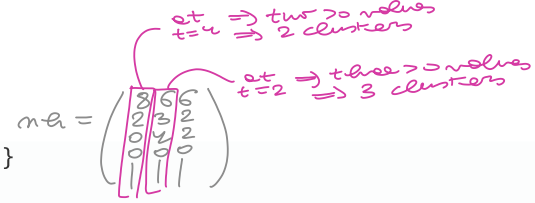
```
/*
 * Code is of the file DepdenetPartitionsAR1LikeAR1Theta_sPPM2.c
 * that one since the R function drpm_fit calls the function which
 * is defined there:
      initial_partition <- 0
      C.out <- .C("drpm_ar1_sppm", // defined in that file
                  as.integer(draws), as.integer(burn),as.integer(thin),
                  as.integer(nsubject),as.i)
 * so it should be the "main" file
 */


/*************************************************************
 * Copyright (c) 2018 Garritt Leland Page
 *
 * This file contains C code for an MCMC algorithm constructed
 * to fit a hierarchical model that incorporates the idea of
 * temporally dependent partitions.
 *
 * I will include model details at a later date
 *
 *************************************************************/
#include "matrix.h"
#include "Rutil.h"
#include <R_ext/Lapack.h>
#include <R.h>
#include <Rmath.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
/*************************************************************
* The following are the inputs of the function that are read from R
*
* draws = total number of MCMC draws
* burn = number of MCMC draws discarded as burn-in
* thin = indicates how much MCMC chain should be thinned
*
* nsubject = integer for the number of subjects in data set
* ntime = integer for the number of time points
* y = double nsubject x ntime matrix containing response for each
subject at time t
* s1 = nsubject x 1 vector containing spatial coordinate one
* s2 = nsubject x 1 vector containing spatial coordinate two
*
* M = double indicating value of M associated with cohesion (scale
parameter of DP).
* alpha = double - prior probability of being pegged, starting value
only if update_alpha is TRUE
* priorvals = vector containing values for prior distributions as
follows
*
* time_specific_alpha = integer - logical indicating wether to make
alpha time-specific or one global alpha.
* update_alpha = integer - logical indicating wether to update alpha
or not.
* update_eta1 = integer - logical indicating whether to update eta1
or set it to zero for all subjects.
* update_phi1 = integer - logical indicating whether to update phi1
or set it to zero.
* sPPM = integer - logical indicating whether to use spatial
information or not
*
* SpatialCohesion = integer indication which cohesion to use
* 1 -Auxiliary
* 2- Double dipper
*
* cParms - vector holding values employed in the cohesion
*
* OUTPUT
* Si -
* mu -
* sig2 -
* eta1
* theta -
* tau2 -
* phi0 -
* phi1
* gamma -
* alpha.out -
* like
* lpml -
* waic -
*************************************************************/
void drpm_ar1_sppm(int *draws, int *burn, int *thin, int *nsubject,
int *ntime,
        double *y, double *s1, double *s2, double *M,
        double *alpha, double *modelPriors, double *alphaPriors,
        int *time_specific_alpha,
        int *update_alpha, int *update_eta1, int *update_phi1,
        int *sPPM, int *SpatialCohesion, double *cParms, double *mh,
        int *space_1, int *simpleModel, double *theta_tau2,
        int *Si, double *mu, double *sig2, double *eta1, double
*theta, double *tau2,
        double *phi0, double *phi1, double *lam2, int *gamma, double
*alpha_out,
```

```
        double *fitted, double *llike, double *lpml, double *waic){

  // i - MCMC iterate
  // ii - MCMC iterate that is saved
  // j - subject iterate
  // jj - second subject iterate
  // t - time iterate
  // k - cluster iterate
  // kk - second cluster iterate
  // p - prediction iterate

  int i, ii, j, jj, t, k, kk;
  ii = 0;

  int nout = (*draws - *burn)/(*thin);
  Rprintf("nsubject = %d\n", *nsubject);
  Rprintf("ntime = %d\n", *ntime);
  Rprintf("nout = %d\n", nout);
  Rprintf("update_alpha = %d\n", *update_alpha);
  Rprintf("update_eta1 = %d\n", *update_eta1);
  Rprintf("update_phi1 = %d\n", *update_phi1);



  //
============================================================================
  //
  // Memory vectors to hold MCMC iterates for non cluster specific
parameters
  //
  //
============================================================================
  // This variable is used to create a "buffer" zone of memory so
that updating
  // things on time boundary do not need special attention in the
algorithm since
  // I have to look at time period before and after when updating
partitions
  int ntime1 = *ntime + 1;
  // I am adding one more year as an empty vector
  // so that the C program does not crash.
  int gamma_iter[(*nsubject)*(ntime1)];
  int Si_iter[(*nsubject)*(ntime1)];
  int nclus_iter[ntime1];
  double *eta1_iter = R_VectorInit(*nsubject, runif(0,1));
  double *theta_iter = R_VectorInit(ntime1, rnorm(0,3));
  double *tau2_iter = R_VectorInit(ntime1, runif(0,
modelPriors[3]*modelPriors[3]));
  double phi0_iter = rnorm(0,3);
  double phi1_iter = runif(0,1);
  double lam2_iter = runif(0, modelPriors[4]*modelPriors[4]);
  double *alpha_iter = R_VectorInit(ntime1, *alpha);

  //
============================================================================
  //
  // Memory vectors to hold MCMC iterates for cluster specific
parameters
  //
  //
============================================================================
  double *muh = R_VectorInit((*nsubject)*(ntime1), 0.0);
  double *sig2h = R_VectorInit((*nsubject)*(ntime1), 1.0);
    if(*simpleModel==1){
      for(t = 0; t < ntime1; t++){
        theta_iter[t] = theta_tau2[0];
        tau2_iter[t] = theta_tau2[1];
      }
    }
  int nh[(*nsubject)*(ntime1)];
  //
============================================================================
  //
  // Initialize a few parameter vectors
  //
  //
============================================================================
  // Initialize Si according to covariates
  // I am adding one time period here to have
  // scratch memory (never filled in) so that
  // I can avoid dealing with boundaries in algorithm
  for(j = 0; j < *nsubject; j++){
    for(t = 0; t < ntime1; t++){ // Note I am not initializing the
"added time memory"
      Si_iter[j*(ntime1) + t] = 1;
      gamma_iter[j*(ntime1) + t] = 0;
      nh[j*(ntime1) + t] = 0;
      if(t==1) Si_iter[j*ntime1 + t] = 1;
      if(t==*ntime) Si_iter[j*(ntime1) + t] = 0;
    }
  }
  // Initial enumeration of number of subjects per cluster;
  for(j = 0; j < *nsubject; j++){
    for(t = 0; t < *ntime; t++){
      nh[(Si_iter[j*(ntime1)+t]-1)*(ntime1) + t] = nh[(Si_iter[j*
(ntime1)+t]-1)*(ntime1) + t] + 1;
```




```
  }
 }
 // Initialize the number of clusters
 for(t = 0; t < *ntime; t++){
 nclus_iter[t] = 0;
   for(j = 0; j < *nsubject; j++){
     if(nh[j*(ntime1) + t] > 0) nclus_iter[t] = nclus_iter[t] + 1;
   }
 }
 nclus_iter[*ntime] = 0;

 //
//============================================================================
 //
 // scratch vectors of memory needed to update parameters
 //
 //
//============================================================================
 // stuff needed to update gamma vectors
 int nclus_red=0, nh_red[*nsubject], n_red=0, gt, n_red_1=0, cit_1;
 int nh_redtmp[*nsubject], nh_tmp[*nsubject];
 int nh_redtmp_no_zero[*nsubject],
nh_tmp_no_zero[*nsubject],nh_red_no_zero[*nsubject];
 int nh_red_1[*nsubject];
 // int nclus_red_1;
 int nh_redtmp_1[*nsubject], nh_tmp_1[*nsubject];
 int nh_redtmp_no_zero_1[*nsubject],
nh_red_no_zero_1[*nsubject],nh_tmp_no_zero_1[*nsubject];
 double *s1_red = R_VectorInit(*nsubject, 0.0);
 double *s2_red = R_VectorInit(*nsubject, 0.0);
 for(j=0; j<*nsubject; j++){
   nh_tmp[j] = 0; nh_red[j] = 0; nh_redtmp[j] = 0;
   nh_redtmp_no_zero[j] = 0;  nh_tmp_no_zero[j] = 0;
   nh_red_no_zero[j] = 0; nh_red_no_zero_1[j] = 0;

   nh_tmp_1[j] = 0; nh_red_1[j] = 0; nh_redtmp_1[j] = 0;
   nh_redtmp_no_zero_1[j] = 0; nh_red_no_zero_1[j] = 0;
nh_tmp_no_zero_1[j] = 0;
 }
 // stuff that I need to update Si (the parition);
 int
comp1t[(*nsubject)],comptm1[(*nsubject)],comp2t[(*nsubject)],comptp1[(
 int rho_tmp[*nsubject], Si_tmp[*nsubject], Si_tmp2[*nsubject];
 int Si_red[*nsubject], Si_red_1[*nsubject];
 int oldLab[*nsubject], reorder[*nsubject];
 int iaux, Rindx1, Rindx2, n_tmp, nclus_tmp, rho_comp, indx;
 double auxm, auxs, mudraw, sigdraw, maxph, denph, cprobh, uu, lCo,
lCn, lCn_1, lpp;
 double *ph = R_VectorInit(*nsubject, 0.0);
 double *phtmp = R_VectorInit(*nsubject, 0.0);
 double *probh = R_VectorInit(*nsubject, 0.0);
 double *lgweight = R_VectorInit(*nsubject, 0.0);
 double *s1o = R_Vector(*nsubject);
 double *s2o = R_Vector(*nsubject);
 double *s1n = R_Vector(*nsubject);
 double *s2n = R_Vector(*nsubject);
 for(j=0; j<(*nsubject); j++){
   comp1t[j] = 0; comptm1[j] = 0, comp2t[j]=0, comptp1[j]=0;
 }
 // stuff I need to update eta1
 double e1o, e1n, logito, logitn, one_phisq;
 // stuff I need to update muh and sig2h
 double mstar, s2star, sumy, sume2;
 double nsig, osig, llo, lln, llr;
 double *mu_tmp = R_VectorInit(*nsubject, 0.0);
 double *sig2_tmp = R_VectorInit(*nsubject, 1.0);

 // stuff that I need for theta and lam2
 double summu, nt, ot, lam2tmp, phi1sq, sumt, op1, np1, ol, nl;
//  double ssq;

 // stuff that I need to update alpha
 int sumg;
 double astar, bstar,alpha_tmp;

 // Stuff to compute lpml, likelihood, and WAIC
 int like0, nout_0=0;
 double lpml_iter, elppdWAIC;
 double *CPO = R_VectorInit((*nsubject)*(ntime1), 0.0);
 double *like_iter = R_VectorInit((*nsubject)*(ntime1), 0.0);
 double *fitted_iter = R_VectorInit((*nsubject)*(ntime1), 0.0);
 double *mnlike = R_VectorInit((*nsubject)*(ntime1), 0.0);
 double *mnllike = R_VectorInit((*nsubject)*(ntime1), 0.0);
 // stuff to predict
 // int gpred[*nsubject], nh_pred[*nsubject];
 //
//============================================================================
 //
 // Prior parameter values
 //
 //
//============================================================================
 // prior values for sig2
 double Asig=modelPriors[2];
 double Atau=modelPriors[3];
   double Alam=modelPriors[4];
```

```
  // priors for phi0
  double m0 = modelPriors[0], s20 = modelPriors[1];
  // priors for alpha
  double a = alphaPriors[0], b = alphaPriors[1];
  //priors for eta1
  double b_eta1 = modelPriors[5];

  // DP weight parameter
  double Mdp = *M;
    Rprintf("Prior values: Asig = %.2f, Atau = %.2f, Alam = %.2f, \n
m0 = %.2f, s20 = %.2f\n\n", Asig, Atau, Alam, m0, s20);
  // Cohesion auxiliary model paramaters for Cohesions 3 and 4
  double k0=cParms[1], v0=cParms[2];
  double *mu0 = R_VectorInit(2,cParms[0]);
  double *L0 = R_VectorInit(2*2,0.0);
  L0[0] = cParms[3]; L0[3] = cParms[3];

    if(*sPPM==1){
    RprintVecAsMat("mu0", mu0, 1, 2);
    Rprintf("k0 = %f\n", k0);
    Rprintf("v0 = %f\n", v0);
    RprintVecAsMat("L0", L0, 2, 2);
    }
  // M-H step tunning parameter
  double csigSIG=mh[0], csigTAU=mh[1], csigLAM=mh[2], csigETA1=mh[3],
csigPHI1=mh[4];
  GetRNGstate();
  //
=================================================================
  //
  // start of the mcmc algorithm;
  //
  //
=================================================================

  for(i = 0; i < *draws; i++){
    if((i+1) % 10000 == 0){
      time_t now;
      time(&now);
      Rprintf("mcmc iter = %d
========================================= \n", i+1);
      Rprintf("%s", ctime(&now));
    }
    // Start updating gamma and partition for each time period
    for(t = 0; t < *ntime; t++){

                                  Original labels (Si): 1 3 3 5 5 4 4 1 2 1
//////////////////////////////////      Relabeled groups (Sirelab): 1 2 2 3 3 4 4 1 5 1
    //                          Reordered cluster sizes (nhrelab): 3 2 2 2 1 0 0 0 0 0
                                        Old labels (oldLab): 1 3 5 4 2 0 0 0 0 0

      // begin by updating gamma (pegged) parameters
      //

////////////////////////////////////////////////////////////////////
      for(j = 0; j < *nsubject; j++){
        // at time period one, all gammas are zero (none are
``pegged'')
        if(t == 0){
          gamma_iter[j*(ntime1) + t] = 0;
        } else {

////////////////////////////////////////////////////////////////////
          // find the reduced partition information
          // i.e., vector of cluster labels;

////////////////////////////////////////////////////////////////////
          Rindx1 = 0;
          for(jj = 0; jj < *nsubject; jj++){
            if(gamma_iter[jj*ntime1 + (t)] == 1){
              if(jj != j){
                Si_tmp[Rindx1] = Si_iter[jj*ntime1 + (t)];
                Si_tmp2[Rindx1] = Si_iter[jj*ntime1 + (t)];
                comptm1[Rindx1] = Si_iter[jj*ntime1 + (t-1)];
                // Also get the reduced spatial coordinates if
                // space is included
                if(*sPPM==1){
                  if((*space_1==1 & t == 0) | (*space_1==0)){
                    s1_red[Rindx1] = s1[jj];
                    s2_red[Rindx1] = s2[jj];
                  }
                }
                Rindx1 = Rindx1 + 1;
              }
            }
          }
          Si_tmp2[Rindx1] = Si_iter[j*ntime1 + (t)];
          comptm1[Rindx1] = Si_iter[j*ntime1 + (t-1)];
          n_red = Rindx1;
          n_red_1 = Rindx1 + 1;
          relabel(Si_tmp, *nsubject, Si_red, reorder, oldLab);
          relabel(Si_tmp2, *nsubject, Si_red_1, reorder, oldLab);
          // I need to keep the relabeled cluster label for the
          pegged
          // individual so that I know what lgweight to keep in the
          // full conditional.
          cit_1 = Si_red_1[Rindx1];
```

Definition 1. We say that partitions ρ_{t-1} and ρ_t are compatible with respect to $\boldsymbol{\gamma}_t$, if ρ_t may be obtained from ρ_{t-1} by reallocating items as indicated by $\boldsymbol{\gamma}_t$, that is, those items i such that $\gamma_{it} = 0$ for $i = 1, \ldots, m$. Note that the compatibility relation is an equivalence relation.

There is a simple way to check if ρ_{t-1} is compatible with ρ_t with respect to $\boldsymbol{\gamma}_t$. Let $\mathfrak{R}_t = \{i : \gamma_{it} = 1\}$ be the collection of units that remain fixed when moving from time $t-1$ to time t, and $\mathfrak{R}_t^C = \{i : \gamma_{it} = 0\}$ is the collection of units that do not. Next denote with $\rho_t^{\mathfrak{R}_t}$ the "reduced" partition at time t that remains after removing all items in $\mathfrak{R}_t^C$ from the subsets of ρ_t. Similarly, let $\rho_{t-1}^{\mathfrak{R}_t}$ be the reduced partition at time $t-1$ based on $\boldsymbol{\gamma}_t$. Then ρ_{t-1} and ρ_t are compatible with respect to $\boldsymbol{\gamma}_t$ if and only if $\rho_{t-1}^{\mathfrak{R}_t} = \rho_t^{\mathfrak{R}_t}$.

```
for(jj = 0; jj < n_red_1; jj++){
  nh_red[jj]=0; nh_red_1[jj]=0;
}
nclus_red = 0;
for(jj = 0; jj < n_red; jj++){
  nh_red[Si_red[jj]-1] = nh_red[Si_red[jj]-1] + 1;
  nh_red_1[Si_red_1[jj]-1] = nh_red_1[Si_red_1[jj]-1] + 1;
  if(Si_red[jj] > nclus_red) nclus_red = Si_red[jj];
}
nh_red_1[Si_red_1[n_red]-1]= nh_red_1[Si_red_1[n_red]-1] +
1;
        // this may need to be updated depending on if the value of
gamma changes
        //nclus_red_1 = nclus_red;
        //if(Si_red_1[n_red] > nclus_red) nclus_red_1 =
Si_red_1[n_red];
        lCo=0.0, lCn=0.0;
        for(k = 0; k < nclus_red; k++){
          if(*sPPM==1){
            // Note that if space is only included for first time
point

            // then it does not inform gamma.
           if((*space_1==1 & t == 0) | (*space_1==0)){
            indx = 0;
            for(jj = 0; jj < n_red; jj++){
              if(Si_red[jj] == k+1){
                s1o[indx] = s1_red[jj];
                s2o[indx] = s2_red[jj];

                s1n[indx] = s1_red[jj];
                s2n[indx] = s2_red[jj];
                indx = indx+1;
              }
            }
            s1n[indx] = s1[j];
            s2n[indx] = s2[j];

            lCo = Cohesion3_4(s1o, s2o, mu0, k0, v0, L0,
nh_red[k], *SpatialCohesion, 1);
            lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0,
nh_red[k]+1,*SpatialCohesion, 1);
          }
        }
        lgweight[k] = log(nh_red[k]) + lCn - lCo;
        Si_red_1[Rindx1] = k+1;
        rho_comp = compatibility(Si_red_1, comptm1, Rindx1+1);
//          if(rho_comp==0) lgweight[k] = log(0);
        }

        // What if pegged subject creates a singleton in the
reduced partition?
        lCn_1=0.0;
        if(*sPPM==1){
          if((*space_1==1 & t == 0) | (*space_1==0)){

            s1o[0] = s1[j];
            s2o[0] = s2[j];
            lCn_1 = Cohesion3_4(s1o, s2o, mu0, k0, v0, L0,
1,*SpatialCohesion, 1);
          }
        }
        lgweight[nclus_red] = log(Mdp) + lCn_1;

        Si_red_1[Rindx1] = nclus_red+1;
        rho_comp = compatibility(Si_red_1, comptm1, Rindx1+1);
//          if(rho_comp == 0) lgweight[nclus_red] = log(0);


        denph = 0.0;
        for(k = 0; k < nclus_red + 1; k++){
          phtmp[k] = lgweight[k] ;
        }
        R_rsort(phtmp,  nclus_red + 1) ;


        maxph = phtmp[nclus_red];
        denph = 0.0;
        for(k = 0; k < nclus_red + 1; k++){

          lgweight[k] = exp(lgweight[k] - maxph);
          denph = denph + lgweight[k];
        }

        for(k = 0; k < nclus_red + 1; k++){
          lgweight[k] = lgweight[k]/denph;
        }


        probh[1] = alpha_iter[t]/(alpha_iter[t] + (1-
alpha_iter[t])*lgweight[cit_1-1]);
        // If gamma is 1 at current MCMC iterate, then there are no
        // concerns about partitions being incompatible as gamma
```

```
// Note that if time_specific_alpha is false, then
// alpha[t] is the same for all value of t
if(*unit_specific_alpha==1){
  probh[1] = alpha_iter[j*(ntime1) + t]/
             (alpha_iter[j*(ntime1) + t] + (1-alpha_iter[j*(ntime1) + t])*lgweight[cit_1-1]);
} else {
  probh[1] = alpha_iter[t]/(alpha_iter[t] + (1-alpha_iter[t])*lgweight[cit_1-1]);
}
```

$$\Pr(\gamma_{it}=1 \mid -) = \frac{\alpha_t}{\alpha_t + (1-\alpha_t)\Pr(\rho_{t-1}^{s_i^{(+)}})/\Pr(\rho_t^{s_i^{(-)}})} \mathrm{I}[\rho_{t-1}^{s_i^{(+)}} = \rho_t^{s_i^{(+)}}] \qquad \text{(S.8)}$$

```
changes
          // from 1 to 0.
          //
          // However, if gamma's current value is 0, then care must
be taken when
          // trying to change from gamma=0 to gamma=1 as the
partitions may
          // no longer be compatible
          if(gamma_iter[j*(ntime1) + t] == 0){

            // To determine compatibility, I need to make sure that
            // comparison of the reduced partitios is being made with
            // correct cluster labeling.  I try to do this by
identifying
            // the sets of units and sequentially assigning "cluster
labels"
            // starting with set that contains the first unit. I
wonder if
            // there is a way to do this in C with out using loops?
Who
            // can I ask about this?
            // Get rho_t | gamma_t = 1 and rho_{t-1} | gamma_t = 1
            // when gamma_{it} = 1;
            Rindx1 = 0;
            for(jj = 0; jj < *nsubject; jj++){
              if(gamma_iter[jj*ntime1 + (t)] == 1){
                comptm1[Rindx1] = Si_iter[jj*ntime1 + (t-1)];
                comp1t[Rindx1] = Si_iter[jj*ntime1 + (t)];
                Rindx1 = Rindx1 + 1;
              }
              // I need to include this because determine what
happens when
              // gamma goes from 0 to 1;
              if(jj == j){
                comptm1[Rindx1] = Si_iter[jj*ntime1 + (t-1)];
                comp1t[Rindx1] = Si_iter[jj*ntime1 + (t)];
                Rindx1 = Rindx1 + 1;
              }
            }
            rho_comp = compatibility(comptm1, comp1t, Rindx1);
            // If rho_comp = 0 then not compatible and probability of
            // pegging subject needs to be set to 0;
            if(rho_comp==0){
              probh[1] = 0;
            }

          }
```

```
          gt = rbinom(1,probh[1]);

          gamma_iter[j*(ntime1) + t] = gt;
        }
      }

//////////////////////////////////////////////////////////////////////////
      //
      // update partition
      //

//////////////////////////////////////////////////////////////////////////
      // The cluster probabilities depend on four partition
probabilities
      //
      // rho_t
      // rho_t.R
      // rho_t+1
      // rho_t+1.R
      //
      // I have switched a number of times on which of these needs to
be computed
      // and which one can be absorbed in the normalizing constant.
Right now I am
      // leaning towards Pr(rho_t+1) and Pr(rho_t+1.R) can be
absorbed.  But I need
      // to use rho_t.R and rho_t+1.R to check compatibility as I
update rho_t.
      //
```

```
  //
  ////////////////////////////////////////////////////////////////////////////
  // The cluster probabilities depend on four partition probabilities
  //
  // rho_t
  // rho_t.Reduced
  // rho_t+1
  // rho_t+1.Reduced
  //
  // I have switched a number of times on which of these needs to be computed
  // and which one can be absorbed in the normalizing constant.  Right now I am
  // leaning towards Pr(rho_t+1) and Pr(rho_t+1.R) can be absorbed.  But I need
  // to use rho_t.R and rho_t+1.R to check compatibility as I update rho_t.
  //
  ////////////////////////////////////////////////////////////////////////////
  for(jj = 0; jj < *nsubject; jj++){
    rho_tmp[jj] = Si_iter[jj*(ntime1) + t];
  }
  // It seems to me that I can use some of the structure used to carry
  // out Algorithm 8 from previous code to keep track of empty clusters
  // etc.
    for(j = 0; j < *nsubject; j++){
  // Only need to update partition relative to units that are not pegged
  //
  // Note that if a centering partition is supplied then gamma = 1 for all units and the
  // first entry of Si_iter is never updated and so this part of codes is never executed
  // for t=0 when rho0 is supplied.
      if(gamma_iter[j*(ntime1) + t] == 0){
    if(nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] > 1){
      // Observation belongs to a non-singleton ...
      nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = nh[(Si_iter[j*(ntime1) + t]-1)*
(ntime1) + t] - 1;
    }else{

      // Observation is a member of a singleton cluster ...

      iaux = Si_iter[j*(ntime1) + t];
      if(iaux < nclus_iter[t]){
        // Need to relabel clusters. I will do this by swapping cluster labels
      // Si_iter[j] and nclus_iter along with cluster specific parameters;

      // All members of last cluster will be assigned subject j's label
      for(jj = 0; jj < *nsubject; jj++){
        if(Si_iter[jj*(ntime1) + t] == nclus_iter[t]){
          Si_iter[jj*(ntime1) + t] = iaux;
          }
        }

      Si_iter[j*(ntime1) + t] = nclus_iter[t];
            // The following steps swaps order of cluster specific parameters
            // so that the newly labeled subjects from previous step retain
            // their correct cluster specific parameters
            auxs = sig2h[(iaux-1)*ntime1 + t];
            sig2h[(iaux-1)*ntime1 + t] = sig2h[(nclus_iter[t]-1)*(ntime1)+t];
            sig2h[(nclus_iter[t]-1)*(ntime1)+t] = auxs;

            auxm = muh[(iaux-1)*ntime1 + t];
            muh[(iaux-1)*ntime1 + t] = muh[(nclus_iter[t]-1)*(ntime1)+t];
            muh[(nclus_iter[t]-1)*(ntime1)+t] = auxm;
            // the number of members in cluster is also swapped with the last
            nh[(iaux-1)*(ntime1)+t] = nh[(nclus_iter[t]-1)*(ntime1)+t];
            nh[(nclus_iter[t]-1)*(ntime1)+t] = 1;

      }

      // Now remove the ith obs and last cluster;
      nh[(nclus_iter[t]-1)*(ntime1)+t] = nh[(nclus_iter[t]-1)*(ntime1)+t] - 1;
      nclus_iter[t] = nclus_iter[t] - 1;
    }
    for(jj = 0; jj < *nsubject; jj++){
      rho_tmp[jj] = Si_iter[jj*(ntime1) + t];
    }
       for(k = 0; k < nclus_iter[t]; k++){
      rho_tmp[j] = k+1;

      // First need to check compatability
      Rindx2=0;
      for(jj = 0; jj < *nsubject; jj++){
        if(gamma_iter[jj*ntime1 + (t+1)] == 1){
          comp2t[Rindx2] = rho_tmp[jj];
          comptp1[Rindx2] = Si_iter[jj*ntime1 + (t+1)];
          Rindx2 = Rindx2 + 1;
        }
      }
      // check for compatibility
      rho_comp = compatibility(comp2t, comptp1, Rindx2);
          if(rho_comp != 1){
        ph[k] = log(0); // Not compatible
          } else {
        // Need to compute Pr(rhot), Pr(rhot.R), Pr(rhot+1), Pr(rhot+1.R)

        for(jj = 0; jj < *nsubject; jj++){
          nh_tmp[jj] = 0;
        }
        n_tmp = 0;
        for(jj = 0; jj < *nsubject; jj++){
          nh_tmp[rho_tmp[jj]-1] = nh_tmp[rho_tmp[jj]-1]+1;
        n_tmp=n_tmp+1;
        }

        nclus_tmp=0;
        for(jj = 0; jj < *nsubject; jj++){
          if(nh_tmp[jj] > 0) nclus_tmp = nclus_tmp + 1;
        }


        lpp = 0.0;
        for(kk = 0; kk < nclus_tmp; kk++){
          // Beginning of spatial part
          lCn = 0.0;
          if(*sPPM==1){
          if((*space_1==1 & t == 1) | (*space_1==0)){
            indx = 0;
          for(jj = 0; jj < *nsubject; jj++){
            if(rho_tmp[jj] == kk+1){
            s1n[indx] = s1[jj];
            s2n[indx] = s2[jj];
            indx = indx+1;
            }
```

```
          }
          lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0, nh_tmp[kk],*SpatialCohesion, 1);
          }
        }
        // End of spatial part

//          lpp = lpp + nclus_tmp*log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn;
//          lpp = lpp + nh_tmp[kk]*log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn;
        lpp = lpp + (log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn);

        }
        if(t==1){// t=1 is first time point after centering partition
              ph[k] = dnorm(y[j*(*ntime) + t],
              muh[k*(ntime1) + t],
              sqrt(sig2h[k*(ntime1) + t]), 1) +
            lpp;

        }
            if(t > 1){// Do I want there to be temporal correlation between rho0 and
rho1?
              ph[k] = dnorm(y[j*(*ntime) + t],
              muh[k*(ntime1) + t] + eta1_iter[j]*y[j*(*ntime) + t-1],
              sqrt(sig2h[k*(ntime1) + t]*(1-eta1_iter[j]*eta1_iter[j])), 1)+
            lpp;
            }
        // use this to test if MCMC draws from prior are correct
//          ph[k] = lpp;

          }
        }

      // Determine if E.U. gets allocated to a new cluster
      // Need to check compatibility first

      rho_tmp[j] = nclus_iter[t]+1;


      // First need to check compatability
      Rindx1 = 0, Rindx2=0;
      for(jj = 0; jj < *nsubject; jj++){
        if(gamma_iter[jj*ntime1 + (t+1)] == 1){
          comp2t[Rindx2] = rho_tmp[jj];
        comptp1[Rindx2] = Si_iter[jj*ntime1 + (t+1)];
        Rindx2 = Rindx2 + 1;
      }
      }
      // check for compatibility
      rho_comp = compatibility(comp2t, comptp1, Rindx2);


      if(rho_comp != 1){
        ph[nclus_iter[t]] = log(0); // going to own cluster is not compatible;
        } else {

        mudraw = rnorm(theta_iter[t], sqrt(tau2_iter[t]));
        sigdraw = runif(0, Asig);

          for(jj = 0; jj < *nsubject; jj++){
            nh_tmp[jj] = 0;
        }
        n_tmp = 0;
          for(jj = 0; jj < *nsubject; jj++){
            nh_tmp[rho_tmp[jj]-1] = nh_tmp[rho_tmp[jj]-1]+1;
            n_tmp=n_tmp+1;
          }

          nclus_tmp=0;
          for(jj = 0; jj < *nsubject; jj++){
            if(nh_tmp[jj] > 0) nclus_tmp = nclus_tmp + 1;
          }

          lpp = 0.0;
          for(kk = 0; kk < nclus_tmp; kk++){

          // Beginning of spatial part
          lCn = 0.0;
          if(*sPPM==1){
            if((*space_1==1 & t == 1) | (*space_1==0)){
              indx = 0;
              for(jj = 0; jj < *nsubject; jj++){

                if(rho_tmp[jj] == kk+1){

                s1n[indx] = s1[jj];
                s2n[indx] = s2[jj];
                indx = indx+1;
              }
            }
            lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0, nh_tmp[kk],*SpatialCohesion, 1);
            }
          }
          // End of spatial part

          lpp = lpp + (log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn);
//          lpp = lpp + nh_tmp[kk]*log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn;
          }

          if(t==1){
            ph[nclus_iter[t]] = dnorm(y[j*(*ntime) + t], mudraw, sigdraw, 1) +
                                lpp;
          }
          if(t > 1){
            ph[nclus_iter[t]] = dnorm(y[j*(*ntime) + t],
                                      mudraw + eta1_iter[j]*y[j*(*ntime) + t-1],
                          sigdraw*sqrt(1-eta1_iter[j]*eta1_iter[j]), 1) +
                        lpp;
          }
//          ph[nclus_iter[t]] =  lpp;
          }
        // Now compute the probabilities
        for(k = 0; k < nclus_iter[t]+1; k++) phtmp[k] = ph[k];

          R_rsort(phtmp,  nclus_iter[t]+1) ;

        maxph = phtmp[nclus_iter[t]];


      denph = 0.0;
      for(k = 0; k < nclus_iter[t]+1; k++){
        ph[k] = exp(ph[k] - maxph);
        denph = denph + ph[k];
          }
```

```
    for(k = 0; k < nclus_iter[t]+1; k++){
      probh[k] = ph[k]/denph;
    }

    uu = runif(0.0,1.0);
    cprobh= 0.0;;
    for(k = 0; k < nclus_iter[t]+1; k++){
      cprobh = cprobh + probh[k];
      if (uu < cprobh){
        iaux = k+1;
        break;
      }
        }
    if(iaux <= nclus_iter[t]){
      Si_iter[j*(ntime1) + t] = iaux;
      nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] = nh[(Si_iter[j*(ntime1) + t]-1)*
(ntime1)+t] + 1;
      rho_tmp[j] = iaux;
        }else{
      nclus_iter[t] = nclus_iter[t] + 1;
      Si_iter[j*(ntime1) + t] = nclus_iter[t];
      nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] = 1;
      rho_tmp[j] = nclus_iter[t];

      muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = mudraw;
      sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = sigdraw*sigdraw;
      if(*simpleModel==1) sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = 1.0;
    }
    }
    for(jj = 0; jj < *nsubject; jj++){
      Si_tmp[jj] = Si_iter[jj*(ntime1) + t];
      Si_tmp2[jj] = 0;
      reorder[jj] = 0;
    }
    // I believe that I have to make sure that groups are order so that
    // EU one is always in the group one, and then the smallest index not
    // with group 1 anchors group 2 etc.

    relabel(Si_tmp, *nsubject, Si_tmp2, reorder, oldLab);

    for(jj=0; jj<*nsubject; jj++){
      Si_iter[jj*(ntime1) + t] = Si_tmp2[jj];
    }
    for(k = 0; k < nclus_iter[t]; k++){
      mu_tmp[k] = muh[k*(ntime1)+t];
      sig2_tmp[k] = sig2h[k*(ntime1)+t];
    }
    for(k = 0; k < nclus_iter[t]; k++){
      nh[k*(ntime1)+t] = reorder[k];
      muh[k*(ntime1)+t] = mu_tmp[(oldLab[k]-1)];
      sig2h[k*(ntime1)+t] = sig2_tmp[(oldLab[k]-1)];
    }
    }
    for(j = 0; j < *nsubject; j++){
      Si_tmp[j] = Si_iter[j*(ntime1) + t];
      Si_tmp2[j] = 0;
    reorder[j] = 0;
    }
    // I believe that I have to make sure that groups are order so that
    // EU one is always in the group one, and then the smallest index not
    // with group 1 anchors group 2 etc.
```

```
    relabel(Si_tmp, *nsubject, Si_tmp2, reorder, oldLab);
    for(j=0; j<*nsubject; j++){
      Si_iter[j*(ntime1) + t] = Si_tmp2[j];
    }
    for(k = 0; k < nclus_iter[t]; k++){
      mu_tmp[k] = muh[k*(ntime1)+t];
      sig2_tmp[k] = sig2h[k*(ntime1)+t];
    }
    for(k = 0; k < nclus_iter[t]; k++){
      nh[k*(ntime1)+t] = reorder[k];
    muh[k*(ntime1)+t] = mu_tmp[(oldLab[k]-1)];
    sig2h[k*(ntime1)+t] = sig2_tmp[(oldLab[k]-1)];
    }

//    for(k = 0; k < nclus_iter[t]; k++) sig2h[k*(ntime1)+t] = 1.0;
    for(k = 0; k < nclus_iter[t]; k++){

      ////////////////////////////////////////
      //                                    //
      // update muh                         //
      //                                    //
      ////////////////////////////////////////
      if(t==1){
        sumy = 0.0;
    for(j = 0; j < *nsubject; j++){
      if(Si_iter[j*(ntime1) + t] == k+1){
        sumy = sumy + y[j*(*ntime)+t];
      }
    }
    s2star = 1/((double) nh[k*(ntime1)+t]/sig2h[k*(ntime1) + t] + 1/tau2_iter[t]);
    mstar = s2star*( (1/sig2h[k*(ntime1) + t])*sumy + (1/tau2_iter[t])*theta_iter[t]);
      }
    if(t > 1){
        sumy = 0.0;
      sume2 = 0.0;
      for(j = 0; j < *nsubject; j++){
        if(Si_iter[j*(ntime1) + t] == k+1){
        sume2 = sume2 + 1.0/(1-eta1_iter[j]*eta1_iter[j]);
        sumy = sumy + (y[j*(*ntime)+t] - eta1_iter[j]*y[j*(*ntime)+t-1])/
                      (1-eta1_iter[j]*eta1_iter[j]);
        }
      }
      s2star = 1/( (1.0/sig2h[k*(ntime1) + t])*sume2  + 1/tau2_iter[t]);
      mstar = s2star*( (1.0/sig2h[k*(ntime1) + t])*sumy + (1/tau2_iter[t])*theta_iter[t]);

    }
    muh[k*(ntime1) + t] = rnorm(mstar, sqrt(s2star));
    ////////////////////////////////////////
    //                                    //
    // update sig2h                       //
    //                                    //
    ////////////////////////////////////////
    osig = sqrt(sig2h[k*(ntime1) + t]);
    nsig = rnorm(osig,csigSIG);
    if(nsig > 0.0 & nsig < Asig){

      lln = 0.0;
      llo = 0.0;
          if(t == 1){
        for(j = 0; j < *nsubject; j++){
          if(Si_iter[j*(ntime1) + t] == k+1){
            llo = llo + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t], osig,1);
```

```
              lln = lln + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t], nsig,1);
            }
          }
        }
        if(t > 1){
          for(j = 0; j < *nsubject; j++){
            if(Si_iter[j*(ntime1) + t] == k+1){
              llo = llo + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t] +
                        eta1_iter[j]*y[j*(*ntime) + t-1],
                      osig*sqrt(1-eta1_iter[j]*eta1_iter[j]),1);
              lln = lln + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t] +
                      eta1_iter[j]*y[j*(*ntime) + t-1],
                      nsig*sqrt(1-eta1_iter[j]*eta1_iter[j]),1);
            }
          }
        }

      llo = llo + dunif(osig, 0.0, Asig, 1);
      lln = lln + dunif(nsig, 0.0, Asig, 1);
//      llo = llo + dgamma(osig*osig, 10, 0.1, 1);
//      lln = lln + dgamma(nsig*nsig, 10, 0.1, 1);


      llr = lln - llo;
      uu = runif(0,1);

      if(log(uu) < llr){
        sig2h[k*(ntime1) + t] = nsig*nsig;
      }
      if(*simpleModel==1) sig2h[k*(ntime1) + t] = 1.0;
        }
      }


    ////////////////////////////////////////////////////////////////////////////
    //                                        //
    // update theta (mean of mh)                          //
    //                                        //
    ////////////////////////////////////////////////////////////////////////////
    summu = 0.0;
    for(k = 0; k < nclus_iter[t]; k++){
    summu = summu + muh[k*(ntime1) + t];
    }

    phi1sq = phi1_iter*phi1_iter;
    lam2tmp = lam2_iter*(1.0 - phi1sq);

    if(t==1){
    s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + 1.0/lam2_iter + phi1sq/lam2tmp);
    mstar = s2star*( (1.0/tau2_iter[t])*summu +
                 (1.0/lam2_iter)*phi0_iter +
                 (1.0/lam2tmp)*phi1_iter*(theta_iter[t+1]-phi0_iter*(1-phi1_iter)));

    } else if(t==(*ntime-1)){

      s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + 1.0/lam2tmp);
      mstar = s2star*((1.0/tau2_iter[t])*summu +
                  (1.0/lam2tmp)*(phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-1]));

    } else {
      s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + (1.0 + phi1sq)/lam2tmp);
    mstar = s2star*( (1.0/tau2_iter[t])*summu +
                  (1.0/lam2tmp)*(phi1_iter*(theta_iter[t-1] + theta_iter[t+1]) +
                                 phi0_iter*(1.0 - phi1_iter)*(1.0 - phi1_iter)));
    }

    theta_iter[t] = rnorm(mstar, sqrt(s2star));
    if(*simpleModel==1) theta_iter[t] = theta_tau2[0];
    ////////////////////////////////////////////////////////////////////////////
    //                                        //
    // update tau2 (variance of mh)                       //
    //                                        //
    ////////////////////////////////////////////////////////////////////////////
    ot = sqrt(tau2_iter[t]);
    nt = rnorm(ot,csigTAU);
    if(nt > 0){

      lln = 0.0;
      llo = 0.0;
      for(k = 0; k < nclus_iter[t]; k++){
      llo = llo + dnorm(muh[k*(ntime1) + t], theta_iter[t], ot,1);
      lln = lln + dnorm(muh[k*(ntime1) + t], theta_iter[t], nt,1);
    }

      llo = llo + dunif(ot, 0.0, Atau, 1);
    lln = lln + dunif(nt, 0.0, Atau, 1);



    llr = lln - llo;
    uu = runif(0,1);

    if(log(uu) < llr){
      tau2_iter[t] = nt*nt;
    }
    if(*simpleModel==1) tau2_iter[t] = theta_tau2[1];
    }
    }
  ////////////////////////////////////////////////////////////////////////////
  //                                        //
  // update eta1 (temporal correlation parameter at likelihood)       //
  //                                        //
  ////////////////////////////////////////////////////////////////////////////
    if(*update_eta1==1){
      for(j = 0; j < *nsubject; j++){
        e1o = eta1_iter[j];
        e1n = rnorm(e1o, csigETA1);

        if(e1n < 1 & e1n > -1){

          llo=lln=0.0;
          for(t=1; t<*ntime; t++){// need to skip the first "Y" as it is a column of zeros
to accomodate rho0
            llo = llo + dnorm(y[j*(*ntime)+t],
                              muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] + e1o*y[j*
(*ntime)+t-1],
                              sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t]*(1-
e1o*e1o)), 1);
            lln = lln + dnorm(y[j*(*ntime)+t],
                              muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] + e1n*y[j*
(*ntime)+t-1],
                              sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t]* (1-
e1n*e1n)), 1);
          }
```

```
        logito = log(0.5*(e1o + 1)) - log(1 - 0.5*(e1o+1));
        logitn = log(0.5*(e1n + 1)) - log(1 - 0.5*(e1n+1));

        llo = llo + -log(2*b_eta1) - (1/b_eta1)*fabs(logito - 0.0);
        lln = lln + -log(2*b_eta1) - (1/b_eta1)*fabs(logitn - 0.0);
        llr = lln - llo;
        uu = runif(0,1);

        if(llr > log(uu)) eta1_iter[j] = e1n;
      }
    }
  }
  ////////////////////////////////////////////////////////////////////////////
  //                                      //
  // update alpha                             //
  //                                      //
  ////////////////////////////////////////////////////////////////////////////
  if(*update_alpha == 1){
  if(*time_specific_alpha == 0 & *unit_specific_alpha==0){ // global  time and unit

    sumg = 0;
    for(j = 0; j < *nsubject; j++){
      for(t = 1; t < *ntime; t++){
      sumg = sumg + gamma_iter[j*ntime1 + t];
    }
    }
  astar = (double) sumg + alphaPriors[0];
  bstar = (double) ((*nsubject)*(*ntime-1) - sumg) + alphaPriors[1];

  alpha_tmp = rbeta(astar, bstar);
  for(t=1;t<*ntime;t++){alpha_iter[t] = alpha_tmp;}
    alpha_iter[0] = 1.0;
    }
    if(*time_specific_alpha == 1 & *unit_specific_alpha==0){   // local time and global
unit
    for(t = 1; t < *ntime; t++){
      sumg = 0;
    for(j = 0; j < *nsubject; j++){
      sumg = sumg + gamma_iter[j*ntime1 + t];
    }

    astar = (double) sumg + alphaPriors[0];
    bstar = (double) ((*nsubject) - sumg) + alphaPriors[1];
    alpha_iter[t] = rbeta(astar, bstar);
      }
    alpha_iter[0] = 1.0;
    }
    if(*time_specific_alpha == 0 & *unit_specific_alpha==1){ // global time and local
unit
      for(j = 0; j < *nsubject; j++){
        sumg = 0;
        for(t = 1; t < *ntime; t++){
      sumg = sumg + gamma_iter[j*ntime1 + t];
        }

    astar = (double) sumg + alphaPriors[j*2 + 0];
    bstar = (double) ((*ntime-1) - sumg) +  alphaPriors[j*2 + 1];

    alpha_iter[j*ntime1 + 1] = rbeta(astar, bstar);
      }
  }
    if(*time_specific_alpha == 1 & *unit_specific_alpha==1){ // local time and local unit
      for(j = 0; j < *nsubject; j++){
        for(t = 1; t < *ntime; t++){
          sumg =  gamma_iter[j*ntime1 + t];
      astar = (double) sumg + alphaPriors[j*2 + 0];
      bstar = (double) ((*ntime-1) - sumg) +  alphaPriors[j*2 + 1];

      alpha_iter[j*ntime1 + t] = rbeta(astar, bstar);
        }
      }
  }
  }

  if(*ntime>2){
    ////////////////////////////////////////////////////////////////////////////
    //                                      //
    // update phi0                              //
    //                                      //
    ////////////////////////////////////////////////////////////////////////////
    phi1sq = phi1_iter*phi1_iter;
    one_phisq = (1-phi1_iter)*(1-phi1_iter);
    lam2tmp = lam2_iter*(1.0 - phi1sq);

    sumt = 0.0;
    for(t=2; t<*ntime; t++){
      sumt = sumt + (theta_iter[t] - phi1_iter*theta_iter[t-1]);
    }

    s2star = 1.0/((*ntime-1)*(one_phisq/lam2tmp) + (1/lam2_iter) + (1/s20));
    mstar = s2star*(((1.0-phi1_iter)/lam2tmp)*sumt + (1/lam2_iter)*theta_iter[0] +
(1/s20)*m0);

    phi0_iter = rnorm(mstar, sqrt(s2star));


    ////////////////////////////////////////////////////////////////////////////
    //                                      //
    // update phi1                              //
    //                                      //
    ////////////////////////////////////////////////////////////////////////////

    if(*update_phi1==1){
      op1 = phi1_iter;
      np1 = rnorm(op1, csigPHI1);

      if(np1 > -1 & np1 < 1){
        llo = 0.0, lln = 0.0;
      for(t=2; t < *ntime; t++){//

        llo = llo + dnorm(theta_iter[t], phi0_iter*(1-op1) + op1*theta_iter[t-1],
                                          sqrt(lam2_iter*(1.0 - op1*op1)), 1);
        lln = lln + dnorm(theta_iter[t], phi0_iter*(1-np1) + np1*theta_iter[t-1],
                                          sqrt(lam2_iter*(1.0 - np1*np1)), 1);
      }

      llo = llo + dunif(op1, -1,1, 1);
      lln = lln + dunif(np1, -1,1, 1);

      llr = lln - llo;
      if(llr > log(runif(0,1))) phi1_iter = np1;
      }
    }
```

```
    ////////////////////////////////////////////////////////////////////////////
    //                                        //
    // update lam2                                  //
    //                                        //
    ////////////////////////////////////////////////////////////////////////////

    // Update lambda with a MH step
    phi1sq = phi1_iter*phi1_iter;

    ol = sqrt(lam2_iter);
    nl = rnorm(ol, csigLAM);
    if(nl > 0.0){
      lln = 0.0;
      llo = 0.0;
      for(t=2; t<*ntime; t++){
        llo = llo + dnorm(theta_iter[t],
                          phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-1], ol*sqrt(1-
phi1sq),1);
        lln = lln + dnorm(theta_iter[t],
                          phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-1], nl*sqrt(1-
phi1sq),1);
      }
      llo = llo + dnorm(theta_iter[0], phi0_iter, ol, 1) + dunif(ol, 0.0, Alam, 1);
      lln = lln + dnorm(theta_iter[0], phi0_iter, nl, 1) + dunif(nl, 0.0, Alam, 1);

      llr = lln - llo;
      uu = runif(0,1);

      if(log(uu) < llr){
        lam2_iter = nl*nl;
      }
    }
  }

/*
  phi1sq = phi1_iter*phi1_iter;
  ssq = 0.0;
  for(t=1; t<*ntime; t++){
    ssq = ssq + (theta_iter[t] - (phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-1]))*
                (theta_iter[t] - (phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-
1]));
  }
  ssq = 1.0/(1.0 - phi1sq)*ssq + (theta_iter[0]-phi0_iter)*(theta_iter[0]-phi0_iter);

  astar = 0.5*(*ntime) + 1;
  bstar = 0.5*ssq + 1/1;

  lam2_iter = 1.0/rgamma(astar, 1/bstar);


    ////////////////////////////////////////////////////////////////////////////
    //                                        //
    // predict partition for new time period                  //
    //                                        //
    ////////////////////////////////////////////////////////////////////////////

    for(p = 0; p < *npred; p++){

      for(j=0; j<*nsubject; j++){
        nh_pred[j] = 0;
        predSi_iter[j*(*npred) + p] = 0;
      }

      if(*update_alpha == 0){
        n_red = 0;
        for(j=0;j<*nsubject;j++){

          gpred[j] = rbinom(1,*alpha);

          if(gpred[j] == 1){
            nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] = nh_pred[Si_iter[j*(ntime1)+
(*ntime)-1] - 1] + 1;
            n_red = n_red + 1;

            predSi_iter[j*(*npred) + p] = Si_iter[j*(ntime1)+(*ntime)-1];
          }
        }

      }


      if(*update_alpha == 1){
        if(*time_specific_alpha == 1){


          n_red = 0;
          for(j=0;j<*nsubject;j++){

            gpred[j] = rbinom(1,alpha_iter[1]);

            if(gpred[j] == 1){
              nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] = nh_pred[Si_iter[j*(ntime1)+
(*ntime)-1] - 1] + 1;
              n_red = n_red + 1;

              predSi_iter[j*(*npred) + p] = Si_iter[j*(ntime1)+(*ntime)-1];
            }
          }

        }else {

        }
      }


      remove_zero(nh_pred, *nsubject, nh_tmp_no_zero);

      nclus_tmp = 0;
      for(j=0; j<*nsubject;j++){
        if(nh_tmp_no_zero[j] > 0){
          nclus_tmp = nclus_tmp + 1;
        }else{
          break;
        }
      }


      for(j=0;j<*nsubject;j++){
        if(gpred[j] == 0){
          for(k = 0; k < nclus_tmp; k++){
            probh[k] = nh_pred[k]/(n_red + Mdp);
          }
          probh[nclus_tmp] = Mdp/(n_red + Mdp);
```

```
          uu = runif(0.0,1.0);

          cprobh= 0.0;;
          for(k = 0; k < nclus_tmp+1; k++){

            cprobh = cprobh + probh[k];

            if (uu < cprobh){

              iaux = k+1;
              break;
            }
          }

          if(iaux <= nclus_tmp){

            predSi_iter[j*(*npred) + p] = iaux;
            nh_pred[iaux-1] = nh_pred[iaux-1] + 1;
          }else{

            nclus_tmp = nclus_tmp + 1;
            predSi_iter[j*(*npred) + p] = nclus_tmp;
            nh_pred[(predSi_iter[j*(*npred) + p]-1)*(*npred)+p] = 1;

          }
          n_red = n_red + 1;

        }
      }
    }
*/


////////////////////////////////////////////////////////////////////////////////////////
    //
    // evaluating likelihood that will be used to calculate LPML and WAIC?
    // (see page 81 Christensen Hansen and Johnson)
    //

////////////////////////////////////////////////////////////////////////////////////////
    if(i > (*burn-1) & i % (*thin) == 0){

      like0=0;
      for(j = 0; j < *nsubject; j++){
        for(t = 1; t < *ntime; t++){

        mudraw = muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t];
        sigdraw = sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t]);


        if(t == 1){

          like_iter[j*(*ntime)+t] = dnorm(y[j*(*ntime)+t], mudraw, sigdraw, 1);
          fitted_iter[j*(*ntime)+t] = mudraw;

        }
        if(t > 1){

          like_iter[j*(*ntime)+t] = dnorm(y[j*(*ntime)+t],
                          mudraw + eta1_iter[j]*y[j*(*ntime)+t-1],
                          sigdraw*sqrt(1-eta1_iter[j]*eta1_iter[j]), 1);
          fitted_iter[j*(*ntime)+t] = mudraw + eta1_iter[j]*y[j*(*ntime)+t-1];
        }


        // These are needed for WAIC
        mnlike[j*(*ntime)+t] = mnlike[j*(*ntime)+t] + exp(like_iter[j*(*ntime)+t])/(double)
nout;
        mnllike[j*(*ntime)+t] = mnllike[j*(*ntime)+t] + (like_iter[j*(*ntime)+t])/(double)
nout;


        if(exp(like_iter[j*(*ntime)+t]) < 1e-320) like0=1;

      }
      }
      if(like0==1) nout_0 = nout_0 + 1;

      if(like0==0){
        for(j = 0; j < *nsubject; j++){
        for(t = 1; t < *ntime; t++){
          CPO[j*(*ntime)+t] = CPO[j*(*ntime)+t] + (1/(double) nout)*(1/exp(like_iter[j*
(*ntime)+t]));
        }
      }
      }
    }



    ////////////////////////////////////////////////////////////////////////////////////
    //                                                //
    // Save MCMC iterates                                     //
    //                                                //
    ////////////////////////////////////////////////////////////////////////////////////
    if((i > (*burn-1)) & ((i+1) % *thin == 0)){
      // Notice that I am not saving the "first" time as it belongs to the
      // vector of zeros added to the data and nothing is updated.
      for(t = 1; t < *ntime; t++){
        if(*unit_specific_alpha==0) alpha_out[ii*(*ntime) + t-1] = alpha_iter[t];
      theta[ii*(*ntime) + t-1] = theta_iter[t];
      tau2[ii*(*ntime) + t-1] = tau2_iter[t];

      for(j = 0; j < *nsubject; j++){
          if(*unit_specific_alpha==1) alpha_out[(ii*(*nsubject) + j)*(*ntime) +  t-1] =
alpha_iter[j*ntime1 + t];
          sig2[(ii*(*nsubject) + j)*(*ntime) + t-1] = sig2h[(Si_iter[j*(ntime1) + t]-1)*
(ntime1) + t];
        mu[(ii*(*nsubject) + j)*(*ntime) + t-1] = muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)
+ t];
        Si[(ii*(*nsubject) + j)*(*ntime) + t-1] = Si_iter[j*ntime1 + t];
        gamma[(ii*(*nsubject) + j)*(*ntime) + t-1] = gamma_iter[j*ntime1 + t];

        llike[(ii*(*nsubject) + j)*(*ntime) + t-1] = like_iter[j*(*ntime)+t];
        fitted[(ii*(*nsubject) + j)*(*ntime) + t-1] = fitted_iter[j*(*ntime)+t];

      }
      }

      for(j=0; j<*nsubject; j++){
        eta1[ii*(*nsubject) + j] = eta1_iter[j];
      }
```

```
      phi1[ii] = phi1_iter;
      phi0[ii] = phi0_iter;
      lam2[ii] = lam2_iter;

      ii = ii+1;

    }
    /**/
  }

  lpml_iter=0.0;
  for(t = 1; t < *ntime; t++){
  for(j = 0; j < *nsubject; j++){

    lpml_iter = lpml_iter + log(1/CPO[j*(*ntime)+t]);

  }
  }
  lpml[0] = lpml_iter;
  elppdWAIC = 0.0;

  for(j = 0; j < *nsubject; j++){
    for(t = 1; t < *ntime; t++){
    elppdWAIC = elppdWAIC + (2*mnllike[j*(*ntime)+t] - log(mnlike[j*(*ntime)+t]));
  }
  }
  waic[0] = -2*elppdWAIC;
  PutRNGstate();
}
```

INPUT:
drows, burnin, thin
nsubjects (n)
ntime (T)
y, s1, s2 (data and spatial coords)
X (the covariate matrix)
M (Dirichlet mass parameter)
α (starting alpha)
model_priors = [m_0, s_0, A_σ, A_τ, A_λ, $b_{\eta 1}$]
α_priors = [a_α, b_α]
time_specific_α
unit_specific_α
update_α
update_η_1
update_φ_1
sPPM (true if we model the spatial coords)
modelX (true if we model the covariates)
spatial_cohesion
covariates_similarity
cParams (vector for the spatial cohesion params: [μ_0, k_0, ν_0, L_0])
mh (vector for metropolis steps update for [σ^2, τ, λ, η_1, φ_1])
space_1 (messo in FALSE in R, era per usare lo spazio solo a t=1 o sempre)
simple_model
θ_{τ^2} (and) used if simple model is TRUE)

OUTPUT:
S_i
μ
σ^2
η_1
θ
τ^2
φ_0
φ_1
λ^2
γ
Yout
fitted (Yest)
llike
LPML
WAIC

RESPECTIVES IN THE CODE:

ntime1 = T+1 := T^*
⇒ nel codice se da $0 \le t < T^*$ quindi le matrici hanno T+1 col, da 0 a T

Si_iter	n×T^* of ones (initializations; tranne 0 al tempo 0 all)
μh	n×T^* of zeros
σ^2_h	n×T^* of ones
η_1_iter	n of $\mathcal{U}(0,1)$
θ_iter	T^* of $\mathcal{N}(0,3^2)$
τ^2_iter	T^* of $\mathcal{U}(0,A_\tau^2)$
φ_0_iter	scalar, $\mathcal{N}(0,3^2)$
φ_1_iter	scalar, $\mathcal{U}(0,1)$
λ^2 iter	scalar, $\mathcal{U}(0,A_\lambda^2)$
γ_iter	n×T^* of zeros
α_iter	T^* of starting_α times ones

altre cose

nclus_iter	T^* (it counts the # of cls at time t)
nh	n×T^* (it counts the numerosity of each cl at each time t) (worst case)

$p(\gamma_{it}=1\mid -) = \dfrac{\alpha_t}{\alpha_t + (1-\alpha_t)\dfrac{p(\rho_t^{R_t(+i)})}{p(\rho_t^{R_t(-i)})}} \cdot \mathbb{1}\{\rho_{t-1}^{R_t(+i)} = \rho_t^{R_t(+i)}\}$

ALGORITMO

\# initialize some params
nout = (drows − burnin)/thin

ii = 0 per ogni MCMC iterates)

S_i_iter = rows 1…n, cols 0…T: (1 … | 0)

γ_iter = rows 1…n, cols 0…T: (0)

nh = rows 1…n (indici come label ora), cols 0…T: (0 … 0)

nclus_iter = cols 0 1 … T: (1 1 … 1) — sono tutti nello stesso cluster inizialmente

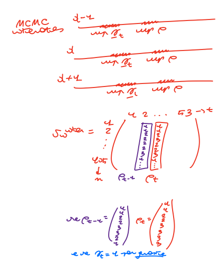
altre cose inizializzate tutte a 0 (variabili ausiliarie per dopo)

\# estrazione delle var. usando le variabili in input

\# start effettivo dell'algoritmo

```
for (i=0, i<drows)
    for (t=0, t<T)
        update γ
        update ρ
        update μh
        update σ²h
        update θ
        update τ²
    update η1
    update α
    update φ0
    update φ1
    update λ²
```

\# update γ
```
for (j=0, j<n)
    if (t==0) γ_iter[j,t] = 0        ~ at the first time instant all units are free to move
    else
        Si^TMP  = Si_iter[jj : jj≠j AND γjjt = 1, t] = ρt^Rt(-j)
        Si^TMP2 = Si_iter[jj : jj=j OR γjjt = 1, t] = ρt^Rt(+j)
        COMP_{t-1} = Si_iter[jj : jj=j OR γjjt = 1, t-1] = ρ_{t-1}^Rt(+j)   ~ questa non serve ora
        s1RED = s1(eg lat)[jj : jj≠j AND γjjt = 1]
        s2RED = s2(eg long)[jj : jj≠j AND γjjt = 1]

        nRED  = Rx = |Si^TMP| = |ρt^Rt(-j)|    ~ we (they) represent how (many) units we selected
        nRED1 = Rx+1 = |Si^TMP2| = |ρt^Rt(+j)|

        SiRED  = relabel(Si^TMP)     ~ forse in julia potremmo evitare questo relabel qui
        SiRED1 = relabel(Si^TMP2)
        cit = SiRED1[end]            ~ we added j as last element, now here we have its label

        nclusRED = max(SiRED)
        nhRED(h)  = [quante unità in SiRED hanno label h]    ~ nclusRED ≠ nclusRED1 possible
        nhRED1(h) = [quante unità in SiRED1 hanno label h]

        lCo = 0, lCn = 0
        # unit j can enter an existing cluster       ~ perché in label partono da 1, ma c da 0
        for (h=0, h<nclusRED)
            s1o = s1RED[jj≠j : SiRED[jj] == h+1]     ~ we take the spatial coords relative to label h
            s2o = //
            s1n = s1o ∪ s1[j]                        ~ original vs new (possible) coords
            s2n = //

            lCo = spatial_cohesion(...)
            lCn = spatial_cohesion(...)
            lweight[h] = ln(nhRED[h]) + lCn − lCo
            SiRED1[end] = h+1                        ~ current label to which we assign unit j

            pcomp = comp(SiRED1, COMP_{t-1})
            // if(pcomp=0) lweight[h] = ln(0)        ~ ma è commentato, quindi per ora lo controllo e non lo uso

        # unit j could create a new cluster (a singleton for now)
        s1o = s1[j]
        s2o = //
        lCn = spatial_cohesion(...)
        lweight[nclusRED] = ln(M_DP) + lCn
        SiRED1[end] = nclusRED + 1
        pcomp = comp(SiRED1, COMP_{t-1})
        // if(pcomp=0) lweight[nclusRED] = ln(0)
        exponentiate (with numerical tricks) the weights and normalize them

        ph = αt / (αt + (1 − αt) lweight[cit − 1])    ~ to pass from the C label to the index ones

        if (γjt = 0)
            COMP_{t-1} = ρ_{t-1}^Rt(+j) = Si_iter[jj≠j : γjjt = 1, t-1] ∪ Si_iter[j, t-1]
            COMP_{1t}  = ρt^Rt(+j) = Si_iter[    "    , t] ∪ Si_iter[j, t]
            ρcomp = comp(COMP_{t-1}, COMP_{1t})
            if (ρcomp = 0) ph = 0

        gt ~ Ber(ph)
        γjt = gt
```



INPUT:

```
draws, burn, thin
nsubjects (n)
ntime (T)
Y, s1, s2 (data and spatial coords)
X (the covariate matrix)
M (Dirichlet mass parameter)
α (starting alpha)
model_priors = [m0, s0, Aσ, Aτ, Aλ, bη1]
α_priors = [aα, bα]
time_specific_α
unit_specific_α
update_α
update_η1
update_φ1
sPPM (true if we model the spatial coords)
modelX (true if we model the covariates)
spatial_cohesion
covariates_similarity
cParams (vector for the spatial cohesion params: [μ0, k0, ν0, L0])
mh (vector for metropolis steps update for [σ², τ, λ, η1, φ1])
space_1 (messo in FALSE in R, era per usare la spatial solo a t=1 o sempre)
simple_model
θ_τ2 (old) used if simple model is TRUE)
```

ALGORITMO

```
# initialize some params
nout = (draws - burnin) / thin

iter = 0  for running MCMC iterates
Si_iter = 1..n × (1 ... T)  (matrix of 1s, first column 0)
γ_iter = 1..n × (0 ... T)  (0)
nh = 1..n × (0 1 ... T)  (0 / n ... 0)
       └ units come label 1
nclus_iter = (0 1 ... T) (1 1 ... 1)   ← nei tutti nello stesso cluster inizialmente
altre cose inizializzate tutte a 0 (variabili ausiliarie per dopo)

# estrazione delle vari variabili in input

# start effettivo dell'algoritmo
for (i=0, i<draws)
    for (t=0, t<T)
        update γ
        update ρ
        update μ_c
        update σ²_c
        update θ
        update τ²
    update η1
    update α
    update φ0
    update φ1
    update λ²
```

update ρ

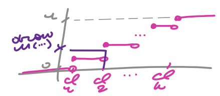
```
ρTMP = copy(ρt) = copy(Si_iter[,t])
for (j=0, j<nsubjects)
    # we only update the partition relatively to the units that can move (we filter γjt=0)
    if (γjt=0)
        # we now update to remove the unit j to the cluster he was belonging to
        if (unit j ∈ a non-singleton cl)
            easy correction
            nh[that cl] -= 1
        else (unit j ∈ a singleton cl)
            less easy correction
            relabel to set unit j's cl as the last one
            then again remove it as in the if

        ρTMP = copy(ρt) = copy(Si_iter[,t])
        for (h=0, h<nclus_iter[t])
            ρTMP[j] = h   ← for each cl we update to assign unit j to them
            COMP_1t = ρTMP^{R_{t+1}} = ρt^{R_{t+1}} | label_j = h
            COMP_t+1 = Si_iter[jj : γ_{jj,t+1} = 1, t+1] = ρ_{t+1}^{R_{t+1}}
```

$$\Pr(c_{it}=h\mid -)\propto\begin{cases}N(Y_{it}\mid\mu^{\star}_{c_{it}=h,t},\sigma^{2\star}_{c_{it}=h,t})\Pr(c_{it}=h)\mathrm{I}[\rho_t^{h\mathfrak{R}_{t+1}}=\rho_{t+1}^{\mathfrak{R}_{t+1}}] & \text{for } h=1,\dots,k_t^{-i},\\ N(Y_{it}\mid\mu^{\star}_{new_h,t},\sigma^{2\star}_{new_h,t})\Pr(c_{it}=h)\mathrm{I}[\rho_t^{h\mathfrak{R}_{t+1}}=\rho_{t+1}^{\mathfrak{R}_{t+1}}] & \text{for } h=k_t^{-i}+1,\end{cases}\tag{S.10}$$

```
            ρCOMP = compare(COMP_1t, COMP_t+1)

            if (ρCOMP = 0)
                ph[h] = log(0)
            else (ρCOMP = 1)      ← i think that there is a smarter way (just add 1 to cluster h and then subtract 1) instead of what he is doing
                recompute nh_TMP
                compute nclus_TMP
                lpp = 0
                for (kk=0, kk<nclus_TMP)
                    sm = [sjj : ρTMP[jj] = kk+1]
                    lCm = spatial_cohesion(sm)
                    lXm = similarity_function(...)        ← here can finally enter the covariates update
                    lpp += log(Mdp) + log Γ(nh_TMP[kk]) + lCm + lXm
                if (t=0)   ← first (c...) time
                    ph[h] = log( f_N(μ*_ht, σ2*_ht)(Yjt) ) + lpp
                else (t>0)      ← autoregressive part for later (>1) times
                    ph[h] = log( f_N(μ*_ht + η1j_iter · Y_{j,t-1}, σ2*_ht (1 - η1j_iter 2))(Yjt) ) + lpp
```

$$\Pr(c_{it}=h)=Pr(\rho_t^h)\propto M\Gamma(|S_{ht}^{-i}\cup\{i\}|)g(\boldsymbol{s}_{ht}^{-i\star}\cup\boldsymbol{s}_i|\nu_0)\prod_{j\neq h}^{k_t^{-i}}M\Gamma(|S_{jt}^{-i}|)g(\boldsymbol{s}_{jt}^{-i\star}|\nu_0),\tag{S.11}$$

```
        # now the case for unit j to be assigned to a new cluster
        ρTMP[j] = nclus_iter[t] + 1
        COMP_1t = ρTMP^{R_{t+1}} = ρt^{R_{t+1}} | label_j = nclus_t + 1
        COMP_t+1 = Si_iter[jj : γ_{jj,t+1} = 1, t+1] = ρ_{t+1}^{R_{t+1}}
        ρCOMP = comp(COMP_1t, COMP_t+1)
        if (ρCOMP = 0)
            ph[nclus_iter[t]] = log(0)
        else (ρCOMP = 1)
            μ_draw = rand(N(θt_iter, τ2t_iter))    ← draw the new params for the new cluster
            σ_draw = rand(U(0, Aσ))
            recompute cl numerosity nh_TMP
            recompute cl number nclus_TMP
            lpp = 0
            for (kk=0, kk<nclus_TMP)
                sm = [sjj : ρTMP[jj] = kk+1]
                lCm = spatial_cohesion(sm)
                lXm = similarity_function(...)
                lpp += log(Mdp) + log Γ(nh_TMP[kk]) + lCm + lXm
            if (t=0)   ← first (c...) time
                ph[h] = log( f_N(μ_draw, σ2_draw)(Yjt) ) + lpp
            else (t>0)
                ph[h] = log( f_N(μ_draw + η1j_iter · Y_{j,t-1}, σ2_draw (1 - η1j_iter 2))(Yjt) ) + lpp

        # now compute the probabilities
        ph_TMP = copy(ph)
        exponentiate them and normalize them
        assign unit to the sampled cluster using a U(0,1)
        now update all the related stuff
          (Si_iter, nh, nclus_iter[t], μc, σ²c)
```



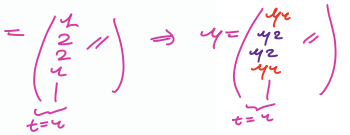

```
Si_TMP = Si_iter[,t]
Si_TMP2, reorder, old_lab = relabel(Si_TMP)   ← serve perché magari da 1 1 1 ... 1 dove consideriamo che è uscita j=1 e questa andava in un nuovo cl (2) e quindi diventava 2 1 1 ... 1 che deve essere relabellato in 1 2 2 ... 2
Si_iter[,t] = Si_TMP2
and for nh, params μc, σ²c we also reorder and relabel variables
```

```
nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] - 1;

          }else{

            // Observation is a member of a singleton cluster ...

            iaux = Si_iter[j*(ntime1) + t];
            if(iaux < nclus_iter[t]){

              // Need to relabel clusters. I will do this by swapping
cluster labels
              // Si_iter[j] and nclus_iter along with cluster
specific parameters;


              // All members of last cluster will be assigned subject
j's label
              for(jj = 0; jj < *nsubject; jj++){

                if(Si_iter[jj*(ntime1) + t] == nclus_iter[t]){

                  Si_iter[jj*(ntime1) + t] = iaux;

                }

              }


              Si_iter[j*(ntime1) + t] = nclus_iter[t];
              // The following steps swaps order of cluster specific
parameters
              // so that the newly labeled subjects from previous
step retain
              // their correct cluster specific parameters
              auxs = sig2h[(iaux-1)*ntime1 + t];
              sig2h[(iaux-1)*ntime1 + t] = sig2h[(nclus_iter[t]-1)*
(ntime1)+t];
              sig2h[(nclus_iter[t]-1)*(ntime1)+t] = auxs;
              auxm = muh[(iaux-1)*ntime1 + t];
              muh[(iaux-1)*ntime1 + t] = muh[(nclus_iter[t]-1)*
(ntime1)+t];
              muh[(nclus_iter[t]-1)*(ntime1)+t] = auxm;

              // the number of members in cluster is also swapped
with the last
              nh[(iaux-1)*(ntime1)+t] = nh[(nclus_iter[t]-1)*
(ntime1)+t];
              nh[(nclus_iter[t]-1)*(ntime1)+t] = 1;
            }


            // Now remove the ith obs and last cluster;
            nh[(nclus_iter[t]-1)*(ntime1)+t] = nh[(nclus_iter[t]-1)*
(ntime1)+t] - 1;
            nclus_iter[t] = nclus_iter[t] - 1;


          }
          for(jj = 0; jj < *nsubject; jj++){

            rho_tmp[jj] = Si_iter[jj*(ntime1) + t];
          }

          for(k = 0; k < nclus_iter[t]; k++){
            rho_tmp[j] = k+1;

            // First need to check compatability
            Rindx2=0;
            for(jj = 0; jj < *nsubject; jj++){
              if(gamma_iter[jj*ntime1 + (t+1)] == 1){
                comp2t[Rindx2] = rho_tmp[jj];
                comptp1[Rindx2] = Si_iter[jj*ntime1 + (t+1)];
                Rindx2 = Rindx2 + 1;
              }
            }
            // check for compatibility
            rho_comp = compatibility(comp2t, comptp1, Rindx2);
            if(rho_comp != 1){
              ph[k] = Log(0); // Not compatible
            } else {
              // Need to compute Pr(rhot), Pr(rhot.R), Pr(rhot+1),
Pr(rhot+1.R)

              for(jj = 0; jj < *nsubject; jj++){
                nh_tmp[jj] = 0;
              }
              n_tmp = 0;
              for(jj = 0; jj < *nsubject; jj++){
                nh_tmp[rho_tmp[jj]-1] = nh_tmp[rho_tmp[jj]-1]+1;
                n_tmp=n_tmp+1;
              }

              nclus_tmp=0;
              for(jj = 0; jj < *nsubject; jj++){
                if(nh_tmp[jj] > 0) nclus_tmp = nclus_tmp + 1;
```

```
            }


            lpp = 0.0;
            for(kk = 0; kk < nclus_tmp; kk++){
              // Beginning of spatial part
              lCn = 0.0;
              if(*sPPM==1){
                if((*space_1==1 & t == 0) | (*space_1==0)){
                  indx = 0;
                  for(jj = 0; jj < *nsubject; jj++){

                    if(rho_tmp[jj] == kk+1){

                      s1n[indx] = s1[jj];
                      s2n[indx] = s2[jj];
                      indx = indx+1;
                    }

                  }
//
                  lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0,
nh_tmp[kk],*SpatialCohesion, 1);
                }
              }
              // End of spatial part

//                lpp = lpp + nclus_tmp*log(Mdp) + lgamma((double)
nh_tmp[kk]) + lCn;
//                lpp = lpp + nh_tmp[kk]*log(Mdp) + lgamma((double)
nh_tmp[kk]) + lCn;
              lpp = lpp + (log(Mdp) + lgamma((double) nh_tmp[kk]) +
lCn);

            }
            if(t==0){
//                              muh[k*(ntime1) + t],
//                              sqrt(sig2h[k*(ntime1) + t]), 1));
              ph[k] = dnorm(y[j*(*ntime) + t],
                            muh[k*(ntime1) + t],
                            sqrt(sig2h[k*(ntime1) + t]), 1) +
                      lpp;
            }
            if(t > 0){
//                               muh[k*(ntime1) + t] +
//                                 eta1_iter[j]*y[j*(*ntime) + t-1],
//                               sqrt(sig2h[k*(ntime1) + t]*
//                                    (1-eta1_iter[j]*eta1_iter[j])),
1));
              ph[k] = dnorm(y[j*(*ntime) + t],
                            muh[k*(ntime1) + t] +
                              eta1_iter[j]*y[j*(*ntime) + t-1],
                            sqrt(sig2h[k*(ntime1) + t]*
                              (1-eta1_iter[j]*eta1_iter[j])), 1)+
                      lpp;
            }
            // use this to test if MCMC draws from prior are
correct
//              ph[k] = lpp;

          }
        }


        // Determine if E.U. gets allocated to a new cluster
        // Need to check compatibility first

        rho_tmp[j] = nclus_iter[t]+1;

        // First need to check compatability
        Rindx1 = 0, Rindx2=0;
        for(jj = 0; jj < *nsubject; jj++){
          if(gamma_iter[jj*ntime1 + (t+1)] == 1){
            comp2t[Rindx2] = rho_tmp[jj];
            comptp1[Rindx2] = Si_iter[jj*ntime1 + (t+1)];
            Rindx2 = Rindx2 + 1;
          }
        }
        // check for compatibility
        rho_comp = compatibility(comp2t, comptp1, Rindx2);
        if(rho_comp != 1){
          ph[nclus_iter[t]] = log(0); // going to own cluster is
not compatible;
        } else {

          mudraw = rnorm(theta_iter[t], sqrt(tau2_iter[t]));
          sigdraw = runif(0, Asig);

          for(jj = 0; jj < *nsubject; jj++){
            nh_tmp[jj] = 0;
          }
          n_tmp = 0;
          for(jj = 0; jj < *nsubject; jj++){
            nh_tmp[rho_tmp[jj]-1] = nh_tmp[rho_tmp[jj]-1]+1;
            n_tmp=n_tmp+1;
```

```
            }

            nclus_tmp=0;
            for(jj = 0; jj < *nsubject; jj++){
              if(nh_tmp[jj] > 0) nclus_tmp = nclus_tmp + 1;

            }

            lpp = 0.0;
            for(kk = 0; kk < nclus_tmp; kk++){
              // Beginning of spatial part
              lCn = 0.0;
              if(*sPPM==1){
                if((*space_1==1 & t == 0) | (*space_1==0)){
                  indx = 0;
                  for(jj = 0; jj < *nsubject; jj++){

                    if(rho_tmp[jj] == kk+1){

                      s1n[indx] = s1[jj];
                      s2n[indx] = s2[jj];
                      indx = indx+1;
                    }

                  }
                  lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0,
nh_tmp[kk],*SpatialCohesion, 1);
                }
              }
              // End of spatial part

              lpp = lpp + (log(Mdp) + lgamma((double) nh_tmp[kk]) +
lCn);
//              lpp = lpp + nh_tmp[kk]*log(Mdp) + lgamma((double)
nh_tmp[kk]) + lCn;
            }

            if(t==0){
              ph[nclus_iter[t]] = dnorm(y[j*(*ntime) + t], mudraw,
sigdraw, 1) +
                          lpp;
            }
            if(t > 0){

              ph[nclus_iter[t]] = dnorm(y[j*(*ntime) + t],
                                        mudraw + eta1_iter[j]*y[j*
(*ntime) + t-1],
                                        sigdraw*sqrt(1-
eta1_iter[j]*eta1_iter[j]), 1) +
                                        lpp;
              }
//              ph[nclus_iter[t]] =  lpp;

            }
            // Now compute the probabilities
            for(k = 0; k < nclus_iter[t]+1; k++) phtmp[k] = ph[k];


            R_rsort(phtmp,  nclus_iter[t]+1) ;



            maxph = phtmp[nclus_iter[t]];


            denph = 0.0;
            for(k = 0; k < nclus_iter[t]+1; k++){

              ph[k] = exp(ph[k] - maxph);
              denph = denph + ph[k];

            }
            for(k = 0; k < nclus_iter[t]+1; k++){
              probh[k] = ph[k]/denph;
            }

            uu = runif(0.0,1.0);
            cprobh= 0.0;;
            for(k = 0; k < nclus_iter[t]+1; k++){
              cprobh = cprobh + probh[k];
              if (uu < cprobh){

                iaux = k+1;
                break;
              }
            }

            if(iaux <= nclus_iter[t]){
              Si_iter[j*(ntime1) + t] = iaux;
              nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] =
nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] + 1;
              rho_tmp[j] = iaux;
            }else{

              nclus_iter[t] = nclus_iter[t] + 1;
              Si_iter[j*(ntime1) + t] = nclus_iter[t];
```

```
            nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] = 1;
            rho_tmp[j] = nclus_iter[t];

            muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = mudraw;
            sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] =
sigdraw*sigdraw;
                    if(*simpleModel==1) sig2h[(Si_iter[j*(ntime1) +
t]-1)*(ntime1) + t] = 1.0;
          }
        }
        for(jj = 0; jj < *nsubject; jj++){
          Si_tmp[jj] = Si_iter[jj*(ntime1) + t];
          Si_tmp2[jj] = 0;
          reorder[jj] = 0;
        }
        // I believe that I have to make sure that groups are order
so that
        // EU one is always in the group one, and then the smallest
index not
        // with group 1 anchors group 2 etc.

        relabel(Si_tmp, *nsubject, Si_tmp2, reorder, oldLab);

        for(jj=0; jj<*nsubject; jj++){
          Si_iter[jj*(ntime1) + t] = Si_tmp2[jj];
        }
        for(k = 0; k < nclus_iter[t]; k++){
          mu_tmp[k] = muh[k*(ntime1)+t];
          sig2_tmp[k] = sig2h[k*(ntime1)+t];
        }
        for(k = 0; k < nclus_iter[t]; k++){
          nh[k*(ntime1)+t] = reorder[k];
          muh[k*(ntime1)+t] = mu_tmp[(oldLab[k]-1)];
          sig2h[k*(ntime1)+t] = sig2_tmp[(oldLab[k]-1)];
        }
      }
      for(j = 0; j < *nsubject; j++){
        Si_tmp[j] = Si_iter[j*(ntime1) + t];
        Si_tmp2[j] = 0;
        reorder[j] = 0;
      }
      // I believe that I have to make sure that groups are order so
that
      // EU one is always in the group one, and then the smallest
index not
      // with group 1 anchors group 2 etc.

      relabel(Si_tmp, *nsubject, Si_tmp2, reorder, oldLab);

      for(j=0; j<*nsubject; j++){
        Si_iter[j*(ntime1) + t] = Si_tmp2[j];
      }
      for(k = 0; k < nclus_iter[t]; k++){
        mu_tmp[k] = muh[k*(ntime1)+t];
        sig2_tmp[k] = sig2h[k*(ntime1)+t];
      }
      for(k = 0; k < nclus_iter[t]; k++){
        nh[k*(ntime1)+t] = reorder[k];
        muh[k*(ntime1)+t] = mu_tmp[(oldLab[k]-1)];
        sig2h[k*(ntime1)+t] = sig2_tmp[(oldLab[k]-1)];
      }

//      for(k = 0; k < nclus_iter[t]; k++) sig2h[k*(ntime1)+t] = 1.0;
      for(k = 0; k < nclus_iter[t]; k++){
        ////////////////////////////////////////
        //
        // udate muh
        //
        ////////////////////////////////////////

        if(t==0){
          sumy = 0.0;
          for(j = 0; j < *nsubject; j++){
            if(Si_iter[j*(ntime1) + t] == k+1){
              sumy = sumy + y[j*(*ntime)+t];
            }

          }
          s2star = 1/((double) nh[k*(ntime1)+t]/sig2h[k*(ntime1) + t]
+ 1/tau2_iter[t]);
          mstar = s2star*( (1/sig2h[k*(ntime1) + t])*sumy +
(1/tau2_iter[t])*theta_iter[t]);
        }
        if(t > 0){
          sumy = 0.0;
          sume2 = 0.0;
          for(j = 0; j < *nsubject; j++){
            if(Si_iter[j*(ntime1) + t] == k+1){
              sume2 = sume2 + 1.0/(1-eta1_iter[j]*eta1_iter[j]);
              sumy = sumy + (y[j*(*ntime)+t] - eta1_iter[j]*y[j*
(*ntime)+t-1])/
                                (1-eta1_iter[j]*eta1_iter[j]);
            }

          }
          s2star = 1/( (1.0/sig2h[k*(ntime1) + t])*sume2  +
```



```
1/tau2_iter[t]);
          mstar = s2star*( (1.0/sig2h[k*(ntime1) + t])*sumy +
(1/tau2_iter[t])*theta_iter[t]);

        }

        muh[k*(ntime1) + t] = rnorm(mstar, sqrt(s2star));
//        muh[k] = 0.0;
        ////////////////////////////////////////
        //                      //
        // udate sig2h                //
        //                      //
        ////////////////////////////////////////
        osig = sqrt(sig2h[k*(ntime1) + t]);
        nsig = rnorm(osig,csigSIG);
        if(nsig > 0.0 & nsig < Asig){

          lln = 0.0;
          llo = 0.0;
          if(t == 0){
            for(j = 0; j < *nsubject; j++){
              if(Si_iter[j*(ntime1) + t] == k+1){
                llo = llo + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) +
t], osig,1);
                lln = lln + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) +
t], nsig,1);
              }
            }
          }
          if(t > 0){
            for(j = 0; j < *nsubject; j++){
              if(Si_iter[j*(ntime1) + t] == k+1){
                llo = llo + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) +
t] +
                                  eta1_iter[j]*y[j*(*ntime) + t-1],
                                   osig*sqrt(1-
eta1_iter[j]*eta1_iter[j]),1);
                lln = lln + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) +
t] +
                                  eta1_iter[j]*y[j*(*ntime) + t-1],
                                   nsig*sqrt(1-
eta1_iter[j]*eta1_iter[j]),1);
              }
            }
          }

          llo = llo + dunif(osig, 0.0, Asig, 1);
          lln = lln + dunif(nsig, 0.0, Asig, 1);
```

(in this one and in mine) others the update step is through Metropolis (not Metropolis & Hastings) method, where:

– we have a symmetric proposal (that's why it's only Metropolis) centered at the old value

σnew ~ N(σold, –)

```
          llr = lln - llo;
          uu = runif(0,1);

          if(log(uu) < llr){
            sig2h[k*(ntime1) + t] = nsig*nsig;
          }
                if(*simpleModel==1) sig2h[k*(ntime1) + t] = 1.0;
        }
      }


//////////////////////////////////////////////////////////////////////////////
      //                                        //
      // update theta (mean of mh)                          //
      //                                        //

//////////////////////////////////////////////////////////////////////////////
      summu = 0.0;
      for(k = 0; k < nclus_iter[t]; k++){
        summu = summu + muh[k*(ntime1) + t];
      }

      phi1sq = phi1_iter*phi1_iter;
      lam2tmp = lam2_iter*(1.0 - phi1sq);

      if(t==0){
        s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] +
1.0/lam2_iter + phi1sq/lam2tmp);
        mstar = s2star*( (1.0/tau2_iter[t])*summu +
                         (1.0/lam2_iter)*phi0_iter +
                         (1.0/lam2tmp)*phi1_iter*(theta_iter[t+1]-
phi0_iter*(1-phi1_iter)));

      } else if(t==(*ntime-1)){

        s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] +
1.0/lam2tmp);
        mstar = s2star*((1.0/tau2_iter[t])*summu +
                        (1.0/lam2tmp)*(phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1]));

      } else {
        s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + (1.0 +
phi1sq)/lam2tmp);
        mstar = s2star*( (1.0/tau2_iter[t])*summu +
```

```
                        (1.0/lam2tmp)*(phi1_iter*(theta_iter[t-1] +
theta_iter[t+1]) +
                                      phi0_iter*(1.0 - phi1_iter)*
(1.0 - phi1_iter)));
      }

      theta_iter[t] = rnorm(mstar, sqrt(s2star));
          if(*simpleModel==1) theta_iter[t] = 0.0;

////////////////////////////////////////////////////////////////////
      //                                          //
      // update tau2 (variance of mh)                       //
      //                                          //

////////////////////////////////////////////////////////////////////
      ot = sqrt(tau2_iter[t]);
      nt = rnorm(ot,csigTAU);
      if(nt > 0){

        lln = 0.0;
        llo = 0.0;
        for(k = 0; k < nclus_iter[t]; k++){

          llo = llo + dnorm(muh[k*(ntime1) + t], theta_iter[t],
ot,1);
          lln = lln + dnorm(muh[k*(ntime1) + t], theta_iter[t],
nt,1);
        }

        llo = llo + dunif(ot, 0.0, Atau, 1);
        lln = lln + dunif(nt, 0.0, Atau, 1);



        llr = lln - llo;
        uu = runif(0,1);

        if(log(uu) < llr){
          tau2_iter[t] = nt*nt;
//          tau2_iter[t] = 5*5;
        }
             if(*simpleModel==1) tau2_iter[t] = theta_tau2[1];
      }


    }

////////////////////////////////////////////////////////////////////
```

```
    //                                          //
    // update eta1 (temporal correlation parameter at likelihood)
//
    //                                          //

////////////////////////////////////////////////////////////////////
    if(*update_eta1==1){
      for(j = 0; j < *nsubject; j++){
        e1o = eta1_iter[j];
        e1n = rnorm(e1o, csigETA1);


        if(e1n < 1 & e1n > -1){

          llo=lln=0.0;
          for(t=1; t<*ntime; t++){

            llo = llo + dnorm(y[j*(*ntime)+t],
                        muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t]
+
                                          e1o*y[j*(*ntime)+t-1],
                                        sqrt(sig2h[(Si_iter[j*(ntime1) +
t]-1)*(ntime1) + t]*
                                          (1-e1o*e1o)), 1);
            lln = lln + dnorm(y[j*(*ntime)+t],
                        muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t]
+
                                          e1n*y[j*(*ntime)+t-1],
                                        sqrt(sig2h[(Si_iter[j*(ntime1) +
t]-1)*(ntime1) + t]*
                                          (1-e1n*e1n)), 1);

          }
          logito = log(0.5*(e1o + 1)) - log(1 - 0.5*(e1o+1));
          logitn = log(0.5*(e1n + 1)) - log(1 - 0.5*(e1n+1));



          llo = llo + -log(2*b_eta1) - (1/b_eta1)*fabs(logito - 0.0);
          lln = lln + -log(2*b_eta1) - (1/b_eta1)*fabs(logitn - 0.0);

          llr = lln - llo;
          uu = runif(0,1);
          if(llr > log(uu)) eta1_iter[j] = e1n;
        }
      }
    }
```

```
////////////////////////////////////////////////////////////////////////
    //                                          //
    // update alpha                                  //
    //                                          //

////////////////////////////////////////////////////////////////////////
    if(*update_alpha == 1){
      if(*time_specific_alpha != 1){
        sumg = 0;
        for(j = 0; j < *nsubject; j++){
          for(t = 1; t < *ntime; t++){

            sumg = sumg + gamma_iter[j*ntime1 + t];

          }
        }
        astar = (double) sumg + a;
        bstar = (double) ((*nsubject)*(*ntime-1) - sumg) + b;


        alpha_tmp = rbeta(astar, bstar);
        for(t=0;t<*ntime;t++){alpha_iter[t] = alpha_tmp;}

      } else {

        for(t = 0; t < *ntime; t++){
          sumg = 0;
          for(j = 0; j < *nsubject; j++){
            sumg = sumg + gamma_iter[j*ntime1 + t];
          }



          astar = (double) sumg + a;
          bstar = (double) ((*nsubject) - sumg) + b;

          alpha_iter[t] = rbeta(astar, bstar);

        }

      }
      alpha_iter[0] = 0.0;
    }


////////////////////////////////////////////////////////////////////////
    //                                          //
    // update phi0                                   //
    //                                          //

////////////////////////////////////////////////////////////////////////
    phi1sq = phi1_iter*phi1_iter;
    one_phisq = (1-phi1_iter)*(1-phi1_iter);
    lam2tmp = lam2_iter*(1.0 - phi1sq);
    sumt = 0.0;
    for(t=1; t<*ntime; t++){
      sumt = sumt + (theta_iter[t] - phi1_iter*theta_iter[t-1]);
    }

    s2star = 1.0/((*ntime-1)*(one_phisq/lam2tmp) + (1/lam2_iter) +
(1/s20));
    mstar = s2star*(((1.0-phi1_iter)/lam2tmp)*sumt +
(1/lam2_iter)*theta_iter[0] + (1/s20)*m0);



    phi0_iter = rnorm(mstar, sqrt(s2star));

////////////////////////////////////////////////////////////////////////
    //                                          //
    // update phi1                                   //
    //                                          //

////////////////////////////////////////////////////////////////////////

    if(*update_phi1==1){
      op1 = phi1_iter;
      np1 = rnorm(op1, csigPHI1);


      if(np1 > -1 & np1 < 1){
        llo = 0.0, lln = 0.0;
        for(t=1; t < *ntime; t++){
          llo = llo + dnorm(theta_iter[t], phi0_iter*(1-op1) +
op1*theta_iter[t-1],
                                                  sqrt(lam2_iter*(1.0 -
op1*op1)), 1);
          lln = lln + dnorm(theta_iter[t], phi0_iter*(1-np1) +
np1*theta_iter[t-1],
                                                  sqrt(lam2_iter*(1.0 -
np1*np1)), 1);

        }
        llo = llo + dunif(op1, -1,1, 1);
        lln = lln + dunif(np1, -1,1, 1);
```

```
        llr = lln - llo;
        if(llr > log(runif(0,1))) phi1_iter = np1;
      }
    }

////////////////////////////////////////////////////////////////////////
    //                                        //
    // update lam2                                 //
    //                                        //

////////////////////////////////////////////////////////////////////////
    // Update lambda with a MH step
    phi1sq = phi1_iter*phi1_iter;
    ol = sqrt(lam2_iter);
    nl = rnorm(ol, csigLAM);
    if(nl > 0.0){
      lln = 0.0;
      llo = 0.0;
        for(t=1; t<*ntime; t++){
        llo = llo + dnorm(theta_iter[t],
                          phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1], ol*sqrt(1-phi1sq),1);
        lln = lln + dnorm(theta_iter[t],
                          phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1], nl*sqrt(1-phi1sq),1);
      }
      llo = llo + dnorm(theta_iter[0], phi0_iter, ol, 1) + dunif(ol,
0.0, Alam, 1);
      lln = lln + dnorm(theta_iter[0], phi0_iter, nl, 1) + dunif(nl,
0.0, Alam, 1);
      llr = lln - llo;
      uu = runif(0,1);
      if(log(uu) < llr){
        lam2_iter = nl*nl;
      }
    }
/*
    phi1sq = phi1_iter*phi1_iter;
    ssq = 0.0;
    for(t=1; t<*ntime; t++){
      ssq = ssq + (theta_iter[t] - (phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1]))*
                  (theta_iter[t] - (phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1]));
    }
    ssq = 1.0/(1.0 - phi1sq)*ssq + (theta_iter[0]-phi0_iter)*
(theta_iter[0]-phi0_iter);
    astar = 0.5*(*ntime) + 1;
    bstar = 0.5*ssq + 1/1;

    lam2_iter = 1.0/rgamma(astar, 1/bstar);
*/

////////////////////////////////////////////////////////////////////////
    //                                        //
    // predict partition for new time period                    //
    //                                        //

////////////////////////////////////////////////////////////////////////
/*
    for(p = 0; p < *npred; p++){

      for(j=0; j<*nsubject; j++){
        nh_pred[j] = 0;
        predSi_iter[j*(*npred) + p] = 0;
      }
      if(*update_alpha == 0){
        n_red = 0;
        for(j=0;j<*nsubject;j++){

          gpred[j] = rbinom(1,*alpha);

          if(gpred[j] == 1){
            nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] =
nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] + 1;
            n_red = n_red + 1;
            predSi_iter[j*(*npred) + p] = Si_iter[j*(ntime1)+
(*ntime)-1];
          }
        }
      }
      if(*update_alpha == 1){
        if(*time_specific_alpha == 1){


          n_red = 0;
          for(j=0;j<*nsubject;j++){

            gpred[j] = rbinom(1,alpha_iter[1]);
            if(gpred[j] == 1){
              nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] =
nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] + 1;
              n_red = n_red + 1;
              predSi_iter[j*(*npred) + p] = Si_iter[j*(ntime1)+
(*ntime)-1];
            }
```

```
      }

    }else {

    }
  }
  remove_zero(nh_pred, *nsubject, nh_tmp_no_zero);
  nclus_tmp = 0;
  for(j=0; j<*nsubject;j++){
    if(nh_tmp_no_zero[j] > 0){
      nclus_tmp = nclus_tmp + 1;
    }else{
      break;
    }
  }

  for(j=0;j<*nsubject;j++){
    if(gpred[j] == 0){
      for(k = 0; k < nclus_tmp; k++){
        probh[k] = nh_pred[k]/(n_red + Mdp);
      }
      probh[nclus_tmp] = Mdp/(n_red + Mdp);

      uu = runif(0.0,1.0);
      cprobh= 0.0;;
      for(k = 0; k < nclus_tmp+1; k++){
        cprobh = cprobh + probh[k];

        if (uu < cprobh){

          iaux = k+1;
          break;
        }
      }

      if(iaux <= nclus_tmp){
        predSi_iter[j*(*npred) + p] = iaux;
        nh_pred[iaux-1] = nh_pred[iaux-1] + 1;
      }else{

        nclus_tmp = nclus_tmp + 1;
        predSi_iter[j*(*npred) + p] = nclus_tmp;
        nh_pred[(predSi_iter[j*(*npred) + p]-1)*(*npred)+p] = 1;

      }
      n_red = n_red + 1;
    }
  }
```

```
    }
*/

////////////////////////////////////////////////////////////////////////
    //
    // evaluating likelihood that will be used to calculate LPML and
WAIC?
    // (see page 81 Christensen Hansen and Johnson)
    //

////////////////////////////////////////////////////////////////////////
    if(i > (*burn-1) & i % (*thin) == 0){

      like0=0;
      for(j = 0; j < *nsubject; j++){
        for(t = 0; t < *ntime; t++){
          mudraw = muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t];
          sigdraw = sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) +
t]);
          if(t == 0){
            like_iter[j*(*ntime)+t] = dnorm(y[j*(*ntime)+t], mudraw,
sigdraw, 1);
            fitted_iter[j*(*ntime)+t] = mudraw;

          }
          if(t > 0){
            like_iter[j*(*ntime)+t] = dnorm(y[j*(*ntime)+t],
                          mudraw + eta1_iter[j]*y[j*(*ntime)+t-1],
                          sigdraw*sqrt(1-eta1_iter[j]*eta1_iter[j]),
1);

            fitted_iter[j*(*ntime)+t] = mudraw + eta1_iter[j]*y[j*
(*ntime)+t-1];
          }


          // These are needed for WAIC
          mnlike[j*(*ntime)+t] = mnlike[j*(*ntime)+t] +
exp(like_iter[j*(*ntime)+t])/(double) nout;
          mnllike[j*(*ntime)+t] = mnllike[j*(*ntime)+t] +
(like_iter[j*(*ntime)+t])/(double) nout;

          if(exp(like_iter[j*(*ntime)+t]) < 1e-320) like0=1;


        }
      }
      if(like0==1) nout_0 = nout_0 + 1;
```

```
      if(like0==0){
        for(j = 0; j < *nsubject; j++){
          for(t = 0; t < *ntime; t++){
            CPO[j*(*ntime)+t] = CPO[j*(*ntime)+t] +
(1/exp(like_iter[j*(*ntime)+t]));
          }
        }
      }
    }

////////////////////////////////////////////////////////////////////
    //                                        //
    // Save MCMC iterates                             //
    //                                        //

////////////////////////////////////////////////////////////////////
    if((i > (*burn-1)) & ((i+1) % *thin == 0)){
      for(t = 0; t < *ntime; t++){
        alpha_out[ii*(*ntime) + t] = alpha_iter[t];
        theta[ii*(*ntime) + t] = theta_iter[t];
        tau2[ii*(*ntime) + t] = tau2_iter[t];
        for(j = 0; j < *nsubject; j++){
          sig2[(ii*(*nsubject) + j)*(*ntime) + t] = sig2h[(Si_iter[j*
(ntime1) + t]-1)*(ntime1) + t];
          mu[(ii*(*nsubject) + j)*(*ntime) + t] = muh[(Si_iter[j*
(ntime1) + t]-1)*(ntime1) + t];
          Si[(ii*(*nsubject) + j)*(*ntime) + t] = Si_iter[j*ntime1 +
t];
          gamma[(ii*(*nsubject) + j)*(*ntime) + t] =
gamma_iter[j*ntime1 + t];
          llike[(ii*(*nsubject) + j)*(*ntime) + t] = like_iter[j*
(*ntime)+t];
          fitted[(ii*(*nsubject) + j)*(*ntime) + t] = fitted_iter[j*
(*ntime)+t];
        }
      }
      for(j=0; j<*nsubject; j++){

        eta1[ii*(*nsubject) + j] = eta1_iter[j];
      }
      phi1[ii] = phi1_iter;
      phi0[ii] = phi0_iter;
      lam2[ii] = lam2_iter;
      ii = ii+1;
    }
/**/
  }
```

```
  lpml_iter=0.0;
  for(t = 0; t < *ntime; t++){
    for(j = 0; j < *nsubject; j++){

      lpml_iter = lpml_iter - log((1/(double) nout-nout_0)*CPO[j*
(*ntime)+t]);

    }
  }
  lpml[0] = lpml_iter;
  elppdWAIC = 0.0;

  for(j = 0; j < *nsubject; j++){
    for(t = 0; t < *ntime; t++){
      elppdWAIC = elppdWAIC + (2*mnllike[j*(*ntime)+t] -
log(mnlike[j*(*ntime)+t]));
    }
  }
  waic[0] = -2*elppdWAIC;
  PutRNGstate();

}
```