Interdisciplinary subjects in Computer science, linguistics and psychology for Master/ARPE internships and PhDs

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Supervisors

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Key words

Computer science, linguistics and psychology, computational psychotherapy, psychiatry, systematic AI assistance for psychotherapy,

Location

The Master and the PhD will be supervised by Alain Finkel at the Ecole Normale Supérieure Paris-Saclay. The internships, visits and PhD could probably be made in co-tutelle with colleagues at Montréal. A one-year stay in Montreal with co-supervision by colleagues in Montreal is strongly considered.

Qualifications and Connections

This internship and the PhD are opened to strongly motivated and excellent Master students who like both computer science *and* linguistics. Knowledges in cognitive-behavioural psychology and philosophy will be a plus.

Ideally, the candidate holds a Master degree in Computer Science (or Applied Mathematics) equivalently is graduated from a Computer Science (or Applied Mathematics) Engineering School. Ideally, the candidate has strong knowledge both in computer science (formal methods, IA, ML, neural nets, LLM,...) or applied mathematics (probability, statistics, ML,...) *and* in computationnal linguistics ; knowledges in cognitive psychology and philosophy will also be appreciated. The internship is an ideal opportunity for starting a PhD thesis (that could be made in collaboration with University of Montréal).

1 FORMALEX : Formalisation of the subjective expérience

Keywords

Subjective experience, automatic recognition of interpretations in narrative texts.

Introduction

Different approaches have attempted to model, even informally, the flux of perceptions, thoughts and emotions : among many philosophers, let us quote Husserl's phenomenology [**?**], introspective psychology [**?**, **?**], cognitive psychology [**?**, **?**], neuroscience [**?**, **?**], computer science, robotics and artificial intelligence (for example, Fodor, Newell, Franklin, Anderson, and Johnson-Laird), statistical physics and probabilistic models (like the Friston's theory [5]). McCulloch and Pitts [**?**] were the first to formally model neurons and Baars was one of the first to propose a mind model based on neural architecture.

Towards a science of the subjective experience ?

In 1991, Varela, a neurobiologist and philosopher, introduced the concept of neurophenomenology, which attempts to link reported subjective experiences to measurable neurological phenomena, thereby seeking an empirical basis for the understanding of consciousness [**?**, **?**, **?**, **?**]. Many authors continued his work, for example : Depraz [**?**] and Gallagher [**?**].

In 1992, Finkel introduced cognitive analysis [**?**] and Finkel and Tellier formalized first-person narratives through cognitive automata models, highlighting individual regularities in decision-making narratives [**?**, **?**]. Finkel introduced the cognitive analysis based on a mind model in [**?**, 4].

In 1994, Vermersch [**?**, **?**] developed the explicitation interview, a method aimed at guiding individuals to precisely verbalize their internal lived experiences, particularly in educational contexts and psychological research. This method is interesting and detailed but has not been validated through a scientific approach and is not formalized.

In 2006, Petitmengin developed micro-phenomenological techniques [**?**, **?**] that are more detailed than Vermersch's explicitation interview, but they have not been validated through a scientific approach and are not formalized.

Even though the neurobiological functioning of the brain is different from the symbolic processing of a computer, the idea of modeling psychological activity using a Turing machine has been revisited by Dehaene [2, 3]. He notes that *this type of machine offers a fairly reasonable model of the operations our brain is capable of performing under the control of consciousness* ([2], p. 151) and emphasizes that *the conscious brain [...] functions like a*

human Turing machine that allows us to mentally execute any algorithm. Its calculations are very slow, as each intermediate result must be stored in working memory before being sent to the next step, but its computing power is impressive ([2], p. 150). This idea has also been recently developed by the computer scientist Blum [1] (who received the Turing Award in 1995 for his contributions to the foundations of complexity theory and its applications to cryptography and program verification). Blum proposed a discrete model of a conscious Turing machine.

Improving communication between humans and robots requires the ability to represent significant data from subjective experience reported verbally in a relevant formalism, i.e., thoughts, perceptions, and emotions. The numerous philosophical, linguistic, and psychological attempts (Husserl, Merleau-Ponty, Lakoff, Austin, Varela, Miller, Vermersch, Petitmengin) to describe subjective experience remain challenging to formalize. The advent of large language models (such as ChatGPT) enhances natural language processing capabilities [**?**]. However, machine learning alone is not sufficient ; a logical, formal, and automatable framework is also needed to represent and describe verbalized subjective experience. The desired model should reflect the cognitive structure of a sequence of perceptions/emotions/thoughts. Our hypothesis is that among a large number of cognitive sequences associated with a task (such as decision-making, emotion management, reasoning) performed by an individual, there are only a small number of different cognitive patterns (relatively independent of the context). Based on the work initiated in Isabelle Tellier's thesis and by defining a system of linguistic features classifying verbs and common nouns inspired by systemic functional linguistics, I aim to develop a formalism to encode a portion of the verbally reported subjective experience, then test/verify cognitive regularities in texts. These regularities could help identify the author (like cognitive fingerprints), improve understanding, define and classify different cognitive styles, assist in psychiatric diagnostics, anticipate risky behaviors, etc.

More generally, all of this could lead to the development of AI Assistance for Computational Psychotherapy, which is also the goal of the AUTOPSY project.

Research Program

— State-of-the-art review on existing formalisms for capturing subjective experience. Development of logical formalisms to encode verbally reported subjective experience (during the 3rd year of Gustave Cortal's PhD : 2024-2025).

— The internship (and the thesis) topic aims to ameliorate the formal models for describing the subjective experience implying perceptions, emotions and thoughts, during a verbally reported cognitive task. These models must reflect the cognitive structure of a sequence of

perceptions, emotions and thoughts.
— Automatic analysis of narrative accounts of emotional scenes (FERA grids, dreams) to highlight territories associated with emotions.
— Our hypothesis is that out of 1000 cognitive behaviors associated with a task like decision making, emotion management, reasoning strategies, produced by an individual, there are not 1000 structurally different behaviors. On the contrary, we believe that there are a small number of patterns in the structure of cognitive strategies that are relatively independent of the goals pursued by the behaviors. We think that there exists only a few number of cognitive structures.
— to construct, as automatically as possible, formal models from the linguistic and cognitive analysis of a cognitive task.
— Identify and construct elements of cognitive style in texts.

Applications

— Computational psychiatry, precision medicine.
— Human-robot communication, human-human communication, AI and health, automatic coaching.
— Training of psychologists, doctors, self-use by patients.
— Measuring the link between verbalized subjective experience and activated neural zones, measuring the influence of the form and content of questions asked.

Recruitment Needs

— 1 ENS M2/ARPE intern.
— 1 PhD student ENS in co-supervision with UdM. Skills/interests in computability, logic, linguistics, AI, NLP, LLM, computational psychiatry, and psychology.
— 1 post-doc UdM. Skills/interests in computability, logic, linguistics, AI, NLP, LLM, computational psychiatry, and psychology.

Références

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