History: Stan

Lea Bührer, Group Goliath

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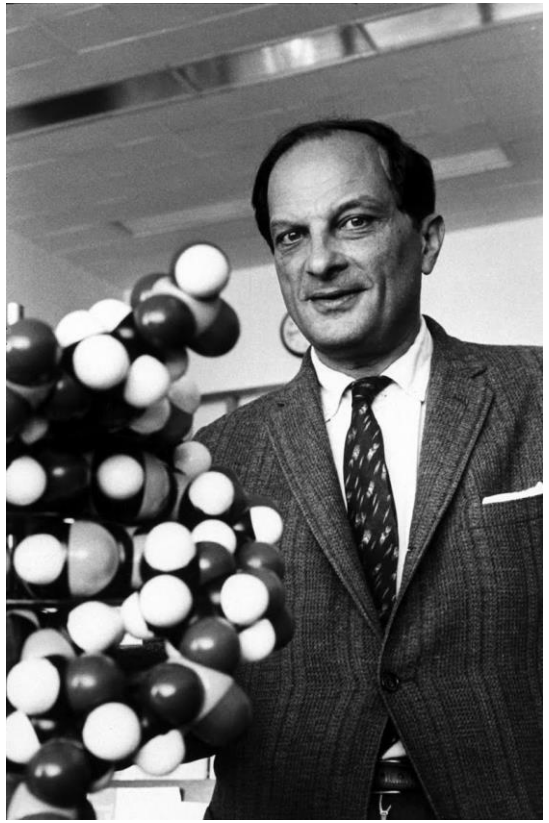
Stanislaw Marcin Ulam

- 1909-1984
- Measure theory, topology, logic
- 1943: Manhattan Project
- Monte-Carlo-Method



Stan - Development

Andrew Gelman

Bob Carpenter

Daniel Lee

Matt Hoffman

Stan - Example

$$Y \sim \mathcal{N}(\mu = 3, \sigma^2 = 100)$$

```
Y <- rnorm(n = 100, mean = 3, sd = 10)                  # Simulate normal distributed data

data {                                                  # stan code that defines the data
  int<lower = 1> N;   // Total number of trials
  vector[N] y;        // Score in each trial}

parameters {                                            # definition of parameters mu and sigma
  real mu;
  real<lower = 0> sigma;}

model {                                                 # definition of prior and likelihood
   // Priors:
  target += normal_lpdf(mu | 0, 20);                    # target: adds terms to the unnormalized log posterior
  target += lognormal_lpdf(sigma | 3, 1);                 probability
  // Likelihood:
  for(i in 1:N)
    target += normal_lpdf(y[i] | mu, sigma);}
```

normal.stan

Stan - Example

$$Y \sim \mathcal{N}(\mu = 3, \sigma^2 = 100)$$

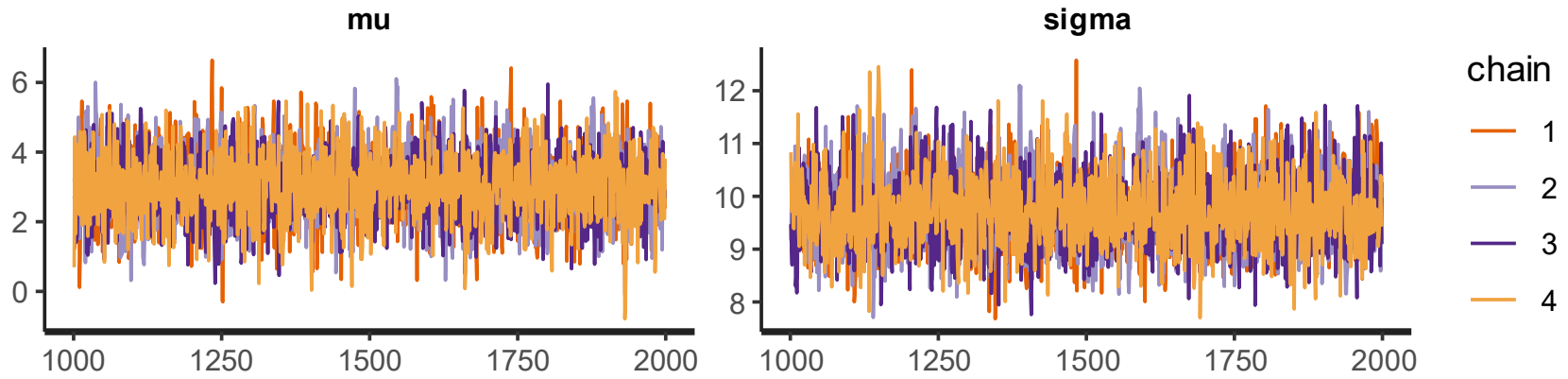
```
lst_score_data <- list(y = Y, N = length(Y))

fit_score <- stan(
 file = normal,
 data = lst_score_data)

traceplot(fit_score, pars = c("mu", "sigma"))
print(fit_score, pars = c("mu", "sigma"))
```

```
# fit the model, default: chain=4, iter=2000
# normal.stan = file that includes
  data/paramaters/model

# traceplot
# print results
```



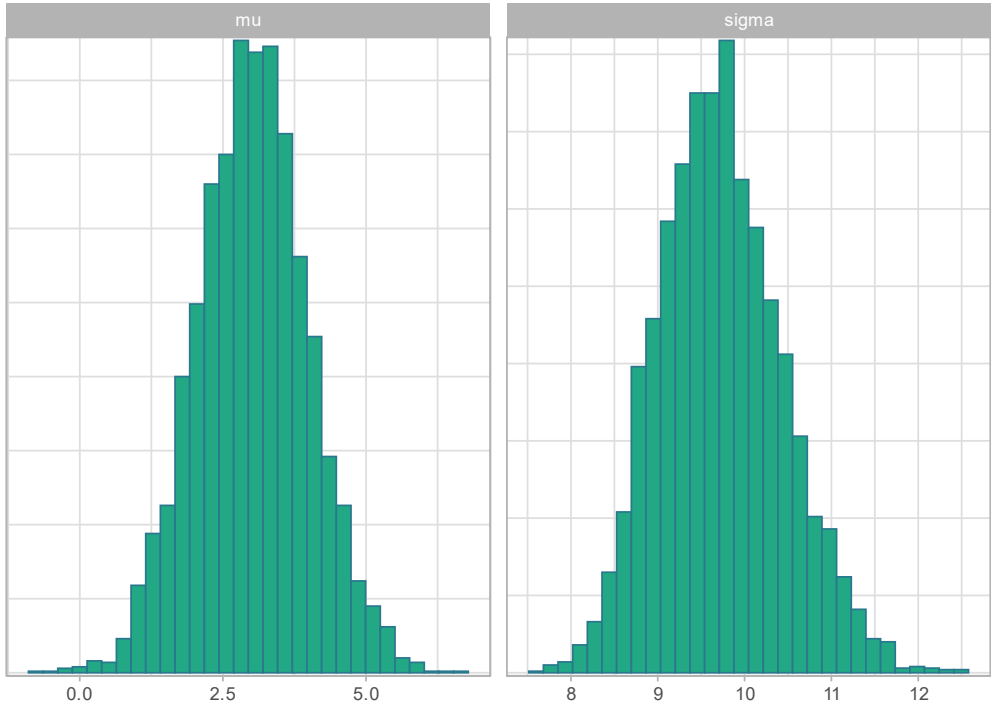
Stan - Example

$$Y \sim \mathcal{N}(\mu = 3, \sigma^2 = 100)$$

```
## Inference for Stan model: normal.
## 4 chains, each with iter=2000; warmup=1000; thin=1;
## post-warmup draws per chain=1000, total post-warmup draws=4000.
##
##       mean se_mean   sd  2.5%  97.5%  n_eff Rhat
## mu    3.02    0.02 0.97  1.13  4.97   3400    1
## sigma 9.73    0.01 0.71  8.45  11.22  3213    1
## …

# Rhat = 1: at convergence
```

```
df_fit_score <- as.data.frame(fit_score)
mcmc_hist(df_fit_score, pars = c("mu", "sigma"))
```



References

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