

$$\langle S \rangle, \langle S^2 \rangle, \langle g(S) \rangle$$

exemplo: medir  $r$  de esferas  
distribuição  $r \Rightarrow P(r)$

$$\langle x \rangle, \langle x^2 \rangle, \langle g(x) \rangle$$

$$\langle r \rangle \Rightarrow \langle \text{Volume} \rangle$$

$$V = \frac{4}{3} \pi r^3$$

Exemplo: sorteios de faces de 1 dado  $\Rightarrow$  6 face

números sorteados: 1, 5, 2, 6, 1, 3, 2, 3, 3, 5, 2, 2, 5, 2, 6, 4

$$\langle x \rangle = \frac{1}{N} \sum_{i=1}^N x_i$$

$$N=20$$

$$\sum_{i=1}^{20} x_i = 65$$

$$\langle x \rangle = \frac{65}{20} = 3,25$$

$$x_i \quad n_i = \Omega(x_i)$$

$$x_{\min} = 1 \quad 3$$

$$\langle x \rangle = (1 \times 3 + 2 \times 6 + 3 \times 3$$

$$+ 4 \times 2 + 5 \times 3 + 6 \times 3) / 20$$

$$\langle x \rangle = 65/20$$

$$2 \quad 6$$

$$3 \quad 3$$

$$4 \quad 2$$

$$5 \quad 3$$

$$6 \quad 3$$

Valores  
discretos  
de  $x_i$

$$\Rightarrow \langle x \rangle = \sum_i (x_i \times n_i) / N$$

$$x_{\max} = 6$$

$$N = \sum n_i = 20$$

$$N=6$$

$$\langle x \rangle = \sum_i x_i \times \left( \frac{n_i}{N} \right) = \sum_i x_i \times P(x_i)$$

$N = \text{nº eventos}$

respostas =  $N$

$$\langle x \rangle = \frac{1}{N} \sum_{i=1}^N x_i = \sum_i x_i \cdot P(x_i)$$

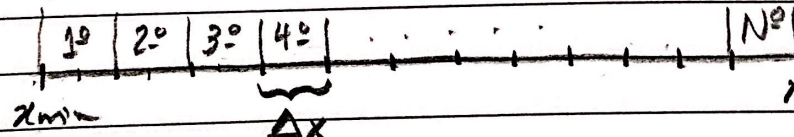
Valores contínuos de  $x$

$$n_i \left( x - \frac{\Delta x}{2}, x + \frac{\Delta x}{2} \right)$$

$x_{\min}, x_{\max}$

respostas em  
intervalos  $\Rightarrow N$

$$\Delta x = \frac{x_{\max} - x_{\min}}{N}$$



$x_{\max}$  gráfico da distribuição = histograma

$$P(x) = \frac{n_i}{N}$$

conjunto de valores de  $N$  eventos  $\{x_i\}_N$

$$\langle x \rangle = \frac{1}{N} \sum_{i=1}^N x_i = \sum_{i=1}^N x_i \times P(x_i)$$

$N = \text{n}^\circ \text{ de intervalos dos valores}$

$$\langle x^2 \rangle = \frac{1}{N} \sum_{i=1}^N x_i^2 = \sum_{i=1}^N x_i^2 \times \frac{n_i}{N}$$

$$\langle x^2 \rangle = \frac{1}{N} \sum_{i=1}^N x_i^2 = \sum_{i=1}^N x_i^2 \times P(x_i)$$

$$\langle g(x) \rangle = \frac{1}{N} \sum_{i=1}^N g(x_i) = \sum_{i=1}^N g(x_i) P(x_i)$$

| $x_i$ | $n_i$ | $x_i^2$ | $g(x_i)$ |
|-------|-------|---------|----------|
| 1     | 3     | 1       | —        |
| 2     | 6     | 4       | —        |
| 3     | 3     | 9       | —        |
| 4     | 2     | 16      | —        |
| 5     | 3     | 25      | —        |
| 6     | 3     | 36      | —        |