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An analysis of the decision process of a clinical diagnostic: from empirical observation to rule-based modelling

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Résumé. Physicians at the Hospices Civils of Lyon (HCL) have at their disposal a Health Information System (HIS) which provides them access to all the available information about their patients. Our goal is to identify relevant improvements that we can make on the current HIS used by physicians at the HCL, to help them during the diagnostic process. According to this aim, we develop an analysis and a model of the clinical diagnostic process. We first show that the decision process unfolded by a physician is mainly based on searching information about the patient. Then, we propose a rule-based model of the decision process to detect which information the physician will need and when s/he will need it during her/his diagnostic process.

Mots-clefs : Bio-medical informatics, Decision Support Systems, Process analysis, Rule-based modelling

Physicians at the Hospices Civils of Lyon (HCL) have at their disposal a Health Information System (HIS) which provides them access to all available information about their patients. With the aim of proposing improvements adapted to physicians' practices, we want to analyze and produce a model of their clinical diagnostic process. We also want to analyze how physicians use their current HIS. This model should be used to understand the physicians' needs during their diagnostic. Also, understanding those needs, it allows us to minimize a possible gap between "design conception" of those improvements and "current realities" [1].
Our collaboration with the HCL led us to observe several clinical diagnostic process in practice. We observed the interactions between the physician and the patient, and also between the physician and her/his HIS. Those observations allowed us to understand the events occurring

during a clinical diagnostic process. We also used process mining methods and algorithms [2, 3] on data and event logged by the HIS during the clinical diagnostic process. Process mining and observation results have been compared to understand what improvements could be made on data collection.
In line with previous analyses [4, 5], we have observed that the decision process of a clinical diagnosis is mainly based on searching useful pieces of information about the patient and it is concluded with a set of prescriptions, if the physician has enough information. A piece of information can be qualitative, such as an administrative fact or a current treatment, or quantitative, such as weight or blood glucose level. The physician can obtain an information by asking to the patient or by using the HIS. A prescription can concern a treatment for the patient, a medical analysis or a follow-up by another physician.
The decision process of a clinical diagnostic could be described as a loop based on the selection of information necessary for the physician to elaborate a prescription. We show that the choice of a prescription can be made during the diagnostic process loop rather than concluding it. The diagnostic process is, in fact, concluded by a synthesis of all prescriptions chosen by the physician. We also show that, when a physician choose a piece of information c_n to collect, at a moment t_i of her/his diagnosis process, s/he bases her/his decision on a set of information already collected $\mathcal{C}_{t_i} = \{c_j(t_i) \neq \emptyset\}$. With $c_j(t_i)$ the content of a piece of information at the moment t_i (ex. $weight(t_i) = 90kg$). Then, at the moment t_{i+1} of her/his diagnosis process, s/he bases her/his decision on the set of information already collected $\mathcal{C}_{t_i} \cup c_n(t_i)$. In other words, the content of a piece of information, at a moment t_i of the diagnosis process, could highly impact the next decisions of piece of information collect and so on. Also, we can see that the set of information known by the physician grows up during the clinical diagnosis process.
Based on these analyses, we conclude that physicians primarily need information. Then, to improve the current HIS used by physicians at the HCL, the priority is to develop a decision support system (DSS) which will anticipate what information the physician will need to look at, and then provide her/him this piece information automatically when s/he needs it, as suggested in [6], thereby anticipating her/his request for this piece of information. Also, the medical context of this improvement implies several ethical constraints, such as transparency of how the system works and how it uses personal data.
We propose a model of medical diagnostic process based on a set of rules used by physicians. We define $T = [t_0 \dots t_n]$ as the set of every moment of the diagnostic process when the physician made a decision. A decision could concern a selection of an unknown piece of information, or a prescription. $\mathcal{C}$ is defined as the set of all possible information that can be known by the physician about a patient and $\mathcal{C}_{t_i} = \{c_j(t_i) \neq \emptyset\}$ as the set of all information known by the physician about the patient at moment t_i of the current diagnostic process, with $c_j(t_i)$ the content of a piece of information $c_j \in \mathcal{C}$ at the moment t_i. $\mathcal{D}$ is defined as the set of all possible decisions the physician can make, with $d(t_i)$ the decision made by the physician at the moment t_i of the diagnostic process. A decision can be the selection of information or the choice of a prescription. We assume that, at a moment t_i of a current diagnostic process, a physician bases her/his decision $d(t_i)$ on the set of known information and her/his previous decisions, and then follows rules such as:

$$\bigwedge_{c_j \in \mathcal{C}_{t_i}} (c_j(t_i) = u) \cup \bigwedge_{t_j < t_i (d(t_j) = v)} \Rightarrow (d(t_i) = w)$$

We assume that, on the basis of this rule-based model, we can detect which information, about the current patient, the physician will need and then provide her/him with it, if the information is in the system. Some difficulties could occur during the establishment of those rules. According to the analysis of 1307 diagnoses by a total of 28 clinicians, made by Leaper in 1973[5], each physician seems to have her/his diagnostic process, looking for different information. In addition, a given physician could have different pathologies to treat, and then s/he will need different information depending on the pathology. However, we can think that it is possible to establish, by learning, general rules from the recurrent information searched by different physicians, for a same pathology.

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