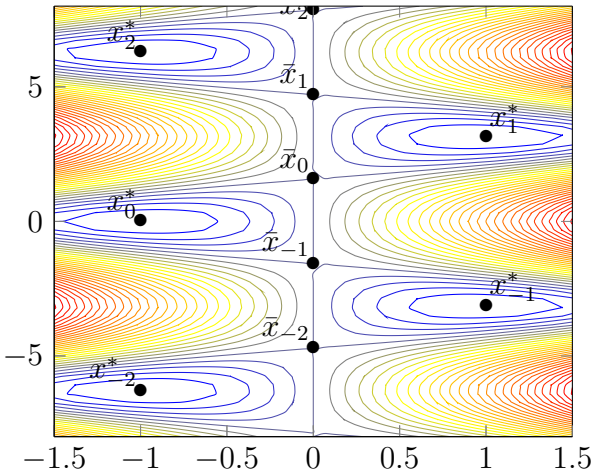
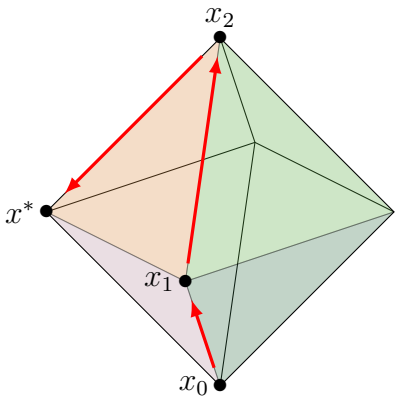
List of Figures



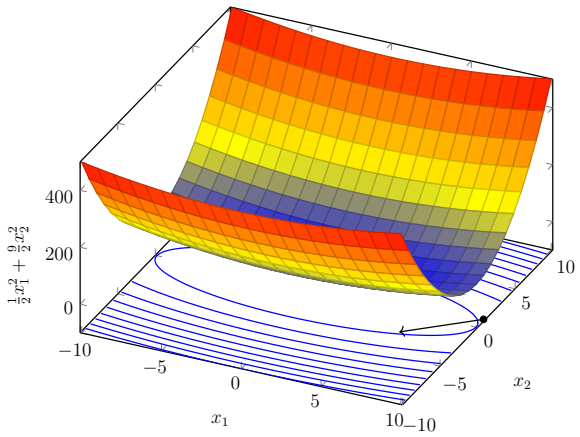

```
\begin{tikzpicture}
  \begin{axis}[view={0}{90}, domain=-1.5:1.5, domain y=-8:8]
    \addplot3[
      contour gnuplot={labels=false, number=40, handler/.style=smooth},
      samples=51,
    ] {0.5*x^2+x*cos(deg(y))};
    \node[
      label={[left, xshift=1mm] $x^*_0$},
      minimum size=1pt
    ] at (axis cs: -1, 3.1415*0){$\bullet$} ;
    \node[
      label={[right, xshift=-1mm] $x^*_1$},
      minimum size=1pt
    ] at (axis cs: 1, 3.1415*1){$\bullet$} ;
    \node[
      label={[right, xshift=-1mm] $x^*_{-1}$},
      minimum size=1pt
    ] at (axis cs:1, -3.1415*1){$\bullet$};
    \node[
      label={[left, xshift=1mm] $x^*_2$},
      minimum size=1pt
    ] at (axis cs: -1, 3.1415*2){$\bullet$} ;
    \node[
      label={[left, xshift=1mm] $x^*_{-2}$},
      minimum size=1pt
    ] at (axis cs: -1, -3.1415*2){$\bullet$} ;
    \node[
      label={[left, xshift=1mm] $\bar{x}_{0}$},
      minimum size=1pt
    ] at (axis cs: 0, 1.5708+0*3.1415){$\bullet$} ;
    \node[
      label={[left, xshift=1mm] $\bar{x}_{1}$},
      minimum size=1pt
    ] at (axis cs: 0, 1.5708+1*3.1415){$\bullet$} ;
    \node[
      label={[left, xshift=1mm] $\bar{x}_{-1}$},
      minimum size=1pt
    ] at (axis cs: 0, 1.5708-1*3.1415){$\bullet$} ;
    \node[
      label={[left, xshift=1mm, yshift=-2mm] $\bar{x}_{2}$},
      minimum size=1pt
    ] at (axis cs: 0, 1.5708+2*3.1415){$\bullet$} ;
    \node[
      label={[left, xshift=1mm] $\bar{x}_{-2}$},
      minimum size=1pt
    ] at (axis cs: 0, 1.5708-2*3.1415){$\bullet$} ;
  \end{axis}
\end{tikzpicture}
```

Figure 1: `3d-07.tex`: Level curves (Gnuplot)



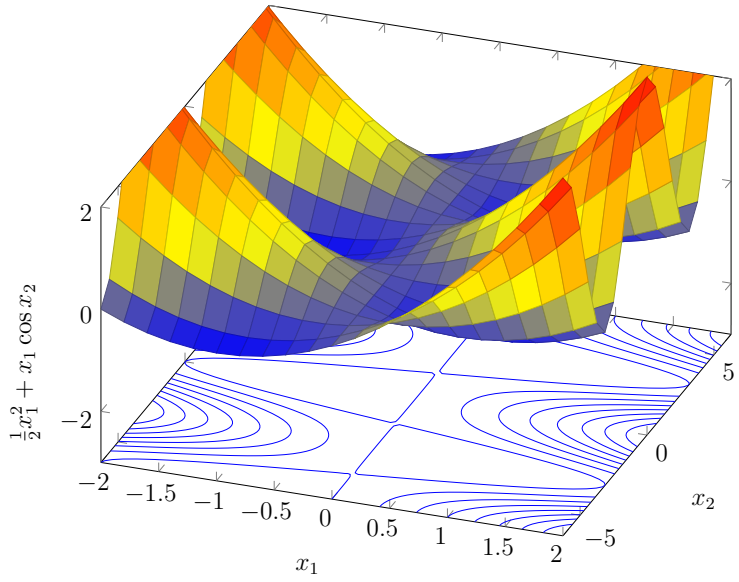

```
\definecolor{pur}{RGB}{186, 146, 162}
\definecolor{cof}{RGB}{219, 144, 71}
\definecolor{greeo}{RGB}{91, 173, 69}
\definecolor{greet}{RGB}{52, 111, 72}
\begin{tikzpicture}[scale=4.6]
  \coordinate (A1) at (0, 0);
  \coordinate (A2) at (0.6, 0.2);
  \coordinate (A3) at (1, 0);
  \coordinate (A4) at (0.4, -0.2);
  \coordinate (B1) at (0.5, 0.5);
  \coordinate (B2) at (0.5, -0.5);

  \draw (A1) -- (A2) -- (A3);
  \draw (B1) -- (A2) -- (B2);

  \draw[fill=cof, opacity=0.3] (A1) -- (A4) -- (B1);
  \draw[fill=pur, opacity=0.3] (A1) -- (A4) -- (B2);
  \draw[fill=greeo, opacity=0.3] (A3) -- (A4) -- (B1);
  \draw[fill=greet, opacity=0.3] (A3) -- (A4) -- (B2);
  \draw (B1) -- (A1) -- (B2) -- (A3) --cycle;
  \node[draw=none] (a1) at (A1) {$\bullet$} ;
  \draw[left] (A1) node {$x^*$};
  \node[draw=none] (b2) at (B2) {$\bullet$} ;
  \draw[left] (B2) node {$x_0$};
  \node[draw=none] (a4) at (A4) {$\bullet$} ;
  \draw[left] (A4) node {$x_1$};
  \node[draw=none] (b1) at (B1) {$\bullet$} ;
  \draw[above] (B1) node {$x_2$};

  \draw[very thick, -latex, red] (b2) -- (a4) ;
  \draw[very thick, -latex, red] (a4) -- (b1) ;
  \draw[very thick, -latex, red] (b1) -- (a1) ;
\end{tikzpicture}
```

Figure 2: `3d-04.tex`: Polytope



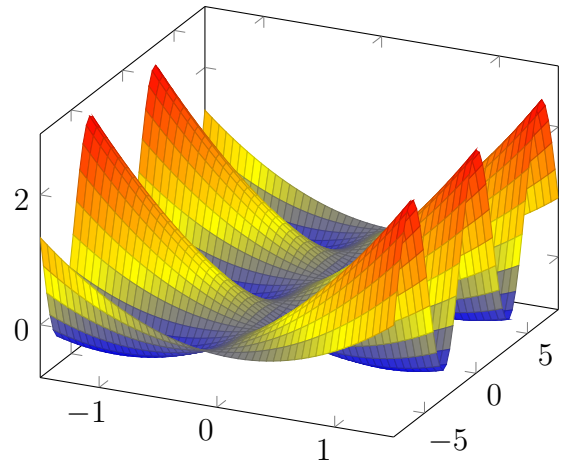

```
\begin{tikzpicture}[scale=0.6]
  \begin{axis}[
      width=12cm,
      view={25}{45},
      enlargelimits=false,
      grid=none,
      domain=-10:10,
      y domain=-10:10,
      xmin=-10.1,
      xmax = 10.1,
      zmin=-100,
      zmax=500,
      samples=21,
      xlabel=$x_1$,
      ylabel=$x_2$,
      thick,
      zlabel={$\frac{1}{2} x_1^2 + \frac{9}{2} x_2^2$}
    ]
    \addplot3[
      no markers,
      blue,
      raw gnuplot,
      z filter/.code={\def\pgfmathresult{-100}},
      mesh=false
    ] gnuplot {
      set contour base;
      set nosurface;
      set cntrparam levels 15;
      set isosamples 100;
      set samples 50;
      splot [-10:10][-10:10] 0.5 * x * x + 4.5 * y * y ;
    };
    \addplot3[surf]  {0.5 * x * x + 4.5 * y * y} ;
    \addplot3[mark=*] coordinates {(10, 1, -100)};
    \draw[thick,->] (axis cs:10, 1, -100) -- (axis cs:6.284, -2.345, -100) ;
  \end{axis}
\end{tikzpicture}
```

Figure 3: `3d-01.tex`: Function, level curves and iteration (Gnuplot)



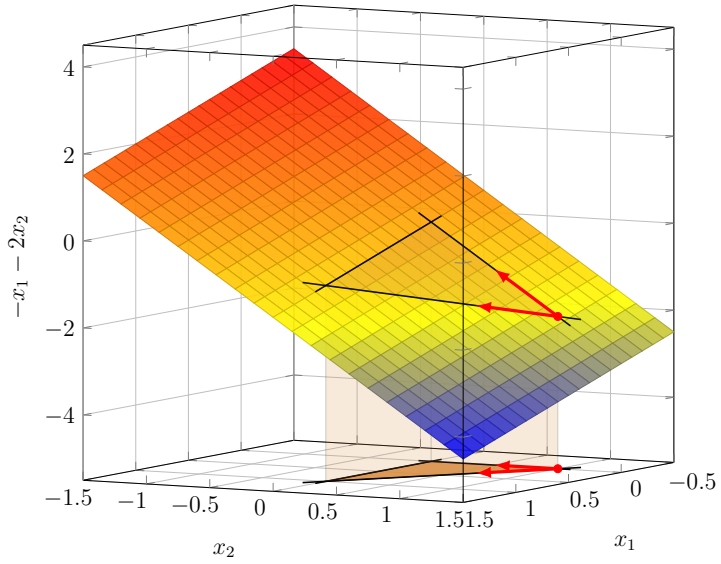

```
\begin{tikzpicture}[scale=0.8]
  \begin{axis}[
      width=12cm,
      view={20}{40},
      enlargelimits=false,
      domain=-2:2,
      y domain=-6.28:6.28,
      zmin=-3,
      zmax=2,
      samples=21,
      xlabel=$x_1$,
      ylabel=$x_2$,
      zlabel={$\frac{1}{2} x_1^2 + x_1 \cos x_2$},
    ]
    \addplot3[
      no markers,
      blue,
      raw gnuplot,
      z filter/.code={\def\pgfmathresult{ -3 }},
      mesh=false
    ] gnuplot {
      set contour base;
      set nosurface;
      set cntrparam levels 15;
      set isosamples 100;
      set samples 50;
      splot [-2:2][-6.28:6.28] 0.5 * x * x + x * cos(y) ;
    };
    \addplot3[surf,opacity=1]  { 0.5 * x * x + x * cos(deg(y)) };
  \end{axis}
\end{tikzpicture}
```

Figure 4: `3d-02.tex`: Function, level curves (Gnuplot)



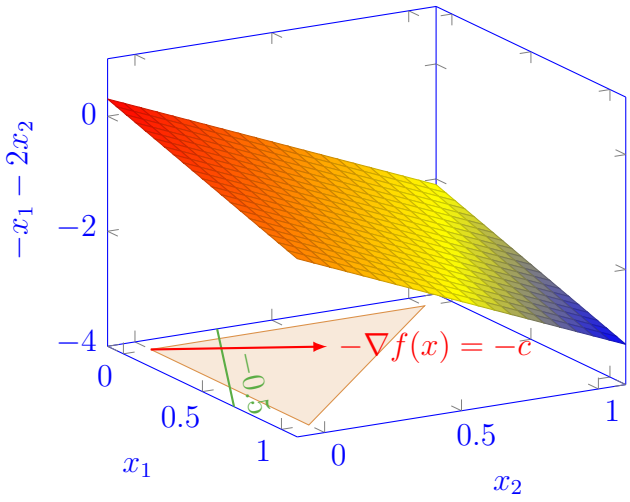

```
\begin{tikzpicture}
  \begin{axis}[
      domain=-1.5:1.5,
      domain y=-8:8
    ]
    \addplot3[
      surf,
      samples=51
    ]
            {0.5 * x^2 + x * cos(deg(y))};
  \end{axis}
\end{tikzpicture}
```

Figure 5: `3d-03.tex`: Function



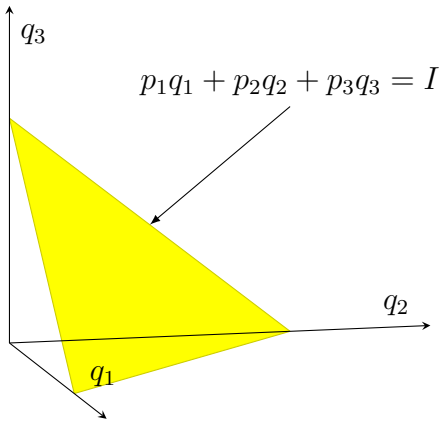

```
\definecolor{cof}{RGB}{219, 144, 71}
 \begin{tikzpicture}[scale=0.75]
  \begin{axis}[
      3d box,
      width=12cm,
      view={119}{6},
      enlargelimits=false,
      grid=major,
      domain=-0.5:1.5,
      y domain=-1.5:1.5,
      zmin=-5.5,
      zmax=4.5,
      samples=21,
      xlabel=$x_1$,
      ylabel=$x_2$,
      zlabel={$-x_1 - 2x_2$},
    ]
    %Feasible set at the bottom
    \addplot3[fill=cof, opacity=0.9] coordinates {(0, 0, -5.5) (1, 0, -5.5) (0, 1, -5.5)} ;
    %Constraints at the bottom
    \addplot3[thick] coordinates {(1.1, 0.0, -5.5) (-0.1, 0.0, -5.5)} ;
    \addplot3[thick] coordinates {(-0.1, 1.1, -5.5) (1.1, -0.1, -5.5)} ;
    \addplot3[thick] coordinates {(0.0, 1.1, -5.5) (0.0, -0.1, -5.5)} ;
    %Vertical rectangles
    \addplot3[fill=cof, opacity=0.1] coordinates {(0, 0, -5.5) (0, 0, 0) (1, 0, -1) (1, 0, -5.5)};
    \addplot3[fill=cof, opacity=0.1] coordinates {(1, 0, -5.5) (1, 0, -1) (0, 1, -2) (0, 1, -5.5)};
    \addplot3[fill=cof, opacity=0.1] coordinates {(0, 0, -5.5) (0, 0, 0) (0, 1, -2) (0, 1, -5.5)};
    %Surface
    \addplot3 [surf, opacity=0.9]{ -x - 2 * y };
    %Feasible set on the surface
    \addplot3[fill=cof, opacity=0.3] coordinates {(0, 0, 0) (1, 0, -1) (0, 1, -2)} ;
    %Constraints on the surface
    \addplot3[thick, opacity=0.9] coordinates {(1.1, 0.0, -1.1) (-0.1, 0.0, 0.1)} ;
    \addplot3[thick, opacity=0.9] coordinates {(-0.1, 1.1, -2.1) (1.1, -0.1, -0.9)} ;
    \addplot3[thick, opacity=0.9] coordinates {(0.0, 1.1, -2.2) (0.0, -0.1, 0.2)} ;
    %Optimal solution
    \addplot3[mark=*, red] coordinates {(0, 1, -2)};
    \addplot3[mark=*, red] coordinates {(0, 1, -5.5)};
    %Arrows
    \addplot3[ultra thick, -latex, red] coordinates {
      (0, 1, -2)
      (0.35355339059327373, 0.6464466094067263, -1.6464466094067263)
    } ;
    \addplot3[ultra thick, -latex, red] coordinates {
      (0, 1, -5.5)
      (0.35355339059327373, 0.6464466094067263, -5.5)
    } ;
    \addplot3[ultra thick, -latex, red] coordinates {(0, 1, -2) (0.0, 0.5, -1.0)} ;
    \addplot3[ultra thick, -latex, red] coordinates {(0, 1, -5.5) (0.0, 0.5, -5.5)} ;
  \end{axis}
\end{tikzpicture}
```

Figure 6: `3d-05.tex`: Linear function with constraints and directions



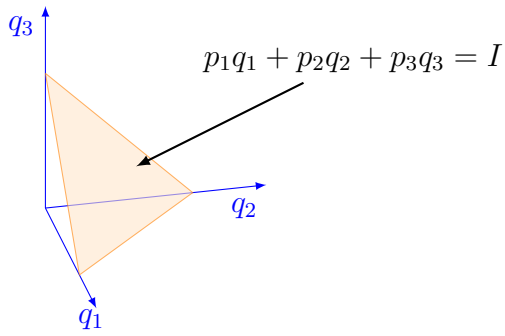

```
\definecolor{cof}{RGB}{219,144,71}
\definecolor{greeo}{RGB}{91,173,69}
\definecolor{greet}{RGB}{52,111,72}
\begin{tikzpicture}[blue]
  \begin{axis}[
      view={60}{20},
      enlargelimits=false,
      domain=-0.1:1.1,
      y domain=-0.1:1.1,
      zmin=-4,
      zmax=1,
      samples=21,
      xlabel=$x_1$,
      ylabel=$x_2$,
      zlabel={$-x_1 - 2x_2$},
    ]
    % Objective function
    \addplot3[surf, opacity=1] {-x -2*y };
    \draw[cof, fill=cof!20] {
      (axis cs:0, 0, -4) --
      (axis cs: 0, 1, -4) --
      (axis cs: 1, 0, -4) -- (axis cs:0, 0, -4)}
    ;
    % Level curve -0.5
    \draw[
      greeo,
      thick
    ] (axis cs: -0.1, 0.3, -4) -- (axis cs: 1.1, -0.3, -4)
    node[midway, above, sloped] (f1) {$-0.5$} ;

    \draw[red, -latex, thick] (axis cs:0, 0) -- (axis cs:0.25, 0.5)
      node[right] {$-\nabla f(x) = -c$};
  \end{axis}
\end{tikzpicture}
```

Figure 7: `3d-06.tex`: Linear function with constraints, directions and gradient




```
\begin{tikzpicture}
  \begin{axis}[view={77}{13},
      axis lines=middle,
      axis on top,
      ticks=none,
      clip=true,
      patch,
      xlabel={$q_1$},
      ylabel={$q_2$},
      zlabel={$q_3$},
      samples=50,
      xmin=0,
      xmax=1.5,
      ymin=0,
      ymax=1.5,
      zmin=0,
      zmax=1.5,
      domain=0:1,
      domain y=0:1,]
    \addplot3[surf] coordinates {
      (1,0,0)
      (0,1,0)
      (0,0,1)
    };
    \node[anchor=south] at (0, 1, 1) {$p_1q_1 + p_2 q_2 + p_3q_3 = I$};
    \draw[-latex] (0, 1, 1) -- (0, 0.5, 0.5) ;
  \end{axis}
\end{tikzpicture}
```

Figure 8: `3d-08.tex`: Simplex




```
\tdplotsetmaincoords{63}{77}
\begin{tikzpicture}[scale=2, tdplot_main_coords]
  \draw[blue, -latex] (0,0,0) -- (1.5,0,0) node[pos=0.9, below] {$q_1$};
  \draw[blue, -latex] (0,0,0) -- (0,1.5,0) node[pos=0.9, below] {$q_2$};
  \draw[blue, -latex] (0,0,0) -- (0,0,1.5) node[pos=0.9, left] {$q_3$};
  \node[anchor=west] (A) at (0,1,1) {$p_1q_1 + p_2 q_2 + p_3q_3 = I$};
   \draw[orange, fill=orange!20, opacity=0.6] {
    (0, 0, 1) --
    (0, 1, 0) --
    (1, 0, 0) --
    (0, 0, 1)
    };
  \draw[thick, -latex] (A) -- (0.5,.5,.5) ;
\end{tikzpicture}
```

Figure 9: `3d-09.tex`: Plane