JAGS Model

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Basic Model: Ambulance + Overdose

Ambulance Call-outs Model

n_A: sample size
x_A: the total number who confirmed they did call an ambulance
p_A: probability of a person call an ambulance

$$x_A \sim Bin(n_A, p_A)$$

We assume $n_A = 1000, p_A = 0.8$.
Suppose the prior of p_A is noninformative.

$$p(p_A) \sim Beta(1,1)$$

Overdose Model

Now we plug in this values into the overdose model and obtain possible O_t values **assuming we have U_t values.**

Also, we have priors.

$$z_t \sim N(\mu, \sigma^2)$$
$$\lambda_t^{OD} = \exp(z_t)$$
$$O_t \sim Poi(\lambda_t^{OD} N)$$
$$U_t \sim Bin(O_t, p_A)$$

For simplicity we set N =10000 for now. We need to generate reasonable U_t values first. Note that U_t comes from μ, σ following all the way through the overdose model.
$\mu = \log 0.05, \sigma = 1, N = 10000$.
We suppose survey data exists: (n_A, x_A) known.

We set for our prior parameters:

$$\mu \sim U(-10, 0)$$
$$\sigma \sim U(0, 5)$$

```
# install packages
if (!require(runjags)) install.packages("runjags")
if (!require(rjags)) install.packages("rjags")
if (!require(coda)) install.packages("coda")

library('runjags')
library('rjags')
library('coda')
```

The data is the same data from pymc3 with Python.
Todo: build a pipeline to connect the python (pymc3) and R (JAGS)

```
df <- read.csv('./basic_data.csv')
df$X <- NULL
head(df)
```

```
##     o_t  u_t x_a
## 1 2475 1969 799
## 2  262  217 798
## 3  318  253 795
## 4  149  119 816
## 5 1151  934 805
## 6   39   34 794
```

Now we set the model which defines the relations of overdose model and ambulance call model.

The model defined as follows.

```
cat("model{
## define the priors
p_a ~ dbeta(alpha, beta)
mu ~ dunif(mu_a, mu_b)
sigma ~ dunif(sigma_a, sigma_b)

## the latent variables
z ~ dnorm(mu, 1/(sigma^2))
lambda <- exp(z)

for (i in 1:n) {
  ## ambulance model
  x_a[i] ~ dbin(p_a, n_a) # each survey result for month
}
for (i in 1:n) {
  ## overdose model
  o_t[i] ~ dpois(lambda*N) # total overdoses per month
}
for (i in 1:n) {
  u_t[i] ~ dbin(p_a, o_t[i]) # ambulanced overdoses per month
}

}", file='basic_model.txt')
```

Pre-set variables.

```
n <-  length(df$o_t) # we have 12 samples
n_a <- 1000
N <- 10000
u_t <- df$u_t
x_a <- df$x_a
```

Define the list providing the values of the variables and the parameters for the priors of the model.

```
dat <- list(
            # priors for ambulance model
            'alpha' = 1,
            'beta' =  1,

            # priors for overdose model
            'mu_a'=(-10),
            'mu_b'=0,
            'sigma_a'=0,
            'sigma_b'=5,
```

```
          # likelihood
          'u_t'=u_t,
          'x_a'=x_a,
          'N'=N, # the population
          'n'= n, # total months
          'n_a'=n_a

          )
```

Note: for the list object usually named 'data' or 'dat' in JAGS context, do not use arrow but use equal sign to define elements of the list.

```
jags.simple <- jags.model(file='basic_model.txt',
                          data=dat)
```

```
## Compiling model graph
##     Resolving undeclared variables
##     Allocating nodes
## Graph information:
##     Observed stochastic nodes: 24
##     Unobserved stochastic nodes: 16
##     Total graph size: 55
##
## Initializing model
```

Reference

first tutorial
second tutorial
JAGS manual
error handling guide