A TechForText Website
A network of websites offering information resources, downloads, and quality products and services

Research Methods for Simple and Complex Systems

By David Alderoty © 2015

Chapter 3) Basic Scientific Research Techniques For Simple & Complex Systems

Over 1,460 words

To contact the author left click for a website communication form, or use: David@TechForText.com

To go to the previous chapter left click on one of the following links:
For HTML) www.TechForText.com/R/Chapter-2
For PDF) www.TechForText.com/R/Chapter-2/PDF.pdf

If you want to go to the table of contents of this chapter left click on these words

To Access Additional Information with Hyperlinks

After I complete a writing task, I select a number of websites from other authors, and link to them. The links are the blue underlined words, and they can be seen throughout this book. The in-line links, such as the link on these words, are to support the material I wrote. The links presented at the end of some of the paragraphs, subsections, and sections are for websites with additional information, alternative points of view, and/or to support the material I wrote. The websites contain articles, videos, and other useful material.

Brown bold text, like these words, represent quotes in this e-book. You can access the original source, by clicking on a link presented just before a quote.

If a link fails, use the blue underlined words as a search phrase, with www.Google.com. If the failed link is for a video use www.google.com/videohp. The search will usually bring up the original website, or one or more good alternatives.

Experimental and Research Techniques For Simple and Complex Systems

Simple and Complex Systems, Experimentation, and Research

It is necessary to use different experimental strategies for simple systems that are predictable, and another type of strategy for systems that are complex and partly or totally unpredictable. This is explained under the following subheadings.

Simple Systems, and Experimentation and Research

Experiments involving simple systems usually can produce precise results, which are reproducible. That is if one scientist performs an experiment involving a simple system, other scientists will generally get identical experimental results. This is assuming they use the same methods and procedures. The experimental results of simple systems usually involve a 100% occurrence. For example, if you test the laws of gravity, by dropping a steel ball in a vacuum 100 times, you will obtain the same results every time you drop the ball. *It probably would be unnecessary to average your results, if your measuring equipment was very precise. With this example, all the experimental trials would provide the same results, for all practical purposes.

A Simple Way of Dealing with Experimental Error and Simple Systems

*The experiment **described above**, can sometimes produce results that very slightly, **which can be caused by limitations of the measuring equipment.** For example, the experimenter might have obtained the following time intervals for the lead ball to fall X meters: 2.0003 sec, 2.0005 sec, and 2.0007 sec. With this example, the results vary by 0.0004. The **simplest** way of representing these results is to round the number down to two decimal places, which is **2.00 sec.** Another **simple** alternative is to represent the results in terms of an average, such as the following. $\frac{2.0003+2.0005+2.0007}{3} = 2.0005$

Experimental Error with Simple and Complex Systems

The variations in experimental results **described above,** is called the experimental error. Experimentation with most simple systems will produce very small experimental error, if the measuring equipment is highly accurate. However, with complex systems, such as in the social, psychological, and medical sciences, the experimental error, (variations in experimental results) will usually be quite large.

Additional Information on Experimental Error, From Other Authors

There is more advanced information for dealing with experimental error at the following websites: **1)** Error Analysis and Significant Figures, **2)** The Analysis of Experimental Data, **3)** Experimental uncertainty analysis, **4)** Error Analysis, **5)** The Concept of Experimental Error and its Statistical Basis, **6)** Experimental Errors and Uncertainty

Statistics and Complex Systems

Statistical Techniques, and Complex Systems

A number of statistical techniques are used when experiments involve complex systems, to deal with the high degree of variations in experimental results. I am presenting two of the most commonly used techniques, under the following subheadings.

Average of Experimental Results, for Complex Systems

The simplest statistical technique used for experimental results of complex systems, is averaging the results from several similar experiments or from a number of experimental trials. Most of us are familiar with this technique, which involves adding up the results of all the experimental trials, and dividing the sum by the number of trials.

I created an **online calculation device**, a couple of years ago, that calculates the average, and a number of other statistical concepts. This device can be accessed by left clicking on the blue underlined words presented above. For a printer friendly version of the calculator, without instructions, left click on these words.

Correlation and Complex Systems

Another statistical technique involves correlations, which is used to determine how closely two factors agree, or disagree with each other. Specifically, when a relationship is suspected with complex systems, correlation coefficients can be calculated. **Examples** are evaluating the correlation for one of the following:

- between poverty and crime
- between wealth and good health
- between diet and a specific disease
- between obesity and culture
- between education and yearly earnings

A correlation of **1** is perfect, and it could be thought of as a 100% agreement between two factors. For a simple example of correlation, let us assume that when **factor-X**, doubles, so does **factor-Y**, such as the following two sets of numbers:

Factor-X={1, 2, 4, 8, 16}

Factor-Y={2, 4, 8, 16, 32}

The two sets of numbers presented above represent a perfect correlation of **1**. A more complex example is as follows:

Factor-A={ 24, 89, 23, 12, 576}

Factor-B={3, 5, 45, 1, 32}

The two sets of numbers presented above represent a correlation of **0.3875139**. There is essentially no relationship between the two sets of numbers with this example.

Correlations can be negative. An example of a correlation of **-1** is represented by the following two sets of numbers:

Factor-D={1, 2, 4, 8, 16}

Factor-E={-2, -4, -8, -16, -32}

A more complex example of a **negative correlation** is presented below:

Factor-F={100, 200, 400, 800}

Factor-G={10, 5, 2.5, 1.25}

The two sets of numbers presented above represent a correlation of **-0.8434783**

Correlations can be difficult to calculate, even with a scientific calculator. As a result, I created an Online Correlation Calculator, about three years ago, which can be accessed by left clicking on the blue underlined words, or on the following URL: www.TechFortext.com/Correlation-Calculator.

Simple Systems, and Experiments that Do not need Correlation Calculations

It is often unnecessary to use correlation calculations when experiments involve the simple systems of the hard sciences (with some exceptions). This is because identical results are obtained each time the same experiment is performed, under a specific set of conditions. For example, when two chemicals are mixed together, the same chemical reaction takes place 100% of the times, which is a correlation of **one**.

Different Strategies for Simple & Complex Systems

Strategies for Using Theories and Techniques, Based on The Complexity & Predictability of the System

Theories, laws, techniques, and methodologies that involve the simple systems of the hard sciences, usually involve a high degree of certainty. If you carry out experiments or other tasks involving the predictable systems of the hard sciences, you are likely to get the results that you expect. This is assuming you carry out the required procedures, without errors.

The high degree of certainty mentioned above, does not apply to the complex systems of the biological, social, and psychological sciences. These complex systems generally are somewhat unpredictable. This can be especially problematic when techniques or entire methodologies based on complex systems are used to obtain a goal or solve a problem. Specifically, even if you carry out all the procedures perfectly, your results may be uncertain, if you are dealing with complex systems that are relatively unpredictable. This is often seen in the medical sciences, when a physician tries to treat a disease with an FDA approved drug. The drug might work most of the time, but it may fail to help some patients, or it may produce serious side effects in some individuals. A general strategy to deal with this uncertainty is presented below.

When you are dealing with any remedy, technique, methodology, or theory that involves complex systems, you should consider your efforts an experiment. Most physicians appear to use the strategy, when they prescribe medication. This involves testing, and evaluating to determine the results. Unlike a true experiment, it is often necessary to include the trial and error process to obtain the desired outcome.

The strategy presented above is generally not necessary when concepts involve the simple systems of the hard sciences, such as techniques, theories, and laws. We can generally be certain that concepts involving the simple systems of the hard sciences will work 100% of the times, assuming we are carrying out all procedures correctly. In this idealized situation, no experimentation is necessary. **However, trials and evaluations may be needed to determine if calculations and procedures were carried out properly.**

See the Following Websites from other Authors for Additional Information, and Alternative Perspectives for Statistical Concepts in the Social & Physical Sciences

1) Quantitative Analysis in Social Sciences: A Brief Introduction for non-Economists, by Miguel Niño-Zarazúa, **2)** A Typology of

Research Methods Within the Social Sciences Gabriele Beissel-Durrant, **3)** Mathematics and Statistics in the Social Sciences Stephan Hartmann, and Jan Sprenger, May 7, 2010, **4)** SOME USEFUL METHODS FOR MEASURING THE BENEFITS OF SOCIAL SCIENCE RESEARCH Henry E. Kilpatrick, Jr., **5)** Social Science Research: Principles, Methods, and Practices, **6)** Making statistical methods more useful: some suggestions from a case study12 November 2012, Michael Wood, **7)** MATHEMATICAL METHODS IN THE PHYSICAL SCIENCES Third Edition MARY L. BOAS DePaul University, **8)** Free Online Math Courses, **9)** Video Courses: LearnersTV, Statistics, **10)** Video: Statistics Explained Through Modern Dance: A New Way of Teaching a Tough Subject, **11)** Free Video Lectures: Statistics, **12)** Video: Intro to Statistics Making Decisions Based on Data, **13)** Statistics Courses and Free Video Lectures, **14)** Collaborative Statistics: Video Lectures, **15)** Statistics 110 Probability, **16)** Videos from YouTube search page: courses on statistics, **17)** Mashpedia The Video Encyclopedia: Statistics

To go to the first page of this chapter left click on these words

HYPERLINK TABLE OF CONTENTS

Below is the hyperlink table of contents of this chapter. If you left click on a section, or subsection, it will appear on your computer screen. Note the chapter heading, the yellow highlighted sections, and the blue subheadings are **all active links.**

To go to the first page of this chapter left click on these words

If you want to go to the next chapter left click on one of the following links
For HTML) www.TechForText.com/R/Chapter-4
For PDF) www.TechForText.com/R/Chapter-4/PDF.pdf

If you want to see a list of all the chapters in this e-book go to www.TechForText.com/R