Projects!

Proposal due one week from Thursday
(as part of Dynamics Homework)

Projects ...

Project:

1. Structure:
   (i) Choose time-dependent phenomenon of interest.
   (ii) Model it with a nonlinear dynamical system.
   (iii) Build simulator for system.
   (iv) Add visualization of behavior and state space structures.
   (v) Add quantitative analyses.
   (vi) Turn into an interactive exploration tool with GUI.
   (vii) Use Python's object-oriented design.

2. Selected in consultation with us.

3. Project report (including code demonstrations),
   presented to class at the *1 & 3 June class meetings*.

5. Written report and running code with documentation due 5 PM *8 June*.

4. Website on the project with the report, code,
   and documentation is preferred.

6. Submitted by email to TA.

Projects ...

Possible topics:

Low-dimensional dynamical systems:

Mechanical systems:
- Double pendulum
- Chaotic water wheel
- Catastrophe machine

Chemical oscillators:
- Belousov-Zhabotinsky (stirred) reaction

Electronic circuits:
- van der Pol's original triode oscillator
- Chua circuit
- Driven Zener diode

Biological population/ecological dynamics

Evolutionary dynamics:
- Dynamics of genetic algorithms

Neurobiology:
- Driven integrate-and-fire neuron
- Heart arrhythmia

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Projects ...

Possible topics ...

Effect of external noise on:
- Chaotic behavior
- This or that kind of bifurcation
- Routes to chaos
- Lyapunov characteristic exponents

Probability densities:
- Time evolution of densities for maps or ODEs
- Approximate invariant distributions

Effect of finite-precision arithmetic on chaos

Quantitative analysis of ODEs:
- Lyapunov characteristic exponent spectrum
- Measure fractal dimension

Transform-based analysis of chaos:
- Fourier analysis
- Wavelet analysis

Chaotic encryption

Sound generation from chaotic system

Visualization:
- Stable & unstable manifolds
- Basins of attraction
- Catastrophes
- Branched manifolds
- ...

Projects ...

Possible topics ...

Spatial systems:

Cellular automata
Map lattices:
  Logistic lattice
  Tent lattice
Chemical pattern formation:
  Belousov-Zhabotinsky (non-stirred)
Biological morphogenesis:
  Turing patterns
Traffic flow
Neurobiology:
  Neural spike propagation: Fitzhugh-Nagumo
Video feedback (see articles on JPC website)
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Projects ...

Possible topics ...

Two examples from previous years:

(See Research Project link on course website.)

Multiagent dynamical systems: Kristin Lui

Agent's play Rock-Scissors-Paper against each other

Play strategy evolves according to past wins

Traffic flow: Nicholas Linesch

Cellular automaton model: spatial dynamical system

Cars accelerate into open space and stop

Red cars move horizontally

Blue cars move vertically

Traffic jams: Depend on density of cars

Projects: Nonlinear Physics, Physics 150/250 (Spring 2010); Jim Crutchfield