Chapter 2
Random Processes and Visual Perception: Stochastic Art

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ABSTRACT

The aim of this chapter is to explore a classic stochastic problem using the tools of the graphics environment. Stochastic processes are associated with the concepts of uncertainty or chance. Major areas of research in mathematical and applied sciences, statistics, finance, and artificial intelligence/machine learning benefit from the knowledge gained studying this process. Visual Art also depends on elements of uncertainty and chance. To explore the commonality of concern between Science and Art and better understand stochastic processes, the author organizes his research according to the Knowledge Visualization framework, examines a graph theory reference model called the "shortest route problem," and, adding additional elements specific to the art-making process, shares his results to highlight the relevance of interdisciplinary studies in the fields of randomness and visual perception.

INTRODUCTION

Randomness by nature is challenging to define.

Many people associate randomness with unpredictability: the randomness of the shuffling of a deck of cards or the randomness of the playing of a musical instrument. However, they are not both equally random. We can use randomness to make choices less predictable. Yet, unpredictability is more than mere randomness; it is an opportunity to select or create a pattern more or less predictable: something that can be easily detected.

According to the Wolfram definition, the word random is synonymous with the term stochastic. It is of Greek origin and means "pertaining to chance". The term stochastic has been used in the past to differentiate art practices such as medicine or rhetoric in which the knowledge and skill of the practitioner

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cannot be measured by the direct result of their work as in most other applied sciences. Today, both terms designate events that are variable or carry unforeseeable outcome.

Science, specifically mathematics, is based on objectivity and hard facts. Its relationship to randomness has always been challenging because of the underlying difference between randomness and uncertainty. For example, randomness can be used to get a very accurate forecast, and uncertainty can be used to get a very reliable forecast, though this is harder and takes longer.

In mathematics, Snell (1997) in a conversation with Joe Doob points out that every non-mathematical probabilistic assertion suggests a mathematical counterpart that sharpens the formulation of the non-mathematical assertion.

The theory of probability, to which the concept of random processes is attached, was introduced by David Lewis in 1884, and later adopted by Charles Darwin, Alfred Wegener, Werner Heisenberg, and many others. Today this field of research has opened to broader and more complex investigation in the area of applied mathematics, mathematical physics, mathematical biology, control theory, and engineering.

Mathematicians Richard Courant and Herbert Robbins (1996) state that Mathematics offers science both a foundation of truth and a standard of certainty based on precision and rigorous proof. Mathematics exacting standards helped pave the way to explore stochastic processes in an objective factual and repeatable manner. Russian mathematician Kolmogorov initiated its study some 70 years ago. Based on Greek axiomatic geometry, it explores the logic of shape, quantity and arrangement.

Shape, quantity, and arrangement are part of the visual artist vocabulary. To a certain extent, the art-making process, its perception, and appreciation depend on a set of random elements, in this case pertaining to light, optical alertness, and various additional physical and cultural parameters. As the world is seeing more research on visualization, we're starting to recognize that learning to understand, read, and interpret an image is a good way to get a deep insight in the subject being studied.

Using a scientific approach to study randomness in art seems like a promising way to understand the medium better: good visualizations are the ones that can be composed and read only if the creator has the knowledge and experience to know what they are. Knowledge visualization is one tool helping achieve this goal.

Knowledge Visualization is a framework that examines the use of visual representations to improve the creation and transfer of knowledge, stated Meyer (2009). Burkhard (2013) in a seminal paper on the structure of the framework describes it as a tool to investigate the power of visual formats to represent knowledge, whose aim is to support cognitive processes in generating, structuring, using, and sharing knowledge. Knowledge visualization facilitates the creation and transfer of knowledge between individuals and groups by giving the originators richer means of expressing what they know.

Following the framework guidelines, I collected information from various scientific sources to understand, interpret, create, and share new information on the study of stochastic processes from the perspective of a graphics and visual communication designer.

To illustrate my point, I selected a model used by Professor of Management Science Evan L. Porteus (2002) to demonstrate the calculation involved in solving a stochastic random process. I broke down each element of the statistical model into separate objects, recombined them according to the scientific narrative, and added distinct components pertaining specifically to a visual communication methodology.

Finally, to ensure the validity of the process, I tested the results with colleagues from the scientific and artistic communities to underscore the common interest of scientific and artistic collaboration in this field and gather information encouraging interdisciplinary effort in the study of randomness and probability.