
Graphics

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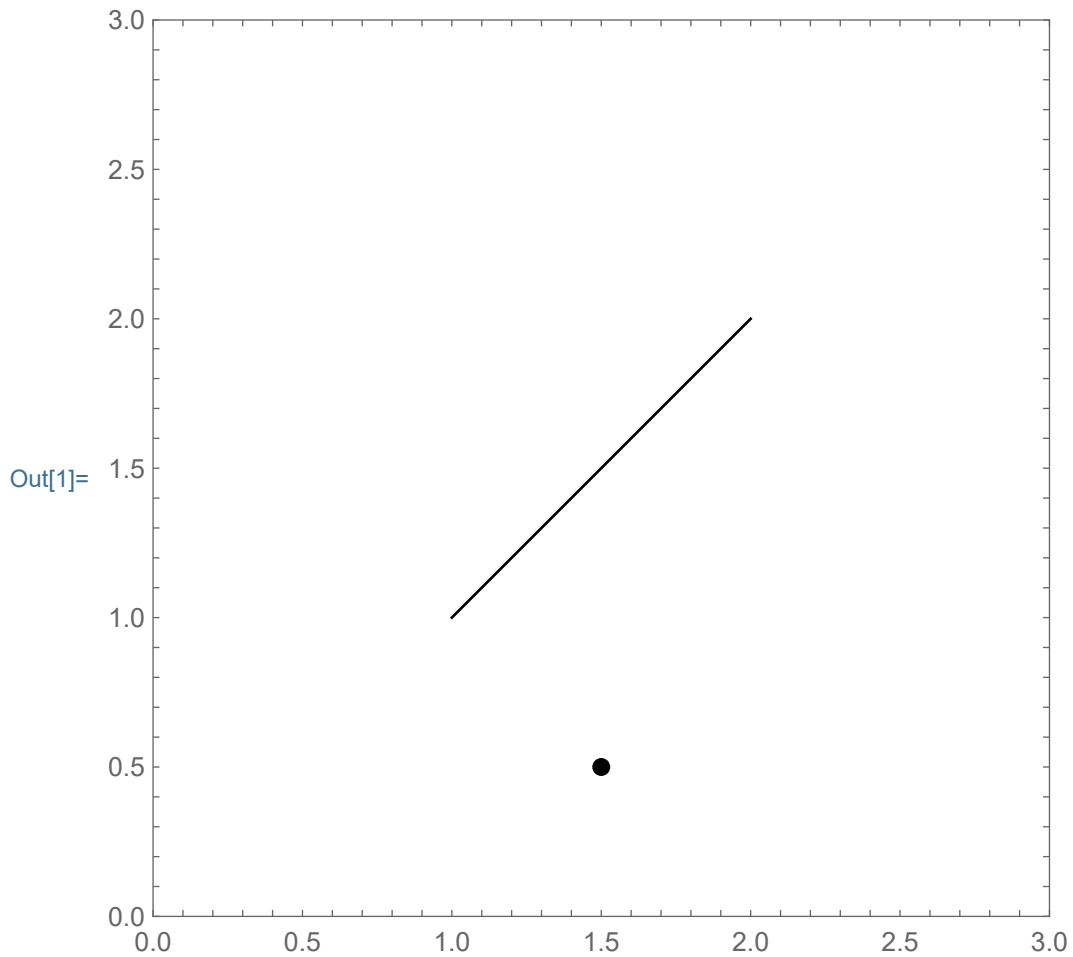
We start with

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Graphics Primitives

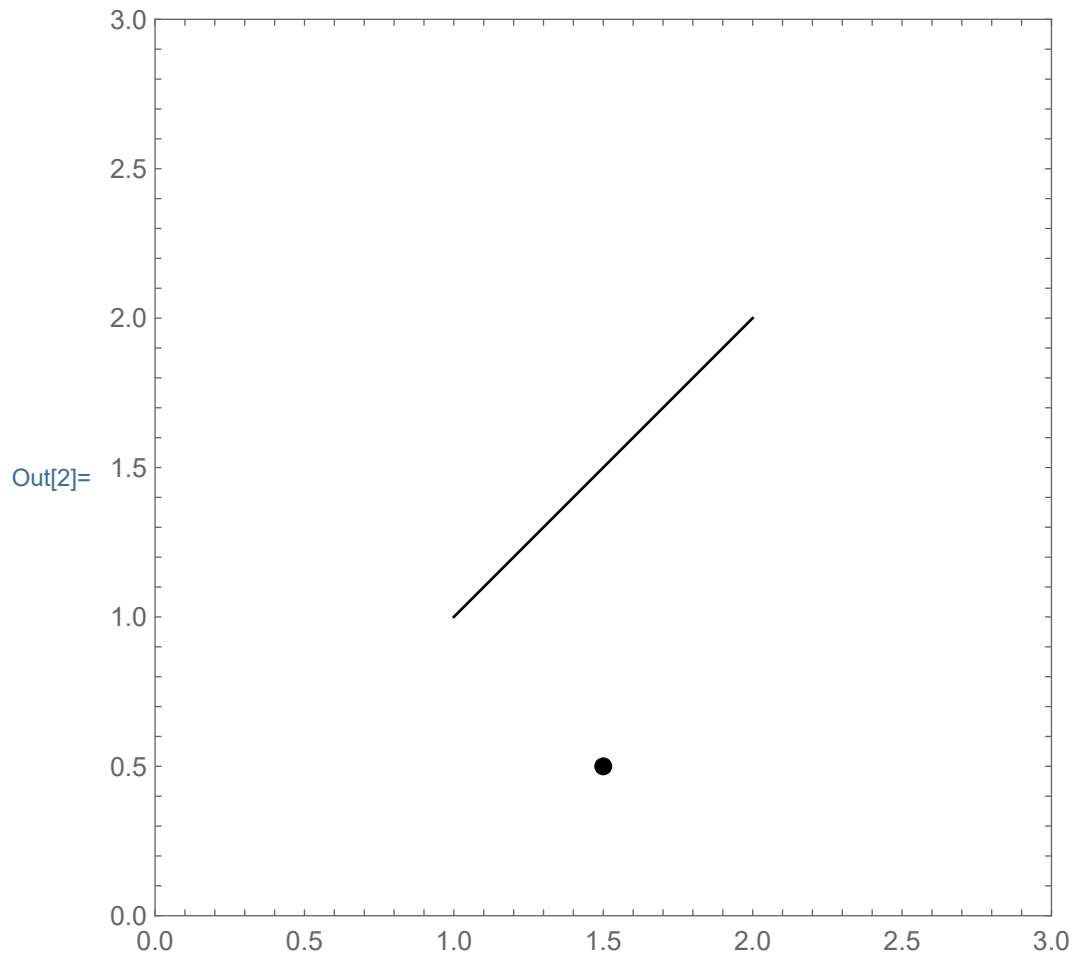
How to draw a line segment in *Mathematica*? Below is a line segment and a point:

```
In[1]:= myli = Graphics[  
  {  
    Line[{{1, 1}, {2, 2}}],  
    {PointSize[0.02], Point[{1.5, .5}]}  
  },  
  Frame → True, PlotRange → {{0, 3}, {0, 3}}  
]
```



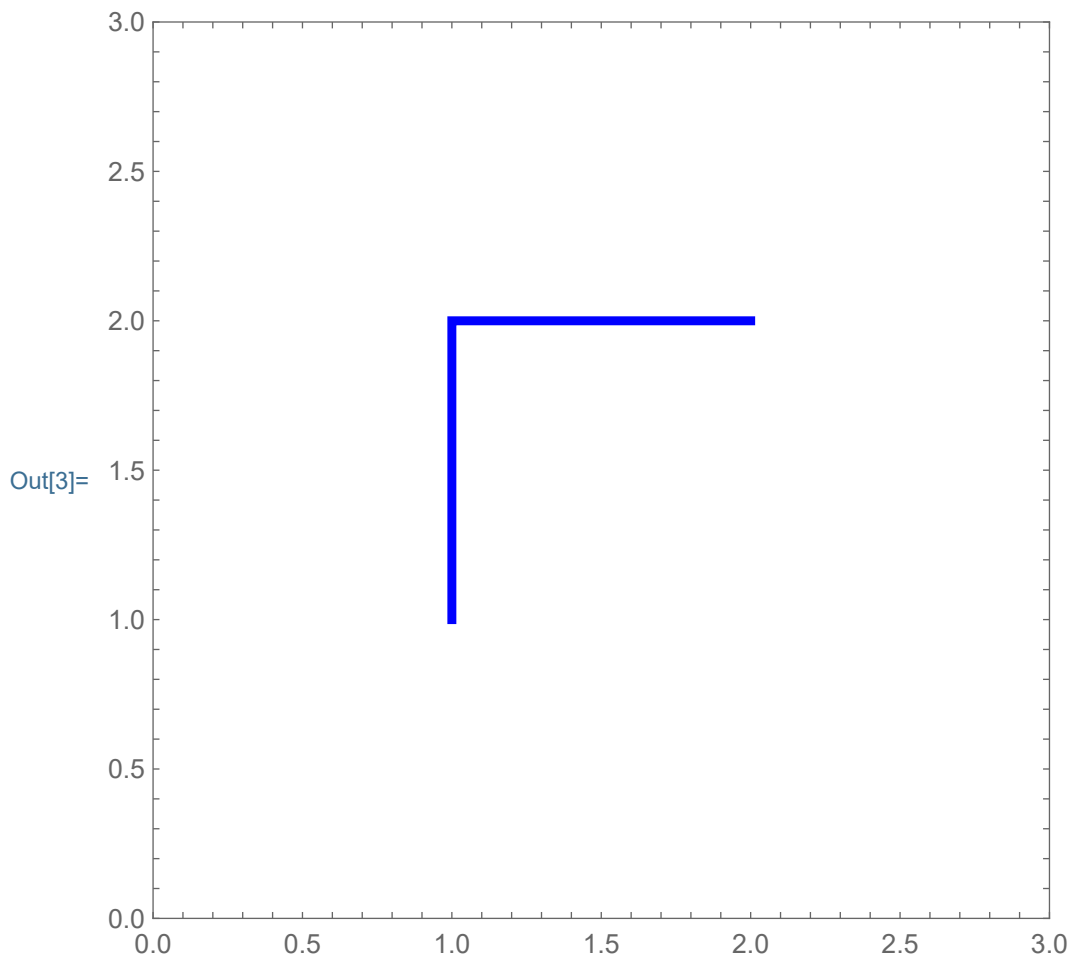
We named our picture myli. To display this picture **Show**

```
In[2]:= Show[myli]
```

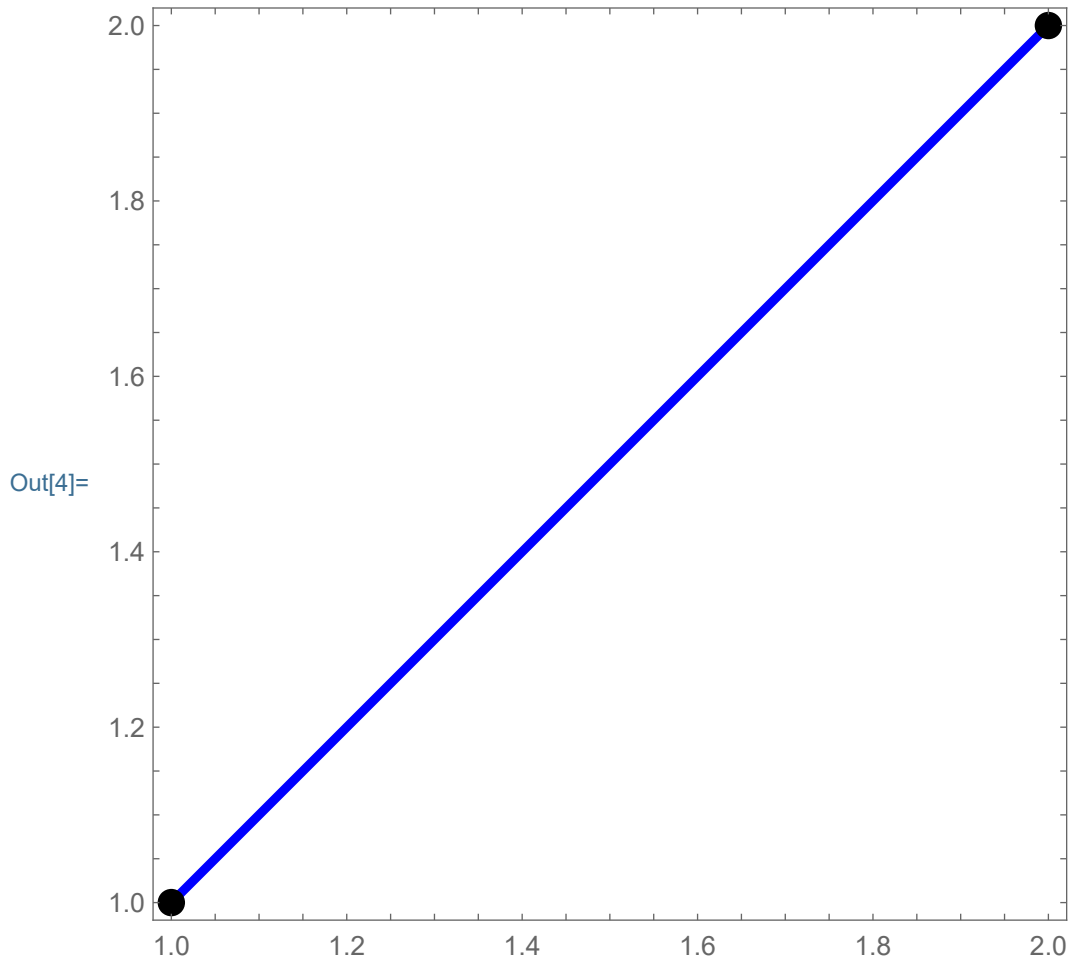


The argument in the **Line** command is a list of points, as below:

```
In[3]:= Graphics[  
  {{Thickness[0.01], RGBColor[0, 0, 1],  
    Line[{{1, 1}, {1, 2}, {2, 2}}]}},  
  Frame → True, PlotRange → {{0, 3}, {0, 3}}  
]
```

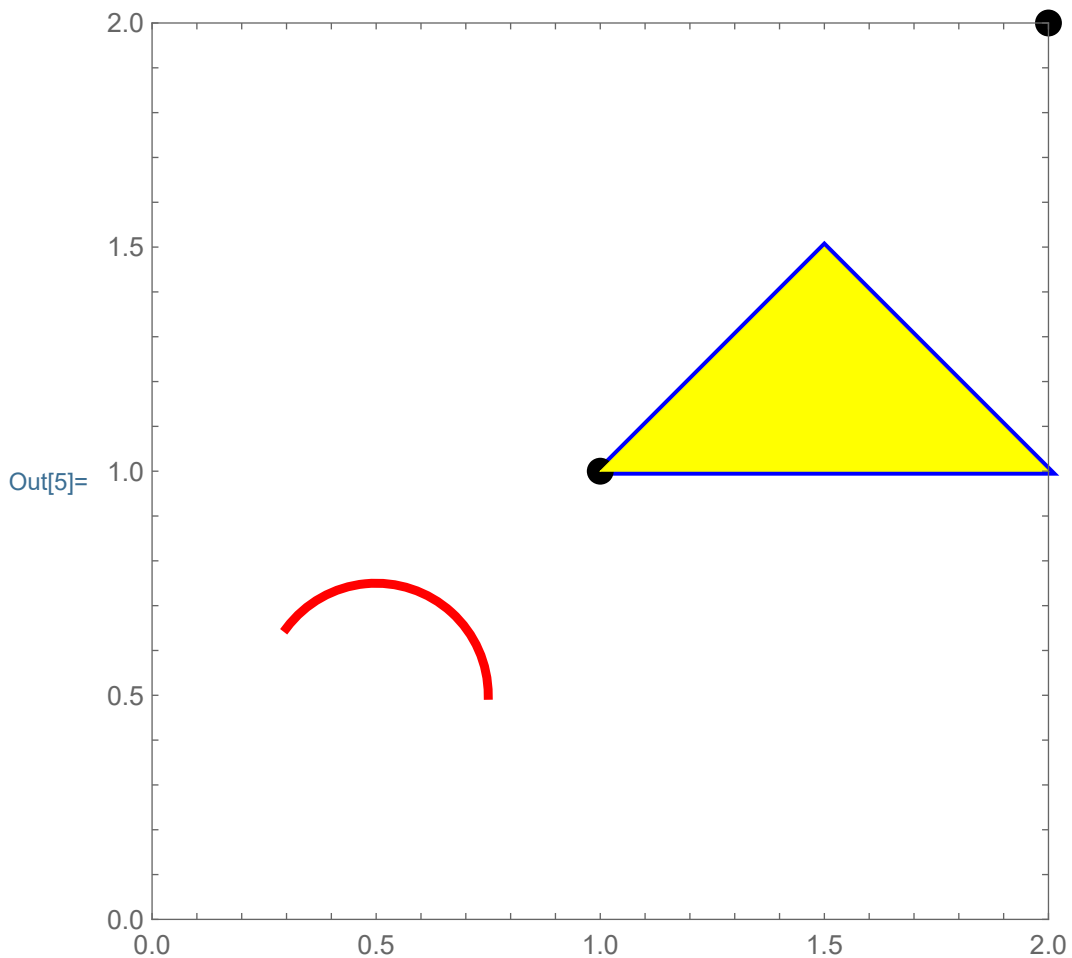


```
In[4]:= Graphics[
  {
    {Thickness[0.01], RGBColor[0, 0, 1],
     Line[{{1, 1}, {2, 2}}]},
    {PointSize[0.03], Point[{1, 1}], Point[{2, 2}]}
  }, Frame → True ]
```



Below is a little bit more what can be done with the **Graphics** command

```
In[5]:= Graphics[
  {
    {Thickness[0.01], RGBColor[0, 0, 1],
     Line[{{1, 1}, {1.5, 1.5}, {2, 1}, {1, 1}]}],
    {PointSize[0.03], Point[{1, 1}], Point[{2, 2}]},
    {Thickness[0.01], RGBColor[1, 0, 0],
     Circle[ {.5, .5}, .25, {0, 2.5} ]},
    {RGBColor[1, 1, 0],
     Polygon[{{1, 1}, {1.5, 1.5}, {2, 1}, {1, 1}]}]
  },
  Frame → True, AspectRatio → Automatic,
  PlotRange → {{0, 2}, {0, 2}}
]
```



To add a circle and a point and some extra stuff explore:

In[6]:= **?Circle**

Out[6]=

Symbol i

Circle[{ x , y }, r] represents a circle of radius r centered at { x , y }.

Circle[{ x , y }] gives a circle of radius 1.

Circle[{ x , y }, { r_x , r_y }] gives an
axis-aligned ellipse with semiaxes lengths r_x and r_y .

Circle[{ x , y }, ..., { θ_1 , θ_2 }] gives a circular or
ellipse arc from angle θ_1 to θ_2 .

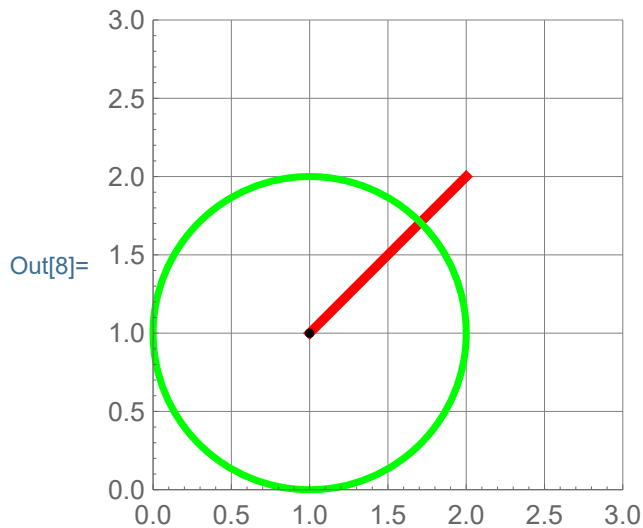
▼

In[7]:= **Options [Show]**

Out[7]= {}

The options of the **Show** command can be used either in the **Show** command or the **Graphics** command

```
In[8]:= Show[
  Graphics[
    {
      {Thickness[.02], RGBColor[1, 0, 0],
       Line[{{1, 1}, {2, 2}}]},
      {Thickness[.015], RGBColor[0, 1, 0], Circle[{{1, 1}, 1]}},
      {PointSize[0.02], Point[{{1, 1}}]}
    }
  ],
  PlotRange → {{0, 3}, {0, 3}}, Axes → True,
  GridLines → Automatic, AspectRatio → 1,
  ImageSize → 200
]
```

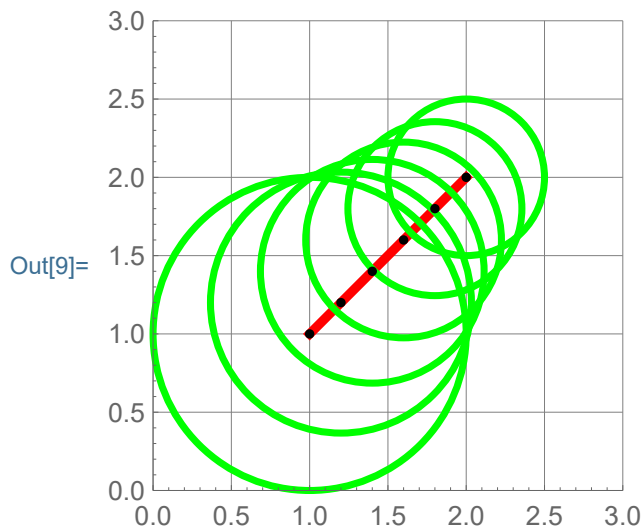


Or adding more of the same type of objects:


```

In[9]:= Show[
  Graphics[
    {
      {Thickness[.02], RGBColor[1, 0, 0],
       Line[{{1, 1}, {2, 2}}]},
      {Thickness[.015], RGBColor[0, 1, 0],
       Table[Circle[{t, t},  $\frac{1}{t}$ ], {t, 1, 2, .2}]},
      {PointSize[0.02], Table[Point[{t, t}], {t, 1, 2, .2}]}
    }
  ],
  PlotRange → {{0, 3}, {0, 3}}, Axes → True,
  GridLines → Automatic, AspectRatio → 1,
  ImageSize → 200
]

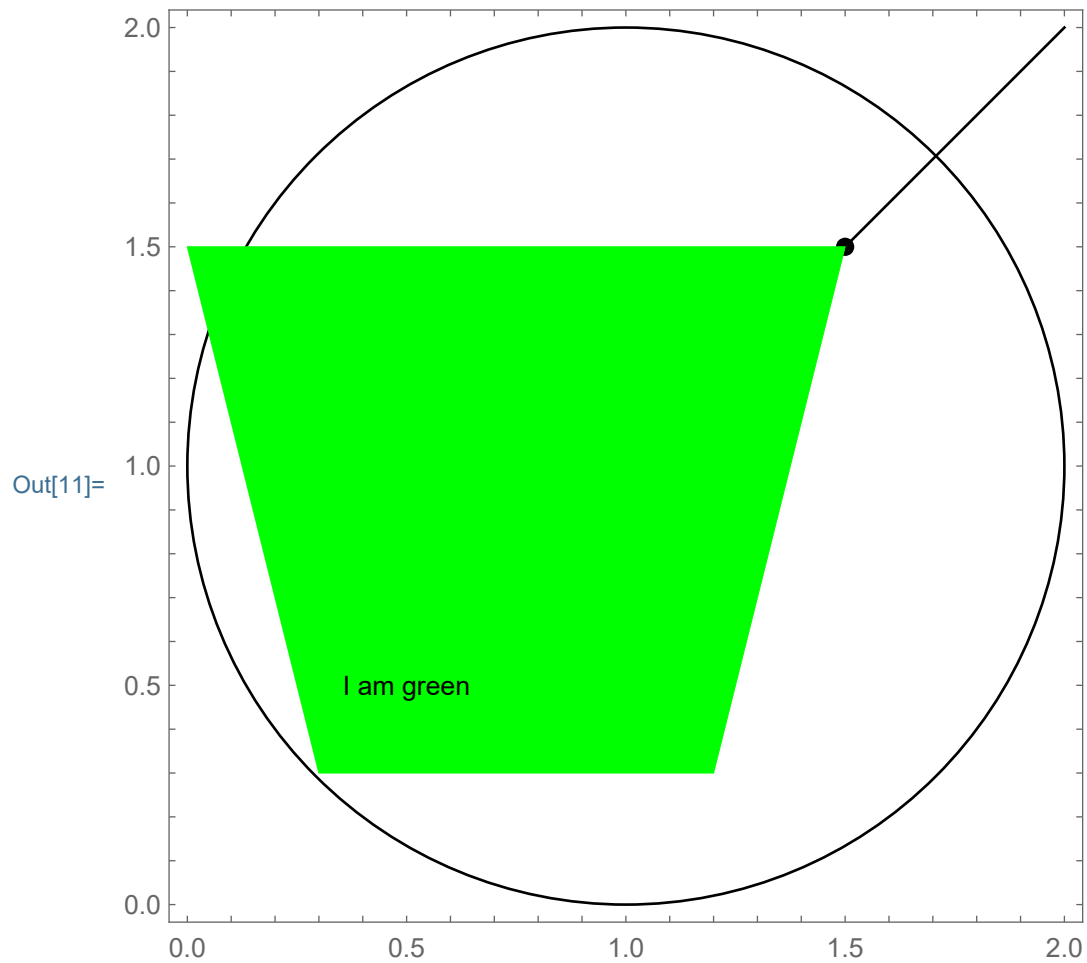
```



In[10]:= **Options [Plot]**

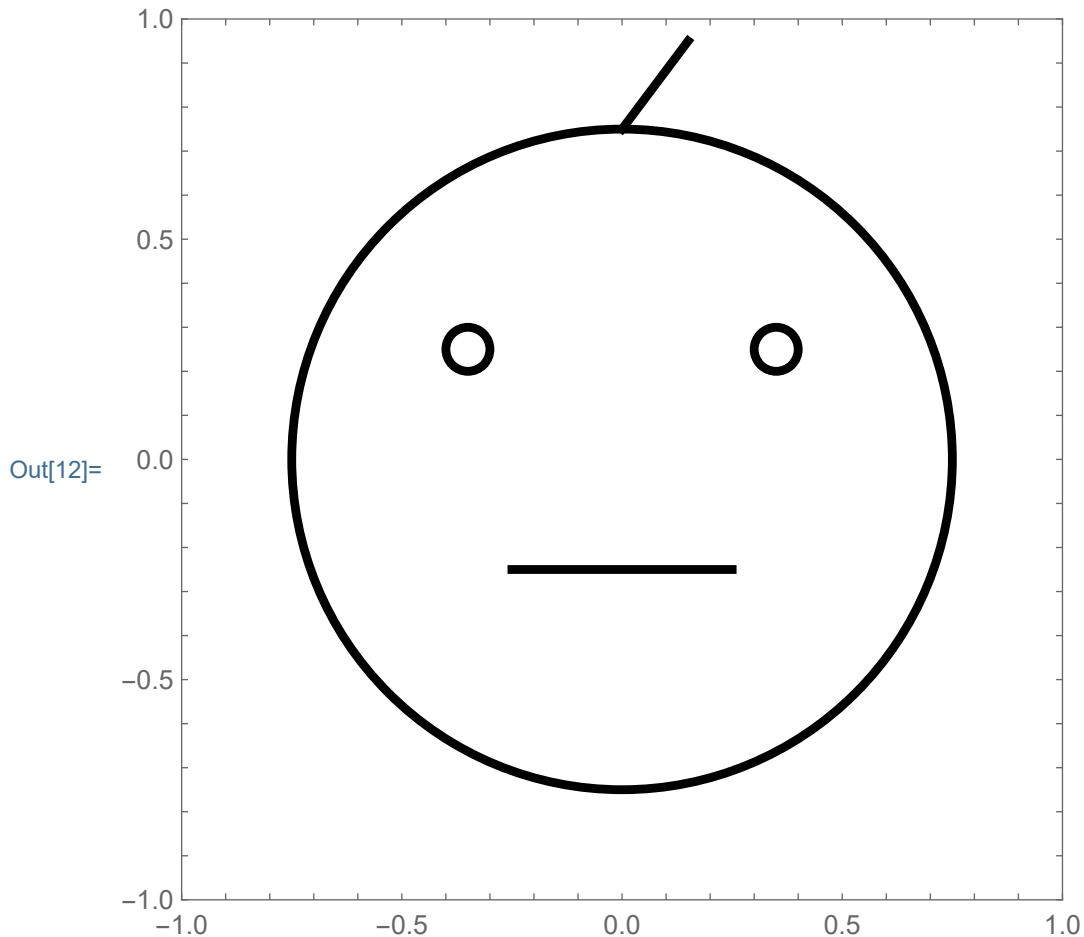
```
Out[10]= {AlignmentPoint → Center, AspectRatio →  $\frac{1}{\text{GoldenRatio}}$ ,
  Axes → True, AxesLabel → None, AxesOrigin → Automatic,
  AxesStyle → {}, Background → None,
  BaselinePosition → Automatic, BaseStyle → {},
  ClippingStyle → None, ColorFunction → Automatic,
  ColorFunctionScaling → True, ColorOutput → Automatic,
  ContentSelectable → Automatic,
  CoordinatesToolOptions → Automatic,
  DisplayFunction := $DisplayFunction, Epilog → {},
  Evaluated → Automatic, EvaluationMonitor → None,
  Exclusions → Automatic, ExclusionsStyle → None,
  Filling → None, FillingStyle → Automatic,
  FormatType := TraditionalForm, Frame → False,
  FrameLabel → None, FrameStyle → {},
  FrameTicks → Automatic, FrameTicksStyle → {},
  GridLines → None, GridLinesStyle → {}, ImageMargins → 0.,
  ImagePadding → All, ImageSize → Automatic,
  ImageSizeRaw → Automatic, LabelingSize → Automatic,
  LabelStyle → {}, MaxRecursion → Automatic, Mesh → None,
  MeshFunctions → {#1 &}, MeshShading → None,
  MeshStyle → Automatic, Method → Automatic,
  PerformanceGoal := $PerformanceGoal, PlotLabel → None,
  PlotLabels → None, PlotLegends → None,
  PlotPoints → Automatic, PlotRange → {Full, Automatic},
  PlotRangeClipping → True, PlotRangePadding → Automatic,
  PlotRegion → Automatic, PlotStyle → Automatic,
  PlotTheme := $PlotTheme, PreserveImageOptions → Automatic,
  Prolog → {}, RegionFunction → (True &),
  RotateLabel → True, ScalingFunctions → None,
  TargetUnits → Automatic, Ticks → Automatic,
  TicksStyle → {}, WorkingPrecision → MachinePrecision}
```

```
In[11]:= Show[
  Graphics[{{Line[{{1, 1}, {2, 2}}]}, {Circle[{{1, 1}, 1}],
    {PointSize[0.02`], Point[{{1.5`, 1.5`}}]},
    {RGBColor[0, 1, 0],
      Polygon[{{0.3`, 0.3`}, {1.2`, 0.3`}, {1.5`, 1.5`},
        {0, 1.5`}, {0.3`, 0.3`}}]},
    {Text["I am green", {0.5`, 0.5`}]}]}, Frame → True,
  AspectRatio → Automatic]
```



In the next graphics I design a simplified face.

```
In[12]:= Show[
  Graphics[
    {{Thickness[0.01`], RGBColor[0, 0, 0],
      Circle[{0, 0}, 0.75` ]},
     {Thickness[0.01`], RGBColor[0, 0, 0],
      Circle[{0.35`, 0.25`}, 0.05` ],
      Circle[{-0.35`, 0.25`}, 0.05` ]},
     {Thickness[0.01`], RGBColor[0, 0, 0],
      Line[{{-0.25`, -0.25`}, {0.25`, -0.25`}]}}],
    {{Thickness[0.01`], RGBColor[0, 0, 0],
      Line[{{0, 0.75`}, {0.15`, 0.95`}]}}}], Frame → True,
  AspectRatio → Automatic, PlotRange → {{-1, 1}, {-1, 1}}]
```



Below I design a more involved play with a face and

Manipulate

We can add some action here by designing various stiles for the mouth, eyes, hair,... and let *Mathematica* choose randomly the face design. The command for a random integer between 1 and 3 is

```
In[13]:= Random[Integer, {1, 3}]
```

```
Out[13]= 2
```

```
In[14]:= Table[Random[Integer, {1, 3}], {k, 1, 10}]
```

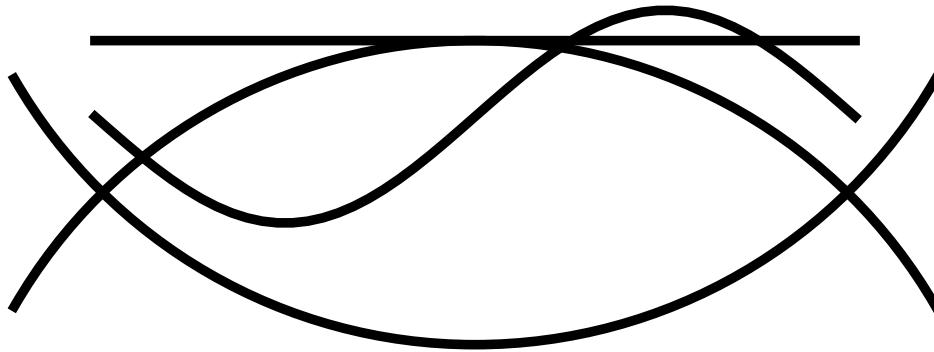
```
Out[14]= {3, 2, 1, 2, 2, 1, 2, 1, 3, 1}
```

```
In[15]:= Mouth :=
```

```
{Graphics[{Thickness[0.01], RGBColor[0, 0, 0],
  Circle[{0, -0.1}, .35, { $\frac{3\pi}{2} - \frac{\pi}{3}$ ,  $\frac{3\pi}{2} + \frac{\pi}{3}$ }]}],
Graphics[{Thickness[0.01], RGBColor[0, 0, 0],
  Circle[{0, -0.6}, .35, { $\frac{\pi}{2} - \frac{\pi}{3}$ ,  $\frac{\pi}{2} + \frac{\pi}{3}$ }]}],
Graphics[{Thickness[0.01], RGBColor[0, 0, 0],
  Line[{{-0.25, -0.25}, {0.25, -0.25}}]}],
Graphics[{Thickness[0.01], RGBColor[0, 0, 0],
  Line[Table[{x, -0.3 + 0.07 Sin[4 Pi x]},
    {x, -0.25, 0.25, 0.01}]}]}]}
```

```
In[16]:= Show[Mouth]
```

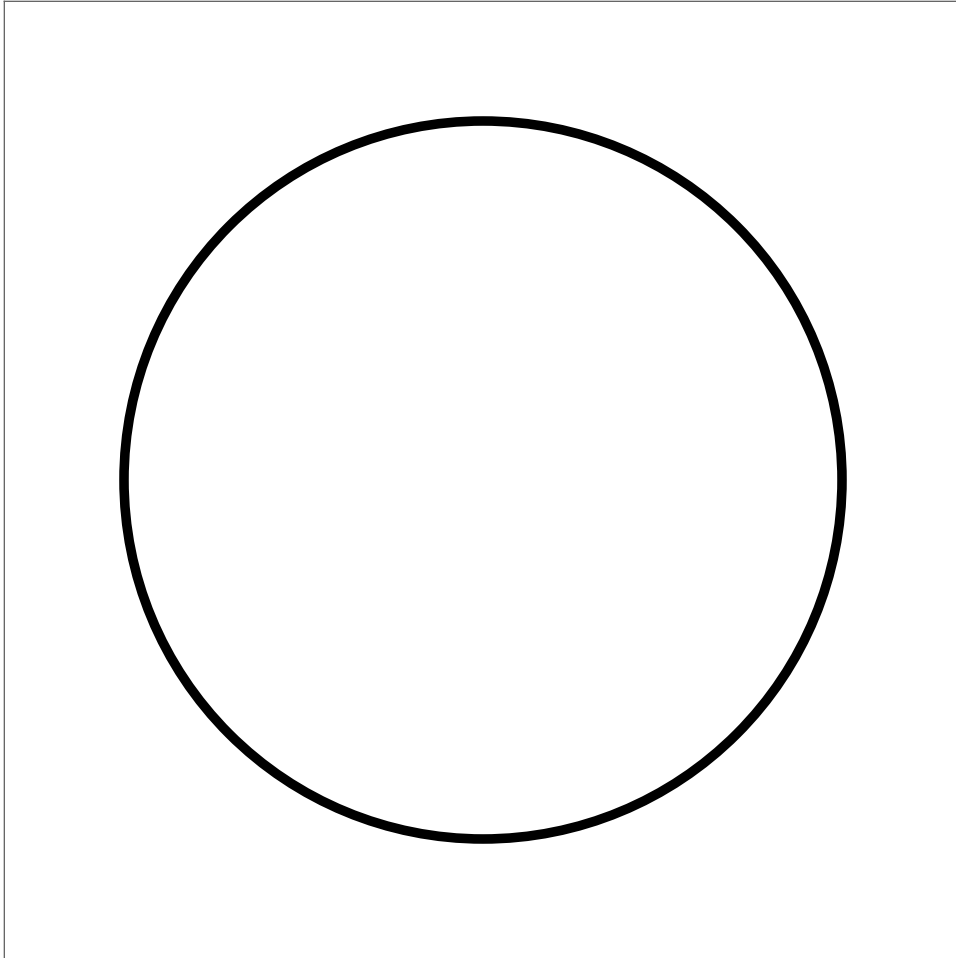
```
Out[16]=
```



```
In[17]:= Face := Graphics [  
  {  
    (* face *)  
    {Thickness[0.01], RGBColor[0, 0, 0], Circle[{0, 0}, .75]}  
  },  
  Frame → True, AspectRatio → Automatic, FrameTicks → None,  
  PlotRange → {{-1, 1}, {-1, 1}}  
]
```

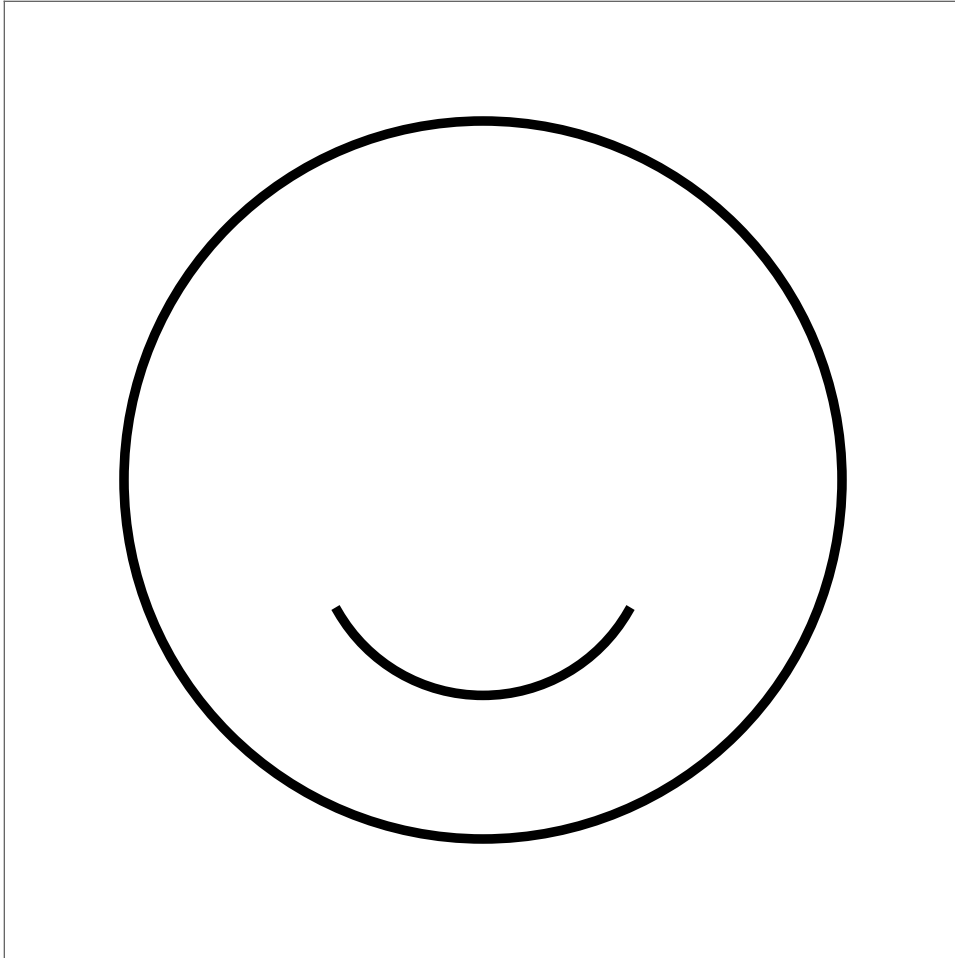
In[18]:= **Face**

Out[18]=



```
In[19]:= Show[Face, Mouth[[1]]]
```







```
Out[19]=
```



```
In[20]:= Eyes :=
```

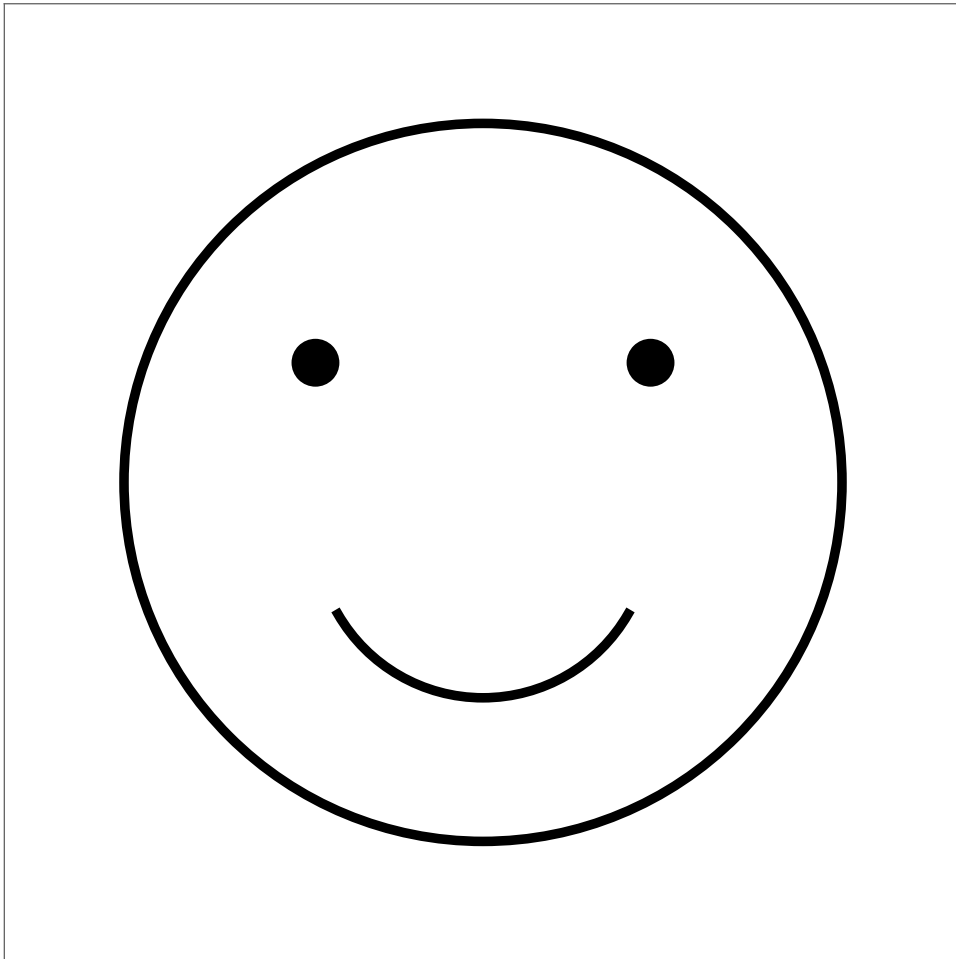
```
{Graphics[{Thickness[0.01], RGBColor[0, 0, 0],  
  Circle[{0.35, 0.25}, .05],  
  Circle[{-0.35, 0.25}, .05]}],  
Graphics[{Thickness[0.01], RGBColor[0, 0, 0],  
  Disk[{0.35, 0.25}, .05],  
  Disk[{-0.35, 0.25}, .05]}],  
Graphics[{Thickness[0.01], RGBColor[0, 0, 0],  
  Disk[{0.35, 0.25}, .05],  
  Circle[{-0.35, 0.25}, .05]}]}
```


In[21]:= **Eyes**

Out[21]= {  ,  ,
 ,  ,  ,  }

In[22]:= **Show[Face, Eyes[[2]], Mouth[[1]]]**

Out[22]=

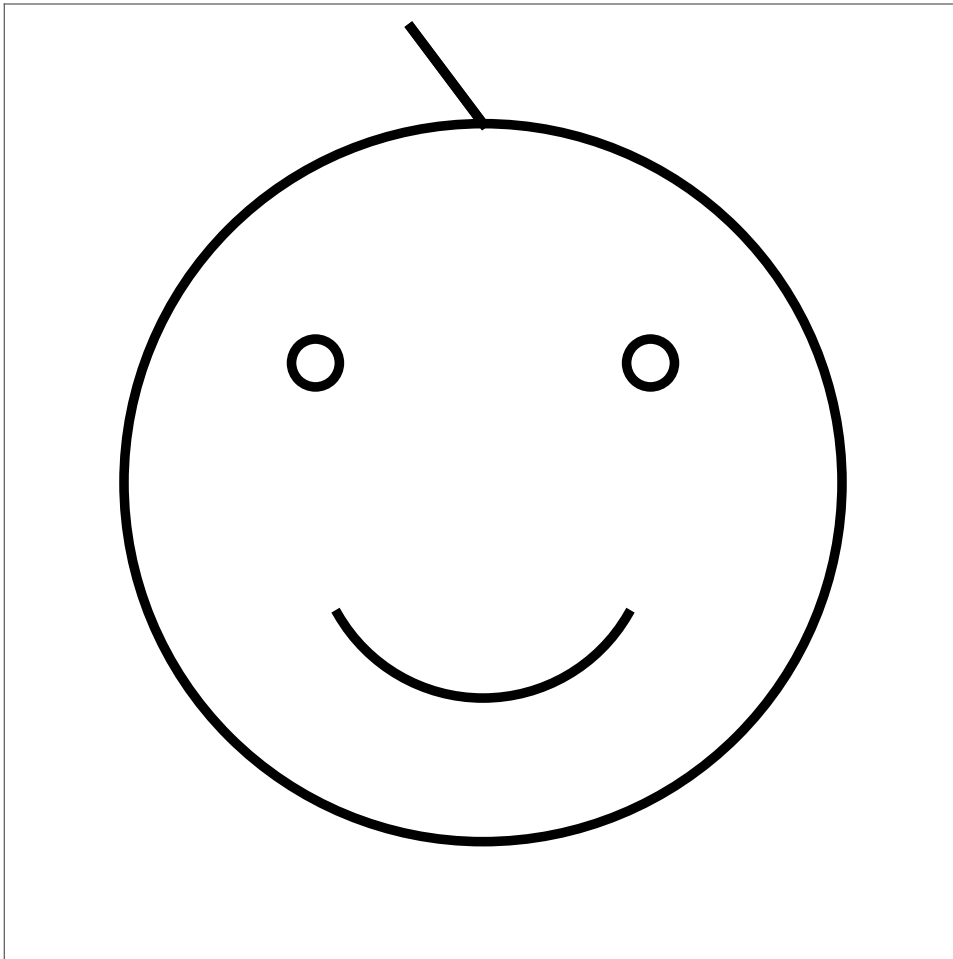


```
In[23]:= Hair :=
  {Graphics[
    {{Thickness[0.01], RGBColor[0, 0, 0],
      Line[{{0, .75}, {0.15, .95}}]}},
  Graphics[
    {{Thickness[0.01], RGBColor[0, 0, 0],
      Line[{{0, .75}, {-0.15, .95}}]}},
  Graphics[
    {{Thickness[0.01], RGBColor[0, 0, 0],
      Line[{{0, .75}, {-0.55, .8}}]}}}
```

```
In[24]:= Cheek :=
  {Graphics[{Thickness[0.01], RGBColor[1, 0, 0],
    Disk[{0.45, -0.1}, .15],
    Disk[{-0.45, -.1}, .15]}},
  Graphics[{Thickness[0.01], RGBColor[1, 1, 1],
    Disk[{0.45, -0.1}, .15],
    Disk[{-0.45, -.1}, .15]}},
  Graphics[{Thickness[0.01], RGBColor[1, 1, 1],
    Disk[{0.45, -0.1}, .15],
    Disk[{-0.45, -.1}, .15]}}
```

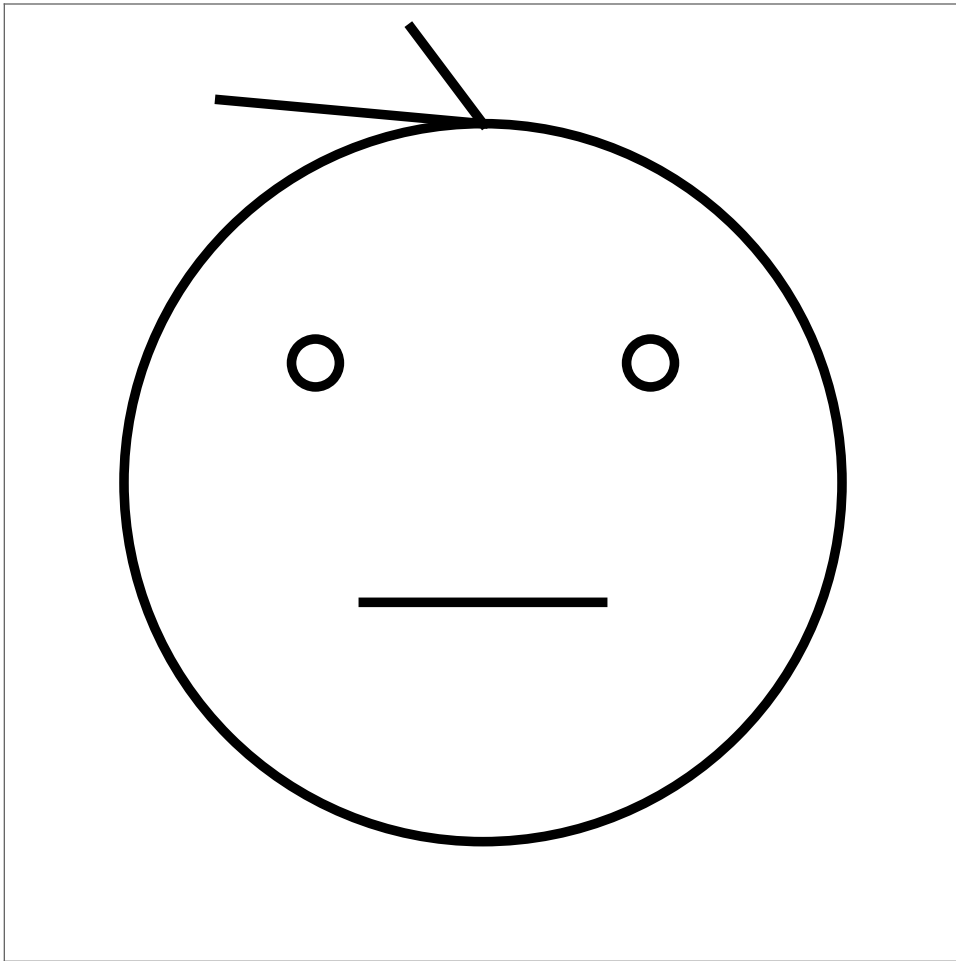
```
In[25]:= Show[{Face, Mouth[[Random[Integer, {1, 4}]]],  
  Eyes[[Random[Integer, {1, 3}]]],  
  Hair[[Random[Integer, {1, 3}]]],  
  Hair[[Random[Integer, {1, 3}]]],  
  Cheek[[Random[Integer, {1, 3}]]]}]
```

Out[25]=



```
In[26]:= Show[{Face, Mouth[[Random[Integer, {1, 4}]]],  
Eyes[[Random[Integer, {1, 3}]]],  
Hair[[Random[Integer, {1, 3}]]],  
Hair[[Random[Integer, {1, 3}]]],  
Cheek[[Random[Integer, {1, 3}]]]}
```

Out[26]=



```
In[27]:= Clear[aa];  
aa = Random[Integer, {1, 4}];  
Manipulate[  
  Show[{Face, Mouth[aa], Eyes[Random[Integer, {1, 3}]]],  
    Hair[Random[Integer, {1, 3}]],  
    Hair[Random[Integer, {1, 3}]],  
    Cheek[Random[Integer, {1, 3}]]}, ImageSize -> 250],  
  Row[{Button["Reset random parameters",  
    {aa = Random[Integer, {1, 4}]}], Appearance -> "Palette",  
    ImageSize -> {250, 28}}], ControlPlacement -> Bottom  
]
```

Out[27]=

