

**Definition** For  $b$  an integer greater than 1,  $w$  a positive integer,  $w'$  a positive integer, and  $x$  a real number the **base  $b$  fixed-width expansion of  $x$  with integer part width  $w$  and fractional part width  $w'$**  is  $(a_{w-1} \cdots a_1 a_0 . c_1 \cdots c_{w'})_{b,w,w'}$  where  $a_0, a_1, \dots, a_{w-1}, c_1, \dots, c_{w'}$  are nonnegative integers less than  $b$  and

$$x \geq \sum_{i=0}^{w-1} a_i b^i + \sum_{j=1}^{w'} c_j b^{-j} \quad \text{and} \quad x < \sum_{i=0}^{w-1} a_i b^i + \sum_{j=1}^{w'} c_j b^{-j} + b^{-w'}$$

3.75 in fixed-width binary, integer part width 2, fractional part width 8	
0.1 in fixed-width binary, integer part width 2, fractional part width 8	

```
welcome $jshell
| Welcome to JShell -- Version 10.0.1
| For an introduction type: /help intro

[jshell> 0.1
$1 ==>

[jshell> 0.2
$2 ==>

[jshell> 0.1 + 0.2
$3 ==>

[jshell> Math.sqrt(2)
$4 ==>

[jshell> Math.sqrt(2)*Math.sqrt(2)
$5 ==>

[jshell> █
```

\_\_\_\_\_ Note: Java uses floating point, not fixed width representation, but similar rounding errors appear in both.