

Series: Mathematics - from zero to engineer (2)

Order of operations:

$$5 - [8 + 7(4 - 1) - 9/3] = \underbrace{5 - [8 + 7 \cdot 3 - 3]}_1 = \underbrace{5 - [8 + 21 - 3]}_2 = \underbrace{5 - 26}_3 = -21$$

Commutative property

$$5 + 8 = 8 + 5 = 13$$

$$5 \cdot 8 = 8 \cdot 5 = 40$$

addition and multiplication are commutative operations

$$4 - 2 \neq 2 - 4$$

$$4 : 2 \neq 2 : 4$$

subtraction and division are not commutative operations

Associative property

$$3 + (4 + 5) = (3 + 4) + 5 = 3 + 4 + 5 = 12$$

$$3 \cdot (4 \cdot 5) = (3 \cdot 4) \cdot 5 = 3 \cdot 4 \cdot 5 = 60$$

- addition and multiplication are associative operations

$$3 - (4 - 5) \neq (3 - 4) - 5$$

$$\Downarrow \\ 4$$

$$\Downarrow \\ -6$$

$$24 : (4 : 2) \neq (24 : 4) : 2$$

$$\Downarrow \\ 12$$

$$\Downarrow \\ 3$$

- subtraction and division are not associative operations

Distributive property

$$3 \cdot (4 + 5) = 3 \cdot 4 + 3 \cdot 5 = 27$$

$$3 \cdot (4 - 5) = 3 \cdot 4 - 3 \cdot 5 = -3$$

$$(3 + 4) \cdot 5 = 3 \cdot 5 + 4 \cdot 5 = 35$$

$$(3 - 4) \cdot 5 = 3 \cdot 5 - 4 \cdot 5 = -5$$

- multiplication is distributive over addition and subtraction

(both left and right distributive)

$$(60 + 15) : 5 = 60 : 5 + 15 : 5 = 15$$

$$(20 - 10) : 5 = 20 : 5 - 10 : 5 = 2$$

$$60 : (15 + 5) \neq 60 : 15 + 60 : 5$$

$$20 : (10 - 5) \neq 20 : 10 - 20 : 5$$

$$\Downarrow \\ 3$$

$$\Downarrow \\ 16$$

$$\Downarrow \\ 4$$

$$\Downarrow \\ -2$$

- division is only right-distributive over addition and subtraction

## Estimation and rounding

- round the following numbers to the nearest 10, 100 and 1,000

a)  $1846 \rightarrow 1850, 1800, 2000$

b)  $-638 \rightarrow -640, -600, -1000$

c)  $445 \rightarrow 450, 400, 0$

- estimate the results of the following calculations by rounding to the nearest 10

a)  $18 \cdot 21 - 19 : 11 \approx 20 \cdot 20 - 20 : 10 = 400 - 2 = 398$

b)  $99 : 101 - 49 \cdot 8 \approx 100 : 100 - 50 \cdot 10 = 1 - 500 = -499$