Computer practicum

3. Presenting information and pixel graphics

Presenting information

- Computers are machines with which we manipulate data.
- They offer visualization, sound, creation and manipulation of informations:
  documents, images, soundtracks, video contents, data sheets, databases, simulated worlds (e.g. video games).
- All of that is just data stored in a computer memory and displayed or played using speakers.
- In what form do we store data in a computer?

Presenting information

- How many numbers can we count with fingers of one hand?

Presenting information

- How many numbers can we count with fingers of one hand?
- How about both hands?

Presenting information

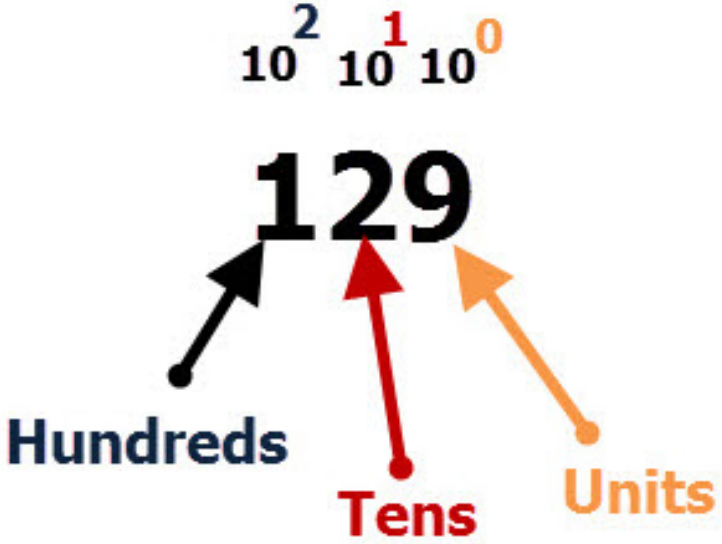
- How many numbers can we count with fingers of one hand?
- How about both hands?
- In a comptuter everything is presented using two values 0 and 1 - **bit** (in fact anything that has two states) - **binary system**.
- With 5 bits we can display **32** different values and with 10 bits we can display up to **1024** different values.

Presenting information

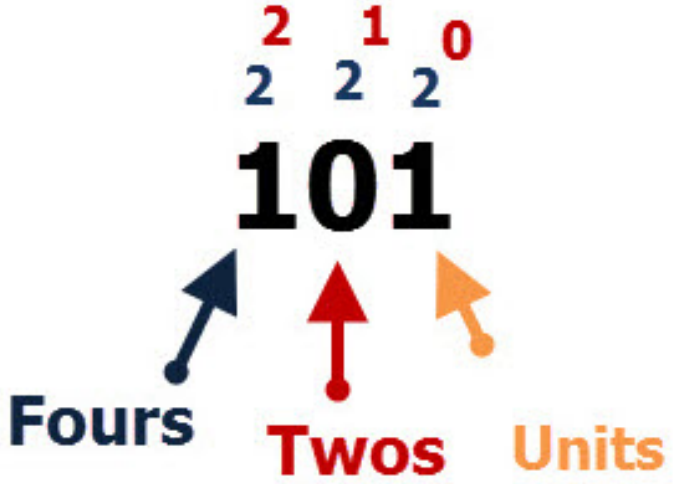
- How many numbers can we count with fingers of one hand?
- How about both hands?
- In a comptuter everything is presented using two values 0 and 1 - **bit** (in fact anything that has two states) - **binary system**.
- With 5 bits we can display **32** different values and with 10 bits we can display up to **1024** different values.
- We often talk about zeroes and ones. In reality those represent different states of mechanisms (*current/no current*, *light/darm materials*, *positive/negative polarity*)

Presenting information

- Classic (decimal) number system



- Binary system



Presenting information

- Writing long binary numbers is time consuming.
- We often use hexadecimal (16) system. With one value we can present 4 bits.
- Example: binary number 1011 1000 1110 0001 can be written in hexadecimal as B8E1.
- Example: the largest 8-bit number 1111 1111 can be written in hexadecimal as FF which in decimal is equal to 255.

Dvojiško	Osmiško	Desetiško	Šestnajstiško
0000	0	0	0
0001	1	1	1
0010	2	2	2
0011	3	3	3
0100	4	4	4
0101	5	5	5
0110	6	6	6
0111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F

Presenting information - exercise

- Write binary number 00110101 in a decimal system.
- Write a decimal number 213 in a binary system of length one byte.
- Write a hexadecimal number 6B in a decimal system.
- Write a decimal number 233 in a hexadecimal system.
- Write a binary number 10100111 in a hexadecimal system.
- Write a hexadecimal number 3D in a binary system of length one byte.

Encoding standard - ASCII

- ASCII - American Standard Code for Information Interchange
- 95 printable signs and 33 control signs (total 128 signs)
- we require 7 bits for all signs
- usually we use the whole 8 bits (1 byte) where the first bit is always 0
- every signs is numbered with a value from 0-255 (in fact 0-127) and represented with that number written in binary
- ASCII standard is still among the more used standards of writing English texts
- Example: small letter e is represented with 01100101

Encoding standard - UTF32

- UTF32 - is UNICODE scheme for encoding signs **of fixed length** using 32 bits
- every sign is represented with a specific value
- UNICODE scheme contains around 120.000 different signs from various languages (even some historic)
- signs are represented using their number value converted to a 32-bit binary number
- all 32 bits are used (if the number is smaller enough zeroes are added in front)
- Example: chinese sign for dog is represented as 00000000 00000000 01110010 10101100
- UTF32 is space consuming and therefore not overly used, a better standards are UTF16 and UTF8

Encoding standard - **UTF8**

- UTF8 - is a UNICODE scheme for encoding signs **of variable length**
- to represent signs we use 8, 16, 24 or 32 bits (1, 2, 3 or 4 bytes)
- it works similarly as UTF32 but we forget about the leading 8-bit segments of all zeroes
- Example: chinese sign for dog is represented in UTF32 as 00000000 00000000 01110010 10101100
- Example: chinese sign for dog is represented in UTF8 as 01110010 10101100
- we therefore use as few bits as possible while using whole bytes

Encoding standard - **UTF16**

- UTF16 - is a UNICODE scheme for encoding signs **of variable length** (as UTF8)
- the standard is quite more complex and is left for you to figure out
- it is used mostly in Windows operating system and programming languages such as Java and JavaScript, etc.

Color schemes

- In school we learned that mixing different colors we get new ones.
- Usually we use three basic colors: red, yellow, and blue.
- red + blue = violet
- red + yellow = orange
- yellow + blue = green
- In computers and other devices such as printers we know different basic colors and color schemes.

Color schemes

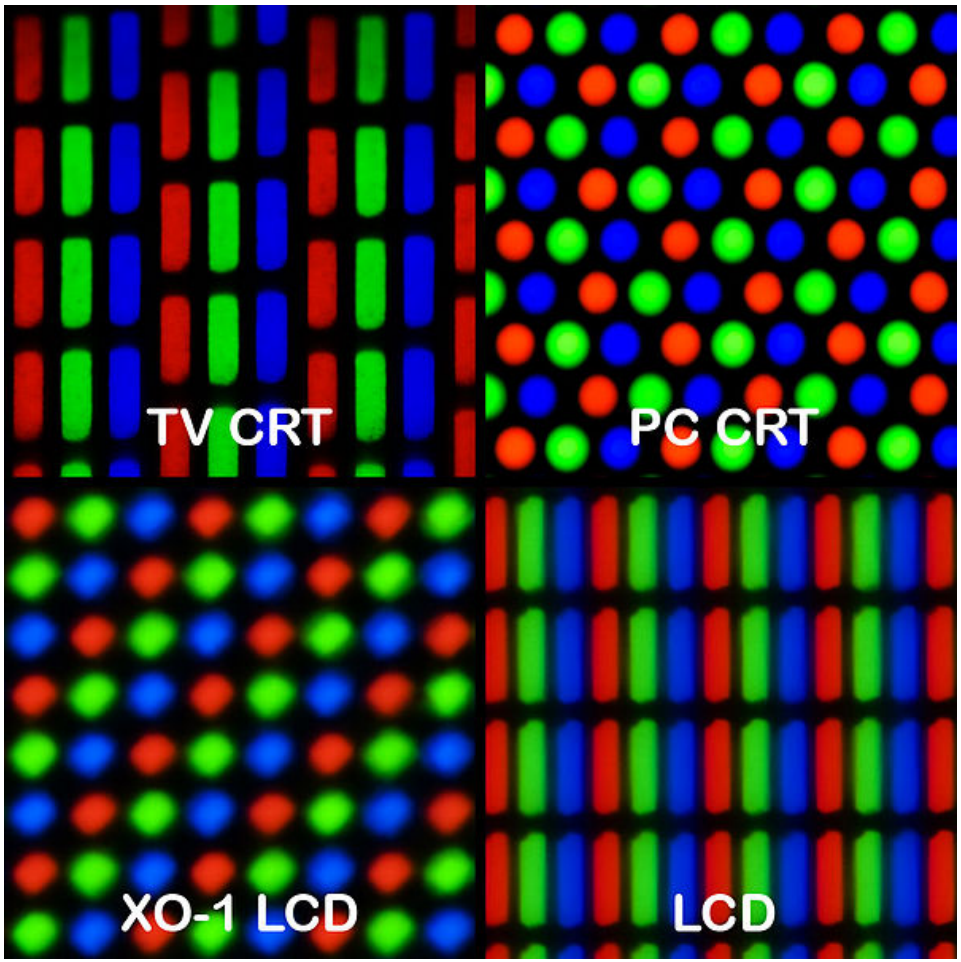
- Printers often use the following colors: **C**ian, **M**agenta, and **Y**ellow, in addition with **K**ey color black - the **CMYK** color scheme.
- Screens often use: **R**ed, **G**reen, and **B**lue - **RGB** color scheme.
- Every one of the basic colors is represented with a value between 0 and 255 (as 8-bit binary number).
- CMYK is subtractive mixing where 255, 255, 255 represents black color and 0,0,0 represents white color.
- RGB is additive mixing where 0,0,0 represents black color and 255, 255, 255 represents white color.

Colors and human eye

- Human eye has about a million photoreceptors (light sensors). There are two types: rods (they sense light/dark) and cones (they sense colors).
- We know three types of cones that sense red, green, blue color each. Colors are then recognized as the amount of each basic color falling on the cones and the amount of light/dark from rods.

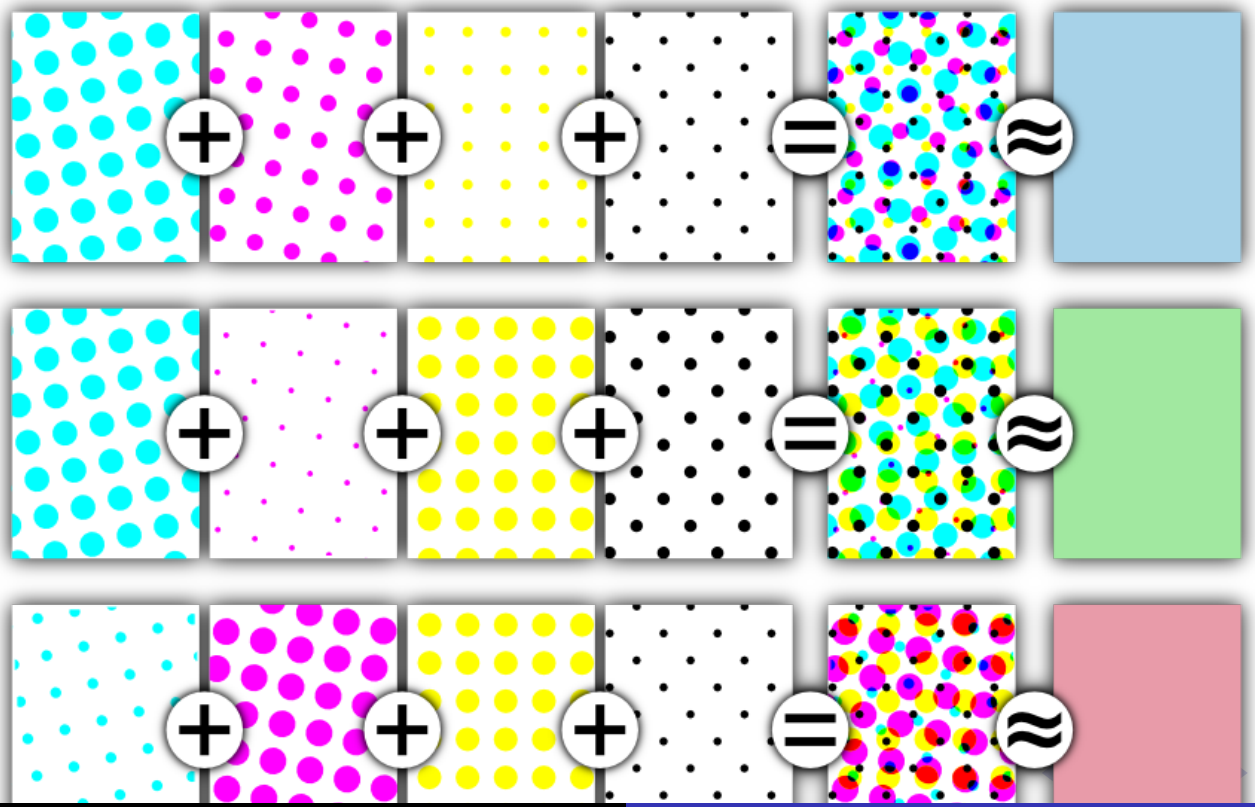
Colors and human eye - screens

- Color points or pixels of computer screens use this by transmitting various amounts of red, green, and blue light at each pixel which is then perceived as the desired color by our eyes.



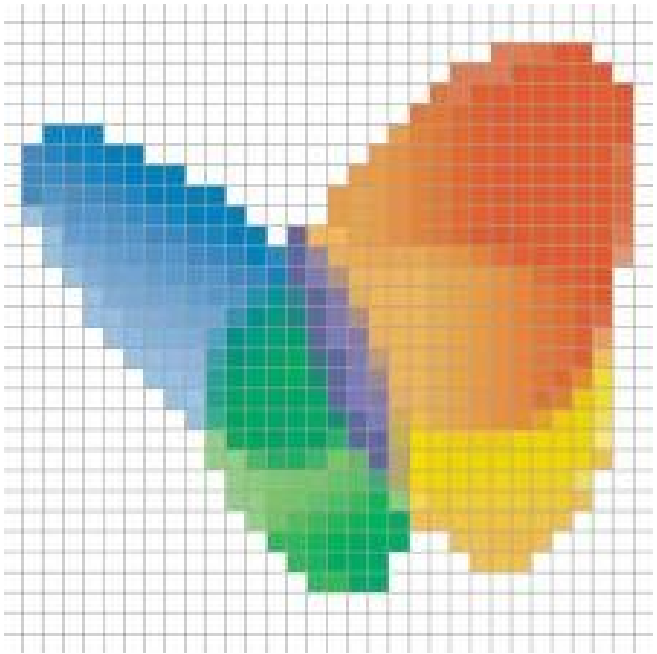
Colors and human eye - printers

- Printers on the other hand use the concentration of each basic color at each point on the paper. This is achieved by printing dots of varying sizes in basic colors which are perceived by our eyes as being at distinct distances. Looking at the printed paper our eye then recognizes the patterns of dots in basic colors (and black color for shading) as the desired color.



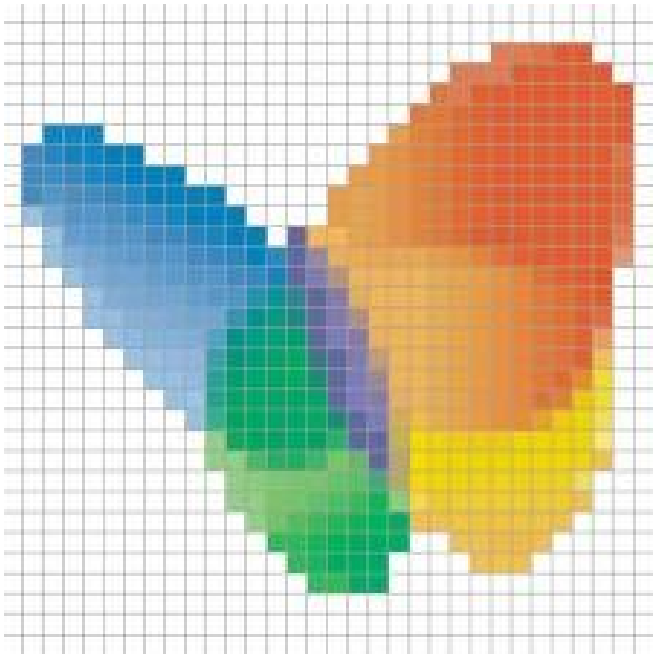
Pixel graphics

- **Pixel graphics** (bit graphics) is a way of presenting graphics as a 2D matrix of colors points. The image is saved in computer memory as a matrix where each pixel contains a data about the color (3 basic colors) and intensity (light/dark).



Pixel graphics

- When the image is transformed, enlarged, rotated, elongated etc.) the image loses sharpness and becomes blurry.
- Pixel graphics is usually used in painter programs.
- Such programs allow the user to create images on a computer screen similarly as painting on a paper.



Formats of pixel graphics

- Two main groups:
  - Compressed: those we further divide into compressed with or without loss. Examples: JPEG (JPG), PNG, GIF, BMP, HEIF, AVIF...
  - Uncompressed: the most famously known is RAW format which is often found when we make an image with a camera and is oten saved as raw uncompressed data.

JPG format

- JPEG (Joint Photographics Experts Group) is commonly used format with loss at compression.
- The amount of compression can be changed which offers a compromise between file size and image quality. JPEG can attain up to 10:1 compression rate with low almost unnoticeable loss of quality.
- Since 1992 JPEG is among the most used standard for image compression of digital images with billions of images in this format.

PNG format

- Portable Network Graphics is a format of pixel graphics with compression without loss. PNG was developed as a better unpatented version of Graphic Interchange Format (GIF).
- PNG can store images that are based on different color palets (24 bit RGB or 32 bit RGBA), gray images (with or without alpha channel for transparency) and full-color images in RGB or RGBA which are not based on color palettes. The developers designed PNG as a format for images online and not for printed graphic of professional quality. Thus, the colors schemes such as CMYK, which are not based on RGB color scheme, are not supported.

GIF format

- Graphic Interchange Format is a bit graphic format developed by CompuServe in 1987. It is widely used due to lots of support and transferability between various applications and operation systems.
- It supports up to 8 bits per pixel which allows that each image has its own color palette with up to 256 distinct colors chosen from 24 bit color space RGB. It also offers animation and separate color palette with up to 256 colors for each frame. Small color palettes make GIF less suitable for reproduction of colored images, but highly suitable for simpler images as graphics or logos.

Apps for pixel images

- PaintShop Pro, Corel Painter, Adobe Photoshop, Paint.NET, Microsoft Paint, and GIMP are all based on pixels.
- When the image is created in pixel graphic app it is formed with millions of pixels.
- Essentially they manipulate images by manipulating each pixel separately. Most are based on the RGB color scheme, but some offer also other color schemes such as CMYK color scheme.

GNU Image Manipulation Program (GIMP)

- GIMP is open source program for manipulating pixel graphics. It was started in 1995 by Spencer Kimball and Peter Mattis. Today a group of volunteers is supporting it and it is protected with a Common license GPL.
- GIMP us mainly used to manipulate digital graphic and photos from the web. It can be used to create graphic backgrounds, logos, cut images, changing colors, mergin with other images using layers, removing unwanted effects on images and transforming between other image formats.



GIMP - quick tutorial

For a quick tutorial we will follow the following site:
https://www.gimp.org/tutorials/GIMP_Quickies/