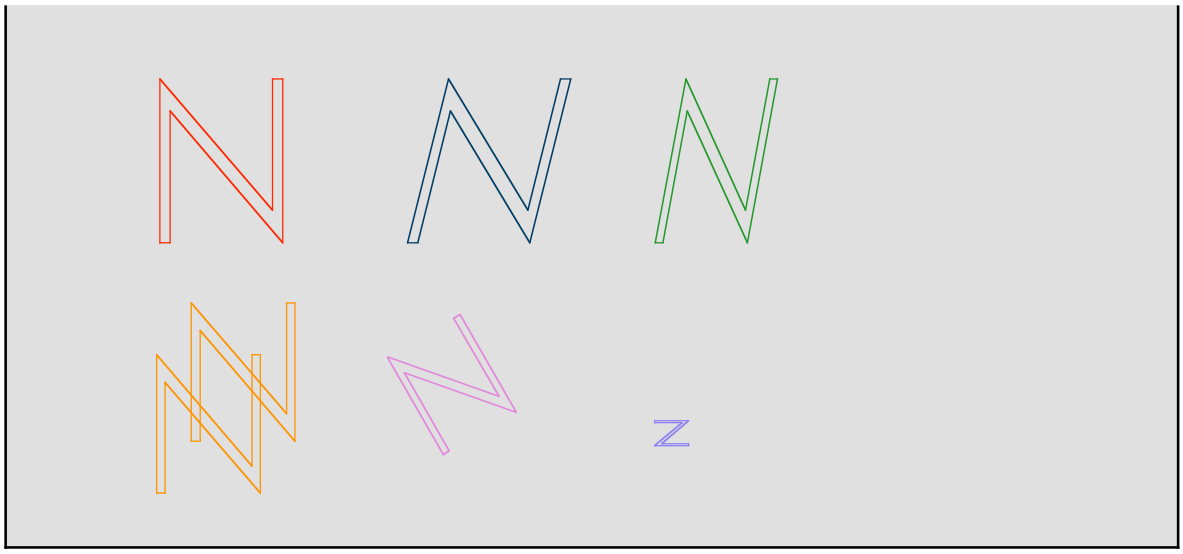
2D-Graphics

We create the 2D graphic images described in Lay's textbook examples 2.7.1 through 2.7.6.



Lay Example 2.7.1
The Letter "N"

■ Data points and adjacency matrix

```
<< LinearAlgebra`MatrixManipulation`
```

```
xs = {0, .5, .5, 6, 6, 5.5, 5.5, 0};
ys = {0, 0, 6.42, 0, 8, 8, 1.58, 8};

data = {xs, ys};
% // MatrixForm
```

$$\text{adj} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix};$$

$$\begin{pmatrix} 0 & 0.5 & 0.5 & 6 & 6 & 5.5 & 5.5 & 0 \\ 0 & 0 & 6.42 & 0 & 8 & 8 & 1.58 & 8 \end{pmatrix}$$

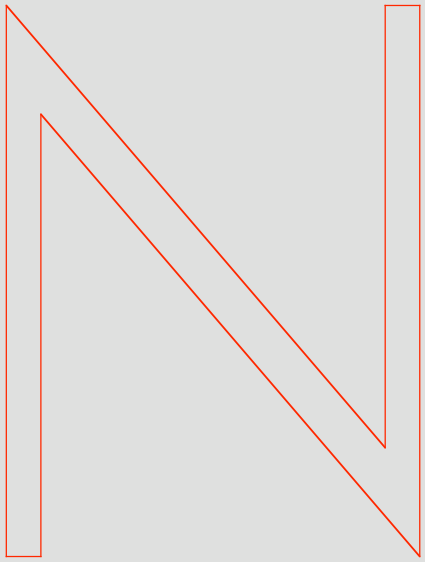
■ RenderData

The procedure RenderData takes an adjacency matrix and a list of points and plots the associated figure in a small screen.

RenderData is from the file "Case2.nb" available in the Case Studies section of the web site supporting Lay's textbook "Linear Algebra, Third Edition."
It is modified slightly to accomodate the data of these examples.

```
n = 8;
viewWindow = {{-1, 10}, {-1, 10}};

RenderData[adjacency_, data_, opts___] := (ptlist = {};
  For[i = 1, i ≤ n, i++,
   For[j = i, j ≤ n, j++,
    If[adjacency[[i, j]] == 1, {pt = {},
      AppendTo[pt, Transpose[data][[i]]],
      AppendTo[pt, Transpose[data][[j]]],
      AppendTo[ptlist, pt]}]]];
  g = {};
  For[i = 1, i ≤ Length[ptlist], i++,
   AppendTo[g, Line[ptlist[[i]]]]];
  Show[Graphics[g, opts], PlotRange -> viewWindow, AspectRatio → 1])
```

```
img1 = RenderData[adj, data,
   DefaultColor → Red];
```



Lay Example 2.7.2
Sheared "N"

```
shear = (1  .25
         0   1 );

shearData = shear.data;
% // MatrixForm
```

$$\begin{pmatrix} 0. & 0.5 & 2.105 & 6. & 8. & 7.5 & 5.895 & 2. \\ 0. & 0. & 6.42 & 0. & 8. & 8. & 1.58 & 8. \end{pmatrix}$$

```
img2 = RenderData[adj, shearData,
   DefaultColor → Indigo];
```

Lay Example 2.7.3
Scaled Sheared "N"

```
shear = ( 1   .25 )
        ( 0    1  );

scale = ( .75  0 )
        ( 0    1 );

scaledShearData = scale.shear.data;
% // MatrixForm
```

$$\begin{pmatrix} 0. & 0.375 & 1.57875 & 4.5 & 6. & 5.625 & 4.42125 & 1.5 \\ 0. & 0. & 6.42 & 0. & 8. & 8. & 1.58 & 8. \end{pmatrix}$$

```
img3 = RenderData[adj, scaledShearData,
   DefaultColor → ForestGreen];
```

Lay Example 2.7.4
Translated "N"

Use homogeneous coordinates.

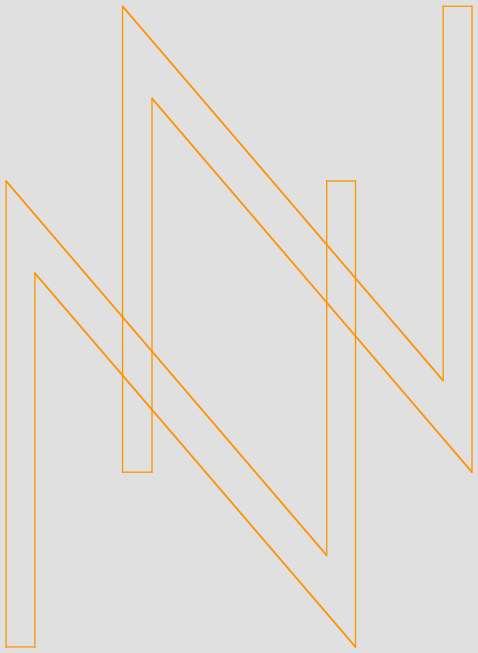
```
zs = Table[1, {k, 8}];

data = {xs, ys};
homogeneousData = {xs, ys, zs};
% // MatrixForm
```

$$\text{translate} = \begin{pmatrix} 1 & 0 & 2 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{pmatrix};$$

$$\begin{pmatrix} 0 & 0.5 & 0.5 & 6 & 6 & 5.5 & 5.5 & 0 \\ 0 & 0 & 6.42 & 0 & 8 & 8 & 1.58 & 8 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{pmatrix}$$

```
<< Graphics`Graphics`
```

```
viewWindow = {{-1, 12}, {-1, 12}};

img4 = DisplayTogether[
   orig = RenderData[adj, data,
     DefaultColor → Orange],
   trans = RenderData[adj, (translate.homogeneousData)[[{1, 2}, All]],
     DefaultColor → ForestGreen]];
```



Lay Example 2.7.5
Rotated "N"

Use homogeneous coordinates.

```
zs = Table[1, {k, 8}];

data = {xs, ys};
homogeneousData = {xs, ys, zs};
% // MatrixForm

φ = π / 6;
rot = ( Cos[φ]  -Sin[φ]  0
      Sin[φ]   Cos[φ]   0
        0        0      1 );
```

$$\begin{pmatrix} 0 & 0.5 & 0.5 & 6 & 6 & 5.5 & 5.5 & 0 \\ 0 & 0 & 6.42 & 0 & 8 & 8 & 1.58 & 8 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{pmatrix}$$

```
viewWindow = {{-4, 12}, {-4, 12}};

rotData = ( rot.homogeneousData)[[{1, 2}, All]];

img5 = RenderData[adj, rotData,
   DefaultColor → Orchid];
```

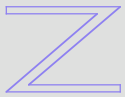
Lay Example 2.7.6
Composite Transformation

Use homogeneous coordinates.

```
zs = Table[1, {k, 8}];

data = {xs, ys};
homogeneousData = {xs, ys, zs};
% // MatrixForm;

scale = .3 IdentityMatrix[3];

φ = π / 2;
rot = {{Cos[φ], -Sin[φ], 0}, {Sin[φ], Cos[φ], 0}, {0, 0, 1}};

translate = {{1, 0, -.5}, {0, 1, 2}, {0, 0, 1}};

composite = translate.rot.scale;
composite // MatrixForm
```

$$\begin{pmatrix} 0. & -0.3 & -0.15 \\ 0.3 & 0. & 0.6 \\ 0. & 0. & 0.3 \end{pmatrix}$$

```
compositeData = (composite.homogeneousData)[[{1, 2}, All]];

viewWindow = {{-4, 12}, {-4, 12}};

img6 = RenderData[adj, compositeData,
   DefaultColor → MediumSlateBlue];
```



Lay Examples 2.7.1-6
Varieties of "N"

```
letters = Show[GraphicsArray[{{img1, img2, img3}, {img4, img5, img6}}]];
```