PHYS4300 Numerical Methods and Scientific Computing

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HW 5
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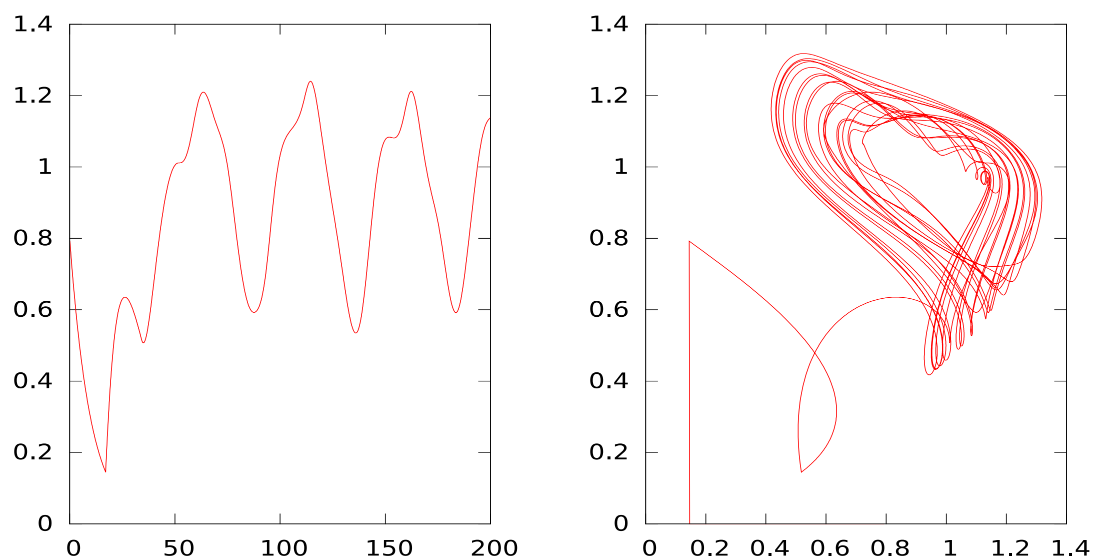
Solution. *Problem 0.* This is a c++ program that uses the 4th order Runge Kutta method that solves the Mackey-Glass ODE usingh the discrete time step $\delta t = 0.1$ for parameters $\beta = 2\gamma = 0.2$, $n = 10$, $\tau = 17$, discarding the first 2τ points. The plots are of $u(t)$ vs. t and $u(t-\tau)$ vs. t.



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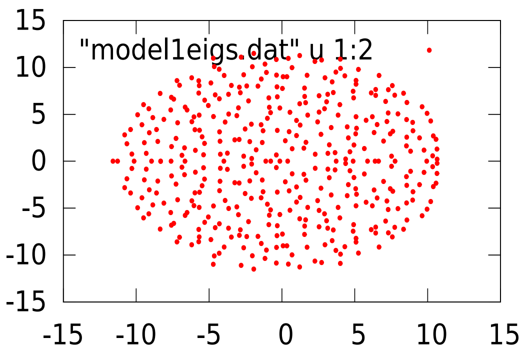
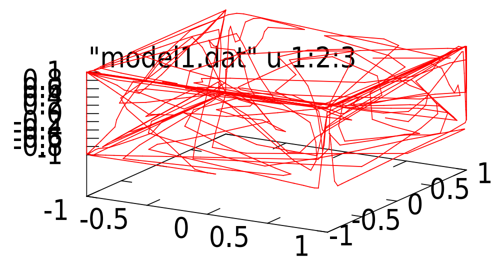
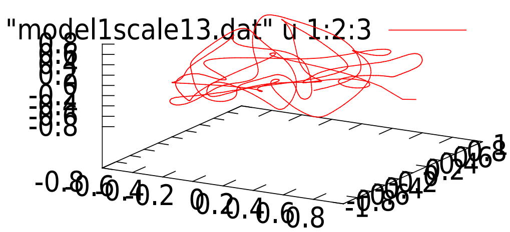
Solution. *Problem 1.* This is the untrained network for for the iterative map $x(t+1) = (1-\alpha)x + \alpha \tanh W x(t)$ using $\alpha = 0.3$. The machine variable dimension is $N = 400$. We use a square matrix W scaled with a maximum eigenvalue of $s_\lambda = 1.3$. Below is a plot of the eigenvalues, the $x(t)$ evolution with the unscaled eigenvalues, and $x(t)$ evolution with scaled eigenvalues.

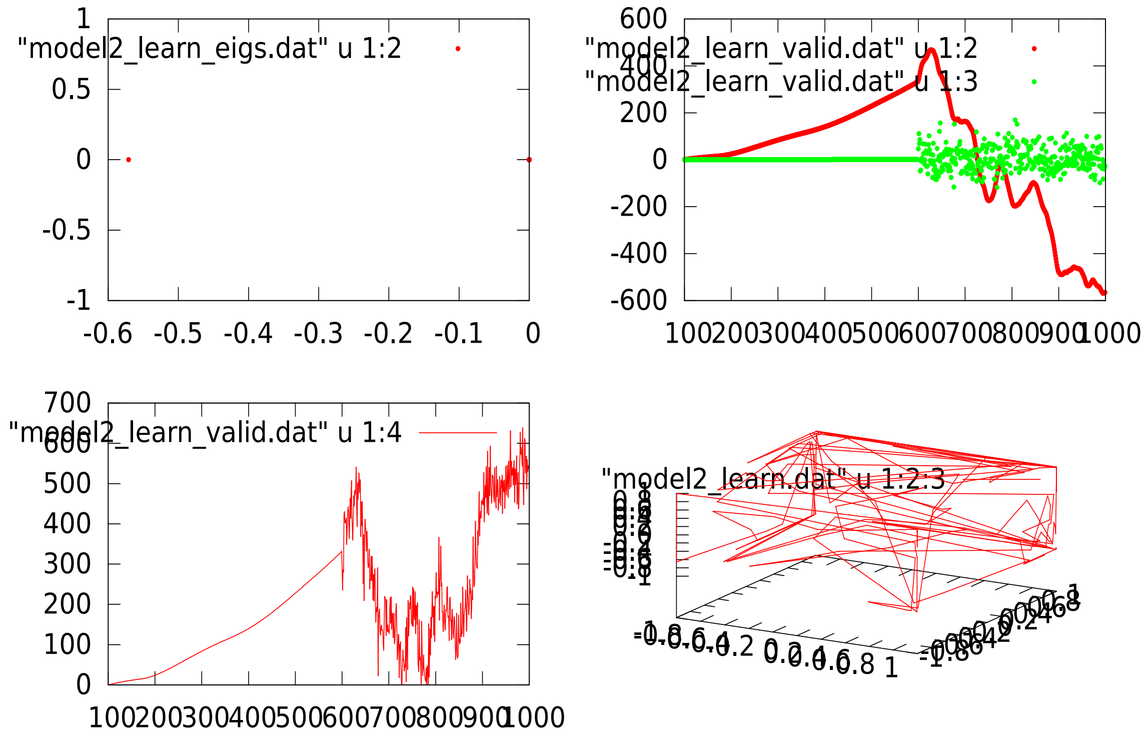






□

Solution. *Problem 2.* This is the driven training network. Here, we now include an additonal term in the hyperbolic tangent function $x(t+1) = (1-\alpha)x + \alpha\tanh(Wx(t) + W_{in}u(t))$. We iterate over 600 time steps and discard the first 100. We then proceed to produce the error validation matrix $E = Y - W_{out}X$, which is 1-dimensional. The top right graph plots $W_{out}X$ vs. t and Y vs. t. The lower left plots the validation error at each time step.



□

Solution. *Problem 3.* This is the autonomous trained network where $W_A = W + W_{in}W_{out}$ is replaced again in the hyperbolic tangent $x(t+1) = (1-\alpha)x + \alpha \tanh W_A x(t)$ starting from the final time step t_f from the driven training network for another $sampleTimes = 400$. We can then use this function along with the original W_{out} matrix to predict the next points in the time series, $y_p(T_f + 1) = W_{out}x(T_f + 1)$. We plot Y vs. t and $W_{out}X_a(t)$ vs. t. I could not get theabsolute difference at each time step to print and clearly the graph below is wrong. □