Classification of psycho-physiological measurements in medical systems

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For many domains it is sufficient to classify measurements obtained by sensors by filtering noisy data and perform a classification of the measurements with some mathematical function. For domains where large numbers of classified measurements are available, neural networks may be used. Unfortunately these methods and techniques are difficult to use for some domains, e.g. diagnosing psycho-physiological dysfunctions, i.e. stress related disorders. Measurements may be so noisy and contain distortions that classification may be to complex with traditional methods. A conventional classification task or a matching procedure may end up with a number of classification candidates. Historic data (previously classified measurements) may be sparse and same measurements may indicate several diagnoses.

We propose a Case-Based Reasoning approach where feature vectors are matched against cases in a case library, and where in-deterministic or weak classifications are validated by an experienced physician, pointing out the features relevant in the classification. The physician's classifications are stored in the case library, continuously improving the systems performance as it is being used. If only a few examples of classified measurements are available, the physician initially points out which feature combinations are used in the classification/diagnosis. The system will thereby improve its ability to classify measurements as the number of cases grows.

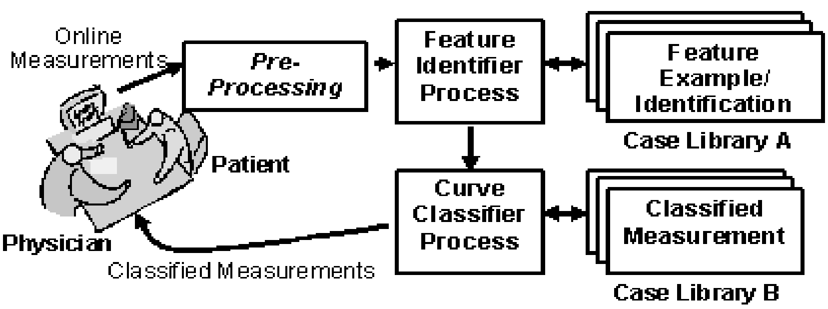

Figure 1: A physician using ICBC in the treatment of a patient.

Physicians diagnosing psycho-physiological dysfunctions use different sensor readings to diagnose a patient. The measurement classification process is difficult and long experience is needed to learn the skill of making accurate classifications. We outline how complex measurements are classified using an Interactive Case Based Classification (ICBC) approach. The classification task is divided into three steps, pre-processing, feature identification and classification. The Interactive Case Base Classification is illustrated in Fig 1.

The pre-processing removes distortion in sensor readings caused by limitations in sensors, patient's movements and other outside interference. To remove the distortions the pre-processing step uses a case library containing models of possible distortions and information on how to remove them. Unsound data is also removed or corrected in this step. Unsound data is non-classifiable data not originating from faulty measurements, i.e. non-sensor related issues. In the feature identification step we identify and extract relevant features used by physicians to classify measurements and create a feature vector. Some features are based on relations between different measurements; hence the feature identification process is divided into two parts. In the first part we extract features from the pre-processed measurements and put the features in a vector. Secondly trends and complex inter-vector dependencies are found and added as complex features in the original vectors. In the third step feature vectors are classified using a nearest neighbour search and a library with previously classified features. Patient specific information is also important for the final classification and diagnosis; it is used to adapt and individualise the final classification based on patient requirements.

Dividing the classification in three steps makes the interaction with physicians easier, as they are able to see what features are identified. The physicians are able to compare the features with their own observations and also compare it with the base of the systems classifications, i.e. similar feature vectors from the database together with additional information about the patient. Once experienced physicians identify new features and refine classification, these new features are added to the feature identification library. An advantage is that experienced physicians appreciate a second opinion when classifying measurements manually, despite the fact that the second opinion is produced by a system. Inexperienced physicians get the opportunity to learn faster and for experienced physicians their awareness on how they perform classification is increased and enables them to refine their skills and add their knowledge to the system.