

Computer Arithmetic

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CSC 210

Faulty Arithmetic

```
public class ArithmeticTest {  
    public static void main(String[] args) {  
  
        double x, y, z;  
  
        x = 9.4;  
        y = x - 9.0;  
        z = y - 0.4;  
  
        System.out.println("x = " + x);  
        System.out.println("y = " + y);  
        System.out.println("z = " + z);  
    }  
}
```

Output:

```
x = 9.4  
y = 0.400000000000000036  
z = 3.3306690738754696E-16
```

Bad Associations

```
public class DoubleTest {
    public static void main(String[] args) {

        double firstProduct;
        double secondProduct;

        firstProduct = (9.4 * 0.2321) * 5.6 ;
        secondProduct = 9.4 * (0.2321 * 5.6);

        System.out.println("(9.4 * 0.2321) * 5.6 = " + firstProduct);
        System.out.println("9.4 * (0.2321 * 5.6) = " + secondProduct);
    }
}
```

Output:

```
(9.4 * 0.2321) * 5.6 = 12.217744
9.4 * (0.2321 * 5.6) = 12.2177440000000001
```

Integer Overflow

```
public class IntegerTest {  
    public static void main(String[] args) {  
  
        int i = 1000000;  
        System.out.println(i * i);  
    }  
}
```

Output:

-727379968

Boeing 787 software trouble

“We are adopting a new airworthiness directive (AD) for all The Boeing Company Model 787 airplanes. This AD requires a repetitive maintenance task for electrical power deactivation on Model 787 airplanes. This AD was prompted by the determination that a Model 787 airplane that has been powered continuously for 248 days can lose all alternating current (AC) electrical power due to the generator control units (GCUs) simultaneously going into failsafe mode. This condition is caused by a software counter internal to the GCUs that will overflow after 248 days of continuous power. We are issuing this AD to prevent loss of all AC electrical power, which could result in loss of control of the airplane.”

www.federalregister.gov

The error happens after 2^{31} centiseconds (248.55134814815 days), indicating a 32 bit signed integer.

Decimal to Binary to Decimal

`http://courses.cs.vt.edu/~csonline/NumberSystems/
Lessons/index.html`
Number Systems

IEEE 754

https://en.wikipedia.org/wiki/IEEE_754-1985
IEEE-754 Standards for Floating Point

<http://babbage.cs.qc.cuny.edu/IEEE-754/>
Decimal to IEEE-754

[http://www.ecs.umass.edu/ece/koren/arith/simulator/FPAdd/floating_point Add/Subtract](http://www.ecs.umass.edu/ece/koren/arith/simulator/FPAdd/floating_point_Add/Subtract)