

Plotting regions and level sets

You can use Mathematica to plot regions, for example, the domain of a function using **RegionPlot** or **RegionPlot3D** and level sets of a function using **ContourPlot** or **ContourPlot3D**. To learn more options to each of these command, you can go to Help, choose 'Find Selected Function', and type the command's name.

1. Regions

The command **RegionPlot** is used to plot a 2D region determined by one or more inequalities. For example, consider the function $f(x, y) = \sqrt{x^2 + y + 1}\sqrt{x - y - 1}$. The domain of this function is the set of points (x, y) such that $x^2 + y + 1 \geq 0$ and $x - y - 1 \geq 0$.

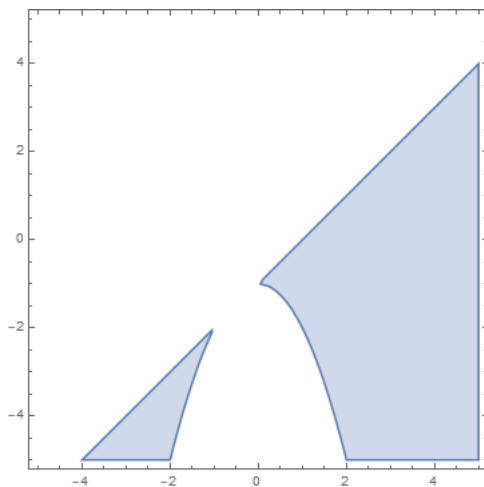
(* draw the domain of f, Figure 1a *)

```
RegionPlot[x^2 + y + 1 >= 0 && x - y - 1 >= 0, {x, -5, 5}, {y, -5, 5}]
```

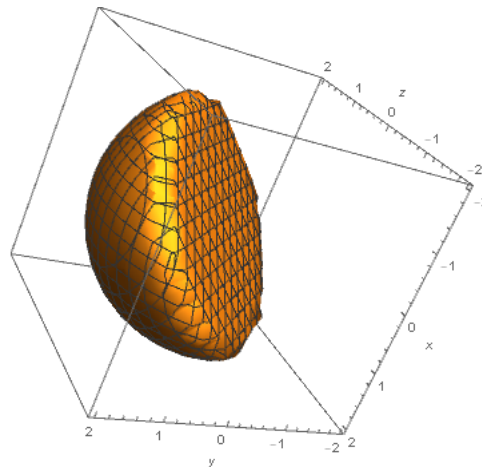
The command **RegionPlot3D** is used to plot a 3D region determined by one or more inequalities. For example, consider the function $g(x, y, z) = \sqrt{x + y + z}\sqrt{4 - x^2 - y^2 - z^2}$. The domain of this function is the set of points (x, y, z) such that $x + y + z \geq 0$ and $x^2 + y^2 + z^2 \leq 4$.

(* draw the domain of g, Figure 1b *)

```
RegionPlot3D[  
  x + y + z >= 0 && x^2 + y^2 + z^2 <= 4, {x, -2, 2}, {y, -2,  
  2}, {z, -2, 2}, AxesLabel -> {x, y, z}]
```



(a)



(b)

Figure 1

2. Level sets

The command **ContourPlot** is used to plot the level sets of a function of two variables. The command **ContourPlot3D** is used to plot the level sets of a function of three variables. For example, consider the function $f(x, y)$ and the function $g(x, y, z)$ given above.

(* define the function f *)

```
f[x_, y_] := Sqrt[x^2 + y + 1]*Sqrt[x - y - 1]
```

```
(* draw many level sets, Figure 2a *)  
ContourPlot[ f[x, y], {x, -5, 5}, {y, -5, 5}]
```

```
(* draw the 0.5-level set, Figure 2b *)  
ContourPlot[ f[x, y] == 0.5, {x, -5, 5}, {y, -5, 5}]
```

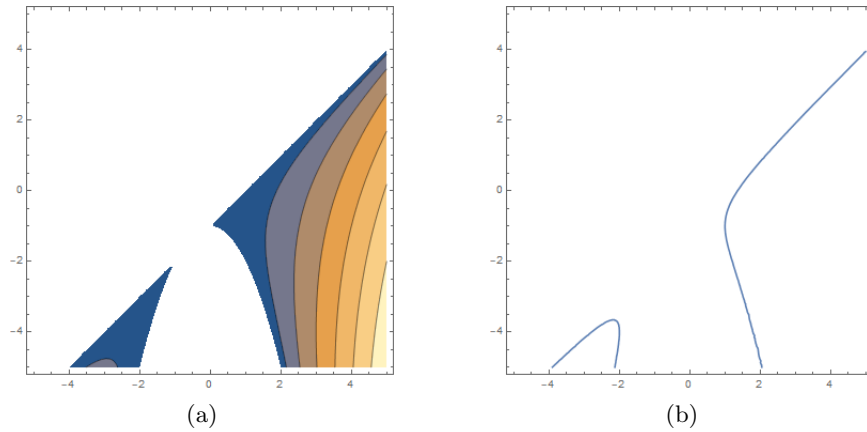


Figure 2

```
(* define the function g *)  
g[x_, y_, z_] := Sqrt[x + y + z]*Sqrt[4 - x^2 - y^2 - z^2]
```

```
(* draw many level sets, Figure 3a *)  
ContourPlot3D[g[x, y, z], {x, -2, 2}, {y, -2, 2}, {z, -2, 2}]
```

```
(* draw the 0-level set, Figure 3b *)  
ContourPlot3D[g[x, y, z] == 0, {x, -2, 2}, {y, -2, 2}, {z, -2, 2}]
```

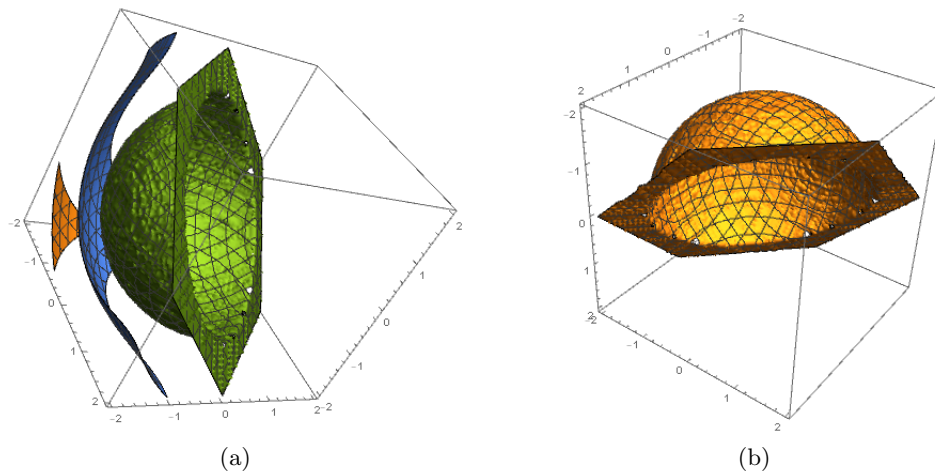


Figure 3