Instructions for Using Mathematica Dialogues and Programs

1 Introduction

The dialogues and programs in this book have been implemented in the Mathematica computer algebra system.

- Dialogues are in the *Mathematica Notebook* (nb) format. To access the notebooks, the Mathematica system must be installed on your computer.

- Mathematica implementations of the *mathematical pseudo-language* (MPL) procedures are in text (txt) files.

Information about the Mathematica software can be found at Mathematica's web site

http://www.wolfram.com.

This document contains instructions for using the dialogues and programs. For general instructions on using the Mathematica system, consult the *Tour of Mathematica* in the system's *help→ Getting Started* menu.

In the book, dialogues and programs in the database are indicated by the word *Implementation* followed by the names of computer algebra systems. For example, the caption to Figure 2.1 on page 19 contains

Implementation: Maple (nb), Mathematica (nb), MuPAD (mnb)

which indicates that the dialogue in Figure 2.1 is available for each of these systems. In a similar way, the caption to Figure 2.2 on page 23 contains

Implementation: Maple (txt), Mathematica (txt), MuPAD (txt)

which indicates that the MPL procedure in Figure 2.2 is available in a text (txt) format for each of these systems.

Important: Mathematica notebooks will work in Mathematica versions 4.0, 4.1, and 4.2 but may not be downward compatible to older versions (< 4.0). In addition, the form of the output of Mathematica operators may vary from version to version and may depend on settings of the system. Procedures in text files will run in earlier versions of Mathematica as long as all the Mathematica operators in the procedure are available and perform as in Mathematica 4.0.

2   Location of Mathematica Dialogues and Programs

Files for Mathematica dialogues and programs are in the folder

MathematicalMethods/Programs/Mathematica.

This folder contains nine folders

Ch1, Ch2, Ch3, Ch4, Ch5, Ch6, Ch7, Ch8, Ch9

which contain the dialogues and programs for the nine chapters of the book.

3   File Names

The following convention is used for file names.

- Dialogues that are referenced in figures or footnotes use abbreviated names that refer to these objects (e.g., Fig3-3.nb (page 71), Foot1.nb (page 5)).

- Dialogues that do not correspond to a figures or footnotes have a descriptive name (e.g., Mathematica-Function-definitions.nb) or the name of a Mathematica operator (e.g., FactorInteger.nb for Mathematica's `FactorInteger` operator that factors an integer (page 27).

- Mathematica implementations of MPL procedures are in text (txt) files that have the name of the procedure. For example, the Mathematica procedure that corresponds to the MPL procedure *Integer_gcd* in Figure 2.2 on page 23 is in the file *IntegerFactors.txt*. (We do not use the underscore character (_) in Mathematica file names because the symbol has special meaning in Mathematica.) Some files have more than one procedure. In this case, the file name corresponds to the main procedure.

4 Using the Dialogues and Programs

The files can be accessed directly from the CD or from a disk drive by copying the folder *MathematicalMethods* from the CD to the disk drive.

- *Notebooks.* Notebooks can be accessed directly through the Mathematica interface by following the folder path to the notebook. For example, to access the Mathematica notebook that corresponds to Figure 2.1 on page 19 of the book, follow the folder path

  MathematicalMethods → *Programs* → *Mathematica* → *Ch2*

  The notebook is in the file Fig2-1-integer-operators.nb.

- *Procedures in Text Files.* Procedures in text files can be viewed and modified with a text editor. Text files can be loaded into a Mathematica session with Mathematica's << command. For example, to load the file *IntegerGcd.txt* the command is

  ```
  << "c:/MathematicalMethods/Programs/Mathematica
          /Ch2/IntegerGcd.txt":
  ```

  (We have assumed here that the folder *MathematicalMethods* is on the C drive in a *Windows* environment. For other environments, modify the path as needed.)

  Important: Some of the procedures require other procedures that are either given in the book (and on the CD) or are described in the exercises. These additional procedures are listed in comments at the beginning of a procedure. For example, in Figure 1 we give the Mathematica implementation of the *Alg_polynomial_gcd* procedure given on page 154 of the book. The comments at the top of this procedure indicate that two other procedures are required. Notice that the statement

3

```
AlgPolynomialGcd[u_,v_,x_,p_,alpha_] := Module[
(*Mathematica implementation of Figure 4.7, page 154.

  This procedure requires the procedures

     AlgRemainder (Figure 4.6, page 152, requires other procedures)
     AlgMonic (Exercise 3, page 163)

Input
  u,v : polynomials in Q[alpha][x]
  x : a symbol
  alpha : a symbol that represents an algebraic number
  p : a monic, irreducible polynomial in  Q[alpha] with Exponent >= 2
Output
  gcd[u,v]
Local*)
  {U,V,R},
U = u;
V = v;
While[V =!= 0,
  R = AlgRemainder[U,V,x,p,alpha];
  U = V;
  V = R
];
Return[AlgMonic[U,x,p,alpha]]
]
```

Figure 1. The Mathematica implementation of the procedure *Alg_polynomial_gcd*.

follows the *AlgRemainder* procedure. This indicates that this procedure also requires additional procedures and these procedures are listed in the file for that procedure.

Important: The source code for procedures that are described in the exercises and used by some procedures is not on the CD. (We have done this since we expect these procedures to be provided by the reader.) For *Windows* platforms, however, executable versions of these procedures are available in a Mathematica package that is described below. This package, which is both version and platform dependent, is not currently available for other platforms. For other platforms, check the book's web site given at the end of these instructions for the availability this package. **Keep in mind that some procedures will not run correctly without these additional procedures.**

Although each procedure can be accessed individually, it is often convenient to load all the procedures at one time.

Windows Platforms. All of the procedures are contained in an executable Mathematica package. To use the package, do the following:

– Copy the file

  MathematicalMethods/Programs/Mathematica/MMWin4-1.mx

  to the folder

  Program Files/Wolfram Research/Mathematica/4.1
  /Addons/Applications

  (We have assumed here that you are using Mathematica 4.1 and the *Wolfram Research* folder is located in the *Program Files* folder.) For other versions, modify the file name (to MMWin4-0 or MMWin4-2) and the path (to 4.0, 4.2).)

– In a Mathematica session, load the package with the command

  $<<$ `"MMWin4-1.mx"`

(We have used the package name for Mathematica 4.1. For other versions, modify the name as needed.) By loading this package, you have access to all the procedures given in the book including those that are described in the exercises and used by these procedures.

5

Unix, Linux, and Mac Platforms. In a Mathematica session, load the file

<p align="center">Procedures.txt</p>

which is in the folder *MathematicalMethods/Programs/Mathematica*. By loading this file, you have access to all the procedures given in the book except those described in the exercises. For the availability of executable versions of the exercises, check the book's web site at the end of these instructions.

5 Catalog of Dialogues and Programs

A catalog of dialogues and programs can be accessed by loading the file

<p align="center">Catalog.htm</p>

in the folder

<p align="center">MathematicalMethods/Programs</p>

with a web browser. The catalog lists all the dialogues and programs including the page in the book, the file name, a brief description of the contents, and additional procedures required by a procedure. For example, the entry

```
Figure 1.6(a), Mathematica's primitive structural-operators page 9
    (Fig1-6(a)-Primitive-structural-operators.nb)
```

describes the Mathematica notebook in Figure 1.6(a). In a similar way, the entry

```
AlgPolynomialGcd, Figure 4.7 page 154 (AlgPolynomialGcd.txt,
    requires the procedures
        AlgRemainder, Figure 4.5 page 151 (requires additional procedures (see file)),
        AlgMonic (Exercise 3, page 163))
```

describes the Mathematica implementation of the procedure in Figure 4.7.

All files listed in the catalog are hyperlinked, and in some environments (such as a *Windows* environment using *Internet Explorer*), clicking on the hyperlink brings up the Mathematica system with the notebook or displays the text file in the browser. To view the text

files with a text editor, from the *Internet Explorer* window choose the menu options

$$View \rightarrow Source.$$

Some other browsers have similar menu options.

Important: In order to view Mathematica notebooks through the catalog, your browser must recognize the notebook file extension (nb). (This happens automatically in a *Windows* environment when using *Internet Explorer*.) If your browser does not recognize the file extension, it will display the source code of the notebook. With some browsers (such as Netscape), you can set the browser to recognize the nb file extension. We have found, however, that the most reliable performance for viewing notebooks from the catalog is obtained with *Internet Explorer* in a *Windows* environment. If you are unable to view the dialogues from the catalog, you can view them using the approach described in Section 4 above.

6 E-book Access to Dialogues and Procedures

In some environments, it is possible to access the Mathematica notebooks and text files of procedures directly from the *E-book*. This approach is described on pages 2-3 of *Instructions for the E-book*.

7 Programming Style

We use a procedural style of programming that is easily implemented using the mathematical operators and programming structures in the Mathematica programming language.

Important: Although we use the underscore character (_) in our pseudo-language procedure and variable names, we do not use it in our Mathematica programs because the symbol has special meaning in Mathematica.)

Although the Mathematica system has over 1000 mathematical operators, we use only a small number of them (about 35). A summary of these operators and other elements of the Mathematica language including the correspondence to our mathematical pseudo-language (MPL) is given in the book in Chapter 1.

Our programming style and the choice of which mathematical operators to use in programs is motivated by the following goals:

- *To present the algorithms in a programming style that applies to the Maple, Mathematica, and MuPAD languages using a small number of mathematical operators from these languages.* Although, in some cases, it is possible to give a shorter or more efficient program by using a particular operator or structure in the Mathematica language, we have avoided doing this so that we can preserve a common programming style and minimize system dependent issues.

- *To use the Mathematica mathematical operator with the least computational power that performs a mathematical operation.* In many cases, there is more than one operator in the Mathematica language that performs a mathematical transformation, and when this happens we use the one with the least computational power.

- *To use the Mathematica mathematical operators that correspond most closely to the MPL operators in the book.* Since mathematical operators in computer algebra systems are quite involved and may change as new versions of a system are introduced, the correspondence between MPL operators and the Mathematica analogues is not exact. For this reason, the tables in Chapter 1 contain the Mathematica operators that correspond *most closely* to the MPL versions.

- *When there is an option of using either a Mathematica operator or a similar operator that is described by an algorithm in the book, we use the Mathematica operator, unless the syntax or semantics or the operator is significantly different from the pseudo-language operator.*

8   Book Web Page

For additional information including notebook and program updates, see the web site:

http://www.cs.du.edu/~jscohen/MathematicalMethods