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FORMING KNOWLEDGE BASES IN THE COMPUTER KNOWLEDGE BANK ON MEDICAL DIAGNOSTICS ¹

Mary Chernyakhovskaya

***Abstract:** Basic types of information resources for the computer knowledge bank on medical diagnostics are presented. They are observation ontology and some examples of observations bases from various fields of medicine. By the observation ontology observation bases can be formed, checked and used in the computer knowledge bank.*

***Keywords:** computer knowledge bank on medical diagnostics, information resources, observation ontology, observations bases, observation group, observation*

***ACM Classification Keywords:** I.2.4 Knowledge Representation Formalisms and Methods; H.2.8 Database Applications*

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Introduction

Computer systems for intellectual supporting medical activity related to examination, diagnostics and treatment of patients are among the most effective means for achieving a high level of physician's skill. These systems have to contain large and repeatedly updated knowledge bases that should be relevant to the up-to-date level of medical science. Such knowledge bases are formed in terms of appropriate medical observation bases [Chernyakhovskaya, 1983]. In turn the observation bases should be reusable, i.e. they should have such properties to be useful in various applications.

The multipurpose knowledge bank developed in the Intellectual systems department of the Institute for automation and control processes, FEBRAS, can contain specialized knowledge banks on different domains including one on medical diagnostics [Orlov, Kleshev, 2003]. This knowledge bank can contain large knowledge bases on various fields of medicine. It is targeted for supporting medical education, medical scientific researches, medical consultations and remote diagnostics of diseases. The knowledge bank on medical diagnostics consists of an information and program content. An ontology and bases of observations are among the components of the information content of the knowledge bank on medical diagnostics.

Forming the observation bases for the bank on medical diagnostics is necessary to create a unified conceptual foundation for forming knowledge bases about diseases and the case record archive. In addition, physicians can also use the observation bases as a computer terminological reference.

The Observation Ontology

The observation ontology contains definitions for all the classes of concepts related to medical observations. This ontology retains the traditional structure of medical knowledge. All the elements of the observation ontology form a hierarchy and can be divided into four classes: observation groups, observations, characteristics and values.

An observation group is a set of a few conceptually connected observations traditionally used in medicine. Complaints, case history, life history, objective examination data, laboratory and instrumental examination methods are some examples of observation groups.

Observations are such elements in the hierarchy that are traditionally defined in medicine as these concepts. Pain, asphyxia, general condition, auscultation, blood count are some examples of observations. An observation can be simple, without an inner structure, or compound, described by characteristics.

Characteristics are elements that describe an observation from different points of view. Localization of pain, character of pain, and intensity of pain are some examples of characteristics of pain. In turn a characteristic can be simple or compound.

A simple observation and a simple characteristic are described with a possible value range. The possible value range of an observation (characteristic) is a set of values that can be obtained as a result of executing this observation (characteristic).

Values can be qualitative or quantitative. In the latter case the possible value range is a numerical interval. For example, a simple observation of the beginning of a disease from the group of case history is described with the possible value range that consists of two values (acute and gradual).

An observation base is a formal representation of observations in a field of medicine. It can be used to form knowledge bases on diseases and case record archives. When described observation groups or examples of observations are too large dots (...) signal that the description of this observation groups or examples of observations is unfinished. Below general descriptions of observation bases for various fields of medicine are presented.

All the observation bases have the structure that is traditional for medicine. This structure is described with the following observation groups:

- COMPLAINTS.
- CASE HISTORY.
- LIFE HISTORY.
- OBJECTIVE EXAMINATION DATA.
- LABORATORY AND INSTRUMENTAL EXAMINATION METHODS.

The observation base on THERAPY contains 45 observation groups, and 252 observations. 140 observations from them are simple and the total number of characteristics is 502 [Chernyakhovskaya et al, 1998].

The observation group of LIFE HISTORY is described with the following observations and observation groups: place of the birth, maturity of the fetus, ontogeny, living conditions, unfavorable factors of the labor activity, had illnesses, had operations, had traumas, hereditary history, allergological history, bad habits, insurance history.

The observation group of BAD HABITS is described with the following observations: smoking, smoking history, use of alcoholic drinks, use of narcotics.

The observation of SMOKING has the following values: does not smoke, smokes sometimes, smokes less than 10 cigarettes a day, smokes more than 10 cigarettes a day.

The observation of SMOKING HISTORY has the following values: less than 5 years, 5-15 years, more than 15 years.

The observation of USE OF ALCOHOLIC DRINKS has the following values: 2 times a month, weekly, a few times a week, daily.

The observation of USE OF NARCOTICS is described with the following characteristics: the name of preparation, duration of use. ...

The observation base on SURGERY contains 32 observation groups, and 203 observations. 105 observations from them are simple and the total number of characteristics is 403 [Chernyakhovskaya, Shramko, 2000]...

The observation group of OBJECTIVE EXAMINATION DATA is described with the following observation groups: general examination, neck, chest, mammary gland, gastroenteric tract, rectum, circulatory system...

The observation of MAMMARY GLAND is described with the following characteristics: developmental defects of mammary gland, side, changes, discharge from papilla, indurations, and tumor.

The characteristic of DEVELOPMENTAL DEFECTS OF MAMMARY GLAND has the following values: amastia, monomastia, polymastia, polythelia.

The characteristic of SIDE has the following values: to the right, to the left, to the both sides.

The characteristic of CHANGES has the following values: increase in volume, different form of mammary glands, different dimensions of mammary glands, different levels of papillae, pulling in of papilla, pulling in of skin (the symptom of orange peel), swelling of papilla, nipple crack, hyperemia, painfulness, fluctuation, hematoma, ulcers, cicatrices, fistulae.

The characteristic of DISCHARGE FROM PAPILLA has the following values: achromatic, yellowish and green, brown, sanguinolent...

The observation base on OPHTHALMOLOGY contains 56 observation groups, and 207 observations. 92 observations from them are simple and the total number of characteristics is 539 [Chernyakhovskaya et al, 2001]...

The observation of REDUCTION OF VISION (the observation group of COMPLAINTS) is described with the following characteristics: eye, character of the beginning, character, degree of reduction, conditions, influence of correction, recoverability.

The characteristic of EYE has the following values: right and left.

The characteristic of CHARACTER OF THE BEGINNING has the following values: acute and gradual.

The characteristic of CHARACTER has the following values: far, close by, skipping individual letters during reading.

The characteristic of DEGREE OF REDUCTION has the following values: insignificant, moderate, and significant.

The characteristic of CONDITIONS has the following values: in the day-time, in the twilight, in the dark.

The characteristic of INFLUENCE OF CORRECTION has the following values: resist to correction, by spectacles, by contact lenses.

The characteristic of RECOVERABILITY has the following values: not to be restored, after sleep, after rest.

The observation base on NEUROLOGY contains 45 observation groups, and 232 observations. 119 observations from them are simple and the total number of characteristics is 592 [Chernyakhovskaya, Zaitchenkov, 2003]...

The observation of BREACH OF SLEEP (the observation group of COMPLAINTS) is described with the following characteristics: character, conditions of origin, frequency of rise, and accompanying phenomena.

The characteristic of CHARACTER has the following values: breach of falling asleep, early awakening, impossibility to fall asleep a second time, sleep in short intervals, daily sleepiness, and slow awaking.

The characteristic of CONDITIONS OF ORIGIN has the following values: without apparent causes, after psychical and emotional loads, and after stimulants.

The characteristic of FREQUENCY OF RISE has numeric or verbal values.

The characteristic of ACCOMPANYING PHENOMENA has the following values: headache, erethism, sensation of morning fatigue, fluctuation of mood, and heart pain.

The observation base on UROLOGY contains 48 observation groups, and 210 observations. 88 observations from them are simple and the total number of characteristics is 569 [Nagornyi, Chernyakhovskaya, 2002]...

The observation of ANALYSIS OF THE SPERM (the observation group of OBJECTIVE EXAMINATION DATA) is described with the following characteristics: volume, Ph, color, viscosity, leukocytes, flora, citric acid, fructose, ions of zinc, quantitative value of spermatozoa in ejaculate, and categories of spermatozoa mobility.

The characteristic of VOLUME has numeric values (normal values are between 2.0 and 6.0 ml).

The characteristic of PH has numeric values (normal values are between 7.2 and 8.0).

The characteristic of COLOR has the following values: whitish, red, yellow and brown, and yellowish.

The characteristic of VISCOSITY is described verbally (in 30 min after dilution sperm drips out is normal)...

The observation of URINARY BLADDER (EXCRETORY UROGRAPHY AND DESCENDING CYSTOGRAPHY from the observation group of LABORATORY AND INSTRUMENTAL EXAMINATION METHODS) is described with the following characteristics: changes, type of filling defect, and localization of filling defect.

The characteristic of CHANGES has the following values: absent, increase of capacity, and small capacity.

The characteristic of TYPE OF FILLING DEFECT has the following values: calculi, neoplasm, and prostate.

The characteristic of LOCALIZATION OF FILLING DEFECT has the following values: fundus, neck, lateral wall to the right, lateral wall to the left, and apex...

The observation base on IMMUNOLOGY AND ALLERGOLOGY contains 10 observation groups, and 110 observations. 81 observations from them are simple and the total number of characteristics is 174 [Chernyakhovskaya et al, 2002]...

The observation group of COMPLAINTS is described with the following observation groups: chief complaints and additional complaints.

The observation group of CHIEF COMPLAINTS is described with the following observations: dyspnea, asphyxia, cough, difficulty of nasal breathing, sneezing, lacrimation, irritation of eyelids, and so on.

The observation of ASPHYXIA is described with the following characteristics: time of beginning, character of beginning, duration, frequency of daily attacks, frequency of nightly attacks, and heaviness.

The characteristic of TIME OF BEGINNING has the following values: in the day-time, in the night-time, in the morning-time, and in the evening-time.

The characteristic of CHARACTER OF BEGINNING has the following values: sudden and gradual.

The characteristic of DURATION has the following values: 5-15 min, 16-30 min, 31 min-1 hour, 1-3 hours, 4-6 hours, and more than 6 hours.

The characteristics of FREQUENCY OF DAILY and NIGHTLY ATTACKS have the following values: 1 time a day, 2-3 times a day, more than 3 times a day, 1 time a week, and 2-3 times a week.

The characteristic of HEAVINESS has the following values: light, of middle heaviness, and serious.

The observation group of CASE HISTORY is described with the following observations: the date of the disease beginning, character of the beginning, the cause of the disease, the first manifestation of the disease, aggravations, development of the disease before a visit to a physician, conducted therapy, conducted examination, diagnosis, and the cause of hospitalization.

The observation of THE CAUSE OF THE DISEASE is described with the following characteristics: had illnesses, everyday allergens, derma allergens, alimentary allergens, pollen allergens, medicinal preparations, perfumery, chemical substances, physical substances, psychical and emotional factors, professional harmfulness, cold and thermal factors, and inoculations.

The characteristic of HAD ILNESSES has the following values: influenza, acute respiratory and viral infections, chronic bronchitis, chronic infection of ears, throat and nose, pneumonia, bacterial infections of skin and subcutaneous fat, fungous infections of skin and mucous membranes, urogenital infections, inflammation of lymphatic glands, rheumatoid arthritis, hemolytic anemia, fever of vague etiology, and inflammatory processes of various localizations.

The characteristic of EVERYDAY ALLERGENS has the following values: domestic dust, library dust, carpets, downy (feather) goods of custom, fodder of aquarium fish, allergens of insects in dwelling (cockroaches, bugs), and allergens of rodents in dwelling (mice, rats).

The characteristic of DERMA ALLERGENS has the following values: hair of domestic animals (cats, dogs, rabbits, hamsters) and feather of birds.

The characteristic of ALIMENTARY ALLERGENS has the following values: fish, egg, milk, flesh, crabs, shrimps, squids, citrus plants (tangerines, lemons, oranges), fruits, (banana, melon, apples), berries (strawberries, raspberries, currants), and chocolate.

The characteristic of POLLEN ALLERGENS has the following values: pollen of grass (timothy-grass, fowl-grass, black grass, fescue, couch-grass, nettle, plantain, sorrel, ambrosia, wormwood), pollen of flowers (buttercup, dandelion, daisy, poppy, tulip), pollen of shrubs (dog-rose, elder, lilac, hazel, filbert), and pollen of trees (birch, oak, ash, poplar, willow, alder, chestnut).

The observation of DIAGNOSTICS OF AUTOIMMUNE COMPONENT (the observation group of LABORATORY AND INSTRUMENTAL EXAMINATION METHODS) is described with the following characteristics: the level of circulating immune complexes, detection of rheumatoid factor, antibodies to DNA, and antibodies to own tissues of the organism.

The characteristic of THE LEVEL OF CIRCULATION IMMUNE COMPLEXES has numeric values (normal values are between 4 and 20).

The characteristics of DETECTION OF RHEUMATOID FACTOR and ANTIBODIES TO DNA have the following values: reaction "-", and reaction "+" (the normal value is «-»).

The characteristic of ANTIBODIES TO OWN TISSUES OF THE ORGANISM has the following values: reaction “-“, and reaction “+” (the normal value is «-») or is described by numeric values (depending on an applied method).

For a preliminary approbation of a few observation bases a PC prototype of a system for intellectual supporting patient examination was developed at the close of the eighties [Koktyisheva, Petryaeva, 2004]. The system gives a possibility to form case record archives by these observation bases. Every case record contains a description of a process of changing patient status with time. The system has been tested at several chairs of the Vladivostok state medical university in the process of teaching students.

Conclusion

Thus, at the medical expert systems laboratory of the Institute for automation and control processes, FEBRAS, observation bases in various fields of medicine have been formed and formalized on the basis of the observation ontology. These bases are components of the information content of the knowledge bank on medical diagnostics. In these observation bases practical medical knowledge is represented that is used for diagnostics of various diseases.

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