This is an important book, fizzing with ideas, promise, and achievement. Arising from two decades of innovative AI research by Douglas Hofstadter and his students, it challenges many assumptions of workers in – and critics of – both classical and connectionist AI. Hofstadter’s computer models are intriguingly different from most others (though similar in spirit to some of the very earliest AI work, namely ANALOGY (Evans 1968) and ARGUS (Reitman 1965), as he remarks in Preface 6, “Two Early AI Approaches to Analogy”). In particular, they focus on an aspect of human thinking often claimed by post-Wittgensteinian philosophers to lie beyond the scope of any possible computational approach: its creative capacity to extend or reconfigure concepts endlessly, as the context changes.

The half-dozen programs described in these 500 pages can be thought of as models of analogy, or creativity. As such, some people might regard them as studies of an optional extra, a desirable feature of the mind to which psychologists can eventually turn after they have discovered how concepts are used in everyday thought. Hofstadter disagrees. For him, the creative extension and interrelation of concepts are fundamental aspects of thought, the rule rather than the exception. “Normal” and “creative” thinking differ in the extent to which concepts are allowed to “slip” from their normal constraints so that some relatively far-fetched similarity should be recognized. Hofstadter’s work thus focusses not on creative analogy considered as a special case, but on conceptual thinking in general.

The central theme is that concepts are intrinsically fluid, or changeable, and that computer models claiming psychological significance should reflect this. Conceptual fluidity allows “conceptual slippage”, wherein the mind applies pre-existing concepts to novel situations in ways that respect the particularities of the current context and that involve new ways of perceiving (describing) contextual items.

Another major theme — or, rather, another way of expressing the same point — is the ongoing reciprocal interaction between high-level perception and concepts. As Hofstadter puts it, “cognition is recognition” (p. 97). Our perception can be significantly altered by analogical thinking, as the initial (perceptual) description may be adapted, or even destroyed, during the recognition of the analogy. (Hofstadter compares this process with conceptual revolutions in science: The initial interpretation is discarded, and a fundamentally different interpretation is substituted for it.)

Most current computer models of analogy focus on the retrieval and mapping of pre-existing concepts, rather than the creative construction of new ones. No fundamental restructuring of concepts takes place. Hofstadter, by contrast, insists that analogy involves, not only comparisons between, but (often) also restructuring of previously existing concepts. He criticizes analogy models such as the Structure-Mapping Engine (SME; Falkenhaimer, Forbus, and Gentner 1990) for relying on (formal, meaningless) structural features that are carefully pre-assigned so that the intended conceptual mapping should take place. Moreover, their representations of concepts are fixed, remaining unaltered after the analogy has been drawn. Similarly, scientific-discovery programs such as BACON (Langley et al. 1987) use ready-made concepts and principles of inference provided by the programmer, so model conscious (and unadventurous) scientific reasoning rather than novel analogical insights. His own approach is significantly different.

Hofstadter’s group have implemented a set of parallel-processing systems including the early Jumbo (which built word-like letter-sequences out of jumbled groups of letters) and the more recent Copycat (which finds analogies between alphabetic letter-strings) and Tabletop (which compares actions directed at various layouts of eating-utensils). The wide range of analogies found by these programs have a “human feel” to them, and are sometimes both non-obvious and intuitively compelling. (For instance: If ABC goes to ABD, what does XYZ go to? Copycat, like people, offers various different answers, including the boring XYD and the more creative WYZ.)

Their novel architecture lies somewhere between classical AI on the one hand and connectionism on the other. Accordingly, they achieve types of computation prominent in the former, such as top-down processing and manipulation of hierarchical structure, as well as types more characteristic of the latter, such as bottom-up processing and multiple constraint satisfaction. In terms of my own distinction between “combinatorial” and “exploratory-transformational” creativity (Boden 1990), Hofstadter’s programs at present model the first more closely than the second. But hierarchical structures and top-down guidance are allowed for, and stylistic constraints might be represented by “clamping” certain concepts or conceptual neighbourhoods more or less firmly. Hofstadter’s general architecture could therefore model the more systematic, sometimes deliberate, exploration and transformation involved in stylistic (as opposed to combinational) creativity.