



**Calhoun: The NPS Institutional Archive**  
**DSpace Repository**

---

Faculty and Researchers

Faculty and Researchers' Publications

---

2010-10

## What is computation? Editor's Introduction

Denning, Peter J.; Wegner, Peter

---

What is computation? (Ubiquity September 2010) The standard reference model for computation, the Turing machine, is a powerful model for digital computers and it can simulate every other computation model ever proposed. Yet the Turing machine information process -- execution sequences of machine configurations -- is not as well matched for the natural, interactive, and continuous information processes frequently encountered today. Other models more closely match the information processes involved and give better predictions of running time and space. PJD organized a symposium of leading thinkers to explore this question.

<http://hdl.handle.net/10945/35460>

---

This publication is a work of the U.S. Government as defined in Title 17, United States Code, Section 101. Copyright protection is not available for this work in the United States.

*Downloaded from NPS Archive: Calhoun*



Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

**Dudley Knox Library / Naval Postgraduate School**  
**411 Dyer Road / 1 University Circle**  
**Monterey, California USA 93943**

<http://www.nps.edu/library>

## Ubiquity Symposium

# What is Computation?

## Editor's Introduction

*by Peter J. Denning and Peter Wegner*

What is computation? This has always been the most fundamental question of our field. In the 1930s, as the field was starting, the answer was that computation was the action of people who operated calculator machines. By the late 1940s, the answer was that computation was steps carried out by automated computers to produce definite outputs. That definition did very well: it remained the standard for nearly fifty years. But it is now being challenged. People in many fields have accepted that computational thinking is a way of approaching science and engineering. The Internet is full of servers that provide nonstop computation endlessly. Researchers in biology and physics have claimed the discovery of natural computational processes that have nothing to do with computers. How must our definition evolve to answer the challenges of brains computing, algorithms never terminating by design, computation as a natural occurrence, and computation without computers?

All these definitions frame computation as the actions of an agent carrying out computational steps. New definitions will focus on new agents: their matches to real systems, their explanatory and predictive powers, and their ability to support new designs. There have been some real surprises about what can be a computational agent and more lie ahead.

To get some answers, we invited leading thinkers in computing to tell us what they see. This symposium is their forum. We will release one of their essays every week for the next fifteen weeks.

It is also your forum: You can add your thoughts in the comments area on the Ubiquity web site (<http://ubiquity.acm.org/article.cfm?id=1870596>), or on the Ubiquity blog ([http://blog.acm.org/ubiquity/2010/10/symposia\\_on\\_ubiquity\\_1.html](http://blog.acm.org/ubiquity/2010/10/symposia_on_ubiquity_1.html)).

Peter J. Denning and Peter Wegner

## Ubiquity Symposium

# What is Computation?

### Table of Contents

1	What is Computation? [opening statement] By Peter J. Denning	9	Computation and Computational Thinking By Al Aho
2	Evolution of Computation By Peter Wegner	10	What is the Right Computational Abstraction for Continuous Scientific Problems? By Joseph Traub
3	Computation is Symbol Manipulation By John Conery	11	Computation, Uncertainty, and Risk By Jeffrey P. Buzen
4	Computation is Process By Dennis J. Frailey	12	Natural Computation By Erol Gelenbe
5	Computing and Computation By Paul Rosenbloom	13	Biological Computation By Melanie Mitchell
6	Computation and Information By Ruzena Bajcsy	14	Is the Symposium Question Harmful? By Peter Freeman
7	Computation and Fundamental Physics By Dave Bacon	15	What is Information? By Paolo Rocchi
8	The Enduring Legacy of the Turing Machine By Lance Fortnow	16	Wrapping it Up [closing statement] By Peter J. Denning