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ex. Ligand binding. polymer conformational analysis.

often find...

$$Q(x) = 1 + x + x^2 + x^3 + \cdots + x^n = \sum_{i=0}^{n} x^i$$

average value of i: $\langle i \rangle = \dfrac{\sum_{i=0}^{n} i\, Q(x)}{\sum_{i=0}^{n} Q(x)}$

$$= \frac{x + 2x^2 + 3x^3 + \cdots + nx^n}{1 + x + x^2 + x^3 + \cdots + x^n}$$

for $n \to \infty$. $\langle i \rangle = \dfrac{t_\infty}{S_\infty} = \dfrac{\frac{ax}{(1-x)^2}}{\frac{a}{1-x}} = \dfrac{x}{1-x}$

ex. Polymerization: without control: chains of many different length.

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k subunits (monomers)

for a monomer ⟨ reactive / unreactive $P_{reactive} = p$ / $1-p$

Average length of the polymer in solution? $\langle k \rangle$

$$P_{\substack{polymer \\ k\,mer}} = p^{k-1}(1-p)$$

$\sum_{k=0}^{N} P_k \neq 1$? not normalized

$$P(k) = \frac{p^{k-1}(1-p)}{\sum_{k=1}^{\infty} p^{k-1}(1-p)}$$

$$\langle k \rangle = \sum_{k=1}^{\infty} k P(k) = \frac{\sum_{k=1}^{\infty} k p^{k-1}(1-p)}{\sum_{k=1}^{\infty} p^{k-1}(1-p)} \cdot \frac{p}{p}$$

$$= \frac{\frac{1}{p} \sum_{k=1}^{\infty} k p^{k}}{\sum_{k=1}^{\infty} p^{k-1}} = \frac{1}{p} \frac{t_\infty}{S_\infty} = \frac{1}{p} \frac{ap}{(1-p)^2} \cdot \frac{1-p}{a}$$

$$= \frac{1}{1-p}$$

Stirling's approximation

$$\ln n! \cong n \ln n - n$$

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Taylor Series

give $f(x)$. $\Rightarrow$ want to expand it ~~as~~ a series. about $x=a$

$$f(x) = f(a) + f'(a)(x-a) + \frac{f''(a)}{2!}(x-a)^2, \dots$$

$$f(x) = \sum_{n=0}^{\infty} \frac{1}{n!} \frac{d^n}{dx^n} f(x)\Big|_{x=a} (x-a)^n$$

ex. $f(x) = e^{-bx}$ expand at $x=0$.

$$f(0) = e^{-b\cdot 0} = 1$$

$$-be^{-bx}\Big|_{x=0} \cdot x = -bx$$

$$\frac{x^2}{2} \cdot \left[(-b)(-b)e^{-bx}\right|_{x=0} = \frac{b^2}{2}x^2$$

$$f(x) = e^{-bx} \approx 1 - bx + \frac{b^2x^2}{2}$$