Handling unsigned bytes in Java

In Java there is no unsigned concept, all integer primitive types are signed, including the byte primitive type.

Signed integer numbers are stored in memory in two's complement binary form. It all depends on how many memory bytes/bits are used to store the number. Taking a scenario where numbers are stored in **N** bits, then numbers from zero up to $2^{(N-1)}-1$ are stored directly with no conversion, **bigger positive numbers cannot be stored**. Negative numbers are stored by decrementing from zero, thus -1 value is always $2^{(N)}-1$. The lowest negative number that can be represented is $-2^{(N-1)}$.

For the byte case we have 8 bits, even though unsigned values for a byte range from zero up to 255, in Java it's regarded as signed, thus they range from -128 up to 127. Notice -1 value is stored by decrementing zero so it will be stored as 255, -2 is stored as 254, and so on.

Problems arise when integers are type casted to bytes. This is a narrowing primitive conversion, for integers it works by copying the less significant bits. In this case, the eight less significant bits from the integer are copied to the byte. If the copied value is above 127 we end up with a negative byte value. Narrowing conversions may change the number and the signal.

The problem is not so much what is stored on the byte type but how it's interpreted. The conversion of an integer value from 128 up to 255 to a byte results in what Java views as a negative number.

Converting back the byte to the original unsigned byte value it´s easy. If Java sees it as a positive number (or zero), no conversion is required. If it's negative, the original unsigned value can be obtained by adding 256. The following code demonstrates this:

```
public class BytesDemo {
    public static void main(String[] args) {
        int i, aux;
        byte b;

        for(i=0;i<256;i++) {

            b=(byte)i;          // INTEGER TO BYTE TYPE CAST

            if(b<0) aux=256+b; else aux=b;

            System.out.println("Original INT:" + i + "   Casted to byte:" + b +
                  "   Converted to integer from byte: " + aux);
        }
    }
}
```

Here are parts of the resulting output:

```
Original INT:0   Casted to byte:0   Converted to integer from byte: 0
Original INT:1   Casted to byte:1   Converted to integer from byte: 1
Original INT:2   Casted to byte:2   Converted to integer from byte: 2
Original INT:3   Casted to byte:3   Converted to integer from byte: 3
Original INT:4   Casted to byte:4   Converted to integer from byte: 4
-----------------------------------------------------------------------
Original INT:120   Casted to byte:120   Converted to integer from byte: 120
Original INT:121   Casted to byte:121   Converted to integer from byte: 121
Original INT:122   Casted to byte:122   Converted to integer from byte: 122
Original INT:123   Casted to byte:123   Converted to integer from byte: 123
Original INT:124   Casted to byte:124   Converted to integer from byte: 124
Original INT:125   Casted to byte:125   Converted to integer from byte: 125
Original INT:126   Casted to byte:126   Converted to integer from byte: 126
Original INT:127   Casted to byte:127   Converted to integer from byte: 127
Original INT:128   Casted to byte:-128   Converted to integer from byte: 128
Original INT:129   Casted to byte:-127   Converted to integer from byte: 129
Original INT:130   Casted to byte:-126   Converted to integer from byte: 130
Original INT:131   Casted to byte:-125   Converted to integer from byte: 131
Original INT:132   Casted to byte:-124   Converted to integer from byte: 132
Original INT:133   Casted to byte:-123   Converted to integer from byte: 133
Original INT:134   Casted to byte:-122   Converted to integer from byte: 134
Original INT:135   Casted to byte:-121   Converted to integer from byte: 135
Original INT:136   Casted to byte:-120   Converted to integer from byte: 136
Original INT:137   Casted to byte:-119   Converted to integer from byte: 137
-----------------------------------------------------------------------
Original INT:247   Casted to byte:-9   Converted to integer from byte: 247
Original INT:248   Casted to byte:-8   Converted to integer from byte: 248
Original INT:249   Casted to byte:-7   Converted to integer from byte: 249
Original INT:250   Casted to byte:-6   Converted to integer from byte: 250
Original INT:251   Casted to byte:-5   Converted to integer from byte: 251
Original INT:252   Casted to byte:-4   Converted to integer from byte: 252
Original INT:253   Casted to byte:-3   Converted to integer from byte: 253
Original INT:254   Casted to byte:-2   Converted to integer from byte: 254
Original INT:255   Casted to byte:-1   Converted to integer from byte: 255
```