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ภาคผนวก

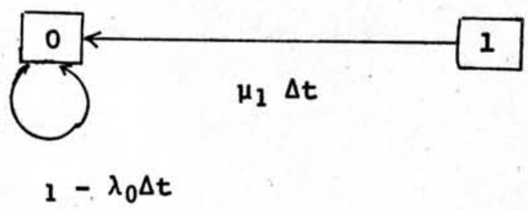
ภาคผนวก

พิสูจน์สมการ 3.18 และ 3.19

เขียน detailed balance เมื่อระบบเข้าสู่ steady-state โดยให้

n แทน state ของระบบ (n = 0, 1,....n,.....M)

เมื่อระบบอยู่ใน state 0



$$P_o\,(t+\Delta_t) = P_o(t)\,(1-\lambda_0\Delta t) + P_1(t)\,\mu_1\Delta t$$

$$\frac{P_0(t+\Delta t)-P_0(t)}{\Delta t} = \mu_1 P_1(t) - \lambda_0\, P_o(t)$$

เมื่อ $\Delta t \longrightarrow 0$ จะได้

$$\frac{d}{dt}\,P_0(t) = \mu_1 P_1(t) - \lambda_0\, P_o(t)$$

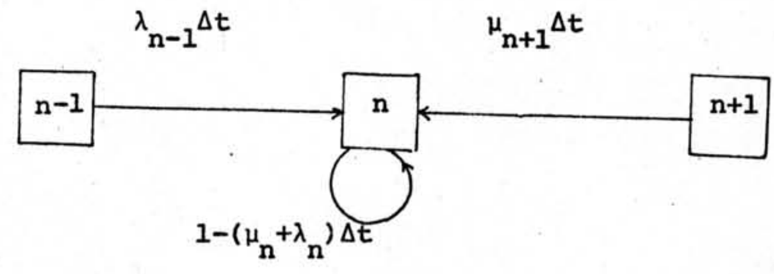
เมื่อระบบเข้าสู่ steady state $\frac{d}{dt}\,P_o(t) = 0$

$$\therefore\ \mu_1 P_1(t) - \lambda_0\, P_o(t) = 0 \longrightarrow 1$$

และโอกาสที่จะมีงานในระบบ = n ไม่ขึ้นกับเวลา t เมื่อระบบเข้าสู่ steady state ดังนั้น ถ้าเราแทนค่า $P_n(t)$ ด้วย $\pi(n)$ จะได้

$$\lambda_0\pi_0 - \mu_1\pi_1 = 0 \longrightarrow 2$$

<u>เมื่อระบบอยู่ใน state n</u>



$$P_n(t+\Delta t) = P_{n-1}(t)(\lambda_{n-1}\Delta t) + P_n(t)\left[1-(\lambda_n+\mu_n)\Delta t\right]$$

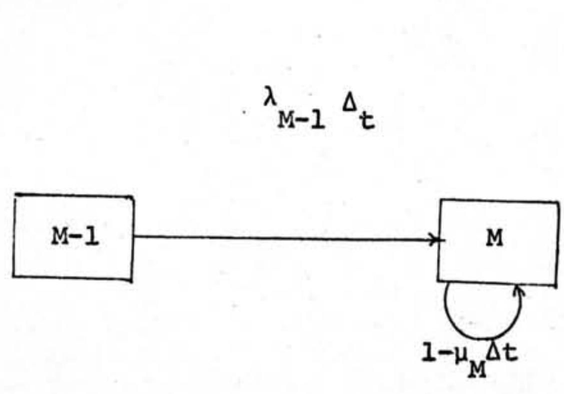
$$+P_{n+1}(\mu_{n+1}\Delta t)$$

$$\frac{P_n(t+\Delta t)-P_n(t)}{\Delta t} = P_{n-1}(t)\lambda_{n-1} - P_n(t)(\lambda_n+\mu_n) + P_{n+1}(t)\mu_{n+1}$$

$$\frac{d}{dt}P_n(t) = 0 = P_{n-1}(t)\lambda_{n-1} - P_n(t)(\lambda_n+\mu_n) + P_{n+1}(t)\mu_{n+1}$$

$$\pi_{n+1}\cdot\mu_{n+1} + \pi_{n-1} - \pi_n(\mu_n+\lambda_n) + \pi_{n-1}\lambda_{n-1} = 0 \longrightarrow 3$$

<u>เมื่อระบบอยู่ใน state M</u>



$$P_M(t+\Delta t) = P_{M-1}(t)\lambda_{M-1}\Delta t + P_M(t)\left[1-\mu_M\Delta t\right]$$

$$\frac{P_M(t+\Delta t)-P_M(t)}{\Delta t} = P_{M-1}(t)\lambda_{M-1} - P_M(t)\mu_m$$

$$\frac{d}{dt} P_M(t) = 0 = P_{M-1}(t)\lambda_{M-1} - P_M(t)\mu_M$$

$$\pi_{M-1}\lambda_{M-1} - \pi_M\mu_M = 0 \longrightarrow 4$$

จาก (2) $\pi_1 = \dfrac{\pi_0\lambda_0}{\mu_1}$ $\longrightarrow$ 5

จาก (3) แทนค่า $n = 1$ จได้

$$\pi_2\mu_2 + \pi_0\lambda_0 - (\mu_1 + \lambda_1)\pi_1 = 0 \longrightarrow 6$$

แทนค่า 5 ใน 6 จะได้

$$\pi_2 \quad \frac{\lambda_0\lambda_1\pi_0}{\mu_1\mu_2} \longrightarrow 7$$

จาก 3 แทนค่า $n = 2$ จะได้

$$\pi_3\mu_3 + \pi_1\lambda_1 - (\mu_2 + \lambda_2)\pi_2 = 0 \longrightarrow 8$$

แทนค่า π_1 และ π_2 ใน 8

$$\therefore \quad \pi_3 = \frac{\lambda_0\lambda_1\lambda_2\pi_0}{\mu_1\mu_2\mu_3} \longrightarrow 9$$

จาก 9 แทนค่า π_0 ในเทอมของ π_2 จากสมการ 7

$$\therefore \quad \pi_3 = \frac{\lambda_2 \pi_2}{\mu_3}$$

$$\therefore \quad \pi_n = \frac{\lambda_{n-1} \cdot \pi_{n-1}}{\mu_n} \longrightarrow 10$$

จาก 9

$$\pi_m = \frac{\lambda_0 \lambda_1 \lambda_2 \cdots \lambda_{m-1}}{\mu_1 \mu_2 \cdots \mu_m} \cdot (\pi_o)$$

$$\pi_m = \prod_{j=1}^{m} \frac{\lambda_{j-1}}{\mu_j} \cdot \pi_0$$

$$\sum_{m=o}^{M} \pi_m = \sum_{m=o}^{M} \prod_{j=1}^{m} \frac{\lambda_{j-1}}{\mu_j} \cdot \pi_0$$

$$1 = \sum_{m=o}^{M} \prod_{j=1}^{m} (M-j+1) \cdot (c/i) \cdot (\pi_0)$$

$$\therefore \pi_0 = \frac{1}{\sum_{m=o}^{M} \frac{M!}{(M-m)!} \cdot (c/i)^m} \longrightarrow 11$$

แทนค่า (3.21) และ (3.22) ใน (11) จะได้

$$\pi_0 = \frac{1}{1 + \sum_{m=1}^{M} \prod_{j=1}^{m} \frac{\lambda_{j-1}}{\mu_j}} \longrightarrow 12$$

ประวัติผู้ทำการวิจัย

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