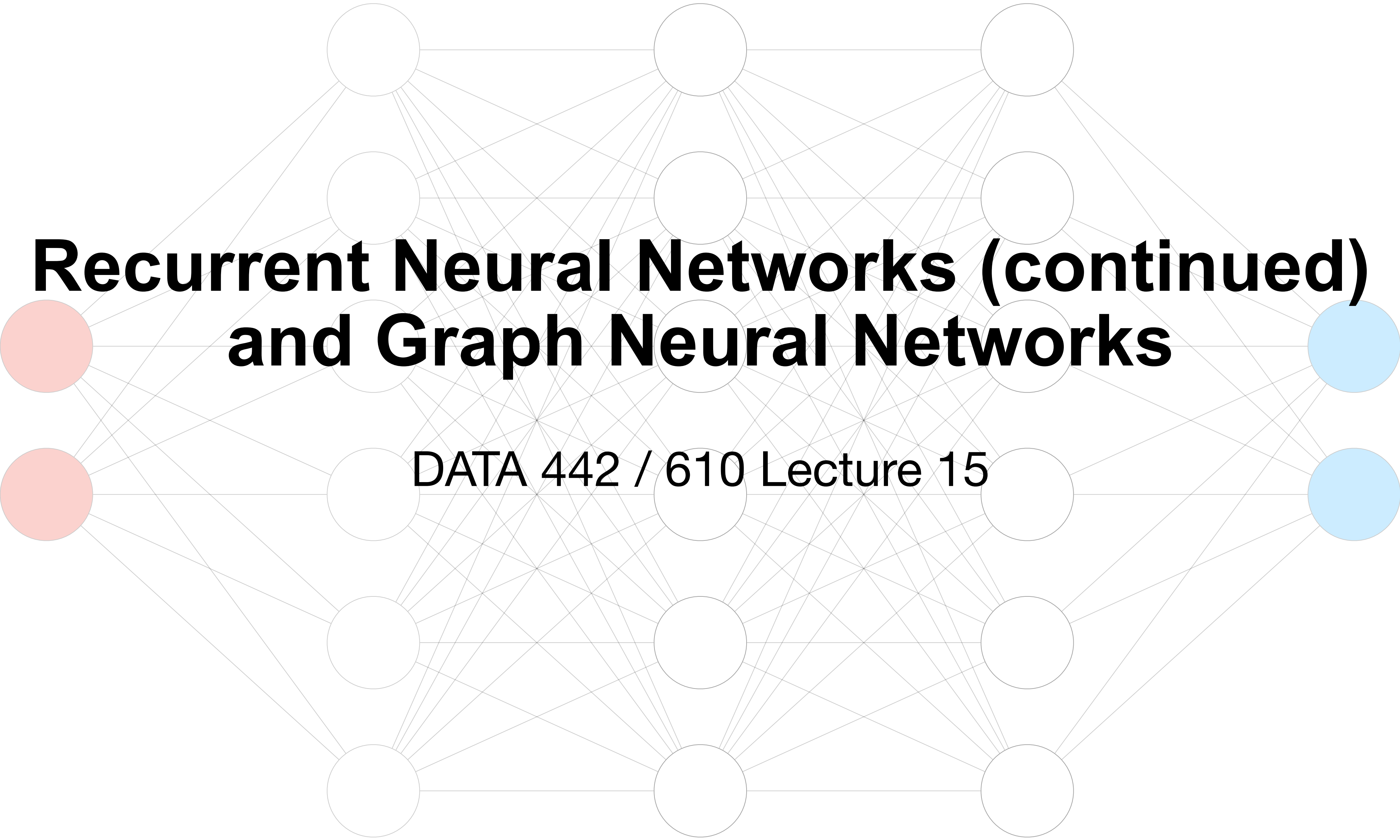




Recurrent Neural Networks (continued) and Graph Neural Networks

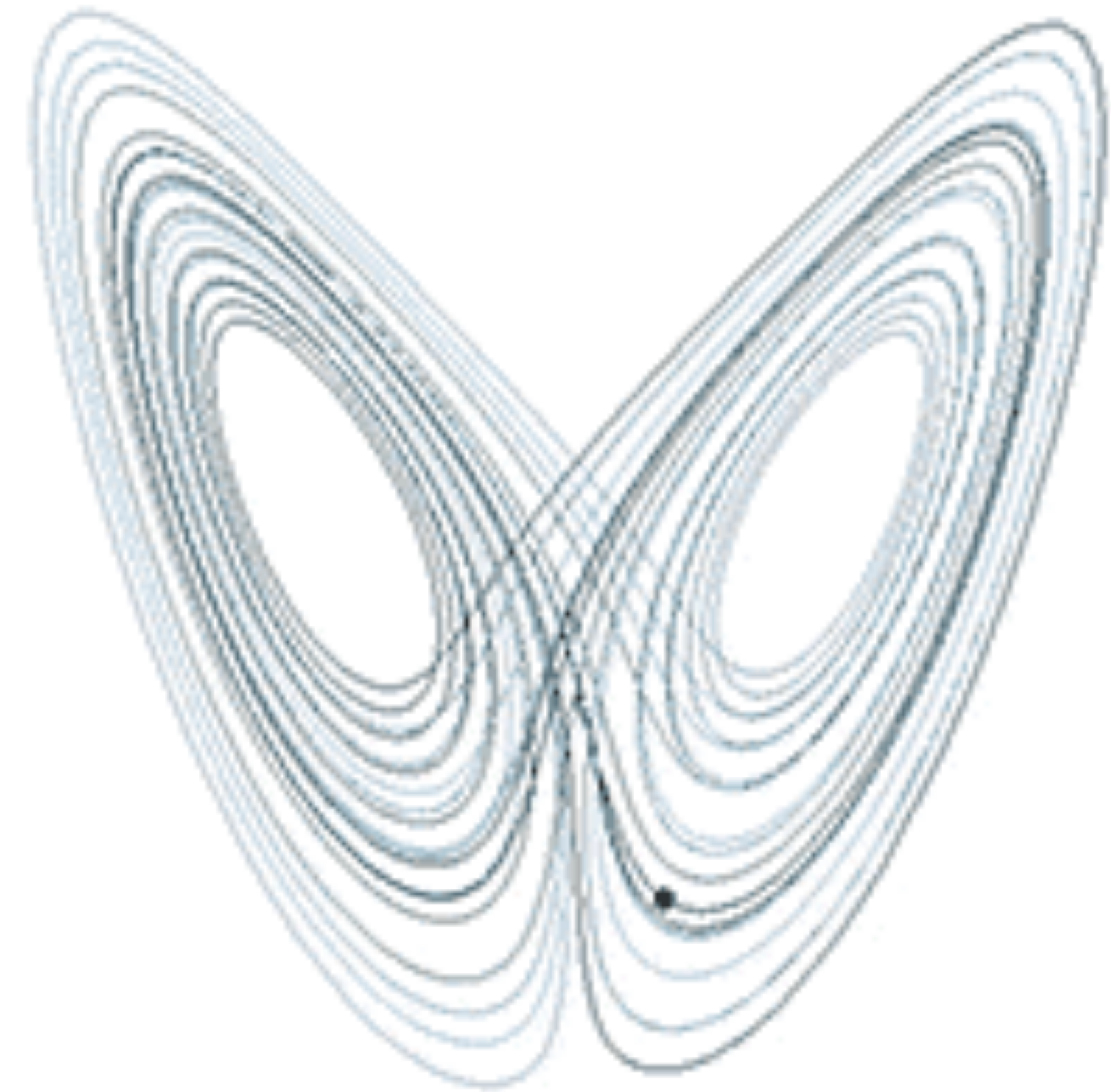
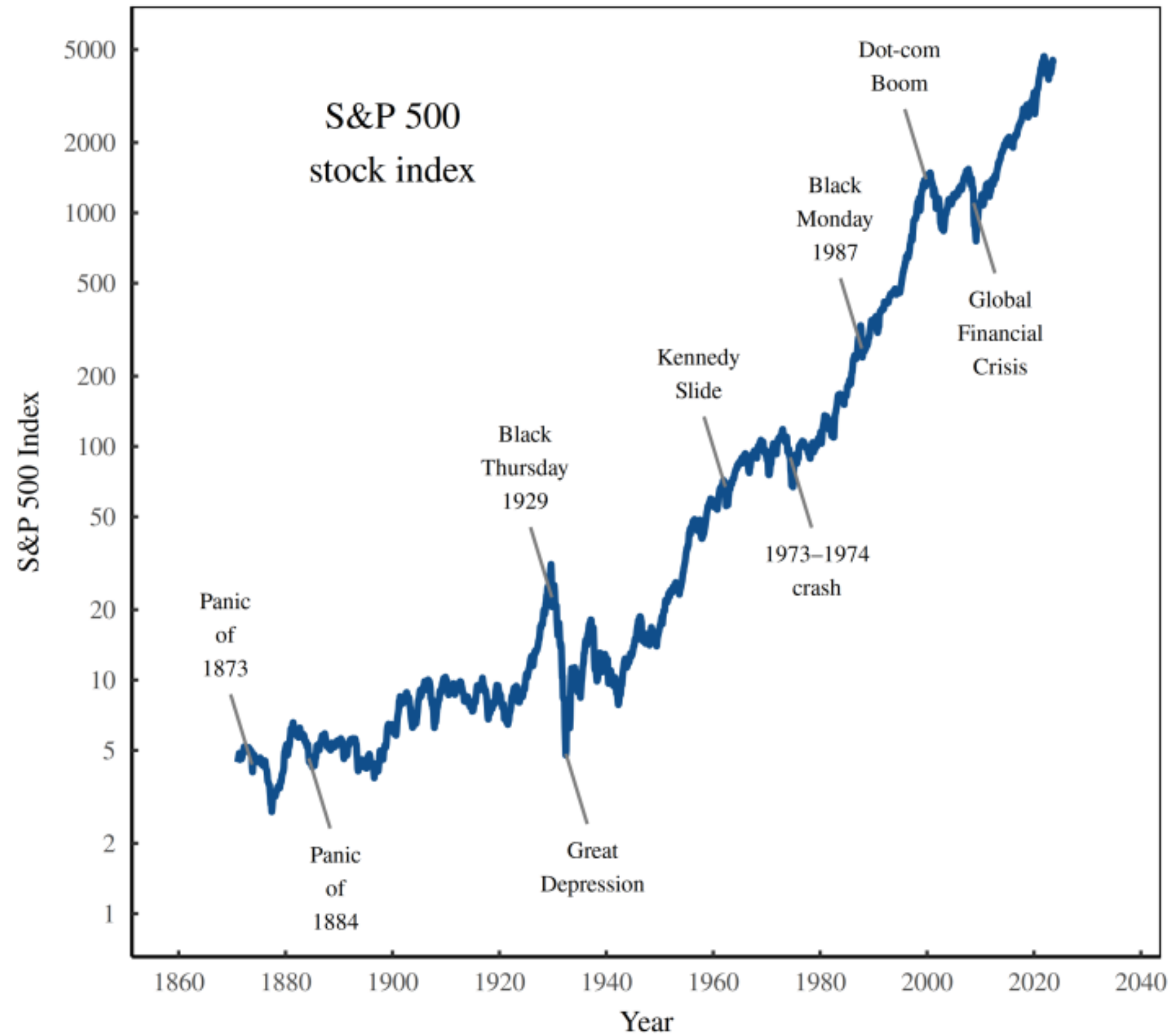
DATA 442 / 610 Lecture 15

Outline

- Time series forecasting
- Introduction to Graph Neural Networks

Reading: *Deep Learning*, Chapter 10 (RNNs), [ArXiv:2104.13478](#) (GNNs)

Time-series forecasting

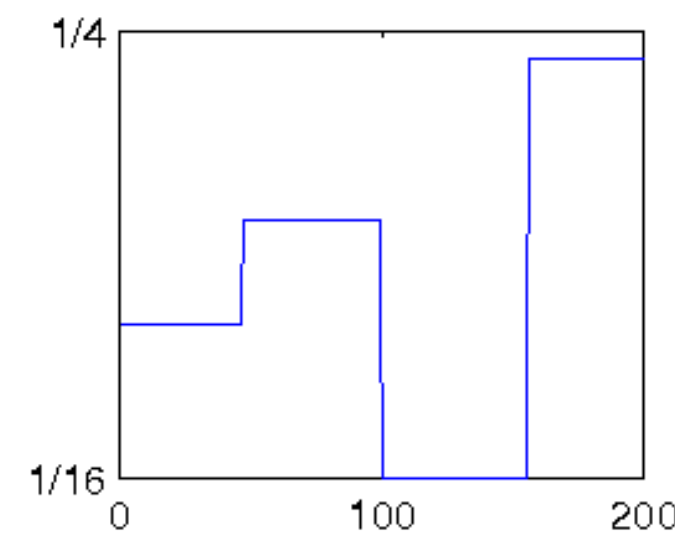


Hands-on with time-series forecasting

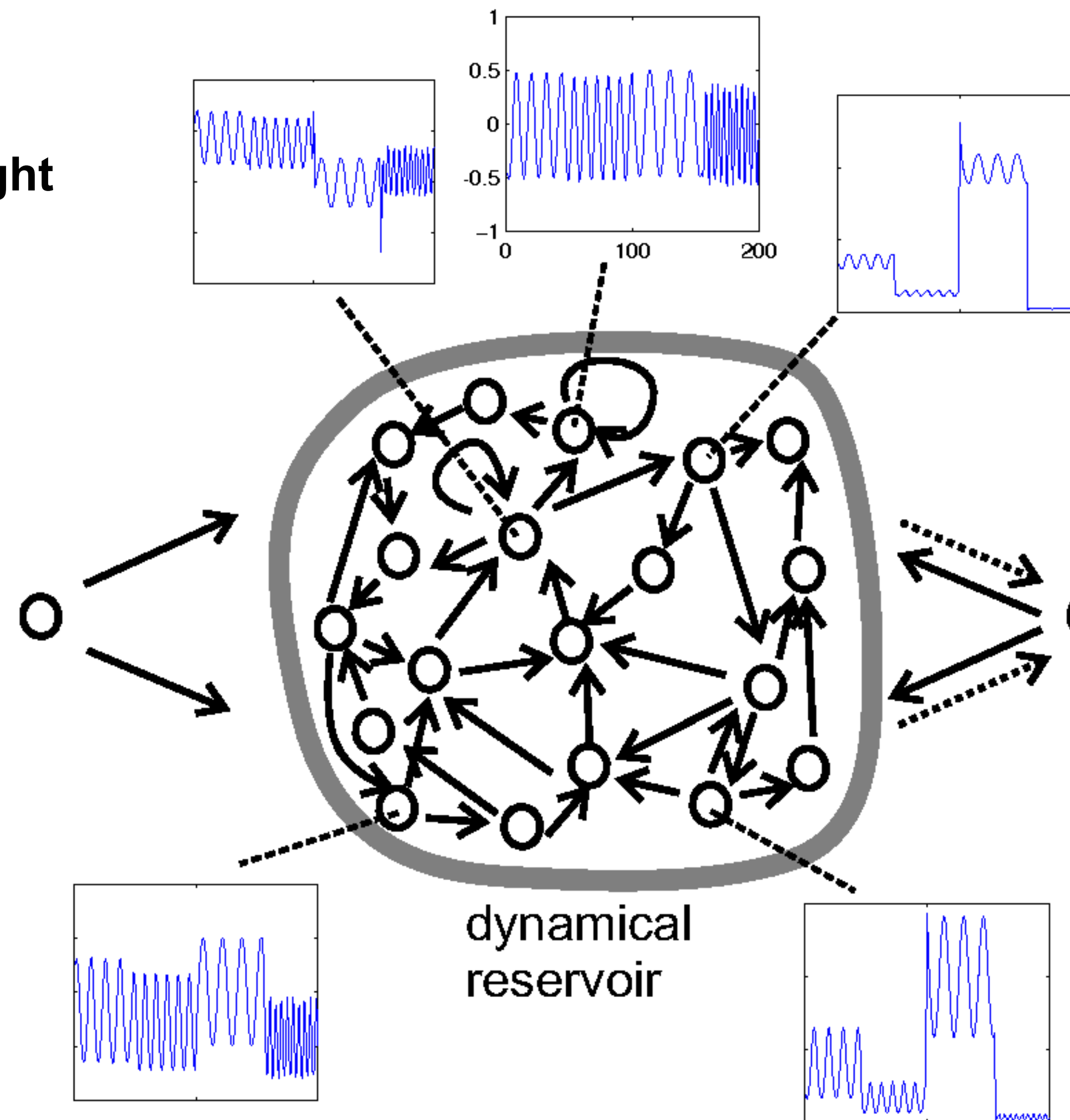


Reservoir computing and Echo State Networks

Fixed, sparsely-connected weight matrix W_{hh} with some desirable spectral properties

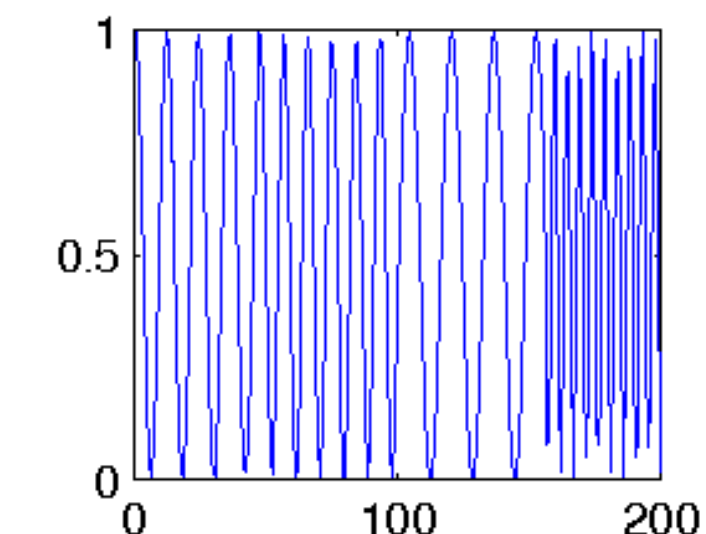


input signal



dynamical
reservoir

Learnable output matrix W_{oh} via simple linear optimization



output (or
teacher)
signal

https://en.wikipedia.org/wiki/Echo_state_network

A “liquid brain”

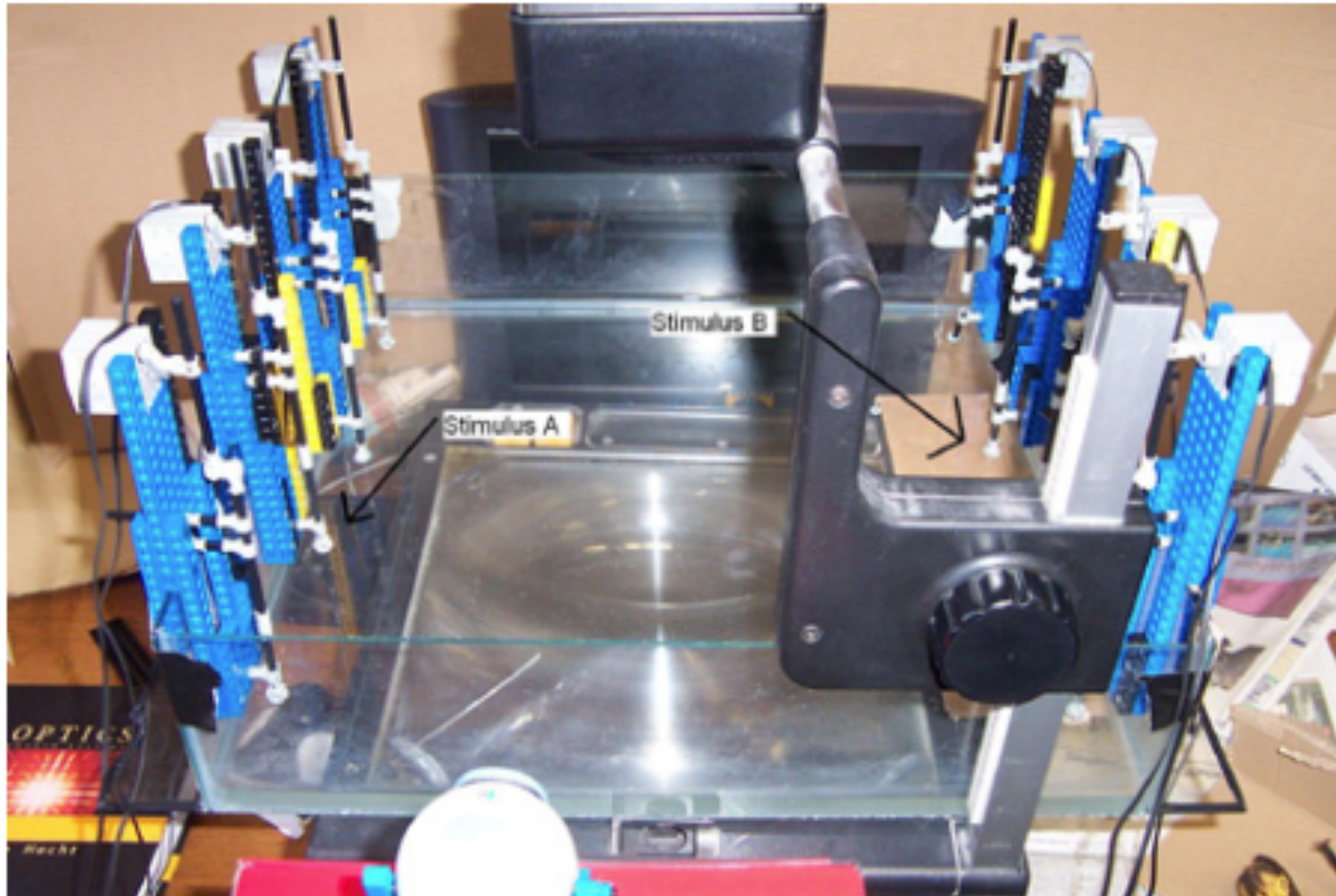


Fig. 1. The Liquid Brain.

Pattern Recognition in a Bucket

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Abstract. This paper demonstrates that the waves produced on the surface of water can be used as the medium for a “Liquid State Machine” that pre-processes inputs so allowing a simple perceptron to solve the XOR problem and undertake speech recognition. Interference between waves allows non-linear parallel computation upon simultaneous sensory inputs. Temporal patterns of stimulation are converted to spatial patterns of water waves upon which a linear discrimination can be made. Whereas Wolfgang Maass’ Liquid State Machine requires fine tuning of the spiking neural network parameters, water has inherent self-organising properties such as strong local interactions, time-dependent spread of activation to distant areas, inherent stability to a wide variety of inputs, and high complexity. Water achieves this “for free”, and does so without the time-consuming computation required by realistic neural models. An analogy is made between water molecules and neurons in a recurrent neural network.

More reservoir computing

Model-Free Prediction of Large Spatiotemporally Chaotic Systems from Data: A Reservoir Computing Approach

[Jaideep Pathak](#)^{1,2,*}, [Brian Hunt](#)^{3,4}, [Michelle Girvan](#)^{1,3,2}, [Zhixin Lu](#)^{1,3}, and [Edward Ott](#)^{1,2,5}

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DOI: <https://doi.org/10.1103/PhysRevLett.120.024102>

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Let's go talk about graphs



That's all!

- Slides will be posted on the course website: <https://colen-teaching.github.io/DATA442-Fall-2026>
- Lab demos will also be posted
- **PS2** due October 25 - *note the extended due date*
- **REMEMBER**: TA Office Hours Tuesday 12-1pm, Student Success Center