

A Relational View of Computing

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For my H211 students:
Indiana University, Fall 2010 & 2011, and Team pw0ni3.

Learning with always trumps learning from.

—Woodie Flowers

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Preface

I think the weakest way to solve a problem is just to solve it; that's what they teach in elementary school. In some math and science courses they often teach you it's better to change the problem. I think it's much better to change the context in which the problem is being stated. Some years ago, Marvin Minsky said, "You don't understand something until you understand it more than one way." I think that what we're going to have to learn is the notion that we have to have multiple points of view.

—Alan C. Kay¹

This book is about changing the context in which computational problems are stated, attempting to understand these problems from the viewpoint of relational programming.

In elementary school I learned to multiply small whole numbers by memorization: I memorized the fact that 3 times 4 is 12. I also learned how to handle larger numbers by multiplying pairs of digits from the two numbers; by simplifying the problem, I could apply my mental collection of facts. My classmates and I solved countless multiplication problems without the faintest idea that we were using fundamental notions of computation: following an algorithm, using a lookup table, using recursion to make a complex problem simpler. We learned to just solve the problem.

Later, in a math course, I learned that numbers can be represented in binary: the multiplication problem 3×4 can be changed into the equivalent binary multiplication problem $11_2 \times 100_2$. I also learned that multiplying a number by 4 in binary is equivalent to adding two 0's to the end of that number:

¹From Kay's 20th anniversary Stanford Computer Forum talk in 1988, "Predicting the Future" (Kay 1989). Also at <http://www.ecotopia.com/webpress/futures.htm>.

11_2 multiplied by 4 is 1100_2 , which is the binary representation of 12. On many computers, using a “shift left” instruction to add two 0’s to the end of a binary number is faster than multiplying the number by 4. I learned it is often better to change the problem.

Alan J. Perlis said, “A language that doesn’t affect the way you think about programming, is not worth knowing.”² The point of view we shall adopt in this book is, “A program that doesn’t run backwards is not worth writing.”

²Epigram 19 from “Epigrams on Programming” (Perlis 1982).
Also at <http://www.cs.yale.edu/quotes.html>.

Chapter 1

Introduction

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