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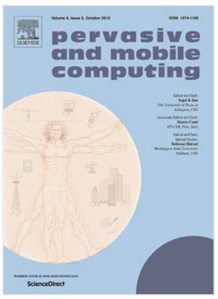

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A Novel Mathematical Framework for Similarity-based Opportunistic Social Networks☆

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Abstract

In this paper we study social networks as an enabling technology for new applications and services leveraging, largely unutilized, opportunistic mobile encounters. More specifically, we quantify mobile user similarity and introduce a novel mathematical framework, grounded in information theory, to characterize fundamental limits and quantify the performance of sample knowledge sharing strategies. First, we introduce generalized, non-temporal and temporal profile structures, beyond geographic location, as a probability mass function. Second, we examine classic and information-theoretic similarity metrics using data in the public domain. A noticeable finding is that temporal metrics give lower similarity indices on the average (i.e., conservative) compared to non-temporal metrics, due to leveraging the wealth of information in the temporal dimension. Third, we introduce a novel mathematical framework that establishes fundamental limits for knowledge sharing among similar opportunistic users. Finally, we show numerical results quantifying the cumulative knowledge gain over time and its upper bound, the knowledge gain limit, using public smartphone data for the user behavior and mobility traces, in the case of fixed as well as mobile scenarios. The presented results provide valuable insights highlighting the key role of the introduced information-theoretic framework in motivating future research along this ripe research direction, studying diverse scenarios as well as novel knowledge sharing strategies.

Keywords: social networks, opportunistic, profiles, similarity, modeling, user traces, numerical results

1. Introduction

Recent studies by the International Telecommunication Union (ITU), e.g., [1], point out that mobile phone coverage is now nearly ubiquitous, with an estimated 95% of the global population about seven billion people living in an area covered by at least a basic 2G cellular network. In

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