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# **CSC4130**

# **Introduction to Human-Computer Interaction**

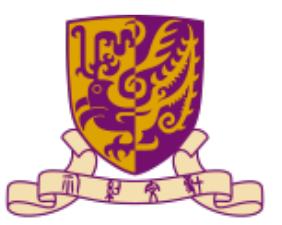
## **Lecture 4**

## **Computer**



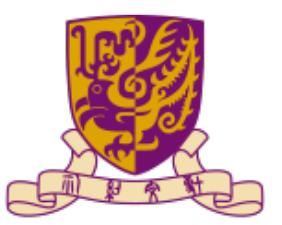
香港中文大學(深圳)

The Chinese University of Hong Kong, Shenzhen



# Outline

- Computer
- Text entry devices
- Positioning, pointing, and drawing
- Display devices
- Physical controls, sensors, and special devices



# Outline

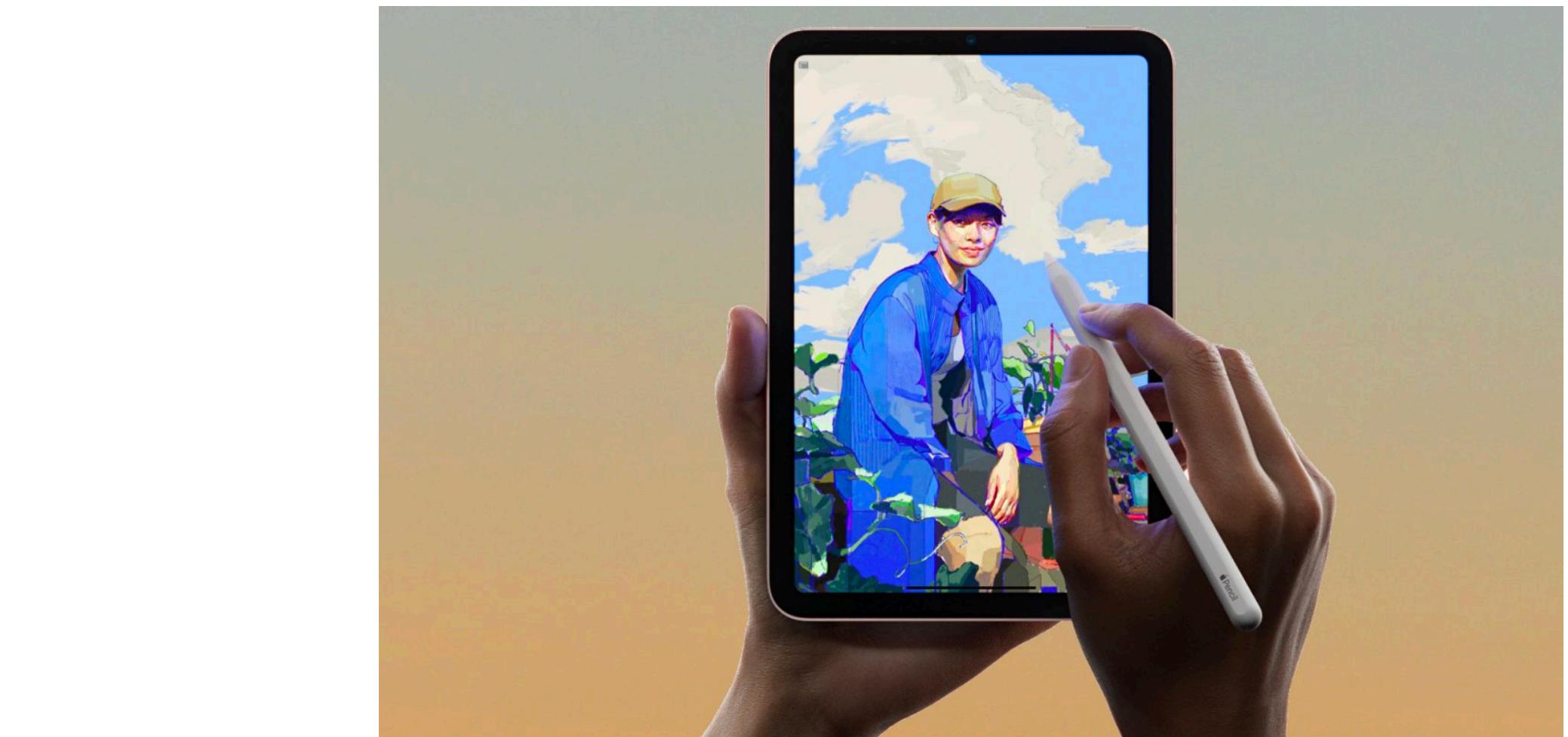
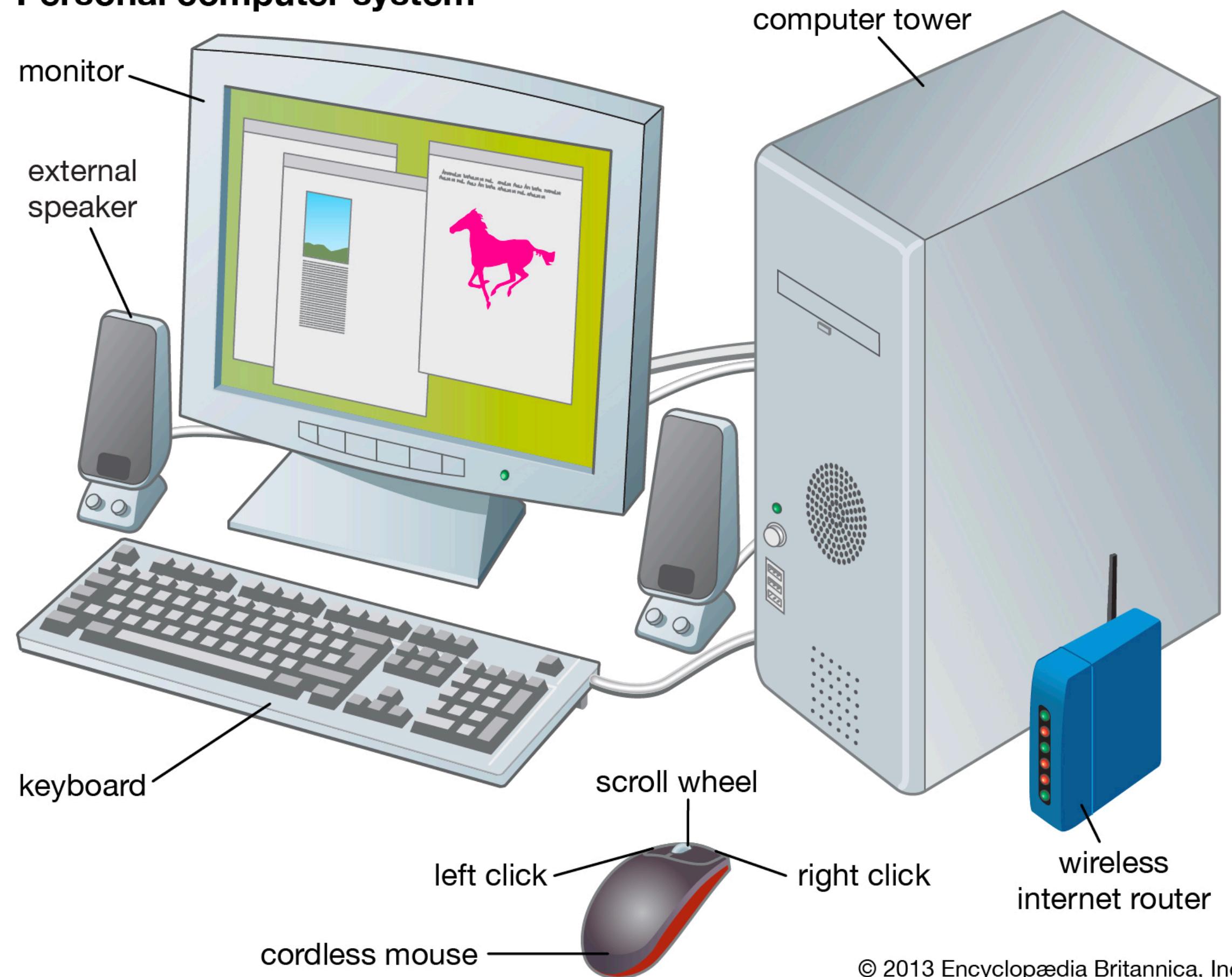
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# Computer

- Made up of various elements and each of these elements will affect the interaction
  - Input devices - text entry and pointing
  - Output devices - screen, digital paper
  - Physical interaction - sound, haptic, bio-sensing
  - Paper - as output (print) and input (scan)
  - Memory - RAM & permanent media, capacity and access
  - Processing - speed of processing, networks

# Computer

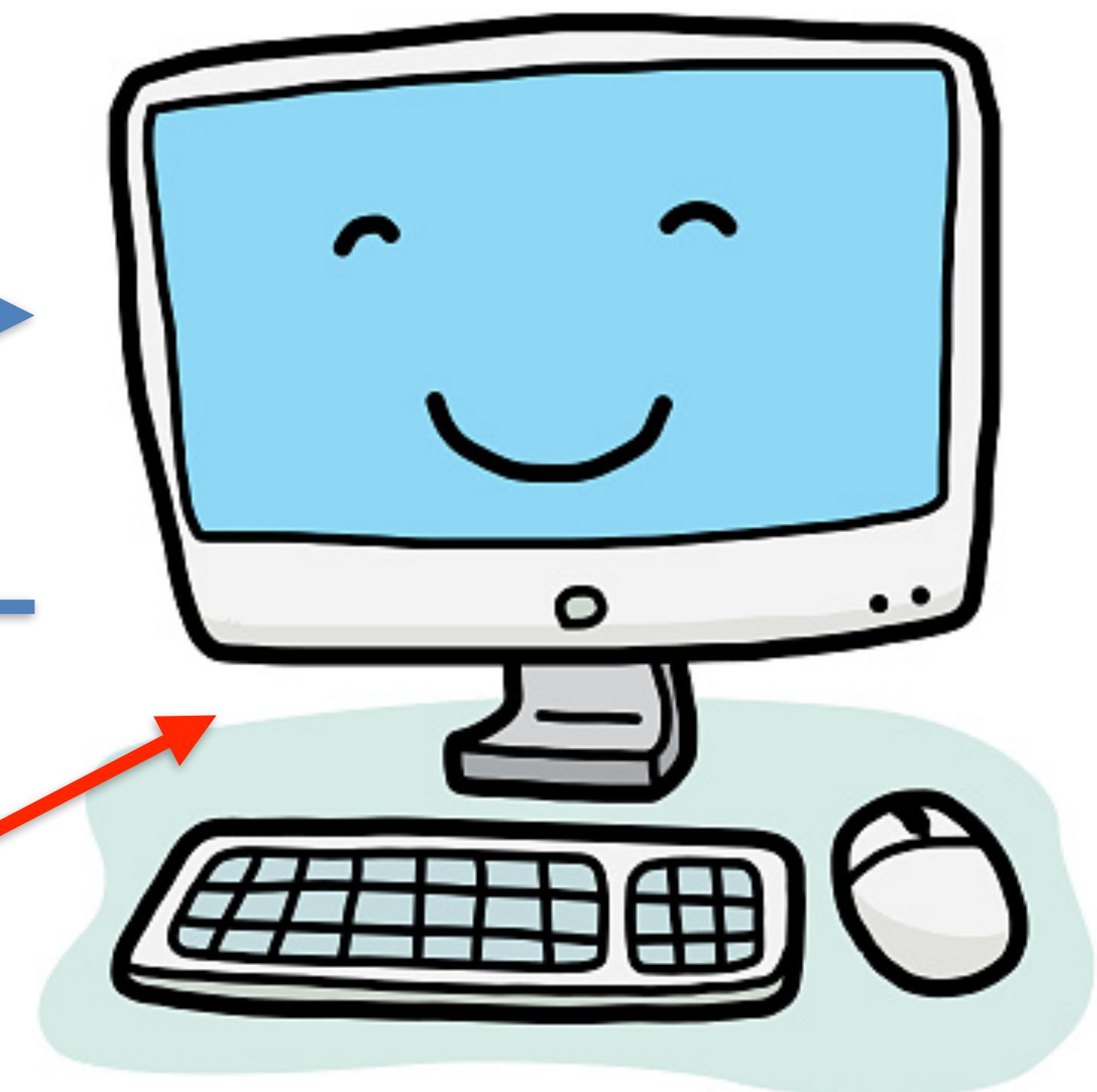
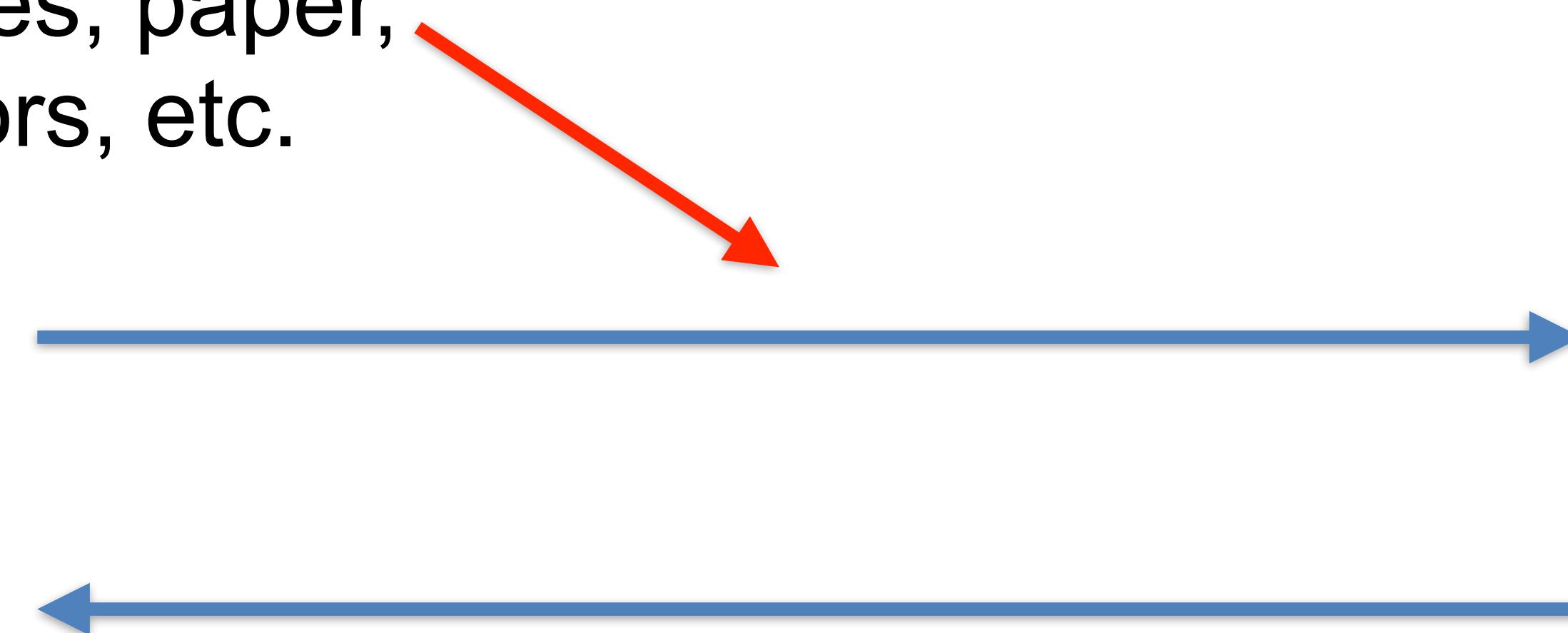
## Personal computer system



# Interacting with computers

- To understand human-computer interaction ... need to understand computers

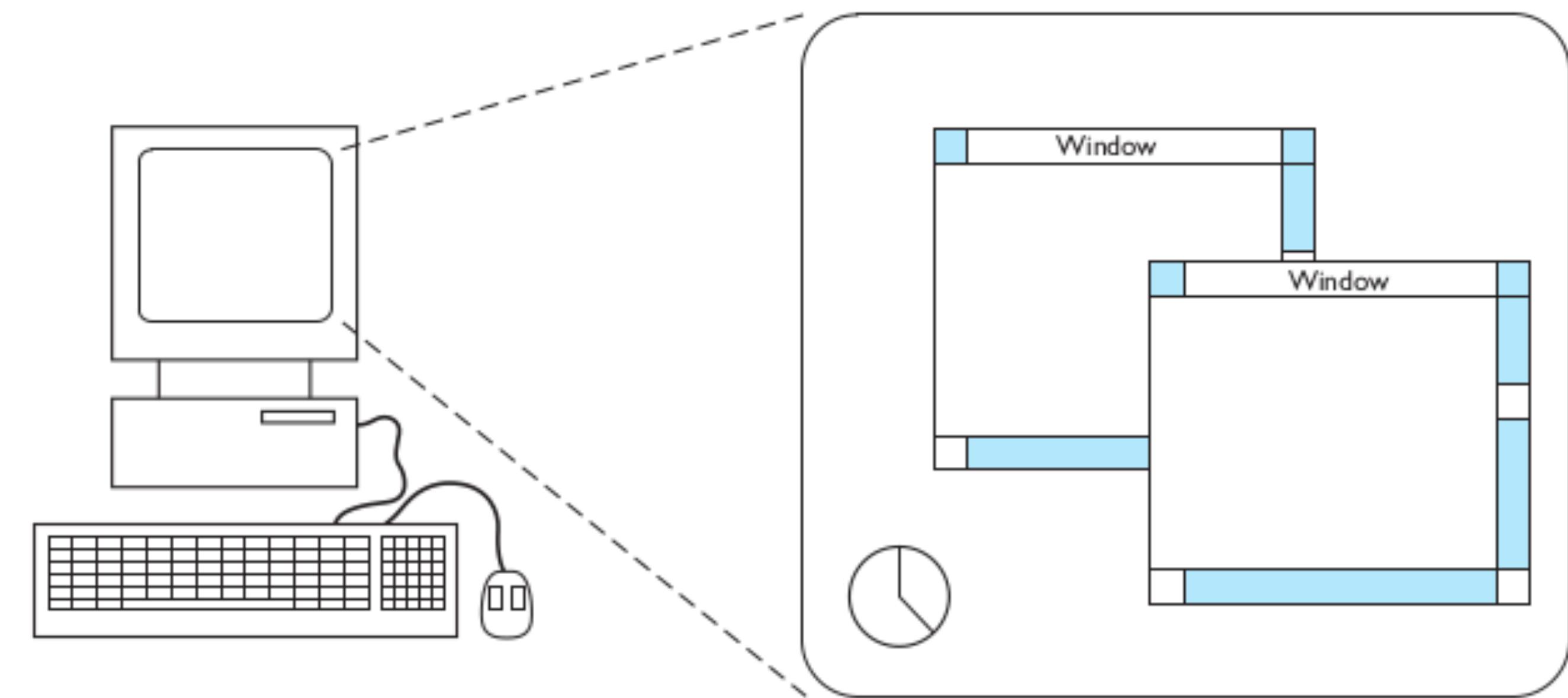
What goes in and out  
devices, paper,  
sensors, etc.

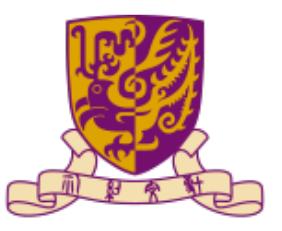


What it can do  
memory, processing, networks, etc.

# A typical computer system

- Screen, monitor on which there are windows
- Keyboard
- Mouse or trackpad
- Variations
  - Personal digital assistant (PDA)
  - Desktop
  - Laptop

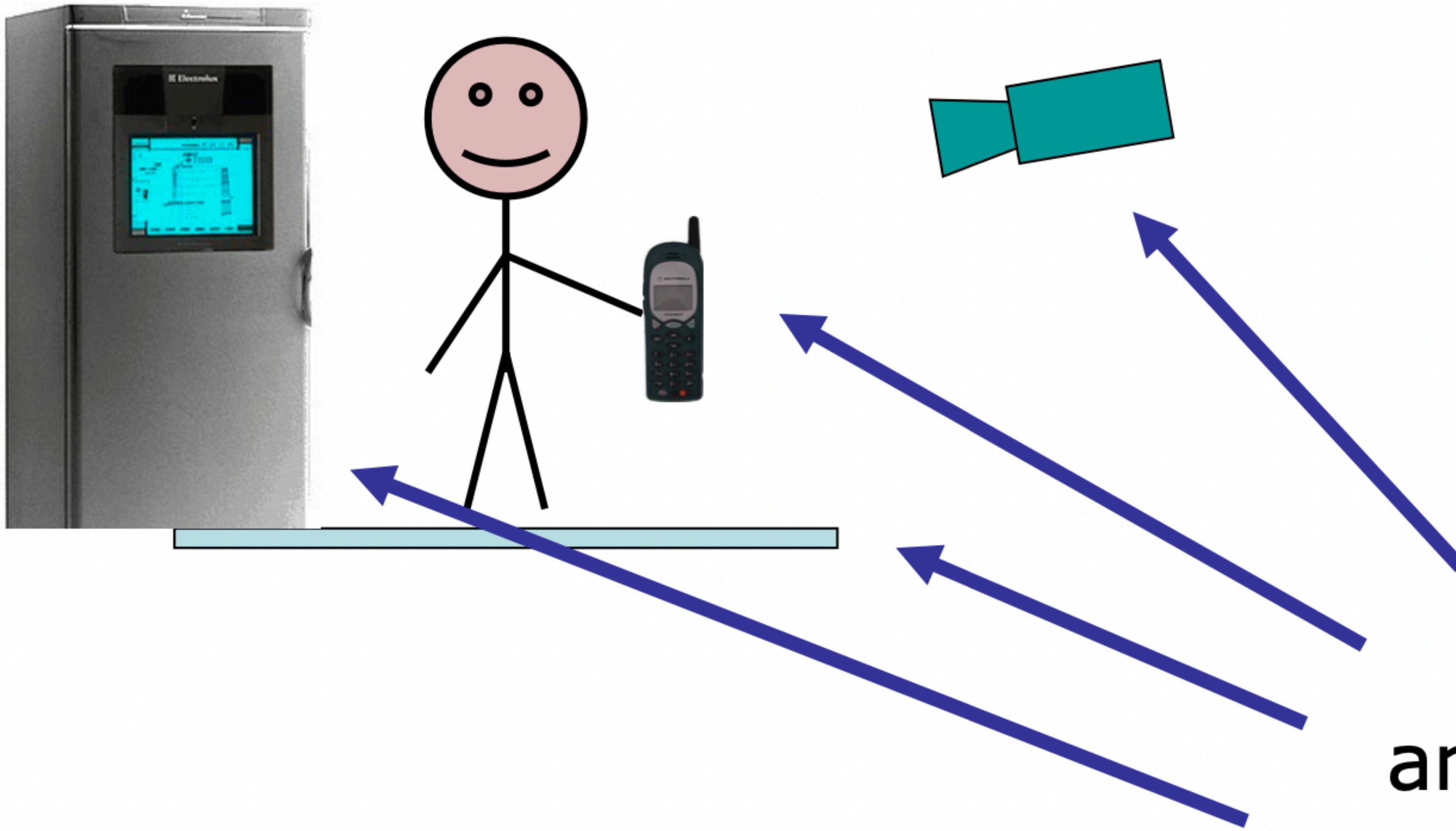




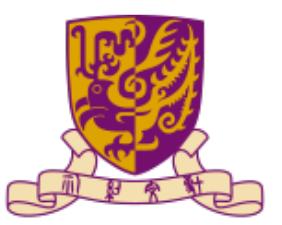
# Interactivity

- Long ago in a galaxy far away ... batch processing
  - Punched card stacks or large data files prepared
  - Long wait ...
  - Line printer output
- Now most computing is interactive
  - Rapid feedback
  - The user in control (most of the time)
  - Doing rather than thinking

# Richer interaction

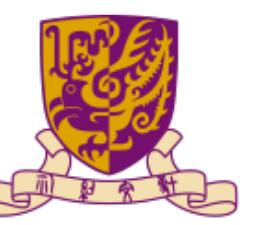


sensors  
and devices  
everywhere



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# Keyboards

- Most common text input device
- Allow rapid entry of text by experienced users
- Keypress closes connection, causing a character code to be sent
- Usually connected by cable, but can be wireless

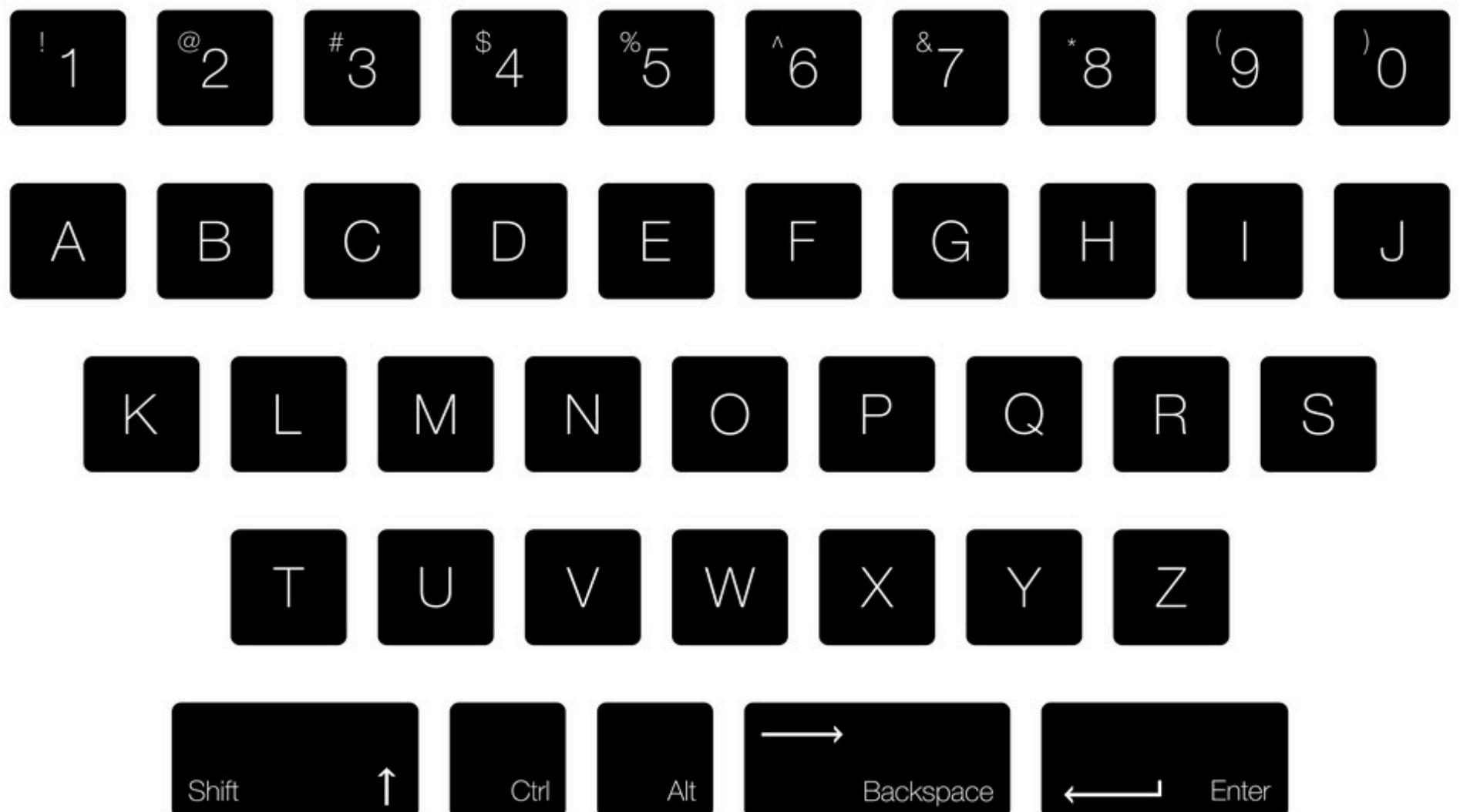
# Layout - QWERTY

- Standardized layout, but
  - Non-alphanumeric keys are placed differently
  - Accented symbols needed for different scripts
- QWERTY arrangement not optimal for typing
  - Layout to prevent typewriter jamming



# Alternative keyboard layouts

- Alphabetic
  - Key arranged in alphabetic order
  - Not faster for trained typists
  - Not faster for beginners either



# Alternative keyboard layouts

- Dvorak
    - Common letters under dominant fingers
    - Biased toward right hand
    - Common combinations of letter alternate between hands
    - 10-155 improvement in speed and reduction in fatigue



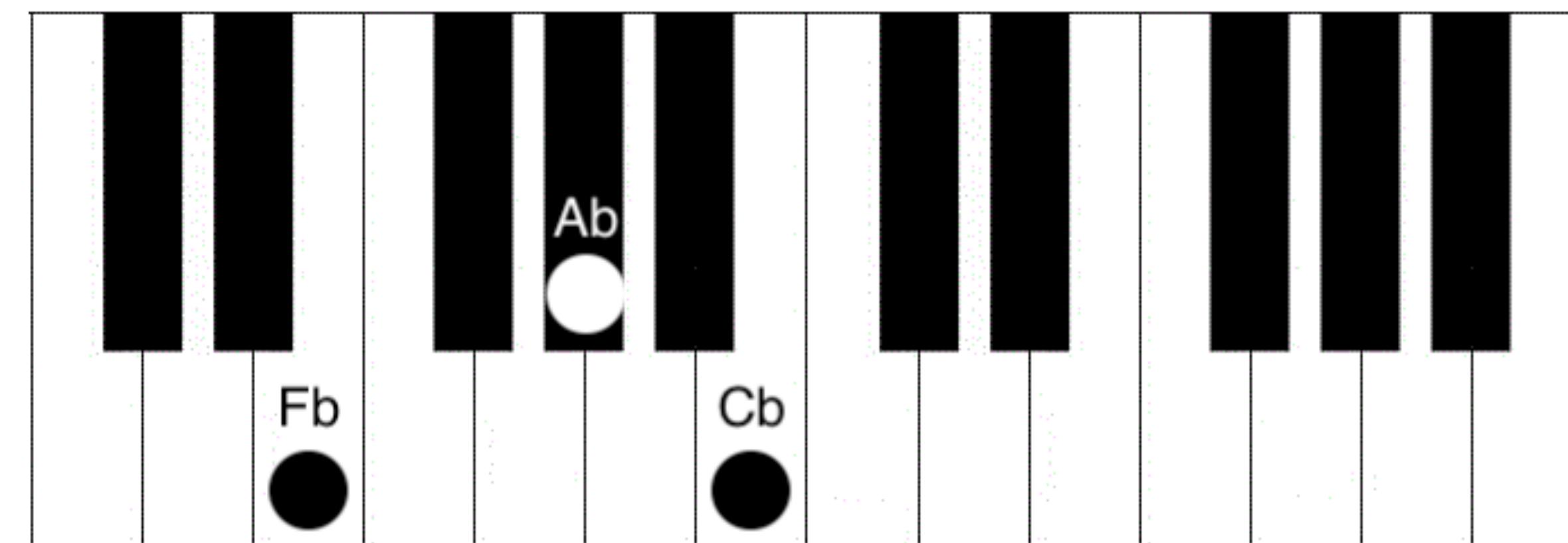
# Special keyboards

- Design to reduce fatigue for repetitive strain injury (RSI)
- For one handed use e.g., the Maltron left-handed keyboard



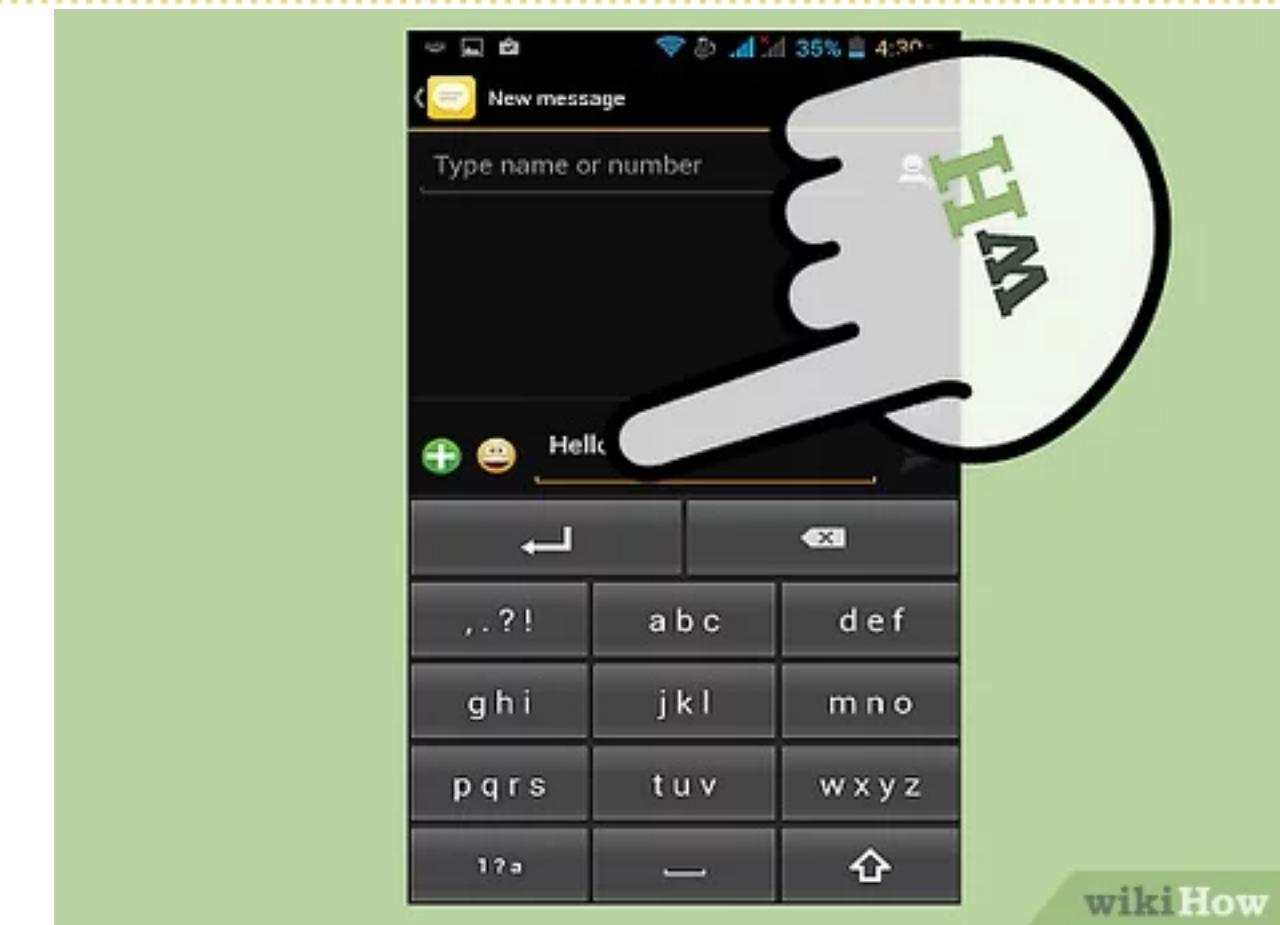
# Chord keyboards

- Only a few keys - 4 to 5
- Letters typed as combination of keypresses
- Compact size (ideal for portable applications)
- Short learning time (keypresses reflect letter shape)
- Fast once you have trained
- But
  - Social resistance, plus fatigue after extended use



# Phone pad and T9 entry

- Use numeric key with multiple presses
  - Hello = 4433555[pause]555666
  - Surprisingly fast
- T9 predictive entry
  - Type as if single key for each letter
  - Use dictionary to guess the right word



T9

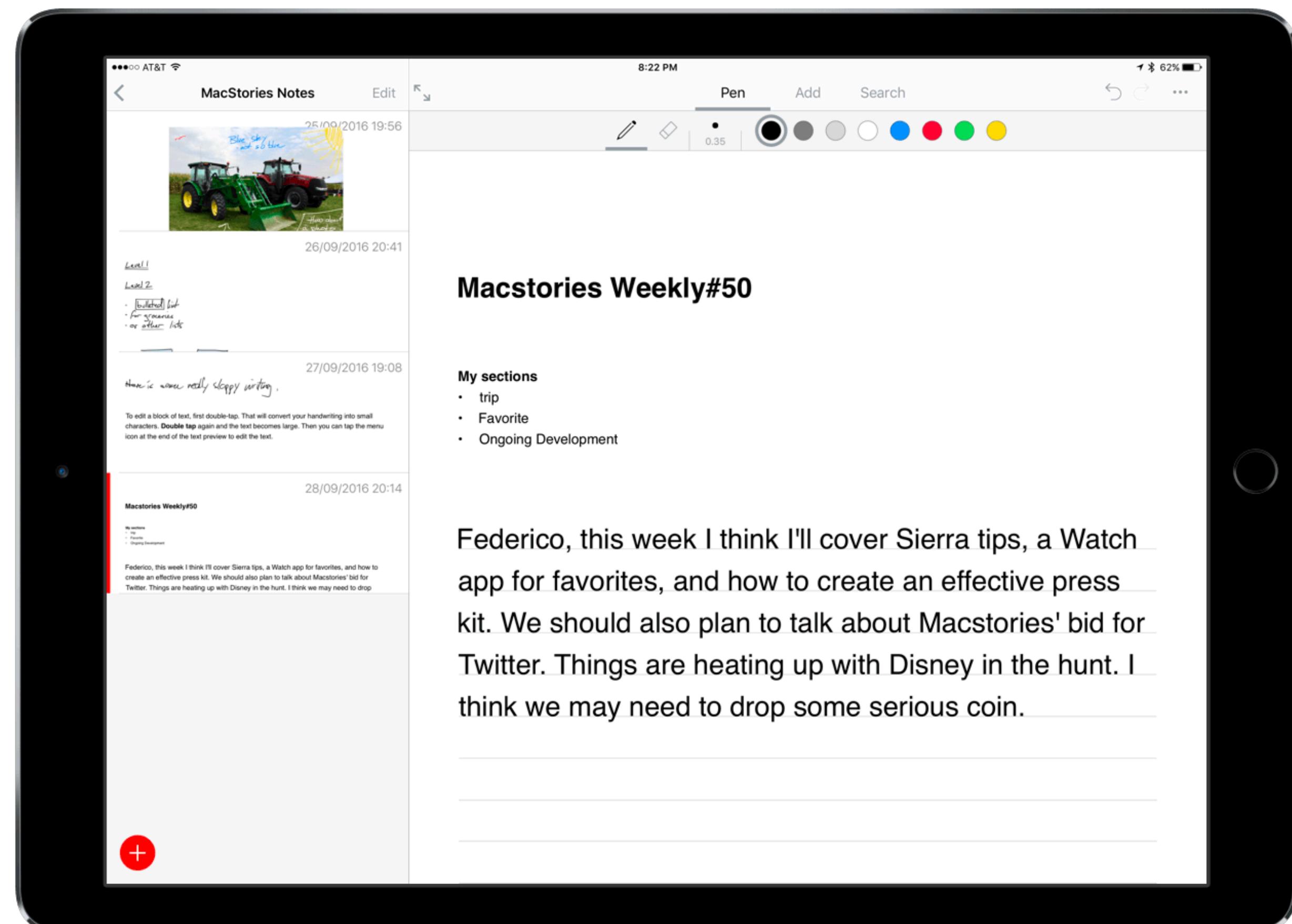
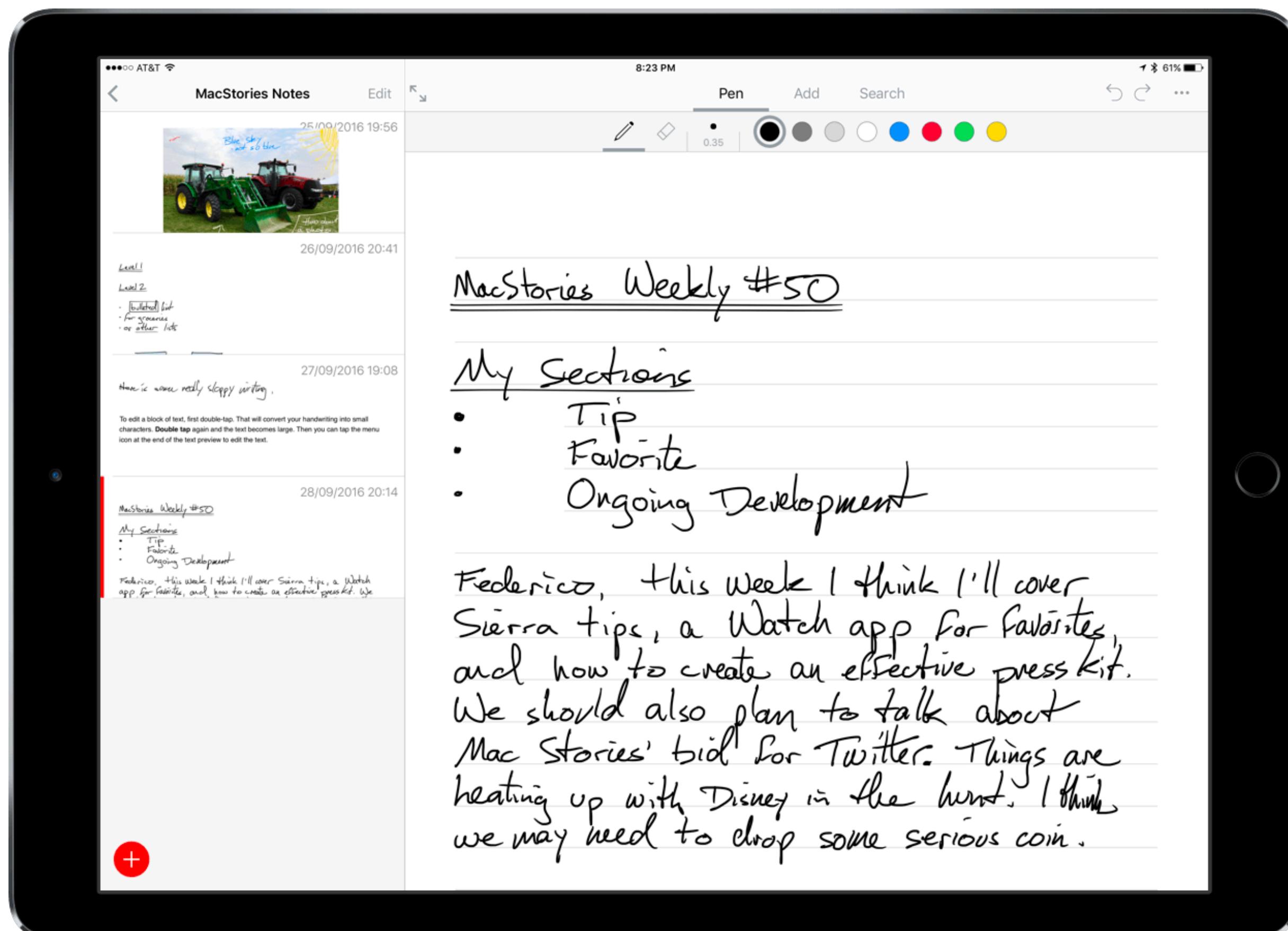
Phone



# Handwriting recognition

- Text can be input into the computer, using a pen and a digesting tablet
- Technical problems:
  - Capturing all useful information - stroke path, pressure, etc.
  - Segmenting joined up writing into individual letters
  - Interpreting individual letters
  - Coping with different styles of handwriting
- Use in PDAs and tablet computers

# Handwriting recognition



# Speech recognition

- Improving rapidly
- Most successful when
  - Single user - initial training and learn peculiarities
  - Limited vocabulary systems
- Problem with
  - External noise interfering
  - Imprecision of pronunciation
  - Large vocabularies
  - Different speakers



# Numeric keypads

- For entering numbers quickly
  - Calculator, PC keyboard
- For telephones

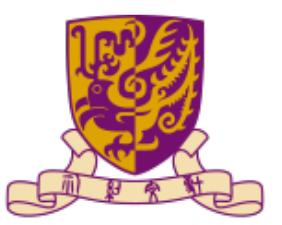
Why are the layouts for phone and calculator different?



Telephone



Calculator

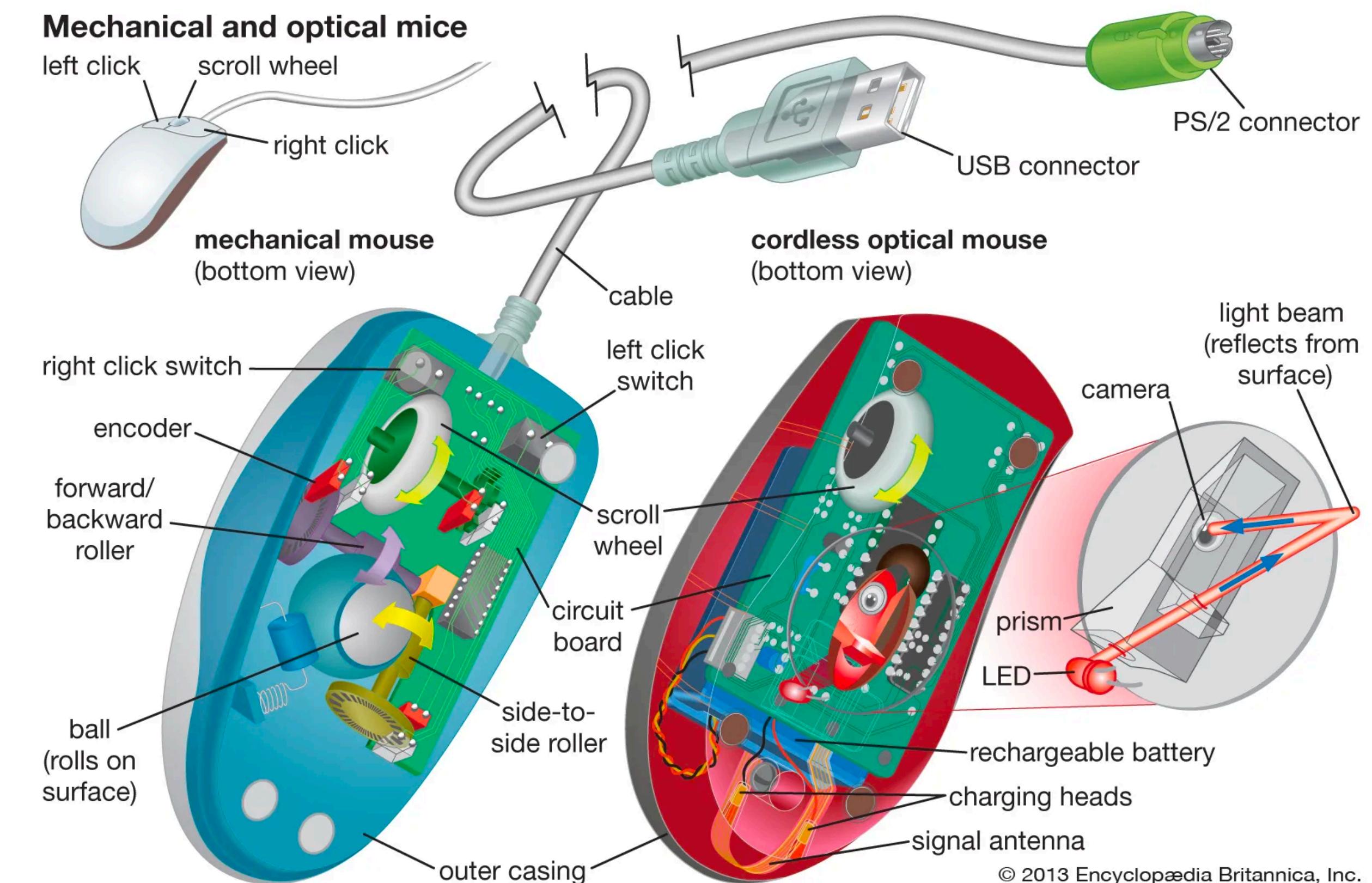


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# Mouse

- Handheld pointing device
  - Very common
  - Easy to use
- Two characteristics
  - Planar movement
  - Buttons



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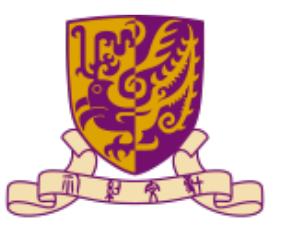


# Mouse

- Located on desktop
  - Require physical space
  - No arm fatigue
- An indirect manipulation device
  - Device itself doesn't obscure screen, is accurate and fast
  - Hand-eye coordination problems for novice users

# How mouse works

- Mechanical
  - Ball on underside of mouse
  - Rotate orthogonal potentiometers
  - Can be used on almost flat surface
- Optical
  - Light emitting diode on underside of mouse
  - May use special grid-like pad or just on desk
  - Less susceptible to dust and dirt
  - Detects fluctuating alterations in reflected light intensity to calculate relative motions in plane



# Even by foot

- Some experiments with the footloose
  - Control mouse movement with feet
  - Not very common
- But foot controls are common elsewhere
  - Car pedals
  - Sewing machine speed control
  - Organ and piano pedals

# Touchpad

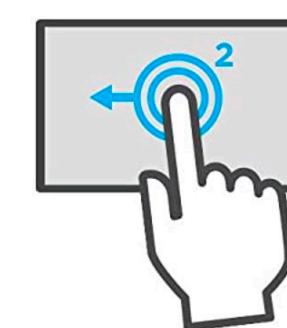
- Small touch sensitive tablets
- Stroke to move mouse pointer
- Used mainly in laptop computers
- Good acceleration setting important
  - Fast stroke
  - Slow stroke



MULTI-TOUCH TOUCHPAD



One finger tap



Tap two times  
and slide



Two fingers tap



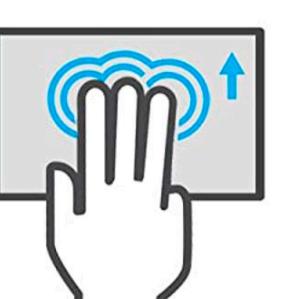
Two fingers  
scroll



Two fingers zoom



Three fingers  
swipe down



Three fingers  
swipe up

# Trackball and thumbwheels

- Trackball
  - Ball is rotated inside static housing
  - Relative motion moves cursor
  - Indirect device, fairly accurate
  - Separate buttons for picking
  - Vary fast for gaming
- Used in some portable and notebook computers
- Thumbwheels
  - For accurate CAD
  - For fast scrolling



# Touch-sensitive screen

- Detect the presence of finger or stylus on the screen
  - Work by interrupting matrix of light beams, capacitance changes or ultrasonic reflections
  - Direct pointing device



# Touch-sensitive screens

- Advantages
  - Fast and require no specialized pointer
  - Good for menu selection
  - Suitable for use in hostile environment: clean and safe from damage
- Disadvantages
  - Finger can mark screen
  - Lifting arm can be tiring
  - Imprecise e.g., difficult to select small regions or perform accurate drawing

# Stylus and light pen

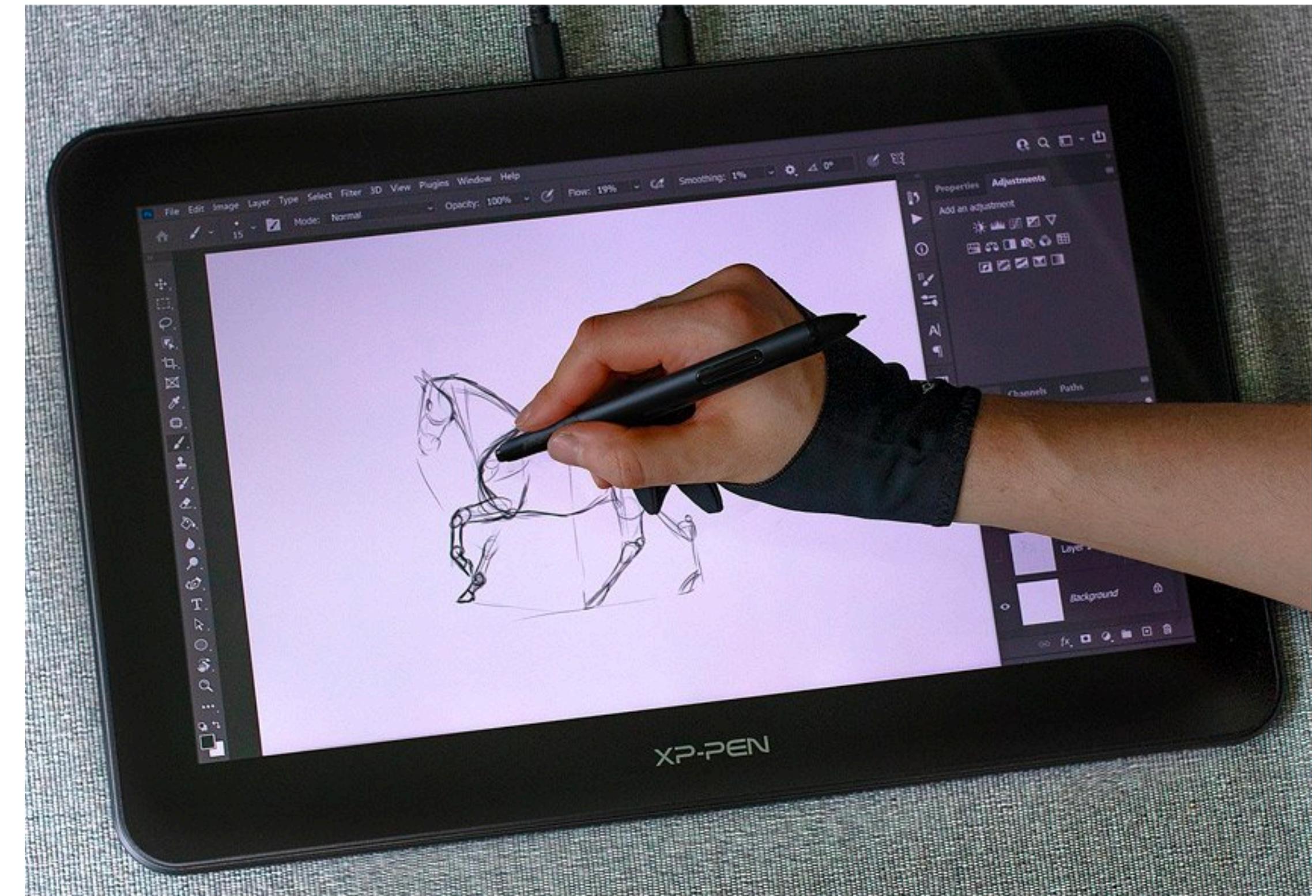
- Stylus
  - Small pen-like pointer to draw directly on screen
  - May use touch sensitive surface or magnetic detection
  - Use in PDA, tablet PCs and drawing tables
- Light pen
  - Now rarely used
  - Use light from screen to detect location
- Both
  - Very direct and obvious to use
  - But can obscure screen



light pen

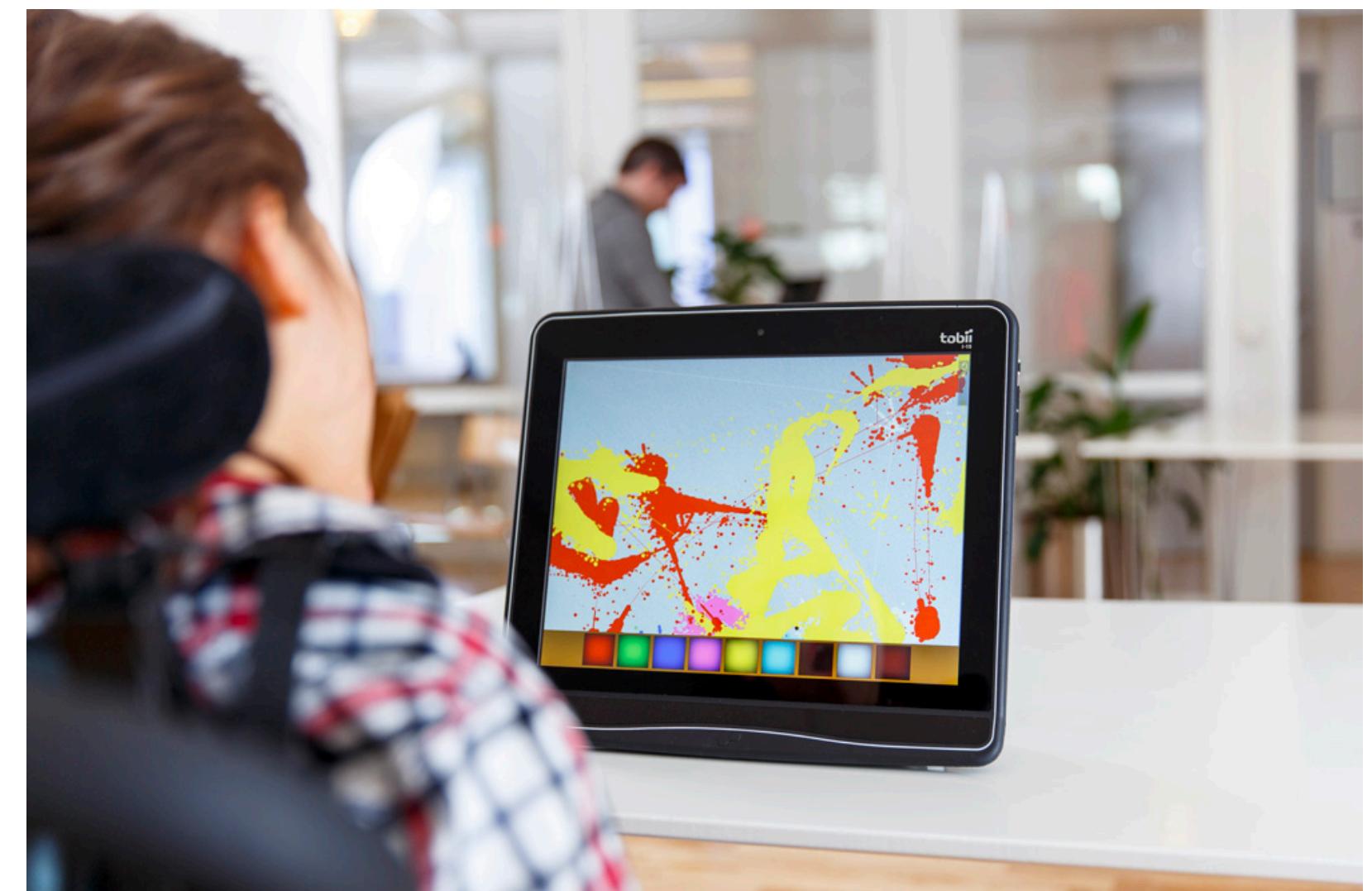
# Digitizing tablet

- Mouse like-device with cross hairs
- Used on special surface rather like stylus
- Very accurate
  - used for digitizing maps



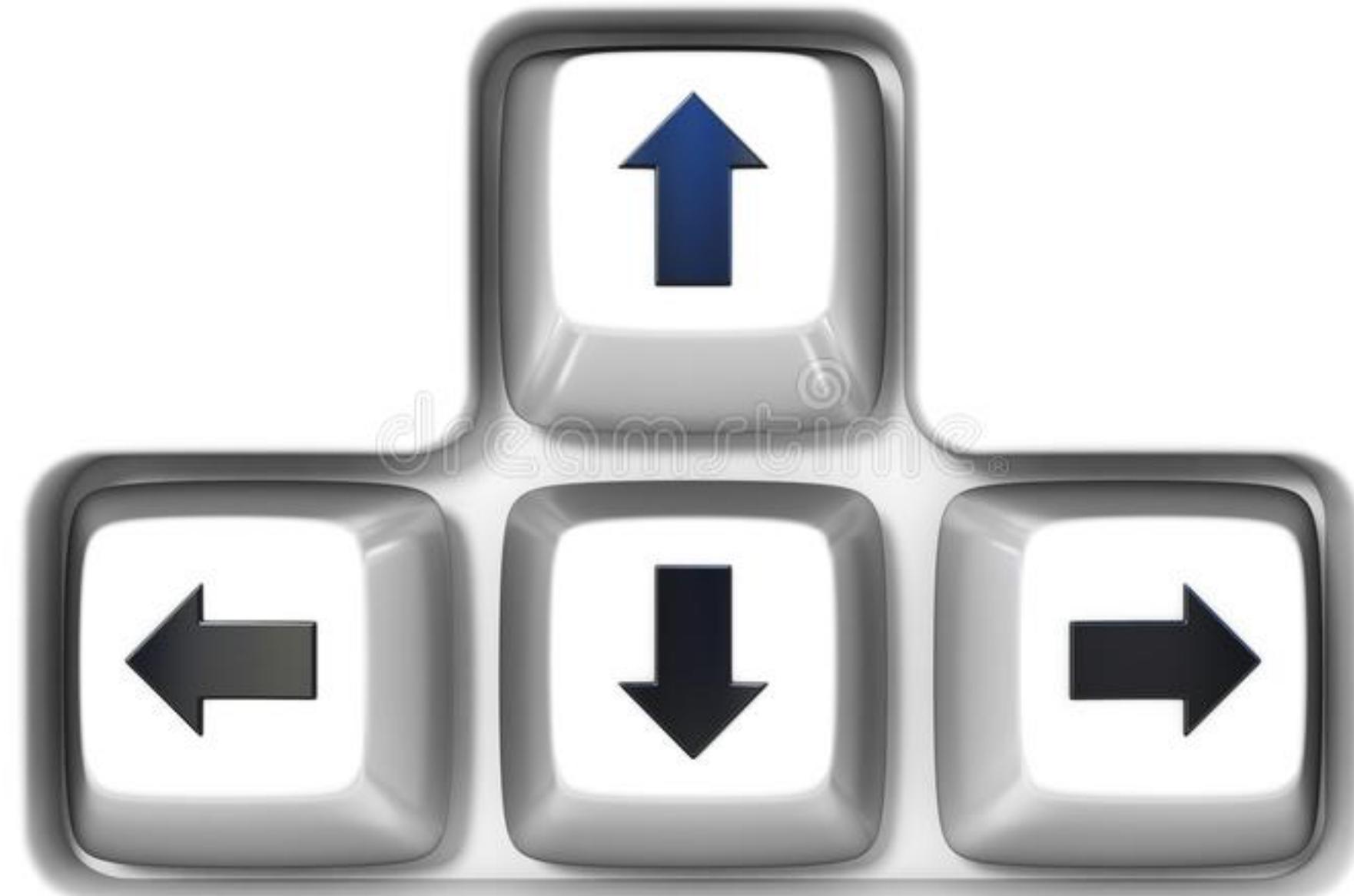
# Eyegaze

- Control interface by eye gaze direction
- Mainly used for evaluation
- Potential for hand-free control
- High accuracy requires headset
- Cheaper and lower accuracy devices available



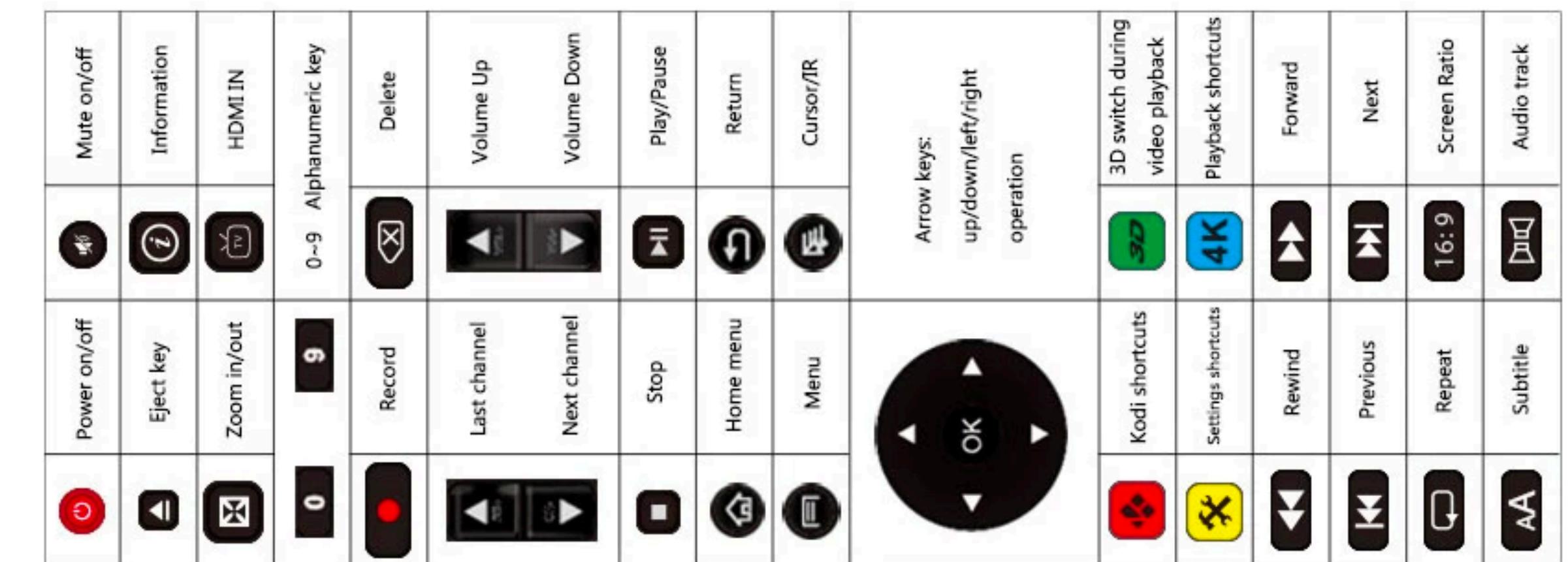
# Cursor keys

- Four keys (up, down, left, right) on keyboard
- Very, very cheap, but slow
- Useful for not much more than basic motion for text-editing tasks



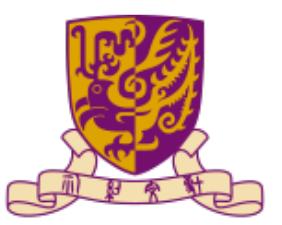
# Discrete positioning controls

- In phones, TV controls, etc.
  - Cursor pads or mini-joysticks
  - Discrete left-right, up-down
  - Mainly for menu-selection



Remote control



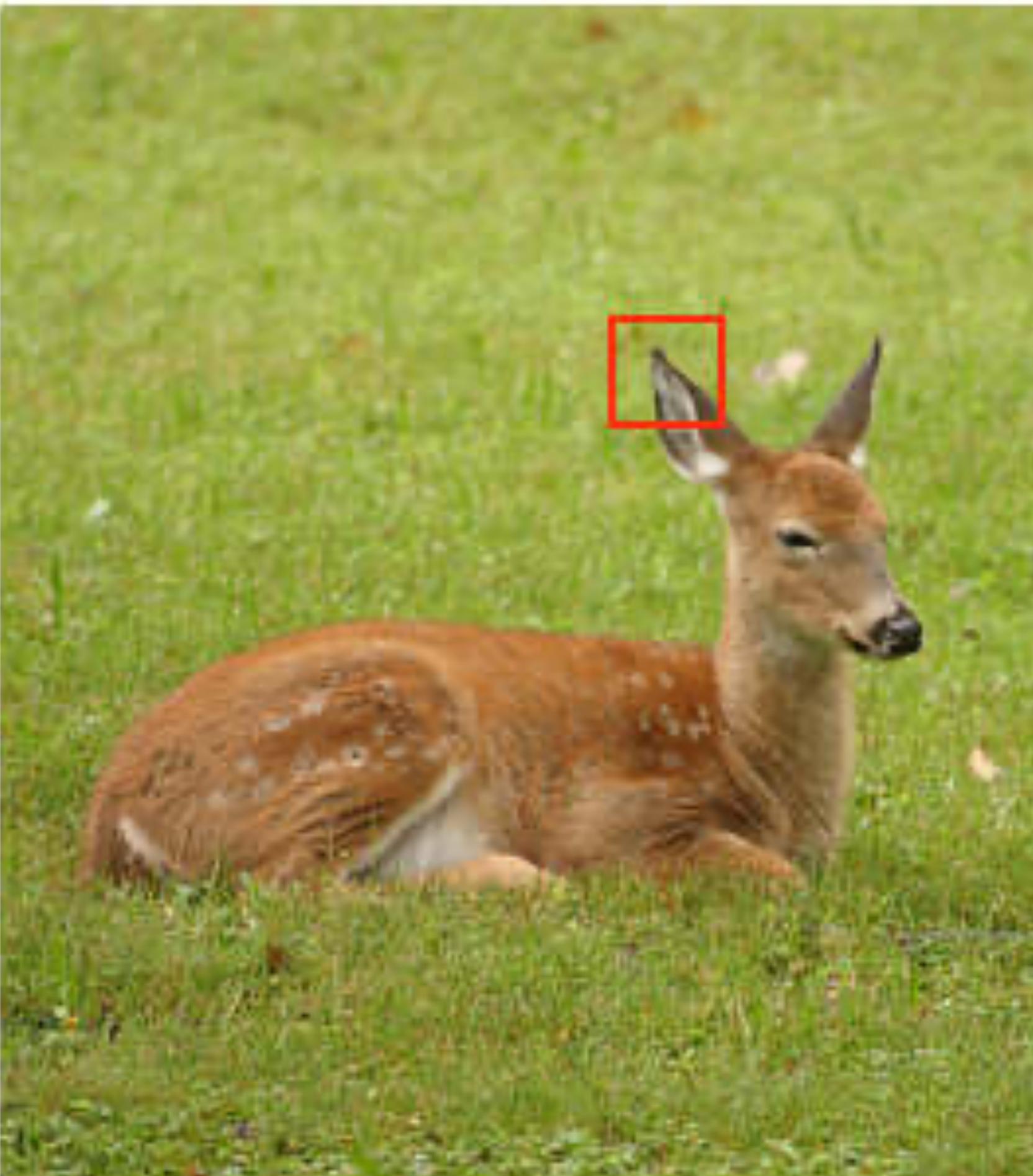


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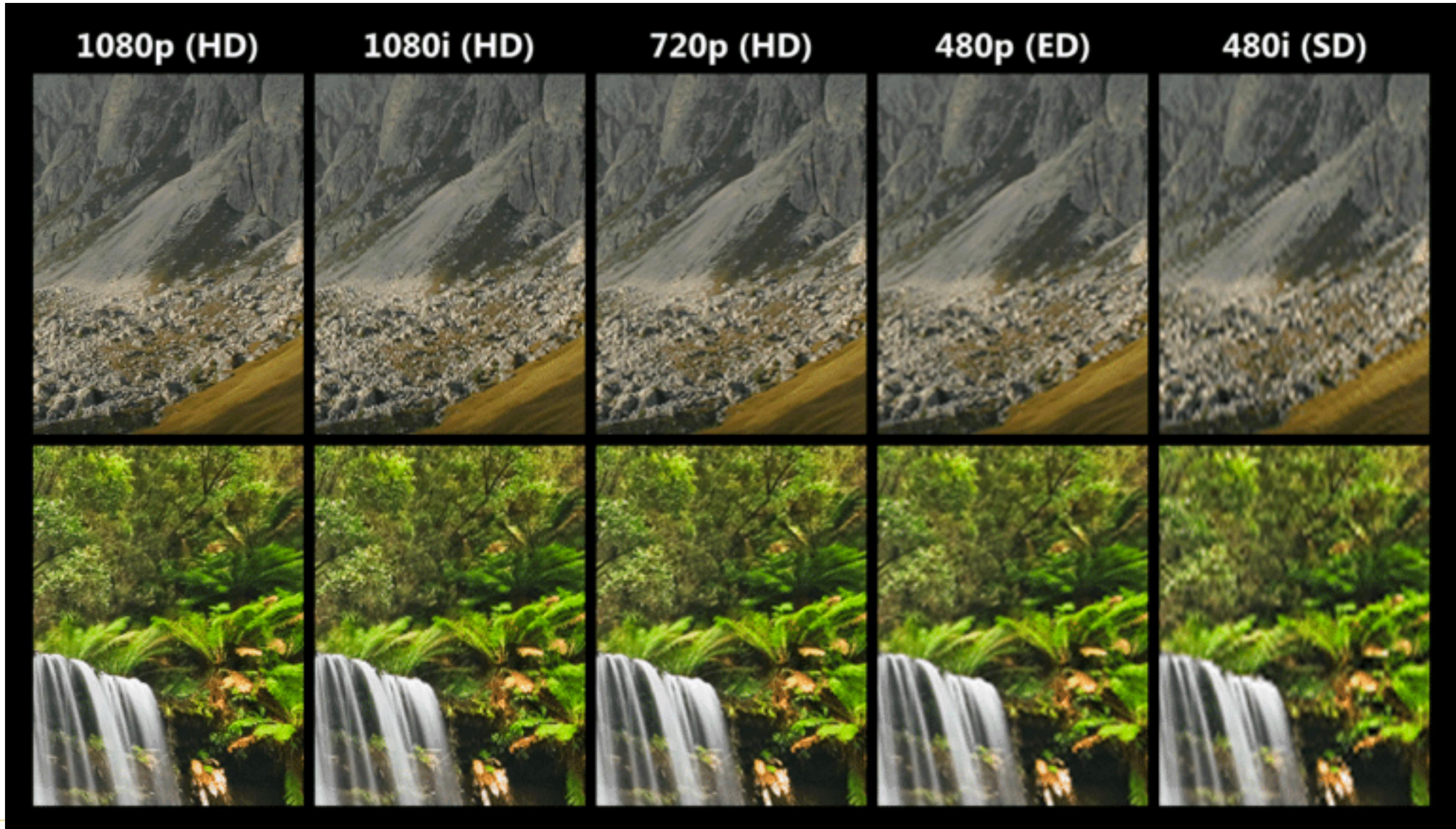
# Bitmap displays

- Store information at each pixel in a rectangular grid
- Each pixel can be limited to black and white, grayscale, or full color



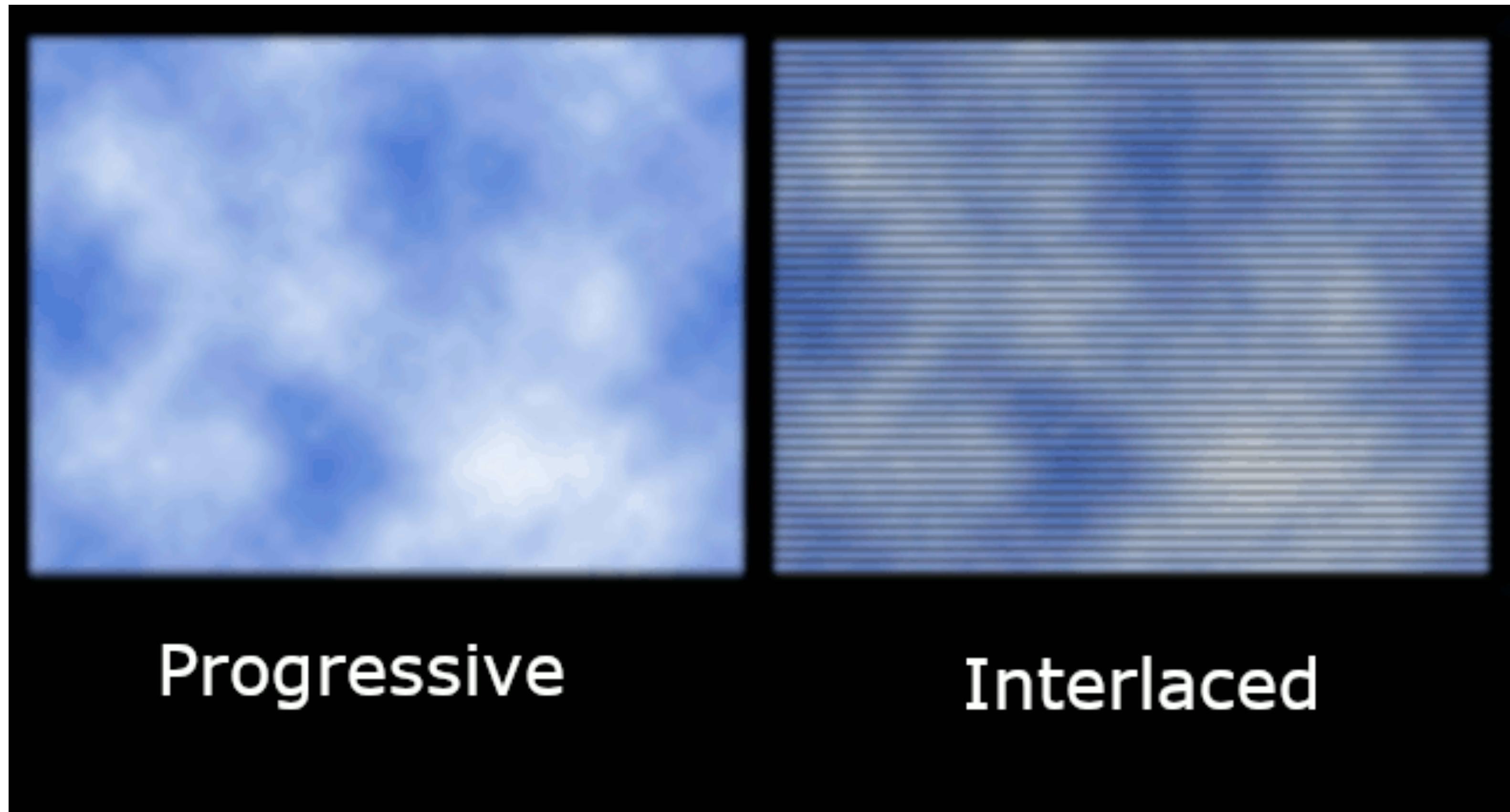
# Resolution

- Total number of pixels (width x height)
- Density of pixels (in pixels or dots per inch - dpi)



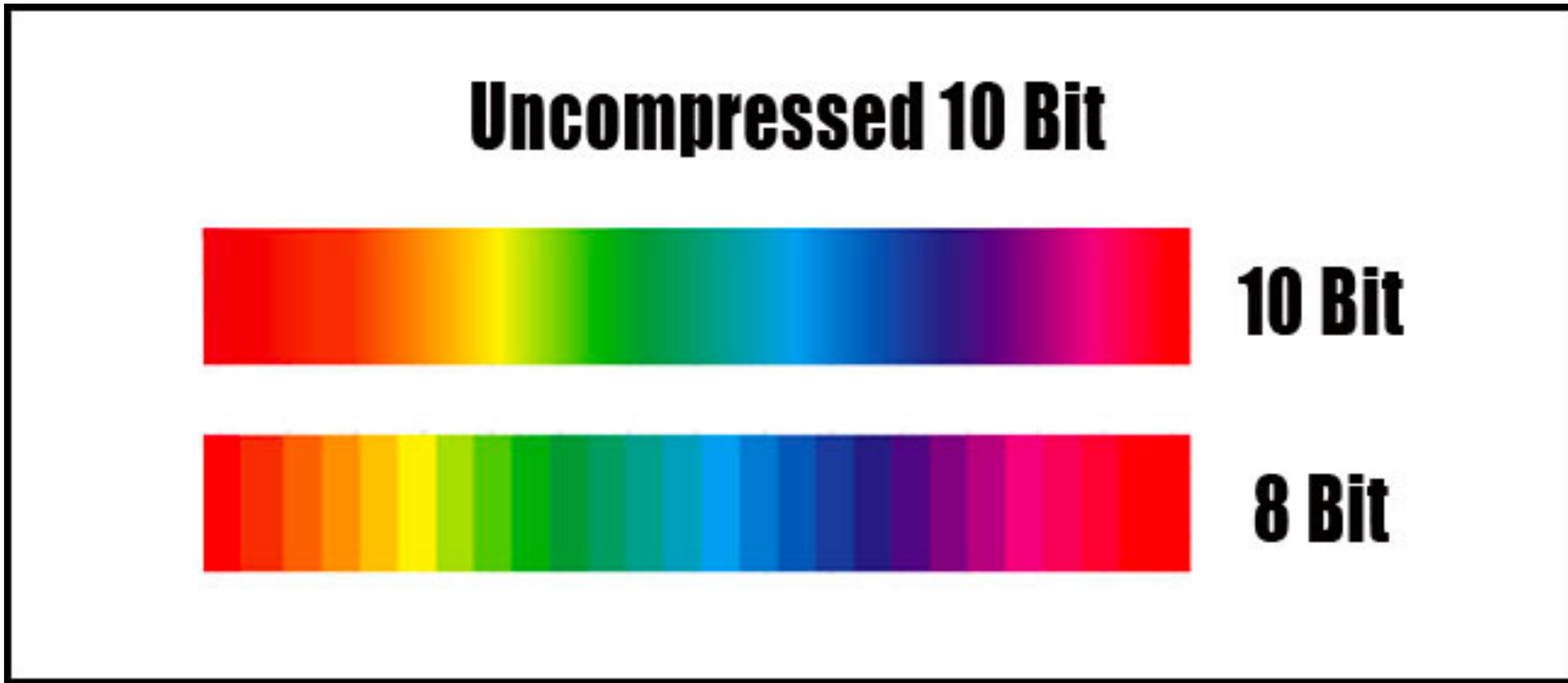
# Resolution

- p: progressive
- I: interlaced



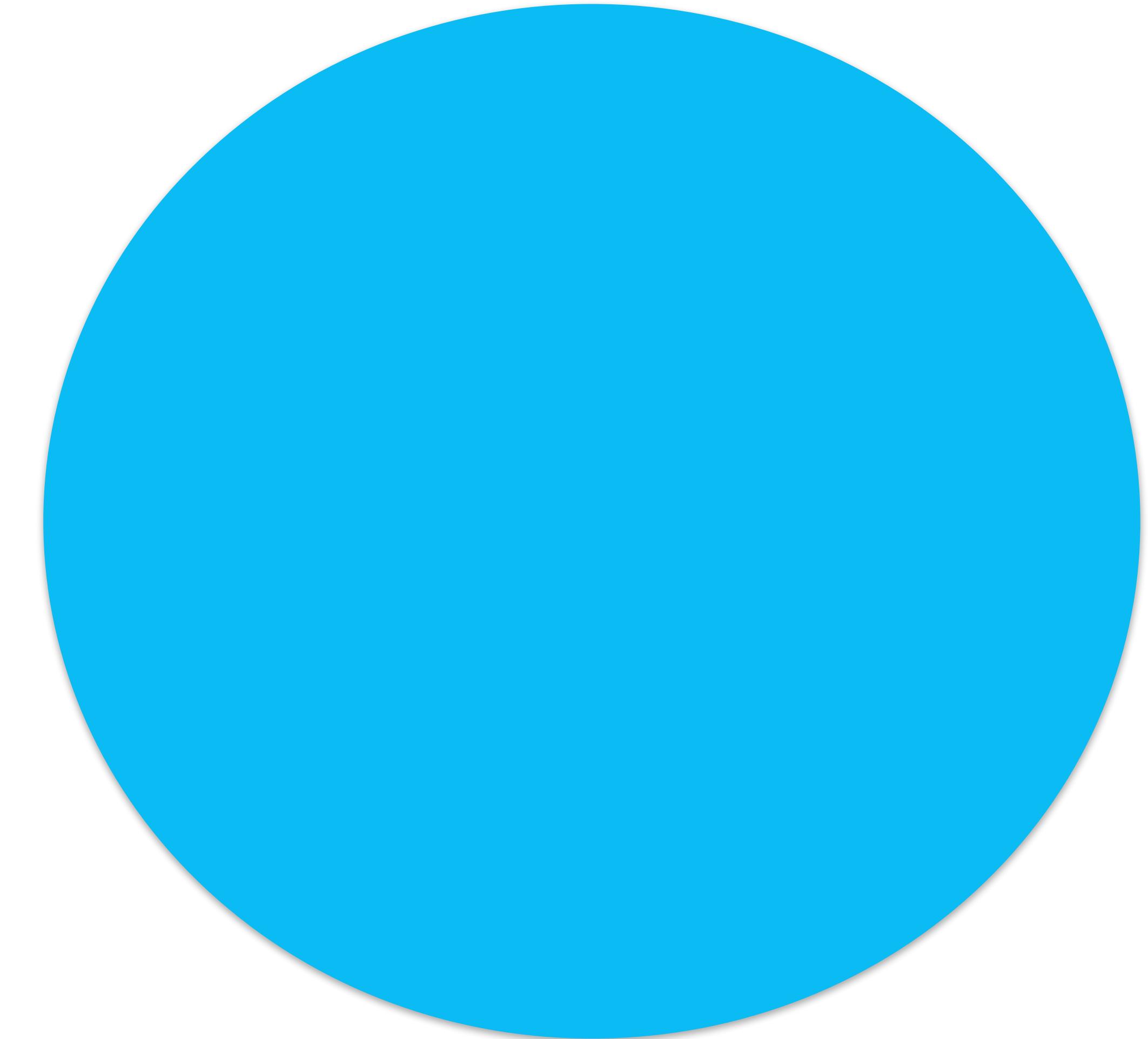
# Color

- The set of color is determined by the number of bits
- Usually represented by three values (red, green, and blue), sometimes by four values (R,G,B, and opacity)



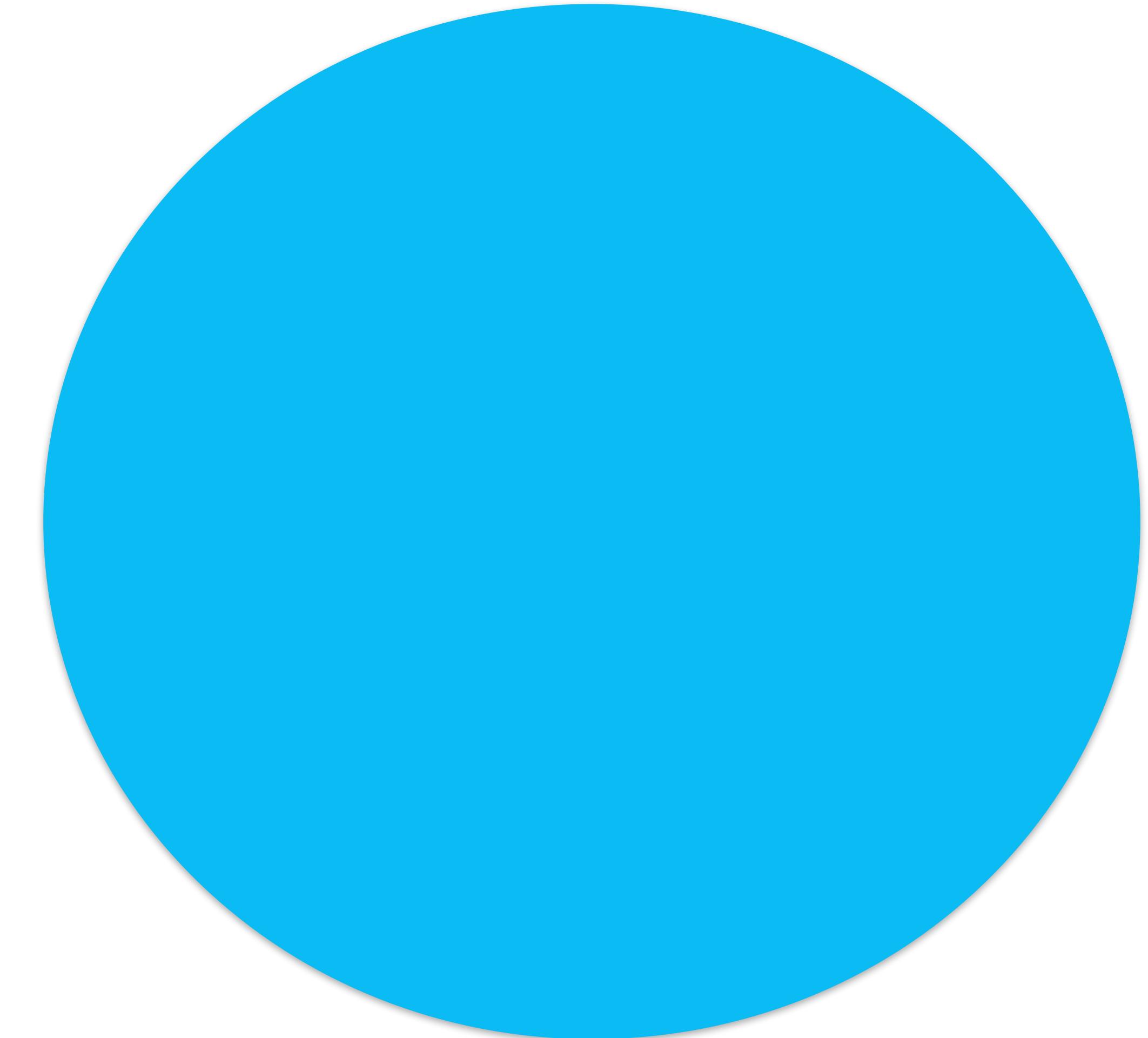
# Color representation

- R,G,B (0,153,204)
- Used for on screen
- The value range of R,G,B is from 0 to 255



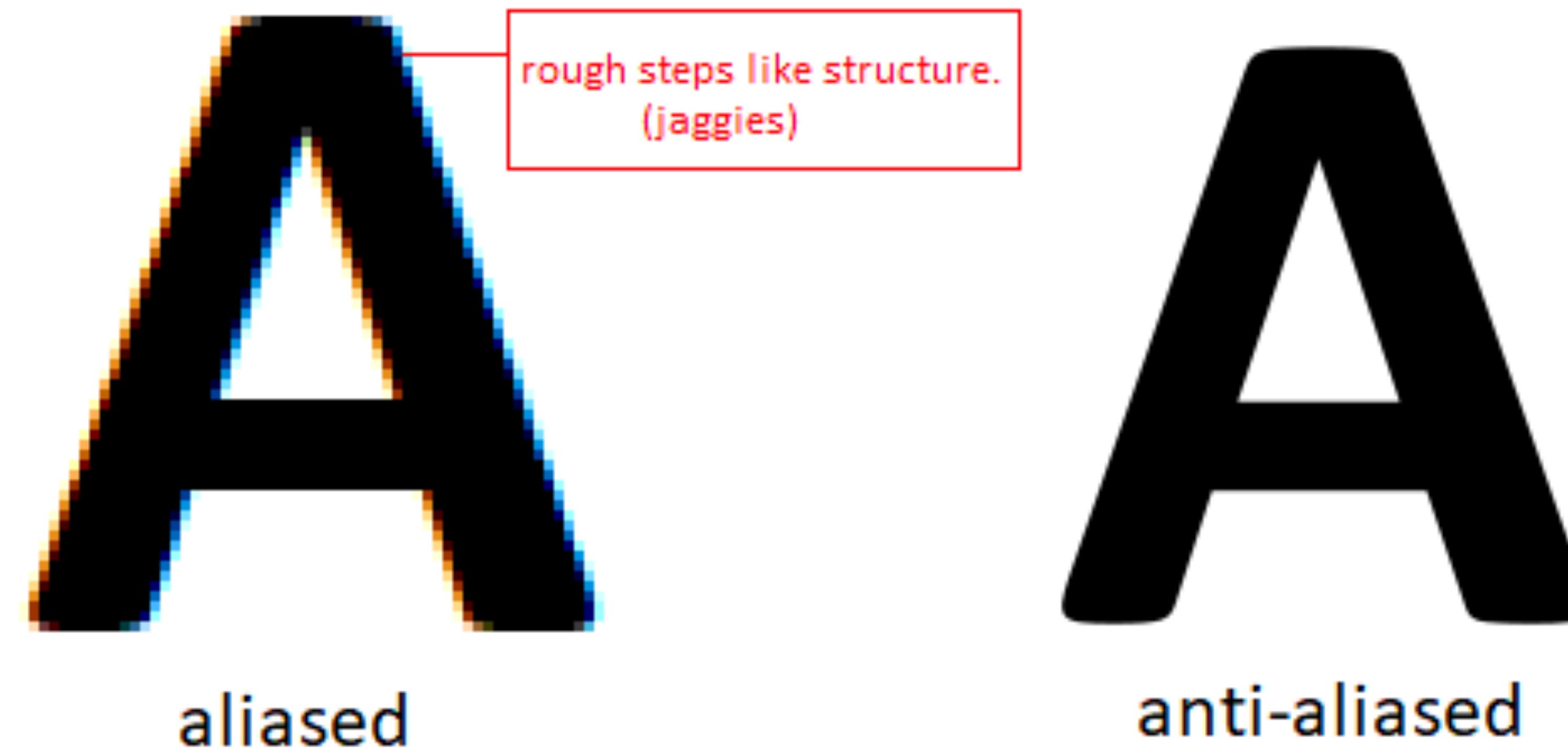
# Color representation

- HEX (#0099CC)
- Used for web design
- Expressed as six digits values
- Made up of numbers 0-9 and letters A-F

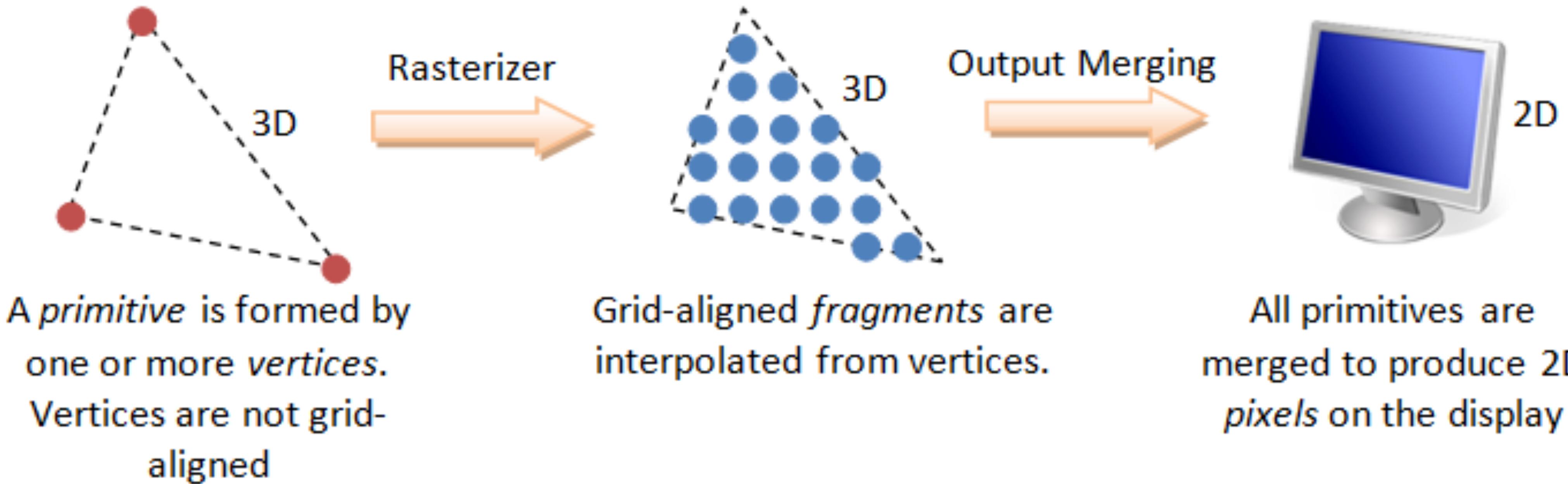


# Jaggies and anti-aliasing

- Jaggy: rough edges cased by approximating the objects with pixels
- Anti-aliasing: soften the edges of objects and blur the discontinuity



# How jaggies occur



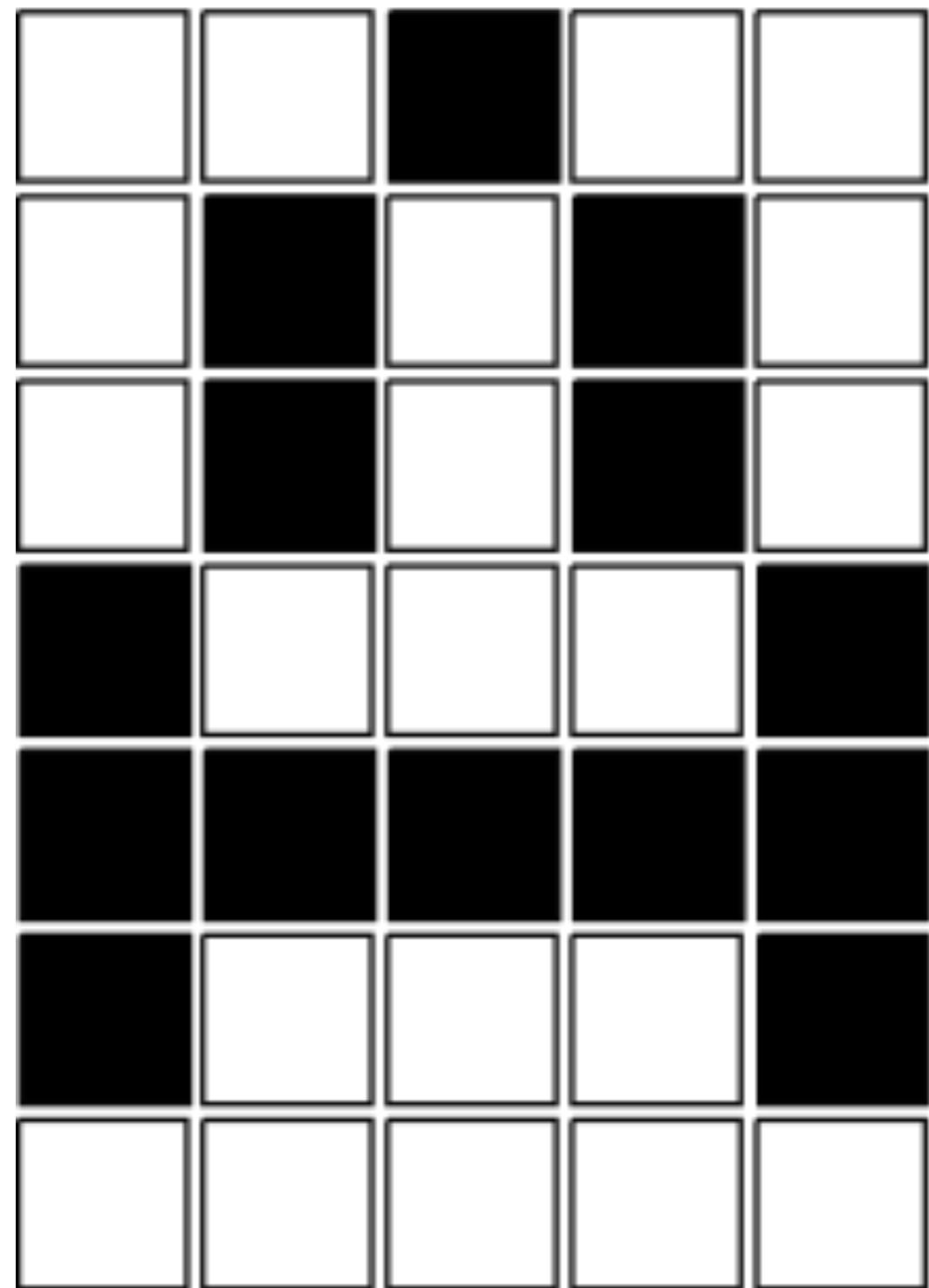
**Vertex, Primitives, Fragment and Pixel**

# How to avoid jaggies

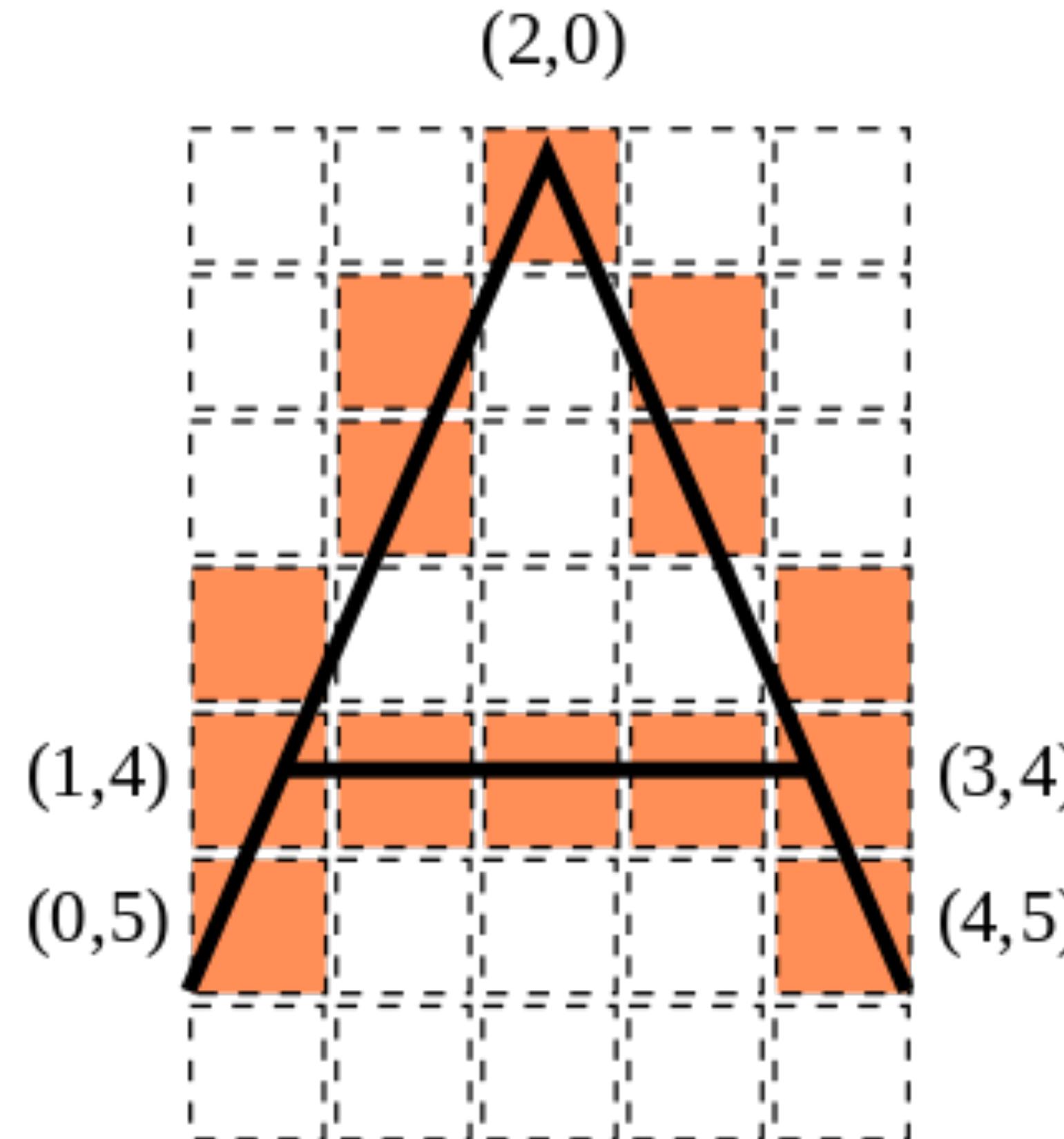
- Increase image resolution
- Store data into vector instead of pixel



# Vector and bitmap



Bitmap-depiction of  
the letter “A”



Vector depiction  
of the letter “A”  
(underlaid with  
bitmap-depiction)

# Large displays

- Used for meetings, lectures, etc.



# Large displays



# Situated displays

- Display in public places
- Display only for information relevant to location
- Interact using stylus, touch sensitive screen
- In all cases, the location matters - meaning of information or interaction is related to the location



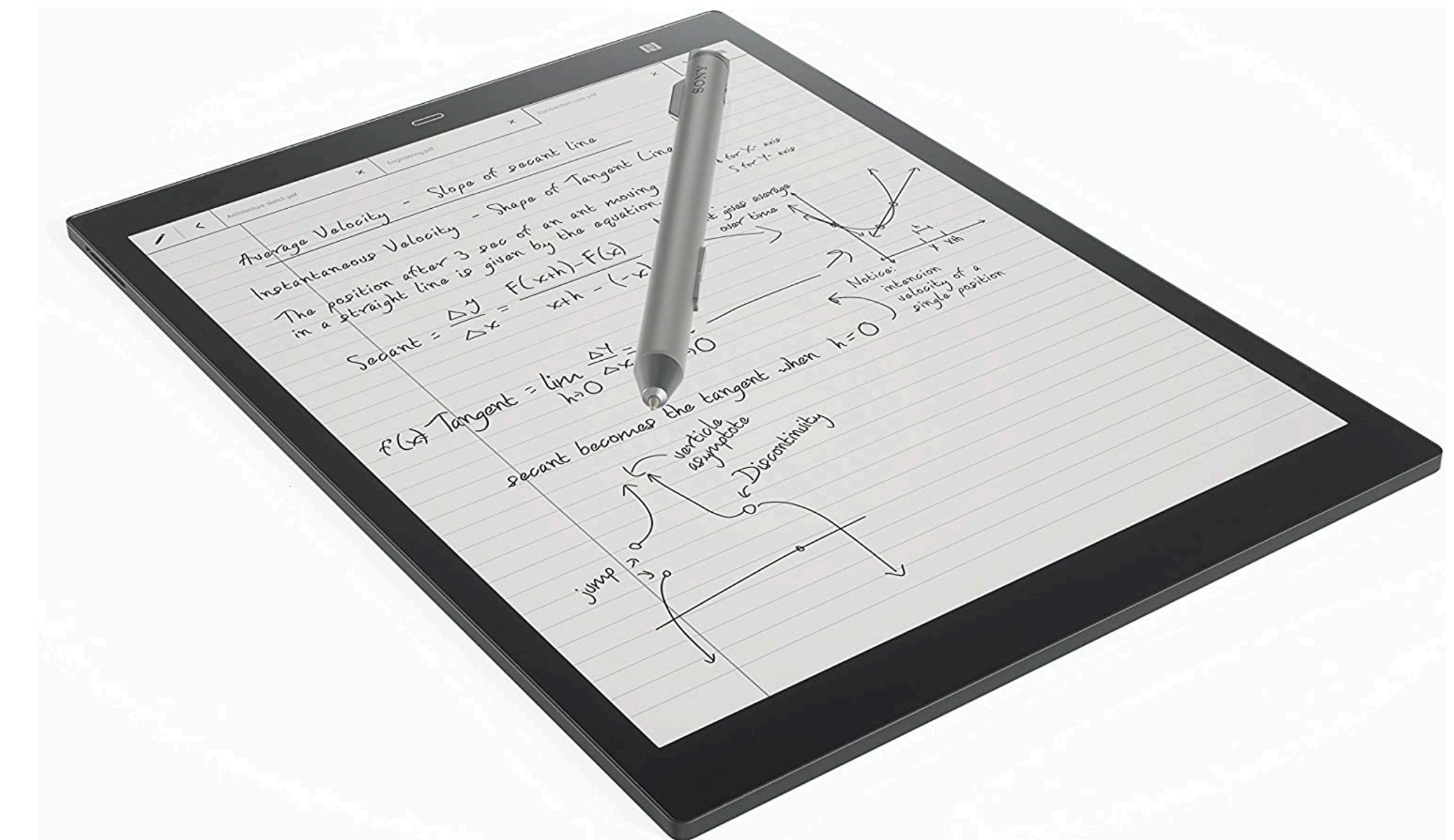
# Situated displays

IEEE VR 2020



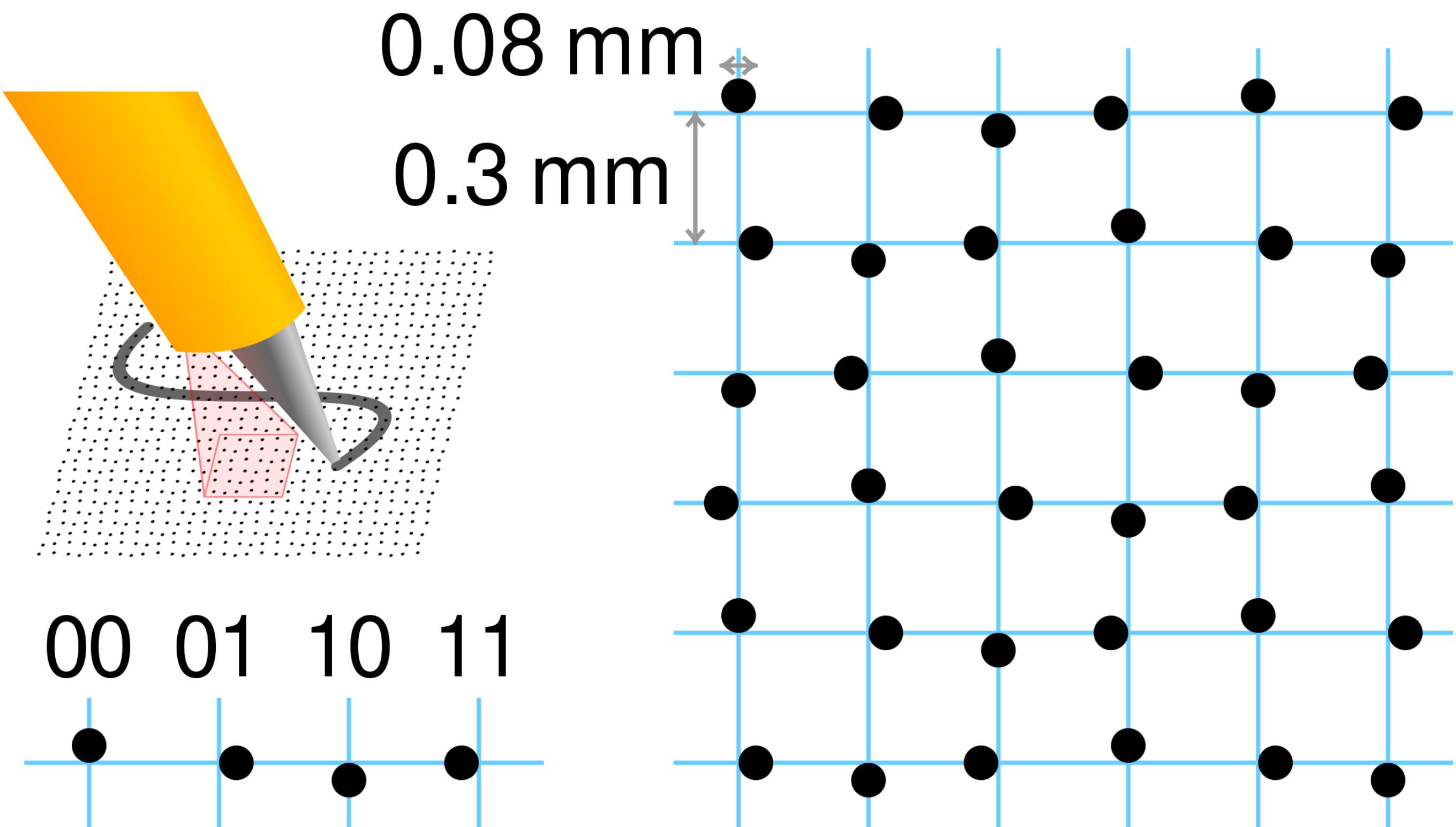
# Digital paper

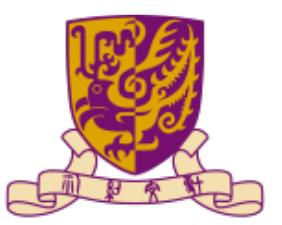
- This flexible sheets
- Updated electronically
- But retain display



# Digital paper

- Small sphere turned
- Channels with colored liquid and contrasting spheres
- Rapidly developing area





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# Dedicated displays

- Analogue representations e.g., dials, gauges, lights, etc.
- Digital displays: small LCD screens, LED lights, etc.
- Head-up displays
- Found in aircraft cockpits
- Show most important controls depending on context



# Sounds

- Beeps, bongs, clunks, whistles, and whirrs
- Used for error indications
- Confirmation for actions e.g., key click



# Touch, feel, and smell

- Touch and feeling important
  - In games, vibration and force feedback
  - In simulation, feel of surgical instruments
  - Called haptic devices
- Texture, smell, and taste
  - Current technology very limited



# BMW iDrive

- For controlling menus
- Feel small bumps for each item
- Make it easier to select options



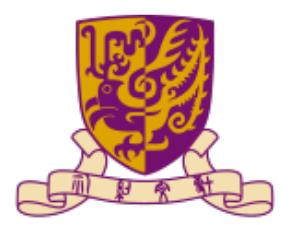
# Physical controls

- Specialist controls needed
  - Industrial controls, consumer products, etc.



# Environment and bio-sensing

- Sensors all around us
  - Car courtesy light - small switch on door
  - Ultrasound detectors - security, washbasins
  - RFID security tags in shops
  - Temperature, weight, location, heart rate, skin response, etc.



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**Thank Prof. Alan Dix for many of the slides!**