Course Description and Tentative Syllabus

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Off. Hrs: By appointment

BASIC IDEA OF THE COURSE:

Science is often portrayed as following a very clearly defined set of procedures: start with a hypothesis, do an experiment, and, based on the results, reject the hypothesis or adopt it as a working assumption. The actual process, however, is rarely so straightforward. In addition, the stories as usually told or recorded may differ from what really happened. For most of the semester we will study some famous, some lesser known, and some infamous experiments, mainly in the physical sciences, selected to illustrate intellectual tours de force, cases of error, cases of fraud, and the murky boundaries between them. Along the way, issues such as the discarding of "faulty data", theoretical bias, and probabilistic tools for hypothesis acceptance and rejection will be discussed. In the latter part of the semester we will discuss how scientific ideas are evaluated by the media, in the courtroom, and in government.

PREREQUISITES:

High school chemistry, physics, and calculus.

COURSE COMPONENTS:

We will use case studies to compare how we imagine (perhaps naively) that conclusions should be drawn from experiments with what is actually done in practice. One or more introductory lectures will provide background for most topics. Relevant material will be studied and then discussed in class.

Homework will consist of reading and pondering over (or participating in other activities related to) background material and preparing short written analyses for the class discussions to follow.

Midterm and final reports will be analyses of experiments or scientific controversies. The midterm report will be based on an experiment by an NYU researcher whom you will contact. The final report will be based on an article in a newspaper or magazine.
Each report will consist of:

• A brief proposal which must be approved before proceeding with the topic,
• A draft report, which will be commented on but not graded, explaining the idea that was tested, how the experiment was done, what conclusions were drawn, and your analysis of the work,
• A final version of up to 4 pages that will be graded.
• An in-class presentation will be done on the midterm project.

**TEXTBOOKS:**


There will regularly be additional handouts, usually from published experimental papers, published historical analyses of the experiments, or newspaper accounts of relevant topics.

**COURSE GRADING:**

• Classroom participation, 20%
• Weekly papers 40%
• Midterm paper 20%
• Final paper 20%

**TENTATIVE SYLLABUS:**

**Week 1, Sep. 2: Introduction to class, some basic statistics and probability**

Activities:

• Introduction to class.
• Start of a short introduction to probability and statistics.

Readings for week 2:

• *Great Experiments in Physics*, M. H. Shamos, chapter 1. (This is the “story” as you may “know” it from high school.)
• *Voodoo Science*, R. L. Park, chapters 1 and 2 (But humans are not logical machines.)

Assignment for week 2:

• Conduct and write up write-up a probability experiment, to be discussed in class.
• Come prepared to discuss how scientists reach conclusions.

**Week 2, Sep. 9: Reaching Conclusions based on data; Continuation of Basic Statistics, Probability, and Hypothesis Testing**
Activities:
- Results of probability experiment.
- Discussion of how scientists reach conclusions.
- Continue introduction to probability, probability distributions, hypothesis testing, and errors of the first and second kind.
- Discussion of midterm project.

Readings for week 3:
  “If AIDS Went the Way of Smallpox,” D.G. McNeil Jr., NY Times Sep. 27, 2009, Week In Review, p. 1. (Statistics is difficult to apply correctly.)
- “And Behind Door No. 1, a Fatal Flaw,” J. Tierney, NY Times, Science Times, April 8, 2008, p. F1 (can be tricky.)
- Voodoo Science, R. L. Park, chapter 3

Assignment for week 3:
- A paper regarding one of the subjects of the readings.
- Come prepared to discuss scientific conclusions in class, including, but not limited to, statistics.

Week 3, Sep. 16: Interpretation of data

Activities:
- Discussion of interpretation of data: when is statistics sufficient? What is convincing statistics?
- Background lecture on general relativity and light deflection by the Sun.

Readings for week 4:

Assignment for week 4:
- A paper on the eclipse measurements and conclusions.
- Come prepared to discuss both subjects covered in the readings.
- Midterm proposal due week 4.
**Week 4, Sep. 23: Statistics Misunderstood?**

**Activities:**
- Discussion of the 1919 British Eclipse expeditions and of cellphone studies.
- Background lecture for the Millikan Oil Drop Experiment.
- Short discussion of pulsars.
- Midterm proposal due.

**Readings for week 5:**
- *Great Experiments in Physics*, M. H. Shamos, chapter 18
- “Pulsars and High Density Physics,” A. Hewish, Nobel Lecture, Dec. 12, 1974
- “Discoverer of pulsars (aka Little Green Men) reflects on the process of discovery and being a female pioneer,” L. Gold, Cornell University Chronicle Online, July 6, 2006

**Assignment for week 5:**
- A paper on the Millikan experiment.
- Come prepared to discuss the readings.

**Week 5, Sep. 30: Rejection of Data, Crediting Work**

**Activities:**
- Discussion of the Millikan Oil Drop Experiment, Rhine’s ESP experiments.
- Discussion of authorship and credit, Millikan, Fletcher, Hewish, Bell.
- Background lecture on radiation, cathode rays, and x-rays

**Readings for week 6:**
- *Great Experiments in Physics*, M.H. Shamos, Chapters 14, 15, and 16.

**Assignment for week 6:**
- Come prepared to discuss the readings.
- Midterm draft due week 6.

**Week 6, Oct. 7: Justified and Unjustified Claims**
Activities:
- Discussion of Roentgen, Becquerel, and Thomson experiments.
- Background lecture on faster than light neutrinos.
- Short background lecture on satellite motion.
- Draft of midterm paper is due.

Assignment for weeks 7 and 8:
- Finish midterm paper (to be handed in at the beginning of week 7)
- Prepare presentation.

Week 7 and Week 8, Oct. 14 and Oct. 21: Midterm Presentations

Activities:
- Mid-term due the start of week 7 class.
- Student mid-term presentations and discussions.

Readings for week 9:
- “Mystery Tug on Spacecraft is Einstein’s ‘I Told You So’,,” D. Overbye, NY Times, Jul. 23, 2012

Assignment for week 9:
- Come prepared to discuss the readings.
- A paper on the role of theory in experiment.

Week 9, Oct. 28: Theory and Experiment, How They Interact, and Which Leads the Way?

Activities:
- Discussion of faster than light neutrinos.
- Discussion of Pioneer Satellite paths.
Discussion of atomic theory
Discussion of Copernicus and Galileo
Discussion of final project.

Readings for week 10:

Assignment for week 10:
- A paper on n-Rays will be assigned in class
- Come prepared to discuss the readings.

Week 10, Nov. 4: Self-Deception

Activities:
- Discussion of N-rays
- Depending on available time, LHC presentation

Readings for week 11:
- “The Denunciation of Dr. Wakefield,” S. Dominus, NY Times Magazine, Apr. 24, 2011, p 36. (It is difficult to disentangle errors from agendas.)
- “New Truths that Only One Can See,” G. Johnson, NY Times, Jan. 21, 2014, p. D1. (Replication is not always the answer.)
- “Opponents of Same-Sex Marriage Take Bad-for-Children Argument to Court,” E.Eckholm, NY Times, Feb. 23, 2014, p.16 (There are implications well beyond pure science.)

Assignment for week 11:
- Come prepared to discuss science, “fake” science, and scientific consensus.
- Final project proposal due week 11.

Week 11, Nov. 11: Science, Fake Science, Scientific Consensus

Activities:
- Discussion on Scientific Consensus
- Background lecture on energy conservation
- Discussion of perpetual motion
Readings for week 12:
- **Voodoo Science**, R. L. Park, chapters 4 to 7
- Wikipedia article on Cold Fusion

Assignment for week 12:
- Come prepared to discuss the readings

**Week 12, Nov. 18: Junk Science, Fraud, Government Policy**

Activities:
- Discussion of junk science and fraud
- Discussion of cold fusion
- Discussion of government policy and science.
- Background lecture on expert testimony and the law

Readings for week 13:
- Frye v.United States 293 F. 1013 ( D.C.. Cir 1923)
- **Voodoo Science**, R. L. Park, chapter 8

Assignment for week 13:
- Come prepared to discuss the readings
- Final project draft due week 13.

**Week of Nov. 25: Thanksgiving Break, No Class**

**Week 13, Dec. 2: Science in the Courtroom**

Activities:
• Discussion of science in the courtroom
• Final project draft due.

Readings for week 14:
• “Global Change and Energy,” P.E. Dimotakis, Engineering and Science Winter 2008 p.12
• Voodoo Science, R. L. Park, chapters 9, 10

Assignment for week 14:
• Final project to be handed in on week 14
• Come prepared to discuss the readings

Week 14, Dec. 9: Science and Journalism

Activities:
• Discussion of science and journalism.
• Climate change
• Final project due.