Data analysis and knowledge validation in intensive care monitoring

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Abstract

Clinical information systems (CIS) produce a complete medical documentation at the bedside. Particularly in on-line monitoring at the intensive care unit, a large amount of minutely measurements is given. The analysis of the data allows to support decision making. This trend towards data-intensive systems [3] invites machine learning or data mining techniques to apply [1], [6]. The combination of knowledge-based reasoning with data-driven prediction and validation has a great impact on evidence-based medicine and decision support [2], [7].

A set of analysis tasks provides physicians with

- alarms,
- recommendation of therapeutical interventions, and
- predictions of effects of the intervention.

Whereas statistical analysis of time series is the kind of method for alarm systems, statistical learning (here: using the support vector machine) proved its success in recommending therapeutical interventions. Inductive logic programming was capable of learning rules about observed effects of interventions. Statistical verifications of the results have been performed as well as a blind test which acquired an expert's response to patient data. [5][4][9]

Moreover, a combination of machine learning and knowledge-based inference, enables us to validate decisions.

- A knowledge base about (intended) drug effects can be compared with the observed outcome.
- A knowledge base modeling a treatment protocol can be compared with the observed sequence of interventions.

Consistency checking or critiquing a knowledge base on the basis of empirical data speeds up the process of protocol developement, focuses medical discussion on critical and relevant questions, and improves the protocol's quality [8][10]. This talk shows how knowledge-based and data-driven procedures in concert contribute to enhanced treatments and protocols. The methods are illustrated by work done at the City Hospital of Dortmund in collaboration with the medical expert Michael Imhoff.

References

[1] Special issue on data mining techniques and applications in medicine. *Artificial Intelligence in Medicine*, 16(1), Mai 1999.

[2] Fernando Alonso, Juan P.Caraca-Valente, Loic Martinez, and Cesar Montes. Discovering similar patterns for characterizing time series in a medical domain. *Knowledge and Information Systems*, 5(2):183 – 200, April 2003.

[3] Werner Horn. AI in medicine on its way from knowledge-intensive to data-intensive systems. *Artificial Intelligence in Medicine*, 23(1):5 – 12, 2001.

[4] Michael Imhoff, Ursula Gather, and Katharina Morik. Development of decision support algorithms for intensive care medicine: A new approach combining time series analysis and a knowledge base system with learning and revision capabilities. In Cremers Burgard, Christaller, editor, *KI-99, Advances in Artificial Intelligence, 23rd Annual German Conference on Artificial Intelligence*, pages p. 219 – 230. Springer, 1999.

[5] Michael Imhoff, Ursula Gather, and Katharina Morik. Dynamic knowledge discovery and validation for medical decision support. In *Healthcare Information and Management Society 2000, Dallas*, 2000.

[6] Nada Lavrac. Selected techniques for data mining in medicine. *Artificial Intelligence in Medicine*, 16(1):3–23, 1999.

[7] Peter Lucas, Nicolette de Bruijn, Karin Schurink, and Andy Hoepelman. A probabilistic and decision-theoretic approach to the management of infectious disease at the ICU. *Artificial Intelligence in Medicine*, 19(3):251 – 279, 2000.

[8] Katharina Morik, Michael Imhoff, Peter Brockhausen, Thorsten Joachims, and Ursula Gather. Knowledge discovery and knowledge validation in intensive care. *Artificial Intelligence in Medicine*, 19(3):225–249, 2000.

[9] Katharina Morik, Thorsten Joachims, Michael Imhoff, Peter Brockhausen, and Stefan Rüping. *Computational Intelligence Processing in Medical Diagnosis*, volume 96 of *Studies in Fuzziness and Soft Computing*, chapter Integrating Kernel Methods into a Knowledge-based Approach to Evidence-based Medicine, pages 71–99. Physica-Verlag, 2002.

[10] Martin Scholz. Using real world data for modeling a protocol for ICU monitoring. In Peter Lucas, Lars Asker, and Silvia Miksch, editors, *Working notes of the IDAMAP 2002 workshop*, pages 85–90, May 2002.