# Attrito Viscoso: una simulazione informatica

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## Indice

## 1 Introduzione

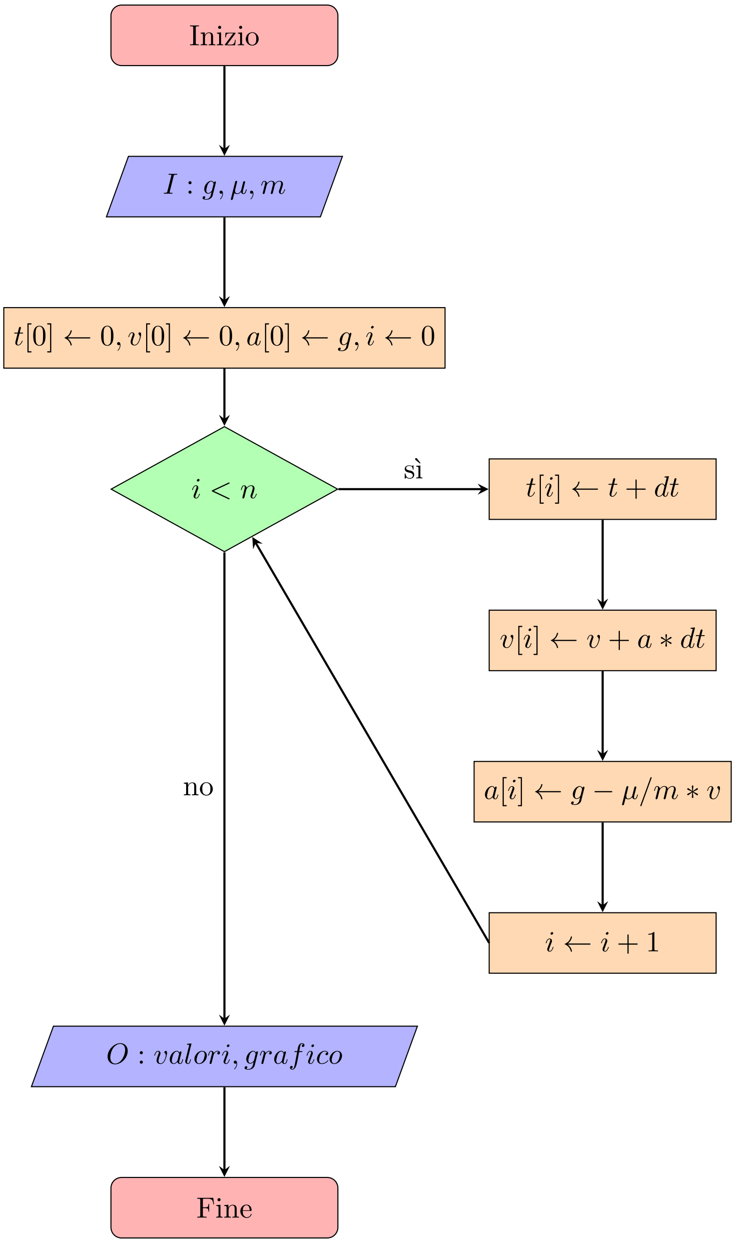
Your text goes here.

### 1.1 Descrizione Fisica

More text.

## 2 Simulazione

Abbiamo simulato, usando il modello fisico sopra descritto, il comportamento di un oggetto che cade in un fluido viscoso. Per fare ciò abbiamo sviluppato un software che, date le costanti fisiche $g$, $\mu$ e $m$, calcoli $n$ valori di Velocità, Tempo e Accelerazione per poter disegnare un grafico Velocità/Tempo sullo schermo, e trovare approssimativamente il valore della velocità terminale.


Inizio
$I : g, \mu, m$
$t[0] \leftarrow 0, v[0] \leftarrow 0, a[0] \leftarrow g, i \leftarrow 0$
$i < n$
sì
$t[i] \leftarrow t + dt$
$v[i] \leftarrow v + a * dt$
$a[i] \leftarrow g - \mu/m * v$
$i \leftarrow i + 1$
no
$O : valori, grafico$
Fine

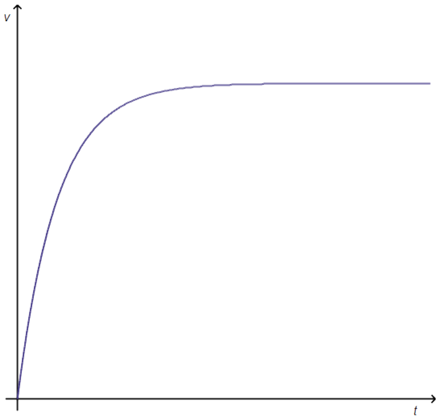
Questo algoritmo riempie una tabella con $n$ valori di tempo, velocità e accelerazione. Disegna inoltre il grafico Velocità/Tempo. Possiamo notare la costante $dt$, che rappresenta la differenza di tempo tra ogni campione e, in un certo senso, la risoluzione del grafico. Ci siamo accorti però che con certi valori di $dt$ il grafico cambiava radicalmente, rappresentando valori errati rispetto al modello fisico. Questo è dato dalle formule(1) usate per calcolare velocità e accelerazione:

$$\begin{aligned} a_1 &= g - \frac{\mu}{m} * v_0 \\ \text{con } v_0 = g * dt \rightarrow a_1 &= g - \frac{\mu}{m} * g * dt \end{aligned} \tag{1}$$

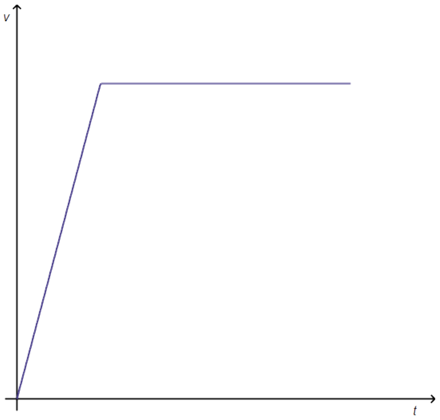
L'accelerazione del corpo deve diminuire tendendo a 0 per rispettare le leggi fisiche, ma ciò non avviene se $dt > \tau$. Ricaviamo $\tau$ ponendo l'accellerazione nel secondo campione pari a zero:

$$\begin{aligned} a_1 = g - \frac{\mu}{m} * g * \tau &= 0 \\ \tau &= \frac{m}{\mu} \end{aligned} \tag{2}$$

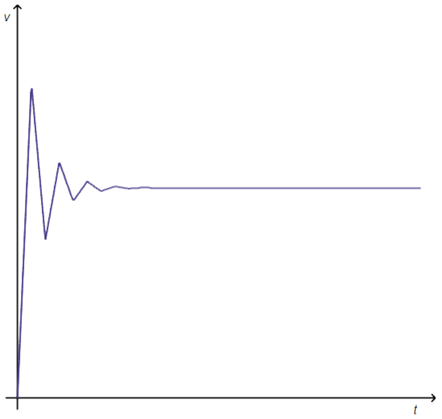
Variando il valore di $dt$ rispetto a $\tau$, il grafico cambia forma in questo modo:



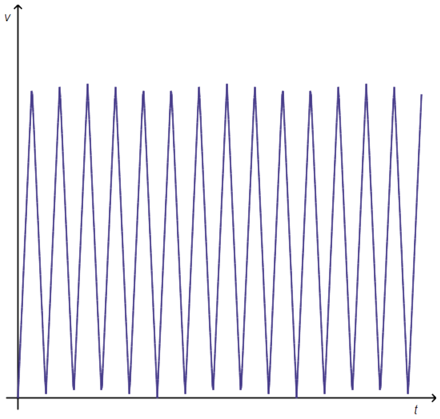
$dt < \tau$



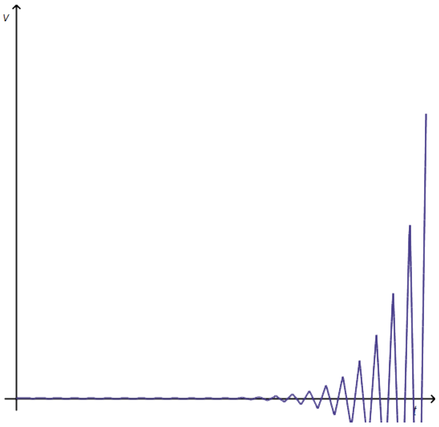
$dt = \tau$



$dt > \tau$



$dt = 2\tau$

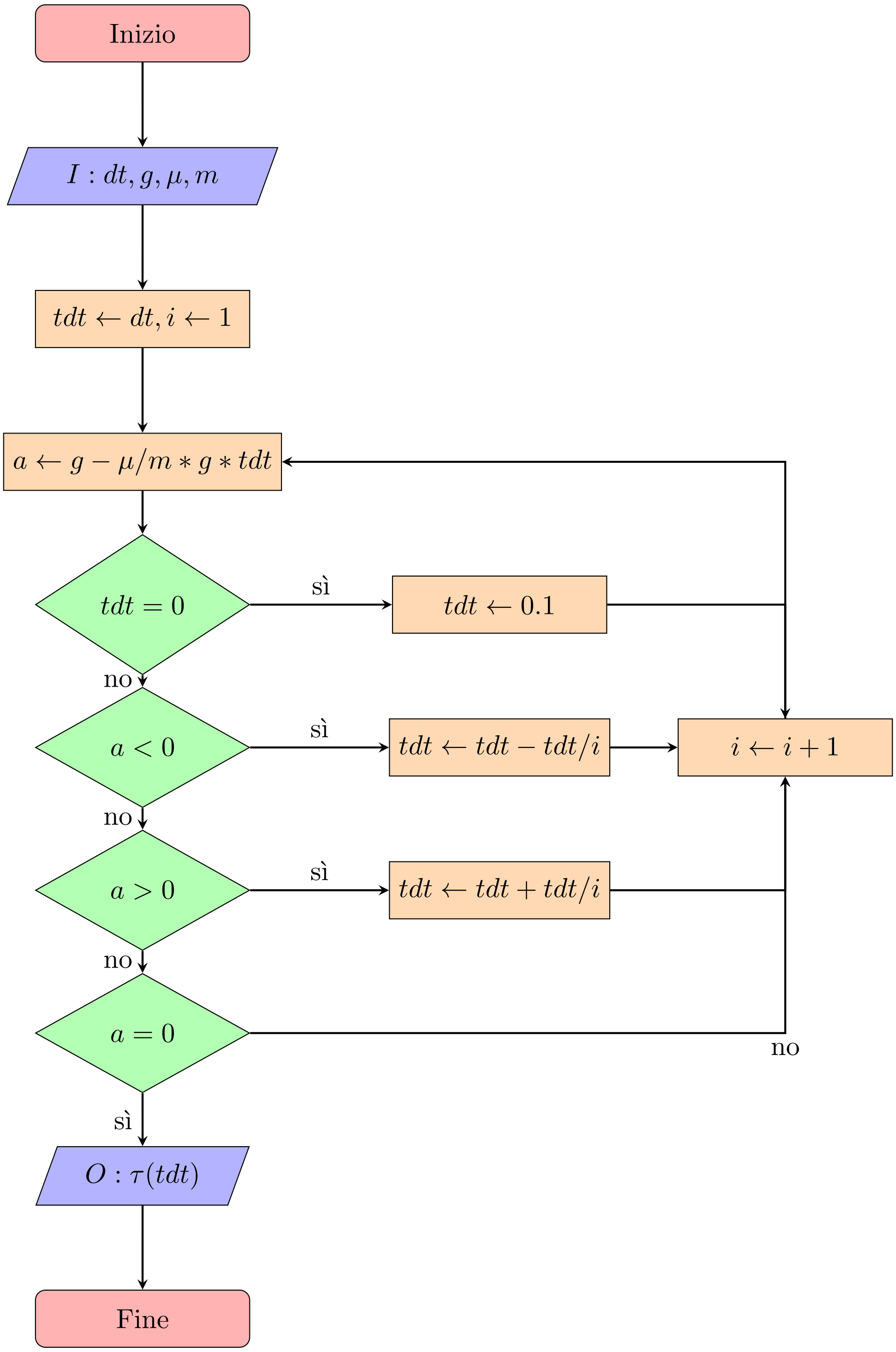


$dt > 2\tau$

Per fornire all'utente un grafico che rappresenti in maniera accurata il fenomeno fisico abbiamo strutturato il programma in modo che visualizzi un avviso nel caso $dt > \tau$, e visualizzi una previsione del grafico in base ai valori di $m$ e $\mu$

## 2.1 Calcolo di $\tau$

Per calcolare il valore approssimato di $\tau$ abbiamo usato un algoritmo che si basa su approssimazioni successive, riducendo o aumentando il valore di $dt$ fino a quando $a$ non sia pari a 0.

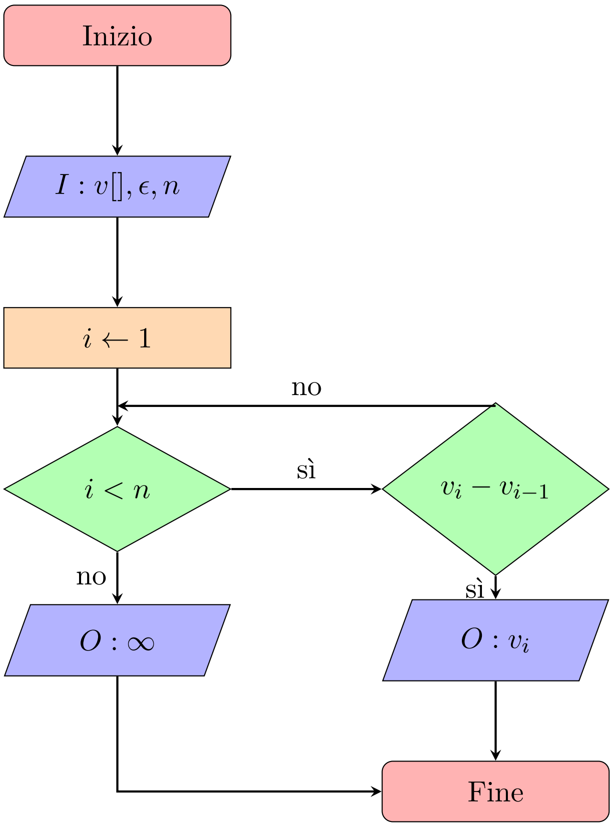


Che si traduce nella seguente funzione C#:

```
private float TauFromData(float dt, float g, float mua, float m)
{
    float tdt = dt; // dt temporaneo
    for (float i = 1f; i < 1000000; i++) // Limita un numero massimo
       di cicli
    {
        float a = g - mua / m * g * tdt; // Calcola accelerazione
        tdt = tdt == 0 ? 0.1f : tdt; // Evita che tdt sia 0
        if (a < 0)
            tdt -= tdt / i;
        else if (a > 0)
            tdt += tdt / i;
        else break;
        i++;
    }
    return tdt;
}
```

## 2.2 Calcolo di $V_t$

Per calcolare il valore approssimato di $V_t$(Velocità terminale) abbiamo usato un algoritmo che si basa su approssimazioni successive:

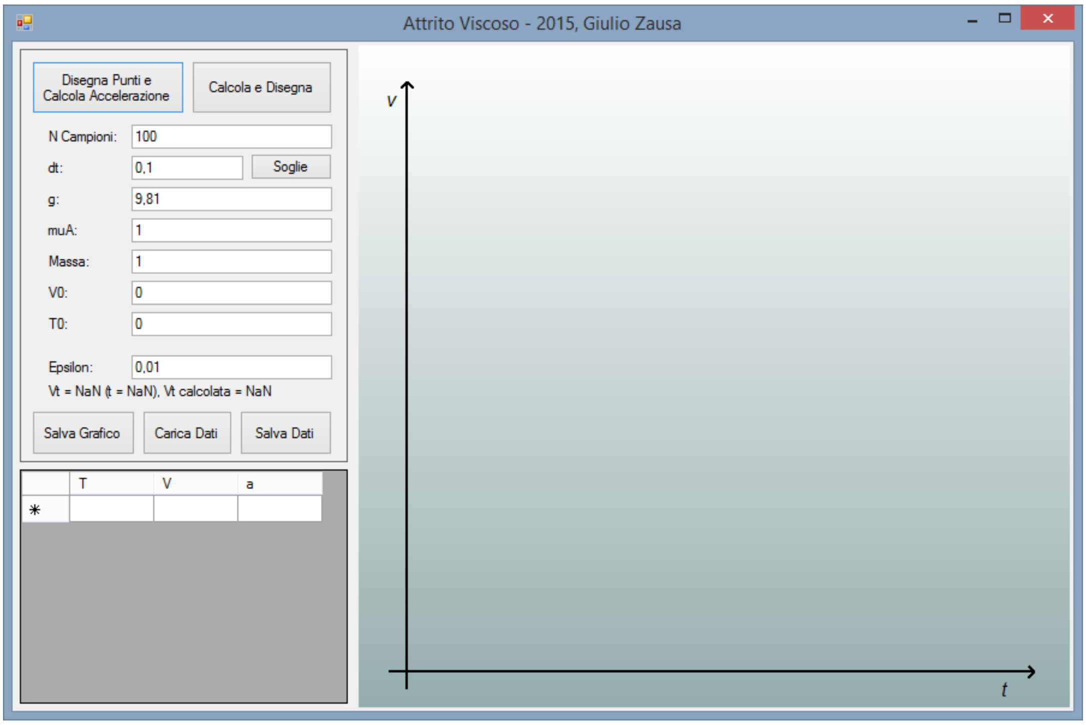


Che si traduce nella seguente funzione C#:

```
private float VtFromData(float[] v)
{
    for (int i = 1; i < v.Length; i++)
    {
        if (v[i] - v[i - 1] < epsilon) // Se differenza < epsilon
        {
            return v[i];
        }
    }
    return float.PositiveInfinity;
}
```

# 3 Realizzazione Grafica

Per sviluppare il software abbiamo scelto il linguaggio C# e le librerie di programmazione .NET Framework. Abbiamo fatto questa scelta a discapito del C++ per avere delle funzioni grafiche più potenti e più semplici.



Attrito Viscoso - 2015, Giulio Zausa
Disegna Punti e Calcola Accelerazione
Calcola e Disegna
Soglie
Salva Grafico
Carica Dati
Salva Dati
T
V
a
v
t

N Campioni: 100
dt: 0,1
g: 9,81
muA: 1
Massa: 1
V0: 0
T0: 0
Epsilon: 0,01
Vt = NaN (t = NaN), Vt calcolata = NaN

La form principale del programma.

Si possono distinguere tre pannelli principali del programma:

- Tabella dei Valori
- Grafico
- Pannello comandi e inserimento dati

# 4 Appendice: Codice sorgente

## 4.1 Program.cs

```
using System;
using System.Windows.Forms;

namespace ProGruppoInfo
{
    class Program
    {
        [STAThread]
        static void Main(string[] args)
        {
            Application.EnableVisualStyles();
            Application.SetCompatibleTextRenderingDefault(false);
            Application.Run(new MainForm());
        }
    }
}
```

## 4.2 MainForm.cs

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Drawing;
using System.Drawing.Drawing2D;
using System.Windows.Forms;

namespace ProGruppoInfo
{
    public partial class MainForm : Form
    {
        int n = 0;
        public static float dt, g, mua, m, v0, t0, epsilon, vt, tf;
        Bitmap bitmap, buffer, soglieb;
        Graphics gr;
        float maxY, maxX;
        Point origin;
        Point[] points;
        PointF[] originalPoints;
        SoglieView soglieForm;

        #region Inizializzazione
        public MainForm() // Costruttore
        {
            InitializeComponent();
            soglieForm = new SoglieView();
        }

        private void panel2_Paint(object sender, PaintEventArgs e) //
           Prepara buffer e disegna sfondo iniziale
        {
```

```
    bitmap = new Bitmap(panel2.Width, panel2.Height);
    buffer = new Bitmap(panel2.Width, panel2.Height);
    gr = Graphics.FromImage(bitmap);
    DrawAxes();
    panel2.CreateGraphics().DrawImage(bitmap, 0, 0);
}

private void MainForm_ResizeEnd(object sender, EventArgs e) //
   Aggiorna dimensione buffer se form ingrandita
{
    bitmap = new Bitmap(panel2.Width, panel2.Height);
    gr = Graphics.FromImage(bitmap);
    DrawAxes();
    panel2.CreateGraphics().DrawImage(bitmap, 0, 0);
}
#endregion

#region Disegno Grafici
// Disegna i dati
private void DrawData()
{
    gr.SmoothingMode = SmoothingMode.HighQuality; //
       Antialiasing
    DrawAxes(); // Disegna assi

    // Trova il massimo
    maxY = 1f;
    for (int i = 0; i < n; i++)
        if ((float)data.Rows[i].Cells[1].Value > maxY)
            maxY = (float)data.Rows[i].Cells[1].Value;
    maxY = maxY / 4f * 5f; // Riduce il massimo a 4/5

    // Trova i punti, interpola
    points = new Point[panel2.Width - 30];
    originalPoints = new PointF[panel2.Width - 30];
    float yval1 = 0, yval2 = 0;
    for (int x = 0; x < points.Length; x++)
    {
        int index1 = (int)Math.Floor((float)x /
           (float)(points.Length) * (float)(n)); // Indici nei
           dati
        int index2 = (int)Math.Ceiling((float)x /
           (float)(points.Length) * (float)(n));
        if (index2 < n && index1 >= 0)
        {
            yval1 = (float)data.Rows[index1].Cells[1].Value /
               maxY * (origin.Y - 30); // Valori di Y
            yval2 = (float)data.Rows[index2].Cells[1].Value /
               maxY * (origin.Y - 30);

            // Calcola X e Y interpolando due punti
            float px = x + 40f, py = origin.Y -
               Linear(((float)x % ((float)points.Length /
               (float)n)) / ((float)points.Length / (float)n),
               yval1, yval2);
            points[x] = new Point((int)px, (int)py);

            // Aggiunge valore X e Y originale interpolato a
               originalPoints per il popup dei valori
            originalPoints[x] = new
               PointF((float)Math.Round(Linear(((float)x %
               ((float)points.Length / (float)n)) /
               ((float)points.Length / (float)n), // X
                (float)data.Rows[index1].Cells[0].Value,
                   (float)data.Rows[index2].Cells[0].Value),
                   3),
                (float)Math.Round(Linear(((float)x %
                   ((float)points.Length / (float)n)) /
                   ((float)points.Length / (float)n), // Y
                (float)data.Rows[index1].Cells[1].Value,
                   (float)data.Rows[index2].Cells[1].Value),
                   3));
        }
        else if (index2 > n)
            maxX = x;
    }

    // Disegna i punti collegati
    for (int i = 1; i < points.Length; i++)
        if (points[i - 1].X != 0 && points[i].X != 0)
            gr.DrawLine(new Pen(new
               SolidBrush(Color.DarkSlateBlue), 2.5f),
               points[i - 1], points[i]);

    // Limite Tratteggiato
    gr.DrawLine(new Pen(new SolidBrush(Color.DarkRed), 1f) {
       DashStyle = DashStyle.Dash }, origin.X - 15, origin.Y -
       yval2, panel2.Width, origin.Y - yval2);
    gr.DrawString(Math.Round(vt, 2).ToString(), new
       Font("Arial", 10, FontStyle.Italic), new
       SolidBrush(Color.Black), 10, origin.Y - yval2 - 15);
    gr.DrawString("reale=\n" + Math.Round(g * m / mua,
       2).ToString(), new Font("Arial", 7, FontStyle.Italic),
       new SolidBrush(Color.DarkRed), 10, origin.Y - yval2);

    // Avviso Grafico
    if (data.RowCount > 3 &&
       (float)data.Rows[1].Cells[1].Value >
       (float)data.Rows[2].Cells[1].Value)
        gr.DrawString("Avviso: grafico errato, dt troppo
           grande", new Font("Arial", 10, FontStyle.Bold),
            new SolidBrush(Color.Red), origin.X + 15, origin.Y
               + 5);
}

private void DrawAxes() // Disegna Assi
{
    Rectangle rect = new Rectangle(0, 0, panel2.Width,
       panel2.Height);
    gr.FillRectangle(new
       System.Drawing.Drawing2D.LinearGradientBrush(rect,
       Color.White, Color.FromArgb(149, 173, 173), 90), rect);
       // Sfumatura
    origin = new Point(40, panel2.Height - 30);

    // Asse Y
    gr.DrawLine(new Pen(new SolidBrush(Color.Black), 2f),
       origin.X, origin.Y + 15, 40, 30);
    gr.DrawLine(new Pen(new SolidBrush(Color.Black), 2f), 40,
       30, 35, 35);
    gr.DrawLine(new Pen(new SolidBrush(Color.Black), 2f), 40,
       30, 45, 35);
    gr.DrawString("v", new Font("Arial", 12,
       FontStyle.Italic), new SolidBrush(Color.Black), 20, 35);

    // Asse X
    gr.DrawLine(new Pen(new SolidBrush(Color.Black), 2f),
       origin.X - 15, origin.Y, panel2.Width - 30, origin.Y);
    gr.DrawLine(new Pen(new SolidBrush(Color.Black), 2f),
       panel2.Width - 30, origin.Y, panel2.Width - 35,
       origin.Y + 5);
    gr.DrawLine(new Pen(new SolidBrush(Color.Black), 2f),
       panel2.Width - 30, origin.Y, panel2.Width - 35,
       origin.Y - 5);
    gr.DrawString("t", new Font("Arial", 12,
       FontStyle.Italic), new SolidBrush(Color.Black),
       panel2.Width - 60, origin.Y + 5);
}

private void Draw_Click(object sender, EventArgs e) // Disegna
   i punti calcolati
{
    CalculateData(); // Calcola i dati
    DrawData(); // Disegna
    panel2.CreateGraphics().DrawImage(bitmap, 0, 0);
}

private void DrawPoints_Click(object sender, EventArgs e) //
   Disegna punti senza calcolare
{
    n = data.RowCount - 1;
    epsilon = float.Parse(tht.Text);
    for (int i = 0; i < n; i++) // Converte tutti i dati in
       float
    {
        data.Rows[i].Cells[0].Value =
           float.Parse(data.Rows[i].Cells[0].Value.ToString());
        data.Rows[i].Cells[1].Value =
           float.Parse(data.Rows[i].Cells[1].Value.ToString());
    }

    // Trova le accellerazioni
    for (int i = 1; i < n; i++)
    {
        float dt = (float)data.Rows[i].Cells[0].Value -
           (float)data.Rows[i - 1].Cells[0].Value;
        float dv = (float)data.Rows[i].Cells[1].Value -
           (float)data.Rows[i - 1].Cells[1].Value;
        data.Rows[i - 1].Cells[2].Value = dv / dt;
    }

    // Calcola vt
    vt = VtFromData(out tf);
    label9.Text = "Vt = " + vt + " (t = " + tf + "), Vt
       calcolata = " + (g * m / mua);

    DrawData(); // Disegna
    panel2.CreateGraphics().DrawImage(bitmap, 0, 0);
}
#endregion

#region Dati
// Calcola i dati
private void CalculateData()
{
    // Legge dalla form
    n = int.Parse(nct.Text);
    dt = float.Parse(dtt.Text); g = float.Parse(gt.Text);
    mua = float.Parse(muat.Text); m = float.Parse(mt.Text);
    v0 = float.Parse(v0t.Text); t0 = float.Parse(t0t.Text);
    epsilon = float.Parse(tht.Text);

    data.Rows.Clear();
    data.Rows.Add();
    data.Rows[0].Cells[0].Value = t0;
    data.Rows[0].Cells[1].Value = v0;
    data.Rows[0].Cells[2].Value = g;
    for (int i = 1; i < n; i++)
    {
        data.Rows.Add();
        float pt = (float)data.Rows[i - 1].Cells[0].Value;
        float pv = (float)data.Rows[i - 1].Cells[1].Value;
        float pa = (float)data.Rows[i - 1].Cells[2].Value;
        data.Rows[i].Cells[0].Value = pt + dt;
        data.Rows[i].Cells[1].Value = pv + pa * dt;
        data.Rows[i].Cells[2].Value = -(mua / m) *
           (float)data.Rows[i].Cells[1].Value + g;
    }

    vt = VtFromData(out tf);
    label9.Text = "Vt = " + vt + " (t = " + tf + "), Vt
       calcolata = " + (g * m / mua);
}

// Trova la velocita terminale con i dati
private float VtFromData(out float time)
{
    for (int i = 1; i < n; i++)
    {
        if ((float)data.Rows[i].Cells[1].Value -
           (float)data.Rows[i - 1].Cells[1].Value < epsilon)
        {
            data.Rows[i].Selected = true;
            time = (float)data.Rows[i].Cells[0].Value;
            return (float)data.Rows[i].Cells[1].Value;
        }
    }
    time = float.PositiveInfinity;
    return float.PositiveInfinity;
}

// Trova tau con i dati
private float TauFromData()
{
    // Legge dati dalla form
    dt = float.Parse(dtt.Text);
    g = float.Parse(gt.Text);
    mua = float.Parse(muat.Text);
    m = float.Parse(mt.Text);
    float tdt = dt; // dt temporaneo
    for (float i = 1f; i < 1000000; i++)
    {
        float a = g - mua / m * g * tdt; // Calcola
           accelerazione
        tdt = tdt == 0 ? 0.1f : tdt; // Evita che tdt sia 0
        if (a < 0)
            tdt -= tdt / i;
        else if (a > 0)
            tdt += tdt / i;
        else break;

        i++;
    }
    return tdt;
}
#endregion

#region File IO
private void Save_Click(object sender, EventArgs e) // Salva
   Immagine
{
    SaveFileDialog dialog = new SaveFileDialog();
    if (dialog.ShowDialog() ==
       System.Windows.Forms.DialogResult.OK)
        bitmap.Save(dialog.FileName);
}

private void LoadData_Click(object sender, EventArgs e) //
   Carica CSV
{
    OpenFileDialog dialog = new OpenFileDialog();
    if (dialog.ShowDialog() ==
       System.Windows.Forms.DialogResult.OK)
    {
        string[] file =
           System.IO.File.ReadAllLines(dialog.FileName);
        n = file.Length;
        for (int i = 0; i < n; i++)
        {
            data.Rows.Clear();
            data.Rows.Add();
            string[] explode = file[i].Split(';');
            data.Rows[i].Cells[0].Value =
               float.Parse(explode[0]);
            data.Rows[i].Cells[1].Value =
               float.Parse(explode[1]);
            data.Rows[i].Cells[2].Value =
               float.Parse(explode[2]);
        }
    }
}

private void SaveData_Click(object sender, EventArgs e) //
   Salva CSV
{
    SaveFileDialog dialog = new SaveFileDialog();
    if (dialog.ShowDialog() ==
       System.Windows.Forms.DialogResult.OK)
    {
        string file = "";
        for (int i = 0; i < n; i++)
            file += (float)data.Rows[i].Cells[0].Value + ";" +
               (float)data.Rows[i].Cells[1].Value + ";"
                + (float)data.Rows[i].Cells[1].Value + ";" +
                   Environment.NewLine;
        System.IO.File.WriteAllText(dialog.FileName, file);
    }
}
#endregion

#region Riquadro Valore
private void panel2_MouseUp(object sender, MouseEventArgs e)
   // Ridisegna quando mouse smette di cliccare
{
    panel2.CreateGraphics().DrawImage(bitmap, 0, 0);
}

private void panel2_MouseLeave(object sender, EventArgs e) //
   Ridisegna quando mouse esce
{
    panel2.CreateGraphics().DrawImage(bitmap, 0, 0);
}

private void panel2_MouseMove(object sender, MouseEventArgs e)
   // Ridisegna la finestra quando mouse muove
{
    if (e.Button == MouseButtons.Left)
        DrawValueBox(e);
}
```

```
private void panel2_MouseDown(object sender, MouseEventArgs e)
   // Disegna la finestra quando mouse clicca
{
    DrawValueBox(e);
}

private void DrawValueBox(MouseEventArgs e) // Disegna la
   finestra sul buffer
{
    if (points != null && e.Location.X - 40 < (maxX != 0 ?
       maxX : 99999)
        && e.Location.X > 40 && e.Location.X < panel2.Width)
           // Se mouse sul grafico
    {
        Graphics g = Graphics.FromImage(buffer);
        g.DrawImage(bitmap, 0, 0); // Sfondo e grafico
        g.FillEllipse(Brushes.Gray, (float)points[e.Location.X
           - 40].X - 3f, (float)points[e.Location.X - 40].Y -
           3f, 6f, 6f); // Pallina
        g.DrawLine(Pens.Gray, points[e.Location.X - 40], new
           Point((int)Clamp(e.Location.X - 1 + 19, 0,
           panel2.Width - 101), points[e.Location.X - 40].Y -
           10)); // Linea
        g.DrawRectangle(Pens.DodgerBlue, Clamp(e.Location.X -
           1 + 20, 0, panel2.Width - 101), points[e.Location.X
           - 40].Y - 21, 101, 16); // Bordo
        g.FillRectangle(Brushes.White, Clamp(e.Location.X +
           20, 0, panel2.Width - 100), points[e.Location.X -
           40].Y - 20, 100, 15); // Rettangolo
        g.DrawString("T: " + originalPoints[e.Location.X -
           40].X + " V: " + originalPoints[e.Location.X -
           40].Y, // Testo
            new Font("Arial", 9, FontStyle.Regular), new
               SolidBrush(Color.Black), Clamp(e.Location.X +
               20, 0, panel2.Width - 100), points[e.Location.X
               - 40].Y - 20);
        panel2.CreateGraphics().DrawImage(buffer, 0, 0); //
           Riquadro
    }
}
#endregion

#region Soglie
private void DrawSoglie() // Disegna finestra soglie
{
    soglieb = new Bitmap(soglieForm.Width, soglieForm.Height);
    Graphics sgr = Graphics.FromImage(soglieb);
    Rectangle rect = new Rectangle(0, 0, soglieForm.Width,
       soglieForm.Height);
    sgr.FillRectangle(new
       System.Drawing.Drawing2D.LinearGradientBrush(rect,
       Color.White, Color.FromArgb(149, 173, 173), 90), rect);
    int width = soglieForm.Width / 5 - 5;
    sgr.DrawImage(Resource1._1, new Rectangle(0, 0, width,
       soglieForm.Height - 70));
    sgr.DrawImage(Resource1._2, new Rectangle(width, 0, width,
       soglieForm.Height - 70));
    sgr.DrawImage(Resource1._3, new Rectangle(width * 2, 0,
       width, soglieForm.Height - 70));
    sgr.DrawImage(Resource1._4, new Rectangle(width * 3, 0,
       width, soglieForm.Height - 70));
    sgr.DrawImage(Resource1._5, new Rectangle(width * 4, 0,
       width, soglieForm.Height - 70));
    DrawSoglieText();
}

private void DrawSoglieText() // Disegna testo finestra soglie
{
    try
    {
        int width = soglieForm.Width / 5 - 5;
        Graphics sgrf = soglieForm.CreateGraphics();
        sgrf.DrawImage(soglieb, 0, 0);
        mua = float.Parse(muat.Text); m = float.Parse(mt.Text);
        float tau = TauFromData();
        sgrf.DrawString("con dt < " + Math.Round(tau, 2), new
           Font("Arial", 12, FontStyle.Italic), new
           SolidBrush(Color.Black), 10, soglieForm.Height -
           65);
        sgrf.DrawString("con dt = " + Math.Round(tau, 2), new
           Font("Arial", 12, FontStyle.Italic), new
           SolidBrush(Color.Black), width + 10,
           soglieForm.Height - 65);
        sgrf.DrawString("con dt > " + Math.Round(tau, 2), new
           Font("Arial", 12, FontStyle.Italic), new
           SolidBrush(Color.Black), 2 * width + 10,
           soglieForm.Height - 65);
        sgrf.DrawString("con dt = " + Math.Round(2f * tau, 2),
           new Font("Arial", 12, FontStyle.Italic), new
           SolidBrush(Color.Black), 3 * width + 10,
           soglieForm.Height - 65);
        sgrf.DrawString("con dt > " + Math.Round(2f * tau, 2),
           new Font("Arial", 12, FontStyle.Italic), new
           SolidBrush(Color.Black), 4 * width + 10,
           soglieForm.Height - 65);
    }
    catch (Exception) { }
}

private void soglie_Click(object sender, EventArgs e) //
   Mostra form soglie
{
    if (soglieForm.Visible == true)
        soglieForm.Hide();
    else
    {
        soglieForm.StartPosition = FormStartPosition.Manual;
```

```
                soglieForm.Location = new Point(this.Location.X +
                   (this.Width / 2) - (soglieForm.Width / 2),
                   this.Location.Y + this.Height);
                soglieForm.Show(this);
                DrawSoglie();
            }
        }

        private void MainForm_Move(object sender, EventArgs e) //
           Sposta form soglie con form principale
        {
            soglieForm.Location = new Point(this.Location.X +
               (this.Width / 2) - (soglieForm.Width / 2),
               this.Location.Y + this.Height);
        }

        private void muat_TextChanged(object sender, EventArgs e) //
           Aggiorna valore soglia con modifica costanti
        {
            DrawSoglieText();
        }

        private void mt_TextChanged(object sender, EventArgs e)
        {
            DrawSoglieText();
        }

        private void MainForm_FormClosing(object sender,
           FormClosingEventArgs e)
        {
            soglieForm.noClose = false;
        }
        #endregion

        // Interpolazione Lineare
        private float Linear(float x, float a, float b)
        {
            return a + (b - a) * x;
        }

        // Restringi valore
        private float Clamp(float v, float min, float max)
        {
            return v >= min ? (v <= max ? v : max) : min;
        }
    }
}
```

## 4.3 MainForm.Designer.cs

```
namespace ProGruppoInfo
{
    partial class MainForm
    {
```

```
/// <summary>
/// Required designer variable.
/// </summary>
private System.ComponentModel.IContainer components = null;

/// <summary>
/// Clean up any resources being used.
/// </summary>
/// <param name="disposing">true if managed resources should
   be disposed; otherwise, false.</param>
protected override void Dispose(bool disposing)
{
    if (disposing && (components != null))
    {
        components.Dispose();
    }
    base.Dispose(disposing);
}

#region Windows Form Designer generated code

/// <summary>
/// Required method for Designer support - do not modify
/// the contents of this method with the code editor.
/// </summary>
private void InitializeComponent()
{
    this.tableLayoutPanel1 = new
       System.Windows.Forms.TableLayoutPanel();
    this.panel2 = new System.Windows.Forms.Panel();
    this.tableLayoutPanel2 = new
       System.Windows.Forms.TableLayoutPanel();
    this.panel1 = new System.Windows.Forms.Panel();
    this.soglie = new System.Windows.Forms.Button();
    this.SaveData = new System.Windows.Forms.Button();
    this.LoadData = new System.Windows.Forms.Button();
    this.Save = new System.Windows.Forms.Button();
    this.label9 = new System.Windows.Forms.Label();
    this.tht = new System.Windows.Forms.TextBox();
    this.label8 = new System.Windows.Forms.Label();
    this.t0t = new System.Windows.Forms.TextBox();
    this.label7 = new System.Windows.Forms.Label();
    this.v0t = new System.Windows.Forms.TextBox();
    this.mt = new System.Windows.Forms.TextBox();
    this.label5 = new System.Windows.Forms.Label();
    this.label6 = new System.Windows.Forms.Label();
    this.muat = new System.Windows.Forms.TextBox();
    this.gt = new System.Windows.Forms.TextBox();
    this.label3 = new System.Windows.Forms.Label();
    this.label4 = new System.Windows.Forms.Label();
    this.dtt = new System.Windows.Forms.TextBox();
    this.nct = new System.Windows.Forms.TextBox();
    this.label2 = new System.Windows.Forms.Label();
    this.label1 = new System.Windows.Forms.Label();
    this.Draw = new System.Windows.Forms.Button();
    this.DrawPoints = new System.Windows.Forms.Button();
    this.data = new System.Windows.Forms.DataGridView();
    this.T = new
       System.Windows.Forms.DataGridViewTextBoxColumn();
    this.V = new
       System.Windows.Forms.DataGridViewTextBoxColumn();
    this.a = new
       System.Windows.Forms.DataGridViewTextBoxColumn();
    this.tableLayoutPanel1.SuspendLayout();
    this.tableLayoutPanel2.SuspendLayout();
    this.panel1.SuspendLayout();
    ((System.ComponentModel.ISupportInitialize)(this.data)).BeginInit();
    this.SuspendLayout();
    //
    // tableLayoutPanel1
    //
    this.tableLayoutPanel1.ColumnCount = 2;
    this.tableLayoutPanel1.ColumnStyles.Add(new
       System.Windows.Forms.ColumnStyle(System.Windows.Forms.SizeType.Absolu
       285F));
    this.tableLayoutPanel1.ColumnStyles.Add(new
       System.Windows.Forms.ColumnStyle());
    this.tableLayoutPanel1.Controls.Add(this.panel2, 1, 0);
    this.tableLayoutPanel1.Controls.Add(this.tableLayoutPanel2,
       0, 0);
    this.tableLayoutPanel1.Dock =
       System.Windows.Forms.DockStyle.Fill;
    this.tableLayoutPanel1.Location = new
       System.Drawing.Point(0, 0);
    this.tableLayoutPanel1.Name = "tableLayoutPanel1";
    this.tableLayoutPanel1.RowCount = 1;
    this.tableLayoutPanel1.RowStyles.Add(new
       System.Windows.Forms.RowStyle());
    this.tableLayoutPanel1.Size = new System.Drawing.Size(883,
       557);
    this.tableLayoutPanel1.TabIndex = 0;
    //
    // panel2
    //
    this.panel2.BackColor = System.Drawing.Color.White;
    this.panel2.Dock = System.Windows.Forms.DockStyle.Fill;
    this.panel2.Location = new System.Drawing.Point(288, 3);
    this.panel2.Name = "panel2";
    this.panel2.Size = new System.Drawing.Size(592, 551);
    this.panel2.TabIndex = 1;
    this.panel2.Paint += new
       System.Windows.Forms.PaintEventHandler(this.panel2_Paint);
    this.panel2.MouseDown += new
       System.Windows.Forms.MouseEventHandler(this.panel2_MouseDown);
    this.panel2.MouseLeave += new
       System.EventHandler(this.panel2_MouseLeave);
    this.panel2.MouseMove += new
       System.Windows.Forms.MouseEventHandler(this.panel2_MouseMove);
    this.panel2.MouseUp += new
       System.Windows.Forms.MouseEventHandler(this.panel2_MouseUp);
```

```
//
// tableLayoutPanel2
//
this.tableLayoutPanel2.ColumnCount = 1;
this.tableLayoutPanel2.ColumnStyles.Add(new
    System.Windows.Forms.ColumnStyle(System.Windows.Forms.SizeType.Percen
    100F));
this.tableLayoutPanel2.Controls.Add(this.panel1, 0, 0);
this.tableLayoutPanel2.Controls.Add(this.data, 0, 1);
this.tableLayoutPanel2.Dock =
    System.Windows.Forms.DockStyle.Fill;
this.tableLayoutPanel2.Location = new
    System.Drawing.Point(3, 3);
this.tableLayoutPanel2.Name = "tableLayoutPanel2";
this.tableLayoutPanel2.RowCount = 2;
this.tableLayoutPanel2.RowStyles.Add(new
    System.Windows.Forms.RowStyle(System.Windows.Forms.SizeType.Absolute
    350F));
this.tableLayoutPanel2.RowStyles.Add(new
    System.Windows.Forms.RowStyle());
this.tableLayoutPanel2.Size = new System.Drawing.Size(279,
    551);
this.tableLayoutPanel2.TabIndex = 2;
//
// panel1
//
this.panel1.BorderStyle =
    System.Windows.Forms.BorderStyle.FixedSingle;
this.panel1.Controls.Add(this.soglie);
this.panel1.Controls.Add(this.SaveData);
this.panel1.Controls.Add(this.LoadData);
this.panel1.Controls.Add(this.Save);
this.panel1.Controls.Add(this.label9);
this.panel1.Controls.Add(this.tht);
this.panel1.Controls.Add(this.label8);
this.panel1.Controls.Add(this.t0t);
this.panel1.Controls.Add(this.label7);
this.panel1.Controls.Add(this.v0t);
this.panel1.Controls.Add(this.mt);
this.panel1.Controls.Add(this.label5);
this.panel1.Controls.Add(this.label6);
this.panel1.Controls.Add(this.muat);
this.panel1.Controls.Add(this.gt);
this.panel1.Controls.Add(this.label3);
this.panel1.Controls.Add(this.label4);
this.panel1.Controls.Add(this.dtt);
this.panel1.Controls.Add(this.nct);
this.panel1.Controls.Add(this.label2);
this.panel1.Controls.Add(this.label1);
this.panel1.Controls.Add(this.Draw);
this.panel1.Controls.Add(this.DrawPoints);
this.panel1.Dock = System.Windows.Forms.DockStyle.Fill;
this.panel1.Location = new System.Drawing.Point(3, 3);
this.panel1.Name = "panel1";
this.panel1.Size = new System.Drawing.Size(273, 344);
this.panel1.TabIndex = 1;
//
// soglie
//
this.soglie.Location = new System.Drawing.Point(191, 86);
this.soglie.Name = "soglie";
this.soglie.Size = new System.Drawing.Size(68, 22);
this.soglie.TabIndex = 24;
this.soglie.Text = "Soglie";
this.soglie.UseVisualStyleBackColor = true;
this.soglie.Click += new
    System.EventHandler(this.soglie_Click);
//
// SaveData
//
this.SaveData.Location = new System.Drawing.Point(182,
    300);
this.SaveData.Name = "SaveData";
this.SaveData.Size = new System.Drawing.Size(77, 37);
this.SaveData.TabIndex = 21;
this.SaveData.Text = "Salva Dati";
this.SaveData.UseVisualStyleBackColor = true;
this.SaveData.Click += new
    System.EventHandler(this.SaveData_Click);
//
// LoadData
//
this.LoadData.Location = new System.Drawing.Point(101,
    300);
this.LoadData.Name = "LoadData";
this.LoadData.Size = new System.Drawing.Size(75, 37);
this.LoadData.TabIndex = 20;
this.LoadData.Text = "Carica Dati";
this.LoadData.UseVisualStyleBackColor = true;
this.LoadData.Click += new
    System.EventHandler(this.LoadData_Click);
//
// Save
//
this.Save.Location = new System.Drawing.Point(9, 300);
this.Save.Name = "Save";
this.Save.Size = new System.Drawing.Size(86, 37);
this.Save.TabIndex = 19;
this.Save.Text = "Salva Grafico";
this.Save.UseVisualStyleBackColor = true;
this.Save.Click += new
    System.EventHandler(this.Save_Click);
//
// label9
//
this.label9.AutoSize = true;
this.label9.Location = new System.Drawing.Point(20, 277);
this.label9.Name = "label9";
this.label9.Size = new System.Drawing.Size(193, 13);
this.label9.TabIndex = 18;
this.label9.Text = "Vt = NaN (t = NaN), Vt calcolata =
   NaN";
//
// tht
//
this.tht.Location = new System.Drawing.Point(92, 254);
this.tht.Name = "tht";
this.tht.Size = new System.Drawing.Size(167, 20);
this.tht.TabIndex = 17;
this.tht.Text = "0,01";
//
// label8
//
this.label8.AutoSize = true;
this.label8.Location = new System.Drawing.Point(20, 257);
this.label8.Name = "label8";
this.label8.Size = new System.Drawing.Size(44, 13);
this.label8.TabIndex = 16;
this.label8.Text = "Epsilon:";
//
// t0t
//
this.t0t.Location = new System.Drawing.Point(92, 218);
this.t0t.Name = "t0t";
this.t0t.Size = new System.Drawing.Size(167, 20);
this.t0t.TabIndex = 15;
this.t0t.Text = "0";
//
// label7
//
this.label7.AutoSize = true;
this.label7.Location = new System.Drawing.Point(20, 221);
this.label7.Name = "label7";
this.label7.Size = new System.Drawing.Size(23, 13);
this.label7.TabIndex = 14;
this.label7.Text = "T0:";
//
// v0t
//
this.v0t.Location = new System.Drawing.Point(92, 192);
this.v0t.Name = "v0t";
this.v0t.Size = new System.Drawing.Size(167, 20);
this.v0t.TabIndex = 13;
this.v0t.Text = "0";
//
// mt
//
this.mt.Location = new System.Drawing.Point(92, 166);
this.mt.Name = "mt";
this.mt.Size = new System.Drawing.Size(167, 20);
this.mt.TabIndex = 12;
this.mt.Text = "1";
this.mt.TextChanged += new
   System.EventHandler(this.mt_TextChanged);
//
```

```
// label5
//
this.label5.AutoSize = true;
this.label5.Location = new System.Drawing.Point(20, 195);
this.label5.Name = "label5";
this.label5.Size = new System.Drawing.Size(23, 13);
this.label5.TabIndex = 11;
this.label5.Text = "V0:";
//
// label6
//
this.label6.AutoSize = true;
this.label6.Location = new System.Drawing.Point(20, 169);
this.label6.Name = "label6";
this.label6.Size = new System.Drawing.Size(41, 13);
this.label6.TabIndex = 10;
this.label6.Text = "Massa:";
//
// muat
//
this.muat.Location = new System.Drawing.Point(92, 140);
this.muat.Name = "muat";
this.muat.Size = new System.Drawing.Size(167, 20);
this.muat.TabIndex = 9;
this.muat.Text = "1";
this.muat.TextChanged += new
   System.EventHandler(this.muat_TextChanged);
//
// gt
//
this.gt.Location = new System.Drawing.Point(92, 114);
this.gt.Name = "gt";
this.gt.Size = new System.Drawing.Size(167, 20);
this.gt.TabIndex = 8;
this.gt.Text = "9,81";
//
// label3
//
this.label3.AutoSize = true;
this.label3.Location = new System.Drawing.Point(20, 143);
this.label3.Name = "label3";
this.label3.Size = new System.Drawing.Size(31, 13);
this.label3.TabIndex = 7;
this.label3.Text = "muA:";
//
// label4
//
this.label4.AutoSize = true;
this.label4.Location = new System.Drawing.Point(20, 117);
this.label4.Name = "label4";
this.label4.Size = new System.Drawing.Size(16, 13);
this.label4.TabIndex = 6;
this.label4.Text = "g:";
//
// dtt
```

```
//
this.dtt.Location = new System.Drawing.Point(92, 88);
this.dtt.Name = "dtt";
this.dtt.Size = new System.Drawing.Size(93, 20);
this.dtt.TabIndex = 5;
this.dtt.Text = "0,1";
//
// nct
//
this.nct.Location = new System.Drawing.Point(92, 62);
this.nct.Name = "nct";
this.nct.Size = new System.Drawing.Size(167, 20);
this.nct.TabIndex = 4;
this.nct.Text = "100";
//
// label2
//
this.label2.AutoSize = true;
this.label2.Location = new System.Drawing.Point(20, 91);
this.label2.Name = "label2";
this.label2.Size = new System.Drawing.Size(19, 13);
this.label2.TabIndex = 3;
this.label2.Text = "dt:";
//
// label1
//
this.label1.AutoSize = true;
this.label1.Location = new System.Drawing.Point(20, 65);
this.label1.Name = "label1";
this.label1.Size = new System.Drawing.Size(64, 13);
this.label1.TabIndex = 2;
this.label1.Text = "N Campioni:";
//
// Draw
//
this.Draw.Location = new System.Drawing.Point(142, 9);
this.Draw.Name = "Draw";
this.Draw.Size = new System.Drawing.Size(117, 44);
this.Draw.TabIndex = 1;
this.Draw.Text = "Calcola e Disegna";
this.Draw.UseVisualStyleBackColor = true;
this.Draw.Click += new
   System.EventHandler(this.Draw_Click);
//
// DrawPoints
//
this.DrawPoints.Location = new System.Drawing.Point(9, 9);
this.DrawPoints.Name = "DrawPoints";
this.DrawPoints.Size = new System.Drawing.Size(127, 44);
this.DrawPoints.TabIndex = 0;
this.DrawPoints.Text = "Disegna Punti e Calcola
   Accelerazione";
this.DrawPoints.UseVisualStyleBackColor = true;
this.DrawPoints.Click += new
   System.EventHandler(this.DrawPoints_Click);
```

```
//
// data
//
this.data.ColumnHeadersHeightSizeMode =
    System.Windows.Forms.DataGridViewColumnHeadersHeightSizeMode.AutoSiz
this.data.Columns.AddRange(new
    System.Windows.Forms.DataGridViewColumn[] {
this.T,
this.V,
this.a});
this.data.Dock = System.Windows.Forms.DockStyle.Fill;
this.data.Location = new System.Drawing.Point(3, 353);
this.data.Name = "data";
this.data.Size = new System.Drawing.Size(273, 195);
this.data.TabIndex = 2;
//
// T
//
this.T.HeaderText = "T";
this.T.Name = "T";
this.T.Width = 70;
//
// V
//
this.V.HeaderText = "V";
this.V.Name = "V";
this.V.Width = 70;
//
// a
//
this.a.HeaderText = "a";
this.a.Name = "a";
this.a.Width = 70;
//
// MainForm
//
this.AutoScaleDimensions = new System.Drawing.SizeF(6F,
    13F);
this.AutoScaleMode =
    System.Windows.Forms.AutoScaleMode.Font;
this.ClientSize = new System.Drawing.Size(883, 557);
this.Controls.Add(this.tableLayoutPanel1);
this.Name = "MainForm";
this.Text = "Attrito Viscoso - 2015, Giulio Zausa";
this.FormClosing += new
    System.Windows.Forms.FormClosingEventHandler(this.MainForm_FormClosi
this.ResizeEnd += new
    System.EventHandler(this.MainForm_ResizeEnd);
this.Move += new System.EventHandler(this.MainForm_Move);
this.tableLayoutPanel1.ResumeLayout(false);
this.tableLayoutPanel2.ResumeLayout(false);
this.panel1.ResumeLayout(false);
this.panel1.PerformLayout();
((System.ComponentModel.ISupportInitialize)(this.data)).EndInit();
this.ResumeLayout(false);
```

```
        }

        #endregion

        private System.Windows.Forms.TableLayoutPanel
           tableLayoutPanel1;
        private System.Windows.Forms.Panel panel2;
        private System.Windows.Forms.TableLayoutPanel
           tableLayoutPanel2;
        private System.Windows.Forms.Panel panel1;
        private System.Windows.Forms.TextBox tht;
        private System.Windows.Forms.Label label8;
        private System.Windows.Forms.TextBox t0t;
        private System.Windows.Forms.Label label7;
        private System.Windows.Forms.TextBox v0t;
        private System.Windows.Forms.TextBox mt;
        private System.Windows.Forms.Label label5;
        private System.Windows.Forms.Label label6;
        private System.Windows.Forms.TextBox muat;
        private System.Windows.Forms.TextBox gt;
        private System.Windows.Forms.Label label3;
        private System.Windows.Forms.Label label4;
        private System.Windows.Forms.TextBox dtt;
        private System.Windows.Forms.TextBox nct;
        private System.Windows.Forms.Label label2;
        private System.Windows.Forms.Label label1;
        private System.Windows.Forms.Button Draw;
        private System.Windows.Forms.DataGridView data;
        private System.Windows.Forms.DataGridViewTextBoxColumn T;
        private System.Windows.Forms.DataGridViewTextBoxColumn V;
        private System.Windows.Forms.DataGridViewTextBoxColumn a;
        private System.Windows.Forms.Label label9;
        private System.Windows.Forms.Button DrawPoints;
        private System.Windows.Forms.Button Save;
        private System.Windows.Forms.Button SaveData;
        private System.Windows.Forms.Button LoadData;
        private System.Windows.Forms.Button soglie;
    }
}
```

### 4.4 SoglieView.cs

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Text;
using System.Windows.Forms;

namespace ProGruppoInfo
{
    public partial class SoglieView : Form
    {
        public bool noClose = true;
        public SoglieView()
        {
            InitializeComponent();
        }

        private void SoglieView_FormClosing(object sender,
           FormClosingEventArgs e)
        {
            this.Hide();
            e.Cancel = noClose;
        }
    }
}
```

## 4.5 SoglieView.Designer.cs

```
namespace ProGruppoInfo
{
    partial class SoglieView
    {
        /// <summary>
        /// Required designer variable.
        /// </summary>
        private System.ComponentModel.IContainer components = null;

        /// <summary>
        /// Clean up any resources being used.
        /// </summary>
        /// <param name="disposing">true if managed resources should
           be disposed; otherwise, false.</param>
        protected override void Dispose(bool disposing)
        {
            if (disposing && (components != null))
            {
                components.Dispose();
            }
            base.Dispose(disposing);
        }

        #region Windows Form Designer generated code

        /// <summary>
        /// Required method for Designer support - do not modify
        /// the contents of this method with the code editor.
        /// </summary>
        private void InitializeComponent()
        {
            this.SuspendLayout();
            //
            // SoglieView
            //
            this.AutoScaleDimensions = new System.Drawing.SizeF(6F,
               13F);
            this.AutoScaleMode =
               System.Windows.Forms.AutoScaleMode.Font;
            this.ClientSize = new System.Drawing.Size(936, 192);
            this.FormBorderStyle =
               System.Windows.Forms.FormBorderStyle.FixedDialog;
            this.Name = "SoglieView";
            this.ShowInTaskbar = false;
            this.Text = "Soglie";
            this.FormClosing += new
               System.Windows.Forms.FormClosingEventHandler(this.SoglieView_FormClo
            this.ResumeLayout(false);

        }

        #endregion
    }
}
```