1. The mean $\mu_X$ of a random variable $X$.

2. The variance $\sigma^2_X$ of a random variable $X$.

3. Combining random variables – the linear case.

   (a) If $c$ is a constant, $X$ a random variable, and $Y = cX$, then $\mu_Y = c\mu_X$ and $\sigma^2_Y = c^2\sigma^2_X$.

   (b) If $X$ and $Y$ are random variables and $Z = X + Y$, then $\mu_Z = \mu_X + \mu_Y$.

   (c) If $X$ and $Y$ are independent random variables and $Z = X + Y$, then $\sigma^2_Z = \sigma^2_X + \sigma^2_Y$.

   (d) If $X$ and $Y$ are independent and have normal distributions, then $Z = X + Y$ has a normal distribution.

4. Nonlinear functions of random variable. If $X$ is a random variable and $Y = h(X)$ for a nonlinear function $h$, we cannot in general compute $\mu_Y$ and $\sigma_Y$ from $\mu_X$ and $\sigma_X$. But there are approximations that are sometimes used. These are called propagation of error formulas and you met them in Physics 133.

   (a) Suppose that $X$ is a random variable $Y = h(X)$. Then

   $$
   \mu_Y \approx h(\mu_X) \quad \sigma^2_Y \approx \left( \frac{dh}{dX} \right)^2 \sigma^2_X
   $$

   where the derivative is evaluated at $\mu_X$.

   (b) Suppose that $X$ and $Y$ are independent random variables and that $Z = h(X,Y)$. Then

   $$
   \mu_Z \approx h(\mu_X, \mu_Y) \quad \sigma^2_Z \approx \left( \frac{\partial h}{\partial X} \right)^2 \sigma^2_X + \left( \frac{\partial h}{\partial Y} \right)^2 \sigma^2_Y
   $$

   where the partial derivatives are evaluated at $(\mu_X, \mu_Y)$.

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**Homework**

1. The width of a casing for a door is given as $24 \pm \frac{1}{8}$ inches. The door itself has a width of $23 \frac{7}{8} \pm \frac{1}{16}$ inches. These two measurements are independent of each other.

   (a) Determine the mean and standard deviation of the difference of the casing and door widths.

   (b) Assuming that a normal model is a good approximation to both the door and casing widths, what is the probability that the door does not fit in the casing?

2. Two resistors of resistance $R_1$ and $R_2$ ohms are connected in parallel. The resistances of the two resistors are reported as $R_1 = 20 \pm 0.5$ ohms and $R_2 = 50 \pm 1$ ohm. Determine the approximate mean and standard deviation of the resistance $R$ of the combination. Recall that this resistance is given by

   $$
   R = \frac{R_1 R_2}{R_1 + R_2}
   $$