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Week 3 response

When I looked up "random" in the American Heritage Dictionary it gave me two separate definitions(1). In general it means lacking pattern, however for mathematics or statistics, it is defined as statistically evenly distributed. The debate between these two definitions is what lies at the core of the argument on whether or not through a software based function can be random and if not then is anything in the world random or are we deceiving ourselves. Even the human mind can be predictable, once given a few sentences to read I was asked afterward for a single digit and a double digit number. Both we're predicted correctly because the wording had given me a patter of thought. Natural events may be random, however they often are hard to monitor. So one random number based on time or voltage fluctuations used as a seed should be sufficient because it is not the pure randomness that simulations desire but more so test cases and inputs that don't conform to a pattern relevant to the experiment, a pattern that would make the results unreasonable in nature and thus the "pseudorandom" numbers seem to satisfy our requirements to test a variety of conditions including those at the edges of the domain with an equal probability and as S.K. Zaremba of the US Army realized, the goal in designing generating functions should be in reducing error and not ensuring randomness if we'd like to make the most possible progress.

Computer simulations I feel are a bridge between the worlds of theory and experimenting. Programming itself is closer to theory in that a theorist tries to develop a pattern in mathematical terms which he believe natural phenomenon adhere to. Programming is creating and writing a pattern is machine languages which the programmer believes will model the natural phenomenon. More often than not though programmers are little more than translators, transcribing mathematical and physical theory in a way that computers can understand and compute quickly. Thus I agree with Galisons belief that programs are marginal in the role of physics because the programmer is generally not making discoveries or the only individual who can program this particular theory, instead the achievement and the uniqueness is usually and rightfully attributed to the physicist. The program is necessary because as as Kowarski argues, computers have permeated into every practice that analyzes data due to their unbarred speed and capacity, and they will never be able to be done away with and in our specialized world it is unlikely that every physicist or experimenter will learn how to translate his theories and models into a computer.

While what programming is has influence over the lives of a select group of people, the question that affects a wider audience is whether or not running a simulation programmed into a computer is equivalent to running a set of experiments. I will discuss the some primary differences between lab and field experimenting and computer simulations, then why I believe they are fundamentally different in nature, and finally why lab experiments must continue to live on. First computers take a model into them that has been created by humans and then encoded for machines by humans, while field and lab work which is the behavior that our model is trying to mimic. Thus the first two disadvantages in computer simulations arise. First our model may be flawed and the flaw may be lack of account for special cases or edges of our domain, a failure to recognize the true domain of all the inputs and conditions, or in the fundamental elements which

make up the model. Experimentation doesn't have any of these flaws in that you test in the natural environment which your product is to be run. The second difference between computers simulations and experiments, is that computer simulations allow you to test an enormous amount of conditions, many times at relatively low cost. In addition you can model conditions which you would be unable to physically reproduce without extreme cost or danger such as low gravity or incredible heat. Third computers allow you to measure any property of any modeled object or group of objects. In experiments you can note see what a single atom is doing when surrounded by billions of other atoms. Experiments require instrumentation that can consume space and become cumbersome to being placed in a non-obstructive manner. As Heisenberg's Uncertainty principle states, if you measure something you always change it to some extent in observing it, computers avoid this because you are not actually observing an object but instead recording it's predicted state. The Monte Carlo project proved particularly incredible in the measurement and safety aspects, each neutron that was being simulated could be fully observed and one didn't have to be in the middle of a nuclear explosion to make these observations, a physical impossibility. The advantage to traditional experimenting here however is if you know your equipment is working and to what degree it is accurate, the confidence of your results being realistic are higher, because you are measuring actual physical effects as opposed to simply predicting them, and these results are more valuable in seeing how your object truly behaves.

The conclusion is that the theory, simulation, and experimentation complement each other and not replace each other. Computers let you sample a far greater variety of conditions, thus allowing you to understand trends and possibly even improve your models based on their output. These simulations though are founded on the theory and if that theory is faulty only lab and field experimentation can guide you the right way. As a result I fell computers are indeed a step away from reality but give us a more complete picture of what may be happening. PhDs should very rarely awarded on computer simulations alone because if it can't be reproduced in strict theory or the field then any work is of little use. If however the computer simulations can come up with information of how to proceed in the field, or accurately estimate something that is not understood they may be of merit. The most honorable use for computers should be in producing a great multitude of test and predictions cheaply and quickly, that can be verified in the lab, and then continuously refined.

1. The American Heritage® Dictionary of the English Language, Fourth Edition
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Galison, Peter. "Monte Carlo Simulations: Artificial Reality." In Image and Logic: A Material Culture of Microphysics (Chicago and London: University of Chicago Press, 1997), pp. 689-780.

Kowarski, L. "The Impact of Computers on Nuclear Science." In Computing As a Language of Physics, edited by International Center for Theoretical Physics (Vienna: International Atomic Energy Agency, 1972), pp. 27-37.