Exercise on Probability Distributions

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This exercise will introduce some probability distributions that you may find useful in Capture-Mark-Recapture JAGS models (and beyond)

Task

The task:

- your group will be assigned a probability distribution (and transformation)
- play with it in R (like a child)
- interview a colleague to try and elicit their prior belief about a cetacean population parameter e.g., through random number generation, e.g., `hist(rbeta(n=10000,30.3,3))`
- show & tell: report back and help your colleagues get-to-know this distribution

Task

You *may* wish to report on how each parameter affects the...

1. mean (expected value)
2. variance (spread)
3. skew (left/right
4. shape (heavy tailed, bell-shaped, convex/concave)

You may also want to report any intuitions or rule's-of-thumb you learn to help your colleagues elicit priors

- e.g., Normal: 68% of the probability density is *within* $\pm$ 1 Standard Deviation (σ) of μ (i.e., values within 1σ are quite likely).
- e.g., Normal: only 5% of the probability density is outside 2 σ from μ. (i.e., values $> (\mu + 2\sigma)$ are quite unlikely.

Task

Tools:

- the internet (wikipedia is GREAT for describing probability distributions)
- play with R

```
r <- rbeta(10000,shape1 = 20, shape2=10)
hist(r) # visualize
quantile(r, c(0.05, 0.5, 0.95)) # 0.05th,0.50th,0.95th quantiles!
```

... repeat...

```
r <- rbeta(10000,shape1 = 10, shape2=20)
hist(r) # visualize
quantile(r, c(0.05, 0.5, 0.95)) # 0.05th,0.50th,0.95th quantiles!
```

It's your prior beliefs!

Remember, it's <u>your</u> prior belief
You must learn to express yourself probabilistically

Warning: JAGS vs R

R and JAGS have slightly different parameterizations for some distributions. Especially, the Normal and Student-t

- in R: `dnorm(x, mean, sd)` or
$$\mathcal{N}(x; \mu, \sigma)$$
- in JAGS: `dnorm(x, mean,precision)` or
$$\mathcal{N}(x; \mu, \tau),$$
$$\text{where } \tau = \frac{1}{\sigma^2}$$
- Student-t: likewise, JAGS parameterizes the Student-t with $\tau = \frac{1}{\sigma^2}$.

Files

- There are some helpful R functions in the file:

`PART2_priors/R_source_distributions.R` ... copy and paste the code into R

Distributions

You will be assigned into teams of:

- Beta: `rbeta`
- logit-Normal: `rlnorm.jags`
- probit-Normal: `rpnorm.jags`
- half-Normal: `rhalfnorm.jags`
- scaled-half-student-t: `rhalft.jags`
- Gamma: `rgamma`
- Inverse-Gamma: `MCMCpack::rinvgamma`

Advanced / if you get bored

- Inverse-Wishart: `MCMCpack::riwish`
- Dirichlet: `MCMCpack::rdirichlet`

Beta, logit-Normal, probit-Normal

for teams studying the Beta, logit-Normal, probit-Normal: pretend you are eliciting a prior for a probability parameter, such as

- annual survival (ϕ), or
- probability of leaving the studying area and becoming a temporary emigrant for the next capture period (γ'').

for teams studying the half-Normal, half-Student-t, or Inverse-Gamma: pretend you are ellicting a prior for a ...

- dispersion parameter (σ, for half-Normal and half-Student-t), or
- variance parameter (σ^2, for Inv-Gamma), or
- precision parameter ($\tau = \frac{1}{\sigma^2}$, for Gamma).

In such cases, pretend your are elicting their prior beliefs about the *natural variation* of a parameter in time. For example:
Sheila: "Hey Gordie, how much do you think survival is likely to *vary* between years?"
Gordie: "Hmmm, I can't imagine it changes much more than ...."

Dirichlet

For team dirichlet, pretend you are elliciting a prior for a simplex of a categorical or multinomial distribution [1].
E.g., for dolphins that live in the Perth river estuary, what are their probabilities of transitioning to:

1. a North Coast strata, or
2. a South Coast strata, or
3. staying at home.

- or any multinomial outcome

[1] like the probabilities governing the outcomes of a dice-rolling experiment