I won't have time to cover the topics of these "two" lectures (**Random graphs and real networks** and **Coding theory**) during the Governor's School. As always, I am running out of preparation time as it is, so I'll leave this material to another occasion ... But the study of networks is tremendously exciting, with many fascinating applications. Here are some of the references I found. The first topic is more a description of results and phenomena. The second topic would be an introduction to a very intricate technical discipline.

Lecture 18: Random graphs and real networks

A random graph occurs when vertices are connected by edges "at random". There are several models for what this might mean precisely. Many results have been proved about such graphs, including information about how connected they must be.

Within the last decade, investigators have tried to apply random graph theory to the Internet and to a variety of social networks. The extent to which the abstract models do apply is interesting.

18.1 The random graph

18.2 Real networks

18.3 Bibliography

[1] `http://topology.eecs.umich.edu/` This is a University of Michigan web site devoted to the topology of the Internet. It has many interesting links. The Internet is seen as a random graph using a power law for degrees: vertices get connected more if they have more connections!

[2] Bill Cheswick of Bell Labs and Hal Burch of Carnegie Mellon University have tried to map the Internet. They are now at Lumeta Corporation and you should see
`http://research.lumeta.com/ches/map/`

[3] `http://www.geog.ucl.ac.uk/casa/martin/atlas/topology.html` Lots of different maps of cyberspace.

[4] M. E. J. Newman, *Random Graphs as Models of Networks* is available on the web at
`http://www.santafe.edu/sfi/publications/wpabstract/200202005`
This is a recently written discussion of aspects of real networks of various kinds, contrasting these with the now-classical (theoretical) random graph. The paper has some very nice examples.

[5] Béla Bollobás *Random Graphs*, second edition, Cambridge University Press, 2001 (500 pages, $45, paperback!).

The following three books are all in paperback, and are all quite recent. Networks are *hot stuff!*

[6] Albert-László Barabási, *Linked: The New Science of Networks*, Plume, 2003 (294 pages, paperback, $14). This book has many interesting applications of networks, including discussion of biological structures. The author also has a website on "self-organized networks" at the University of Notre Dame: `http://www.nd.edu/~networks/`.

[7] Duncan J. Watts, *Six Degrees: The Science of a Connected Age*, Norton, 2003 (368 pages, paperback, $16). I read this book (June, 2003), and really enjoyed it. The author is an excellent writer. He received a math doctorate but is now a member of a sociology department. The book has a very useful bibliography. Watts also wrote *Small Worlds*, a paperback which I have not read published by Princeton University Press.

[8] Steven Strogatz, *Sync: The Emerging Science of Spontaneous Order*, Hyperion, 2004, (352 pages, paperback, $15). This was just published in paperback. I intend to read it soon.

The idea of "scale-free" graphs emerged from studies of actual networks. The web page `http://stat-www.berkeley.edu/users/aldous/Networks/` contains links to the paper

[8] *Statistical Mechanics of Complex Networks* by Albert and Barabási, which takes a nonrigorous approach towards the phenomena, and to the paper

[9] *Mathematical Results on scale-free random graphs* by B. Bollobás, which, by contrast, spends a great deal of time establishing a rigorous framework for the study of appropriate models of networks.

Lecture 19: Coding theory

Coding theory deals with the efficient and secure storage and transmission of information.

19.1 Check digits and casting out

19.2 Hashing

19.3 Error-correction & error-detection

19.4 Information theory; Shannon's limits

19.5 Bibliography

[1] Robert J. McEliece, *The Theory of Information and Coding*, 2nd edition, Cambridge University Press, 2002, 450 pages, $90. A standard reference.

[2] Richard W. Hamming, *Coding and Information Theory*, Prentice Hall, 1986. This was used for upper-level undergraduate electrical engineering course at Rutgers. Every text I've read by Hamming has been lovely. I think most of this text could be read by a well-motivated high-school student.

[3] John Robinson Pierce, *An Introduction to Information Theory: Symbols, Signals and Noise*, second edition, 1980, Dover Publications (300 pages, paperback, $12.00). I don't know this book but it gets good reviews and the price is right!

[4] Joseph Kirtland, *Identification Numbers and Check Digit Schemes*, 2001, Mathematical Association of America (174 pages, paperback $32). An introductory text.