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РАЗРАБОТКА ИНФОРМАЦИОННОЙ СИСТЕМЫ ДЛЯ ПЕРЦЕПТИВНОГО ОБУЧЕНИЯ В РАДИОЛОГИЧЕСКОЙ ДИАГНОСТИКЕ

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Резюме. В процессе адаптивного обучения широко используются информационные технологии, позволяющие создавать интерактивные курсы, учитывающие индивидуальные особенности студентов и интернов. В основу разрабатываемых информационных систем положены различные математические модели психологических процессов. Одним из таких подходов является перцептивное обучение .Целью работы явилось повышение восприятия радиологической диагностики с помощью компьютерных методов перцептивного обучения. В статье представлен практический опыт разработки системы PLIS для тренинга специалистов в области радиологической диагностики заболеваний опорно-двигательной системы, в частности, позвоночника. В основу информационной системы PLIS положена классическая модель интервальных повторений Аткинсона. Модификация этой модели заключается в задании различных уровней «мастерства» в овладении определенными разделами знаний. Из большого набора обучающего материала (кейсов, снимков) создается обучающая последовательность, персонально упорядоченная. Этот порядок базируется на приоритете обучения и постоянно перестраивается, в процессе прохождения курса, адаптируясь под личные показатели ответа студента на каждый вопрос: правильность, временная задержка, категория к которой относится материал.

Ключевые слова: информационная система; перцептивное обучение; радиологическая диагностика; позвоночник.

DEVELOPMENT OF INFORMATION SYSTEM FOR PERCEPTUAL TRAINING IN RADIOLOGICAL DIAGNOSTICS

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Summary. The article describes Perceptual Learning in medicine. The technology is customized and adapted for medical education, especially for diagnostics learning. PL information system (PLIS) gives computer-based tool for producing mastery, objective assessment and adoption for learner's personality. Mastery criteria are based on response time and correctness.

Key words: information systems; perceptual learning; radiological diagnostics; spine.

INTRODUCTION

The article describes our experience of creation of information systems for medical education using perceptual learning (PL) technologies. PL is especially effective in teaching professional intuition, patterns of expert thinking, and speed of reaction.

Traditional medical education is based on procedural knowledge, consisting of special algorithm for producing operations. Learning some terms and cultivating some skills is a foundation of the future professional practice and performance. The main problem is the lack of fluency in pattern recognition by students. They have some understanding but act slowly and ineffective in time-limited or tough situations. Latest research shows that masters and experts have fluency in extracting relevant information more easy, with higher speed and lower cognitive load.

Kellman [8] extracts two main aspects of professional thinking: fluency and discovery. Discovery aspect determines the improved search skill of the most problem relevant information. Practice makes them ignore irrelevant information better. Fluency aspect gives automaticity in skills with small overhead for loading knowledge base.

E.Gibson in their fundamental research [5] of PL notices "changes in the picking up of information as a result of practice or experience" which are particularly effective in tasks of classifications. Applying to medicine, it gives improved skills, especially in diagnostics. Recent works [7,10] investigate PL effect and show that pattern matching skill can be improved by orders with it. These observations about the origins of advanced expertise apply to many high-level domains of human competence; in medicine, they are

crucial for understanding the skills of the expert radiologist, pathologist, and surgeon. The skilled radiologist, for example, must detect the pathology in a new image or set of images, where tumor may be manifested in a different location, size, orientation, contrast, and situated amidst novel and variable background anatomy. Classification or clusterization task learning needs huge amount of different cases to form extraction mechanism that ignores irrelevant information and selects important one. The mastership comes from PL not by training memory but by fast and precisely classified knowledge base.

TECHNOLOGY

In many domains, expertise comes not from learning facts, but from experience, case study and practice time. With personal learning curve and lack of experts in system of education computer-based technologies based on principles of perceptual learning can be a good addition or sometimes a substitution of the expert tutor. PL technology is based on many short attempts of classification task solving and receiving feedback. There are some important aspects:

- Variety of case set: never or seldom repeat.
- Different levels of details.
- Positive instances have different characteristics.
- Positive instances come with negatives.

There are some articles that show the role of perceptual structure in science, technology, engineering (STEM) learning domains [6,11], as well as the potential of PL in mathematics [9,11]. However, the most valuable PL technology is in medical learning. We see big impact of using PL in radiology, where there are many classifications of diseases, spanning not only a number of pathology conditions but also different imaging modalities. Fixed standard views, 3D models for process exploration, for example, ultra sound; the most important information can be obtained only in animation. Everybody knows that development of expert radiologist needs watching and task solving for a long time of practice. We have started to approbate PL technology in diagnostics of the spine pathologies to create a system that can help in medical learning of radiologists. The main property of this system is adapting.

Adapting of student learning curve is sometimes restricted by the failure to adapt to the personality. They have different level of knowledge, different speed of learning, etc. Situation "one instructor – a lot of students" does not give a chance to select a strategy that fits everyone's abilities. Instructor even cannot accurately evaluate students' progress because they are usually tested twice in a term. This can be dramatically improved by using our information system approach.

PERCEPTUAL LEARNING INFORMATION SYSTEM (PLIS)

The main idea of our software is based on classic Atkinson method [4] with proven effectiveness of well-learned models [12]. In addition, we introduce mastery criteria as a function of accuracy and speed of pattern recognition.

To make a long story short, we have a set of learning units, tagged by categories. To personalize education curve, we build an ordering on this set. This ordering can be interpreted as a priority to demonstrate particular item. This order is changed every step of iteration of student interaction. Priority of a unit is a function of user answer's characteristics (correctness, delay, last time, category, mastery threshold). In addition, the response affects priority values of other units. The identification of this model's parameters, especially mastery threshold, is done on research of experts' UI responses. There are some heuristics or principles in the foundation of the system:

1. Correctness and delay are inversely to priority
2. Time of the last demonstration is in direct ratio of priority
3. Successful answer decreases priorities of all units in the same category
4. Wrong answer triggers a delay to avoid showing of the same unit in a sequence and to exclude extracting right answer from working memory
5. Units or categories, whose priority is less than some mastery threshold, are excluded from education sequence and considered to be completed.

When it comes to mastery, the response time becomes determining. Unit with correct answers but big response time gets relatively high priority. In addition, we try to maximize the time interval of showing the same unit while being able to get a successful response [13].

We omit mathematical and technical details, but this scheme is very flexible by selecting different function parameters. As a result, system adapts to a particular knowledge base and student.

We think that our system has a potential for a better testing of student's knowledge. Every unit in knowledge base is assessed on the base of accuracy and response time. Aggregated information for a group of students can give better statistics for different categories of education course.

APPLICATIONS OF PERCEPTUAL LEARNING INFORMATION SYSTEM IN RADIOLOGY

The training information system helps to optimize the perception of radiation diagnosis, which is considered to be the main method of patients' examination with the musculoskeletal system diseases, in particular, in the spine [1,2,3].

Fig. 1. Screenshot of PLIS. Choosing an X-ray for particular pathology.

Every educational unit in knowledge base has following structure: x-ray image, pathology and diagnosis details. Every unit can be tagged by different categories of disease classifications. Then, we can automatically build different types of questions:

1. If there is any pathology (select image with

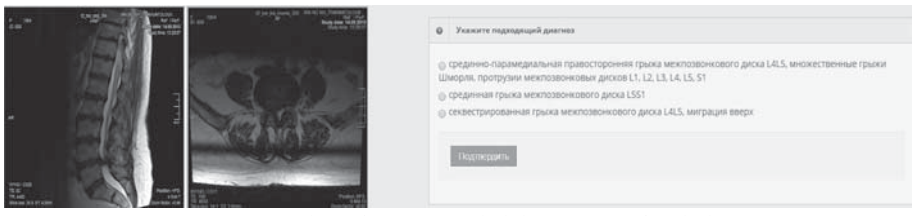

Fig. 2. Screenshot of PLIS. Detailed diagnostics of pathology.

pathology).

2. Select a particular pathology from different x-rays. (see Fig. 1)

3. Select diagnosis details. (see Fig. 2).

There are opportunities for variation other types of questions. Our work is in progress, but our first results show that perception learning can affect a solid progress for a short learning time.

PERCEPTUAL LEARNING AND MEDICAL SIMULATIONS

If you have cutting-edge simulations, it is not enough to solve the problem of education improvement. However, PL can offer an objective method to increase the learning effectiveness. Most of the procedural tasks depend on improvements in picking up knowledge. PLIS can be customized to perception action scenarios. Advanced simulations based on perceptual learning offer to be relevant to the practice.

One of the main results of perceptual learning implementation is an objective performance assessment with mastery criteria. We can count statistics of performance for different categories including correctness, response time, and level of knowledge. Although, time response is very important; it is usually not trained or measured by traditional education practice. Benefits of PLIS will give acceleration in training, solid testing and reduction of medical mistakes in diagnostics and other practice.

CONCLUSION

To reduce medical errors and improve medical education we need modern effective learning and simulation techniques. In both simulation and learning, we can get noticeable advance. Perceptual learning is proven able to increase pattern matching, extracting knowledge of new cases, fluency and mastery in general. Customizable interactive learning technology of PLIS can adapt to every student providing more personalized and efficient education. The certification of mastery has solid base and diversity in measurements. We sampled this technology in radiology learning but we see perspectives of it in different medical domains to improve training and practice as a result.

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