

Wavelet and Fourier Analysis Final Project

Math 320 Prof. Leise

Goal: To delve deeply into a topic of interest in wavelets or Fourier analysis by finding and studying an article or section of a book on that topic and then writing a report, which should include mathematical analysis or computation or a mix of these.

Feel free to talk to me at any point about finding sources and what material should be included in the final report.

Timeline:

- Choose a topic of interest by Monday November 16 and email me a sentence or two describing what you want to do and what sources you plan to use (books or articles).
- Individual meetings during the week of December 7 to check on progress. You should bring a detailed outline of your project to this meeting.
- Final written report due 4pm Monday December 21. You may email the report to me or hand in a printed copy.

Report guidelines: The report should be roughly 8-10 pages double-spaced, using Word, LaTeX, Mathematica (which has some nice document styles), or other appropriate format. The report should include some mathematics (theoretical or computational), but may also include less technical explanations and relevant background, for example, some historical information on who developed the theory (and when) and what their motivation was.

Sources: You should use at least three sources of information, which may include your textbook, other books, and scholarly articles. You should not use a website as a source of information (since websites often contain incorrect information), but searching the web may be helpful initially as an idea-generator of interesting topics and for basic information. Searching JSTOR and MathSciNet may also be helpful, in addition to a general 5 College library search (get started early in case you need to ask for an interlibrary loan or order an article to be delivered).

There is a nice selection of books on Fourier analysis and on wavelets in the science library. Please be kind to your fellow classmates and only check out one or two of these books at a time. Do not check out a big stack of them, as this prevents others from being able to access any of those books.

Your report should list all sources used in researching for your report. You may use any standard style to cite them, for example:

Baker, G.L., and Gollub, J.P. *Chaotic Dynamics: An Introduction*, Cambridge University Press, Cambridge, 1990.

Li, T.-y., and Yorke, J., "Period Three Implies Chaos." *American Mathematical Monthly* **82** (1975), 985-992.

There are two purposes in citing your sources: first, to give credit to those who did the work and published it, and second, to enable readers to find these article or books if they want to read further about that topic.

When you refer to a source of information in the text of your report, cite that source using a standard style, as in the following examples:

One author: How fireflies oscillate in synchrony can be explained using a relatively simple nonlinear system (Strogatz, 1994).

Two authors: Tyson and Novak (2001) discovered a bifurcation that explains the cell cycle.

More than two authors: Tyson et al. (2004) found that something interesting occurred.

If you copy a figure, cite the source in the caption.

Examples of possible topics (you are certainly not limited to these):

- Historical account of Fourier's work and its role in the development of rigorous definitions of convergence of sequences of functions
- Rigorous proof of Fourier transform inversion formula
- Rigorous proof of Dirichlet (or other) theorem on convergence of Fourier series
- Theoretical analysis of the Gibbs phenomenon in Fourier series
- Time-frequency analysis of stock market data
- Discrete cosine transform and jpeg image format
- Fingerprint compression
- Boundary value problems and Fourier series
- Radon transform and medical imaging
- Compressive sensing
- Spectrogram analysis of an audio recording using Matlab
- Automated pitch correction methods
- Wavelet-based edge detection methods
- Other types of image processing using Fourier or wavelet-based methods