https://www.halvorsen.blog

Optimization with MATLAB

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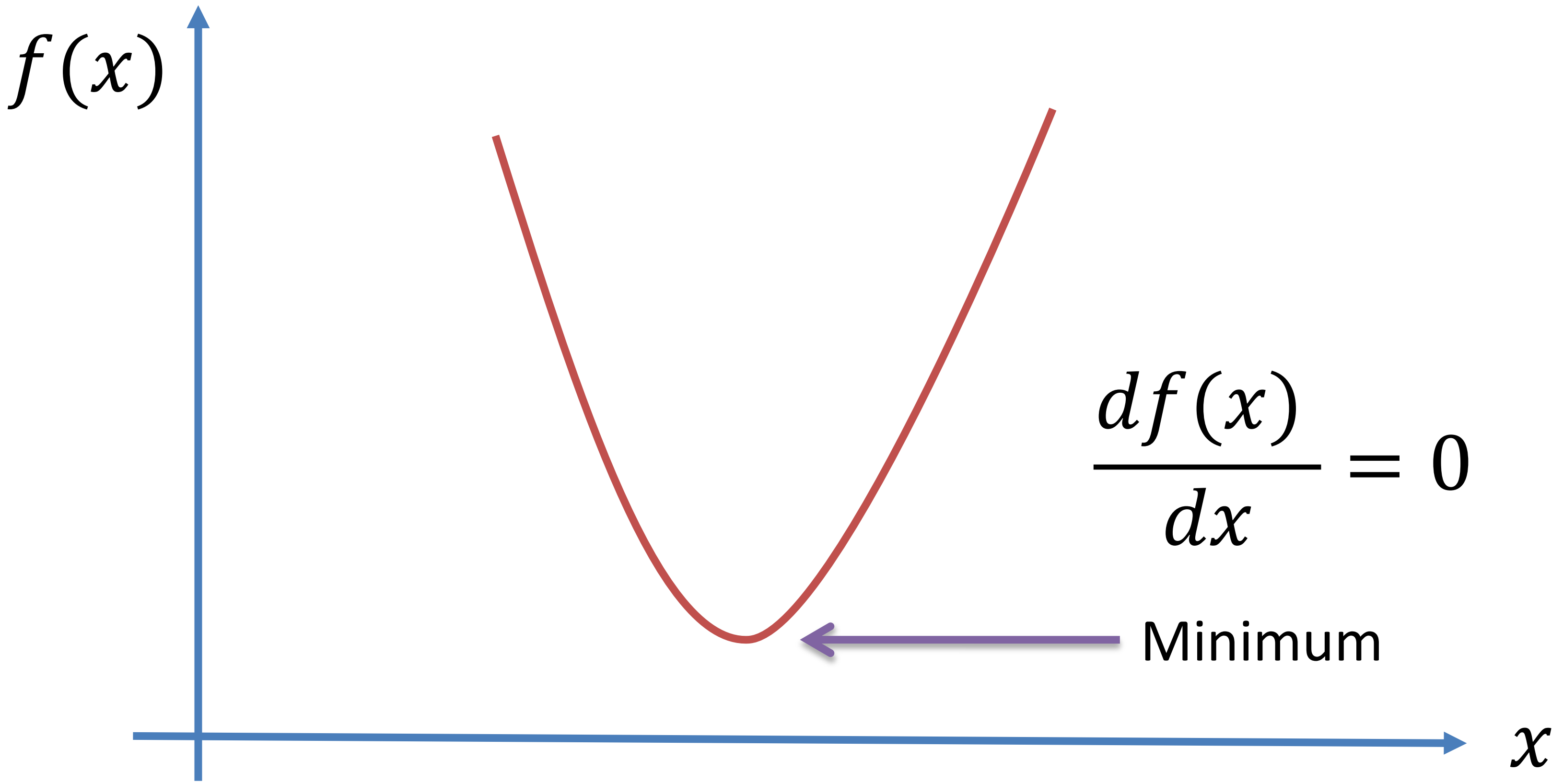
Optimization

Optimization is based on finding the minimum of a given criteria function.



Optimization

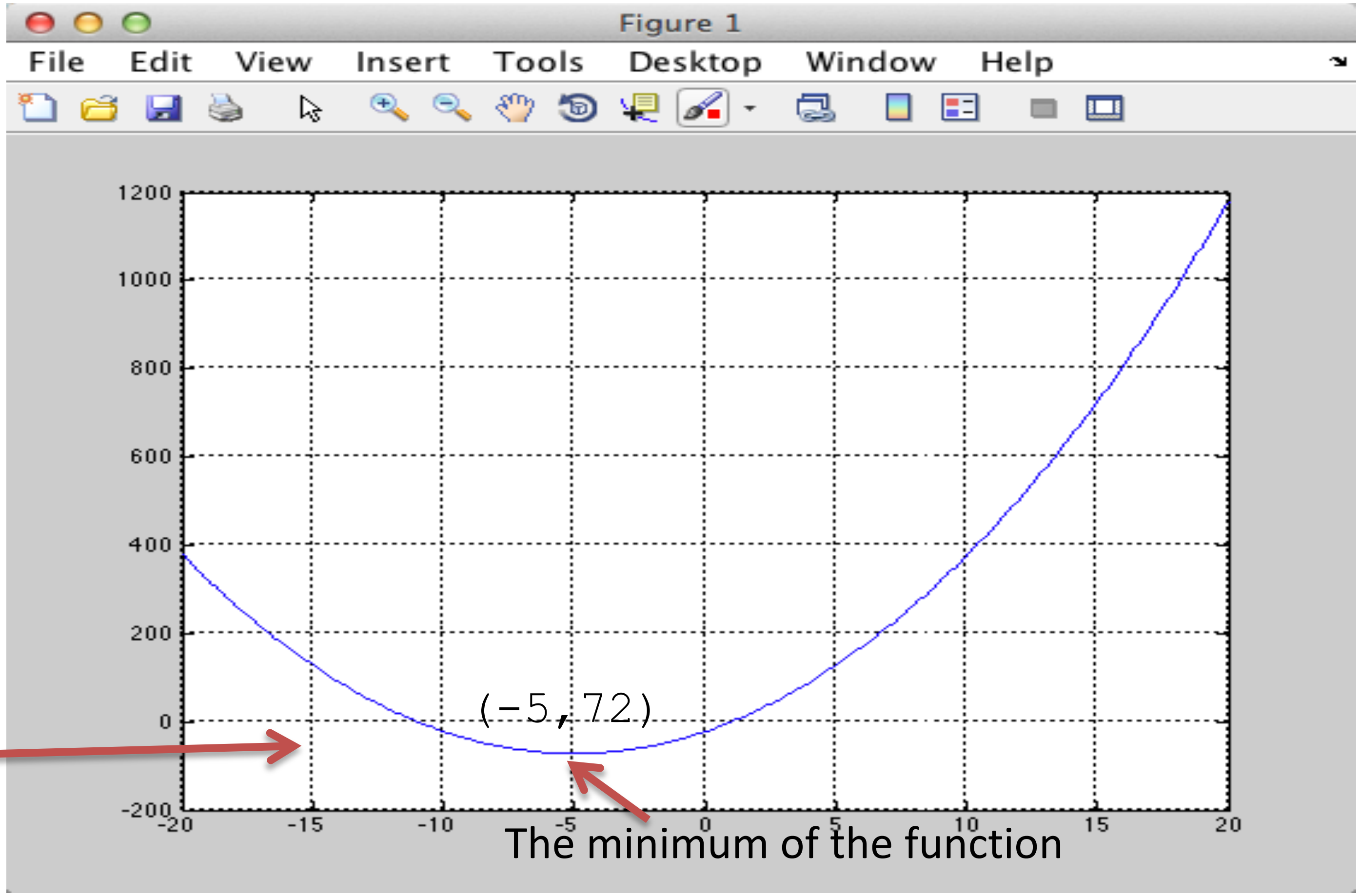
- Optimization is important in modelling, control and simulation applications.
- Optimization is based on finding the minimum of a given criteria function.
- It is typically used with Model based Control (MPC)
- MATLAB functions:
  - *fminbnd()* - Find minimum of single-variable function on fixed interval
  - *fminsearch()* - this function is similar to *fminbnd()* except that it handles functions of many variables

Optimization

Example: $y(x) = 2x^2 + 20x - 22$

We want to find for what value of x the function has its minimum value:

```
clear
clc

x = -20:0.1:20;
y = 2.*x.^2 + 20.*x - 22;
plot(x,y)
grid

i=1;
while ( y(i) > y(i+1) )
   i = i + 1;
end

x(i)
y(i)
```



Example:

Optimization

$$y(x) = 2x^2 + 20x - 22$$

```
function f = mysimplefunc(x)

f = 2*x.^2 + 20.*x -22;
```

```
x_min =

    -5


y =

   -72
```

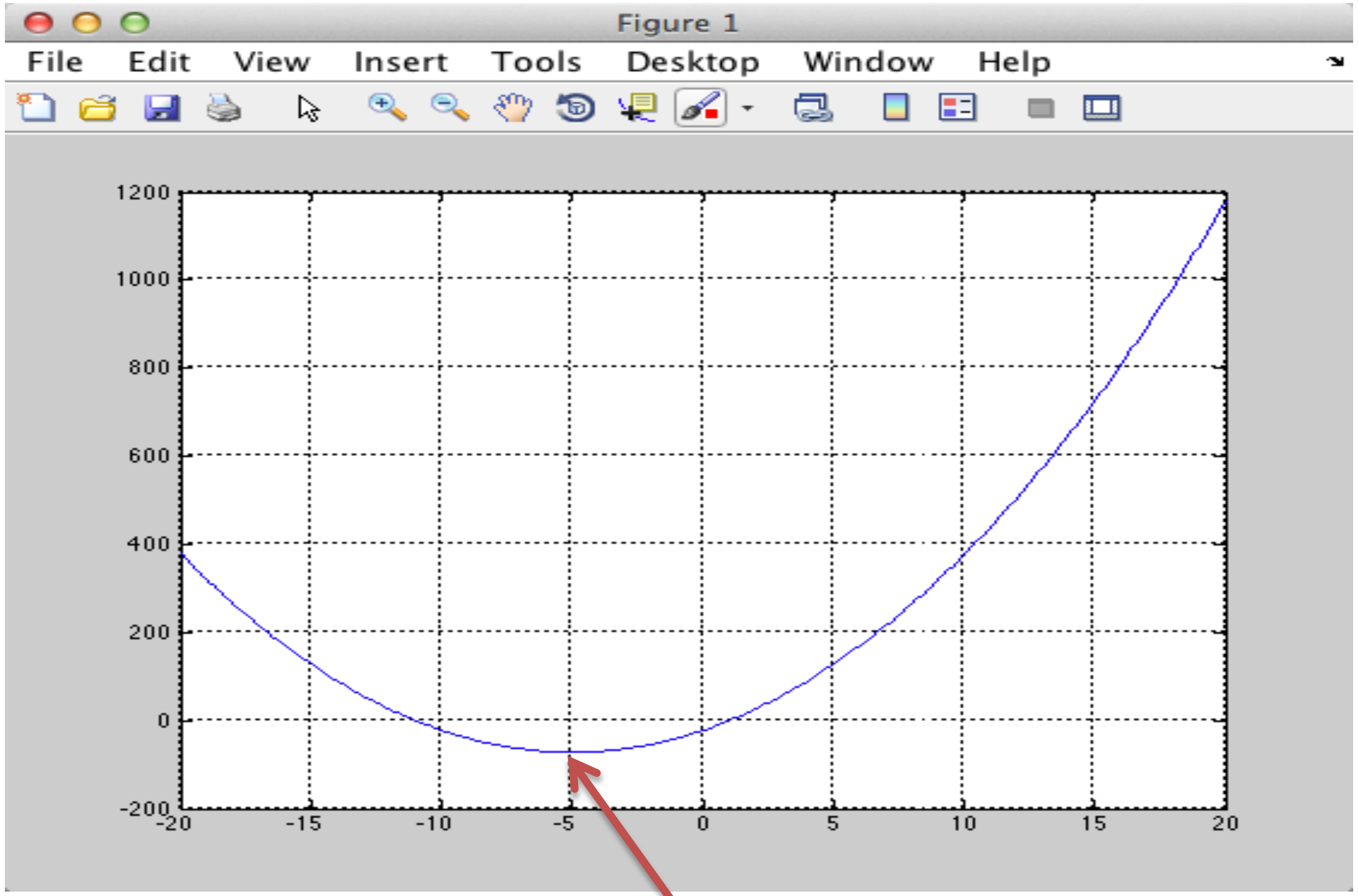
We got the same results as previous slide

```
clear
clc
close all

x = -20:1:20;
f = mysimplefunc(x);
plot(x, f)
grid

x_min = fminbnd(@mysimplefunc, -20, 20)

y = mysimplefunc(x_min)
```

Note! if we have more than 1 variable, we have to use e.g., the *fminsearch()* function

Optimization

Example: $y(x) = 2x^2 + 20x - 22$



(−5,72)

The minimum of the function

We have that:

$$\frac{dy}{dx} = 4x + 20$$

Minimum when:

$$\frac{dy}{dx} = 0$$

This gives:

$$4x + 20 = 0$$

$$x = -5$$

Optimization

Given the following function:

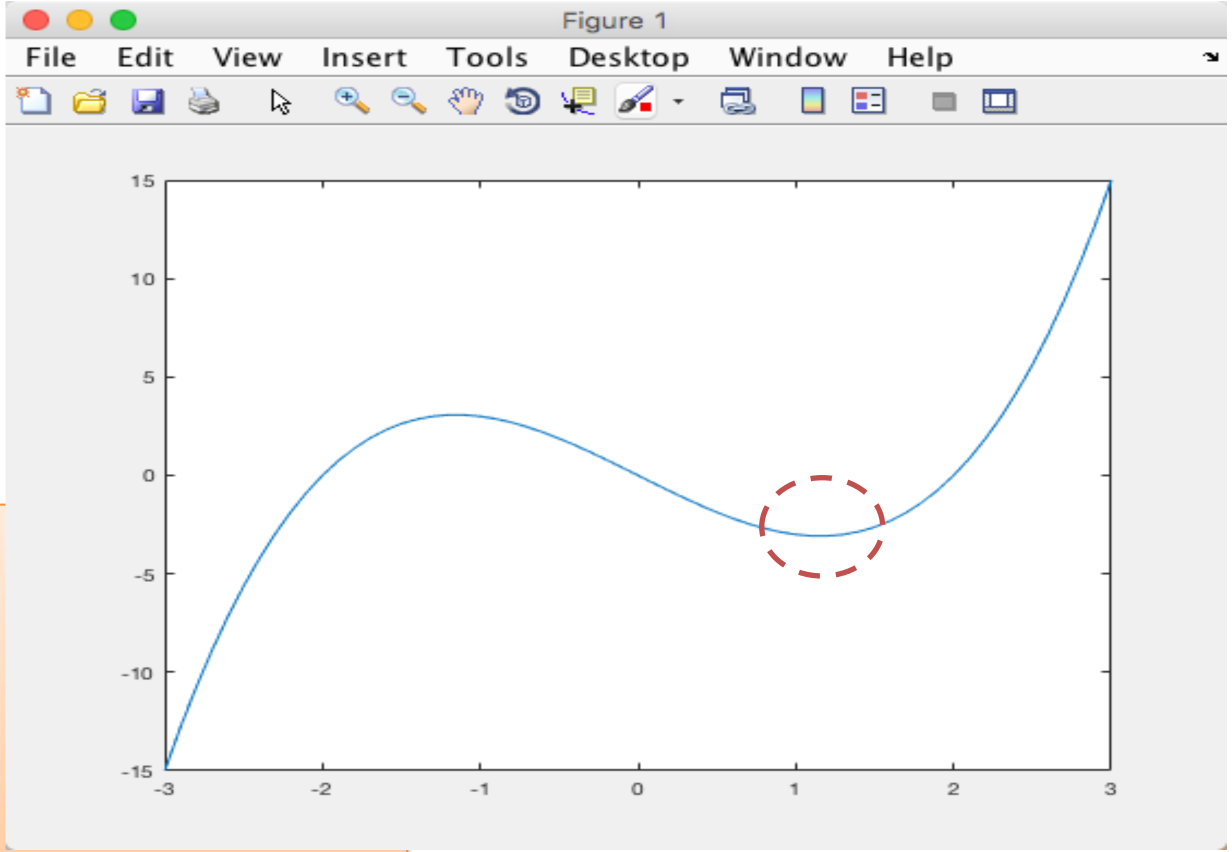
$$f(x) = x^3 - 4x$$

We will:

- Plot the function
- Find the minimum for this function

```
function f = myefunction(x)

f = x.^3 - 4*x;
```

```
clear, clc
x = -3:0.1:3;
f = mysimplefunc(x);
plot(x, f)

[xmin,fmin] = fminbnd(@myfunction, -3, 3)
```



This gives:

```
xmin =
     1.1547
fmin =
    -3.0792
```

$$\frac{dy}{dx} = 3x^2 - 4 = 0 \rightarrow x_{min} = \sqrt{\frac{4}{3}} \approx 1.1547$$

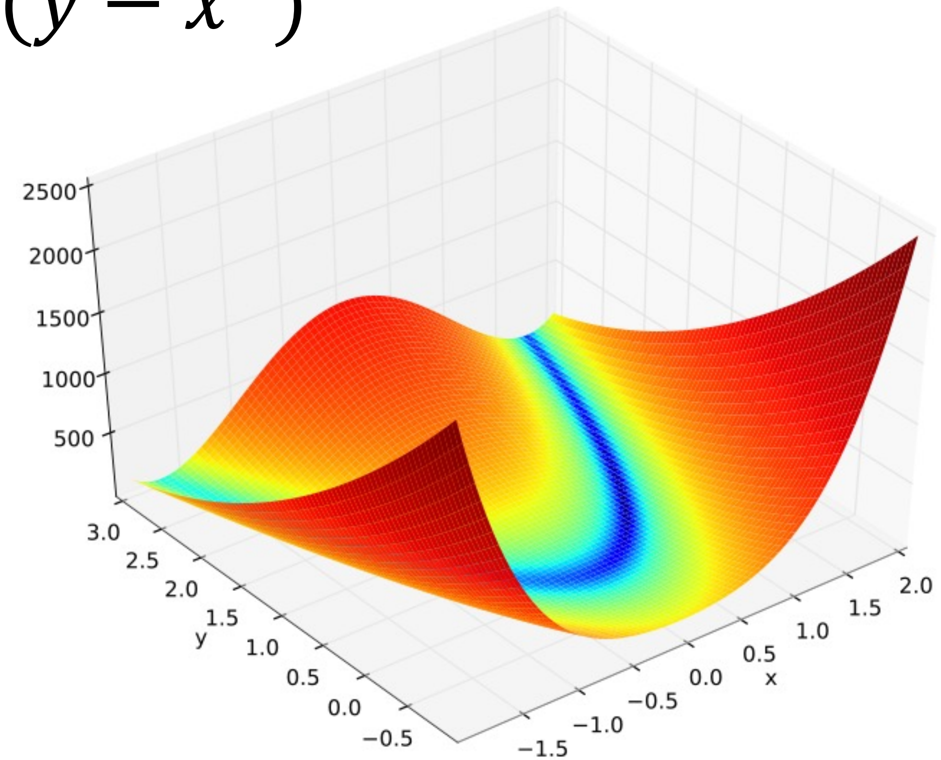
Optimization - Rosenbrock's Banana Function

Given the following function:

Rosenbrock's banana function is a famous test case for optimization software

$$f(x,y) = (1-x)^2 + 100(y-x^2)^2$$

This function is known as Rosenbrock's banana function.



We will:

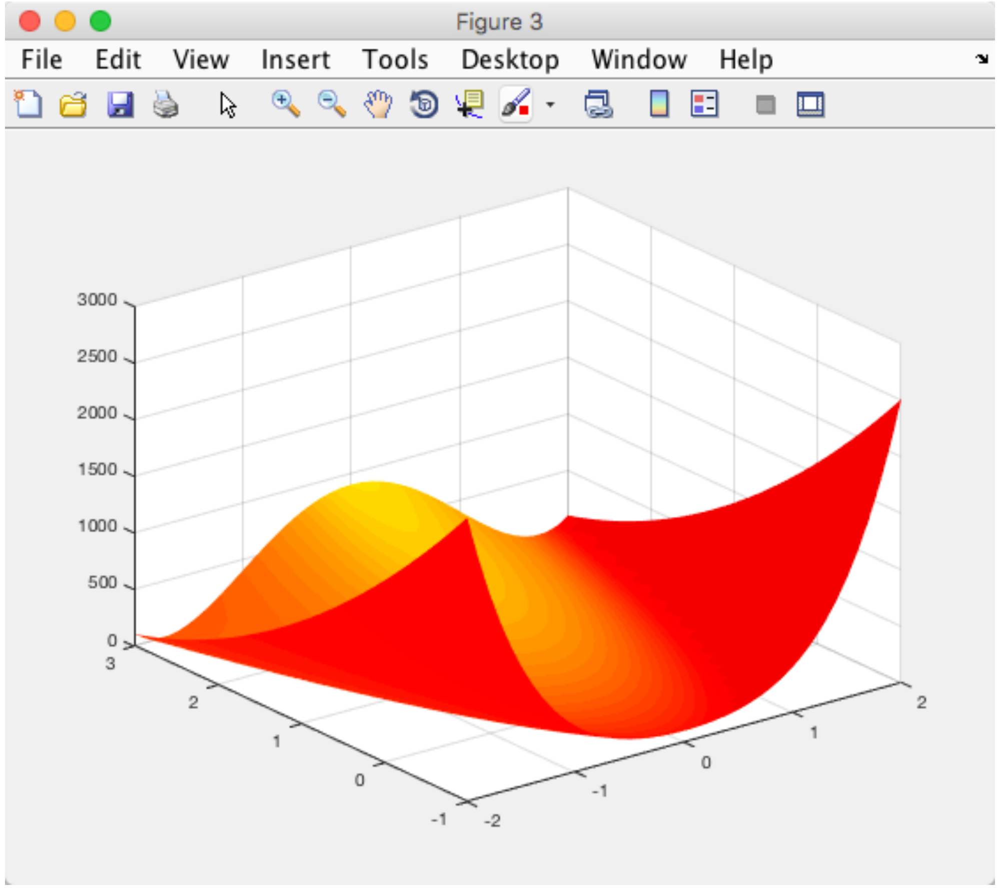
→ Plot the function

→ Find the minimum for this function

https://en.wikipedia.org/wiki/Rosenbrock_function

We plot the Banana function:

```
clear,clc

[x,y] = meshgrid(-2:0.1:2, -1:0.1:3);

f = (1-x).^2 + 100.*(y-x.^2).^2;

figure(1)
surf(x,y,f)

figure(2)
mesh(x,y,f)


figure(3)
surfl(x,y,f)
shading interp;
colormap(hot);
```



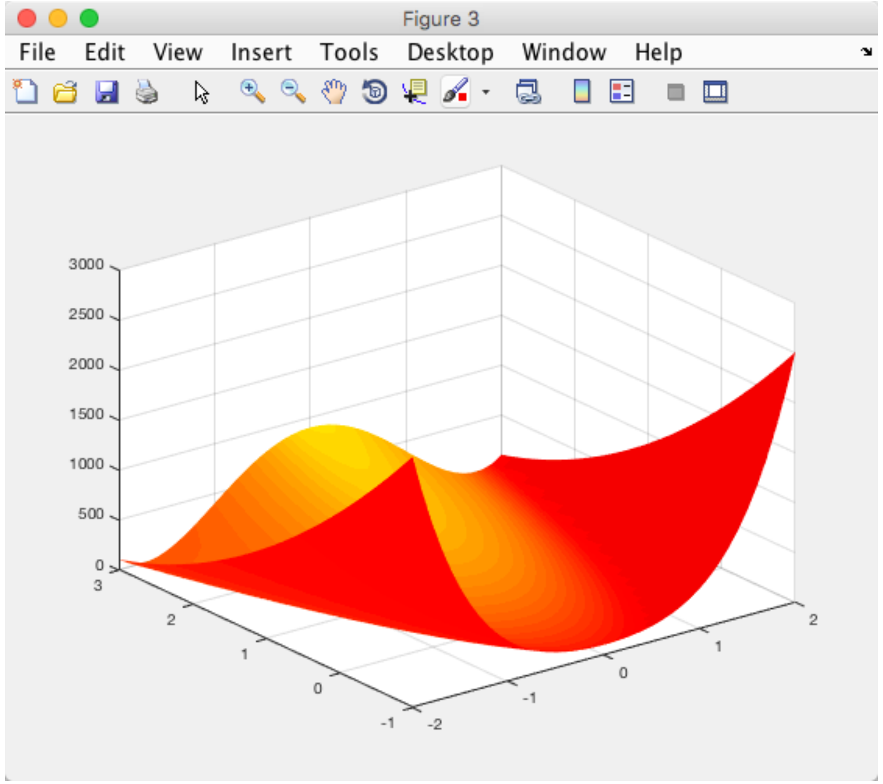
```
function f = bananafunc(x)

f = (1-x(1)).^2 + 100.*(x(2)-x(1).^2).^2;
```

```
[x,fval] = fminsearch(@bananafunc, [-1.2;1])
```

From MATLAB we get:

```
x =      1.0000     1.0000

fval =    8.1777e-10
```

Which is correct



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