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Course 565/665 Lecturer Prof. Covagnero

Day 2.2.04 Date 9:55 am

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$\langle x^m \rangle = \int_a^b x^m p(x)\, dx$ for continuous distribution

$\langle i^m \rangle = \sum_{i=1}^{t} i^m P(i)$ discrete

In case of un-nomalized "probability" ψ. $\langle x^m \rangle = \frac{\int_a^b x^m \psi(x) dx}{\int_a^b \psi(x)\, dx}$

0th moment. $\langle x^m \rangle = \langle x^0 \rangle = 1$

$\langle i^m \rangle = \langle i^0 \rangle = 1$

1st moment: $\langle x^1 \rangle = \boxed{\langle x \rangle = \int_a^b x\, p(x)\, dx}$

↳ average, or expectation value.

$\langle i^1 \rangle = \boxed{\langle i \rangle = \sum_{i=1}^{t} i\, P(i)}$ ← weighted average

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2nd moment: $\langle x^2 \rangle = \int_a^b x^2 P(x)\, dx$; $\langle i^2 \rangle = \sum_{i=1}^{t} i^2 P(i)$
and so on ......

Note: can write expressions above: $i \rightarrow f(i)$; $x \rightarrow f(x)$.

Variance.

σ^2: it gives us a sense for the width of a distribution

standard deviation σ (square root of variance)

$\sigma^2 = \langle (x - \langle x \rangle)^2 \rangle$ $\qquad \langle x \rangle \equiv a$.

$= \langle (x-a)^2 \rangle = \langle x^2 - 2ax + a^2 \rangle$

aside: Properties of averages.

① $\langle a f(x) \rangle = a \langle f(x) \rangle$ (a: constant)

② $\langle f(x) + g(x) \rangle = \langle f(x) \rangle + \langle g(x) \rangle$

So, $\sigma^2 = \langle x^2 \rangle - 2a\langle x \rangle + \langle a^2 \rangle$

$= \langle x^2 \rangle - 2a^2 + a^2 = \boxed{\langle x^2 \rangle - \langle x \rangle^2 = \sigma^2}$

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(ex). Ave # of heads in 4 coin flips. (H/T).

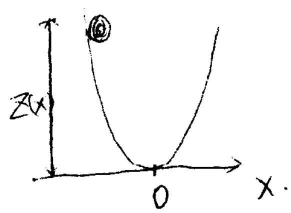
$$\langle m_H \rangle = \sum_{m_H=0}^{4} m_H P_{m_H, N} = 0 \cdot \frac{1}{16} + 1 \cdot \frac{4}{16} + 2 \cdot \frac{6}{16} + 3 \cdot \frac{4}{16} + 4 \cdot \frac{1}{16}$$
$$= 2$$

$$\langle m_H^2 \rangle = \sum_{m_H=0}^{4} m_H^2 P_{m_H, N} = 0 \cdot \frac{1}{16} + 1^2 \cdot \frac{4}{16} + 2^2 \cdot \frac{6}{16} + 3^2 \frac{4}{16} + 4^2 \frac{1}{16}$$
$$= 5$$

$$\sigma^2 = \langle m_H^2 \rangle - \langle m_H \rangle^2 = 5 - 2^2 = 1$$

ch2 : what drives equilibrium ?

(ex)



potential energy

$V(z) = mg\,z(x)$

$z(x) = x^2$

$$V(x) = mgx^2$$

$$\frac{d\,V(x)}{dx} = 0$$