The Stan Modeling Language

Stan

Hamiltonian Monte Carlo

Modeling Language

Automatic Differentiation

Adaptation

A Stan model is defined by five program blocks

```
data

transformed data

parameters                 (required)

transformed parameters

model                      (required)

generated quantities
```

The “data” block reads external information

```
data {
  int N;
  int x[N];
  int offset;
}
```

The “transformed data” block allows for preprocessing of the data

```
transformed data {
  int y[N];
  for (n in 1:N)
    y[n] <- x[n] - offset;
}
```

The “parameters” block defines the sampling space

```
parameters {
  real<lower=0> lambda1;
  real<lower=0> lambda2;
}
```

The “transformed parameters” block allows for parameter processing before the posterior is computed

```
transformed parameters {
  real<lower=0> lambda;
  lambda <- lambda1 + lambda2;
}
```

In the “model” block we get to define our posterior

```
model {
  y ~ poisson(lambda);
  lambda1 ~ cauchy(0, 2.5);
  lambda2 ~ cauchy(0, 2.5);
}
```

Lastly, the "generated quantities" block allows for postprocessing

```
generated quantities {
  int x_predict;
  x_predict <- poisson_rng(lambda)
                 + offset;
}
```

```
data {
  int N;
  int x[N];
  int offset;
}

transformed data {
  int y[N];
  for (n in 1:N)
    y[n] <- x[n] - offset;
}

parameters {
  real<lower=0> lambda1;
  real<lower=0> lambda2;
}

transformed parameters {
  real<lower=0> lambda;
  lambda <- lambda1 + lambda2;
}

model {
  y ~ poisson(lambda);
  lambda1 ~ cauchy(0, 2.5);
  lambda2 ~ cauchy(0, 2.5);
}

generated quantities {
  int x_predict
  x_predict <- poisson_rng(lambda) + offset;
}
```

	data	transformed data	parameters	transformed parameters	model	generated quantities
Execution	Per chain	Per chain	NA	Per leapfrog	Per leapfrog	Per sample
Variable Declarations	Yes	Yes	Yes	Yes	Yes	Yes
Variable Scope	Global	Global	Global	Global	Local	Local
Variables Saved?	No	No	Yes	Yes	No	Yes
Modify Posterior?	No	No	No	No	Yes	No
Random Variables	No	No	No	No	No	Yes

Stan has two primitive types

`int` is an integer type

`real` is a floating point precision type

Both can be bounded

```
int<lower=1> N;

real<upper=5> alpha;
real<lower=-1,upper=1> beta;

real gamma;
real<upper=gamma> zeta;
```

Reals extend to linear algebra types

```
vector[10] a;     // Column vector
matrix[10, 1] b;

row_vector[10] c; // Row vector
matrix[1, 10] d;
```

Arrays of int, reals, vectors, and matrices are available

```
real a[10];

vector[10] b[10];

matrix[10, 10] c[10];
```

Stan also implements a variety of constrained types

```
simplex[5] theta;          // sum(theta) = 1

ordered[5] o;              // o[1] < ... < o[5]
positive_ordered[5] p;

corr_matrix[5] C;          // Symmetric and
cov_matrix[5] Sigma;       // positive-definite
```

All of your favorite statements are available, too

```
if/then/else

for (i in 1:I)

while (i < I)
```

There are two ways to modify the posterior

```
y ~ normal(0, 1);

increment_log_posterior(log_normal(y, 0, 1));
```

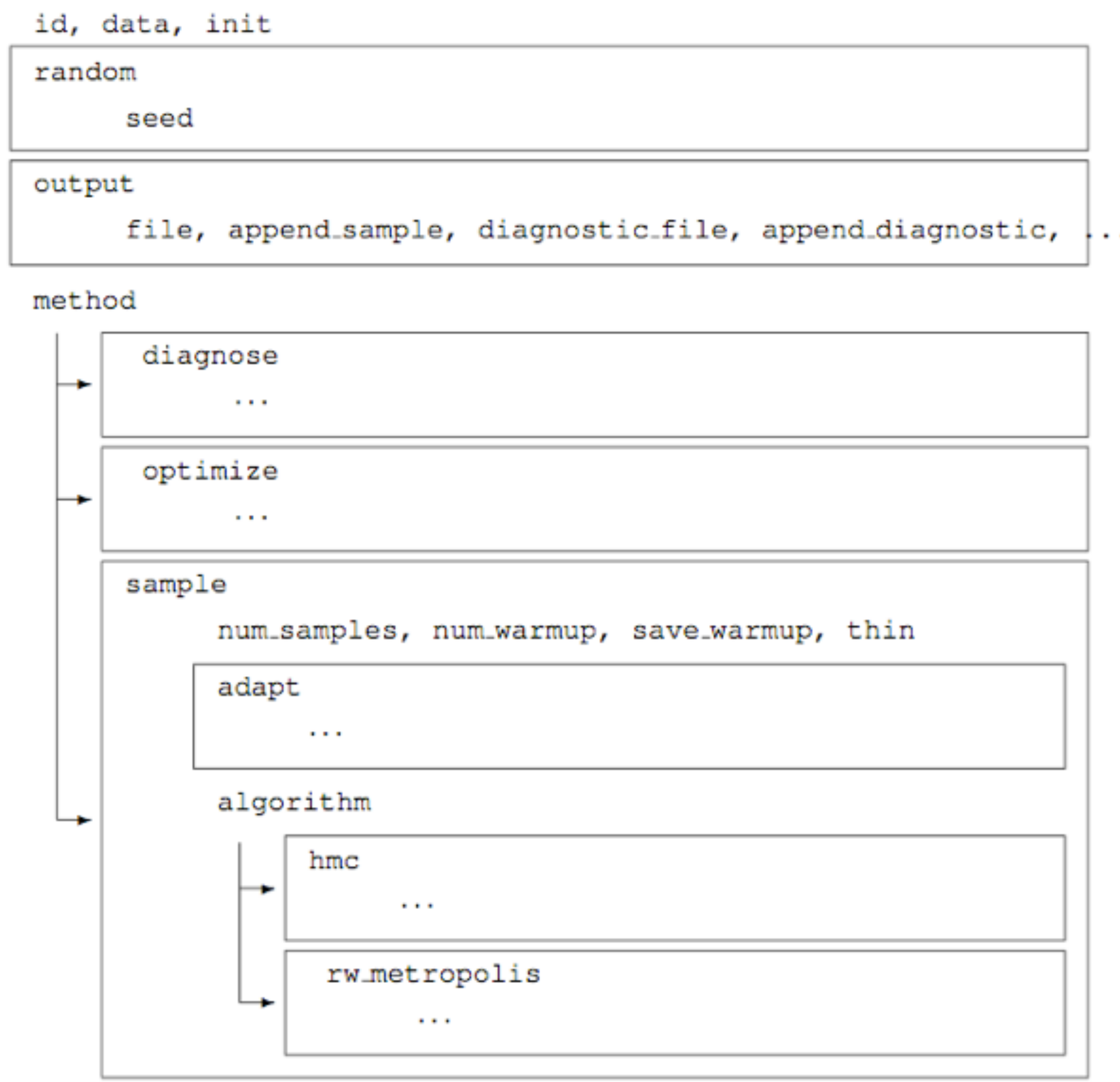
Many sampling statements are *vectorized*

```
parameters {
  real mu[N];
  real<lower=0> sigma[N];
}

model {

  for (n in 1:N)
    y[n] ~ normal(mu[n], sigma[n]);



}
```

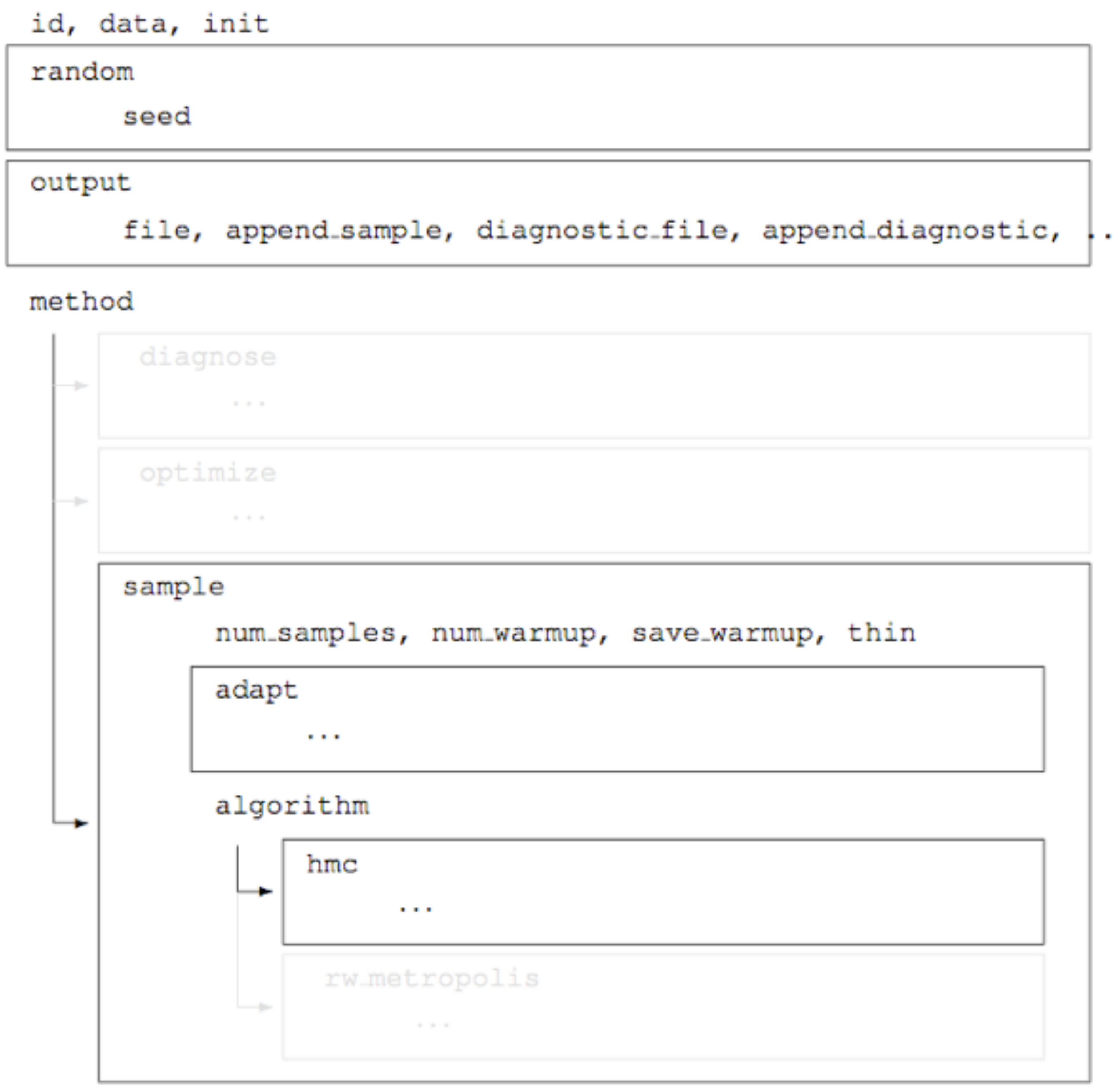
Many sampling statements are *vectorized*

```
parameters {
  real mu[N];
  real<lower=0> sigma[N];
}

model {

  for (n in 1:N)
    y[n] ~ normal(mu[n], sigma[n]);

  y ~ normal(mu, sigma);

}
```

Because of the huge number of possible configurations, Stan uses hierarchical arguments



Because of the huge number of possible configurations, Stan uses hierarchical arguments



Groups

Because the Stan developers and users are distributed geographically, almost all of the discussions of Stan takes place on our group mailing lists. We prefer to communicate to a wide audience via the users group than to individuals via e-mail.

There is also an issue tracker which can be used to report code bugs or documentation typos and to request features.

Users Group

The users group is for general discussion of Stan, including modeling and installation issues:

- Stan Users Group (on Google Groups)

Everyone who joins the users group has posting privileges.

Developers Group

The developers group is for the development team to discuss Stan's code:

- Stan Developers Group (on Google Groups)

The developers group is open for everyone to read, but posting is restricted to Stan developers; see the contribution page if you want to contribute code.

Announcement Group

This group is only used to announce new releases:

- Stan Announcement Group (on Google Groups)

Buildbot Group

Stan follows a continuous integration process. To receive mail about integration test failures, sign up for:

- Stan Buildbot Group (on Google Groups)

Home
RStan
PyStan
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Manual
Examples
Groups
Issues
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Source
Citations
Team

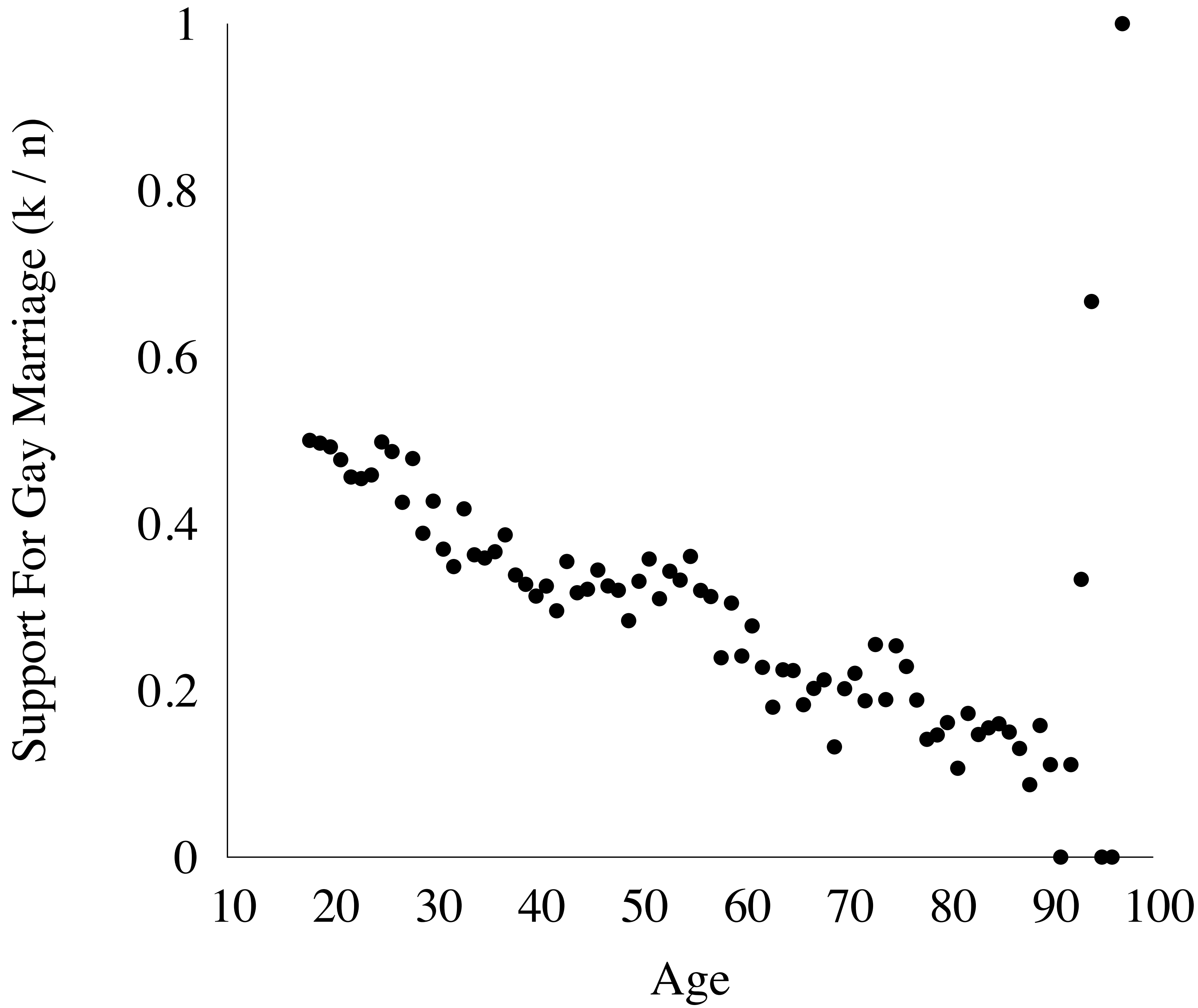
Interactive example

http://www.mc-stan.org/mlss14/support.data.R

http://www.mc-stan.org/mlss14/support-data.json

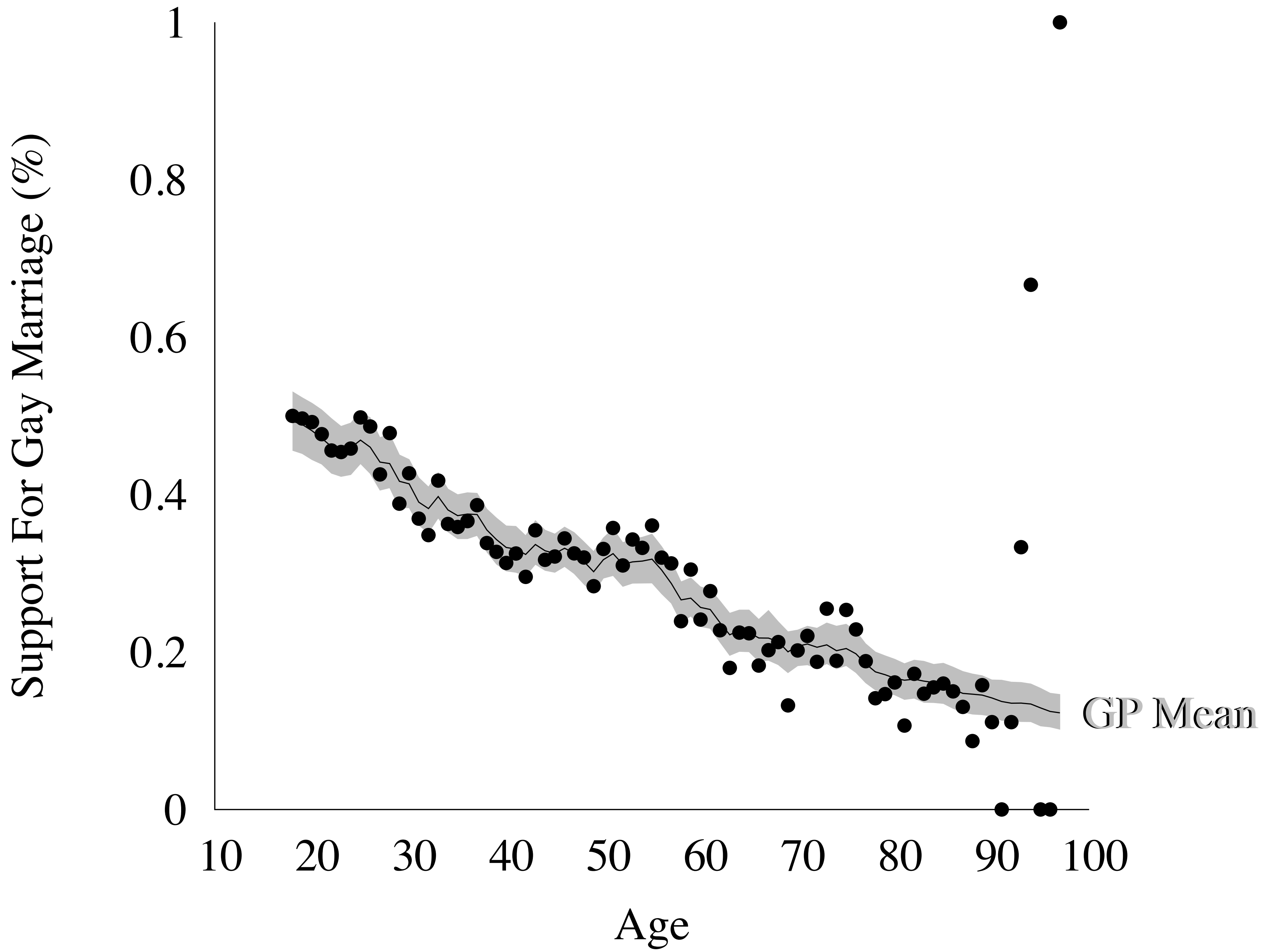
http://www.mc-stan.org/mlss14/support-data.pkl

Younger Americans are more likely to support the statewide legalization of gay marriage



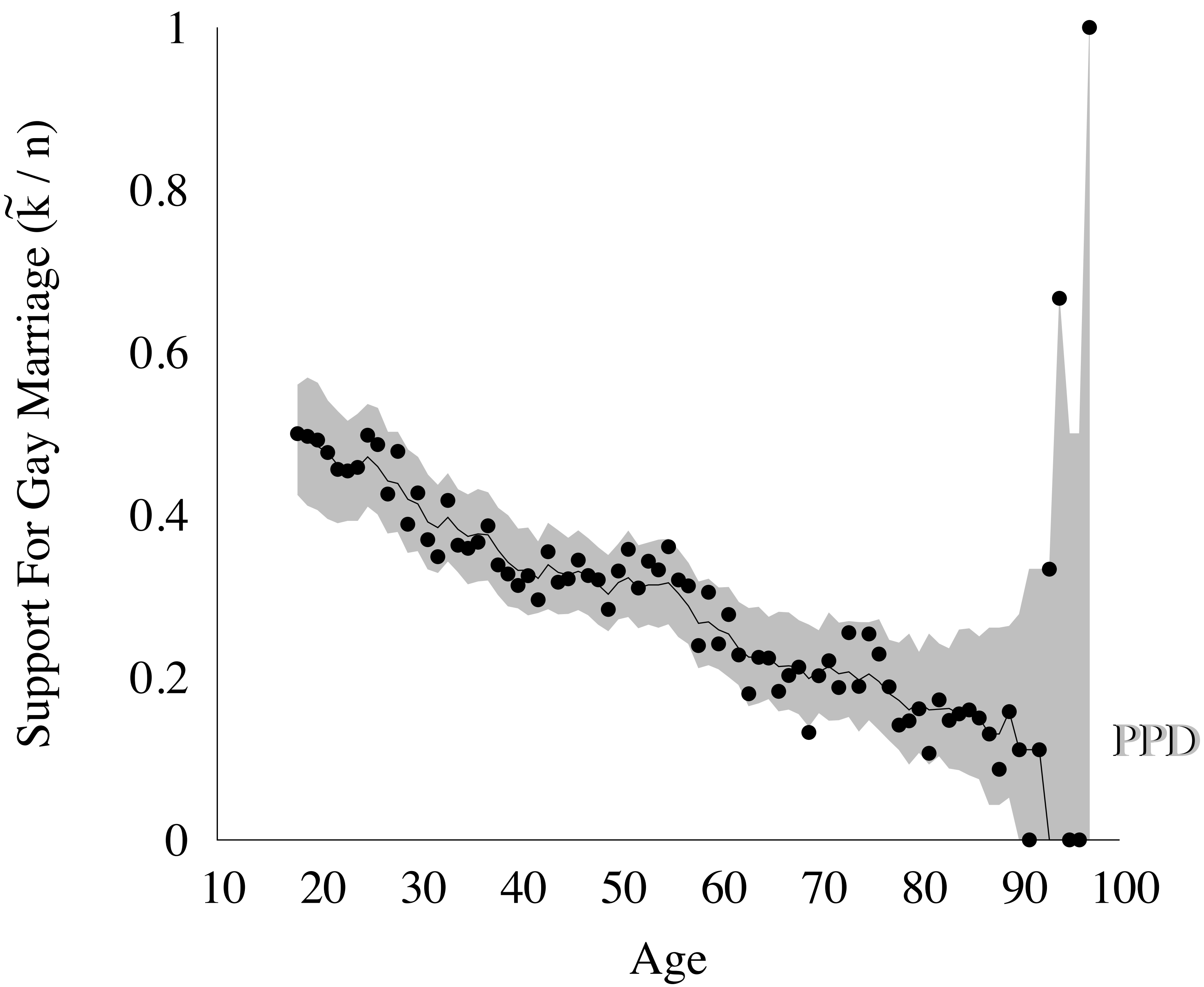
http://www.mc-stan.org/mlss14/support.data.R

The GP models the data well



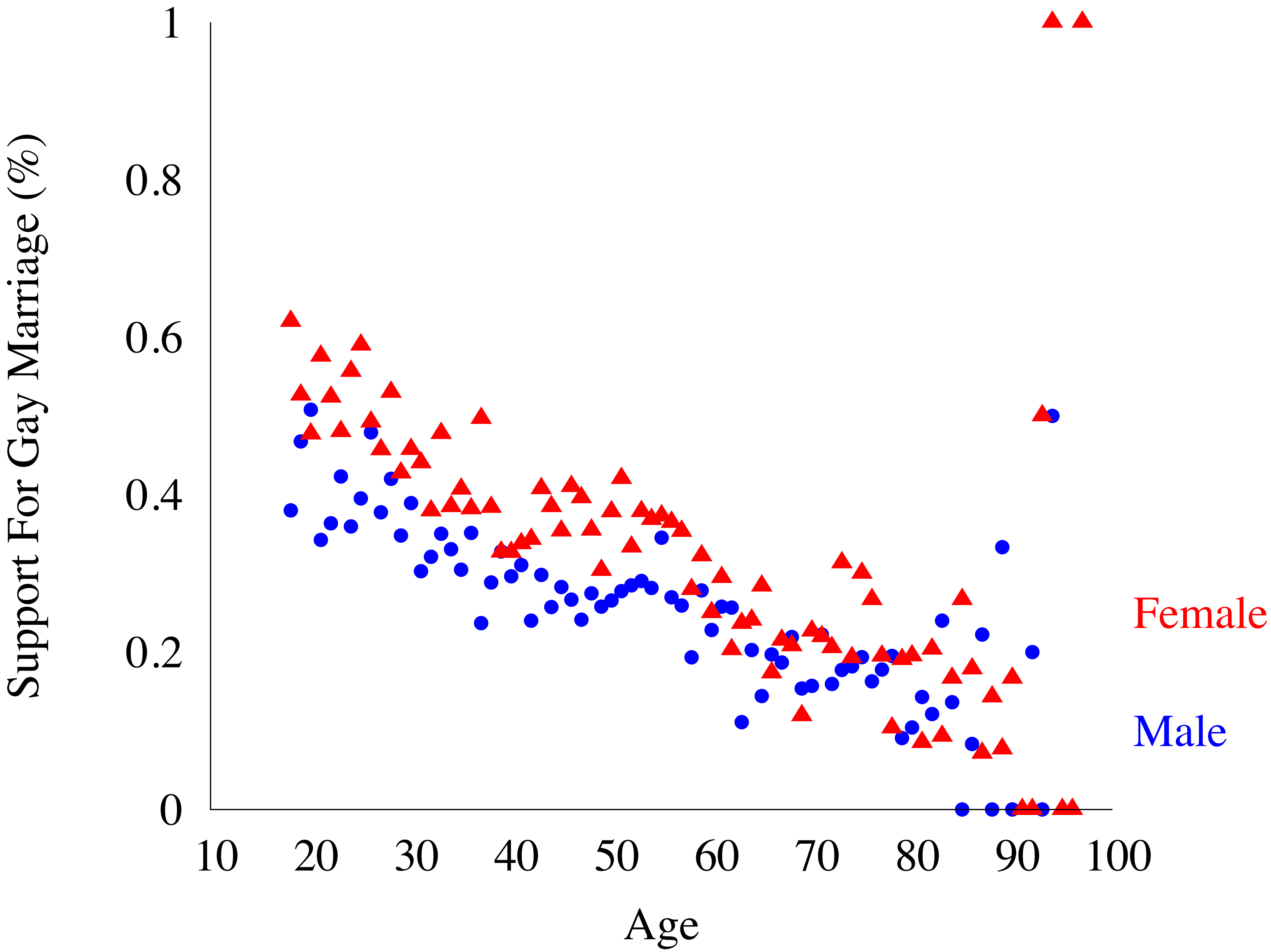
http://www.mc-stan.org/mlss14/support.data.R

And the posterior predictive checks indicate consistency

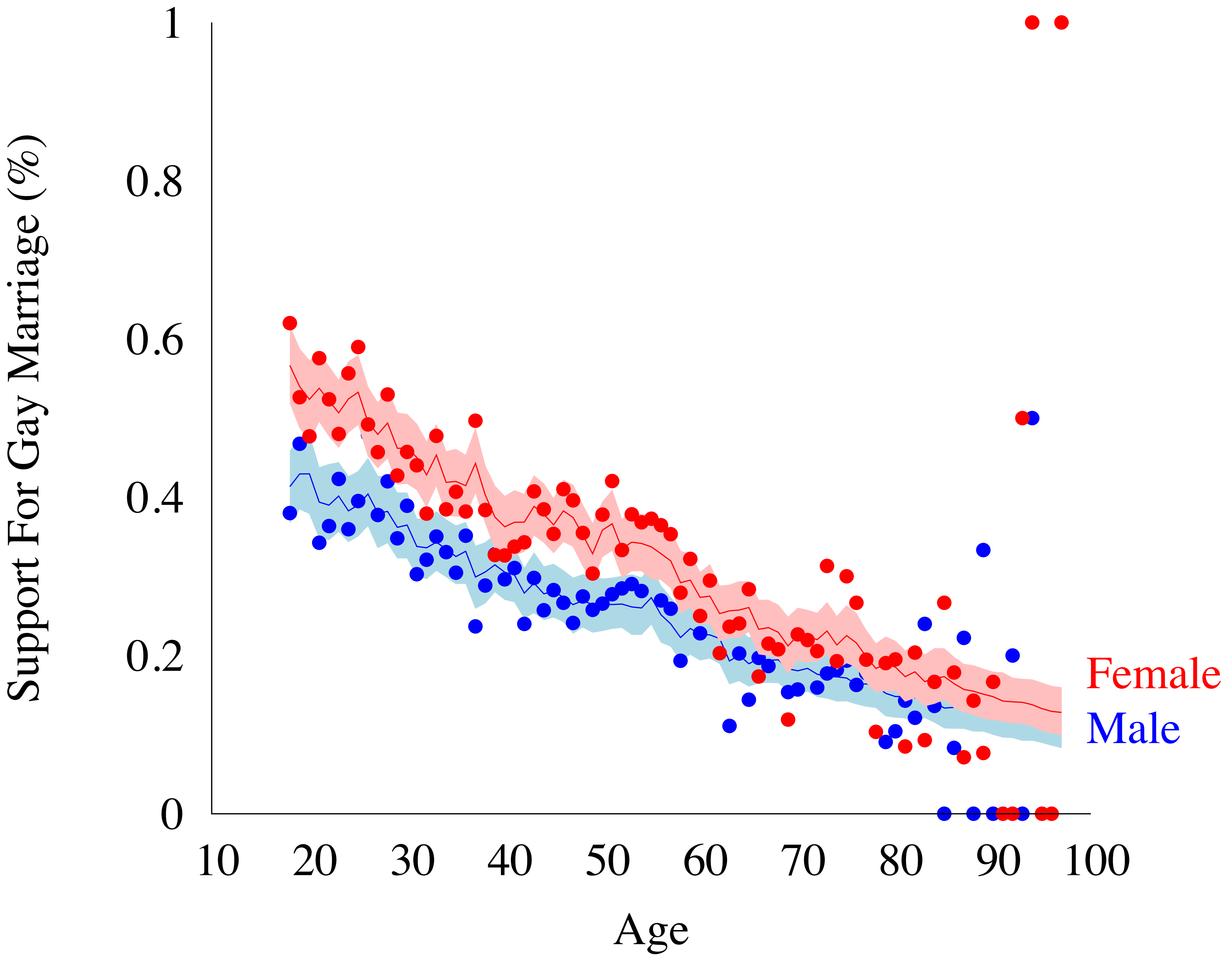


http://www.mc-stan.org/mlss14/support.data.R

But what about the covariates we've ignored?



http://www.mc-stan.org/mlss14/support.data.R



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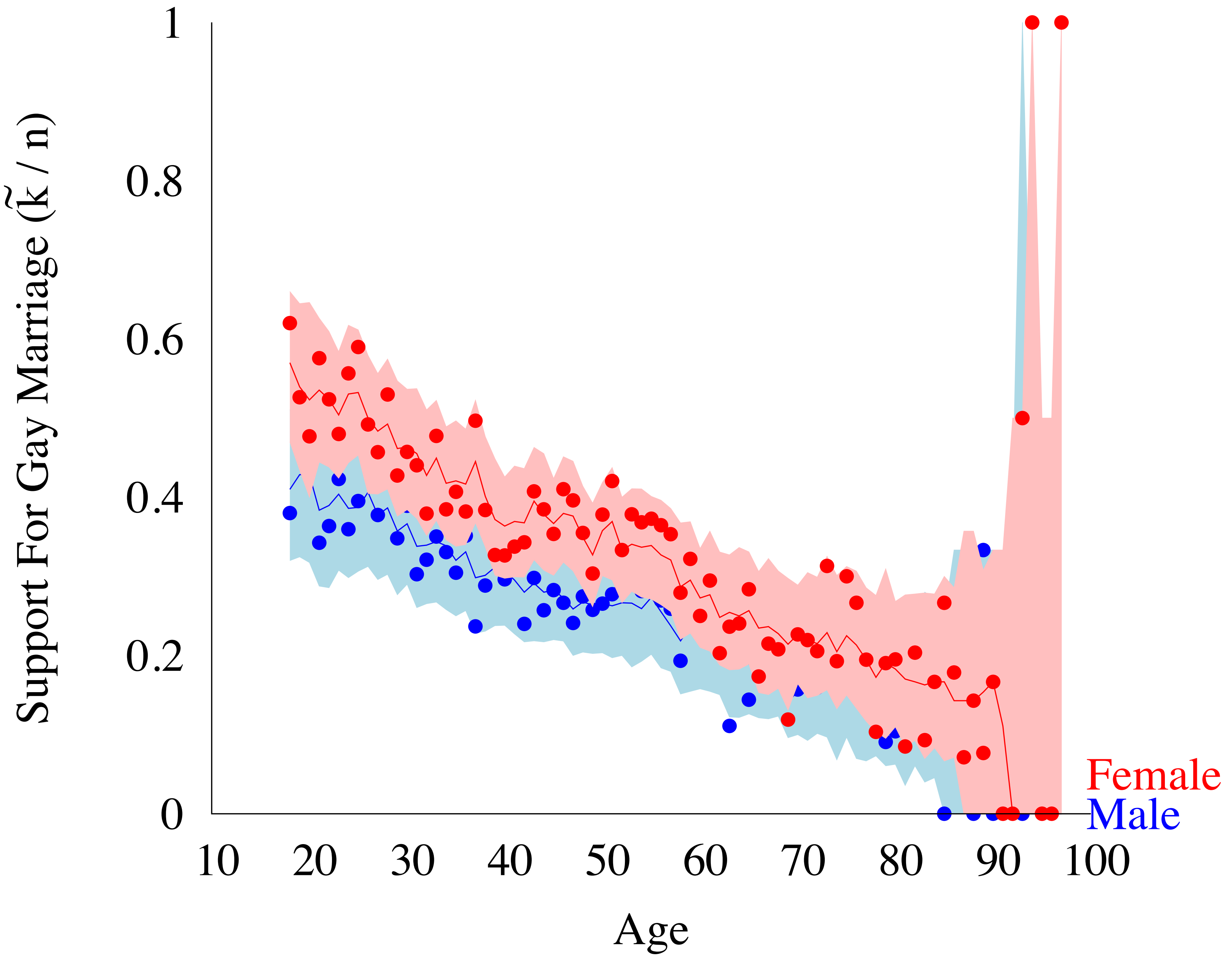

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