

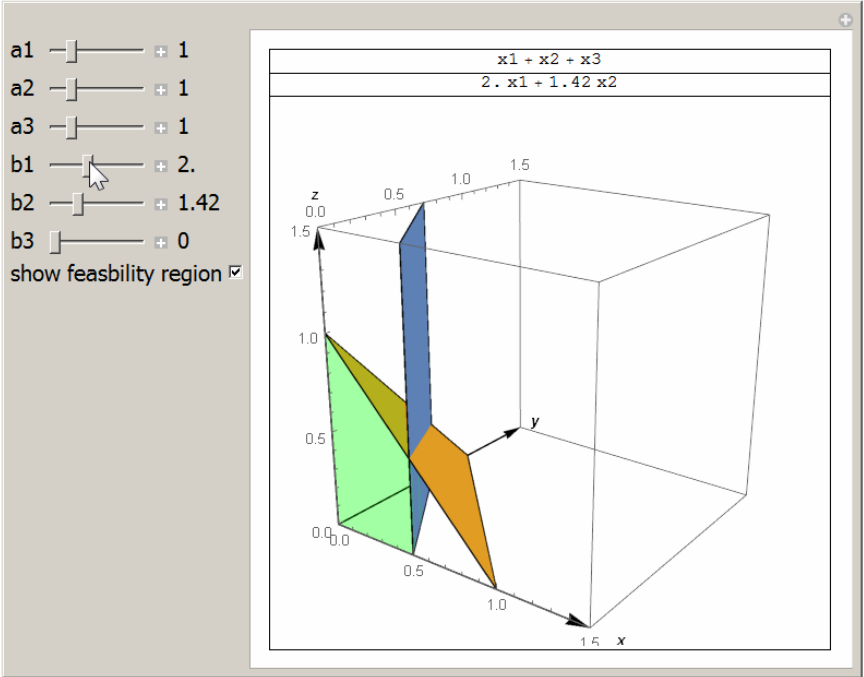
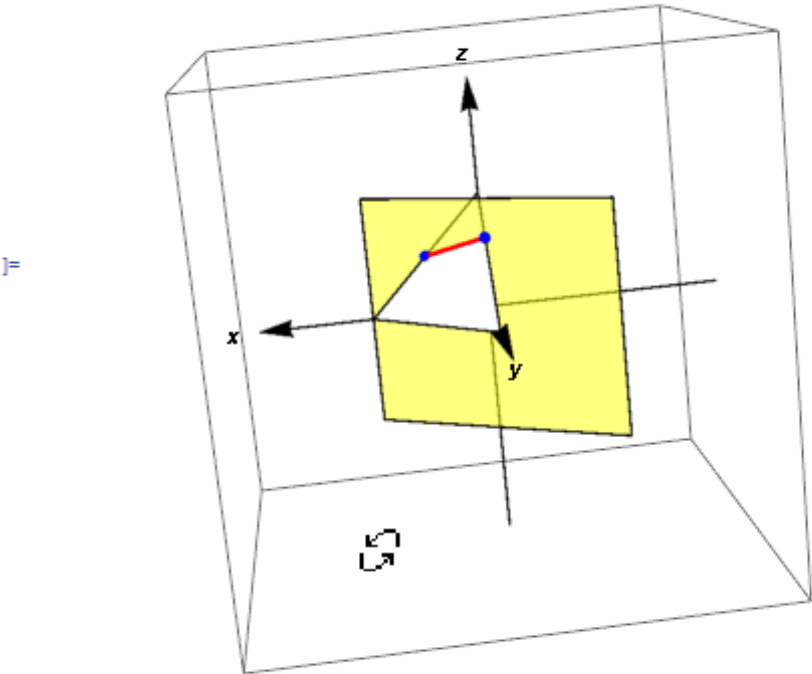
Unit simplex animation showing feasibility region

Nasser M. Abbasi

March 16, 2016 Compiled on July 23, 2025 at 6:02am

This small animation shows the feasibility region and the the intersection line between $a_1x_1 + a_2x_2 + a_3x_3 = 1$ and $b_1x_1 + b_2x_2 + b_3x_3 = 1$ and with $x_i \geq 0$. The light Green region is the one in which $a_1x_1 + a_2x_2 + a_3x_3 \leq 1$ and $b_1x_1 + b_2x_2 + b_3x_3 \leq 1$. The optimal solution will be on a vertex on the line of interesection between the two planes shown. Done for class HW.

$$\begin{aligned} 2\,x_1 + 3\,x_2 &= 1 \\ x_1 + x_2 + x_3 &= 1 \end{aligned}$$



This small animation shows the feasibility region which is the intersection line between unit simplex given by $x_1 + x_2 + x_3 = 1$ and plane $2x_1 + 3x_2 = 1$.

Source code used to generate the first movie is

```
Manipulate[
  len = 1.5;
  h = a1 x1 + a2 x2 + a3 x3;
  g = b1 x1 + b2 x2 + b3 x3;

  g1 = ContourPlot3D[{h == 1, g == 1}, {x1, 0, len}, {x2, 0, len}, {x3, 0, len},
    PlotRange -> {{0, len}, {0, len}, {0, len}},
    SphericalRegion -> True, MeshStyle -> {{Thick, Blue}}, Mesh -> {{0}},
    Lighting -> {"Ambient", White}}
  ];
  g2 = RegionPlot3D[h <= 1 && g <= 1, {x1, 0, len}, {x2, 0, len}, {x3, 0, len},
    PlotRange -> {{0, len}, {0, len}, {0, len}},
    SphericalRegion -> True, Mesh -> 0,
    PlotStyle -> Directive[Green, Opacity[0.2]],
    Lighting -> {"Ambient", White}];

  g3 = Graphics3D[{
    Arrow[{{0, 0, -len}, {0, 0, len}}],
    Text[Style[z, Bold], {0, 0, 1.1 len}],
    Arrow[{{0, -len, 0}, {0, len, 0}}],
    Text[Style[y, Bold], {0, 1.1 len, 0}],
    Arrow[{{-len, 0, 0}, {len, 0, 0}}],
    Text[Style[x, Bold], {1.1 len, 0, 0}]
  ]];
  Grid[{
    {h},
    {g},
    {
      If[showRegion,
        Show[g1, g2, g3, ImageSize -> 400, ImagePadding -> 5]
      ,
        Show[g1, g3, ImageSize -> 400, ImagePadding -> 5]
      ]
    },
    Frame -> All],
  {{a1, 1, "a1"}, 0, 5, .01, Appearance -> "Labeled", ImageSize -> Tiny},
  {{a2, 1, "a2"}, 0, 5, .01, Appearance -> "Labeled", ImageSize -> Tiny},
  {{a3, 1, "a3"}, 0, 5, .01, Appearance -> "Labeled", ImageSize -> Tiny},
  {{b1, 2, "b1"}, 0, 5, .01, Appearance -> "Labeled", ImageSize -> Tiny},
  {{b2, 3, "b2"}, 0, 5, .01, Appearance -> "Labeled", ImageSize -> Tiny},
  {{b3, 0, "b3"}, 0, 5, .01, Appearance -> "Labeled", ImageSize -> Tiny},
  Row[{"show feasibility region ", Checkbox[Dynamic[showRegion]]}],
  ControlPlacement -> Left
]
```

Source code used to generate the second movie is

```
eq1 = 2 x1 + 3 x2 == 1;
eq2 = x1 + x2 + x3 == 1;
len = 2;
g2 = Graphics3D[Simplex[{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}]];
g1 = ContourPlot3D[Evaluate@eq1, {x1, -1, 1}, {x2, -1, 1}, {x3, -1, 1},
  ContourStyle -> Directive[FaceForm[Yellow], Opacity[.5]], Mesh -> None,
  Lighting -> {"Ambient", White}, Boxed -> True, Axes -> False];
g3 = Graphics3D[{
  Arrow[{{0, 0, -len}, {0, 0, len}}], Text[Style[z, Bold], {0, 0, 1.1 len}],
  Arrow[{{0, -len, 0}, {0, len, 0}}], Text[Style[y, Bold], {0, 1.1 len, 0}],
  Arrow[{{-len, 0, 0}, {len, 0, 0}}], Text[Style[x, Bold], {1.1 len, 0, 0}],
  {Blue, Sphere[{0, 1/3, 2/3}, .05]},
  {Blue, Sphere[{1/2, 0, 1/2}, .05]},
  {Red, Thick, Line[{{0, 1/3, 2/3}, {1/2, 0, 1/2}}]}
```

```
    }];  
Grid[{{Column[{eq1, eq2}]},  
      {Show[g1, g2, g3, PlotRange -> All, ImageSize -> 400,  
            SphericalRegion -> True]}}]
```