

Apéndice A

CÓDIGO DEL MODELO EN LENGUAJE C

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#include <time.h> #include <stdio.h> #include <math.h>

#define mx0 1 /* dimensi inicial */ #define U0 0 /*valor
inicial*/ #define mm 4 /* cota superior per a la dimensi
mxima */ #define MM 15 /* cota superior per a l'estat
mxim=(1<<mm)-1*/ #define FRS 7 /* 1<<(mm-1)-1 */ #define NP
50 /* Poblaci */

#define Dat "med_.dat" #define Out "med_.out" #define Tau
"med_.tau"
#define Out_ "%s.out"
#define Tau_ "%s.tau"

char imprmx,neonat[NP],peek(),fora,novatau=0; char
fnom[35],cap[31],estat[300],moments[300],fila[300],cr[2]; char
taufila[MM+7][124]; int mx,m[NP],MXz,Mz[NP],NM,S; int
tanatos=20000,progres=10000; int Ka,Kr,Ke,Qc,Ce,MOH; int
mKa,mKr,mKe,mQc,mCe,mMOH,MaKa,MaKr,MaKe; int
MaQc,MaCe,MaMOH,dKa,dKr,dKe,dQc,dCe,dMOH; int
actlMaxU[MM+1],MaxU[MM+1],actlDom[MM+1],MaxDom[MM+1],Smin; long
int T,Ti,dT,F[MM+1][NP],B[NP]; float
nt1[NP],natal[NP],P[MM+1][NP],PIO[MM+1],PI[MM+1][NP]; float
st[MM+1],gas[MM+1],gar[MM+1],rga[MM+1],rs[MM+1],em[MM+1], float
EMz[NP],a[NP],bz[NP]; float
sts[MM+1][NP],ferocitat[MM+1],PR[NP],SR[NP]; float
PRO[mm+1],SRO[mm+1],PG[MM+1][NP],acti[NP],PGM,SPG,mG,sG,mU, float
sU,rGU; float aT[NP],Tr[NP],eT[NP]; float gs,gr,rg; float
imp(int,int,int); float ec0=2*NP,ec,cl,rI,roI,ro[MM+1][NP]; float
ecmin,mGMax,mGmin,rGUmin; FILE *df,*pf,*rf,*tf,*uf; main() {void
exit();

char fnomdades[35];
printf(cr, " ");
printf("%10s*** Programa MED_ en execuci... ***\n", " ");
printf(fnomdades,Dat);

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if((df=fopen(fnomdades,"rb, recfm=f, lrecl=80"))==NULL)
    {printf("IMPOSSIBLE OBRIR EL FITXER DE LECTURA Med_ DAT\n");
    exit(0);}
fscanf(df,"%d",&mKa); fscanf(df,"%d",&MaKa); fscanf(df,"%d",&dKa);
fscanf(df,"%d",&mKr); fscanf(df,"%d",&MaKr); fscanf(df,"%d",&dKr);
fscanf(df,"%d",&mKe); fscanf(df,"%d",&MaKe); fscanf(df,"%d",&dKe);
fscanf(df,"%d",&mCe); fscanf(df,"%d",&MaCe); fscanf(df,"%d",&dCe);
fscanf(df,"%d",&mQc); fscanf(df,"%d",&MaQc); fscanf(df,"%d",&dQc);
fscanf(df,"%d",&mMOH); fscanf(df,"%d",&MaMOH); fscanf(df,"%d",&dMOH);
fscanf(df,"%ld",&Ti);
fclose(df);
for(Qc=mQc;Qc<=MaQc;Qc+=dQc)
for(Ce=mCe;Ce<=MaCe;Ce+=dCe)
for(Ke=mKe;Ke<=MaKe;Ke+=dKe)
for(Kr=mKr;Kr<=MaKr;Kr+=dKr)
for(Ka=mKa;Ka<=MaKa;Ka+=dKa)
for(MOH=mMOH;MOH<=MaMOH;MOH+=dMOH)
mas();
fclose(tf); copiTAU();
printf("*** TERMINACI ADEQUADA. ***\n"); exit(0);
} /* main */ mas() {
    inici();
    valors();
    estadistica();
    iteracio();
} /* mas */ inici() {void srand(),exit(); time_t time(); char
fnomtipus[35];
int N,U; short int i;
srand((unsigned int)time(NULL)/2);
sprintf(fnom,"%lx",time(NULL));
sprintf(fnomtipus,Out);
if((pf=fopen(fnomtipus,"wb, recfm=v, lrecl=32756"))==NULL)
    {printf("IMPOSSIBLE OBRIR EL FITXER D'ESCRIPURA Med_ OUT");
    exit(0);}
if(novatau==0)
    {sprintf(fnomtipus,Tau);
    if((tf=fopen(fnomtipus,"wb, recfm=v, lrecl=32756"))==NULL)
        {printf("IMPOSSIBLE OBRIR EL FITXER D'ESCRIPURA Med_ TAU");
        exit(0);}
    }
novatau=1;
fora=0; T=0; dT=100; mx=mx0; imprmx=1; MXz=(1<<mx)-1;

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ec=ec0; cl=.01*Qc; rl=0; roI=0;
gs=gr=rg=0;
S=NP; ecmin=ec0; mGMax=0; mGmin=1; rGUmin=1;
for(U=0;U<=MM;U++)
  {MaxU[U]=actlMaxU[U]=0; MaxDom[U]=actlDom[U]=0;
   gas[U]=gar[U]=rga[U]=rs[U]=0;}
for(N=0;N<NP;N++)
  {m[N]=mx; Mz[N]=MXz; bz[N]=0; B[N]=0; neonat[N]=1;
   natal[N]=5+161*(NP/2-abs(NP/2-abs(N-NP/4)))/NP;
   for(U=0;U<=MM;U++) {P[U][N]=0; B[N]+=(F[U][N]=natal[N]*(U==U0));}
  } /* N */
} /* inici */
valors() {int U,j,Uj,N;
float cost,forza;
for(U=0;U<=MM;U++)
  { PIO[U]=0; cost=1;
   for(j=0;j<mm;j++)
    {Uj=((U>>j)%2);
     PIO[U]+=Uj;
     if(!Uj) {cost*=mm-1-j; cost/=mm-1;}
    } /* j */
   if((U%2)==0) PIO[U]+=.8;
   PIO[U]/=mm;
   ferocitat[U]=1-cost; forza=(float)2*U/(MM-1);
   st[U]=forza*ferocitat[U];
   em[U]=(float)U/MM;
   PIO[U]-=.02*MM*Ce*forza*cost*PIO[U]/(MM-1);
   if(PIO[U]<0) PIO[U]=0;
  } /* U */
for(N=0;N<NP;N++)
  repressio(N);
} /* valors */ estadistica() {int mj,Mj,U;
double sqrt();
for(mj=0;mj<=mm;mj++)
  {Mj=(1<< mj)-1; PRO[mj]=0; SRO[mj]=0;
   for(U=0;U<=Mj;U++) {PRO[mj]+=PIO[U]; SRO[mj]+=PIO[U]*PIO[U];}
   PRO[mj]/=Mj+1; SRO[mj]/=Mj+1;
   SRO[mj]=sqrt((double)SRO[mj]-PRO[mj]*PRO[mj]);
  } /* mj */
} /* estadistica */ repressio(N)
int N;
{int U;

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for(U=0;U<=MM;U++) sts[U][N]=st[U];
} /* repressio */ iteracio() {int U;
  avaluacio();
  impressio(); if(for) return;
  if(T+dT>Ti) {sortida(); return;}
  T+=dT;
  ciencia();
  aprenentatge(); if(for) return;
  iteracio(); if(for) return;
} /* iteracio */ avaluacio() {int ER=0,N,NN,U,V,d;
  gs=0;
  for(U=0;U<=MM;U++) {actlMaxU[U]=0; gas[U]=0;}
  for(N=0;N<NP;N++)
    if(B[N]!=0)
      {a[N]=.09; bz[N]=0; aT[N]=0; Tr[N]=0; eT[N]=0;
        for(U=0;U<=MXz;U++)
          {P[U][N]=(float)F[U][N]/B[N]; a[N]-=P[U][N]*U*.18/MM;
            if(P[U][N]>.5) actlMaxU[U]++;
            if((U!=7) && (U!=6) && (U!=MM-1)&&(U!=15)&&(U>3)&&(P[U][N]>.5)&&(.5*ec/NP==1))
              for(V=0;V<=MM;V++)
                {
                  sprintf(estat,"%4d %2d %2d %2d %4.2f %2d %2d %2d %2d %2d %2d %4.2f
                    %4.2f %4.2f",T,U,N,V,.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH,P[V][N],PG[V][N],PR[N]);
                  sprintf(moments,"%d %d",actlMaxU[U],actlDom[U]);
                  sprintf(fila,"%s APA%X %s %s\n",cap,U,estat,moments);
                  lTAU(fila);
                }
            aT[N]+=U*P[U][N]; Tr[N]+=(ferocitat[U]+1)*P[U][N];
            eT[N]+=(float)2*U/(MM-1)*(1-ferocitat[U])*(ec0-ec)*P[U][N];
            if(U>Mz[N]) bz[N]+=P[U][N];
            PI[U][N]=(PIO[U]-ro[U][N])*ec/ec0;
            gs+=PI[U][N]*P[U][N];
            gas[U]+=PI[U][N]*P[U][N];
          } /* U */
        if(m[N]<mm) increment(N);
        aT[N]/=Ka*dT*MM; Tr[N]*=Kr*dT; eT[N]/=Ke*dT;
      } /* N */
  /* EFECTE REVOLTA */
  ER=actlMaxU[4];
  for(U=4;U<MM;U++)
    if((U!=FRS) && (U!=6) && (U!=MM-1)) ER+=actlMaxU[U];
  if(ER>0) dT=5; else dT=100;

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for(U=2;U<=MM;U++)
{
  if(MaxU[U]==0 && actlMaxU[U]>0)
  {
    printf(estat,"%4.2f %2d %2d %2d %2d %2d %2d",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);
    printf(moments,"%d %d",actlMaxU[U],actlDom[U]);
    printf(fila,"%s APA%X %s %s\n",cap,U,estat,moments);
    lTAU(fila);
  }
  if(actlMaxU[U]>=MaxU[U] && actlMaxU[U]>0)
  {
    MaxU[U]=actlMaxU[U];
    printf(estat,"%4.2f %2d %2d %2d %2d %2d %2d",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);
    printf(moments,"%d %d",actlMaxU[U],actlDom[U]);
    printf(taufila[U],"%s MXI%X %s %s\n",cap,U,estat,moments);
  }
  if(MaxDom[U]==0 && actlDom[U]>0)
  {
    printf(estat,"%4.2f %2d %2d %2d %2d %2d %2d",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);
    printf(moments,"%d %d",actlMaxU[U],actlDom[U]);
    printf(fila,"%s ADO%X %s %s\n",cap,U,estat,moments);
    lTAU(fila);
  }
  if(actlDom[U]>=MaxDom[U] && actlDom[U]>0)
  {
    MaxDom[U]=actlDom[U];
    if(ec<=0 & ec==0)
    {
      ec=0; printf(estat,"%4.2f %2d %2d %2d %2d %2d %2d",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);
      printf(moments,"%d %d",actlMaxU[U],actlDom[U]);
      printf(fila,"%s Heca %s %s\n",cap,estat,moments);
      lTAU(fila);
      sortida(); return;
    }
    if(S<=0 && T>0) {S=0; printf(estat,"%4.2f %2d %2d %2d %2d %2d %2d",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);
    printf(moments,"%d %d",actlMaxU[U],actlDom[U]);
    printf(fila,"%s MDSA %s %s\n",cap,estat,moments);
    lTAU(fila);
    sortida(); return;}
  }
} /* avaluacio */ increment(N)
int N;
{if(rand()+32767*bz[N]+32767*B[N]/progres>=32767)
  {++m[N]; Mz[N]=(1<<m[N])-1; repressio(N);

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        if(m[N]>mx) {mx=m[N]; MXz=Mz[N]; imprmx=1;}
    }
} /* increment */ impressio() {int N,U; char linia[124],c[2];
printf(cap,"%s ",fnom); lOUT(cap);
printf(linia,"%4ld ",T); lOUT(linia);
for(N=0;N<NP;N++)
    {if(B[N]!=0)
        {c[0]='-';
            for(U=0;U<=MXz;U++)
                if(P[U][N]>.5)
                    {sprintf(c,"%X",U);
                        break;
                    } /* U */
            }
        else c[0]=' ';
        OUTch(c[0]);
    } /* N */
/*sprintf(estat," %4.2f %2d %2d %2d %2d %2d %2d %2d",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);*/
printf(estat," %4.2f %2d %2d %2d %2d %2d %2d %2d ",.5*ec/NP,S,Ka,Kr,Ke,Qc,Ce,MOH);
printf(fila,"%s\n",estat); lOUT(fila);
} /* impressio */ aprenentatge() {int U,V,N,NN,d,w;
float AuxU;
double sqrt();
float sigma,cosigma,PL[MM+1],L,VUM,sign[MM+1],kk;
gr=rg=0;
mG=sG=mU=sU=rGU=0;
for(U=0;U<=MM;U++)
    {
        actlDom[U]=0;
        gar[U]=rga[U]=0;rs[U]=0; rs[U]=0;
    }
for(N=0;N<NP;N++)
    {if(B[N]!=0)
        {L=PGM=SPG=VUM=0;
            for(U=0;U<=MXz;U++)
                { /* REPRESSIO */
                    sigma=0; S=0;
                    for(NN=0;NN<NP;NN++) if(B[NN]!=0)
                        {++S;
                            for(V=0;V<=MXz;V++) if(V!=U)
                                { d=NP/2-abs(NP/2-abs(NN-N));
                                    sigma+=P[V][NN]*P[V][NN]*sts[V][NN]*imp(V,NN,N);
                                }
                            }
                    }
            }
        }
    }

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    if(sigma<0) {printf("%6.2f",sigma); sortida();
        return; }
    }
} /* NN */
rs[U]=NP*st[U];
gr+=sts[U][N]*P[U][N]*ec/ec0;
gar[U]+=sts[U][N]*P[U][N]*ec/ec0;
rs[U]+=sts[U][N];
if(S!=0) sigma/=S; else {sortida(); return;}
cosigma=1-sigma; sigm[U]=sigma;
sts[U][N]+=dT*(sigma-sts[U][N])*aT[N];
PG[U][N]=PI[U][N]*cosigma; if(PG[U][N]<0) PG[U][N]=0;
/* COMUNICACIO CIENTIFICA */
PL[U]=P[U][N];
for(NN=0;NN<NP;NN++) if(NN!=N)
    if(B[NN]!=0)
        { d=NP/2-abs(NP/2-abs(NN-N));
        for(V=0;V<=MXz;V++)
            PL[U]+=EMz[N]*P[U][NN]*EMz[NN]*P[V][NN]*imp(V,NN,N);}
L+=PL[U]; PGM+=PG[U][N]*PL[U];
SPG+=PG[U][N]*PG[U][N]*PL[U];
AuxU=(float)U; VUM+=AuxU*P[U][N];
/*printf("%ld %d %d %2.6f \n",T,N,U,PG[U][N]); */
}/* U printf("\n");*/
acti[N]=PG[0][N];
for(w=1;w<=MXz;w++)
    if(PG[w][N]>acti[N]) acti[N]=PG[w][N];
for(U=2;U<=MXz;U++)
    if(P[U][N]>0.5 && PG[U][N]==acti[N]) actlDom[U]++;
PGM/=L; SPG/=L; SPG-=PGM*PGM;
if(SPG<0) SPG=0;
SPG=sqrt((double)SPG);
mG+=PGM; sG+=PGM*PGM; mU+=VUM; sU+=VUM*VUM; rGU+=PGM*VUM;
B[N]=0;
/* RESIGNACIO */
if(neonat[N]) {PR[N]=PRO[m[N]]; SR[N]=SRO[m[N]]; neonat[N]=0;}
else {PR[N]+=dT*(PGM-PR[N])/Tr[N];
    SR[N]+=dT*(SPG-SR[N])/Tr[N];}
/*SISTEMA NATURAL */
if (ec/ec0<1)
{nt1[N]=2+(natal[N]/(-20*(ec/ec0)*(ec/ec0)+25));
natal[N]+=(nt1[N]-natal[N])/MOH;}

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/* APRENTATGE INDIVIDUAL */
for(U=0;U<=MXz;U++)
  {if(SR[N]>.0001)
    F[U][N]+=2*dT*(PG[U][N]-PR[N])*PL[U]*SRO[m[N]]/SR[N];
    F[U][N]*=(F[U][N]>0);
    B[N]+=F[U][N];
  } /* U */
NM=N;
}
/* REPRODUCCIO */
if(rand()+32767*a[N]+32767*(1-a[N])*B[N]/tanatos>=32767)
  {if(B[N]==0)
    {short NN=N; while(B[NN]==0) NN=(NN+1)%NP;
    m[N]=m[NN]; Mz[N]=(1<<m[N])-1;
    }
  for(U=0;U<=MXz;U++) F[U][N]=natal[N]*(U<=Mz[N]);
  B[N]=natal[N]*(Mz[N]+1);
  repressio(N);
  neonat[N]=1;
  }
} /* N */
if(S!=0)
{mG/=S; sG/=S; sG-=mG*mG;
mU/=S; sU/=S; sU-=mU*mU;
rGU/=S; rGU-=mG*mU;
if(sG<0) sG=0;
sG=sqrt((double)sG);
if(sU<0) sU=0;
sU=sqrt((double)sU);
if(sG*sU>0) {rGU/=sG; rGU/=sU;} else rGU=1;
}
/* RECICLATGE */
rl=(cl*ec<ec0-ec+gs+gr)?(cl*ec):(ec0-ec+gs+gr);
roI=(ec0-ec-rl+gs+gr); if(roI>ec0) roI=ec0;
if(roI<0) roI=0;
for(U=0;U<=MXz;U++)
  for(N=0;N<NP;N++)
    {if(S!=0) ro[U][N]=eT[N]*roI/(ec0*S);
    if(ro[U][N]<0) ro[U][N]=0;
    if(ro[U][N]>PIO[U]) ro[U][N]=PIO[U];
    if(B[N]!=0)
      { P[U][N]=(float)F[U][N]/B[N];

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        rg+=ro[U][N]*P[U][N];
        rga[U]+=ro[U][N]*P[U][N];}
    } /* N */
ec+=rl+rg-gs-gr;
if(ec>ec0) ec=ec0;
if(ec<0) ec=0;
} /* aprenentage */ ciencia() {short N,U;
for(N=0;N<NP;N++) if(B[N]!=0)
    {EMz[N]=0;
    for(U=0;U<=MXz;U++) EMz[N]+=P[U][N]*em[U];
    } /* N */
} /* ciencia */ sortida() {char fnomtipus[35];
taula();
fora=1;
fclose(pf);
copiOUT();
return;
} /* sortida */ copiOUT() {char fnomtipus[35];
sprintf(fnomtipus,Out);
if((pf=fopen(fnomtipus,"rb, recfm=v, lrecl=32756"))==NULL)
    {printf("IMPOSSIBLE OBRIR EL FITXER DE LECTURA Med_ OUT");
    exit(0);}
sprintf(fnomtipus,Out_,fnom);
if((rf=fopen(fnomtipus,"wb, recfm=v, lrecl=32756"))==NULL)
    {printf("IMPOSSIBLE OBRIR EL FITXER D'ESCRIPURA OUT"); exit(0);}
while(!feof(pf)) putc(getc(pf),rf);
fclose(pf); fclose(rf);
} /* copiOUT */ copiTAU() {char fnomtipus[35];
sprintf(fnomtipus,Tau);
if((tf=fopen(fnomtipus,"rb, recfm=v, lrecl=32756"))==NULL)
    {printf("IMPOSSIBLE OBRIR EL FITXER DE LECTURA Med_ TAU");
    exit(0);}
sprintf(fnomtipus,Tau_,fnom);
if((uf=fopen(fnomtipus,"wb, recfm=v, lrecl=32756"))==NULL)
    {printf("IMPOSSIBLE OBRIR EL FITXER D'ESCRIPURA TAU"); exit(0);}
while(!feof(tf)) putc(getc(tf),uf);
fclose(tf); fclose(uf);
} lOUT(fila)
char *fila;
{int L;
for(L=0;L<strlen(fila);L++) OUTch(fila[L]);
} /* lOUT */ lTAU(fila)

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char *fila;
{int L;
  for(L=0;L<strlen(fila);L++) TAUch(fila[L]);
} /* lTAU */ OUTch(c)
char c;
{fputc(c,pf);} /* OUTch */ TAUch(c)
char c;
{fputc(c,tf);}
float imp(U,M,N)
  int U,N,M;
{int d;
  float dis,c,dis1,c1;
  d=NP/2-abs(NP/2-abs(M-N));
  if (U==0) return 10*(!d);
  dis=(float)2*U/3;
  dis1=(float)U/2;
  c=(float)d/dis;c1=(float)d/dis1;
  if(U%2==1 && U<=15) return (c*exp(-.5*c*c)*(U*exp(-.5*U*U/8.064)*6.124+.15))/1.32;
  if(U%2==0 && U<=15) return (natal[N]*exp(-.5*c1*c1)*(2.3019*exp(-.5*U*U/7.25)+U/21));
} taula() {int U;
  for(U=1;U<=MM;U++)
  {if(MaxU[U]>0 & MaxDom[U]>0 ) lTAU(taufila[U]);}
  sprintf(estat,"%4ld",T);
  sprintf(fila,"%s FINI  %s\n",cap,estat);
  lTAU(fila);
} /* taula */ /* fin de MEd .C */

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