If a Tree Casts a Shadow Is It Telling the Time?

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Abstract. Physical processes are computations only when we use them to externalize thought. Computation is the performance of one or more fixed processes within a contingent environment. We reformulate the Church-Turing thesis so that it applies to programs rather than to computability. When suitably formulated agent-based computing in an open, multi-scalar environment represents the current consensus view of how we interact with the world. But we don’t know how to formulate multi-scalar environments.

1 Introduction

In the preface to the first edition of the International Journal of Unconventional Computation, the editorial board [1] welcomed papers in “information processing based on physics, chemistry and biology.” But the Board left undefined what it means to say (a) that a physical, chemical, or biological system is doing “information processing” or (b) that information processing is “based on physics, chemistry, or biology.” In this paper we explore these issues by focusing on these questions.

– What is computation?
– How can computation be distinguished from other natural processes?
– What is the relationship between ideas and computations?
– What is the relationship between a computational process and the environment within which it occurs?

Our conclusions will be that physical processes are considered computation when we treat them as externalized thought and that computation itself involves the playing out of fixed processes against a contingent environment. We re-interpret the Church-Turing Thesis: programs represent how we understand rigorous thought to be expressed. We then agree with Wegner [2] that the agent-based model of computation is the right way to think about interaction with an environment. But we claim that we are not yet in a position to specify environments that are multi-scalar.

1.1 Is Google Reading My Email?

That’s the first question in the Google Gmail help center [3]. This question arises because Gmail places ads next to email messages, and the selection of ads
is based on the contents of the messages. Google’s answer to this question has varied over time. On March 13, 2006, the posted answer was as follows.

Google computers scan the text of Gmail messages in order to filter spam and detect viruses, just as all major webmail services do. Google also uses this scanning technology to deliver targeted text ads and other related information. The process is completely automated and involves no humans. [Emphasis added.]

In other words, Google’s computers are reading your email—but no human beings are. That most people find this reassuring illustrates the intuition that it’s what goes on in the mind of a human being that matters to us.

One might object that if a computer is reading one’s email (and storing its contents in a database), a person might read it later. That’s quite true, and the fact that only Google computers (and not Google employees) are reading one’s email when selecting ads does not guarantee one’s privacy. But if no person ever reads one’s email, then most people will not feel that their privacy has been violated.

After all, all email is read by a number of computers as it passes from sender to receiver. No one has ever worried about that. The moment of violation occurs when some living human being becomes consciously aware of one’s personal information.

But, one might argue, the kind of reading that occurs when a computer transmits a message along a communication channel is qualitatively different from the kind of reading that occurs when a Google computer determines which ads to place next to a message. The former kind of reading treats messages as character strings. No meaning is extracted. The kind of reading that Google computers do extracts (or attempts to extract) meaning so that related ads can be displayed.

This raises the question of what we understand by the term meaning. That’s clearly a larger topic than we can settle here, but our short answer is that our intuitive sense of meaning has something to do with an idea or thought forming in a mind. At this stage in the development of technology, most people don’t believe it makes sense to say that an idea has formed in the mind of a computer—or even to say that a computer has a mind at all. We may speak informally and say something like “the computer is doing this because it thinks that.” But when we say these sorts of things, we are deliberately speaking metaphorically. Until we start to think of computers as having minds that have subjective experience, minds in which ideas can form—then most people will feel comfortable with Google’s reply that its computers, but no human beings, are reading one’s email.

1.2 To Come

Section 2 continues the discussion of thoughts and introduces the notion of thought tools, for which it provides a brief history. Section 3 considers how computation might be defined. Section 4 discusses the agent-based computing