Chapter 3

Theorical neuroScience, Dayan - Abbott (2001)

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Question 7

a) $$\langle \Delta z \rangle = \int \frac{\partial \ln(P[r|s])}{\partial s} \Big(\underbrace{P[r|s+\Delta s]}_{\approx P[r|s] + \Delta s \frac{\partial P[r|s]}{\partial s}} - P[r|s] \Big) \, dr$$

$$= \int \frac{\partial \ln(P[r|s])}{\partial s} \Big(\Delta s \underbrace{\frac{\partial P[r|s]}{\partial s}}_{\text{privious Question: } \frac{\partial \ln(P[r|s])}{\partial s} \times P[r|s]} \Big) \, dr$$

$$= \Delta s \times \underbrace{\int \left(\frac{\partial \ln(P[r|s])}{\partial s} \right)^2 P[r|s] \, dr}_{I_F(s)}$$

$$\rightarrow \boxed{\langle \Delta z \rangle = \Delta s \times I_F(s)}$$

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b) $$\langle z \rangle = \int \underbrace{\frac{\partial \ln(P[r|s])}{\partial s}}_{\frac{\partial P[r|s]}{\partial s} \times \frac{1}{P[r|s]}} P[r|s] \, dr$$

$$\langle z \rangle = \int \frac{\partial P[r|s]}{\partial s} \, dr = \frac{\partial}{\partial s} \underbrace{\int P[r|s] \, dr}_{1} = \frac{\partial (1)}{\partial s} = 0$$

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c) $$\mathrm{Var}(z(r)) = \overset{\text{expected value or } \langle\rangle}{E} \left[\left(z(r) - \underbrace{\langle z \rangle}_{0} \right)^2 \right] = \langle z(r)^2 \rangle \xrightarrow{\text{eq. (3.19)}}$$

$$\mathrm{Var}(z) = \left\langle \left(\frac{\partial \ln(P[r|s])}{\partial s} \right)^2 \right\rangle \overset{\text{eq (3.43)}}{=} I_F(s)$$