

# Exercise 1: Estimating Mean and SD

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## Objective

In this exercise, you will be introduced to the Stan programming language by estimating the mean and standard deviation (SD) of a simulated dataset. You will use concepts described during the workshop to create your first Stan program.

## Background

Data used in this exercise will be randomly generated from a normal distribution with fixed mean and SD. The R code to initialize workspace, generate data, and package and send the data with initial values to Stan are provided in the “Ex1\_mean.R” file located in the “Ex1\_mean” folder. The instructor will review this R file with you. Your task will be to create the Stan file using the Stan code provided below. You are encouraged to type rather than copy/paste the code into a new .stan document. The model you will fit to individual observations  $i$  is:

$$\begin{array}{ll} \text{Model:} & y_i = \mu + \epsilon_i \\ & \epsilon_i \sim \text{Normal}(0, \sigma) \\ \text{Priors:} & \mu \sim \text{Normal}(0, 100) \\ & \sigma \sim \text{half-cauchy}(0, 5) \end{array}$$

## R packages required for this exercise

1. rstan

## Directions

Create a new text file and save it as “Ex1\_est\_mean\_sd.stan” in the “Ex1\_mean” folder. Enter the Stan code below in the new .stan file.

## Stan code

```
data{
  int<lower=0> n; //number of observations
  vector[n] y;   //observations as a vector
}

parameters {
  real<lower=0> sigma; //standard deviation to be estimated
  real mu;           //Mean to be estimated
}

model {
```

```

//reference priors
sigma ~ cauchy(0,5);
mu ~ normal(0,100);

//likelihood, loop through number of observations
for(i in 1:n){
  y[i] ~ normal(mu, sigma);
}
}

```

## R Code

Open “Ex1\_mean.R” and run lines 1 through the lines:

```

#send everything to Stan
fit1 <- stan(file = 'Ex1_est_mean_sd.stan',
             data = dataList ,
             init = initslst,
             chains = nchains,
             iter = 1000 ,
             warmup = 500 ,
             thin = 1 )

```

Traceplots, parameter estimates and plots of results can be viewed using the code below (note this code is provided):

```

#View traceplots
traceplot(fit1)
#view results
fit1

#extract results
est_mean=rstan::extract(fit1,"mu")$mu
est_sd=rstan::extract(fit1,"sigma")$sigma

#plot results
par(mfrow=c(1,2))
hist(est_mean,breaks=50);abline(v=mu,lwd=5);
hist(est_sd,breaks=50);abline(v=sd,lwd=5);
par(mfrow=c(1,1))

```