

Paper Assignment #1: Research Topic. Due Monday March 1.

- (a) Pick one of the following themes and develop it into a focused research topic appropriate for a 15-20 page essay. Please submit your research topic to the link in the Brightspace Assignments Folder in the form of a document that includes:
- (i) A specific research question related to the theme that can be addressed in a 15-20 page essay. This question should be as focused as possible: it should not be broad or general.
 - (ii) An initial abstract that provides a brief (one paragraph) summary of how you intend to address your research question.
 - (iii) An initial list of sources that are relevant to the research question and that can serve as the basis for a bibliography for a 15-20 page essay. Please read the guidelines on writing a research paper that were discussed in class to make sure your sources are appropriate (they should not be Wikipedia entries, lecture notes, or webpages and/or online articles that have not undergone peer review, or that have not been approved by me).
- (b) Your research question, your initial abstract, and your initial list of sources don't have to be identical to those that appear in the first draft of your essay (due at a later date). It's ok for all three to be modified over the course of your research. But they should not be modified *too* much: In particular, you may tweak your research question a bit between now and your first draft, but it should remain more or less the same question (on the same theme).
- (c) If you'd like to develop a research question on a theme that does not appear below, please let me know in advance to make sure the theme is appropriate for the topics of our seminar.

Sample Themes:

Classical Information: Shannon, Fisher

Maxwell's Demon

Quantum Information: teleportation, dense coding, error correction

Entropy: Shannon, thermodynamic, Boltzmann, Gibbs, von Neumann

Spacetime and Physical Computability

Information-Theoretic Physics:

- Spacetime & QECs
- QM from quantum info
- Physics from Fisher info

Sample Research Questions:

1. How are Shannon information, Fisher information, and quantum information conceptually distinct? How are they similar?

2. Can statistical mechanics and/or thermodynamics be given an information-theoretic foundation?
3. Can Maxwell's Demon be defeated by information-theoretic means?
4. Explain how the protocols of quantum teleportation and quantum dense coding depend crucially on entanglement. What is the current experimental evidence for these protocols?
5. In what sense can quantum information be more robustly protected against errors than Shannon information?
6. Is there a single concept underlying the following types of entropy: Shannon, thermodynamic, Boltzmann, Gibbs, von Neumann?
7. What role does the structure of spacetime play in theoretical limitations on Turing computability?
8. Can spacetime be conceived as a quantum error correction code?
9. Can quantum mechanics be conceived as a theory about quantum information?
10. Can theories in physics be conceived as theories about Fisher information?