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# Preface

## Informatics and Medicine

Over the last few decades informatics has played an increasingly important role in all aspects of our lives, particularly in medicine and biology. Information systems for healthcare, medicine and biology are becoming increasingly numerous and better, more fine-tuned but also more complex to develop, evaluate and use. They are being developed for a variety of reasons ranging from team decision making, improving diagnoses, educating patients and training clinicians to facilitating discovery and improving workflow. Developing good and useful systems is not simply a matter of writing efficient code. Having an information system that functions correctly and efficiently is just the beginning. Today's systems have to fit in with or improve existing conditions. They need to take strengths and weaknesses of intended users into account together with their preferences, environment, work styles and even personal characteristics. System development and implementation in any healthcare setting is further complicated by the need to focus on safety and privacy. Frequent evaluations help improve the systems by uncovering problems and providing guidance. But it's not an easy task.

Evaluating information systems and user testing fits in well with modern software development cycles. The best systems will have included evaluation by representative users from the very first development of components and will continue the interaction until the entire system has been integrated into its intended settings. The studies themselves are straightforward; deception is seldom required, there are many willing and interested stakeholders and the studies have potential to, indirectly, help improve our quality of life. However, conducting studies is often time consuming, sometimes expensive and only rewarding when the study was well enough designed so that the conclusions are valid. As a result, it is important not to waste time, money and other resources on poorly designed studies.

This book aims to be a practical guide to conducting user studies, also called controlled experiments or randomized trials. Such studies allow the experimenter to draw causal conclusions. This book focuses on designing *user* studies to test *information technology*. It is about information technology to be used by people; therefore the technology should be evaluated by people. This book will not discuss evaluations that do not include humans. For example, a database stored procedure that is being stress-tested for access and speed does not require a user study. However, studies are

not limited to the evaluation of entire systems. Individual algorithms and interfaces that affect or present human interaction with a system can be evaluated separately. It is wise to test individual components when possible and not to wait until all components have been built and integrated. Early evaluations will ensure better systems and will further make the evaluation process manageable and efficient. The goal, after all, is to develop information technology that is useful and wanted, and that achieves its goal in a user-friendly, effective and efficient manner.

Currently, few books exist that are written specifically for user studies in informatics. The existing books generally belong to one of two categories. One category focuses on design and development of software in computer science and how to program, use data structures and algorithms, and design and develop complete systems. These books seldom cover user studies. As a result, many information and computer science professionals are never taught the basics of user studies. The other category of books belongs to the behavioral sciences. These books focus on measuring psychological traits, intentions and beliefs. The studies are used to build, support or refute theories and sometimes require deceiving participants. They generally require more complicated designs and associated statistical analyses than what is needed for evaluation in informatics.

This book was written to bridge the gap between informatics and the behavioral sciences. It links the two fields and combines the necessary elements from both informatics and the behavioral sciences. The most commonly used and required studies that are useful in computing are explained in detail. An overview and additional references are provided for readers who want to complement their user studies with other forms of evaluations such as case studies, quasi-experiments, or correlation studies. However, these are not the focus of this book. The included topics will provide the necessary foundation and knowledge for the majority of user studies in informatics.

The principles discussed in this book apply to all domains where information systems are employed. The examples are chosen to demonstrate individual features of evaluations. They are taken from medicine, biomedicine, biology and other healthcare-related fields. These fields were chosen because they have a high impact on our life and are incorporating technology at a fast pace. Furthermore, these fields place a strong emphasis on doing controlled studies, the randomized controlled trials that allow causal conclusions. Those are the types of studies addressed in this book. Even though there are many other types of studies that provide high quality and valuable information, randomized controlled trials are considered the gold standard in medicine and it is crucial to have a clear understanding of how to conduct them. Statistical details are included as necessary to demonstrate the underlying principles. For interested readers, references are provided to in-depth materials that served as the basis for these discussions. Since statistical software packages change and improve over time, no detailed step-by-step instructions are included. However, since the statistical models covered in this book are standard, not esoteric, pointers to commonly found options in the statistical packages, e.g., Model I or Model II specification, are included and explained.

## Audience

This book is intended for managers and developers in industry and academic settings. User studies will improve software design and can demonstrate superiority. A well designed study is the cornerstone for developers to learn about the strengths and weaknesses of their algorithms and systems. This in turn leads to better products and sales, enhancing the reputation of any business. Developing information systems is very costly. By doing studies early on, the researcher and developer can increase chances of success significantly. Developing a system without errors, that provides a clear advantage and leads to high user satisfaction, is essential to any software company. Indirectly, a valid evaluation is also an excellent marketing tool for businesses. For developers in a research setting, a well designed study is necessary to get the results published at a conference or in a journal. It is also essential to winning research grant proposals.

This book is also intended for instructors and students in the different flavors of the informatics fields. Over the years, there has been little focus on conducting user studies in most computing majors. This trend has significant consequences. At universities, students choose different projects that require ‘only’ a survey because they mistakenly think that survey research is easy. Many graduates see evaluation as a major hurdle in the system development life cycle. Many are overwhelmed by the variety of studies that can be conducted and their associated statistical analysis. Reviewers perform poor (or erroneous!) reviews of programs and studies because they do not understand the design of studies. Recently, one of our students had a paper returned where one of the reviewers did not know the meaning of a ‘quasi-experiment’ and stated this in the review. It was clear that many questions this reviewer posed would have been answered if he had known the meaning of that term. Even more frustrating is that studies meant to evaluate software sometimes fail to show effects because the study was not properly designed, which is a waste of money and talent. In other cases, designers rely on effects that are untrustworthy because the study was not designed properly. Finally, many instructors in informatics do not include user studies in their courses because there is a lack of sufficient, high quality and comprehensive teaching materials to use as a base. And although few courses include this topic, quality journals and funding sources require it and all software would benefit from it.

In short, this book explains what an experimenter who is serious about evaluating an information system, be it a student, developer or researcher, should pay attention to and why. A good, trustworthy evaluation of an information system is a valuable activity that contributes to the bottom line. It does not have to be extremely expensive or time consuming but should be to the point and support moving the system development forward by providing informed choices. Proper evaluation leads to better information systems and can demonstrate their strengths and weaknesses.

Well designed user studies are a vital ingredient for success in informatics.





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Designing User Studies in Informatics

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