**The problem**: A certain ground motion has an $x$ percent probability of being exceeded in $Y$ years. What is the probability, $w$, that that same ground motion is exceeded in $Z$ years?

**The solution**: In the algorithm used to create the maps, one specifies a probability of exceedance for a given number of years. The computer finds the ground motion that has an annual rate that satisfies the following equation:

$$1 - r(a) = F(a) = e^{-T\varphi(a)}$$

where *r(a)* is the exceedance probability of the ground motion *a*, *F(a)* is sthe corresponding probability of non-exceedance, *e* is the base of the natural logarithm scale, *T* is the number of years for which we want to know the corresponding probability, and $\varphi(a)$ is the annual rate of exceedance of ground motion *a*. This equation is nothing more than the Poisson probability that given an expected number *n* of events, $e^{-n}$ is the probability of getting none.

Given a ground motion, *a*, the annual rate at a site $\varphi(a)$ is constant. Taking logs and solving for $\varphi(a)$, we can make the equation,

$$\frac{\ln F(a)}{T} = -\varphi(a)$$

and equate for the two cases, number of years $=Y$ and $Z$

$$\frac{\ln(1-x)}{Y} = \frac{\ln(1-w)}{Z}$$

Solving for $1 - w$,

$$\ln(1-w) = \frac{Z}{Y}\ln(1-x)$$

$$(1-w) = e^{\frac{Z}{Y}\ln(1-x)} = (1-x)^{\frac{Z}{Y}}$$

So, for instance, for $r = 0.10$, $Y = 50$, and $Z = 500$; $F = 0.9$ and

$$(1-w) = (0.90)^{10} = 0.35, \ \textit{hence } w = 0.65$$

In a similar way, for $r$=0.05, $w$ = 0.40, and for $r$ = 0.02, $w$ = 0.18

| **If a ground motion has this probability of being exceeded in 50 years,** | **the same ground motion has the following probability of being exceeded in 500 years.** | **Prob of exceedance in 500 ––––––––––––––––––––– Prob of exceedance in 50** |
|---|---|---|
| 0.02 | 0.18 | 9.0 |
| 0.05 | 0.40 | 8.0 |
| 0.10 | 0.65 | 6.5 |