How to think about why we might need to model groups as a stochastic process (aka random effect).

Science question: What is the effect of latitude on species richness?

Proposed design:
  Choose 2 states:
        Texas, Alaska.
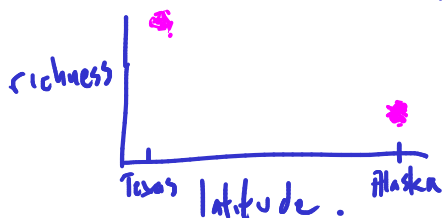   1000 randomly selected sites in each state.

Proposed model:

species → $Y_i \sim Poisson(M_i)$
richness

$$M_i = \beta_0 + \beta_1 latitude$$

What is wrong with this design and model?

Pseudoreplicated: looks like 1000 data points per latitude.

        We really have only 2 samples, 1 per latitude.

Perhaps the entire difference is caused by Texas vs Alaska and has nothing to do with latitude.

richness | Texas latitude. Alaska

Our effective number of independent samples is somewhere between 2 and 1000 but probably much closer to 2 in this example. This critically affects our uncertainty about latitude effects on species richness.