INSTITUT DES SYSTEMES INTELLIGENTS ET DE ROBOTIQUE
OFFRE DE THÈSE

Sujet de thèse

Titre de la thèse : Efficient Interaction through Information Maximization

Directrice ou directeur de thèse : Julien Gori (CNRS)

Co-direction éventuelle : Olivier Rioul (Télécom Paris, Institut Polytechnique de Paris)

Laboratoire d'accueil : ISIR (*Institut des Systèmes Intelligents et de Robotique*), Campus Pierre et Marie Curie, 4 place Jussieu, 75005 Paris.

Personne à contacter

Prénom Nom : Julien Gori

Email : gori@isir.upmc.fr

Please send a CV, M1/M2 transcripts, and a copy of your master thesis if available when applying.

Date limite de dépôt de la candidature : au fil de l'eau

Description of the subject (in English)

More information on https://jgori-ouistiti.github.io/academic/files/phd_hcimi.pdf

Context: Designing user interfaces is an iterative process. A designer creates an initial version based on their intuition and experience, then tests it with users and refines it based on feedback. This cycle is repeated until the interface is considered satisfactory. While effective, this approach is often slow and resource-intensive, as it requires many rounds of trial and error between designers and users.
To address this, researchers have proposed computational methods that automatically generate or optimize interface designs [2]. These methods rely on defining an objective (or "cost function") that captures what makes a good interface, and then optimizing the design accordingly. However, a major limitation is that such objectives must be carefully crafted for each specific problem, which can be difficult.
This thesis explores a different approach: instead of designing task-specific objectives, it investigates whether general principles from information theory, specifically measures of how much information is exchanged between user and system, can be used to guide interface design in a more universal way.

Goal of the thesis: One promising idea in this direction is Bayesian Information Gain (BIG), introduced by Liu et al [1]. BIG is an interaction technique in which the system actively guides the user toward actions that are most informative (ie., actions that help the system quickly understand the user's goal). Intuitively, the system tries to "ask the best possible question" at each step through its interface, so that the user's response reveals as much useful information as possible. Although promising, BIG has several limitations. It is computationally expensive, has mainly been tested in small and discrete settings, and requires a calibration phase before use, which limits its practicality and adaptability. It also does not account for important usability aspects, such as proximality (the interface should not change too abruptly between steps, to avoid disorienting users) and intrinsic state value (some interface states may be inherently preferable, regardless of how informative they are). More broadly, BIG is only one of several

recent approaches that use information-theoretic measures to design interactions (see positioning section). The first goal of this thesis is therefore to review and compare these different information-based approaches. This includes analyzing their theoretical properties, but also their practical characteristics, such as computational cost, ability to handle continuous or real-time interaction, and suitability for different application contexts. The second goal is to address the limitations of BIG. Since many of these approaches rely on similar mathematical concepts (notably mutual information), improvements developed for BIG are likely to extend to other methods as well. Key challenges include estimating information efficiently from limited user data, and incorporating usability constraints such as smooth transitions and meaningful interface states. As part of this work, the candidate will develop a software library implementing both existing and newly proposed methods. The third goal is to evaluate these approaches in realistic applications (map navigation, text entry etc.)

Required Profile: The candidate will have an interest and demonstrated expertise in computational modeling or machine learning. Interest and experience in experimental research and software programming, as well as knowledge of basic information theoretic notions will be appreciated but are not required.