TEWA 1: Advanced Data Analysis

Lecture 12

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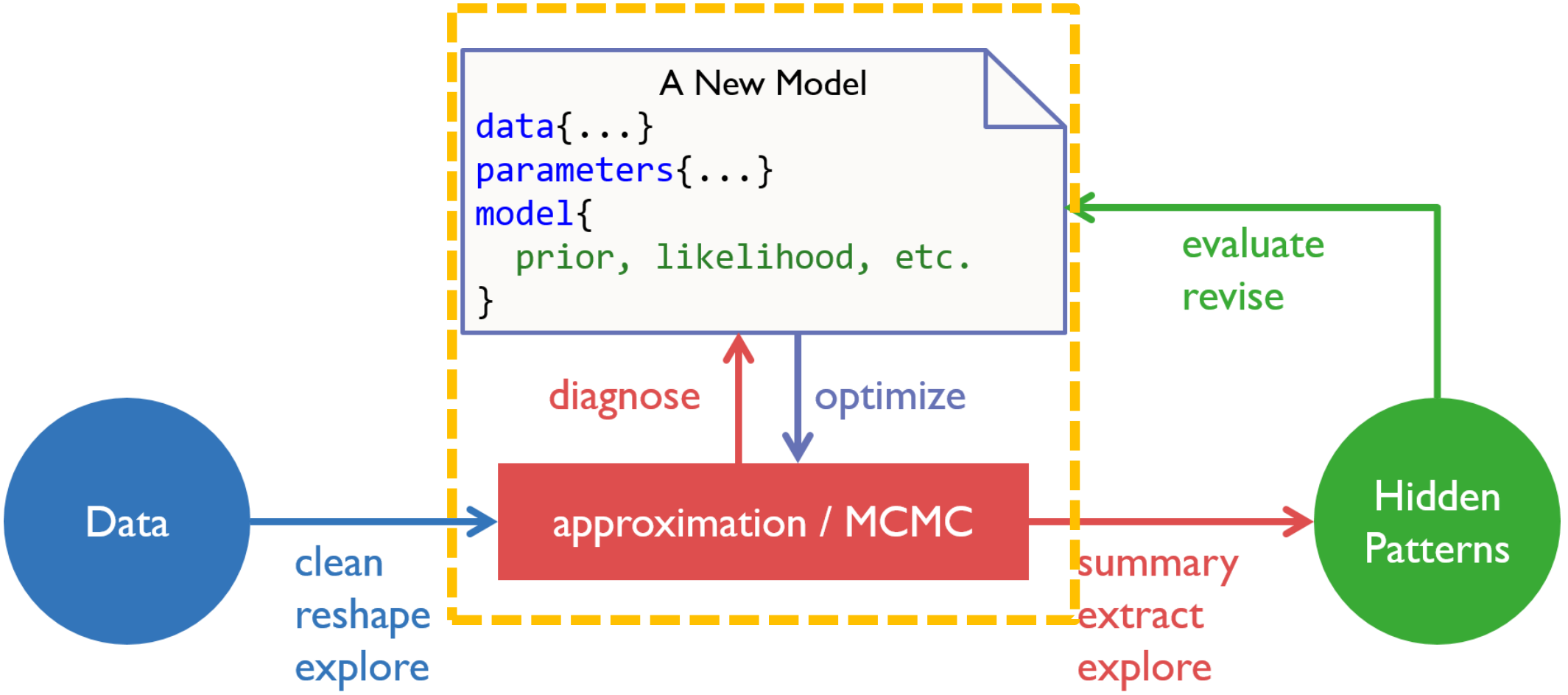
https://github.com/lei-zhang/tewa1_univie

STAN DEBUGGING

cognitive model
statistics
computing



Stan Style Tips

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Make it Reproducible

- Scripts are good documentations!
- Save your seed (not cross platform*)

Make it Readable

- Choose a consistent style
- Give meaningful variable names

Start with Simulated Data

Design Top-Down, Code Bottom-Up

Write Comments

- Code never lies!

* Stan seed depends on hardware etc.

The Editor of your Choice

```
data {
  int<lower=0> w;
  int<lower=0> N;
}

parameters {
  real<lower=0,upper=1> p;
}

model {
  p ~ uniform(0,1);
  w ~ binomial(N, p);
}
```


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* Click on each logo to visit their homepage.
** Comparison

Common Error / Warning Types

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ERRORS

forget " ; "
mis-indexing: mismatch or constant
support mismatch
improper constrain
improper dimension declaration
vectorizing when not supported
wrong data type
wrong distribution names
forget priors
miss spelling

WARNINGS

forget last blank line
use earlier version of Stan
numerical problems
divergent transitions
hit max_treedepth
BFMI too low
improper prior

see also: Brief Guide to Stan's Warnings

Debugging in Stan

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- always use a *.stan file
- press Check in RStudio
- use `lookup()`
- start with simulated data
- be careful with copy/paste
- run 1 chain, 1 sample
- debugging by printing

```
for (s in 1:1) {
  vector[2] v;
  real pe;
  v <- initV;

  for (t in 1:nTrials) {
    choice[s,t] ~ categorical_logit( tau[s] * v );

    print("s = ", s, ", t = ", t, ", v = ", v);

    pe <- reward[s,t] - v[choice[s,t]];
    v[choice[s,t]] <- v[choice[s,t]] + lr[s] * pe;
  }
}
```

```
> lookup(dnorm)
    StanFunction                              Arguments ReturnType Page SamplingStatement
344       normal                (reals mu, reals sigma)       real  369              TRUE
348   normal_log (reals y, reals mu, reals sigma)       real  369             FALSE
```

Debugging Stan in RStudio

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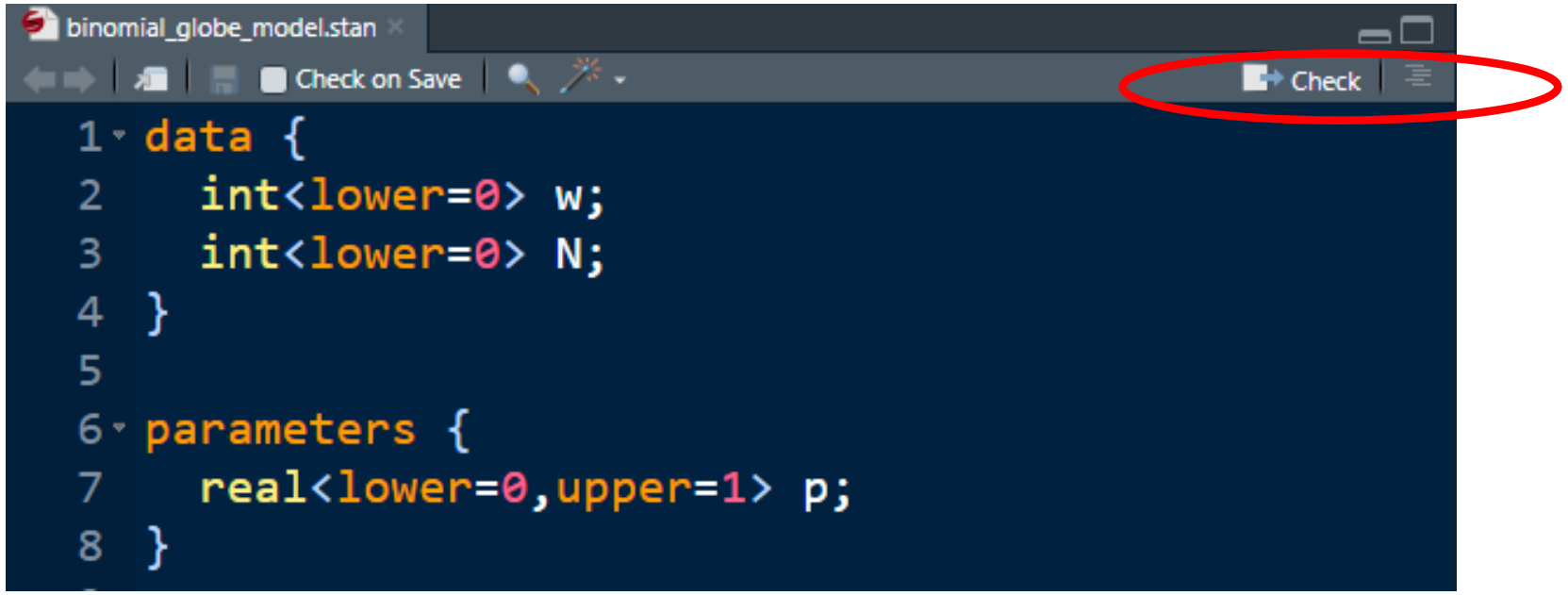


```
rstan::rstudio_stanc("_scripts/binomial_globe_model.stan")
```

Example: Memory Retention

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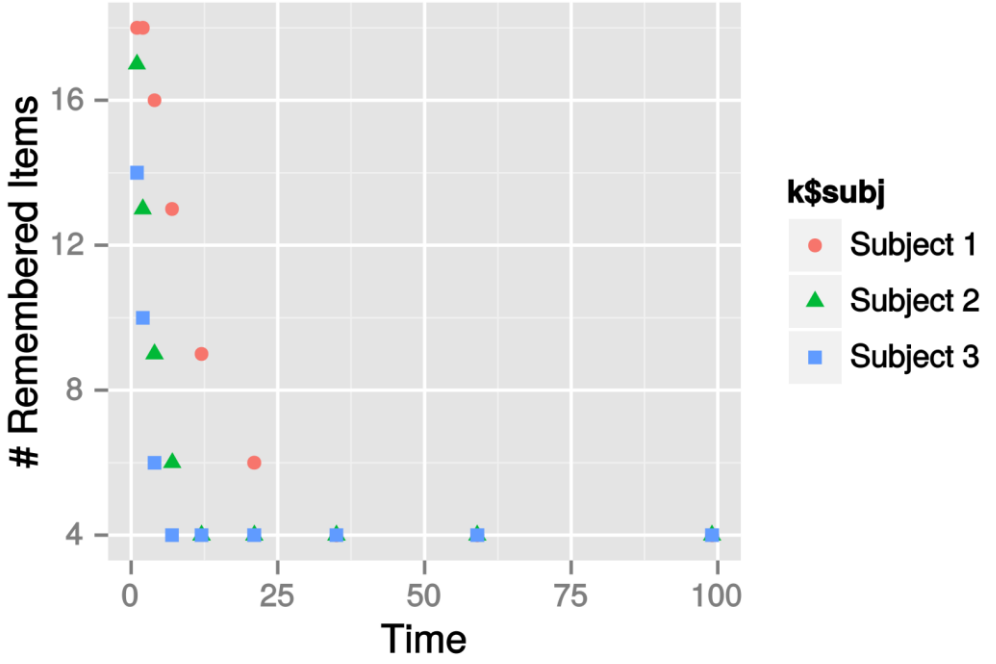

	Time Interval								
Subject	1	2	4	7	12	21	35	59	99
1	18	18	16	13	9	6	4	4	4
2	17	13	9	6	4	4	4	4	4
3	14	10	6	4	4	4	4	4	4

Lee & Wagenmakers (2013)

Simple Exponential Decay Model

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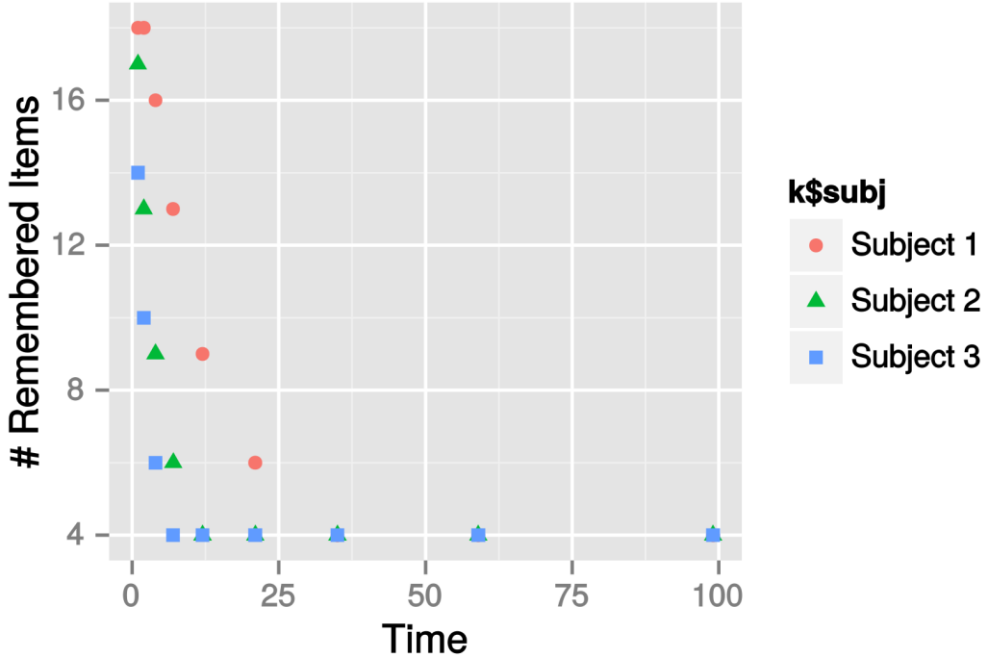

$$\theta_t = \min(1.0, \exp(-\alpha t) + \beta)$$

p(remember) decay rate baseline

Lee & Wagenmakers (2013)

Exercise XIV

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…/09.debugging/_scripts/exp_decay_main.R

TASK: Debugging the Memory retention model

>= 9 errors!

Viel Spaß!

```
> dataList
$`k`
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
[1,]   18   18   16   13    9    6    4    4    4
[2,]   17   13    9    6    4    4    4    4    4
[3,]   14   10    6    4    4    4    4    4    4

$nItem
[1] 18

$intervals
[1]  1  2  4  7 12 21 35 59 99

$ns
[1] 3

$nt
[1] 9
```

Satisfied with the results?

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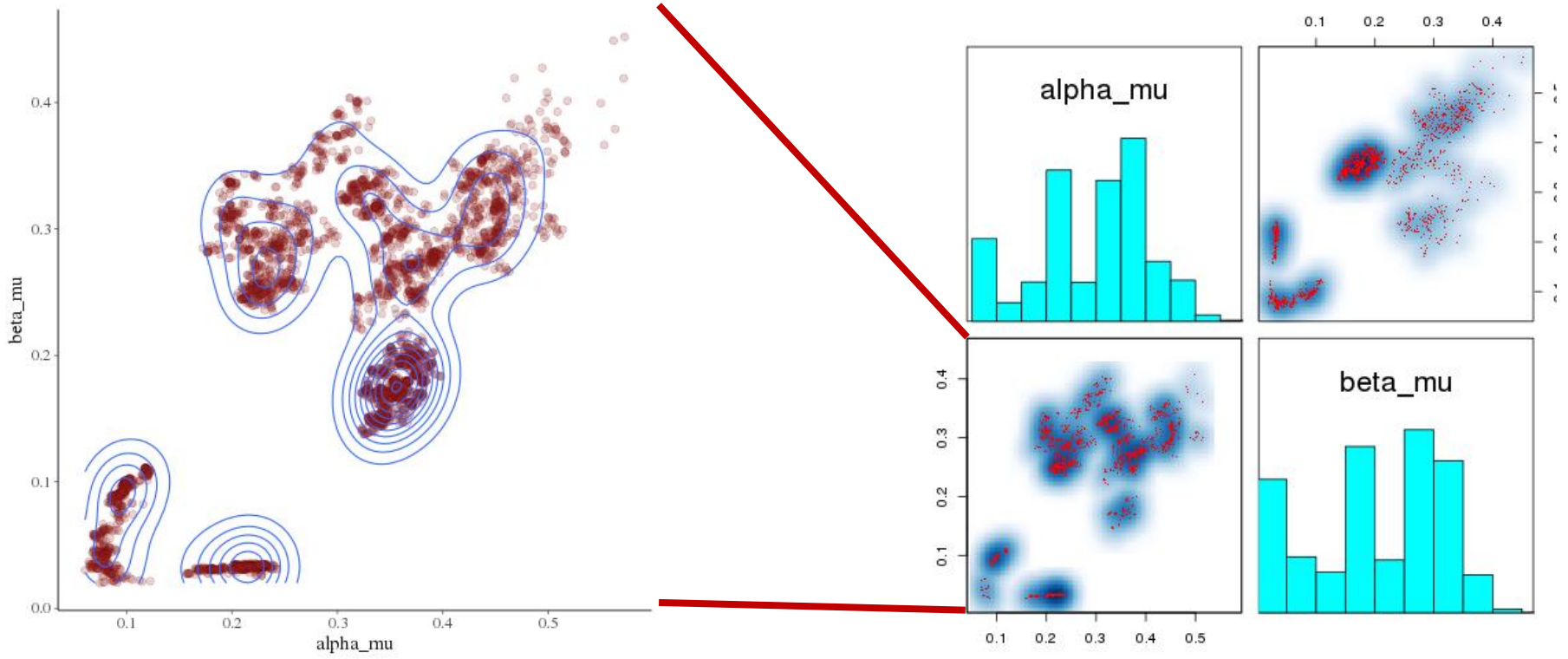
```
Warning messages:
1: There were 3998 divergent transitions after warmup. Increasing adapt_delta above 0.8 may help. See
http://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup
2: Examine the pairs() plot to diagnose sampling problems
```



Why Stan Fails?

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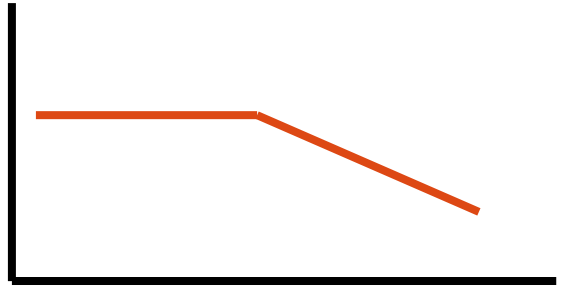
```
for (s in 1:ns) {
  for (t in 1:nt) {
    theta[s,t] = fmin(1.0, exp(-alpha[s] * intervals[t]) + beta[s]);
    k[s,t] ~ binomial(nItem, theta[s,t]);
  }
}
```

Non-differentiable link (likelihood) functions are bad news, particularly in Stan, which relies on derivatives.



What to look for?

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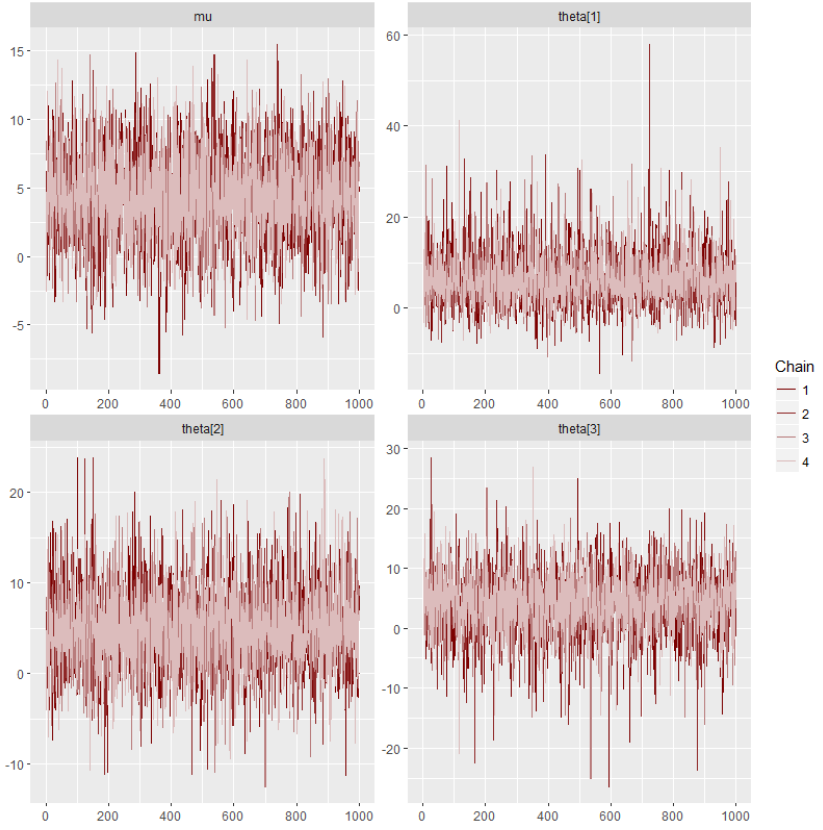
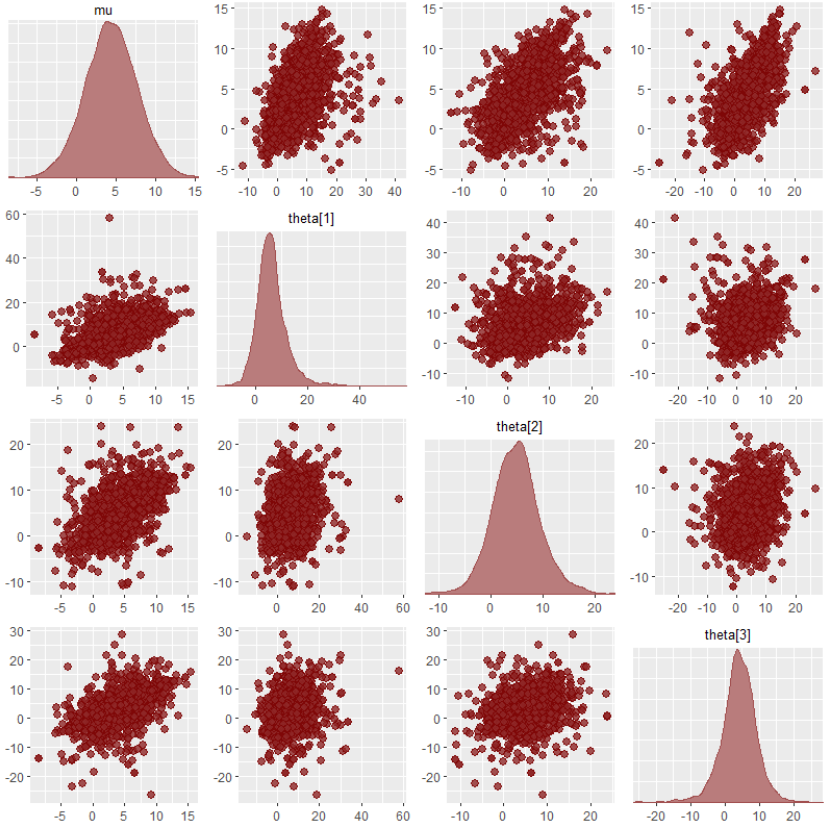
```
> source('stan_utility.R')
> check_all_diagnostics(fit)
[1] "n_eff / iter looks reasonable for all parameters"
[1] "Rhat looks reasonable for all parameters"
[1] "0 of 4000 iterations ended with a divergence (0%)"
[1] "0 of 4000 iterations saturated the maximum tree depth of 10 (0%)"
[1] "E-BFMI indicated no pathological behavior"
```





Credit: Michael Betancourt


ANY
QUESTIONS
?

Happy Computing!