

C. Britton Rorabaugh

# ERROR CODING COOKBOOK

Practical **C/C++**  
Routines and Recipes  
for Error Detection  
and Correction



C. Britton Ro

**ERRO  
CODI  
COOK**

ON RETURN  
PLEASE CHECK FOR  
CD  
DISK TAPE

**Practical C  
Routines an  
for Error De  
and Correct**

97

04661

**BLDSC**

**IMPORTANT**

**NCB  
RESTRICTED  
STOCK  
NOT FOR HOME  
READING**

This item must be consulted on  
library premises only

THIS ITEM MUST BE RETURNED  
BY RECORDED DELIVERY  
**CAGE**

**NOT FOR LONG LOAN**

**PLEASE DO NOT USE  
VAN SCHEME  
FOR RETURN**

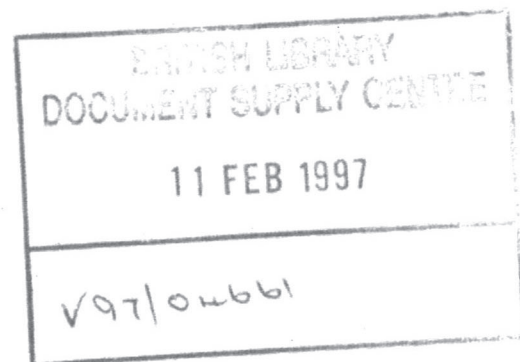
**Please  
DO NOT REMOVE**

V

# Error Coding Cookbook

Practical C/C++  
Routines and Recipes for  
Error Detection and Correction

*C. Britton Rorabaugh*



**McGraw-Hill**

New York San Francisco Washington, D.C. Auckland Bogotá  
Caracas Lisbon London Madrid Mexico City Milan  
Montreal New Delhi San Juan Singapore  
Sydney Tokyo Toronto

**McGraw-Hill**

A Division of The McGraw-Hill Companies



©1996 by The McGraw-Hill Companies.

Printed in the United States of America. All rights reserved. The publisher takes no responsibility for the use of any materials or methods described in this book, nor for the products thereof.

hc 1 2 3 4 5 6 7 8 9 DOC/DOC 9 0 0 9 8 7 6

Product or brand names used in this book may be trade names or trademarks. Where we believe that there may be proprietary claims to such trade names or trademarks, the name has been used with an initial capital or it has been capitalized in the style used by the name claimant. Regardless of the capitalization used, all such names have been used in an editorial manner without any intent to convey endorsement of or other affiliation with the name claimant. Neither the author nor the publisher intends to express any judgment as to the validity or legal status of any such proprietary claims.

**Library of Congress Cataloging-in-Publication Data**

Rorabaugh, C. Britton.

Error coding cookbook : practical C/C++ routines and recipes for error detection and correction / by C. Britton Rorabaugh.

p. cm.

Includes index.

ISBN 0-07-911720-1 (h)

1. C (Computer program language) 2. Debugging in computer science. I. Title.

QA76.73.C15R67 1995

005.7'2—dc20

95-22892

CIP

McGraw-Hill books are available at special quantity discounts to use as premiums and sales promotions, or for use in corporate training programs. For more information, please write to the Director of Special Sales, McGraw-Hill, 11 West 19th Street, New York, NY 10011. Or contact your local bookstore.

Acquisitions editor: Steve Chapman

Editorial team: Lori Flaherty, Executive Editor

Andrew Yoder, Book Editor

Production team: Katherine G. Brown, Director

Lisa M. Mellott, Coding

Wanda S. Ditch, Desktop Operator

Joann Woy, Indexer

Design team: Jaclyn J. Boone, Designer

Katherine Lukaszewicz, Associate Designer

9117201

EL3

# Contents

## Introduction *xi*

### **1 Strategic Issues 1**

- 1.1 Why Code? 1
- 1.2 Data Errors 1
  - 1.2.1 Binary Symmetric Channel 1
  - 1.2.2 Burst Channel 1
  - 1.2.3 Binary Erasure Channel 2
- 1.3 Software Notes 2

### **2 Mathematical Tools for Coding 5**

- 2.1 Modulo Arithmetic 5
  - 2.1.1 Modulo-2 Arithmetic 6
- 2.2 Finite Fields 9
  - 2.2.1 Groups 9
  - 2.2.2 Fields 11
- 2.3 Introduction to Polynomials 13
- 2.4 Extension Fields 16
- 2.5 Binary Extension Fields: Manual Construction 20
  - 2.5.1 Constructing the Field 22
  - 2.5.2 Representing the Field Elements 24
- 2.6 Computer Methods for Galois Fields 26
  - 2.6.1 Representing Field Elements 27
- 2.7 More About Polynomials 30
- 2.8 Cyclotomic Cosets 33
- 2.9 Finding Minimal Polynomials 36

### **3 Block and Cyclic Codes 41**

- 3.1 Introduction 41
- 3.2 Linear Block Codes 44

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.