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Chapter 1

INFORMATION AND INFORMATION PROCESSES. METHODS AND TOOLS OF ITS DEVELOPMENT IN MEDICINE AND HEALTH CARE

1.1. INFORMATION AND ITS PROPERTIES

Definition

In Latin, information means an explanation, statement of something or description of something. **Information** is data about our environment that reduces the incompleteness of knowledge about the objects and events in it. **Information** is a collection of data that determines the extent of our understanding of certain events, phenomena or factors.

The concept of information, along with matter and energy, is one of the fundamental concepts of the universe, so it is tough to define it accurately.

Concerning computer data processing, information is understood as a particular sequence of symbolic values (letters, numbers, coded graphic images and sounds, etc.) that possesses a precise meaning and is presented in a computer-readable format. Each new symbol in such a sequence increases the information volume of the message.

Information acts as an ability of objects and phenomena (processes) to generate a variety of conditions that are transmitted using the reflection from one object to another. Data covers all aspects and all branches of social life, which is an intricate part of every person's life, affecting their way of thinking and behaviour. It provides communication between people, social groups, classes, nations, and countries, helps people to develop a scientific world outlook, to understand the diverse phenomena and processes of social life, to improve their level of culture and education, learn and abide by the laws and moral principles. The role of information in management is immense and irreplaceable. In fact, if there is no information, it is impossible to speak about any management or purposeful activity of interrelated objects and systems.

The definition of information includes such concepts as *signal*, *data*, *information*, and *knowledge*.

A *signal* is a time-dependent physical process that reflects the specific characteristics of an object. The propagation of a signal is completed by inte-

raction with physical bodies, which is called signal registration. This is when data form. *Data* is the properties of objects registered on a medium that can be measured or compared with certain standards.

Information is data that has been perceived (understood) by a subject (person) and can be used in their (professional) activity. Therefore, information can be defined as the data that is used.

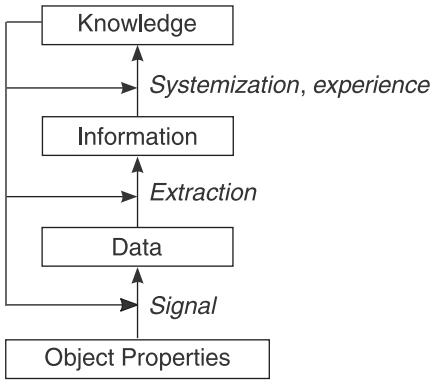

Fig. 1.1. General Model of Information Processes

Knowledge is information about an object that is systematically confirmed through experiment or logic.

Thus, the overall scheme of information processes can be represented, as shown in fig. 1.1.

For example, if electrocardiographic (ECG) method is used to study the condition of the cardiovascular system, the heart is the study object, the bioelectric activity of the heart is the signal, the electrocardiogram is the registered signal, i.e. the data. The ECG record gives the cardiologist information about the state of the cardiovascular system. Processed and analysed ECG records and their correlation with the state of the cardiovascular system is knowledge about the heart, which can be transferred to young staff for practical use.

Let's list the properties of information.

- *Objectivity* and *subjectivity* reflect the adequacy of information extracting methods. Information objectivity means that it always results from the data on the properties of particular *objects.* Subjectivity means that some person (a subject) can extract information from specific data, while someone else will fail to do so. For example, objective information on a patient's rhythmic activity disorder would be the registered unequal intervals between heartbeats. And subjective information would be the «fluttering» and «freezing» in the chest that the patient feels now and then.
- *Accuracy*: the degree to which the information corresponds to the real condition of the source of information. For example, a medical certificate without data on the applicant's previous diseases would present inaccurate information.
- *Reliability* is a probabilistic characteristic that describes the correspondence of information to reality. It is secondary to accuracy.

- *Sufficiency* or *completeness* is the information that is necessary to solve a specific problem. For example, the detection of a characteristic white rash on the inner mucous surface of the cheek (Koplik's spots) would be sufficient to diagnose a child with measles.
- *Availability* or *simplicity* is the possibility to perform procedures to obtain and transform information. In informatics, the availability of data is the avoidance of temporary or permanent concealment of information from users who have obtained access rights. For example, the health information contained in an outpatient medical history is available to the patient. The patient can take their medical history from the registry, get acquainted with the information presented there, submit it to a doctor so that the latter can add information to it. However, if the same patient is admitted to a hospital, they won't have access to medical history. After the patient is discharged, they get access to the discharge report.
- *Relevance*: a value that characterises the period between the moment of occurrence of an event and the presentation of information about it. For example, information about how many times the patient coughs per day, their cough characteristics (productive/non-productive, paroxysmal, painful, etc.), the amount of sputum is relevant for the doctor to diagnose the patient while the latter is sick. But a while after the patient was cured, the information about their cough becomes irrelevant.
- *Value*: the degree of usefulness of information for a particular user. For example, information about the nature of the patient's diet is valuable for a nutritionist to draw up recommendations but is of no value at all for a manager who is selling a computer to the same person.

Information processes include any actions performed with the information: sorting, storage, transfer, and processing.

There are the following levels of *information processes*:

- level 1 — information technologies, which include technical means of information support, software and software systems, information factor, intellectual efforts, and human labour;
- level 2 — information systems: sets of information technologies aimed at such processes as collection, processing, storage, retrieval, transmission, and display of information of the subject area;
- level 3 — information resources: sets of corresponding information systems that are studied additionally, also at social and economic standards of description and application.

1.2. DATA ENCRYPTION

Definition

Data encryption means converting information from one form of representation to another. **Decoding** is the restoration of encrypted information.

In EDPMs, information can be presented in two formats: *analogue* and *digital*.

Analogue means a continuous signal that changes proportionally to the change in information, i.e. the data is encoded by a time-dependent voltage or current. This is the way information was presented in *analogue computing systems* (*ANACOMS*). However, such devices were not developed further, mainly due to the low accuracy of their calculations.

The *digital presentation format* is used in *digital computing systems* (*DCC*). These devices encode the information with numbers. Numbers can be used to encrypt different kinds of information: numbers, letters, sounds, and images. Digital computing systems use the *binary numeric system*, which operates using only two numbers: 0 and 1. There are also other numeric systems: octonary, decimal, hexadecimal, and many others. However, the binary system is characterised by a high degree of reliability of information presentation. It is much easier to recognise two conditions (0 or 1) than, say, ten conditions. In living systems, binary coding of information in the form of rest potential and action potential, biological 0 and 1, is also used to transmit data. In the binary number system, it is possible to perform all mathematical operations, just like in the universal decimal number system.

In digital computing systems, two voltage levels are used to encrypt binary symbols. Typically, 1 means a higher voltage (about 5 V), and 0, a lower one (less than 0.8 V).

There are special devices for converting the analogue to digital, and vice versa. Such devices are called respectively *analogue-to-digital converters* (*ADCs*) and *digital-to-analogue converters* (*DACs*). The process of converting continuous signals into the digital format consists of three stages: discretisation, quantisation, and coding.

The discretisation is the process of splitting the signal into separate components taken at equal intervals, the values of which depend on the discretisation frequency (fig. 1.2, *a*).

The quantisation is the measurement of a discrete value of the signal at the moments t_1, t_2, t_3, and presenting them with precise accuracy. The accuracy is determined by the quantisation levels, i.e. the number of levels of splitting the value of signal *y*.

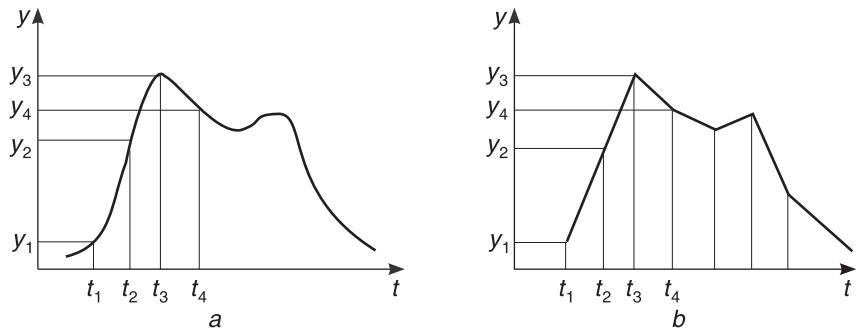

Fig. 1.2. Stages of Discretization (*a*) and reverse conversion of information from digital to analogue (*b*)

Coding is translating the value of the quantisation level into the binary numeric system.

The digital information obtained is called *discrete* information.

DACs perform the reverse process: transform digital signals into *analogue* (fig. 1.2, *b*).

1.2.1. Number coding

Thus, digital computing systems present the information in binary code (i.e. a sequence of 0s and 1s). Each digit is referred to as a bit (*binary digit*). An 8-bit sequence is called a *byte*. A byte can represent a decimal number from 0 to 255, as $2^8 = 256$. Increasing to 16 bit allows encrypting integer numbers between 0 and 65,535 ($2^{16} = 65{,}536$).

In digital computing systems, numbers can be presented in two formats: *fixed-point numbers* and *floating-point numbers* (standard form). In fixed-point numbers, the integer part of the number is separated from the fractional part by a point, for example, 25.386; –0.0025. This is the format that is used for input and output of numeric information.

The floating-point format allows presenting a number more compactly, avoiding using zeroes before and after the point, thus expanding the range of the names that can be used. In its standard form, a number can be presented like:

$$N = \pm M \times 10^{\pm k},$$

with M being the mantissa of the number; k being the power of the number. In this case, the numbers above will look as follows: $+0.25386 \times 10^2$; -0.25×10^{-2}.