INTRODUCTION TO 80x86 Assembly Language and Computer Architecture

THIRD EDITION

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For my mother,
Emma Langenhop Detmer Baldwin Toombs,
and my uncle,
Carl E. Langenhop, both of whom encouraged
me to become a scholar.

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Preface

The first edition of *Introduction to 80x86 Assembly Language and Computer Architecture* emphasized computer architecture over assembly language. In the years since it was published, assembly language use has declined but the need for a computer scientist to understand how the computer works "on the inside" has not. The *Second Edition* emphasized basic 80x86 architecture even more than the first. I remain convinced that learning a real instruction set and writing assembly language programs for a real computer are excellent ways to become acquainted with the basics of computer architecture. This emphasis on computer architecture continues with the *Third Edition*.

New to the *Third Edition*

The text has been updated to be used with Visual Studio® 2012, although it remains compatible with earlier versions of Visual Studio. All programs presented in this book have been tested using Visual Studio® 2012, Professional Edition. There are over 100 new exercises and programming exercises. The design has been improved, with clearer layout and easier-to-read illustrations. There has been a major effort to eliminate errors. Ancillary materials include PowerPoint lecture outlines, sample examinations, and answers to all exercises for instructors. Additionally, all program examples in this text are provided for students and instructors on the book's website at http://www.jblearning.com/catalog/9781284036121/. The book remains suitable as a standalone text in an assembly language course or as a supplement in a computer architecture course

Features of the *Second Edition*

There were several major changes in the *Second Edition*, also incorporated in the *Third Edition*. For many people the most significant was the use of the Microsoft® Visual Studio® environment instead of stand-alone software. Visual Studio is widely used in academic and professional settings, and provides a robust environment for editing, assembling, debugging, and executing programs. Microsoft® DreamSpark (https://www.dreamspark.com/) (formerly the Microsoft Academic Alliance) makes Visual Studio and other development software available to academic institutions at very low cost.

The 80x86 microprocessor family has expanded considerably in the past few years. This book continues to emphasize basic architecture; that is, features that are found on most CPUs, not just the 80x86 line. Since 64-bit processors now commonly power new PCs and 64-bit operating systems are now popular, this book includes 64-bit architecture. Much of the time 64-bit instructions are just "more of the same," but there are a few major differences. This book's topics are arranged so that 64-bit operations can be covered or omitted at the instructor's discretion. It is impossible in a textbook to provide full coverage of all 80x86 instructions. Intel® provides comprehensive documentation on their website (http://www.intel.com/content/www/us/en/processors/architectures-software-developer-manuals.html).

The *Second Edition* had decreased emphasis on input/output, with corresponding increased emphasis on using the debugger to see what is going on inside the computer. Macros for I/O, macros for converting from an ASCII string to a 2's complement integer, and macros for converting from a 2's complement integer to an ASCII string were included. The macros for I/O used dialog boxes and message boxes instead of console I/O.

Chapter 6, "Procedures," was changed to focus on the *cdecl* protocol. Using a standard protocol makes it possible to cover calling assembly language procedures from a high-level language or an HLL procedure from assembly language. The very different 64-bit procedure protocol was also covered.

Chapter 9, "Floating Point Operations," had major updates. Since all current 80x86 CPUs have floating point units, it no longer discussed how to code floating point operations using processors without an FPU. It covered some SSE instructions because these are normally used instead of the FPU for FP operations in 64-bit mode. It omitted inline assembly but includes calling assembly language procedures with floating point parameters from a high-level language.

The chapter on binary coded decimal (BCD) was omitted in the *Second Edition*, although BCD representations were still covered lightly in Chapter 1, "Representing Data in a Computer." Chapter 8, "String Operations," was retained because these instructions provide a striking example of the complex instruction set nature of the 80x86.

The *First Edition* listed the number of clock cycles required for each instruction on different 80x86 CPUs. With current pipelined CPUs this information is almost irrelevant, and thus has been omitted. The previous chapter-ending "something extra" sections were eliminated, but much of their content was incorporated in appropriate places within the chapters.

Instructor and Student Resources

I always remind my students that they don't receive answers to exercises on an exam or in real life and need to develop confidence in their own answers. However, at the request of a few instructors and many students, I have included answers to selected exercises in Appendix C. These exercises are marked with an asterisk (*) within the chapters. Answers to all exercises are available to registered instructors at http://www.jblearning.com/catalog/9781284036121/. PowerPoint lecture slides, code from the text, and sample examination questions are also available at this site.

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I would like to thank the many students who have taken my 80x86 assembly language classes over the last 20+ years. They have always made teaching worthwhile.