Article

A Java software for drawing graphs

WenJun Zhang
School of Life Sciences, Sun Yat-sen University, Guangzhou 510275, China; International Academy of Ecology and Environmental Sciences, Hong Kong
E-mail: zhwj@mail.sysu.edu.cn, wjzhang@iaees.org

Received 7 May 2011; *Accepted 13 August 2011*; *Published online 1March 2012*
IAEES

Abstract
In this study the software for drawing graphs, which is run as a Java application, was described. It can be freely downloaded and run on Windows platforms. The software can be used to draw directed, undirected, cyclic and acyclic graphs.

Keywords software; graph; drawing; Java.

1 Introduction

Java is an object oriented and platform independent programming language. It has been widely used in the development of various biological software (Liu and Zhang, 2011; Zhang, 2011a, b). A lot of network and graph related software have been developed using Java, e.g., NetLogo, Repast, et al.

In the following sections, the software for drawing various graphs, running as a Java application, is described (Zhang, 2012). It can be freely downloaded and run on various Windows platforms.

2 Array Storage of Graph

The graph in present study is stored in computer using a method, Two Linear Array (Zhang, 2012). For instance, the directed graph in Fig. 1 can be expressed in Two Linear Array as:

$$S_1=(v_1, v_1, v_1, v_2, v_2, v_2, v_3, v_3, v_5, v_6),$$
$$S_2=(v_2, v_4, v_3, v_2, v_3, v_4, v_4, v_4, v_5, v_6),$$
$$S=(1, 1, -1, 3, 1, 1, 2, -2, 3, 0).$$

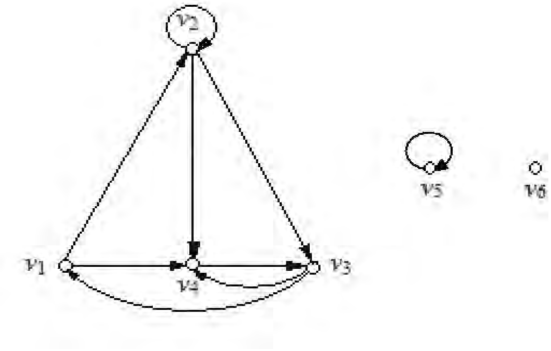


Fig. 1 A directed graph (Zhang, 2012)

Changing the graph in Fig. 1 to undirected graph, its Two Linear Array representation will be:

$$S_1=(v_1, v_1, v_1, v_2, v_2, v_2, v_3, v_4, v_5, v_6),$$
$$S_2=(v_2, v_3, v_4, v_2, v_3, v_4, v_4, v_3, v_5, v_6),$$
$$S=(1, -1, 1, 3, 1, 1, 2, 2, 5, 4).$$

where 1 denotes there is only one edge between two vertices, and the edge is a positive-directed edge; -1 denotes there is only one edge between two vertices, but the edge is a negative-directed edge; 2 denotes two parallel edges; 3 denotes self-loop; 4 denotes isolated vertex, and 5 denotes the self-loop of an isolated vertex.

3 Java Implementation

The software was implemented based on JDK 1.1.8, in which several classes were included (http://www.iaees.org/publications/software/index.asp; In BioNetAnaly). The following are Java codes, netGenerator, re-invented from JDK and Zhang (2007), for generating a graph (Zhang, 2012):

```
//Loading example: java netGenerator netgenerator
//where netgenerator is the name of table in the database “dataBase”
/*Graph is stored in Two Arrays Listing. s1[1-e]: from-vertex; s2[1-e]: to-vertex; tt[1-e]: 1 if it is a forward edge; -1 is for backward edge; 4 if s1[i]=s2[i], i.e., the vertex is an isolated vertex with no self-loop; 2: parallel edges; 3: self-loop for non-isolated vertex; 5: an isolated vertex with self-loop. */
public class netGenerator {
public static void main(String[] args){
String tablename=args[0];
readDatabase readdata=new readDatabase("dataBase",tablename, 3);
int mm=readdata.m;
String s1[]=new String[mm+1];
String s2[]=new String[mm+1];
int s[]=new int[mm+1];
for (int i=1;i<=mm;i++) {
for (int i=1;i<=mm;i++) {
s1[i]=readdata.data[i][1];
s2[i]=readdata.data[i][2];
s[i]=(Integer.valueOf(readdata.data[i][3])).intValue(); }
new GraphicsFrame(new NetGraph(s1,s2,s),"Black and blue edges are forward and backward edges respectively. Self-loop is labeled by semicircle on the vertex. Parallel edges are labeled by between-vertex parallel lines.").resize(720,550);
} }
```

The following are Java classes, NetGraph, NetVertex, NetEdge, and NetPanel, loaded by above class, netGenerator:

```
import java.util.*;
import java.awt.*;
import java.applet.Applet;
import java.awt.event.*;
public class NetGraph extends Applet implements ActionListener {
Button close;
NetPanel panel;
Panel controlPanel;
String s[][], c[];
int e, v, m;
public int t[];
public NetGraph(String s1[], String s2[], int tt[]) {
e=s1.length;
s=new String[5][e+1];
c=new String[2000];
t=new int[e+1];
for(int i=1;i<=e;i++) {
s[1][i]=s1[i];
s[2][i]=s2[i];
t[i]=tt[i]; }
v=1;
c[1]=s[1][1];
for(int i=1;i<=2;i++)
for(int j=1;j<=e;j++) {
m=0;
for(int k=1;k<=v;k++)
if (!(s[i][j].equals(c[k]))) m++;
if (m==v) {
v++;
c[v]=s[i][j]; } }
begin(); }

public void begin() {
close=new Button("Close");
setLayout(new BorderLayout());
panel=new NetPanel();
add("Center", panel);
controlPanel=new Panel();
add("South",controlPanel);
controlPanel.add(close); close.addActionListener(this);
for(int k=1;k<=e;k++)
panel.addEdge(s[1][k],s[2][k],t[k]);
Dimension d=getSize();
resize(d.width-15, d.height-15);
setLocation(20,20);
validate();
show(); }

public void init() {
}

public void paint(Graphics g) {
repaint(); }

public void destroy() {
remove(panel);
remove(controlPanel); }

public void actionPerformed(ActionEvent e) {
Object src=e.getSource();
if (src==close) {
this.hide();
this.getParent().hide();
System.exit(0); }
return; }

public String getAppletInfo() {
return "Ecological Network Generator"; }
}
```

```
class NetVertex {
double x,y,w,h;
boolean fixed;
String lab; }

class NetEdge {
int from,to,type; }

class NetPanel extends Panel implements MouseListener, MouseMotionListener {
int nvertice,nedges;
NetVertex vertice[]=new NetVertex[2000];
NetEdge edges[]=new NetEdge[50000];
NetVertex pick;
boolean pickfixed;
Image offscreen;
Dimension offscreensize;
Graphics offgraphics;
Color posColor=Color.black;
Color negColor=Color.blue;

public NetPanel() {
addMouseListener(this);
addMouseMotionListener(this); }

public int findVertex(String lab) {
for(int i=0;i<nvertice;i++)
if (vertice[i].lab.equals(lab)) return i;
return addVertex(lab); }

public int addVertex(String lab) {
NetVertex v=new NetVertex();
v.x=100+350*Math.random();
v.y=100+350*Math.random();
v.lab=lab;
vertice[nvertice]=v;
return nvertice++; }

public void addEdge(String from, String to, int type) {
NetEdge e=new NetEdge();
e.from=findVertex(from);
e.to=findVertex(to);
e.type=type;
edges[nedges++]=e; }

public void paintVertex(Graphics g, NetVertex v, FontMetrics mtr) {
int x=(int)v.x;
int y=(int)v.y;
g.setColor(Color.white);
int w=mtr.stringWidth(v.lab)+10;
int h=mtr.getHeight()+4;
v.w=w;
v.h=h;
g.fillRect(x-w/2,y-h/2,w,h);
g.setColor(Color.black);
g.drawRect(x-w/2,y-h/2,w-1,h-1);
g.drawString(v.lab,x-(w-10)/2,(y-(h-4)/2)+mtr.getAscent()); }
```

```
public void update(Graphics g) {
Dimension d=getSize();
if ((offscreen==null) || (d.width!=offscreensize.width) || (d.height!=offscreensize.height)) {
offscreen=createImage(d.width, d.height);
offscreensize=d;
offgraphics=offscreen.getGraphics();
offgraphics.setFont(getFont()); }
offgraphics.setColor(getBackground());
offgraphics.fillRect(0,0,d.width,d.height);
for(int i=0;i<nedges;i++) {
NetEdge e=edges[i];
int x1=(int)vertice[e.from].x;
int y1=(int)vertice[e.from].y;
int x2=(int)vertice[e.to].x;
int y2=(int)vertice[e.to].y;
if ((e.type==1) | (e.type==-1)) {
if (e.type==1) offgraphics.setColor(posColor);
else offgraphics.setColor(negColor);
offgraphics.drawLine(x1,y1,x2,y2); }
if (e.type==2) {
offgraphics.setColor(posColor);
offgraphics.drawLine(x1,y1-5,x2,y2-5);
offgraphics.setColor(negColor);
offgraphics.drawLine(x1,y1+5,x2,y2+5); }
if ((e.type==3) | (e.type==5)) {
int w=(int)vertice[e.from].w;
int h=(int)vertice[e.from].h;
int rad=w-1;
offgraphics.setColor(posColor);
offgraphics.drawArc(x1-(int)(0.5*w),y1-h,rad,rad,0,360); } }
FontMetrics mtr=offgraphics.getFontMetrics();
for(int i=0;i<nvertice;i++) paintVertex(offgraphics,vertice[i],mtr);
g.drawImage(offscreen,0,0,null); }

public void paint(Graphics g) {
repaint(); }

public void mousePressed(MouseEvent e) {
double bestdist=Double.MAX_VALUE;
int x=e.getX();
int y=e.getY();
for(int i=0;i<nvertice;i++) {
NetVertex v=vertice[i];
double dist=(v.x-x)*(v.x-x)+(v.y-y)*(v.y-y);
if (dist<bestdist) {
pick=v;
bestdist=dist; } }
pickfixed=pick.fixed;
pick.fixed=true;
pick.x=x;
pick.y=y;
repaint();
e.consume(); }

public void mouseReleased(MouseEvent e) {
pick.x=e.getX();
pick.y=e.getY();
pick.fixed=pickfixed;
pick=null;
repaint();
e.consume(); }

public void mouseDragged(MouseEvent e) {
pick.x=e.getX();
pick.y=e.getY();
repaint();
e.consume(); }
public void mouseClicked(MouseEvent e) {}
public void mouseEntered(MouseEvent e) {}
public void mouseExited(MouseEvent e) {}
public void mouseMoved(MouseEvent e) {}
}
```

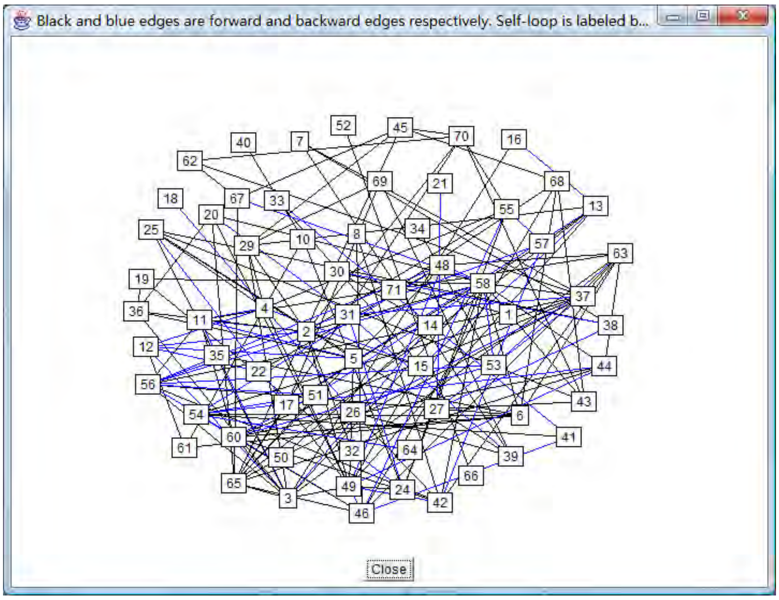
The following is the class GraphicsFrame, used by class netGenerator:

```
import java.awt.*;
import java.applet.*;
public class GraphicsFrame extends Frame {
public GraphicsFrame(Applet applet) {
this.resize(600,400);
add(applet);
setVisible(true); }

public GraphicsFrame(Applet applet, String str) {
this.resize(600,400);
this.setTitle(str);
add(applet);
setVisible(true); }
}
```

4 Application

Some ecological graphs have been drawn using the software, for example, the graphs in Fig. 2 and Fig. 6 of Zhang (2011c), and the graph in Fig. 2.



Black and blue edges are forward and backward edges respectively. Self-loop is labeled b...

Fig. 2 An arthropod interactions graph generated by software

References

Liu GH, Zhang WJ. 2011. Computer generation of initial spatial distribution for cell automata. Computational Ecology and Software, 1(4): 244-248

Zhang WJ. 2007. Computer inference of network of ecological interactions from sampling data. Environmental Monitoring and Assessment, 124: 253–261

Zhang WJ. 2011a. A Java program to test homogeneity of samples and examine sampling completeness. Network Biology, 1(2): 127-129

Zhang WJ. 2011b. An algorithm for calculation of degree distribution and detection of network type: with application in food webs. Network Biology, 1(3-4): 159-170

Zhang WJ. 2011c. Constructing ecological interaction networks by correlation analysis: hints from community sampling. Network Biology, 1(2): 81-98

Zhang WJ. 2012. Computational Ecology: Graphs, Networks and Agent-based Modeling. World Scientific, Singapore