LAMPIRAN

Program Utama

```
unit main;

interface

uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls,
Forms,Dialogs,Menus,unitparam,unitgraph, ExtDlgs, ExtCtrls,
StdCtrls,math, ComCtrls, Series,TeEngine,about,pcxctrl;

type dataimage=array of array of byte;
type datareal=array of array of real;
type mode=(none,train,apply);

type
  TForm1 = class(TForm)
    MainMenu1: TMainMenu;
    File1: TMenuItem;
    simp: TMenuItem;
    Open1: TMenuItem;
    Exit1: TMenuItem;
    Train1: TMenuItem;
    Parameter1: TMenuItem;
    Run1: TMenuItem;
    bukadata: TOpenDialog;
    Stop1: TMenuItem;
    Panel1: TPanel;
    ShowGraph1: TMenuItem;
    progress: TProgressBar;
    OpenImage1: TMenuItem;
    simpan: TSaveDialog;
    Recognition1: TMenuItem;
    BacaImage1: TMenuItem;
    ScrollBox1: TScrollBox;
    lembar: TImage;
    Memo1: TMemo;
    About1: TMenuItem;
    bukaimage: TOpenDialog;
    StatusBar1: TStatusBar;
    SimpanData1: TMenuItem;
    procedure Exit1Click(Sender: TObject);
    procedure Parameter1Click(Sender: TObject);
    procedure FormCreate(Sender: TObject);
    procedure Run1Click(Sender: TObject);
    procedure Stop1Click(Sender: TObject);
    procedure ShowGraph1Click(Sender: TObject);
    procedure simpClick(Sender: TObject);
    procedure OpenImage1Click(Sender: TObject);
    procedure BacaImage1Click(Sender: TObject);
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```
    procedure Open1Click(Sender: TObject);
    function  bacakarakter(sbaris,skolom:integer):integer;
    procedure About1Click(Sender: TObject);
    procedure aktiptrain(aktip:boolean);
    procedure SimpanData1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;


var
  Form1: TForm1;
  jgambar,jhiden,lgambarop:integer;
  alpha,miu,mineror:real;
  working:mode;
  iunit,ounit,iterasi,jumdata:integer;
  hunit:array of integer;
  identitas:array of string;
  input,output,target:datareal;
  hin:array of array of real;
  hiden,wbobot:datareal;
  vbobot:array of datareal;
  stop,showg:boolean;
  template,gambarc,gambar:tpcxbitmap;
  tinggi,lebar,val:integer;

const dataperimage:integer=20; //jumlah gambar yang akan
dimasukkan
const pembagi:real=2;              //jumlah pembagi yang digunakan
                                   untuk membagi gambar

implementation

{$R *.DFM}


function bytetobin(bil:byte):string;
var a      :byte;
begin
 result:='';
  for a:=7 downto 0 do
   begin
     if bil and (1 shl a)<>0 then
     begin  result:=result+'1'; end
     else
     begin result:=result+'0'; end;
   end;
end;

procedure tform1.aktiptrain(aktip:boolean);
```

```
begin
 parameter1.Enabled:=not aktip;
 run1.Enabled:=aktip;
 showgraph1.Enabled:=aktip;
end;


procedure hapusmemo;
begin
 form1.memo1.Visible:=false;
 if form1.memo1.Lines.Count>0 then
   form1.memo1.Lines.Clear;
end;


procedure nguyen(var bobot:datareal);
var beta:real;
    a,b :integer;
    old :array of real;
begin
 beta:=0.7*(power(hunit[0]-1,1/(iunit-1)));
 setlength(old,hunit[0]);
 for a:=1 to hunit[0]-1 do
   begin
    old[a]:=0;
    for b:=1 to iunit-1 do
      old[a]:=old[a]+sqr(vbobot[0,b,a]);
    old[a]:=sqrt(old[a]);
    for b:=1 to iunit-1 do
      vbobot[0,b,a]:=beta*vbobot[0,b,a]/old[a];
    vbobot[0,0,a]:=beta*(1-2*random);
   end;
end;

procedure inisialisasitarget;
var a,b:integer;
    bin:string;
    val:integer;
begin
 setlength(target,jgambar,ounit);
 for a:=0 to jgambar-1 do
   begin
   // bin:=bytetobin(a+1);
 //    val:=11+a*4;
  //   target[a,0]:=(val div 10)/10;
  //   target[a,1]:=(val mod 10)/10;

     for b:=0 to ounit-1 do
      begin
  //     target[a,b]:=0.05+a*0.95/jgambar;
  //     target[a,b]:=0.2+0.6*strtoint(bin[length(bin)-b]);
       target[a,b]:=0;
```

```pascal
    end;
    target[a,a]:=1;
  end;
end;

procedure TForm1.Exit1Click(Sender: TObject);
begin
close;
end;


procedure caribatas(template:tpcxbitmap;var
left,top,right,bottom:integer);
var x,y,val   :integer;
    baris:pbytearray;
begin
  for y:=0 to template.Height-1 do
   for x:=0 to template.Width-1 do
    begin
    val:=getpixel(template.Canvas.Handle,x,y);
    if val<127 then          // warna hitam
      begin
        if left>x then left:=x;
        if right<x then right:=x;
        if top>y then top:=y;
        if bottom<y then bottom:=y;
      end
    end;
end;


procedure bacagambar(startx,starty:integer);
var kiri,atas,kanan,bawah:integer;
    besar,tengah,tengah1,tengah2:integer;
begin
  template:=tpcxbitmap.Create;
  template.PixelFormat:=pf8bit;
  template.Width:=lebar;
  template.Height:=tinggi;

bitblt(template.Canvas.Handle,0,0,lebar,tinggi,gambar.Canvas.Hand
le,startx,starty,srccopy);
  kiri:=39; atas:=39;
  kanan:=0; bawah:=0;
  caribatas(template,kiri,atas,kanan,bawah);
  //template.SaveToFile('c://temp.bmp');
  gambarc:=tpcxbitmap.Create;
  gambarc.PixelFormat:=pf8bit;
  gambarc.Width:=round(lebar/pembagi);
  gambarc.Height:=round(tinggi/pembagi);
  {besar:=max((bawah-atas),(kanan-kiri));
  tengah:=besar div 2;
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  tengah1:=atas+((bawah-atas) div 2);
  tengah2:=kiri+((kanan-kiri) div 2);

StretchBlt(gambarc.Canvas.Handle,0,0,gambarc.Width,gambarc.Height
,template.Canvas.Handle,tengah2-tengah,tengah1-
tengah,besar+1,besar+1,srccopy);}

StretchBlt(gambarc.Canvas.Handle,0,0,gambarc.Width,gambarc.Height
,template.Canvas.Handle,kiri,atas,(kanan-kiri)+1,(bawah-
atas)+1,srccopy);
// gambarc.SaveToFile('c:/temp2.bmp');
  template.Free;
end;

procedure initinput;
var x,y,val :integer;
begin
  inc(jumdata);
  setlength(input,jumdata);
  setlength(input[jumdata-
1],(round(tinggi/pembagi))*(round(lebar/pembagi))+1);
  input[jumdata-1,0]:=1;
  for y:=0 to gambarc.Height-1 do
    for x:=0 to gambarc.Width-1 do
      begin
        val:=getpixel(gambarc.Canvas.Handle,x,y);
        if val>127 then
          input[jumdata-1,1+x+y*(round(tinggi/pembagi))]:=0 //warna
putih
        else
          input[jumdata-1, +x+y*(round(tinggi/pembagi))]:=1; //warna
hiram
        end;
    gambarc.Free;
end;

procedure TForm1.Parameter1Click(Sender: TObject);
var a,b,c,d:integer;
    temp:string;
    hlebar,htinggi:integer;
begin
working:=none;
hapusmemo;
jumdata:=0;
parameter:=tparameter.Create(self);
parameter.ShowModal;
if working=train then
  begin
    a:=0;
    aktiptrain(true);
    bacaimage1.Enabled:=false;
    lembar.Width:=1;
```

```
  lembar.Height:=1;
  setlength(identitas,jgambar);
  repeat
   bukaimage.Title:='Buka Data Image Ke '+inttostr(a+1)+' dari
'+inttostr(jgambar)+' image';
   if not bukaimage.Execute then
    begin
     working:=none;
     jumdata:=0;
     setlength(input,jumdata);
     exit;
    end
   else
    begin
     gambar:=tpcxbitmap.Create;
     gambar.PixelFormat:=pf8bit;
     gambar.LoadFromFile(bukaimage.FileName);

temp:=copy(extractfilename(bukaimage.FileName),1,length(extractfi
lename(bukaimage.FileName))-
length(extractfileext(bukaimage.FileName)));
     if not inputquery('Nama Karakter','Nama Untuk Karakter
:',temp) then
       application.MessageBox(pchar('Anda tidak menekan tombol
OK'+#13+'Character identified as '+temp),'Confirmation',mb_ok or
mb_iconexclamation);
     identitas[a]:=temp;
     b:=0; c:=0; d:=0;
     repeat
      bacagambar(c,b);
      initinput;
      inc(c,40);
      if c > gambar.Width-1 then
       begin
        c:=0;
        inc(b,40)
       end;
       inc(d);
       if d>=dataperimage then break;
     until b>gambar.Height-1;
     inc(a);
     gambar.Free;
    end;
  until a>=jgambar;
  iunit:=(round(lebar/pembagi))*(round(tinggi/pembagi))+1;
//menghitung input unit
  ounit:=jgambar;
  setlength(output,jgambar,ounit);
  inisialisasitarget;
  end;
end;
```

```
procedure pesaneror(isi,caption:pchar);
begin
 application.MessageBox(isi,caption,mb_ok or mb_iconstop);
end;

procedure TForm1.FormCreate(Sender: TObject);
begin
gambar:=tpcxbitmap.Create;
gambar.PixelFormat:=pf8bit;
showg:=false;
working:=none;
jumdata:=0;
lebar:=40;
tinggi:=40;
end;

procedure randombobot(var bobot:datareal;satu,dua:integer);
var a,b:integer;
begin
 for a:=0 to satu-1 do
  for b:=0 to dua-1 do
   bobot[a,b]:=random;
end;

function sigmoid(nilai:real):real ;
begin
result:=1/(1+(exp(-nilai))); //fungsi aktivasi
// result:=(2/(1+(exp(-2*nilai))))-1;
end;

function turunansigmoid(nilai:real):real ;
begin
result:= sigmoid(nilai)*(1-sigmoid(nilai));    //turunan fungsi
aktivasi
//result:=(4*(exp(-2*nilai)))/sqr(1+(exp(-2*nilai)));
end;

procedure TForm1.Run1Click(Sender: TObject);
var loop,a,b,c,d:integer;
    perorj,perorinj:array of array of real;
    perork,oin:array of real;
    vbobot0,vbobotd:array of datareal;
    wbobot0,wbobotd:datareal;
    erormak,suberor:integer;
    realeror:real;
    seltotitem,seltot:real;
 begin
  stop1.Enabled:=true;
  run1.Enabled:=false;
  simp.Enabled:=true;
  stop:=false;
```

```
setlength(hiden,jhiden); //mengeset hiden dengan jhiden
setlength(perorj,jhiden);
setlength(perorinj,jhiden);
setlength(hin,jhiden);
setlength(vbobot,jhiden);
setlength(vbobot0,jhiden);
setlength(vbobotd,jhiden);

for a:=0 to jhiden -1 do
 begin
   setlength(hiden[a],hunit[a]);
   setlength(perorj[a],hunit[a]);
   setlength(perorinj[a],hunit[a]);
   setlength(hin[a],hunit[a]);
   if a=0 then
    begin
      setlength(vbobot[a],iunit,hunit[0]);
      setlength(vbobot0[a],iunit,hunit[0]);
      setlength(vbobotd[a],iunit,hunit[0]);
      randombobot(vbobot[0],iunit,hunit[0]);
      nguyen(vbobot[0]);
    end
   else
    begin
      setlength(vbobot[a],hunit[a-1],hunit[a]);
      setlength(vbobot0[a],hunit[a-1],hunit[a]);
      setlength(vbobotd[a],hunit[a-1],hunit[a]);
      randombobot(vbobot[a],hunit[a-1],hunit[a]);
    end;
end;
setlength(perork,ounit);
setlength(oin,ounit);
setlength(wbobot,hunit[jhiden-1],ounit);
setlength(wbobot0,hunit[jhiden-1],ounit);
setlength(wbobotd,hunit[jhiden-1],ounit);
randombobot(wbobot,hunit[jhiden-1],ounit);
for a:=0 to jhiden-1 do
 begin
   if a=0 then
    begin
     for b:=0 to iunit-1 do
       for c:=0 to hunit[0]-1 do
        vbobot0[a,b,c]:=vbobot[a,b,c];
    end
   else
    begin
     for b:=0 to hunit[a-1]-1 do
       for c:=0 to hunit[a]-1 do
        vbobot0[a,b,c]:=vbobot[a,b,c];
    end;
 end;
```

```
 for a:=0 to hunit[jhiden-1]-1 do
  for b:=0 to ounit-1 do
   wbobot0[a,b]:=wbobot[a,b];
statusbar1.Visible:=true;
progress.Visible:=true;
progress.Max:=iterasi;

for loop:=1 to iterasi do
 begin
  application.ProcessMessages;

  if stop then
  begin
   aktiptrain(false);
   exit;
  end;
  progress.Position:=loop;
  erormak:=0;
  seltot:=0;
  for a:=0 to jumdata-1 do
    begin
 //---------feddforward----------------//
     for b:=0 to jhiden-1 do
      begin
       hiden[b,0]:=1.0;
       for c:=1 to hunit[b]-1 do
        begin
         hin[b,c]:=vbobot[b,0,c];
         if b=0 then
          begin
           for d:=1 to iunit-1 do   //dipakai apabila unit input
saja
            hin[b,c]:=hin[b,c]+input[a,d]*vbobot[b,d,c];
//hin(baru)=hin(lama)+(input*bobot)
           end
          else
           begin
            for d:=1 to hunit[b-1]-1 do   //dipakai apabila ada
unit hidden
             hin[b,c]:=hin[b,c]+hiden[b-1,d]*vbobot[b,d,c];
//hind(baru)=hin(lama)+(unit hiden*bobot)
           end;
          hiden[b,c]:=sigmoid(hin[b,c]); //function aktivasi
         end;
       end;
      for b:=0 to ounit-1 do
       begin
        oin[b]:=wbobot[0,b];
        for c:=1 to hunit[jhiden-1]-1 do
         oin[b]:=oin[b]+hiden[jhiden-1,c]*wbobot[c,b];
        output[a div dataperimage,b]:=sigmoid(oin[b]);
       end;
```

```
//-------------backforward-----------//
    seltotitem:=0;
    for b:=0 to ounit-1 do
     begin
        perork[b]:=(target[a div dataperimage,b]-output[a div
dataperimage,b])*turunansigmoid(oin[b]);
        //error
        seltotitem:=seltotitem+ sqr(target[a div dataperimage,b]-
output[a div dataperimage,b]);
        //total kuadrat kesalahan
     end;
    seltotitem:=seltotitem/ounit; //grafik
    seltot:=seltot+seltotitem;
    if seltotitem < mineror then
     inc(erormak);

    for b:=jhiden-1 downto 0 do
     begin
        for c:=1 to hunit[b]-1 do
        begin
          if b=jhiden-1 then
           begin
             for d:=0 to ounit-1 do
              perorinj[b,c]:=perork[d]*wbobot[c,d]; //menghitung
antara hiden dan bobot
           end
          else
           begin
             for d:=1 to hunit[b+1]-1 do

perorinj[b,c]:=perorj[b+1,d]*vbobot[b+1,c,d];//menghitung antara
input dan hiden
           end;

perorj[b,c]:=perorinj[b,c]*turunansigmoid(hin[b,c]);//turunan
fungsi aktivasi
        end;
     end;

    //---------update w-------------------
    for b:=0 to ounit-1 do
        for c:=0 to hunit[jhiden-1]-1 do
          wbobotd[c,b]:=wbobot[c,b]-wbobot0[c,b];

    for b:=0 to ounit-1 do
        for c:=0 to hunit[jhiden-1]-1 do
         begin
          wbobot0[c,b]:=wbobot[c,b];
          wbobot[c,b]:=wbobot[c,b]+(alpha*perork[b]*hiden[jhiden-
1,c])+miu*wbobotd[c,b];
          //bobot
```

```
        end;

   //----------update  v-----------------
       for b:=0 to jhiden-1 do
         begin
          if b=0 then
            begin
             for c:=0 to iunit-1 do
                for d:=0 to hunit[0]-1 do
                  vbobotd[b,c,d]:=vbobot[b,c,d]-vbobot0[b,c,d];
             end
           else
             begin
              for c:=0 to hunit[b-1]-1 do
                 for d:=0 to hunit[b]-1 do
                   vbobotd[b,c,d]:=vbobot[b,c,d]-vbobot0[b,c,d];
              end;
           end;

        for b:=0 to jhiden-1 do
          begin
           if b=0 then
             begin
              for c:=0 to iunit-1 do
                 for d:=1 to hunit[0]-1 do
                   begin
                    vbobot0[b,c,d]:=vbobot[b,c,d];

vbobot[b,c,d]:=vbobot[b,c,d]+(alpha*perorj[0,d]*input[a,c])+miu*v
bobotd[b,c,d];
                   end;
             end
            else
              begin
               for c:=0 to hunit[b-1]-1 do
                  for d:=1 to hunit[b]-1 do
                    begin
                     vbobot0[b,c,d]:=vbobot[b,c,d];

vbobot[b,c,d]:=vbobot[b,c,d]+(alpha*perorj[b,d]*hiden[b-
1,c])+miu*vbobotd[b,c,d];
                    end;
                end;
             end;
          end;
       end;
      if erormak=jumdata then
        begin
         statusbar1.panels[0].Text:='Identitifikasi karakter
'+inttostr(erormak)+' dari '+inttostr(jumdata);
         for a:=0 to jumdata-1 do
         begin
          for b:=0 to jhiden-1 do
```

```
      begin
        hiden[b,0]:=1.0;
        for c:=1 to hunit[b]-1 do
          begin
            hin[b,c]:=vbobot[b,0,c];
            if b=0 then
              begin
                for d:=1 to iunit-1 do
                  hin[b,c]:=hin[b,c]+input[a,d]*vbobot[b,d,c];
              end
            else
              begin
                for d:=1 to hunit[b-1]-1 do
                  hin[b,c]:=hin[b,c]+hiden[b-1,d]*vbobot[b,d,c];
              end;
            hiden[b,c]:=sigmoid(hin[b,c]);
          end;
      end;
    for b:=0 to ounit-1 do
      begin
        oin[b]:=wbobot[0,b];
        for c:=1 to hunit[jhiden-1]-1 do
        oin[b]:=oin[b]+hiden[jhiden-1,c]*wbobot[c,b];
        output[a div dataperimage,b]:=turunansigmoid(oin[b]);
      end;
    seltotitem:=0;
    for b:=0 to ounit-1 do
      seltotitem:=seltotitem+ (target[a div dataperimage,b]-
output[a div dataperimage,b]);
    seltotitem:=seltotitem/ounit;
    if seltotitem < mineror then
      dec(erormak);
  end;
  if erormak=0 then
    begin
      application.MessageBox('Maksimum error '+#13+'Training
sudah selesai','Error Information',mb_ok or mb_iconexclamation);
      progress.Visible:=false;
      stop1.Enabled:=false;
      run1.Enabled:=true;
      stop:=true;
    end;
  end;
  seltot:=seltot/jumdata;
  if loop mod 10=0 then statusbar1.panels[0].Text:='Identifikasi
karakter '+inttostr(erormak)+' dari '+inttostr(jumdata);
  if showg then
    graf.Chart1.Series[0].AddXY(loop,seltot,'',clred);
  end;
  if not stop then
    application.MessageBox('Maximum Iteration Reached','Training
Information',mb_ok or mb_iconexclamation);
```

```
  statusbar1.Visible:=false;
  stop1.Enabled:=false;
  run1.Enabled:=true;
  stop:=true;
end;

procedure TForm1.Stop1Click(Sender: TObject);
var a:integer;
begin
stop1.Enabled:=false;
run1.Enabled:=true;
stop:=true;
progress.Visible:=false;
progress.Position:=0;
end;

procedure TForm1.ShowGraph1Click(Sender: TObject);
begin
showg:=true;
graf.Show;
form1.BringToFront;
end;

procedure TForm1.simpClick(Sender: TObject);
var a,b,c,d:integer;
    F:textfile;
begin
if not simpan.Execute then exit
else
 begin
 AssignFile(F,simpan.FileName);   //menyimpan bobot
 Rewrite(F);
 Writeln(F,'Hasil Training Character Recognition Using
Backpropagation');
 Writeln(F,'Jumlah karakter        = '+inttostr(jgambar));
 Writeln(F,'Tinggi karakter        = '+inttostr(tinggi));
 Writeln(F,'Lebar karakter         = '+inttostr(lebar));
 Writeln(F,'Jumlah unit input      = '+inttostr(iunit));
 Writeln(F,'Jumlah unit output     = '+inttostr(ounit));
 Writeln(F,'Jumlah hidden layer    = '+inttostr(jhiden));
 for a:=1 to jhiden do
  Writeln(F,'Jumlah unit hidden '+inttostr(a)+' =
'+inttostr(hunit[a-1]));
 for a:=1 to jgambar do
  Writeln(F,'Identitas karakter ke '+inttostr(a)+' =
'+identitas[a-1]);
 Writeln(F,'Error Toleration  = '+ floattostr(mineror));
 for b:=0 to jhiden-1 do
  begin
    if b=0 then
     begin
      Writeln(F,'Weight antara input dan hiden 1');
```

```
      for c:=0 to iunit-1 do
        for d:=0 to hunit[0]-1 do
          Writeln(F,FloatToStrF(vbobot[b,c,d],ffgeneral,8,4));
      end
    else
      begin
        Writeln(F,'Weight antara hiden '+inttostr(b)+' dan hiden
'+inttostr(b+1));
        for c:=0 to hunit[b-1]-1 do
          for d:=0 to hunit[b]-1 do
            Writeln(F,FloatToStrF(vbobot[b,c,d],ffgeneral,8,4));
      end;
    end;
  Writeln(F,'Weight antara hiden '+inttostr(jhiden)+' dan
output');
  for b:=0 to ounit-1 do
    for c:=0 to hunit[jhiden-1]-1 do
      Writeln(F,FloatToStrF(wbobot[c,b],ffgeneral,8,4));
  Writeln(F,'');
  Writeln(F,'--------------------------------------------------
-------');
  Writeln(F,'---------------------===== completed =====---------------
-------');
  Writeln(F,'----------------------Copyright @2002--------------
----');
  closefile(F);
  end;
end;

procedure TForm1.OpenImage1Click(Sender: TObject);
begin
if not bukaimage.Execute then exit
else
begin
  simp.Enabled:=false;
  bacaimage1.Enabled:=true;
  aktiptrain(false);
  gambar:=tpcxbitmap.Create;
  gambar.Free;
  gambar:=tpcxbitmap.Create;
  gambar.PixelFormat:=pf8bit;
  gambar.LoadFromFile(bukaimage.FileName);
  lembar.Width:=gambar.Width;
  lembar.Height:=gambar.Height;
  lembar.Picture:=nil;
  lembar.Canvas.Draw(0,0,gambar);
end;
end;

procedure initinputread;
var x,y,val :integer;
begin
```

```
 setlength(input,1);

setlength(input[0],(round(tinggi/pembagi))*(round(lebar/pembagi))
+1);
 input[0,0]:=1;
 for y:=0 to gambarc.Height-1 do
    for x:=0 to gambarc.Width-1 do
      begin
        val:=getpixel(gambarc.Canvas.Handle,x,y);
        if val>127 then
          input[0,1+x+y*(round(tinggi/pembagi))]:=0 //warna putih
        else
          input[0,1+x+y*(round(tinggi/pembagi))]:=1; //warna hitam
      end;
 gambarc.Free;
end;


function binertobyte:byte;
var a:byte;
    temp:real;
begin
 val:=0;
 temp:=0;
 for a:=0 to ounit-1 do
  begin
    if output[0,a]>temp then
     begin
       temp:=output[0,a];
       val:=a;
     end;
  end;
  result:=val;
end;


function tform1.bacakarakter(sbaris,skolom:integer):integer;
var a,b,c,d    :integer;
    oin,erorout:array of real;
    sel,jum:real;
    bin:string;
begin
 bacagambar(sbaris,skolom);
 initinputread;
   for b:=0 to jhiden-1 do
    begin
      hiden[b,0]:=1.0;
      for c:=1 to hunit[b]-1 do
        begin
          hin[b,c]:=vbobot[b,0,c];
          if b=0 then
            begin
```

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```
              for d:=1 to iunit-1 do
                hin[b,c]:=hin[b,c]+input[0,d]*vbobot[b,d,c];
              end
            else
              begin
                for d:=1 to hunit[b-1]-1 do
                  hin[b,c]:=hin[b,c]+hiden[b-1,d]*vbobot[b,d,c];
                end;
              hiden[b,c]:=sigmoid(hin[b,c]);
              end;
          end;

      setlength(oin,ounit);
      for b:=0 to ounit-1 do
        begin
          oin[b]:=wbobot[0,b];
          for c:=1 to hunit[jhiden-1]-1 do
            oin[b]:=oin[b]+hiden[jhiden-1,c]*wbobot[c,b];
          output[0,b]:=sigmoid(oin[b]);
        end;
// result:=binertobyte-1;
  setlength(erorout,jgambar);
  for a:=0 to jgambar-1 do
    begin
      erorout[a]:=0;
      for b:=0 to ounit-1 do
        erorout[a]:=erorout[a]+sqr(output[0,b]-target[a,b]);
    end;
  jum:=100;
  result:=0;
  for a:=0 to jgambar-1 do
    begin
      if erorout[a]<jum then
        begin
          jum:=erorout[a];
          result:=a;
        end;
    end;
end;


procedure TForm1.BacaImage1Click(Sender: TObject);
var a,b:integer;
    posx,posy:integer;
    baris,bin:string;
begin
hapusmemo;
working:=apply;
memo1.Visible:=true;
memo1.Lines.Add('----------=== HASIL PEMBACAAN ===----------');
memo1.Lines.Add('');
inisialisasitarget;
```

```
baris:='';
posx:=0; posy:=0;
repeat
 a:=bacakarakter(posx,posy);
 baris:=baris+identitas[a]+' ';
 inc(posx,40);
 if posx+40>lembar.Width then
  begin
    posx:=0;
    inc(posy,40);
    memo1.Lines.Add(baris);
    baris:='';
  end;
until posy+40>lembar.Height;
end;

function caripos(s:string):integer;
var a:integer;
    temp:string;
begin
 a:=1;
 repeat
  temp:=copy(s,a,length(s)-a+1);
  inc(a);
 until ansistrscan(pchar(temp),'=')=nil;
 result:=a;
end;

function strtofloatsaya(s:string):real;
var a,b,c:integer;
    pengali:real;
begin
pengali:=0.1;
b:=0;
if s[1]='-' then b:=1;
if b=1 then a:=2
else a:=1;
 repeat
   if s[a]='.' then
    break;
   pengali:=pengali*10;
   inc(a);
 until a>length(s);

 if b=1 then a:=3
 else a:=2;
 result:=strtoint(s[a-1])*pengali;
 pengali:=pengali/10;
  repeat
   if s[a] in ['0'..'9'] then
    begin
     result:=result+strtoint(s[a])*pengali;
```

```
        pengali:=pengali/10;
      end;
    inc(a);
  until a>length(s);
if b=1 then result:=-result;
end;




procedure TForm1.Open1Click(Sender: TObject);
var a,b,c,d:integer;
      F: TextFile;
      s: string;
begin
if not bukadata.Execute then exit
else
  begin
    simp.Enabled:=false;
    aktiptrain(false);
    AssignFile(F, bukadata.FileName);    //File pilih pada dialog
    Reset(F);
    Readln(F, s);
    if s<>'Hasil Training Character Recognition Using
Backpropagation' then
      begin
      application.MessageBox('File tak berisi data
trainning'+#13+'Try open another file','Error on opening
file',mb_ok or mb_iconstop);
      exit;
      end;
    Readln(F, s);
    jgambar:=strtoint(copy(s,caripos(s),length(s)));
    setlength(identitas,jgambar);
    Readln(F, s);
    tinggi:=strtoint(copy(s,caripos(s),length(s)));
    Readln(F, s);
    lebar:=strtoint(copy(s,caripos(s),length(s)));
    Readln(F, s);
    iunit:=strtoint(copy(s,caripos(s),length(s)));
    Readln(F, s);
    ounit:=strtoint(copy(s,caripos(s),length(s)));
    Readln(F, s);
    jhiden:=strtoint(copy(s,caripos(s),length(s)));
    setlength(hunit,jhiden);
    for a:=1 to jhiden do
      begin
       readln(F, s);
       hunit[a-1]:=strtoint(copy(s,caripos(s),length(s)));
      end;
    for a:=1 to jgambar do
      begin
       readln(F, s);
```

```
      identitas[a-1]:=copy(s,caripos(s),length(s));
     end;
   Readln(F, s);
   mineror:=strtofloat(copy(s,caripos(s),length(s)));

// setlength(dataall,1,tinggi,lebar);
   setlength(hin,jhiden);
   setlength(input,1,iunit);
   setlength(output,1,ounit);
   setlength(hiden,jhiden);
   setlength(vbobot,jhiden);
   for a:=0 to jhiden -1 do
   begin
    setlength(hiden[a],hunit[a]);
    setlength(hin[a],hunit[a]);
    if a=0 then
     begin
      setlength(vbobot[a],iunit,hunit[0]);
     end
    else
     begin
      setlength(vbobot[a],hunit[a-1],hunit[a]);
     end;
   end;
   setlength(wbobot,hunit[jhiden-1],ounit);

   for b:=0 to jhiden-1 do
   begin
    if b=0 then
     begin
      Readln(F, s);
      for c:=0 to iunit-1 do
       for d:=0 to hunit[0]-1 do
        begin
         Readln(F, s);
         vbobot[b,c,d]:=strtofloat(s);
        end;
     end
    else
     begin
      Readln(F, s);
      for c:=0 to hunit[b-1]-1 do
       for d:=0 to hunit[b]-1 do
        begin
         Readln(F, s);
         vbobot[b,c,d]:=strtofloat(s);
        end;
     end;
   end;
   Readln(F, s);
   for b:=0 to ounit-1 do
    for c:=0 to hunit[jhiden-1]-1 do
```

```
      begin
          Readln(F, s);
          wbobot[c,b]:=strtofloat(s);
      end;
    closefile(F);
  end;
end;


procedure TForm1.About1Click(Sender: TObject);
begin
abot:=tabot.Create(self); //buat panggil about
abot.ShowModal;
end;


procedure TForm1.SimpanData1Click(Sender: TObject);
var a,b,c,d:integer;
    F:textfile;
    s:string;
begin
if not simpan.Execute then exit
else
 begin
 AssignFile(F,simpan.FileName);  //menyimpan file
 Rewrite(F);
 Writeln(F,'input=[');
 Writeln(F,'');
 for a:=0 to jumdata-1 do
  begin
   s:='';
   for b:=0 to iunit-2 do
    s:=s+floattostr(input[a,b])+' ';
   s:=s+floattostr(input[a,iunit-1])+';';
   Writeln(F,s);
  end;
 writeln(F,'];');
 Writeln(F,'output=[');
 Writeln(F,'');
 for a:=0 to jumdata-1 do
  begin
   s:='';
   for b:=0 to ounit-2 do
    s:=s+floattostr(target[a div dataperimage,b])+' ';
   s:=s+floattostr(target[a div dataperimage,ounit-1])+';';
   Writeln(F,s);
  end;
  write(F,'];');
  closefile(F);
 end;
end;
end.
```

Program menampilkan grafik;

```
unit unitgraph;

interface

uses Windows, SysUtils, Classes, Graphics, Forms, Controls,
StdCtrls,
   Buttons, ExtCtrls, TeEngine, Series, TeeProcs, Chart;

type
   TGraf = class(TForm)
      Chart1: TChart;
      Series1: TLineSeries;
   private
      { Private declarations }
   public
      { Public declarations }
   end;

var
   Graf: TGraf;

implementation

{$R *.DFM}

end.
```

Program Parameter

```
unit Unitparam;

interface

uses Windows, SysUtils, Classes, Graphics, Forms, Controls,
StdCtrls,
   Buttons, ExtCtrls, Mask,dialogs;

type
   Tparameter = class(TForm)
      OKBtn: TButton;
      CancelBtn: TButton;
      Bevel1: TBevel;
      Label3: TLabel;
      Label4: TLabel;
      ComboBox3: TComboBox;
      MaskEdit1: TMaskEdit;
      Label5: TLabel;
      Label6: TLabel;
```

```
    MaskEdit2: TMaskEdit;
    Label7: TLabel;
    ComboBox4: TComboBox;
    MaskEdit3: TMaskEdit;
    Label1: TLabel;
    Edit1: TEdit;
    procedure FormCreate(Sender: TObject);
    procedure OKBtnClick(Sender: TObject);
    procedure ComboBox4Change(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  parameter: Tparameter;
  htemp    : array of integer;
  jum      : integer;

implementation
uses main;

{$R *.DFM}

procedure Tparameter.FormCreate(Sender: TObject);
var a:integer;
begin
 for a:=5 to 100 do
  combobox3.Items.Add(inttostr(a));
end;

procedure Tparameter.OKBtnClick(Sender: TObject);
var a:integer;
begin
 main.jgambar:=strtoint(combobox3.Text);
 main.jhiden:=strtoint(combobox4.Text);
 main.iterasi:=strtoint(edit1.Text);
 setlength(main.hunit,jum);
 for a:=0 to main.jhiden-1 do
  main.hunit[a]:=htemp[a];
 main.alpha:=strtofloat(trim(maskedit1.Text));
 main.miu:=strtofloat(trim(maskedit2.Text));
 main.mineror:=strtofloat(trim(maskedit3.Text));
 main.working:=train;
end;

procedure Tparameter.ComboBox4Change(Sender: TObject);
var a:integer;
    temp:string;
begin
 jum:=strtoint(combobox4.Text);
```

```
 setlength(htemp,jum);
 for a:=0 to jum-1 do
  begin
   temp:='10';
   inputquery('Jumlah Unit Hiden Ke - '+inttostr(a+1),'Jumlah
Unit :',temp);
   htemp[a]:=strtoint(temp);
  end;
end;

end.
```

Unit PCXCTRL

```
unit Utstpcx;

interface

uses
   SysUtils, Windows,{WinTypes, WinProcs,} Messages, Classes,
Graphics, Controls,
   Forms, Dialogs, StdCtrls, ExtCtrls, Menus, Mimage;

type
   TForm1 = class(TForm)
     Panel1: TPanel;
     MainMenu1: TMainMenu;
     GetPCXFile1: TMenuItem;
     OpenDlg: TOpenDialog;
     Image1: TImage;
     procedure GetPCXFile(Sender: TObject);
   end;

var
   Form1: TForm1;

implementation
{$R *.DFM}
uses PcxCtrl;
procedure TForm1.GetPCXFile(Sender: TObject);
var
     Bitmap: TPCXBitmap;
begin
     Bitmap := TPCXBitmap.Create;
   if OpenDlg.Execute then
   try
     Bitmap.LoadFromFile(OpenDlg.Filename);
     ClientHeight := Bitmap.Height + 2;
     ClientWidth := Bitmap.Width + 2;
     Image1.Picture.Assign(Bitmap);
   except
```
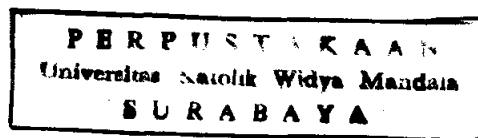
```
      MessageDlg('Invalid PCX file format.' + #13 +
      'Probably 24 bit or higher image.', mtError, [mbOk], 0);
  end;
  Bitmap.Free;
end;

end.
```

BIODATA

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