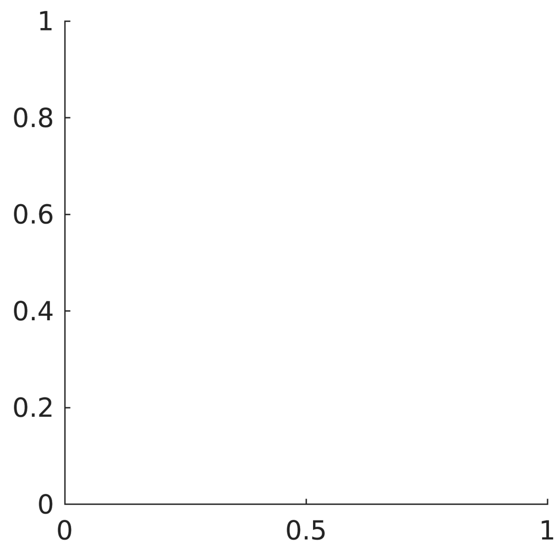
Rosenbrock constrained

```
%{
Rosenbrock's function is a standard test function in optimization. It has
a unique minimum value of 0 attained at the point [1,1].
Finding the minimum is a challenge for some algorithms because the function
has a shallow minimum inside a deeply curved valley.
The solution for this problem is not at the point [1,1] because that point
does not satisfy the constraint.
%}
close all
format compact
```

```
rosenbrock = @(x)100*(x(:,2) - x(:,1).^2).^2 + (1 - x(:,1)).^2;
 %{
 The rosenbrock function handle calculates Rosenbrock's function at any
 number of 2-D points at once. This “Vectorization” speeds the
 plotting of the function, .
 The function f(x) is called the objective function. The objective function
is the function you want to minimize.
 %}
figure1 = figure('Position',[1 200 600 300]);
```

```
colormap('gray');axis square;
```




```
R = 0:.002:1;TH = 2*pi*(0:.002:1);
X = R'*cos(TH);Y = R'*sin(TH); % This is the way to produce polar
%                          coordinate-grid, think of column*row
Z = log(1 + rosenbrock([X(:),Y(:)])); % Take logarithmic scale.
Z = reshape(Z,size(X));
```

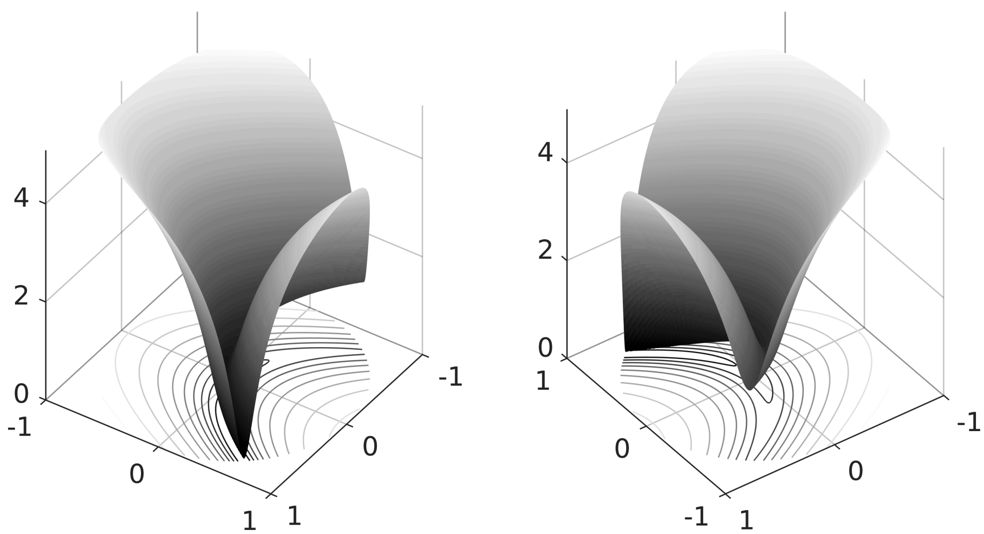
Create subplot

```
subplot1 = subplot(1,2,1,'Parent',figure1);
view([124 34]);grid on;hold on

 % Create surface
 surf(X,Y,Z,'Parent',subplot1,'Linestyle','none')
 % Create contour
 contour(X,Y,Z,'Parent',subplot1)
 % Create subplot
 subplot2 = subplot(1,2,2,'Parent',figure1);
 view([234 34]);grid('on');hold on

 % Create surface
 surf(X,Y,Z,'Parent',subplot2,'LineStyle','none');

 % Create contour
 contour(X,Y,Z,'Parent',subplot2);
```



The inequality $x_1^2 + x_2^2 \leq 1$ is called constraint. You can have any number of constraints, which are inequalities or equations

```
 type unitdisk
```

```
function [c,ceq] = unitdisk(x)
c = x(1)^2 + x(2)^2 - 1;
ceq = [ ];
```

```
 %{
 function [c,ceq] = unitdisk(x)
c = x(1)^2 + x(2)^2 - 1;  % LHS of inequality c(x) <= 0
ceq = [ ];                % No equality constraints
 %}
```

optimoptions

```
options = optimoptions(@fmincon,'Display','iter',...
    'Algorithm','interior-point');
% options is now a struct. See it:
options
```

```
options = 
  fmincon options:

   Options used by current Algorithm ('interior-point'):
   (Other available algorithms: 'active-set', 'sqp', 'sqp-legacy', 'trust-region-reflective')

   Set properties:
                    Algorithm: 'interior-point'
                      Display: 'iter'
   Default properties:
               CheckGradients: 0
          ConstraintTolerance: 1.0000e-06
     FiniteDifferenceStepSize: 'sqrt(eps)'
         FiniteDifferenceType: 'forward'
         HessianApproximation: 'bfgs'
                   HessianFcn: []
           HessianMultiplyFcn: []
                  HonorBounds: 1
      MaxFunctionEvaluations: 3000
                MaxIterations: 1000
               ObjectiveLimit: -1.0000e+20
          OptimalityTolerance: 1.0000e-06
                    OutputFcn: []
                      PlotFcn: []
                 ScaleProblem: 0
    SpecifyConstraintGradient: 0
     SpecifyObjectiveGradient: 0
                StepTolerance: 1.0000e-10
          SubproblemAlgorithm: 'factorization'
                     TypicalX: 'ones(numberOfVariables,1)'
                  UseParallel: 0
   Show options not used by current Algorithm ('interior-point')
```

```
% Alternatively you can change any option by an
% assignment of the type: options.Algorithm ='interior-point'
```

Run:

```
[x,fval] = fmincon(rosenbrock,[0 0],...
   [],[],[],[],[],[],@unitdisk,options)
```

```
                                            First-order      Norm of
 Iter F-count            f(x)  Feasibility   optimality         step
    0       3    1.000000e+00    0.000e+00    2.000e+00
    1      13    7.753537e-01    0.000e+00    6.250e+00    1.768e-01
    2      18    6.519648e-01    0.000e+00    9.048e+00    1.679e-01
    3      21    5.543209e-01    0.000e+00    8.033e+00    1.203e-01
    4      24    2.985207e-01    0.000e+00    1.790e+00    9.328e-02
    5      27    2.653799e-01    0.000e+00    2.788e+00    5.723e-02
    6      30    1.897216e-01    0.000e+00    2.311e+00    1.147e-01
    7      33    1.513701e-01    0.000e+00    9.706e-01    5.764e-02
    8      36    1.153330e-01    0.000e+00    1.127e+00    8.169e-02
    9      39    1.198058e-01    0.000e+00    1.000e-01    1.522e-02
   10      42    8.910052e-02    0.000e+00    8.378e-01    8.301e-02
   11      45    6.771961e-02    0.000e+00    1.365e+00    7.149e-02
   12      48    6.437664e-02    0.000e+00    1.146e-01    5.701e-03
```

```
    13      51    6.329037e-02    0.000e+00    1.883e-02    3.774e-03
    14      54    5.161934e-02    0.000e+00    3.016e-01    4.464e-02
    15      57    4.964194e-02    0.000e+00    7.913e-02    7.894e-03
    16      60    4.955404e-02    0.000e+00    5.462e-03    4.185e-04
    17      63    4.954839e-02    0.000e+00    3.993e-03    2.208e-05
    18      66    4.658289e-02    0.000e+00    1.318e-02    1.255e-02
    19      69    4.647011e-02    0.000e+00    8.006e-04    4.940e-04
    20      72    4.569141e-02    0.000e+00    3.136e-03    3.379e-03
    21      75    4.568281e-02    0.000e+00    6.437e-05    3.974e-05
    22      78    4.568281e-02    0.000e+00    8.000e-06    1.083e-07
    23      81    4.567641e-02    0.000e+00    1.601e-06    2.793e-05
    24      84    4.567482e-02    0.000e+00    2.411e-08    6.916e-06

Local minimum found that satisfies the constraints.

Optimization completed because the objective function is non-decreasing in 
feasible directions, to within the value of the optimality tolerance,
and constraints are satisfied to within the value of the constraint tolerance.

<stopping criteria details>
x = 1×2
    0.7864    0.6177
fval = 0.0457
```

```
% The six sets of empty brackets represent optional constraints that are
% not being used in this example. See the fmincon function reference
% pages for the syntax.
```

Complete the picture in a fancy way.

Create textarrow

```
annotation(figure1,'textarrow',[0.4 0.31],...
    [0.055 0.16],...
    'String',{'Minimum at (0.7864,0.6177)'});

% Create arrowrrow
annotation(figure1,'arrow',[0.59 0.62],[0.065 0.34]);
title("Rosenbrock's Function: Two Views")
```