Dissecting dynamical components of complex decision-making using a computer game-based task

ABSTRACT:

Background
Learning a complex skill requires searching a potentially enormous search space. While artificial intelligence (AI) can now approach human levels of performance in many complex tasks, they require much more training than humans. This may be because only humans can infer and apply generalizable principles from limited experiences. However, the statistics that underlie this learning process are both poorly understood and hard to investigate in the large state spaces found in most complex tasks.

Aims
Our goal is to design a cognitive task that is simple enough to study using the tools of psychophysics, but complex enough to induce intelligent search. We aim to define the statistical principles that shape efficient search to improve models of natural and artificial intelligence.

Method
We designed a puzzle with minimal verbal instruction and thousands of potential solutions, only a few of which meet the criterion of success. We launched the game as a smartphone-based app (hexxed.io), allowing us to collect data from ~10k human participants and compared their learning to artificial neural networks (ANNs). We analysed pupil dynamics to reveal how subjects plan.

Results
Unlike the AI, humans 1) search a highly restricted subset of the policy space; 2) attempt even poor solutions many times before discarding them; 3) arrive at the optimal policy suddenly and unpredictably with a "leap of insight". 4) plan more for trials with longer reaction times, as revealed by greater pupil movement.

Conclusions
Our data suggest a "top-down" learning process in which people learn by proposing explanatory theories which they refine or replace only upon collecting sufficient evidence to the contrary.

Keywords
Problem solving, Intelligence, Skill learning, Decision making, Epiphany

Researcher's Contacts:

Gautam Agarwal
Keck Science Center
925 N. Mills Ave.
Claremont, CA 91711
USA

Phone: +1 9096076522