The Auditory System and Human Sound-Localization Behavior

Exercises Chapter 8

Problem 8-1 **a** Show that the pdf, *P(x)* of the sum (and difference) of two independent random variables, x_1 and x_2, each with pdf's $P_1(x_1)$ and $P_2(x_2)$, respectively, is given by the convolutions:

$$x = x_1 + x_2 \implies P(x) = \int_{-\infty}^{\infty} P_1(s) \cdot P_2(x - s) \cdot ds$$
$$x = x_1 - x_2 \implies P(x) = \int_{-\infty}^{\infty} P_1(s) \cdot P_2(x + s) \cdot ds$$

Hint: Use the property of independence (probabilities multiply), and the constraint on x_1 and x_2 with respect to x.

b Apply this result to obtain the result of Eqn. 8.2 for two Gaussian random variables with the same variance, σ, but with means of 0 and μ, respectively.

c Same as in b, but now for two Gaussians with different variances and means.

Problem 8-2 Transform the general Gaussian (mean μ, standard deviation σ) into the standard form of (mean zero, and standard deviation one) to arrive at Eqn. 8.7 for the cumulative distribution.

Problem 8-3

a From Fig. 8.2 (bottom panel), and the definition of the standard cumulative normal distribution, $\Phi_G(x)$, derive Eqn. 8.12.

b Derive Eqn. 8.13

c Evaluate at β=1 the relation between hit rate and false alarm rate.

Problem 8-4 Derive Eqn. 8.15.

Problem 8-5

a Verify Eqn. 8.32, and extend the twist model to include the azimuth response components.

b Identify the regression parameters of Eqns. 8.33 and 8.34 with the fit results (the connected filled dots) of the data in Figure 8.18. In particular, how do the bias

drift parameters for elevation (Δr) and azimuth (Δn) become apparent in the fit, and what about the gain drifts (Δs and Δn)?

c How would the response grids in Fig 8,18 change when the drift gain parameters were both zero? What if only the bias parameters were zero?

Problem 8-6 Extend Fig. 8.16 to binaural models for which the two different weighting schemes (WM and MW) are incorporated. Where would azimuth-dependent spatial information enter the system in either scheme?

Problem 8-7 Make use of Fig. 8.20 to derive Eqn. 8.36.