Smart Journey Mining for Improved Service Quality

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Abstract—This paper describes emergent challenges in extending and uniting research in service science and process mining. By combining formal representations of user journeys with process mining constructs, we aim to develop tools for automated capture and analysis of user interactions extending across service systems. Based on the resulting database of actual user journeys and user models, we will use logic-based techniques and machine learning to expose deviations and predict possible behaviours for pre-emptive problem solving and service recovery.

Index Terms—user journey, process mining, formal models

I. Introduction

The digitalization of our society's service systems fundamentally changes the way public and private services are developed, delivered and experienced by humans. Considerable attention is devoted to digital transformation and the alluring possibilities of increased flexibility, automation, efficiency, freeing up resources and saving costs [1]. Comparably, little attention is being paid to failing user interactions and incoherent service experiences, even though service quality and enhanced service experience is one of the top priorities within current service research [2].

Unlike business process models, user (or customer-) journeys consider processes entirely from the perspective of end-users [3]. A user journey represents the steps (touchpoints) experienced by an end-user to achieve a specific goal, and it may involve several systems and even multiple service providers [4]. Journey methodology has become widespread among public and private service providers to design new services and to improve service quality [5]. User journeys certainly advocates user-centred design; however, the lack of formalism and tools to automatically capture the actual journeys for analytical purposes hinders its operational use [6].

The ultimate goal of the presented work is to discuss the development of a process analysis framework based on formalized user journeys which will enable identification of patterns that optimize the user experience and service quality. Fig. 1 shows how we plan to tackle the initial steps of the research challenges. The actual behaviour of users interacting with the service system is tracked through, e.g., events recorded in various business systems and databases. *Process mining* extracts traces of user behaviour into a *semantic journey database*, to be systematised and abstracted into models of user journeys, but process mining also enables the relation between the user journeys and the accumulated information
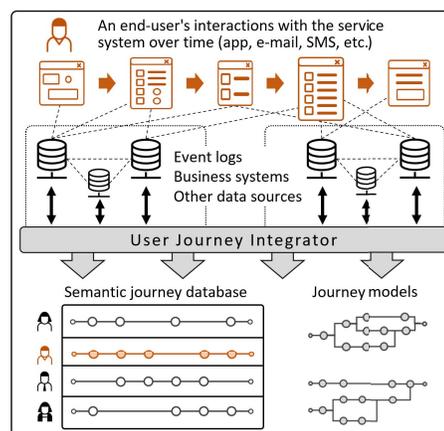
Fig. 1. The main research idea.

in the service system to be made explicit. Extracting both the user journeys and the corresponding descriptions of how they interact with the infrastructure of the service system, enables models of the user journeys to be combined with models of the infrastructure, thereby enabling model-driven analyses and improvements to the user journeys, based on formal, executable models. Thus, there are three methodological components to the overall process: process mining, user journey modelling and resource-sensitive formal models.

Process mining is a fast-growing research field that utilises the wealth of data generated during execution of a business process, allowing organisations to reverse-engineer their business processes by analysing digital traces (events) left in information systems [7].Data is put into the context of an end-to-end business process by automatically discovering the as-is business process model based on data recorded in the form of an event log [8].

Customer journey modelling language (CJML) is a language for specification and visualisation of user journeys and service processes [9]. In this paper we map the major CJML concepts against the major concepts used in process mining and the closely related XES standard [10] for event data.

The semantic journey database will, together with journey models, form the basis for journey analysis at three levels: a descriptive level for discovery and monitoring, a predictive level for anomaly detection, and a prescriptive level for pre-

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emptive problem solving. Resource-aware formal models will be used to capture the overall behaviour of user journeys in the context of the service system's infrastructure as an executable formal model that can be used to analyse user journeys. To reflect the typically decentralised infrastructure of the service providers and to formalise user experience, we need to describe not only the concurrent interactions between different actors, but additionally capture aspects related to time and resources related to the journeys. To this aim, we will use the *Abstract Behavioral Specification* (ABS) language [11], which is designed to develop executable models with a parallel, object-oriented program flow, and supports the modelling of timed and resource-sensitive distributed behaviour [12].

II. KNOWLEDGE NEEDS AND RESEARCH CHALLENGES

Some initial research has been reported on adopting the data-driven view of process mining towards user journey [13]–[17]; however, challenges remain and several knowledge gaps have been identified: (1) Process mining as a research field does not have a profound user focus. Methods to represent and capture the user's experience throughout execution of multiple related processes are lacking; (2) Data integration and fusion challenges need to be solved to track user journey data across systems, which is a prerequisite for adopting a process view of the user journey. Today, users face a service delivery network [4] rather than a single service provider in their endeavour to complete their goals. This results in data being scattered across service systems and heterogeneous data sources that need to be integrated. In addition, data traces often exist at different levels of granularity and from different perspectives, making it necessary to transform the traces into a common level of abstraction for analysis in a user journey model. This leads to the following research questions:

- RQ1: How can existing conceptual models for user journey documentation and analysis be extended to represent the data recorded during the user journey?
- RQ2: How can this data be retrieved, integrated and raised to an appropriate level of granularity in the context of a user journey?

III. INTEGRATING CORE CONCEPTS AND CONSTRUCTS

As a start, we explored the relationship between common concepts and constructs used in CJML and in process mining to prepare our investigation of the research questions. In Fig. 2 the classical definition of an event log and a business process, as used in process mining [8], is extended with and linked to the core concepts of CJML. The event log concepts, e.g., as captured by an event log in IEEE XES standard [10], are shown with a white background whereas the CJML concepts are highlighted in green.

A. CJML

The main constructs of CJML are *customer journey* and *touchpoint*. A customer journey is defined as a sequence or constellation of touchpoints involved for a customer or user to achieve a specific goal or a desired outcome. Unlike other customer journey approaches, CJML distinguish two states of a journey: (1) the hypothetical state as intended by the service provider (planned journey, which we omitted in Fig. 2 for the sake of space), and (2) the dynamic state as the journey is executed by an end-user (actual journey). Touchpoints can be of two main types. *Communication points* are instances of communication or interaction between a user and a service provider (e.g. an e-mail). *Actions* are non-communicative events or activities (e.g. customer signs a document). User experience is handled in line with HCI research; as a subjective, dynamic, and context dependent phenomenon [18], and thus pertinent for actual journeys only. The communication points form the backbone of a journey, and have attributes inspired by the Shannon-Weaver model of communication [19] where a sender transmits a message to a receiver through a communication channel.

B. Business Processes and Event Logs

In classical process mining, each process consists of multiple activities which can be performed in well-defined sequences. When an instance of a process is executed it is denoted as case and it is assumed that each instance of an activity linked to a case results in one or more events being recorded. Each of the events carries multiple attributes, for instance defining the time of occurrence, the responsible human or non-human resource, and potentially many more.

In contrast to the existing related work on relating customer journey concepts with process mining [13], [17] we do not map the customer journey directly to the concept of a *process*. In fact, a customer journey may be supported by many business processes and can often even span across several organisational units or organisations [4]. Thus, any connection to process mining concepts should allow to map a single *actual journey* to a set of different *processes*. Following the same line of thought a *touchpoint* may be linked to many *activities*, e.g., a communication with a customer requires multiple process activities to be performed.

Based on this, we proposed a mapping between the actual journey and the data recorded in event logs that is more suitable for analysing complex customer journeys. Often, the events relating to the user journey are spread across several event logs, e.g., a sales process and a help-desk process. In addition, there may be events recorded that are related to the user journey but not related to any of the service providers processes, e.g., the event log of a user browsing the general website of the organisation for information.

IV. DISCUSSION AND FUTURE WORK

During service consumption, end-users expect seamless interactions across departments and organisations. However, they often meet a fragmented, incoherent services [6]. Therefore, we consider the complex interaction between a user journey with several business processes of service providers. This is in contrast to the state-of-the-art in process mining on user journeys which generally takes a simplistic view considering the whole journey as a single process.
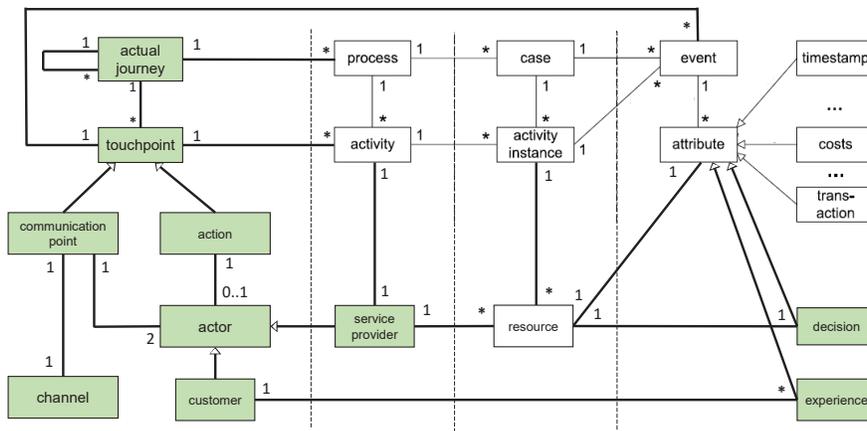
Fig. 2. Integrating CJML and user journeys concepts (highlighted in green) with common concepts used in process mining and events log. Adapted from [8].

Based on the resulting semantic journey database and journey models, we will investigate the use of logic-based techniques and machine learning to expose deviations and predict possible behaviours. For this purpose, we will develop resource-aware formal models integrating the different concepts described in Fig. 2. We then plan to adapt techniques from the analysis of cloud computing software [20] for the exploration of resource-aware models of user journeys, in which resource-aware executable models can be driven by system logs. Here, we will use the semantic user journeys derived with process mining technology to feed the resource-aware model with data from the real world.

We expect this integrated approach to form the basis for developing analytics for user journeys, in which resource consumption associated with the user's actions and communications with the service provider in the model accumulate to quantitatively reflect the user experience from different journeys. Finally we contend that combining data-driven analyses of user journeys with formal methods and pattern recognition (through machine learning) will reveal patterns to inform the design of coherent and satisfying digital services. Such *user journey patterns* will be validated against empirical investigations of actual journeys by involving end-users [6].

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