Pries: 460 Information and Coding Theory, Spring 2019
Information about project reports and posters.

The project posters and reports are an opportunity to learn something new in greater depth and develop skills at communicating and writing mathematics. They will give us an overview of many interesting topics that we wouldn't see otherwise.

Deadlines:
Mon 4/1: Hand in first two choices for topic
Fri 4/19: Hand in extended outline and 2 references.
Thurs 5/9: Poster session 9 am.
Fri 5/10: Written report. Guideline - 2-4 quality pages.

Things to include:

1. What: topic title, definitions needed for topic.

2. Where/When/Why: motivation for topic, history of topic, applications of topic.

3. **** Facts: important properties and theorems about topic.

4. *** Examples: by hand or using computer.

5. ** Visual: graph, data, picture.

6. Proofs or code (especially for written report).

7. References at end of report (only for written report).

Possible topics The topic of your project should be connected to one of the central themes of this class: information theory or coding theory. LA=linear algebra, CS=computer science, NT=number theory, P=probability.

Information theory topics

1. (need permission) Huffman encoding and Noiseless Coding Theorem: proof that it is the most efficient, connection with entropy.

2. (need permission) Extensions of an information source and minimum average code length.

3. Entropy of infinite probability distributions (P)

4. Bernouilli trials and typical sequences (P).

5. ** Conditional entropy, mutual information, and channel capacity (P).

6. *** Noisy coding theorem.

Topics about error-correcting codes

1. Channels: Gaussian, erasure, best code for given channel parameters

2. Encoding and decoding, Mixed error detection and error correction.

3. Extending, shortening, and direct sums of codes. Equivalent codes (LA).

4. ** Standard arrays: Efficient algorithms for finding the minimal distance, probability of correct decoding (CS).

5. ** Burst errors.

6. ** Dual of a linear code, self-dual codes, simplex codes (LA).

7. Parity check matrices: efficient computation of minimum distance and syndrome decoding, (LA,CS).

8. ** Turbo codes

9. convolutional codes, Justesen codes.

10. QR scanners (this topic usually does not turn out well).

Topics about bounds

1. * $A_r(n, d)$, the maximum number of codewords in a code of length n and minimum distance d.

2. ** Plotkin bound, Gilbert-Varshamov bound R5.4, Johnson bound and Elias bound.

3. *** Weight distributions (uses characters) and linear programming bound.

4. Asymptotic bounds.

Special kinds of codes

1. (need permission) Perfect codes and Golay codes.

2. ** Cyclic codes (NT) R7.1, automorphism group of a code

3. ** BCH codes.

4. Reed-Mueller codes

5. * Projective plane codes, Fano plane, quadratic residue codes, Latin squares

6. **** Goppa codes (uses some algebraic geometry).

7. Hadamard codes and Hadamard matrices.

8. * Maximum distance separable codes.