

BACK OF THE ENVELOPE REASONING: ABSTRACT

Quick quantitative estimates are a part of everyday life – how long will it take to get there? how much money will I spend on the coming vacation? Economists, engineers, scientists and analysts make such estimates to guide detailed analyses and make decisions – how long will it take to eliminate the Federal debt? What is the photon flux at the eye from a faint visible star? Some domains like environmental sciences and biophysics are so complex that many times a rough estimate is all one can manage with the available knowledge and data. Such estimates are highly important when solving problems under time pressure, with partial and incomplete information – for example, how long it will take for USS Cole to become fully operational again? Enrico Fermi immortalized this spirit by asking his Physics class “How many piano tuners are there in Chicago?”

The goal of my research is to build computer programs that can answer such questions, and in the process, learn something about human cognition. Making such estimates, or “Back of the Envelope” reasoning, I think, is at the heart of common sense reasoning. The problem-solving techniques that I am building are heavily based on similarity and experiential knowledge, and are equipped with a “feel for numbers.” I have proposed a theory that explains how people develop intuitions for what is high, low and reasonable from exposure to a domain. This work is at the intersection of qualitative reasoning, cognitive psychology and linguistics, and builds on existing evidence in these fields to potentially contribute to the understanding of quantities in all the three.

Understanding and using common sense reasoning is a necessary prerequisite to creating useful software that collaborates with human partners to accomplish tasks like damage control assessment, operations planning, sifting through on-line information for relevant data, teaching and tutoring, and developing complex scientific and engineering models. This has relevance for education, especially engineering education, where such estimation skills are crucial but rarely taught.