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Course 565/665 Lecturer Prof. Cavagnero

Day 2.20.04 Date 9:55 am

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let $g = \sum_{i=1}^{t} p_i - 1 = 0$

$$\frac{\partial S/k}{\partial p_i} - \alpha\left(\frac{\partial g}{\partial p_i}\right)_{j \neq i} = 0 \quad \text{for } i = 1, 2 \cdots t.$$

or
$$\sum_{i=1}^{t}\left[\left(\frac{\partial S/k}{\partial p_i}\right)_{j\neq i} - \alpha\left(\frac{\partial g}{\partial p_i}\right)_{j\neq i}\right] = 0 \quad \cdots \quad (1)$$

$$\left(\frac{\partial S/k}{\partial p_i}\right)_{j\neq i} = -(\ln p_i + 1) \; ; \; \left(\frac{\partial g}{\partial p_i}\right)_{j\neq i} = 1$$

So for each independent term in eqn. (1):

$$-(\ln p_i + 1) - \alpha = 0$$

$$\ln p_i = -(1+\alpha) \qquad p_i^* = e^{-(1+\alpha)} \quad \text{for each } i$$

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p_i^*: p_i that maximize $\frac{S}{k}$.
p_i^* is the same for all i. $\Rightarrow$ flat distribution

(B). If S_{max} + experimental knowledge is available
then distribution ? ($\downarrow \langle \varepsilon_i \rangle$)

(ex) die toss.

Total score: $E = \sum_{i=1}^{t} \varepsilon_i n_i$, $p_i = \frac{n_i}{N}$

$$\langle \varepsilon_i \rangle = \frac{E}{N} = \sum_{i=1}^{t} p_i \varepsilon_i$$

All constraints:

$\rightarrow g$ ① $\sum_{i=1}^{t} p_i = 1$; $\sum_{i=1}^{t} dp_i = 0$

$\rightarrow h$ ② $\langle \varepsilon_i \rangle = \sum_{i=1}^{t} p_i \varepsilon_i$; $\sum_{i=1}^{t} dp_i \varepsilon_i = 0$

$$\left(\frac{\partial S/k}{\partial p_i}\right) - \alpha\left(\frac{\partial g_i}{\partial p_i}\right) - \beta\left(\frac{\partial h}{\partial p_i}\right) = 0 \quad \text{for all } i$$

$$\frac{\partial (S/k)}{\partial p_i} = -1 - \ln p_i \; ; \quad \frac{\partial g}{\partial p_i} = 1 \; ; \quad \frac{\partial h}{\partial p_i} = \varepsilon_i .$$

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so $-1 - \ln P_i - \alpha - \beta \varepsilon_i = 0$

$$\ln P_i = -1 - \alpha - \beta \varepsilon_i$$

$$P_i^* = e^{-(1+\alpha)} e^{-\beta \varepsilon_i}$$

normalize: $$P_i^* = \frac{P_i^*}{\sum P_i^*} = \frac{e^{-(1+\alpha)} e^{-\beta \varepsilon_i}}{\sum \left(e^{-(1+\alpha)} e^{-\beta \varepsilon_i}\right)}$$

$$\therefore \boxed{P_i^* = \frac{e^{-\beta \varepsilon_i}}{\sum_{i=1}^{t} e^{-\beta \varepsilon_i}}}$$ Boltzmann distribution

$$q = \sum_{i=1}^{t} e^{-\beta \varepsilon_i}$$ partition function