

# **Display and Visualization Systems**

**Lecture SIX**

Use video data format  
to describe display and  
visualization systems

- a) Identify display and visualization systems
- b) Describe basic parts of a display and visualization system
- c) Demonstrate the operation of various display and visualization systems
- d) Describe various applications of display and visualization systems

Video data format is correctly used to describe display and visualization systems

# Data Visualization

- Data visualization is the **graphical representation** of information and data.
- By using visual elements like **charts**, **graphs**, and **maps**, data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data.
- Additionally, it provides an excellent way to present data to non-technical audiences without confusion.

# Data Visualization ...

- The term is often used interchangeably with others, **including information graphics, information visualization and statistical graphics.**
- Data visualization provides a quick and effective way to communicate information in a universal manner using visual information.
- It is the practice of translating information into a visual context, such as a map or graph, **to make data easier for the human brain to understand and pull insights from.**
- The main goal of data visualization is to make it easier **to identify patterns, trends and outliers in large data sets.**

# Data Visualization ...

- Data visualization is an element of the broader Data Presentation Architecture (DPA) discipline, which aims to **identify, locate, manipulate, format and deliver data in the most efficient way possible.**
- Data visualization is important for almost every career.
- It can be used by teachers to display student test results, by computer scientists exploring advancements in artificial intelligence (AI) or by executives looking to share information with stakeholders.
- **It also plays an important role in big data projects.**
- As businesses accumulated massive collections of data during the early years of the **big data trend**, they needed a way to get an overview of their data quickly and easily.

# Data Visualization ...

- **Examples of data visualization**
- The most common visualization technique used including the following:
  - infographics
  - bubble clouds
  - bullet graphs
  - heat maps
  - fever charts
  - time series charts, etc.

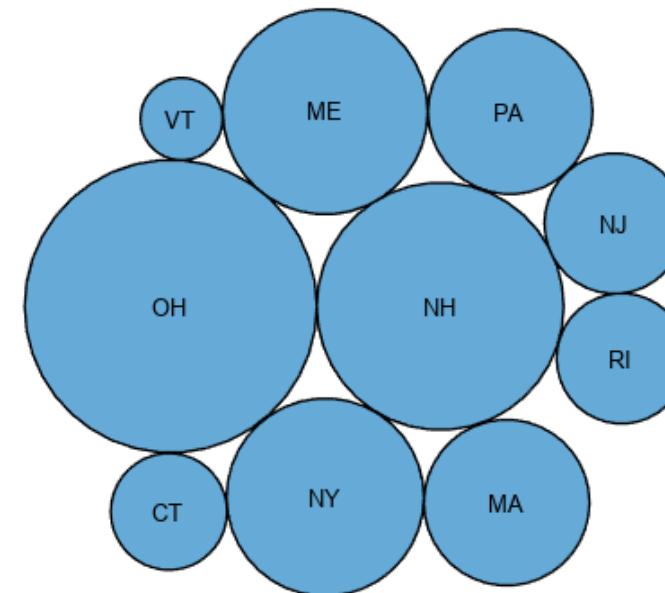
# Data Visualization ...

- An **infographic** is defined as a visualization of data that tries to convey complex information to an audience in a manner than can be quickly consumed and easily understood.
- An infographic is **a collection of imagery**, data visualizations like **pie charts** and **bar graphs**, and minimal text that gives an easy-to-understand overview of a topic.

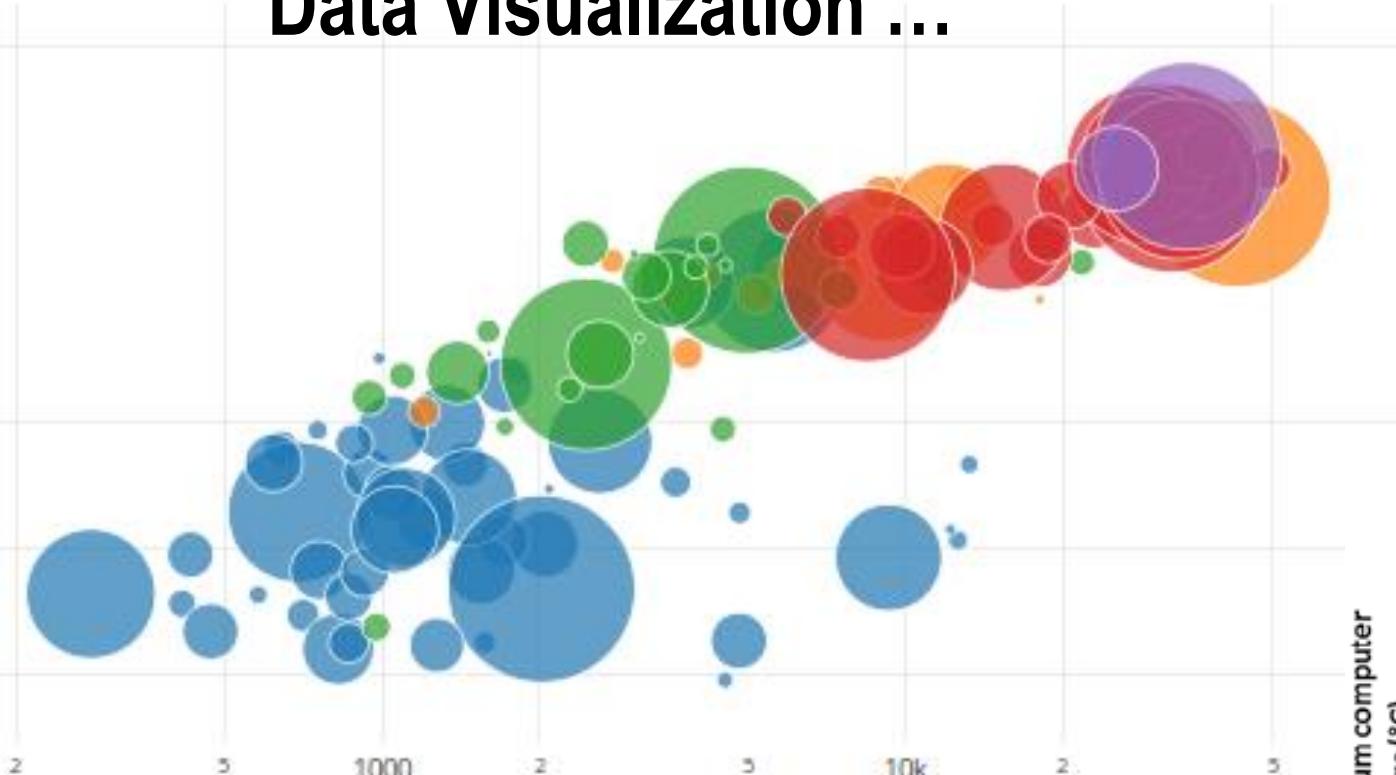
# Data Visualization ...

- **Bubble cloud charts** are useful for illustrating the relationship between elements in your data set and the set as a whole.
- For example, **you can visualize data collected from different cities**, and represent each city as a bubble whose size is proportional to the value for that city.

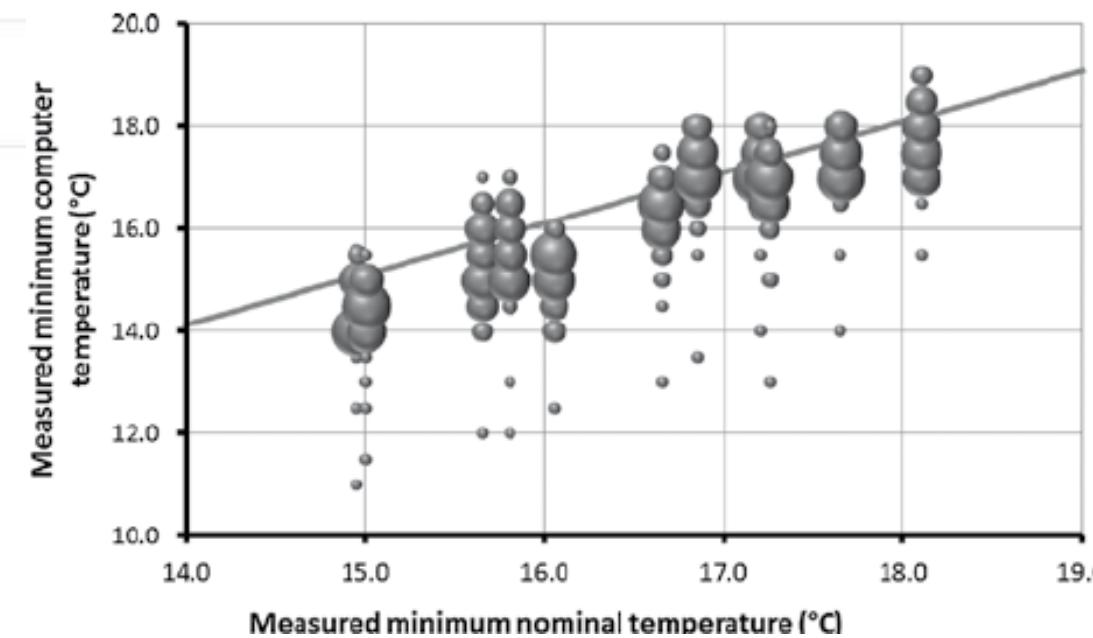
Mislabeled	State	Manufacturing Plant
58	"NJ"	"Plant A"
115	"NY"	"Plant A"
81	"MA"	"Plant A"
252	"OH"	"Plant A"
180	"NH"	"Plant A"
124	"ME"	"Plant A"
40	"CT"	"Plant A"
80	"PA"	"Plant B"
50	"RI"	"Plant B"
20	"VT"	"Plant B"



# Data Visualization ...



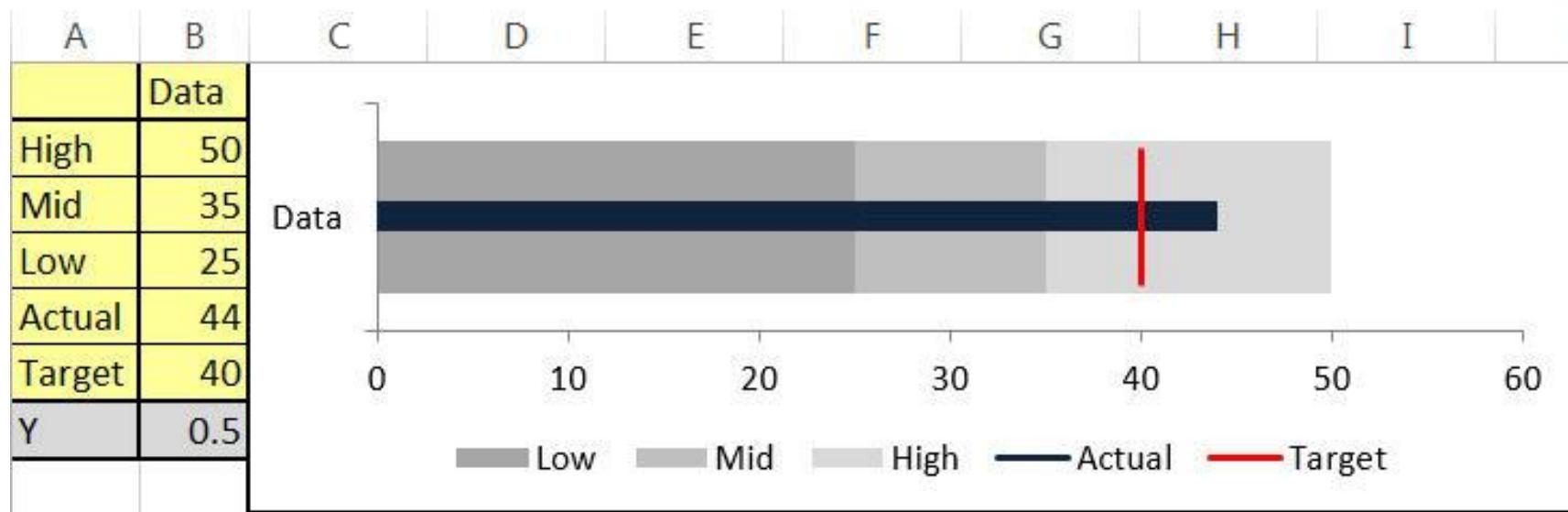
- Africa
- Americas
- Asia
- Europe
- Oceania



- The difference being the size of the bubble also determines a value.

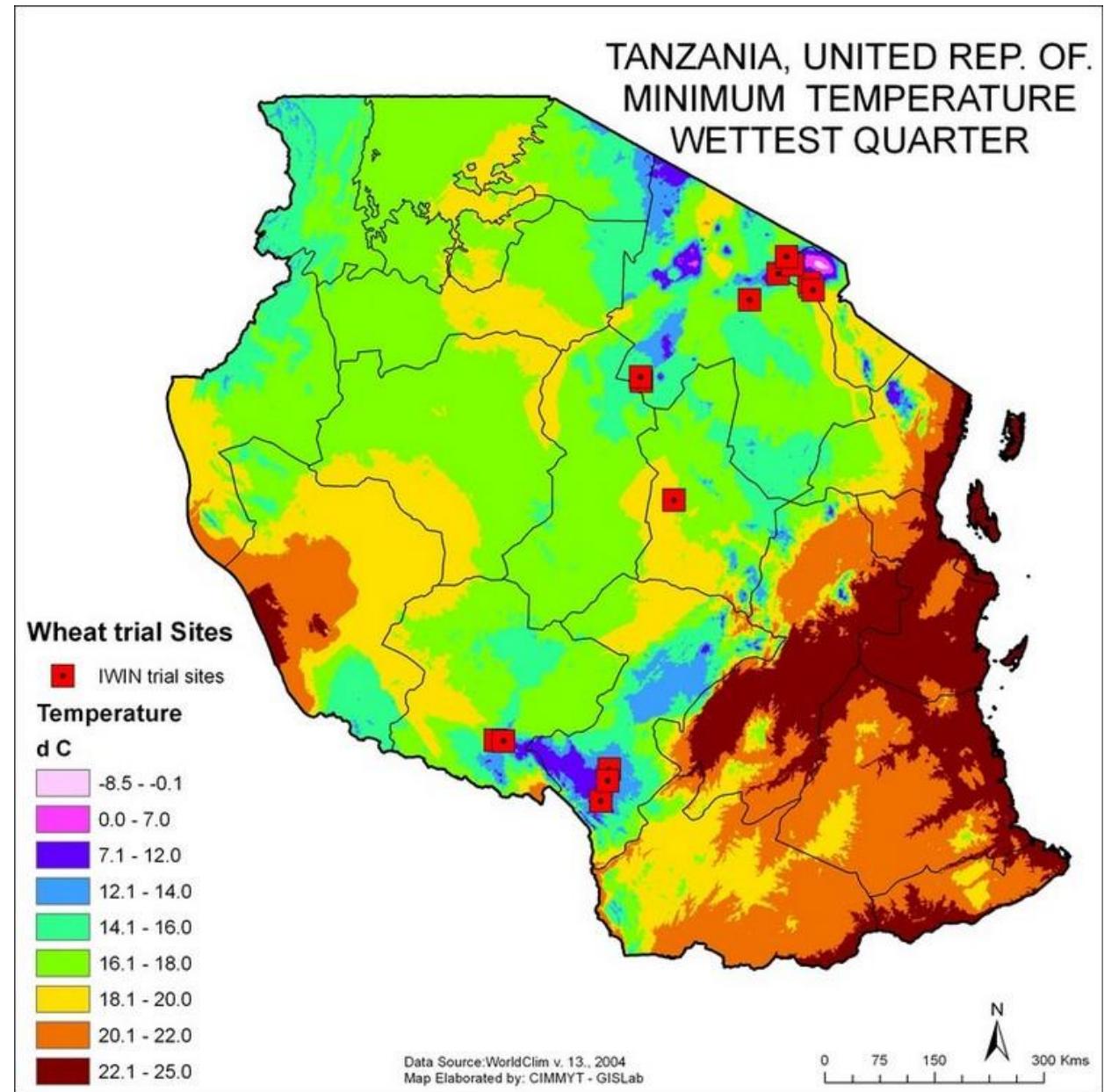
# Data Visualization ...

- A **bullet graph**, or a **bullet chart**, is a variation of a bar chart, typically consisting of a primary bar layered on top of a secondary stack of less-prominent bars.
- Bullet graphs are best **used for making comparisons**, such as showing progress against a target or series of thresholds.



# Data Visualization ...

- A **heat map** is a visual representation of data, which displays numeric values as color schemes.

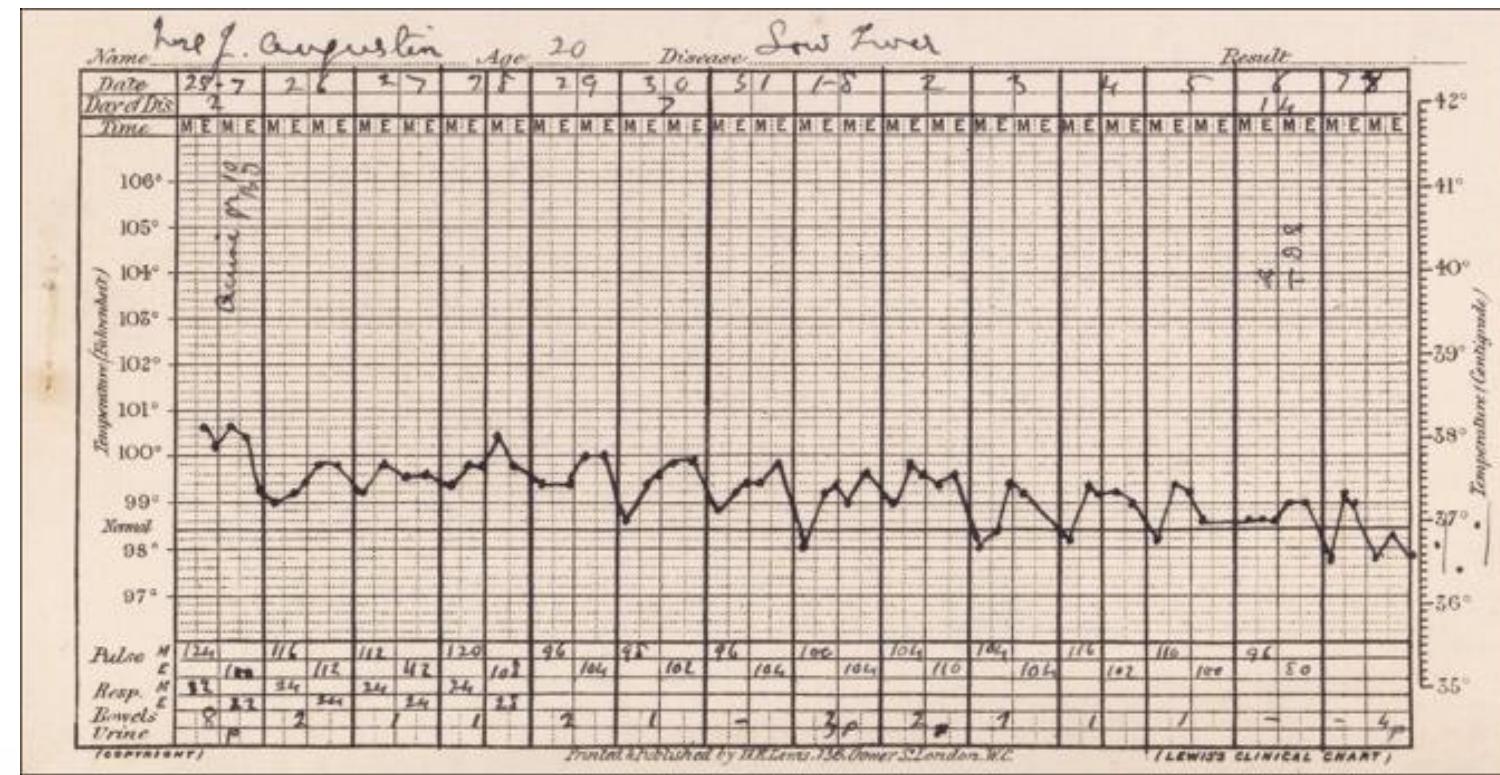
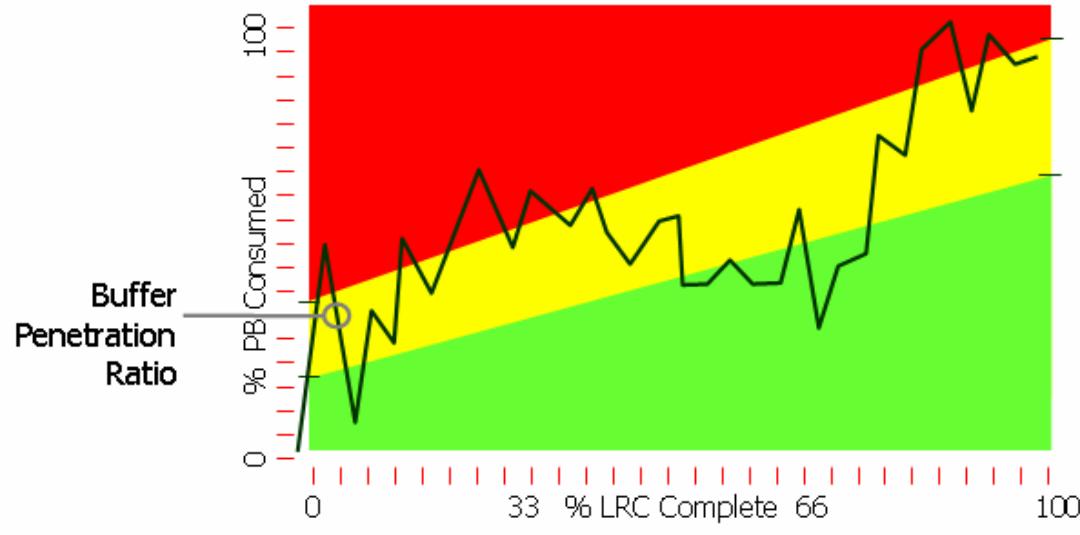


# Data Visualization ...

- A **fever chart** is a graphical representation of changing data over time.
- When the values of variables are recorded and viewed over a long period of time, it is difficult to derive patterns or trends from plain data.
- However, when the same data is represented in a fever chart, it becomes easier to spot trends or patterns.

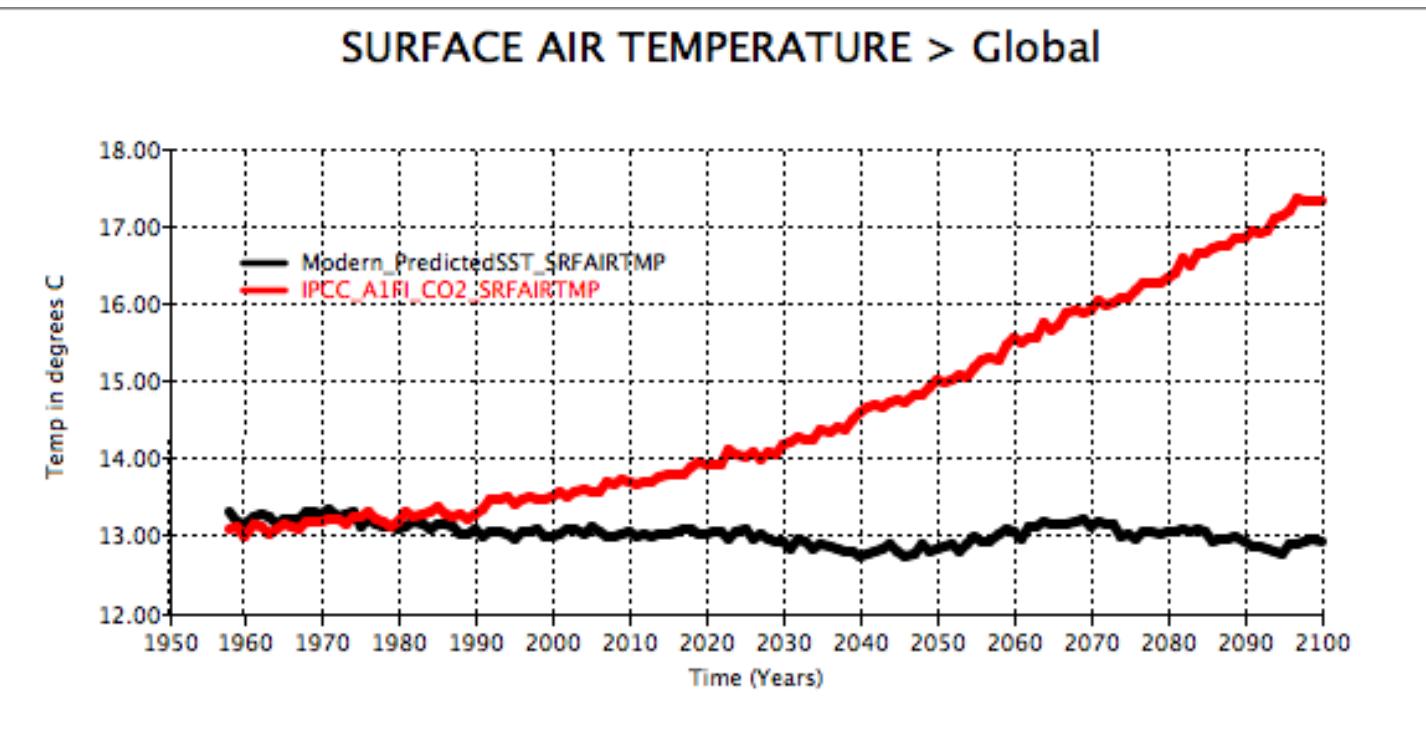
	Oral/Forehead	Underarm	Rectal/Ear
 High Fever	Over 103°F	Over 102°F	Over 104°F
 Moderate Fever	102.9°F   101°F	101.9°F   100°F	103.9°F   102°F
 Mild Fever	100.9°F   100°F	99.9°F   99°F	101.9°F   100.4°F
 Normal	99.9°F   95.5°F	98.9°F   95°F	100.3°F   96°F
 Low	Under 95.4°F	Under 94.9°F	Under 95.9°F

# Data Visualization ...



# Data Visualization ...

- Time series charts present a series of data points collected over a specified reporting period.



- **Modern\_PredictedSST** is a simulation that demonstrates what future climate would be like with **no increase** in greenhouse gases or any other variables, such as solar luminosity.
- This is the **baseline for any climate change experiments**.
- **IPCC\_A1FI\_CO<sub>2</sub>** is the climate change experiment where **the greenhouse gas quantities increase gradually as the model runs**.

# Data Visualization ...

- Some other popular techniques are as follows:
- **Line charts.** Line charts display how variables can change over time.
- **Area charts.** This displays multiple values in a time series or a sequence of data collected at consecutive, equally spaced points in time.
- **Scatter plots.** This technique displays the relationship between two variables.
- **Treemaps.** This method shows hierarchical data in a nested format. The size of the rectangles used for each category is proportional to its percentage of the whole. Treemaps **are best used when multiple categories are present**, and the goal is to compare different parts of a whole.

# VISUALIZATION SYSTEMS

- System visualization **is the process of mapping the flow and/or function of a system or data flow.**
- Visualizations are beneficial to help a team more quickly diagnose issues, communicate across departments, and efficiently build or update a system.
- A **display** is a core ingredient in a human-machine interface (HMI), the dynamic device through which information is entered and presented, as text or images.
- Not too many years ago, **the CRT (cathode ray tube) monitor large, heavy, and bulky was the common display device.**

# DISPLAYS AND DATA TYPES

- A display is an electronic device whose main purpose is **an interface to show the reading (information) as the result of a certain process of a computer or electronic circuit.**
- The information (data types) could be a **text, picture (images), or video** which is a sequence of pictures.
- Two main technologies, **liquid crystals** and **organic light-emitting diodes**, currently dominate the market for visual displays.
- An older technology, the cathode ray tube, has all but vanished from the scene, and **plasma monitors also see use in some applications.**

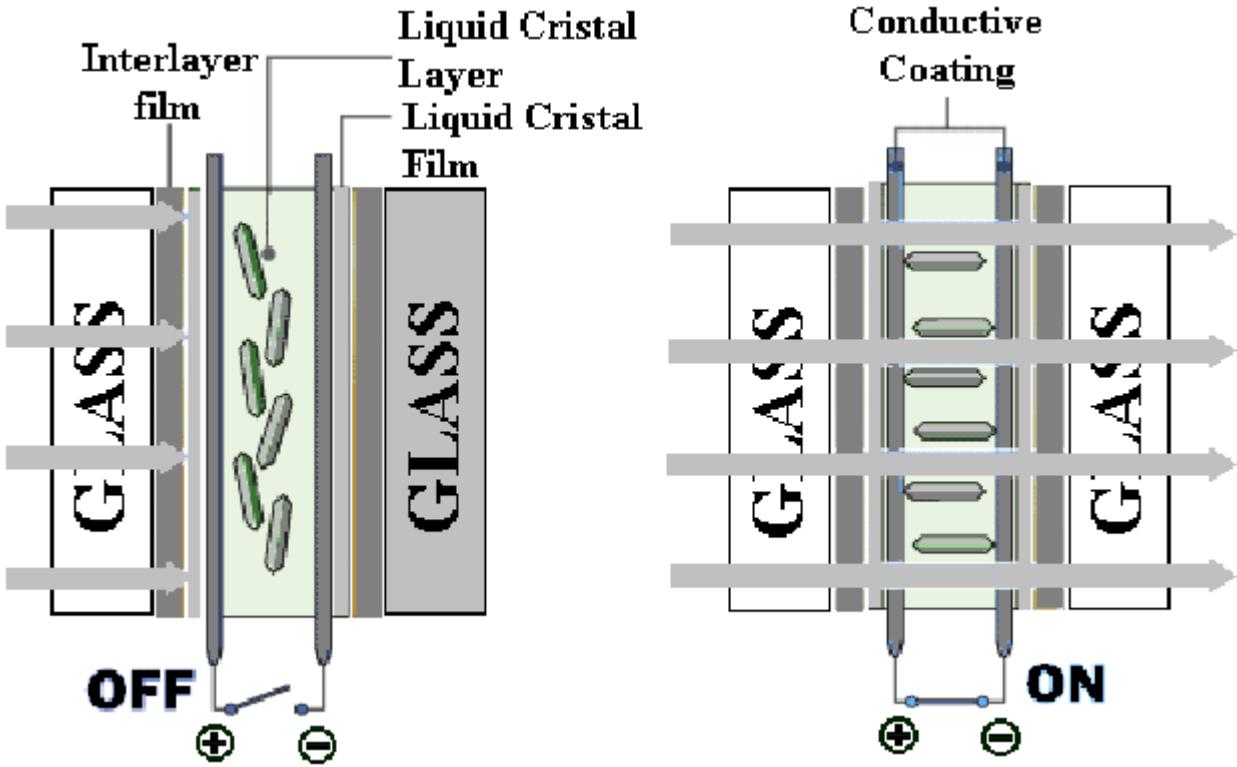
# **DISPLAYS AND DATA TYPES ...**

## **Common components**

- A display consists of three primary components:
  1. display assembly,
  2. controller, and
  3. backlight.

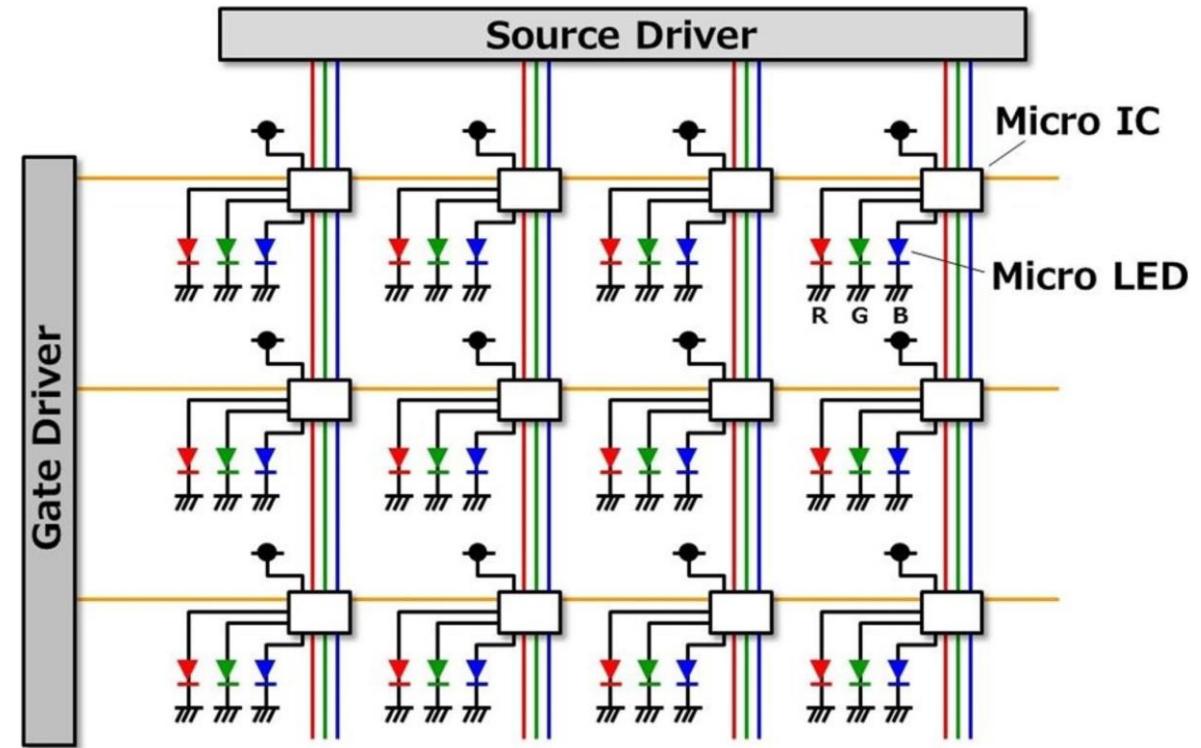
# DISPLAYS AND DATA TYPES ...

- In liquid crystal technology, as an example, **display assembly** is a **liquid crystal structure, sandwiched between layers of glass**.
- Individual display elements are called **pixels**, each one addressable in a row-and-column format.
- In simple terms, pixel response provides flexibility the amount depending on display type to create graphics and text in combination, **in monochrome or color**.



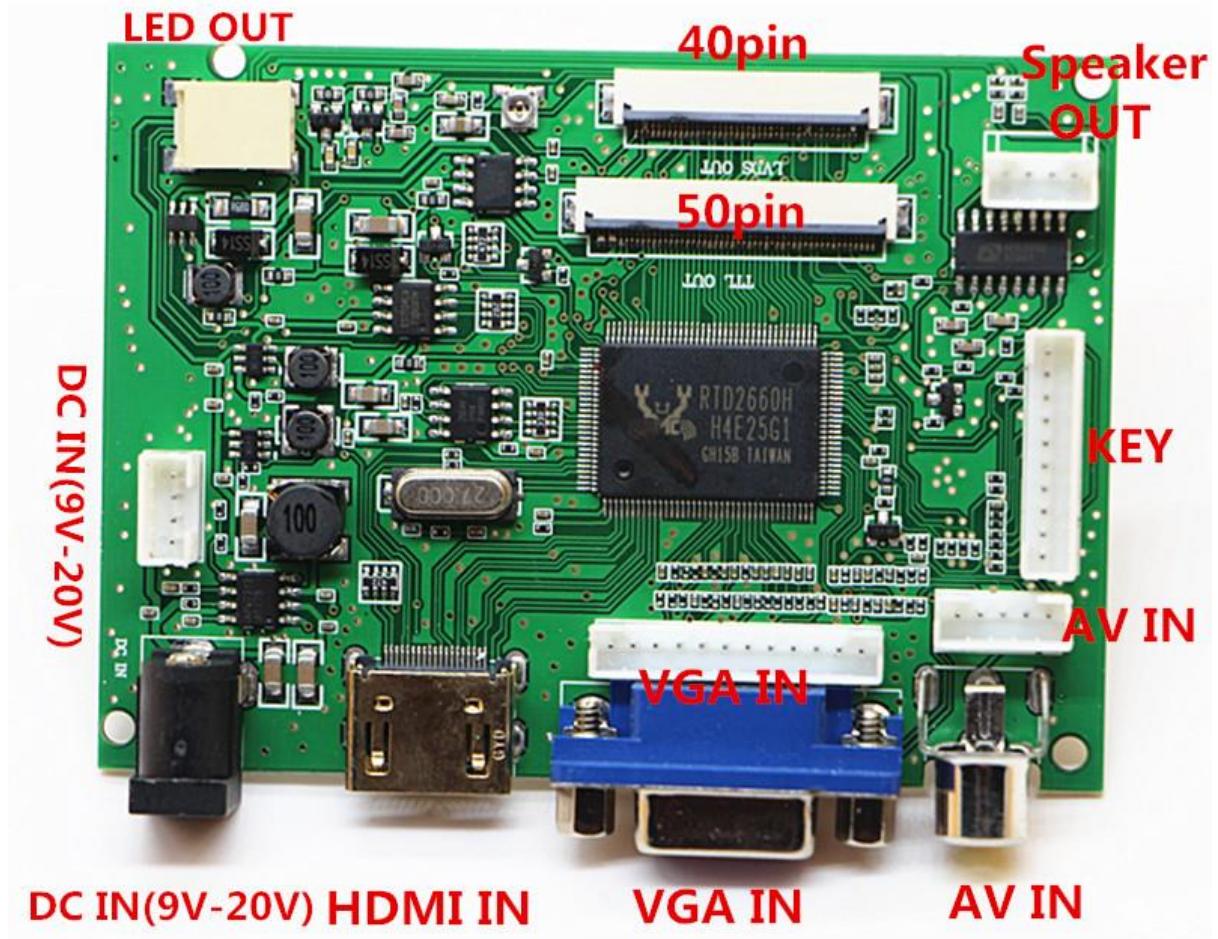
# DISPLAYS AND DATA TYPES ...

- Active matrix driving technology integrating red-green-blue (RGB) microscale light emitting diodes (micro LEDs) and a microscale integrated circuit (micro IC) in each pixel for the Crystal LED display system.



# DISPLAYS AND DATA TYPES ...

- A **controller**, either built-in to the assembly or external, **guides the operation of the display assembly**.
- In most cases, the controller is integrated into the display.
- When external to the device, it may take the form of a separate card or be a built-in function of a Single Board Computer (SBC).



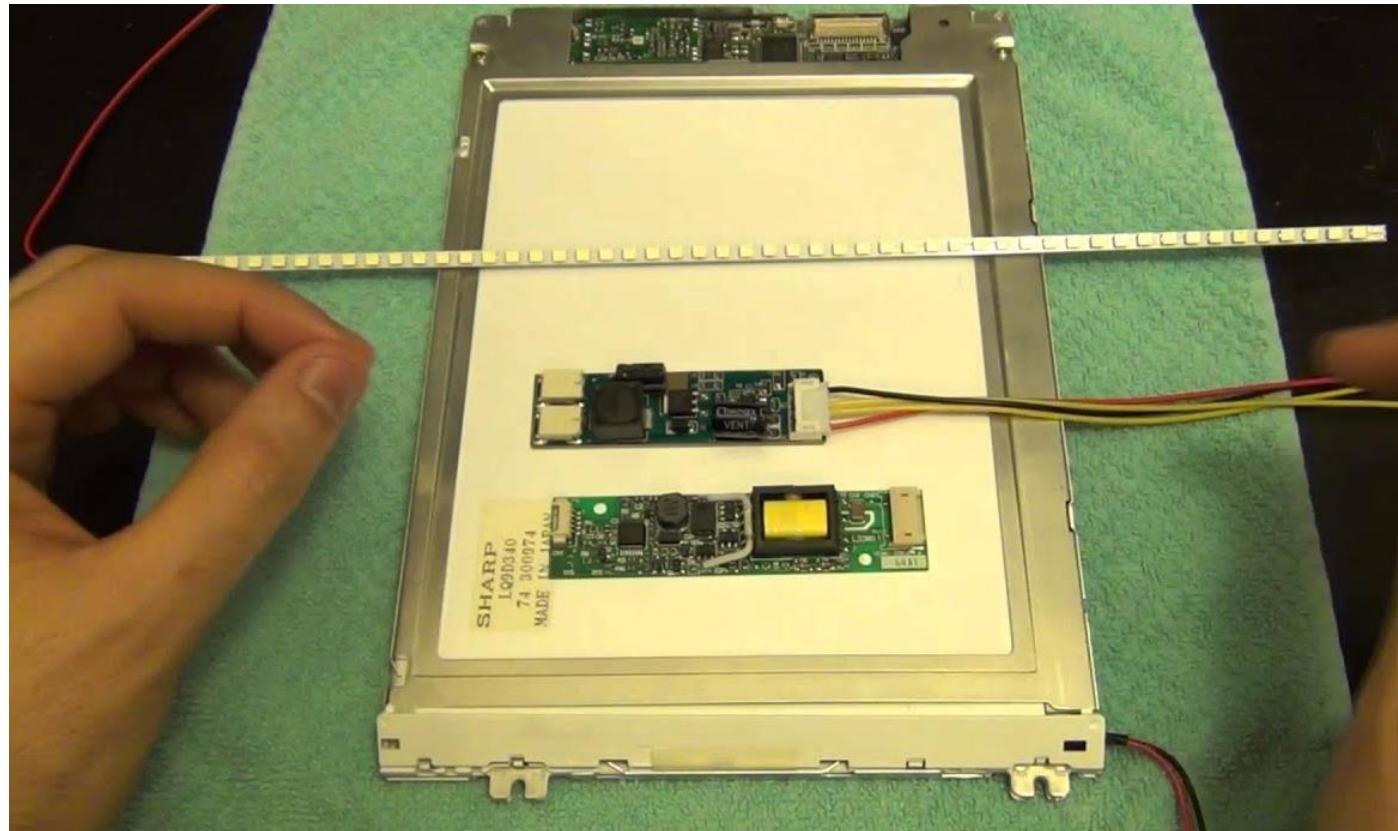
## DISPLAYS AND DATA TYPES ...

- A **backlight** is a form of **illumination** used in **liquid crystal displays** (LCDs).
- As LCDs **do not produce light by themselves** unlike, for example, cathode ray tube (CRT), plasma (PDP) or OLED displays.
- They need illumination (ambient light or a special light source) to produce a visible image.
- Backlights illuminate the LCD from the side or **back of the display panel**, unlike front-lights, which are placed in front of the LCD.



# DISPLAYS AND DATA TYPES ...

- Backlights are used in small displays to **increase readability in low light conditions** such as in wristwatches, and are used in **smart phones, computer displays** and **LCD televisions** to produce light in a manner similar to a CRT display.



# THE DISPLAY TYPES

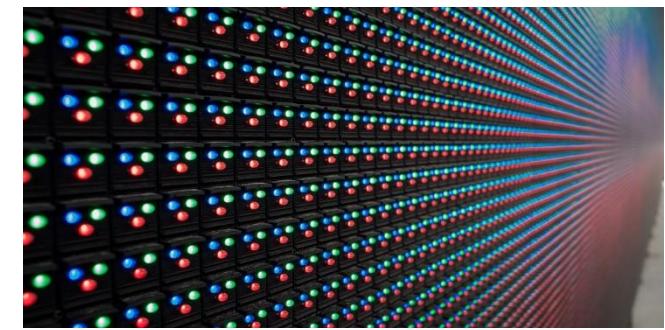
## Cathode Ray Tubes (CRT):

- This type of display has a big size, heavy, and bulky dimension.
- Not the first choice in the 21<sup>st</sup> era.



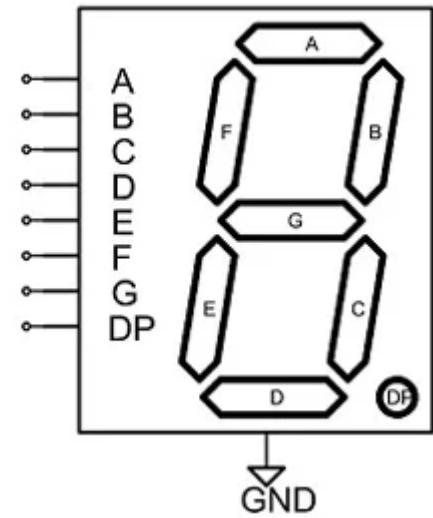
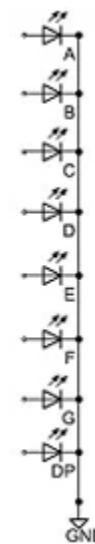
## LED Displays:

Light emitting diode (LED) is the most commonly used device **for displaying the status of microcontroller pins**.



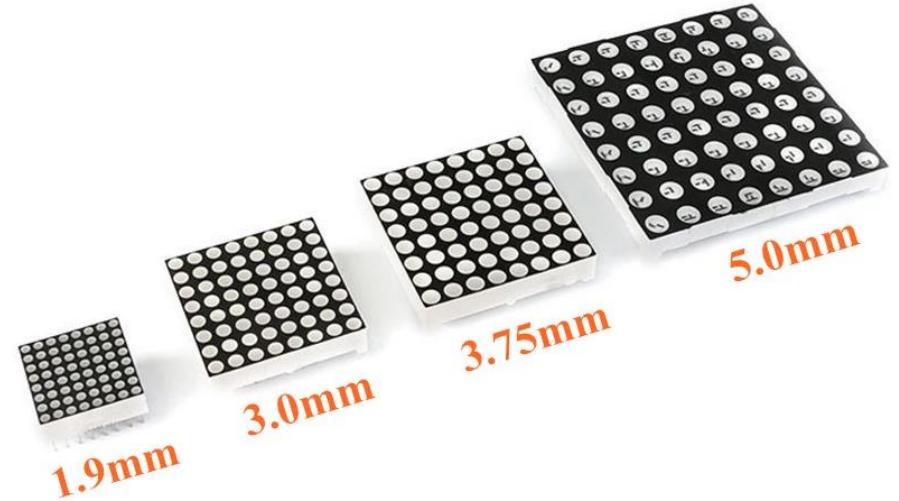
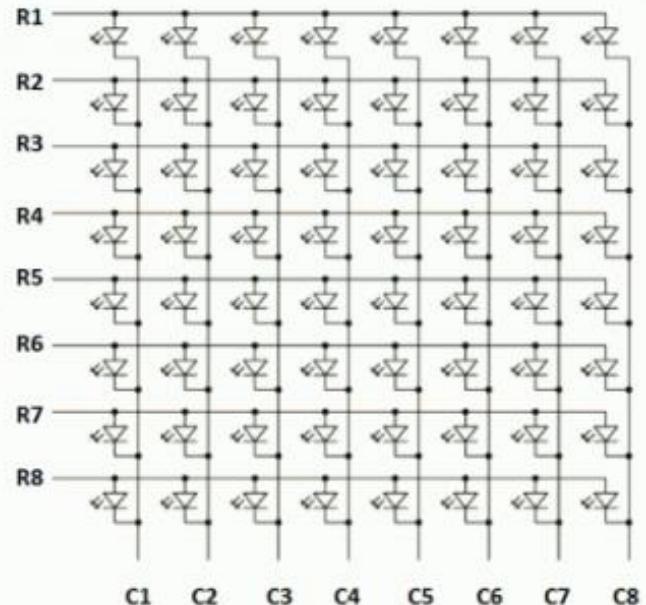
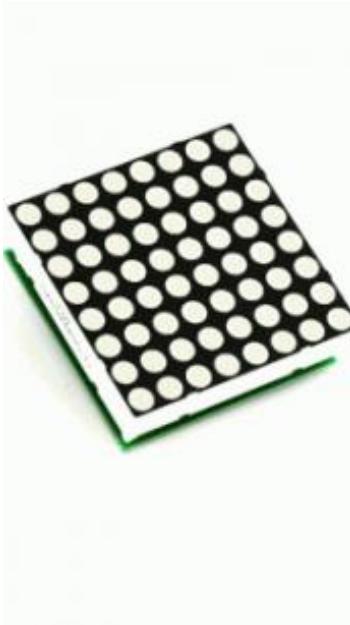
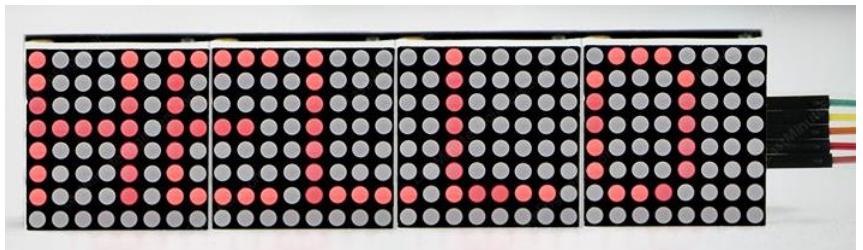
## 7-Segment LED Display:

- 7-Segment LED display can be used for **displaying digits and few characters**.
- A seven segment display consists of 7 LEDs arranged in the form of Square '8' and a single LED as dot character.
- Different characters can be displayed by selecting the required LED segments.



## Dot Matrix LED Display:

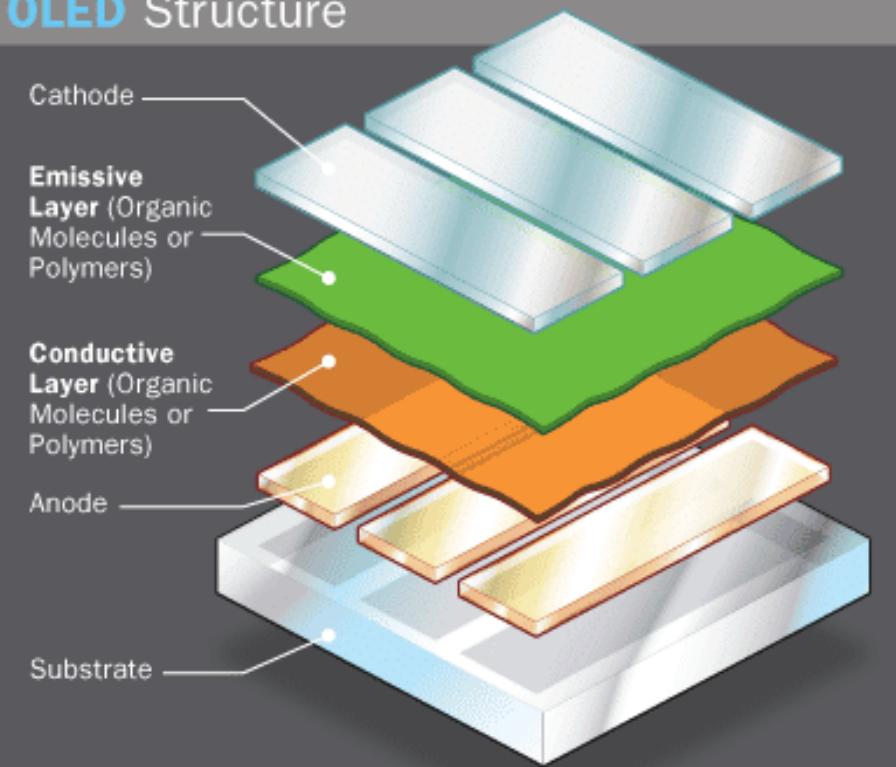
- Dot matrix LED display contains the group of LEDs as a **two dimensional array**.
- They can display **different types of characters or a group of characters**.
- Dot matrix display is manufactured **in various dimensions**.
- By using this dot matrix display we can reduce the number of pins required for controlling all the LEDs.



# Organic Light-Emitting Diode (OLED)

- Although the OLED screen is lightly similar to LCD technology, **OLEDs require no backlight; they produce their own light.**
  - Because of this advantage, **OLED displays can be much thinner than an LCD equivalent.**
  - And because a backlight consumes significant amounts of energy, **OLEDs help improve battery life in mobile devices.**
  - Although the image quality of OLED displays is very good, **their working lifetime is currently not as good as LCDs.**

## OLED Structure



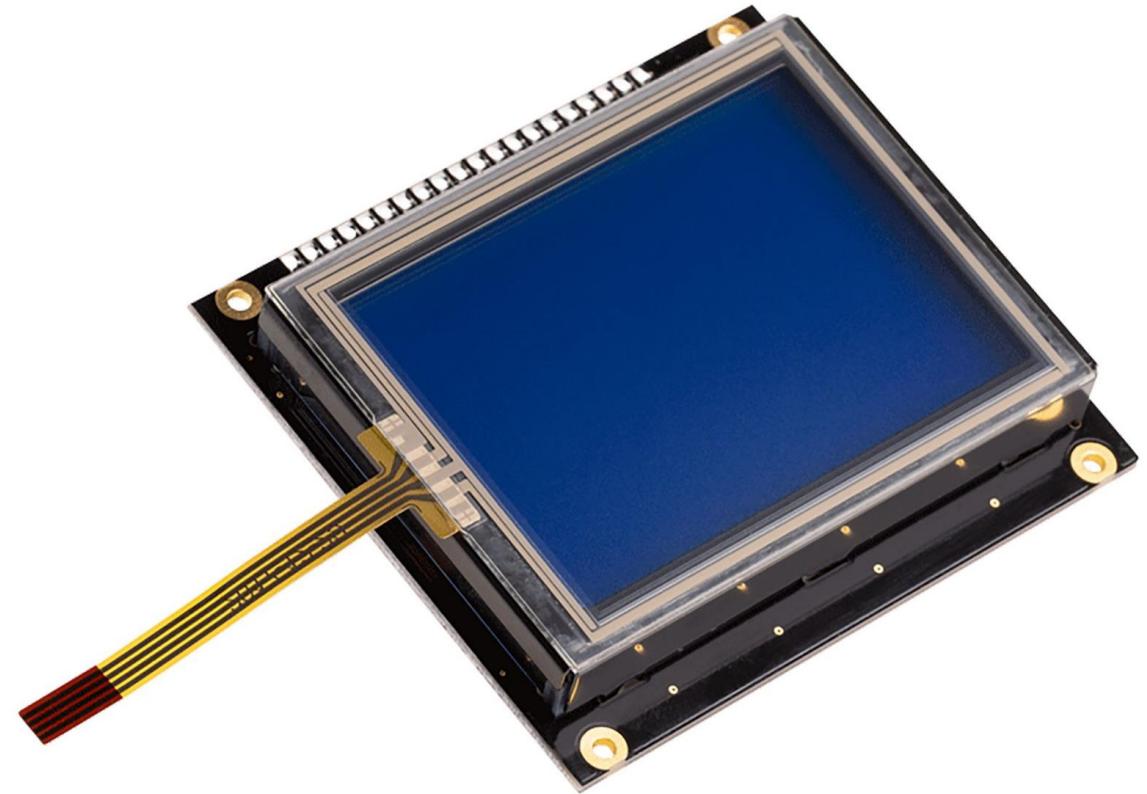
# Liquid Crystal Displays (LCD)

- Liquid crystals are liquid materials **that have some of the optical properties of crystals**.
- A display **made of liquid crystals** acts like an array of tiny shutters that transmit or block light.
- A bright light source called a **backlight**, **situated behind the LCD screen**, shines through the LCD, creating thousands of tiny dots of red, blue and green that form a color image.
- Because the backlight is **sealed inside the display**, you normally never see it directly, only its light filtered through the LCD panel.



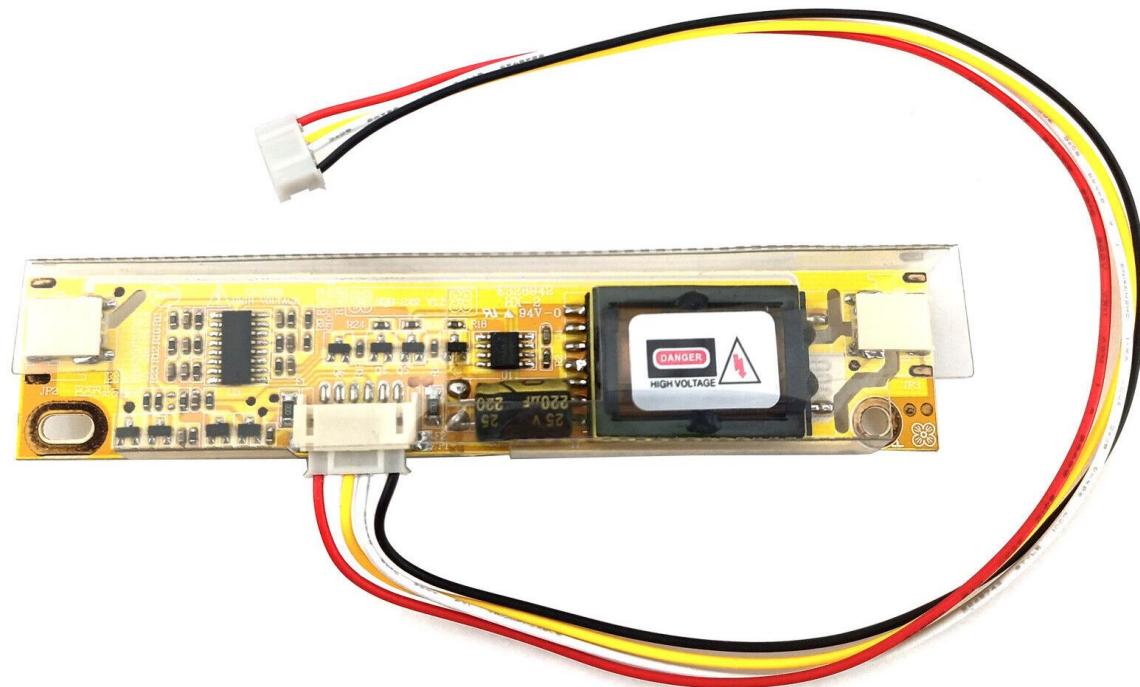
- The LCD is much **more** informative output device than a single LED.
- The LCD is a display that **can easily show characters on its screen.**
- Some LCDs are specially designed for specific applications to display graphic images such as **16×2 LCD** (HD44780) module is commonly used.

- The graphical LCDs can be used to display customized characters and images.
- The graphical LCDs find use in many applications like video games, mobile phones, and lifts as display units.
- The most commonly used GLCD is JHD12864E.
- This LCD has a display format of  $128 \times 64$  dots.



- The most common add-on to an LCD is a touch-panel.
- In this **four-wire resistive technology** example, a glass panel is uniformly coated with **electrically conductive and resistive layers**.
- A **Polyester cover sheet** is suspended over the top of the glass and separated from it by small, transparent insulating separators.
- During operation, an **electrical current moves through the touchscreen**.
- When activated by a touch, the conductive coating makes contact with the coating on the glass and a touch point is registered.

- Images are brought to the display surface by a **backlight** , typically CCFL (cold cathode fluorescent lamps) powered by a **high-voltage power supply called an inverter**.



An inverter

- As light-emitting diode (LED) and organic light-emitting diode (OLED) technologies **advance in power consumption** and lumen output, they are increasingly popular.
- A logic-powered light source, **the LED requires no inverter.**
- While CCFL is still the backlight of choice in large displays and laptops, **LEDs are found in smaller displays** (5-in. diagonal and less), cellphones, and a variety of other devices, such as intelligent thermostats.
- OLED displays embody low voltage, 3x self-illumination, and high brightness.
- With improving life, future OLED use will escalate.

## Plasma

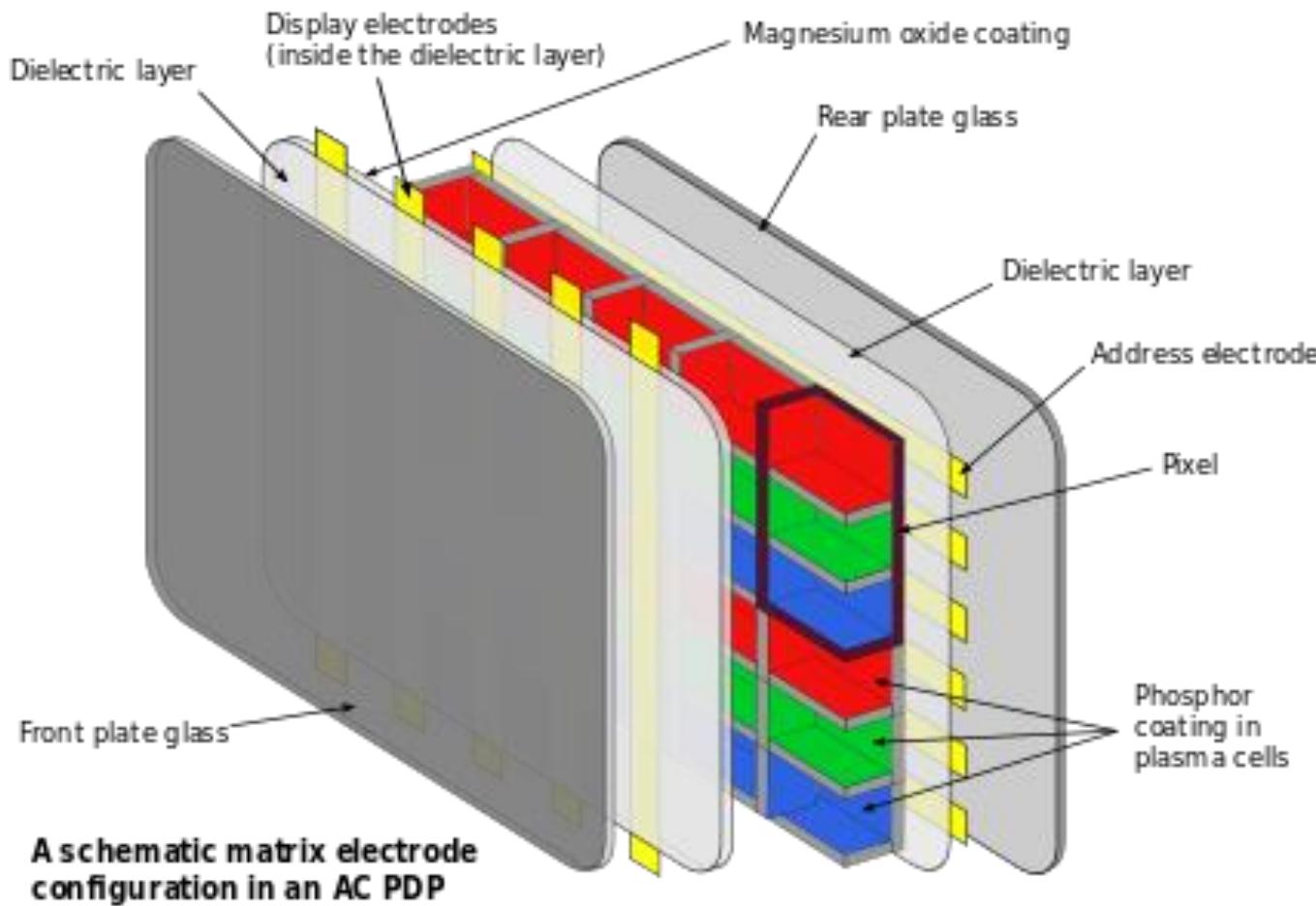
- A **plasma display panel (PDP)** is a type of **flat panel display** that uses small cells containing plasma: ionized gas that responds to electric fields.
- Plasma televisions were the first large (over 32 inches diagonal) flat panel displays to be released to the public.
- A plasma display screen consists of tiny gas capsules arranged in a grid; when stimulated by electricity, the gas glows much in the same manner as a neon sign.

## Plasma ...

- Plasma TVs are actually very similar to CRTs.
- Instead of having a beam that scans, a plasma produces light from its pixels when an electric charge is applied to a cell containing a noble gas, or "plasma".
- These plasma chambers are sealed units, the gas will never escape.

# Plasma ...

- Plasma displays have **two glass plates**, containing electrodes, sealed to form an envelope filled with a **neon and xenon gas mixture**.
- A gas discharge plasma is created by applying an **electric field between the electrodes**.
- The plasma generates ultraviolet light which in turn excites the phosphor coating inside the glass envelope.



## Plasma ...

- The phosphor **emits a single color of visible light.**
- Each **pixel consists of three sub-pixels, one each of red, green and blue.**
- By combining these primary colors at varying intensities, all colors can be formed.
- Some aspects of image quality, such as the darkness of blacks and the vividness of colors, can be better in plasma screens than LCDs.
- However, **LCDs are more energy-efficient than plasmas**; due to battery life concerns, virtually all laptop computers have LCD screens and not plasma technology.
- Most plasma screens currently sold tend to be in the 40-inch to 60-inch size range where image quality helps justify the greater energy consumption.

# The Display Specifications

## 1. Resolution

- It determines the total number of pixels on the screen.
- The most common is 1920×1080 that is Full-HD or 1080p.
- On its development, more resolution is introduced such as 2K, 1440p, 4K, even 5K and 8K for professionals.

## 2. Size

- This is often explained in inch size, e.g. 22", 55" etc.
- The size is measured diagonally just for your information.
- To keep the image quality sharp and clear, a bigger size display may need a bigger resolution.

<b><u>STANDARD</u></b>	<b><u>DESCRIPTION</u></b>	<b><u>RESOLUTION</u></b>
CGA	Color Graphics Adapter	640 x 200 (monochrome) 320 x 200 (4-color)
EGA	Enhanced Graphics Adapter	640 x 350 (4-color)
VGA	Video Graphics Array	640 x 480
XGA	Extended Graphics Array	1024 x 768
SXGA	Super Extended Graphics	1280 x 1024
UXGA	Ultra Extended Graphics	1600 x 1200
WXGA	Wide Extended Graphics	1366 x 768
WSXGA	Wide Super Extended Graphics	1680 x 1050
WUXGA	Wide Ultra Extended Graphics	1920 x 1200

### **3. Aspect Ratio**

- This is to represent the width to the height.
- It can be measured from the resolution too.
- The common aspect ratios are:
  1. Wide – 16:9
  2. Ultra-Wide – 21:9
  3. Super-Wide – 32:9

### **4. Refresh Rate**

- It represents how often a **display can update per second** (Hertz or Hz).
- The common refresh rates are 60Hz, 75Hz, 90Hz, 120Hz-Gaming, and 144Hz-Gaming.

## 5. Viewing Angles

- It is measured by two numbers such as 160/120 where 160 is **the horizontal viewing angle** and 120 is the **vertical viewing angle**.
- As long as you are in 160 out of 180 degrees horizontally and 120 out 180 degrees, you will still get a clear view.

## 6. Brightness

- The units used are **nits or cd/m<sup>2</sup>**.
- The adequate standard is about **200-300 nits**.