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%This program calculates the powers of the tests based on estimators of
the survival probabilities at the end of study period and the weighted
log rank test.

clear
tau = 36;
n =2000;
sim =1000;
p = 0.5;
q = 0.5;
hr=1.5;

lambdaT11=0.04;
lambdaT22=lambdaT11*hr;
lambdaS1=0.5;
lambdaS2=0.5;

locationT1=2;
locationT2=locationT1;
cf=(hr)^(1/locationT1);

scaleT1=50;
scaleT2=cf*scaleT1;

scaleS1=45;
scaleS2=45;
locationS1=1.5;
locationS2=locationS1;

M=100;

VT1=zeros(sim,1);
VT2=zeros(sim,1);
VT3=zeros(sim,1);
VT4=zeros(sim,1);
allT4=zeros(sim,1);
reject11=zeros(sim,1);
reject12=zeros(sim,1);
reject2=zeros(sim,1);
reject3=zeros(sim,1);
reject4=zeros(sim,1);
death=0;
mr=0;

tic


for l = 1:sim

distribution=2;

%exponential distribution
if (distribution ==1)
t1=copularnd('frank',5,n);
T11=-log(t1(:,1))/lambdaT11;
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S1=-log(t1(:,2))/lambdaS1;

t2=copularnd('frank',6,n);
T22=-log(t2(:,1))/lambdaT22;
S2=-log(t2(:,2))/lambdaS2;
end

%Weibull distribution
if (distribution ==2)
t1=copularnd('frank',5,n);
T11=scaleT1*(-log(t1(:,1))).^(1/locationT1
S1=scaleS1*(-log(t1(:,2))).^(1/locationS1);

t2=copularnd('frank',6,n);
T22=scaleT2*(-log(t2(:,1))).^(1/locationT2
S2=scaleS2*(-log(t2(:,2))).^(1/locationS2);
end

V1=exprnd(1,n,1);
V2=exprnd(2,n,1);
T12=S1+V1;
T21=S2+V2;

C=M*unifrnd(0,1,n,1);

X=binornd(1,p,n,1);
Z=binornd(1,q,n,1);

U=zeros(n,1);
T=zeros(n,1);
R=zeros(n,1);
S=zeros(n,1);
delta=zeros(n,1);
for i = 1:n
  if(X(i)==0)
    S(i)=S1(i);
    R(i)=(S1(i)<=T11(i)&S1(i)<=C(i));
    if(R(i)==0)
       T(i)=T11(i);
       U(i)=min(T(i),C(i));
       delta(i)=(T(i)<=C(i));
    end
    if(R(i)==1&&Z(i)==0)
       T(i)=T11(i);
       U(i)=min(T(i),C(i));
       delta(i)=(T(i)<=C(i));
    end
    if(R(i)==1&&Z(i)==1)
       T(i)=T12(i);
       U(i)=min(T(i),C(i));
       delta(i)=(T(i)<=C(i));
    end
  end

  if(X(i)==1)
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```
    S(i)=S2(i);
    R(i)=(S2(i)<=T22(i)&& S2(i)<=C(i));
    if(R(i)==0)
       T(i)=T22(i);
       U(i)=min(T(i),C(i));
       delta(i)=(T(i)<=C(i));
    end
    if(R(i)==1&&Z(i)==0)
       T(i)=T21(i);
       U(i)=min(T(i),C(i));
       delta(i)=(T(i)<=C(i));
    end
    if(R(i)==1&&Z(i)==1)
       T(i)=T22(i);
       U(i)=min(T(i),C(i));
       delta(i)=(T(i)<=C(i));
    end
  end
end

death=death+sum(delta)/sim;
mr=mr+mean(R)/sim;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

Q1=(1-X).*(1-R+R.*(1-Z)./(1-q))./(1-p);
Q2=X.*(1-R+R.*Z./q)./p;
Q=ones(n,1);


data=[U'; delta'; Q1'; Q2'; S'; R'; X'; Z']';
data = SORTROWS(data);
U=data(:,1);
delta=data(:,2);
Q1=data(:,3);
Q2=data(:,4);
S=data(:,5);
R=data(:,6);
X=data(:,7);
Z=data(:,8);

tQ1=zeros(n,1);
tQ2=zeros(n,1);
for iq = 1:n
  tQ1(iq)=(1-X(iq))*((1-Z(iq))*(S(iq)<=U(iq))/(1-q)+(S(iq)>U(iq)))/(1-
p);
  tQ2(iq)=X(iq)*(Z(iq)*(S(iq)<=U(iq))/q+(S(iq)>U(iq)))/p;
end

dLambda1 = zeros(n,1);
dLambda2 = zeros(n,1);
tdLambda1 = zeros(n,1);
tdLambda2 = zeros(n,1);
dLambdaC = zeros(n,1);
dLambda=zeros(n,1);
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```
sumQ1 = zeros(n,1);
sumQ2 = zeros(n,1);
sumtQ1 = zeros(n,1);
sumtQ2 = zeros(n,1);
sumQ = zeros(n,1);
KS1=ones(n,1);
KS2=ones(n,1);
tKS1=ones(n,1);
tKS2=ones(n,1);
NS1=ones(n,1);
NS2=ones(n,1);
MS1=ones(n,1);
MS2=ones(n,1);
Lambda1=zeros(n,1);
Lambda2=zeros(n,1);
hatS=ones(n,1);
hatSC=ones(n,1);
T4=0;

for i = 1:n

    for j = i:n
        sumQ1(i)=sumQ1(i)+Q1(j);
        sumQ2(i)=sumQ2(i)+Q2(j);
        sumQ(i)=sumQ(i)+Q(j);
        sumtQ1(i)=sumtQ1(i)+((1-X(j))/(1-p))*(((1-Z(j))/(1-
q))*(S(j)<U(i))+(S(j)>U(i)));
        sumtQ2(i)=sumtQ2(i)+(X(j)/p)*((Z(j)/q)*(S(j)<U(i))+(S(j)>U(i)));
    end
    if (sumQ1(i)>0)
        dLambda1(i)=Q1(i)*delta(i)/sumQ1(i);
    end
    if (sumQ1(i) == 0)
        dLambda1(i) = 0;
    end
    if (sumQ2(i)>0)
        dLambda2(i)=Q2(i)*delta(i)/sumQ2(i);
    end
    if (sumQ2(i) == 0)
       dLambda2(i) = 0;
    end



    if (sumtQ1(i)>0)
        temp =((1-X(i))/(1-p))*(((1-Z(i))/(1-
q))*(S(i)<U(i))+(S(i)>U(i)));
        tdLambda1(i) = temp*delta(i)/sumtQ1(i);
    end
    if (sumtQ1(i) == 0)
        tdLambda1(i) = 0;
    end
    if (sumtQ2(i)>0)
        temp = (X(i)/p)*((Z(i)/q)*(S(i)<U(i))+(S(i)>U(i)));
        tdLambda2(i) = temp*delta(i)/sumtQ2(i);
    end
    if (sumtQ2(i) == 0)
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    tdLambda2(i) = 0;
end


if(i==1)
    dLambda(i) = Q(i)*delta(i)/sumQ(i);
    dLambdaC(i) = Q(i)*(1-delta(i))/sumQ(i);
    hatSC(i) = 1-dLambdaC(i);
    hatS(i)= 1-dLambda(i);
end
if(i>1)
  dLambdaC(i) = Q(i)*(1-delta(i))/sumQ(i);
  dLambda(i) = Q(i)*delta(i)/sumQ(i);
  hatSC(i) = hatSC(i-1)*(1-dLambdaC(i));
  hatS(i) = hatS(i-1)*(1-dLambda(i));
  if(hatSC(i)==0)
      hatSC(i)=hatSC(i-1);
  end
  if(hatS(i)==0)
       hatS(i)=hatS(i-1);
  end
end
if (sumQ(i) == 0)
   hatSC(i) = hatSC(i-1);
   hatS(i) = hatS(i-1);
   if(hatSC(i)==0)
       hatSC(i)=hatSC(i-1);
   end
   if(hatS(i)==0)
       hatS(i)=hatS(i-1);
   end
end

if(i==1)
  KS1(i)=1-dLambda1(i);
  KS2(i)=1-dLambda2(i);
  tKS1(i)=1-tdLambda1(i);
  tKS2(i)=1-tdLambda2(i);
  Lambda1(i)=dLambda1(i);
  Lambda2(i)=dLambda2(i);
end
if(i>1)
  KS1(i) = KS1(i-1)*(1-dLambda1(i));
  KS2(i) = KS2(i-1)*(1-dLambda2(i));
  tKS1(i) = tKS1(i-1)*(1-tdLambda1(i));
  tKS2(i) = tKS2(i-1)*(1-tdLambda2(i));
  Lambda1(i) = Lambda1(i-1) + dLambda1(i);
  Lambda2(i) = Lambda2(i-1) + dLambda2(i);
  if(KS1(i)==0)
      KS1(i)=KS1(i-1);
  end
  if(KS2(i)==0)
      KS2(i)=KS2(i-1);
  end
end
NS1(i)=exp(-Lambda1(i));
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    NS2(i)=exp(-Lambda2(i));
    MS1(i)=1-mean(data(:,2).*data(:,3).*(data(:,1)<=data(i,1))./hatSC);
    MS2(i)=1-mean(data(:,2).*data(:,4).*(data(:,1)<=data(i,1))./hatSC);

    %calculate log-rank statistic
    if (sumQ1(i)>0&&sumQ2(i)>0&&U(i)<=tau)
       T4=T4+sumQ2(i)*Q1(i)*delta(i)/(sumQ1(i)+sumQ2(i))-
sumQ1(i)*Q2(i)*delta(i)/(sumQ1(i)+sumQ2(i));
    end
end


hatKS1=min(KS1(data(:,1)<=tau));
hatKS2=min(KS2(data(:,1)<=tau));
thatKS1=min(tKS1(data(:,1)<=tau));
thatKS2=min(tKS2(data(:,1)<=tau));
hatNS1=min(NS1(data(:,1)<=tau));
hatNS2=min(NS2(data(:,1)<=tau));
hatMS1=min(MS1(data(:,1)<=tau));
hatMS2=min(MS2(data(:,1)<=tau));
allhatKS1(l)=hatKS1;
allhatKS2(l)=hatKS2;
allthatKS1(l)=thatKS1;
allthatKS2(l)=thatKS2;
allT4(l)=T4;
allhatNS1(l)=hatNS1;
allhatNS2(l)=hatNS2;
allhatMS1(l)=hatMS1;
allhatMS2(l)=hatMS2;
%%%%%%%%%%%%%%%%%%%%

varK1=0;
varK2=0;
vartK1=0;
vartK2=0;
varLR=0;
varN1=0;
varN2=0;
varM1=0;
varM2=0;
for k = 1:n
  integralK=0;
  integralK1=0;
  integralK2=0;
  integralL=0;
  integralN=0;
  temp1=0;
  temp2=0;
  for j = 1:n
     if(U(j)<=tau&&U(j)<=U(k))
       integralK=integralK+dLambda1(j)/(KS1(j)*hatSC(j));
       tQ1jk=(1-X(k))*((1-Z(k))*(S(k)<=U(j))/(1-q)+(S(k)>U(j)))/(1-p);
       tQ2jk=X(k)*(Z(k)*(S(k)<=U(j))/q+(S(k)>U(j)))/p;
       integralK1=integralK1+tQ1jk*dLambda1(j)/(KS1(j)*hatSC(j));
       integralK2=integralK2+tQ2jk*dLambda1(j)/(KS1(j)*hatSC(j));
       integralL=integralL+dLambda1(j);
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      integralN=integralN+dLambda1(j)/(NS1(j)*hatSC(j));
    end
    G01=(KS1(k)-hatKS1)/hatS(k);
    G02=(KS2(k)-hatKS2)/hatS(k);
    temp1=temp1+(Q1(j)*(U(j)<=tau)-G01)^2*(U(j)>=U(k));
    temp2=temp2+(Q2(j)*(U(j)<=tau)-G02)^2*(U(j)>=U(k));
  end
  temp1=temp1/n;
  temp2=temp2/n;

  varK1=varK1+(Q1(k))^2*(delta(k)*(U(k)<=tau)/(KS1(k)*hatSC(k))-
integralK)^2;
  varK2=varK2+(Q2(k))^2*(delta(k)*(U(k)<=tau)/(KS1(k)*hatSC(k))-
integralK)^2;
  vartK1=vartK1+(tQ1(k)*delta(k)*(U(k)<=tau)/(KS1(k)*hatSC(k))-
integralK1)^2;
  vartK2=vartK2+(tQ2(k)*delta(k)*(U(k)<=tau)/(KS1(k)*hatSC(k))-
integralK2)^2;

  varN1=varN1+(Q1(k))^2*(delta(k)*(U(k)<=tau)/(NS1(k)*hatSC(k))-
integralN)^2;
  varN2=varN2+(Q2(k))^2*(delta(k)*(U(k)<=tau)/(NS1(k)*hatSC(k))-
integralN)^2;


varM1=varM1+(U(k)<=tau)*(temp1*delta(k)*dLambdaC(k)/hatS(k)+(Q1(k))^2*d
elta(k)/hatSC(k));

varM2=varM2+(U(k)<=tau)*(temp2*delta(k)*dLambdaC(k)/hatS(k)+(Q2(k))^2*d
elta(k)/hatSC(k));

  varLR=varLR+((Q1(k))^2*(delta(k)*(U(k)<=tau)-
integralL)^2+(Q2(k))^2*(delta(k)*(U(k)<=tau)-integralL)^2)/4;
end
varK1=(hatKS1)^2*varK1/n^2;
varK2=(hatKS2)^2*varK2/n^2;
vartK1=(thatKS1)^2*vartK1/n^2;
vartK2=(thatKS2)^2*vartK2/n^2;
varN1=(hatNS1)^2*varN1/n^2;
varN2=(hatNS1)^2*varN2/n^2;
varM1=varM1/n^2;
varM2=varM2/n^2;

allvarK1(l)=varK1;
allvarK2(l)=varK2;
allvartK1(l)=vartK1;
allvartK2(l)=vartK2;

allvarM1(l)=varM1;
allvarM2(l)=varM2;

allvarLR(l)=varLR;

allvarN1(l)=varN1;
allvarN2(l)=varN2;
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```
Test11=(hatKS1-hatKS2)/sqrt(varK1+varK2);
reject11(l)=abs(Test11)>1.96;
Test12=(thatKS1-thatKS2)/sqrt(vartK1+vartK2);
reject12(l)=abs(Test12)>1.96;
T2=(hatNS1-hatNS2)/sqrt(varN1+varN2);
reject2(l)=abs(T2)>1.96;
T3=(hatMS1-hatMS2)/sqrt(varM1+varM2);
reject3(l)=abs(T3)>1.96;
T4=T4/sqrt(varLR);
reject4(l)=abs(T4)>1.96;

end

toc

[mean(reject11) mean(reject12) mean(reject2) mean(reject3)
mean(reject4)]
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