Reproducible workflows

- Reports from .R files
- e.g. 04_5_bootstrap_p-value.R

Main points McElreath Ch8

- MCMC: Monte Carlo Markov Chain
- Series of random numbers where each number depends on the previous one
- Sample less from low probability areas; more bang for your random buck
- Algorithms
  - Metropolis-Hastings
  - Gibbs sampling
  - HMC: Hamiltonian Monte Carlo
- We'll mostly use HMC

MCMC algorithms

- Get an intuition for their behavior:
- https://chi-feng.github.io/mcmc-demo/app.html#HamiltonianMC,standard

Bayesian tools

- Stan
  - Gelman group
  - Hamiltonian Monte Carlo
  - Betancourt (2017) A conceptual introduction to Hamiltonian Monte Carlo (https://arxiv.org/abs/1701.02434A)
  - open source
  - models with continuous parameters only
  - state of the art
- http://mc-stan.org

Bayesian tools

- BUGS (Bayesian inference Using Gibbs Sampling) (and Metropolis-Hastings)
- http://www.openbugs.info
- Older, original standard tool for MCMC
- Exceedingly difficult to run on Mac
- Several newer tools are based on BUGS code style
- Lots of books and publications use BUGS
- Recommend: don't use anymore

Bayesian tools

- JAGS (Just Another Gibbs Sampler)
- http://mcmc-jags.sourceforge.net/
  - cross platform, open source
  - basically the same as BUGS
  - often faster
  - highly recommended for models that can't be fit in Stan (e.g. discrete parameters)
  - easy install
- Best to run from R
  - Install R2jags package (install from R)

Main points McElreath Ch8

- Using HMC via Stan to fit models
- Now getting posterior samples from HMC
- First use map2stan in rethinking to do HMC to follow examples. Same syntax as sampost or map
- rstanarm does the same
  - Stan group's linear models package
  - syntax like lm

Main points McElreath Ch8

- rstanarm also uses Stan, HMC
  - Stan group's linear models package
  - syntax like lm
  - default priors

map2stan or sampost

```
m1 <- map2stan(
  alist(
    y ~ dnorm(mu,sigma),
    mu <- a + b*x,
    a ~ dnorm(0,100),
    b ~ dnorm(0,10),
    sigma ~ dcauchy(0,2)
  ),
  data=d1)
```

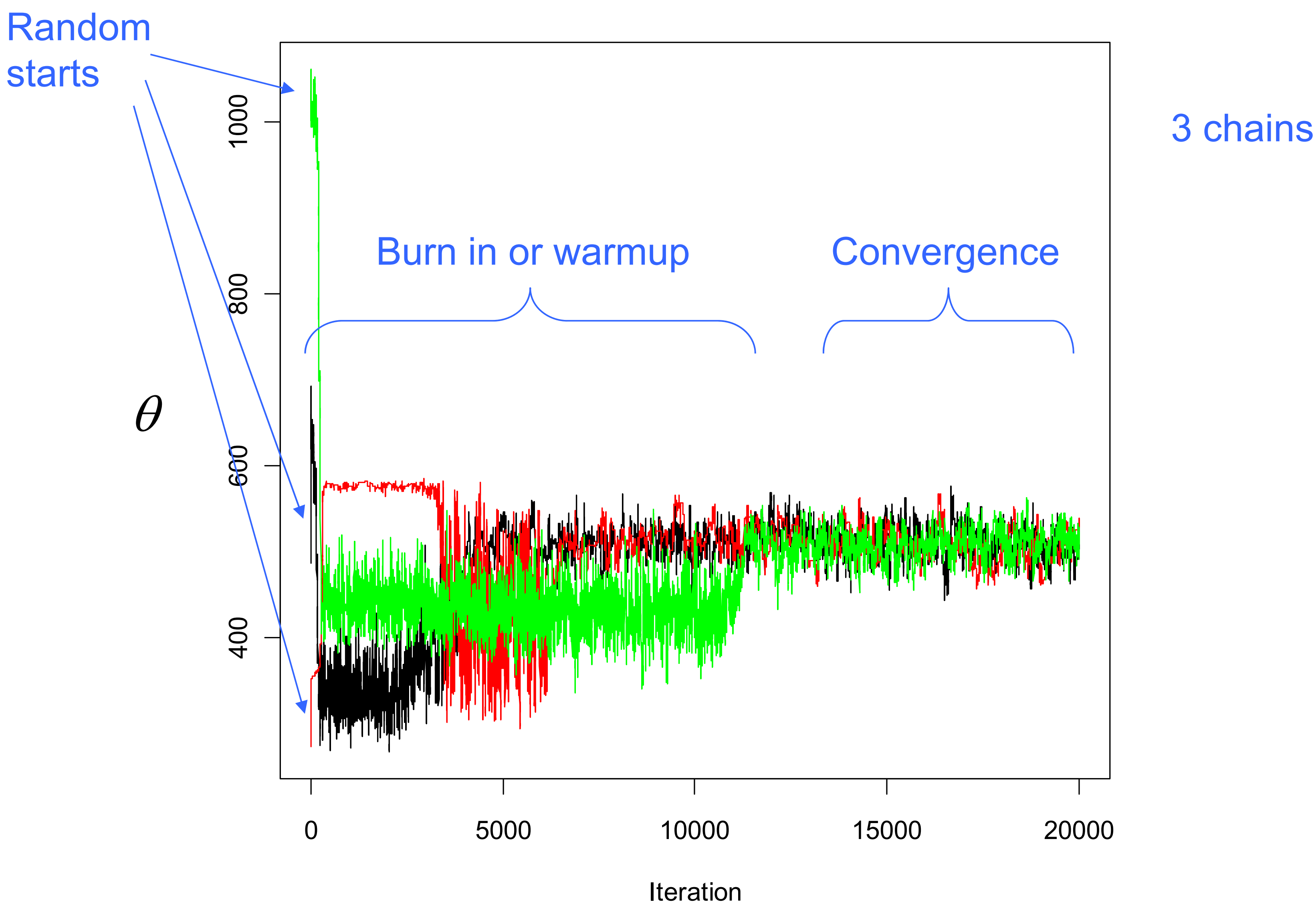
rstanarm

```
m1 <- stan_glm(y ~ b, data=d1)
```

Main points McElreath Ch8

- Good choice of priors (weakly informative) can be helpful to tame model fit
  - e.g. Half-Cauchy instead of uniform
- Look at MCMC diagnostics to judge convergence of fit
  - rhat, n_eff
  - plot chain traces ("time series")
- Visualize posteriors
  - histograms, pairs plot

Chains


Random
starts
3 chains
Burn in or warmup
Convergence
θ
1000
800
600
400
0
5000
10000
15000
20000
Iteration