

MONT 107N – Understanding Randomness  
Paper 1 – February 12, 2010

*General Information*

The first formal writing assignment this semester will be an essay about one of the topics listed below. Your paper should be prepared using MS Word or equivalent software, at least 5 double-spaced pages in length. You will be submitting it by email as for some assignments in the fall. The due date is *Friday, February 26*. (Note: this is one week later than the original due date listed in the first version of the course schedule. The schedule has been modified because of the timing of the Natural World Cluster Common Event on February 18.)

*Description*

The main objective of this essay will be to explore some consequences or ideas related to our discussions of chance and randomness.

Which topic you are considering should be clearly stated in the first paragraph. Then the body of the paper should be your responses to the questions posed below in the topic description. As on the essays last term, your job is to convince your reader of the soundness of your conclusions, starting “from the beginning.” That is, you should not assume the reader has been present for any of the discussions that we have had in class, or that you might have had with other Natural World cluster students. You might try explaining a possible opposing point of view, then giving your reasons for rejecting it as part of your argument.

*Sources*

For the first topic below you will not need to produce a “research papers,” but you may want to consult sources for specific information about some of the questions posed there.

The second topic deals with a specific article from the Wall Street Journal by Leonard Mlodinow (the author of *The Drunkard’s Walk*) that goes into more detail about something we discussed briefly in class. If you really get “into” this topic you may want to consult other sources mentioned there.

The third topic *is* essentially a research paper and will require some work to find and digest the information you need. Ms. Barbara Merolli, our science librarian and Montserrat library liaison person for the Natural World Cluster in Montserrat, will be able to steer you in the direction of some good sources on chaos theory, determinism, etc. if you choose this topic.

In any case, you should include a listing of all the sources you made use of in preparing your essay. For books, give the author, title, publisher, place and year of publication. For articles, give the author, title, name of the periodical, and date of publication. For online sources, give a *full URL (web address)* and the date you consulted it online.

### *A Suggestion*

I will be happy to discuss (or read a first draft of) your paper and give you some preliminary comments by email. Or, you can come by my office hours if you want to “run your paper by me.” Alternatively, I think you may find it very helpful to have a first draft of your paper read by another student in the class. I can set up “reading pairs” working on different topics if you are interested.

### *Evaluation*

I will provide written comments on your work, and assign two grades for each paper – one for how well your conclusions are presented and supported (in other words, for how convincing your arguments are), the other for how well your writing follows the standards for formal written English. (For instance, how well is the paper subdivided into paragraphs each addressing a particular item in your argument? Are the paragraphs arranged in a logical, recognizable sequence? Are the sentences within each paragraph ordered well? Are they grammatically correct? Are there awkward sentences? Are there overly flowery, overly colloquial, or incorrectly-used words or phrases? Is punctuation used correctly? Are there spelling and/or typographical errors?)

### *Something to Keep in Mind*

The topic descriptions below each include a number of different ideas; you will want to focus on two or three in each case and aim for a coherent essay rather than a collection of short answers.

### *Topic 1 – Artists, Choices, and Chance*

*Note: This topic will draw on your experiences and impressions concerning the demonstration/performance by Carol Lieberman and Mark Kroll on Thursday, February 18.* Which “version” of the violin and keyboard did you prefer – original, or modern (in terms of sound quality, in terms of expressive potential, and so forth)? Are there analogous cases in popular music where instruments have developed over time, and music first performed sometime in the past would sound different if played on current instruments? In the case of the music Carol and Mark performed, or for more contemporary music that you may know, what do you think the composers would have thought? Would they have preferred the instruments they knew, or the modern ones? It might be somewhat difficult to say, of course, but there is a historical record on what a number of composers thought about issues like this. For instance, there were some composers who were always complaining about the shortcomings of the instruments that were available to them, while others seemed to have been satisfied to make use of what was at hand. How did Beethoven think about this, for one? To what extent do you think composers of music and other creators in performing arts should get to *control* the way performers make choices about how their work is presented (for instance which instruments to use, and what interpretive choices are made)? Are there examples from contemporary popular music that you know where a composer

has reacted badly to a performance of their music that did not follow their original ideas of what it should sound like? What modern classical or popular composers have made intentional use of chance or random elements in their music? Why do you suppose they make that choice?

*Topic 2 – How likely are “streaks” in sports?*

One of the most famous records in baseball is Joe DiMaggio’s 1941 56-game hitting streak. This is often cited as the one record that will never be broken in the future history of the game (mainly because no one has really come close to breaking it in the 68 years since it was established). But is that really the case? There have been a lot of studies about whether the phenomenon of “streaks” in sports can be explained purely on the basis of the way chance models like box models can produce unlikely results over relatively short strings of draws (even though things average out in the long run). Leonard Mlodinow summarized some of the research in this area in the article “The Triumph of the Random From banking to baseball, winning streaks owe much to the laws of chance,” published in the Wall Street Journal on July 9, 2009. For this topic, you would read this analysis carefully, explain the conclusions in your own words, using ideas we have discussed in our discussion of chance processes, and then present your own views on whether you think this statistical approach really captures what happens in situations like baseball games. Are there human elements that are not accounted for by the probability model? Do they matter over the long run? How and why to human beings mis-estimate the likelihood of streaks?

*Topic 3 – Is there really such a thing as randomness?*

*Note: Some aspects of this topic are related to mathematics that is more advanced than we have discussed in our class, and this topic will probably require a fair amount of background reading before you can start to formulate what you want to say. If you have taken a calculus or physics course, though, you have seen at least some of the technical points behind what is going on here.* One question that we have not asked in our study of chance processes and their applications in statistics is *whether there actually are truly random phenomena in the natural world.* It is important to ask this because the kinds of physical systems that we have discussed as chance processes (throwing coins or dice, spinning a roulette wheel, etc.) are things that can be very well described by *Newtonian physics.*

For instance, if we knew the exact speed at which a roulette wheel was spinning, exactly where the ball was released, with what speed and direction, the temperature, humidity, air currents in the room containing the wheel, etc. then in principle it would be possible to predict where the ball would end up using more general versions of Newton’s equation  $F = ma$ . A normal roulette player does not try to do this, of course, because the necessary calculations are not the kind of thing one can do in one’s head in the space of a few seconds while the ball is spinning, before the opportunity to place a bet is over. But interestingly enough, there is a book from the 1980’s called *The Eudaemonic Pie*, by Thomas Bass, that tells the story of a group of physics graduate students at the University of California at Santa Cruz who set out to build a small computer capable of making those

calculations, put it into the sole of a shoe—where input could be entered by toe tapping and output could be sensed on the foot—and take it into a casino to “beat the house” at roulette. If we don’t have a computer like that, though, is the apparent randomness of the roulette wheel just a consequence of our *human limitations* in knowledge and computational speed? One could ask the same question, of course, about the process of throwing dice or tossing a coin.

The idea that outcomes like where a roulette ball lands are completely known if we know the *initial conditions* (exactly when and where the ball was released, with what speed and direction, the temperature, humidity, air currents in the room containing the wheel, etc.) is often called (scientific) *determinism*. If you really believe in calculus and Newtonian physics, the whole universe is a deterministic system.

So does that mean that *nothing is random*? Does that seem right? What is *chaos theory* (in physics and mathematics(!)) and what does it have to say about the possibility chaotic behavior in deterministic systems, and the implications for predicting outcomes in those systems? Do physicists believe that there are truly random processes in the natural world? If so, what are they? Where does this leave Mlodinow’s ideas from *The Drunkard’s Walk*—are there implications for everyday life?