Small Data, Big Impact: Navigating Resource Limitations in Point-of-Interest Recommendation for Individuals with Autism

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Abstract

Autism Spectrum Disorder (ASD) affects sensory perception, making spatial exploration difficult. Recommender systems can assist ASD users by suggesting Points of Interest (POIs) aligned with their sensory preferences. However, demographic constraints, difficulties in engaging ASD users, and the complexity of obtaining sensory data position POI recommendation for ASD people as a low-resource problem. In this paper, we identify key challenges in developing such systems and present our ongoing efforts. Using a local ASD center as a use case, we are developing a structured user involvement protocol. From the limited data, we are deriving knowledge graphs (KGs) to model preferences and sensory aspects. We are then exploring KG-based techniques to generate paths from users to POIs to suggest. With psychologists, we are refining the paths structure to match varying complexity levels and translate them into natural language accessible for people with ASD.

CCS Concepts

• **Information systems → Users and interactive retrieval**; • **Human-centered computing → Accessibility technologies**.

Keywords

Autism, POI Recommendation, Knowledge Graphs, Path Reasoning.

1 Introduction

Background. Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition with a rising global prevalence [35].

Diagnoses have significantly increased in regions such as Europe, the UK [22], and the US [6], driven by greater awareness, improved diagnostic practices, and public health initiatives. The autism spectrum encompasses a wide range of cognitive abilities, from individuals with severe language and intellectual impairments to those with typical or above-average intelligence [12]. Challenges in most cases include difficulties in social interaction, restricted interests [2], and atypical sensory perception [26, 27]. These factors often lead to sensory overload in environments that neurotypical individuals navigate with ease. Spatial exploration, which involves exposure to unpredictable environmental stimuli, can be particularly challenging and anxiety-inducing [23]. As a result, many individuals with ASD experience increased stress when visiting unfamiliar places.

Problem Statement. Digital technologies have proven valuable in supporting individuals with ASD, as they respond positively to the predictability of these systems [28]. Most existing solutions focus on addressing social challenges, such as facilitating face-to-face conversations [7], aiding in emotion regulation [24], and promoting social engagement [8]. Beyond this, digital technologies can also assist in navigating spaces. Recommender systems, in particular, can help ASD users explore new locations by suggesting Points of Interest (POIs) tailored to their sensory preferences. Yet, recommendation approaches often rely solely on user preferences [21], whereas prior work has shown that incorporating sensory aversions alongside preferences can enable a more effective support to ASD individuals [18]. Additionally, such people heavily rely on sensory information when deciding which places to visit [10]. As a result, there is a pressing need for a user modeling approach that considers all these aspects in POI recommendation for ASD users.

State of the Art and Limitations. The current state of research on POI recommendation for ASD individuals is constrained by several limitations, many stemming from its low-resource nature. First, studies typically rely on small sample sizes due to limited access to ASD participants, restricting their generalizability. Conducting research with them has unique challenges due to their social interaction difficulties and reluctance to engage in new experiences [25]. However, despite these constraints, prior studies have shown that insights can still be derived from small cohorts of 10–30 participants [10, 18]. Additionally, existing research predominantly focuses on children, with limited studies targeting adults with ASD [15]. The scarcity of data for such a group is concerning as they increasingly require support in achieving independence [13]. Finally, there is a

lack of sensory data about locations, due to the omission of such details in location-related sources and the need to obtain this data directly from ASD users, whose engagement is inherently hard.

2 Open Challenges

Developing recommender systems for ASD users presents key challenges we face, arising from addressing the above limitations.

C1. **Limited population size and availability for system development and testing**. Autistic users represent a small portion of the overall population [35], many orders of magnitude less than what is needed to train modern recommendation models. Moreover, reaching them for research purposes often proves challenging given social difficulties [2], resulting in insufficient gathered data. This scarcity of interaction- and sensory-related data impacts the system's ability to learn and adapt to users.

C2. **Negative consequences of inaccurate suggestions**. Poorly matched recommendations could trigger sensory overload, anxiety, or distress due to the sensory sensitivities and rigid preferences often associated with autism. Unlike common consumer scenarios where a bad suggestion merely results in user dissatisfaction, recommendations for ASD users can have significant impacts on emotional well-being and daily functioning [14].

C3. **Demanding degree of personalization for ASD people's environmental idiosyncrasies**. Traditional recommender systems that rely on peer profile matching or latent factor extraction often fail to capture the unique sensory aversions and preferences that impact how people with ASD experience places and activities. Sensory information represents a crucial feature for POI recommendation [18]. However, the available information is often sparse or incomplete. This requires exploring extraction techniques from proxy information sources (e.g., reviews [19]) to bridge the sensory data scarcity gaps. Still, collecting information alone is insufficient, as it often remains unstructured and does not naturally reveal the relationships among sensory features, idiosyncratic aversions, and POI preferences. Promising solutions suggest designing ontologies that enable Knowledge Graphs (KGs) from collected data [11, 29].

C4. **Transparency of recommendations**. People with ASD tend to employ more structured, logic-driven decision-making processes compared to neurotypical individuals, often requiring clearer reasoning pathways to reach conclusions and spending a lot of time collecting and collating information [17, 30]. Matching explanations with recommendations can help improve the systems' transparency, thereby supporting ASD users' decision-making. Explanations based on reasoning pathways [1, 4] could be effective, as they may reduce cognitive load.

C5. **Essential accessibility requirements for information delivery**. Item information and explanations must be carefully elaborated and presented in ways that accommodate the perceptual and cognitive patterns of individuals with autism [5]. This requires work in content adaptation and interface design to ensure that information is not just available but truly accessible and comprehensible to the target ASD users [16].

C6. **Need of specialized care on recommender systems evaluation**. Evaluating recommender systems for ASD users requires specialized methodologies due to their unique engagement patterns and cognitive characteristics. Individuals with ASD often have limited attention spans and reduced engagement periods [20], rendering traditional user study designs less effective [9]. Furthermore, effective evaluation necessitates close coordination with healthcare professionals and caregivers.

3 Our Progress So Far

We are addressing the outlined challenges in collaboration with the *Regional Center for Autism Spectrum Disorders in Adulthood - ASL City of Turin*[1]. Specifically, we are engaging with its experts to recruit users, gather requirements, and iteratively refine our design. **Specialized involvement protocol.** To mitigate the impact of C1 and C6, we are creating a structured, reproducible user-centered involvement protocol in collaboration with ASD specialists, leveraging a participatory co-design methodology. This protocol aims to facilitate participant recruitment, ensure ethical considerations, and maximize the relevance of collected data on user preferences and sensory aversions to enable the subsequent steps of the design. **Graph-based data modelling.** With C2 and C3 in mind, we leveraged the demonstrated success of KGs in other recommendation domains [33, 34]. First, we developed a novel ontology informed by previous studies [10, 18]. This ontology models the relationships between autistic users, sensory aversions, POI categories, and POI sensory features, integrating expert-defined criteria to ensure compatibility between user needs and environmental characteristics. Using this ontology, we then constructed a KG (25,468 triples, 551 entities, and 5 relations) from the small dataset collected in [10, 18]. **KG-based path reasoning recommendation models.** We are developing explainable recommendation models based on path-reasoning techniques [4, 31] (C4). These models enable explanations by traversing structured meta-paths within the KG, mirroring human reasoning patterns to provide more intuitive justifications for recommendations. Our approach explores two complementary path-based strategies. The first leverages reinforcement learning [31, 32], with an agent traversing the KG, whereas the second employs language models [3], interpreting KG elements as tokens. **Tailored recommendation delivering.** To address C5 and C6, we are developing tailored explainable recommendation delivery strategies for ASD users. As part of this effort, we are preparing a survey following [1] to collect feedback on preferred explanation formats, structured around the generated paths. Prior to this, we involved psychologists to adapt explanation templates and optimize the user interface for mid-high functioning ASD users, such that the former match individual cognitive and linguistic capacity.

While many challenges exist and arise, and much work remains to be done, we think that our approach to recommendation can positively contribute to a more inclusive framework for ASD users.

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[1]Center's webpage: https://bit.ly/regional-center-asd-in-adulthood-asl-turin.

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