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Reading and Writing Memories in Artificial and Human Reasoning

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Abstract : Memory networks aim to integrate some of the recent successes in machine learning with a dynamic memory base that can be updated and deployed in artificial reasoning tasks. These models involve training networks to identify, update, and operate over stored elements in a large memory array in order, for example, to ably perform question and answer tasks parsing real-world and simulated discourses. This family of approaches still faces numerous challenges: the performance of these network models in simulated domains remains considerably better than in open, real-world domains, wide-context cues remain elusive in parsing words and sentences, and even moderately complex sentence structures remain problematic. This innovation, employing an array of stored and updatable 'memory' elements over which the system operates as it parses text input and develops responses to questions, is a compelling one for at least two reasons: first, it addresses one of the difficulties that standard machine learning techniques face, by providing a way to store a large bank of facts, offering a way forward for the kinds of long-term reasoning that, for example, recurrent neural networks trained on a corpus have difficulty performing. Second, the addition of a stored long-term memory component in artificial reasoning seems psychologically plausible; human reasoning appears replete with invocations of long-term memory, and the stored but dynamic elements in the arrays of memory networks are deeply reminiscent of the way that human memory is readily and often characterized. However, this apparent psychological plausibility is belied by a recent turn in the study of human memory in cognitive science. In recent years, the very notion that there is a stored element which enables remembering, however dynamic or reconstructive it may be, has come under deep suspicion. In the wake of constructive memory studies, amnesia and impairment studies, and studies of implicit memory—as well as following considerations from the cognitive neuroscience of memory and conceptual analyses from the philosophy of mind and cognitive science—researchers are now rejecting storage and retrieval, even in principle, and instead seeking and developing models of human memory wherein plasticity and dynamics are the rule rather than the exception. In these models, storage is entirely avoided by modeling memory using a recurrent neural network designed to fit a preconceived energy function that attains zero values only for desired memory patterns, so that these patterns are the sole stable equilibrium points in the attractor network. So although the array of long-term memory elements in memory networks seem psychologically appropriate for reasoning systems, they may actually be incurring difficulties that are theoretically analogous to those that older, storage-based models of human memory have demonstrated. The kind of emergent stability found in the attractor network models more closely fits our best understanding of human long-term memory than do the memory network arrays, despite appearances to the contrary.

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