Knowledge Helper for Medical and Other Information users

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Introduction (What)

- Prediction of outputs in response to inputs
- Construction of a model based on the available information about system behavior
Introduction (Examples)

- Enhancing the monitoring online of the functioning of Sodium Fast Reactors using acoustic signals

Model
Characterizing the noises of steam generator

Available information: Measurements of the noises of the steam generator

Normal functioning

Fault functioning (Leakage)
Introduction (Examples)

- Premature detection of micro leaks in refrigerated liquid tanks

Available information: measurements about the liquid level in the tank during the past consumption
Introduction (Examples)

- Monitoring of the quality of folded pieces

Available information: Measurements about the noises of folding process + human experience
Introduction (Examples)

- Discrimination of hemiparetic patients and follow up of their response to a specific medical treatment
  - Hemiparetic patients present gait disturbances resulting of lesions in their central nervous system
  - Quantifying of the inter-segmental coordination between two body segments using the Continuous Relative Phase (CRP) measure
Introduction (Examples)

Healthy subject

Hemiparetic subject

Gait cycle (%)

CRP_{Thigh-Shank} (°)  CRP_{Shank-Foot} (°)

Seminar-CREATIS-7/04/2010-Lyon
Introduction (Examples)

Model characterizing the human gait

Available information: Two signals + doctors evaluations

Quantification of the positive response to treatment
Introduction (Aims)

- Effective automated information extraction
  - Automated analysis and indexing for medical information (images, data, texts, ..)
  - Trustable results at a level of understability adapted to users (personalization to the class and expertise of user)
  - Helping clinicians in reasoning over similar cases (Diagnosis aid)
  - Providing updated, related and timely results
Methods (How)

- Two categories of methods:
  - Model-based methods (Quantitative [GEN 07]/Qualitative [CAS 99])
  - Reasoning-based methods [DUB 90], [DUD 01]
- The available information, objectives and system size determine the method(s) to be used
Methods (Constraints)

- Available information
  - Many sources (Images 2D, 3D and 4D, Texts, measurements, reports on patients, diagnosis, ..)
  - Different representation
  - Different level of trust and target user expertise
  - Huge size (125 TB)
  - Exponential increasing rate (100 GB of images per day from 400 patients)
  - Evolving environment
Methods (Constraints)

- Available information
  - Conflict data
  - Incomplete, imprecise and uncertain information
  - High dimensional data

- Objectives
  - Making decision in real time
  - Taking into account the collaboration between different actors of different expertise levels and domains
  - Following a situation evolution over time
Methods (Constraints)

- System size
  - Centralized
  - Dcentralized
Methods (How)

- Reasoning-based methods:
  - Knowledge-based methods [DUB 01]
  - Machine learning methods

- Machine learning methods
  - Statistical Pattern Recognition [DUD 01]
    - Parametric [DUB 90]
    - Non-parametric [PAR 62] [ANI 00]
  - Structural/syntaxic Pattern Recognition [CHE 90] [FU 82]
  - Neural networks [ZWI 95], [DUB 01]
  - Support Vector Machines (SVMs) [VAP 99], [CHA 08]
Pattern Recognition

- Pattern recognition principal

Pattern Recognition System

Observation vector $y$ → Feature extraction → Feature vector $x$ → Classifier → One of the classes → Decision space → Output decision
Pattern Recognition

Transmission rates according to the two wavelengths

Model characterizing the type of plastic material

PVC (Class 1)
PEHD (Class 2)
PET (Class 3)
Pattern Recognition

- XOR example
Pattern Recognition (How)

- Filter method ranks features or feature subsets independently of the predictor (classifier) [SAE 07]
  - Univariate method: considers one variable at a time [BEN 82]
  - Multivariate method: considers subsets of variables together [HAL 99]
- Wrapper method: uses a classifier to assess features or feature subsets [KIT 78]
Pattern Recognition (How)

- Structural Pattern recognition principal
Pattern Recognition (How)

- Supervised classification methods [DUD 01]
  - Fuzzy methods [ZAD 65]
  - Possibilistic methods [DUB 88], [ZAD 78]
  - Evidence methods [SHA 76]
- Unsupervised classification methods
  - Hierarchical methods [LEB 95]
  - Partitioning methods [BEZ 81]
- Semi-supervised classification methods [CHA 06]
- Semi-supervised clustering methods [BAS 02]
- Semi-supervised learning [SAY 10]
Pattern Recognition (How)

- Active learning [OLS 09]
- Incremental learning [SAY 02]
- Multi-classifiers [CHE 97]
  - Classifier fusion (Serial/Parallel)
  - Classifier selection (static/dynamic)
- Dynamic Pattern Recognition
  - Substitution of patterns [NAK 97], [LEC 06]
  - Selection of useful patterns [ANG 00], [MAR 98], [HAR 10]
Summary

- Active, incremental, dynamic semi-supervised learning
- Dynamic multi-classifiers selection system
- Dynamic feature space
- Hybrid (structural/statistical) Pattern Recognition
- Adaptive Human-Machine Interface
- Decentralized structure of processing
References


References


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References


[LEC 06] Lecoeuche, S., Mercère, G., Amadou-Boubacar, H., Modelling of Non-stationary Systems based on a Dynamical Decision Space, 14th IFAC Symposium on System Identification (SYSID06), 2006.

References


References


