Cotutelle thesis project

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Development of sequence grouping methods for modeling and optimizing care paths

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1 Description

Low back pain is the leading cause of disability worldwide [Wu et al., 2020]. Some 75 to 80% of people will suffer from it at least once in their lives, and 619 million were affected in 2020, with an estimated 843 million in 2050 [GBD 2021 Low Back Pain Collaborators, 2023]. Its annual cost amounts to several billion euros, impacting both patients' quality of life and healthcare systems [Fatoye et al., 2023]. The management of low back pain is complex, due to the diversity of treatment options (e.g. physiotherapy, surgery, neurostimulation) and the lack of consensus on treatments [Mavrocordatos and Cahana, 2006]. Treatment choices are often based on clinical experience, which can lead to inappropriate and time-consuming care [Meints et al., 2013]. It is therefore necessary to identify patient sub-populations in order to guide them towards personalized care pathways according to their clinical and psychosocial characteristics at a given time.

The multidisciplinary approach to pain (MPA) is based on shared decisions between specialists, but its application remains limited by reduced access to specialized centers and difficulties in interdisciplinary coordination. The aim of this project is to develop an automated system for identifying optimal care sequences based on patient characteristics and treatment history. A care sequence can be modeled as a succession of states. Sequence Analysis (SA) methods can be used to cluster these sequences to define "typical pathways". Although promising, SA is not widely applied in medicine. Our aim is to jointly model care trajectories and the evolution of health status, despite the complexity induced by concomitant therapies. Several challenges remain in AS: the management of sequences of different durations, the inclusion of temporal covariates in clustering, and the estimation of causal relationships, essential for medical decision support. Recent work [Studer et al., 2018, Fauser, 2020] attempts to integrate time-dependent covariates and apply causal methods, but remains limited to fully address the challenges of this project.

The objectives of this thesis are:

- Identify typical care pathways for patients with low back pain.
- Jointly model care trajectories, clinical and psychosocial characteristics.
- Integrate confounding variables to model the effect of therapeutic changes on health status.
- Apply the methods developed to real-life databases from the PRISMATICS laboratory, including over 400 patients.

The PRISMATICS laboratory (CHU de Poitiers) and the Mathematics and Applications laboratory (Université de Poitiers) have previously collaborated to study the development of statistical algorithms designed to personalize the assessment of chronic pain patients using latent class models. These algorithms have led to new methods for personalized, multidimensional pain assessment, integrating the sensory, functional and psychological dimensions of pain, while taking into account the behavioral and sociodemographic specificities of each patient [Rigoard et al., 2021, Ounajim et al., 2023]. This collaboration has resulted in several scientific publications [Rigoard et al., 2021, Ounajim et al., 2021, 2023] and the creation of an R package available on CRAN (`MixLFA` in [Ounajim et al., 2024]).

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