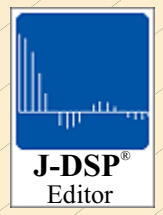
J-DSP-C® Editor

J-DSP-CONTROL: A CONTROL SYSTEMS SIMULATION ENVIRONMENT



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ASU Arizona State University

J-DSP-C

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J-DSP concept by Andreas Spanias
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Telecommunication Research Center (TRC)
Arizona State University

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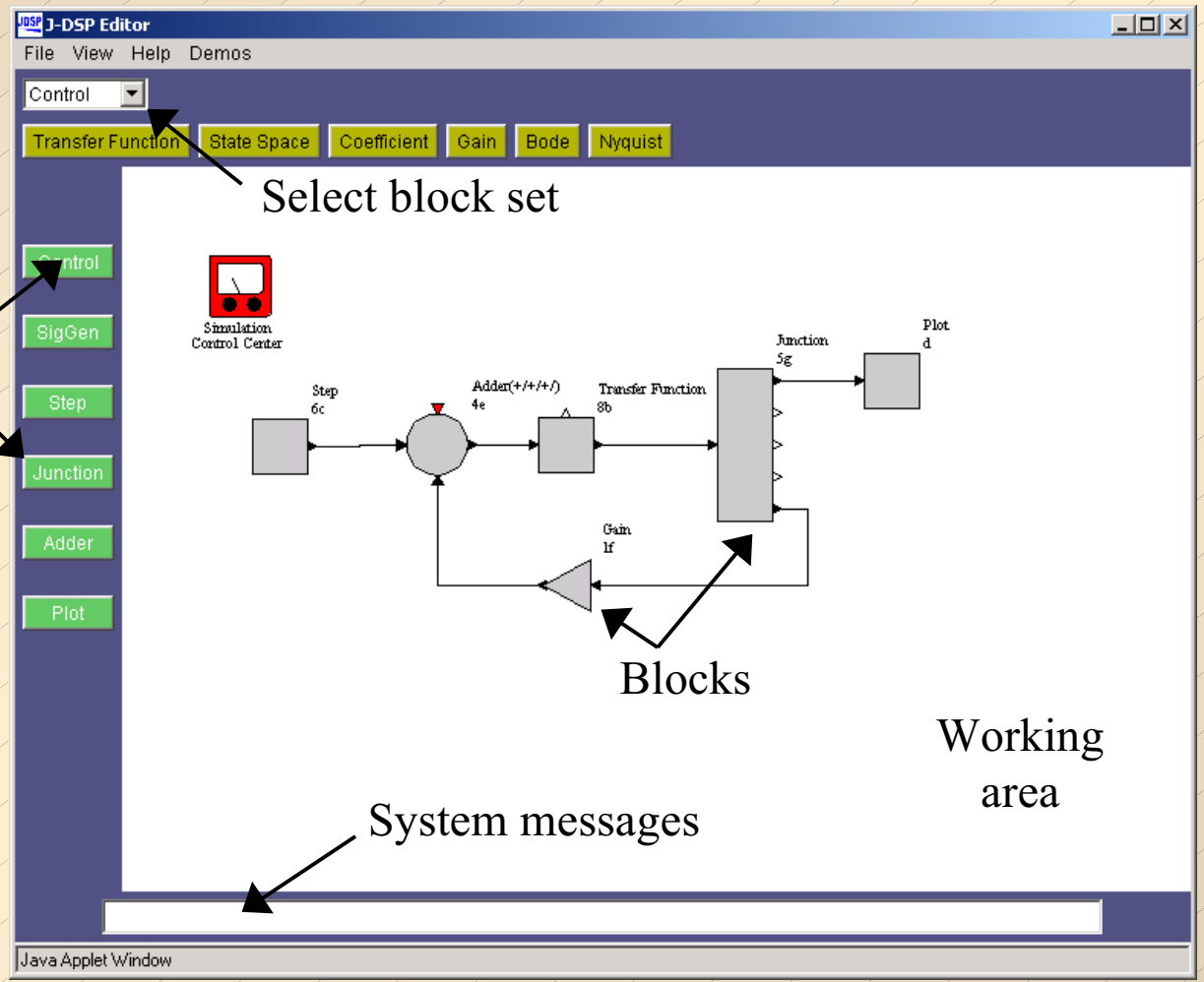
J-DSP-C basics

- J-DSP-C is an on-line, object-oriented graphical control systems editor written as a Java applet
- Quick and easy simulation of feedback control systems
- Graphical or numerical results
- Simple and user-friendly interface

J-DSP-C Supports:

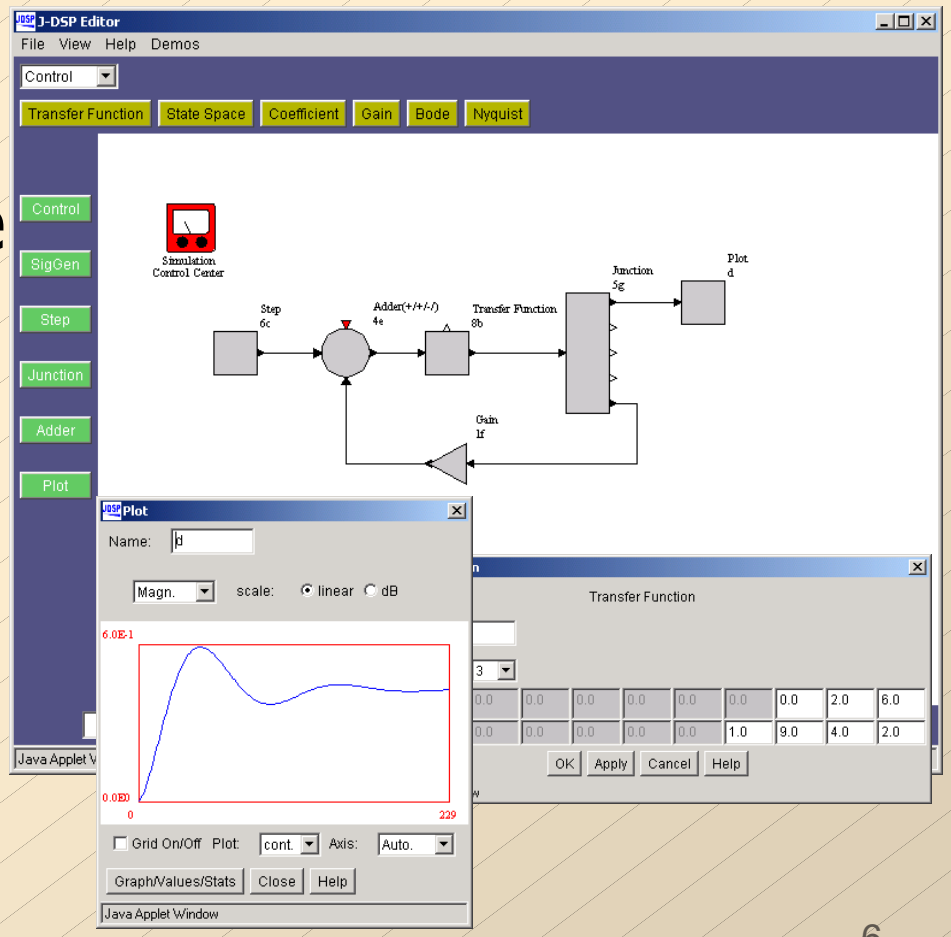
- Arbitrary interconnection topology
  - Including feedback systems
- Signal generators and various arithmetic operations
- Basic control systems building blocks
- State-space or transfer function models
- Plotting and visualization blocks

J-DSP-C Environment



Simulating Systems

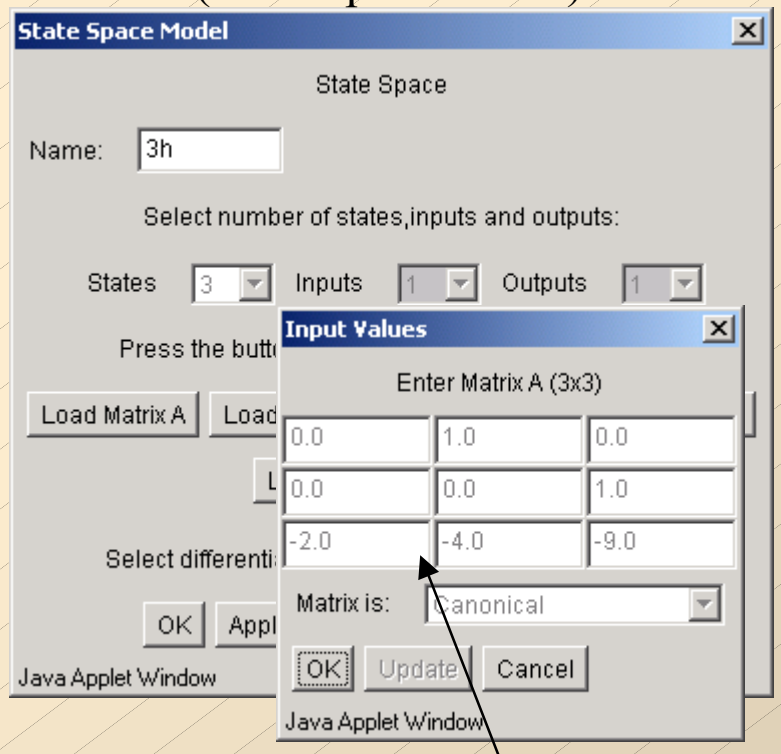
- Each block represents a system
- Simulation models are built by connecting blocks together



Editing Blocks

- Each block can be edited through a dialog window
  - Edit block parameters values
- Display of results

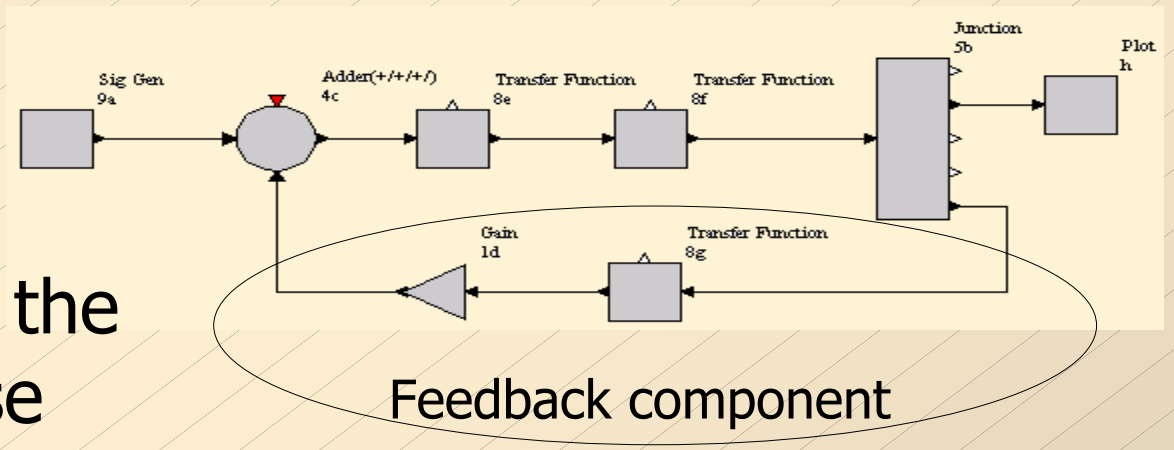
Typical block dialog box
(State Space model)



State space system representation

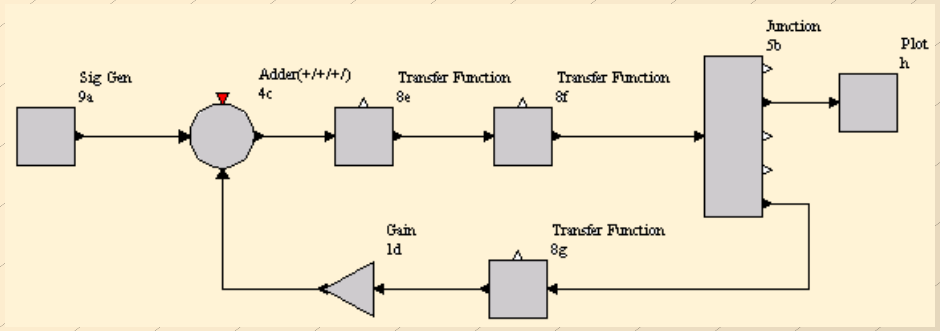
Feedback systems

- Manual start of simulation
- Recursive and iterative computation of the system response
  - Discrete-time approx.



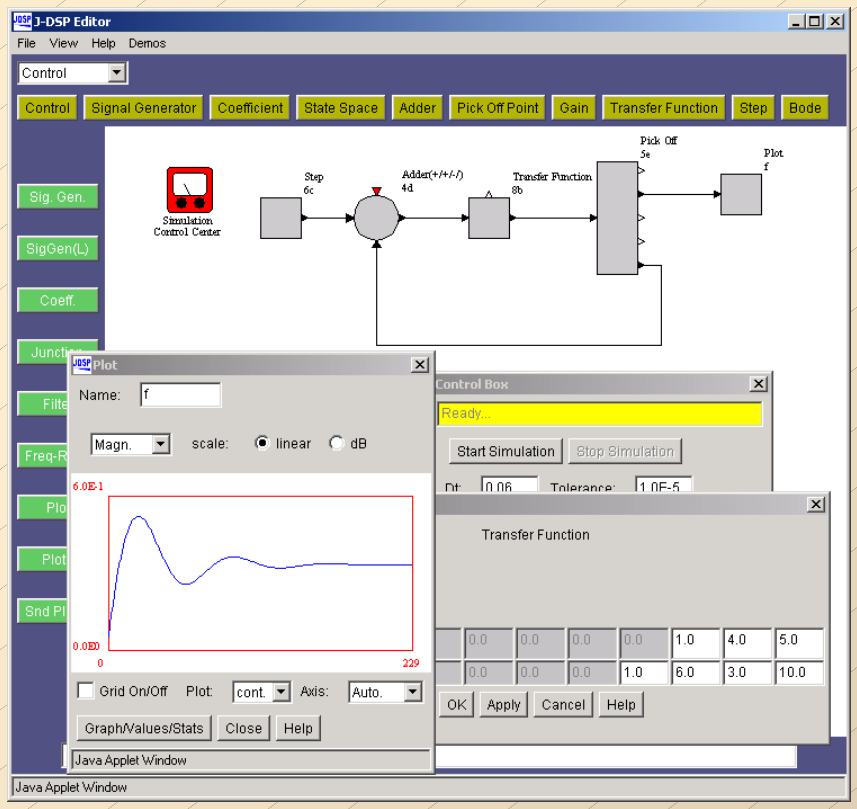
Arbitrary connection topology

- Rotate and flip blocks
- Modify connections
- Square, round and triangle blocks (as commonly used in feedback systems literature)



Control Systems

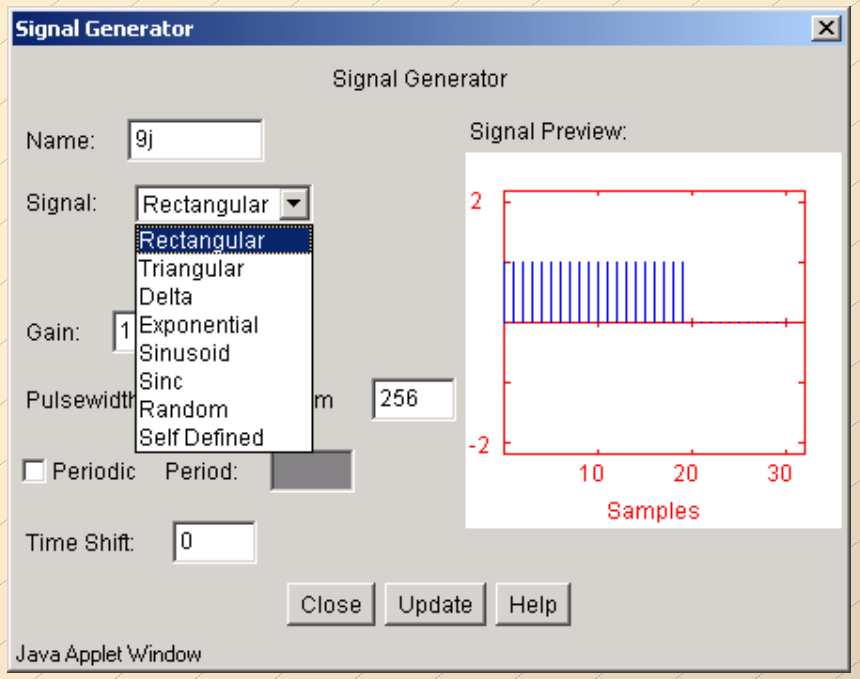
- Feedback systems
- Dynamical systems
  - Transfer Functions
  - State Space Models
  - Multiple inputs/outputs
- Bode plots and time responses



Step response

Signal generators

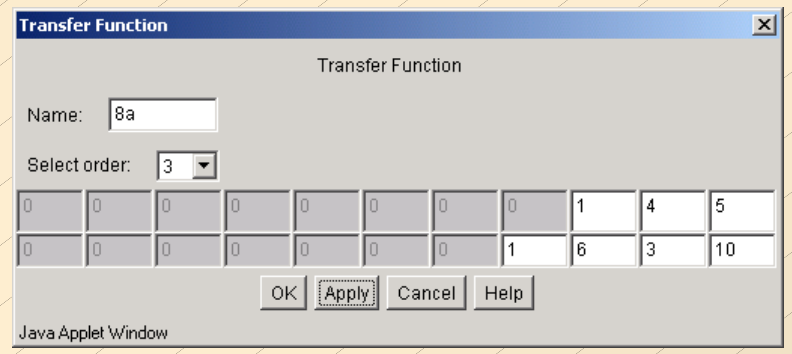
- Various types of signals
  - Pulses
  - Sinusoids
  - Random
  - ... etc



Dynamical Systems

- Transfer functions

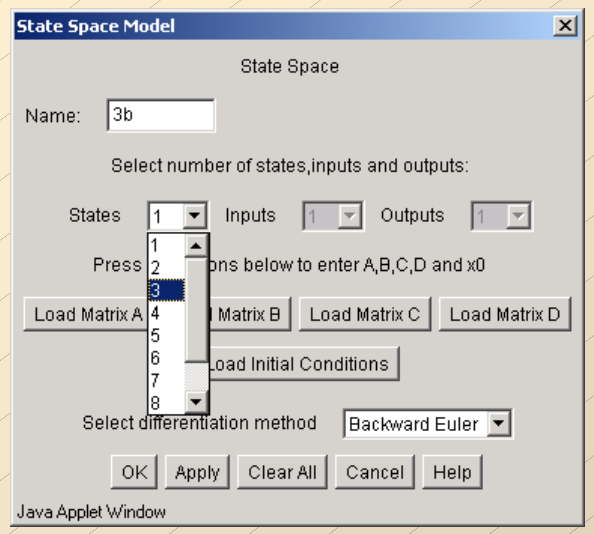
$$H(s) = \frac{\sum_{i=0}^{n} b_i s^i}{\sum_{i=0}^{n} a_i s^i}$$



- State space

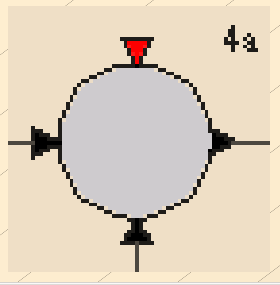
$$\dot{\underline{x}} = A\underline{x} + Bu$$

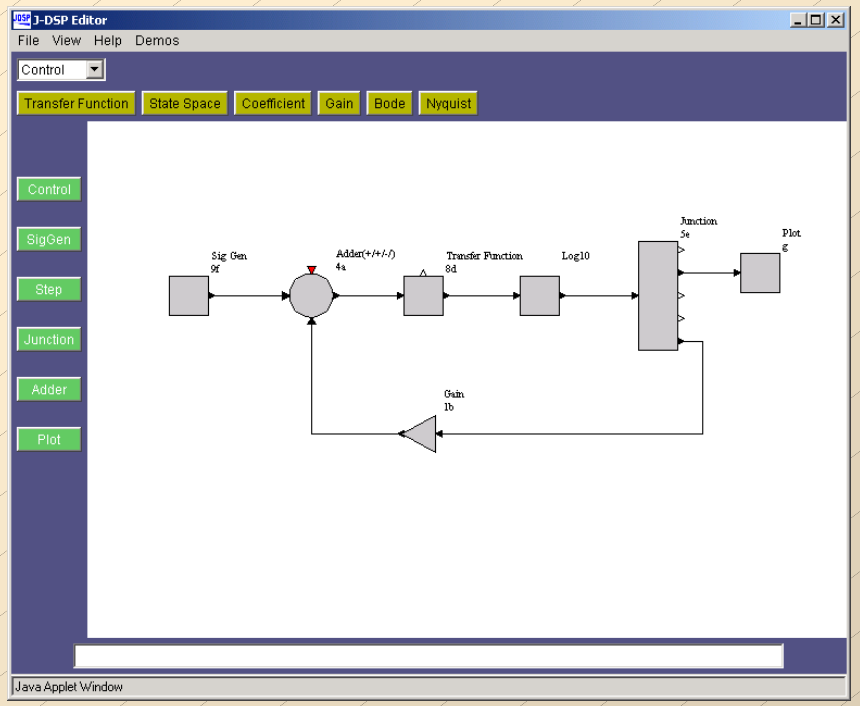
$$y = C\underline{x} + Du$$



Arithmetic operations

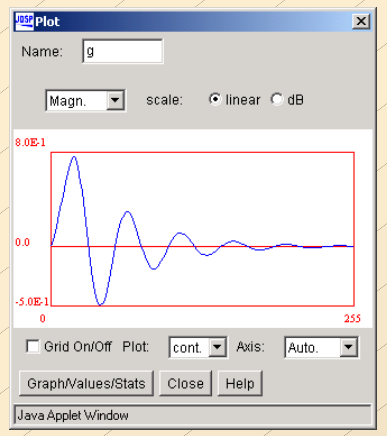
- Various types of math functions
  - Gain
  - Summation nodes
  - Logarithms
  - Exponentials
  - Multipliers

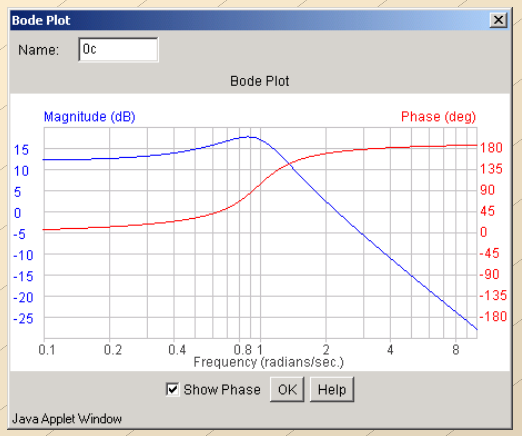




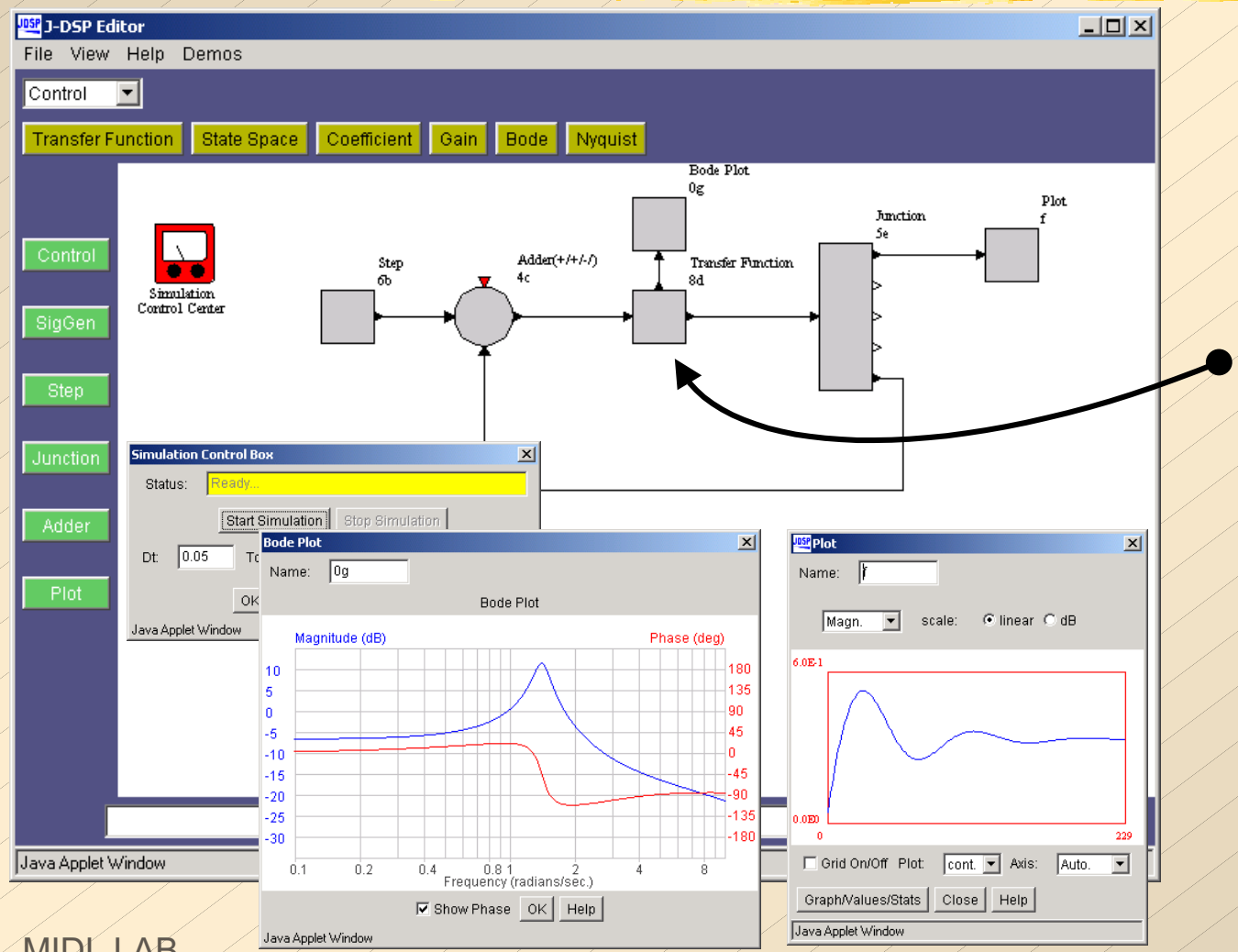
Plot and visualization

- Plotting blocks
  - Plot
    Zoom-in, dB plots
  - Bode plot
    Magnitude and phase response



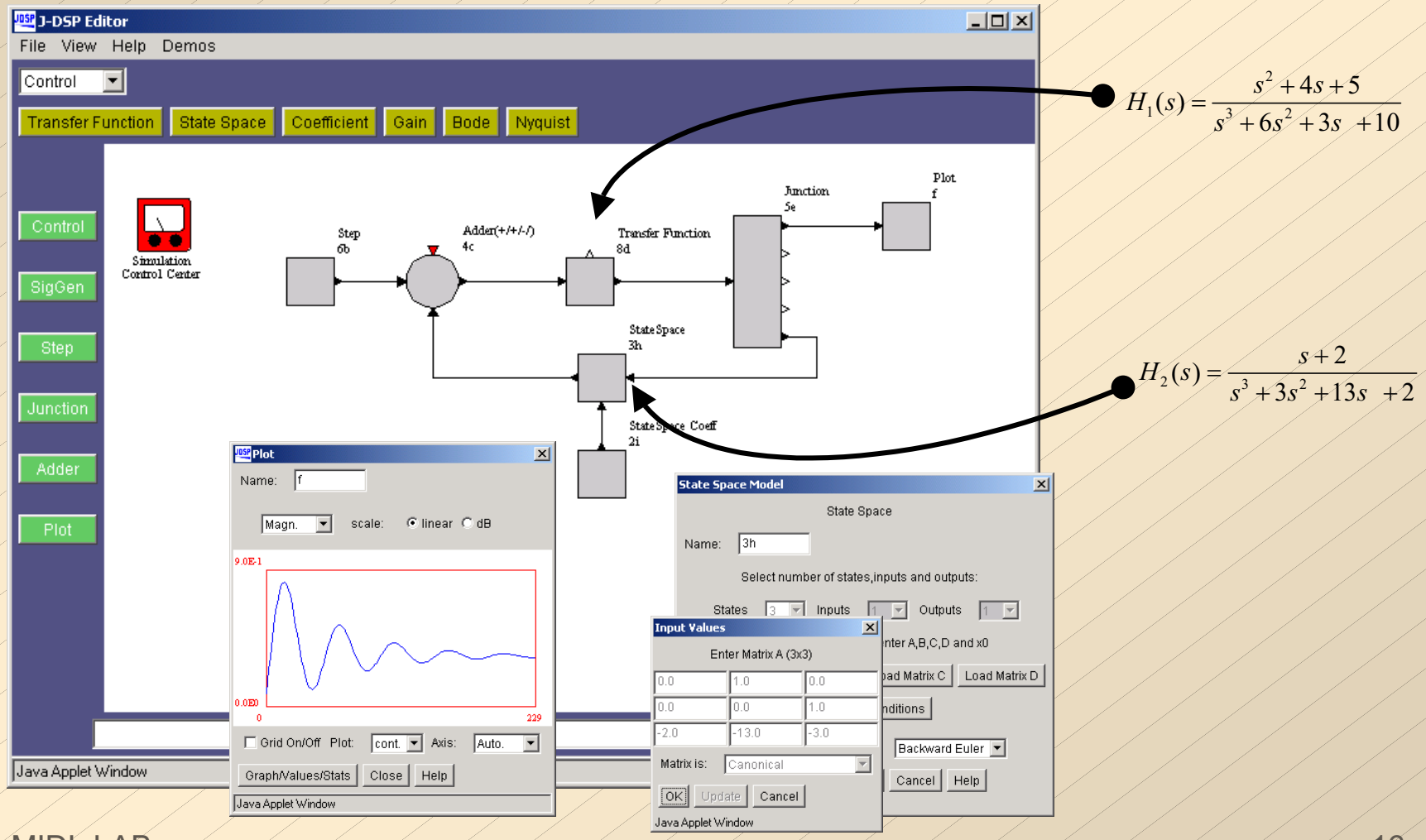


Sample Simulation (1)



$$H(s) = \frac{s^2 + 4s + 5}{s^3 + 6s^2 + 3s + 10}$$

Sample Simulation (2)



$$H_1(s) = \frac{s^2 + 4s + 5}{s^3 + 6s^2 + 3s + 10}$$

$$H_2(s) = \frac{s + 2}{s^3 + 3s^2 + 13s + 2}$$

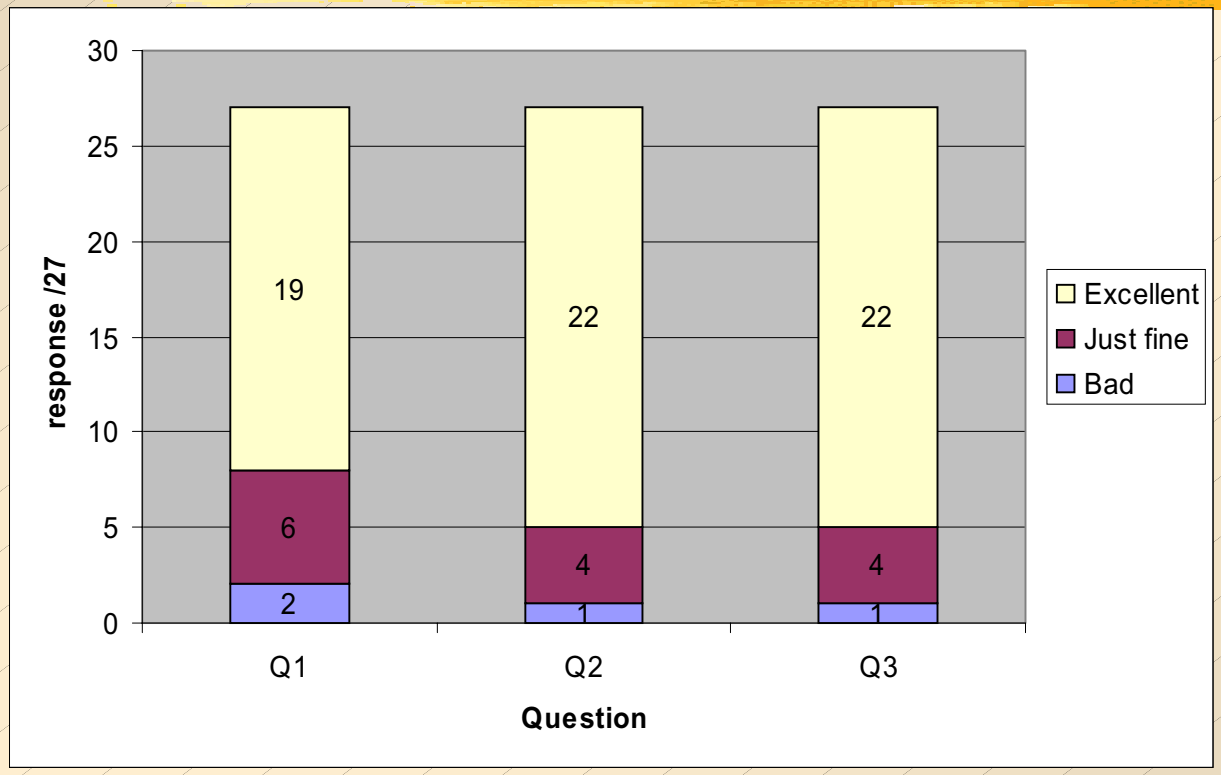
General J-DSP-C evaluation

Evaluations derived out of a sample of 27 students taking EEE480 ASU Control systems class, Fall 2002

	C Excellent	Just Fine	D Bad
How would you rate the J-DSP-C concept?	89%	0%	11%
The graphical interface of J-DSP-C is intuitive and user friendly	59%	26%	15%
Should the J-DSP-C be established as a full-fledged tool?	70%	15%	15%
Establishing and connecting blocks is easy	81%	11%	8%

Specific lab evaluation

Evaluations derived out of a sample of 27 students taking EEE480 ASU Control systems class, Fall 2002

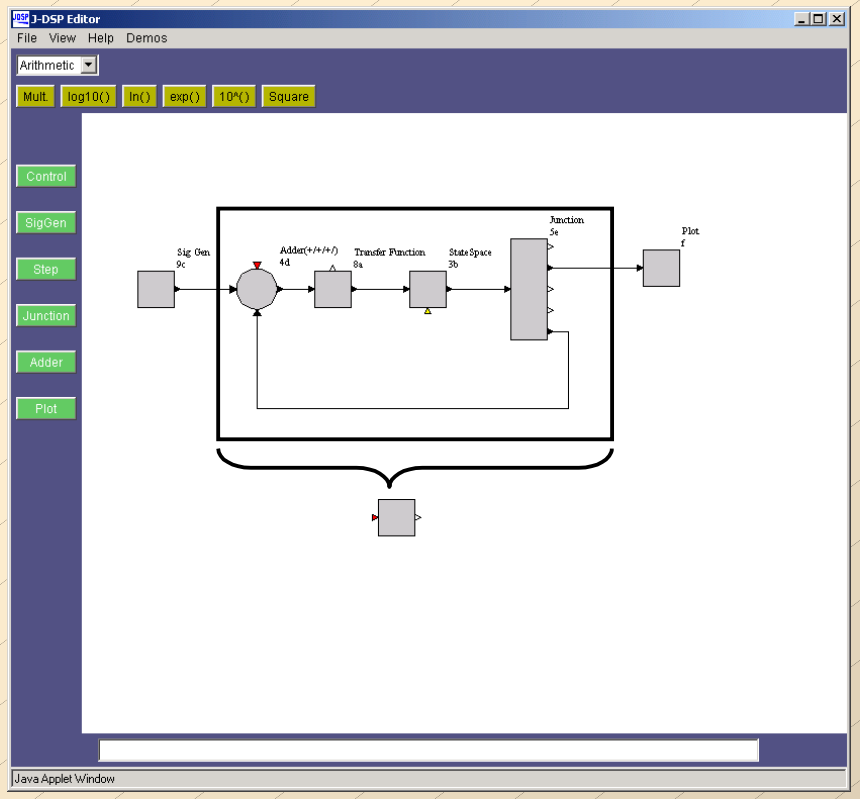


Questions asked after completion of a J-DSP based lab related to simple system concepts

- Q1:Your understanding of the time constant on the step and frequency response of a system has now improved
- Q2:The effect of the damping ratio or the step response is now clearer
- Q3: The simulations allowed you to better comprehend the overall parameters affecting the system overshoot

Future work

- Matrix manipulations
- Least squares approx.
- Adaptive systems
- Multivariable
- Grouping of several blocks to create a composite one



Summary

- J-DSP-C simulates control systems in a straightforward manner
- J-DSP-C maintains a classical textbook appearance
- J-DSP-C runs in any computer through a web browser
- J-DSP-C can be used to integrate interactive examples into classroom web content

Other J-DSP Extensions:

- Basic DSP systems
- Speech analysis-synthesis
- Image processing
- Communications systems
- Time frequency representations