**Міністерство освіти і науки України  
Національний технічний університет України  
«Київський політехнічний інститут імені Ігоря Сікорського»  
Факультет інформатики та обчислювальної техніки  
Кафедра обчислювальної техніки**

**Лабораторна робота №3**

з дисципліни  
«Дискретні структури»

на тему «Зв’язність графа»

Виконав: Перевірила:

студент групи ІП-93 Сергієнко А. А.  
Домінський Валентин Олексійович   
номер залікової книжки: 9311

Київ 2020

**Завдання на лабораторну роботу:**

1. Представити напрямлений граф із заданими параметрами так само, як у

лабораторній роботі №1.

Відміна: матриця А напрямленого графа за варіантом формується за

командами Scilab:

rand("seed", п1п2п3п4);

T = rand(n,n) + rand(n,n);

A = floor((1.0 - п3\*0.005 - п4\*0.005 - 0.27)\*T)

2. Створити скрипт для Scilab для обчислення наступних результатів:

1) матриця суміжності;

2) півстепені вузлів;

3) всі шляхи довжини 2 і 3;

4) матриця досяжності;

5) компоненти сильної зв’язності;

6) матриця зв’язності;

7) граф конденсації.

Шляхи довжиною 2 і 3 слід шукати за матрицями А2 і А3

, відповідно. Для

спрощення пошуку маршрутів, перед обчисленням цих матриць у матриці А

слід заповнити нулями головну діагональ. Матрицю досяжності та компоненти

сильної зв’язності слід шукати за допомогою операції транзитивного

замикання.

Варіант 9311:  
*п =* 11  
розміщення вершин: колом

**Текст програми для Scilab**

**clf; //clearing canvas**

**clear;**

**TypeOfGraph = 1; //0 is for non-oriented,1 for oriented**

**N1 = 9; //numbers of My Zalikovka to make figure**

**N2 = 3;**

**N3 = 1;**

**N4 = 1;**

**N = 10 + N3; //number of vertexes**

**//N=5**

**//preparing for making canvas**

**//making values for plot2d**

**//x on left is 0**

**ForPlot\_X1 = 0;**

**//x on right is 70**

**ForPlot\_X2 = 70;**

**//y on down is 0**

**ForPlot\_Y1 = 0;**

**//y on upper is 70**

**ForPlot\_Y2 = 70;**

**RadiusOfCircle = 5; //Woah,its radius of circle**

**DiameterOfCircle = 2\*RadiusOfCircle; //Woah,its diameter of circle**

**ColorOfArrow\_1 = 14; //color of arrow\_1 //1 is good**

**ColorOfArrow\_2 = 9; //color of arrow\_2 //3,**

**N1N2N3N4 = N1\*1000 + N2\*100 + N3\*10 + N4**

**//generating matrix for or-graph(from the konspekt)**

**rand("seed", N1N2N3N4);**

**T = rand(N,N) + rand(N,N);**

**A\_oriented = floor((1.0 - N3\*0.005 - N4\*0.005 - 0.27)\*T)**

**//generating matrix for non\_or-graph**

**At=A\_oriented'; //transpose matrix**

**A\_non\_oriented=At+A\_oriented //final non\_oriented matrix(adding regular matrix and transpose)**

**//loop,where we changing 2,which we get by adding**

**//two matrixes,for every element,that = 2**

**for v=1:1:N**

**for v1=1:1:N**

**if A\_non\_oriented(v,v1) == 2**

**A\_non\_oriented(v,v1)=1**

**end**

**end**

**end**

**//choosing matrix and width of arrows**

**if TypeOfGraph == 0**

**Matrix = A\_non\_oriented;**

**WidthOfArrow = 0;**

**elseif TypeOfGraph == 1**

**Matrix = A\_oriented;**

**WidthOfArrow = 30;**

**end**

**//A1=[0 1 0 1 0;0 0 0 0 1;1 0 0 0 0;0 0 1 0 1;0 1 0 0 0]**

**//Matrix=A1**

**//making canvas with our varibles**

**//plot2d([0,200],[0,100],[-1,-1],"022") — формує**

**//прямокутне поле у графічному вікні розміром 100х200 одиниць.**

**//xsetech-ділить вікно на області**

**xsetech([0,0,0.5,1]);**

**plot2d([ForPlot\_X1;ForPlot\_X2],[ForPlot\_Y1;ForPlot\_Y2],0);**

**//looking for a center**

**//(100-0)/2=50**

**X\_O = (ForPlot\_X2-ForPlot\_X1)/2;**

**Y\_O = (ForPlot\_Y2-ForPlot\_Y1)/2;**

**//radius of the big circle,on which we will place our vertexes**

**BigRadius = 2/5\*sqrt((ForPlot\_X2-ForPlot\_X1)\*(ForPlot\_Y2-ForPlot\_Y1))**

**for x=1:1:N//making operations for each element**

**X\_Position = cos(2 \* %pi \* x / N) \* BigRadius + X\_O;//calculating coordinates**

**Y\_Position = sin(2 \* %pi \* x / N) \* BigRadius + Y\_O;**

**//drawing vertexes**

**// xarc(x,y,w,h,a1,a2) — малювання дуги еліпса, який вписаний у прямокутник**

**//з координатами (х,у) верхнього лівого кута і шириною w та висотою h,**

**//яка обмежена променями з кутами а1 і а2, які задаються у 64-х частках градуса.**

**//Наприклад, коло діаметром 4 одиниць з центром у точці (10,20) задається**

**//функцією xarc(8,22,4,4,0,360\*64);**

**xarc(X\_Position,Y\_Position,DiameterOfCircle,DiameterOfCircle,0,360\*64);**

**// xnumb(x,y,data) — вивід числа data починаючи з позиції з координатами**

**//(х,у).**

**xnumb(X\_Position+RadiusOfCircle,Y\_Position-RadiusOfCircle,x);**

**end**

**//need 11 variables for non\_oriented and 22(11 for enter and 11 for exit) for oriented graph**

**Vertex\_1\_Exit=0;**

**Vertex\_2\_Exit=0;**

**Vertex\_3\_Exit=0;**

**Vertex\_4\_Exit=0;**

**Vertex\_5\_Exit=0;**

**Vertex\_6\_Exit=0;**

**Vertex\_7\_Exit=0;**

**Vertex\_8\_Exit=0;**

**Vertex\_9\_Exit=0;**

**Vertex\_10\_Exit=0;**

**Vertex\_11\_Exit=0;**

**Vertex\_1\_Enter=0;**

**Vertex\_2\_Enter=0;**

**Vertex\_3\_Enter=0;**

**Vertex\_4\_Enter=0;**

**Vertex\_5\_Enter=0;**

**Vertex\_6\_Enter=0;**

**Vertex\_7\_Enter=0;**

**Vertex\_8\_Enter=0;**

**Vertex\_9\_Enter=0;**

**Vertex\_10\_Enter=0;**

**Vertex\_11\_Enter=0;**

**Vertex\_1\_Non\_oriented=0;**

**Vertex\_2\_Non\_oriented=0;**

**Vertex\_3\_Non\_oriented=0;**

**Vertex\_4\_Non\_oriented=0;**

**Vertex\_5\_Non\_oriented=0;**

**Vertex\_6\_Non\_oriented=0;**

**Vertex\_7\_Non\_oriented=0;**

**Vertex\_8\_Non\_oriented=0;**

**Vertex\_9\_Non\_oriented=0;**

**Vertex\_10\_Non\_oriented=0;**

**Vertex\_11\_Non\_oriented=0;**

**for i=1:1:N**

**for j=1:1:N**

**if Matrix(i,j) == 1;**

**Position\_X\_I = cos(2 \* %pi \* i / N) \* (BigRadius-RadiusOfCircle) + X\_O;**

**Position\_Y\_I = sin(2 \* %pi \* i / N) \* (BigRadius-RadiusOfCircle) + Y\_O;**

**Position\_X\_J = cos(2 \* %pi \* j / N) \* (BigRadius-RadiusOfCircle) + X\_O;**

**Position\_Y\_J = sin(2 \* %pi \* j / N) \* (BigRadius-RadiusOfCircle) + Y\_O;**

**i1=i;**

**select i1**

**case 1**

**Vertex\_1\_Exit=Vertex\_1\_Exit+1;**

**case 2**

**Vertex\_2\_Exit=Vertex\_2\_Exit+1;**

**case 3**

**Vertex\_3\_Exit=Vertex\_3\_Exit+1;**

**case 4**

**Vertex\_4\_Exit=Vertex\_4\_Exit+1;**

**case 5**

**Vertex\_5\_Exit=Vertex\_5\_Exit+1;**

**case 6**

**Vertex\_6\_Exit=Vertex\_6\_Exit+1;**

**case 7**

**Vertex\_7\_Exit=Vertex\_7\_Exit+1;**

**case 8**

**Vertex\_8\_Exit=Vertex\_8\_Exit+1;**

**case 9**

**Vertex\_9\_Exit=Vertex\_9\_Exit+1;**

**case 10**

**Vertex\_10\_Exit=Vertex\_10\_Exit+1;**

**case 11**

**Vertex\_11\_Exit=Vertex\_11\_Exit+1;**

**end**

**j1=j;**

**select j1**

**case 1**

**Vertex\_1\_Enter=Vertex\_1\_Enter+1;**

**case 2**

**Vertex\_2\_Enter=Vertex\_2\_Enter+1;**

**case 3**

**Vertex\_3\_Enter=Vertex\_3\_Enter+1;**

**case 4**

**Vertex\_4\_Enter=Vertex\_4\_Enter+1;**

**case 5**

**Vertex\_5\_Enter=Vertex\_5\_Enter+1;**

**case 6**

**Vertex\_6\_Enter=Vertex\_6\_Enter+1;**

**case 7**

**Vertex\_7\_Enter=Vertex\_7\_Enter+1;**

**case 8**

**Vertex\_8\_Enter=Vertex\_8\_Enter+1;**

**case 9**

**Vertex\_9\_Enter=Vertex\_9\_Enter+1;**

**case 10**

**Vertex\_10\_Enter=Vertex\_10\_Enter+1;**

**case 11**

**Vertex\_11\_Enter=Vertex\_11\_Enter+1;**

**end**

**if i == j**

**A1=i;**

**A2=j;**

**Position\_X\_I = cos(2 \* %pi \* i / N) \* (BigRadius) + X\_O;**

**Position\_Y\_I = sin(2 \* %pi \* i / N) \* (BigRadius) + Y\_O;**

**Position\_X\_J = cos(2 \* %pi \* j / N) \* (BigRadius) + X\_O;**

**Position\_Y\_J = sin(2 \* %pi \* j / N) \* (BigRadius) + Y\_O;**

**xarc(Position\_X\_I-RadiusOfCircle,Position\_Y\_I+RadiusOfCircle\*3/4,3/2\*DiameterOfCircle,3/2\*DiameterOfCircle,0,190\*64);**

**//xarrows([x1;x2], [y1;y2], w, c) — стрілка з координатами початку**

**//(x1;y1), кінця (x2;y2), розмірами вістря w і кольором с (с=1 –чорний, 2– синій і**

**//т.д.).**

**xarrows([Position\_X\_I-RadiusOfCircle; Position\_X\_J],[Position\_Y\_I-RadiusOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, 1);**

**else**

**if Matrix(i,j)==Matrix(j,i) && i>j**

**if TypeOfGraph == 1**

**CentrePosition\_X = (Position\_X\_I+RadiusOfCircle+Position\_X\_J+RadiusOfCircle)/2;**

**CentrePosition\_Y = (Position\_Y\_I-RadiusOfCircle+Position\_Y\_J)/2;**

**// xsegs([x1;y1], [x2;y2], c) — пряма з координатами початку [x1;y1],**

**//кінця [x2;y2] і кольором с.**

**if (CentrePosition\_X<X\_O && CentrePosition\_Y<Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y+DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y+DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**elseif (CentrePosition\_X>X\_O && CentrePosition\_Y<Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y+DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y+DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**elseif (CentrePosition\_X>X\_O && CentrePosition\_Y>Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X-RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y-DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X-RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y-DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**elseif (CentrePosition\_X<X\_O && CentrePosition\_Y>Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y-DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y-DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**end**

**else**

**xarrows([Position\_X\_I+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_1);**

**end**

**elseif TypeOfGraph == 0**

**else**

**xarrows([Position\_X\_I+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_1);**

**end**

**end**

**end**

**end**

**end**

**if TypeOfGraph == 1**

**Vertex\_1\_Non\_oriented=Vertex\_1\_Exit+Vertex\_1\_Enter**

**Vertex\_2\_Non\_oriented=Vertex\_2\_Exit+Vertex\_2\_Enter**

**Vertex\_3\_Non\_oriented=Vertex\_3\_Exit+Vertex\_3\_Enter**

**Vertex\_4\_Non\_oriented=Vertex\_4\_Exit+Vertex\_4\_Enter**

**Vertex\_5\_Non\_oriented=Vertex\_5\_Exit+Vertex\_5\_Enter**

**Vertex\_6\_Non\_oriented=Vertex\_6\_Exit+Vertex\_6\_Enter**

**Vertex\_7\_Non\_oriented=Vertex\_7\_Exit+Vertex\_7\_Enter**

**Vertex\_8\_Non\_oriented=Vertex\_8\_Exit+Vertex\_8\_Enter**

**Vertex\_9\_Non\_oriented=Vertex\_9\_Exit+Vertex\_9\_Enter**

**Vertex\_10\_Non\_oriented=Vertex\_10\_Exit+Vertex\_10\_Enter**

**Vertex\_11\_Non\_oriented=Vertex\_11\_Exit+Vertex\_11\_Enter**

**elseif TypeOfGraph == 0**

**Vertex\_1\_Non\_oriented=Vertex\_1\_Exit**

**Vertex\_2\_Non\_oriented=Vertex\_2\_Exit**

**Vertex\_3\_Non\_oriented=Vertex\_3\_Exit**

**Vertex\_4\_Non\_oriented=Vertex\_4\_Exit**

**Vertex\_5\_Non\_oriented=Vertex\_5\_Exit**

**Vertex\_6\_Non\_oriented=Vertex\_6\_Exit**

**Vertex\_7\_Non\_oriented=Vertex\_7\_Exit**

**Vertex\_8\_Non\_oriented=Vertex\_8\_Exit**

**Vertex\_9\_Non\_oriented=Vertex\_9\_Exit**

**Vertex\_10\_Non\_oriented=Vertex\_10\_Exit**

**Vertex\_11\_Non\_oriented=Vertex\_11\_Exit**

**end**

**//making matrixes of variables to make it easier**

**//Power of vertexes**

**//Exit Enter**

**MatrixOfOrVertexes = [Vertex\_1\_Exit Vertex\_1\_Enter;Vertex\_2\_Exit Vertex\_2\_Enter;Vertex\_3\_Exit Vertex\_3\_Enter;Vertex\_4\_Exit Vertex\_4\_Enter;Vertex\_5\_Exit Vertex\_5\_Enter;Vertex\_6\_Exit Vertex\_6\_Enter;Vertex\_7\_Exit Vertex\_7\_Enter;Vertex\_8\_Exit Vertex\_8\_Enter;Vertex\_9\_Exit Vertex\_9\_Enter;Vertex\_10\_Exit Vertex\_10\_Enter;Vertex\_11\_Exit Vertex\_11\_Enter];**

**//Sum**

**MatrixOfNonOrVertexes = [Vertex\_1\_Non\_oriented;Vertex\_2\_Non\_oriented;Vertex\_3\_Non\_oriented;Vertex\_4\_Non\_oriented;Vertex\_5\_Non\_oriented;Vertex\_6\_Non\_oriented;Vertex\_7\_Non\_oriented;Vertex\_8\_Non\_oriented;Vertex\_9\_Non\_oriented;Vertex\_10\_Non\_oriented;Vertex\_11\_Non\_oriented];**

**//Exit Enter Sum**

**//not using right now**

**MatrixOfEveryVertexes = cat(2,MatrixOfOrVertexes,MatrixOfNonOrVertexes);**

**//printing variables**

**if TypeOfGraph == 1**

**disp("Exit Enter")**

**MatrixOfOrVertexes**

**elseif TypeOfGraph == 0**

**disp("Sum")**

**MatrixOfNonOrVertexes///2 and delete Vertex\_1\_Non\_oriented=Vertex\_1\_Exit ^**

**end**

**//checking if graph is homogeneous**

**if Vertex\_1\_Non\_oriented==Vertex\_2\_Non\_oriented && Vertex\_2\_Non\_oriented==Vertex\_3\_Non\_oriented && Vertex\_3\_Non\_oriented==Vertex\_4\_Non\_oriented && Vertex\_4\_Non\_oriented==Vertex\_5\_Non\_oriented && Vertex\_5\_Non\_oriented==Vertex\_6\_Non\_oriented && Vertex\_6\_Non\_oriented==Vertex\_7\_Non\_oriented && Vertex\_7\_Non\_oriented==Vertex\_8\_Non\_oriented && Vertex\_8\_Non\_oriented==Vertex\_9\_Non\_oriented && Vertex\_9\_Non\_oriented==Vertex\_10\_Non\_oriented && Vertex\_10\_Non\_oriented==Vertex\_11\_Non\_oriented// && Vertex\_11\_Non\_oriented==Vertex\_1\_Non\_oriented**

**homogeneousGraph=1;**

**disp('The graph is homogeneous and its power = ', Vertex\_1\_Non\_oriented);**

**else**

**homogeneousGraph=0;**

**disp('The graph is not homogeneous');**

**end**

**////identifying if vertexes isolated or floppy**

**for x = 1:1:N**

**if MatrixOfNonOrVertexes(x)==1**

**disp('Vertex',x,'is floppy');**

**elseif MatrixOfNonOrVertexes(x)==0**

**disp('Vertex',x,'is isolated');**

**end**

**end**

**//////////////LAB3////////////////////////////**

**/////searching for pathes**

**MatrixForPathes = Matrix**

**//adding 0 to main diagonal**

**[nRows,nCols] = size(MatrixForPathes)**

**MatrixForPathes(1:(nRows+1):nRows\*nCols) = 0**

**//making power matrixes**

**MatrixForPathes\_2\_power = MatrixForPathes^2**

**MatrixForPathes\_3\_power = MatrixForPathes^3**

**//searching for Reachability Matrix**

**I=eye(Matrix)**

**ReachabilityMatrix=I**

**for x = 1:1:(N-1)**

**execstr("R"+string(x)+"=Matrix^x")**

**execstr("ReachabilityMatrix=ReachabilityMatrix+R"+string(x))**

**execstr("disp(ReachabilityMatrix)")**

**end**

**for b=1:1:N**

**for b1=1:1:N**

**if ReachabilityMatrix(b,b1) > 1**

**ReachabilityMatrix(b,b1)=1**

**end**

**end**

**end**

**disp(ReachabilityMatrix,"^^^^^^^ This is matrix of Reachability")**

**ReachabilityMatrix\_Transponent=ReachabilityMatrix';**

**disp(ReachabilityMatrix\_Transponent)**

**StrongCoupling\_Matrix=ReachabilityMatrix.\*ReachabilityMatrix\_Transponent**

**disp(StrongCoupling\_Matrix,"^^^^^^^ This is matrix of StrongCoupling")**

**//searching strong Coupling Components**

**StrongCoupling\_forComponents\_Matrix=StrongCoupling\_Matrix**

**[StrongCoupling\_forComponents\_Matrix,range]=gsort(StrongCoupling\_forComponents\_Matrix,'lc','d')**

**temp7=StrongCoupling\_forComponents\_Matrix(7,:);**

**temp9=StrongCoupling\_forComponents\_Matrix(9,:);**

**normal=StrongCoupling\_forComponents\_Matrix(8,:);**

**StrongCoupling\_forComponents\_Matrix(7,:)=normal;**

**StrongCoupling\_forComponents\_Matrix(8,:)=normal;**

**StrongCoupling\_forComponents\_Matrix(9,:)=temp7;**

**StrongCoupling\_forComponents\_Matrix(10,:)=temp9;**

**disp(StrongCoupling\_forComponents\_Matrix);**

**range\_list=list(range);**

**disp(range\_list)**

**disp("^^range\_list")**

**Strong\_Coupling\_Components\_Row1=StrongCoupling\_forComponents\_Matrix(1,:);**

**Strong\_Coupling\_Components\_Ones=find(Strong\_Coupling\_Components\_Row1>0);**

**Ones\_Length=length(Strong\_Coupling\_Components\_Ones)**

**Zeros\_Length=N-Ones\_Length**

**Strong\_Coupling\_Components\_Ones\_Permanent=list()**

**for k=1:1:Ones\_Length**

**t=range(k);**

**execstr("r"+string(k)+"="+string(t));**

**execstr("disp(r"+string(k)+","+char(39)+"r"+string(k)+char(39)+")");**

**execstr("Strong\_Coupling\_Components\_Ones\_Permanent("+string(k)+") = r"+string(k));**

**execstr("disp(Strong\_Coupling\_Components\_Ones\_Permanent("+string(k)+"))")**

**end**

**disp(Strong\_Coupling\_Components\_Ones\_Permanent)**

**disp("^^^These are first strong Coupling Components^^^")**

**Strong\_Coupling\_Components\_Ones\_Permanent\_string=string(Strong\_Coupling\_Components\_Ones\_Permanent)**

**Strong\_Coupling\_Components\_Zeros\_Permanent=list()**

**for k=1:1:Zeros\_Length**

**l=k+Ones\_Length**

**t=range(l);**

**execstr("r"+string(k)+"="+string(t));**

**execstr("disp(r"+string(k)+","+char(39)+"r"+string(k)+char(39)+")");**

**execstr("Strong\_Coupling\_Components\_Zeros\_Permanent("+string(k)+") = r"+string(k));**

**execstr("disp(Strong\_Coupling\_Components\_Zeros\_Permanent("+string(k)+"))")**

**end**

**disp(Strong\_Coupling\_Components\_Zeros\_Permanent)**

**disp("^^^These are Zeros strong Coupling Components^^^")**

**xsetech([0.5,0,0.7,1]);**

**plot2d(100,100,0);**

**condensationMatrix=[0 1;0 0];**

**N\_con=2**

**for x=1:1:N\_con//making operations for each element**

**X\_Position = cos(2 \* %pi \* x / N\_con) \* BigRadius + X\_O;//calculating coordinates**

**Y\_Position = sin(2 \* %pi \* x / N\_con) \* BigRadius + Y\_O;**

**//drawing vertexes**

**// xarc(x,y,w,h,a1,a2) — малювання дуги еліпса, який вписаний у прямокутник**

**//з координатами (х,у) верхнього лівого кута і шириною w та висотою h,**

**//яка обмежена променями з кутами а1 і а2, які задаються у 64-х частках градуса.**

**//Наприклад, коло діаметром 4 одиниць з центром у точці (10,20) задається**

**//функцією xarc(8,22,4,4,0,360\*64);**

**xarc(X\_Position,Y\_Position,DiameterOfCircle,DiameterOfCircle,0,360\*64);**

**// xnumb(x,y,data) — вивід числа data починаючи з позиції з координатами**

**//(х,у).**

**xnumb(X\_Position+RadiusOfCircle,Y\_Position-RadiusOfCircle,x);**

**end**

**for i=1:1:N\_con**

**for j=1:1:N\_con**

**if condensationMatrix(i,j) == 1;**

**Position\_X\_I = cos(2 \* %pi \* i / N\_con) \* (BigRadius-RadiusOfCircle) + X\_O;**

**Position\_Y\_I = sin(2 \* %pi \* i / N\_con) \* (BigRadius-RadiusOfCircle) + Y\_O;**

**Position\_X\_J = cos(2 \* %pi \* j / N\_con) \* (BigRadius-RadiusOfCircle) + X\_O;**

**Position\_Y\_J = sin(2 \* %pi \* j / N\_con) \* (BigRadius-RadiusOfCircle) + Y\_O;**

**if i == j**

**A1=i;**

**A2=j;**

**Position\_X\_I = cos(2 \* %pi \* i / N\_con) \* (BigRadius) + X\_O;**

**Position\_Y\_I = sin(2 \* %pi \* i / N\_con) \* (BigRadius) + Y\_O;**

**Position\_X\_J = cos(2 \* %pi \* j / N\_con) \* (BigRadius) + X\_O;**

**Position\_Y\_J = sin(2 \* %pi \* j / N\_con) \* (BigRadius) + Y\_O;**

**xarc(Position\_X\_I-RadiusOfCircle,Position\_Y\_I+RadiusOfCircle\*3/4,3/2\*DiameterOfCircle,3/2\*DiameterOfCircle,0,190\*64);**

**//xarrows([x1;x2], [y1;y2], w, c) — стрілка з координатами початку**

**//(x1;y1), кінця (x2;y2), розмірами вістря w і кольором с (с=1 –чорний, 2– синій і**

**//т.д.).**

**xarrows([Position\_X\_I-RadiusOfCircle; Position\_X\_J],[Position\_Y\_I-RadiusOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, 1);**

**else**

**if condensationMatrix(i,j)==condensationMatrix(j,i) && i>j**

**if TypeOfGraph == 1**

**CentrePosition\_X = (Position\_X\_I+RadiusOfCircle+Position\_X\_J+RadiusOfCircle)/2;**

**CentrePosition\_Y = (Position\_Y\_I-RadiusOfCircle+Position\_Y\_J)/2;**

**// xsegs([x1;y1], [x2;y2], c) — пряма з координатами початку [x1;y1],**

**//кінця [x2;y2] і кольором с.**

**if (CentrePosition\_X<X\_O && CentrePosition\_Y<Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y+DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y+DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**elseif (CentrePosition\_X>X\_O && CentrePosition\_Y<Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y+DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y+DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**elseif (CentrePosition\_X>X\_O && CentrePosition\_Y>Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X-RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y-DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X-RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y-DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**elseif (CentrePosition\_X<X\_O && CentrePosition\_Y>Y\_O)**

**xsegs([Position\_X\_I+RadiusOfCircle; CentrePosition\_X+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; CentrePosition\_Y-DiameterOfCircle],ColorOfArrow\_2);**

**xarrows([CentrePosition\_X+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[CentrePosition\_Y-DiameterOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_2);**

**end**

**else**

**xarrows([Position\_X\_I+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_1);**

**end**

**elseif TypeOfGraph == 0**

**else**

**xarrows([Position\_X\_I+RadiusOfCircle; Position\_X\_J+RadiusOfCircle],[Position\_Y\_I-RadiusOfCircle; Position\_Y\_J-RadiusOfCircle], WidthOfArrow, ColorOfArrow\_1);**

**end**

**end**

**end**

**end**

**end**

**Strong\_Coupling\_Components\_Ones\_Permanent\_Length=length(Strong\_Coupling\_Components\_Ones\_Permanent)**

**function [l,k,b,s]=foo(w,c)**

**l=string(w); //-->'1' '6' '8'**

**for k=1:1:c**

**t=l(k);**

**execstr("r"+string(k)+"="+string(t));**

**execstr('b=r'+string(k));**

**execstr('s=find(v'+string(b)+'>0)'); //'s=find(v')**

**end**

**endfunction**

**//Making variables for each row in matrix**

**for x=1:1:N**

**execstr("v"+string(x)+"=Matrix("+string(x)+",:)");**

**end**

**for y=1:1:N**

**execstr("disp(v"+string(y)+","+char(39)+"v\_str"+string(y)+char(39)+")");**

**end**

**//Making variables for each element in a matrix**

**for i = 1:1:N**

**for j = 1:1:N**

**//making variables and displaying them**

**execstr("M"+string(i)+string(j)+"=v"+string(i)+"("+string(j)+")"); //working**

**execstr(['if M'+string(i)+string(j)+'>0 then';**

**'w=find(v'+string(j)+'>0)'; //2,4**

**'z=string(w)';**

**'c=length(w)';**

**'end']);**

**execstr(['if M'+string(i)+string(j)+'>0 then';**

**'[l,k,b,s]=foo(w,c)';**

**'disp('+char(39)+'first vertex is '+string(i)+char(39)+')'**

**'disp('+char(39)+'second is '+string(j)+char(39)+')'**

**'disp('+char(39)+'next is '+char(39)+'+ string(w))'**

**'disp('+char(39)+'and the last one is '+char(39)+'+string(s))'**

**'disp('+char(39)+'/////////////////////'+char(39)+')'**

**'else'**

**'end'])**

**end**

**end**

**//making Incidence matrix**

**TotalLines=0;**

**Incidence\_matrix=zeros(N,TotalLines);**

**for x=1:1:N**

**for y=1:1:N**

**if Matrix(x,y) == 1**

**TotalLines=TotalLines+1;**

**if x~=y**

**Incidence\_matrix(x,TotalLines)=-1**

**Incidence\_matrix(y,TotalLines)=1**

**else**

**Incidence\_matrix(x,TotalLines)=0**

**end**

**end**

**end**

**end**

**Згенеровані матриці суміжності**

Орграф:

1. 0. 1. 0. 0. 0. 0. 0. 1. 0. 0.

0. 0. 0. 1. 1. 0. 0. 1. 0. 1. 0.

0. 1. 0. 0. 1. 0. 0. 0. 1. 1. 0.

0. 0. 1. 0. 0. 1. 0. 1. 0. 1. 0.

0. 0. 1. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 1. 1. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

1. 0. 1. 0. 0. 1. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

Неорграф:

1. 0. 1. 0. 0. 0. 0. 0. 1. 1. 0.

0. 0. 1. 1. 1. 0. 0. 1. 0. 1. 0.

1. 1. 0. 1. 1. 0. 0. 0. 1. 1. 0.

0. 1. 1. 0. 0. 1. 0. 1. 0. 1. 0.

0. 1. 1. 0. 0. 1. 0. 0. 0. 0. 0.

0. 0. 0. 1. 1. 0. 0. 0. 0. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 1. 0. 1. 0. 0. 0. 0. 0. 1. 0.

1. 0. 1. 0. 0. 0. 0. 0. 0. 0. 0.

1. 1. 1. 1. 0. 1. 0. 1. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

**Матриця інцидентності:**

0. -1. -1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0.

0. 0. 0. -1. -1. -1. -1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 1. 0. 0. 0. 0. 0. -1. -1. -1. -1. 1. 0. 0. 0. 1. 0. 0. 0. 0. 1. 0.

0. 0. 0. 1. 0. 0. 0. 0. 0. 0. 0. -1. -1. -1. -1. 0. 1. 0. 0. 0. 0. 0.

0. 0. 0. 0. 1. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0. -1. 0. 1. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. -1. -1. 0. 0. 0. 1.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. -1. 0. 0. 0.

0. 0. 1. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 1. 0. 0. 0. 1. 0. 0. 0. 1. -1. -1. -1.

**A^2:**

0. 1. 0. 0. 1. 0. 0. 0. 1. 1. 0.

1. 0. 3. 0. 0. 2. 0. 1. 0. 2. 0.

1. 0. 2. 1. 1. 1. 0. 1. 0. 1. 0.

1. 1. 1. 1. 2. 1. 0. 0. 1. 2. 0.

0. 1. 0. 0. 1. 0. 0. 0. 1. 1. 0.

0. 0. 2. 0. 0. 1. 0. 1. 0. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

1. 0. 1. 0. 0. 1. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 1. 1. 1. 2. 0. 0. 0. 2. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

**A^3:**

1. 0. 2. 1. 1. 1. 0. 1. 0. 1. 0.

2. 3. 3. 2. 5. 2. 0. 0. 4. 4. 0.

1. 2. 4. 1. 3. 2. 0. 1. 3. 4. 0.

2. 1. 6. 2. 3. 3. 0. 2. 2. 3. 0.

1. 0. 2. 1. 1. 1. 0. 1. 0. 1. 0.

1. 2. 1. 1. 3. 1. 0. 0. 2. 3. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 1. 1. 1. 2. 0. 0. 0. 2. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

1. 1. 4. 1. 2. 2. 0. 2. 1. 3. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

**Маршрути:**

"first vertex is 1"

"second is 1"

"next is 1" "next is 3" "next is 9"

"/////////////////////"

"first vertex is 1"

"second is 3"

"next is 2" "next is 5" "next is 9" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6

"/////////////////////"

"first vertex is 1"

"second is 9"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 2"

"second is 4"

"next is 3" "next is 6" "next is 8" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 2"

"second is 5"

"next is 3"

"and the last one is 2" "and the last one is 5" "and the last one is 9" "and the last one is 10"

"/////////////////////"

"first vertex is 2"

"second is 8"

"next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 2"

"second is 10"

"next is 1" "next is 3" "next is 6"

"and the last one is 4" "and the last one is 5"

"/////////////////////"

"first vertex is 3"

"second is 2"

"next is 4" "next is 5" "next is 8" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 3"

"second is 5"

"next is 3"

"and the last one is 2" "and the last one is 5" "and the last one is 9" "and the last one is 10"

"/////////////////////"

"first vertex is 3"

"second is 9"

"and the last one is 2" "and the last one is 5" "and the last one is 9" "and the last one is 10"

"/////////////////////"

"first vertex is 3"

"second is 10"

"next is 1" "next is 3" "next is 6"

"and the last one is 4" "and the last one is 5"

"/////////////////////"

"first vertex is 4"

"second is 3"

"next is 2" "next is 5" "next is 9" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 4"

"second is 6"

"next is 4" "next is 5"

"and the last one is 3"

"/////////////////////"

"first vertex is 4"

"second is 8"

"next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 4"

"second is 10"

"next is 1" "next is 3" "next is 6"

"and the last one is 4" "and the last one is 5"

"/////////////////////"

"first vertex is 5"

"second is 3"

"next is 2" "next is 5" "next is 9" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 6"

"second is 4"

"next is 3" "next is 6" "next is 8" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 6"

"second is 5"

"next is 3"

"and the last one is 2" "and the last one is 5" "and the last one is 9" "and the last one is 10"

"/////////////////////"

"first vertex is 8"

"second is 10"

"next is 1" "next is 3" "next is 6"

"and the last one is 4" "and the last one is 5"

"/////////////////////"

"first vertex is 10"

"second is 1"

"next is 1" "next is 3" "next is 9"

"/////////////////////"

"first vertex is 10"

"second is 3"

"next is 2" "next is 5" "next is 9" "next is 10"

"and the last one is 1" "and the last one is 3" "and the last one is 6"

"/////////////////////"

"first vertex is 10"

"second is 6"

"next is 4" "next is 5"

"and the last one is 3"

"/////////////////////"

**Матриця досяжності:**

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0.

1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1.

**Матриця зв’язності:**

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1.

**Стовпчики:**

1. 2. 3. 4. 5. 6. 8. 10. 7. 9. 11.

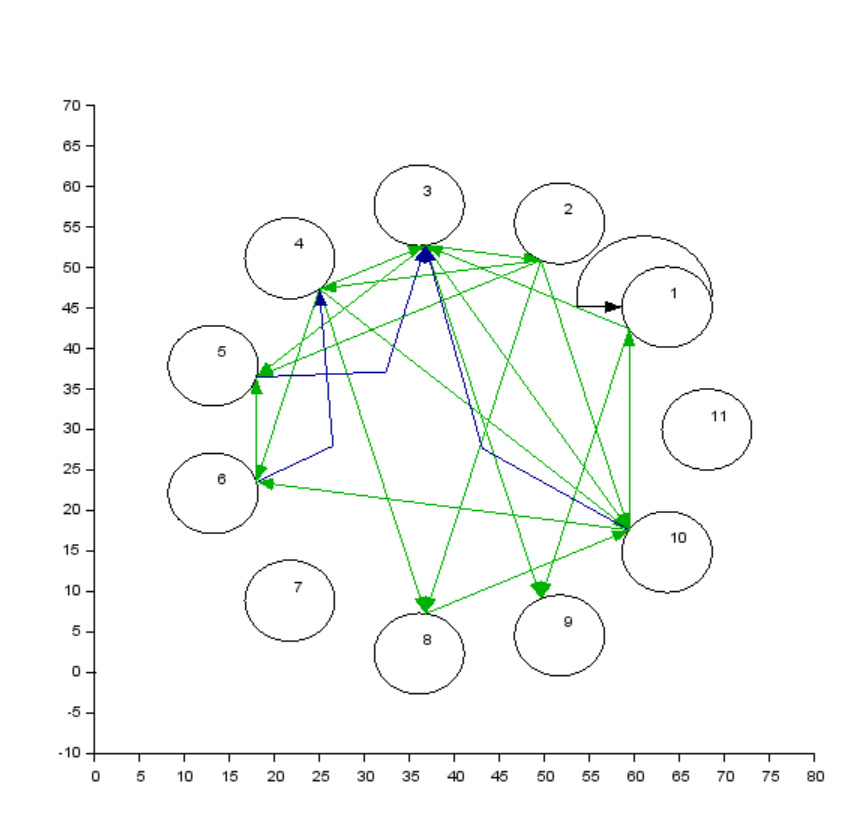
**Матриця графа конденсації:**

0. 1.

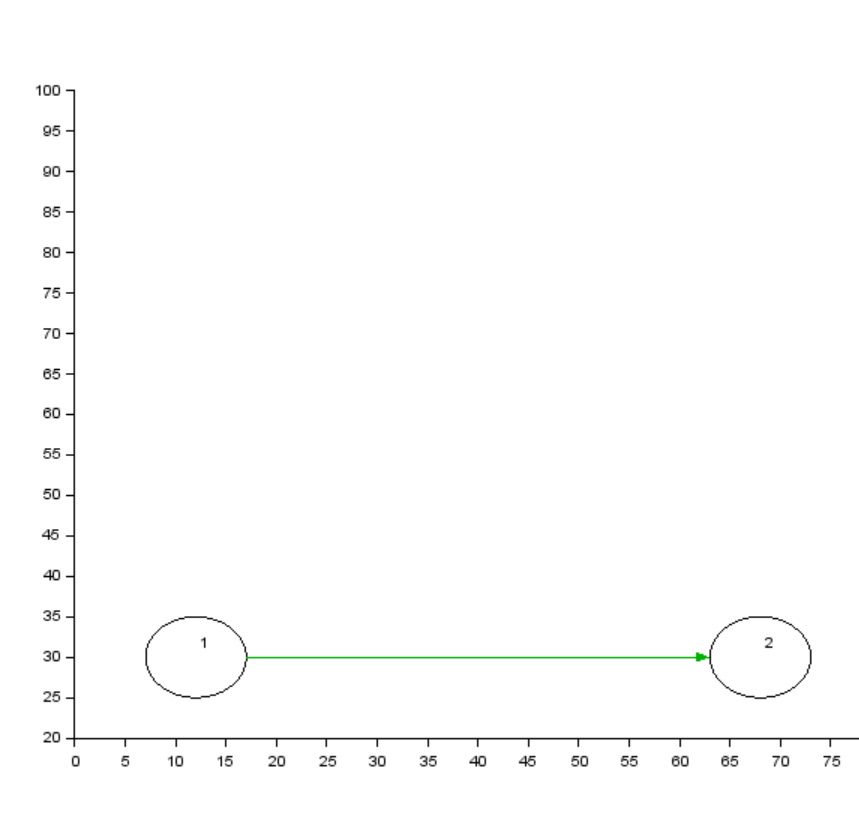
0. 0.

**Результати виконання програми:**

Орграф:



Граф конденсації:



**Висновки:**

Я навчився досліджувати зв’язність графів, матриці інцидентності, досяжності, зв’язності, шляхи, компоненти сильної зв’язності та графи конденсації