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The Complexity of a Clinical History

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Abstract. The paper describes a new metrics for measuring the structural complexity of clinical history (modelled by a HINe model) in order to compare different clinical histories and then assign it to the right types of learners.

Keywords. Complexity, Petri Nets, Health Issue, Health Issue Network

1. Introduction

Today physicians manage patients with multiple chronic diseases and need to predict their evolutions. The Health Issue Network (HIN) model describes the patient's medical history and highlights: (i) how health issues have changed over time; (ii) how affect each other [1]. This paper defines a complexity metrics for HIN graphs for the educational aim of evaluating the difficulty of an exercise based on graphs. The complexity is related to the drawing, analysis and interpretation of a HIN graph. At present, our metric does not consider the clinical complexity of the modeled case.

2. Methodology and Results

The HIN model allows to implement clinical exercises for undergraduate medical students to develop their clinical reasoning ability in multimorbidity chronic conditions [2]. The HIN model is based on the Petri Net (PN); the PN is a direct graph with two types of nodes, places (Health Issues, HI, such as diagnosis, symptom, any other clinical information), and transitions (the evolutions between HIs), linked by directed edges [3].

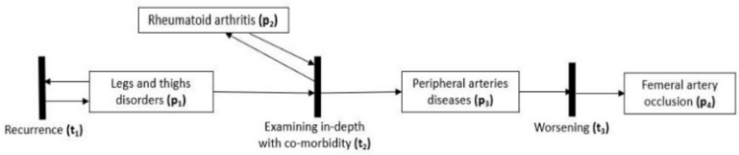

Figure 1. Example of the HINe model

Figure 1 shows a patient who develops, over time, occlusion of the femoral artery. Each HI is identified by a label p_i, while each transition is identified by a label t_i. We were inspired by the Extended Cardoso Metric [4] because it focuses on the transitions of a PN (the evolutions). In the HIN model the different types of evolutions have different

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semantics and different weight in the complexity calculation. We assigned a weight also to the AND splits/joins because they influence the structural complexity of a HIN model (Table 1). These weights were inductively inferred from the errors of medical students in solving a sample of clinical exercises. The weights were finally agreed after a discussion with medical experts and are expressed in arbitrary units.

Table 1. Complexity weights

HINe Element	Weight
Worsening, Improvement, Persistence	1
Examining in-depth, Complication, Cause, AND splits/joins	2
Recurrence, Co-morbidity, Co-presence	3

Note: for the definitions of evolutions, see [2]

The complexity measuring of a HIN model is reported in the Eq. (1):

$$HIC = \sum_{p \in P} \sum_{t \in p\bullet} W_t(t) + \sum_{a \in A} W_a(a) + |P| \quad (1)$$

- P and T, the finite set of places/HIs and transitions/evolutions, with $P \cap T = \emptyset$;
- A, the finite set of AND splits/joins, with $A \subseteq T$;
- W: $T \rightarrow \mathbb{N}$, the function of the complexity weight (see Table 1);

The formula $\sum_{t \in p\bullet} W_t(t)$ calculates the total weight of transitions/evolutions, output of place p ($t \in p\bullet$). For the HIN model depicted in Figure 1, the Eq. (1) becomes:

$$\boldsymbol{HIC} = \left[W_t(t_1)|_{t_1 \in p_1\bullet} + W_t(t_2)|_{t_2 \in p_1\bullet}\right] + W_t(t_2)|_{t_2 \in p_2\bullet} + W_t(t_3)|_{t_3 \in p_3\bullet} + W_a(a) * |\{t_2\}| + |\{p_1, p_2, p_3, p_4\}| = [3+2] + 3 + 1 + (2*1) + 4 = \mathbf{15}$$

Next, this HIC can be compared to the HICs of other clinical histories to establish the clinical history with the most complex structure.

3. Discussion and Conclusions

The assessment of the difficulty of an exercise allows to students to be provided with exercises with a progressive cognitive load. Future works will consider the clinical difficulty for an overall evaluation of complexity of a clinical case. A wider evaluation by medical students and doctors (professors, doctoral students, residents, physicians) in agreement with the Italian Society for Medical Education (SIPeM) is ongoing.

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