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FOREWORD

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Chapter 1

Introduction

1.1 Mathematics and its Notation

A distinguishing feature of mathematics is the use of a complex and highly evolved system of two-dimensional symbolic notation. As J. R. Pierce writes in his book on communication theory, mathematics and its notation should not be viewed as one and the same thing [Pierce1961]. Mathematical ideas can exist independently of the notation that represents them. However, the relation between meaning and notation is subtle, and part of the power of mathematics to describe and analyze derives from its ability to represent and manipulate ideas in symbolic form. The challenge before a Mathematical Markup Language (MathML) in enabling mathematics on the World Wide Web is to capture both notation and content (that is, its meaning) in such a way that documents can utilize the highly evolved notation of written and printed mathematics as well as the new potential for interconnectivity in electronic media.

Mathematical notation evolves constantly as people continue to innovate in ways of approaching and expressing ideas. Even the common notation of arithmetic has gone through an amazing variety of styles, including many defunct ones advocated by leading mathematical figures of their day [Cajori1928]. Modern mathematical notation is the product of centuries of refinement, and the notational conventions for high-quality typesetting are quite complicated and subtle. For example, variables and letters which stand for numbers are usually typeset today in a special mathematical italic font subtly distinct from the usual text italic; this seems to have been introduced in Europe in the late sixteenth century. Spacing around symbols for operations such as +, -, × and / is slightly different from that of text, to reflect conventions about operator precedence that have evolved over centuries. Entire books have been devoted to the conventions of mathematical typesetting, from the alignment of superscripts and subscripts, to rules for choosing parenthesis sizes, and on to specialized notational practices for subfields of mathematics. The manuals describing the nuances of present-day computer typesetting and composition systems can run to hundreds of pages.

Notational conventions in mathematics, and in printed text in general, guide the eye and make printed expressions much easier to read and understand. Though we usually take them for granted, we, as modern readers, rely on numerous conventions such as paragraphs, capital letters, font families and cases, and even the device of decimal-like numbering of sections such as is used in this document. Such notational conventions are perhaps even more important for electronic media, where one must contend with the difficulties of on-screen reading. Appropriate standards coupled with computers enable a broadening of access to mathematics beyond the world of print. The markup methods for mathematics in use just before the Web rose to prominence importantly included TEX (also written `TeX`) [Knuth1986] and approaches based on SGML ([AAP-math], [Poppelier1992] and [ISO-12083]).

It is remarkable how widespread the current conventions of mathematical notation have become. The general two-dimensional layout, and most of the same symbols, are used in all modern mathematical communications, whether the participants are, say, European, writing left-to-right, or Middle-Eastern,

writing right-to-left. Of course, conventions for the symbols used, particularly those naming functions and variables, may tend to favor a local language and script. The largest variation from the most common is a form used in some Arabic-speaking communities which lays out the entire mathematical notation from right-to-left, roughly in mirror image of the European tradition.

However, there is more to putting mathematics on the Web than merely finding ways of displaying traditional mathematical notation in a Web browser. The Web represents a fundamental change in the underlying metaphor for knowledge storage, a change in which *interconnection* plays a central role. It has become important to find ways of communicating mathematics which facilitate automatic processing, searching and indexing, and reuse in other mathematical applications and contexts. With this advance in communication technology, there is an opportunity to expand our ability to represent, encode, and ultimately to communicate our mathematical insights and understanding with each other. We believe that MathML as specified below is an important step in developing mathematics on the Web.