*Computers Still Can't Do* (1992), and, with his brother Stuart, *Mind Over Machine* (1986). Similarly, philosopher Kenneth Sayre (1993) said "Artificial intelligence *pursued within the cult of computationalism* stands not even a ghost of a chance of producing durable results." The technology they criticized came to be called **Good Old-Fashioned AI (GOFAI)**.

Good Old-Fashioned AI (GOFAI)

GOFAI corresponds to the simplest logical agent design described in Chapter 7, and we saw there that it is indeed difficult to capture every contingency of appropriate behavior in a set of necessary and sufficient logical rules; we called that the **qualification problem**. But as we saw in Chapter 12, probabilistic reasoning systems are more appropriate for open-ended domains, and as we saw in Chapter 21, deep learning systems do well on a variety of "informal" tasks. Thus, the critique is not addressed against computers *per se*, but rather against one particular style of programming them with logical rules—a style that was popular in the 1980s but has been eclipsed by new approaches.

One of Dreyfus's strongest arguments is for situated agents rather than disembodied logical inference engines. An agent whose understanding of "dog" comes only from a limited set of logical sentences such as "$Dog(x) \Rightarrow Mammal(x)$" is at a disadvantage compared to an agent that has watched dogs run, has played fetch with them, and has been licked by one. As philosopher Andy Clark (1998) says, "Biological brains are first and foremost the control systems for biological bodies. Biological bodies move and act in rich real-world surroundings." According to Clark, we are "good at frisbee, bad at logic."

Embodied cognition

The **embodied cognition** approach claims that it makes no sense to consider the brain separately: cognition takes place within a body, which is embedded in an environment. We need to study the system as a whole; the brain's functioning exploits regularities in its environment, including the rest of its body. Under the embodied cognition approach, robotics, vision, and other sensors become central, not peripheral.

Overall, Dreyfus saw areas where AI did not have complete answers and said that AI is therefore impossible; we now see many of these same areas undergoing continued research and development leading to increased capability, not impossibility.

### 27.1.2 The argument from disability

The "argument from disability" makes the claim that "a machine can never do *X*." As examples of *X*, Turing lists the following:

> Be kind, resourceful, beautiful, friendly, have initiative, have a sense of humor, tell right from wrong, make mistakes, fall in love, enjoy strawberries and cream, make someone fall in love with it, learn from experience, use words properly, be the subject of its own thought, have as much diversity of behavior as man, do something really new.

In retrospect, some of these are rather easy—we're all familiar with computers that "make mistakes." Computers with metareasoning capabilities (Chapter 5) can examine their own computations, thus being the subject of their own reasoning. A century-old technology has the proven ability to "make someone fall in love with it"—the teddy bear. Computer chess expert David Levy predicts that by 2050 people will routinely fall in love with humanoid robots. As for a robot falling in love, that is a common theme in fiction,[1] but there has been only limited academic speculation on the subject (Kim *et al.*, 2007). Computers have

[1] For example, the opera Coppélia (1870), the novel *Do Androids Dream of Electric Sheep?* (1968), the movies *AI* (2001), *Wall-E* (2008), and *Her* (2013).