The Challenge
Standard medical practice is moving from relatively ad-hoc and subjective decision making to data-driven healthcare. Rulex efficiently analyzed the large volumes of medical data of the two most important Northern Italy Pulmonary Departments and extracted potentially useful information and biomarkers for Malignant pleural mesothelioma (MPM) Diagnosis. MPM is a highly aggressive cancer whose diagnosis may be hampered by the occurrence of diseases with atypical similar symptoms (in particular: benign pleurisies, BP, and pleural metastases from other tumors, MTX).

SMRP, CYFRA21-1 and CEA are tumor markers that have been recently demonstrated to be differently concentrated in pleural effusions of patients with different plural diseases. However, a classification method for the differential diagnosis of MPM does not exist yet.

The Rulex approach

The Logic Learning Machine (LLM) method, implemented in RULEX, is able to extract simple intelligible rules for classification purposes. LLM was applied to the concentration values of SMRP, CYFRA21-1 and CEA measured in 169 patients admitted to the two Pulmonary Departments from 2009 to 2011 (52 MPM, 62 MTX and 55 BD, respectively). Taking into account the multivariate correlation between the considered markers, LLM was able to extract intelligible rules by identifying a small set of cut-off values for each considered marker.

About Rulex

Rulex is a revolutionary prescriptive analytics platform: decision makers can now quickly extract actionable knowledge from the available data and define effective actions for the future.

Based on the next generation machine-learning technology, Rulex provides actionable rules (if-then) and insights, which are inferred automatically from data coming from multiple heterogeneous sources.

Rulex is available as desktop software with GUI or as server with APIs to be built into automatic processes.

Rulex is being successfully used by banks, insurances, telecoms, retailers and consumer goods producers to meet their big data challenges with a scalable and automatic approach.

Rulex, Inc. is headquartered in Boston, MA (USA).
Inputs / Tumor markers
Input variables included: SMRP, CYFRA21-1 and CEA concentrations in pleural effusion at the time of patient’s diagnosis.

Output / Diagnostic accuracy
Proportion of correct classification (accuracy) of the generated rules was evaluated in the three groups of patients (MPM, BP and MTX).

Model / MPM vs. MTX vs. BP
The performance of LLM was compared to that of three standard methods of supervised machine learning (namely, decision tree, artificial neural network and k-Nearest Neighbor classifier). A leave-one-out cross-validation was performed to control the overfitting bias. Classification based on LLM showed a 78% of global accuracy and outperformed any other considered method. LLM rules clearly pointed out that high values of SMRP and CYFRA21-1 and low values of CEA are strong predictors of MPM. MTX can be identified by high values of CEA and CYFRA, whereas low values of all markers are specific for BP diagnosis.

Ready to be proactive
In the realm of healthcare Rulex is contributing the way Doctors make decisions and diagnose complex patients, significantly improving accuracy and catching deadly issues before symptoms even present themselves!

RULEX provides a flexible and powerful tool for the differential classification of malignant mesothelioma.
The proprietary algorithm of the Logic Learning Machine has been demonstrated to be potentially applicable to problems related to cancer diagnosis in the presence of non-specific symptoms, a very frequent issue encountered in clinical settings. A correct diagnosis is often mandatory to address therapeutic approaches and to improve the survival of cancer patients.

Rulex can give to the Hospital the opportunity to take advantage of the massive amounts of data and provide “right intervention to the right patient at the right time”. Managing in the right way data permit to personalize care to the patient and increase benefits for all the components of a healthcare system (provider, payer, patient, and management).

Moreover, better define cancer diagnosis can guide efficient resources utilization and can potentially save millions of lives and dollars/euros!

Example of rule
If SMRP > 4.5 nmol/l and if CYFRA21-1 > 71.3ng/l and also if CEA ≤ 8.75 then diagnosis = MPM.

Case Study Metrics
Data pre-processing: 1 Second
Model extraction: 3 seconds
Hardware: Standard Intel PC

www.rulex-inc.com