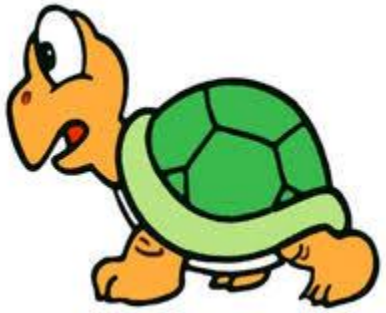
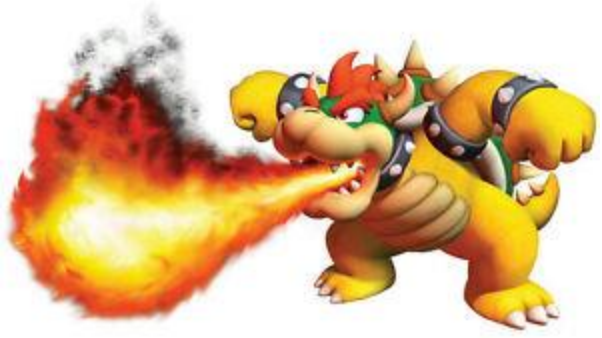
Mario has life 10,000
Mario attacks using

- Fireball (attack point 5,000)
- Iceball (attack point 2,500)

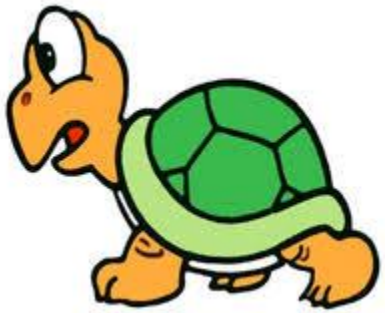
Tortoise has life 8,000
It attacks Mario.



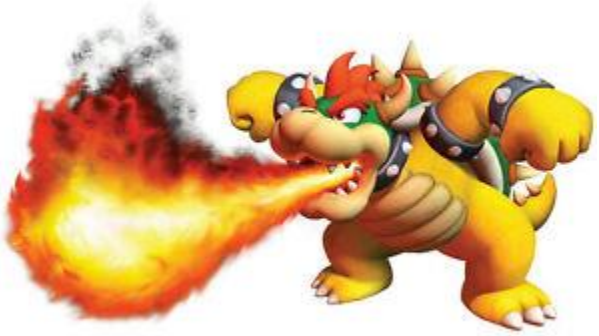
FireDragon has life 25,000
It attacks Mario.
Fireballs strengthen it.



```
...
short int fireballs_in_stock= <some value>;
short int iceballs_in_stock= <some value>;
...
throw_fireball(){
        fireballs_in_stock = fireballs_in_stock - 5000;
}
throw_iceball(){
        iceballs_in_stock = iceballs_in_stock - 2500;
}
```



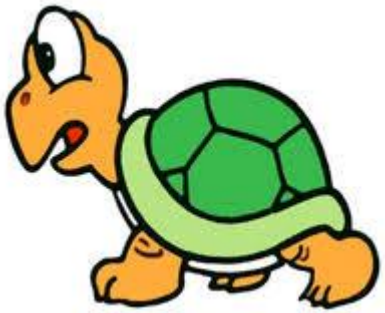
```
short int life_tortoise = 8000;
attack_mario(){
        life_mario = life_mario - 2500;
}
attack_by_mario(){
        if(fireball)
                life_tortoise = life_tortoise - 5000;
        else
                life_tortoise = life_tortoise - 2500;
}
```



```
short int life_firedragon = 25000;
attack_mario(){
        life_mario = life_mario - 5000;
}
attack_by_mario(){
        if(fireball)
                life_firedragon = life_firedragon + 5000;
        else
                life_firedragon = life_firedragon - 2500;
}
```

If Mario attacks Firedragon with fireballs, then life of Firedragon improves

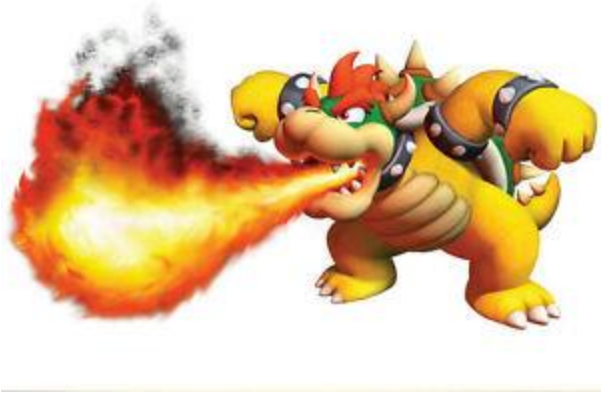
Mario faces Tortoise



Mario must throw 2 fireballs or 4 iceballs before Tortoise reaches Mario

```
short int life_tortoise = 8000;
attack_mario(){
        life_mario = life_mario - 3000;
}
attack_by_mario(){
        if(fireball)
                life_tortoise = life_tortoise - 5000;
        else
                life_tortoise = life_tortoise - 2500;
}
```

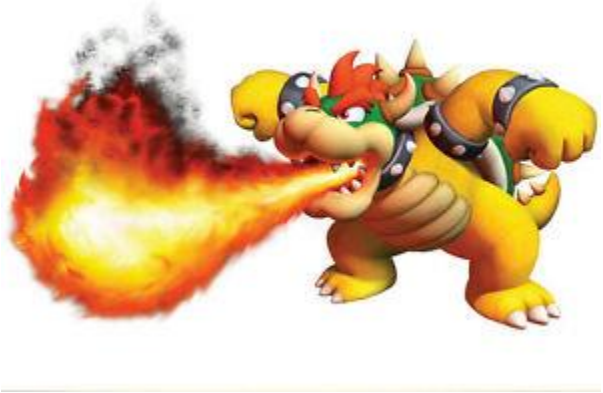
Mario faces Firedragon



Mario must throw 10 iceballs before Firedragon kills Mario.

```
short int life_firedragon = 25000;
attack_mario(){
        life_mario = life_mario - 5000;
}
attack_by_mario(){
        if(fireball)
                life_firedragon = life_firedragon + 5000;
        else
                life_firedragon = life_firedragon - 2500;
}
```

Mario faces Firedragon



Mario must throw 10 iceballs before Firedragon kills Mario.

Can Mario survive till he throws 10 iceballs?
Is there a ‘cheat’?

Signed integer

Let us consider 16-bit signed short integer

```
short int a=3;
```

0000 0000 0000 0011

How it is stored in computer

```
short int a=1;
```

0000 0000 0000 0001

How it is stored in computer

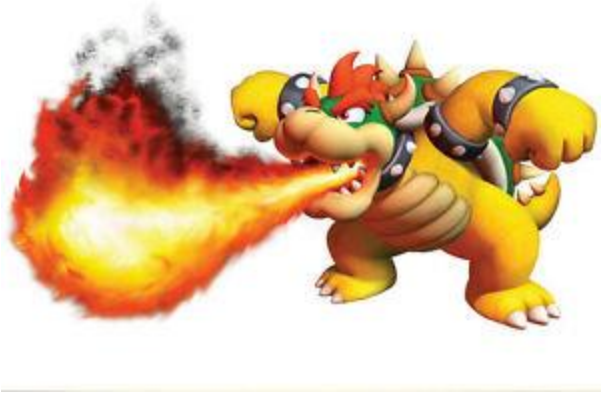
Signed integer

Let us consider 16-bit signed short integer

`short int a=3;`	0000 0000 0000 0011	How it is stored in computer
`short int a=1;`	0000 0000 0000 0001	How it is stored in computer
`short int a=-1;`	1111 1111 1111 1111	How it is stored in computer
`short int a=-3;`	1111 1111 1111 1101	How it is stored in computer

All negative integers have most significant bit = 1

Mario faces Firedragon

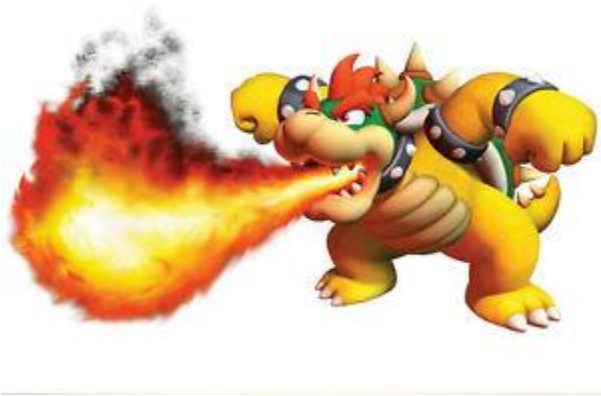


Initially

short int life_firedragon = 25000;

0110000110101000

Mario faces Firedragon



Initially

short int life_firedragon = 25000;

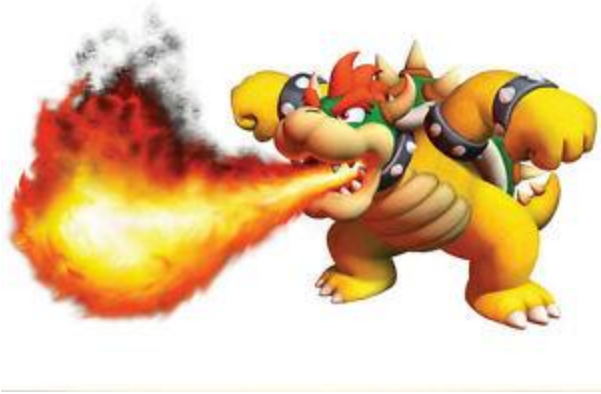
0110000110101000

Mario throws one fireball

short int life_firedragon = 30000;

0111010100110000

Mario faces Firedragon



Initially

```
short int life_firedragon = 25000;
```

0110000110101000

Mario throws one fireball

```
short int life_firedragon = 30000;
```

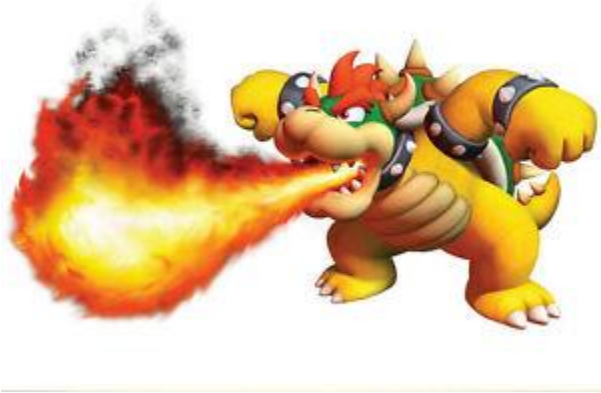
0111010100110000

Mario throws another fireball

```
short int life_firedragon = 35000;
```

1000100010111000

Mario faces Firedragon



Initially

```
short int life_firedragon = 25000;
```

0110000110101000

Mario throws one fireball

```
short int life_firedragon = 30000;
```

0111010100110000

Mario throws another fireball

```
short int life_firedragon = 35000;
```

1000100010111000

Most significant bit has become 1.

Recap: negative numbers have most significant bit 1.

→ Life of FireDragon is negative, it dies ☺