- Clinical relevant holistic metrics that integrate physiological parameters were derived using non-standard algorithms in order to permit a comprehensive and automatic assessment of the patient health status, which is currently non-existent, as a basis for new preventive and treatment approaches. Algorithms employing clinically relevant metrics are the key elements for early home-based monitoring systems assessing patient routine behaviour and sleep modalities. In all likelihood these metrics will also be relevant for other chronic diseases.

1.5 Outline of the thesis

This thesis presents recent methodological approaches in three areas: i) design and evaluation of methods for ubiquitous, patient-centric technologies (chapters 2 and chapter 3); ii) analysis of continuous and real life patients' data to generate new insights into the disease (chapters 4 and 5); and iii) algorithms for patient behavioural pattern understanding and disease severity classification (chapters 6 and 7). Finally, conclusions are presented in chapter 8.

1.6 Own contributions

Different ubiquitous frameworks and data analytics methodologies have been proposed during this research activity to improve patient's management and will be extensively explained throughout this manuscript. The author's main contributions are summarized in this section.

Two smartphone based frameworks are presented for data recording and patient training, respectively. In particular, in chapter 2 a framework for sensors data acquisition, signal processing, pattern analysis, interaction and feedback is introduced and formally evaluated. The framework provides components to read smartphone and external sensor data, supporting annotations, and various output components. It proved to be well-suited for prototyping health applications in real-life, where online sensor data recording and recognition is needed. A new smartphone-based training system that integrates in clinical routines and serves as a tool for therapist and patient is illustrated in chapter 3. Only the smartphone's build-in inertial sensors were used to monitor exercise execution and providing acoustic feedback on exercise performance and exercise errors. A Teach-mode was used to personalize the system by training under the guidance of a therapist and deriving exercise model parameters. Subsequently, in a Train-mode, the system provides exercise feedback. System performance, trainee performance, and feedback efficacy were analysed and viability of the training system demonstrated.

New insights and understanding were generated related to daily physical activity and sleep of patients with COPD. As described in chapter 4 daily physical activity measures and hourly patterns were analysed based on data from a multi-sensor armband. Principal component analysis and cluster analysis were applied to physical activity measures to identify clusters of patients with COPD. These clusters may be useful to develop interventions aiming to promote physical activity in COPD. Chapter 5 describes how relations between sleep and daytime physical activity data were analysed. The main factors associated with sleep impairment were identified. Moreover, the association of nocturnal sleep impairment with patients' subsequent physical activity, and daytime sleep, was investigated showing a clear relationship between COPD patients' sleep and the amount of activity they undertake during the next waking day.