RULES FOR MAPPING A CONCEPTUAL MODEL ONTO VARIOUS DATA BASE MANAGEMENT SYSTEMS.

Volume 2

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by

Jayasri Chaudhuri

University of Aston in Birmingham

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APPENDIX C

PROGRAM LISTINGS

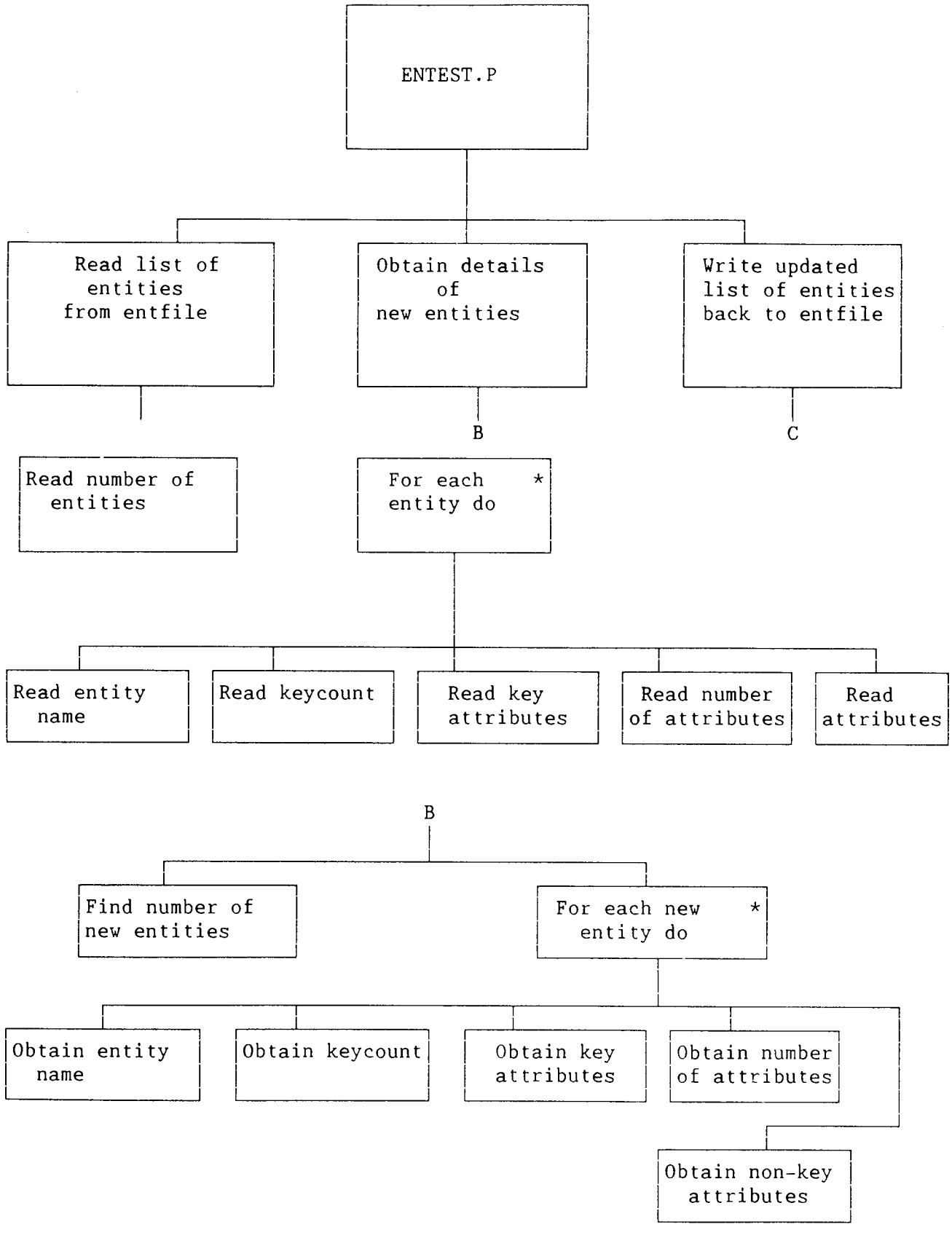
ENTEST.P

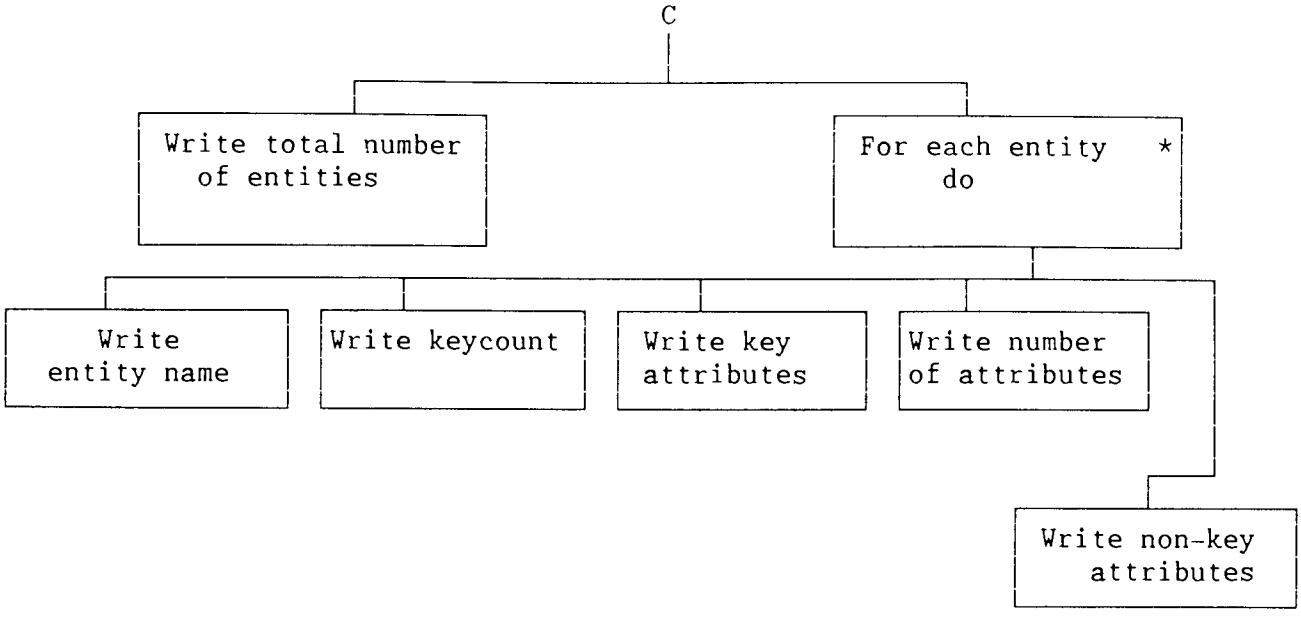
```
{THIS PROGRAM DOCUMENTS THE ENTITIES IDENTIFIED BY THE DESIGNER}

program  entest (input, output, entfile);

const maxstrlength = 20;
      maxnoent = 40;
      maxnoatt = 20;
      primarykey = 'PRIMARY KEY         ';

type str =  array [1..maxstrlength] of char;
     attrib = str;
     attributes = array [0..maxnoatt] of attrib;
     entity = record
              ename: str; {NAME OF THE ENTITY}
              keycount : integer;  {THE NUMBER OF ATTRIBUTES THAT MAKE THE KEY}
              noatts: integer;    {TOTAL NUMBER OF ATTRIBUTES}
              entatt: attributes  {NAMES OF THE ATTRIBUTES}
              end;

var entchart: array [1..maxnoent] of entity; {THE LIST OF ENTITIES}
    noofentities: integer;  {TOTAL NO OF EXISTING ENTITIES}
    entfile: text;
    i, j, k, l: integer;
    nonewent: integer;   {NUMBER OF NEW ENTITIES TO BE INSERTED}


procedure readstr (var f: text; var s: str); {READS A STRING OF CHARACTERS}
     var ptr: integer;
     begin
     ptr := 0;
     while not eoln (f) and (ptr < maxstrlength) do
           begin
           ptr := ptr + 1;
           read (f, s[ptr])
           end;
     while ptr < maxstrlength do
           begin
           ptr := ptr + 1;
           s[ptr] := ' '
           end
     end;

procedure writestr (var f: text; var s: str);  {WRITES A STRING OF CHARACTERS}
     var i: integer;
     begin
     for i := 1 to maxstrlength do
         write (f, s[i]);
     end;
```

```
begin
{READ IN THE LIST OF ENTITIES FROM THE FILE INTO THE MEMORY}
{FOR EACH ENTITY READ ITS NAME, NUMBER OF ATTRIBUTES IN THE KEY}
{TOTAL NUMBER OF ATTRIBUTES, NAME OF THE ATTRIBUTES}
reset (entfile, 'hospent');
readln (oldent, noofentities);
for i := 1 to noofentities do
    with entchart[i] do
         begin
         readln (oldent);
         readstr (oldent, ename);
         readln (oldent);
         readln (oldent, keycount);
         readln (oldent, noatts);
         readln (oldent);
         for l := 0 to keycount do readstr (oldent, entatt[l]);
         readln (oldent);
         readln (oldent);
         k := 1;
         for j := (keycount + 1) to noatts do
             begin
             readstr (oldent, entatt[j]);
             k := k+1;
             if k > 4 then
                begin
                readln (oldent);
                k := 1
                end
             end;

         readln (oldent);
         readln (oldent)
         end;

{READ IN THE NEW ENTITIES FROM THE TERMINAL}
writeln ('Number of new entities');
readln (nonewent);  {NOTE THE NUMBER OF NEW ENTITIES TO BE INSERTED}
for i := 1 to nonewent do
    begin
    noofentities := noofentities + 1{INCREASE THE TOTAL NUMBER OF ENTITIES}
    with entchart[noofentities] do
         begin
         writeln;
         writeln ('Entity name');
         readstr (input, ename);
         readln;
         writeln ('NO of attributes in the primary key');
         readln (input, keycount);
         writeln ('No of attributes');
         readln (input, noatts);
         entatt[0] := primarykey;
         writeln ('Input the attributes one per line');
         for j := 1 to noatts do
             begin
             readstr (input, entatt[j]);
             readln
             end
         end
    end;
```

```
{WRITE THE ENTITIES BACK TO THE ENTITY FILE}
rewrite (entfile, 'hospent');
writeln (newent, noofentities);
for i := 1 to noofentities do
    with entchart[i] do
         begin
         writeln (newent);
         writestr (newent, ename);
         writeln (newent);
         writeln (newent, keycount);
         writeln (newent, noatts);
         writeln (newent);
         for l := 0 to keycount do writestr (newent, entatt[l]);
         writeln (newent);
         writeln (newent);
         k := 1;
         for j := (keycount + 1) to noatts do
             begin
             writestr (newent, entatt[j]);
             k := k+1;
             if k > 4 then
                begin
                writeln (newent);
                k:= 1
                end
             end;
         writeln (newent);
         writeln (newent)
         end;

end.
```

ENTEST.P


ENTEST.P
Read list of entities from entfile
Obtain details of new entities
Write updated list of entities back to entfile
B
C
Read number of entities
For each entity do *
Read entity name
Read keycount
Read key attributes
Read number of attributes
Read attributes
B
Find number of new entities
For each new entity do *
Obtain entity name
Obtain keycount
Obtain key attributes
Obtain number of attributes
Obtain non-key attributes


C
Write total number of entities
For each entity do *
Write entity name
Write keycount
Write key attributes
Write number of attributes
Write non-key attributes

```
{THIS PROGRAM DOCUMENTS THE RELATIONSHIPS IDENTIFIED BY THE DESIGNER}

program relationtest (input, output, relfile);

const maxstrlength = 20;
      maxnorel = 40;
      maxnoent = 40;
      maxnoatt = 20;
      maxrelatt = 10;
      awith =    'WITH               ';
      awithout = 'WITHOUT            ';

type str =  array [1..maxstrlength] of char;
     relstat = (weth, wethout);  {DENOTES IF RELATIONSHIP HAS ANY ATTRIBUTE}
     relation = record
                rname: str;  {NAME OF THE RELATIONSHIP}
                entitya: integer;  {POINTER TO ENTITYA }
                degenta: char;  {DEGREE OF ENTITYA}
                membshpa: char; {MEMBERSHIP CLASS OF ENTITYA}
                entityb: integer;  {POINTER TO ENTITYB}
                degentb: char;   {DEGREE OF ENTITYB}
                membshpb: char;  {MEMBERSHIP CLASS OF ENTITYB}
                case rs : relstat of
                   weth: (norelatt : integer; {NUMBER OF ATTRIBUTES IF ANY}
                          relatt : array [1..maxrelatt] of str);  {ATTRIBUTES}
                   wethout: ()
                end;


    attributes = array [0..maxnoatt] of str;

    entity = record
             ename: str;
             keycount: integer;
             noatts: integer;
             entatt : attributes
             end;

var relchart: array [1..maxnorel] of relation;  {THE LIST OF RELATIONSHIPS}
    entchart : array [1..maxnoent ] of entity;
    noofrelations: integer;
    relfile: text;
    relform : text;
    i, j, k, l : integer;
    norelfile: integer;
    noofentities: integer;
    entfile : text;
    tempbuff : str;
    found : boolean;
    correct : boolean;
    answer : str;
```

```
procedure readstr (var f: text; var s: str);
     var ptr: integer;
     begin
     ptr := 0;
     while not eoln (f) and (ptr < maxstrlength) do
           begin
           ptr := ptr + 1;
           read (f, s[ptr]);
           end;
     while ptr < maxstrlength do
           begin
           ptr := ptr + 1;
           s[ptr] := ' '
           end
     end;


procedure writestr (var f: text; var s: str);
     var i: integer;
     begin
     for i := 1 to maxstrlength do
         write (f, s[i]);
     end;


function equalstr(a, b: str): boolean; {COMPARES TWO STRINGS}
    var ptr : integer;
        equal : boolean;
    begin
    equal := true;
    ptr := 0;
    while equal and (ptr < maxstrlength ) do
                begin
                ptr := ptr + 1;
                if a[ptr] <> b[ptr] then
                equal := false
                end;
    equalstr := equal
    end;

procedure findent (var int : integer);  {SEARCHES IF AN ENTITY EXISTS}
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities) do
         begin
         l := l+ 1;
         if equalstr (tempbuff, entchart[l].ename) then
            begin
            int := l;
            found := true
            end
         end
     end;
```

```
begin
{READ IN THE ENTITY FILE}
reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
    with entchart[i] do
         begin
         readln (entfile);
         readstr (entfile, ename);
         readln (entfile);
         readln (entfile, keycount);
         readln (entfile, noatts);
         readln (entfile);
         for l := 0 to keycount do readstr (entfile, entatt[l]);
         readln (entfile);
         readln (entfile);
         k := 1;
         for j := (keycount + 1) to noatts do
             begin
             readstr (entfile, entatt[j]);
             k := k+1;
             if k > 4 then
                begin
                readln (entfile);
                k := 1
                end
             end;
         readln (entfile);
         readln (entfile)
         end;

{READ IN THE RELATIONSHIPS FROM THE FILE INTO THE MEMORY}
{FOR EACH RELATIONSHIP READ ITS NAME, POINTERS TO THE PARTICIPATING ENTITIES}
{DEGREE AND MEMBERSHIP CLASSES OF THE ENTITIES}
{ATTRIBUTES OF THE ENTITIES}

reset (relfile, 'hosprel');
readln (relfile, noofrelations);
for i := 1 to noofrelations do
    with relchart[i] do
         begin
         readln (relfile);
         readstr (relfile, rname);
         readln (relfile);
         readstr (relfile, tempbuff);
         findent (entitya);
         readln (relfile, degenta);
         readln (relfile, membshpa);
         readstr (relfile, tempbuff);
         findent (entityb);
         readln (relfile, degentb);
         readln (relfile, membshpb);
         readstr (relfile, tempbuff);
         if tempbuff = awith then rs := weth
         else rs := wethout;
         readln (relfile);
```

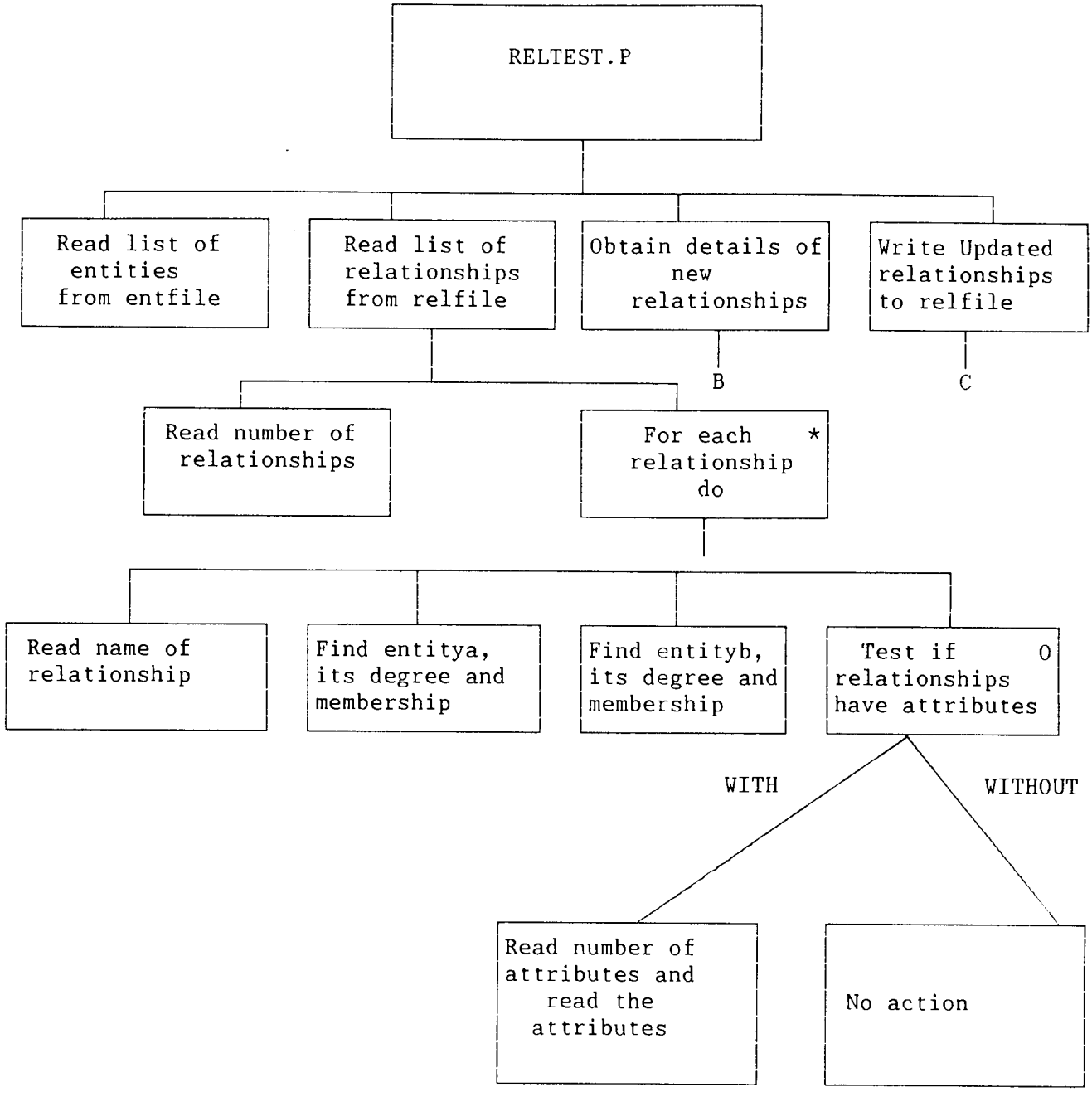
```
          if rs = weth then
             begin
             readln (relfile, norelatt);
             k := 1;
             for j := 1 to norelatt do
                 begin
                 readstr(relfile, relatt[j]);
                 k := k+1;
                 if k > 4 then
                 begin
                 readln (relfile);
                 k := 1
                 end
                 end
             end
          end;


{READ IN FROM THE TERMINAL}
writeln (' Number of new relationships');
readln (norelfile);  {NOTE THE NUMBER OF NEW RELATIONSHIPS TO BE INSERTED}
for i := 1 to norelfile do
    begir.
    noofrelations := noofrelations + 1;  {INCREASE RELATIONSHOP TOTAL}
    with relchart[noofrelations] do
         begin
         writeln;
         writeln ('Relationship name');
         readstr (input, rname);
         readln;
         writeln ('First entity');
         repeat
         readstr (input, tempbuff);
         readln;
         findent (entitya);
         if (not found) then  writeln ('THIS ENTITY DOES NOT EXIST')
         until found = true;
         writeln ('Degree of first entity 1 or m');
         readln (input, degenta);
         writeln ('Membership of first entity o for obligatory n for
         non-obligatory');
         readln (input, membshpa);
         writeln ('Second entity');
         repeat
         readstr (input, tempbuff);
         readln;
         findent (entityb);
         if (not found) then writeln ('THIS ENTITY DOES NOT EXIST')
         until found = true;
         writeln ('Degree of second entity 1or n');
         readln (input, degentb);
         writeln ('Membership of second entity o or n');
         readln (input, membshpb);
```

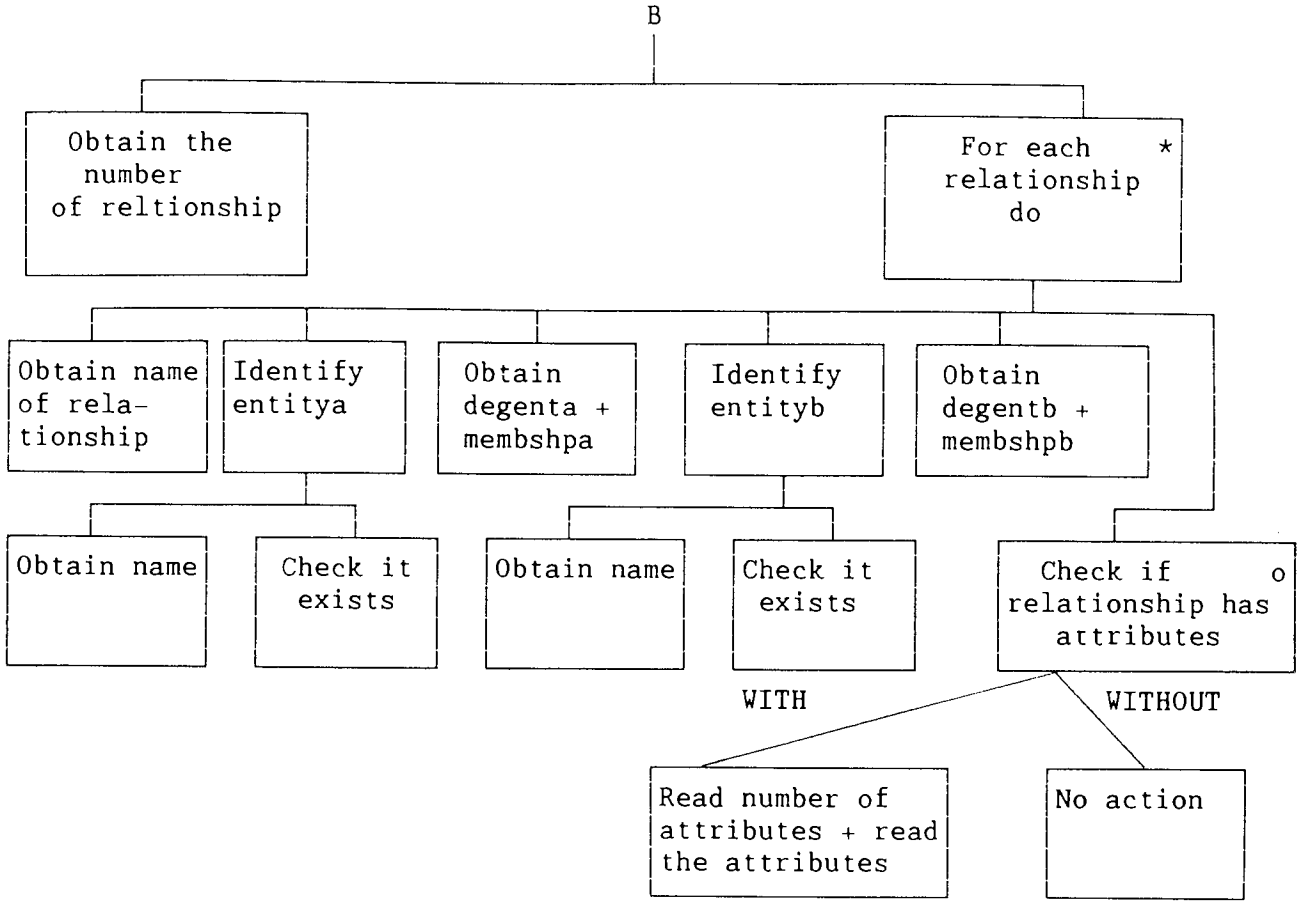
```
        if membshpb = 'o' then
          begin

          {CHECK IF THE KEY OF ENTITYA FORMS PART OF THE KEY OF ENTITYB}
          {IF IT IS THEN ASSIGN MEMBERSHIP CLASS S TO ENTITYB}

          found := false;
          j := 0;
          while (not found) and (j < entchart[entityb].keycount) do
             begin
             j := j+1;
             if equalstr (entchart[entitya].entatt[1], entchart[entityb].
                                                       entatt[j]) then
                 found := true
             end;
           if found then membshpb := 's'
           end;
        correct := false;
          repeat
          writeln ('State WITH or WITHOUT Attributes');
          readstr (input, answer);
          readln;
          if answer = awith then
             begin
             rs := weth;
             correct := true
             end
          else if answer = awithout then
               begin
               rs:= wethout;
               correct := true
               end
          else writeln ('INVALID RESPONSE')
          until correct = true;
         if rs = weth  then
            begin
            writeln ('Number of Attributes');
            readln (input, norelatt);
            writeln ('State one attriute per line');
            for j := 1 to norelatt do
                begin
                readstr (input, relatt[j]);
                readln
                end
            end

        end
end;
```

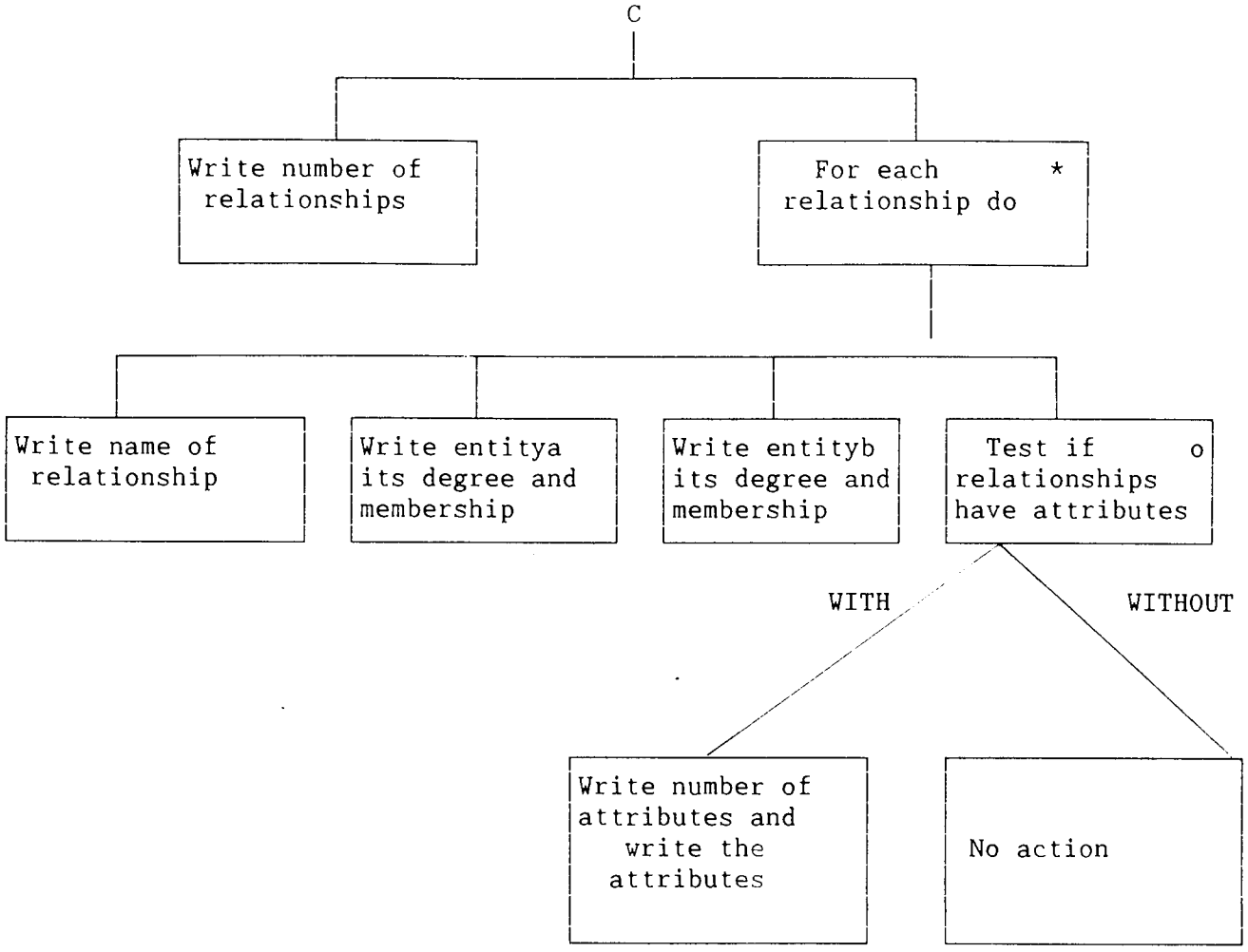
```
{WRITE THE RELATIONSHIP BACK TO THE RELFILE}

rewrite (relfile, 'hosprel');
writeln (relfile, noofrelations);
for i := 1 to noofrelations do
    with relchart[i] do
         begin
         writeln (relfile);
         writestr (relfile, rname);
         writeln (relfile);
         writestr (relfile, entchart[entitya].ename);
         writeln (relfile,degenta);
         writeln (relfile, membshpa);
         writestr ( relfile, entchart[entityb].ename);
         writeln (relfile, degentb);
         writeln (relfile, membshpb);
         if rs = weth then write(relfile, awith)
         else write (relfile, awithout);
         writeln (relfile );
         if rs = weth then
            begin
            writeln (relfile, norelatt);
            k := 1;
            for j := 1 to norelatt do
                begin
                writestr (relfile, relatt[j]);
                k := k+1;
                if k> 4 then
                   begin
                   writeln(relfile);
                   k := 1
                   end
                end
              end
         end;
```

```
{WRITE THE RELATION IN THE FORMATTED FORM}

rewrite (relform,'format-rel');
write(relform,'RELATION-NAME       ');
write(relform,'ENTITY-A            ');
write(relform,'ENTITY-B            ');
write(relform, 'DEGREE-A    ');
write(relform, 'DEGREE-B    ');
write(relform,  'MEMB-A    ');
writeln(relform, 'MEMB-B');
writeln (relform);
for i := 1 to noofrelations do
  with relchart[i] do
  begin
  writestr (relform, rname);
  writestr (relform, entchart[entitya].ename);
  writestr (relform, entchart[entityb].ename);
  write (relform,'      ');
  write(relform, degenta);
  write (relform,'     ');
  write (relform,'      ');
  write (relform,degentb);
  write (relform,'     ');
  write (relform,'      ');
  write (relform, membshpa);
  write(relform, '           ');
  writeln(relform,membshpb);
  writeln (relform)
  end
end.
```

RELTEST.P


RELTEST.P
Read list of entities from entfile
Read list of relationships from relfile
Obtain details of new relationships
Write Updated relationships to relfile
B
C
Read number of relationships
For each relationship do
*
Read name of relationship
Find entitya, its degree and membership
Find entityb, its degree and membership
Test if relationships have attributes
0
WITH
WITHOUT
Read number of attributes and read the attributes
No action


B
Obtain the number of reltionship
For each relationship do *
Obtain name of rela-tionship
Identify entitya
Obtain degenta + membshpa
Identify entityb
Obtain degentb + membshpb
Obtain name
Check it exists
Obtain name
Check it exists
Check if relationship has attributes o
WITH
WITHOUT
Read number of attributes + read the attributes
No action


C
Write number of relationships
For each * relationship do
Write name of relationship
Write entitya its degree and membership
Write entityb its degree and membership
Test if o relationships have attributes
WITH
WITHOUT
Write number of attributes and write the attributes
No action

```
{THIS PROGRAM DOCUMENTS INFORMATION ABOUT THE IDENTIFIED FUNCTIONS}

program functest (input, output, funcfile);

const maxstrlength = 20;
      maxnofunc = 20;
      maxnoacc = 15;
      maxselcrit = 4;
      maxnoatt = 15;
      maxnoent = 40;
      maxnorel = 40;
      primary = 'PRIMARY              ';
      secondary = 'SECONDARY            ';
      ent = 'ENTITY               ';
      reln = 'RELATIONSHIP         ';
      selbyrel = 'SELECT.BY.RELATION  ';
      selbyatt = 'SELECT.BY.ATTRIBUTES';
      selbykey = 'SELECT.BY.KEY        ';
      range =    'RANGE                ';
      equijoin=  'EQUIJOIN             ';
      awith = 'WITH';
      awithout = 'WITHOUT';
      maxrelatt = 10;

type str =  array [1..maxstrlength] of char;
     relstat = (weth, without);
     selopts = (sbyr, sbya, sbyp);
     selectdet = record
                   case opts : selopts of
                        sbyr : (relpnt : integer);
                        sbyp : (ppnt : char);
                        sbya : (apnt : integer;
                                aclaus : char);
                     end;
     accent = record
              entname : integer;  {POINTER TO THE ENTITY}
              eselectcrit : selectdet  {SELECTION CRITERIA}
              end;
     entacc = array [1..maxnoacc] of accent;

     func = record
            funcname : str;  {NAME OF THE FUNCTION}
            funcfreq : integer;  {FREQUENCY OF THE FUNCTION}
            funcstatus : integer; {STATUS OF THE FUNCTION}
            noacc : integer;  {NUMBER OF ENTITIES ACCESSED}
            entarr : entacc  {LIST SHOWING THE ENITITIES ACCESED}
            end;

     attributes = array [0..maxnoatt] of str;

     entity = record
              ename: str;
              keycount: integer;
              noatts : integer;
              entatt : attributes
              end;
```

```
    relation = record
                rname: str;
                entitya: integer;
                degenta: char;
                membshpa : char;
                entityb: integer;
                degentb: char;
                membshpb: char;
                case rs: relstat of
                    weth: (norelatt : integer;
                           relatt : array [1..maxrelatt] of str);
                    without : ()
                end;

var funcchart: array [1..maxnofunc] of func;
    entchart : array [1..maxnoent] of entity;
    relchart : array [1..maxnorel] of relation;
    nooffunc: integer;
    funcfile: text;
    entfile : text;
    relfile : text;
    i, j, k, l: integer;
    noofnewfunc: integer;
    noofentities : integer;
    noofrelations : integer;
    entindex : integer;
    tempbuff : str;
    found : boolean;


procedure readstr (var f: text; var s: str);
    var ptr: integer;
    begin
    ptr := 0;
    while not eoln (f) and (ptr < maxstrlength) do
          begin
          ptr := ptr + 1;
          read (f, s[ptr])
          end;
    while ptr < maxstrlength do
          begin
          ptr := ptr + 1;
          s[ptr] := ' '
          end
    end;


procedure writestr (var f: text; var s: str);
    var i: integer;
    begin
    for i := 1 to maxstrlength do
        write (f, s[i]);
    end;
```

```
function equalstr (a, b: str ) : boolean;
    var ptr : integer;
        equal : boolean;
    begin
    equal := true;
    ptr := 0;
    while equal and (ptr < maxstrlength ) do
                begin
                ptr := ptr + 1;
                if a[ptr] <> b[ptr] then
                equal := false;
                end;
    equalstr := equal
    end;


procedure findent (var int : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities ) do
         begin
         l := l+1;
         if equalstr (tempbuff, entchart[l].ename) then
            begin
            int := l;
            found := true
            end
         end
      end;

procedure findrel (var int : integer);  {SEARCHES IF A RELATIONSHIP EXISTS}
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities) do
         begin
         l := l+1;
         if equalstr (tempbuff, relchart[l].rname) then
            begin
            int := l;
            found := true
            end
         end
      end;
```

```
procedure findatt (var int : integer; var entindex : integer);
{SEARCHES IF AN ATTRIBUTE EXISTS}
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < entchart[entindex].noatts) do
         begin
         l := l+1;
         if equalstr (tempbuff, entchart[entindex].entatt[l]) then
            begin
            int := l;
            found := true
            end
         end
      end;

procedure findrelatt (var int: integer; var relindex : integer);
{SEARCHES IF AN ATTRIBUTE OF A RELATIONSHIP EXISTS
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < relchart[relindex]. norelatt ) do
         begin
         l := l + 1;
         if equalstr (tempbuff, relchart[relindex].relatt[l]) then
            begin
            int := l;
            found := true
            end
          end
      end;

begin

{READ IN THE ENTITY FILE}

reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
    with entchart [i] do
         begin
         readln (entfile);
         readstr (entfile, ename);
         readln (entfile);
         readln (entfile, keycount);
         readln (entfile, noatts);
         readln (entfile);
         for l := 0 to keycount do readstr (entfile, entatt[l]);
         readln (entfile);
         readln (entfile);
         k := 1;
```

```
        for j := (keycount + 1) to noatts do
            begin
            readstr (entfile, entatt[j]);
            k := k+1;
            if k > 4 then
               begin
               readln (entfile);
               k := 1
               end
            end;
        readln (entfile);
        readln (entfile)
        end;

{READ IN THE RELATION FILE}

reset (relfile, 'hosprel');
readln (relfile, noofrelations );
for i := 1 to noofrelations do
    with relchart[i] do
        begin
        readln (relfile);
        readstr (relfile, rname);
        readln (relfile);
        readstr (relfile, tempbuff);
        findent (entitya);
        readln (relfile, degenta);
        readln (relfile, membshpa);
        readstr (relfile, tempbuff);
        findent (entityb);
        readln (relfile, degentb);
        readln (relfile, membshpb);
        readstr (relfile, tempbuff);
         if tempbuff = awith then rs := weth
         else rs := without;
         readln (relfile);
         if rs = weth then
            begin
            readln (relfile, norelatt);
            k := 1;
            for j := 1 to norelatt do
                begin
                readstr (relfile, relatt[j]);
                k := k + 1;
                if k > 4 then
                   begin
                   readln (relfile);
                   k := 1
                   end
                end
            end
        end;
```

```
{READ IN THE FUNCTIONS FROM THE FILE CONTAINING THE LIST OF FUNCTIONS}

reset (funcfile, 'hospfunc');
readln (funcfile, nooffunc);
for i := 1 to nooffunc do
    with funcchart[i] do

{FOR EACH FUNCTION NOTE ITS NAME, STATUS, FREQUENCY AND NUMBER OF ENTITIES
ACCESSED}

        begin
        readln (funcfile);
        readstr (funcfile, funcname);
        readstr (funcfile, tempbuff);
        if equalstr (tempbuff, primary) then funcstatus := 1
        else funcstatus := 2;
        readln (funcfile, funcfreq);
        readln (funcfile, noacc);

{FOR EACH ENTITY ACCESSED NOTE ITS NAME, HOW IT IS SELECTED}
{IDENTIFY THE RELATION OR ATTRIBUTE/S USED TO SELECT THE ENTITY}
{IF SELECTED BY ATTRIBUTE NOTE WHETHER RANGE OR EQUALITY CLAUSE WAS USED}

        for j := 1 to noacc do
        with entarr[j] do
                begin
                readstr (funcfile, tempbuff);
                findent (entname);
                readstr (funcfile, tempbuff);
                readln(funcfile);
                if equalstr (tempbuff, selbyrel) then
                   eselectcrit.opts := sbyr
                else
                if equalstr (tempbuff, selbyatt) then
                   eselectcrit.opts := sbya
                else
                   eselectcrit.opts := sbyp;
                if eselectcrit.opts = sbyr then
                   begin
                   readstr (funcfile, tempbuff);
                   readln (funcfile);
                   findrel (eselectcrit.relpnt)
                   end
                 else
                if eselectcrit.opts = sbya  then
                   begin
                   readstr (funcfile, tempbuff);
                   findatt (eselectcrit.apnt, entname);
                   readstr (funcfile, tempbuff);
                   if equalstr (tempbuff, range) then
                      eselectcrit.aclaus := 'r'
                   else
                      eselectcrit.aclaus := 'e';
                      readln(funcfile)
                   end
```

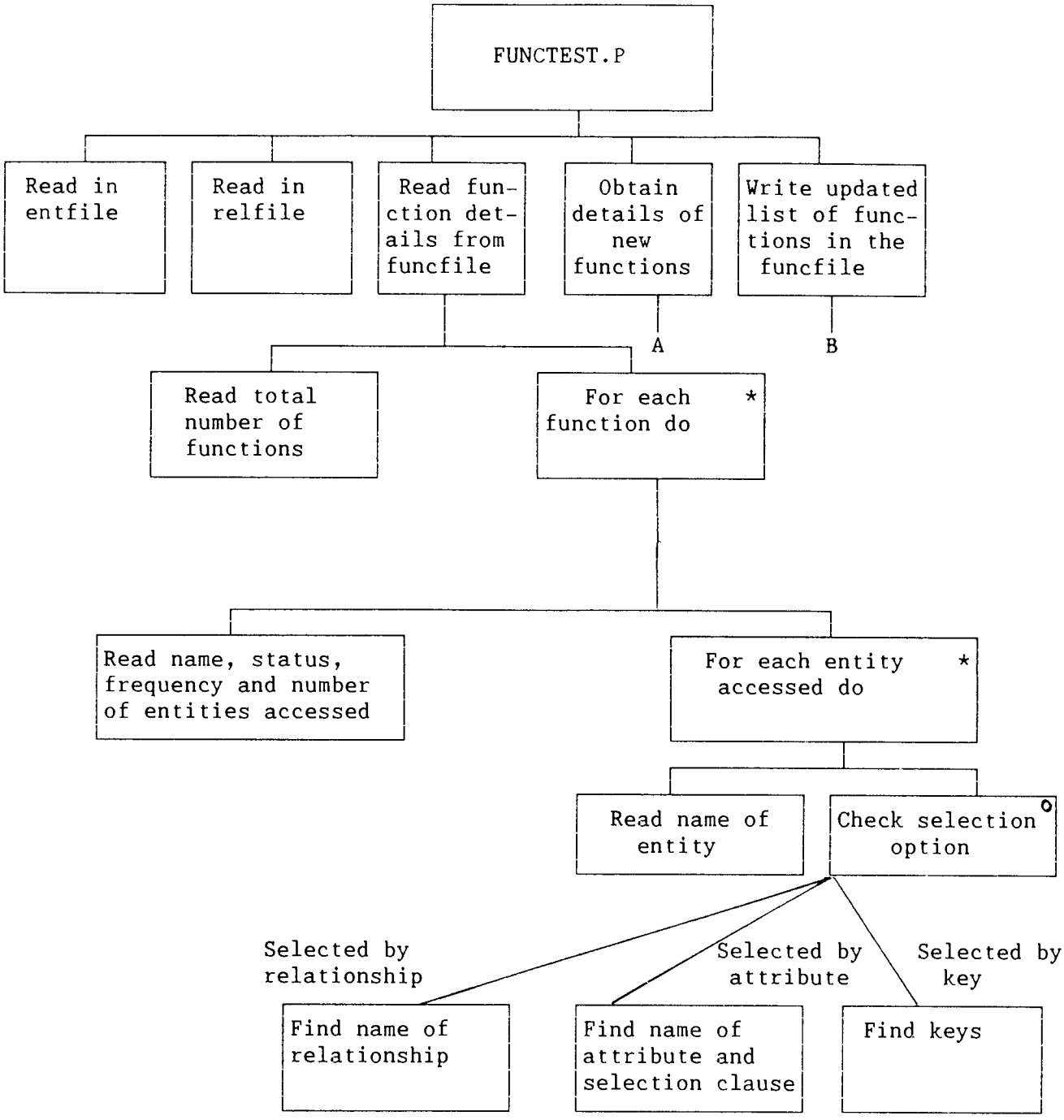
```
                    else
                       begin
                       for k := 1 to entchart[entname].keycount do
                       readstr (funcfile, tempbuff);
                       readln (funcfile)
                       end;
                    readln (funcfile)
                 end
              end;


{FIND OUT THE NUMBER OF NEW FUNCTIONS TO BE INSERTED}
{FOR EACH FUNCTION NOTE THE DETAILS DESCRIBING THE FUNCTION}

writeln ('Number of new function');
readln (noofnewfunc);
for i := 1 to noofnewfunc do
    begin
    nooffunc := nooffunc + 1;
    with funcchart[nooffunc] do
         begin
         writeln;
         writeln ('Function name');
         readstr ( input, funcname );
         readln;
         writeln ('Status of function');
         readstr (input, tempbuff);
         if equalstr (tempbuff, primary ) then funcstatus := 1
         else funcstatus := 2;
         readln;
         writeln ('Frequency of the function' );
         readln (input, funcfreq);
         writeln ('Number of ENTITY accessed');
         readln ( input,  noacc);
         for j := 1 to noacc do
         with entarr[j] do
            begin
```

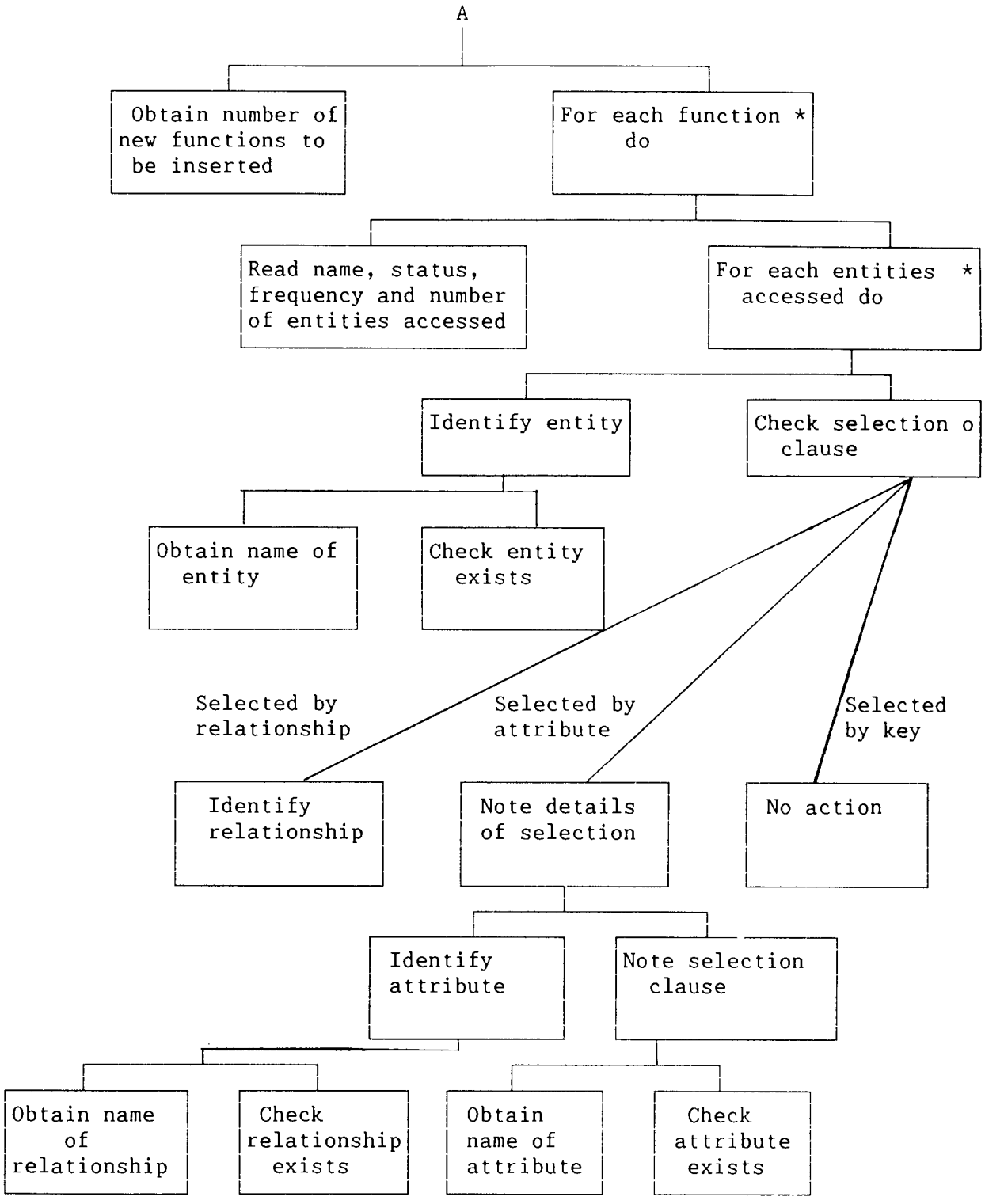
```
      {CHECK WHETHER THE ENTITY EXISTS}

         writeln ('Name of entity');
         repeat
         readstr (input, tempbuff) ;
         readln;
         findent( entname);
         if (not found) then
            writeln ('THIS ENTITY DOES NOT EXIST. TRY AGAIN')
         until found = true;
          writeln ('State whether SELECT.BY.KEY/RELATION/ATTRIBUTES');
          readstr(input,tempbuff);
          if equalstr (tempbuff, selbyrel) then
                     eselectcrit.opts := sbyr
           else if equalstr (tempbuff, selbyatt) then
                     eselectcrit.opts := sbya
          else       eselectcrit.opts := sbyp;
          readln;
          if eselectcrit.opts = sbyr then
             begin
             writeln('State the name of the relation used');



             {CHECK WHETHER THE STATED RELATIONSHIP EXISTS}

             repeat
             readstr (input, tempbuff);
             readln;
             findrel (eselectcrit.relpnt);
             if (not found) then
             writeln( 'THIS RELATION DOES NOT EXIST. TRY AGAIN.')
             until found = true
             end
          else
          if eselectcrit.opts = sbya then
           begin
           writeln( 'State the attribute');
           repeat
           readstr (input, tempbuff);
           readln;
           findatt(eselectcrit.apnt,entname);
           if (not found) then
                  writeln ('THIS ATTRIBUTE DOES NOT EXIST. TRY AGAIN')
           until found = true ;
           writeln ('State selection clause RANGE or EQUIJOIN.');
           readstr (input, tempbuff);
           if equalstr (tempbuff, range) then
              eselectcrit.aclaus := 'r'
           else
              eselectcrit.aclaus := 'e'
           end
        end
     end
end;
```

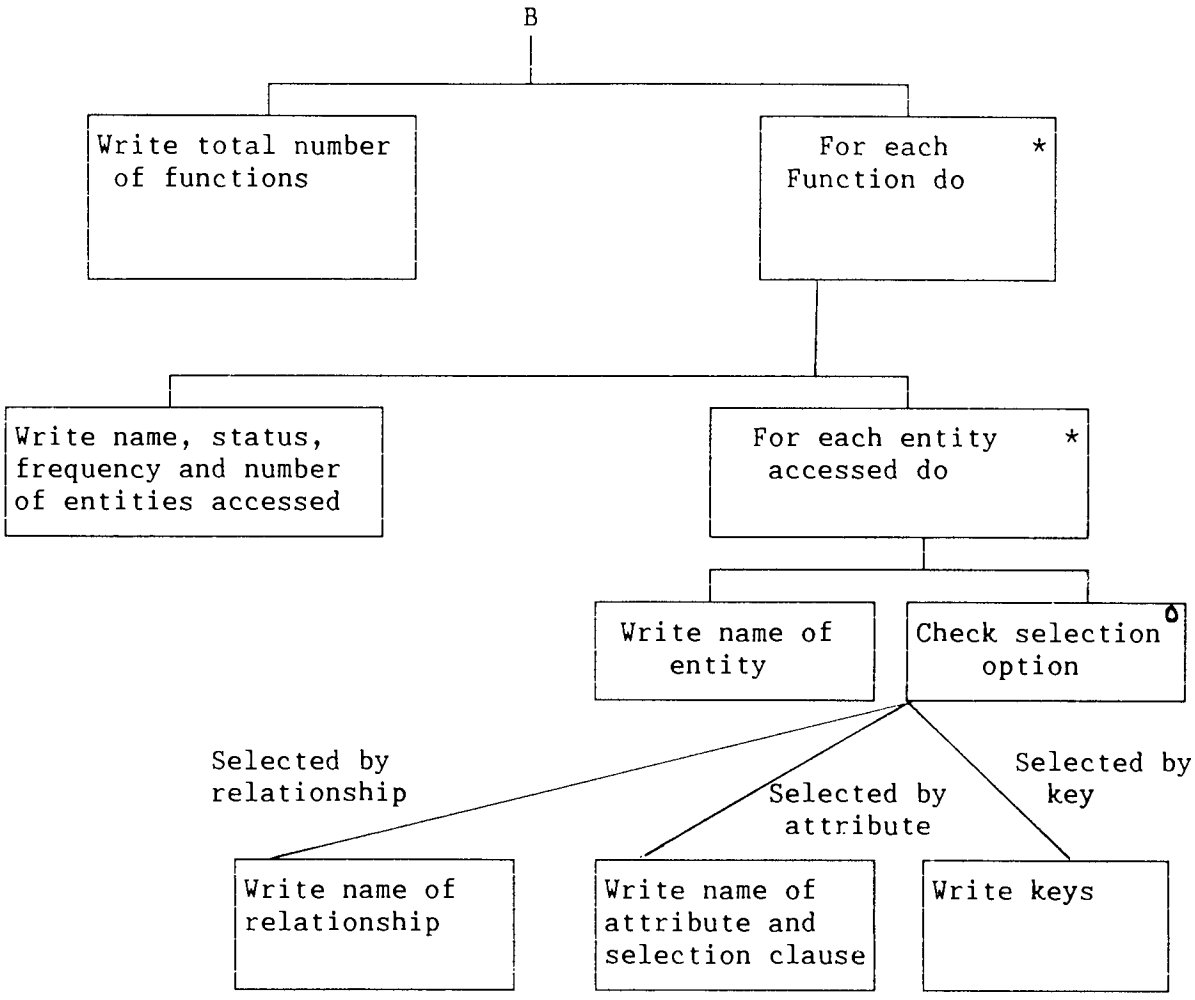
```
{WRITE BACK ALL THE FUNCTION DESCRIPTIONS IN THE FUNCFILE};

rewrite(funcfile, 'hospfunc');
writeln (funcfile,nooffunc);
for i := 1 to nooffunc do
with funcchart[i] do
   begin
   writeln (funcfile);
   writestr (funcfile,funcname);  {WRITE FUNCTION NAME}
   if funcstatus =1 then tempbuff := primary
   else tempbuff := secondary;


   {WRITE WHETHER FUNCTION IS PRIMARY OR SECONDARY}
   writestr (funcfile, tempbuff);
   writeln (funcfile, funcfreq);  {WRITE FREQUENCY OF THE FUNCTION}
   writeln (funcfile, noacc);  {WRITE NUMBER OF ENTITIES ACCESSED}
   for j := 1 to noacc do
   with entarr[j] do
     begin
     writestr (funcfile, entchart[entname].ename);  {WRITE THE NAME OF THE}
                                                    {ENTITY}

     {CHECK WHETHER SELECTED BY RELATIONSHIP/KEY/ATTRIBUTE}

     if eselectcrit.opts = sbyr then
        tempbuff := selbyrel
     else
     if eselectcrit.opts = sbya then
         tempbuff := selbyatt
     else
         tempbuff := selbykey;

     {WRITE WHETHER SELECTED BY KEY/ATTRIBUTE/ RELATIONSHIP}
     writestr (funcfile, tempbuff);
     writeln (funcfile);
```

```
    if eselectcrit.opts = sbyr then

     {IF SELECTED BY RELATIONSHIP THEN WRITE NAME OF RELATIONSHIP}
        begin
        writestr (funcfile, relchart[eselectcrit.relpnt].rname);
        writeln (funcfile)
        end
     else
     if eselectcrit.opts = sbyp then

     {IF SELECTED BY KEY THEN WRITE THE KEY ATTRIBUTES}

        begin
        for k := 1 to entchart[entname].keycount do
        writestr (funcfile, entchart[entname].entatt[k]);
        writeln (funcfile)
        end
      else
        begin

      {IF SELECTED BY ATTRIBUTE THEN WRITE THE ATTRIBUTE}

        writestr (funcfile, entchart[entname].entatt[eselectcrit.apnt]);
        if eselectcrit.aclaus = 'r' then
           tempbuff := range
        else
           tempbuff := equijoin;
        writestr (funcfile, tempbuff);  {WRITE WHETHER RANGE OR EQUIJOIN}
                                                                {ACCESS}
        writeln (funcfile)
        end;
     writeln (funcfile)
     end
end
end.
```

FUNCTEST.P


FUNCTEST.P
Read in entfile
Read in relfile
Read function details from funcfile
Obtain details of new functions
Write updated list of functions in the funcfile
A
B
Read total number of functions
For each function do *
Read name, status, frequency and number of entities accessed
For each entity accessed do *
Read name of entity
Check selection option o
Selected by relationship
Selected by attribute
Selected by key
Find name of relationship
Find name of attribute and selection clause
Find keys


A
Obtain number of new functions to be inserted
For each function * do
Read name, status, frequency and number of entities accessed
For each entities * accessed do
Identify entity
Check selection o clause
Obtain name of entity
Check entity exists
Selected by relationship
Selected by attribute
Selected by key
Identify relationship
Note details of selection
No action
Identify attribute
Note selection clause
Obtain name of relationship
Check relationship exists
Obtain name of attribute
Check attribute exists


B
Write total number of functions
For each Function do *
Write name, status, frequency and number of entities accessed
For each entity accessed do *
Write name of entity
Check selection option
Selected by relationship
Selected by attribute
Selected by key
Write name of relationship
Write name of attribute and selection clause
Write keys

```
{THIS PROGRAM ANALYSES THE RESULT OF THE FUNCTIONAL ANALYSIS}

program analysis (input, output, funcfile);

const maxstrlength = 20;
      maxnofunc = 20;
      maxnoacc = 15;
      maxselcrit = 4;
      maxnoatt = 15;
      maxnoent = 40;
      maxnorel = 40;
      maxoutedge = 20;
      maxinedge = 20;
      maxnoedge = 400;
      primary = 'PRIMARY              ';
      secondary = 'SECONDARY            ';
      ent = 'ENTITY               ';
      reln = 'RELATIONSHIP         ';
      selbyrel = 'SELECT.BY.RELATION  ';
      selbyatt = 'SELECT.BY.ATTRIBUTES';
      selbykey = 'SELECT.BY.KEY        ';
      awith = 'WITH                 ';
      awithout = 'WITHOUT              ';
      maxrelatt = 10;
      range = 'RANGE                ';
      equijoin = 'EQUIJOIN             ';

type str =  array [1..maxstrlength] of char;
     relstat = (weth, without);
     selopts = (sbyr, sbya, sbyp);
     selectdet = record
                   case opts : selopts of
                        sbyr : (relpnt : integer);
                        sbyp : (ppnt : char);
                        sbya : (apnt : integer;
                                aclaus : char);
                  end;

     accent = record
               entname : integer;
               eselectcrit : selectdet
               end;

     entacc = array [1..maxnoacc] of accent;

     func = record
            funcname : str;
            funcfreq : integer;
            funcstatus : integer;
            noacc : integer;
            entarr : entacc
            end;

     attributes = array [0..maxnoatt] of str;
```

```
     entity = record
              ename: str;
              keycount: integer;
              noatts : integer;
              entatt : attributes
              end;

     relation = record
                rname: str;
                entitya: integer;
                degenta: char;
                membshpa : char;
                entityb: integer;
                degentb: char;
                membshpb: char;
                case rs: relstat of
                    weth: (norelatt : integer;
                           relatt : array [1..maxrelatt] of str);
                    without : ()
                end;

     accdet = record
              rangefreq: integer;  {FREQUENCY OF USAGE IN RANGE CLAUSE}
              equifreq : integer   {FREQUENCY OF USAGE IN EQUALITY CLAUSE}
              end;

     analdet = record
               primdet: accdet;  {USAGE OF AN ATTRIBUTE IN PRIMARY FUNCTION}
               seconddet: accdet {USAGE OF AN ATTRIBUTE IN SECONDARY FUNCTION}
               end;

     eusagedet= record  {USAGE DETAIL OF AN ENTITY}
                usagedet : array[1..maxnoatt] of analdet
                end;

     rusagedet = record  {USAGE DETAIL OF A RELATIONSIP}
                 primfreq : integer;  {FREQUENCY OF USAGE IN PRIMARY FUNCTION}
                 secfreq : integer  {FREQUENCY OF USAGE IN SECONDARY FUNCTION}
                 end;

var funcchart: array [1..maxnofunc] of func;
    entchart : array [1..maxnoent] of entity;
    relchart : array [1..maxnorel] of relation;
    eusagemat : array [1..maxnoent] of eusagedet;  {ATTRIBUTE USAGE DETAILS}
    rusagemat : array [1..maxnorel] of rusagedet;  {RELATIONSHIP USAGE DETAILS}
    nooffunc: integer;
    funcfile: text;
    entfile : text;
    relfile : text;
    analysisfile : text;
    i, j, k, l: integer;
    noofnewfunc: integer;
    noofentities : integer;
    noofrelations : integer;
    entindex : integer;
    tempbuff : str;
    found : boolean;
```

```
procedure readstr (var f: text; var s: str);
     var ptr: integer;
     begin
     ptr := 0;
     while not eoln (f) and (ptr < maxstrlength) do
           begin
           ptr := ptr + 1;
           read (f, s[ptr])
           end;
     while ptr < maxstrlength do
           begin
           ptr := ptr + 1;
           s[ptr] := ' '
           end
     end;


procedure writestr (var f: text; var s: str);
     var i: integer;
     begin
     for i := 1 to maxstrlength do
         write (f, s[i]);
     end;

function equalstr (a, b: str ) : boolean;
    var ptr : integer;
        equal : boolean;
    begin
    equal := true;
    ptr := 0;
    while equal and (ptr < maxstrlength ) do
                begin
                ptr := ptr + 1;
                if a[ptr] <> b[ptr] then
                equal := false;
                end;
    equalstr := equal
    end;


procedure findent (var int : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities ) do
         begin
         l := l+1;
         if equalstr (tempbuff, entchart[l].ename) then
            begin
            int := l;
            found := true
            end
         end
      end;
```

```
procedure findrel (var int : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities) do
         begin
         l := l+1;
         if equalstr (tempbuff, relchart[l].rname) then
            begin
            int := l;
            found := true
            end
         end
      end;

procedure findatt (var int : integer; var entindex : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < entchart[entindex].noatts) do
         begin
         l := l+1;
         if equalstr (tempbuff, entchart[entindex].entatt[l]) then
            begin
            int := l;
            found := true
            end
         end
      end;

procedure findrelatt (var int: integer; var relindex : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < relchart[relindex]. norelatt ) do
         begin
         l := l + 1;
         if equalstr (tempbuff, relchart[relindex].relatt[l]) then
            begin
            int := l;
            found := true
            end
          end
      end;
```

```
begin

{READ IN THE ENTITY FILE}
reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
    with entchart [i] do
         begin
         readln (entfile);
         readstr (entfile, ename);
         readln (entfile);
         readln (entfile, keycount);
         readln (entfile, noatts);
         readln (entfile);
         for l := 0 to keycount do readstr (entfile, entatt[l]);
         readln (entfile);
         readln (entfile);
         k := 1;
         for j := (keycount + 1) to noatts do
             begin
             readstr (entfile, entatt[j]);
             k := k+1;
             if k > 4 then
                begin
                readln (entfile);
                k := 1
                end
             end;
         readln (entfile);
         readln (entfile)
         end;

{READ IN THE RELATION FILE}
reset (relfile, 'hosprel');
readln (relfile, noofrelations );
for i := 1 to noofrelations do
    with relchart[i] do
         begin
         readln (relfile);
         readstr (relfile, rname);
         readln (relfile);
         readstr (relfile, tempbuff);
         findent (entitya);
         readln (relfile, degenta);
         readln (relfile, membshpa);
         readstr (relfile, tempbuff);
         findent (entityb);
         readln (relfile, degentb);
         readln (relfile, membshpb);
         readstr (relfile, tempbuff);
          if tempbuff = awith then rs := weth
          else rs := without;
          readln (relfile);
```

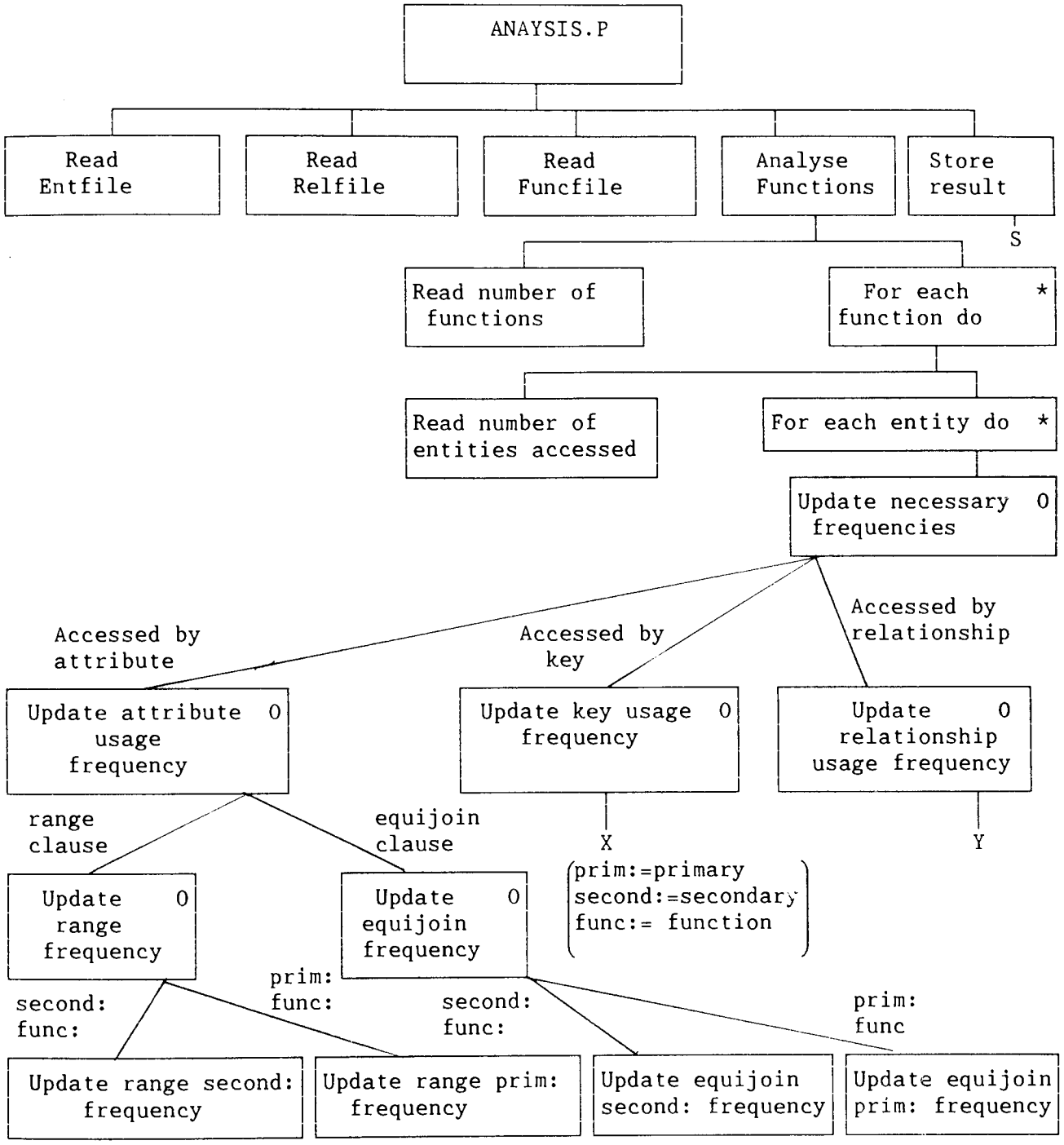
```
          if rs = weth then
             begin
             readln (relfile, norelatt);
             k := 1;
             for j := 1 to norelatt do
                 begin
                 readstr (relfile, relatt[j]);
                 k := k + 1;
                 if k > 4 then
                    begin
                    readln (relfile);
                    k := 1
                    end
                 end
              end
          end;

{READ IN THE FUNCTION FILE}
reset (funcfile, 'hospfunc');
readln (funcfile, nooffunc);
for i := 1 to nooffunc do
    with funcchart[i] do
          begin
          readln (funcfile);
          readstr (funcfile,funcname);
          readstr (funcfile,tempbuff);
          if equalstr(tempbuff, primary) then
                     funcstatus := 1
          else funcstatus := 2;
          readln (funcfile, funcfreq);
          readln (funcfile, noacc);
          for j := 1 to noacc do
          with entarr[j] do
               begin
               readstr (funcfile, tempbuff);
               findent (entname);
               readstr (funcfile, tempbuff);
               readln (funcfile);
               if equalstr (tempbuff, selbyrel) then
                  eselectcrit.opts := sbyr
               else
               if equalstr (tempbuff, selbyatt) then
                  eselectcrit.opts := sbya
               else
                  eselectcrit.opts := sbyp;
               if eselectcrit.opts = sbyr then
                  begin
                  readstr (funcfile, tempbuff);
                  readln (funcfile);
                  findrel (eselectcrit.relpnt)
                  end
                else
                if eselectcrit.opts = sbya then
                  begin
                  readstr (funcfile, tempbuff);
                  findatt (eselectcrit.apnt, entname);
                  readstr (funcfile, tempbuff);
                  if equalstr (tempbuff, range) then
                     eselectcrit.aclaus :='r'
```

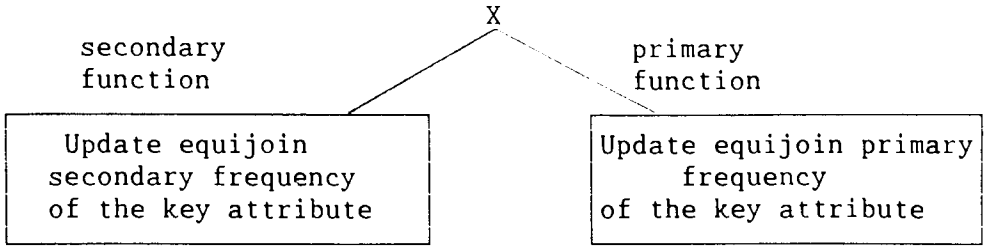
```
                else
                   eselectcrit.aclaus := 'e';
                   readln (funcfile)
                end
                else
                begin
                for k := 1 to entchart[entname].keycount do
                readstr (funcfile, tempbuff);
                readln (funcfile)
                end;
        readln (funcfile)
              end
           end;


{ANALYSE THE FUNCTIONS}
for i := 1 to nooffunc do  {FOR EACH FUNCTION PERFORM THE FOLLOWING}
with funcchart [i] do
begin
    for j := 1 to noacc do  {FOR EACH ENTITY ACCESSED}
    with entarr[j] do
    begin
    if eselectcrit.opts = sbya then  {IF SELECTED BY AN ATTRIBUTE}
    begin
        if eselectcrit.aclaus = 'r' then  {IF THE SELECTION CLAUSE IS RANGE}
          begin

    {UPDATE NECESSARY RANGE FREQUENCY}

          if funcstatus = 1 then
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.rangefreq:=
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.rangefreq +
                                              funcfreq
          else
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.rangefreq:=
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.rangefreq +
                                               funcfreq
          end

          else
      {IF SELECTION CLAUSE IS EQUIJOIN THEN UPDATE NECESSARY EQUIJOIN FREQUENCY}

          begin
          if funcstatus = 1 then
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.equifreq:=
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.equifreq +
                                               funcfreq
          else
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.equifreq :=
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.equifreq +
                                               funcfreq
          end
       end
```

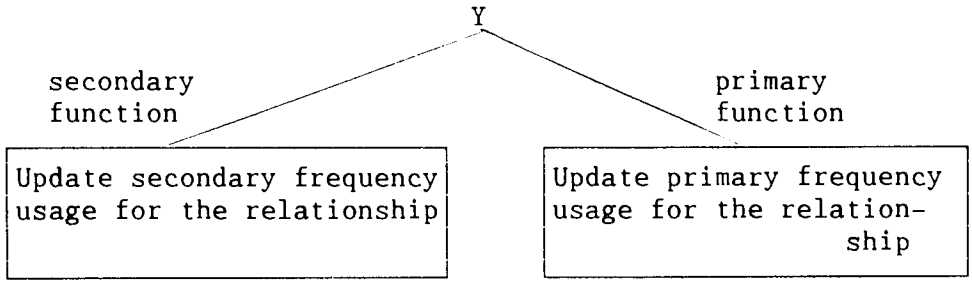
```
     else
     {IF SELECTION CRITERIA IS THE KEY}

     if eselectcrit.opts = sbyp then
        begin
        if funcstatus = 1 then
           begin
           for k := 1 to entchart[entname].keycount do
             begin

      {UPDATE THE EQUIJOIN FREQUENCY OF THE KEY ATTRIBUTE}

             eusagemat[entname].usagedet[k].primdet.equifreq :=
             eusagemat[entname].usagedet[k].primdet.equifreq + funcfreq
             end
           end
        else
           begin
           for k := 1 to entchart[entname].keycount do
              begin
              eusagemat[entname].usagedet[k].seconddet.equifreq :=
              eusagemat[entname].usagedet[k].seconddet.equifreq + funcfreq
              end
           end
        end
        else

        {UPDATE THE REATIONSHIP USAGE FREQUENCY}

           begin
           if funcstatus = 1 then
           rusagemat[eselectcrit.relpnt].primfreq :=
           rusagemat[eselectcrit.relpnt].primfreq + funcfreq
           else
           rusagemat[eselectcrit.relpnt].secfreq :=
           rusagemat[eselectcrit.relpnt].secfreq + funcfreq
           end
      end
  end;


{WRITE THE RESULT OF THE ENTITY ANALYSIS}

rewrite (analysisfile, 'analentity');
for i := 1 to noofentities do
with entchart[i] do
with eusagemat[i] do
begin
  writeln (analysisfile);
  write (analysisfile, 'Entity-Name :-   ');
  writestr (analysisfile, ename);
  writeln (analysisfile);
  write(analysisfile, '                    ');
  write(analysisfile,'    Primary functions    ');
  write(analysisfile,'    Secondary functions    ');
  writeln (analysisfile);
  write(analysisfile, '                        ');
  write(analysisfile, '  Rfrequency   ');
  write(analysisfile,'  Efrequency   ');
```

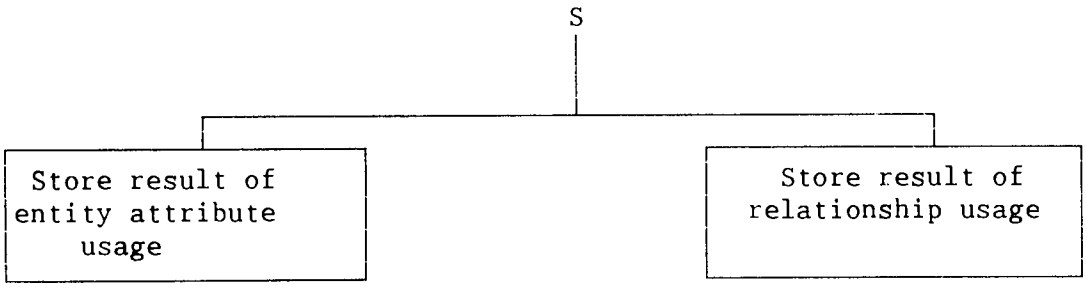
```
  write(analysisfile,'  Rfrequency   ');
  write(analysisfile,'  Efrequency   ');
  writeln (analysisfile);
  write (analysisfile, 'Primary-key         ');
  write (analysisfile, usagedet[1].primdet.rangefreq);
  write (analysisfile, usagedet[1].primdet.equifreq);
  write (analysisfile, '            ');
  write (analysisfile, usagedet[1].seconddet.rangefreq);
  write (analysisfile, usagedet[1].seconddet.equifreq);
  writeln (analysisfile);
  for j := (keycount + 1) to noatts do
    begin
    writestr (analysisfile, entatt[j]);
    write (analysisfile, usagedet[j].primdet.rangefreq);
    write (analysisfile, usagedet[j].primdet.equifreq);
    write(analysisfile, '            ');
    write (analysisfile, usagedet[j].seconddet.rangefreq);
    write (analysisfile,usagedet[j].seconddet.equifreq);
    writeln (analysisfile);
    end
  end;

 {WRITE THE RESULT OF THE RELATIONSHIP ANALYSIS}
 rewrite (analysisfile, 'analreln');
 writeln (analysisfile);
 write (analysisfile, '                    ');
 write (analysisfile, '     Relationship Name      ');
 write (analysisfile, '  Primary Function Frequency  ');
 write (analysisfile, '  Secondary Function Frequency');
 writeln (analysisfile);
 for i := 1 to noofrelations do
 with relchart[i] do
 with rusagemat[i] do
 begin
     write (analysisfile, '                    ');
     writestr (analysisfile, rname);
     write (analysisfile, '            ');
     write (analysisfile, primfreq);
     write (analysisfile, '            ');
     write (analysisfile, '           ');
     write (analysisfile, secfreq);
     writeln (analysisfile);
  end
end.
```

ANALYSIS.P


ANAYSIS.P
Read Entfile
Read Relfile
Read Funcfile
Analyse Functions
Store result
S
Read number of functions
For each function do *
Read number of entities accessed
For each entity do *
Update necessary frequencies 0
Accessed by attribute
Accessed by key
Accessed by relationship
Update attribute usage frequency 0
Update key usage frequency 0
Update relationship usage frequency 0
range clause
equijoin clause
X
Y
(prim:=primary
second:=secondary
func:= function)
Update range frequency 0
Update equijoin frequency 0
prim: func:
second: func:
second: func:
prim: func
Update range second: frequency
Update range prim: frequency
Update equijoin second: frequency
Update equijoin prim: frequency


X
secondary function
primary function
Update equijoin secondary frequency of the key attribute
Update equijoin primary frequency of the key attribute


Y
secondary function
primary function
Update secondary frequency usage for the relationship
Update primary frequency usage for the relation-ship


S
Store result of entity attribute usage
Store result of relationship usage

```
{THIS PROGRAM MAPS THE ENTITIES AND RELATIONSHIPS INTO NORMALISED}
{RELATIONAL STRUCTURE}

program relmap (input, output, relfile);

const maxstrlength = 20;
      maxnorel = 40;
      maxnoent = 40;
      maxnoatt = 20;
      maxrelatt = 20;
      maxnokey = 5;
      maxnoidnt = 5;
      maxnoprops = 20;
      awith =    'WITH               ';
      awithout = 'WITHOUT            ';


type str = array [1..maxstrlength] of char;
     relstat = (weth, without);

     props = record
             entptr: integer;
             attptr: integer
             end;

     relation = record
                rname : str;
                entitya : integer;
                degenta : char;
                membshpa : char;
                entityb : integer;
                degentb : char;
                membshpb : char;
                case rs : relstat of
                     weth : (norelatt : integer;
                        relatt : array [1..maxrelatt] of str);
                        without : ()
                end;

         attributes = array[0..maxnoatt] of str;

         entity = record
                    ename : str;
                    keycount : integer;
                    noatts : integer;
                    entatt : attributes
                    end;

{NORMENT DESCRIBES A RELATION THAT REPRESENTS AN ENTITY IN A RELATIONAL SCHEMA}

         norment = record
                   nename : str;
                   noofprops : integer;
                   identcnt: integer;
                   norentatts: array[1..maxnoprops] of props
                   end;
```

```
{NORMREL DESCRIBES A RELATION THAT REPRESENTS A RELATIONSHIP IN A RELATIONAL}
{SCHEMA}
          normrel = record
                    nrname : integer;
                       identcnt : integer;
                       norreiidnt : array [1..maxnoidnt] of props;
                       nrkeycnt : integer;
                       norrelkey :array [1..maxnokey] of props;
                       case nrs : relstat of
                        weth : (nrattcnt : integer;
                             nrelatt : array [1..maxrelatt] of integer);
                        without : ()
                        end;

       var relchart : array [1..maxnorel] of relation;
            entchart : array [1..maxnoent] of entity;
            norrelchtr : array [1..maxnorel] of normrel;
            norentchtr: array[1..maxnoent] of norment;
            noofrelations : integer;
            relfile: text;
            i, j, k, l : integer;
            norelfile : integer;
            noofentities : integer;
            entfile : text;
            mapfile : text;
            tempbuff : str;
            found : boolean;
            correct : boolean;
            answer : str;
           noofnormrel : integer;


 procedure readstr (var f : text; var s : str);
         var ptr: integer;
         begin
         ptr := 0;
         while not eoln (f) and (ptr < maxstrlength ) do
                   begin
                   ptr := ptr + 1;
                   read (f, s[ptr]);
                   end;
         while ptr < maxstrlength do
                   begin
                   ptr := ptr + 1;
                   s[ptr] := ' '
                   end
         end;

 procedure writestr (var f : text; var s : str);
         var i : integer;
         begin
         for i := 1 to maxstrlength do
                   write (f, s[i]);
         end;
```

```
function equalstr (a, b : str): boolean;
        var ptr : integer;
            equal : boolean;
        begin
        equal := true;
        ptr := 0;
        while equal and (ptr < maxstrlength ) do
                begin
                ptr := ptr + 1;
                if a[ptr] <> b[ptr] then equal := false
                end;
        equalstr := equal
        end;

procedure findent (var int : integer);
        var l : integer;
        begin
        l := 0;
        found := false;
        while (not found) and (l < noofentities) do
                begin
                l := l + 1;
                if equalstr (tempbuff, entchart[l].ename) then
                        begin
                        int := l;
                        found := true
                        end
                end
        end;
begin
{READ IN THE ENTITY FILE}
reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
        with entchart[i]  do
                begin
                readln (entfile);
                readstr (entfile, ename);
                readln (entfile);
                readln (entfile, keycount);
                readln (entfile, noatts);
                readln (entfile);;
                for l := 0 to keycount do readstr (entfile,entatt[l]);
                readln (entfile);
                readln (entfile);
                k := 1;
                for j := (keycount + 1) to noatts do
                        begin
                        readstr (entfile, entatt[j]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                readln (entfile);
                                k := 1
                                end
                        end;
                readln (entfile);
                readln (entfile)
        end;
```

```
{READ IN THE RELATION FILE}
reset (relfile, 'hosprel');
readln (relfile, noofrelations);
for i := 1 to noofrelations do
with relchart[i] do
        begin
        readln (relfile);
        readstr (relfile, rname);
        readln (relfile);
        readstr (relfile, tempbuff);
        findent (entitya);
       readln (relfile, degenta);
        readln (relfile, membshpa);
        readstr (relfile, tempbuff);
        findent (entityb);
        readln (relfile, degentb);
        readln (relfile, membshpb);
        readstr (relfile, tempbuff);
        if tempbuff = awith then rs := weth
        else rs := without;
        readln (relfile);
        if rs = weth then
                begin
                readln (relfile, norelatt);
                k := 1;
                for j := 1 to norelatt do
                        begin
                        readstr (relfile, relatt[j]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                readln (relfile);
                                k := 1
                                end
                        end
                end
        end;
```

```
{FORM THE RELATIONAL SCHEMA}

j := 0;
for i := 1 to noofrelations do
with relchart[i] do
        begin

{DO NOT SELECT THOSE RELATIONSHIPS WHICH ARE 1:1 or 1:n AND HAVE AN OBLIGATORY}
{MEMBERSHIP FOR ENTITY-B}

        if (degenta <> '1' ) and (membshpb <> 'o' ) then
         begin
          j := j + 1;
          with norrelchtr [j] do
            begin
            if (degenta = '1') and (degentb = '1') and (membshpb = 'n') then
                  begin
                  nrname := i;
                  identcnt := entchart[entitya].keycount;
                  for k := 1 to identcnt do
                    begin
                    norrelidnt[k].entptr := entitya;
                    norrelidnt[k].attptr := k
                    end;
                  nrkeycnt := entchart[entityb].keycount;
                  for k := 1 to nrkeycnt do
                            begin
                            norrelkey[k].entptr := entityb;
                            norrelkey[k].attptr := k
                            end
                  end
             else

{IF THE RELATIONSHIP IS OF DEGREE 1:n AND THE MEMBERSHIP OF ENTITY-B}
{IS NOT OBLIGATORY THEN CREATE A RELATION}

             if (degenta = '1') and (degentb = 'n') and (membshpb = 'n') then
                  begin
                  nrname := 1;
                  identcnt := entchart[entityb].keycount;
                  for k := 1 to identcnt do
                            begin
                            norrelidnt[k].entptr := entityb;
                            norrelidnt[k].attptr := k
                            end;
                  nrkeycnt := entchart[entitya].keycount;
                  for k := 1 to nrkeycnt do
                            begin
                            norrelkey[k].entptr := entitya;
                            norrelkey[k].attptr := k
                            end
                  end
              else
```

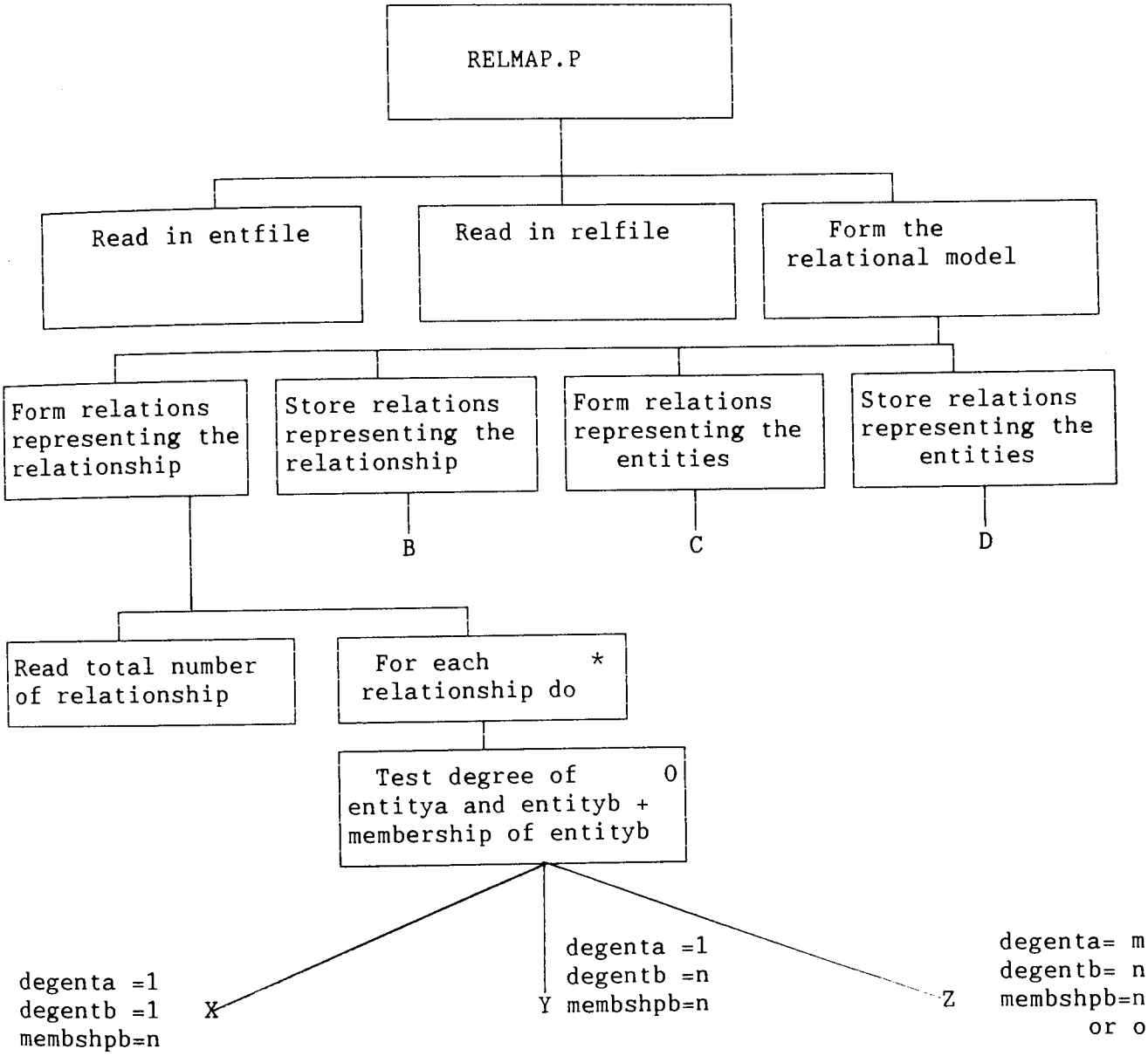
```
{CREATE RELATIONS TO REPRESENT RELATIONSHIP OF DEGREE m:n}

                    begin
                    nrname := i;
                    identcnt := (entchart[entitya].keycount) +
                                    (entchart[entityb].keycount);
                    for k := 1 to entchart[entitya].keycount do
                              begin
                              norrelidnt[k].entptr := entitya;
                              norrelidnt[k].attptr := k
                              end;
                    l := 0;
                    for k := ((entchart[entitya].keycount)+1) to identcnt do
                              begin
                              l := l + 1;
                              norrelidnt[k].entptr := entityb;
                              norrelidnt[k].attptr := l
                              end;
                    nrkeycnt := 0
                    end;
          nrs := rs;
          if nrs = weth then
                    begin
                    nrattcnt := norelatt;
                    for k := 1 to nrattcnt do
                              begin
                              nrelatt[k] := k
                              end
                    end
          end
          end
end;
noofnormrel := j;

{WRITE THE NORMALISED RELATIONS REPRESENTING THE RELATIONSHIPS IN THE MAPFILE}

rewrite (mapfile, 'norhosprel');
writeln (mapfile, noofnormrel);
for i := 1 to noofnormrel do
with norrelchtr[i] do
          begin
          writestr (mapfile, relchart[nrname].rname);
          writeln (mapfile);
          writeln (mapfile, identcnt);
          k := 1;
          for j := 1 to identcnt do
          with norrelidnt[j] do
                    begin
                    writestr (mapfile, entchart[entptr].entatt[attptr]);
                    k := k + 1;
                    if k > 4 then
                              begin
                              writeln (mapfile);
                              k := 1
                              end
                    end;
```

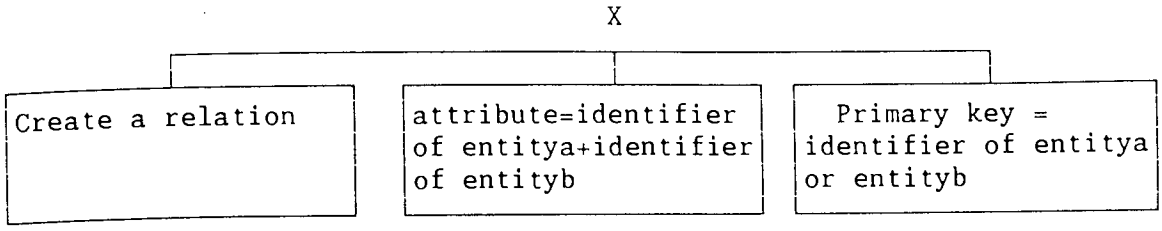
```
for j := 1 to nrkeycnt do
with norrelkey[j] do
          begin
          writestr (mapfile, entchart[entptr].entatt[attptr]);
          k := k + 1;
          if k> 4 then
                    begin
                    writeln(mapfile);
                    k := 1
                    end;
          end;
if nrs = weth then
          begin
          for j := 1 to nrattcnt do
          with relchart[nrname]  do
                    begin
                    writestr (mapfile, relatt[nrelatt[j]]);
                    k := k + 1;
                    if k > 4 then
                              begin
                              writeln (mapfile);
                              k := 1
                              end
                    end
          end;
writeln (mapfile)
end;
```

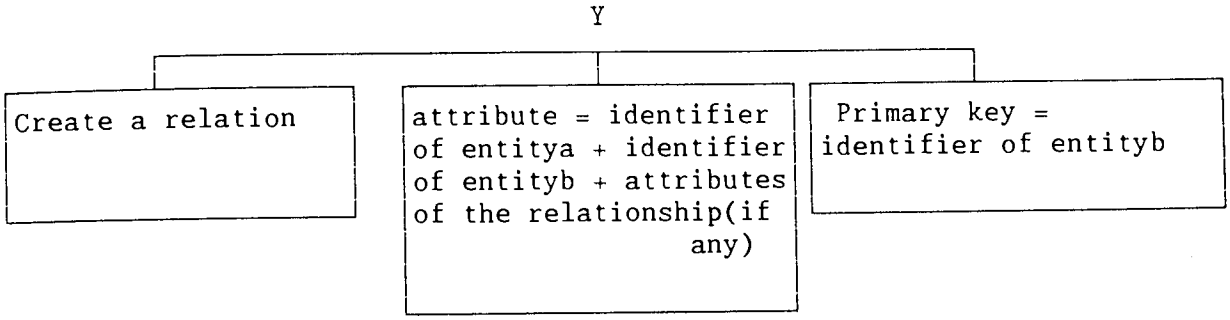
```
{MAP ALL THE ENTITIES}

for i := 1 to noofentities do
   with norentchtr[i] do
      begin
      nename := entchart[i].ename;
      identcnt := entchart[i].keycount;
      noofprops := entchart[i].noatts;
      for j := 1 to entchart[i].noatts do
          begin
          norentatts[j].entptr := i;
          norentatts[j].attptr := j
          end;
      l := 0;
      while l < noofrelations do
         begin
         {IF THE ENTITY IS THE ENTITYB OF A RELATIONSHIP OF DEGREE 1:1 or 1:n}
         {AND THE MEMBERSHIP OF ENTITYB IS OBLIGATORY, THEN POST THE IDENTIFIER}
         {OF ENTITYA AS A FOREIGN KEY TO ENTITYB AND INCREASE THE NUMBER OF}
         {ATTRIBUTES ENTITYB}

         l := l+1;
         if relchart[l].entityb = i then
            begin
            if (relchart[l].degenta = '1') and (relchart[l].membshpb = 'o') then
               begin
               for k := 1 to entchart[relchart[l].entitya].keycount do
                   begin
                   noofprops := noofprops + 1;
                   norentatts[noofprops].entptr := relchart[l].entitya;
                   norentatts[noofprops].attptr :=k
                   end
               end
            end
      end;
```

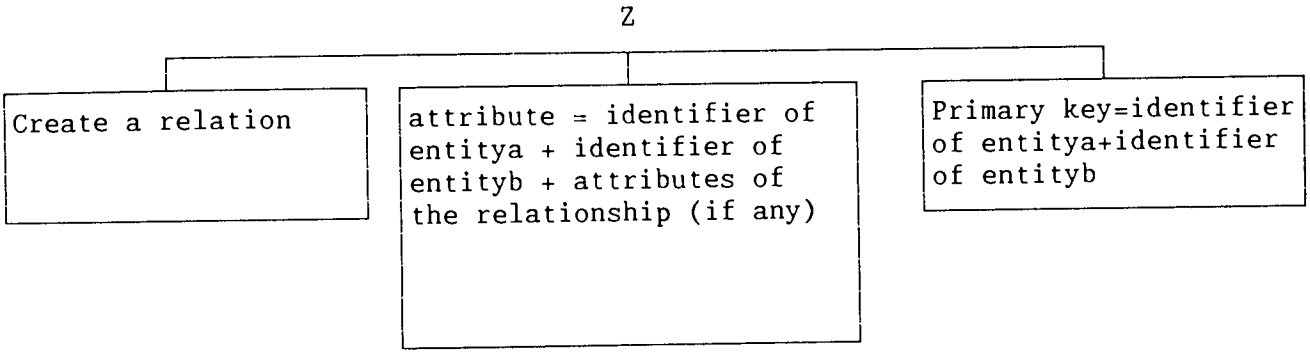
```
{WRITE TO THE MAPFILE}
rewrite (mapfile, 'hospmap');
writeln (mapfile, noofentities);
for i := 1 to noofentities do
    with norentchtr[i] do
        begin
        writeln (mapfile);
        writestr (mapfile, nename);
        write (mapfile, noofprops);
        write (mapfile, ' ' );
        writeln (mapfile, identcnt);
        for j := 1 to identcnt do
        with norentatts[j] do
           writestr (mapfile, entchart[entptr].entatt[attptr]);
        writeln(mapfile);
        k := 1;
        for j := (identcnt + 1) to noofprops do
        with norentatts[j] do
            begin
            writestr (mapfile, entchart[entptr].entatt[attptr]);
            k := k+1;
            if k > 4 then
               begin
               writeln (mapfile);
               k := 1
               end
             end;
          writeln (mapfile);
          writeln (mapfile)
          end
end.
```

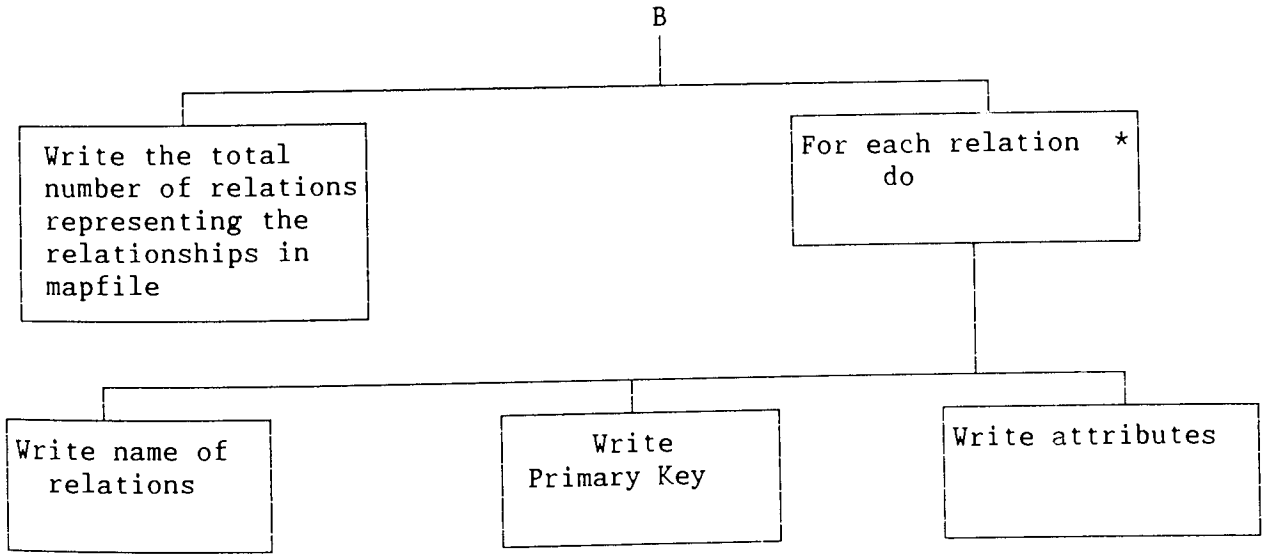
RELMAP.P

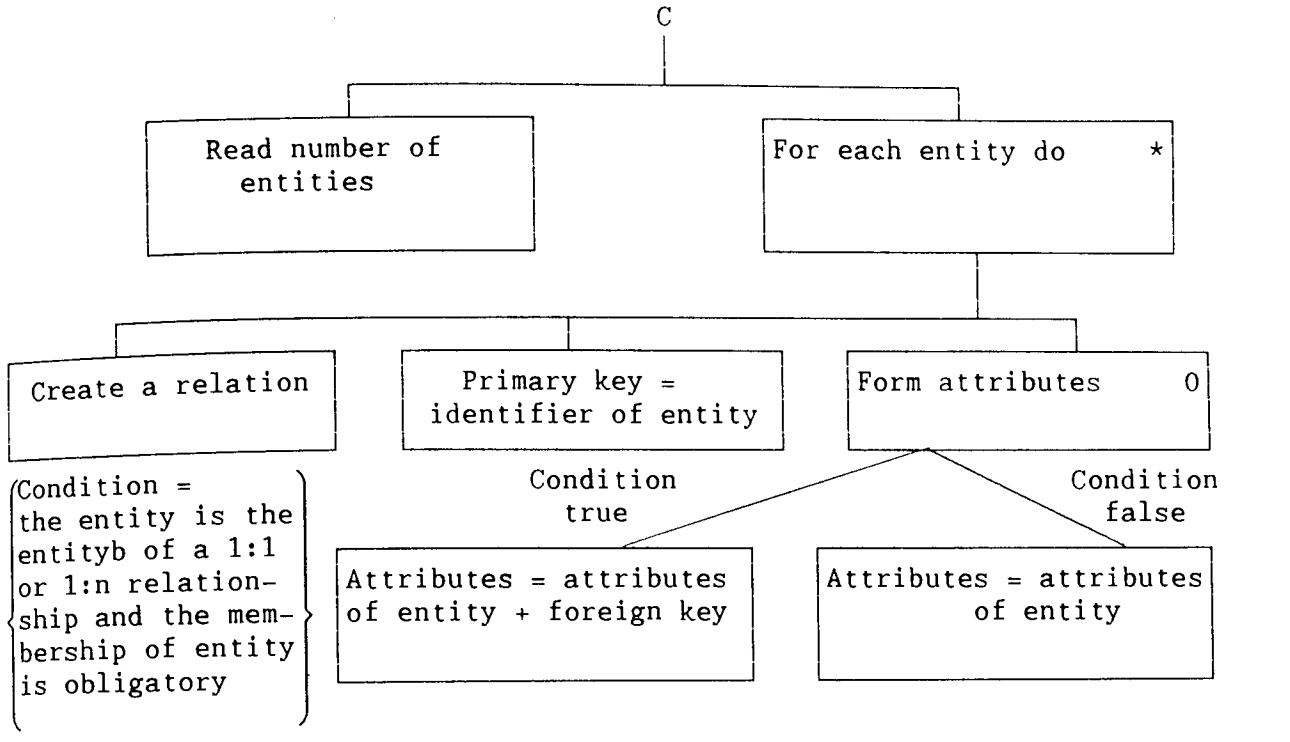

RELMAP.P
Read in entfile
Read in relfile
Form the relational model
Form relations representing the relationship
Store relations representing the relationship
Form relations representing the entities
Store relations representing the entities
B
C
D
Read total number of relationship
For each * relationship do
Test degree of 0 entitya and entityb + membership of entityb
degenta =1 degentb =1 membshpb=n
X
degenta =1 degentb =n membshpb=n
Y
Z
degenta= m degentb= n membshpb=n or o

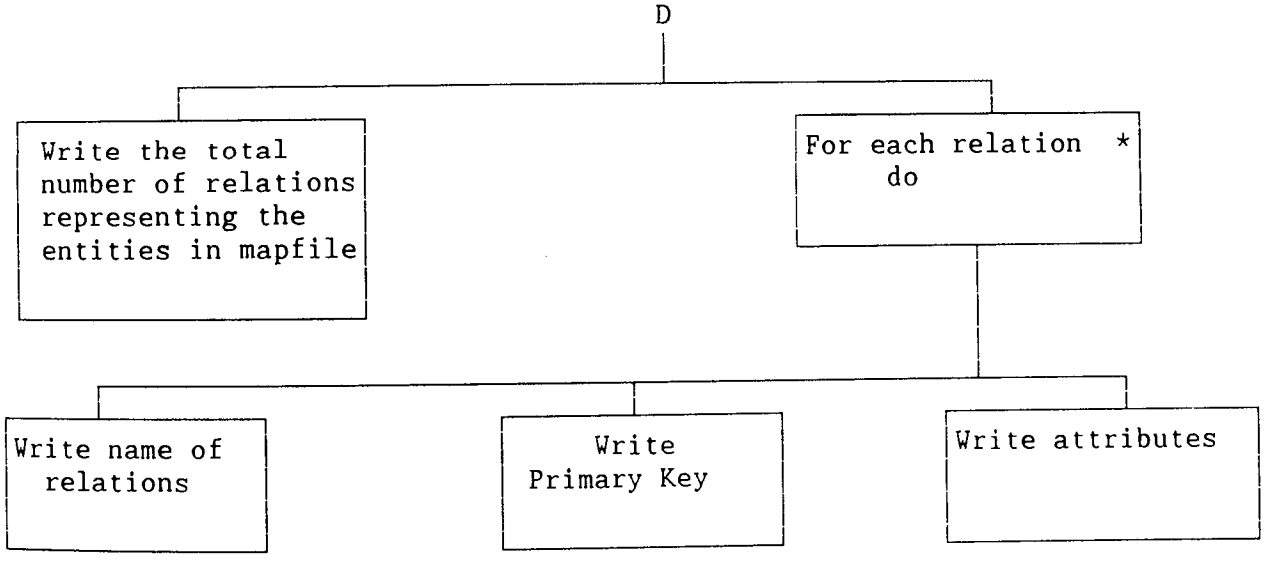

X
Create a relation
attribute=identifier of entitya+identifier of entityb
Primary key = identifier of entitya or entityb


Y
Create a relation
attribute = identifier of entitya + identifier of entityb + attributes of the relationship(if any)
Primary key = identifier of entityb


Z
Create a relation
attribute = identifier of entitya + identifier of entityb + attributes of the relationship (if any)
Primary key=identifier of entitya+identifier of entityb


B
Write the total number of relations representing the relationships in mapfile
For each relation * do
Write name of relations
Write Primary Key
Write attributes


C
Read number of entities
For each entity do *
Create a relation
Primary key = identifier of entity
Form attributes 0
Condition = the entity is the entityb of a 1:1 or 1:n relation-ship and the mem-bership of entity is obligatory
Condition true
Condition false
Attributes = attributes of entity + foreign key
Attributes = attributes of entity


D
Write the total number of relations representing the entities in mapfile
For each relation * do
Write name of relations
Write Primary Key
Write attributes

```
{THIS PROGRAM MAPS THE ENTITIES AND RELATIONSHIPS INTO A CODASYL STRUCTURE}

program codmap (input, output, relfile);

const maxstrlength = 20;
      maxnorel = 40;
      maxmodrel = 50;
      maxnoent = 40;
      maxnoatt = 20;
      maxrelatt = 10;
      maxnokey = 5;
      maxnoidnt = 5;
      awith = 'WITH';
      awithout = 'WITHOUT';
      primarykey = 'PRIMARY KEY          ';

type str =  array [1..maxstrlength] of char;
     relstat = (weth, without);
     props = record
             entptr: integer;
             attptr: integer
             end;

     relation = record
                rname: str;
                entitya: integer;
                degenta: char;
                membshpa: char;
                entityb: integer;
                degentb: char;
                membshpb: char;
                case rs : relstat of
                   weth: (norelatt : integer;
                          relatt : array [1..maxrelatt] of str);
                   without: ()
                end;

    attributes = array [0..maxnoatt] of str;
    entity = record
             ename: str;
             keycount: integer;
             noatts: integer;
             entatt : attributes
             end;

     modreln = record
               mrtype : char;  {REPRESENTS WHETHER MODIFIED OR ORIGINAL}
               mrname : str;  {NAME OF THE RELATIONSHIP}
               mentitya : integer;  {POINTER TO ENTITYA}
               mdegenta : char;  {DEGREE OF ENTITYA}
               mmembshpa :char;  {MEMBERSHIP OF ENTITYA}
               mentityb : integer;  {POINTER TO ENTITYB}
               mdegentb : char;  {DEGREE OF ENTITYB}
               mmembshpb : char;  {MEMBERSHIP OF ENTITYB}
               end;
```

```
var relchart: array [1..maxnorel] of relation;
    entchart : array [1..maxnoent ] of entity;
    modrelchart : array [1..maxmodrel] of modreln;
    noofrelations: integer;
    relfile: text;
    codent: text;
    codrel: text;
    i, j, k, l : integer;
    norelfile: integer;
    noofentities: integer;
    noofmodrel : integer;
    entfile : text;
    mapfile : text;
    modrelfile : text;
    modent : text;
    tempbuff : str;
    found : boolean;
    correct : boolean;
    answer : str;
    noofnormrel : integer;
    tempstr : str;


procedure readstr (var f: text; var s: str);
     var ptr: integer;
     begin
     ptr := 0;
     while not eoln (f) and (ptr < maxstrlength) do
           begin
           ptr := ptr + 1;
           read (f, s[ptr]);
           end;
     while ptr < maxstrlength do
           begin
           ptr := ptr + 1;
           s[ptr] := ' '
           end
     end;



procedure writestr (var f: text; var s: str);
     var i: integer;
     begin
     for i := 1 to maxstrlength do
         write (f, s[i]);
     end;
```

```
function equalstr(a, b: str): boolean;
    var ptr : integer;
        equal : boolean;
    begin
    equal := true;
    ptr := 0;
    while equal and (ptr < maxstrlength ) do
                begin
                ptr := ptr + 1;
                if a[ptr] <> b[ptr] then
                equal := false
                end;
    equalstr := equal
    end;



procedure findent (var int : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities) do
         begin
         l := l+ 1;
         if equalstr (tempbuff, entchart[l].ename) then
            begin
            int := l;
            found := true
            end
         end
     end;



procedure formstring (var r: str; var s: str; var t: str);

{FORMS THE NAME OF THE MODIFIED ENTITY}
     begin
     write (' The entity name is ');
     writestr (output, s);
     writeln;
     write (' The name of the entity formed from the relationship is ');
     writestr (output, t );
     writeln;
     write (' State the name of the relationship between these entities ');
     writeln;
     readstr (input, r);
     readln
     end;
```

```
{READ IN THE ENTITY FILE}

begin
reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
    with entchart[i] do
         begin
         readln (entfile);
         readstr (entfile, ename);
         readln (entfile);
         readln (entfile, keycount);
         readln (entfile, noatts);
         readln (entfile);
         for l := 0 to keycount do readstr (entfile, entatt[l]);
         readln (entfile);
         readln (entfile);
         k := 1;
         for j := (keycount + 1) to noatts do
             begin
             readstr (entfile, entatt[j]);
             k := k+1;
             if k > 4 then
                begin
                readln (entfile);
                k := 1
                end
             end;
         readln (entfile);
         readln (entfile)
         end;


{READ IN THE RELATION FILE}

reset (relfile, 'hosprel');
readln (relfile, noofrelations);
for i := 1 to noofrelations do
    with relchart[i] do
         begin
         readln (relfile);
         readstr (relfile, rname);
         readln (relfile);
         readstr (relfile, tempbuff);
         findent (entitya);
         readln (relfile, degenta);
         readln (relfile, membshpa);
         readstr (relfile, tempbuff);
         findent (entityb);
         readln (relfile, degentb);
         readln (relfile, membshpb);
         readstr (relfile, tempbuff);
         if tempbuff = awith then rs := weth
         else rs := without;
         readln (relfile);
          if rs = weth then
             begin
             readln (relfile, norelatt);
             k := 1;
```

```
            for j := 1 to norelatt do
                begin
                readstr(relfile, relatt[j]);
                k := k+1;
                if k > 4 then
                begin
                readln (relfile);
                k := 1
                end
                end
            end
        end;

{MODIFY THE RELATIONS INTO CODASYL COMPATIBLE FORM}

k := 0;
for j := 1 to noofrelations do
with relchart[j] do
  begin

{1:n RELATIONS WITHOUT ATTRIBUTES DO NOT NEED TO BE MODIFIED}

  if (degenta = '1') and (rs = without) then
    begin
    k := k + 1;
    with modrelchart[k] do
         begin
         mrtype := '0';
         mrname := rname;
         mentitya := entitya;
         mdegenta := degenta;
         mmembshpa := membshpa;
         mentityb := entityb;
         mdegentb := degentb;
         mmembshpb := membshpb
         end
    end
  else

{1:n RELATIONS WITH ATTRIBUTES NEED TO BE MODIFIED}

  if (degenta = '1') and (rs = weth) then
     begin

{A NEW ENTITY IS CREATED TO REPLACE THE RELATIONSHIP}

     noofentities := noofentities + 1;
     with entchart[noofentities] do
          begin
          ename := rname;
          keycount := entchart[entityb].keycount;
          noatts := keycount + norelatt;
          entatt[0] := primarykey;
          for l := 1 to keycount do
              begin
              entatt[l] := entchart[entityb].entatt[l]
              end;
```

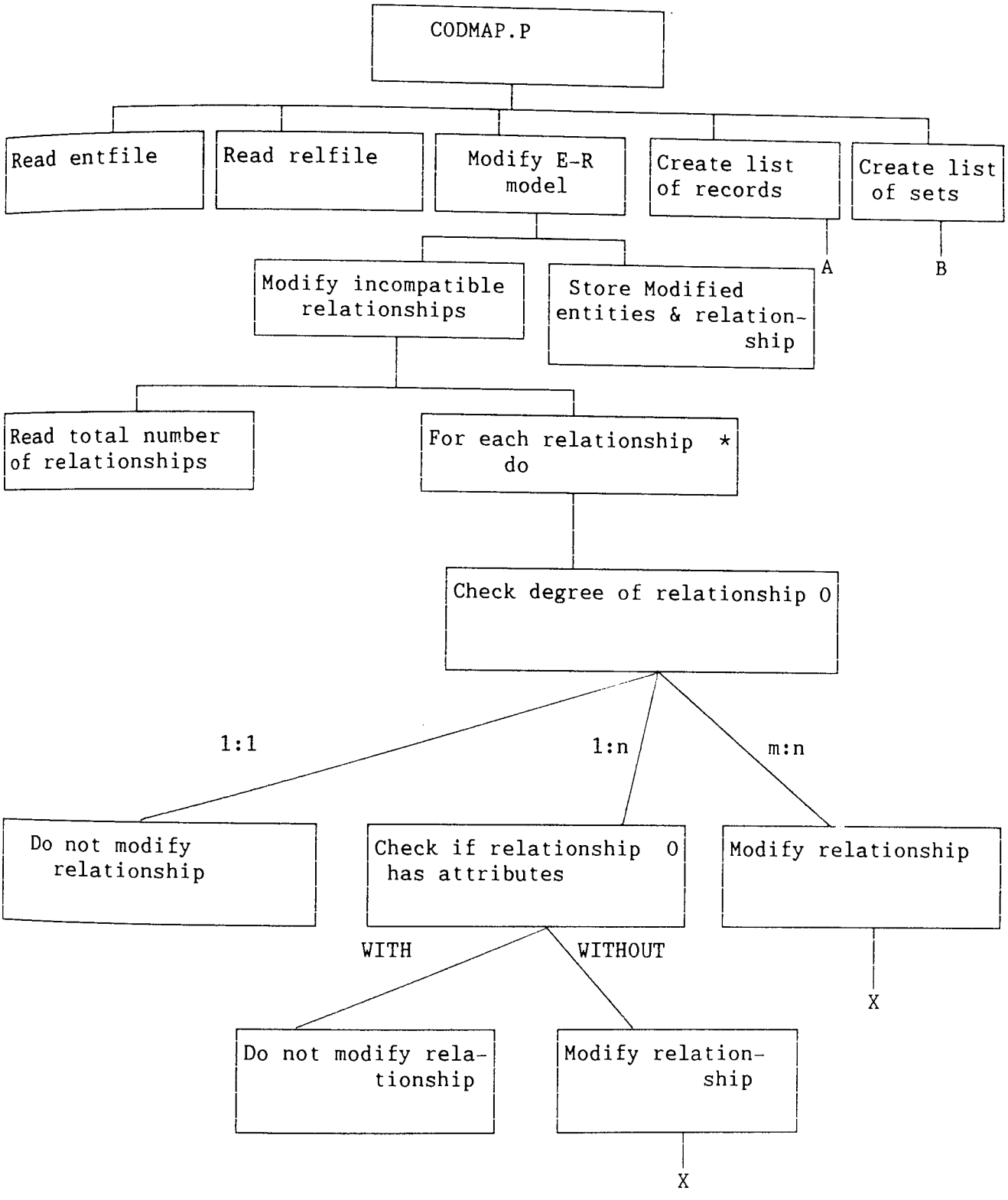
```
          i := 0;
          for l:= (keycount+1) to noatts do
              begin
              i := i + 1;
              entatt[l] := relatt[i]
              end
      end;

{TWO ADDITIONAL RELATIONSHIPS NEED TO BE CREATED}

      k :=k + 1;
      formstring (tempstr, entchart[entitya].ename, rname);
      with modrelchart[k] do
         begin
         mrtype := 'C';
         mrname := tempstr;
         mentitya:= entitya;
         mdegenta :='1';
         mmembshpa := membshpa;
         mentityb:= noofentities;
         mdegentb := degentb;
         mmembshpb := 'o'
         end;
      k := k + 1;
      formstring (tempstr, entchart[entityb].ename, rname);
      with modrelchart[k]do
         begin
         mrtype := 'C';
         mrname :=tempstr;
         mentitya := entityb;
         mdegenta := '1';
         mmembshpa := membshpb;
         mentityb := noofentities;
         mdegentb := '1';
         mmembshpb := 'o'
         end
      end

{IF THE DEGREE OF THE RELATIONSHIP IS m:n THEN A NEW ENTITY}
{AND TWO ADDITIONAL RELATIONSHIPS ARE CREATED}

      else
         begin
         noofentities := noofentities + 1;
         with entchart[noofentities] do
            begin
            ename := rname;
            keycount := (entchart[entitya].keycount) +
                        (entchart[entityb].keycount);
            noatts := keycount;
            entatt[0] := primarykey;
            for l := 1 to entchart[entitya].keycount do
                entatt[l] := entchart[entitya].entatt[l];
            i := 0;
            for l := (entchart[entitya].keycount + 1) to keycount do
                begin
                i := i + 1;
                entatt[l] := entchart[entityb].entatt[i];
                end;
```

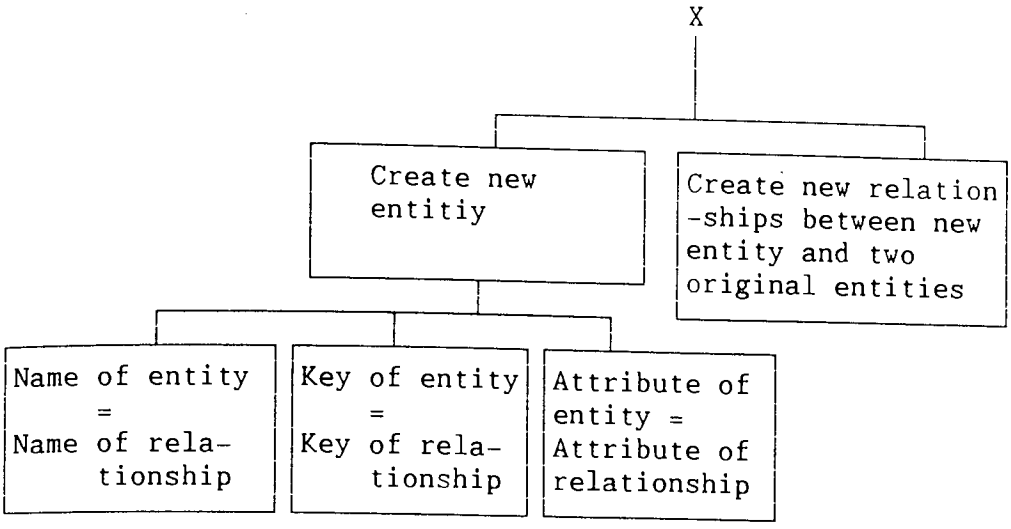
```
        if rs = weth then
           begin
           noatts := noatts + norelatt;
           i := 0;
           for l := (keycount + 1) to noatts do
               begin
               i := i+1;
               entatt[l] := relatt[i]
               end
           end;
        k := k + 1;
        formstring (tempstr, entchart[entitya].ename, rname);
        with modrelchart[k] do
           begin
           mrtype := 'C';
           mrname := tempstr;
           mentitya := entitya;
           mdegenta := '1';
           mmembshpa := membshpa;
           mentityb := noofentities;
           mdegentb := 'n';
           mmembshpb := 'o'
           end;
        k := k + 1;
        formstring(tempstr, entchart[entityb].ename, rname);
        with modrelchart [k] do
           begin
           mrtype := 'C';
           mrname := tempstr;
           mentitya := entityb;
           mdegenta := '1';
           mmembshpa := membshpb;
           mentityb := noofentities;
           mdegentb := 'n';
           mmembshpb := 'o'
           end
    end
   end
  end;
noofmodrel := k;

{WRITE THE ORIGINAL AND NEWLY CREATED ENTITIES BACK INTO THE MODENTFILE.}

rewrite (modent, 'modhospent');
writeln (modent, noofentities);
for i := 1 to noofentities do
with entchart[i] do
   begin
   writeln (modent);
   writestr (modent, ename);
   writeln (modent);
   writeln (modent, keycount);
   writeln (modent, noatts);
   writeln (modent);
```

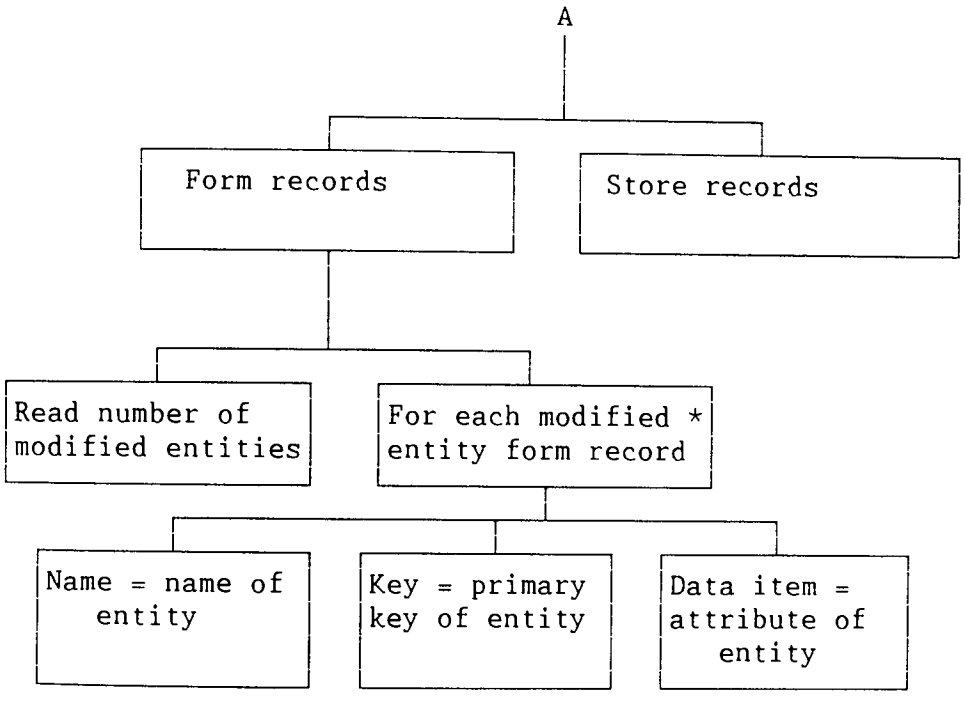
```
   k := 1;
   for l := 0 to keycount do
       begin
       writestr (modent, entatt[l]);
       k := k + 1;
       if k > 4 then
          begin
          writeln (modent);
          k := 1
          end
       end;
   writeln (modent);
   k := 1;
   for j := (keycount + 1) to noatts do
       begin
       writestr (modent, entatt[j]);
       k := k + 1;
       if k > 4 then
          begin
          writeln (modent);
          k := 1
          end
        end;
   writeln (modent);
   writeln (modent)
   end;


{WRITE THE ORIGINAL AND MODIFIED RELATIONSHIPS INTO THE MODRELFILE}

rewrite (modrelfile, 'modhosprel');
writeln (modrelfile, noofmodrel);
for i := 1 to noofmodrel do
with modrelchart[i] do
   begin
   writestr (modrelfile, mrname);
   writeln (modrelfile);
   writestr (modrelfile, entchart[mentitya].ename);
   write (modrelfile, mdegenta);
   write (modrelfile, '    ');
   write (modrelfile, mmembshpa);
   writeln (modrelfile);
   writestr (modrelfile, entchart[mentityb].ename );
   write (modrelfile, mdegentb);
   write (modrelfile, '    ');
   write (modrelfile, mmembshpb);
   writeln (modrelfile);
   writeln (modrelfile)
   end;
```

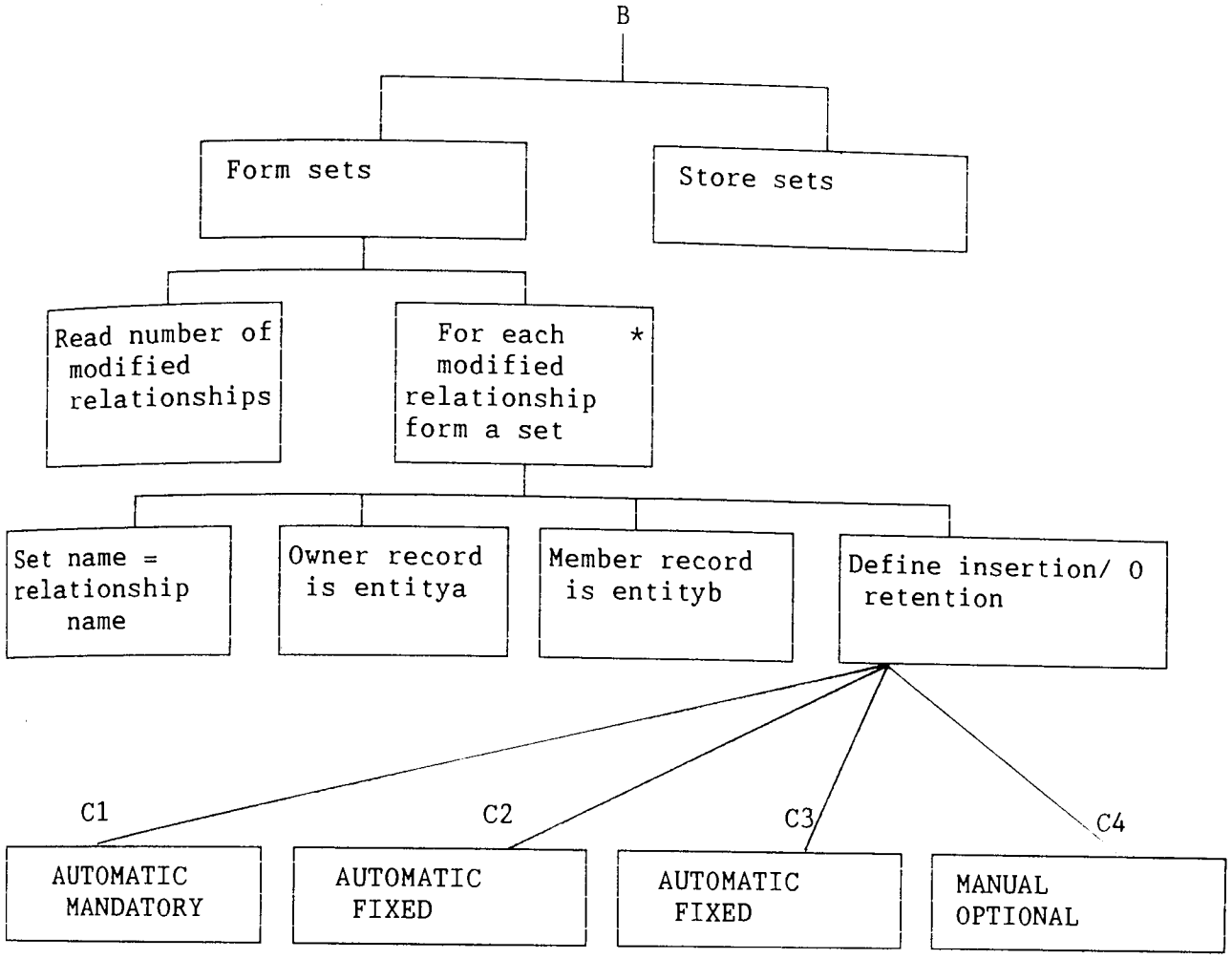
```
{FORM A RECORD CORRESPONDING TO EACH ENTITY}
{WRITE THE RECORDS IN THE RECORD FILE}

rewrite (codent, 'hosprec');
for i := 1 to noofentities do
with entchart[i] do
   begin
   write (codent, 'Record name is ');
   writestr(codent, ename);
   writeln (codent);
   writestr(codent, ename);
   write(codent,'KEY is ');
   for j := 1 to keycount do
       begin
       writestr(codent,entatt[j]);
       if (j < keycount) then write (codent,',')
       end;
    writeln (codent);
    for j := (keycount + 1) to noatts do
        begin
        write(codent,'    ');
        writestr(codent, entatt[j]);
        writeln (codent,';')
        end;
     writeln (codent);
     writeln (codent)
     end;


{CORRESPONDING TO EACH RELATIONSHIP IN MODIFIED RELATIONSHIP FILE}
{FORM A SET AND WRITE THE SETS IN THE SET FILE}


rewrite(codrel,'hospset');
for i := 1 to noofmodrel do
with modrelchart[i] do
   begin
   write (codrel, 'Set name is ');
   writestr(codrel, mrname);
   writeln(codrel);
   write(codrel, 'Owner record is ');
   writestr(codrel, entchart[mentitya].ename);
   writeln(codrel);
   writeln(codrel,'Member record is ');
   writestr(codrel, entchart[mentityb].ename);
   if (mmembshpb = 'o') and (mrtype = '0') then
      write(codrel,' AUTOMATIC MANDATORY')
   else
   if (mmembshpb = 's') and (mrtype = '0') then
       write (codrel, 'AUTOMATIC FIXED')
   else
   if (mmembshpb = 'o') and (mrtype = 'C') then
      write(codrel, 'AUTOMATIC FIXED')
    else
      write(codrel, 'MANUAL OPTIONAL');
    writeln(codrel);
    writeln(codrel)
    end;
end.
```

CODMAP.P


CODMAP.P
Read entfile
Read relfile
Modify E-R model
Create list of records
Create list of sets
A
B
Modify incompatible relationships
Store Modified entities & relation-ship
Read total number of relationships
For each relationship * do
Check degree of relationship 0
1:1
1:n
m:n
Do not modify relationship
Check if relationship 0 has attributes
Modify relationship
WITH
WITHOUT
X
Do not modify rela-tionship
Modify relation-ship
X


X
Create new entitiy
Create new relation -ships between new entity and two original entities
Name of entity = Name of rela- tionship
Key of entity = Key of rela- tionship
Attribute of entity = Attribute of relationship


A
Form records
Store records
Read number of modified entities
For each modified * entity form record
Name = name of entity
Key = primary key of entity
Data item = attribute of entity



C1 = membership of entityb is obligatory + type of relationship is original
C2 = primary key of entityb is extension of the primary key of entitya
+ type of relationship is original
C3 = membership of entityb is obligatory + type of relationship is modified
C4 = any other condition

```
{THIS PROGRAM DETERMINES WAYS OF ORGANISING DATA}

program edgelabel (input, output, funcfile);

const maxstrlength = 20;
      maxnofunc = 20;
      maxnoacc = 15;
      maxselcrit = 4;
      maxnoatt = 15;
      maxnoent = 40;
      maxnorel = 40;
      maxoutedge = 40;
      maxinedge = 40;
      maxnoedge = 400;
      primary = 'PRIMARY             ';
      secondary = 'SECONDARY           ';
      ent = 'ENTITY               ';
      reln = 'RELATIONSHIP         ';
      selbyrel = 'SELECT.BY.RELATION  ';
      selbyatt = 'SELECT.BY.ATTRIBUTES';
      selbykey = 'SELECT.BY.KEY       ';
      awith = 'WITH                 ';
      awithout = 'WITHOUT             ';
      maxrelatt = 10;
      range = 'RANGE                ';
      equijoin = 'EQUIJOIN            ';

type str =  array [1..maxstrlength] of char;
     relstat = (weth, without);
     selopts = (sbyr, sbya, sbyp);
     selectdet = record
                   case opts : selopts of
                        sbyr : (relpnt : integer);
                        sbyp : (ppnt : char);
                        sbya : (apnt : integer;
                                aclaus : char);
                  end;

      accent = record
               entname : integer;
               eselectcrit : selectdet
               end;

      entacc = array [1..maxnoacc] of accent;

      func = record
             funcname : str;
             funcfreq : integer;
             funcstatus : integer;
             noacc : integer;
             entarr : entacc
             end;

      attributes = array [0..maxnoatt] of str;
```

```
entity = record
         ename: str;
         keycount: integer;
         noatts : integer;
         entatt : attributes
         end;

relation = record
           rname: str;
           entitya: integer;
           degenta: char;
           membshpa : char;
           entityb: integer;
           degentb: char;
           membshpb: char;
           case rs: relstat of
              weth: (norelatt : integer;
                     relatt : array [1..maxrelatt] of str);
              without : ()
           end;

accdet = record
         rangefreq: integer;
         equifreq : integer
         end;

analdet = record
          primdet: accdet;
          seconddet: accdet
          end;

eusagedet= record
           usagedet : array[1..maxnoatt] of analdet
           end;

rusagedet = record
            primfreq : integer;
            secfreq : integer
            end;

outdet = record
         oedgetype : char;  {EDGE TYPE}
         oedgepnt : integer;  {POINTER TO KEY/ATTRIBUTE/RELATIONSHIP}
         oedgefreq : integer;  {USAGE FREQUENCY}
         oedgelabel: char  {DATA ORGANISATION LABEL}
         end;

 indet = record
         iedgepnt : integer;  {POINTER TO THE RELATIONSHIP}
         iedgefreq : integer;  {USAGE FREQUENCY}
         iedgelabel : char  {DATA ORGANISATION LABEL}
         end;
```

```
        edgedet = record
                  edgelab : char;  {LABEL ASSIGNED TO THE EDGE}
                  edgefreq : integer;  {FREQUENCY OF USAGE}
                  edgetype : char;  {TYPE OF THE EDGE}
                  edgepnt1 : integer;
                  edgepnt2 : integer;
                  edgepnt3 : integer;
                  edgepnt4 : integer
                  end;

         graphdet = record
                    noofoutedge : integer;  {NUMBER OF OUTEDGES}
                    noofinedge : integer;  {NUMBER OF INEDGES}
                    outedge : array[1..maxoutedge] of outdet; {OUTEDGE DETAILS}
                    inedge : array[1..maxinedge] of indet {INEDGE DETAILS}
                    end;

         sortedge = record
                    sortfreq : integer;
                    sortpnt : integer
                    end;


var funcchart: array [1..maxnofunc] of func;
    entchart : array [1..maxnoent] of entity;
    relchart : array [1..maxnorel] of relation;
    eusagemat : array [1..maxnoent] of eusagedet;
    rusagemat : array [1..maxnorel] of rusagedet;
    sortlist : array [1..maxnoedge] of sortedge;
    labelmat : array [1..maxnoent] of graphdet;{ENTITY EDGE DESCRIPTION}
    edgemat: array [1..maxnoedge] of edgedet;{EDGE DESCRIPTION}
    noofedges : integer;
    labelc : integer;
    ilabelw : integer;
    olabelw : integer;
    noofswap : integer;
    tempfreq : integer;
    temppnt : integer;
    nooffunc: integer;
    funcfile: text;
    entfile : text;
    relfile : text;
    analysisfile : text;
    labelfile : text;
    edgefile: text;
    i, j, k, l: integer;
    noofnewfunc: integer;
    noofentities : integer;
    noofrelations : integer;
    entindex : integer;
    tempbuff : str;
    found : boolean;
```

```
procedure readstr (var f: text; var s: str);
     var ptr: integer;
     begin
     ptr := 0;
     while not eoln (f) and (ptr < maxstrlength) do
           begin
           ptr := ptr + 1;
           read (f, s[ptr])
           end;
     while ptr < maxstrlength do
           begin
           ptr := ptr + 1;
           s[ptr] := ' '
           end
     end;


procedure writestr (var f: text; var s: str);
     var i: integer;
     begin
     for i := 1 to maxstrlength do
         write (f, s[i]);
     end;

function equalstr (a, b: str ) : boolean;
    var ptr : integer;
        equal : boolean;
    begin
    equal := true;
    ptr := 0;
    while equal and (ptr < maxstrlength ) do
                begin
                ptr := ptr + 1;
                if a[ptr] <> b[ptr] then
                equal := false;
                end;
    equalstr := equal
    end;


procedure findent (var int : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities ) do
         begin
         l := l+1;
         if equalstr (tempbuff, entchart[l].ename) then
            begin
            int := l;
            found := true
            end
         end
      end;
```

```
procedure findrel (var int : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < noofentities) do
         begin
         l := l+1;
         if equalstr (tempbuff, relchart[l].rname) then
            begin
            int := l;
            found := true
            end
         end
      end;

procedure findatt (var int : integer; var entindex : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < entchart[entindex].noatts) do
         begin
         l := l+1;
         if equalstr (tempbuff, entchart[entindex].entatt[l]) then
            begin
            int := l;
            found := true
            end
         end
       end;

procedure findrelatt (var int: integer; var relindex : integer);
     var l : integer;
     begin
     l := 0;
     found := false;
     while (not found) and (l < relchart[relindex]. norelatt ) do
         begin
         l := l + 1;
         if equalstr (tempbuff, relchart[relindex].relatt[l]) then
            begin
            int := l;
            found := true
            end
          end
       end;
```

```
begin

{READ IN THE ENTITY FILE}

reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
    with entchart [i] do
         begin
         readln (entfile);
         readstr (entfile, ename);
         readln (entfile);
         readln (entfile, keycount);
         readln (entfile, noatts);
         readln (entfile);
         for l := 0 to keycount do readstr (entfile, entatt[l]);
         readln (entfile);
         readln (entfile);
         k := 1;
         for j := (keycount + 1) to noatts do
             begin
             readstr (entfile, entatt[j]);
             k := k+1;
             if k > 4 then
                begin
                readln (entfile);
                k := 1
                end
             end;
          readln (entfile);
          readln (entfile)
          end;

 {READ IN THE RELATION FILE}
 reset (relfile, 'hosprel');
 readln (relfile, noofrelations );
 for i := 1 to noofrelations do
     with relchart[i] do
          begin
          readln (relfile);
          readstr (relfile, rname);
          readln (relfile);
          readstr (relfile, tempbuff);
          findent (entitya);
          readln (relfile, degenta);
          readln (relfile, membshpa);
          readstr (relfile, tempbuff);
          findent (entityb);
          readln (relfile, degentb);
          readln (relfile, membshpb);
          readstr (relfile, tempbuff);
           if tempbuff = awith then rs := weth
           else rs := without;
           readln (relfile);
           if rs = weth then
              begin
              readln (relfile, norelatt);
              k := 1;
              for j := 1 to norelatt do
```

```
                begin
                readstr (relfile, relatt[j]);
                k := k + 1;
                if k > 4 then
                   begin
                   readln (relfile);
                   k := 1
                   end
                end
             end
        end;

{READ IN THE FUNCTION FILE}
reset (funcfile, 'hospfunc');
readln (funcfile, nooffunc);
for i := 1 to nooffunc do
    with funcchart[i] do
        begin
        readln (funcfile);
        readstr (funcfile,funcname);
        readstr (funcfile,tempbuff);
        if equalstr(tempbuff, primary) then
                funcstatus := 1
        else funcstatus := 2;
        readln (funcfile, funcfreq);
        readln (funcfile, noacc);
        for j := 1 to noacc do
        with entarr[j] do
             begin
             readstr (funcfile, tempbuff);
             findent (entname);
             readstr (funcfile, tempbuff);
             readln (funcfile);
             if equalstr (tempbuff, selbyrel) then
                eselectcrit.opts := sbyr
             else
             if equalstr (tempbuff, selbyatt) then
                eselectcrit.opts := sbya
             else
                eselectcrit.opts := sbyp;
             if eselectcrit.opts = sbyr then
                begin
                readstr (funcfile, tempbuff);
                readln (funcfile);
                findrel (eselectcrit.relpnt)
                end
              else
              if eselectcrit.opts = sbya then
                begin
                readstr (funcfile, tempbuff);
                findatt (eselectcrit.apnt, entname);
                readstr (funcfile, tempbuff);
                if equalstr (tempbuff, range) then
                   eselectcrit.aclaus :='r'
                else
                   eselectcrit.aclaus := 'e';
                   readln (funcfile)
                end
```

```
                else
                begin
                for k := 1 to entchart[entname].keycount do
                readstr (funcfile, tempbuff);
                readln (funcfile)
                end;
        readln (funcfile)
              end
           end;

{ANALYSE THE FUNCTIONS}
for i := 1 to nooffunc do
with funcchart [i] do
begin
    for j := 1 to noacc do
    with entarr[j] do
    begin
    if eselectcrit.opts = sbya then
    begin
        if eselectcrit.aclaus = 'r' then
          begin
          if funcstatus = 1 then
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.rangefreq:=
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.rangefreq +
                                                funcfreq
          else
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.rangefreq:=
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.rangefreq +
                                                funcfreq
          end
          else
          begin
          if funcstatus = 1 then
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.equifreq:=
          eusagemat[entname].usagedet[eselectcrit.apnt].primdet.equifreq +
                                                funcfreq
          else
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.equifreq :=
          eusagemat[entname].usagedet[eselectcrit.apnt].seconddet.equifreq +
                                                funcfreq
          end
      end

     else
     if eselectcrit.opts = sbyp then
        begin
        if funcstatus = 1 then
           begin
           for k := 1 to entchart[entname].keycount do
             begin
             eusagemat[entname].usagedet[k].primdet.equifreq :=
             eusagemat[entname].usagedet[k].primdet.equifreq + funcfreq
             end
           end
```

```
        else
           begin
           for k := 1 to entchart[entname].keycount do
              begin
              eusagemat[entname].usagedet[k].seconddet.equifreq :=
              eusagemat[entname].usagedet[k].seconddet.equifreq + funcfreq
              end
           end
        end
        else
           begin
           if funcstatus = 1 then
           rusagemat[eselectcrit.relpnt].primfreq :=
           rusagemat[eselectcrit.relpnt].primfreq + funcfreq
           else
           rusagemat[eselectcrit.relpnt].secfreq :=
           rusagemat[eselectcrit.relpnt].secfreq + funcfreq
           end
      end
  end;

noofedges := 0;
for i := 1 to noofentities do
with eusagemat[i] do
with entchart[i] do
with labelmat[i] do
   begin
   noofoutedge := 1;
   noofinedge := 0;

   {THE FIRST OUTEDGE OF THE ENTITY IS THE PRIMARY KEY EDGE}
   {FILL IN THE NECESSARY DETAILS FOR THE FIRST EDGE}

   outedge[noofoutedge].oedgetype := 'p';
   outedge[noofoutedge].oedgepnt := 1;
   outedge[noofoutedge].oedgefreq := usagedet[1].primdet.rangefreq +
                                     usagedet[1].primdet.equifreq;
   outedge[noofoutedge].oedgelabel := 'I';

   {FILL IN THE DETAILS FOR THE REST OF THE EDGES}

   noofedges := noofedges + 1;
   with edgemat[noofedges] do
      begin
      edgelab := 'I';
      edgefreq := outedge[noofoutedge].oedgefreq;
      edgetype := 'p';
      edgepnt1 := i;
      edgepnt2 := 1;
      edgepnt3 := noofoutedge;
      end;
  for j := (keycount +1) to noatts do
      begin
      noofoutedge := noofoutedge + 1;
      outedge[noofoutedge].oedgetype := 'a';
      outedge[noofoutedge].oedgefreq := usagedet[j].primdet.rangefreq +
                                        usagedet[j].primdet.equifreq;
      outedge[noofoutedge].oedgelabel := 'I';
      noofedges := noofedges + 1;
```

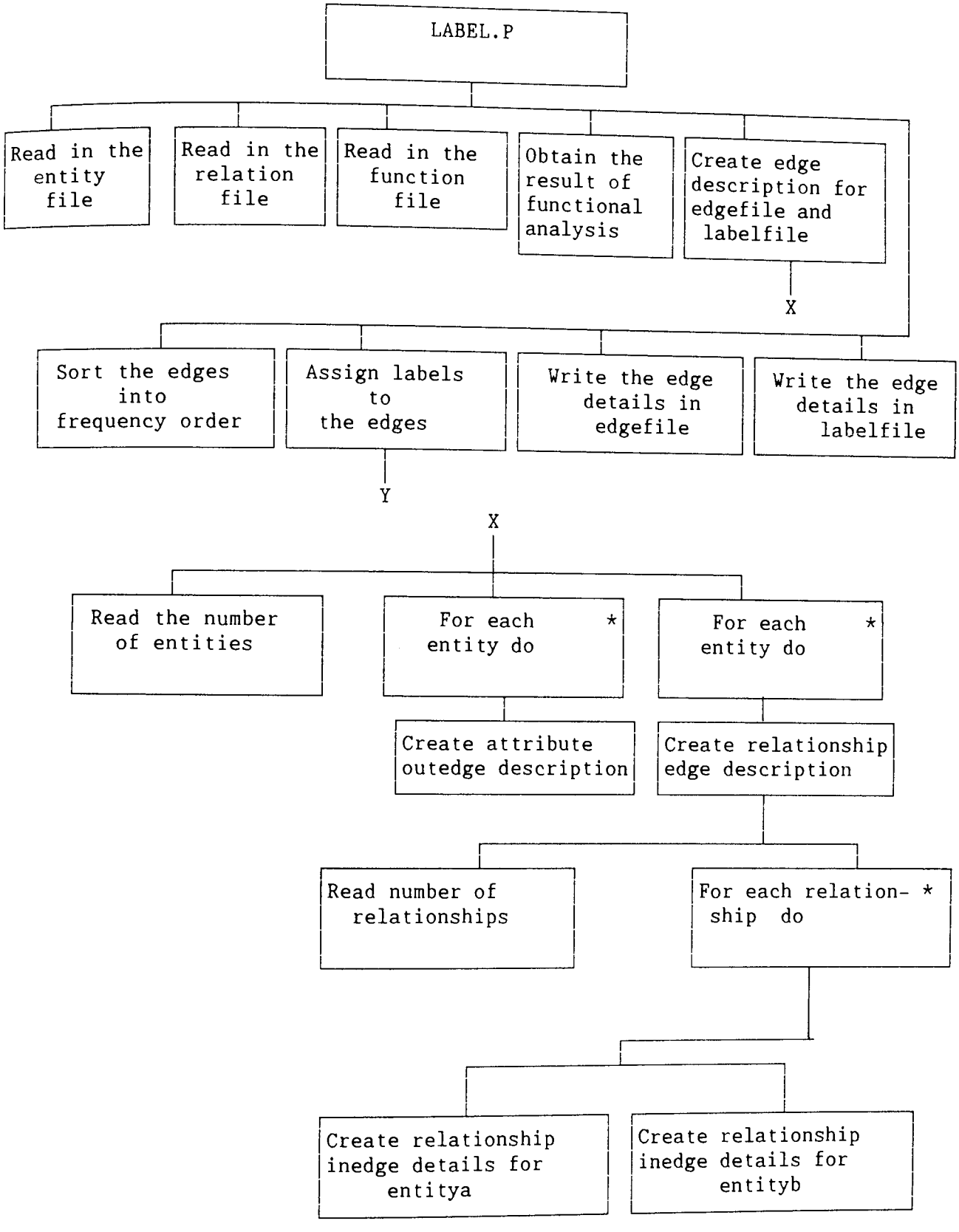
```
      with edgemat[noofedges] do
         begin
         edgelab := 'I';
         edgefreq := outedge[noofoutedge].oedgefreq;
         edgetype := 'a';
         edgepnt1 := i;
         edgepnt2 := j;
         edgepnt3 := noofoutedge
         end
       end
   end;

for k := 1 to noofrelations do
with relchart[k] do

{RELATIONSHIP EDGES ARE OUTEDGES FOR ENTITYA}
{RELATIONSHIP EDGES ARE INEDGES FOR ENTITYB}

   begin
   noofedges := noofedges + 1;
   with labelmat[entitya] do
      begin
      noofoutedge := noofoutedge + 1;
      outedge[noofoutedge].oedgetype := 'r';
      outedge[noofoutedge].oedgepnt := k;
      outedge[noofoutedge].oedgefreq := rusagemat[k].primfreq;
      outedge[noofoutedge].oedgelabel := 'I';
      edgemat[noofedges].edgepnt3 := noofoutedge
      end;
   with labelmat[entityb] do
      begin
      noofinedge := noofinedge + 1;
      inedge[noofinedge].iedgepnt := k;
      inedge[noofinedge].iedgefreq := rusagemat[k].primfreq;
      inedge[noofinedge].iedgelabel := 'I';
      edgemat[noofedges].edgepnt4 := noofinedge
      end;
   edgemat[noofedges].edgepnt1 := entitya;
   edgemat[noofedges].edgepnt2 := entityb;
   edgemat[noofedges].edgetype := 'r';
   edgemat[noofedges].edgelab := 'I';
   edgemat[noofedges].edgefreq := rusagemat[i].primfreq
   end;

{FORM THE LIST FOR SORTING}
for i := 1 to noofedges do
   begin
   sortlist[i].sortfreq := edgemat[i].edgefreq;
   sortlist[i].sortpnt := i;
   end;
```

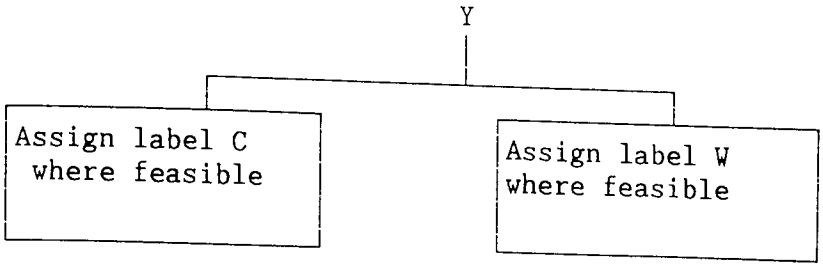
```
{SORT THE LIST INTO FREQUENCY ORDER}
noofswap :=1;
repeat
noofswap := 0;
for i := 1 to noofedges do
   begin
   if sortlist[i+1].sortfreq > sortlist[i].sortfreq then
      begin
      tempfreq := sortlist[i].sortfreq;
      temppnt := sortlist[i].sortpnt;
      sortlist[i].sortfreq := sortlist[i+1].sortfreq;
      sortlist[i].sortpnt := sortlist[i+1].sortpnt;
      sortlist[i+1].sortfreq := tempfreq;
      sortlist[i+1].sortpnt := temppnt;
      noofswap := noofswap + 1
      end
   end
 until noofswap = 0;


{TRAVERSE IN FREQUENCY ORDER AND ASSIGN LABEL C WHERE FEASIBLE}

for i := 1 to noofedges do
with sortlist [i] do
   begin
   labelc := 0;
   with edgemat[sortpnt] do
      begin
      for j := 1 to labelmat[edgepnt1].noofoutedge do
      with labelmat[edgepnt1] do
         begin
         if outedge[j].oedgelabel = 'C' then
            labelc := labelc + 1
         end;
      if labelc = 0 then
         begin
         edgelab := 'C';
         labelmat[edgepnt1].outedge[edgepnt3].oedgelabel := 'C';
         if edgetype = 'r' then
            labelmat[edgepnt2].inedge[edgepnt4].iedgelabel :=  'C'
         end
        end
     end;
```

```
{TRAVERSE IN FREQUENCY ORDER AND ASSIGN LABEL W WHERE FEASIBLE}
for i := 1 to noofedges do
with sortlist[i] do
   begin
   labelc := 0;
   olabelw := 0;
   ilabelw := 0;
   with edgemat[sortpnt] do
      begin
      if edgelab = 'C' then
         begin
         for j := 1 to labelmat[edgepnt1].noofoutedge do
         with labelmat[edgepnt1] do
            begin
            if outedge[j].oedgelabel = 'C' then
               begin
               if edgepnt3 <> j then
                  labelc := labelc + 1
               end;
             if outedge[j].oedgelabel = 'W' then
               begin
               if edgepnt3 <> j then
                  olabelw := olabelw + 1
               end
            end;
for j := 1 to labelmat[edgepnt1].noofinedge do
with labelmat[edgepnt1] do
   begin
   if inedge[j].iedgelabel = 'W' then
      begin
      ilabelw := ilabelw + 1
      end
   end;

if (labelc = 0) and (olabelw =0) and (ilabelw = 0) then
   begin
   edgelab := 'W';
   labelmat[edgepnt1].outedge[edgepnt3].oedgelabel := 'C';
   if edgetype = 'r' then
      labelmat[edgepnt2].inedge[edgepnt4].iedgelabel := 'C'
   end
end
end
end;
```

```
{WRITE IN THE EDGE DETAILS}
rewrite (edgefile, 'hospedge');
writeln (edgefile, noofedges);
for i := 1 to noofedges do
with edgemat[i] do
   begin
   write (edgefile, edgelab);
   write (edgefile, edgefreq);
   write (edgefile, edgetype);
   write (edgefile, edgepnt1);
   write (edgefile, edgepnt2);
   write (edgefile, edgepnt3);
   write (edgefile, edgepnt4);
   writeln (edgefile)
   end;

{WRITE IN THE LABELLED FILE}

rewrite (labelfile, 'hosplabel');
writeln (labelfile, noofentities);
for i := 1 to noofentities do
with labelmat[i] do
   begin
   writeln (labelfile,noofoutedge);
   writeln (labelfile, noofinedge);
   for j := 1 to noofoutedge do
   with outedge[j] do
      begin
      write (labelfile, oedgetype);
      write (labelfile, oedgepnt);
      write (labelfile, oedgefreq);
      write (labelfile, oedgelabel);
      writeln (labelfile)
      end;
   for j := 1 to noofinedge do
   with inedge[j] do
      begin
      write (labelfile, iedgepnt);
      write (labelfile, iedgefreq);
      write (labelfile, iedgelabel);
      writeln (labelfile)
      end
   end
end.
```

LABEL.P


LABEL.P
Read in the entity file
Read in the relation file
Read in the function file
Obtain the result of functional analysis
Create edge description for edgefile and labelfile
X
Sort the edges into frequency order
Assign labels to the edges
Write the edge details in edgefile
Write the edge details in labelfile
Y
X
Read the number of entities
For each entity do *
For each entity do *
Create attribute outedge description
Create relationship edge description
Read number of relationships
For each relation- ship do *
Create relationship inedge details for entitya
Create relationship inedge details for entityb


Y
Assign label C
where feasible
Assign label W
where feasible

```
{THIS PROGRAM CREATES A LOGICAL MODEL SUITABLE FOR INGRES DBMS}

program ingimp (input, output, relfile);

const maxstrlength = 20;
      maxnorel = 40;
      maxnoent = 40;
      maxnoatt = 20;
      maxrelatt = 20;
      maxnokey = 5;
      maxnoidnt = 5;
      awith = 'WITH';
      awithout = 'WITHOUT';
      maxnoprops = 20;
      maxinedge = 40;
      maxoutedge = 40;
      maxnoedge = 400;

type str = array [1..maxstrlength] of char;
     relstat = (weth, wethout);
     props = record
             entptr: integer;
             attptr: integer
             end;
     relation = record
                rname : str;
                entitya : integer;
                degenta : char;
                membshpa : char;
                entityb : integer;
                degentb : char;
                membshpb : char;
                case rs : relstat of
                     weth : (norelatt : integer;
                             relatt : array [1..maxrelatt] of str);
                     wethout : ()
                end;
        attributes = array[0..maxnoatt] of str;

        entity = record
                 ename : str;
                 keycount : integer;
                 noatts : integer;
                 entatt : attributes
                 end;

      normrel = record
                nrname : integer;
                identcnt : integer;
                norrelidnt : array [1..maxnoidnt] of props;
                nrkeycnt : integer;
                norrelkey :array [1..maxnokey] of props;
                case nrs : relstat of
                     weth : (nrattcnt : integer;
                        nrelatt : array [1..maxrelatt] of integer);
                     wethout : ()
                end;
```

```
    norment = record
              nename : str;
              noofprops : integer;
              identcnt : integer;
              norentatts : array [1..maxnoprops] of props
              end;

  outdet = record
           oedgetype : char;
           oedgepnt : integer;
           oedgefreq : integer;
           oedgelabel : char
           end;

  indet = record
          iedgepnt : integer;
          iedgefreq : integer;
          iedgelabel : char
          end;

   edgedet = record
             edgelab : char;
             edgefreq : integer;
             edgetype : char;
             edgepnt1 : integer;
             edgepnt2 : integer;
             edgepnt3 : integer;
             edgepnt4 : integer
             end;

  graphdet = record
             noofoutedge : integer;
             noofinedge : integer;
             outedge : array[1..maxoutedge] of outdet;
             inedge : array[1..maxinedge] of indet
             end;

   ingent = record
            struc : char;
            edgeno : integer;
            diredge : char
            end;

    var relchart : array [1..maxnorel] of relation;
        entchart : array [1..maxnoent] of entity;
        norrelchtr : array [1..maxnorel] of normrel;
        norentchrt : array [1..maxnoent] of norment;
        ingentchart : array [1..maxnoent] of ingent;
        edgemat: array[1..maxnoedge] of edgedet;
        labelmat : array[1..maxnoent] of graphdet;
        noofrelations : integer;
        relfile: text;
        i, j, k, l : integer;
        norelfile : integer;
        noofentities : integer;
        entfile : text;
        mapfile : text;
```

```
        tempbuff : str;
        found : boolean;
        correct : boolean;
        answer : str;
        noofnormrel : integer;
        totinfreq : integer;
        condition : boolean;
        icondition : boolean;
        edgefile : text;
        labelfile : text;
        noofedges : integer;


procedure readstr (var f : text; var s : str);
    var ptr: integer;
    begin
    ptr := 0;
    while not eoln (f) and (ptr < maxstrlength ) do
            begin
            ptr := ptr + 1;
            read (f, s[ptr]);
            end;
    while ptr < maxstrlength do
            begin
            ptr := ptr + 1;
            s[ptr] := ' '
            end
    end;

procedure writestr (var f : text; var s : str);
    var i : integer;
    begin
    for i := 1 to maxstrlength do
            write (f, s[i]);
    end;

function equalstr (a, b : str): boolean;
    var ptr : integer;
        equal : boolean;
    begin
    equal := true;
    ptr := 0;
    while equal and (ptr < maxstrlength ) do
            begin
            ptr := ptr + 1;
            if a[ptr] <> b[ptr] then equal := false
            end;
    equalstr := equal
    end;
```

```
procedure findent (var int : integer);
        var l : integer;
        begin
        l := 0;
        found := false;
        while (not found) and (l < noofentities) do
                begin
                l := l + 1;
                if equalstr (tempbuff, entchart[l].ename) then
                        begin
                        int := l;
                        found := true
                        end
                end
        end;

begin
{READ IN THE ENTITY FILE}
reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
        with entchart[i]  do
                begin
                readln (entfile);
                readstr (entfile, ename);
                readln (entfile);
                readln (entfile, keycount);
                readln (entfile, noatts);
                readln (entfile);;
                for l := 0 to keycount do readstr (entfile,entatt[l]);
                readln (entfile);
                readln (entfile);
                k := 1;
                for j := (keycount + 1) to noatts do
                        begin
                        readstr (entfile, entatt[j]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                readln (entfile);
                                k := 1
                                end
                        end;
                readln (entfile);
                readln (entfile)
        end;

{READ IN THE RELATION FILE}
reset (relfile, 'hosprel');
readln (relfile, noofrelations);
for i := 1 to noofrelations do
with relchart[i] do
```

```
        begin
        readln (relfile);
        readstr (relfile, rname);
        readln (relfile);
        readstr (relfile, tempbuff);
        findent (entitya);
        readln(relfile, degenta);
        readln (relfile, membshpa);
        readstr (relfile, tempbuff);
        findent (entityb);
        readln (relfile, degentb);
        readln (relfile, membshpb);
        readstr (relfile, tempbuff);
        if tempbuff = awith then rs := weth
        else rs := wethout;
        readln (relfile);
        if rs = weth then
                begin
                readln (relfile, norelatt);
                k := 1;
                for j := 1 to norelatt do
                        begin
                        readstr (relfile, relatt[j]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                readln (relfile);
                                k := 1
                                end
                        end
                end
        end;

{MAP THE RELATIONS}
j := 0;
for i := 1 to noofrelations do
with relchart[i] do
        begin
        if (degenta <> '1' ) and (membshpb <> 'o' ) then
          begin
          j := j + 1;
          with norrelchtr [j] do
            begin
            if (degenta = '1') and (degentb = '1') and (membshpb = 'n') then
                begin
                nrname := i;
                identcnt := entchart[entitya].keycount;
                for k := 1 to identcnt do
                  begin
                  norrelidnt[k].entptr := entitya;
                  norrelidnt[k].attptr := k
                  end;
                nrkeycnt := entchart[entityb].keycount;
                for k := 1 to nrkeycnt do
                        begin
                        norrelkey[k].entptr := entityb;
                        norrelkey[k].attptr := k
                        end
                end
```

```
            else
            if (degenta = '1') and (degentb = 'n') and (membshpb = 'n') then
                begin
                nrname := 1;
                identcnt := entchart[entityb].keycount;
                for k := 1 to identcnt do
                        begin
                        norrelidnt[k].entptr := entityb;
                        norrelidnt[k].attptr := k
                        end;
                nrkeycnt := entchart[entitya].keycount;
                for k := 1 to nrkeycnt do
                        begin
                        norrelkey[k].entptr := entitya;
                        norrelkey[k].attptr := k
                        end
                end
            else

                begin
                nrname := i;
                identcnt := (entchart[entitya].keycount) +
                            (entchart[entityb].keycount);
                for k := 1 to entchart[entitya].keycount do
                        begin
                        norrelidnt[k].entptr := entitya;
                        norrelidnt[k].attptr := k
                        end;
                l := 0;
                for k := ((entchart[entitya].keycount)+1) to identcnt do
                        begin
                        l := l + 1;
                        norrelidnt[k].entptr := entityb;
                        norrelidnt[k].attptr := l
                        end;
                nrkeycnt := 0
                end;
        nrs := rs;
        if nrs = weth then
                begin
                nrattcnt := norelatt;
                for k := 1 to nrattcnt do
                        begin
                        nrelatt[k] := k
                        end
                end
        end
        end
end;
noofnormrel := j;
```

```
{MAP ALL THE ENTITIES}
for i := 1 to noofentities do
    with norentchrt[i] do
       begin
       nename := entchart[i].ename;
       identcnt := entchart[i].keycount;
       noofprops := entchart[i].noatts;
       for j := 1 to entchart[i].noatts do
           begin
           norentatts[j].entptr := i;
           norentatts[j].attptr := j
           end;
       l := 0;
       while l < noofrelations do
          begin
          l := l + 1;
          if relchart[l].entityb = i then
            begin
            if  (relchart[l].degenta  =  '1')  and (relchart[l].membshpb = 'o')
            then
              begin
              for k := 1 to entchart[relchart[l].entitya].keycount do
                begin
                noofprops := noofprops + 1;
                norentatts[noofprops].entptr := relchart[l].entitya;
                norentatts[noofprops].attptr := k
                end
              end
             end
            end
    end;

{READ THE EDGE DETAILS}

reset (edgefile, 'hospedge');
readln (edgefile, noofedges);
for i := 1 to noofedges do
with edgemat[i] do
   begin
   read (edgefile, edgelab);
   read (edgefile, edgefreq);
   read (edgefile, edgetype);
   read (edgefile, edgepnt1);
   read (edgefile, edgepnt2);
   read (edgefile, edgepnt3);
   read (edgefile, edgepnt4);
   readln (edgefile)
   end;

{READ THE LABELLED FILE}

reset (labelfile, 'hosplabel');
readln (labelfile, noofentities);
for i := 1 to noofentities do
with labelmat[i] do
   begin
   readln (labelfile, noofoutedge);
   readln (labelfile, noofinedge);
   for j := 1 to noofoutedge do
```

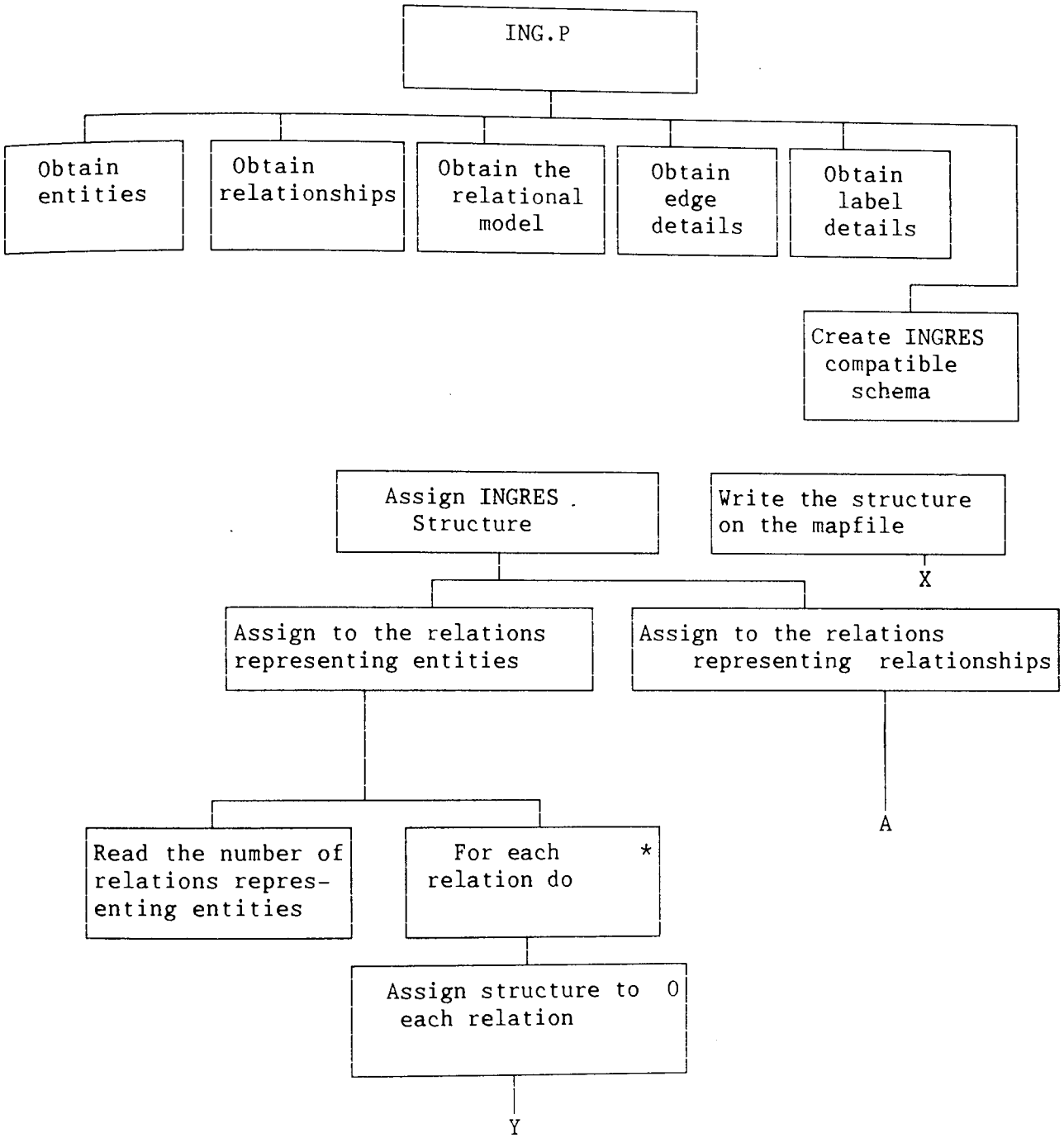
```
   with outedge[j] do
      begin
      read (labelfile, oedgetype);
      read (labelfile, oedgepnt);
      read (labelfile, oedgefreq);
      read (labelfile, oedgelabel);
      readln (labelfile)
      end;
    for j := 1 to noofinedge do
    with inedge[j] do
       begin
       read (labelfile, iedgepnt);
       read (labelfile, iedgefreq);
       read (labelfile, iedgelabel);
       readln (labelfile)
       end
     end;

for i := 1 to noofentities do
with norentchrt[i] do
with labelmat[i] do
   begin
   j := 0;
   condition := false;
   while (j < noofoutedge) and (not condition) do
       begin
       j := j + 1;
       if (outedge[j].oedgelabel = 'W' ) or
          (outedge[j].oedgelabel = 'C') then
          condition := true
       end;
   totinfreq := 0;
   for k := 1 to noofinedge do
       begin
       totinfreq := totinfreq + inedge[k].iedgefreq
       end;

 l:= 0;
 icondition := false;
 while (l< noofinedge) and (not icondition) do
     begin
     l := l +1;
     if (inedge[l].iedgelabel = 'W') or
        (inedge[l].iedgelabel = 'C') then
        icondition := true
      end;

{IF fi + SUM(INEDGE FREQUENCY)  > FREQUENCY OF EDGE MARKED 'W' or 'C'}
         {THEN HASH ON IDENTIFIER EDGE}

if condition then
   begin
   if outedge[1].oedgefreq + totinfreq >= outedge[j].oedgefreq then
      begin
      ingentchart[i].struc := 'H';
      ingentchart[i].edgeno := 1;
      ingentchart[i].diredge := 'o'
      end;
```

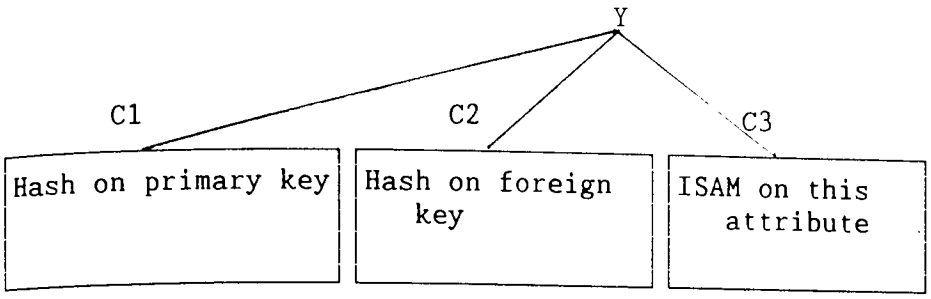
```
{IF OUTEDGE MARKED 'W' OR 'C' IS AN ATTRIBUTE THEN ISAM ON THAT PROPERTY}

  if (outedge[1].oedgefreq + totinfreq < outedge[j].oedgefreq) and
     (outedge[j].oedgetype = 'a') then
     begin
     ingentchart[i].struc := 'M';
     ingentchart[i].edgeno := j;
     ingentchart[i].diredge := 'o'
     end
end

{IF INEDGE MARKED 'W' or 'C' HASH ON PRIMARY KEY}
else if icondition then
    begin
    ingentchart[i].struc := 'H';
    ingentchart[i].edgeno := relchart[inedge[1].iedgepnt].entitya;
    ingentchart[i].diredge := 'i'
    end

else
    begin
    ingentchart[i].struc := 'H';
    ingentchart[i].edgeno := 1;
    ingentchart[i].diredge := 'o'
    end
end;

{WRITE TO THE MAPFILE SUITABLE FOR INGRES SCHEMA}

rewrite (mapfile, 'ingfile');
writeln (mapfile,noofentities);
for i := 1 to noofentities do
with norentchrt[i] do
with ingentchart[i] do
   begin
   writeln (mapfile);
   writestr (mapfile,nename);
   write (mapfile, noofprops);
   write (mapfile,' ');
   writeln (mapfile,identcnt);
   for j := 1 to identcnt do
   with norentatts[j] do
      writestr (mapfile, entchart[entptr].entatt[attptr]);
   writeln (mapfile);
   k:= 1;
   for j:= (identcnt + 1) to noofprops do
   with norentatts[j] do
      begin
      writestr (mapfile, entchart[entptr].entatt[attptr]);
      k := k+1;
      if k > 4 then
      begin
      writeln (mapfile);
      k := 1
      end
    end;
   writeln (mapfile);
   if struc = 'H' then
   write (mapfile, 'Hash it on');
```

```
   if struc = 'M' then
   write (mapfile, 'ISAM it on ');
   if diredge = 'o' then
     begin
     if edgeno = 1 then
        begin
        for j := 1 to identcnt do
        writestr (mapfile, entchart[i].entatt[j])
        end
      else
         writestr (mapfile,entchart[i].entatt[edgeno])
         end
   else
        begin
        for j := 1 to entchart[edgeno].keycount do
        writestr (mapfile, entchart[edgeno].entatt[j])
        end;
      writeln (mapfile)
    end;


{WRITE THE NORMALISED RELATIONS SUITABLE FOR INGRES SCHEMA IN THE MAPFILE}

rewrite (mapfile, 'ingrel');
writeln (mapfile, noofnormrel);
for i := 1 to noofnormrel do
with norrelchtr[i] do
     begin
     writestr (mapfile, relchart[nrname].rname);
     writeln(mapfile);
     writeln (mapfile, identcnt);
     k := 1;
     for j := 1 to identcnt do
     with norrelidnt[j] do
          begin
          writestr (mapfile, entchart[entptr].entatt[attptr]);
          k := k+1;
          if k > 4 then
             begin
             writeln(mapfile);
             k := 1
             end
          end;
      for j := 1 to nrkeycnt do
      with norrelkey[j] do
         begin
         writestr(mapfile, entchart[entptr].entatt[attptr]);
         k := k + 1;
         if k > 4 then
             begin
             writeln (mapfile);
             k := 1
             end
         end;
```

```
     if nrs = weth then
        begin
        for j := 1 to nrattcnt do
        with relchart[nrname] do
             begin
             writestr(mapfile, relatt[nrelatt[j]]);
             k := k +1;
             if k > 4 then
                  begin
                  writeln(mapfile);
                  k := 1
                  end
             end
         end;
     writeln(mapfile);
     write(mapfile, 'Hash it on ');
     for k := 1 to entchart[relchart[nrname].entitya].keycount do
         begin
         writestr (mapfile,entchart[relchart[nrname].entitya].entatt[k])
         end;
      writeln (mapfile)
      end
end.
```

ING.P

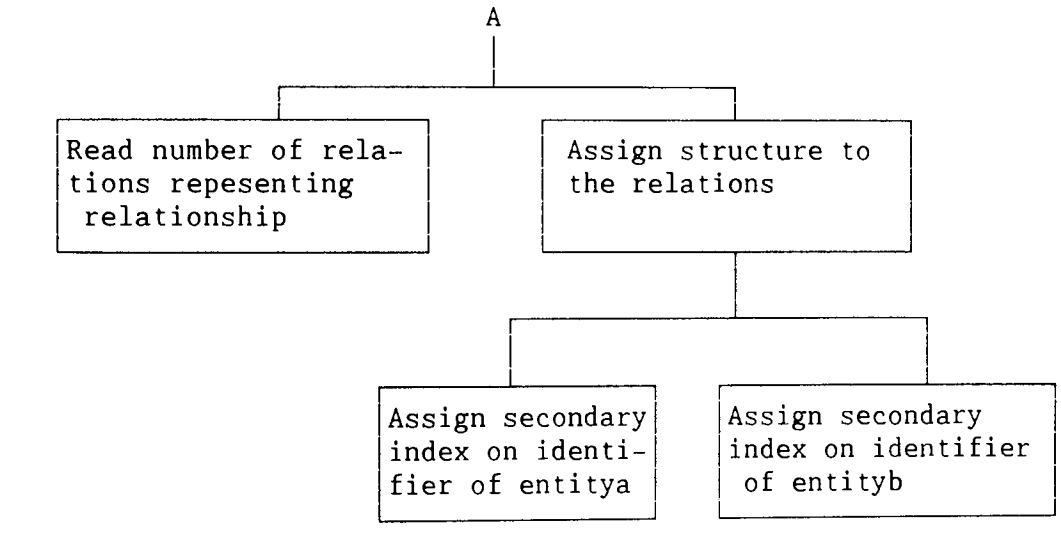

ING.P
Obtain entities
Obtain relationships
Obtain the relational model
Obtain edge details
Obtain label details
Create INGRES compatible schema
Assign INGRES Structure
Write the structure on the mapfile
X
Assign to the relations representing entities
Assign to the relations representing relationships
A
Read the number of relations repres-enting entities
For each relation do
*
Assign structure to each relation
0
Y

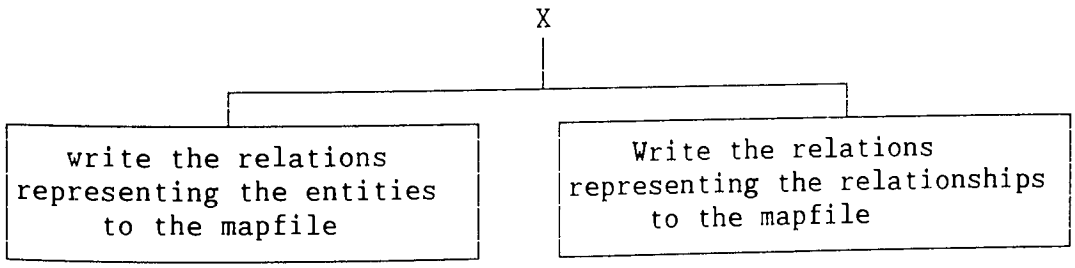


C1 = Outedge is labelled W or C
sum of frequency of inedges
is greater than the frequency
of outedge

C2 = Inedge is labelled W or C

C3 = Outedge is labelled W or C
and sum of inedge frequency
is less than the frequency
of outedge





```
{THIS PROGRAM CREATES A SCHEMA SUITABLE FOR MIMER DBMS}

program mimimp (input, output, relfile);

const maxstrlength = 20;
      maxnorel = 40;
      maxnoent = 40;
      maxnoatt = 20;
      maxrelatt = 20;
      maxnokey = 5;
      maxnoidnt = 5;
      awith = 'WITH';
      awithout = 'WITHOUT';
      maxnoprops = 20;
      maxinedge = 40;
      maxoutedge = 40;
      maxnoedge = 400;

type str = array [1..maxstrlength] of char;
     relstat = (weth, wethout);
     props = record
             entptr: integer;
             attptr: integer
             end;
     relation = record
                rname : str;
                entitya : integer;
                degenta : char;
                membshpa : char;
                entityb : integer;
                degentb : char;
                membshpb : char;
                case rs : relstat of
                     weth : (norelatt : integer;
                             relatt : array [1..maxrelatt] of str);
                     wethout : ()
                end;
     attributes = array[0..maxnoatt] of str;

        entity = record
                 ename : str;
                 keycount : integer;
                 noatts : integer;
                 entatt : attributes
                 end;

       normrel = record
                 nrname : integer;
                 identcnt : integer;
                 norrelidnt : array [1..maxnoidnt] of props;
                 nrkeycnt : integer;
                 norrelkey :array [1..maxnokey] of props;
                 case nrs : relstat of
                      weth : (nrattcnt : integer;
                         nrelatt : array [1..maxrelatt] of integer);
                      wethout : ()
                 end;
```

```
norment = record
          nename : str;
          noofprops : integer;
          identcnt : integer;
          norentatts : array [1..maxnoprops] of props
          end;

outdet = record
         oedgetype : char;
         oedgepnt : integer;
         oedgefreq : integer;
         oedgelabel : char
         end;

indet = record
        iedgepnt : integer;
        iedgefreq : integer;
        iedgelabel : char
        end;

edgedet = record
          edgelab : char;
          edgefreq : integer;
          edgetype : char;
          edgepnt1 : integer;
          edgepnt2 : integer;
          edgepnt3 : integer;
          edgepnt4 : integer
          end;

graphdet = record
           noofoutedge : integer;
           noofinedge : integer;
           outedge : array[1..maxoutedge] of outdet;
           inedge : array[1..maxinedge] of indet
           end;

miment = record
         struc : char;
         edgeno : integer;
         diredge : char
         end;

var relchart : array [1..maxnorel] of relation;
    entchart : array [1..maxnoent] of entity;
    norrelchtr : array [1..maxnorel] of normrel;
    norentchrt : array [1..maxnoent] of norment;
    mimentchart : array [1..maxnoent] of miment;
    edgemat: array[1..maxnoedge] of edgedet;
    labelmat : array[1..maxnoent] of graphdet;
    noofrelations : integer;
    relfile: text;
    i, j, k, l : integer;
    norelfile : integer;
    noofentities : integer;
    entfile : text;
    mapfile : text;
    tempbuff : str;
```

```
        found : boolean;
        correct : boolean;
        answer : str;
        noofnormrel : integer;
        totinfreq : integer;
        condition : boolean;
        icondition : boolean;
        edgefile : text;
        labelfile : text;
        noofedges : integer;


procedure readstr (var f : text; var s : str);
      var ptr: integer;
      begin
      ptr := 0;
      while not eoln (f) and (ptr < maxstrlength ) do
            begin
            ptr := ptr + 1;
            read (f, s[ptr]);
            end;
      while ptr < maxstrlength do
            begin
            ptr := ptr + 1;
            s[ptr] := ' '
            end
      end;

procedure writestr (var f : text; var s : str);
      var i : integer;
      begin
      for i := 1 to maxstrlength do
            write (f, s[i]);
      end;

function equalstr (a, b : str): boolean;
      var ptr : integer;
          equal : boolean;
      begin
      equal := true;
      ptr := 0;
      while equal and (ptr < maxstrlength ) do
            begin
            ptr := ptr + 1;
            if a[ptr] <> b[ptr] then equal := false
            end;
      equalstr := equal
      end;
```

```
procedure findent (var int : integer);
        var l : integer;
        begin
        l := 0;
        found := false;
        while (not found) and (l < noofentities) do
                begin
                l := l + 1;
                if equalstr (tempbuff, entchart[l].ename) then
                        begin
                        int := l;
                        found := true
                        end
                end
        end;

begin
{READ IN THE ENTITY FILE}
reset (entfile, 'hospent');
readln (entfile, noofentities);
for i := 1 to noofentities do
        with entchart[i]  do
                begin
                readln (entfile);
                readstr (entfile, ename);
                readln (entfile);
                readln (entfile, keycount);
                readln (entfile, noatts);
                readln (entfile);;
                for l := 0 to keycount do readstr (entfile,entatt[l]);
                readln (entfile);
                readln (entfile);
                k := 1;
                for j := (keycount + 1) to noatts do
                        begin
                        readstr (entfile, entatt[j]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                readln (entfile);
                                k := 1
                                end
                        end;
                readln (entfile);
                readln (entfile)
        end;
```

```
{READ IN THE RELATION FILE}
reset (relfile, 'hosprel');
readln (relfile, noofrelations);
for i := 1 to noofrelations do
with relchart[i] do
        begin
        readln (relfile);
        readstr (relfile, rname);
        readln (relfile);
        readstr (relfile, tempbuff);
        findent (entitya);
        readln (relfile, degenta);
        readln (relfile, membshpa);
        readstr (relfile, tempbuff);
        findent (entityb);
        readln (relfile, degentb);
        readln (relfile, membshpb);
        readstr (relfile, tempbuff);
        if tempbuff = awith then rs := weth
        else rs := wethout;
        readln (relfile);
        if rs = weth then
                begin
                readln (relfile, norelatt);
                k := 1;
                for j := 1 to norelatt do
                        begin
                        readstr (relfile, relatt[j]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                readln (relfile);
                                k := 1
                                end
                        end
                end
        end;

{MAP THE RELATIONS}

j := 0;
for i := 1 to noofrelations do
with relchart[i] do
        begin
        if (degenta <> '1' ) and (membshpb <> 'o' ) then
          begin
          j := j + 1;
          with norrelchtr [j] do
            begin
            if (degenta = '1') and (degentb = '1') and (membshpb = 'n') then
                begin
                nrname := i;
                identcnt := entchart[entitya].keycount;
                for k := 1 to identcnt do
                  begin
                  norrelidnt[k].entptr := entitya;
                  norrelidnt[k].attptr := k
                  end;
                nrkeycnt := entchart[entityb].keycount;
```

```
                for k := 1 to nrkeycnt do
                        begin
                        norrelkey[k].entptr := entityb;
                        norrelkey[k].attptr := k
                        end
                end
            else
            if (degenta = '1') and (degentb = 'n') and (membshpb = 'n') then
                begin
                nrname := 1;
                identcnt := entchart[entityb].keycount;
                for k := 1 to identcnt do
                        begin
                        norrelidnt[k].entptr := entityb;
                        norrelidnt[k].attptr := k
                        end;
                nrkeycnt := entchart[entitya].keycount;
                for k := 1 to nrkeycnt do
                        begin
                        norrelkey[k].entptr := entitya;
                        norrelkey[k].attptr := k
                        end
                end
             else

                begin
                nrname := i;
                identcnt := (entchart[entitya].keycount) +
                            (entchart[entityb].keycount);
                for k := 1 to entchart[entitya].keycount do
                        begin
                        norrelidnt[k].entptr := entitya;
                        norrelidnt[k].attptr := k
                        end;
                l := 0;
                for k := ((entchart[entitya].keycount)+1) to identcnt do
                        begin
                        l := l + 1;
                        norrelidnt[k].entptr := entityb;
                        norrelidnt[k].attptr := l
                        end;
                nrkeycnt := 0
                end;
        nrs := rs;
        if nrs = weth then
                begin
                nrattcnt := norelatt;
                for k := 1 to nrattcnt do
                        begin
                        nrelatt[k] := k
                        end
                end
        end
        end
end;
noofnormrel := j;
```

```
{MAP ALL THE ENTITIES}
for i := 1 to noofentities do
    with norentchrt[i] do
       begin
       nename := entchart[i].ename;
       identcnt := entchart[i].keycount;
       noofprops := entchart[i].noatts;

       for j := 1 to entchart[i].noatts do
           begin
           norentatts[j].entptr := i;
           norentatts[j].attptr := j
           end;
       l := 0;
       while l < noofrelations do
          begin
          l := l + 1;
          if relchart[l].entityb = i then
            begin
            if  (relchart[l].degenta  =  '1')  and (relchart[l].membshpb = 'o')
then
              begin
              for k := 1 to entchart[relchart[l].entitya].keycount do
                begin
                noofprops := noofprops + 1;
                norentatts[noofprops].entptr := relchart[l].entitya;
                norentatts[noofprops].attptr := k
                end
              end
             end
            end
    end;

{READ THE EDGE DETAILS}

reset (edgefile, 'hospedge');
readln (edgefile, noofedges);
for i := 1 to noofedges do
with edgemat[i] do
   begin
   read (edgefile, edgelab);
   read (edgefile, edgefreq);
   read (edgefile, edgetype);
   read (edgefile, edgepnt1);
   read (edgefile, edgepnt2);
   read (edgefile, edgepnt3);
   read (edgefile, edgepnt4);
   readln (edgefile)
   end;
```

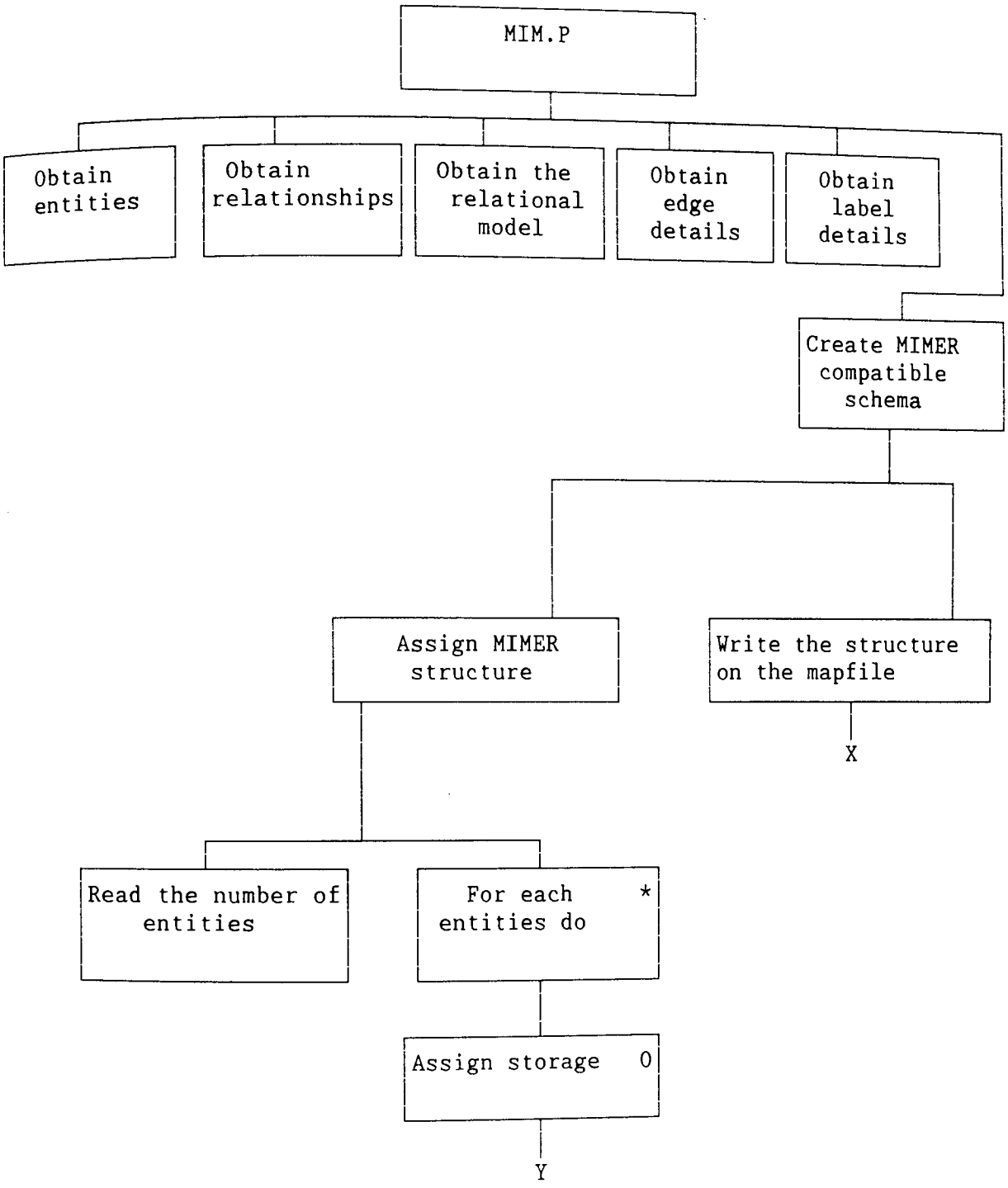
```
{READ THE LABELLED FILE}

reset (labelfile, 'hosplabel');
readln (labelfile, noofentities);
for i := 1 to noofentities do
with labelmat[i] do
   begin
   readln (labelfile, noofoutedge);
   readln (labelfile, noofinedge);
   for j := 1 to noofoutedge do
   with outedge[j] do
      begin
      read (labelfile, oedgetype);
      read (labelfile, oedgepnt);
      read (labelfile, oedgefreq);
      read (labelfile, oedgelabel);
      readln (labelfile)
      end;
    for j := 1 to noofinedge do
    with inedge[j] do
       begin
       read (labelfile, iedgepnt);
       read (labelfile, iedgefreq);
       read (labelfile, iedgelabel);
       readln (labelfile)
       end
     end;


for i := 1 to noofentities do
with norentchrt[i] do
with labelmat[i] do
   begin
   j := 0;
   condition := false;

{CHECK WHETHER ANY OUTEDGE OF THE ENTITY IS LABELLED 'W' or 'C'}
   while (j < noofoutedge) and (not condition) do
       begin
       j := j + 1;
       if (outedge[j].oedgelabel = 'W' ) or
          (outedge[j].oedgelabel = 'C') then
          condition := true
       end;

 l:= 0;
 icondition := false;

{CHECK WHETHER ANY INEDGE OF THE ENTITY IS LABELLED 'W' or 'C'}
 while (l< noofinedge) and (not icondition) do
     begin
     l := l +1;
     if (inedge[l].iedgelabel = 'W') or
        (inedge[l].iedgelabel = 'C') then
        icondition := true
      end;
```

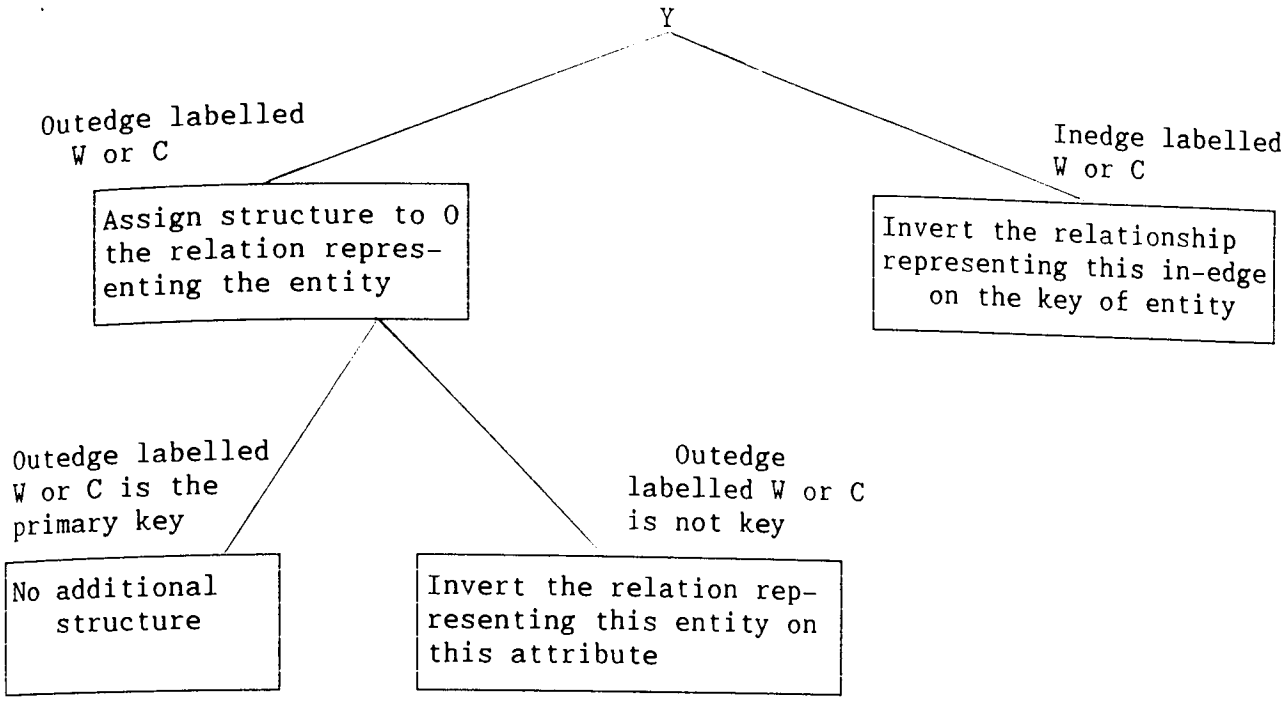
```
{IF THE LABELLED OUTEDGE IS NOT THE PRIMARY KEY}
{CREATE SECONDARY INDEX ON THAT ATTRIBUTE}

if (condition)  and (j<> 1) then
   begin

       mimentchart[i].struc := 'I';
       mimentchart[i].edgeno := j;
       mimentchart[i].diredge := 'o'
   end
  else

{IF AN INEDGE IS LABELLED 'W' OR 'C' THEN CREATE SECONDARY INDEX ON}
{THE KEY OF THE ENTITYA OF THE RELATIONSHIP}
  if icondition then
    begin
    mimentchart[i].struc := 'I';
    mimentchart[i].edgeno := relchart[inedge[l].iedgepnt].entitya;
    mimentchart[i].diredge := 'i'
    end
   else
    begin
    mimentchart[i].struc := 'N';
    mimentchart[i].edgeno := 0;
    mimentchart[i].diredge := 'n'
    end

end;

{WRITE THE MIMER SCHEMA ON THE MAPFILE}
{FIRST WRITE THE RELATIONS CORRESPONDING TO THE ENTITIES}

rewrite (mapfile, 'mimfile');
writeln(mapfile, noofentities);
for i := 1 to noofentities do
with norentchrt[i] do
with mimentchart[i] do
   begin
   writeln (mapfile);
   writestr (mapfile, nename);
   write(mapfile,noofprops);
   write(mapfile,' ');
   writeln (mapfile,identcnt);
   for j := 1 to identcnt do
   with norentatts[j] do
      writestr (mapfile, entchart[entptr].entatt[attptr]);
   writeln(mapfile);
   k := 1;
   for j := (identcnt + 1) to noofprops do
   with norentatts[j] do
      begin
      writestr (mapfile, entchart[entptr].entatt[attptr]);
      k := k +1;
      if k > 4 then
         begin
         writeln (mapfile);
         k := 1
         end
       end;
```

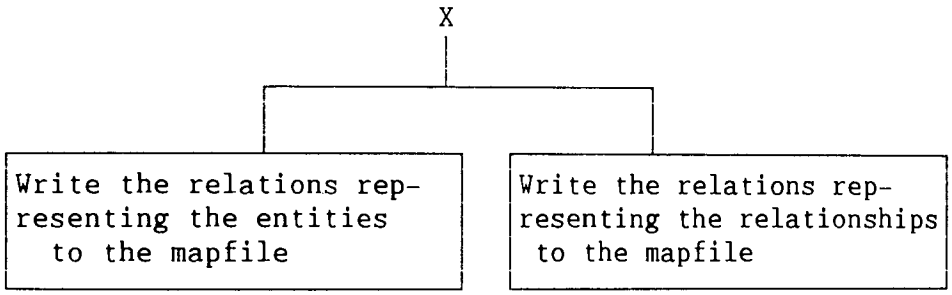
```
      writeln (mapfile);
      if struc <> 'N' then
      begin
      write (mapfile, 'Invert it on ');
      if diredge = 'o' then
        writestr(mapfile, entchart[i].entatt[edgeno])
      else
        begin
        for j := 1 to entchart[edgeno].keycount do
        writestr (mapfile, entchart[edgeno].entatt[j])
        end
       end;
     writeln (mapfile);
end;

{THEN WRITE THE RELATIONS CORRESPONDING TO THE RELATIONSHIPS IN THE MAPFILE}

rewrite (mapfile, 'mimrel');
writeln (mapfile, noofnormrel);
for i := 1 to noofnormrel do
with norrelchtr[i] do
        begin
        writestr (mapfile, relchart[nrname].rname);
        writeln (mapfile);
        writeln (mapfile, identcnt);
        k := 1;
        for j := 1 to identcnt do
        with norrelidnt[j] do
                begin
                writestr (mapfile, entchart[entptr].entatt[attptr]);
                k := k + 1;
                if k > 4 then
                        begin
                        writeln (mapfile);
                        k := 1
                        end
                end;
        for j := 1 to nrkeycnt do
        with norrelkey[j] do
                begin
                writestr (mapfile, entchart[entptr].entatt[attptr]);
                k := k + 1;
                if k> 4 then
                        begin
                        writeln(mapfile);
                        k := 1
                        end;
                end;
```

```
        if nrs = weth then
                begin
                for j := 1 to nrattcnt do
                with relchart[nrname]  do
                        begin
                        writestr (mapfile, relatt[nrelatt[j]]);
                        k := k + 1;
                        if k > 4 then
                                begin
                                writeln (mapfile);
                                k := 1
                                end
                        end
                end;
        writeln (mapfile);
   write (mapfile, 'Invert it on ');
   for k := 1 to entchart[relchart[nrname].entitya].keycount do
      begin
      writestr (mapfile, entchart[relchart[nrname].entitya].entatt[k])
      end;
    writeln (mapfile)
        end
end.
```

MIM.P


MIM.P
Obtain entities
Obtain relationships
Obtain the relational model
Obtain edge details
Obtain label details
Create MIMER compatible schema
Assign MIMER structure
Write the structure on the mapfile
X
Read the number of entities
For each entities do *
Assign storage 0
Y


Y
Outedge labelled
W or C
Inedge labelled
W or C
Assign structure to
the relation repres-
enting the entity
Invert the relationship
representing this in-edge
on the key of entity
Outedge labelled
W or C is the
primary key
Outedge
labelled W or C
is not key
No additional
structure
Invert the relation rep-
resenting this entity on
this attribute


X
Write the relations rep-
resenting the entities
to the mapfile
Write the relations rep-
resenting the relationships
to the mapfile

APPENDIX D

TYPICAL RUNS OF PROGRAMS

A Typical Run of the Program ENTEST.P

```
Script started on Mon Feb 23 16:23:01 1987
$ px entest.ex


Number of new entities

1

Entity name

Supplier

NO of attributes in the primary key

1

No of attributes

4

Input the attributes one per line

supplier-no

name

address

status


23293 statements executed in 0007.840 seconds cpu time.
script done on Mon Feb 23 16:29:56 1987
```

The run of the program 'ENTEST.P' shows the insertion of a new entity named 'Supplier'. The responses of the user of the tools are in bold type.

The run shows that the user intends to insert one entity. The entity name is 'Supplier'. The entity has four attributes which are

supplier-no

name

address

status

The identifier of the entity is a single attribute, which is the 'supplier-no'.

A Typical Run of the Program RELTEST.P

```
Script started on Mon Feb 23 16:33:53 1987
$ pix reltest.p
Execution begins...


Number of new relationships

1

Relationship name

Supplied drug

First entity

Suplier

THIS ENTITY DOES NOT EXIST

Supplier

Degree of first entity 1 or m

m

Membership of first entity o for obligatory n for non-obligatory

n

Second entity

Drug

Degree of second entity 1or n

n

Membership of second entity o or n

n

State WITH or WITHOUT Attributes

WITHOUT

Execution terminated.


34850 statements executed in 0011.760 seconds cpu time.
$ ^D
script done on Mon Feb 23 16:38:22 1987
```

The run of the Program 'RELTEST.P' shows the insertion of a new relationship named 'Supplied drug'. The responses of the user are in bold type.

The name of the first entity is 'Supplier'. On the first instance, the user makes a mistake with the spelling of the entity 'Supplier'. Due to this mistake, the program does not recognise the entity and reports that the entity does not exist in the entity list. The user tries again, and types the name of the entity. The program recognises the entity and accepts it as the first entity. The program then enquires about the degree of the first entity. The user types in 'm'. The program then enquires about the membership of the first entity. The user types in 'n' for non-obligatory. The program then asks questions about the second entity. The user types in the name, degree and the membership of the second entity, which are 'Drug', 'n' and 'n' respectively. The relationship has no attributes.

A Typical Run of the Program FUNCTEST.P

```
Script started on Mon Feb 23 12:03:41 1987
$ px functest.ex


Number of new function

1

Function name

Select-nurse

Status of function

PRIMARY

Frequency of the function

400

Number of ENTITY accessed

1

Name of entity

Nurse

THIS ENTITY DOES NOT EXIST. TRY AGAIN

Nurses

State whether SELECT.BY.KEY/RELATION/ATTRIBUTES

SELECT.BY.ATTRIBUTES

State the attribute

grade

State selection clause RANGE or EQUIJOIN.

RANGE


42252 statements executed in 0014.380 seconds cpu time.
$ ^D
script done on Mon Feb 23 12:07:11 1987
```

The run of the Program 'FUNCTEST.P' shows the user inserting information regarding a new function named 'Select-nurse'. The function has a 'Primary' status. The responses of the user is in bold type.

The number of times the function is performed in a day is 400. A single entity 'Nurses' is accessed by the function. The entity is selected by an attribute. The attribute 'grade' is used to select the entity and the selection clause used is the 'range' clause.

As the entity name is 'Nurses' the program does not recognise the when the user types in 'Nurse' and gives an error message.

APPENDIX E

OUTPUTS FROM PROGRAMS

Output of ENTEST.P
ENTFILE

```
       26

Patient
         1
        12

PRIMARY KEY          pat-no

pat-name             pat-address          pat-category         reference
sex                  date-of-birth        marital status       next-of-kin
blood group          allergy              x-ray information


Disease
         1
         4

PRIMARY KEY          disease-no

disease-name         contageous           treatment


Consultant
         1
         4

PRIMARY KEY          emp-no

con-name             con-address          speciality


Clinical-session
         2
         9

PRIMARY KEY          clinic-no            date

time-of-start        time-of-finish       speciality           est: new pat
est: repeat pat      new pat booked       rep: pat booked


Clinic-time-schedule
         3
         5

PRIMARY KEY          clinic-no            date                 time

free/booked          new/repeat
```

O/p-W/l
1
4

PRIMARY KEY	W/l-no		
speciality	list size	selection criteria	

Surgical W/l
1
4

PRIMARY KEY	S-W/l-no		
speciality	list length	selection criteria	

Surgical-session
2
8

PRIMARY KEY	session-no	date	
start time max: minor cases	end time booked minor cases	max: major cases	booked major cases

Admission W/l
1
4

PRIMARY KEY	A-W/l-no		
speciality	list length	selection criteria	

Blood request
1
9

PRIMARY KEY	Request-no		
reason reserve conc: units	date. doctors no:	save serum blood taker's no:	reserve blood units date of request

Pat-rec-blood
1
8

PRIMARY KEY	ref-no		
ward-code past-trans	blood-group antibody	haemoglobin level prev:/ref-no	pregnancies

Antibody cases
1
8

PRIMARY KEY	anti-ref		
blood group B.T.S confirm	phenotype date	antibody comment	E.D.C

Drug
1
5

PRIMARY KEY	drug-code		
name	strength	pack-size	expirey-code

supplier
1
4

PRIMARY KEY	supplier-no	
name	address	status

Prescription
1
3

PRIMARY KEY	pres-no
pres-date	prescriber

X-ray request
1
5

PRIMARY KEY	request-no		
investigation	requestor	urgency	reason

X-ray sessions
4
6

PRIMARY KEY X-ray type	date	unit	morning/afternoon
maximum load	numbers booked		

Staff details
1
5

PRIMARY KEY	emp-no		
name	grade	F.T/P.T	address

Wards
1
6

PRIMARY KEY	Ward-code		
no-of-beds nursing dependency	w-type	w-description	nursing load

Ward bed
2
4

PRIMARY KEY	Ward-code	bed-no
male/female	free/occupied	

Nurses
1
10

PRIMARY KEY	emp-no		
N.I.no entry grade full eqivalent	name location code	grade qualification code	unit code date of birth

Duty
4
5

PRIMARY KEY grade	date	shift	W-code
number required			

Ind: workload
2
4

PRIMARY KEY	week commencing	emp-no
max-hours	hours-booked	

In-patient
4
8

PRIMARY KEY pat-no w-code bed-no
date entering

discharge date illness patient type comment

N-absence rec
4
5

PRIMARY KEY emp-no day month
year

reason

Supplier
1
4

PRIMARY KEY supplier-no

name address status

Output from RELTEST.P
RELFILE

22

Pat-Cons
Patient m
o
Consultant n
n
WITH
1
Date registered
Pat-Disease
Patient m
n
Disease n
n
WITH
1
Date diagnosed
Cons-Clinic
Consultant 1
n
Clinical-session n
o
WITHOUT

Clinic/schedule
Clinical-session 1
o
Clinic-time-schedulen
s
WITHOUT

Appointment
Patient 1
n
Clinic-time-schedulen
n
WITHOUT

Consultant/S-W/l
Consultant 1
n
Surgical W/l n
o
WITHOUT

Consultant/S-session
Consultant 1
n
Surgical-session n
o
WITHOUT

Pat/Blood req
Patient 1
n
Blood request n
o
WITHOUT

Pat/Pat-rec-blood
Patient 1
n
Pat-rec-blood n
o
WITHOUT

Patient/Antibody
Patient 1
n
Antibody cases 1
o
WITHOUT

Pat/prescription
Patient 1
n
Prescription n
o
WITHOUT

Pat/X-ray request
Patient 1
n
X-ray request n
o
WITHOUT

X-ray sess/Pat
X-ray sessions m
n
Patient n
n
WITH
1
suggestion
Staff/session
Staff details m
n
X-ray sessions n
o
WITHOUT

Pat/O/p-W/l
Patient m
n
O/p-W/l n
n
WITH
4
position reference complaints urgency

```
Pat/S-W/l
Patient                 m
n
Surgical W/l            n
n
WITH
          5
urgency                 op-code                 suggestion              non-availability
position
Consultant/O/p-W/l
Consultant              1
n
O/p-W/l                 n
o
WITHOUT

Duty-rota
Nurses                  m
n
Duty                    n
n
WITHOUT

Nurses/Wards
Nurses                  m
n
Wards                   n
n
WITHOUT

Nurses/Workload
Nurses                  1
n
Ind: workload           n
s
WITHOUT

Pat/In-pat
Patient                 1
n
In-patient              n
s
WITHOUT

Supplied drug
Supplier                m
n
Drug                    n
n
WITHOUT
```

FORMAT-REL

RELATION-NAME	ENTITY-A	ENTITY-B	DEGREE-A	DEGREE-B
Pat-Consno	Patient	Consultant	m	n
Pat-Diseasenn	Patient	Disease	m	n
Cons-Clinicno	Consultant	Clinical-session	1	n
Clinic/scheduleos	Clinical-session	Clinic-time-schedule	1	n
Appointmentnn	Patient	Clinic-time-schedule	1	n
Consultant/S-W/lno	Consultant	Surgical W/l	1	n
Consultant/S-sessionno	Consultant	Surgical-session	1	n
Pat/Blood reqno	Patient	Blood request	1	n
Pat/Pat-rec-bloodno	Patient	Pat-rec-blood	1	n
Patient/Antibodyno	Patient	Antibody cases	1	1
Pat/prescriptionno	Patient	Prescription	1	n
Pat/X-ray requestno	Patient	X-ray request	1	n
X-ray sess/Patnn	X-ray sessions	Patient	m	n
Staff/sessionno	Staff details	X-ray sessions	m	n
Pat/O/p-W/lnn	Patient	O/p-W/l	m	n
Pat/S-W/lnn	Patient	Surgical W/l	m	n
Consultant/O/p-W/lno	Consultant	O/p-W/l	1	n
Duty-rotann	Nurses	Duty	m	n

Appendix E

				Outputs
Nurses/Wards	Nurses	Wards	m	n
n n				
Nurses/Workload	Nurses	Ind: workload	1	n
n s				
Pat/In-pat	Patient	In-patient	1	n
n s				
Supplied drug	Supplier	Drug	m	n
n n				

Output from FUNCTEST.P
FUNCFILE

7

Enquirey	PRIMARY	300
4		
Patient	SELECT.BY.KEY	
pat-no		
Clinic-time-schedule	SELECT.BY.RELATION	
Appointment		
Clinical-session	SELECT.BY.RELATION	
Clinic/schedule		
Consultant	SELECT.BY.RELATION	
Cons-Clinic		
Query blood	PRIMARY	350
2		
Patient	SELECT.BY.ATTRIBUTES	
pat-name	EQUIJOIN	
Pat-rec-blood	SELECT.BY.RELATION	
Pat/Pat-rec-blood		
Fix-Appt:	PRIMARY	350
5		
Patient	SELECT.BY.KEY	
pat-no		
O/p-W/l	SELECT.BY.RELATION	
Pat/O/p-W/l		
Consultant	SELECT.BY.RELATION	
Consultant/O/p-W/l		
Clinical-session	SELECT.BY.RELATION	
Cons-Clinic		
Clinic-time-schedule	SELECT.BY.RELATION	
Clinic/schedule		
Sel-nurse-rota	SECONDARY	150
2		
Duty	SELECT.BY.ATTRIBUTES	
grade	EQUIJOIN	
Ind: workload	SELECT.BY.RELATION	
Nurses/Workload		

Outputs

Check rota 2	PRIMARY		200	
Duty	SELECT.BY.KEY			
date	shift	W-code		grade
Nurses	SELECT.BY.RELATION			
Duty-rota				
Pat/dis enq 2	PRIMARY		200	
Patient	SELECT.BY.KEY			
pat-no				
Disease	SELECT.BY.RELATION			
Pat-Disease				
Select-nurse 1	PRIMARY		400	
Nurses	SELECT.BY.ATTRIBUTES			
grade	RANGE			

Output from ANALYSIS.P
ANALYSISFILE(Entity Analysis)

Entity-Name :- Patient

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	850	0	0
pat-name	0	350	0	0
pat-address	0	0	0	0
pat-category	0	0	0	0
reference	0	0	0	0
sex	0	0	0	0
date-of-birth	0	0	0	0
marital status	0	0	0	0
next-of-kin	0	0	0	0
blood group	0	0	0	0
allergy	0	0	0	0
x-ray information	0	0	0	0

Entity-Name :- Disease

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
disease-name	0	0	0	0
contageous	0	0	0	0
treatment	0	0	0	0

Entity-Name :- Consultant

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
con-name	0	0	0	0
con-address	0	0	0	0
speciality	0	0	0	0

Entity-Name :- Clinical-session

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
time-of-start	0	0	0	0
time-of-finish	0	0	0	0
speciality	0	0	0	0
est: new pat	0	0	0	0
est: repeat pat	0	0	0	0
new pat booked	0	0	0	0
rep: pat booked	0	0	0	0

Entity-Name :- Clinic-time-schedule

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
free/booked	0	0	0	0
new/repeat	0	0	0	0

Entity-Name :- O/p-W/l

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
speciality	0	0	0	0
list size	0	0	0	0
selection criteria	0	0	0	0

Entity-Name :- Surgical W/l

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
speciality	0	0	0	0
list length	0	0	0	0
selection criteria	0	0	0	0

Entity-Name :- Surgical-session

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
start time	0	0	0	0
end time	0	0	0	0
max: major cases	0	0	0	0
booked major cases	0	0	0	0
max: minor cases	0	0	0	0
booked minor cases	0	0	0	0

Entity-Name :- Admission W/l

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
speciality	0	0	0	0
list length	0	0	0	0
selection criteria	0	0	0	0

Entity-Name :- Blood request

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
reason	0	0	0	0
date	0	0	0	0
save serum	0	0	0	0
reserve blood units	0	0	0	0
reserve conc: units	0	0	0	0
doctors no:	0	0	0	0
blood taker's no:	0	0	0	0
date of request	0	0	0	0

Entity-Name :- Pat-rec-blood

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
ward-code	0	0	0	0
blood-group	0	0	0	0
haemoglobin level	0	0	0	0
pregnancies	0	0	0	0
past-trans	0	0	0	0
antibody	0	0	0	0
prev:/ref-no	0	0	0	0

Entity-Name :- Antibody cases

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
blood group	0	0	0	0
phenotype	0	0	0	0
antibody	0	0	0	0
E.D.C	0	0	0	0
B.T.S confirm	0	0	0	0
date	0	0	0	0
comment	0	0	0	0

Entity-Name :- Drug

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
name	0	0	0	0
setength	0	0	0	0
pack-size	0	0	0	0
expirey-code	0	0	0	0

Entity-Name :- supplier

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
name	0	0	0	0
address	0	0	0	0
status	0	0	0	0

Entity-Name :- Prescription

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
pres-date	0	0	0	0
prescriber	0	0	0	0

Entity-Name :- X-ray request

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
investigation	0	0	0	0
requestor	0	0	0	0
urgency	0	0	0	0
reason	0	0	0	0

Entity-Name :- X-ray sessions

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
maximum load	0	0	0	0
numbers booked	0	0	0	0

Entity-Name :- Staff details

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
name	0	0	0	0
grade	0	0	0	0
F.T/P.T	0	0	0	0
address	0	0	0	0

Entity-Name :- Wards

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
no-of-beds	0	0	0	0
w-type	0	0	0	0
w-description	0	0	0	0
nursing load	0	0	0	0
nursing dependency	0	0	0	0

Entity-Name :- Ward bed

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
male/female	0	0	0	0
free/occupied	0	0	0	0

Entity-Name :- Nurses

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
N.I.no	0	0	0	0
name	0	0	0	0
grade	400	0	0	0
unit code	0	0	0	0
entry grade	0	0	0	0
location code	0	0	0	0
qualification code	0	0	0	0
date of birth	0	0	0	0
full eqivalent	0	0	0	0

Entity-Name :- Duty

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	200	0	0
number required	0	0	0	0

Entity-Name :- Ind: workload

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
max-hours	0	0	0	0
hours-booked	0	0	0	0

Entity-Name :- In-patient

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
discharge date	0	0	0	0
illness	0	0	0	0
patient type	0	0	0	0
comment	0	0	0	0

Entity-Name :- N-absence rec

	Primary functions		Secondary functions	
	Rfrequency	Efrequency	Rfrequency	Efrequency
Primary-key	0	0	0	0
reason	0	0	0	0

ANALYSISFILE(Relationship Analysis)

Relationship Name	Primary Function Frequency	Secondary Function Frequency
Pat-Cons	0	0
Pat-Disease	200	0
Cons-Clinic	650	0
Clinic/schedule	650	0
Appointment	300	0
Consultant/S-W/l	0	0
Consultant/S-session	0	0
Pat/Blood req	0	0
Pat/Pat-rec-blood	350	0
Patient/Antibody	0	0
Pat/prescription	0	0
Pat/X-ray request	0	0
X-ray sess/Pat	0	0
Staff/session	0	0
Pat/O/p-W/l	350	0
Pat/S-W/l	0	0
Consultant/O/p-W/l	350	0
Duty-rota	200	0
Nurses/Wards	0.	0
Nurses/Workload	0	150
Pat/In-pat	0	0

Output from RELMAP.P
MAPFILE

25

Patient	12	1	
pat-no			
pat-name	pat-address	pat-category	reference
sex	date-of-birth	marital status	next-of-kin
blood group	allergy	x-ray information	
Disease	4	1	
disease-no			
disease-name	contageous	treatment	
Consultant	4	1	
emp-no			
con-name	con-address	speciality	
Clinical-session	10	2	
clinic-no	date		
time-of-start	time-of-finish	speciality	est: new pat
est: repeat pat	new pat booked	rep: pat booked	emp-no
Clinic-time-schedule	5	3	
clinic-no	date	time	
free/booked	new/repeat		
O/p-W/l	5	1	
W/l-no			
speciality	list size	selection criteria	emp-no
Surgical W/l	5	1	
S-W/l-no			
speciality	list length	selection criteria	emp-no
Surgical-session	9	2	
session-no	date		
start time	end time	max: major cases	booked major cases
max: minor cases	booked minor cases	emp-no	
Admission W/l	4	1	
A-W/l-no			
speciality	list length	selection criteria	

Outputs

Blood request	10	1	
Request-no			
reason	date	save serum	reserve blood units
reserve conc: units	doctors no:	blood taker's no:	date of request
pat-no			
Pat-rec-blood	9	1	
ref-no			
ward-code	blood-group	haemoglobin level	pregnancies
past-trans	antibody	prev:/ref-no	pat-no
Antibody cases	9	1	
anti-ref			
blood group	phenotype	antibody	E.D.C
B.T.S confirm	date	comment	pat-no
Drug	5	1	
drug-code			
name	strength	pack-size	expirey-code
supplier	4	1	
supplier-no			
name	address	status	
Prescription	4	1	
pres-no			
pres-date	prescriber	pat-no	
X-ray request	6	1	
request-no			
investigation	requestor	urgency	reason
pat-no			
X-ray sessions	6	4	
date	unit	morning/afternoon	x-ray type
maximum load	numbers booked		
Staff details	5	1	
emp-no			
name	grade	F.T/P.T	address

Wards	6	1	
Ward-code			
no-of-beds	w-type	w-description	nursing load
nursing dependency			
Ward bed	4	2	
Ward-code	bed-no		
male/female	free/occupied		
Nurses	10	1	
emp-no			
N.I.no	name	grade	unit code
entry grade	location code	qualification code	date of birth
full eqivalent			
Duty	5	4	
date	shift	W-code	grade
number required			
Ind: workload	4	2	
week commencing	emp-no		
max-hours	hours-booked		
In-patient	8	4	
pat-no	w-code	bed-no	date entering
discharge date	illness	patient type	comment
N-absence rec	5	4	
emp-no	day	month	year
reason			

Output from CODMAP.P
CODENT

```
Record name is Patient
Patient              KEY is pat-no
    pat-name             ;
    pat-address          ;
    pat-category         ;
    reference            ;
    sex                  ;
    date-of-birth        ;
    marital status       ;
    next-of-kin          ;
    blood group          ;
    allergy              ;
    x-ray information    ;


Record name is Disease
Disease              KEY is disease-no
    disease-name         ;
    contageous           ;
    treatment            ;


Record name is Consultant
Consultant           KEY is emp-no
    con-name             ;
    con-address          ;
    speciality           ;


Record name is Clinical-session
Clinical-session     KEY is clinic-no          ,date
    time-of-start        ;
    time-of-finish       ;
    speciality           ;
    est: new pat         ;
    est: repeat pat      ;
    new pat booked       ;
    rep: pat booked      ;


Record name is Clinic-time-schedule
Clinic-time-scheduleKEY  is  clinic-no              ,date              ,time

    free/booked          ;
    new/repeat           ;


Record name is O/p-W/l
O/p-W/l              KEY is W/l-no
    speciality           ;
    list size            ;
    selection criteria   ;
```

```
Record name is Surgical W/l
Surgical W/l          KEY is S-W/l-no
    speciality              ;
    list length             ;
    selection criteria      ;


Record name is Surgical-session
Surgical-session      KEY is session-no          ,date
    start time              ;
    end time                ;
    max: major cases        ;
    booked major cases      ;
    max: minor cases        ;
    booked minor cases      ;


Record name is Admission W/l
Admission W/l         KEY is A-W/l-no
    speciality              ;
    list length             ;
    selection criteria      ;


Record name is Blood request
Blood request         KEY is Request-no
    reason                  ;
    date                    ;
    save serum              ;
    reserve blood units     ;
    reserve conc: units     ;
    doctors no:             ;
    blood taker's no:       ;
    date of request         ;


Record name is Pat-rec-blood
Pat-rec-blood         KEY is ref-no
    ward-code               ;
    blood-group             ;
    haemoglobin level       ;
    pregnancies             ;
    past-trans              ;
    antibody                ;
    prev:/ref-no            ;


Record name is Antibody cases
Antibody cases        KEY is anti-ref
    blood group             ;
    phenotype               ;
    antibody                ;
    E.D.C                   ;
    B.T.S confirm           ;
    date                    ;
    comment                 ;
```

```
Record name is Drug
Drug                KEY is drug-code
    name                ;
    strength            ;
    pack-size           ;
    expirey-code        ;


Record name is supplier
supplier            KEY is supplier-no
    name                ;
    address             ;
    status              ;


Record name is Prescription
Prescription        KEY is pres-no
    pres-date           ;
    prescriber          ;


Record name is X-ray request
X-ray request       KEY is request-no
    investigation       ;
    requestor           ;
    urgency             ;
    reason              ;


Record name is X-ray sessions
X-ray   sessions              KEY  is  date                          ,unit
,morning/afternoon   ,x-ray type
    maximum load        ;
    numbers booked      ;


Record name is Staff details
Staff details       KEY is emp-no
    name                ;
    grade               ;
    F.T/P.T             ;
    address             ;


Record name is Wards
Wards               KEY is Ward-code
    no-of-beds          ;
    w-type              ;
    w-description       ;
    nursing load        ;
    nursing dependency  ;


Record name is Ward bed
Ward bed            KEY is Ward-code          ,bed-no
    male/female         ;
    free/occupied       ;
```

```
Record name is Nurses
Nurses                KEY is emp-no
    N.I.no                ;
    name                  ;
    grade                 ;
    unit code             ;
    entry grade           ;
    location code         ;
    qualification code    ;
    date of birth         ;
    full eqivalent        ;


Record name is Duty
Duty                       KEY is date                  ,shift                  ,W-code
,grade
    number required       ;


Record name is Ind: workload
Ind: workload         KEY is week commencing      ,emp-no
    max-hours             ;
    hours-booked          ;


Record name is Pat-Cons
Pat-Cons              KEY is pat-no               ,emp-no
    Date registered       ;


Record name is Pat-Disease
Pat-Disease           KEY is pat-no               ,disease-no
    Date diagnosed        ;


Record name is X-ray sess/Pat
X-ray   sess/Pat                KEY  is  date                                ,unit
,morning/afternoon    ,x-ray type           ,pat-no
    suggestion            ;


Record name is Staff/session
Staff/session                KEY is emp-no                ,date                  ,unit
,morning/afternoon    ,x-ray type


Record name is Pat/O/p-W/l
Pat/O/p-W/l           KEY is pat-no               ,W/l-no
    position              ;
    reference             ;
    complaints            ;
    urgency               ;
```

```
Record name is Pat/S-W/l
Pat/S-W/l           KEY is pat-no                ,S-W/l-no
    urgency              ;
    op-code              ;
    suggestion           ;
    non-availability     ;
    position             ;


Record name is Duty-rota
Duty-rota                   KEY is emp-no                ,date                ,shift
,W-code               ,grade


Record name is Nurses/Wards
Nurses/Wards        KEY is emp-no                ,Ward-code
```

CODREL

```
Set name is Pat/Pat-Cons
Owner record is Patient
Member record is
Pat-Cons              AUTOMATIC FIXED

Set name is Cons/Pat-Cons
Owner record is Consultant
Member record is
Pat-Cons              AUTOMATIC FIXED

Set name is Pat/Pat-Dis
Owner record is Patient
Member record is
Pat-Disease           AUTOMATIC FIXED

Set name is Dis/Pat-Dis
Owner record is Disease
Member record is
Pat-Disease           AUTOMATIC FIXED

Set name is Cons-Clinic
Owner record is Consultant
Member record is
Clinical-session      AUTOMATIC MANDATORY

Set name is Clinic/schedule
Owner record is Clinical-session
Member record is
Clinic-time-scheduleAUTOMATIC FIXED

Set name is Appointment
Owner record is Patient
Member record is
Clinic-time-scheduleMANUAL OPTIONAL

Set name is Consultant/S-W/l
Owner record is Consultant
Member record is
Surgical W/l          AUTOMATIC MANDATORY

Set name is Consultant/S-session
Owner record is Consultant
Member record is
Surgical-session      AUTOMATIC MANDATORY

Set name is Pat/Blood req
Owner record is Patient
Member record is
Blood request         AUTOMATIC MANDATORY

Set name is Pat/Pat-rec-blood
Owner record is Patient
Member record is
Pat-rec-blood         AUTOMATIC MANDATORY
```

```
Set name is Patient/Antibody
Owner record is Patient
Member record is
Antibody cases          AUTOMATIC MANDATORY

Set name is Pat/prescription
Owner record is Patient
Member record is
Prescription            AUTOMATIC MANDATORY

Set name is Pat/X-ray request
Owner record is Patient
Member record is
X-ray request           AUTOMATIC MANDATORY

Set name is X-sess/Detail
Owner record is X-ray sessions
Member record is
X-ray sess/Pat          AUTOMATIC FIXED

Set name is Pat/Detail
Owner record is Patient
Member record is
X-ray sess/Pat          AUTOMATIC FIXED

Set name is Staff session detail
Owner record is Staff details
Member record is
Staff/session           AUTOMATIC FIXED

Set name is X-ray/staff detail
Owner record is X-ray sessions
Member record is
Staff/session           AUTOMATIC FIXED

Set name is Pat-O/p-W/l det:
Owner record is Patient
Member record is
Pat/O/p-W/l             AUTOMATIC FIXED

Set name is O/p-W/l/Pat det:
Owner record is O/p-W/l
Member record is
Pat/O/p-W/l             AUTOMATIC FIXED

Set name is Pat-S-W/l det:
Owner record is Patient
Member record is
Pat/S-W/l               AUTOMATIC FIXED

Set name is S-W/l Pat Det:
Owner record is Surgical W/l
Member record is
Pat/S-W/l               AUTOMATIC FIXED

Set name is Consultant/O/p-W/l
Owner record is Consultant
Member record is
O/p-W/l                 AUTOMATIC MANDATORY
```

```
Set name is Nurses/Duty-rota
Owner record is Nurses
Member record is
Duty-rota              AUTOMATIC FIXED

Set name is Duty/Duty-rota
Owner record is Duty
Member record is
Duty-rota              AUTOMATIC FIXED

Set name is Nurses/Wards details
Owner record is Nurses
Member record is
Nurses/Wards           AUTOMATIC FIXED

Set name is Wards/Nurses details
Owner record is Wards
Member record is
Nurses/Wards           AUTOMATIC FIXED

Set name is Nurses/Workload
Owner record is Nurses
Member record is
Ind: workload          AUTOMATIC FIXED
```

Output of LABEL.P
EDGEFILE

	152				
W	850p	1	1	1	0
I	350a	1	2	2	0
I	0a	1	3	3	0
I	0a	1	4	4	0
I	0a	1	5	5	0
I	0a	1	6	6	0
I	0a	1	7	7	0
I	0a	1	8	8	0
I	0a	1	9	9	0
I	0a	1	10	10	0
I	0a	1	11	11	0
I	0a	1	12	12	0
W	0p	2	1	1	0
I	0a	2	2	2	0
I	0a	2	3	3	0
I	0a	2	4	4	0
W	0p	3	1	1	0
I	0a	3	2	2	0
I	0a	3	3	3	0
I	0a	3	4	4	0
W	0p	4	1	1	0
I	0a	4	3	2	0
I	0a	4	4	3	0
I	0a	4	5	4	0
I	0a	4	6	5	0
I	0a	4	7	6	0
I	0a	4	8	7	0
I	0a	4	9	8	0
W	0p	5	1	1	0
I	0a	5	4	2	0
I	0a	5	5	3	0
W	0p	6	1	1	0
I	0a	6	2	2	0
I	0a	6	3	3	0
I	0a	6	4	4	0
W	0p	7	1	1	0
I	0a	7	2	2	0
I	0a	7	3	3	0
I	0a	7	4	4	0
W	0p	8	1	1	0
I	0a	8	3	2	0
I	0a	8	4	3	0
I	0a	8	5	4	0
I	0a	8	6	5	0
I	0a	8	7	6	0
I	0a	8	8	7	0
W	0p	9	1	1	0
I	0a	9	2	2	0
I	0a	9	3	3	0
I	0a	9	4	4	0
W	0p	10	1	1	0
I	0a	10	2	2	0
I	0a	10	3	3	0
I	0a	10	4	4	0
I	0a	10	5	5	0
				140	

I	0a	10	6	6	0
I	0a	10	7	7	0
I	0a	10	8	8	0
I	0a	10	9	9	0
W	0p	11	1	1	0
I	0a	11	2	2	0
I	0a	11	3	3	0
I	0a	11	4	4	0
I	0a	11	5	5	0
I	0a	11	6	6	0
I	0a	11	7	7	0
I	0a	11	8	8	0
W	0p	12	1	1	0
I	0a	12	2	2	0
I	0a	12	3	3	0
I	0a	12	4	4	0
I	0a	12	5	5	0
I	0a	12	6	6	0
I	0a	12	7	7	0
I	0a	12	8	8	0
W	0p	13	1	1	0
I	0a	13	2	2	0
I	0a	13	3	3	0
I	0a	13	4	4	0
I	0a	13	5	5	0
W	0p	14	1	1	0
I	0a	14	2	2	0
I	0a	14	3	3	0
I	0a	14	4	4	0
W	0p	15	1	1	0
I	0a	15	2	2	0
I	0a	15	3	3	0
W	0p	16	1	1	0
I	0a	16	2	2	0
I	0a	16	3	3	0
I	0a	16	4	4	0
I	0a	16	5	5	0
W	0p	17	1	1	0
I	0a	17	5	2	0
I	0a	17	6	3	0
W	0p	18	1	1	0
I	0a	18	2	2	0
I	0a	18	3	3	0
I	0a	18	4	4	0
I	0a	18	5	5	0
W	0p	19	1	1	0
I	0a	19	2	2	0
I	0a	19	3	3	0
I	0a	19	4	4	0
I	0a	19	5	5	0
I	0a	19	6	6	0
W	0p	20	1	1	0
I	0a	20	3	2	0
I	0a	20	4	3	0
I	0p	21	1	1	0
I	0a	21	2	2	0
I	0a	21	3	3	0
W	400a	21	4	4	0
I	0a	21	5	5	0
				141	

I	0a	21	6	6	0
I	0a	21	7	7	0
I	0a	21	8	8	0
I	0a	21	9	9	0
I	0a	21	10	10	0
W	200p	22	1	1	0
I	0a	22	5	2	0
W	0p	23	1	1	0
I	0a	23	3	2	0
I	0a	23	4	3	0
W	0p	24	1	1	0
I	0a	24	5	2	0
I	0a	24	6	3	0
I	0a	24	7	4	0
I	0a	24	8	5	0
W	0p	25	1	1	0
I	0a	25	5	2	0
I	0r	1	3	13	1
I	0r	1	2	14	1
I	0r	3	4	5	1
I	0r	4	5	9	1
I	0r	1	5	15	2
I	0r	3	7	6	1
I	0r	3	8	7	1
I	0r	1	10	16	1
I	0r	1	11	17	1
I	0r	1	12	18	1
I	0r	1	15	19	1
I	0r	1	16	20	1
I	0r	17	1	4	1
I	0r	18	17	6	1
I	0r	1	6	21	1
I	0r	1	7	22	2
I	0r	3	6	8	2
I	0r	21	22	11	1
I	0r	21	19	12	1
I	0r	21	23	13	1
I	0r	1	24	23	1

LABELFILE

```
          25
          23
           1
p          1        850C
a          0        350I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
r          1          0I
r          2        200I
r          5        300I
r          8          0I
r          9        350I
r         10          0I
r         11          0I
r         12          0I
r         15        350I
r         16          0I
r         21          0I
          13          0I
           4
           1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
           2        200I
           8
           1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
r          3        650I
r          6          0I
r          7          0I
r         17        350I
           1          0I
           9
           1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
r          4        650I
           3        650I
```

```
          3
          2
p          1          0C
a          0          0I
a          0          0I
          4        650I
          5        300I
          4
          2
p          1          0C
a          0          0I
a          0          0I
a          0          0I
         15        350I
         17        350I
          4
          2
p          1          0C
a          0          0I
a          0          0I
a          0          0I
          6          0I
         16          0I
          7
          1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
          7          0I
          4
          0
p          1          0C
a          0          0I
a          0          0I
a          0          0I
          9
          1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
          8          0I
          8
          1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
```

```
a          0          0I
a          0          0I
           9        350I
           8
           1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
          10          0I
           5
           0
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
           4
           0
p          1          0C
a          0          0I
a          0          0I
a          0          0I
           3
           1
p          1          0C
a          0          0I
a          0          0I
          11          0I
           5
           1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
          12          0I
           4
           1
p          1          0C
a          0          0I
a          0          0I
r         13          0I
          14          0I
           6
           0
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
r         14          0I
           6
           1
p          1          0C
```

```
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
          19          0I
           3
           0
p          1          0C
a          0          0I
a          0          0I
          13
           0
p          1          0I
a          0          0I
a          0          0I
a          0        400C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
a          0          0I
r         18        200I
r         19          0I
r         20          0I
           2
           1
p          1        200C
a          0          0I
          18        200I
           3
           1
p          1          0C
a          0          0I
a          0          0I
          20          0I
           5
           1
p          1          0C
a          0          0I
a          0          0I
a          0          0I
a          0          0I
          21          0I
           2
           0
p          1          0C
a          0          0I
```

Output of ING.P
MAPFILE (Entities)

25

```
Patient                    12          1
pat-no
pat-name                   pat-address          pat-category          reference
sex                        date-of-birth        marital status        next-of-kin
blood group                allergy              x-ray information
Hash it onpat-no

Disease                     4          1
disease-no
disease-name               contageous           treatment
Hash it ondisease-no

Consultant                  4          1
emp-no
con-name                   con-address          speciality
Hash it onemp-no

Clinical-session           10          2
clinic-no                  date
time-of-start              time-of-finish       speciality            est: new pat
est: repeat pat            new pat booked       rep: pat booked       emp-no

Hash it onclinic-no                date

Clinic-time-schedule        5          3
clinic-no                  date                 time
free/booked                new/repeat
Hash it onclinic-no                date                      time

O/p-W/l                     5          1
W/l-no
speciality                 list size            selection criteria    emp-no

Hash it onW/l-no

Surgical W/l                5          1
S-W/l-no
speciality                 list length          selection criteria    emp-no

Hash it onS-W/l-no

Surgical-session            9          2
session-no                 date
start time                 end time             max: major cases      booked major cases
max: minor cases           booked minor cases   emp-no
Hash it onsession-no               date

Admission W/l               4          1
A-W/l-no
speciality                 list length          selection criteria
Hash it onA-W/l-no
```

Outputs

Blood request		10	1	
Request-no				
reason	date		save serum	reserve blood units
reserve conc: units	doctors no:		blood taker's no:	date of request
pat-no				
Hash it onRequest-no				
Pat-rec-blood		9	1	
ref-no				
ward-code	blood-group		haemoglobin level	pregnancies
past-trans	antibody		prev:/ref-no	pat-no
Hash it onref-no				
Antibody cases		9	1	
anti-ref				
blood group	phenotype		antibody	E.D.C
B.T.S confirm	date		comment	pat-no
Hash it onanti-ref				
Drug		5	1	
drug-code				
name	strength		pack-size	expirey-code
Hash it ondrug-code				
supplier		4	1	
supplier-no				
name	address		status	
Hash it onsupplier-no				
Prescription		4	1	
pres-no				
pres-date	prescriber		pat-no	
Hash it onpres-no				
X-ray request		6	1	
request-no				
investigation	requestor		urgency	reason
pat-no				
Hash it onrequest-no				
X-ray sessions		6	4	
date	unit		morning/afternoon	x-ray type
maximum load	numbers booked			
Hash it ondate	unit		morning/afternoon	x-ray type
Staff details		5	1	
emp-no				
name	grade		F.T/P.T	address
Hash it onemp-no				

Outputs

Wards	6	1		
Ward-code				
no-of-beds	w-type	w-description	nursing load	
nursing dependency				
Hash it onWard-code				
Ward bed	4	2		
Ward-code	bed-no			
male/female	free/occupied			
Hash it onWard-code	bed-no			
Nurses	10	1		
emp-no				
N.I.no	name	grade	unit code	
entry grade	location code	qualification code	date of birth	
full eqivalent				
ISAM it on grade				
Duty	5	4		
date	shift	W-code	grade	
number required				
Hash it ondate	shift	W-code	grade	
Ind: workload	4	2		
week commencing	emp-no			
max-hours	hours-booked			
Hash it onweek commencing	emp-no			
In-patient	8	4		
pat-no	w-code	bed-no	date entering	
discharge date	illness	patient type	comment	
Hash it onpat-no	w-code	bed-no	date entering	
N-absence rec	5	4		
emp-no	day	month	year	
reason				
Hash it onemp-no	day	month	year	

MAPFILE (Relationships)

7
Pat-Cons
2
pat-no emp-no Date registered
Hash it on pat-no

Pat-Disease
2
pat-no disease-no Date diagnosed
Hash it on pat-no

X-ray sess/Pat
5
date unit morning/afternoon x-ray type
pat-no suggestion
Hash it on date unit morning/afternoon x-ray type

Pat/O/p-W/l
2
pat-no W/l-no position reference
complaints urgency
Hash it on pat-no

Pat/S-W/l
2
pat-no S-W/l-no urgency op-code
suggestion non-availability position
Hash it on pat-no

Duty-rota
5
emp-no date shift W-code
grade
Hash it on emp-no

Nurses/Wards
2
emp-no Ward-code
Hash it on emp-no

Output of MIM.P
MAPFILE (Entities)

25

Patient	12	1	
pat-no			
pat-name	pat-address	pat-category	reference
sex	date-of-birth	marital status	next-of-kin
blood group	allergy	x-ray information	
Disease	4	1	
disease-no			
disease-name	contageous	treatment	
Consultant	4	1	
emp-no			
con-name	con-address	speciality	
Clinical-session	10	2	
clinic-no	date		
time-of-start	time-of-finish	speciality	est: new pat
est: repeat pat	new pat booked	rep: pat booked	emp-no
Clinic-time-schedule	5	3	
clinic-no	date	time	
free/booked	new/repeat		
O/p-W/l	5	1	
W/l-no			
speciality	list size	selection criteria	emp-no
Surgical W/l	5	1	
S-W/l-no			
speciality	list length	selection criteria	emp-no
Surgical-session	9	2	
session-no	date		
start time	end time	max: major cases	booked major cases
max: minor cases	booked minor cases	emp-no	
Admission W/l	4	1	
A-W/l-no			
speciality	list length	selection criteria	

			Outputs
Blood request	10	1	
Request-no			
reason	date	save serum	reserve blood units
reserve conc: units	doctors no:	blood taker's no:	date of request
pat-no			
Pat-rec-blood	9	1	
ref-no			
ward-code	blood-group	haemoglobin level	pregnancies
past-trans	antibody	prev:/ref-no	pat-no
Antibody cases	9	1	
anti-ref			
blood group	phenotype	antibody	E.D.C
B.T.S confirm	date	comment	pat-no
Drug	5	1	
drug-code			
name	strength	pack-size	expirey-code
supplier	4	1	
supplier-no			
name	address	status	
Prescription	4	1	
pres-no			
pres-date	prescriber	pat-no	
X-ray request	6	1	
request-no			
investigation	requestor	urgency	reason
pat-no			
X-ray sessions	6	4	
date	unit	morning/afternoon	x-ray type
maximum load	numbers booked		
Staff details	5	1	
emp-no			
name	grade	F.T/P.T	address
Wards	6	1	
Ward-code			
no-of-beds	w-type	w-description	nursing load
nursing dependency			

Outputs

Ward bed Ward-code male/female	4 bed-no free/occupied	2	
Nurses emp-no N.I.no entry grade full eqivalent Invert it on grade	10 name location code	1 grade qualification code	unit code date of birth
Duty date number required	5 shift	4 W-code	grade
Ind: workload week commencing max-hours	4 emp-no hours-booked	2	
In-patient pat-no discharge date	8 w-code illness	4 bed-no patient type	date entering comment
N-absence rec emp-no reason	5 day	4 month	year

MAPFILE (Relationships)

```
        7
Pat-Cons
        2
pat-no                  emp-no                  Date registered
Invert it on pat-no
Pat-Disease
        2
pat-no                  disease-no              Date diagnosed
Invert it on pat-no
X-ray sess/Pat
        5
date                    unit                    morning/afternoon   x-ray type
pat-no                  suggestion
Invert  it  on date                 unit                    morning/afternoon   x-ray
type
Pat/O/p-W/l
        2
pat-no                  W/l-no                  position            reference
complaints              urgency
Invert it on pat-no
Pat/S-W/l
        2
pat-no                  S-W/l-no                urgency             op-code
suggestion              non-availability        position
Invert it on pat-no
Duty-rota
        5
emp-no                  date                    shift               W-code
grade
Invert it on emp-no
Nurses/Wards
        2
emp-no                  Ward-code
Invert it on emp-no
```

APPENDIX F

LOGICAL MODEL DEFINITION FOR INGRES

```
**
**  booking (b)  -  "booking for patient coming in"
**
create booking(
        pat-no          = c7,           patient id
        ward-code       = c3,           ward id
        bedno           = i3,           bed number
        entrydate       = c10,          date entered
        stay            = i2,           expected length of stay in days
        comment         = c80)          comment

modify  booking to isam on pid, wid, bedno, entrydate
save    booking until june 21 1986


**
**  pat-outpat (po)  -  "patient and out-patient waiting list"
**
create pat-op(
        pat-no          = c7,           patient id
        W/l-no          = c3,           out-patient waiting list id
        entrydate       = c10,          date entered the waiting list
        urgency         = c10,          medical urgency
        operation       = c4,           operation code
        remark          = c30,          consultant's suggestion
        notavail        = c25,          dates patient not available
        source          = c7)           source patient came from

modify  pat-outpat to hash on pat-no
save    pat-outpat until june 21 1986


**
**  pat-admin (pad)  -  "patient and admission waiting list"
**
create pat-admission(
        pat-no          = c7,           patient id
        A-W/L-no        = c3,           admission waiting list id
        entrydate       = c10,          date entered
        urgency         = c40,          medical urgency
        notavail        = c35,          dates not available for admission
        position        = i2,           position in waiting list
        comment         = c80)          consultant's comment

modify  pat-admin to isam on pat-no,
save    pat-admin until june 21 1986
```

```
**
**  disease (dis)  -  "contains details of different medical conditions"
**
create disease(
        disease-no      = c7,           identifying code/number
        name            = c30,          scientific/identifying name
        contag          = c1,           contageous (Y/N)
        treatment       = c30)          description of treatment using codes

modify  disease to hash on id
save    disease until june 21 1986


**
**  pat-dis (pd)  -  "patient and disease"
**
create  pat-dis(
        pid             = c7,           patient id
        did             = c7,           disease id
        date            = c10)          date diagnosed with disease

modify  pat-dis to isam on pid, did, date
save    pat-dis until june 21 1986


**
**  patient (p)
**
create patient(
        pat-no          = c7,    identifying number (e.g. p999999)
        pat-name        = c30,   full name
        pat-address     = c80,   full address & telephone no.
        sex             = c1,    M = male and F = Female
        dob             = c10,   date of birth
        status          = c10,   marital status
        kin             = c30,   full name of next of kin
        blood           = c10,   blood group details
        x-ray           = c80)   x-ray information

modify  patient to hash on pat-no
save    patient until june 21 1986


**  **  outpat-wl (o)  -  "out-patient waiting list"
**
create outpat-wl(
        W/l-no          = c3,           identifying code/number
        speciality      = c20,
        criteria        = c30,          selection criteria for waiting list
        list size       = i2            maximum size for waiting list
        emp-no          = c7)           identifier of consultant
modify  outpat-wl to hash on  W/-no
save    outpat-wl until june 21 1986
```

```
**
**  admission-wl (a)  -  "admission waiting list"
**
create admission(
        A-W/l-no        = c3,          identifying code/number
        speciality      = c20
        length          = i2,          current length of the waiting list
        criteria        = c30)         selection criteria for the waiting list

modify  admission-wl to hash on A-W/l-no
save    admission-wl until june 21 1986


**
**  pat-surg (psurg)  -  "patient and surgical waiting list"
**
create pat-surg(
        pat-no          = c7,           patient id
        S-W/l-no        = c3           surgical waiting list id
        urgency         = c40
        position        = i2
        reference       = c7
        complaints      = c40)

modify  pat-surg to isam on pat-no
save    pat-surg until june 21 1986


**
**  pat-consult (pc)  -  "patient and consultant"
**
create pat-consult(
        pat-no          = c7,          patient id
        emp-no          = c7           consultant id
        date reg:       = c6)


modify  pat-consult to hash on pat-no
save    pat-consult until june 21 1986


**
**  pat-prog (pp)  -  "patient progress"
**
create pat-prog(
        pat-no          = c7,          patient id
        clinic-no       = c3,          clinical session id
        date            = c10,         date of clinical session
        start           = i2,          start time of clinical session
        drugs           = c30,         medicine/drugs being taken
        progress        = c30,
        nexttime        = c10,         date of next appointment
        arrangement     = c20)         travel arrangements for appointment

modify  pat-prog to isam on pat-no
save    pat-prog until june 21 1986
```

```
**
**  surg-wl (surg)  -  "surgical waiting list"
**
create surg-wl(
        S-W/l-no        = c3,          identifying code/number
        speciality      = c20,
        criteria        = c30,         selection criteria for waiting list
        maxsize         = i2           maximum size for waiting list
        emp-no          = c7 )          identifier of consultant

modify  surg-wl to hash on S-W/l-no
save    surg-wl until june 21 1986


**
**  con-surg (csurg)  -  "consultant and surgical waiting list"
**
create con-surg(
        emp-no          = c7,          consultant id
        S-W/l-no        = c10)         surgical waiting list id

modify  con-surg to isam on emp-no
save    con-surg until june 21 1986


**
**  consultant (c)
**
create  consultant(
        emp-no          = c7,          identifying code/number (e.g. c999999)
        name            = c30,         full name
        address         = c80,         full address & telephone no.
        speciality      = c20)         consultant's medical speciality

modify  consultant to hash on emp-no
save    consultant until june 21 1986


**
**  pat-session (ps)  -  "patient and surgical session"
**
create pat-session(
        pat-no          = c7,          patient id
        session-no      = c3,          surgical session id
        date            = c10)         date of surgical session

modify  pat-session to isam on pat-no
save    pat-session until june 21 1986
```

```
**
**  session-wl (s)  -  "surgical session waiting list"
**
create session-wl(
        S-W/l-no        = c3,           identifying number
        date            = c10,          date of surgical session
        start           = i2,           start time of surgical session
        finish          = i2,           finish time of surgical session
        maxmajor        = i2,           maximum major cases allowed
        maxminor        = i2,           maximum minor cases allowed
        majorbooked     = i2,           number of major cases booked so far
        minorbooked     = i2)           number of minor cases booked so far

modify  session-wl to isam on S-/l-no
save    session-wl until june 21 1986

**
**  con-session (cs)  -  "consultant and surgical session"
**
create con-session(
        emp-no          = c3,           consultant id
        session-no      = c3,           surgical session id
        date            = c10)          date of surgical session

modify  con-session to isam on emp-no
save    con-session until june 21 1986

**
**  clinical (clin)  -  "clinical session"
**
create clinical(
        clinic-no       = c3,           identifying number
        date            = c10,          date of clinic
        cid             = c7,           consultant id
        start           = i2,           start time of clinic
        finish          = i2,           finishing time of clinic
        doctor          = c7,           id of doctor in charge
        speciality      = c20,          clinic's speciality
        maxnew          = i2,           maximum new patients allowed
        maxrep          = i2,           maximum repeat patients allowed
        newbooked       = i2,           number of new patients booked so far
        repbooked       = i2)           number of repeat patients booked so far

modify  clinical to hash on clinic-no,date
save    clinical until june 21 1986

**
**  schedule (sch)  -  "clinical session's time schedule"
**
create schedule(
        clinic-no       = c3,           clinical session's id
        date            = c10,          date of clinic
        time            = i2,           time of patient's appointment
        status          = c1            free or booked
        type            = c3)           "new" or "old" (i.e. repeat)

modify  schedule to hash on  clinic-no, date, time
save    schedule until june 21 1986
```

```
create anticoag
              ( id = c3,                          anticoagulant #
                pat-no c7,                        patient id.
                did = c7,                         doctor sending
                reason = c15,                     reason for sending
                urgency = c10 )                   urgency
        modify anticoag to hash on id
        save anticoag until june 21 1986

**      bloodreq (br)   - requests for blood
**
create  bloodreq
              ( reqno = c5,                       request #
                pat-no= c7,                       patient id.
                reason = c15,                     reason for request
                timereq = i2,                     time required
                datereq = c10,                    date required
                serum = c1,                       saved serum or not
                rwbu = c1,                        reserve whole blood units
                rccu = c1,                        reserve concentrated cell units
                date = c10,                       date
                taker = c30 )                     blood taker
        modify bloodreq to hash on reqno
        save bloodreq until june 21 1986


**      patreceive (pr) - patient receiving blood
**
create patreceive
              ( patrefno = c5,                    patient reference #
                pat-no = c7,                      patient id.
                ward = c3,                        ward patient in
                haem = c5,                        patient's current haemoglobin
                preg = c1,                        pregnancies or not
                pasttran = c1,                    past transfusion or not
                antibody = c10,                   known antibody in blood
                previous = c5,                    last previous reference #
                quantity = c5,                    quantity
                date = c10 )                      date
        modify patreceive to hash on patrefno
        save patreceive until june 21 1986


**      proteinpat (prp) - protein patint record
**
create proteinpat
              ( labcode = c6,                     lab code
                date = c10,                       date
                pid = c7,                         patient id.
                testcode = c5,                    test code
                result = c10 )                    result
        modify proteinpat to isam on labcode,date,pid
        save proteinpat until june 21 1986
```

```
**      proteinday (prd) - protein day record
**
create proteinday
              ( labcode = c6,                    lab code
                date = c10,                      date
                notest = i2 )                    number of patients tested
        modify proteinday to isam on labcode,date
        save proteinday until june 21 1986

**      antibodyprob (ap) - antibody problem cases
**
create antibodyprob
              ( id = c6,                         anti-ref
                pat-no = c7,                     patient id.
                phenotype = c2,                  phenotype
                antibody = c10,                  antibody
                edc = c1,                        edc
                bts = c1,                        bts confirmation
                date = c10,                      date
                comment = c15 )                  comment
        modify antibodyprob to hash on id
        save antibodyprob until june 21 1986


**      proteinspec (prs) - protein special cases
**
create proteinspec
              ( prospref = c6,                   prospref
                pid = c7,                        patient id.
                diag = c10,                      diagnosis
                treat = c20,                     treatment
                qereport = c15 )                 textual report from QE
        modify proteinspec to hash on prospref
        save proteinspec until june 21 1986


**      proteinint (pri) - protein interesting cases
**
create proteinint
              ( prointref = c6,                  prointref
                pid = c7,                        patient id.
                diag = c10,                      diagnosis
                treat = c20 )                    treatment
        modify proteinint to hash on prointref
        save proteinint until june 21 1986
```

```
**      coagpat (cp)     - coag clinic patient
**
create coagpat
              ( coagref = c6,                    coag-ref
                pid = c7,                        patient id.
                diag = c15,                      diagnosis
                regeme = c15,                    drug regeme
                commther = c10,                  commence therapy
                nextclinic = c10,                next clinic date
                comment = c20 )                  comment
        modify coagpat to hash on coagref
        save coagpat until june 21 1986

**      coagpatprog (cpp) - coag clinic patient progress
**
create coagpatprog
              ( coagref = c6,                    coag-ref
                date = c10,                      date
                pid = c7,                        patient id.
                result = c15,                    result
                dose = c10 )                     dose
        modify coagpatprog to isam on coagref,date
        save coagpatprog until june 21 1986


**      coagclinic (cc) - coag clinic
**
create coagclinic
              ( date = c10,                      date
                time = i2,                       time
                maxpat = i2,                     max. number of patients in list
                nopat = i2 )                     number of patients in list
        modify coagclinic to isam on date,time
        save coagclinic until june 21 1986


**      spectestreq (spt) - specimen test requests
**
create spectestreq
              ( reqno = i2,                      request #
                reqcode = c5,                    request code
                pid = c7,                        patient id.
                date = c10,                      date of request
                source = c10,                    source of request
                status = c6 )                    status
        modify spectestreq to hash on reqno
        save spectestreq until june 21 1986
```

```
**      specimen (sp)   - specimen
**
create specimen
              ( specno = i2,                    specimen #
                spectype = c10,                 specimen type
                reqno = i2,                     request #
                invest = c1,                    investigation required
                urgency = c10,                  urgency
                testcode = c5,                  test code
                labcode = c6,                   lab code
                result = c10,                   result
                comment = c20 )                 comment
        modify specimen to hash on specno
        save specimen until june 21 1986

****            drug - Not abbreviated
****
****            Information relating to any single drug

create drug (
        drug-code       = c7,           Drug identification number
        name            = c40,          Name of drug
        descr           = c80,          Description of Drug, including use
        strength        = c10,          Concentration of drug, eg 40mg/litre
        packsize        = i4,           Number in packs held in stock
        expiry-code     = c10 )         Roughly best before codes

modify drug to hash on drug-code
save drug until june 21 1986


****            prescr-dets - Abbreviated to pred
****
****            Details of individual drugs on any single prescription

create prescr-dets (
        prescr-no       = c7,           These details relate to prescription
        drugid          = c7,           Drug identification number for this
        qty             = i2,           Quantity prescribed
        dose            = c10,          Number to be taken per time period
        duration        = c10 )         Time over which drug must be taken,

modify prescr-dets to isam on prescr-no
save prescr-dets until june 21 1986
```

```
****            prescrip - Abbreviated to presd
****
****            Fields in a presciption that occur ONCE per prescription

create prescrip (
        prescr-no       = c7,           Prescription number
        date            = c10,          Date prescribed
        prescrib-id     = c7,           Prescribers identification number
        patient-id      = c7 )          Patients identification number

modify prescrip to hash on prescr-no
save prescrip until june 21 1986


****            ward-order - Abbreviated to wo
****
****            Details of a bulk order for a whole ward

create ward-order (
        id              = c7,           Ward order identification number
        ward-id         = c7,           Ward identifiaction number
        date-req        = c10 )         Date required at ward for distribution

modify ward-order to isam on id, ward-id
save ward-order until june 21 1986


****            wo-details - Abbreviated to wod
****
****            Item details for a ward order

create wo-details (
        woid            = c7,           Ward order identification number
        drug-id         = c7,           Drug identification number
        qty             = i4 )          Quantity required by whole ward

modify wo-details to isam on id, drug-id
save wo-details until june 21 1986


****            supplier - Abbreviated to sup
****
****            Supplier for various types of drugs

create supplier (
        supplier-no     = c7,           Supplier identification number
        name            = c30,          Name and address of supplier
        address         = c80,
        status          = c8 )

modify supplier to hash  on supplier-no
save supplier until june 21 1986
```

```
****            purch-dets - Abbreviated to purd
****
****            Details of purchases from a supplier, itemised in purch-items

create purch-dets (
        id              = c7,           Purchase details identifier, used in
                                                purch-items
        supplier        = c7,           Supplier code who supplied the items
        order-no        = c10 )         Hospitals order number placed on
                                                supplier

modify purch-dets to isam on id
save purch-dets until june 21 1986


****            purch-items - Abbreviated to puri
****
****            Item list for a purchase detail (above)

create purch-items (
        pdid            = c7,           Purchase-Detail identification number
        drugid          = c7,           Drug identifiaction number purchased
        qty-ordered     = i4,           -
        date-ordered    = c10,          -
        qty-recd        = i4,           -
        date-recd       = c10 )         -

modify purch-items to isam on pdid, drugid
save purch-items until june 21 1986


****            stock-rec - Abbreviated to srec
****
****            Stock record, current holdings of any drug ; also older versions
: i.e. stocks on previous days

create stock-rec (
        drugid          = c7,           Drug identification number
        date            = c10           Date relating to this stock record
        balance         = i4,           Closing balance on this drug for today
        stock-recd      = i4,           Stock received today
        stock-issued    = i4 )          Stock issued (Prescriptions/ward orders)
today

modify stock-rec to isam on stock-code

**
** ward (w) - ward details
**
create ward(
        ward-code       = c3,           ward code
        type            = c10,          ward type
        description     = c10,
        nobeds          = i3,           number of beds
        nursesreq       = i1,           number of nurses required
        dependency      = i1)           nursing dependency

modify ward to hash on ward-code
save ward until june 21 1986
```

```
**
** ward-bed (wb) - details for each bed in ward
**
create ward-bed(
        ward-code       = c3,           ward code
        bedno           = i3,           bed number
        sex             = c1,           sex
        occupied        = c1)           free or occupied

modify ward-bed to hash on ward-code, bedno
save ward-bed until june 21 1986


**
** entry (e) - inpatient entry record ~ uniquely identifies a inpatient
**
create entry(
        pat-no          = c7,           patient identifier
        ward-code       = c3,           ward code
        bedno           = i3,           bed number
        entrydate       = c10,          date entering ward
        id              = c7)           patient entry identifier

modify entry to hash on pid, wid, bedno, entrydate
save entry until june 21 1986


**
** inpatient (i) - inpatient details
**
create inpatient(
        pat-no          = c7
        w-code          = c3
        bedno           = i3
        date ent:       = c10
        expdischarge    = c10,          date expected for discharge
        illness         = c20,          type of illness
        activities      = c20,          daily activities
        type            = c1,           type of patient(P=private/S=state)
        comment         = c30)          comment

modify inpatient to hash on pat-no,w-code,bedno,date ent:
save pat-bed until june 21 1986


**
** consult-bed (cb) - consultant attending a particular bed
**
create consult-bed(
        wid             = c3,           ward code
        bedno           = i3,           bed number
        cid             = c7)           consultant identifier

modify consult-bed to isam on wid, bedno, cid
save consult-bed until june 21 1986
```

```
**
** drug-pat (dp) - details of drug being given to patient
**
create drug-pat(
        eid             = c7,           patient entry identifier
        drugid          = c5,           drug code
        root            = c10,          root of drug
        dose            = c10,          dose
        ntimes          = i1,           number of times
        prescriber      = c7)           prescriber

modify drug-pat to isam on eid, drugid
save drug-pat until june 21 1986

**
** pat-med (pm) - details of when medication has been given to patient
**
create pat-med(
        eid             = c7,           patient entry identifier
        drugid          = c5,           drug code
        date            = c10,          date
        time            = i2,           time
        givenby         = c7,           given by(e.g. nurse code)
        comment         = c30)          comment

modify pat-med to isam on eid, drugid, date, time
save pat-med until june 21 1986

**
** pat-report (pr) - report entry of patients condition (temperature, blood
pressure)
**
create pat-report(
        eid             = c7,           patient entry identifier
        date            = c10,          date
        time            = i2,           time
        temp            = i1,           temperature
        pressure        = i1,           blood pressure
        seenby          = c7,           seen by (doctor's code)
        comment         = c30)          comment

modify pat-report to hash on eid, date, time
save pat-report until june 21 1986


**
** disch-pat (dp) - details relating to a discharged patient
**
create disch-pat(
        eid             = c7,           patient entry identifier
        datedisch       = c10,          date discharged
        condition       = c20,          condition when discharged
        treatment       = c20,          back-up treatment
        homecare        = c1,           home care required (Y/N)
        presdrug        = c1)           prescribed drug

modify disch-pat to isam on eid, datedisch
save disch-pat until june 21 1986
```

```
**
** nurse (n) - record of nurse details
**
create nurse(
        id              = c7,           nurse identifier
        natno           = c9,           national insurance number
        name            = c30,          name
        grade           = c3,           grade
        gradedate       = c10,          entry to grade
        location        = c3,           location code
        qual            = c15,          qualification code
        dob             = c10,          date of birth
        wholetime       = f1)           whole time equivalent

modify nurse to isam on grade
save nurse until june 21 1986


**
** absence (a) - details for a day when a nurse is absent
**
create absence(
        id              = c7,           nurse identifier
        date            = c10,          date absent
        reason          = c20)          reason for absence

modify absence to hash on id, date
save absence until june 21 1986


**
** duty (d) - duty details
**
create duty(
        id              = c3,           duty code
        date            = c10,          date
        shift           = i1,           shift
        wid             = c3,           ward code
        grade           = c3,           grade required
        noreq           = i1)           number of nurses required

modify duty to hash on date, shift, wid, grade
save duty until june 21 1986


**
** rota (r) - duty performed by nurse
**
create rota(
        nid             = c7,           nurse identifier
        dutyid          = c3)           duty code

modify rota to hash on nid
save rota until june 21 1986
```

```
**
** load (l) - record of work done by a nurse for a particular week
**
create load(
        commence        = c10,          week commencing
        nid             = c7,           nurse identifier
        totalhrs        = i1,           total hours for week
        bookedhrs       = i1)           number of hours booked

modify load to isam on commence, nid
save load until june 21 1986


**
** ward-nurse (wn) - ward which nurse works on
**
create ward-nurse(
        wid             = c3,           ward code
        nid             = c7)           nurse identifier

modify ward-nurse to hash on wid, nid
save ward-nurse until june 21 1986


**
** holiday (h) - holiday details for a nurse
**
create holiday(
        nid             = c7,           nurse identifier
        year            = i2,           year commencing
        maxhols         = i1,           maximum holiday days
        daystaken       = i1)           number of days taken

modify holiday to isam on nid, year
save holiday until june 21 1986


**
** nurseleft (nl) - details about a nurse which has left the hospital
**
create nurseleft(
        natno           = c7,           national insurance number
        name            = c30,          name
        address         = c80,          last known address
        dateleft        = c10,          date left
        qualleft        = c15,          qualification when left
        gradeleft       = c3,           grade when left
        reason          = c15,          reason for leaving
        comment         = c30)          comment

modify nurseleft to isam on natno
save nurseleft until june 21 1986
```