Bringing Bayesian networks to bedside: a web-based framework

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Motivation: The use of statistical methods and quantitative analysis in the clinical decision-making process, is one of the ways of using the latest scientific evidence. Despite its advantages, the availability of inference software in clinical settings is still limited. The nature of biomedical data requires the application of techniques that go beyond traditional biostatistics, such as Bayesian networks. Bayesian approaches have an extreme importance in clinical problems, since they provide both qualitative and quantitative perspectives. They consider prior knowledge, making data analysis an update processing of prior knowledge with observed evidence.

Solution: To potentiate the use of the statistical methods within the daily practice, we created simple web forms (A and B). These web forms do not require complex interactions, receiving clinical inputs and transmitting them to a Bayesian network inference engine. The information is processed by the engine and the output data is sent to the end-user through the same web form. This approach makes the derived models usable at bedside by both the clinicians and the patients themselves.

A. Prognosis of disabling Crohn's disease

Crohn's disease (CD) is a chronic and progressive disease of unknown etiology, prone to relapses and disabling events. Our aim was to implement models for disabling CD and reoperation based solely on clinical/demographic data.

The models developed in this case study were Tree-Augmented Naïve Bayes [TAN] classifiers. The Bayesian models achieved an area under the curve (AUC) of 78% for disabling disease and 86% for reoperation.
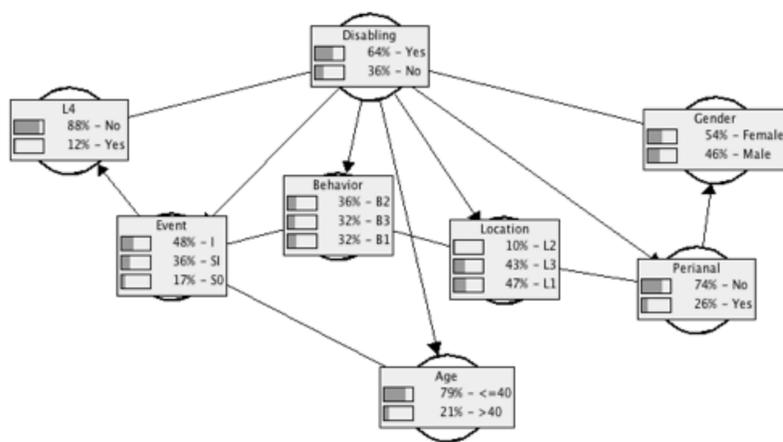

Figure 1. Bayesian network for disabling Crohn's disease. The bars within each variable represent the prior marginal probabilities for each variable's category.

Figure 2. Web-based form for disabling Crohn's disease and reoperation. Bottom table presents predicted risks for the patient described above.

B. Prognosis of endoscopic gastric submucosal dissection

Efficacy and adverse events probabilities influence decisions regarding the best options to manage patients with gastric superficial lesions. We have implemented Bayesian models to individualize the prediction of outcomes after gastric endoscopic submucosal dissection (ESD). Naive Bayesian models presented AUC higher than 74% in cross-validation for both cure and post procedural bleeding outcomes.
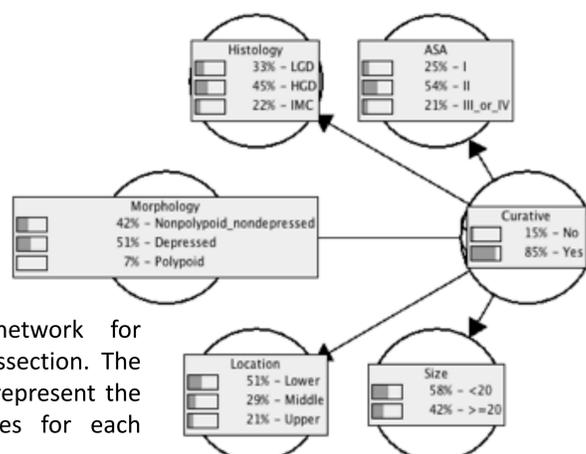

Figure 3. Bayesian network for endoscopic submucosal dissection. The bars within each variable represent the prior marginal probabilities for each variable's category.

Figure 4. Web-based form for curative endoscopic submucosal dissection. Bottom table presents predicted risks for the patient described above.

Future Steps: Future work will aim at improving the user interface, allowing for a better interaction and usage of the tool. This work will consider the target user (physician or patient) comprising adjustments when it comes to scientific knowledge and used language.

An additional objective, to be prosecuted further, is the automatic development of online forms from Bayesian networks, subject to subsequent review, but making it unnecessary to manually create each form from scratch. In this case, one will also develop tools that allow the addition of contents of interest by the developer of the Bayesian network.