Lab news

July 2022. Qiong Zhang presents at MathPsych 2022 at Toronto, Candada

May 2022. Qiong Zhang presents at CEMS at Toronto, Candada

Main page:

We combine computational modeling, behavioral methods and neural imaging to understand the computational principles that underlie human memory. We do this by contrasting human memory behavior to machine learning algorithms when both are pitted against the same memory tasks. By comparing how human and AI “brains” perform the same task, we can understand the human mind better and how to unlock more performance from our own memories.

Research:

A rational explanation for human memory

How to best encode and represent information and later efficiently retrieve them is a challenging computational problem. We analyze these aspects of human memory system by comparing human behavior to optimal or rational solutions to such computational problems.

Such analysis can explain why certain patterns of cognitive processes occur – because these patterns are useful in approximating the optimal solution of the task.

Neural basis of cognitive processes

While traditional neuroscience approaches can identify brain regions predictive of a particular behavior, they do not say much about how particular brain regions are involved in producing said behavior. To fill this gap, we analyze neural data constrained by formal models of cognition, which characterize the underlying cognitive processes that produce a particular behavior. This way we can identify how exactly particular brain regions produce a given behavior by understanding what cognitive processes they are involved in.

Understand suboptimality in human individuals and artificial agents

Once we understand what optimal memory behavior is, we can diagnose suboptimalities in individual participants and devise interventions to improve their memory performance. These results can also offer tantalizing insights into how to design artificial agents in completing the same memory or learning tasks.

In other words, we study the purpose or function of a given behavior (e.g. the function of heart of to pump the blood) in addition to the internal structure that give rise to the behavior (e.g. the mechanisms that give rise to pumping )

We try to understand not only what gives rise to the observations, but more importantly, why we observe them in the first place.

Science is about explaining phenomena. While the memory literature has predominately focused on providing mechanistic explanations (i.e. what it is that give rise to observed human behavior), our lab focuses on providing rational explanations (i.e. why the behavior occurs in the first place).

This is done by comparing human behavior to optimal or rational solutions to such computational problems.

Such analysis can explain why – because these patterns are useful in approximating the optimal solution of the task.

While it has been fruitful to explore rational explanations in biology (e.g. the function of the heart is to pump the blood) and sociology (e.g. explaining people’s behavior as rational in terms of their beliefs and goals), the field of cognitive science has predominately focused on providing mechanistic explanations: experimental studies uncover a range of behavioral patterns, with computational models specifying the necessary architectures and algorithms to capture these patterns.

How to best encode and represent information and later efficiently retrieve them is a challenging computational problem. We analyze these aspects of human memory system by comparing human behavior to optimal or rational solutions to such computational problems.

Such analysis can explain why – because these patterns are useful in approximating the optimal solution of the task.