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%% Chaotic time series prediction
clc, clf
% Initialize
N = 3;
neurons = 500;
wIN = randn([neurons, N])*sqrt(0.002);
w = randn([neurons, neurons])*sqrt(2/500);
k = 0.01;

wOUT = TrainReservoirComputer(wIN, w, neurons, k, csvread('training-set.csv'));

T = 500;
xP = csvread('test-set-9.csv');
O = PredictContinuation(wIN, w, wOUT, T, N, neurons, xP);
csvwrite('prediction.csv', O(2,:))

hold on
plot3(xP(1,:), xP(2,:), xP(3,:))
plot3(O(1,:), O(2,:), O(3,:))
hold off

% Functions
function wOUT = TrainReservoirComputer(wIN, w, neurons, k, x)
    r = zeros(neurons, length(x));
    for t = 1:length(x)-1
        r(:,t+1) = tanh(w*r(:,t) + wIN*x(:,t));
    end

    if 0 == det((r*r' + k*eye(neurons)))
        disp("Matriz is singular. Problem is unstable")
    end

    wOUT = x*r.' * inv((r*r' + k*eye(neurons)));
end

function O = PredictContinuation(wIN, w, wOUT, T, N, neurons, x)
    r = zeros(neurons, 1);
    for t = 1:length(x)
        r = tanh(w*r + wIN*x(:,t));
    end

    O = zeros(N, T);
    for t = 1:T
        O(:,t) = wOUT*r;
        r = tanh(w*r + wIN * O(:,t));
    end
end
```