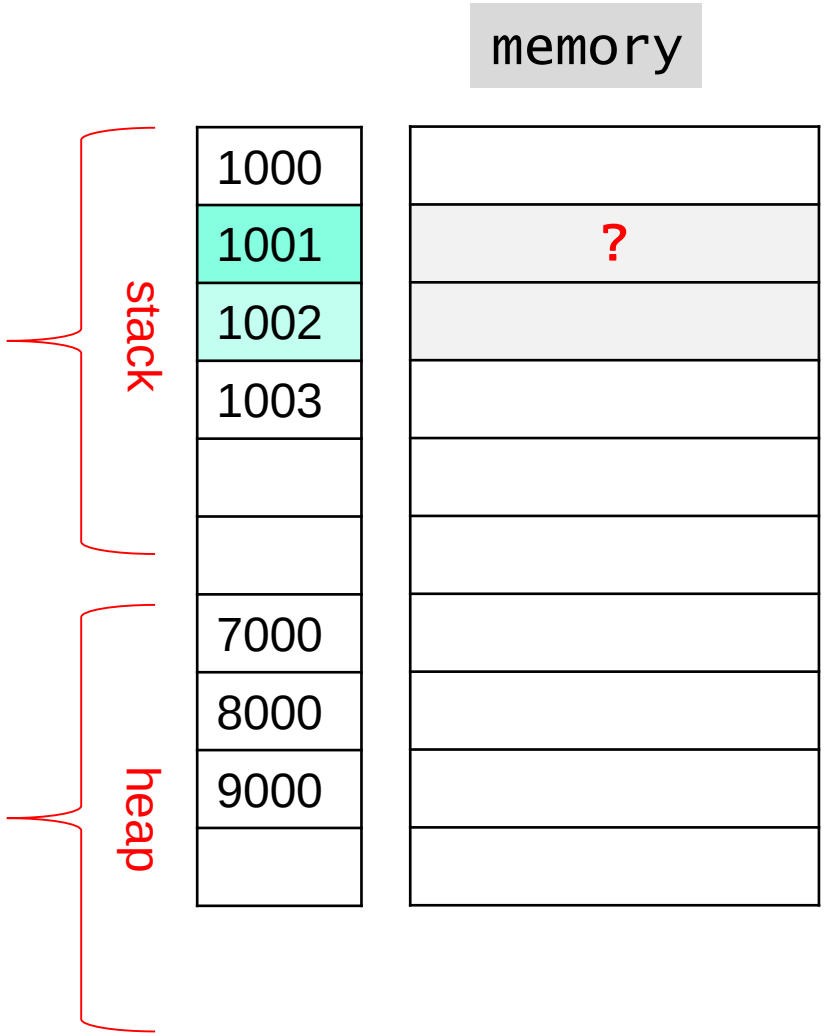
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- How can we represent very large integers in Java?
- Java is a strongly typed compiled language.

```
int number = 5; // assume 2 bytes per integer
number = 50000;
number = 500000000000;
```

mapping

number	1001



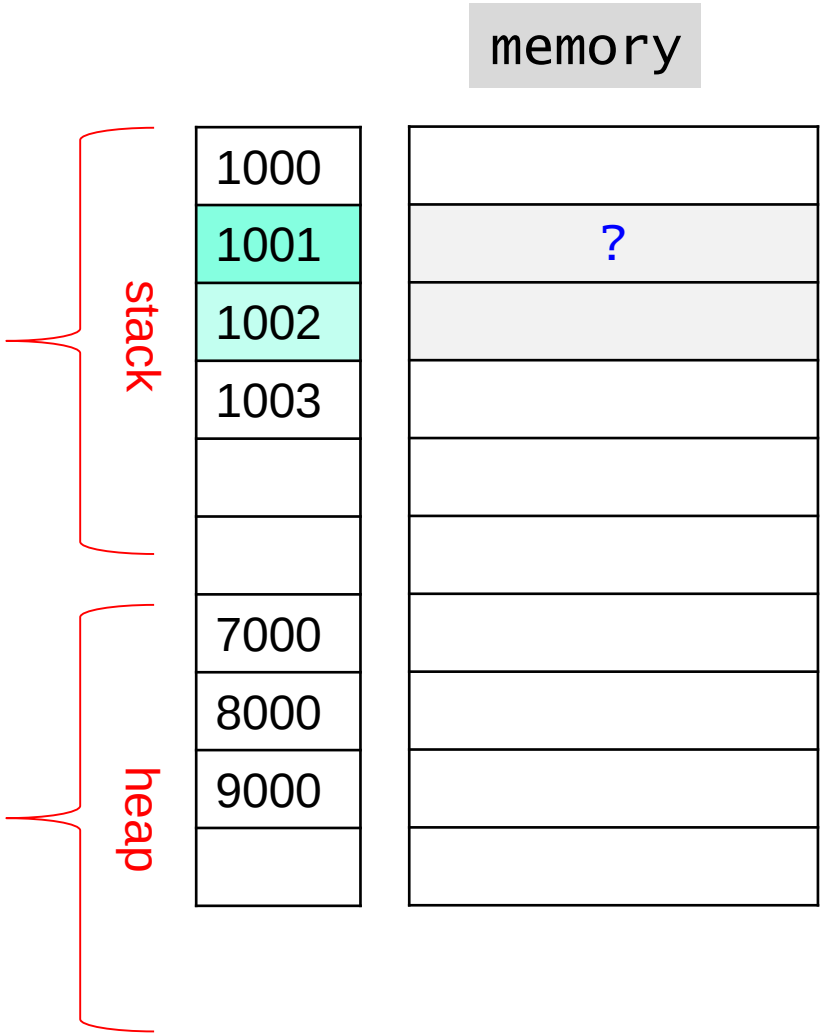
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- How can we represent very large integers in Java?
- Java is a strongly typed compiled language.

```
int number = 5; // assume 2 bytes per integer
number = 50000;
number = 500000000000;
number = 10.34; // needs double the bytes
```

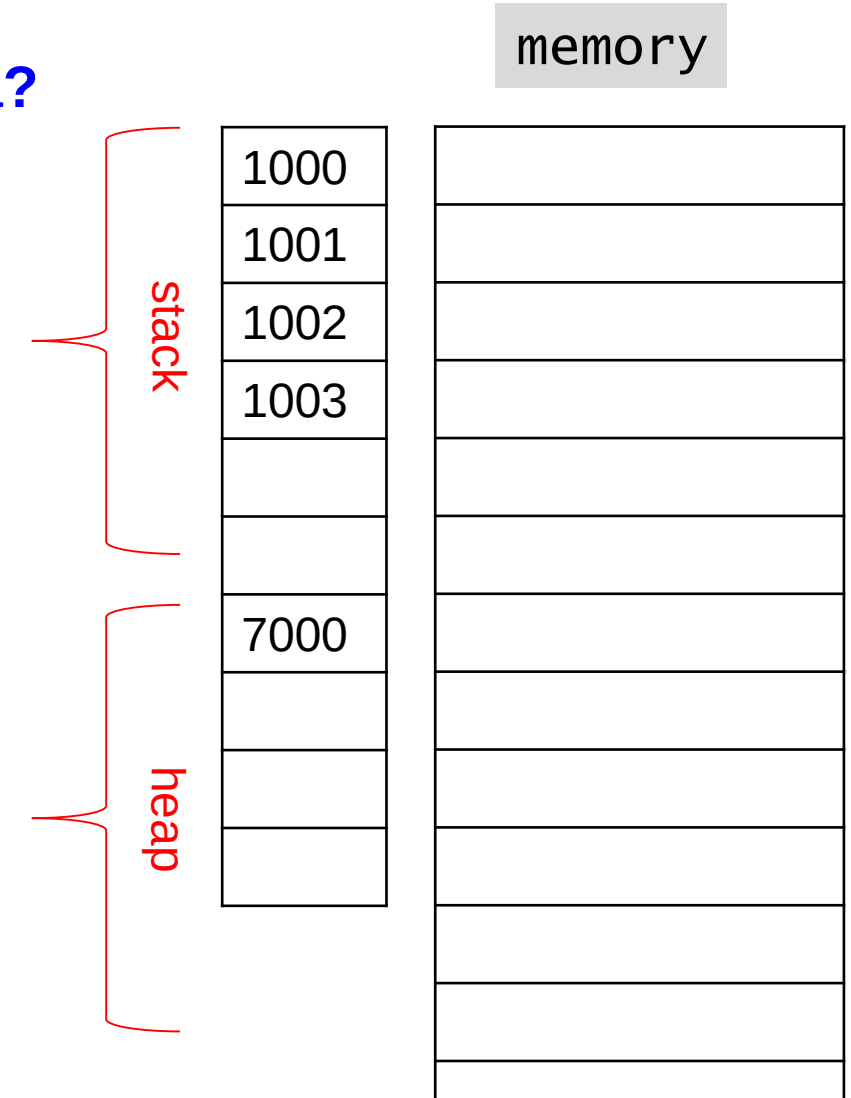
mapping

number	1001



Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Java's `BigInteger` class!** `BigInteger`



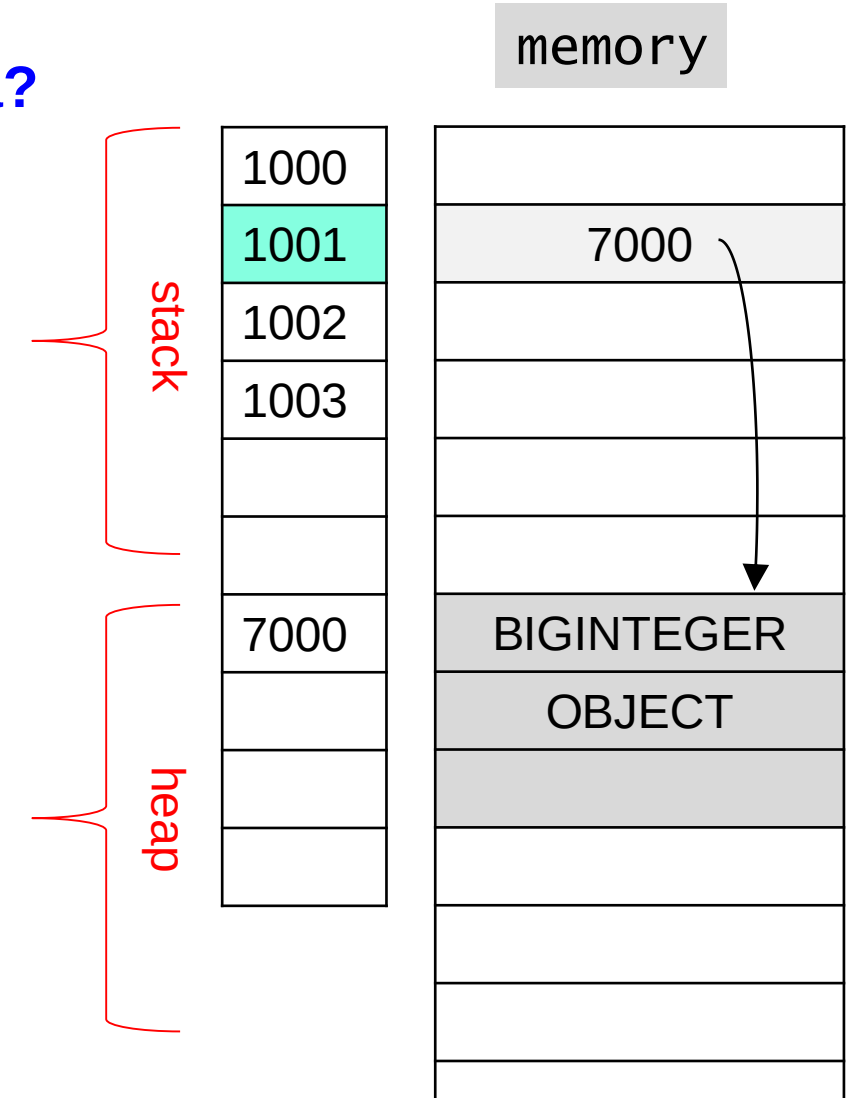
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Java's `BigInteger` class!** `BigInteger`

```
BigInteger number = new BigInteger( 5000000 );
```

mapping

number	1001



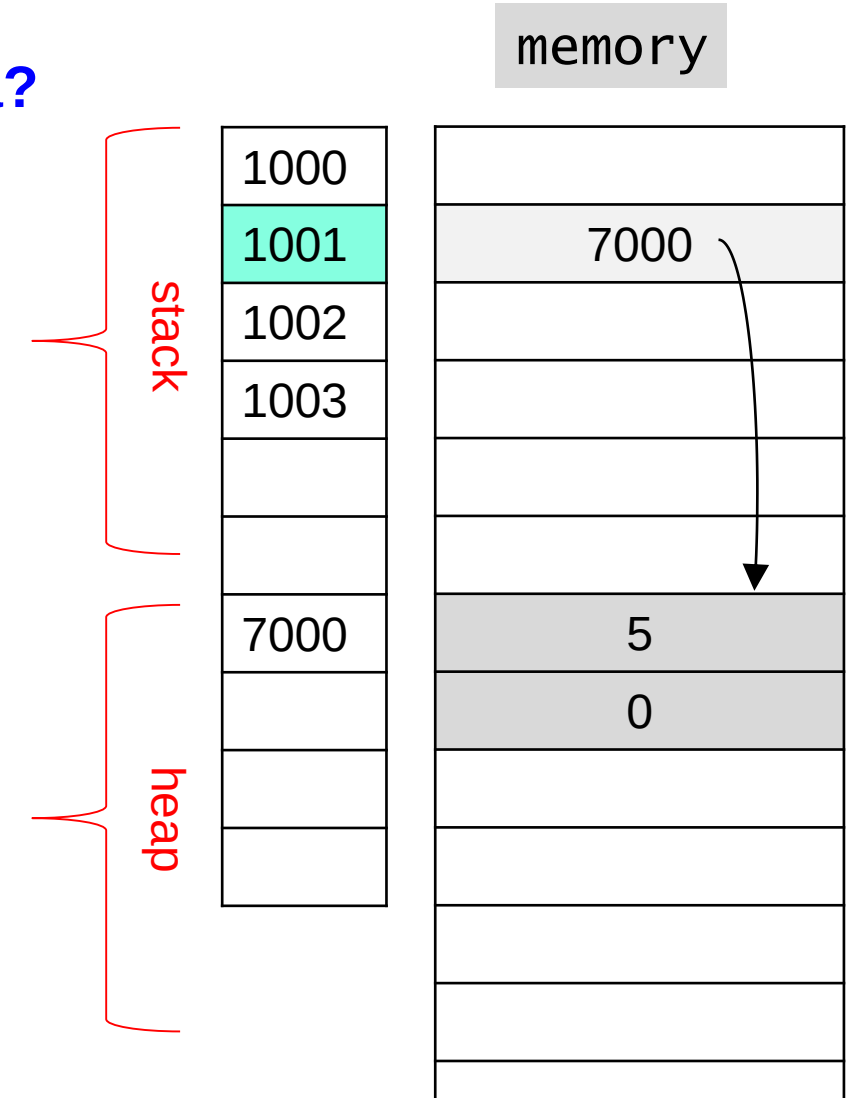
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Using an array to represent an integer!**

```
int[] number = {5,0}; // 50
```

mapping

number	1001



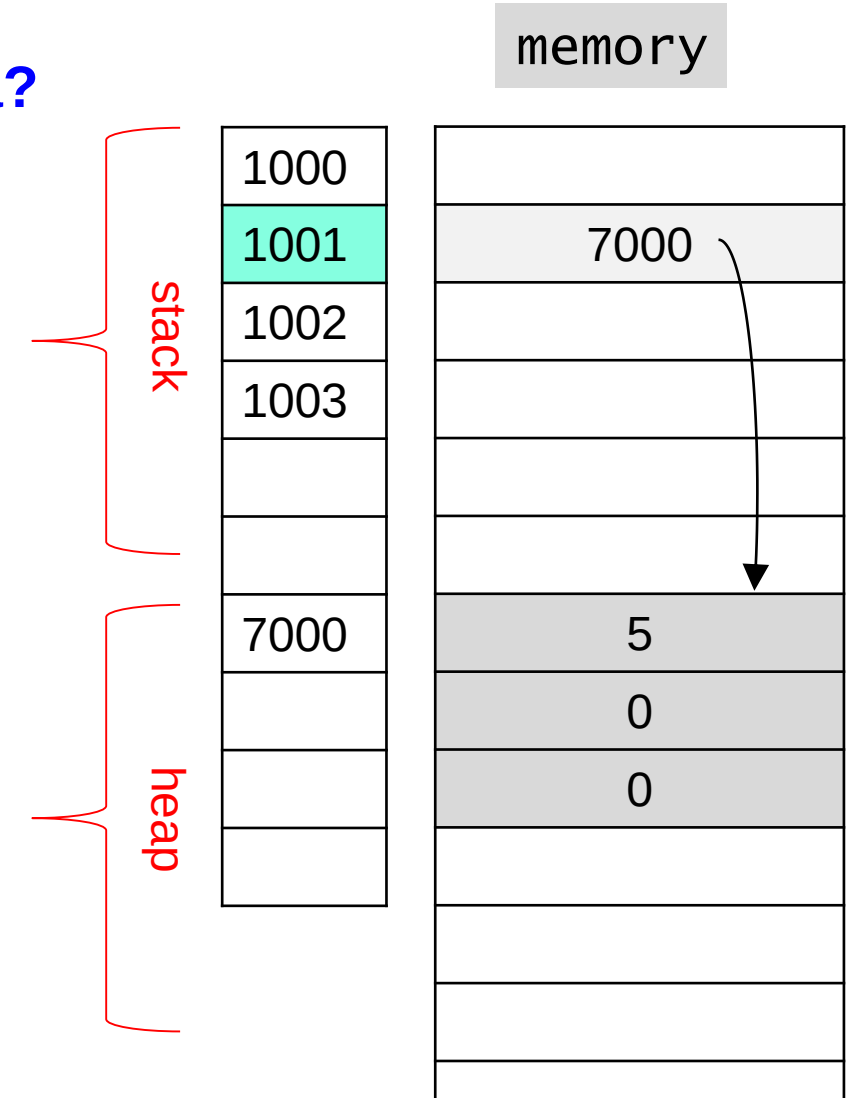
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Using an array to represent an integer!**

```
int[] number = {5,0,0}; // 500
```

mapping

number	1001



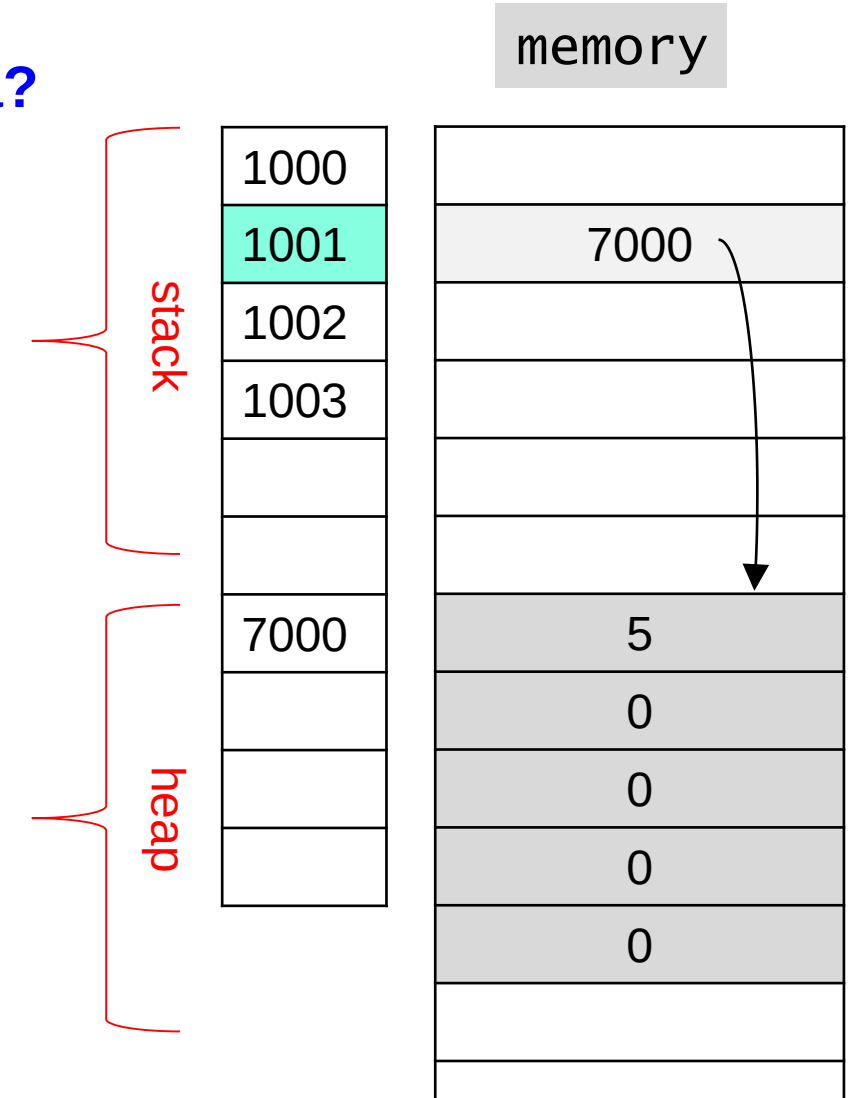
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Using an array to represent an integer!**

```
int[] number = {5,0,0,0,0}; // 50000
```

mapping

number	1001



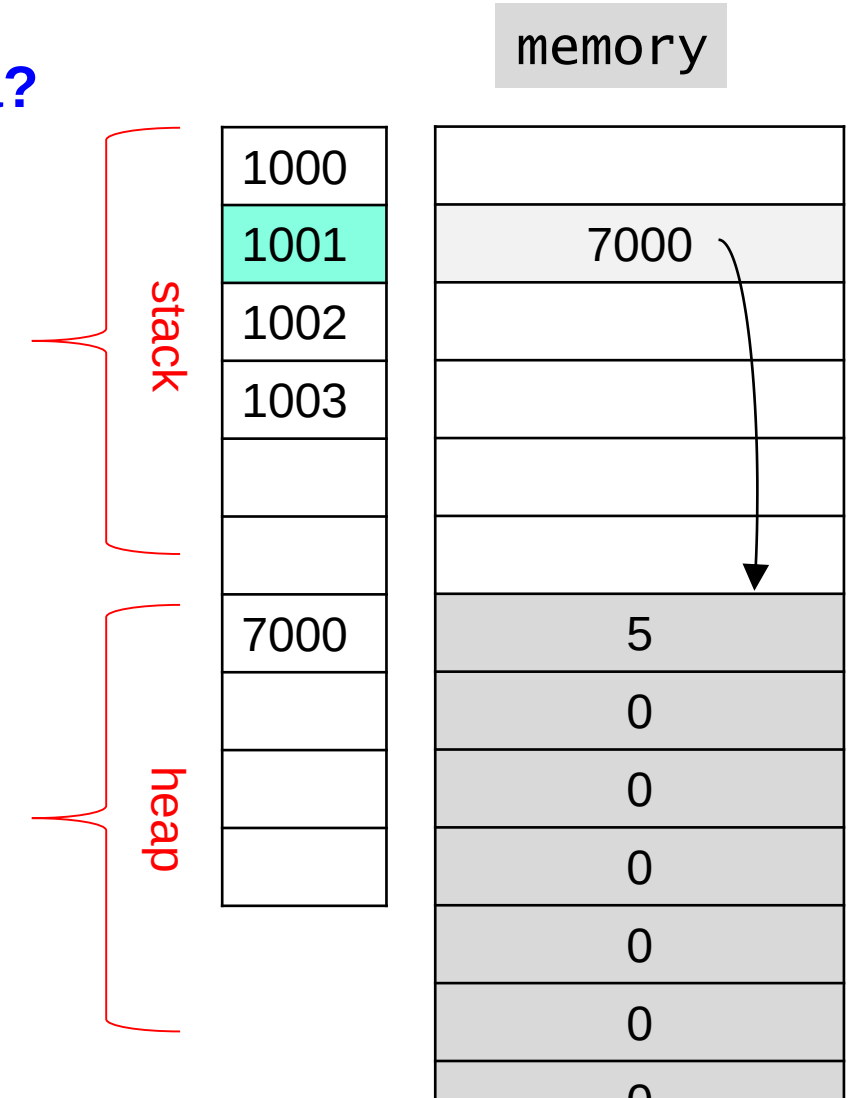
Understanding BigInt

- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Using an array to represent an integer!**

```
int[] number = {5,0,0,0,0,0,0,0,0,0,0,0,0,0,0};
```

mapping

number	1001



Understanding BigInt

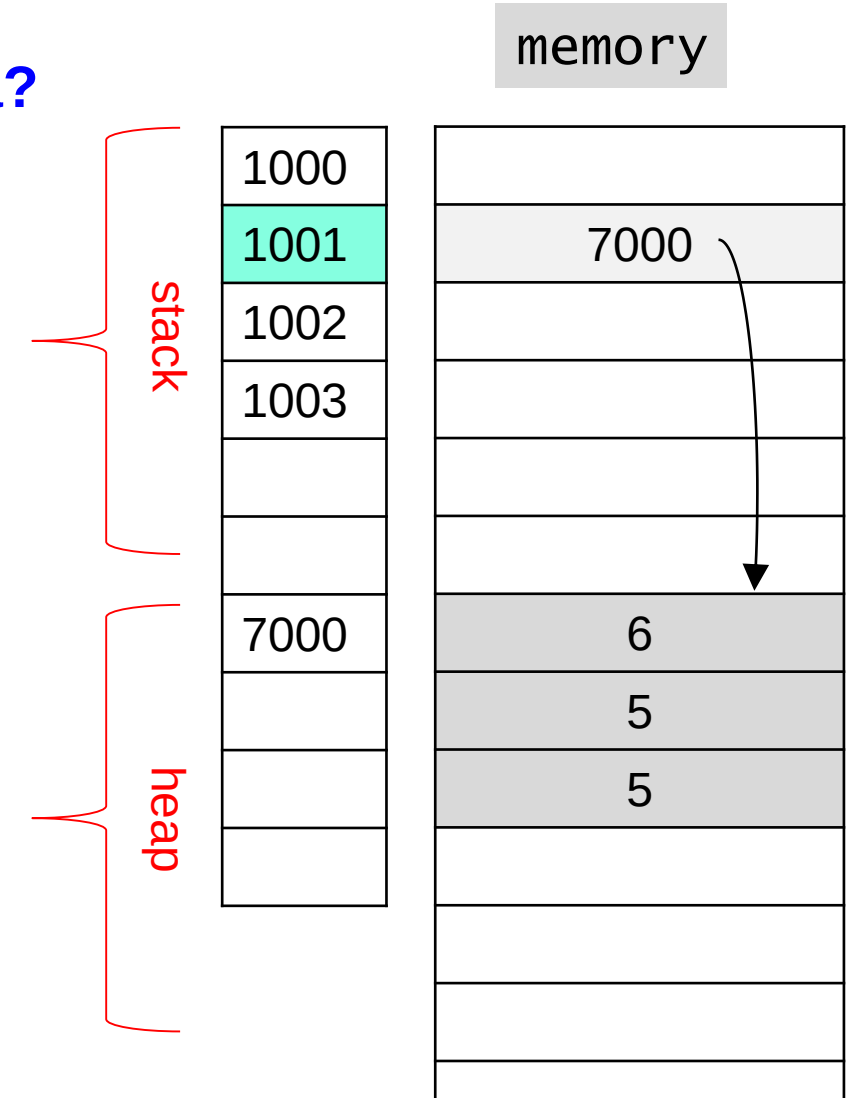
- We know that the largest integer we can store in a primitive variable in Java is an `unsigned long`.
- **How can we represent very large integers in Java?**
- **Using an array to represent an integer!**

```
int[] number = {6,5,5};
```

3 significant digits

mapping

number	1001



Understanding BigInt

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- **How can we represent very large integers in Java?**
- **Using an array to represent an integer!**

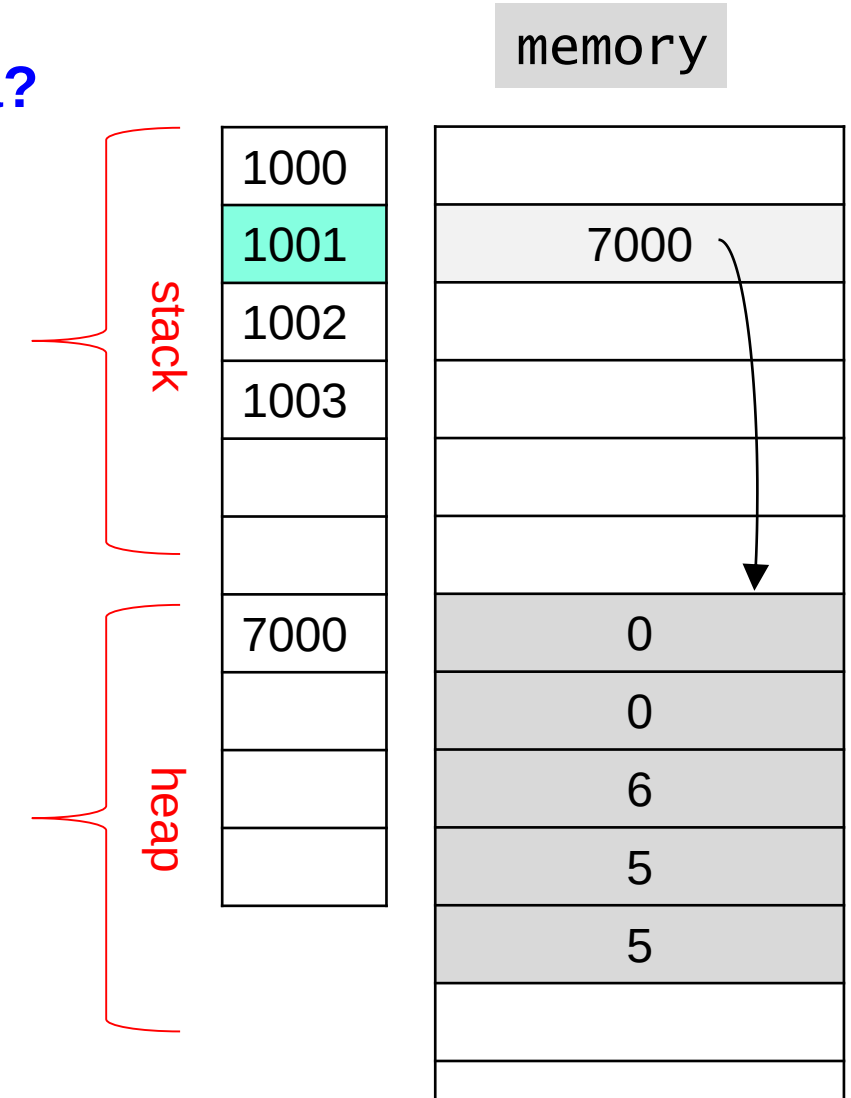
```
int[] number = {0,0,6,5,5};
```

hundred tens ones

also 3 significant digits

mapping

number	1001



Understanding BigInt

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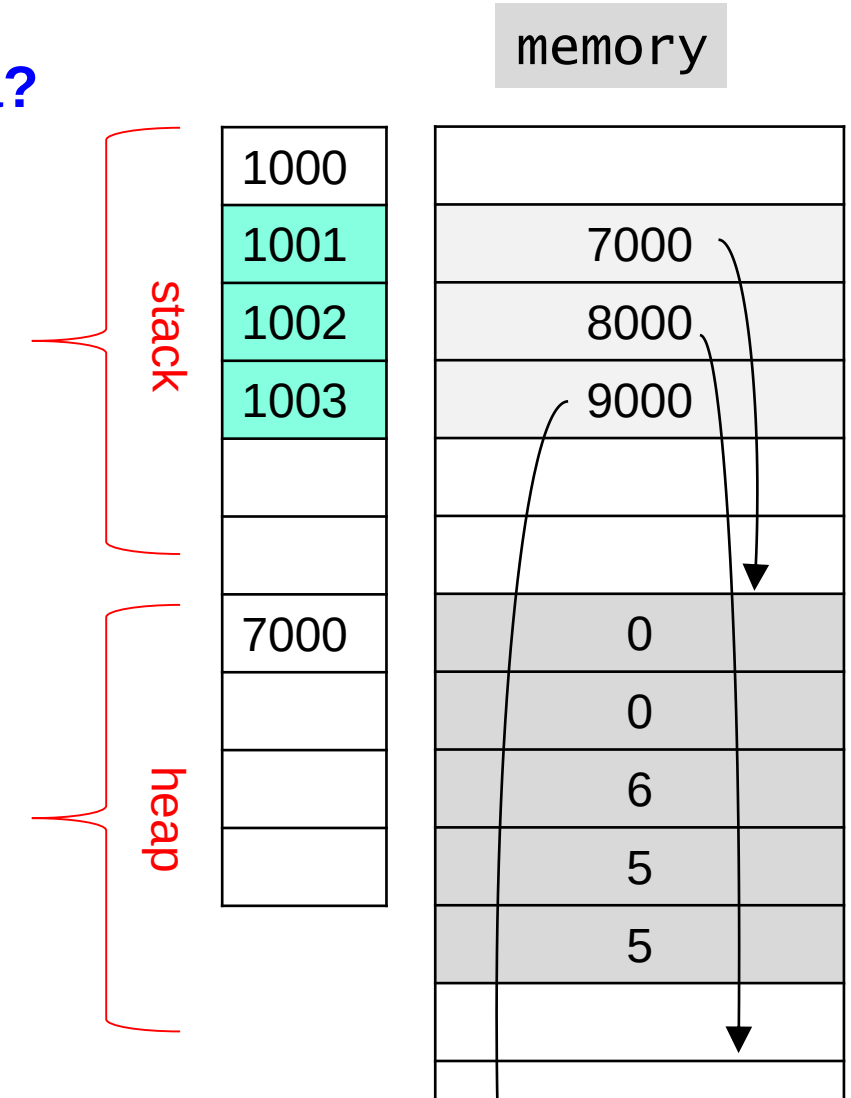
- **Using an array to represent an integer!**

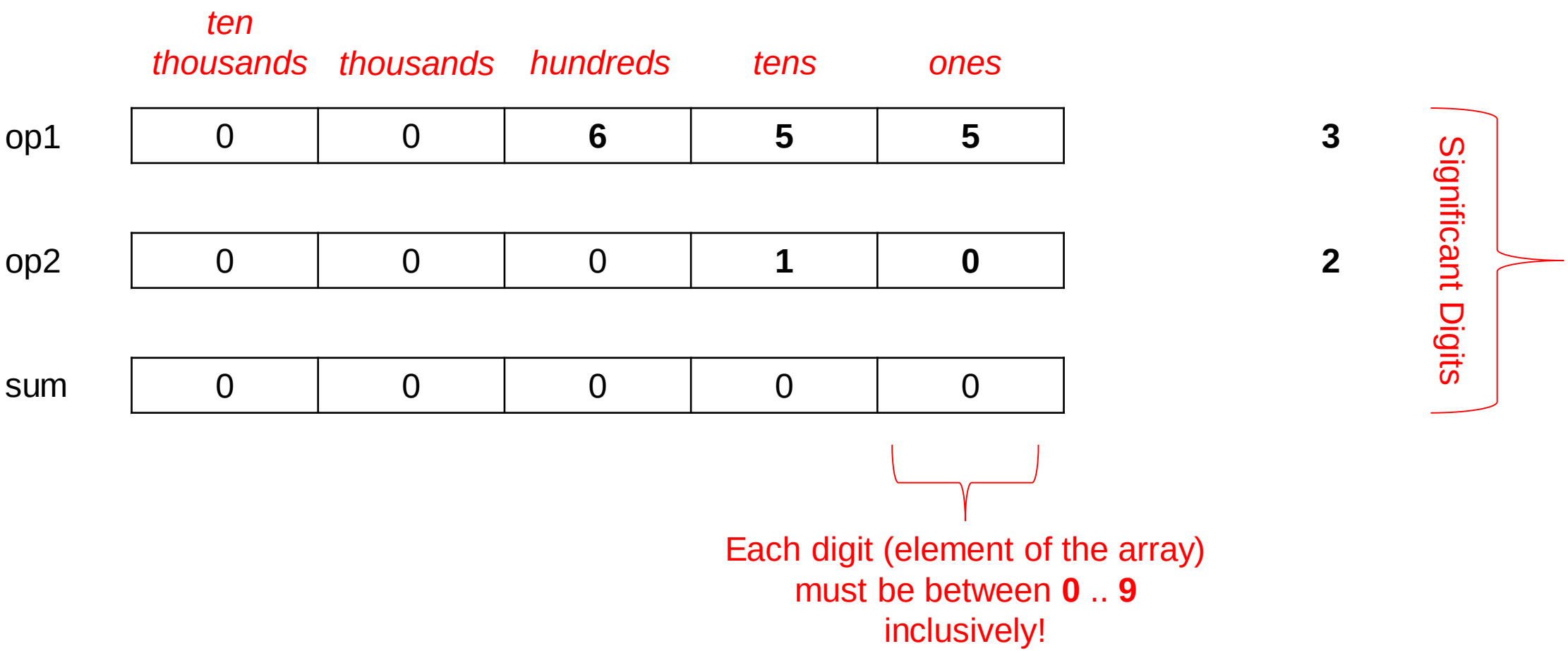
```
int[] op1 = {0,0,6,5,5};   // 655
int[] op2 = {0,0,0,1,0};   // 10
int[] sum = {0,0,0,0,0};   // 0
```

mapping

op1	1001
op2	1002
sum	1003



Representing integers with Arrays



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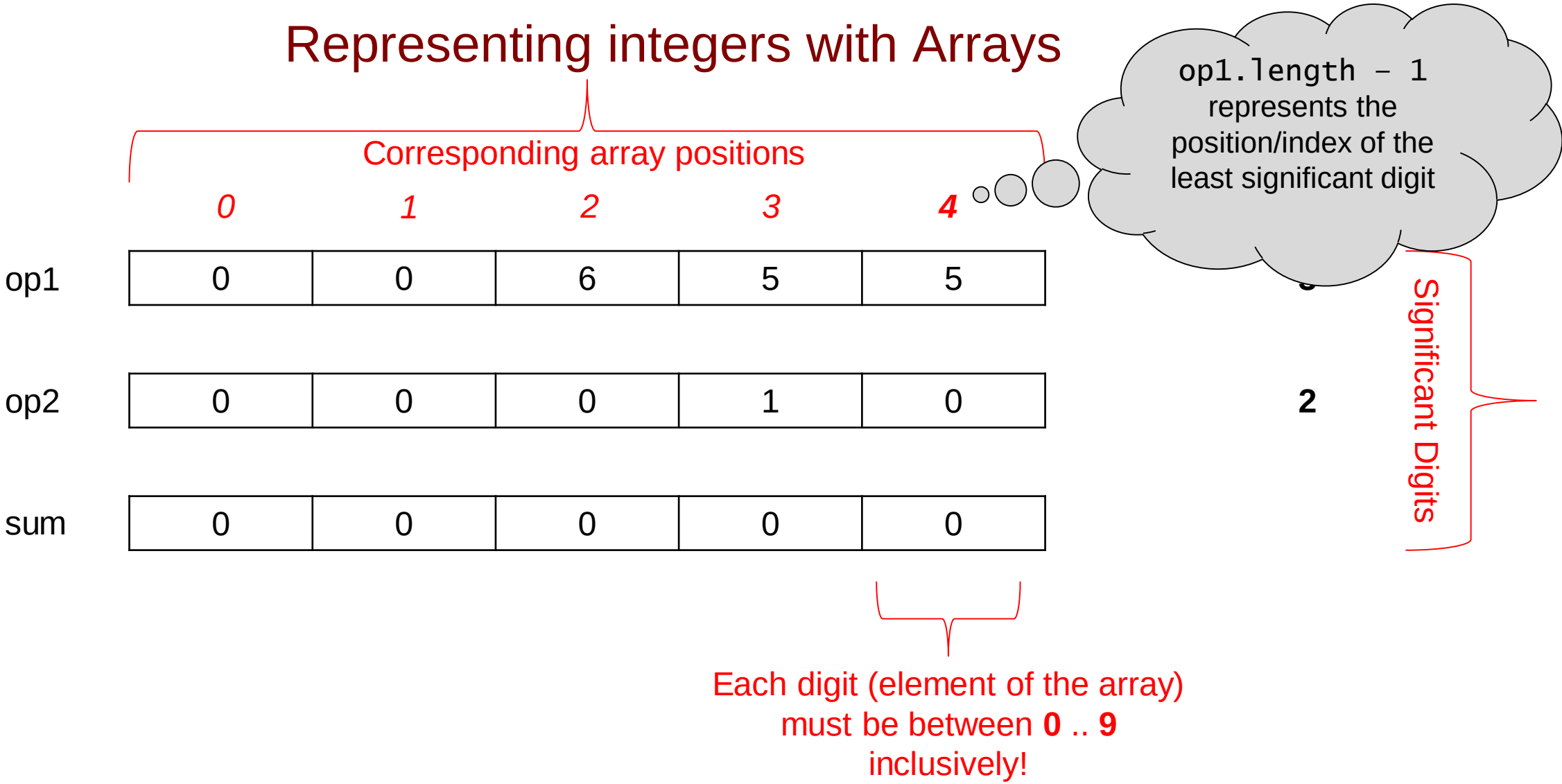

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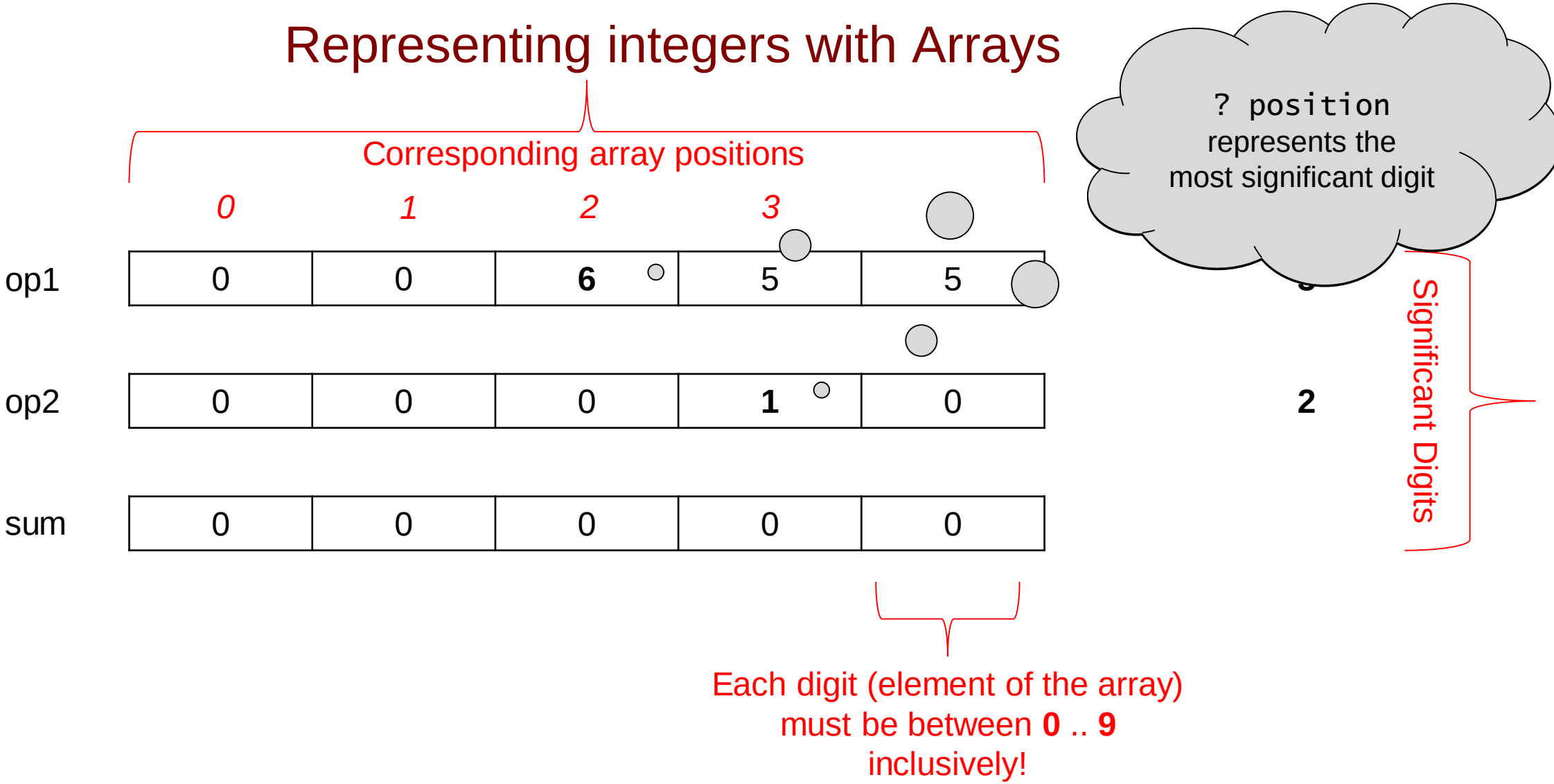

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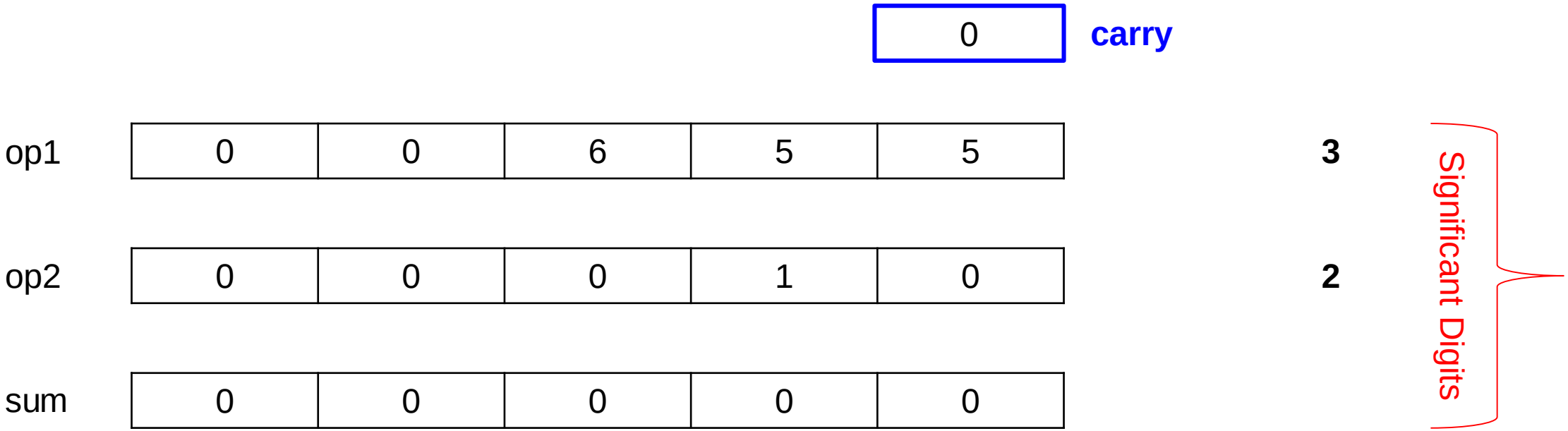

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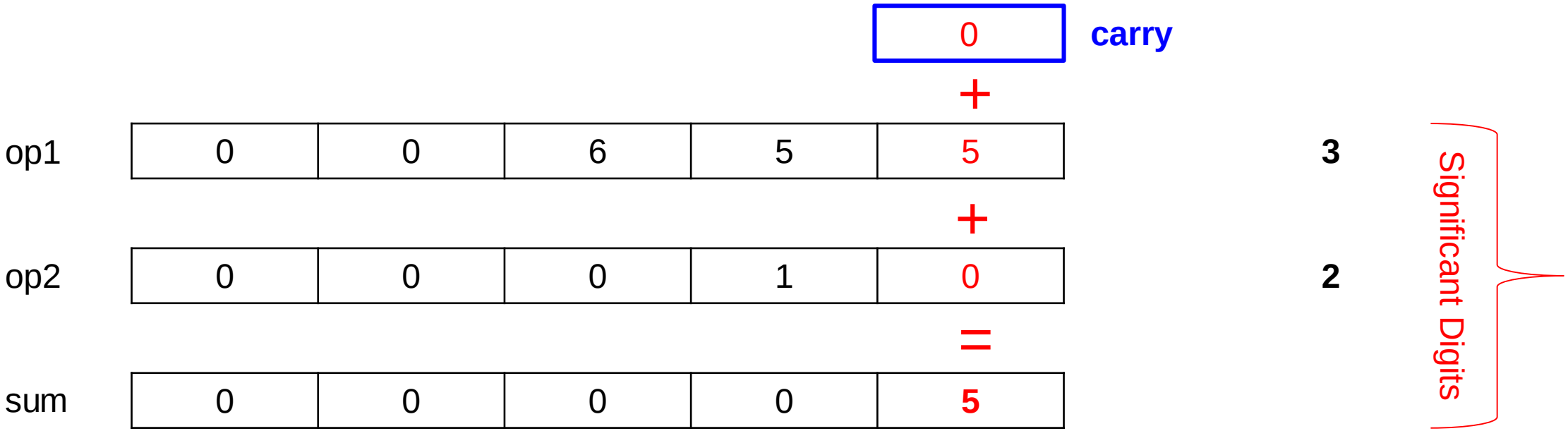

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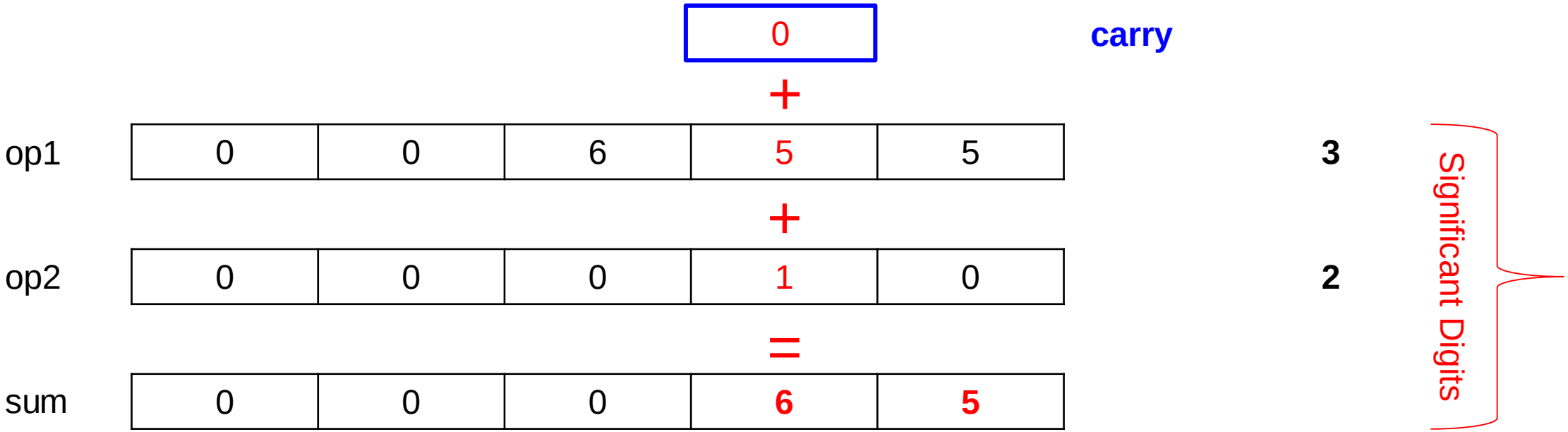

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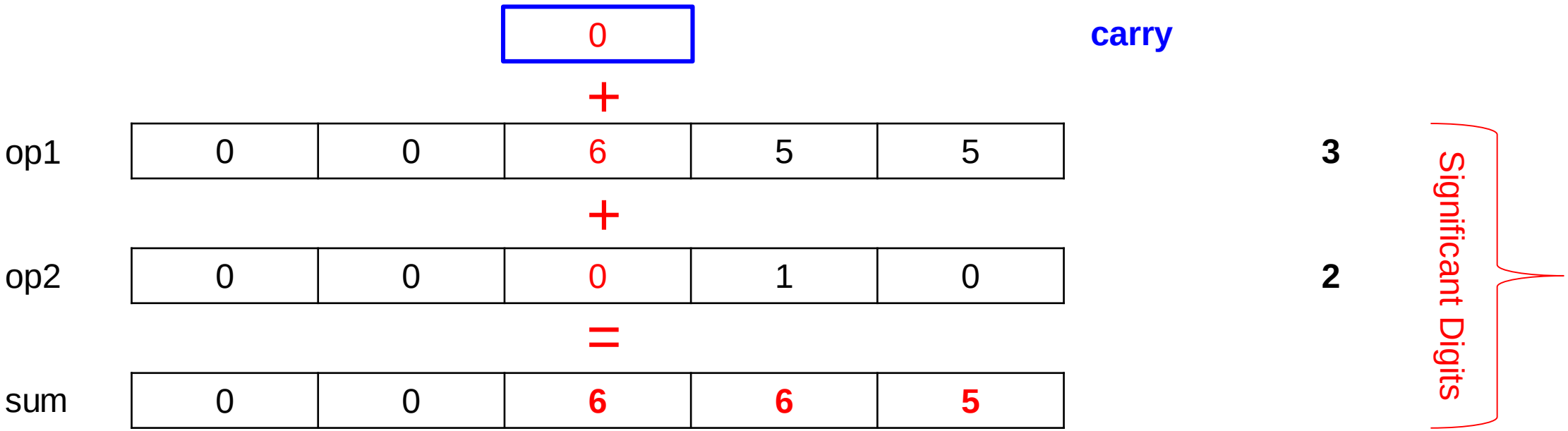

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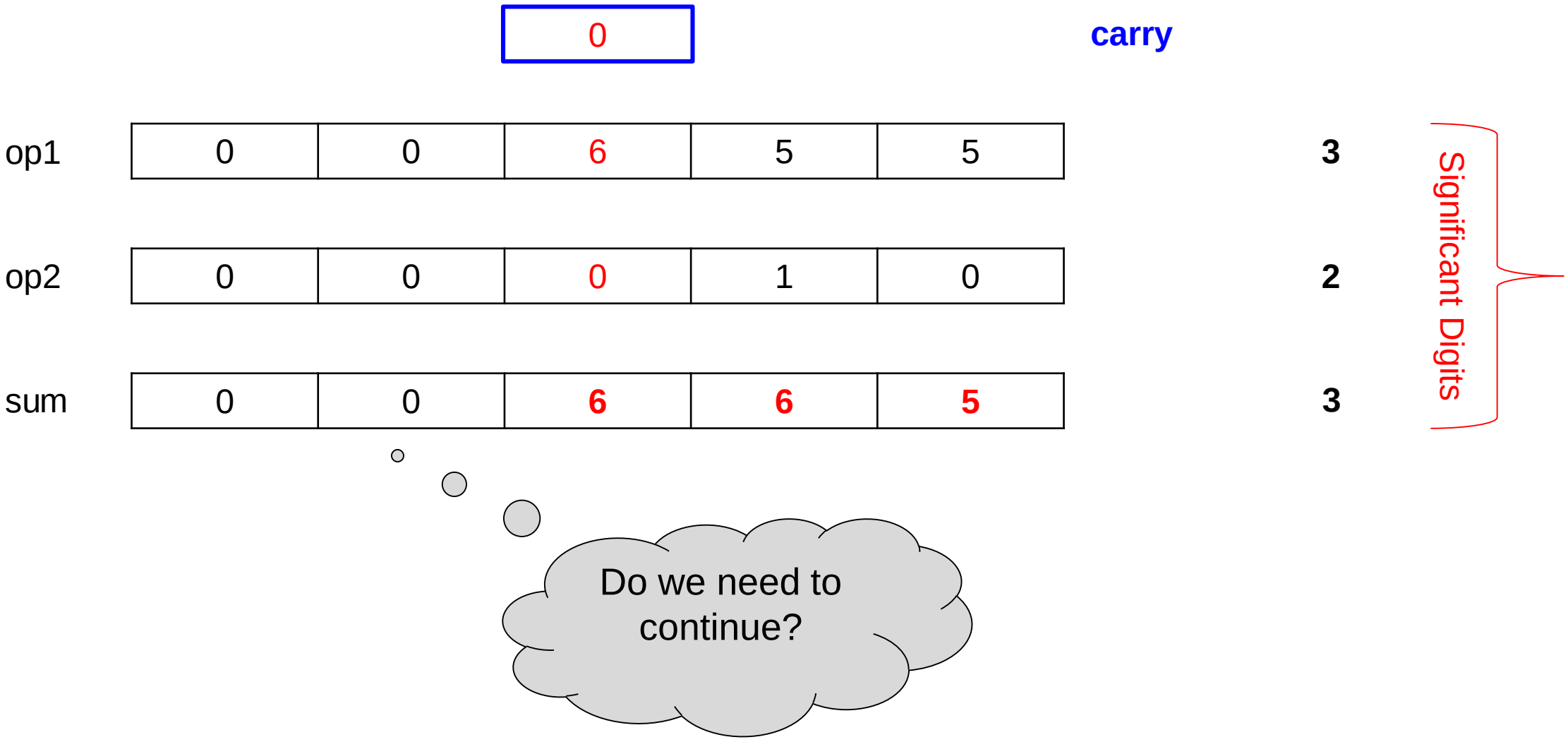

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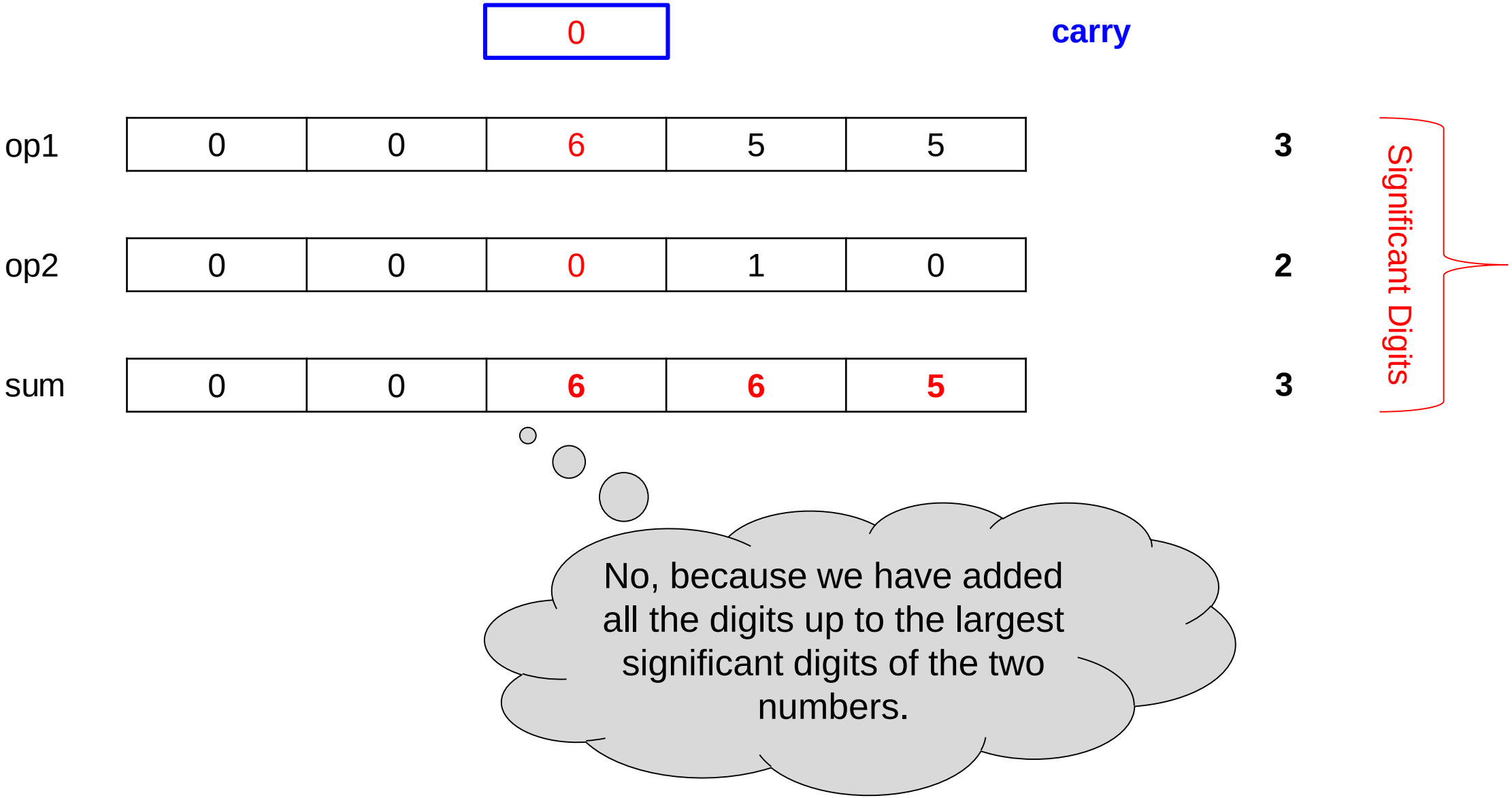
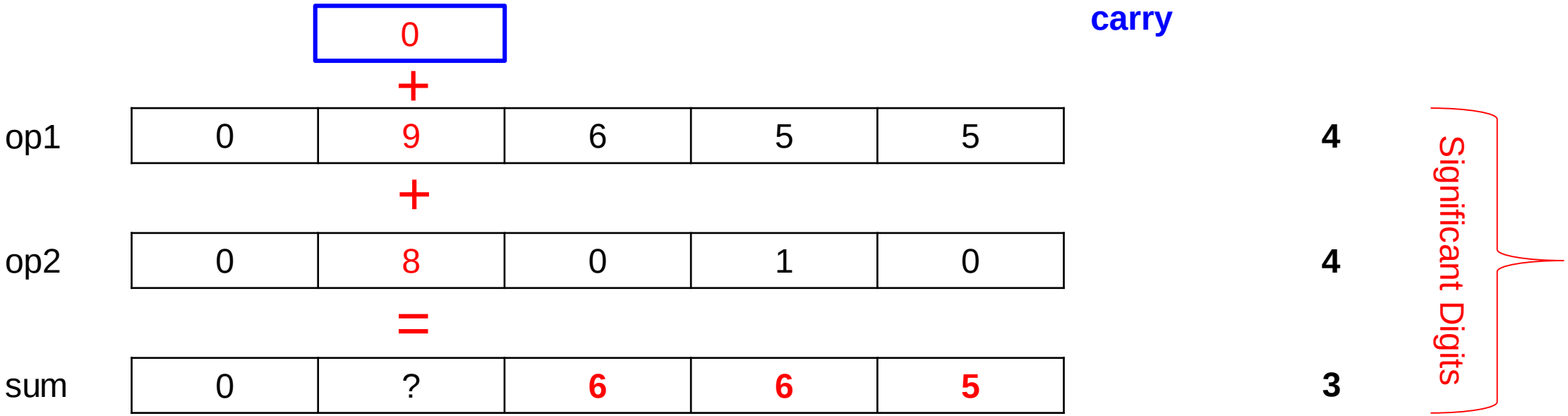


Representing integers with Arrays:
what if?



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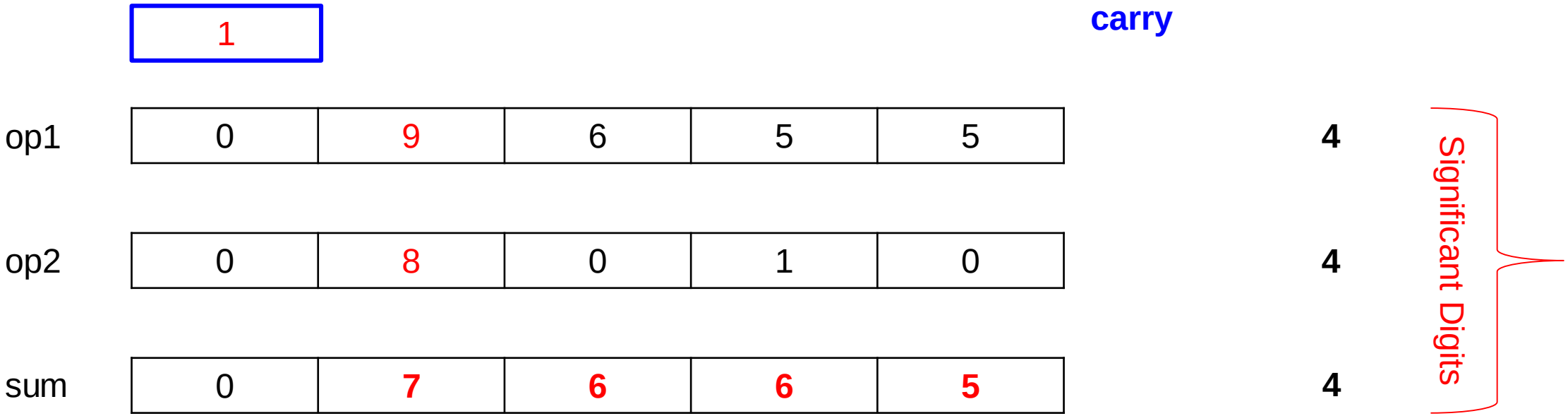

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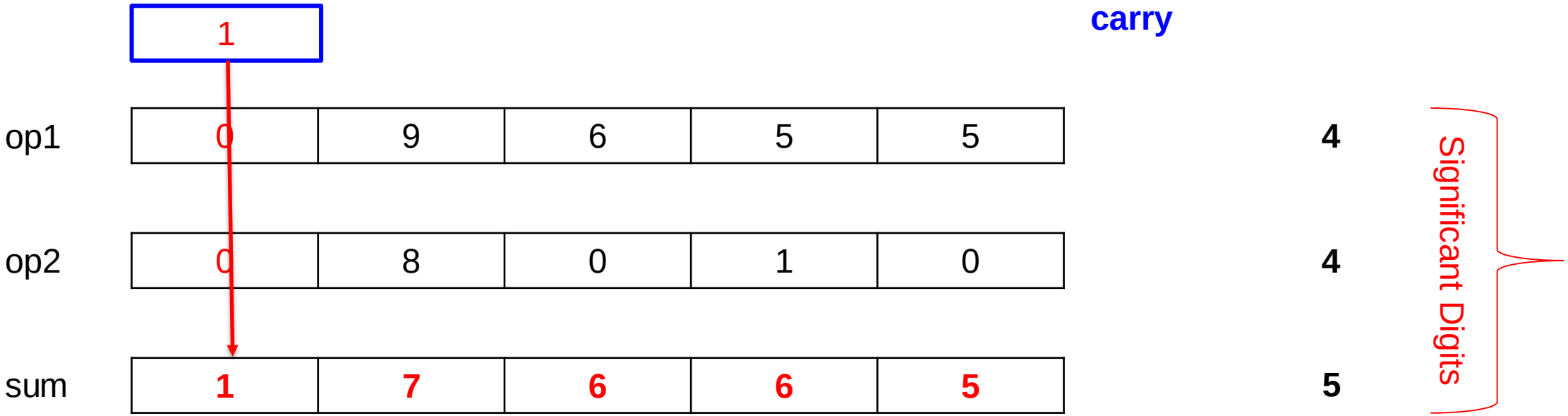
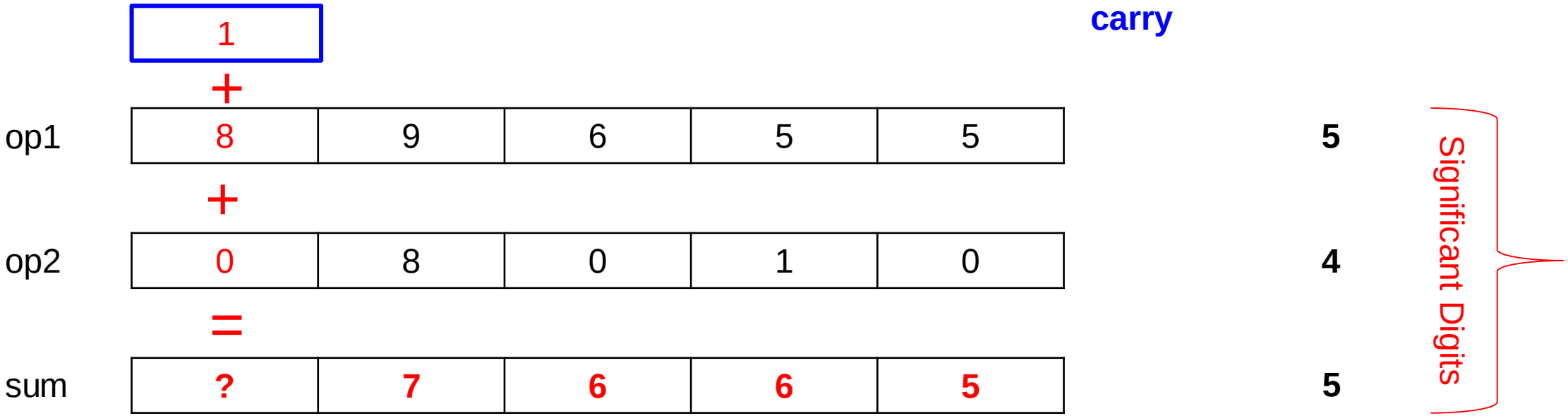
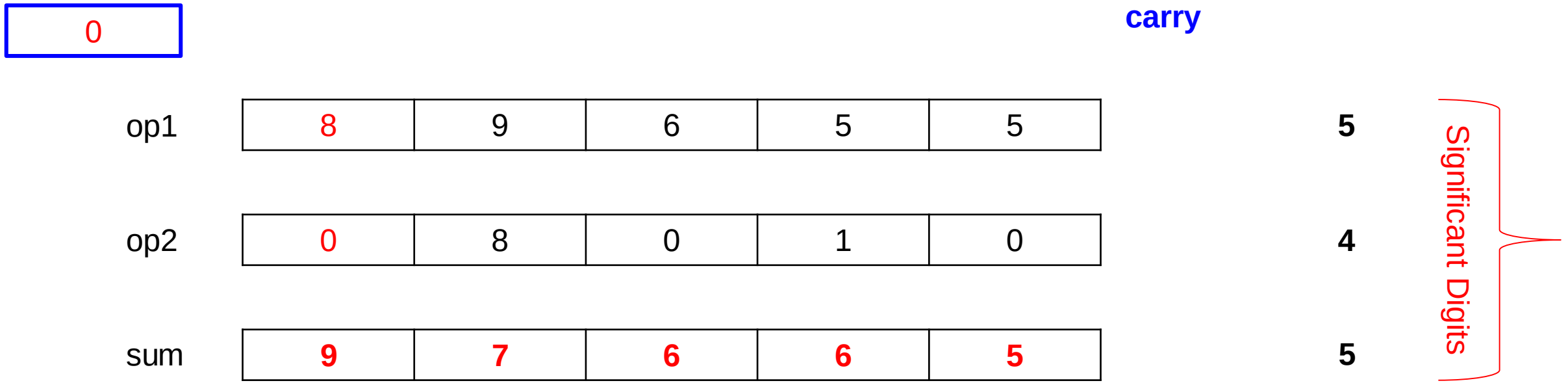


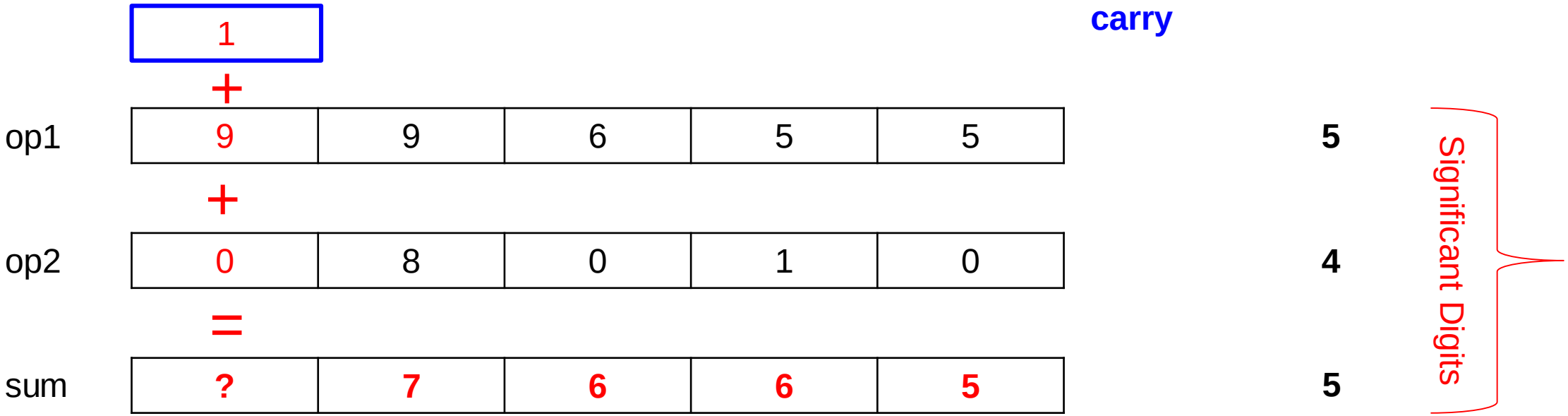
Representing integers with Arrays:
another what if?



Representing integers with Arrays: ***another*** what if?



Representing integers with Arrays: yet ***another*** what if?



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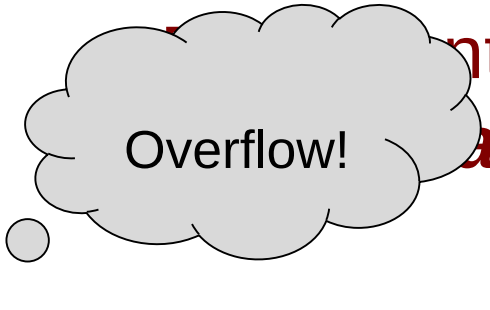
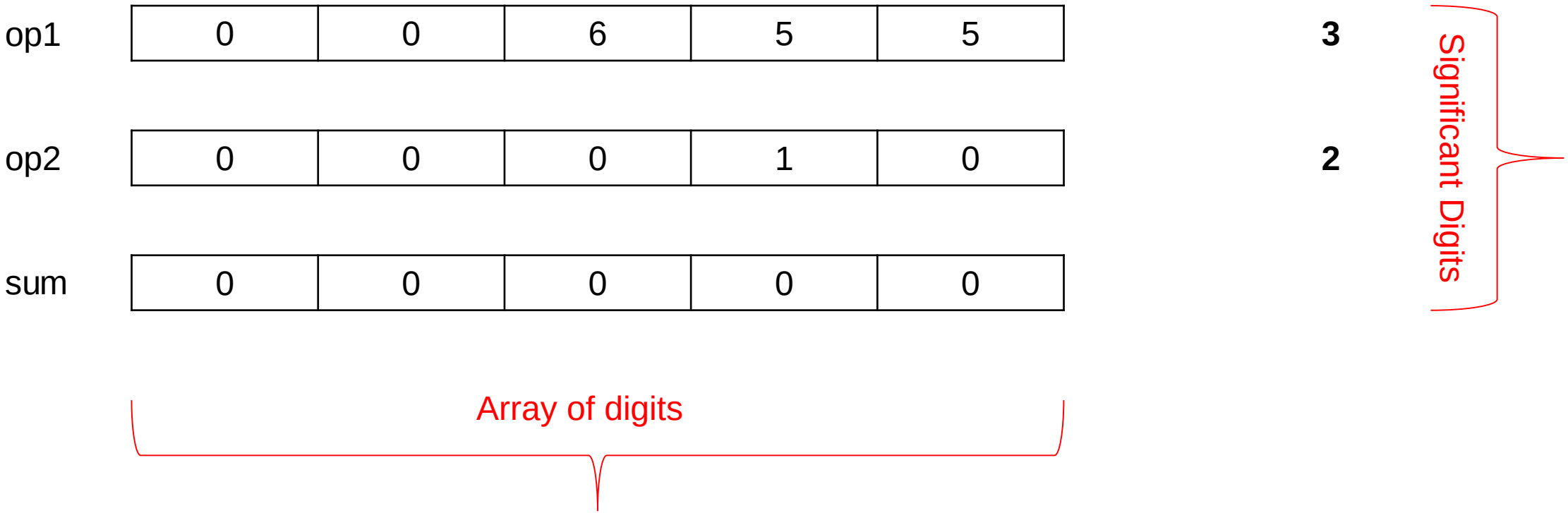
another what if?



	1					carry
op1	9	9	6	5	5	**5**
op2	0	8	0	1	0	**4**
sum	**0**	**7**	**6**	**6**	**5**	**5**

Significant Digits

Representing integers with Arrays



Procedural solution with just Arra

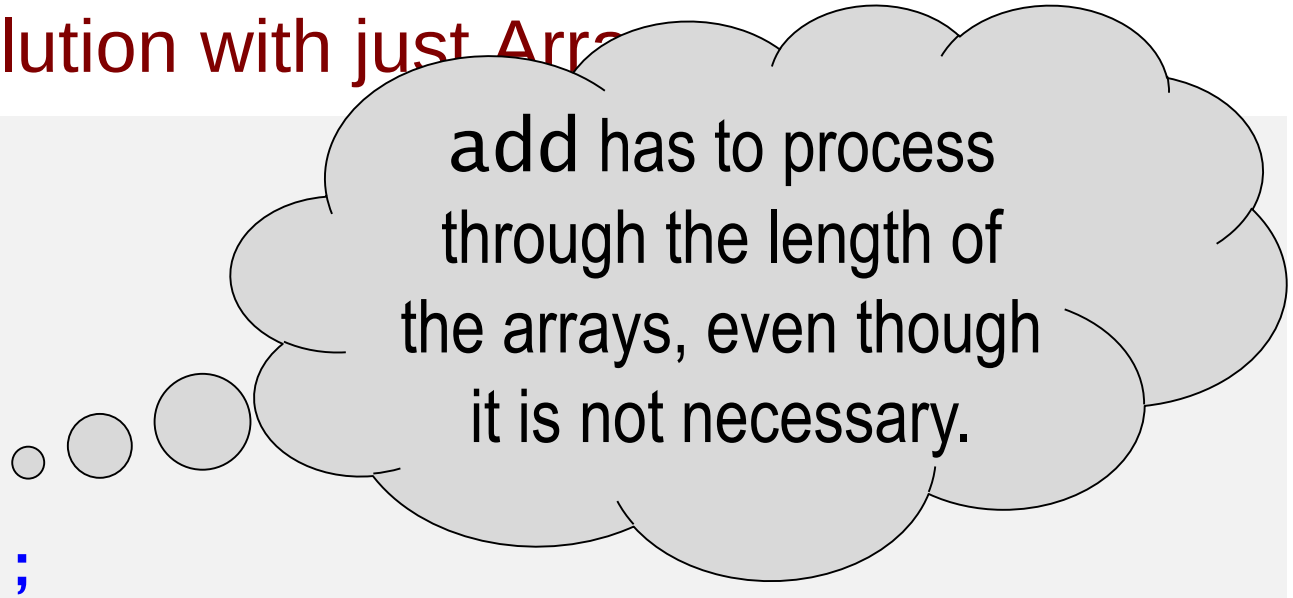
```
{

    int[] op1 = {0,0,3,4,5};

    int[] op2 = {0,0,0,9,8};

    int [] sum = add(op1, op2);

}
```



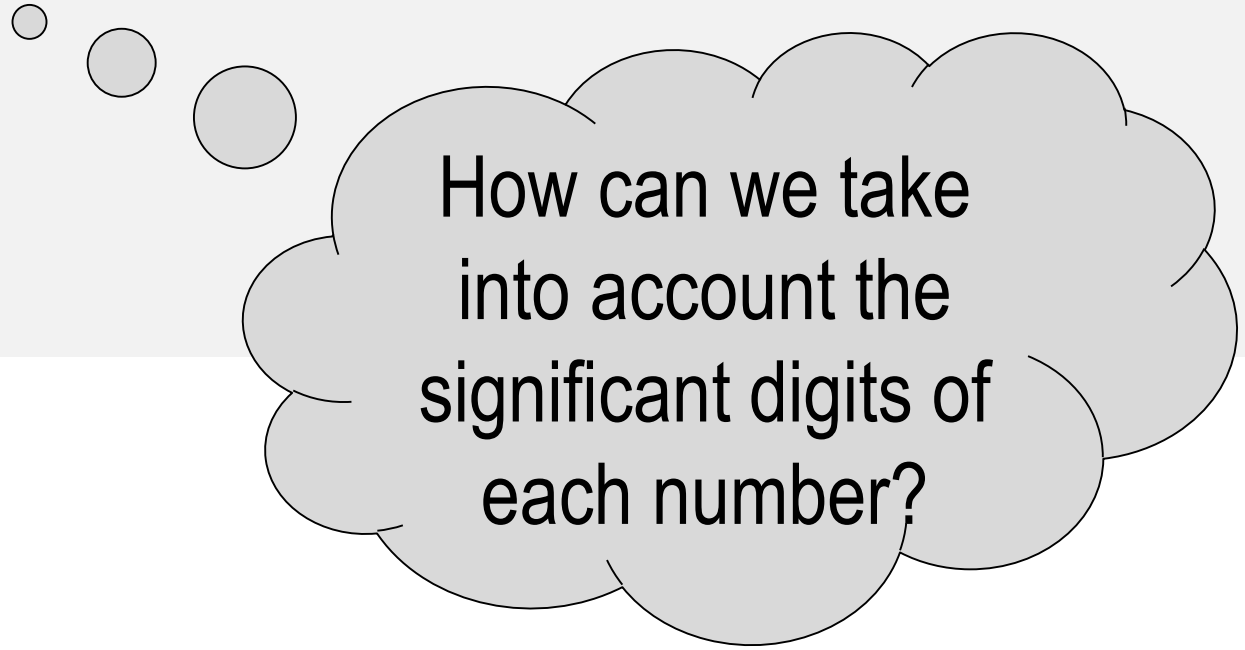
Procedural solution with just Arrays

```
{

    int[] op1 = {0,0,3,4,5}, op2 = {0,0,0,9,8};



}
```



Procedural solution with just Arrays

```
{

   int[] op1 = {0,0,3,4,5}, op2 = {0,0,0,9,8};

   int s_op1 = 3; // significant digits of op1

   int s_op2 = 2; // significant digits of op2

}
```

Procedural solution with just Arrays

```
{

    int[] op1 = {0,0,3,4,5}, op2 = {0,0,0,9,8};

    int s_p1 = 3, s_op2 = 2;

    int[] sum = add(op1, s_p1, op2, s_op2);

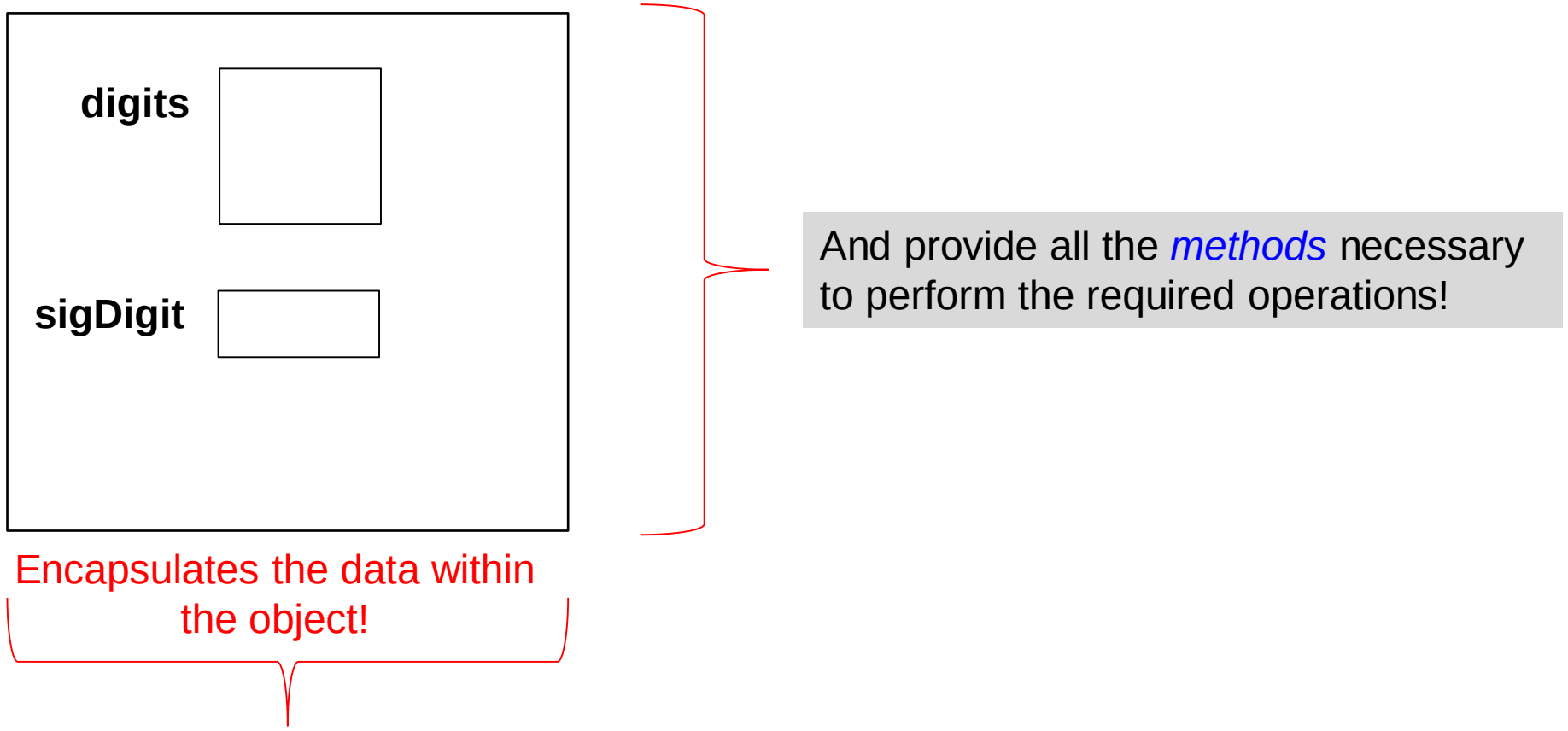
}
```

Procedural solution with just Arrays

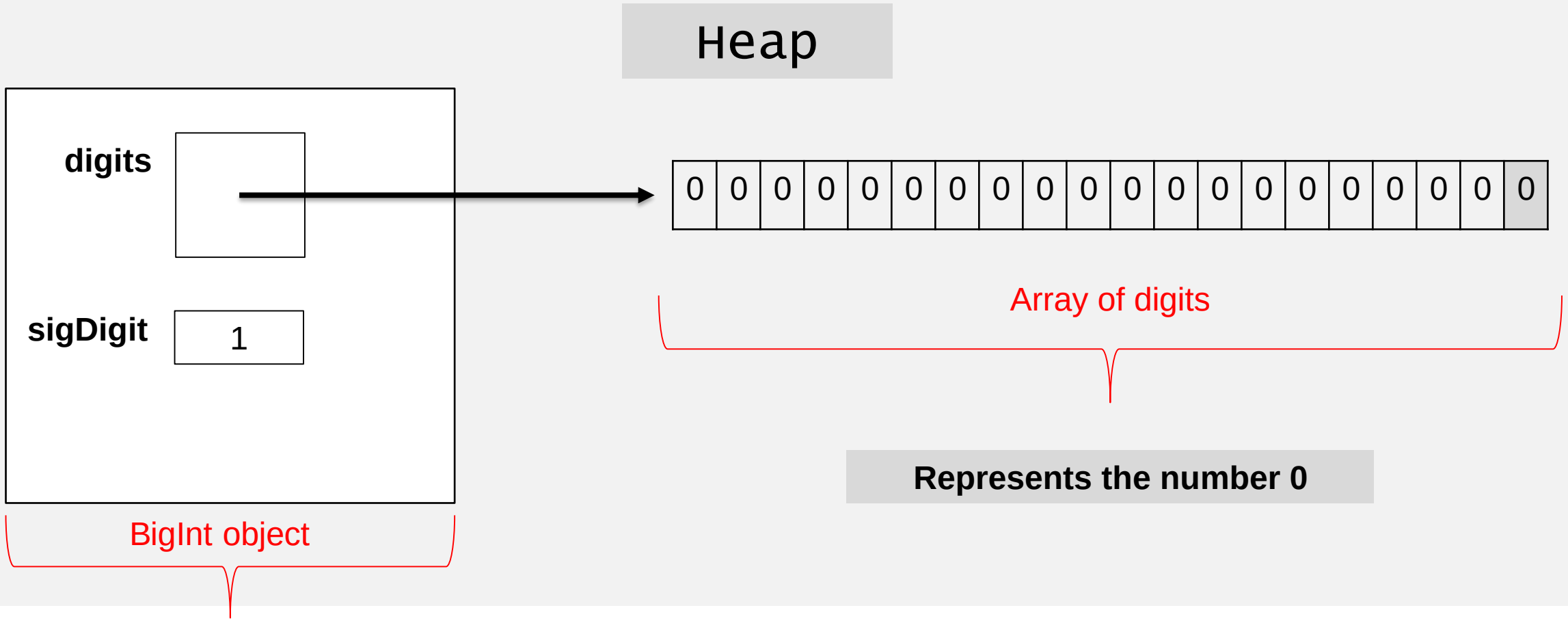
```
{
    int[] op1 = {0,0,3,4,5}, op2 = {0,0,0,9,8};
    int s_p1 = 3, s_op2 = 2;
    int[] sum = add(op1, s_p1, op2, s_op2);
}
```

```
public static int[] add(int[] o1, int s1, int[] o2, int s2) {
    int[] sum = {0,0,0,0,0};
    . . . .
    return sum;
}
```

Object Oriented Design:
Encapsulating the data into a **BigInt** object

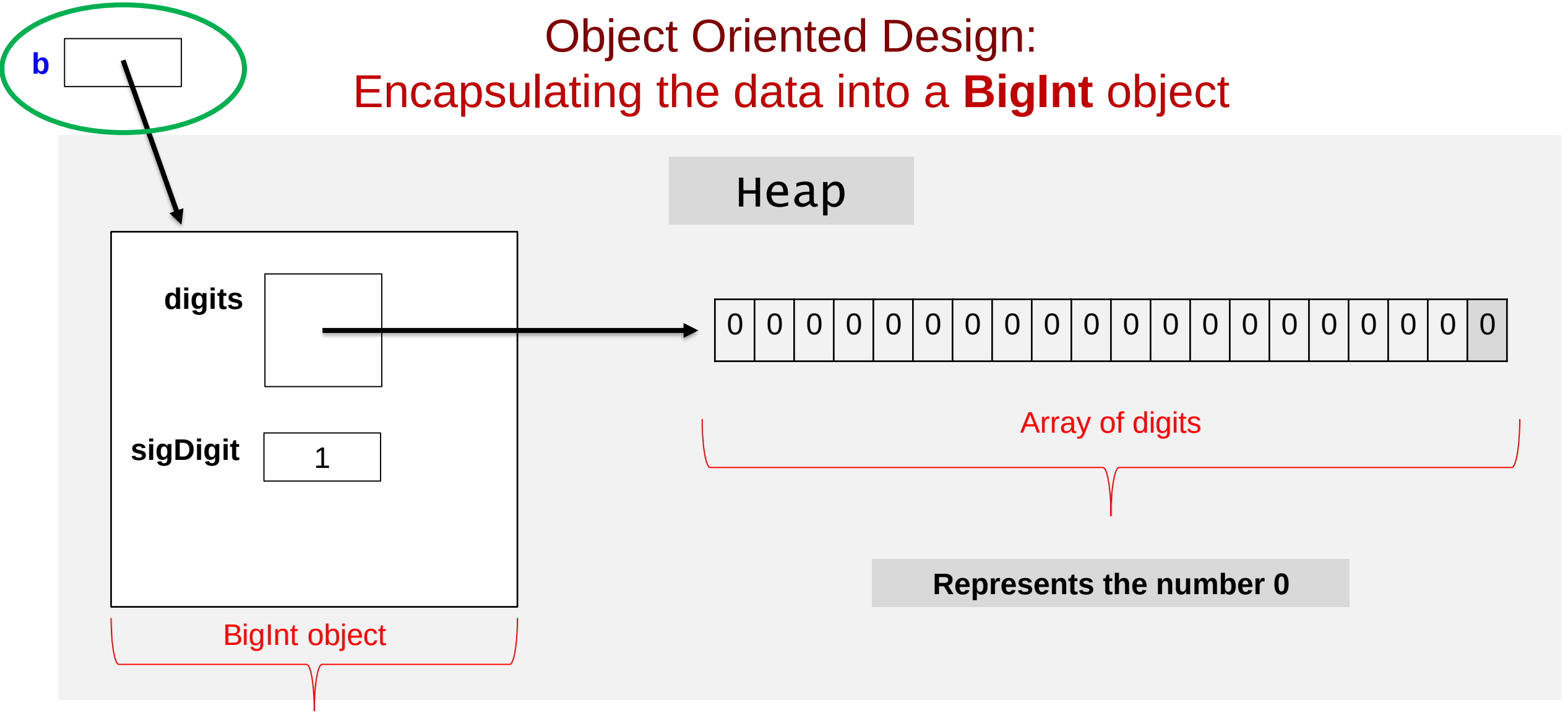


Object Oriented Design:
Encapsulating the data into a **BigInt** object



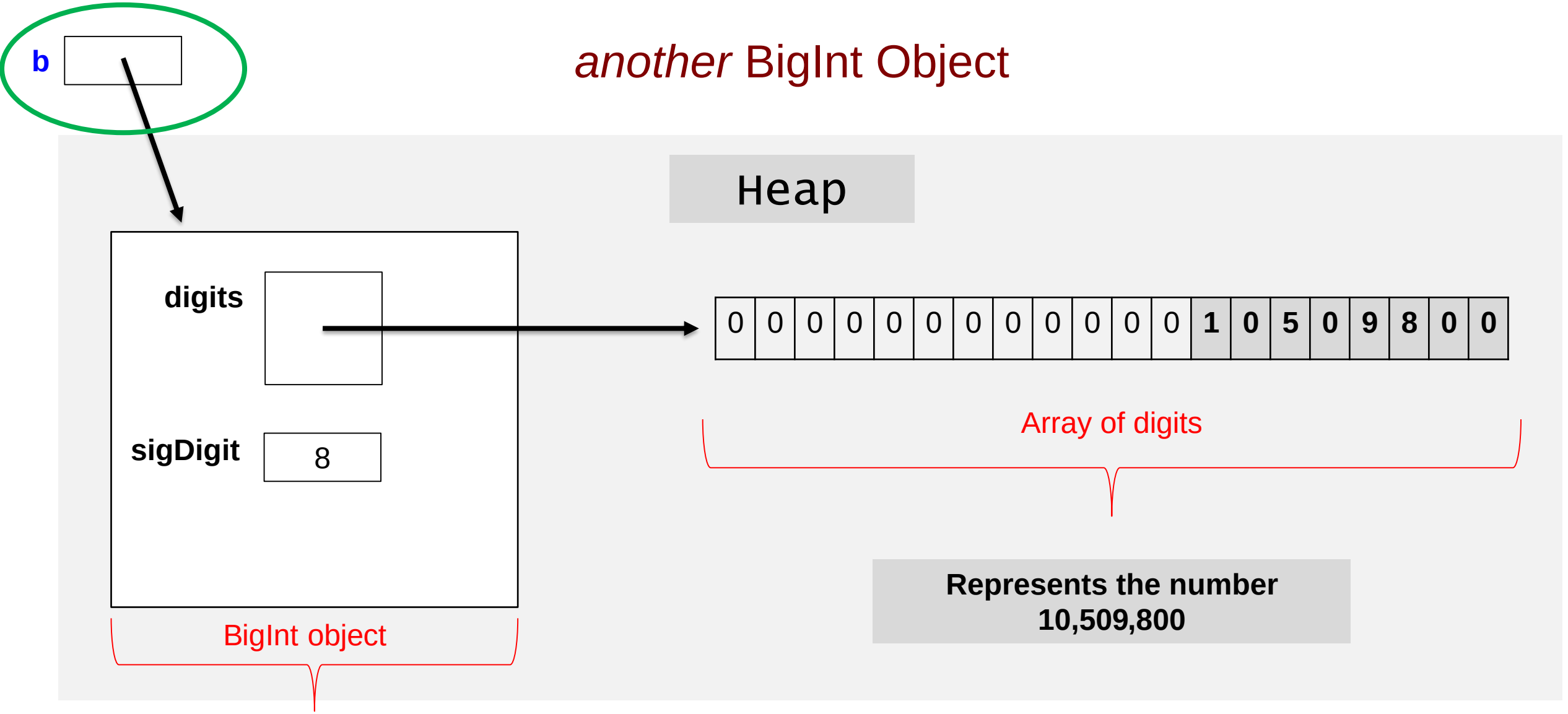

```
BigInt b = new BigInt();  // no-arg constructor
```

Object Oriented Design:
Encapsulating the data into a **BigInt** object




```
BigInt b = new BigInt();  // b references the object
```

another BigInt Object




```
BigInt b = new BigInt(10509800); // custom constructor
```

Programming with Objects:

Mathematical Operations

```
{

    BigInt b = new BigInt();        // should create a BigInt object representing 0

    System.out.println( b );        // output the contents - need toString()









}
```

Programming with Objects:

Mathematical Operations

```
{

    BigInt b = new BigInt();       // should create a BigInt object representing 0

    System.out.println( b.toString() );    // this is the call Java will make…









}
```

Programming with Objects:

Mathematical Operations

```
{
    BigInt b = new BigInt();        // should create a BigInt object representing 0

    System.out.println( b );        // output the contents of the object

    int[] arr = {1,2,3};          // array representing the number 123

    b = new BigInt( arr );        // create a new BigInt object from the array passed

    System.out.println( b );









}
```

Programming with Objects:

Mathematical Operations

```
{
    BigInt b = new BigInt();        // should create a BigInt object representing 0

    System.out.println( b );        // output the contents of the object

    int[] arr = {1,2,3};          // array representing the number 123

    b = new BigInt( 3567 );     // or, create a new BigInt object from the integer passed

    System.out.println( b );









}
```

Programming with Objects:

Mathematical Operations

```
{
    BigInt op1 = new BigInt(13456);     // create a BigInt object representing 13,456

    BigInt op2 = new BigInt( 223 );     // create a BigInt object representing 223

    BigInt sum = op1.add(op2);    // Compute the sum and store in another Bigint object

    System.out.println( op1 + “+” + op2 + “=“ + sum );









}
```

Baby steps…