CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY (CSJMU)

in association with

INDIAN INSTITUTE OF TECHNOLOGY KANPUR (IITK)

organizes

A FIVE DAY NATIONAL WORKSHOP on **INTRODUCTION TO MATLAB**

Introduction to MATLAB: Matlab plotting

by

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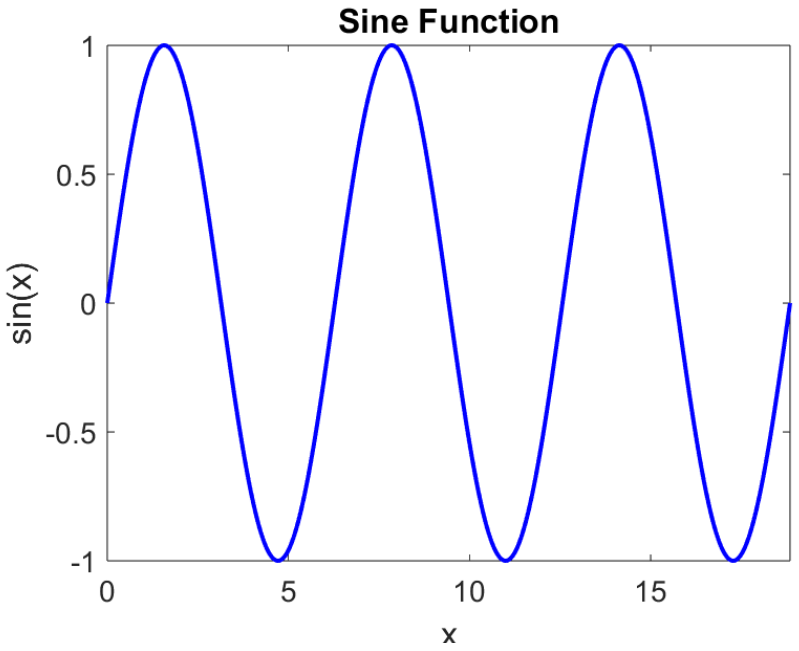
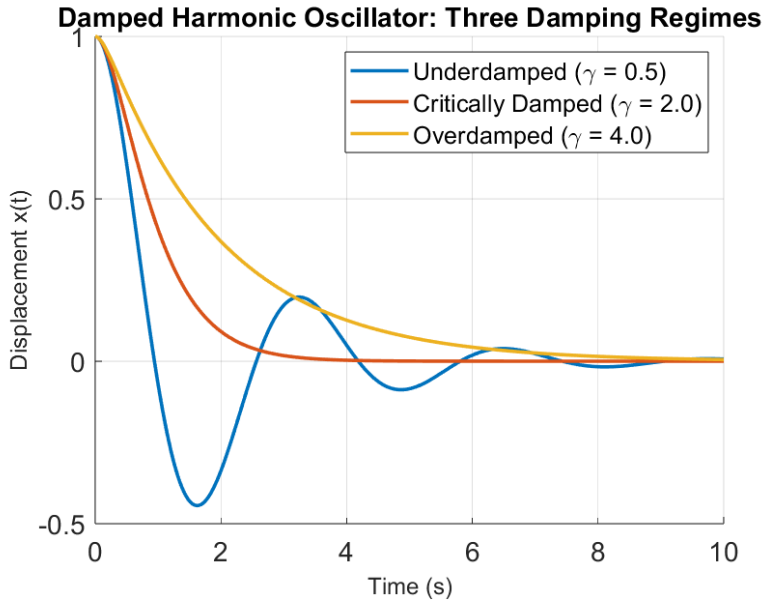
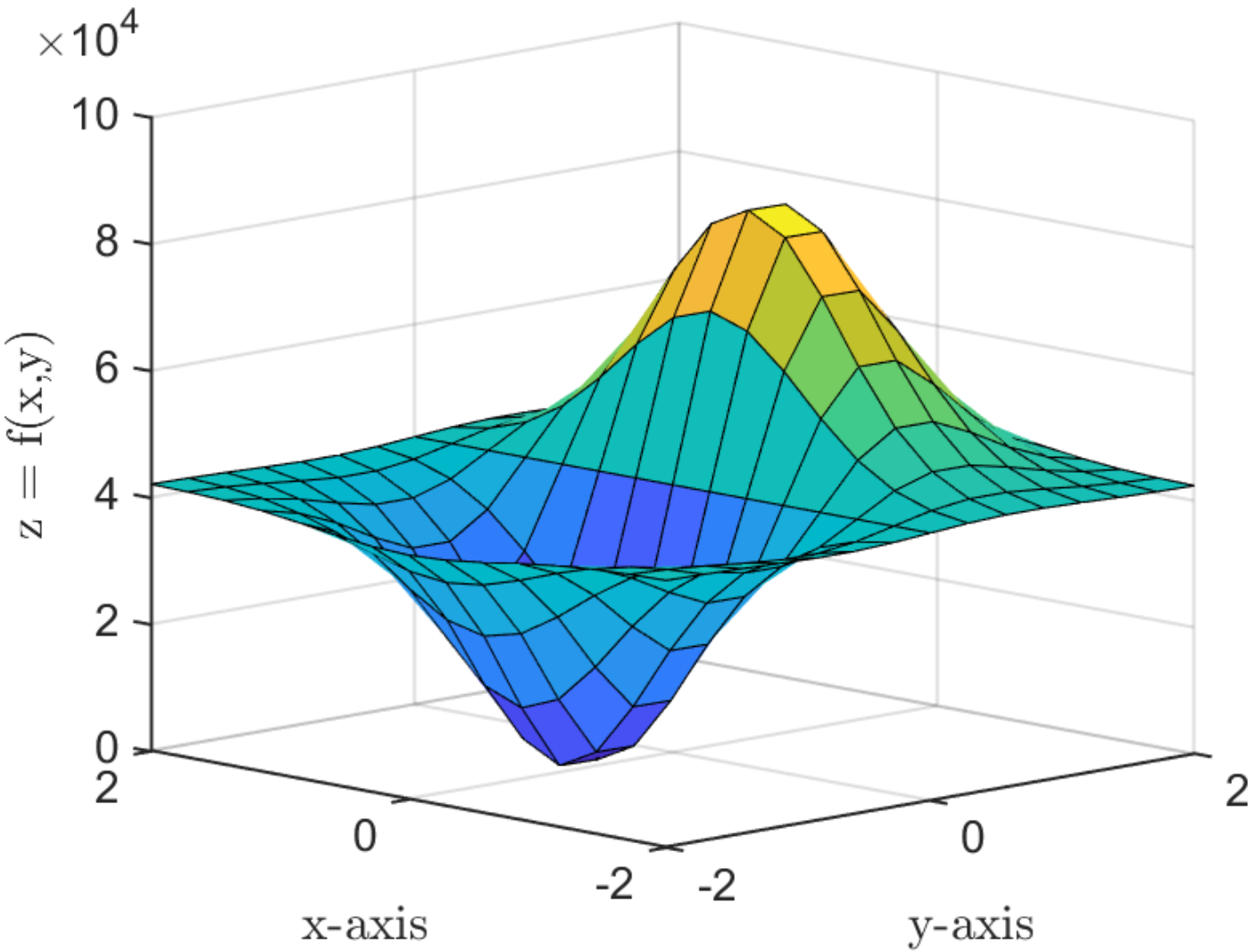
Indian Institute of Technology Kanpur

Date: 10th April, 2025

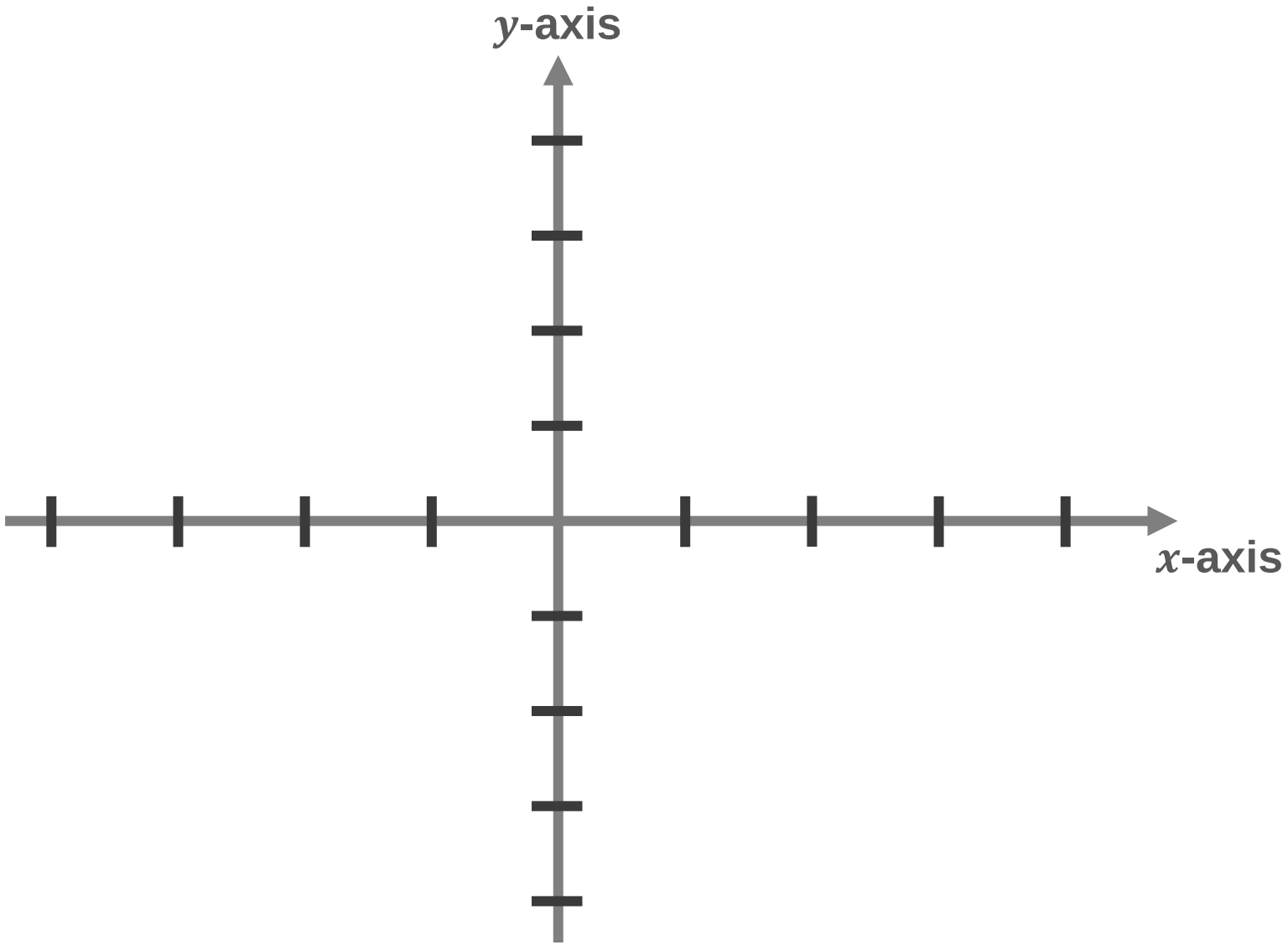
Different plots in MATLAB



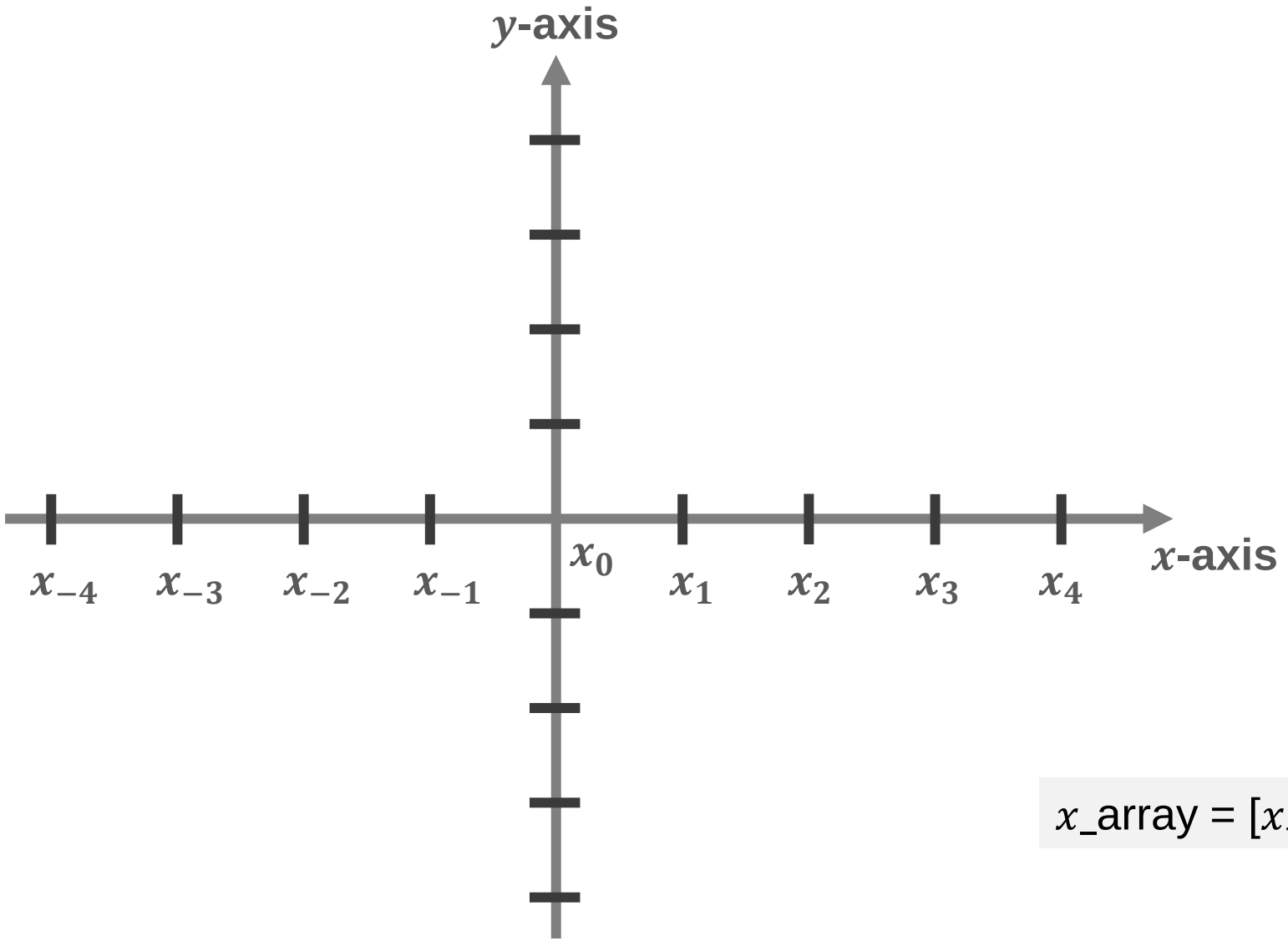




2-dimensional plot in MATLAB: line plot

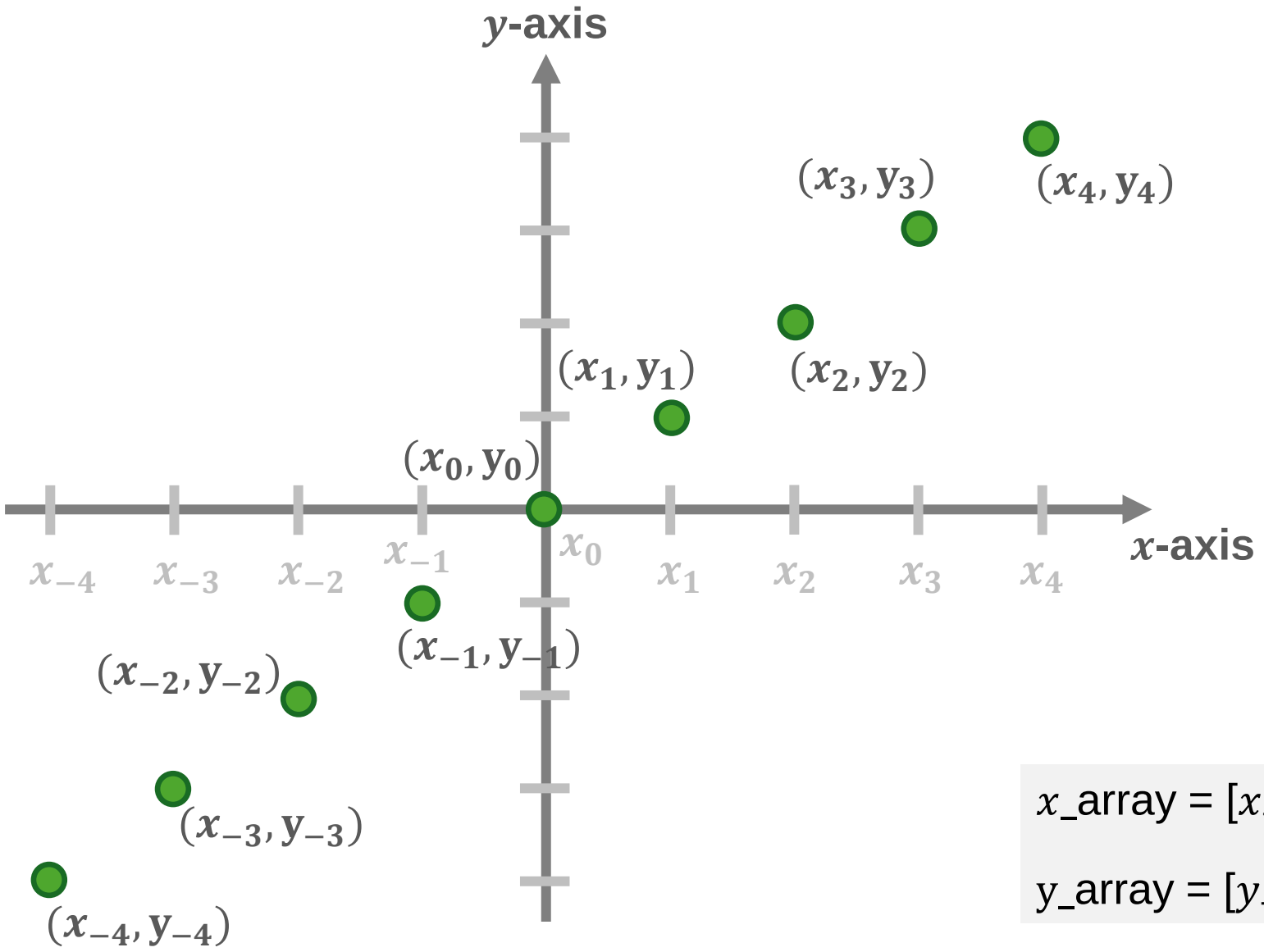


2-dimensional plot in MATLAB: line plot



x_array = [x_{-4} , x_{-3} , x_{-2} , x_{-1} , x_0 , x_1 , x_2 , x_3 , x_4]

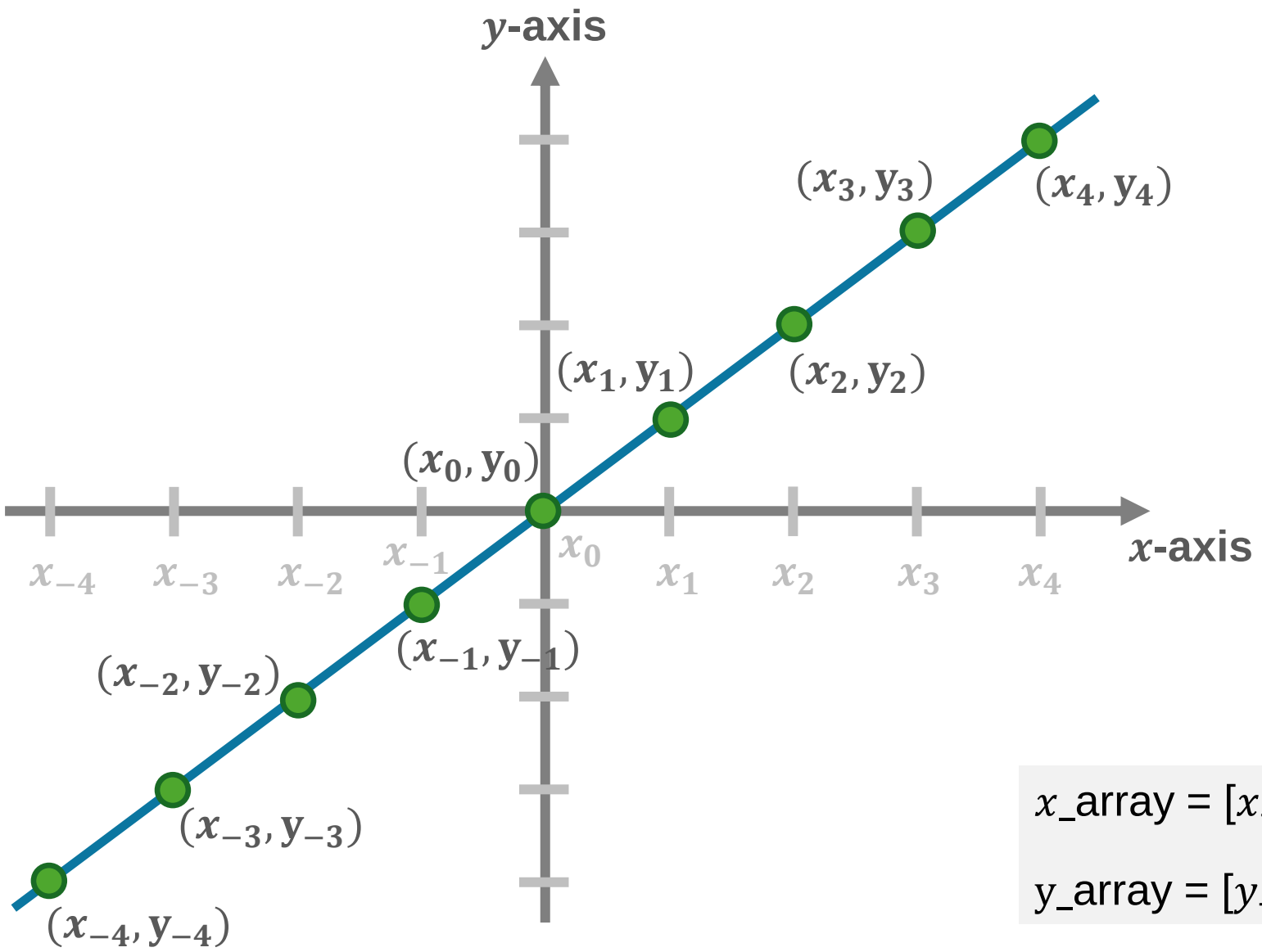
2-dimensional plot in MATLAB: line plot



$x\_array = [x_{-4}, x_{-3}, x_{-2}, x_{-1}, x_0, x_1, x_2, x_3, x_4]$

$y\_array = [y_{-4}, y_{-3}, y_{-2}, y_{-1}, y_0, y_1, y_2, y_3, y_4]$

2-dimensional plot in MATLAB: line plot



x_array = $[x_{-4}, x_{-3}, x_{-2}, x_{-1}, x_0, x_1, x_2, x_3, x_4]$

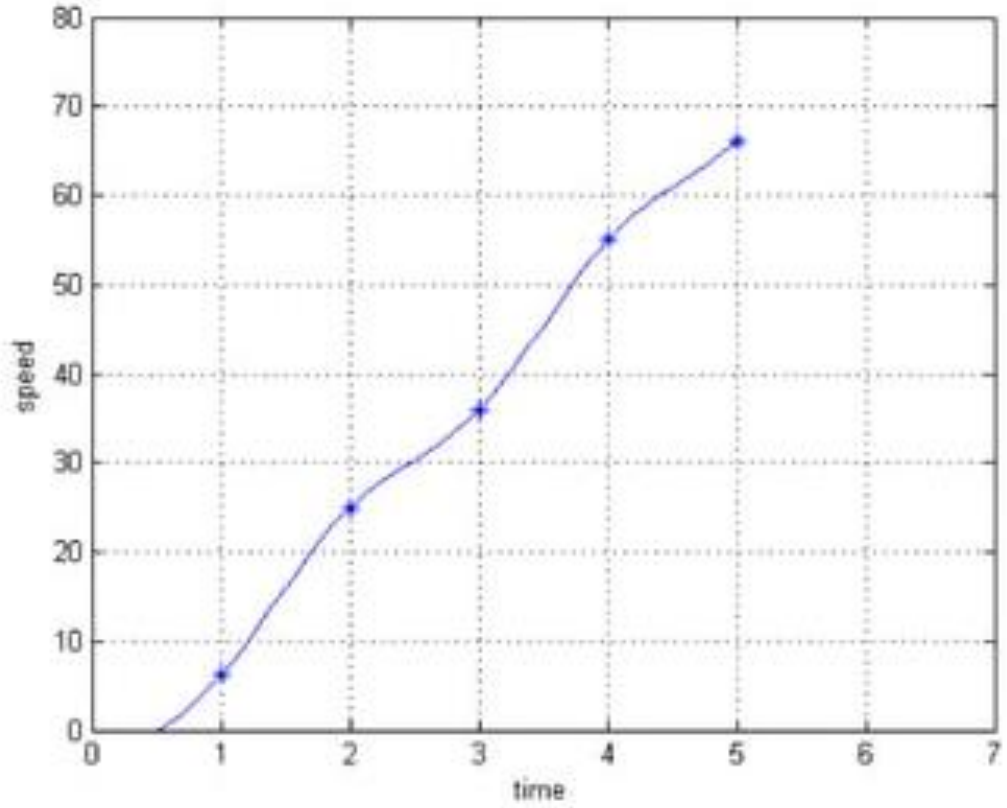
y_array = $[y_{-4}, y_{-3}, y_{-2}, y_{-1}, y_0, y_1, y_2, y_3, y_4]$

2-dimensional plot in MATLAB: line plot

Plotting

$$s = 2\sin(3t + 2) + 15t - 7$$

t	0	1	2	3	4	5
s	-5.18	6.08	24.97	36	54.98	66.07



2-dimensional plot in MATLAB: line plot

TWO-DIMENSIONAL plot() COMMAND

Basic 2-D plot command is:

Plot(x,y)

where **x is a vector (one dimensional array), and y is a vector.**

Both vectors **must** have the same number of elements.

- The plot command creates a single curve with the x values on the abscissa (horizontal axis) and the y values on the ordinate (vertical axis).
- The curve is made from segments of lines that connect the points that are defined by the x and y coordinates of the elements in the two vectors.

2-dimensional plot in MATLAB: line plot

CREATING THE X AND Y VECTORS

- If data is given, the information is entered as the elements of the vectors x and y.

- If the values of y are determined by a function from the values of x, than a vector x is created first, and then the values of y are calculated for each value of x. The spacing (difference) between the elements of x must be such that the plotted curve will show the details of the function.

2-dimensional plot in MATLAB: line plot

LINE SPECIFIERS IN THE `plot()` COMMAND

Line specifiers can be added in the **`plot`** command to:

- Specify the style of the line.
- Specify the color of the line.
- Specify the type of the markers (if markers are desired).

```
plot(x,y,'line specifiers')
```

2-dimensional plot in MATLAB: line plot

LINE SPECIFIERS IN THE `plot()` COMMAND

```
plot(x,y,'line specifiers')
```

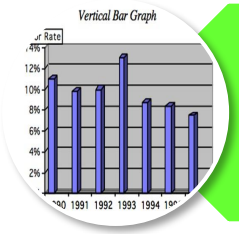
Line Style	Specifier	Line Color	Specifier	Marker Type	Specifier
Solid	-	red	r	plus sign	+
dotted	:	green	g	circle	o
dashed	--	blue	b	asterisk	*
dash-dot	-.	Cyan	c	point	.
		magenta	m	square	s
		yellow	y	diamond	d
		black	k		

2-dimensional plot in MATLAB: types of bar graphs

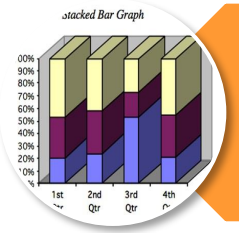
Used to compare quantities across categories

- Data input: Vector or matrix (e.g., sales per day)

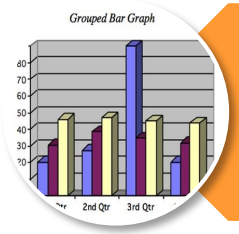
✅ Ideal for: Daily counts, measurements, group comparison



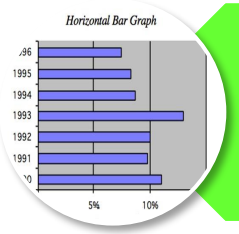
Single (vertical)



Stacked



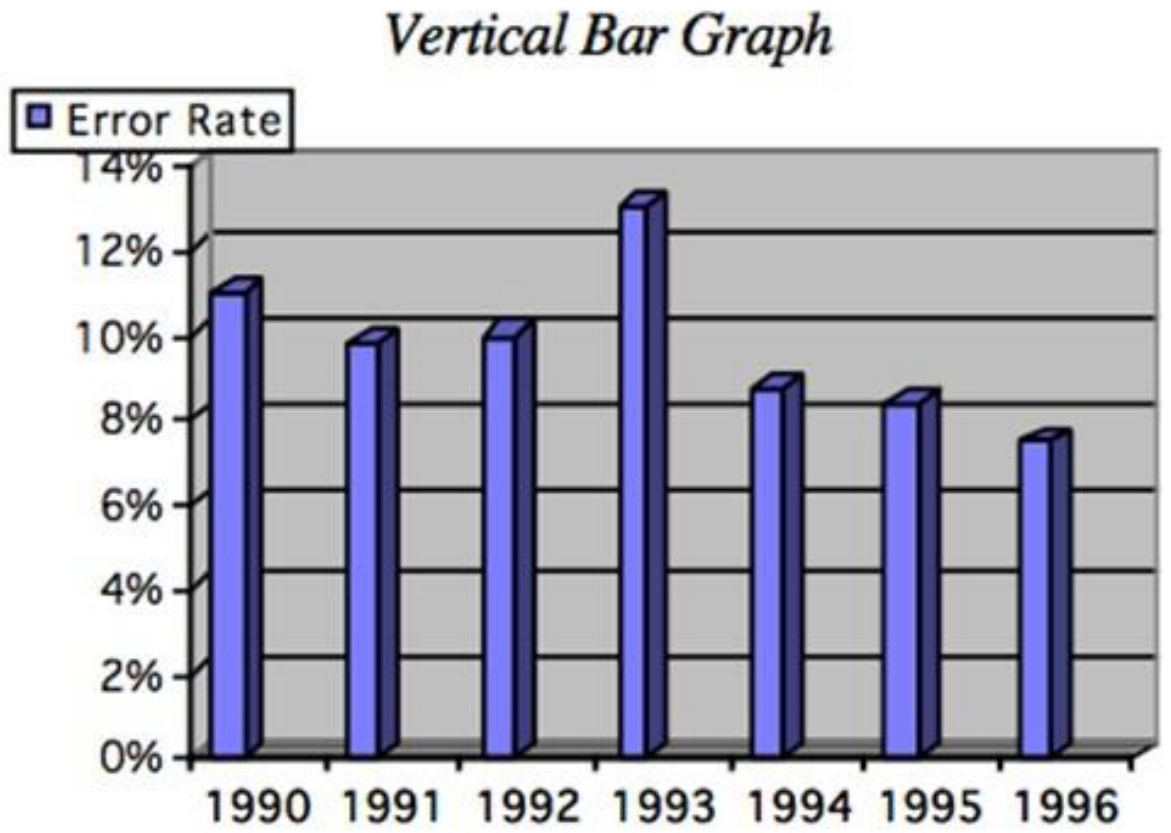
Grouped



Horizontal

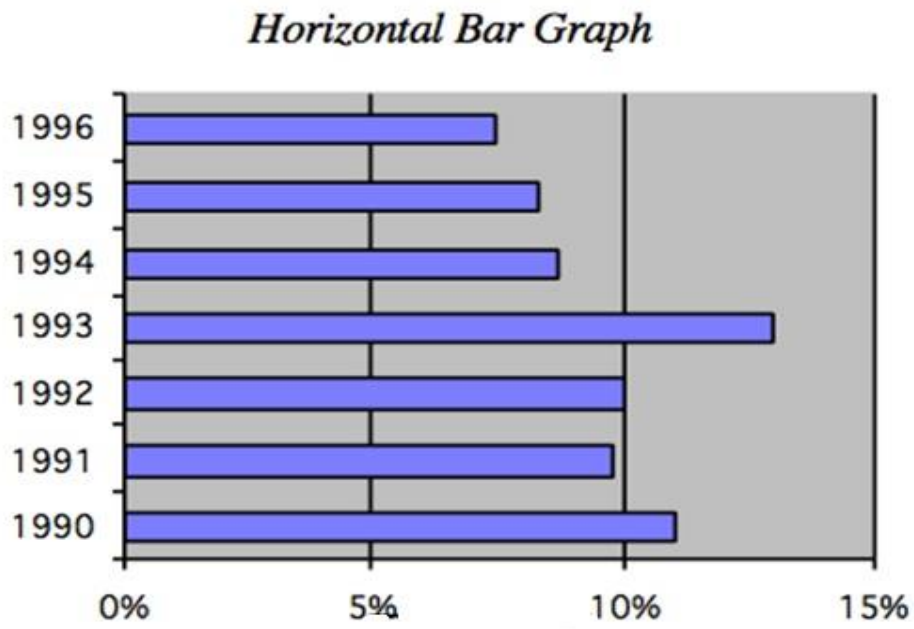
2-dimensional plot in MATLAB: types of bar graphs

- Single bar graphs are used to convey the discrete value of the item for each category shown on the opposing axis.



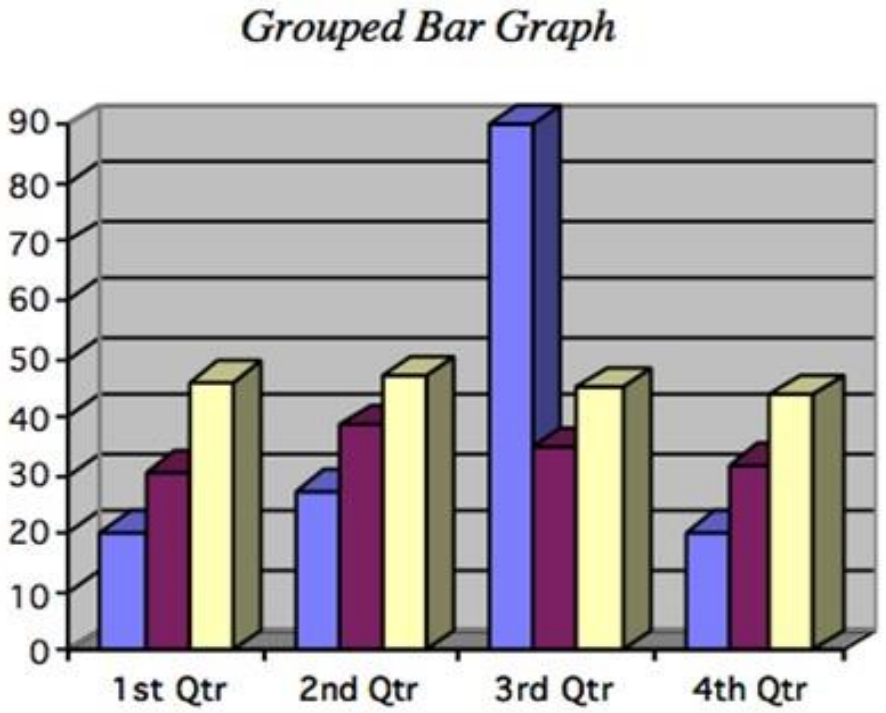
2-dimensional plot in MATLAB: types of bar graphs

- it is also possible to draw bar charts so that the bars are horizontal which means that the longer the bar, the larger the category.



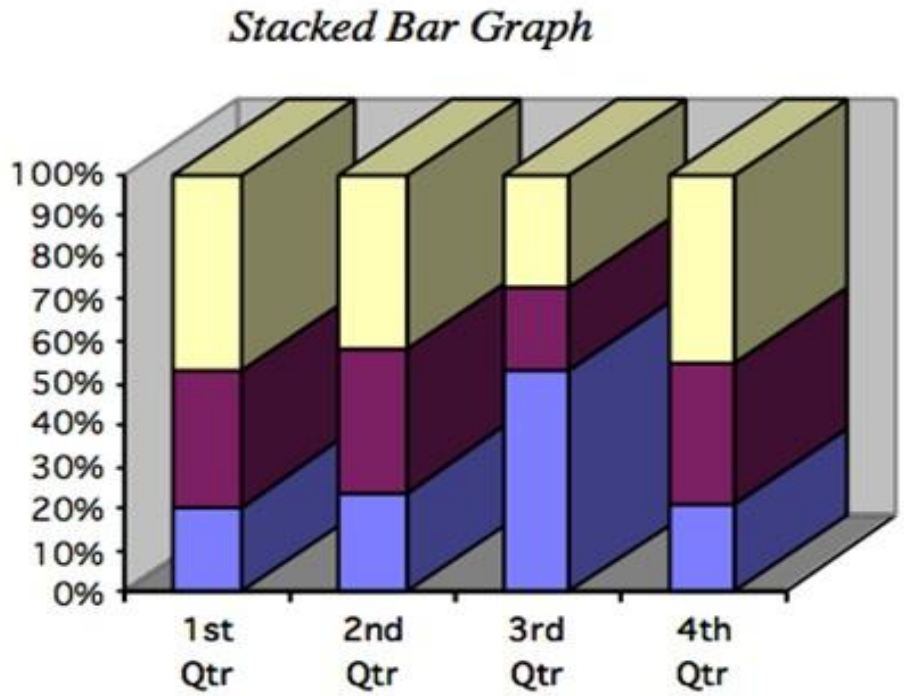
2-dimensional plot in MATLAB: types of bar graphs

- A grouped or clustered bar graph is used to represent discrete values for more than one item that share the same category.
- Grouped bar charts are a way of showing information about different sub-groups of the main categories.
- but care needs to be taken to ensure that the chart does not contain too much information making it complicated to read and interpret.



2-dimensional plot in MATLAB: types of bar graphs

- Some bar graphs have the bar divided into subparts that represent the discrete value for items that represent a portion of a whole group.



2-dimensional plot in MATLAB: scatter plot

- A scatter plot is a type of plot or mathematical diagram using Cartesian coordinates to display values for typically two variables for a set of data.

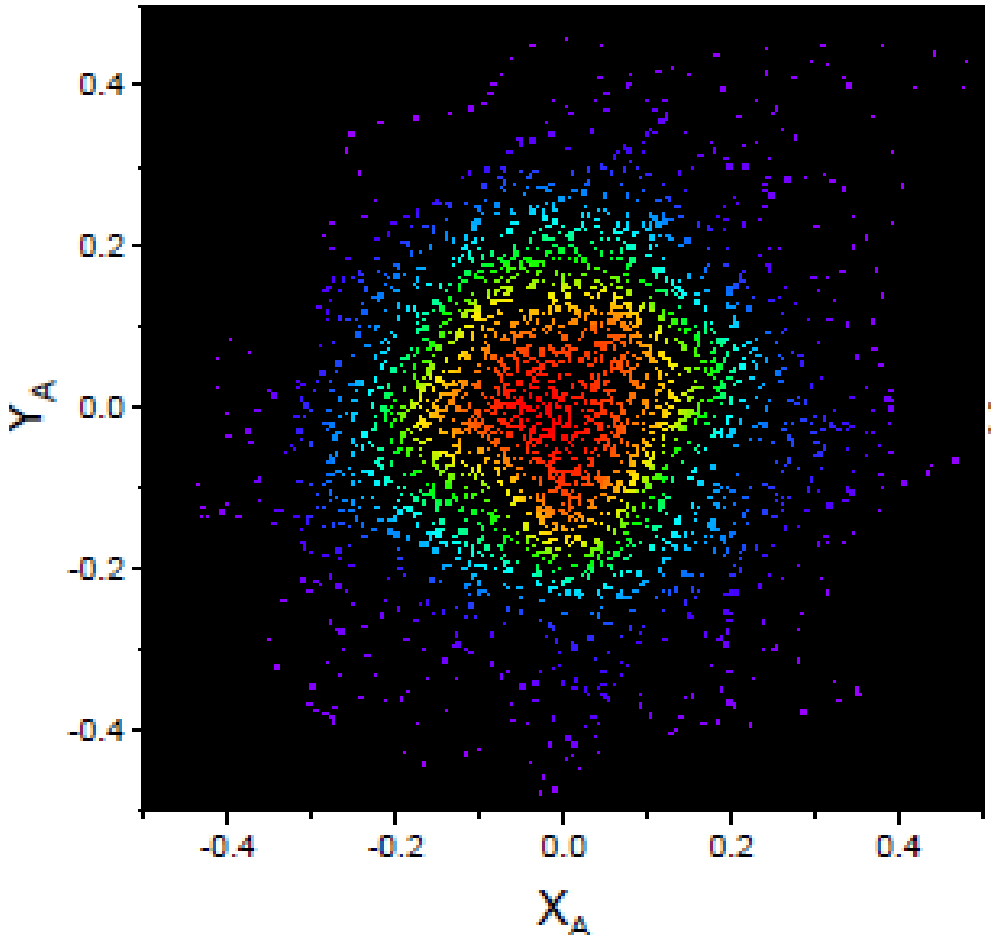
- It is also called as scatter graph, scatter chart, scattergram, or scatter diagram.

2-dimensional plot in MATLAB: scatter plot

- Scatter plot used to determine whether or not two variables have a relationship or correlation.
- A scatter plot (aka scatter chart, scatter graph) uses dots to represent values for two different numeric variables.

- When to use scatter plot
  - When we have paired numerical data
  - When there are multiple values of the dependent

variable for a unique value of an independent variable



3-dimensional plot in MATLAB: line plot

- Be it 2D, 3D, or any higher dimension, a (straight or curved) line always consists of **a single independent parameter**.

3-dimensional plot in MATLAB: line plot

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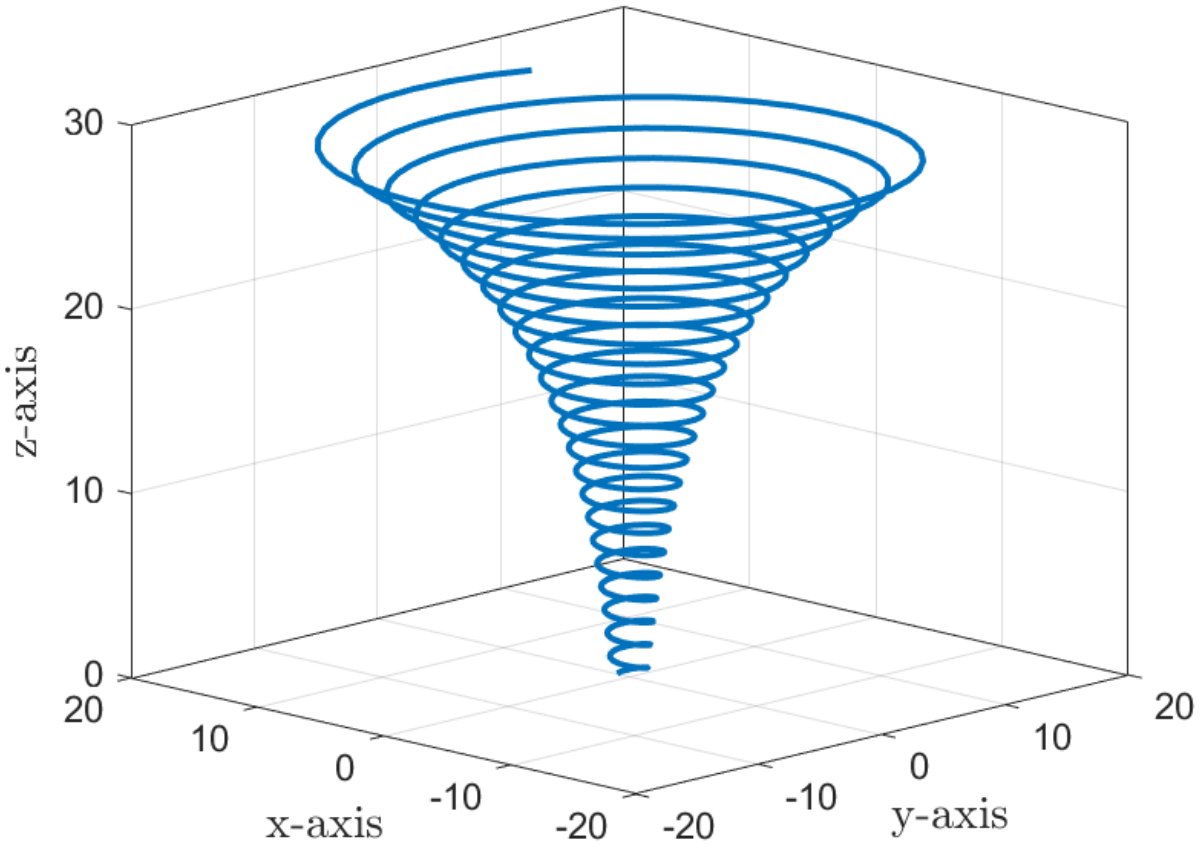
- In this case, z-axis is the independent parameter.

$$z = [\ldots\ z_i\ \ldots]$$
$$x = e^{z/k}\sin\omega z$$
$$y = e^{z/k}\cos\omega z$$



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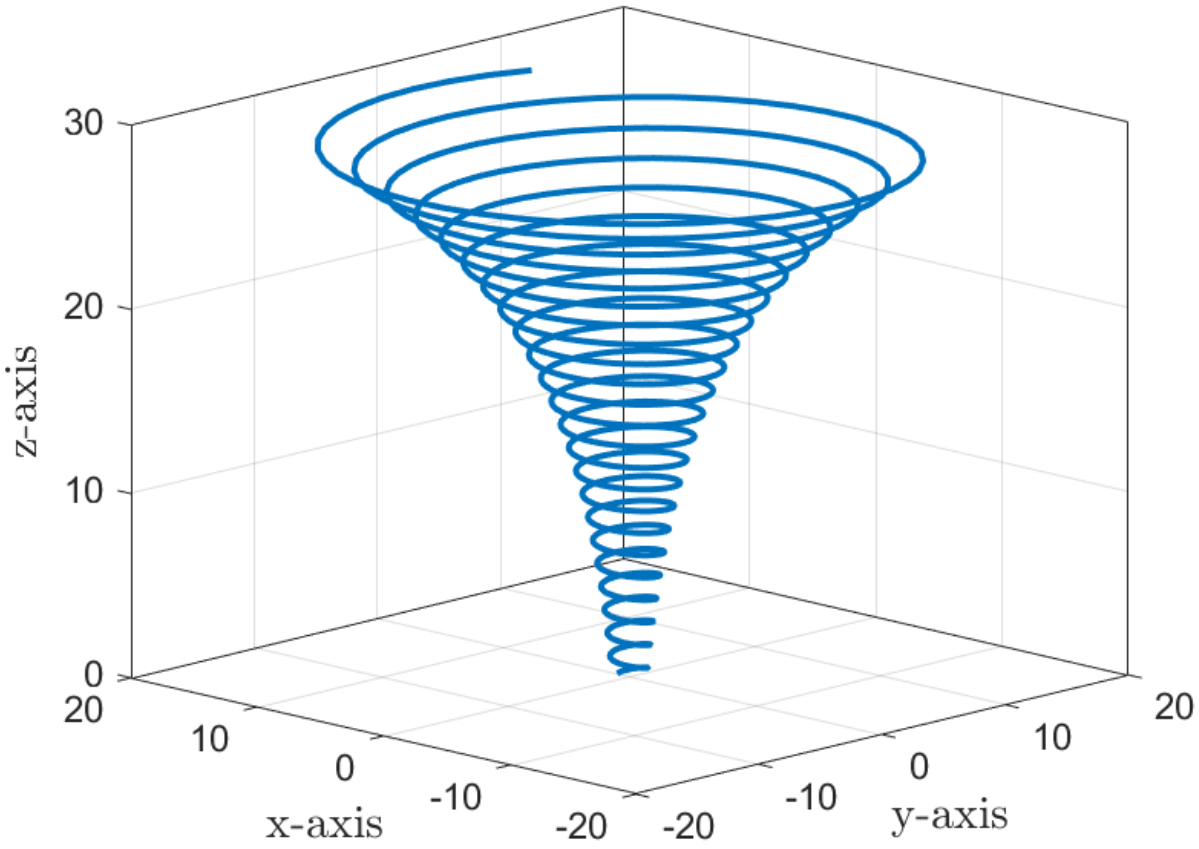
$$z = [\ldots\ z_i\ \ldots]$$
$$x = e^{z/k}\sin\omega z$$
$$y = e^{z/k}\cos\omega z$$

z-array = [… … , z_i, … …]$_{1\times n}$

x-array = [… … , x_i, … …]$_{1\times n}$

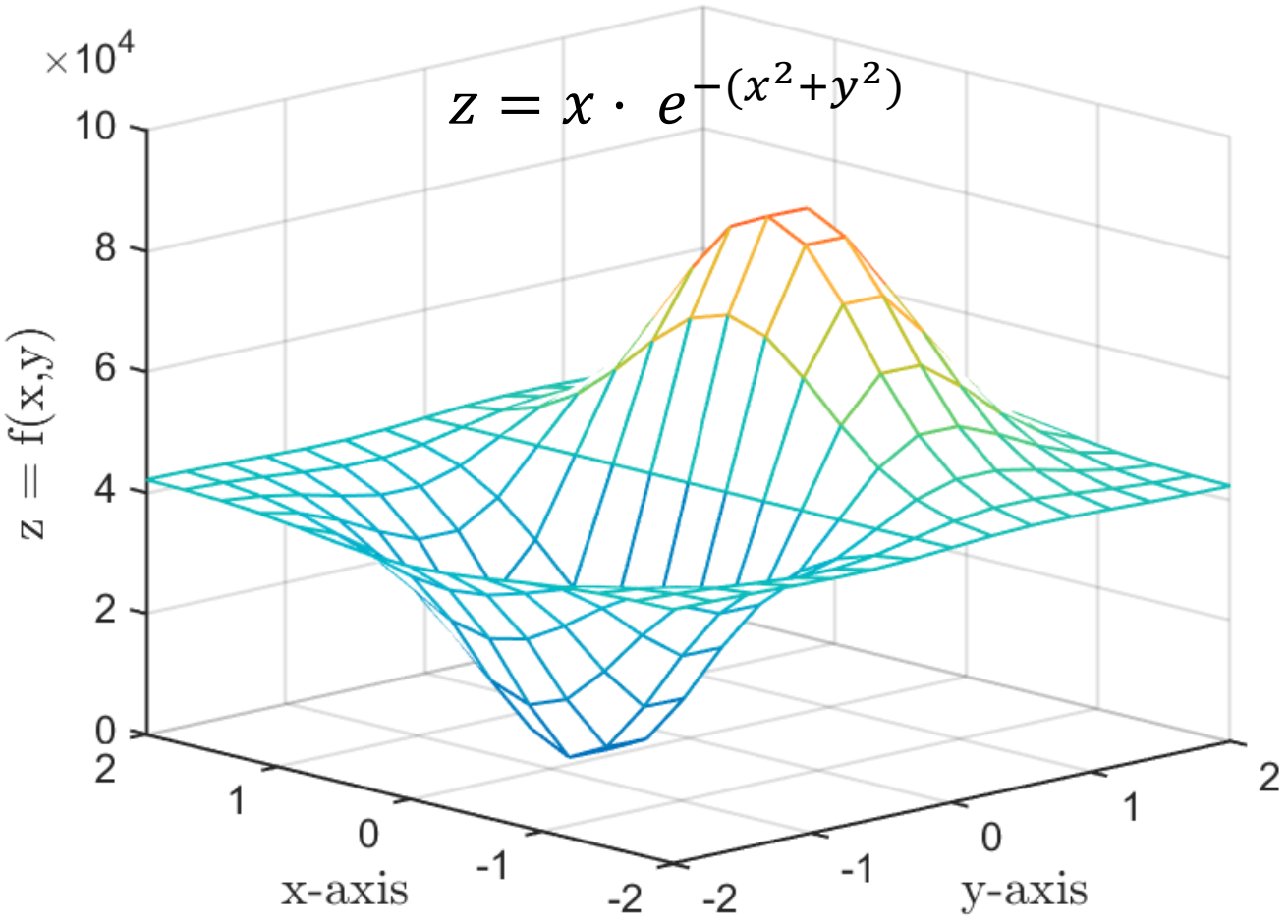
y-array = [… … , y_i, … …]$_{1\times n}$

plot3(x-array, y-array, z-array)



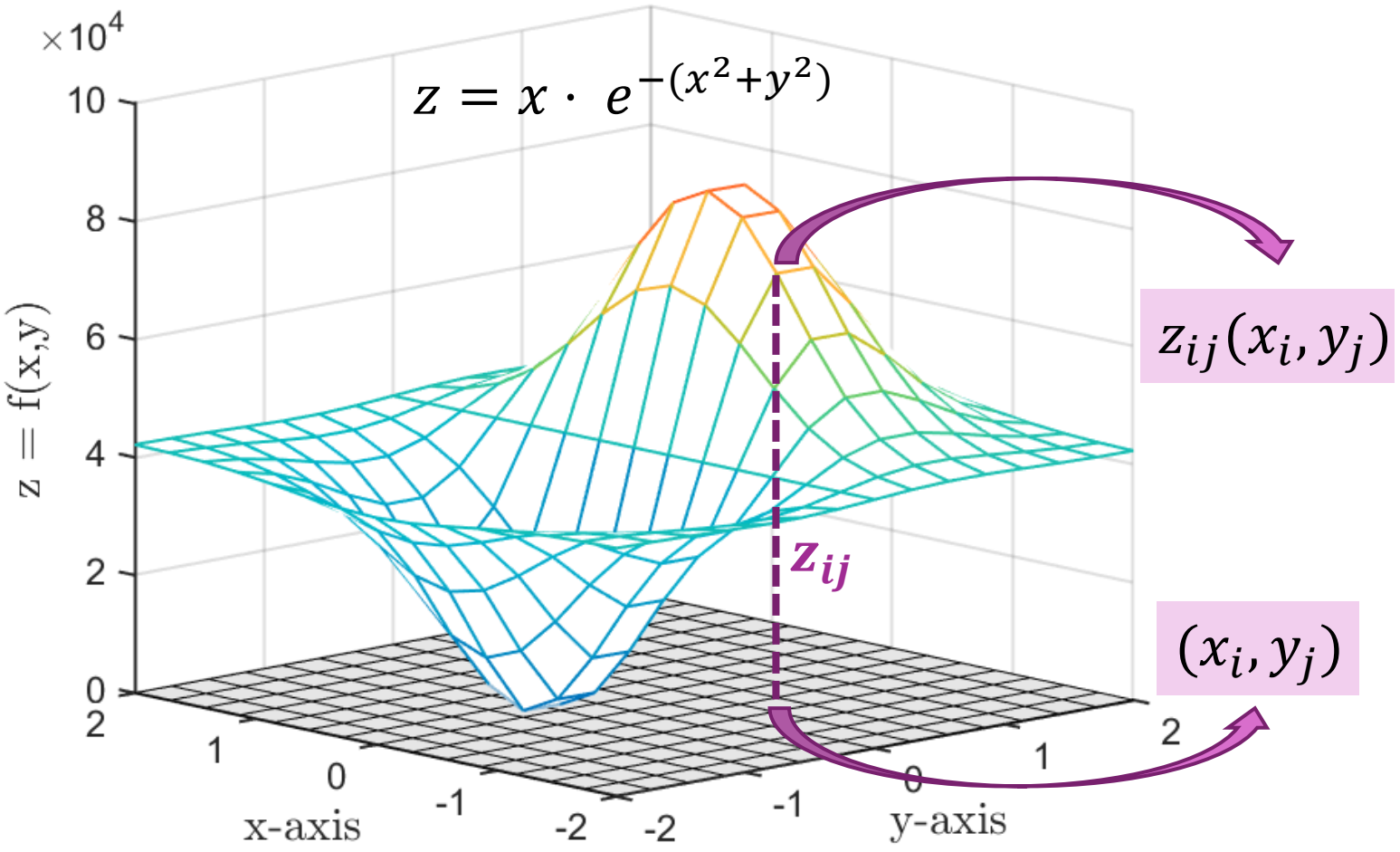
3-dimensional plot in MATLAB: mesh surface plot

- A (plane or curved) surface always consists of **two independent parameters**.



3-dimensional plot in MATLAB: mesh surface plot

- A (plane or curved) surface always consists of **two independent parameters**.
- In this case, x and y are the independent parameters & z in the dependent parameter.



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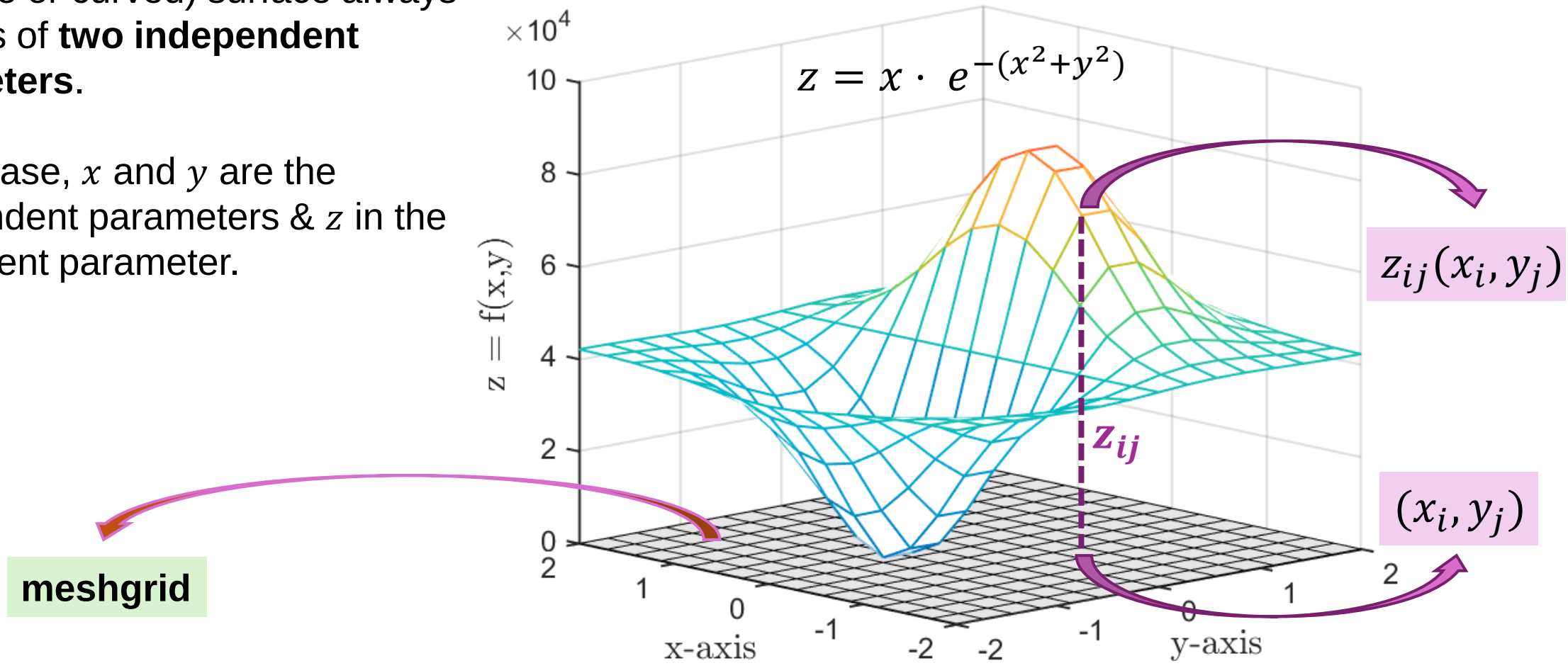
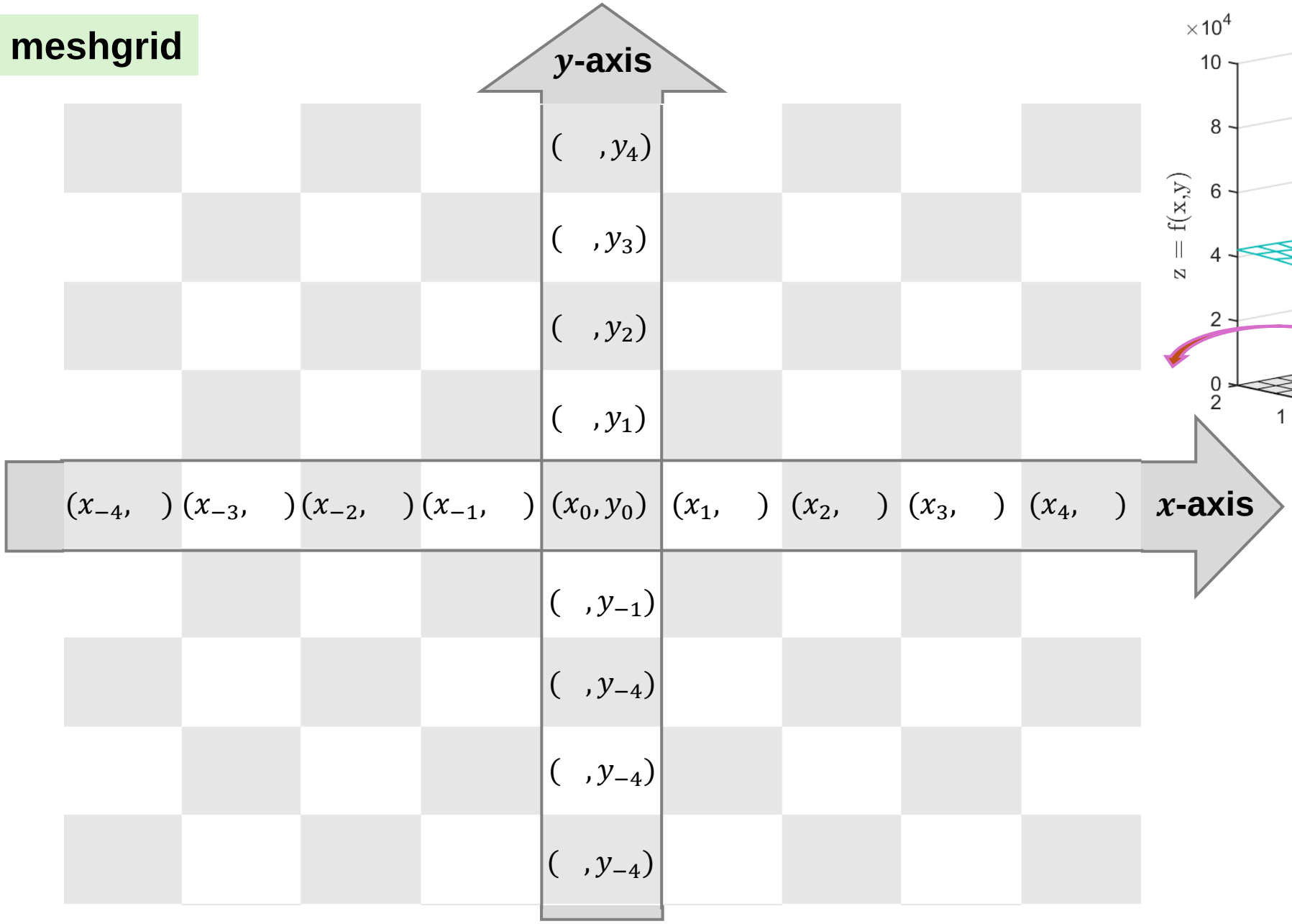
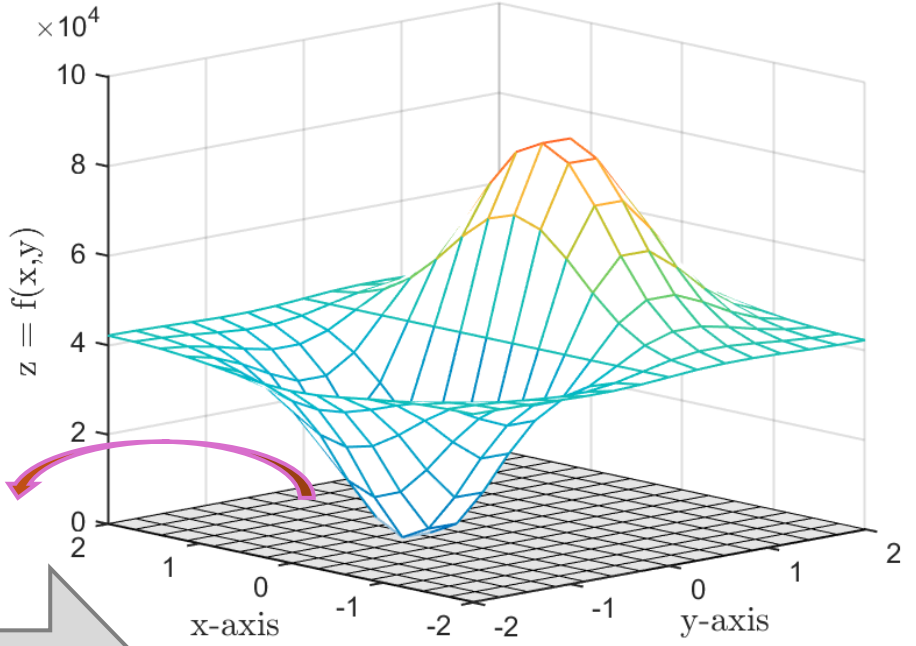


3-dimensional plot in MATLAB: mesh surface plot

meshgrid



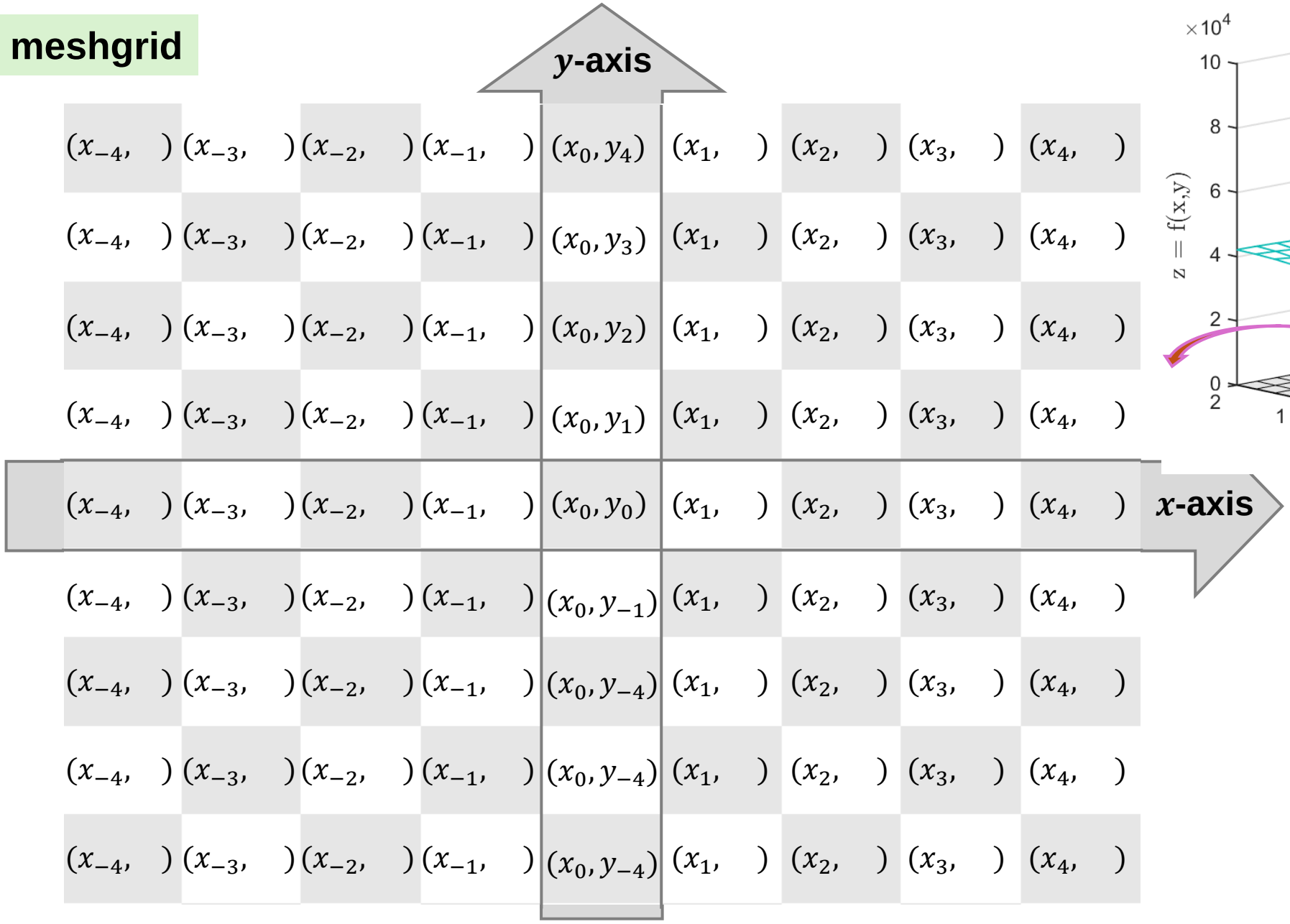


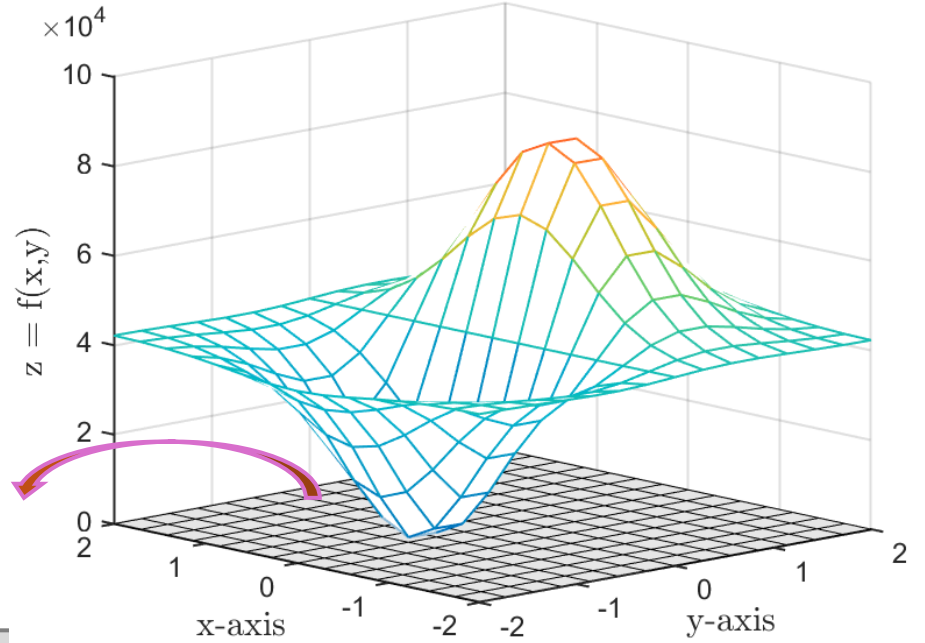
x-array = $[\ \ldots\ldots, x_i, \ldots\ldots]_{1\times m}$

y-array = $[\ \ldots\ldots, y_j, \ldots\ldots]_{1\times n}$

3-dimensional plot in MATLAB: mesh surface plot

meshgrid





x-array = $[\ \ldots\ldots, x_i, \ldots\ldots\ ]_{1\times m}$

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x-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & x_i & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

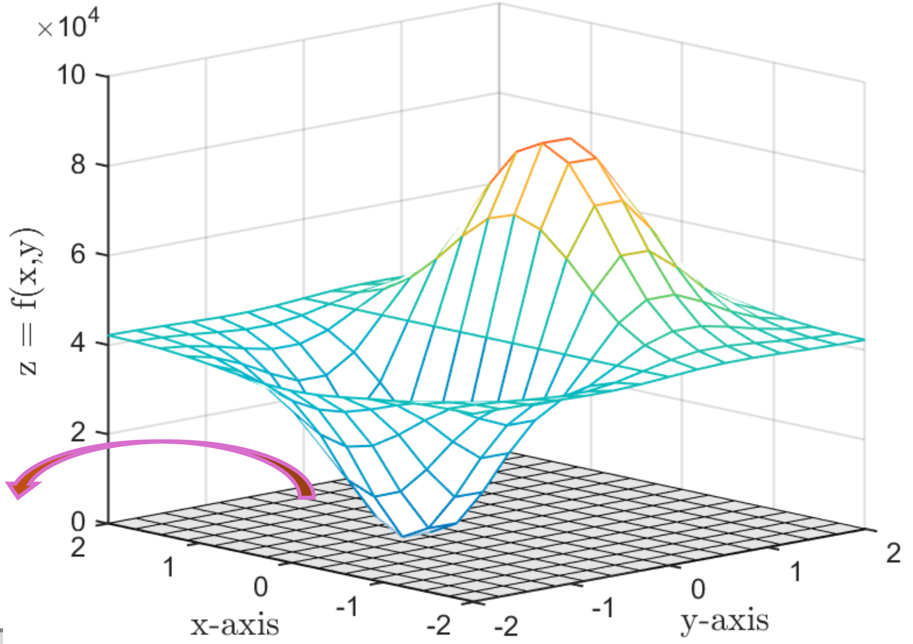
3-dimensional plot in MATLAB: mesh surface plot

meshgrid

y-axis

(x_{-4}, y_4)	(x_{-3}, y_4)	(x_{-2}, y_4)	(x_{-1}, y_4)	(x_0, y_4)	(x_1, y_4)	(x_2, y_4)	(x_3, y_4)	(x_4, y_4)
(x_{-4}, y_3)	(x_{-3}, y_3)	(x_{-2}, y_3)	(x_{-1}, y_3)	(x_0, y_3)	(x_1, y_3)	(x_2, y_3)	(x_3, y_3)	(x_4, y_3)
(x_{-4}, y_2)	(x_{-3}, y_2)	(x_{-2}, y_2)	(x_{-1}, y_2)	(x_0, y_2)	(x_1, y_2)	(x_2, y_2)	(x_3, y_2)	(x_4, y_2)
(x_{-4}, y_1)	(x_{-3}, y_1)	(x_{-2}, y_1)	(x_{-1}, y_1)	(x_0, y_1)	(x_1, y_1)	(x_2, y_1)	(x_3, y_1)	(x_4, y_1)
(x_{-4}, y_0)	(x_{-3}, y_0)	(x_{-2}, y_0)	(x_{-1}, y_0)	(x_0, y_0)	(x_1, y_0)	(x_2, y_0)	(x_3, y_0)	(x_4, y_0)
(x_{-4}, y_{-1})	(x_{-3}, y_{-1})	(x_{-2}, y_{-1})	(x_{-1}, y_{-1})	(x_0, y_{-1})	(x_1, y_{-1})	(x_2, y_{-1})	(x_3, y_{-1})	(x_4, y_{-1})
(x_{-4}, y_{-4})	(x_{-3}, y_{-4})	(x_{-2}, y_{-4})	(x_{-1}, y_{-4})	(x_0, y_{-4})	(x_1, y_{-4})	(x_2, y_{-4})	(x_3, y_{-4})	(x_4, y_{-4})
(x_{-4}, y_{-4})	(x_{-3}, y_{-4})	(x_{-2}, y_{-4})	(x_{-1}, y_{-4})	(x_0, y_{-4})	(x_1, y_{-4})	(x_2, y_{-4})	(x_3, y_{-4})	(x_4, y_{-4})
(x_{-4}, y_{-4})	(x_{-3}, y_{-4})	(x_{-2}, y_{-4})	(x_{-1}, y_{-4})	(x_0, y_{-4})	(x_1, y_{-4})	(x_2, y_{-4})	(x_3, y_{-4})	(x_4, y_{-4})

x-axis



x-array = $[\ \dots\dots, x_i, \dots\dots\ ]_{1\times m}$

y-array = $[\ \dots\dots, y_j, \dots\dots\ ]_{1\times n}$

x-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & x_i & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

y-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & y_j & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

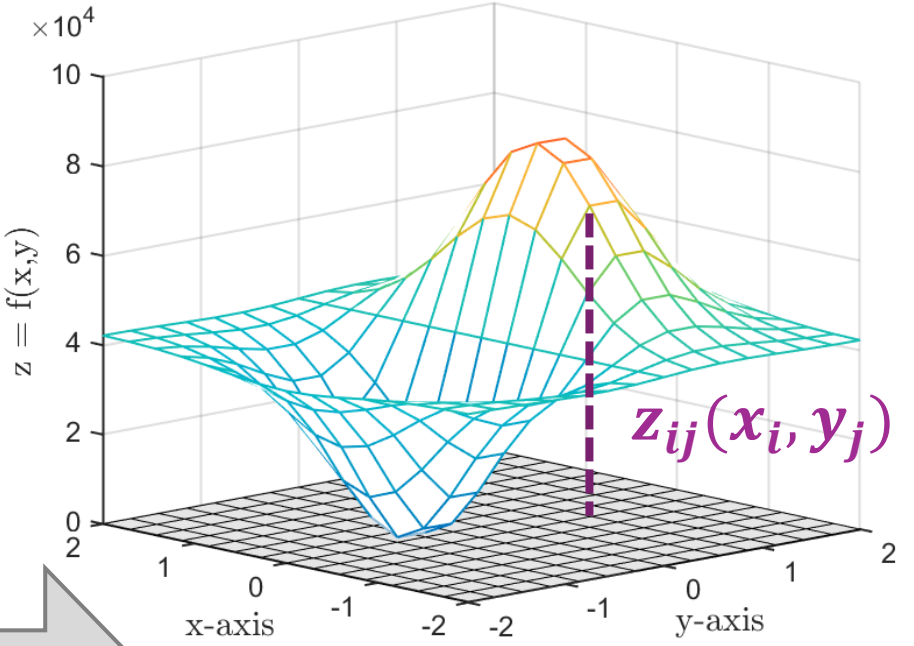
3-dimensional plot in MATLAB: mesh surface plot

meshgrid

y-axis

$z_{-4,4}$	$z_{-3,4}$	$z_{-2,4}$	$z_{-1,4}$	$z_{0,4}$	$z_{1,4}$	$z_{2,4}$	$z_{3,4}$	$z_{4,4}$
$z_{-4,3}$	$z_{-3,3}$	$z_{-2,3}$	$z_{-1,3}$	$z_{0,3}$	$z_{1,3}$	$z_{2,3}$	$z_{3,3}$	$z_{4,3}$
$z_{-4,2}$	$z_{-3,2}$	$z_{-2,2}$	$z_{-1,2}$	$z_{0,2}$	$z_{1,2}$	$z_{2,2}$	$z_{3,2}$	$z_{4,2}$
$z_{-4,1}$	$z_{-3,1}$	$z_{-2,1}$	$z_{-1,1}$	$z_{0,1}$	$z_{1,1}$	$z_{2,1}$	$z_{3,1}$	$z_{4,1}$
$z_{-4,0}$	$z_{-3,0}$	$z_{-2,0}$	$z_{-1,0}$	$z_{0,0}$	$z_{1,0}$	$z_{2,0}$	$z_{3,0}$	$z_{4,0}$
$z_{-4,-1}$	$z_{-3,-1}$	$z_{-2,-1}$	$z_{-1,-1}$	$z_{0,-1}$	$z_{1,-1}$	$z_{2,-1}$	$z_{3,-1}$	$z_{4,-1}$
$z_{-4,-2}$	$z_{-3,-2}$	$z_{-2,-2}$	$z_{-1,-2}$	$z_{0,-2}$	$z_{1,-2}$	$z_{2,-2}$	$z_{3,-2}$	$z_{4,-2}$
$z_{-4,-3}$	$z_{-3,-3}$	$z_{-2,-3}$	$z_{-1,-3}$	$z_{0,-3}$	$z_{1,-3}$	$z_{2,-3}$	$z_{3,-3}$	$z_{4,-3}$
$z_{-4,-4}$	$z_{-3,-4}$	$z_{-2,-4}$	$z_{-1,-4}$	$z_{0,-4}$	$z_{1,-4}$	$z_{2,-4}$	$z_{3,-4}$	$z_{4,-4}$

x-axis



x-array = $[\ \ldots\ldots, x_i, \ldots\ldots\ ]_{1\times m}$

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x-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & x_i & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

y-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & y_j & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

3-dimensional plot in MATLAB: mesh surface plot

x-array = [… … , x_i, … …]$_{1\times m}$

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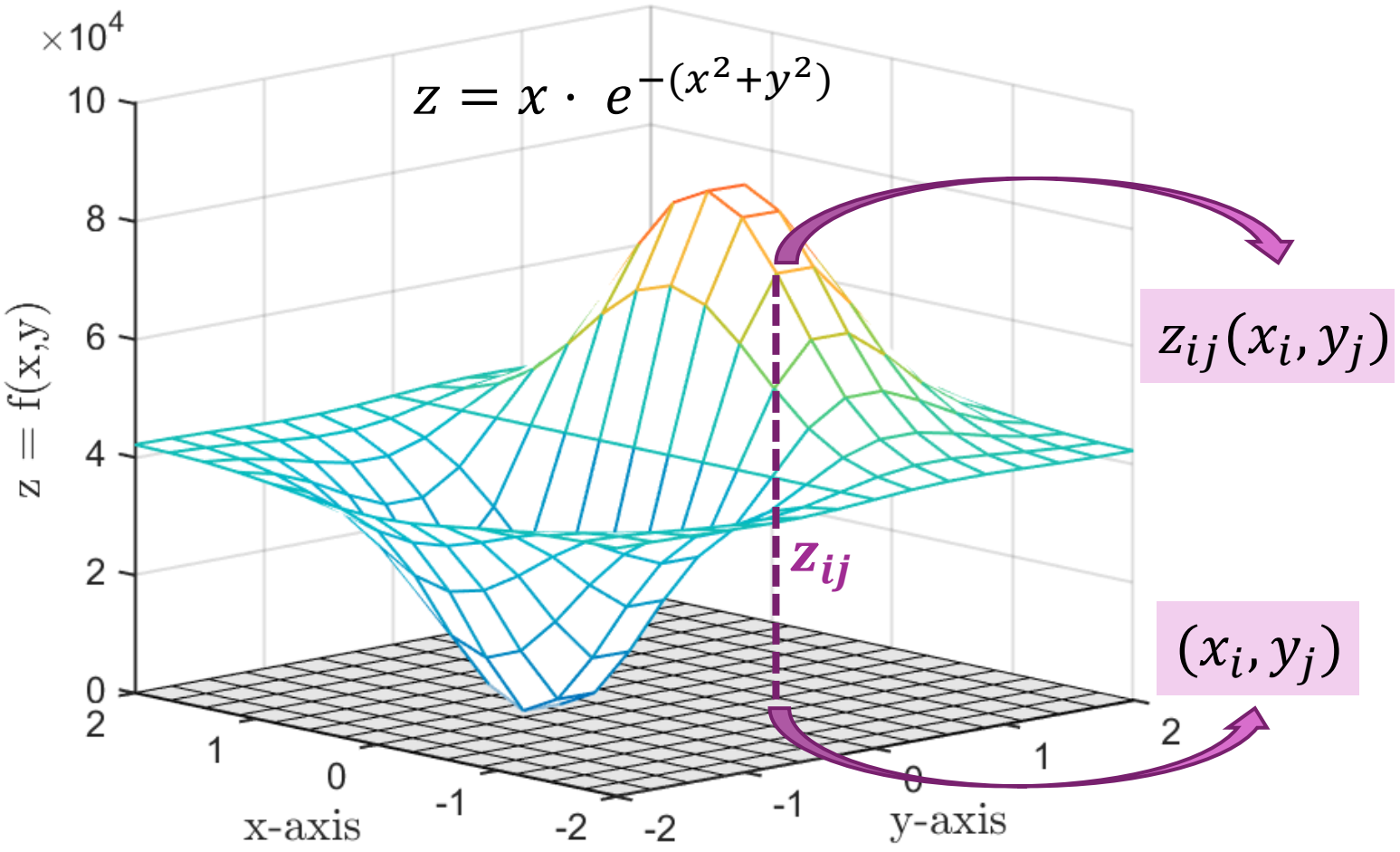
y-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & y_j & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

z-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & z_{ij} & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

mesh(x-grid , y-grid , z-grid)



3-dimensional plot in MATLAB: surface plot

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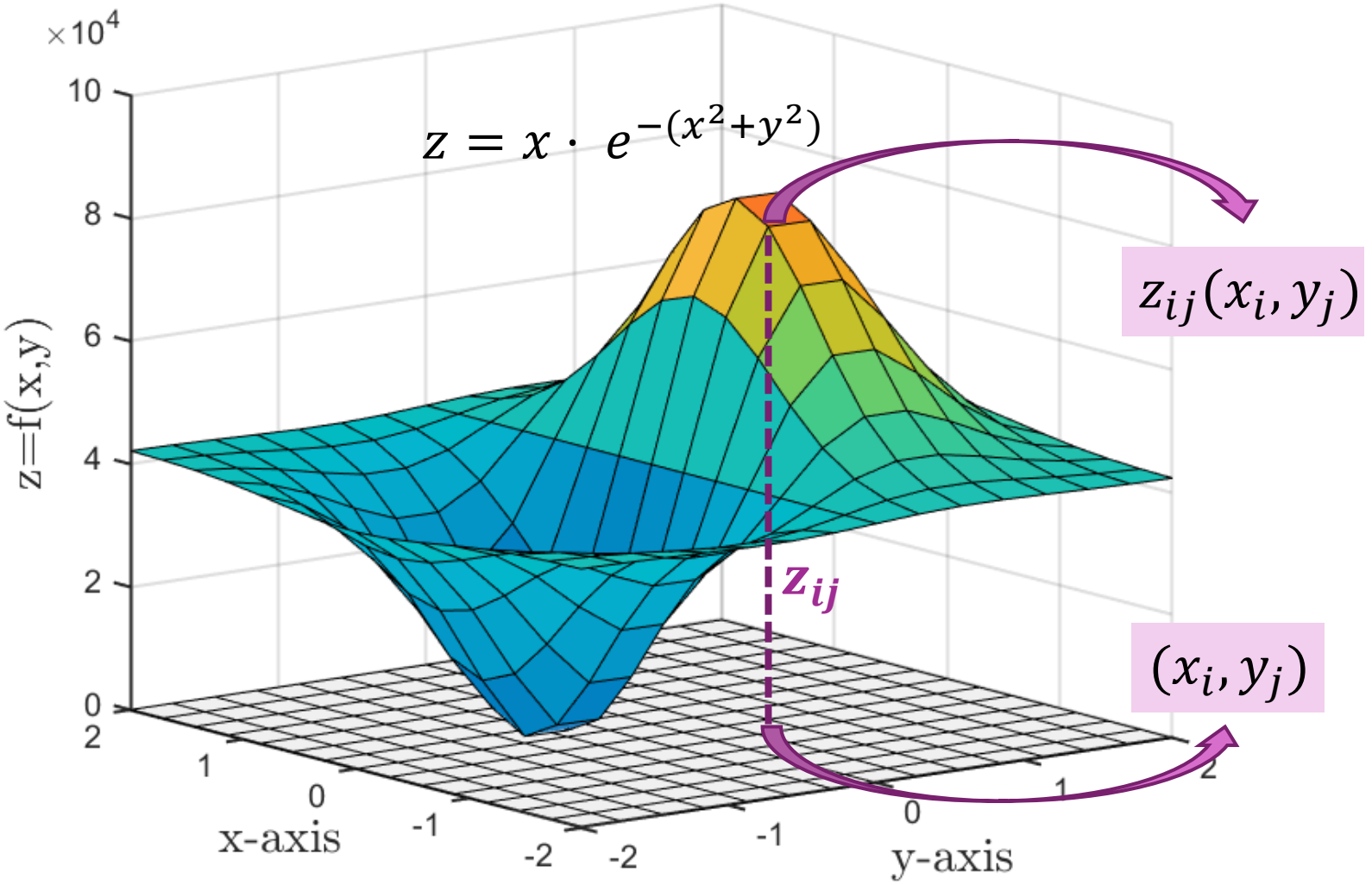
y-array = $[\ \ldots\ldots, y_j, \ldots\ldots\ ]_{1\times n}$

x-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & x_i & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

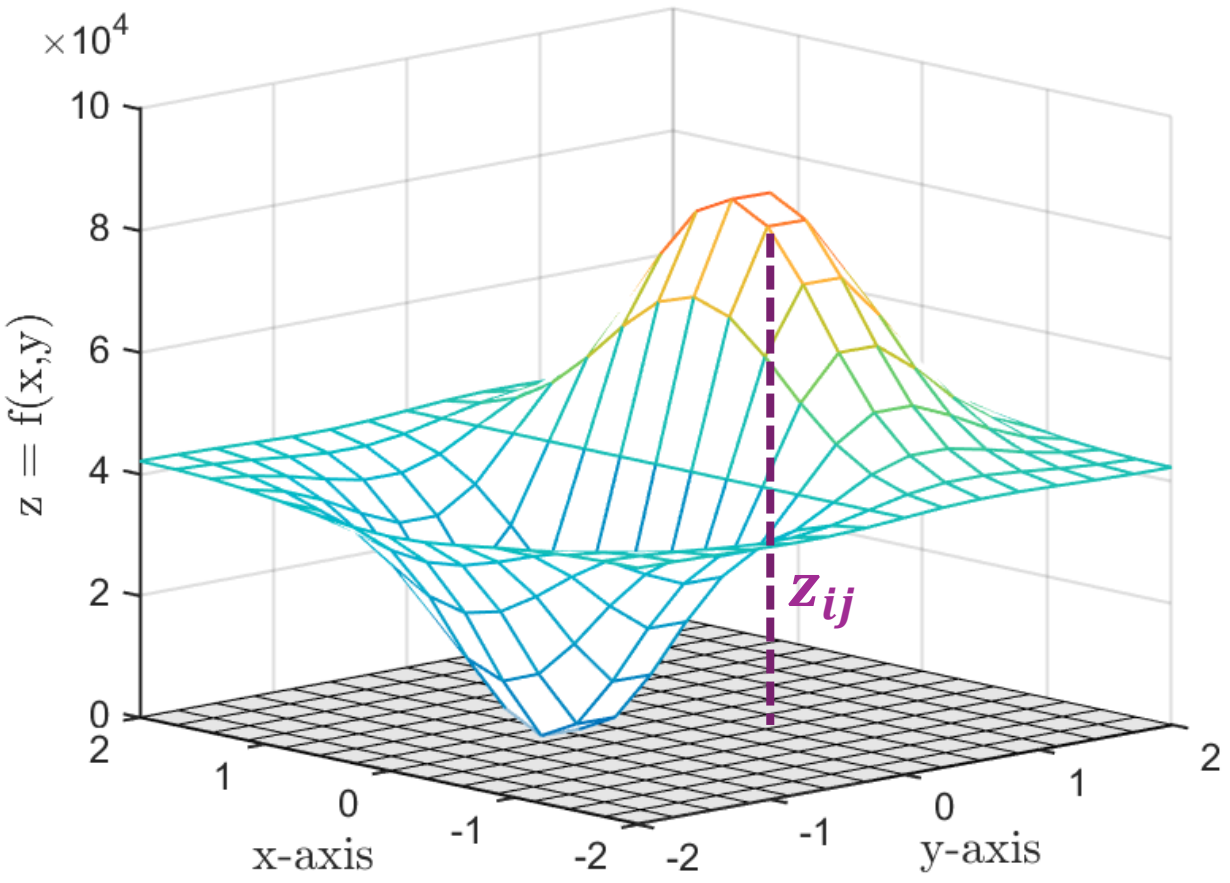
y-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & y_j & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

z-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & z_{ij} & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

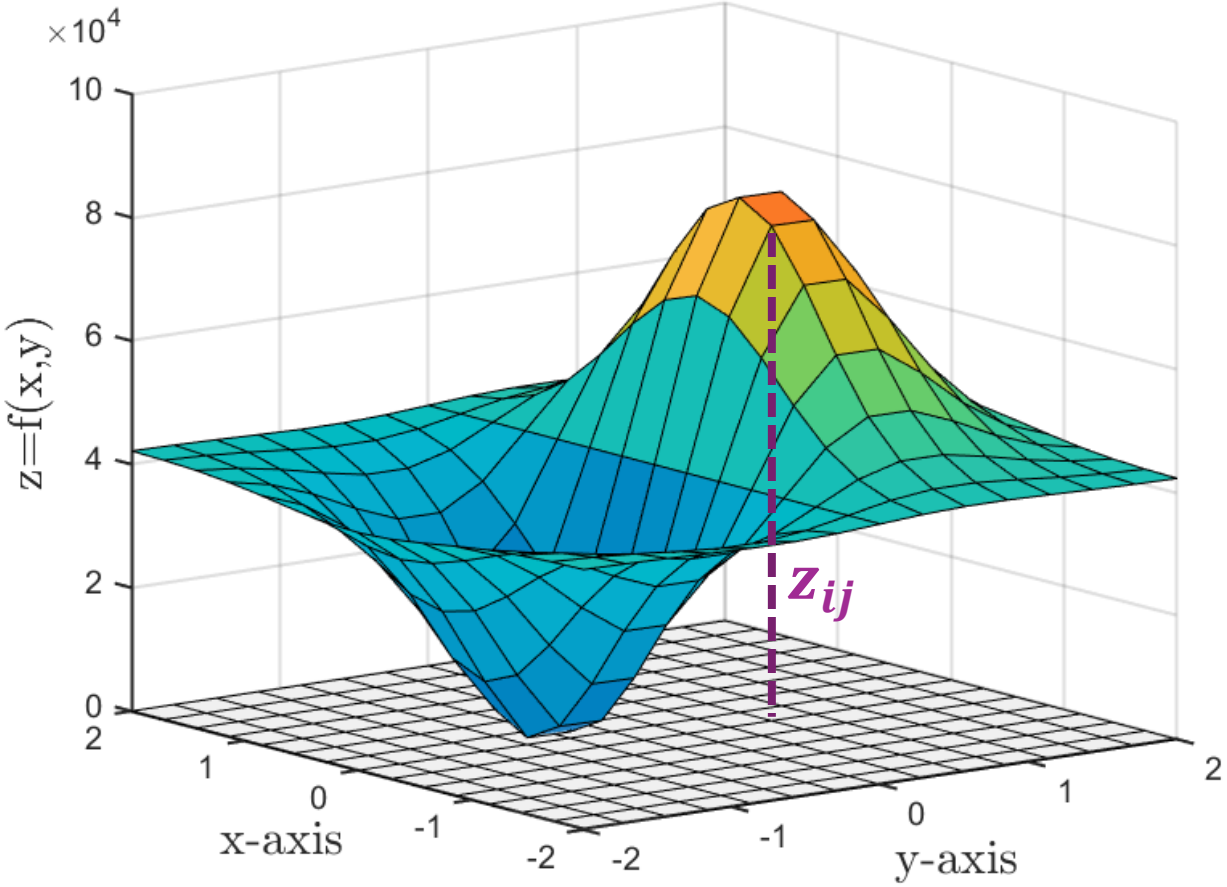
surf(x-grid , y-grid , z-grid)



3-dimensional plot in MATLAB: mesh plot vs surface plot



mesh plot



surface plot

3-dimensional plot in MATLAB: contour plot

$$z = x \cdot e^{-(x^2+y^2)}$$

x-array = $[\ \dots\dots, x_i, \dots\dots\ ]_{1\times m}$

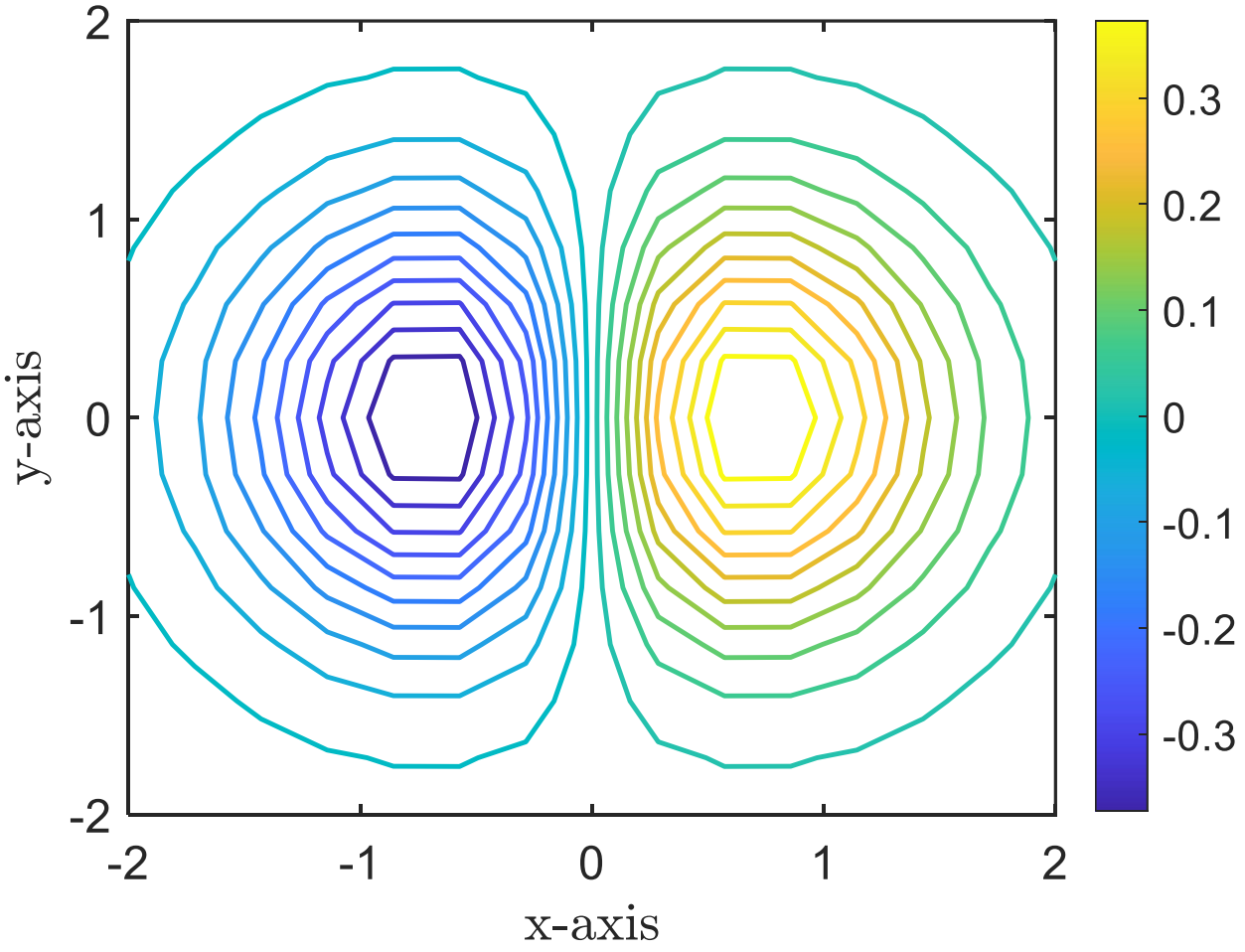
y-array = $[\ \dots\dots, y_j, \dots\dots\ ]_{1\times n}$

x-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & x_i & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

y-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & y_j & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

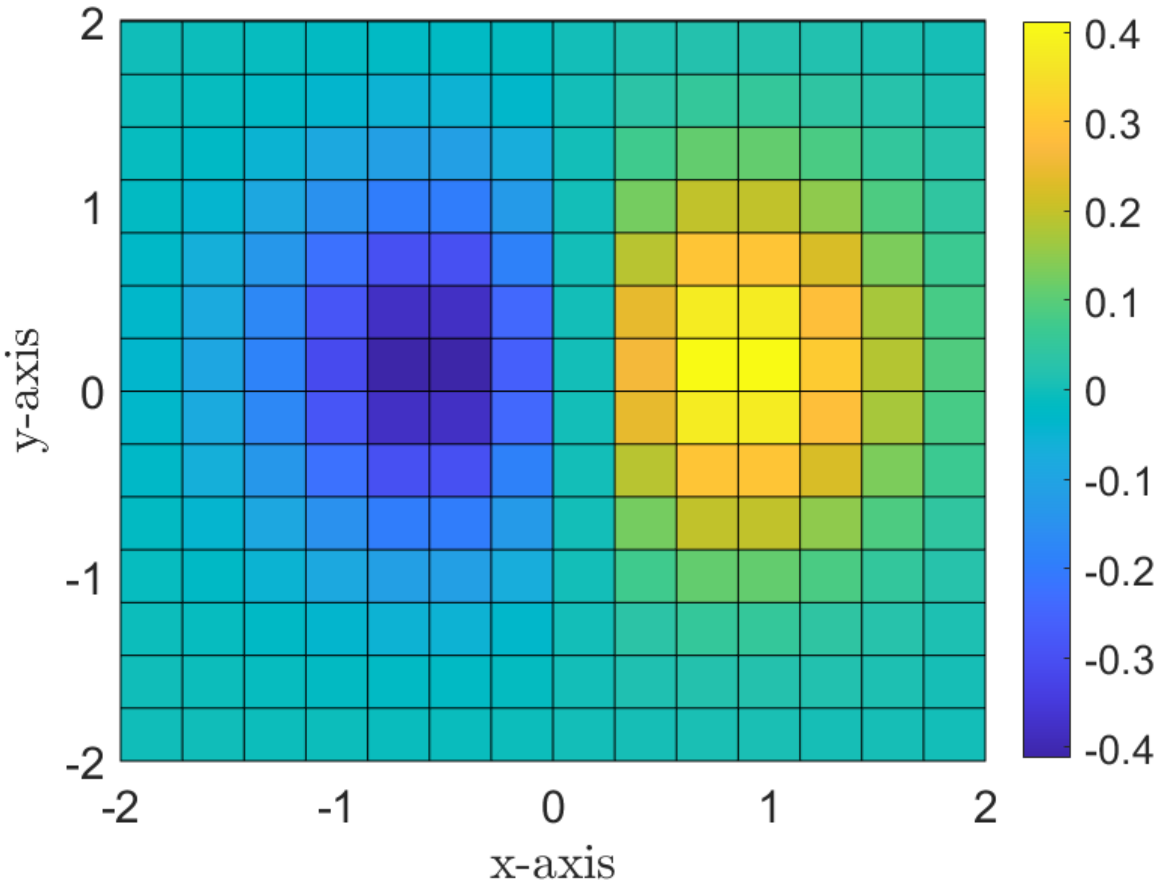
z-grid = $\begin{bmatrix} \cdots & \cdots & \cdots \\ \cdots & z_{ij} & \cdots \\ \cdots & \cdots & \cdots \end{bmatrix}_{n\times m}$

contour(x-grid , y-grid , z-grid)

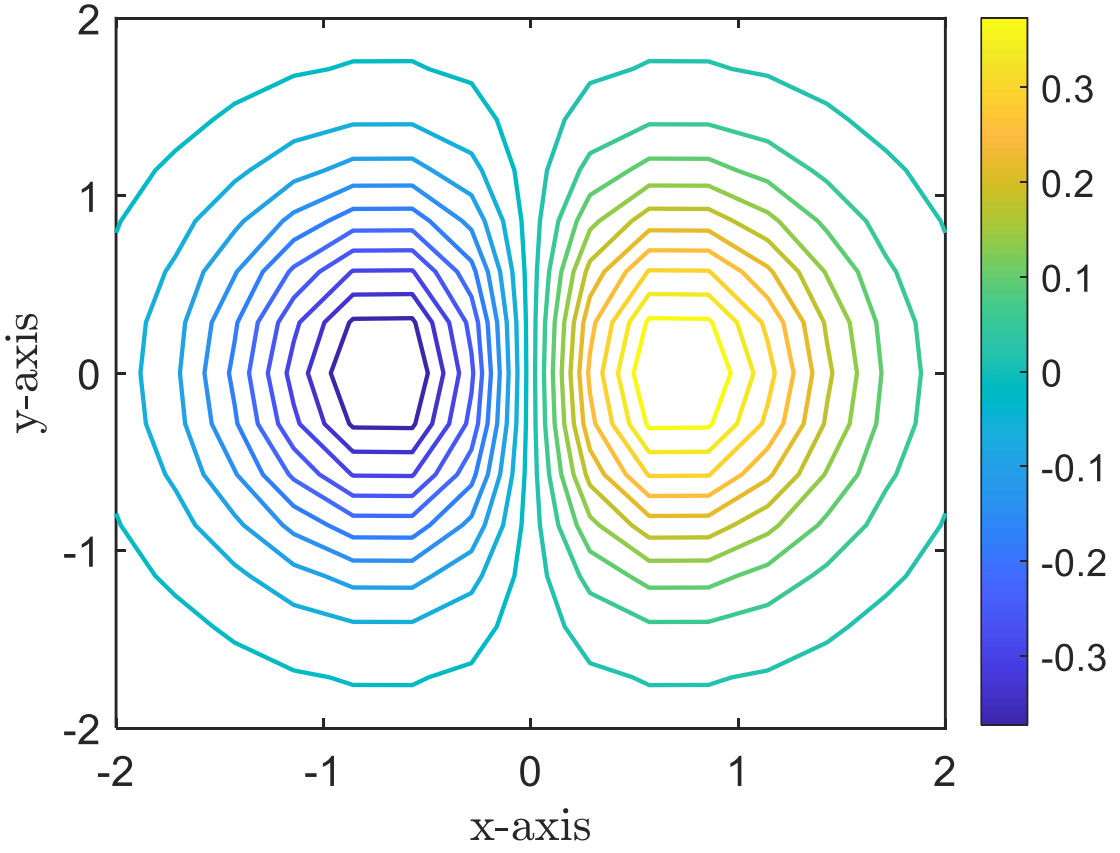


3-dimensional plot in MATLAB: surface plot vs contour plot

$$z = x \cdot e^{-(x^2+y^2)}$$



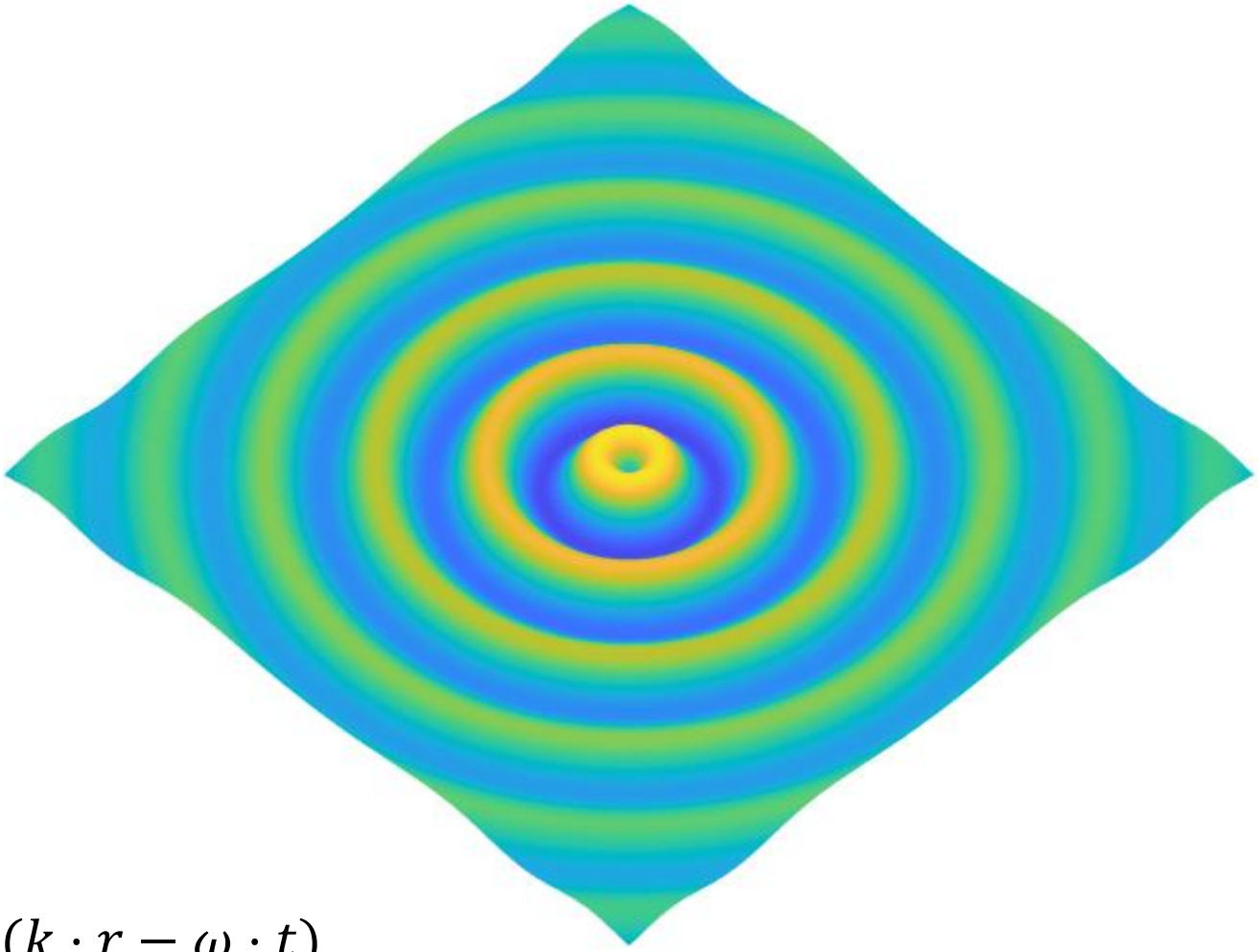
surface plot



contour plot

3-dimensional plot in MATLAB: plane wave with damping

Drop a pebble in a pond and
you will see such plane waves.



Equation is given by,

$$z(x, y, t) = e^{-\Gamma \cdot t} \cdot e^{-\gamma \cdot r} \cdot \sin(k \cdot r - \omega \cdot t)$$

Where, $r = \sqrt{x^2 + y^2}$, Γ is temporal damping and γ is radial damping.