MINISTRY OF HEALTH OF UKRAINE
KHARKIV NATIONAL MEDICAL UNIVERSITY
DEPARTMENT OF MEDICAL AND BIOLOGICAL PHYSICS
AND MEDICAL INFORMATION SCIENCE

MEDICAL INFORMATICS

Lectures

KHARKIV – 2018/2019

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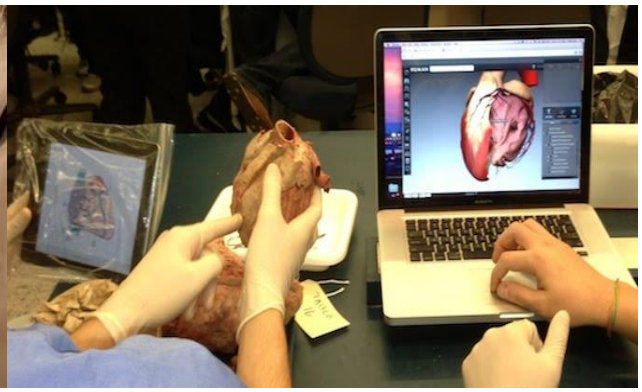
BASES OF MEDICAL INFORMATION SCIENCE

Lecture 1

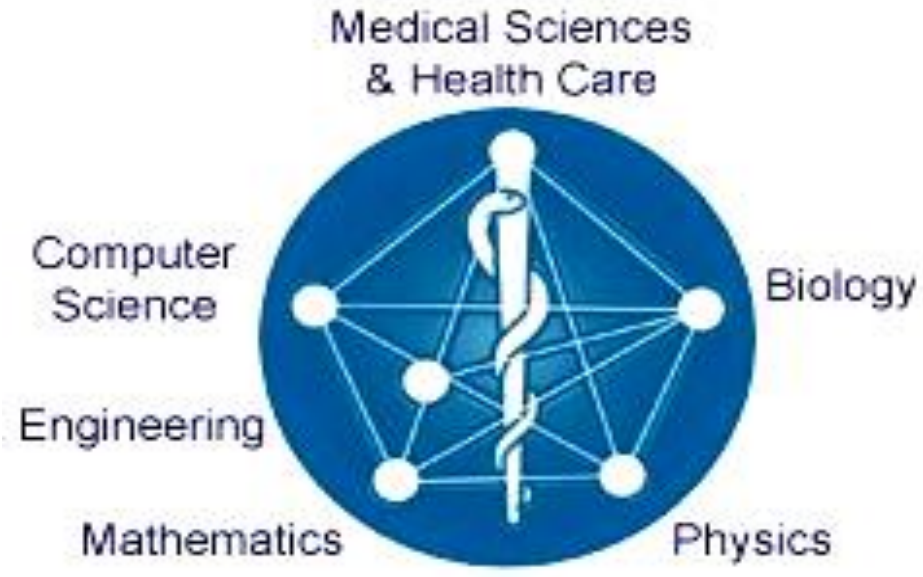
•***Medical informatics (MI)*** studies the processes ***of transmission, analysis, storage and presentation of medical data using modern informational technologies.***

INFORMATION - is new knowledge about the data describing the observed phenomenon and ideas about the world in the form of signs and symbols.



- ***The processes of creation and transformation of data (collection, transmission, analysis, storage, and use)*** are called ***informational processes.*** These are studied in a separate field of science called ***informatics.***

Medical informatics is an *interdisciplinary* research field that is uniquely placed at the intersection of the following fields:



•***Message*** is ***information presented in a certain form and meant for transmission.***

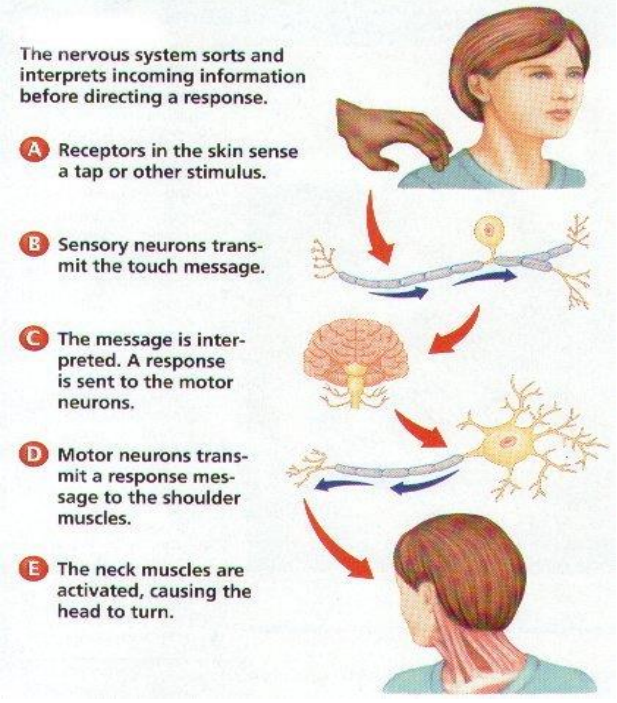
•***Signal*** is ***any process containing information.***

•***Communication channel*** is ***the environment where signals are transmitted***.

•During ***an oral conversation speech is a signal*, and *air is a communication channel***,

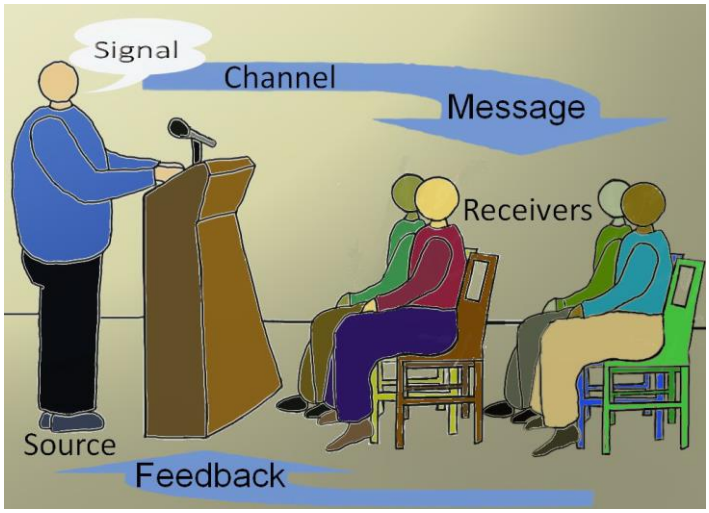
•during radio transmission of music, sound is a signal, and electromagnetic field and air are communication channels,

•*in nervous* ***system nervous impulses are signals* and *nerve fibers are channels***.

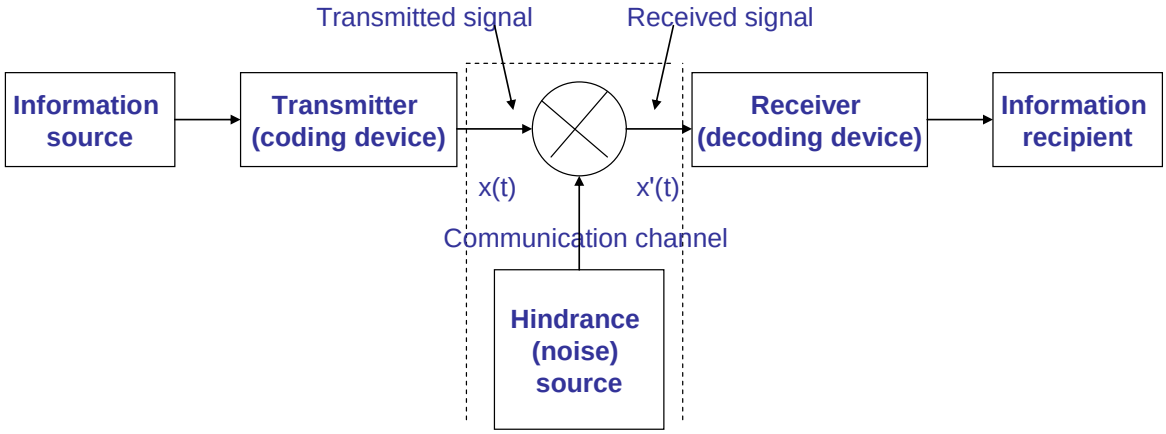


- ***The physical signal carrier*** are can be *all possible kinds of substance* which can alter during signal transmission.

- ***Signals are to satisfy the isomorphism requirements***.

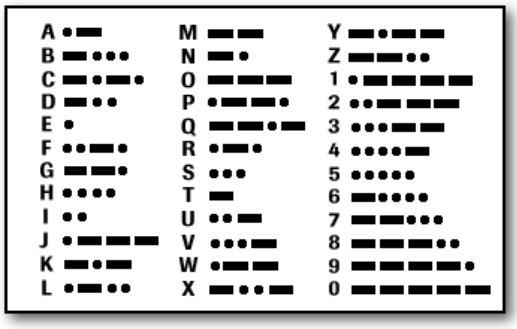


- Under ***isomorphism notion*** is understood such a compliance of physically different phenomena where *the transmitted message content is kept and not distorted*. The isomorphism infringement leads to the information distortion.
- ***The signals distortion in the result of isomorphism infringement as well as in the result of exterior hindrance is called noise***.

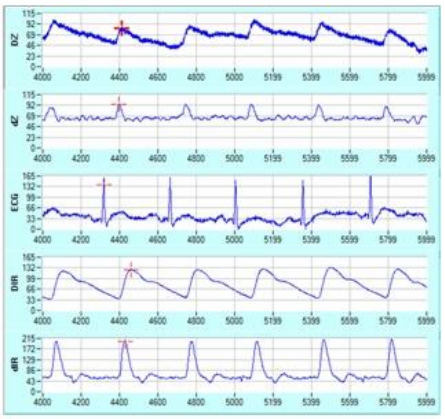


A typical scheme of transmitting information

- **Signals** are divided into **discontinuous and continuous.**
- *The example* ***of discontinuous signal*** is the usage **of Morse alphabet** or transmission of digits by current impulses, *the example* ***of continuous signal*** is the voltage change in a chain, corresponding to temperature and **blood pressure change**.



Morse alphabet



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Display showing simultaneously acquired signals

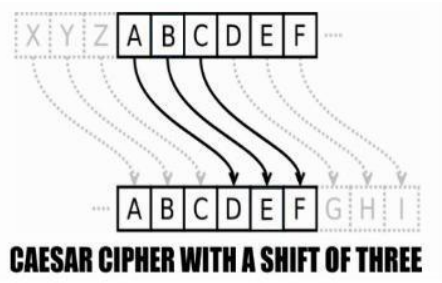
The blood pressure change

•Any message consists of simple signals combination of certain physical nature.

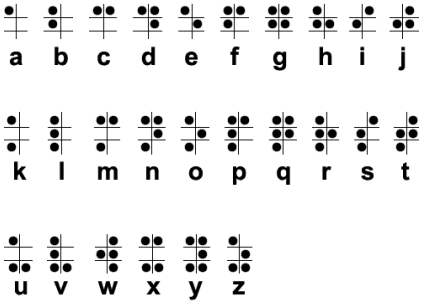
•***The full set of such signals*** is called ***alphabet, one signal*** is called ***an alphabet letter.***

The description of some message with the help of certain alphabet, is called ***coding***.

The coding of a message into another alphabet is called ***conversion***; the decryption of a message is called ***decoding***.



Procedure coding
This form of encryption is often called the Caesar Shift Cipher, because Julius Caesar frequently used it in his writings.



Procedure decoding
Braille-alphabet. Programming is merely a set of steps that give a result.

•Any information can be coded with the help of ***two numbers (0 and 1) -*** digital encoding.

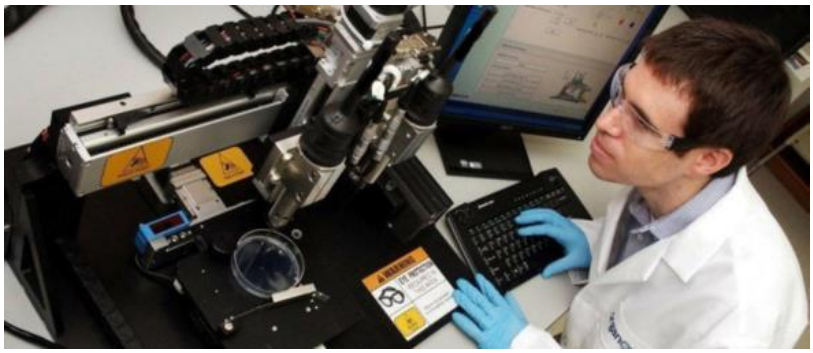
•***The code of this kind is called a binary code*** (This is the so-called ***"binary code presentation of information)".***

The minimum feasible unit of information is a "bit" (0 or 1).

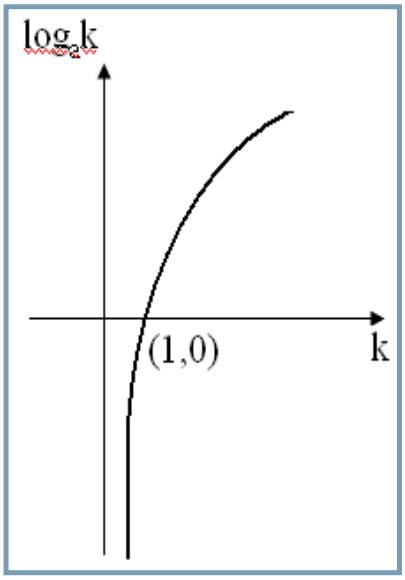
•"**Byte**" is the basic unit used in measuring the volume of information in a computer; it is defined as a sequence of eight "bits".

If the event has two equally likely outcomes, the amount of information in the message is equal to 1 bit:

$k=2; \quad I=\log_2 2=1$ bit



•Information - additive quantity: the information contained in the message that there were two events must equal the sum of information about each of them: $f(k_1k_2)=f(k_1)+f(k_2)$. All these requirements are satisfied by function $f(x)=\log_a(x)$.



а) It is a monotonically increasing function;
б) f(1)=0;
в) function is additive:
$\log_a(k_1k_2)=\log_a k_1+\log_a k_2$.

Hartley's formula:

$$I(A) = \log_2 k = \log_2 \frac{1}{P} = \log_2 P^{-1} = -\log_2 P$$

where I (A) - the amount of information about the outcome of event A;
k - number of equally probable outcomes;
P – probability of the event (P=1/k)

•Let's consider *the calculation method of information quantity*, ***contained in one message, offered by Shannon*** and used in modern information theory.

• ***(Shannon is the American mathematician, specializing in telephone connections of Bell Company).***

- By analogy with the thermodynamical entropy ***the average amount of information per one message*** can be calculated as follows

$$H = -\sum_{i=1}^{k} p_i \log_a p_i$$

where
p - the probability;
i - the event (i=1; 2; 3; …; k).
This formula is called ***Shannon equation*** or *entropy* or ***information entropy***.

Classification of computers

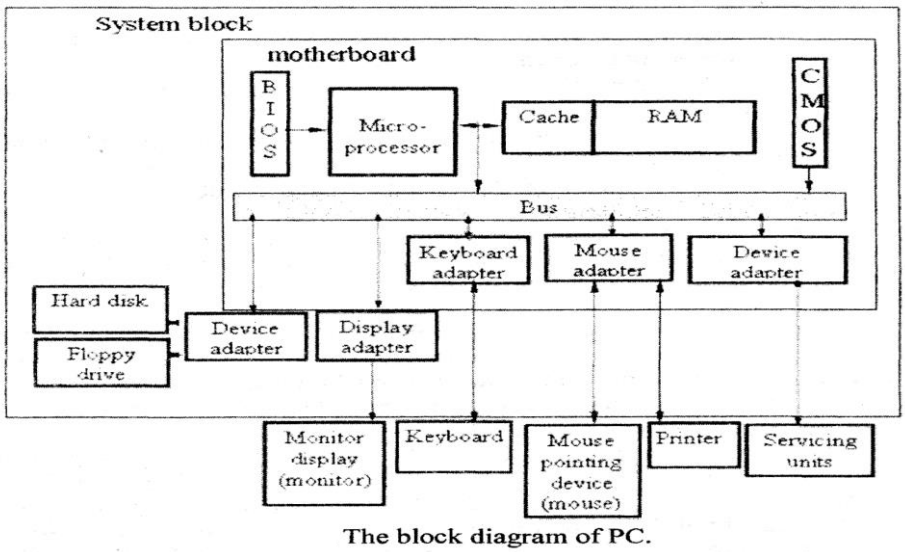
Use-oriented classification distinguishes between three types:

- **Large computers;**
- **Micro-computers**
- **Personal computers**

Hardware components of a computer

• The basic configuration of a PC consists of ***a system bloc, a display, a keyboard and a mouse.***

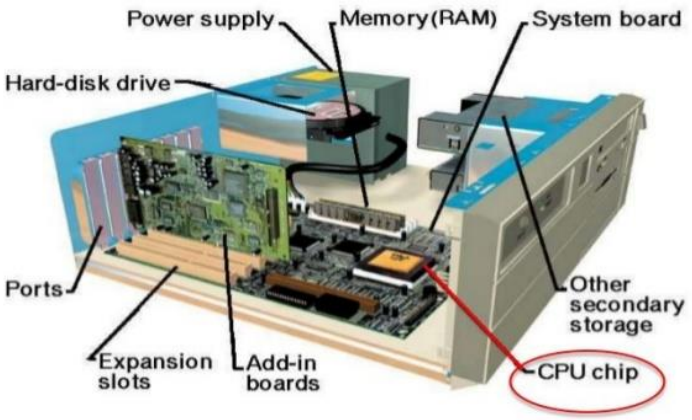
•Any computer includes the following five types of devices: ***a processor, the operating memory, long-term memory, input and output devices***.



The block diagram of PC.

•***The system bloc is the key component of a PC.*** It contains *a processor, operating memory, a long-term (external) memory device, boards*, and *ports*, which allow other devices, such as printer and modem, to be connected to a PC. These are all called ***internal devices***.

The inside of a system unit

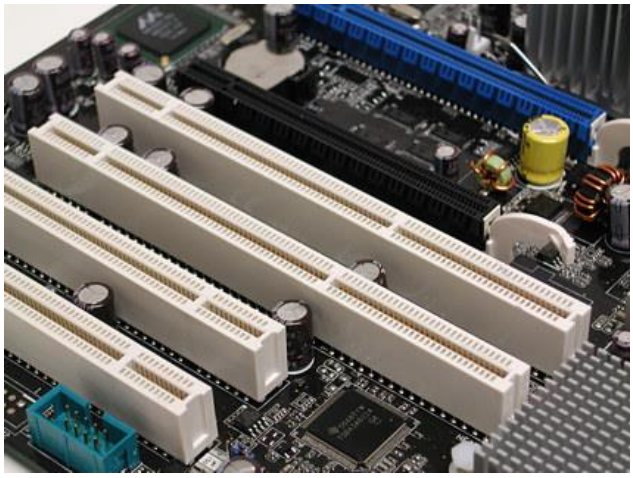


•Additional components, designed for the input, output, and storage of data, are called "*external components*". This is the so-called "***open architecture principle***": the main electronic component of an IBM PC (system- or mother-board) only include blocs required for the processing of information (calculations).

•Blocs, who control all other devices (display, discs, printers, etc) are included in separate boards (called "***controllers***").

•These can be connected to the mother-board through standard sockets - ***slots***.

•All electronic blocs are powered from a single source, and for convenience and safety they are all contained within a single plastic and/or metal box - ***the system bloc***.



Expansion Slots

Microprocessor

The main unit of the system block is the microprocessor or ***Central processor*** (CPU - Central Processing Unit) is the basic microchip, which executes all the mathematical and logical operations.
This is a computer "brain", it realizes the processing of data stored in a computer. ***The main parameters of a processor are "processing capacity", working frequency, and the size of its flash-memory***.

"Processing capacity" of a processor indicates the amount of data (in "bits") it can accept and process at a time.

The working frequency indicates the speed with which operations are carried out by the processor. Modern processors allow for up to 1 billion operations per second to be carried out.

Types of memory:

- ***Random Access Memory*** (RAM, operating memory) is designed to temporarily store data when the computer is switched on;
- ***External long-term memory*** is intended for long-term storage of large amounts of data and program at hard disk, compact discs, flash discs;
- ***Cache memory*** is superfast part of RAM. It keeps more frequently used RAM fragments;

Types of memory:

- ***Read Only Memory*** (ROM, BIOS) contains the data inputted during its manufacturing, keeps programs supporting input/output operations;
- ***Complementary Metal-Oxide Semiconductor*** (CMOS) is a type of internal memory used for storage of computer parameters supplied by an accumulator;
- ***Video*** memory is used for storing image data displayed on the monitor.

Flash-memory is a fast-response memory located within the processor, which allows to reduce the amount of time the processor has to address the operating memory of the PC, which is significantly slower.

The processor installed in a PC determines its type.

Thank You for Attention!