CHAPTER 1

OVERVIEW AND INTRODUCTION

This book examines meme media architectures and their application frameworks developed by the author and his colleagues for allowing people to reedit and redistribute intellectual resources over the Internet just through direct manipulation. Intellectual resources denote not only multimedia documents, but also application tools and services provided by local or remote servers. They cannot be simply classified as information content since they also include tools and services.

Media used to externalize some of our knowledge as intellectual resources and to distribute them among people are generally defined as knowledge media. Some people may use the term “information media” to denote a similar type of media. Whereas information media denote those media that externalize information content, knowledge media are used to externalize not only information content but also tools and services, and, furthermore, to distribute them among people. Some knowledge media that provide direct manipulation operations for people to reedit and redistribute their content are called meme media. Chapters 2 and 3 discuss the details of these definitions. This chapter shows why we need meme media, and how meme media change the environment of publishing, reediting, and redistributing intellectual resources for their further reuse by other people.

1.1 WHY MEME MEDIA?

During the last decade, we observed the rapid accumulation of intellectual resources on the Web. These intellectual resources include not only multimedia documents, but also application tools running on the client side, and services provided by remote servers. Today, from the Web, you can almost obtain whatever information items, application tools, or services you may think of. You can just access some search engine and type in appropriate keywords that characterize the intellectual resource you want to access. Then the search engine returns an address list of candidate Web pages. In this list, you will probably find more than one appropriate Web page including the intellectual resource you want to get.
The publication and reuse of intellectual resources using Web technologies can be characterized by the schematic model in Figure 1.1. In order to publish your set of intellectual resources, you have to represent it in HTML (Hyper Text Markup Language), and to register it in an HTTP (Hyper Text Transfer Protocol) server on the Internet. The worldwide distribution of HTTP servers, together with the HTTP protocols on the Internet, forms a worldwide publication repository called the WWW (World-Wide Web), or simply the Web. Web publication uses a compound document representation of intellectual resources. Compound documents denote documents with embedded content such as multimedia content, visual application tools, and/or interactive services provided by servers. Such a compound document published on the Web is called a Web page. In order to access Web pages published by other people, you need to know their URL (Uniform Resource Locator) address. You may input a URL to a Web browser such as Internet Explorer or Netscape Navigator to view the corresponding Web page. Some Web pages may have a button to upload or to download a file to and from a remote server. Some others may have input forms for you to fill in. Such Web pages use your inputs to issue a query to the corresponding application server or database server, which then sends back a new Web page as its output.

In the model in Figure 1.1, we do not have any support for extracting any portion of published Web pages, combining them for their local reuse, or publishing the newly defined composite object as a new Web page. We need some support to reedit and redistribute Web content for their further reuse.

It is widely recognized that a large portion of our paperwork consists of taking some portions of already existing documents, and rearranging their copies in different formats on different forms. This tendency has been significantly growing since we began to perform our paperwork on personal computers. Since the reediting is so fundamental in our daily information processing, personal computers introduced the copy and paste operations as fundamental operations. Now these operations are undoubtedly the most frequently used operations on digital content.

Figure 1.2 shows a new model that the author proposes in this book for the worldwide publication, reediting, and redistribution of intellectual resources. As in the case of the Web, you can publish a set of your intellectual resources as a compound document into a worldwide publication repository. You can use a browser to view such documents pub-
lished by other people. In addition to these operations, you can extract any portions of viewed documents as reusable components, combine them together to define a new compound document for your own use, and publish this new compound document in the repository for its reuse by other people. This new model of publishing, reediting, and redistributing intellectual resources assumes that all these operations can be performed only through direct manipulation. Meme media technologies that are discussed in detail in this book realize this new model. They provide the direct manipulation operations necessary for reediting and redistributing intellectual resources. Current Web technologies provide none of these direct manipulation operations.

1.2 HOW DO MEME MEDIA CHANGE THE REUSE OF WEB CONTENT?

Figures 1.3 to 1.5 show an example process of reediting and redistributing intellectual resources over the Web. The “meme media” technologies provide these operations as generic operations on intellectual resources represented as “meme media” objects. This example accesses two Web pages, i.e., Lycos Finance Stock Quotes and Charts, and Yahoo Finance Currency Conversion (Figure 1.3). The former allows you to specify an arbitrary company, and then shows its current stock quote together with its stock quote chart. The latter allows you to specify two currencies and the amount in one of them, and then outputs its conversion to the other currency. Browsers showing the two Web pages are wrapped by meme media wrappers, and work as meme media objects. These wrapped browsers allow us to specify any input forms and/or any displayed objects such as character strings and images to work as I/O ports for interoperation with other meme media objects. You can directly specify which portions will work as ports through mouse operations.

On the conversion Web page, you may fill in the source and target currency input forms with “U.S. dollar” and “Japanese Yen.” Then you may specify the amount input form to work as an I/O port, and the character string representing the converted amount to work as
an output port. You may connect a text I/O component to each of these ports, make the wrapped browser hide its display, and resize it (Figure 1.4). The result is a currency conversion tool from U.S. dollars to Japanese Yen. This tool wraps the Yahoo Finance Currency Conversion service, and works as an interoperable meme media object. Through mouse operations, you can also specify that the dollar input port will work as the primary port of this media object.

On the Stock Quote and Chart Web page, you may input some company in the input form, and specify the output portion representing the current stock quote to work as an output port (Figure 1.3). Now you can paste the wrapped currency conversion tool on this Stock Quote and Chart Web page, and connect the primary port of the conversion tool to the current stock quote port of the Stock Quote and Chart page (Figure 1.5). This defines a composite tool that combines two services provided by the two different servers. Now you may input a different company in the input form of the base Web page. Then the composite tool will return its current stock quote both in U.S. dollars and in Japanese yen.

Meme media technologies also allow us to republish this composite tool as a new Web page. Other people can access this Web page and reuse its composite function using a legacy Web browser.

Figure 1.6 shows another example of reediting Web content to define a new tool as a Web page. Here we access the Google search engine, and specify its keyword input form to work as an input port, and the first four search-result Web links to work as output ports. Then we make the background display of this page invisible, and paste one text I/O component and four browsers, all represented as meme media objects, on this page. The text I/O component is connected to the keyword input port, whereas the four browsers are con-
1.2 HOW DO MEME MEDIA CHANGE THE REUSE OF WEB CONTENT?

The result is a new tool that accesses Google to search for Web pages including input keywords, and shows the first four candidate Web pages. You may publish this tool as a new Web page on the Web.

If we apply meme media representation to all types of intellectual resources including those on the Web and local tools, we can combine extracted Web contents with local tools to compose a new tool. Figure 1.7 shows such an example. Here we access the Yahoo Finance Historical Prices Web page. You may input a company code to obtain the details of its stock quote changes as a table. Meme media technologies allow you to extract this table as a meme media object just through mouse operations. The extracted meme media object

![Figure 1.4](image)

**Figure 1.4** You can easily wrap the Yahoo Finance Currency Conversion page to create a new interoperable tool, simply by specifying the amount input form and the converted amount to work as an I/O port or as an output port, respectively.

You can paste the wrapped currency conversion tool on the Stock Quote and Chart Web page, and connect the primary port of the conversion tool to the current stock quote port of the Stock Quote and Chart page to define a new composite tool.

![Figure 1.5](image)

**Figure 1.5** You can paste the wrapped currency conversion tool on the Stock Quote and Chart Web page, and connect the primary port of the conversion tool to the current stock quote port of the Stock Quote and Chart page to define a new composite tool.
Figure 1.6  You can easily wrap the Google Web page to define a portal that shows the first four candidate Web pages for arbitrarily given keywords.

Figure 1.7  Application of meme media representation to all types of intellectual resources including those on the Web and local tools allows us to easily combine extracted Web content with local tools for the composition of new tools.
has a polling function to periodically access the Yahoo Finance server for updating its table contents. In this figure, the extracted table is dropped on a table tool to transfer its contents to this tool. This table tool allows you to extract a column as another meme media object, which you may drag and drop on a chart tool to obtain its chart representation.

All the above examples tell us how fundamental the reediting and redistribution operations are to the creative reuse of a large accumulation of available contents, application tools, and services. These operations are especially fundamental in the evolution of knowledge in science and technology. Based on the knowledge of published research works, researchers make new assumptions, evaluate them, establish new knowledge, and publish it for others to reuse. People used to use books and journals to publish their knowledge. Because of this restriction, they had to type printed table data for analysis using computer programs. They had to develop a program to calculate a printed formula even if the author of this formula had already developed such a program. Publication with paper media did not allow authors to publish their new formulas together with the corresponding calculation programs. Web publishing has remarkably changed these situations. We can make a copy of Web content and paste it on a local document or on a table we are currently editing. We can publish a formula together with its calculation program. However, we cannot reedit Web contents including application tools and services through direct manipulation.

In bioinformatics, for example, more than 3000 different services are now available on the Web. They include data base services, data analysis services, simulation services, and related reference information services. Researchers in this field, however, have no tools to interoperate some of these services for their own use. There is no way on the client side to connect the output of one service to the input form of another service other than making a copy of the appropriate output text portion on the source page and pasting it in the input form of the target page. Meme media technologies that we will discuss in detail in this book will open a new vista in the advanced reuse and interoperation of such services.

### 1.3 HOW DO MEME MEDIA WORK?

Instead of directly dealing with component objects as in the case of object-oriented, component-based software systems, meme media wrap each object with a standard media wrapper and treat it as a meme media object. They can wrap not only Web content as shown in the previous sections, but also any objects including multimedia documents, multimedia components, application programs, and services provided by either local or remote servers. Each meme media object has both a standard user interface and a standard connection interface. The user interface of every meme media object has a card-like view on the screen and a standard set of operations such as “move,” “resize,” “copy,” “paste,” and “peel.” As a connection interface, every meme media object provides a list of I/O ports called slots, a standard set of messages—“set” and “gimme”—to access each of these slots, and another standard message, “update,” to propagate a state change of one meme media object to another.

Since meme media objects have card-like appearances on the screen, they are called pads. This book will also introduce the three-dimensional version of meme media, called boxes. You may paste a pad on another pad through mouse operation on the screen. You may use paste operations in arbitrary ways; for example, to overlay multiple translucent component pads of the same size, or to arrange multiple component pads on the same
base component pad. When a pad \( P_2 \) is pasted on another pad \( P_1 \), the pad \( P_2 \) becomes a child pad of \( P_1 \), and \( P_1 \) becomes the parent pad of \( P_2 \). Our meme media architecture allows you to connect each child pad to one of the slots provided by its parent pad. Each child pad interoperates with its parent pad by exchanging three standard messages through their slot connection. No pad may have more than one parent pad. Pads are decomposable persistent objects. You can easily decompose any composite pad by simply peeling off the primitive or composite pad from its parent pad.

### 1.4 FREQUENTLY ASKED QUESTIONS AND LIMITATIONS

Some readers of this book may think that Web service technologies can provide us with similar functions for the interoperation of Web contents. Web service technologies enable us to interoperate services published over the Web. However, they assume that the API (application program interface) library to access such a service is a priori provided by the server side. You need to write a program to interoperate more than one Web service. Meme media technologies, on the other hand, provide only the client-side direct manipulation operations for users to reedit intellectual resources embedded in Web pages, to define a new combination of them together with their interoperation, and to republish the result as a new Web page. Chapter 11 of this book will compare, in detail, the meme media technologies on the Web with Web service technologies. In addition, meme media technologies are applicable not only to the Web, but also to local objects. Meme media can wrap any documents and tools, and make each of them work as interoperable meme media objects. Their wrapping, however, cannot use the same generic wrapper as in the case of wrapping Web contents. Different types of tools may require different wrappers.

Some other readers of this book may become worried about the copyright problem. Copyright policies, however, have been reconsidered and modified every time people introduced new media technologies. Whenever a new media technology is introduced, the consensus on new copyright policies gradually coevolves with new copyright protection and/or license management technologies. We have been and are observing such coevolution of new policies with the Web technologies. Some have established closed services on the Web that are exclusive to their members, whereas others have established a closed network, such as the I-mode cellular phone network in Japan by NTT DoCoMo, to implement a micropayment scheme for charging each access to the registered information services. Many other types of license and account management are currently being tried on the Web. The same situation will occur for meme media technologies. Chapter 12 of this book provides a basis to solve the technological aspects of this problem.

Meme media may wrap any objects, whether they are texts, images, figures, charts, or program modules, to provide them with both their visual representations on the display screen and I/O ports to interoperate with each other. Between 1993 and 1997, major software industries in Japan mistook meme media technologies for CBSD (component-based software development) technologies. Around that time, Fujitsu tried to exploit meme media technologies as the basis of their middleware architecture. Since meme media objects work as interoperable components, and allow us to combine them together easily through direct manipulation, their technologies are applicable to the component-based development of client systems with visual man–machine interfaces. Chapter 16 of this book discusses software engineering with meme media technologies.

It should be noted, however, that there are significant differences in the granularity of reusable components between their applications to the reediting and redistribution of in-
tellectual resources and their use as component-based software development environments. Whereas components in the former applications are reused by users who reedit content only through direct manipulation, those in the latter applications are reused by programmers for software development. Although users are usually not interested in modifying internal mechanisms of tools, programmers like to modify them. Therefore, the typical granularity of reusable components in the latter applications is generally much finer than that in the former applications.

It should be also pointed out that meme media technologies cannot be applied to the development of all types of software. Their application is limited to the development of client systems with compound-document interfaces. It is obvious that we cannot even define any visual components if we try to apply meme media technologies to the development of some language compilers.

Meme media objects are assumed to be manually combined by users to compose new ones. Meme media technologies themselves do not focus on how machine intelligence can perform such composition for given specifications; they provide only a basic framework on which you may study such machine intelligence.

In order to make some object work as a meme media object, you have to wrap it with a meme media wrapper. In general, this is not an easy task, and requires programming skill. However, for those objects with de facto standard object architectures such as the HTML document architecture and the Microsoft ActiveX control architecture, we can a priori provide generic meme media wrappers; users can easily wrap any of these objects, without writing any program, to make them work as meme media objects.

1.5 ORGANIZATION OF THIS BOOK

This book proposes meme media architectures and their application frameworks. Chapter 1 gives a brief description of why we need meme media, how meme media change the environment of publishing, reediting, and redistributing intellectual resources for their further reuse by other people, and what the limitations of meme media are. It also provides guidelines on how to read this book.

Chapter 2 gives a philosophical introduction to knowledge media and meme media. It clarifies the difference between information media, knowledge media, and meme media. Then it discusses the importance of meme media for all kinds of human interaction with information and knowledge through their life cycle. Meme media together with their worldwide publication repository form a meme pool, i.e., a worldwide pool of reeditable and reusable intellectual resources. Such a meme pool will evolve through people's reediting and redistributing meme media objects. Chapter 2 discusses the similarity between biological evolution and meme pool evolution, and clarifies what kind of technologies are required to accelerate meme pool evolution. We will review the history of books to see the importance of media architectures, and to understand the roles of knowledge media and meme media.

Chapter 3 gives a survey of past and current research and development efforts and technologies that are closely related to meme media and meme pool architectures and technologies. It gives a brief technological history of augmentation media and knowledge media on computers, and a brief survey on current Web technologies as knowledge media technologies. It also clarifies the difference between Web technologies and meme media technologies.

Chapter 4 gives an outline of two meme media systems—IntelligentPad and Intelli-
gentBox. They externalize some of our knowledge respectively using 2D (two-dimensional) and 3D (three-dimensional) representations.

If you are interested in meme media concepts, but not in the technical details, you may read only Chapters 1, 2, 3, and 4. These first four chapters focus on concepts rather than technical details. They are intended to help readers understand the concept of meme media, their use in related technologies, and their capabilities as well as limitations. The remaining chapters, which constitute the main body of this book, clarify the technical details of meme media architectures, their utilities, and their application frameworks.

If your interest is in technical aspects of meme media architectures, you should proceed to Chapters 5, 6, and 7. These chapters focus on the basic architecture of the 2D meme media system, IntelligentPad. Chapters 5 and 6 provide basic knowledge on the MVC (model, view, controller) framework, and on component integration architectures, respectively. These two chapters are fundamental to understanding the component architecture and the interoperation architecture of meme media systems. Chapter 7 gives the technical details of 2D meme media architectures.

Chapters 8, 11, 12, and 19 focus on meme media utilities and their architectures. Chapter 8 provides basic utilities. These include a collaboration tool for more than one user, and a script programming tool to simulate user's manipulation of meme media objects. Chapter 11 gives the architectures for publishing meme media objects, and discusses their relationships to Web technologies. This chapter will propose several different versions of meme pool architectures. Chapter 11 is the highlight of this book. If you are interested in how meme media objects can be published, reedited, and redistributed to form a worldwide meme pool, you should read this chapter. Readers interested in Web services are also strongly recommended to read this chapter. Chapter 12 clarifies how the reediting and redistribution of meme media objects can be allowed without violating the rights of authors and distributors. Readers who are interested in copyrights and the billing should read this chapter. Chapter 19 deals with how to organize and access a huge accumulation of meme media objects, and proposes a new framework named Topica. In this chapter, readers interested in Semantic Web will find another approach to the semantic organization and access of intellectual resources.

Chapters 9, 10, 13, 14, and 17 focus on its application frameworks. Chapters 9 and 10 provide multimedia and database application frameworks, respectively. Readers who are involved in the development of database applications are strongly urged to read Chapter 10. Chapter 13 gives application frameworks for the spatiotemporal editing of meme media objects. Chapter 14 discusses the interoperability of meme media objects and workflow modeling to coordinate their interoperations. Chapter 17 gives a survey of other applications of meme media.

Chapters 15 and 16 discuss software engineering aspects of meme media technologies. Chapter 15 introduces concurrency among meme media objects, whereas Chapter 16 discusses CBSD with meme media technologies. If you are interested in software engineering aspects of meme media technologies, you should read Chapter 16.

Chapter 18 extends the preceding discussions to 3D representation in meme media. If you are interested in 3D computer animation, 3D information visualization, or 3D scientific visualization, you will learn in this chapter how 3D meme media technologies provide direct manipulation capabilities as well as the capabilities of reediting and redistributing their environments and component objects.

Chapter 20 gives some concluding remarks with information about available meme media software systems.